

Project:

Project: Augusta Victoria Hospital Triage Department

Specifications

Civil Works

September, 2018

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

| Item | Title | Page | | |
|---|--|----------|------|----------|
| | | From | Thru | To |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION 01: GENERAL REQUIREMENTS</u> | | | | |
| 01010 | Summary of Work | 01010-01 | thru | 01010-01 |
| 01025 | Measurment and Payment | 01025-01 | thru | 01025-02 |
| 01027 | Applications for Payment | 01027-01 | thru | 01027-01 |
| 01028 | Modification Procedures | 01028-01 | thru | 01028-02 |
| 01030 | Alternates | 01030-01 | thru | 01030-01 |
| 01039 | Coordination and Meetings | 01039-01 | thru | 01039-02 |
| 01041 | Project Coordination | 01041-01 | thru | 01041-01 |
| 01049 | Mechanical & Electrical Coordinator | 01049-01 | thru | 01049-01 |
| 01050 | Field Engineering | 01050-01 | thru | 01050-01 |
| 01090 | Reference Standards | 01090-01 | thru | 01090-01 |
| 01200 | Project Meetings | 01200-01 | thru | 01200-02 |
| 01300 | Submittals | 01300-01 | thru | 01300-02 |
| 01310 | Progress Schedules | 01310-01 | thru | 01310-02 |
| 01340 | Shop Drawings, Product Data and Samples | 01340-01 | thru | 01340-02 |
| 01380 | Construction Photographs | 01380-01 | thru | 01380-02 |
| 01400 | Quality Control | 01400-01 | thru | 01400-01 |
| 01410 | Testing Laboratory Services | 01410-01 | thru | 01410-02 |
| 01500 | Construction Facilities and Temporary Controls | 01500-01 | thru | 01500-02 |
| 01540 | Security | 01540-01 | thru | 01540-01 |
| 01550 | Access Roads and Parking Areas | 01550-01 | thru | 01550-02 |
| 01560 | Temporary Controls | 01560-01 | thru | 01560-01 |
| 01580 | Project Identification and Signs | 01580-01 | thru | 01580-01 |
| 01590 | Field Offices and Sheds | 01590-01 | thru | 01590-02 |
| 01600 | Material and Equipment | 01600-01 | thru | 01600-01 |
| 01630 | Substitutions and Product Options | 01630-01 | thru | 01630-02 |
| 01650 | Starting of Systems | 01650-01 | thru | 01650-01 |
| 01700 | Contract Close-out | 01700-01 | thru | 01700-01 |
| 01710 | Cleaning | 01710-01 | thru | 01710-01 |
| 01720 | Project Record Documents | 01720-01 | thru | 01720-02 |
| 01730 | Operation and Maintenance Data | 01730-01 | thru | 01730-03 |

VOLUME III

DIVISION - 02: EXCAVATION, BACKFILLING AND SITE WORK

| | | | | |
|-------|-----------------------------------|----------|------|----------|
| 02100 | Excavations and Earthworks | 02100-01 | thru | 02100-03 |
| 02110 | Site Clearing | 02110-01 | thru | 02110-01 |
| 02210 | Site Grading | 02210-01 | thru | 02210-01 |
| 02219 | Structure Excavation and Backfill | 02219-01 | thru | 02219-05 |
| 02221 | Trenching | 02221-01 | thru | 02221-04 |
| 02229 | Rock Removal | 02229-01 | thru | 02229-01 |
| 02260 | Finish Grading | 02260-01 | thru | 02260-01 |
| 02480 | Landscape Development | 02480-01 | thru | 02480-01 |
| 02513 | Asphaltic Concrete Paving | 02513-01 | thru | 02513-03 |
| 02521 | Pre-Cast Concrete Units | 02521-01 | thru | 02521-02 |
| 02577 | Pavement Marking | 02577-01 | thru | 02577-02 |

| Item | Title | Page | | |
|--|---|----------|------|----------|
| | | From | Thru | To |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 03: CONCRETE WORK</u> | | | | |
| 03100 | Concrete Formwork | 03100-01 | thru | 03100-03 |
| 03200 | Concrete Reinforcement | 03200-01 | thru | 03200-02 |
| 03251 | Expansion, Contracting and Control Joints | 03251-01 | thru | 03251-04 |
| 03300 | Cast-In-Place Concrete | 03300-01 | thru | 03300-09 |
| 03346 | Concrete Floor Finishing | 03346-01 | thru | 03346-02 |
| 03370 | Concrete Curing | 03370-01 | thru | 03370-01 |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 04: MASONRY WORKS</u> | | | | |
| 04100 | Mortar | 04100-01 | thru | 04100-01 |
| 04220 | Concrete Masonry Unit | 04220-01 | thru | 04220-03 |
| 04450 | Natural Stone Work | 04450-01 | thru | 04450-06 |
| 04455 | Natural Marble | 04455-01 | thru | 04455-05 |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 05: METALS</u> | | | | |
| 05500 | Metal Fabrications | 05500-01 | thru | 05500-04 |
| 05520 | Handrails and Railings | 05520-01 | thru | 05520-02 |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 06: WOOD AND PLASTIC</u> | | | | |
| 06200 | Finish Carpentry | 06200-01 | thru | 06200-02 |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 07: THERMAL AND MOISTURE PROTECTION</u> | | | | |
| 07111 | Bituminous Membrane Waterproofing for Underground Works | 07111-01 | thru | 07111-02 |
| 07120 | Fluid Applied Waterproofing | 07120-01 | thru | 07120-02 |
| 07181 | Elastomeric Waterproofing System | 07181-01 | thru | 07181-02 |
| 07212 | Rockwool Insulation | 07212-01 | thru | 07212-01 |
| 07535 | Modified Bitumen Roofing Membrane | 07535-01 | thru | 07535-05 |
| 07600 | Flashing and Sheet Metal | 07600-01 | thru | 07600-02 |
| 07900 | Sealants | 07900-01 | thru | 07900-02 |
| <u>VOLUME III</u> | | | | |
| <u>DIVISION - 08: DOORS AND WINDOWS</u> | | | | |
| 08110 | Steel Doors | 08110-01 | thru | 08110-01 |
| 08111 | Standard Steel Frames | 08111-01 | thru | 08111-01 |
| 08210 | Wood door and frames | 08210-01 | thru | 08210-02 |
| 08305 | Access Doors | 08305-01 | thru | 08305-02 |
| 08520 | Aluminium Windows , Doors,Screens and Curtain Walls | 08520-01 | thru | 08520-02 |
| 08700 | Hardware | 08700-01 | thru | 08700-01 |
| 08800 | Glazing | 08800-01 | thru | 08800-02 |

| Item | Title | Page | | |
|------|-------|------|--|--|
|------|-------|------|--|--|

VOLUME III

DIVISION - 09: FINISHES

| | | | | |
|--------------|----------------------------------|-----------------|------|-----------------|
| 09220 | Potrland Cement Plaster | 09220-01 | thru | 09220-04 |
| 09260 | Gypsum Board Systems | 09260-01 | thru | 09260-02 |
| 09310 | Ceramic Tiles | 09310-01 | thru | 09310-02 |
| 09410 | Portland cement terrazo | 09410-01 | thru | 09410-03 |
| 09510 | Acoustical Ceiling | 09510-01 | thru | 09510-02 |
| 09513 | Metal Tiles False Ceiling System | 09513-01 | thru | 09513-02 |
| 09610 | Stone Flooring | 09610-01 | thru | 09610-05 |
| 09695 | Carpeting with Underlay | 09695-01 | thru | 09695-02 |
| 09900 | Painting | 09900-01 | thru | 09900-06 |

VOLUME III

DIVISION - 10: SPECIALTIES

| | | | | |
|--------------|-----------------------------|-----------------|------|-----------------|
| 10105 | Visual Display Boards | 10105-01 | thru | 10105-01 |
| 10191 | Cubicle Curtains | 10191-01 | thru | 10191-02 |
| 10260 | Wall and Corner Guards | 10260-01 | thru | 10260-01 |
| 10441 | Plastic Signs | 10441-01 | thru | 10441-02 |
| 10508 | Metal Wardrobe Lockers | 10508-01 | thru | 10508-02 |
| 10800 | Toilet and Bath Accessories | 10800-01 | thru | 10800-01 |

DIVISION - 11: EQUIPMENT

Not Applicable

DIVISION - 12: FURNISHING

Not Applicable

VOLUME III

DIVISION - 13: SPECIAL CONSTRUCTION

Not Applicable

VOLUME III

DIVISION - 14: CONVEYING SYSTEMS

| | | | | |
|--------------|----------------------|-----------------|------|-----------------|
| 14210 | Electrical elevators | 14210-01 | thru | 14210-05 |
|--------------|----------------------|-----------------|------|-----------------|

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

**ARCHITECTURAL WORKS, STRUCTURAL WORKS, MECHANICAL WORKS,
ELECTRICAL WORKS, EXTERNAL WORKS AND SUNDRY ITEMS OF THE
CONSTRUCTION OF**

BAHRAIN PEDIATRIC HOSPITAL
RAMALLAH-PALESTINE

As more particularly specified are covered in the relevant Bill of Quantities.

1.02 Related Requirements

- A. Instructions to Tenderers.
- B. Conditions of Contract.

1.03 Contracts

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

END OF SECTION

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 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.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 01027
APPLICATIONS FOR PAYMENT

PART 1 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.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 01028
MODIFICATION PROCEDURES

PART 1 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.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 01030
ALTERNATES

PART 1 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.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

Not applicable.

END OF SECTION

SECTION 01039
COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 Section Includes

- A. Coordination.
- B. Preconstruction meeting.
- C. Site mobilization meeting.
- D. Progress meetings.
- E. Preinstallation meetings.
- F. Examination.
- G. Preparation
- H. Cutting and Patching.
- I. Alteration Project Procedures.

1.2 Related Sections

- A. Section 01041 - Project Coordination.
- B. Section 01049 - Mechanical and Electrical Coordinator.
- C. Section 01050 - Field Engineering.

1.3 Coordination

- A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to assure efficient and orderly sequence of installation of interdependent construction elements , with provisions for accommodating items installed later.
- B. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- C. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- D. Coordinate completion and clean up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Employer's partial occupancy.
- E. After Employer occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Employer's activities.

1.4 Preconstruction Meeting

- A. Employer and the Engineer will schedule a meeting after Notice of Award.
- B. Attendance Required: Employer, the Engineer and Contractor.
- C. Agenda:
 - 1) Execution of Employer-Contractor Agreement.
 - 2) Submission of executed bonds and insurance certificates.
 - 3) Distribution of Contract Documents.
 - 4) Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.
 - 5) Designation of personnel representing the parties in Contract, and the Engineer .
 - 6) Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract close-out procedures.
 - 7) Scheduling.
 - 8) Scheduling activities of a Geo-technical Engineer .
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer , Employer, participants, and those affected by decisions made.

1.5 Site Mobilization Meeting

- A. The Engineer and/or Employer will schedule a meeting at the Project site prior to Contractor occupancy.
- B. Attendance Required: Employer, Engineer, Contractor, and major Subcontractors.

1.5 Site Mobilization Meeting (cont'd)

- C. Agenda:
 - 1) Use of premises by Employer and Contractor.
 - 2) Employer's requirements.
 - 3) Construction facilities and controls provided by Employer.
 - 4) Temporary utilities provided by Employer.
 - 5) Survey and building layout.
 - 6) Security and housekeeping procedures.
 - 7) Schedules.
 - 8) Procedures for testing.
 - 9) Procedures for maintaining record documents.
 - 10) Requirements for start - up equipment.
 - 11) Inspection and acceptance of equipment put into service during construction period.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to the Engineer and Employer, participants, and those affected by decisions made.

1.6 Progress Meetings

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required: Main Contractor, major Subcontractors and Suppliers, Employer, the Engineer as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems which impede planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Coordination of projected progress.
 - 11. Maintenance of quality and work standards.
 - 12. Effect of proposed changes on progress schedule and coordination.
 - 13. Other business relating to Work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to the Engineer, Employer, participants, and those affected by decisions made.

1.7 Preinstallation Meeting

- A. When required in individual specification sections, convene a pre-installation meeting at work site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
 - C. Notify the Engineer four days in advance of meeting date.
 - D. Prepare agenda and preside at meeting:
 - 1) Review conditions of installation, preparation and installation procedures.
 - 2) Review coordination with related work.
 - E. Record minutes and distribute copies within two days after meeting to participants, with two copies to the Engineer, Employer, participants, and those affected by decisions made.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

Not applicable.

END OF SECTION

SECTION 01041
PROJECT COORDINATION

PART 1 GENERAL

1.1 Section Includes

- A. Project coordination by the Project Coordinator.
- B. Schedules.
- C. Close-out procedures.
- D. Submittals.
- E. Coordinate drawings.
- F. Close-out Procedures.

1.2 Related Sections

- A. General Conditions.
- B. Section 01010 - Summary of Work.
- C. Section 01039 - Coordination and Meetings.
- D. Section 01700 - Contract Close-out.

1.3 Construction Mobilization

- A. Cooperate with the Engineer in allocation of mobilization areas of site; for field offices and sheds, access traffic and parking facilities.
- B. During the work, coordinate use of site and facilities through the Engineer.
- C. Comply with Project Coordinator's procedures for intra-project communications; reports and records, schedules, and recommendations; and resolution of ambiguities and conflicts.
- D. Comply with instructions of the Engineer for use of temporary utilities.

1.4 Submittals

- A. Submit applications for payment on forms for review, and to The Engineer Approval.
- B. Submit requests for interpretation of Contract Documents, and obtain instructions through the Engineer.
- C. Process requests for substitutions, and change orders, through the Engineer.
- D. Deliver close-out submittals for review and preliminary inspection reports, to The Engineer.

1.5 Coordination Drawings

- A. Provide information required by the Engineer for preparation of coordination drawings.
- B. Review drawings prior to submission to the Engineer.

1.6 Close-out Procedures

- A. Notify The Engineer when Work is considered ready for Substantial Completion.
- B. Comply with The Engineer instructions to correct items of work listed in executed Certificates of Substantial Completion.
- C. Notify The Engineer when Work is considered finally complete.
- D. Comply with The Engineer instructions for completion of items of Work determined by The Engineer's final inspection.

END OF SECTION

SECTION 01049
MECHANICAL AND ELECTRICAL COORDINATOR

PART 1 GENERAL

1.1 Section Includes

- A. Mechanical and electrical coordinator.
- B. Submittals.
- C. Coordination required.
- D. Coordination documents.
- E. Coordination of submittals.
- F. Coordination of substitutions and modifications.
- G. Observation of Work.
- H. Documentation.
- I. Inspection and acceptance of equipment.

1.2 Related Sections

- A. Section 01010 - Summary of Work.
- B. Section 01039 - Coordination and Meetings.
- C. Section 01041 - Project Coordination.
- D. Section 01310 - Progress Schedules.
- E. Section 01340 - Submittals: Shop drawings, product data, and samples.
- F. Section 01600 - Material and Equipment.
- G. Section 01700 - Contract Closeout.

1.3 Mechanical And Electrical Work Coordinator.

The Contractor shall employ and pay for services of a firm, technically qualified and administratively experienced in field coordination for the type of mechanical and electrical work required for this stage, for the duration of the Work.

1.4 Submittals For Review

- A. Submit name, address, and telephone number of Coordinator to Employer, for review.
- B. Submit coordination schedules prior to submitting, product data, and samples.

1.5 Coordination Required

- A. Coordinate progress schedules, including dates for submittals and Product's delivery.
- B. Conduct meetings among Subcontractors and/or separate contractors and others concerned with the Work, to establish and maintain coordination and schedules, and to resolve coordination matters in dispute.
- C. Participate in progress meetings. Report on progress of Work to be adjusted under coordination requirements, and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

1.6 Coordination Of Submittals

- A. Review, Product Data, and Samples for compliance with Contract Documents and for coordination with work of the Project Manual. Transmit for review, copy reviewed documents to the Engineer.
- B. Check field dimensions; clearances and relationship to available space and anchors.
- C. Check compatibility with work of other sections, electrical characteristics, and operational control requirements.
- D. Coordinate controls, interlocks, wiring of pneumatic switches, and relays.
- E. Coordinate wiring and control diagrams.
- F. Review the effect of any changes on work of other sections.

1.7 Coordination of Substitutions and Modifications

- A. Review proposals and requests from contractors.
- B. Verify compliance with Contract Documents and for compatibility with Work and Products of other sections.
- C. Submit with recommendation for action.

1.8 Observation Of Work

- A. Observe Work for compliance with Contract Documents.
- B. Maintain a list of observed deficiencies and defects; promptly submit.

END OF SECTION

SECTION 01050
FIELD ENGINEERING

PART 1 - GENERAL

1.01 Requirements Included

- A. Provide and pay for field engineering services required for Project.
 - 1. Survey work required in execution of Project.
 - 2. Civil, structural or other professional engineering services specified, or required to execute Contractor's construction methods.
- B. The Contractor shall be responsible identifying existing control points and property line corner stakes indicated on the drawings as required, including handing over to the Engineer.

1.02 Related Requirements

- A. Conditions of the Contract
- B. Section 01010: Summary of Work.
- C. Section 01720: Project Record Documents.

1.03 Qualifications Of Surveyor Or Engineer

- A. Qualified Engineer or registered land surveyor, acceptable to the Engineer.
- B. Registered professional Engineer of the discipline required for the specific service on the Project, licensed in Palestine.

1.04 Survey Reference Points

- A. Existing basic horizontal and vertical control points for the Project are those designated on drawings.
- B. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction.
 - 1. Make no changes or relocations without prior written notice to the Engineer.
 - 2. Report to the Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
 - 3. Require surveyor to replace Project control points which may be lost or destroyed.
 - Establish replacements based on original survey control.

1.05 Project Survey Requirements

- A. Establish a minimum of eight permanent bench marks on or around the site, referenced to data established by survey control points.
 - 1. Record locations, with horizontal and vertical data.
- B. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:
 - 1. Site improvements.
 - a. Stakes for grading, fill and topsoil placement.
 - b. Utility slopes and invert elevations.
 - 2. Batter boards for structures.
 - 3. Building foundation, column locations and floor levels.
 - 4. Controlling lines and levels required for mechanical and electrical trades.
- C. From time to time, verify layouts by same methods.

1.06 Records

- A. Maintain a complete, accurate log of all control and survey work as it progresses.
- B. On completion of all the work, prepare a certified survey showing all dimensions, locations, angles, etc.

1.07 Submittals

- A. Submit name and address of Surveyor to the Engineer.
- B. On request of the Engineer, submit documentation to verify accuracy of field engineering work.
- C. Submit certificate signed by registered Engineer or surveyor certifying that elevations and locations of improvements are in conformance, or non-conformance, with Contract Documents.

END OF SECTION

SECTION 01090
REFERENCE STANDARDS

PART 1 GENERAL

1.1 Section Includes

Quality assurance.

1.2 Related Work

General Conditions: Reference standards.

1.3 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.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 01200
PROJECT MEETINGS

PART 1 GENERAL

1.01 Requirements Included

- A. The Engineer shall schedule and administer pre-construction meeting, periodic progress meetings, and specially called meetings throughout progress of the work.
 - 1. Prepare agenda for meetings.
 - 2. Distribute written notice of each meeting four days in advance of meeting date.
 - 3. Make physical arrangements for meetings.
 - 4. Preside at meetings.
 - 5. Record the minutes; include significant proceedings and decisions.
 - 6. Reproduce and distribute copies of minutes within three days after each meeting.
 - a. To participants in the meeting.
 - b. To parties affected by decisions made at the meeting.
- B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents
- C. The Engineer shall ascertain that Work is expedited consistent with Contract Documents and construction schedules.

1.02 Related Requirements

- A. Section 01340: Shop Drawings, Product Data and Samples.
- B. Section 01720: Project Record Documents.

1.03 Pre-Construction Meeting

- A. Schedule within 15 days after date of Notice to Proceed.
- B. Location: A central site, convenient for all parties, designated by the Contractor.
- C. Attendance:
 - 1. Employer's Representative.
 - 2. The Engineer.
 - 3. Resident Project Representative.
 - 4. Contractor's Superintendent.
 - 5. Major Subcontractors.
 - 6. Major suppliers.
 - 7. Others as Appropriate.
- D. Suggested Agenda:
 - 1. Distribution and discussion of:
 - a. List of major subcontractors and suppliers.
 - b. Projected Construction Schedules.
 - c. List of Contractor's personnel with areas of responsibility.
 - 2. Critical work sequencing.
 - 3. Major equipment/materials deliveries and priorities.
 - 4. Project Coordination.
 - a. Designation of responsible personnel.
 - 5. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Applications for Payment.
 - 6. Adequacy of distribution of Contract Documents.
 - 7. Procedures for maintaining Record Documents.
 - 8. Use of premises:
 - a. Office, work and storage areas, pending adequacy of the Site.
 - b. Employer's requirements.
 - 9. Construction facilities, controls and construction aids.
 - 10. Temporary utilities.
 - 11. Safety and first-aid procedures.
 - 12. Security procedures.
 - 13. Housekeeping procedures.

1.04 Progress Meetings

- A. Schedule regular periodic meetings, as required.
- B. Hold called meetings as required by progress of the work.
- C. Location of the meetings: Project field office of Contractor.
- D. Attendance:
 - 1. The Engineer, and his professional consultants as needed.
 - 2. Subcontractors as appropriate to the agenda.
 - 3. Suppliers as appropriate to the agenda.
 - 4. Others.
- E. Suggested Agenda
 - 1. Review, approval of minutes of previous meeting.
 - 2. Review of work progress since previous meeting.
 - 3. Field observations, problems, conflicts.
 - 4. Problems which impede Construction Schedule.
 - 5. Review of off-site fabrication, delivery schedules.
 - 6. Corrective measures and procedures to regain projected schedule.
 - 7. Revisions to Construction Schedule.
 - 8. Progress, schedule, during succeeding work period.
 - 9. Coordination of schedules.
 - 10. Review submittal schedules; expedite as required.
 - 11. Maintenance of quality standards.
 - 12. Pending changes and substitutions.
 - 13. Review proposed changes for:
 - a. Effect on Construction Schedule and on completion date.
 - b. Effect on other contracts of the Project.
 - 14. Other business.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 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.

PART 2 PRODUCTS

Not applicable

PART 3 EXECUTION

Not applicable

END OF SECTION

SECTION 01310
PROGRESS SCHEDULES

PART 1 GENERAL

1.1 Section Includes

- A. Format.
- B. Content.
- C. Revisions to schedules.
- D. Submittals.

1.2 Related Sections

- A. Section 01010 - Summary of Work.
- B. Section 01300 - Submittals.

1.3 Format

- A. Prepare Bar Chart method for construction operations.
- B. Sequence of Listings: The chronological order of the start of each item of Work.
- C. Scale and Spacing: To provide space for notations and revisions.
- D. Sheet Size: Minimum 560 x 432 mm.

1.4 Content

- A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
- B. Resources: define resources assigned for each activity of work.
- C. Identify each item by specification section number.
- D. Identify work of separate stages and/or separate floors and other logically grouped activities.
- E. Provide sub-schedules for each stage of Work identified in Section 01010.
- F. Provide sub-schedules to define critical portions of the entire schedule.
- G. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
- H. Provide separate schedule of submittal dates for shop drawings, product data, and samples, including dates reviewed submittals will be required from Engineer. Indicate decision dates for selection of finishes.

1.5 Revisions to Schedules

- A. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
- B. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
- C. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including the effect of changes on schedules of separate contractors.

1.6 Submittals

- A. Submit preliminary outline Schedules within 15 days after date of Employer-Contractor Agreement for coordination with work of separate contracts. After review, submit detailed schedules within 15 days modified to accommodate revisions recommended by the Engineer.
- B. Submit revised Progress Schedules with each Application for Payment.
- C. Submit two opaque reproduction and one reproducible transparency to the Engineer.

1.7 Distribution

- A. Distribute copies of reviewed schedules to Project site file, Subcontractors, suppliers, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

1.8 Reports

A. Daily Report

The contractor shall submit a daily report in writing to the Engineer in an agreed form giving daily records of the following items:-

- Number of men employed on the site divided into staff tradesmen and others.
- Accidents to employees.
- Weather condition of each day and night.
- Progress of the works in general terms.
- Plant on site.
- Materials on site.

B. Monthly Report

The contractor shall submit to the Engineer each month a report comprising the following:-

- Progress chart.
- Progress photographs (as described elsewhere).
- Statement regarding the progress of the works.
- Extent and nature of the work completed.
- Any problems relating to the works (with adequate documentation if applicable).
- Financial statement.
- Record of materials, equipment and plant tested with test results.
- Detailed schedule of work to be performed during the coming months and a general testing of work to be performed during the coming three months.
- The contents and format of all reports shall be subject to the approval of the Engineer.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

Not applicable.

END OF SECTION

SECTION 01340
SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 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 01380
CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.1 Section Includes

- A. Photography.
- B. Prints.
- C. Negatives.
- D. Technique.
- E. Submittals.

1.2 Related Sections

- A. General Conditions and applicable Supplementary Conditions.
- B. Section :01010 - Summary of Work.
- C. Section 01700 - Contract Closeout: Project record documents.

1.3 Photography

- A. Provide photographs of [site and] construction throughout progress of Work produced by a commercial photographer, acceptable to Engineer.
 - B. Take photographs on date for each application for a payment, three days prior to each application for a payment, each month and as follows:
 - 1. Site clearing.
 - 2. Excavations.
 - 3. Foundations.
 - 4. Structural framing.
 - 5. Enclosure of building.
 - 6. Final completion.
 - C. Take photographs as evidence of existing project conditions as follows:
 - 1. Interior views.
2. Exterior views.

1.4 Prints

- A. Full color three prints of each view.
- B. Paper (Black and White):
 - 1. Brilliance: Matte.
 - 2. Texture: Smooth.
 - 3. Tint: White.
 - 4. Weight: Single.
- C. Contrast Grade (Black and White): 4, Extra Hard.
- D. Size 5 x 7 inch (125 x 175 mm).
- E. Identify each print on back front. Identify name of Project, contract number phase orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.

1.5 Negatives

Deliver negatives to Owner with project record documents. Catalog and index negatives in chronological sequence; provide typed table of contents.

1.6 Technique

- A. Provide factual presentation.
- B. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.

1.7 Views

- A. Provide aerial photographs from different views at each specified time, until structure is enclosed.
- B. Provide non-aerial photographs from different views at each specified time, until Date of Substantial Completion.
- C. Consult with Engineer for instructions on views required.

1.8 Submittals

Deliver prints with each Application for Payment within three days after exposure with transmittal letter specified under Section 01300.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

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 01410
TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 Requirements Included

Contractor shall employ and pay for the services of an Independent Testing Laboratory to perform specific services and testing.

1.02 Related Requirements

- A. Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.
- B. Related Requirements Specified in Other Sections.
- C. Respective sections of specifications: Certification of products.
- D. Each specification section listed: Laboratory tests required, and standards for testing.
- E. Testing Laboratory inspection, sampling and testing is required as elsewhere indicated in Contract Documents.

1.03 Qualification Of Laboratory

- A. Meet basic requirements of the Local Authorities General Specifications.
- B. Authorized to operate in Palestine.
- C. Testing Equipment:
 - Calibrated at reasonable intervals by devices of accuracy traceable to either:
 - a. National Bureau of Standards.
 - b. Accepted values of natural physical constants.

1.04 Laboratory Duties

- A. Cooperate with the Engineer and Contractor; provide qualified personnel after due notice.
- B. Perform specified inspections, sampling and testing of materials and methods of construction:
 - 1. Comply with specified standards.
 - 2. Ascertain compliance of materials with requirements of Contract Documents.
- C. Promptly notify the Engineer and the Contractor of observed irregularities or deficiencies of work or products.
- D. Promptly submit five copies of written report of each test and inspection to the Engineer. Each report shall include:
 - 1. Date of test.
 - 2. Project title and number.
 - 3. Testing laboratory name, address and telephone number.
 - 4. Name and signature of laboratory inspector.
 - 5. Date and time of sampling or inspection.
 - 6. Record of temperature and weather conditions.
 - 7. Identification of product and specification section.
 - 8. Location of sample or test in the Project.
 - 9. Type of inspection or test.
 - 10. Results of tests and compliance with Contract Documents.
 - 11. Interpretation of test results, when requested by the Engineer.
- E. Perform additional tests as required by the Engineer or the Employer.

1.05 Limitations Of Authority Of Testing Laboratory

- A. Laboratory is not authorized to:
 - 1. Release, revoke, alter or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of the Work.
 - 3. Perform any duties of the Contractor.

1.06 Contractor's Responsibilities

- A. Cooperate with laboratory personnel, provide access to Work, to Manufacturer's operations.
- B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.
- C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other materials mixes which require control by the testing laboratory.
- D. Furnish copies of Products test reports as required.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to Work to be tested.
 - 2. To obtain and handle samples at the Project site or at the source of the product to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For storage and curing of test samples.
- F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
 - 1. When tests or inspections cannot be performed after such notice, reimburse Employer for laboratory personnel and travel expenses incurred due to Contractor's negligence.
- G. Employ and pay for the services of a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required:
 - 1. For the Contractor's convenience.
 - 2. When initial tests indicate Work does not comply with Contract Documents.
- H. Make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience.

END OF SECTION

SECTION 01500
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 Requirements Included

- A. Electricity, Lighting.
- B. Heat, Ventilation.
- C. Telephone Service.
- D. Water.
- E. Sanitary Facilities.
- F. Construction Aid.
- G. Temporary Roofing.
- H. Enclosures.
- I. Barriers.
- J. Cleaning During Construction.
- K. Project Identification.
- L. Field Offices and Sheds.

1.02 Related Requirements

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

1.03 Electricity, Lighting

- A. Provide service required for construction operations, with branch wiring and distribution boxes located to allow service and lighting by means of construction type power cords.
- B. Provide lighting for construction operations.

1.04 Heat, Ventilation

- A. Provide as required to maintain specified conditions for construction operations, to protect materials and finishes from damage due to temperature or humidity.
- B. Provide ventilation of enclosed areas to cure materials, to disperse humidity, and to prevent accumulations of dust, fumes, vapors, or gases.

1.05 Telephone Service

Provide telephone service to field offices.

1.06 Water

Provide service required for construction operations. Extend branch piping with outlets located so that water is available by use of hoses.

1.07 Sanitary Facilities

Provide and maintain required facilities and enclosures.

1.08 Construction Aid

- A. Provide construction aid and equipment required by personnel and to facilitate execution of the Work: Scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other such facilities and equipment.
 - Refer to respective sections for particular requirements for each trade.
- B. Provide adequate first aid facilities on site.

1.09 Enclosures

Provide temporary weather-tight closures of openings in exterior surfaces to provide acceptable working conditions and protection for materials, to allow for temporary heating, and to prevent entry of unauthorized persons. Provide doors with self-closing hardware and locks.

1.10 Barriers

Provide as required to prevent public entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.

1.11 Cleaning During Construction

- A. Control accumulation of waste materials and rubbish; periodically dispose of off-site.
- B. Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

1.12 Project Identification

- A. Provide Project identification sign of steel frame construction, painted, with exhibit lettering by professional sign painter, to the Engineer's design and colors. List title of Project, names of Employer, Engineer, and Contractor.
- B. Erect on site at location established by the Engineer.
- C. Allow no other signs to be displayed.

1.13 Field Offices and Sheds

Provide approved furnished field offices for the Engineer's staff.

1.14 Removal

- A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary facilities. Remove underground installations; grade site as indicated. Restore existing facilities used during construction to specified, or to original, condition.

END OF SECTION

SECTION 01540
SECURITY

PART 1 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 01550
ACCESS ROADS AND PARKING AREAS

PART 1 GENERAL

1.1 Section Includes

- A. Access roads.
- B. Parking.
- C. Existing pavements and parking areas.
- D. Permanent pavements and parking facilities.
- E. Maintenance.
- F. Removal, repair.

1.2 Related Sections

- A. Section 01010 - Summary of Work
- B. Section 01039 - Coordination and Meetings
- C. Section 01500 - Construction Facilities and Temporary Controls.
- D. Section 02211 - Rough Grading.

PART 2 PRODUCTS

2.1 Materials

- A. Temporary Construction: Contractor's option.
- B. Earthwork,Paving Base,Topping,Permanent Construction: As specified in product specification sections.

PART 3 EXECUTION

3.1 Prepration

Clear areas, provide surface drainage of road, parking, area premises, and adjacent areas.

3.2 Access Roads

- A. Construct temporary access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- D. Location as approved by Engineer.
- E. Provide unimpeded access for emergency vehicles. Maintain 6 m width driveways with turning space between and around combustible materials.
- F. Provide and maintain access to fire hydrants and control valves free of obstructions.

3.3 Parking

- A. Provide temporary parking areas to accommodate use of construction personnel.
- B. When site space is not adequate, provide additional off-site parking.
- C. Location as approved by Engineer.

3.4 Existing Pavements and Parking Areas

- A. Use of designated existing on-site streets and driveways used for construction traffic is not permitted. Tracked vehicles not allowed on paved areas.
- B. Use of designated areas of existing parking facilities used by construction personnel is not permitted.
- C. Do not allow heavy vehicles or construction equipment in parking areas.

3.5 Permanent Pavements and Parking Facilities

- A. Prior to Substantial Completion the base for permanent roads and parking areas may be used for construction traffic.
- B. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.
- C. Use of permanent parking structures permitted.

3.6 Maintenance

- A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, Products, mud, snow, and ice.
- B. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.7 Removal, Repair

- A. Remove temporary materials and construction [when permanent paving is usable.at Substantial Completion.
- B. Remove underground work and compacted materials to a depth of (600) mm; fill and grade site as specified.
- C. Repair existing facilities damaged by use, to specified condition.

END OF SECTION

SECTION 01560

TEMPORARY CONTROLS

PART 1 GENERAL

1.1 Section Includes

- A. Water control
- B. Dust control.
- C. Erosion and sediment control.
- D. Noise control.
- E. Pest control.
- F. Pollution control.

1.2 Related Sections

- A. Section 01010 - Summary of Work.
- B. Section 01039 - Coordination and Meetings.
- C. Section 01500 - Construction Facilities and Temporary Controls.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.1 Water Control

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

3.2 Dust Control

- A. Execute Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

3.3 Erosion and Sediment Control

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize amount of bare soil exposed at one time.
- C. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

3.4 Noise Control

Provide methods, means, and facilities to minimize noise from and noise produced by construction operations.

3.5 Pest Control

Provide methods, means, and facilities to prevent pests and insects from accessing invading premises.

3.6 Pollution Control

Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

END OF SECTION

SECTION 01580
PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.1 Section Includes

- A. Project identification sign.
- B. Project informational signs.
- C. Maintenance.
- D. Removal.

1.2 Related Sections

- A. Section 01010 - Summary of Work.
- B. Section 01500 - Construction Facilities and Temporary Controls.
- C. Section 01570 - Traffic Regulations.

1.3 Quality Assurance

- A. Design sign and structure to withstand 80 km/hr wind velocity.
- B. Sign Painter: Experienced as a professional sign painter for minimum three years.
- C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

1.4 Submittals

- A. Section 01300 - Submittals: Shop drawings and product data.
- B. Show content, layout, lettering, color, foundation, structure, sizes, and grades of members.

PART 2 PRODUCTS

2.1 Sign Materials

- A. Structure and Framing: metal, structurally adequate.
- B. Sign Surfaces: as approved by the engineer.
- C. Paint and Primers: Exterior quality, two coats; sign background of colors as selected.
- D. Lettering: Exterior quality paint, colors as selected.

2.2 Project Identification Sign

- A. One painted sign of construction, design, and content shown on Drawings, location designated.
- B. Content:
 - 1. Project number, title, logo and name of Owner as indicated on Contract Documents.
 - 2. Names and titles of authorities.
 - 3. Names and titles of Architect/Engineer and Consultants.
 - 4. Name of Prime Contractor and major Subcontractors.
- C. Graphic Design, Colors, Style of Lettering: Designated by Engineer.

2.3 Project Informational Signs

- A. Painted informational signs of same colors and lettering as Project Identification sign, or standard products; size lettering to provide legibility at (30 m) distance.
- B. Provide at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as Work progress requires.
- C. Provide municipal traffic agency directional traffic signs to and within site.

PART 3 EXECUTION

3.1 Installation

- A. Install project identification sign within 30 days after date fixed by Owner- Contractor Agreement.
- B. Erect at location of high public visibility adjacent to main entrance to site.
- C. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
- D. Install sign surface plumb and level, with butt joints. Anchor securely.
- E. Paint exposed surfaces of sign, supports, and framing.

3.2 Maintenance

Maintain signs and supports clean, repair deterioration and damage.

3.3 Removal

Remove signs, framing, supports, and foundations at completion of Project and restore the area.

END OF SECTION

SECTION 01590
FIELD OFFICES AND SHEDS

PART 1 GENERAL

1.1 Section Includes

- A. Temporary field offices and sheds.
- B. Maintenance and cleaning.
- C. Removal.

1.2 Related Sections

- A. Section 01010 - Summary of Work.
- B. Section 01500 - Construction Facilities and Temporary Controls.
- C. Section 01600 - Material and Equipment: Storage and protection.

1.3 Use of Existing Facilities

Existing facilities shall not be used for field offices or for storage.

1.4 Use of Permanent Facilities

Permanent facilities shall not be used for field offices or for storage.

PART 2 PRODUCTS

2.1 Materials, Equipment, Furnishings

Materials, Equipment, Furnishings: Serviceable, new or used, adequate for required purpose.

2.2 Construction

- A. Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations, with steps and landings at entrance doors.
- B. Construction: Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work; remove at completion of Work.
- C. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
- D. Exterior Materials: Weather resistant, finished in color acceptable to Engineer.
- E. Interior Materials in Offices: Sheet type materials for walls and ceilings, pre-finished or painted; resilient floors and bases.
- F. Lighting for Offices: (50) ft-C (538 lx) at desk top height, exterior lighting at entrance doors.
- G. Fire Extinguishers: Appropriate type fire extinguisher at each office and each storage area.
- H. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.

2.3 Environmental Control

- A. Heating, Cooling, and Ventilating for Offices: Automatic equipment to maintain comfort conditions. (68) degrees F (20) degrees C) heating and (76)degrees F (23) degrees Ccooling.
- B. Storage Spaces: Heating and ventilation as needed to maintain Products in accordance with Contract Documents; adequate lighting for maintenance and inspection of Products.

2.4 Contractor Office and Facilities

- A. Size: For Contractor's needs and to provide space for project meetings.
- B. Telephone: As specified in Section 01500.

- C. Furnishings in Meeting Area: Conference table and chairs to seat at least eight persons; racks and files for Contract Documents, submittals, and project record documents.
- D. Other Furnishings: Contractor's option.
- E. Equipment: Six adjustable band protective helmets for visitors, (250 mm) outdoor weather thermometer .

2.5 Engineer Office

- A. Separate space for sole use of Engineer, with separate entrance door with new lock and two keys.
- B. Area: Minimum (14 sq m), minimum dimension (2.4m).
- C. Windows: Minimum three of minimum total area of 10 percent of floor area, with operable sash and insect screens. Locate to provide views of construction area.
- D. Electrical Distribution Panel: Two circuits minimum, 110 volt, 60 hz service.
- E. Minimum four(110) volt duplex convenience outlets, one on each wall.
- F. Telephone: As specified in Section 01500.
- G. Sanitary Facilities: Convenient access to private lavatory toilet facilities.
- H. Drinking Fountain: Convenient access by workers.
- I. Furnishings:
 - 1. One desk (1.4 x 0.75 m), with three drawers.
 - 2. One drafting table (one x 1.8 m), with one equipment drawer and a full width parallel straight edge.
 - 3. One metal, double-door storage cabinet under table.
 - 4. Plan rack to hold working Drawings, shop drawings, and record documents.
 - 5. One standard four-drawer-size metal filing cabinet with locks and twokeys per lock.
 - 6. Six (2 m) of metal bookshelves.
 - 7. Two swivel arm chairs.
 - 8. Two straight chairs.
 - 9. One drafting table stool.
 - 10. One tackboard (1 x 0.75m).
 - 11. One waste basket per desk and table.
 - 12. Calculator.
 - 13. Measuring tools.
 - 14. One computers set (minimum Pentium II with appropriate printer).
 - 15. Fax.

2.6 Storage Areas and Sheds

Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01600.

PART 3 EXECUTION

3.1 Prepration

Fill and grade sites for temporary structures to provide drainage away from buildings.

3.2 Installation

- A. Install office spaces ready for occupancy 15 days after date fixed in Owner-Contractor Agreement.
- B. Parking: Two hard surfaced parking spaces for use by the Engineer, connected to office by hard surfaced walk.
- C. Employee Residential Occupancy: Not allowed on Owner's property.

3.3 Maintenance and Cleaning

- A. Weekly janitorial services for offices; periodic cleaning and maintenance for office and storage areas.
- B. Maintain approach walks free of mud, water, and snow.

3.4 Removal

At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

END OF SECTION

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 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 01650
STARTING OF SYSTEMS

PART 1 GENERAL

1.1 Section Includes

- A. Starting systems.
- B. Demonstration and instructions.
- C. Testing, adjusting, and balancing.

1.2 Related Sections

- A. Section 01400 - Quality Control: Manufacturers field reports.
- B. Section 01700 -Contract Closeout: System operation and maintenance data and extra materials.

1.3 Starting Sysrems

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Engineer seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable Contractors' personnel in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly.

1.4 Demonstration and Instructions

- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate Project equipment by a qualified manufacturers' representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at designated location.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.5 Testing, Adjusting, and Balancing

- A. Owner will appoint and employ services of an independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services from cash allowance .
- B. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

Not Applicable

END OF SECTION

SECTION 01700
CONTRACT CLOSE-OUT

PART 1 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

PART 1 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

PART 1 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

PART 1 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 02100
EXCAVATIONS AND EARTHWORKS

PART 1 GENERAL

This Section shall be read in conjunction with Sections 02110, 02210 and 02219. In case of discrepancy between this specification and the above sections, this specification shall take precedence.

1.01 Scope Of Work

The Contractor shall provide all requisite equipment, labor and materials, necessary for executing the excavation works, in a manner that will meet the Engineer's acceptance and approval.

The work to be carried out by the Contractor, shall include, not by way of limitation, but in amplification to what is shown on the drawings and /or, the existing site conditions and/or the structural engineering requirements, or all, for the full and proper execution of the proposed Project, the following :

- A. Removal of all vegetation including the grubbing out of roots, within the site area.
- B. Excavations to reduce level within the Site area.
- C. Grading to required levels and sub - grade preparations.
- D. Stock piling of the suitable excavated soil for back-filling under the Engineer's supervision.
- E. Loading and carting away of surplus and /or unsuitable excavated material, and the disposal of same to an approved dumping area.

1.02 Weather Limitations

Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.03 Inspection Of The Site Documents

- A. The Report on Geotechnical Investigations for the Project Site (Which includes the results of the field and laboratory investigation, geotechnical analysis and interpretation of the findings, and conclusions and recommendations to aid the design and construction of foundations) may be inspected at the Engineer's office. This inspection shall be for the Contractor's information and guidance only, but without guarantee of accuracy, and therefore does not form part of the Contract Documents.
- B. No claim for extra compensation or extension of time will be allowed on account of subsurface conditions inconsistent with the data given in the Report on "Geotechnical Investigations" or for want of knowledge of the Site or the nature of the sub-soil.
- C. The contractor shall visit the Site and make all investigation which he deems necessary to ascertain the nature of the existing ground and the sub-soil to be excavated, and shall if he wishes to do so, drill as much boreholes as he deems necessary to satisfy himself as to the form and nature of the sub soil, and the existing site conditions in general.
- D. The plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the contractor shall have examined them for himself during the bidding period, as no additional compensation will be made for errors or inaccuracies that may be found therein.

1.04 Profiles

The Contractor shall provide and erect profiles, templates, sight rails and the like and properly set out the proposed works from the base lines, levels, coordinates or datum given by the Engineer's, and/or indicated on the drawings, or both.

1.05 Bench Marks

Establish permanent bench marks determined by an approved land surveyor or professional civil Engineer. Maintain all established bounds and bench marks and replace as directed those which are destroyed or disturbed due to the excavation operations, at no cost to the Employer.

1.06 Site Survey

- A. As soon as the Site is handed over to the Contractor, and before commencing any excavation works, the contractor shall at his own expense, carry out a check on the Site survey submitted by the Employer for the whole project Site; prepare and submit for the Engineer approval a grid plan; the grid sides shall be 5 meters with levels taken at the corners, and all levels shall be referred to the approved bench mark; verify all levels and dimensions and notify the Engineer in writing of any discrepancies. Do not proceed with excavation works until discrepancies have been corrected and are acceptable to the Engineer.
- B. The Contractor shall also be responsible for the accurate setting out of excavations and for keeping all reference axes and bench marks reasonably clear, and far from the working area.

PART 2 PREPARATION

2.01 Site Clearance

The Contractor shall carry out Site clearance which shall include clearing out the whole site area of all kinds of vegetation, debris, rubbish, etc., including the grubbing out of roots, including loading and carting away to an approved dumping area prior to any site preparation and /or setting - out is begun.

2.02 Preparation And Setting - Out

- A. Before any particular excavation is begun, the Contractor shall submit for the Engineer approval his proposals for marking the area to be excavated and for controlling the depth and profile of the excavation to the dimensions and levels shown on the drawings. The Contractor shall give the Engineer not less than 24 hours notice in writing of his intention to set out the works to enable the Engineer to make arrangements for checking. The check by the Engineer shall in no way absolve the Contractor from his responsibility for setting-out the Works correctly.
- B. Establish extent of excavation by area and elevation; designate and identify datum elevation.
- C. Set required lines and levels.
- D. Maintain bench marks, and other reference points.

PART 3 EXECUTION

3.01 Excavations Generally

- A. Excavation works shall be carried out in any type of soil met with during the course of excavation, whether earth, clay, gravel, sand, conglomerates, boulders, solid rock or any other material to any depth, as shown on the drawings or as directed and instructed by the Engineer.
- B. Where excavation works are carried out by power excavating equipment such as bulldozers, power shovels and back-hoes, power drills, or any other equipment which the contractor may propose to use, sufficient depth shall be left unexcavated to enable the exact depth required to be obtained by hand excavation.
Excavations shall be to the lines, levels and dimensions indicated on the drawings, or instructed by the Engineer's.
- D. All foundations shall be placed on undisturbed soil.
- E. Should any excavation be made below the levels shown on the drawings, or those required by the Engineer's, the excess depth of excavation shall be filled with rubber or mass concrete of 20 Mpa characteristic compressive strength, at the contractor's own expense.
- F. The use of explosives on site is strictly forbidden, and in no case shall the contractor or his employees revert to the use of explosives of whatever type or size.
- G. The Contractor shall keep the area around excavations clear for a distance of one meter in all directions until concrete is placed and has set.
- H. The bottom of footings and foundation excavations shall be cut true to level and kept clean of loose material and debris at all times. Bottoms of excavations will be inspected and approved by the Engineer's before foundations or pipes are laid.
- I. The Contractor will be held responsible for upholding the sides of excavations, and no claim for additional excavations, concrete, or other material will be considered in this respect, not withstanding the methods the Contractor elects to adopt for upholding the sides of excavation.

3.02 Excavation's Safety

- A. All excavation works shall be carried out in a safe manner to the lines and levels shown on the drawings or to such lines and levels as the Engineer may direct as the work proceeds, depending on the nature of the ground exposed. The Contractor shall provide timbering, or use other approved methods to support the sides of excavations in such a way as to minimize ground movement.
- B. The Contractor shall be responsible for all safety measures needed to support the sides of the excavations for the safety of workers in particular, and the works in general.
- C. The from time-to-time directions by the Engineer's shall not relieve the Contractor of his Contractual obligations to maintain the sides of excavation's safety and to ensure safety of the workers and the works.

3.03 Reducing Levels

- A. All excavations for reducing levels shall be carried out to the lines and levels shown on the drawings or to such lines and levels as ordered by the , Engineer's.
- B. If, from any cause whatsoever, excavations are carried out beyond their true line and level other than that ordered by the Engineer, the Contractor shall, at his own cost , make good to the required lines and levels with mass concrete as instructed by the Engineer
- C. All Excavations shall be performed so that the works are continually and effectively drained.

3.04 Inspection

- A. All excavation shall be inspected and approved by the Engineer's as the work proceeds and/or upon completion.
- B. The Contractor shall advise the Engineer's within adequate time when the excavation, or part thereof, is ready for such inspection. The Contractor must not proceed with other phasing until it has been inspected and/or authorized by the Engineer's.

3.05 Dewatering

- A. Prior to commencing excavation works, all dewatering proposals shall be submitted to the Engineer's for his written approval.
- B. The Contractor shall provide, maintain, alter and/or improve, and clear away on completion all dewatering equipment, temporary drains and the like.
- C. The Contractor shall use all necessary measures to keep the excavation free from surface water, storm water, percolating water and subsoil water by the use of pumping or any other means approved by the Engineer's.
- D. Where deemed necessary by the Engineer's, protective filter shall be used at pumping location to prevent the removal of the fine materials from the surrounding ground.

3.06 Haulage And Transportation Of Excavated Materials

The Contractor shall regulate the loading and carting away of excavated materials, debris, rubbish, etc. day by day , to an approved dumping area, as the excavation works proceed.

3.07 Surplus Excavated Material

All surplus excavated material not used in backfilling or leveling shall be loaded and removed from the site and disposed-off at the Contractor's expense to a dump to be selected by the Contractor and approved by the Municipality or local authorities.

END OF SECTION

SECTION 02110

SITE CLEARING

PART 1 GENERAL

1.01 Work Included

- A. Clear site of trees, shrubs, plant life and grass.
- B. Remove root system of trees and shrubs 75 mm and over in diameter at base.
- C. Remove rocks, boulders and other debris.

1.02 Related Work

- A. Section 02100; Excavation & Earthwork
- B. Section 02210; Site Grading

1.03 Protection

- A. Protect bench marks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic.
- B. Maintain designated temporary roadways, walkways and detours, for vehicular and pedestrian traffic.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.01 Preparation

Maintain bench marks, monuments and other reference points. Re-establish if disturbed or destroyed, at no cost to Employer.

3.02 Clearing

- A. Clear areas as required for access to site excavation and performance of Work.
- B. Cut down trees and shrubs within marked areas. Grub out stumps, roots, embedded rocks, boulders and abandoned concrete.
- C. Clear out undergrowth and deadwood, without disturbing sub-soil.

3.03 Removal Of Debris

- A. Promptly remove cleared debris from site. Burning of debris on site is not permitted, unless permission is obtained from applicable regulatory authority.
- B. Obtain permission from applicable regulatory authority for disposal of debris to waste disposal site.

END OF SECTION

SECTION 02210
SITE GRADING

PART 1 GENERAL

1.01 Work Included

- A. Remove any topsoil and stockpile on site for later use.
- B. Upon The Engineer's instruction's and recommendations load and cartaway.
- C. Excavate sub-soil and reform to grades, contours and levels.
- D. Excavate for roadways, walks, curbs, parking areas and landscaped areas.

1.02 Related Work

- A. Section 02110: Clearing
- B. Section 02211: Rock Removal

1.03 Existing Conditions

Known underground, surface and aerial utility lines, and buried objects are indicated on the Drawings.

1.04 Protection

- A. Protect bench marks, and existing structures, fences, roads, sidewalks, paving and curbs against damage from equipment and vehicular traffic.
- B. Protect aerial, surface, or underground utility lines or appurtenances which are to remain.
- C. Repair damage.

PART 2 PRODUCTS

Not applicable

PART 3 EXECUTION

3.01 Preparation

- A. Establish and identify required lines, levels, contours and datum.
- B. Maintain bench marks, monuments, and other reference points. Re-establish if disturbed or destroyed, at no cost to Employer.
- C. Before start of grading, establish the location and extent of utilities in the work areas. Notify utility Authorities and arrange to remove and relocate lines which are in the way of construction.
- D. Maintain, protect, reroute or extend as required existing utilities to remain which pass through the work area.
- E. All vegetation, such as roots, brush, heavy sods, heavy growth of grass, and all decayed vegetable matter, rubbish and other unsatisfactory material within the areas upon which fill is to be placed shall be stripped or otherwise removed before the fill is placed; in no case will unsatisfactory material remain in or under the fill area.

3.02 Grading

- A. Grade site to required levels, profiles, contours and elevations as shown on the drawings.
- B. All unsatisfactory material including any soil which is disturbed by the contractor's operations or softened due to exposure to the elements and water, and surplus material shall be removed from site.
- C. In the event that it is necessary to remove unsatisfactory material to a depth greater than specified, the Engineer shall be notified.
- D. Excavation shall be performed in a manner and sequence that will provide drainage at all times, thus ensuring that excavations are kept free from water.

3.03 Surplus Material

Remove part of the surplus materials from site as per the Engineer's instructions..

END OF SECTION

SECTION 02219
STRUCTURE EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 Definitions

- A. Relative Compaction:
 - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
 - 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by ENGINEER.
- B. Optimum Moisture Content:
 - 1. Determined in accordance with ASTM Standard specified determine maximum dry density for relative compaction.
 - 2. Determine field moisture content on basis of fraction passing 22 mm (3/4-inch) sieve.
- C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
- D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- E. Completed Course: A course of layer that is ready for next layer or next phase of work.
- F. Lift: Loose (uncompacted) layer of material.
- G. Well Graded:
 - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - 1. 300 mm outside outermost edge at base of foundations or slabs.
 - 2. 300 mm outside outermost edge at surface of roadways or shoulder.
 - 3. 150 mm outside exterior at spring line of pipes or culverts.
- I. Borrow Material: Material from required excavations or from designated borrow areas on or nor site.
- J. Select (or Selected) Backfill Material: Materials available onsite that ENGINEER determines to be suitable for specific use.
- K. Imported Material: Material obtained by CONTRACTOR from sources offsite, suitable for specified use.
- L. Structural Fill: Fill materials as required under structures, pavements, and other facilities.
- M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.
- N. Base Rock: Undisturbed, intact rock beneath excavation.
- O. Bedding or Bedding Material: Imported granular pipe bedding material installed under and around the pipes from trench Base Rock to 300 mm, or as shown in the drawings which ever in greater, above top of installed pipes and ducts.
- P. Trench Backfill: Includes full trench width and extends from top of bedding material to ground surface (less pavement components). May include select backfill material or graded aggregate.
- Q. Common Fill or Common Backfill: Shall be material similar to that found at surface level in the immediate vicinity.
- R. Reinstatement: Reinstatement of surface (surface restoration) as specified or as indicated on the Drawings.
- S. Standard Specifications: When referenced in this section, shall mean latest edition of ASTM Standards unless indicated otherwise.

1.02 Work Included

- A. Excavate for isolated column bases and strip footings and stockpile the suitable excavated material for backfilling and remove the unsuitable materials from the site to an approved dumping area from site under the supervision of the Engineer.
- B. Cap off and seal discontinued utility services and remove portions of lines within excavated areas.
- C. Dewater excavations.
- D. Backfilling around foundations and walls to the levels as required.
- E. The Contractor shall be responsible for remove the Cave In Material which occurs in the sides of the excavations and on the contractor's own expense.

1.03 Related Work

1.04 Site Compaction And Testing

- A. Testing of compacted fill materials shall be performed by an approved Testing Laboratory.
- B. Compaction shall be accomplished by approved equipment well suited to the soil being compacted.
- C. Laboratory tests shall be performed for each type of fill material used, to obtain the maximum density according to Engineer's Instructions.
- D. All compaction requirements stated relate to the laboratory maximum density.
- E. The moisture content of the fill materials and subgrade at the time of compaction shall be uniform and as close as possible to the optimum moisture content as determined by laboratory testing.
- F. All test results shall be submitted to the Engineer within 3 days of placing fill.
- G. If, during progress of the work, test results indicate that compacted materials do not meet specified requirements, all defective work shall be removed (or replaced) and recompact and retested at the Contractor's expense.
- H. Ensure compacted fills are tested and passed before proceeding with placement of surface materials.
- I. The frequency and type of testing shall be as follows:
One test shall be made for every 50 cubic metres of fill material placed. A minimum of four tests shall be allowed for at areas to be chosen by the Engineer.

1.05 Submittals

- A. Submit minimum, samples of each type of excavated and imported fill material to be used taken at source. Forward samples to appointed testing laboratory, packed tightly in containers to prevent contamination.
- B. If recent test results are available for fill materials to be used, disregard samples submission. Such test results are to clearly indicate types of materials and composition, hardness, compactability and suitability for proposed usage.
- C. Quality Control Submittals:
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
 - 2. Certified test results from independent testing agency.

1.06 Protection

- A. Protect bench marks and against damage from equipment and vehicular or foot traffic.
- B. Notify the Engineer of unexpected sub- surface conditions and discontinue work in area until the Engineer provides notification to resume work.
- C. Protect bottom of excavations and soil around and beneath foundations from flooding.

1.07 Sequencing and Scheduling

- A. Complete applicable work specified in Sections 2100 site clearing, 2110 site grading; and 2100, EXCAVATION and earthwork, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained 70 percent of design strength. Obtain ENGINEER's acceptance of concrete work and attained strength prior to placing backfill.
- C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03300, CAST-IN-PLACE CONCRETE.
- D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared.

PART 2 PRODUCTS

2.01 Source Quality Control

- A. Gradation Tests:
 - 1. As necessary to locate acceptable sources of imported material.
 - 2. During production of imported material, test once per every 20 cubic meters of placed material.
- B. Samples: Collected in accordance with ASTM D75:
 - 1. During production of imported material, provide samples once per every 100 cubic meters of placed material.

2.02 Fill Materials

- A. Granular Fill and Base Course:
 - 1. Aggregate for use as granular fill shall be crushed stone. Aggregate may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

2. Crushed stone and crushed gravel shall consist of hard, durable and sound particles of fragments of stone, free from other deleterious substances not mentioned below, other requirements are gypsum, or flakey particle. Other requirements:
 - a. Gypsum content (expressed as SO₃) 20% max.
 - b. Clay Lumps and friable particles 8% max.
 - c. Elongated and flakey particles for crushed rock (Determined in accordance with BS812 Part 1: 1975)
 - d. Granite & Basalt 40% max. each
 - e. Lime Stone 35% max. each
 - f. Maximum Dry density (g/cm³) 2.1 min.
 3. Chert content (determined as percentage by weight insoluble in hydrochloric acid to be specified in specified in special technical specification.
 4. Methods used in production of crushed rock shall ensure that the finished product will be as uniform as practicable. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve at least 80 % by weight shall have at least two fractured faces.
 5. Any material passing 4.75 mm (No. 4) sieve and produced in the crushing process shall be incorporated in the base material up to the gradation limits of aggregate.
 6. Crushed aggregate for base course delivered to road site shall meet the requirements of gradations as shown in table below, when tested in accordance with AASHTO T 27 after dry mixing and just before spreading and prior to compacting. The actual gradation shall, in all cases, be continuous and smooth within the actual limits. Gap graded aggregate will not be accepted. If gradation is tested after compaction a tolerance of 3% is allowed in upper limit for percentage of material passing sieve 200.
- Gradation of granular fill:
- | <u>Sieve Size</u> | <u>%Passing</u> |
|-------------------|-----------------|
| 50 mm | 100 |
| 25 mm | 95 |
| 20 mm | 95 to 100 |
| 16 mm | 75 to 100 |
| 10 mm | 55 to 85 |
| No. 4 | 35 to 60 |
| No. 16 | 15 to 35 |
| No. 40 | 10 to 25 |
| No. 200 | 5 to 10 |
- B. Sand: Clean natural river or bank sand; free from silt, clay, loam, friable or soluble materials, and organic matter; graded within the following limits:

| <u>Sieve Size</u> | <u>%Passing</u> |
|-------------------|-----------------|
| No. 4 | 100 |
| No. 14 | 10 to 100 |
| No. 48 | 5 to 90 |
| No. 100 | 4 to 30 |
| No. 200 | 0 |
 - C. Sub-soil: Free from roots, rock larger than 75 mm in size and building debris.
 - D. Unsatisfactory materials include PT, CH, MH, OL, OH and gypsiferous soils: also rock, man-made fills, refuse or backfills from previous construction

PART 3 EXECUTION

3.01 General

- A. Keep placement surface free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials is horizontal lift or uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure even.
- D. Do not place or backfill, keep level of fill and backfill around each structure even.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 600mm above top to item to be laid.
 - 2. Excavation trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 02225, TRENCHING.
 - 4. Install item.
 - 5. Backfill envelop zone and remaining trench, as specified in Section 02225, TRENCHING, before resuming filling or backfilling specified in this section.
- F. Tolerance:
 - 1. Final Lines and Grades: Within a tolerance of 30mm unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement or fill or backfill material.

3.02 Preparation And Layout

- A. Establish extent of excavation by area and elevation; designate and identify datum elevation.
- B. Set required lines and levels.
- C. Maintain bench marks, monuments and other reference points.

3.03 Utilities

- A. Before starting excavation, establish location and extent of underground utilities occurring in work area.
- B. Notify utility Authorities to remove and relocate lines which are in the way of excavation.
- C. Maintain, re-route or extend as required, existing utility lines to remain which pass through work area.
- D. Pay costs for this work, except those covered by utility Authorities.
- E. Protect utility services uncovered by excavation.
- F. Remove abandoned utility service lines from areas of excavation; cap, plug or seal such lines and identify at grade.
- G. Accurately locate and record abandoned and active utility lines routed or extended, on Project Record Documents.

3.04 Excavation

- A. Excavate sub-soil in accordance with lines and levels required for construction of the work, including space for forms, bracing and shoring, applying dampproofing, waterproofing and to permit inspection.
- B. Do additional excavation only by written authorization of the Engineer.
- C. Hand trim excavations and leave free from loose or organic matter.
- D. When complete, verify soil bearing capacities, depths and, dimensions.
- E. Correct unauthorized excavation as directed, at no cost to Employer.
- F. Fill over-excavated areas under structure bearing surfaces with concrete as specified for foundations.
- G. Excavations are not to interfere with normal 45 degree bearing splay of any foundation.
- H. Stockpile excavated sub-soil for reuse where directed. Remove excess or unsuitable excavated sub-soil from site.
- I. Excavations shall be performed so that the works are continually and effectively drained.

3.05 Backfilling

- A. The Contractor shall stockpile fill materials at his own responsibility in area(s) that do not affect the progress of works, provided the Engineer's approval is obtained prior to proceeding with the works.

- B. Do not start backfilling operations until all associated works have been inspected and approved.
- C. Ensure areas to be backfilled are free from debris, ice and water, and that ground surfaces are not in a frozen condition.
- D. Do not backfill over existing sub-grade surface which are porous, wet or spongy.
- E. Compact existing sub-grade surfaces if densities are not equal to that required for backfill materials.
- F. Cut out soft areas of existing sub-grade. Backfill with suitable fill material and compact to required density.
- G. Backfill areas to grades, contours, levels and elevations.
- H. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.
- I. Place and compact fill materials in continuous layers not exceeding 200 mm loose depth. Use a method so as not to disturb or damage other works.
- J. Maintain optimum moisture content of backfill materials to attain required compacting density.
- K. Backfill simultaneously on each side of foundation walls to equalize soil pressures. Do not backfill against foundation walls until the main floor is in place.
- L. Where temporary unbalanced pressures are liable to develop on walls before floor slabs are placed, erect necessary shoring to counteract imbalance. Leave in place until their removal is approved by the Engineer.

3.06 Compaction

- A. Compaction shall be achieved using suitable compaction equipment.
- B. Each layer shall not exceed 200 mm thick, dewatered and compacted to not less than the percentage of 95 %.

3.07 Surplus Materials

- A. Remove surplus backfill materials from site.
- B. Leave stockpile areas completely free of all excess fill materials.

END OF SECTION

SECTION 02221

TRENCHING

PART 1 GENERAL

1.01 Work Included

- A. Excavate trenches for utilities.
- B. Compacted bed and compacted fill over utilities.
- C. Compaction requirements.

1.02 Related Work

- A. Section 01410 Testing Laboratory Services: Compaction requirements of backfill.
- B. Section 02211 Rock Removal.

1.03 Tests

Tests and analysis of fill materials will be performed in accordance with ANSI/ASTM D1557 and with Section 01410.

1.04 Reference Standards

- A. ANSI/ASTM C136 Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D1556 Density of Soil in Place by Sand-Cone Method.
- C. ANSI/ASTM D1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 10 lb (4.54kg) Rammer and 18 inch (457mm) Drop.

1.05 Samples

- A. Submit Samples in accordance with Section 01410.
- B. Submit 5 Kg. Sample of each type of fill to testing laboratory, in air-tight containers.

1.06 Protection

- A. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in or loose soil from falling into excavation.
- B. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.
- C. Notify the Engineer's of unexpected subsurface conditions and discontinue work in affected area until notification to resume work.
- D. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- E. Grade excavation top perimeter to prevent surface water run-off into excavation.

PART 2 PRODUCTS

2.01 Select Bed And Fill Materials

- A. Type A-Coarse Stone: Gravel: (Pit run, Angular, Crushed, or natural stone): free of shale, clay, friable materials and debris; graded in accordance with ANSI/ASTM C136 within the following limits:

| Sieve Size | Percent Passing |
|-----------------|-----------------|
| 50 mm | 100 |
| 25 mm | 95 |
| 19 mm | 95 to 100 |
| 16 mm | 75 to 100 |
| 9 mm | 55 to 85 |
| No. 4(4.75 mm) | 35] to 60 |
| No. 16(1.18 mm) | 15 to 35 |
| | 10 to 25 |

- B. Type B - Pea Gravel: Natural stone, free of clay, shale, organic matter; 6 mm minimum to 16 mm maximum size graded in accordance with ANSI/ASTM C136.
- C. Type C - Sand: Natural wadi or bank sand; free of silt, clay, loam, friable or soluble materials and organic matter; graded in accordance with ANSI/ASTM C136 within the following limits:

2.01 Select Bed And Fill Materials (cont'd)

| Sieve Size | Percent Passing |
|-----------------------|-----------------|
| No. 4(4.75 mm) | 100 |
| No. 14 (1.40 mm) | 10 to 100 |
| No. 50 (300 micro m) | 5 to 90 |
| No. 100 (150 micro m) | 4 to 30 |
| No. 200 (75 micro m) | 0 |

2.02 Common Fill Materials

Subsoil: Reused; Imported; free of gravel larger than 75 mm size, and debris.

PART 3 EXECUTION

3.01 Inspection

- A. Verify stockpiled fill to be reused as approved.
- B. Verify foundation perimeter drainage installation when shown on plans has been inspected.
- C. Verify areas to be backfilled are free of debris or water.

3.02 Preparation

- A. Identify required lines, levels, contours and datum.
- B. When necessary, compact subgrade surfaces to density requirements for backfill material.

3.03 Trench Excavation

- A. Excavate subsoil required for sanitary sewer, water piping; also for power and telecommunication cables.
- B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.
- C. Hand trim excavation and leave free of loose matter. Hand trim for bell and spigot pipe joints.
- D. Remove lumped subsoil, boulders, and rock up to 0.25 cu/m, measured by volume. Remove larger material under Section 02211.
- E. Excavation shall not interfere with normal 45 degrees bearing splay of foundations.
- F. Correct unauthorized excavation at no cost to Employer.
- G. Fill over-excavated areas under pipe bearing surfaces in accordance with direction by the Engineer.
- H. Stockpile excavated material in area designated on site and remove excess subsoil not being reused, from site.

3.04 Trench Preparation

- A. Water Control
 - 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to -compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete. lay pipe, conduit, direct-buried cable, or duct bank in water.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.05 Trench Bottom

- A. Firm Subgrade: Grade with hand tools, remove loose, and disturbed material, and trim off high areas. Allow space for bedding material.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify ENGINEER. ENGINEER will determine depth of over excavation, if any required.

3.06 Geotextile Installation

- A. Install where shown or required to prevent migration of bedding and backfill materials as follows:
 - 1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
 - 2. Anchor geotextile trench walls prior to placing trench stabilization 'or bedding material.
 - 3. Provide 600mm minimum overlap at joints.

3.07 Bedding Material

- A. Furnish imported bedding material.
- B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 200mm.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
 - 1. Minimum thickness beneath pipes 150 mm.
- D. Check grade and correct irregularities in bedding material. Loosen top 50mm of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- E. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.
 - 1. Upper limit of Bedding Material shall not be less than 300mm over top of pipe
- G. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- H. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipes 250mm and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.
 - 2. Pipes Over 250mm Diameter: Maximum 150mm lifts.
- I. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
- J. After the full depth of the backfill material has been placed, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

3.08 Marking Tape Installation

- A. Continuously install marking tape along centerline of all buried piping. Coordinate with piping installation drawings.
 - 1. Metallic Marking Tape: Install with nonmetallic piping and non-metallic water pipelines.
 - 2. Plastic Marking Tape: Install with metallic piping and metallic water pipelines.

3.09 Concrete Encasement

- A. Concrete encasement shall be carried out in accordance with SECTION; 3300, CAST-IN-PLACE CONCRETE.

3.10 Backfill Above Bedding Material

- A. To include Common fill, Selected Backfill, and Base Course
- B. General:
 - 1. Process excavated material to meet specified gradation requirements or import suitable material as appropriate.
 - 2. Adjust moisture content as necessary to obtain specified compaction.
 - 3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 600mm of backfill has been provided over the top of pipe.
 - 4. Place and compact in layers not exceeding 200mm.
 - 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
 - 6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.
 - 7. Mechanically compact each lift prior to placing succeeding lifts. Compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557.
 - 8. Determine proper type of compaction equipment, method to use, and amount of compaction necessary to prevent settlement and to achieve required compaction degree.
- C. Controlled Low Strength Concrete Fill:
 - 1. Discharge from truck mounted drum type mixer into trench.
 - 2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
 - 3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.

3.11 Maintenance of Trench Backfill

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the

- adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
 - C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
 - D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 02575, PAVEMENT REPAIR AND RESURFACING (REINSTATEMENT).
 - E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.12 Settlement of Backfill

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill. CONTRACTOR shall, at his cost, promptly repair defective compaction to the satisfaction of ENGINEER.

3.13 Tolerances

- A. Top Surface of Back filling: Plus or minus 12.5 mm.

3.14 Compaction Testing

- A. Compaction testing will be performed in accordance with ANSI/ASTM D1557 and with Section 01410.

END OF SECTION

SECTION 02229
ROCK REMOVAL

PART 1 GENERAL

1.01 Work Included

- A. Removal of rock materials from site.
- B. Security measures to prevent unauthorized persons from entering work area.

1.02 Related Work

- A. Section 02110: Clearing.
- B. Section 02210: Site Grading.

1.03 References

Not used.

1.04 Definitions

Rock: this material all of which cannot be removed with a 0.60 cubic meter capacity power shovel without drilling or blasting. Rock is also interpreted as solid boulders with a volume of more than 0.25 cubic meter. Blasting will not be permitted on this Contract.

1.05 Seismic Survey

Not used.

1.06 Soils Report

Location of test bore holes is indicated in Soil Investigation Data.

1.07 Existing Conditions

- A. Visit site and note characteristics and irregularities affecting work of this section.
- B. Proceeding with work means, acceptance of conditions, and failure to comply with site visit requirements will in no sense form basis for any claims.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.01 Rock Removal

- A. Perform rock removal by experienced personnel in accordance with the Construction Engineer's and approval.
- B. In utility trenches, excavate 150 mm below invert elevation of pipe and 600 mm wider than pipe diameter or as shown on drawings.
- C. Remove rock to provide sound and unsheltered base for footings and foundations.
- D. Remove excavated material from site.

END OF SECTION

SECTION 02260

FINISH GRADING

PART 1 GENERAL

1.01 Work Included

- A. Finish grade sub-soil in areas where paving or structures do not occur.
- B. Place, finish grade and compact top soil.

1.02 Related Work

Section 02210 : Site Grading.

1.03 Protection

Prevent damage to existing trees, landscaping, natural features, bench marks, pavement, utility lines and other works. Correct damage at no cost to the Employer.

PART 2 PRODUCTS

2.01 Materials

Topsoil: friable loam free from subsoil, roots, grass, excessive amount of weeds, stones and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 4% and a maximum of 25% organic matter.

PART 3 EXECUTION

3.01 Sub Soil Preparation

- A. Rough grade sub-soil systematically to allow for a maximum amount of natural settlement and compaction. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, etc. in excess of 75 mm in size. Remove sub-soil which has been contaminated with petroleum products.
- B. Cut out areas, to sub-grade elevation, which are to receive stabilizing base for paving and are to be used for construction of buildings.
- C. Bring sub-soil to required levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- D. Slope grade away from building minimum 50 mm in 3 m unless indicated otherwise on drawings.
- E. Cultivate sub-grade to a depth of 75 mm where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.
- F. Compact sub-soil to the following:
 - 1) 90% maximum density for cohesive materials, and 95% for cohesionless materials, where topsoil is to be placed.
 - 2) 95% maximum density for cohesive materials, and 100% for cohesionless materials, under tiled areas.

3.02 Placing Topsoil

- A. Place topsoil in areas where seeding, sodding or planting is to be performed. Place to the following minimum depths, up to finished grade elevations:
 - 1. 150 mm for seeded areas.
 - 2. 115 mm for sodded areas.
 - 3. 600 mm for shrub beds.
 - 4. 460 mm for flower beds.
- B. Use topsoil in relatively dry state. Place during dry weather.
- C. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles and contours of sub-grades.
- D. Remove stone, roots, grass, weeds, debris and other foreign material while spreading.
- E. Manually spread topsoil around trees, plants, and other obstructions to prevent damage which may be caused by raiding equipment.
- F. Lightly compact placed topsoil.

3.03 Surplus Material

- A. Remove surplus sub-soil and topsoil from site.
- B. Leave stockpile areas and entire job site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 02480
LANDSCAPE DEVELOPMENT

PART 1 GENERAL

This Section pertains to structures, street furniture, site amenities and special paving related to Landscape Development.

1.01 Work Included

- A. Provide labor and materials to construct landscape structures, including planters, edging, divider strips, steps, other constructs as indicated on the Landscape Plans.
- B. Provide and install pre-cast concrete pavers, interlocking tiles concrete tiles, stone flooring, as indicated on the landscape plans.

1.02 Related Work

| | |
|---------------|-----------------------------|
| Section 02483 | Landscape Planting. |
| Section 02521 | Pre cast Concrete Units |
| Section 02513 | Asphalt Paving. |
| Section 02517 | Interlocking Concrete Tiles |
| Section 02577 | Pavement Marking |
| Section 02482 | Landscape Planting |

1.03 Submittals

- A. Shop Drawings:
 - Upon instructions by the Engineer provide shop drawings for any of the items listed under this section for verification and approval.
- B. Samples:
 - 1) Concrete Paver.
 - 2) Interlocking Tiles Pavers
 - 3) Stone Flooring

PART 2 PRODUCTS

2.01 Materials

- A. Cast - In - Place concrete: Where applicable for walls, planter boxes, steps, edging and other items as indicated on the Landscape Development Plans shall conform to the requirements of Section 03300 Cast - In - Place Concrete and Section 03100 Concrete Form work.
- B. Pre - Cast concrete: Where applicable products shall conform to the requirements of Section 02521 Pre cast Concrete Units.

PART 3 EXECUTION

All work performed under this Section shall be of the highest quality, and performed by experienced craftsmen, and performed in a timely manner, coordinated with other trades and crafts.

END OF SECTION

SECTION 02513
ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 Work Included

- A. Prepare sub-grade to receive base course.
- B. Place stabilizing base course, work and compact.
- C. Prime base course, place asphalt pavement.

1.02 Related Work

- A. Section 01410: Testing Laboratory Services.
- B. Section 02210: Site Grading.
- C. Section 02577: Pavement Markings.

1.03 Reference Standards

- A. ATSM D1557 - Tests for Moisture - Density Relationship of Soils using 10 lb. (4.5 kg) Rammer in 18 inch (457 mm) Drop.
- B. Asphalt Institute Manuals.

1.04 Testing And Inspection

- A. Testing and inspection of asphalt pavement mix(es) and testing of placed stabilizing base course and asphalt pavement will be performed by independent testing laboratory appointed and paid for by Contractor in accordance with Section 01410. Testing and inspection will be performed so as to minimize disruption to Work.
- B. Allow testing laboratory access to the mixing plant for verification of weights or proportions, character of materials used and determination of temperatures used in the preparation of asphalt concrete mix.
- C. When and if required, the testing laboratory will perform laboratory tests on proposed asphalt pavement mix to determine conformity with requirements.
- D. The testing laboratory will perform two (2) series of compaction tests for stabilizing base course and for each asphalt pavement. Pay for costs of additional testing as required due to improper performance of work.
- E. When stabilizing base course or portion thereof has been placed and compacted in accordance with requirements, notify the testing laboratory to perform density tests. Do not place asphalt pavement until results have been verified and base course installation approved.
- F. If compaction tests indicate that stabilizing base course or asphalt paving do not meet specified requirements, remove defective work, replace and retest at own expense.

PART 2 PRODUCTS

2.01 Stabilizing Base Course Materials

- A. Granular Base: Angular crushed natural stone; free from shale, organic matter and debris; graded within following limits:

| Sieve Size | Percent Passing |
|--------------------------|-----------------|
| 22 mm | 100 |
| 19 mm | 80 to 100 |
| 16 mm | 75 to 100 |
| 13 mm | 70 to 90 |
| No. 4 (5 mm) | 40 to 70 |
| No. 10 (2 mm) | 25 to 50 |
| No. 14 (1.40 mm) | 15 to 35 |
| No. 40 (425 micrometers) | 15 to 30 |
| No. 200(75 micrometers) | 3 to 8 |

- B. Primer: Homogeneous medium curing liquid asphalt; of type recommended for asphaltic paving; of grade to suit job conditions (according to Asphalt Institute recommendations).

2.02 Asphalt Pavement Materials

- A. Coarse Aggregate(s): Crushed rock, slag or gravel, or a combination thereof; free of clay, silt or other deleterious materials; graded within the following limits.
- | Sieve Size | Percent Passing |
|-------------------------|-----------------|
| <u>(Surface Course)</u> | |
| 1/2 inch (13 mm) | 100 |
| 3/8 inch (10 mm) | 50 to 73 |
| No. 4 (4.75 mm) | 0 to 10 |
- B. Fine Aggregate(s): Clean, hard, durable natural sand, manufactured sand or screenings resulting from the crushing of rock, stone or gravel; free of clay, silt or other objectionable material; graded within the following limits:
- | Sieve Size | Percent Passing |
|--------------------------|-----------------|
| <u>(Surface Course)</u> | |
| No. 4 (5 mm) | 100 |
| No. 8 (2 mm) | 80 to 100 |
| NO. 16 (1 mm) | 55 to 90 |
| No. 30 (600 micrometers) | 35 to 70 |
| No. 50 (300 micrometers) | 15 to 40 |
| No. 100(150 micrometers) | 5 to 18 |
| No. 200(75 micrometers) | 0 to 8 |
- C. Asphalt Cement: Homogeneous; free of water; will not foam when heated to 177 degrees C; 60/70, 85/100 or 150/200 penetration grade.
- D. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust acceptable to Engineer; free of clay, silt or other deleterious matter; graded within following limits:
- | Sieve Size | Percent Passing |
|--------------------------|-----------------|
| No. 30 (600 micrometers) | 100 |
| No.200 (75 micrometers) | 80 |

2.03 Asphalt Pavement Mix

- A. Combine mineral constituents in proportions to produce a mixture conforming to following gradation requirements:
- | Sieve Size | Percent Passing |
|--------------------------|-----------------|
| 13 mm | 100 |
| 10 mm | 72 to 88 |
| No. 4 (4.75 mm) | 45 to 65 |
| No. 8 (2 mm) | 36 to 65 |
| No. 30 (600 micrometers) | 16 to 45 |
| No. 50 (300 micrometers) | 7 to 26 |
| No. 100(150 micrometers) | 2 to 10 |
| No. 200(75 micrometers) | 0 to 5 |
- B. Percentage by weight of asphalt cement in mixture; 5.0% to 7.0% for surface course.
- C. Maintain thorough and uniform mixture.
- D. Bring asphalt cement and mineral constituents to required temperatures before mixing. Ensure aggregates are sufficiently dry so as to cause foaming in mixture.
- E. Job mix formula: The Contractor shall prepare all asphaltic concrete for use on the project in accordance with the following criteria (unless an alternative specification is agreed with Engineer).
- Stability 820 kg (min.)
- Flow, units
- 2 mm min. 4 mm max.
- % Air Voids 3 min., 5 max.
- Density
- (in situ) 98% - 100% laboratory density.

PART 3 EXECUTION

3.01 Preparation

- A. Ensure grading of sub-grade to required elevation.
- B. Scarify sub-grade, where asphalt pavement is to be placed, to a depth of minimum 300 mm. Window loosened soil to one side. Recompact in two layers to 100% density as measured by ASTM 1557 150 mm. Rework the wind rowed soil to as finely a divided condition as possible, spreading over compacted surfaces and compact to densities mentioned above.
- C. Where existing gravel has been wind rowed and retained for sub-grade, incorporate such into the top 150 mm by mixing and blading. Compact as specified in the preceeding paragraph.

3.01 Preparation (cont'd)

- D. Water and thoroughly mix sub-grade until optimum moisture content is obtained when deficiency of moisture content exists. When excess of moisture exists, rework and aerate sub-grade until optimum moisture content is obtained.
- E. Before final rolling, shape entire section, add additional sub-soil as required and compact sub-grade to provide grades, elevation and cross-section indicated. Points of finished sub-grade surface shall be within 12.5 mm of elevations indicated.

3.02 Placement Of Stabilizing Base Course

- A. Add water during compaction to bring granular material to optimum moisture content.
- B. Spread base course materials over prepared granular sub-base to a compacted depth as shown on the drawings. Compact to 100% density. Ensure top surface of base course is true to lines and grades indicated, with all points within 12.5 mm of elevations indicated.
- C. Add water during compaction to bring stabilizing base course materials to optimum moisture content. When an excess moisture exists, rework stabilizing base course materials until optimum moisture content is obtained.

3.03 Priming Prepared Stabilized Base Course

- A. Ensure stabilized base course is dry and free of loose or foreign material before priming.
- B. Apply primer over prepared stabilizing base course at a uniform rate as recommended by Manufacturer and approved by Engineer, 2.25 liters per square meter. Ensure primer is at recommended temperature. Use clean natural sand to blot excess primer.
- C. Similarly prime surfaces of curbs and catchpits which will be in contact with asphalt pavement.
- D. Coat surfaces of manholes, catch basins which are to remain free of asphalt with oil to prevent asphalt adhesion.

3.04 Placement Of Asphalt Pavement

- A. Place asphalt pavement within 24 hours of priming stabilizing base course.
- B. Place asphalt pavement to compacted depth indicated.
- C. Do not place asphalt pavement when surface temperature is 4 degrees C or lower. Ensure asphalt pavement is minimum 118 degrees C immediately after placing and prior to initial rolling.
- D. Compact asphalt paving to required density, with approved rolling equipment. Start compaction as soon as pavement will bear equipment without checking or undue displacement.
- E. Carry out compaction in three operations in pass sequence. Ensure each pass of roller overlaps previous passes to ensure smooth surface free of roller marks. Keep roller wheels sufficiently moist so as not to pick up material.
- F. Perform hand tamping in areas not accessible to rolling equipment.
- G. Ensure joints made during paving operations are straight, clean, vertical and free of broken or loose material. Prime vertical surfaces of joints to ensure tight bond.
- H. Ensure surface of completed asphalt pavement is true to lines, profiles and elevations indicated, and is free from depressions exceeding 3 mm when measured with a 3 meter straight-edge.
- I. Do not allow vehicular traffic on newly paved areas until surface has cooled to atmospheric temperature.
- J. In areas where pavements are to be used for playing courts, apply a seal coat in accordance with Asphalt Institute Manual No. 13 (MS-13).

END OF SECTION

SECTION 02521
PRECAST CONCRETE UNITS

PART 1 GENERAL

1.01 Work Included

- A. Precast concrete curb stones and laying.
- B. Precast concrete tiles with plain surface finish and laying.

1.02 Related Work

- A. Section 02210: Site Grading.
- B. All sections relevant to concreting operations, contained within these specifications.

1.03 References

- A. BS 340 Concrete Curbs
- B. BS 1197 Concrete Tiles
- C. BS 8110 C-BS 8110 - Concrete Work Generally.

1.04 Storage

All precast units shall be stored on site away from traffic areas; avoid excessive handling and protect from accidental damage.

1.05 Submittals

Sample tiles and curbs shall be submitted together with details of design for approval by the Engineer's; the approved samples shall be used as the standard for the works.

PART 2 PRODUCTS

2.01 Materials

- A. Precast concrete curbs shall be as shown on the Drawings or of such size and shape as approved by the Engineer's on site.
- B. Precast concrete tiles; shall have a surface finish with an approved colour of a single source.

2.02 Mixes

- A. All Mixes are to be approved by the Engineer's on site.
- B. The crushing strength of the precast concrete units shall be 30 MPa at 28 days.
- C. The concrete slump in the slump test shall not exceed 75mm.
- D. The colour of the top surface of all the units shall be uniform throughout. The use of colour additive is not permitted without the approval of the Engineer's
- E. The requirements of other sections relating to concrete in this specification shall also apply.

2.03 Fabrication.

- A. Concrete shall be mixed and handled as specified in other sections in this specification.
- B. Moulds shall be metal high density plywood or plastic; they shall be watertight and of sufficient rigidity to produce the required shape, size and surface texture.
- C. The required surface finish shall be determined by the Engineer's.
- D. The edges of all tiles and curbs shall be uniformly chamfered or straight as required and perfectly at right angles, the surfaces shall be free from weariness, chipped arrises and other defects.
- E. Patching up and making good of any defective units is not permitted.
- F. All units shall be cured by totally immersing them in water for at least 24 hours after the initial set has taken place, and allowed to mature for a period of 28 days before transport and laying.

PART 3 EXECUTION

3.01 Inspection and Preparation

- A. Ensure that all surfaces to receive the precast concrete units are free from any loose material, dry, and uniformly graded and compacted as required and approved by the Engineer's.
- B. Ensure that the surface to receive the precast concrete curbs is of sufficient width and depth to have a concrete bedding placed as required therein to receive the curb.
- C. Do not commence work until unsatisfactory conditions are corrected.

3.01 Inspection and Preparation (cont'd)

- D. Paving tiles and curbs shall not be laid until the major work in the vicinity of the area has been completed. When laid, they shall be protected and kept free of any oils, paints, etc. liable to cause damage or stains.
- E. Verify that substrate is level and to the correct gradient; smooth, capable of supporting pavers and imposed loads and ready to receive work of this section.

3.02 Installation Of Curbs, Paving Tiles, Covers

- A. The plan layout, showing lines and levels of the curbs shall be adhered to.
- B. The curbs shall be set as shown on the drawings. The mix of the concrete shall be approved by the Engineer's
- C. All joints between the curb and the paving tiles, and between the curb sections themselves shall be filled with a sand cement mortar, as for the paving tiles.
- D. Paving tiles shall be laid on an approved sand bed underlay of an appropriate thickness, and a mortar bed.
- E. Coordinate installation of pre-cast concrete units.
- F. Spread sand evenly over prepared substrate surface to the required thickness.
- G. Dampen and compact sand to a level and even surface.
- H. Screed and scarify top 12mm of sand-bed underlay.
- I. Lay mortar bed to the required thickness.
- J. Lay paver units from straight reference edge.
- K. Place special shaped units at edge and interruptions.
- L. Maintain evenly spaced joints.
- M. Grout with an approved cementitious grout.

3.03 Protection and Cleaning

- A. Surfaces of all precast units shall be carefully cleaned on completion, taking care to avoid any damage.
- B. Adequate protection shall be given to all the completed work, to avoid damage from any subsequent activities.
- C. Any damage caused to completed work shall be made good by the Contractor at his own expense.

END OF SECTION

SECTION 02577
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 Work Included

Pavement markings.

1.02 Reference Standards

Federal Specification TT-P-115E Paint Traffic, Highway, White, Yellow.

1.03 Submittals

- A. The Manufacturer's specifications and application recommendations shall be submitted to the Engineer's.
- B. Samples and details of the paint shall be submitted (about 60 days before application), for approval.

1.04 Storage

The paint shall be stored in sealed containers which clearly show the designated name, formula or specification number, batch number, colour, date of manufacture, manufacturers name and directions for use.

1.05 Job Conditions

- A. Air and pavement temperatures shall be above 4 degrees C during application of the paint.
- B. All markings shall be adequately protected to prevent damage.

PART 2 PRODUCTS

2.01 Materials

The paint shall be homogenous, and shall show no objectionable characteristics during the storage period prior to usage.

The paint shall conform to Federal Specification TT-P-115E, colour as selected.

PART 3 EXECUTION

3.01 Preparation And Inspection

- A. New pavement surfaces shall be allowed to cure for a period of time of not less than 30 days before application of marking materials.
- B. All surfaces to be marked shall be thoroughly cleaned before application of the paint.
- C. All pavement cleaning operations shall be performed only after approval by the Engineer.
- D. Mechanical preparation and/or priming as may be required shall be in accordance with the material Manufacturer's Instructions and as applicable to the types of pavement and material involved.

3.02 Layouts And Tolerance

- A. The Contractor shall provide the work necessary to layout the marking work in conformance with the requirements of the MOC standards for Road Safety Features and with the typical details shown on the Contract Drawings and within the specified tolerances. Layout marks shall be removed following completion of marking materials application.
- B. Any variation in the alignment of stripes or broken lines shall not exceed 25 mm in 25 meters, and the width of stripes or broken lines shall not vary more than plus or minus 10 mm from the width shown.
- C. Any line required to be curved shall have uniform curvature throughout the arc length, and shall be accurately aligned and free from offsets at tangent point intersections with lines at straight roadway sections.
- D. All markings shall be in positions as shown on the Contract Drawings and with an accuracy of 50 mm transversely with respect to the roadway centerline, and longitudinally within 100 mm with respect to survey stations.
- E. Broken lines shall be uniform in length and spacing and shall not vary from the dimensions indicated more than plus or minus 50 mm.
- F. Parallel strips and/or broken lines shall be uniformly spaced apart as shown and any variation in spacing between them shall not exceed plus or minus 10 mm.

3.03 Application

- A. Marking material shall be applied at a rate of 4 litre per sq. metre or in accordance with the Manufacturer's Instructions as approved.
- B. Paint shall be applied pneumatically.
- C. Application shall not be made in conditions of blowing sand and dust, nor when the pavement surface is wet or damp, nor when the ambient and/or surface temperatures exceed the extremes permitted by the Manufacturer nor otherwise when weather conditions would adversely affect the finished work.
- D. Adjacent surfaces shall be maintained or otherwise cleaned free from marking materials not required to be applied.
- E. When complete, the installed marking material shall be uniform in colour, level and smooth, and free from inclusions of sand or other deleterious substances, stains, discolouration or other irregularities. Edges of the work shall be neat, straight and free from raggedness or other unevenness; and corners shall be neatly cut off square or true and sharp to the angle required. Any markings applied outside the tolerances specified in Article 3.02 shall be completely removed and re-applied correctly.
- F. Each colour required shall be uniform in hue and reflectance throughout the work.

3.04 Safety And Protection Of Work

- A. The Contractor shall provide and use sufficient safety devices and methods to protect all personnel on site.
- B. Markings shall be protected until they are sufficiently cured to be driven across without damage. The Contractor shall plan his operations for working only in hours of daylight.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 Work Includes

- A. Plain and fair face formwork of wood, Steel and Fibrous glass reinforced plastic formwork, for cast-in place concrete, complete with shoring, bracing and anchorage.
- B. Form openings for mechanical and electrical work.
- C. Coordinate installation of items supplied by other sections of work.
- D. Pre-formed construction joints
- E. Forming of expansion joints.

1.02 Related Work

- A. Section 03200: Concrete Reinforcement
- B. Section 03251: Expansion and Contraction Joints
- C. Section 03300: Cast-in-Place Concrete
- D. Section 04220: Concrete Masonry Unit
- E. Supports, Anchors and Seals for Mechanical Installations.
- F. Supporting Devices for Electrical Installations.

1.03 Quality Assurance

Construct and erect concrete formwork in accordance with The Engineer's Instructions.

1.04 Shop Drawings

- A. Submit shop drawings in accordance with Section 01340.
- B. Indicate pertinent dimensioning, methods of construction, materials, arrangement of joints, ties and shores, location of bracing and temporary supports, schedule of erection and stripping.
- C. Prepare shop drawings under seal of Professional Structural Engineer.

PART 2 PRODUCTS

2.01 Wood Form Materials

- A. Plywood: Douglas Fir or Spruce species; sheathing grade; sound undamaged sheets with clean true edges.
- B. Lumber: spruce species; sheathing grade; with grade stamp clearly visible.
- C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required; of sufficient strength and character to maintain formwork in place while pouring concrete.

2.02 Formwork Accessories

- A. Form Ties: Removable or Snap-off metal type of fixed or adjustable length; form ties should be free of defects and should not leave a hole larger than 25 mm in the concrete surface.
- B. Form Release Agent: Colorless mineral oil which will not stain concrete or impair natural bonding or color characteristics of coating intended for use on concrete.
- C. Fillets for Chamfered corners: Rigid foam plastic type; of required size; maximum possible lengths.

2.03 Acceptable Manufacturers

Other Acceptable Manufacturers:

The Contractor shall submit to the Engineer the names of 3 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.

2.04 Concrete Accessories

Impregnated fiberboard in the form of permanent formwork, to be used as an expansion joint filler.

PART 3 EXECUTION

3.01 Formwork Erection

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.
- B. Construct formwork, shoring and bracing to meet design and code requirements, so that resultant finished concrete conforms to required shapes, lines and dimensions.
- C. Arrange and assemble formwork to permit dismantling and stripping, so that concrete is not damaged during its removal.
- D. Align joints and make watertight, to prevent leakage of mortar and disfigure appearance of concrete. Keep form joints to minimum.
- E. Obtain the Engineer's review for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.
- F. Arrange forms to allow stripping without removal of principal shores, where and when these are required to remain in place.
- G. Obtain the Engineer's review before framing openings in structural members, which are no drawings.
- H. Provide bracing to ensure stability of formwork. Prop or strengthen previously constructed formwork liable to be over stressed by construction loads.
- I. Provide chamfer strips on external corners of members only where shown on drawings.
- J. Construct formwork to provide completed concrete surfaces after removal of forms and prior to patching and finishing of cast-in-place formed surfaces.
- K. Form expansion joints in the positions shown on the drawings and finish-off as follows:
 - Joint filled with polystyrene filler boards in the form of permanent formwork.
- L. Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.
- M. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.02 Inserts, Embedded Parts, And Openings

- A. Provide formed openings where required for pipes, conduits, sleeves, and other work to be embedded in and passing through concrete members.
- B. Locate and set in place items which will be cast directly into concrete.
- C. Coordinate work of other sections and cooperate with trade involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts. Do not perform work unless specifically indicated on drawings or reviewed prior to installation.
- D. Install concrete accessories in accordance with manufacturer's recommendations; straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- D. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

3.03 Field Quality Control

- A. Inspect and check completed formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and parts are secure.
- B. Inform the Engineer when formwork is complete and has been cleaned, to allow for inspection. Obtain review prior to placing concrete.
- C. Allow the Engineer to inspect each section of formwork prior to reuse.

3.04 Finishes

- A. Plain Finish:
Formwork generally and to concrete surfaces to be plastered may be sawn formwork.
- B. Fair Faced Finish :
 - 1. Concrete surface which are described as fair face finished shall be finished free from honeycombing and excessive air holes, fines and projections arising from defective mixing, placing of formwork, and shall, if necessary, be filled with mortar and rubbed with fine carborundum stone The finish shall be integral with the body of the concrete and shall not be obtained by means of an applied rendering.
 - 2. The quality of the surface of concrete exposed to view shall be consistent throughout the project and the following methods shall be adopted to obtain the required fancy. The Contractor may submit alternative proposals for the approval of the Engineer if he so desires.

3.04 Finishes (cont'd)

- a. Formwork for fair faced concrete shall be either of steel, fibrous glass reinforced plastic or exterior grade plywood not less than 16mm thick properly detailed to the satisfaction of the Engineer whose approval is required in writing before order the formwork. The Formwork boards shall not be used more than (4) times.
 - b. In addition to the above forms of linings, the forms shall be coated before placing the reinforcement with an approved colourless mineral oil free of kerosene, and shall be applied in accordance with the manufacturer's printed instructions.
 - c. All surplus oil on form surface and any oil on reinforcing steel shall be removed.
- Approval by the Engineer to Fair Faced Finishes:
- 1. The Contractor shall submit for approval of the Engineer a sample panel not less than 60cm x 120cm to demonstrate the quality of the exposed concrete to be produced by forms, at his own expense.
 - 2. The quality of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Engineer without any additional cost.
 - 3. The quality of the finished surfaces shall be of uniform colour and consistency throughout the project. Should there be any inconsistency in colour or texture in any of the finished surfaces the Engineer may order the repair or the demolition of a portion of concrete work and its reconstruction at the contractor's own expense.
 - 4. Construction joints, in special cases of weather conditions and if approved by the Engineer, shall be studied in detail ahead of time and the joints shall be grooved in a predetermined pattern approval by the Engineer.

3.05 Cleaning

- A. Clean forms as erection proceeds, to remove foreign Matter: Remove cuttings, shavings, and debris from within forms. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-outs ports.
- B. During cold weather, remove ice from within forms. Do not use de-icing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.06 Form Removal

- A. Notify Engineer prior to removing formwork.
- B. Do not remove forms, shores and bracing until concrete has gained sufficient strength to carry its own weight, and construction and design load which are liable to be imposed upon it. Verify strength of concrete by compressive test results.
- C. Remove formwork progressively and in accordance with code requirements and so that no shock loads or unbalanced loads are imposed on structure.
- D. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against concrete surfaces.
- E. Leave forms loosely in place, against vertical surfaces, for protection until complete removal is approved by the Engineer.
- F. Store removed forms, for exposed architectural concrete, in manner that surfaces to be in contact with fresh concrete will not be damaged. Marked or scored forms will be rejected.
- G. Reshore structural members where required due to design requirements or construction conditions and as required to permit progressive construction. Remove load supporting forms only when concrete has attained 75 percent of required 28 day compressive strength, provided construction is reshored.
- H. Remove forms not directly supporting weight of concrete as soon as stripping operations will not damage concrete.

END OF SECTION

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 Work Included

- A. Reinforcing steel bars, and punching shear cages for cast-in-place concrete, complete with tie wire.
- B. Support chairs, bars supports, spacers for reinforcing.

1.02 Related Work

Section 03300: Cast-in-place concrete.

1.03 Quality Assurance

Perform concrete reinforcing work in accordance with the Engineer's Instructions.

1.04 Source Quality Control

- A. Submit 3 certified copies of mill test report of supplied concrete reinforcing, indicating physical and chemical analysis.
- B. Provide the Engineer with access to fabrication plant to facilitate inspection of reinforcement. Notify of commencement and duration of shop fabrication, in sufficient time to allow for proper inspection.

PART 2 PRODUCTS

2.01 Reinforcing

| | |
|--------------|-------------------------------|
| Grade | Minimum Yield Strength |
|--------------|-------------------------------|

| | |
|------------------|---------|
| High Yield Steel | 420 MPa |
|------------------|---------|

| | |
|------------|---------|
| Mild Steel | 300 MPa |
|------------|---------|

Reinforcing Steel: High yield deformed weldable steel bars, BS 4449, BS 4461 or BS 4483.

2.02 Quality Requirements

Steel reinforcement shall be hot rolled high strength high bond.

2.03 Fabrication

- A. Fabricate concrete reinforcing in accordance with BS 4449, BS 4461 or BS 4483.
- B. Locate reinforcing splices, not indicated on drawings, at points of minimum stress. Location of splices: to be reviewed by the Engineer.

2.04 Accessory Materials

- A. Tie Wire: Minimum 1.5mm gauge annealed type, or patented system accepted by Engineer.
- B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcing during construction conditions.
- C. Special Chairs, Bolsters, Bar Supports, Spacers where adjacent to architectural concrete surfaces: Plastic coated type; sized and shaped as required.

PART 3 EXECUTION

3.01 Placement And Fixing Of Reinforcement

- A. Place reinforcing supported and secured against displacement. Do not deviate from true alignment.
- B. Before placing concrete, ensure reinforcing is clean, free of loose scale, dirt, or other foreign coatings which would reduce bond to concrete.
- C. All reinforcement shall be fixed rigidly in position. At intersections the bars shall be bound together with tying wire and the loose ends of the wire shall be turned towards the inside of the member.
- D. Reinforcement shall only be spliced or welded where shown on the drawings. All welding procedures shall be subject to approval.
Reinforcement shall be fixed in the positions shown on the drawings within a tolerance of 5mm of 5% of the lowest dimension of the cross-section of the member, whichever is greater.

3.01 Placement And Fixing Of Reinforcement (cont'd)

- F. The concrete cover to the reinforcement shall be carefully maintained utilizing approved spacers where necessary. The minimum concrete cover to all steel shall be:
50mm for concrete below grade.
30 mm for exposed fair faced concrete surfaces.
25mm for internal concrete faces above grade.
- G. Where concrete spacer blocks are used they shall not exceed 50mm square in section and shall be precast from concrete of similar mix proportions and strength as the adjacent concrete, except that the largest size of aggregate shall be 10mm.
- H. Spacer blocks shall not be used where the concrete face will be visible in the finished work, without the approval of the Engineer.
- I. Each concrete spacer block shall be securely fixed to the reinforcement with wire or a clip. The wire or clip shall be embedded in the center of the blocks so that it does not subsequently cause rust marks on the concrete surface.
- J. Supports and other subsidiary bars necessary to maintain the reinforcement in position shall be provided at approved intervals with concrete cover not less than that of the adjacent reinforcement.
- K. Fabric reinforcement shall be used in standard sheets where possible. Adjoining sheets shall overlap by at least on rectangle or 60 diameters of the bar at the lap, whichever is the greater.
- L. Scaffold boards shall be provided to ensure that the reinforcement is not displaced by being walked upon during concreting or other operations .
- M. During concreting operations a competent steel fixer shall be in attendance to ensure that the reinforcement is maintained in the position as pouring and compaction proceeds.

3.02 Measurements and Rates

Rates

- A. Calculation of Steel reinforcement bars, weight to be calculated as follows:

| <u>Diameter (mm)</u> | <u>Weight (Kg/mm)</u> |
|----------------------|-----------------------|
| 6 | 0.222 |
| 8 | 0.395 |
| 10 | 0.617 |
| 12 | 0.888 |
| 14 | 1.210 |
| 16 | 1.580 |
| 18 | 2.000 |
| 20 | 2.460 |
| 22 | 2.980 |
| 24 | 3.550 |
| 25 | 3.850 |
| 26 | 4.170 |
| 30 | 5.550 |
| 32 | 6.318 |

- B. Unit rate shall include all labor, reinforcing, tie wires and all necessary materials needed (chair, spacers ...etc.) for the completion of the work as specified.

END OF SECTION

SECTION 03215
DOWELING FOR CONCRETE

PART 1 GENERAL

1.01 References

- A. The following is a list of standards which may be referenced in this section:
 - 1. American National Standards Institute (ANSI).
 - 2. American Society for Testing and Materials (ASTM):
 - a. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - c. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - d. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - e. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
 - f. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - 3. International Conference of Building Officials (ICBO): Uniform Building Code (UBC).

1.02 Definitions

- A. ICBO Reports: Published by ICBO for concrete anchor manufacturers.
- B. Special Inspection: As governed by the ICBO UBC.

1.03 Submittals

- A. Shop Drawings: Technical data for adhesive, grouts, and bonding agents.
 - 1. Mixed Adhesive: Current test data indicating cured adhesive meets or exceeds design loads required.
- B. Samples: two random samples of each batch of products delivered to site, for independent testing.
- C. Quality Control Submittals:
 - 1. Manufacturer's specific instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 - 2. Manufacturer's qualifications, to include client name, address, contact person, phone number, project location, and description of work.
 - 3. Manufacturer's Certificate of Proper Installation.
 - 4. Manufacturer's written letter of certification identifying installer's qualifications to install products.
 - 5. Doweling system manufacturer's ICBO Reports.
 - 6. Provide detailed step-by-step instructions for the Special Inspection procedure in accordance with ICBO Reports and UBC.
 - 7. Copy of manufacturer's operation and repair manuals for each type of equipment delivered to site.

1.04 Quality Assurance

- A. Qualifications:
 - 1. Manufacturer: At least three similar projects with same products within the last 3 years.
 - 2. Installer: Trained and certified by manufacturer.
- B. Regulatory Requirements: Adhesive and grouts shall be acceptable to EPA and health agencies for use in potable water structures.

1.05 Delivery, Storage, and Handling

- A. Store epoxy/ adhesive components on pallets or shelving in a covered storage area.
- B. Control temperature above 15 degrees C and dispose of product if shelf life has expired.
- C. Dispose of product if stored at other than manufacturer's instructions.
- D. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

PART 2 PRODUCTS

2.01 Materials

- A. Two-component, insensitive to moisture, designed to be installed in adverse freeze/ thaw environments.
- B. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
- C. Mixed Adhesive: Nonsag light paste consistency with ability to remain in a 25 mm diameter overhead drilled hole without runout.
- D. Manufacturers and Products:
 - 1. ITW Ramset/ Red Head, Paris, KY 40361; Epcon Ceramic 6 Epoxy Anchor System.
 - 2. Covert Operations, Long Beach, CA or Chester, NJ; CIA Epoxy Anchors with viscosity to suit application.
 - 3. The Rawlplug Co., Inc., New Rochelle, NY; Foil Fast Epoxy Injection Gel System.
 - 4. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT C-100).
 - 5. Or equal approved.

2.02 Anchor Rods

- A. Threaded Steel Rods: Sized by adhesive manufacturer for design loads required and adhesive system used:
 - 1. ASTM A307, Grade A.
 - 2. ASTM A 193 (B7), high strength.
 - 3. ASTM A 193 (B8), Type 304, stainless steel.
- B. Reinforcing Bars: As specified in Section 03210, REINFROING STEEL.
- C. Smooth Epoxy-Coated Plain Reinforcing Bars: As specified in Section 03210, REINFROING STEEL

PART 3 EXECUTION

3.01 General

- A. Dispensing, Metering, or Mixing Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.
- B. Install in accordance with manufacturer's specific instructions.
- C. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.
- D. Mixing Nozzles:
 - 1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
 - 2. Nonremovable internal static mixer required to ensure proper blending of components.
- E. Where large meter and mixing pumps are impractical, provide adhesive packaged as follows:
 - 1. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
 - 2. Dispense components through a mixing nozzle that thoroughly mixes components and places adhesive at base of predrilled hole.
 - 3. Mixing Nozzles:
 - a. Disposable, manufactured in several sizes to accommodate sizes of reinforcing dowels.
 - b. Nonremovable internal static mixer required to ensure proper blending of components.

3.02 Testing of Automatic Metering and Mixing Devices

- A. Tests for Proper Ratio:
 - 1. Retain small amount of dispensed adhesive for inspection after each time the pump is refilled.
 - 2. Check these samples for color change.
 - 3. Should change in color occur, follow manufacturer's service instructions to obtain proper operation.
- B. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.
- C. Ratio Check Procedure:
 - 1. Disconnect dispensing head behind ON/OFF valve.
 - 2. Place volume containers of the required proportions under the "B" and "A" component hose end.
 - 3. Actuate the pump.
 - 4. Both cups should fill in an equal time to the proper volume, thereby verifying the proportion ratio by volume.

3.03 Dowel Sizing and Installation

- A. Follow adhesive manufacturer's instructions for installation.

- B. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
 - 2. Hollow drills with flushing air systems are preferred.
 - 3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- C. Hole Diameter:
 - 1. As small as possible to allow dowel to be embedded to required depth.
 - 2. Use drill bit diameter meeting ICBO Report requirement and as recommended by the manufacturer.
- D. Obstructions in Drill Path:
 - 1. When existing reinforcing steel is encountered during drilling and when approved by the ENGINEER, enlarge the hole by 4 mm, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or redrill hole 25 mm from original location, beginning in the same line at the surface, redirecting the drill to miss reinforcing steel.
 - 2. Place dowels in both the misdrilled hole and the new one.
 - 3. When using epoxy anchors, dowels may be prebend prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
 - 5. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.

3.04 Manufacturer's Services

- A. Provide manufacturer's representative at site in accordance with Section 01640, MANUFACTURER'S SERVICES, for installation assistance, inspection, and certification of proper installation.

END OF SECTION

SECTION 03251
EXPANSION, CONTRACTING, CONSTRUCTION, AND CONTROL JOINTS

PART 1 GENERAL

1.1 References

- A. The following is a list of standards which may be referenced in this section:
- 1) American Society for Testing and Materials (ASTM):
 - a. A36, Standard Specification for Structural Steel.
 - b. A525, Standard Specification for General Requirements for Steel Sheets, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - c. A767/767M, Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - d. D226, Standard Specification for Asphalt-Standard Organic Felt Used in Roofing and Waterproofing.
 - e. D227, Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing.
 - f. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type) (AASHTO M33).
 - g. D1056, Standard Specification for Flexible Cellular Materials-Sponge for Expanded Rubber.
 - h. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 2) Corps of Engineer (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
 - 3) American National Standards Institute (ANSI): ANSI/NSF 61, Drinking Water System Components, and Health Effects.

1.2 Submittals

- A. Shop Drawings:
- 1) Plastic Type Water Stops: Details of splices to be used and method of securing water stop in the forms and supporting water stop so as to maintain proper orientation and location during concrete placement.
 - 2) Construction Joints: Layout and location indicating type to be used.
 - 3) Joint fillers for horizontal and sloped joints.
 - 4) Preformed control joints.
 - 5) Water stop.
- B. Samples: Splice, joint, and fabricated cross of each size, shape, and fitting of water stop(s) proposed for use.
- C. Quality Control Submittals:
- 1) Joint Filler for Potable Water Structures: Copy of applicable NSF listing.
 - 2) Water stop manufacturer's written instructions for product shipment, storage, handling, installation fields splices, and repair.
 - 3) Joint Filler and Primer: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.
 - 4) Preformed Control Joint: Manufacturer's written instructions for product shipment, storage, handling, application, and repair.

1.3 Quality Assurance

- A. Regulatory Requirements: Acceptance of pourable joint filler for potable water structures by federal EPM or by a state health agency.
- 1) Pourable Joint Filler: Certified as meeting NSF 61.
- B. Qualifications: Water stop manufacturer shall demonstrate 5 years, minimum, continuous successful experience in production of PVC water stops.

1.4 Delivery, Storage, and Handling

- A. Acceptance at Site: Verify that water stops delivered are in accordance with cross-section dimensions as shown and manufacturer's product data prior to unloading and storing onsite.
- B. Storage: Store water stops under tarps to protect from oil, dirt, and sunlight.

PART 2 PRODUCTS

2.1 Plastic Water Stop

- A. Extruded form an elastomeric plastic compound of which the basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain any scrapped material, reclaimed material, or pigment.
- B. Specific Gravity: Approximately 1.37.
- C. Shore Durometer Type A Hardness: Approximately 80.
- D. Performance Requirements: Corps of Engineers' Specification CRD-C-572.
- E. Type: Center bulb with a number of parallel ribs or protrusions on each side of strip center.
- F. Corrugated or tapered type water stops are not acceptable.
- G. Thickness: Constant from bulb edge to the outside stop edge.
- H. Minimum Weight per Meter of Water Stop:
 - 1. 2.4 kg for 10 mm by 150 mm.
- I. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

2.2 Wire Looped Plastic Water Stop

- A. Furnish as an alternative to plastic water stops.
- B. Same material and geometry as plastic water stops.
- C. Furnish with continuous galvanized wire looping at edge for convenience in positioning and securing stop in place in the forms.

2.3 Bond Breaker

- A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape, same width as the joint, that will adhere to the premolded joint material or concrete surface.
- B. Use either bond breaker tape or a bond prevention material as specified in Section 03300, CAST-IN-PLACE CONCRETE, except where a tape is specifically called for.

2.4 Premolded Joint Filler

- A. Bituminous Type: ASTM D994 or D1751.
- B. Sponge Rubber: Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with a compression deflection, 25 percent deflection (limits), 119 to 168 kPa (17 to 24 psi) minimum.

2.5 Premolded Control Filler

- A. One-Piece, Flexible, Polyvinyl Chloride Joint Former.
- B. One-Piece Steel Strip with Preformed Groove.
- C. Furnish in full-length, unspliced pieces.

2.6 Pourable Joint Fillers

- A. Filler for Water Structures:
 - 1) Meet requirements of ANSI/NSF 61.
 - 2) Multicomponent sealant, self-leveling or nonsag as required for level, sloping, or vertical joints.
 - 3) Color: White.
 - 4) Manufacturers and Products:
 - a. Sika Chemical Co., Lyndhurst, NJ; Sikaflex-2C or Sikaflex-1A.
 - b. Or equal approved.
- B. Urethane or Polyurethane Filler for Aeration or Oxygenation Basins: Two-component, pourable, immiscible, and compatible with a high purity oxygen environment; of self-leveling or nonsag consistency.
 - 1) Manufacturers and Products:
 - a. Sika Chemical Co.
 - b. Or equal approved.
 - 2) Primer: As recommended by the manufacturer.

2.7 Steel Expansion Joint Dowels

- Dowels: ASTM A36 round smooth steel bars.

2.8 Accessories

- A. Nonshrink Grout:
 - 1) As specified in Section 03600, GROUT.
 - 2) Compatible with joint sealant.
- B. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.
- C. Reinforcing Steel: As specified in Section 03210, REINFORCING STEEL.
- D. Nails: As required for securing bituminous type premolded joint filler.
- E. Masking Tape: As required to temporarily adhere to concrete at each side of joint to receive filler.
- F. Galvanized Rebar at Control Joints: ASTM A767/767/M and A615 Grade 60 prior to galvanizing.
- G. Ties for PVC Water Stop: "Hog Rings" or grommets for each edge at 12-inch maximum spacing.

PART 3 EXECUTION

3.1 General

- A. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.
- B. Commence concrete placement after the joint preparation is complete.
- C. Time Between Concrete Pours: As specified in Section 03300, CAST-IN-PLACE CONCRETE.
- D. Reservoir Walls:
 - 1) Horizontal construction joints are not permitted.
 - 2) Vertical joints in addition to those shown may be used; meet design requirements for joints in walls.

3.2 Surface Preparation

- A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:
 - 1) Remove Laitance and spillage from reinforcing steel and dowels.
 - 2) Roughen surface to a minimum of 1/4-inch amplitude:
 - a. Sandblast after the concrete has fully cure.
 - b. Water blast after the concrete has partially cured.
 - c. Green cut fresh concrete with high pressure water and hand tools.
 - 3) Perform cleaning so as not to damage water stop, if one is present.
- B. Expansion Joint with Pourable Filler:
 - 1) Use motorized wire brush or other motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic water stop to the top of the joint.
 - 2) Use clean and dry high pressure air to remove dust and foreign material, and dry joint.
 - 3) Prime surfaces before placing joint filler.
 - 4) Avoid damage to water stop.
- C. Contraction Joint with Pourable Filler:
 - 1) Coat concrete surfaces above and below plastic water stop with bon breaker.
 - 2) Do not damage water stop.
- D. Control Joint:
 - 1) Coat concrete surfaces above and below plastic water stop with bond breaker.
 - 2) Do not damage water stop.
 - 3) Furnish correct type and size of reinforcing and dowels.
 - 4) Construction Joint with Hydrophilic Water Stop:
 - a. Follow manufacturer's written instructions.
 - b. Clean all debris, dirt, dust, and foreign material from concrete surface.
 - c. Concrete surface must be smooth, clean, and dry.

3.3 Installation of Water Stops

- A. General:
 - 1) Join water stops at intersections to provide continuous seal.
 - 2) Center water stop on joint.
 - 3) Secure water stop in correct position to avoid displacement during concrete placement by tying to rebar above and below using grommets, "Hog Rings", or rebar tie wire at maximum spacing of 12 inches.
 - 4) Repair or replace damaged water stop.
 - 5) Place concrete and vibrate to obtain impervious concrete in the vicinity of all joints.
 - 6) Joints in Footing and Slabs:
 - a. Ensure that space beneath plastic water stop is completely filled with concrete.

- b. During concrete placement, make a visual inspection of the entire water stop area.
- c. Limit concrete placement to elevation of water stop in first pass, vibrate the concrete under the water stop, lift the water stop to confirm full consolidation without voids, then place remaining concrete to full height of slab.
- d. Apply procedure to full length of plastic water stops.

3.3 Installation of Water Stops (cont'd)

B. Plastic Water Stop:

- 1) Install in accordance with manufacturer's written instructions.
- 2) Splice in accordance with the water stop manufacturer's written instructions using a teflon coated thermostatically controlled heating iron at approximately 250 degrees C.
 - a. Allow at least 10 minutes before the new splice is pulled or strained in any way.
 - b. Finished splices shall provide a cross-section that is dense and free of porosity with tensile strength of not less than 80 percent of the unspliced materials.
 - c. Use only factory made water stop fabrications for all intersections, changes of directions and transitions.
 - d. Field splice permitted only for straight butt welds.
- 3) Wire looped plastic water stop may be substituted for plastic water stop.

3.4 Expansion Joint Installation

A. General:

1) Premold Joint Filler:

- a. Sufficient in width to completely fill the joint space where shown.
- b. If a water stop is in the joint, cut premold joint filler to butt tightly against the water stop and the side forms.

- 2) Precut premold joint filler to the required depth at locations where joint filler or sealant is to be applied.
- 3) Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material. Entire joint above water stop, in slabs, shall be formed and removed so that entire space down to water stop can be filled with the pourable joint filler.
- 4) Vibrate concrete thoroughly along the joint form to produced a dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

- 1) Drive nails approximately 450 mm on center through the filler, prior to installing, to provide anchorage embedment into the concrete during concrete placement.
- 2) Secure premolded joint filler in forms before concrete is placed.
- 3) Install in walkways, at changes in direction, at intersections, at each side of driveway entrances, and at 15 m intervals, maximum.

C. Pourable Joint Filler:

- 1) General: Install in accordance with the manufacturer's written instructions, except as specified below:
 - a. Apply primer prior to pouring joint filler.
 - b. Fill entire joint above the water stop with joint filler as shown.
 - c. Use masking tape on top of slabs at sides of joints; clean spillage. Remove masking tape afterwards.
- 2) Multicomponent Type for Water Structures: Install in accordance with manufacturer's written instructions.

3.5 Contracting Joint Installation

A. General:

- 1) Place bond breaker above and below stop.
- 2) Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.

3.6 Control Joint Installation

A. Locate galvanized reinforcing as shown.

B. Install PVC water stop.

C. Concrete surfaces shall be dense and smooth.

D. Install bond breaker to concrete surfaces above and below water stop.

3.7 Performed Control Joints

A. Use only where specifically shown; do not use in water-holding basins.

B. Locate flush, or slightly below the top of slab.

C. Install in accordance with manufacturer's written instructions in straight, full-length unspliced pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 Work Included

- A. Poured-in-place concrete foundations, walls and floors for external works.
- B. Prepare concrete base slabs to receive toppings.

1.02 Related Work

- A. Section 03100: Formwork for Concrete.
- B. Section 03200: Concrete Reinforcement.
- C. Section 03370: Concrete Curing.

1.03 Quality Assurance

Perform cast-in-place concrete work in accordance with the Engineer's Instructions.

1.04 Testing Agency

- A. Inspection and testing will be performed by a firm in accordance with Section 01410.
- B. Provide free access to work and cooperate with the appointed firm.
- C. Submit proposed mix design to inspection and the testing firm for review prior to commencement of work.
- D. Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.
- E. Six (6) concrete standard test cubes will be taken for every 60 or less cubic meters of concrete placed.
- F. Six (6) additional test cubes will be taken during either hot or cold weather concreting, and be cured on job site under same conditions as concrete it represents.
- G. One (1) slump test will be taken for each set of test Cube taken.

1.05 Certifying The Batching Plant

- A. The Contractor shall seek the Engineer's approval on the batching plant used for concrete production. Contractor shall provide an access to the plant for the Engineer's personnel and shall assist them to check the batching plant prior to granting the Engineer's approval thereon and regularly thereafter as required by the Engineer's.
- B. Checking shall include without limitations :
 - 1. The integrity of the mixing blade and its compatibility with the profile of the mixing bowl.
 - 2. The weighing accuracy :

Weighing devices shall be examined and its accuracy shall fall within the following tolerances

| | |
|--------------|--|
| Cement + | 2% of the weight of the cement in the batch. |
| Aggregate + | 2% of the weight of each aggregate in the Batch. |
| Water + | 2% of the weight of water added to the batch. |
| Admixtures + | 5% of the amount to be added to the batch. |
 - 3. Calibration of weighing equipment:

Sufficient test weighing shall be kept available on site for checking the accuracy of all scales. The scales shall be checked at the commencement of preliminary concrete tests and checks shall be carried out at intervals as directed by the Engineer but in any case not greater than 2-weeks. The results of these checks shall be recorded and submitted to the Engineer.

All scales shall be inspected and tested over their complete range by a specialist and at least every three months, the results being record and submitted to the Engineer.

With admixture dispensers, a calibrated container shall be provided to check the accuracy of measurement at least once each month.

1.06 Warranty/Guarantee

All warranties/guarantees to be issued by the Supplier, manufacturers and sub-contractors shall be counter-signed by Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

PART 2 PRODUCTS

2.01 Concrete Materials

A. Cement: Furnish from one source.

Cement: Ordinary Portland Cement.

Cement shall comply with the relevant standards.

Cement shall be Portland Type, originating from approved manufacturers, obtained in sealed and labeled bags, each 50 kg net capacity, name and brand of the manufacturer shall plainly be identified thereon and delivered to Site in good condition. Cement delivered in bulk shall be accepted only if a central mixing plant is used. The quality of cement shall conform to the Standard Specification for Portland CEMENT of ASTM Designation: C150 -74 Type I- for use in general concrete construction. All cement shall be stored in suitable waterproof and approved storage sheds, which will protect the cement from dampness. These storage sheds shall be erected in locations approved by the Supervisor. Provisions for storage shall be ample, and the consignment of cement as received shall be separately stored in such a manner as to provide easy access for the identification and inspection of each consignment. Cement shall be used in the order of its delivery to site; new deliveries shall not be used unless the cement from earlier deliveries has been completely used. Stored cement shall meet the test requirements at any time after storage whenever asked at the Contractor's expense.

The Contractor shall keep accurate records of the deliveries of cement and of its use in the work. Copies of these records shall be supplied to the Supervisor in such form as may be required.

The total alkali content shall not be in excess of 0.60 percent by weight of cement when tested in accordance with "Standard Method of Chemical Analysis of Hydraulic Cement ASTM C114-69".

The expansion due to sulphate exposure in fourteen (14) days shall be less than 0.045 percent when tested in accordance with "Standard Method of Test for Potential Expansion of Portland Cement Mortars exposed to Sulphate ASTM C452-68".

The heat of hydration shall not exceed 70 calories per gram and 80 calories per gram at seven (7) days and twenty-eight (28) days respectively when tested in accordance with "Standard Method of Test for Heat Hydration of Portland Cement ASTM C186-68".

The autoclave expansion shall not exceed 0.80 percent, in accordance with "Standard Method of Test for Autoclave Expansion of Portland Cement ASTM C151-68".

The Contractor shall notify the Supervisor of dates of delivery so that there will be sufficient time for sampling the cement, either at the mill or upon delivery.

The provisional acceptance of the cement at the mill shall not deprive the Supervisor of the right to reject on a retest of soundness at the time of delivery of the cement to the Site. Packages of cement varying by 5 percent or more from the specified weight shall be rejected and if the average weight of packages in any consignment, as shown by weighing 50 packages taken at random, is less than that specified, the entire consignment shall be rejected and the Contractor shall remove it forthwith from the Site at his own expense and replace it with cement of satisfactory quality.

Stale cement or cement reclaimed from cleaning bags shall not be used and cement, which for any reason has become partially set, or contains lumps or caked cement, shall be rejected.

B. Aggregate from one source.

1. Fine Aggregate

All fine aggregate for concrete shall conform to Standard Specification for Concrete Aggregates of ASTM Designation: C-33 and also to the detailed requirements given in the following table. It shall not contain harmful materials such as iron pyrites, coal, mica, shale, alkali coated grains, or similar laminated materials such as soft and flaky particles, or any material which may attack the reinforcement, in such a form and in sufficient quantity to affect adversely the strength and durability of the concrete. Fine aggregate passing sieve No. 4 shall not contain any voided shells. Fine aggregates shall be washed thoroughly with demineralized water to ensure compliance with the appropriate requirements and limitations of Specifications. The Contractor shall provide and maintain for that purpose approved sand-washing plant.

Fine aggregates shall be delivered and stored separately on Site in such a manner as to prevent segregation and contamination or the admixture of foreign materials. Aggregate which has become segregated or contaminated with foreign matter during storage or handling will be rejected and shall be removed and replaced with material of acceptable quality at the Contractor's expense. Aggregates of quality and colour selected shall be stored in sufficient quantity to avoid interruption of concerning work at any time.

2.01 Concrete Materials (Cont'd)

| REQUIREMENTS OF FINE AGGREGATES | |
|---|--|
| GRADING SIEVE | PERCENT PASSING |
| 3/8 | 100 |
| No. 4 | 95 - 100 |
| No. 8 | 80 – 100 |
| No. 16 | 50 - 85 |
| No. 30 | 25 - 60 |
| No. 50 | 10 - 30 |
| No. 100 | 2 - 10 |
| No. 200 | 0 - 3 |
| Fineness modulus | 2.50 - 2.15 |
| Organic impurities | The colour shall have an intensity not darker than two-thirds the intensity of the standard colour solution. (Not darker than Plate 2 as determined by the Standard Method of Test for Organic Impurities in Sands for Concrete of ASTM Designation: C-40. |
| Chlorides soluble in dilute Nitric Acid | Not more than 0.10 percent by weight when expressed as sodium chloride (CaCl). |
| Total acid soluble sulphates | Not more than 0.50 percent by weight when expressed as sulphur trioxide (SO ₃). |
| Silt | Not more than 2 percent |
| Mortar strength | Compression ratio not less than 95%. |
| Soundness | Weighted average loss when subjected to 5 cycles of the soundness test using magnesium sulphate, not more than 10%. |

2. Coarse Aggregates

All coarse aggregates for concrete shall conform to Standard Specifications for Concrete Aggregates of ASTM Designation: C-33. Coarse aggregate shall consist of gravel, crushed gravel, or crushed stone, having hard, strong durable pieces, free from adherents. It shall not contain harmful materials such as iron pyrites, coal, mica, alkali, laminated materials, or any material which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the Concrete.

Coarse aggregates shall be delivered and stored separately on Site in such a manner as to prevent segregation and contamination or the admixture of foreign materials. Aggregate which has become segregated or contaminated with foreign matter during storage or handling will be rejected and shall be removed and replaced with material of acceptable quality at the Contractor's expense. Aggregates of the quality and color selected shall be stored in sufficient quantity to avoid interruption of concerning work at any time.

The amount of deleterious substances in coarse aggregates shall not exceed the following limits:

| | Maximum Permissible Limit Percent by Weight |
|--|--|
| Soft fragments | 2.0 |
| Coal and lignite | 0.5 |
| Clay lumps | 0.25 |
| Materials passing the No. 200 sieve | 1.0 |
| Thin or elongated pieces (length greater than 5 times average thickness) | 4.0 |
| Other local deleterious substances | 0.0 |
| Chlorides soluble in dilute Nitric acid when expressed as sodium Chloride (NaCl) | 0.05 |
| Total acid soluble sulphates when expressed as sulphur trioxide (SO ₃) | 0.5 |

The percentage of wear, in coarse aggregate shall not be more than 30 in accordance with Los Angeles test.

When the coarse aggregate is subjected to five alternations of the sodium sulphate soundness test, the weighted loss shall not exceed 10 (ten) percent. In the event of failing to obtain a satisfactory result it shall be subjected to an alternate freezing thawing test.

Coarse aggregate, when tested according to the requirements of ASTM, shall meet the following gradation and shall be uniformly graded within stated limits at following table:

2.01 Concrete Materials (Cont'd)

| GRADING OF COARSE AGGREGATE | | | |
|-----------------------------|---------------------------------------|----------------------|-------------------------|
| ASTM | PERCENTAGE BY WEIGHT PASSING | | |
| | GRADING ($\frac{3}{4}$ " - NO. 4) | GRADING (1"-NO.4) | GRADING (2" - NO. 4) |
| 2½ inch | - | - | 100 |
| 2 inch | - | - | 95-100 |
| 1½ inch | - | 100 | - |
| 1 inch | 100 | 95-100 | 35-70 |
| $\frac{3}{4}$ inch | 95-100 | - | - |
| $\frac{1}{2}$ inch | - | 25-60 | 10-30 |
| 3⁄8 inch | 20-55 | - | - |
| No. 4 | 0-10 | 0-10 | 0-5 |
| No. 8 | 0-5 | 0-5 | - |
| No. 200 | 0-1 | 0-1 | 0-1 |

Approved fine and coarse aggregate in each batch of concrete shall be combined in proportions as approved by the Supervisor, according to test results giving the required compressive concrete stress as specified per type of concrete.

The combined aggregate gradation using the 3/4-inch to No. 4 gradation shall be used for concrete members with reinforcement too close to permit proper placement and consolidation of the concrete. Changes from one gradation to another shall not be made during the progress of the work unless approved by the Supervisor. Such changes are admitted only after being proved by test results.

3. Aggregate for Mortar

Aggregate for mortar shall conform to the Standard Specification for Aggregate for Masonry Mortar of ASTM Designation: C-144 and shall consist of hard, strong, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

Fine aggregate for mortar when subjected to the calorimetric test for organic impurities and producing colour darker than the standard colour shall be rejected.

4. Water

Water for mixing of concrete shall be fresh, clean and free from injurious amounts of oil, acid, or any other deleterious mineral and/or organic matter. It shall not contain chlorides such as sodium chloride in excess of 700 PPM, or sulphates such as sodium sulphate in excess of 500 PPM. It shall not contain any impurities in amount sufficient to cause a change in the time of setting of Portland Cement of more than 10 percent, nor a reduction in compressive strength of mortar of more than 5 percent compared to results obtained with distilled water.

The pH of the water for mixing and curing of concrete shall not be less than pH 4.5 or more than pH 8.5.

When required by the Supervisor the quality of the mixing water shall be determined by the Standard Method of Test for Quality of Water to be used in Concrete, as specified in BS 3148: 1959 Tests for Water for Making Concrete.

In sampling water for testing, care shall be taken to ensure that containers are clean and that samples are representative.

C. Water: Clean and potable containing less than 50 ppm of chlorides.

D. Admixtures: Furnish from one source. The use of admixtures shall be required to provide the mix with workability, impermeability, resistance to shrinkage cracks, etc., as the concrete grade and use may dictate. Comply with Engineer's Instructions.

Other than those prescribed in these specifications, no other admixture will be permitted unless:

1. It has been proven by testing the trial mixes that its addition enhances the concrete strength and durability properties.
2. It has been proven by chemical analysis that it contains no chloride or sulphate compounds.
3. It has been expressly approved by the Engineer.

Following are the basic admixtures required for concrete mixes. Contractor shall include the cost of these admixtures in the price of concrete:

- a. Feb flow LD 10 : Plasticiser for concrete.
- b. Feb proof : Integral liquid waterproof.

Amount per cubic meter of finished concrete shall be in accordance with the Manufacturer's recommendations and instructions, and the Engineer's approval. (FEB products or approved equal)

2.02 Water-Tight Concrete Construction

- A. General: Concrete described as "Water-tight" shall be constructed in accordance with the General Specifications except where modified by the following provisions. The Contractor shall give the necessary care and attention to the work at all stages to obtain a water-tight construction. Concrete which does not satisfy this requirement shall be made water-tight at the Contractor's expense.
- B. Aggregates: Aggregates shall have a low drying shrinkage and shall have an absorption not greater than 3 percent, measured in accordance with Engineer's Instructions.
- C. Workability: The workability of the concrete shall be carefully chosen to ensure that the concrete can be fully compacted in the formwork and around the reinforcement without a water cement ratio, such as will result in a porous concrete. The Contractor shall continuously monitor the workability of the concrete being placed and shall reject anywhere where the deviation from the chosen slump exceeds plus or minus 25 mm. All concrete shall be mechanically vibrated.
- D. Formwork: Formwork ties which pass through any part of the structure shall not be used unless effective precautions are taken to ensure water-tightness after removal. All ties cavities are to be filled with an approved non-shrink cement mortar.
- E. Curing: The concrete shall be cured in accordance with Engineer's Instructions but for not less than 4 days. The Contractor shall also take measures to limit the fluctuations in surface temperature of the concrete.
- F. Joints: Concrete shall be placed continuously between and up to predetermined joints. The surface of the concrete during placing shall be kept reasonably level between vertical joints. In the event of an unavoidable stoppage in positions not predetermined, the concrete shall be terminated on horizontal planes and against vertical surfaces, and the Contractor shall take any additional action required to make a water-tight joint at his own expense.
The locations and details of predetermined joints shall be as shown on the drawings and shall comply with the following :
Kickers are to be cast monolithically with the concrete on which they stand (not less than 150mm high).
Particular care shall be taken to ensure that wall formwork fits tightly on the kicker or lower lift of concrete to prevent loss of grout which could cause porosity of the joint.
- G. Testing: As soon as possible after the structure has been completed and the concrete has achieved its 28 days strength, it shall be tested for water-tightness by filling it with water.

2.03 Light Weight Aggregates

- A. General
All light weight aggregate for concrete shall conform to BS 3797 Part 2 "light weight Aggregates for Concrete".
- B. Grading
Light weight aggregate shall be well and uniformly graded and shall be approved by the Supervising Engineer.
Combined Aggregates
Approved fine and coarse aggregate in each batch of concrete shall be combined in proportion as approved by the Supervising Engineer according to test results giving the required compressive concrete stress as specified per type of concrete.
Special combined aggregate gradation shall be used for concrete members with reinforcement to close to permit proper gradation to another, this shall not be made during the progress of the work unless approved by the Supervising Engineer. Such changes will be admitted only after satisfactory test results.

2.04 Acceptable Suppliers

List of Approved Sub-Contractors/Suppliers:
Out of the Work of sub-contractors and suppliers of material needed for concrete works, the Contractor shall limit his selection to the Sub-Contractors/Suppliers approved by the Engineer.

2.05 Accessories

Non-shrink Grout: premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 17MPa in 2 days and 48 MPa in 28 days.

2.06 Concrete Mixes

- A. Mix Concrete in accordance with the Engineer's Instructions

Concrete mixing shall be made in conformity to the requirements outlined in the foregoing sections for concrete material, on the other sections pertaining to controlling temperature, and on the mixes properties outlined in the following tables.

- B. The following table gives general guidelines on the constituents of different mixes to be produced: Trial mixes to be made by the Contractor, to establish mix design for all the concrete types.

| Concrete Grade | Minimum Cement Content (Kg/M3) | Maximum Size of Aggregates (MM) | Maximum Free Water Cement Ratio | Characteristic Cube Strength <u>MPA</u> | | Slump (MM) | Used in the following: |
|----------------|--------------------------------|---------------------------------|---------------------------------|---|-----------|------------|----------------------------------|
| | | | | At 7days | At 28days | | |
| C15 | 200 | 20 | 0.70 | 10 | 15 | 100-150 | As shown on drawings |
| C20 | 250 | 20 | 0.65 | 13 | 20 | 100-150 | Concrete Backing for stone walls |
| C25 | 300 | 20 | 0.60 | 17 | 25 | 80-120 | As shown on drawings |
| C30 | 350 | 20 | 0.55 | 20 | 35 | 80-120 | As shown on drawings |

- C. Under all circumstances, the use of accelerating admixtures will not be allowed.

- D. Trial Mixes:

1. Immediately upon award of Contract, the Contractor, shall make trial mixes in adequate number of specimens as per the relevant standards and in accordance with the Engineer's Instructions.
2. From the results of tests made on the Specimens, Contractor shall propose the mix design of the concrete grade listed in the tabulation referred to in sub article 2.05-B.
3. Additionally, the Contractor shall perform the trial mixes incorporating the additive.

PART 3 EXECUTION

3.01 Placing Concrete

- A. Preparation: Place concrete in accordance with Engineer's Instructions.

1. General

Prior to pouring concrete in any structure, the Contractor shall secure a written order to commence from the Supervisor.

In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matters shall be removed from the interior of forms, struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall not be permitted unless the authorisation in writing of the Supervisor is obtained. In case an inferior quality of concrete is produced by the use of such conveyors, the Supervisor may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal lined and shall be of rounded cross section to avoid the accumulation of concrete in corners. The chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. The slope shall be steep enough (1 vertical to 2 1/2 horizontal) to permit flow without requiring a slump greater than that specified or required for placement.

All chutes troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than 1.50 meter, it shall be deposited through sheet metal or other approved pipes. As far as practicable the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial setting of concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars that project.

3.01 Placing Concrete (Cont'd)

2. Hot Weather Concreting

The temperature of concrete when placed shall not exceed 27 degree centigrade when the relative humidity is 50 percent or less and shall not exceed 32 degree centigrade when the relative humidity

exceed 70 percent. For values of relative humidity between 50 percent and 70 percent, the maximum temperature of concrete shall be found by interpolation.

In lieu of above, the temperature of concrete when placed shall not exceed 32 degree centigrade, regardless of the relative humidity.

The Contractor shall comply with the above requirements by the following procedures:

- a. Cooling the mixing water and/or replacing 50% of the mixing water by crushed ice. Where crushed ice is used it shall be stored at a temperature that will prevent formation of lumps. The ice shall be completely melted by the time mixing is completed.
- b. Shading aggregate stockpiles and/or keeping moist by sprinkling them with water.
- c. Cement shall not be used if its temperature exceeds 27 degree centigrade.
- d. Painting the mixer drum white and spraying it with cool water or shading the mixer from direct sunrays.
- e. Maintaining the mixing time and the delivery time to the minimum acceptable.
- f. Sprinkling of forms sub-grade and reinforcement with cool water prior to placement of concrete.
Water reducing and retarding admixture shall be used in all concrete work when the temperature of concrete exceeds 27 degree centigrade.
The water cement ratio inclusive of free surface moisture on aggregates and any admixtures shall be kept to a minimum.

3. Vibrating Concrete

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

- a. The vibration shall be internal unless special authorisation of other methods is given by the Supervisor or as provided herein.
- b. The Supervisor shall of a type and design approve vibrators. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.
- c. The intensity of vibration shall be such as to visibly affect a mass of concrete of 25-mm slump over a radius of at least 500-mm.
- d. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms.
- e. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures, and into the corners and angles of the forms.
- f. Only experienced operators under close supervision, at the point of deposit and in the area of freshly deposited concrete shall apply vibration. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any point to the extent that localized areas of grout are formed.
- g. Application of vibration shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.
- h. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
- i. Vibrator shall be supplemented by such spading as is necessary to insure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.
- j. The use of implements such as compressors that are likely to disturb or disarrange reinforcement or formwork shall not be permitted.
- k. Concrete shall be placed in horizontal layers not more than 300 mm thick except as hereinafter provided, when less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with preceding layer that has taken initial set.
- l. When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of Latinate and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible points as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.

3.01 Placing Concrete (Cont'd)

- m. Immediately following an approved discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement bars and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are removed prior to the concrete becoming set, care shall be exercised not

- to injure or break the concrete-steel bond at and near the surface of the concrete, while cleaning the reinforcement bars.
- B. Maintain records of poured concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, are not disturbed during concrete placement.
- D. Prepare previously placed concrete by cleaning with steel brush.
- E. Pour concrete continuously between predetermined construction and control joints.
- F. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- G. Maintain concrete cover to reinforcement as noted on structural drawings.
- H. Maximum size of concrete placements: Where expansion joints, contraction joints, or control joints are not shown or where expansion joints or control joints are spaced at more than 18 metres, or where wall expansion or control joints are spaced more than 6 metres from wall corners or intersections, provide intermediate construction joint at maximum spacing of 12 metres with a maximum distance from a wall corner of 6 metres.
- I. Minimum time between adjacent placements:
 1. Construction Joints: 14 days (7 days wet cure and 7 days dry cure).
 2. Control Joints: 6 days.
 3. Expansion Joints: 1 day.
 4. At least 2 hours shall elapse after depositing concrete in long columns and walls thicker than 200 mm before depositing concrete in beams, girders, or slabs supported thereon.
 5. For columns and walls, 3 metres in heights or less, wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.
- J. Concrete Bonding: To old Concrete:
 1. Mechanically roughen existing concrete surfaces to a clean, rough surface to remove existing concrete surface, and provide a minimum roughness profile of 6 mm.
 2. Saturate surface with water for 24 hours prior to adding new.

3.02 Construction Joints

As specified in Section 03251, EXPANSION, CONTRACTION, CONSTRUCTION AND CONTROL JOINTS.

3.03 Blinding Concrete

Thickness shall be as shown on the drawings. Blinding concrete shall be used under all structural ground floor slabs, grade beams and reinforced concrete footings.

3.04 Patching

Allow the Engineer to inspect concrete surfaces immediately upon removal of forms. Patch imperfections as directed.

3.05 Repairing Concrete

- A. General:
 1. Prior to starting the repairing work, obtain quantities of repair material and manufacturer's detailed instructions for use to provide a repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
 2. Develop repair techniques with material manufacturer on mockup panels prior to starting actual repair work, and show how finish color will blend with adjacent surfaces, obtain approval from ENGINEER.
 3. Repair of concrete shall provide a structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to ENGINEER.
- B. Defective Concrete (Areas): Surface defects that include honeycomb, rock pockets, indentations, cracks 0.125 mm wide and larger, and cracks that leak in water-holding basins, spalls, chips, air bubbles, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.
- C. Modify or replace concrete not conforming to required lines, details and elevations.
- D. Repair or replace concrete not properly placed resulting in excessive honeycombing and other defects. Do not patch, fill, touch-up, repair, or replace exposed architectural concrete except upon express direction of Engineer for each individual area.

3.05 Repairing Concrete (Cont'd)

- E. Remove:
 1. Remove defective concrete to a depth of sound concrete.

2. Small shallow holes caused by air entrapment at surface of forms shall not be considered defective unless amount is so great as to be considered not the standard of the industry.
3. If chipping is required, make edges perpendicular to surface with minimum of 12 mm in depth. Do not feather edges. Obtain ENGINEER's approval of chipping work.
4. Patch defective area to match appearance of adjacent concrete surfaces after cracks are fill.

3.06 Concrete Finishing

Provide concrete surfaces to be left exposed as directed and in accordance with the Engineer's Instructions.

3.07 Curing And Protection

Beginning immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete. As specified in Section 03370, CONCRETE CURING.

END OF SECTION

SECTION 03346
CONCRETE FLOOR FINISHING

PART 1 GENERAL

1.01 Section Includes

Finishing to concrete floor slabs with cement screed.

1.02 Submittals

Product Data Provide data on cold rolled wire mesh..

1.03 Maintenance Data

Maintenance Data Provide data on maintenance operations.

1.04 Quality Assurance

- A. Perform Work in accordance with the Engineer's instructions and recommendations.
- B. Maintain 2 copies of each document on Site.
- C. Floor Finishers
 - Bonded concrete screed with cold rolled continuous wire mesh reinforcement (where required).

1.05 Mockup

- A. Provide mockup of floor finish as instructed by the Engineer's.
- B. Construct mockup area under conditions similar to those which will exist during actual placing, not more than (5 m x 5 m) with coatings applied.
- C. Mockup may remain as part of the Work.

1.06 Delivery, Storage, And Handling

- A. Deliver, store, protect, and handle products to site in strict accordance with the Manufacturer's written instructions.
- B. Deliver materials in manufacturer's packaging including application instructions.

1.07 Environmental Requirements

Temporary lighting, heating and ventilation shall be in strict accordance with manufacturer's instructions and recommendations.

PART 2 EXECUTION

2.01 Examination

Verify that floor surfaces are acceptable to receive the work of this section.

2.02 Preparation

- A. Clean sub-floor down to a hard base with a rotating wire brush to remove concrete laitance.
- B. Remove thicker patches of crumbling concrete by means of a hammer and cold chisel, or with a suitable motor equipment.
- C. Completely remove from site loosened materials, debris etc. by sweeping and vacuum cleaner.
- D. Wash the Concrete sub-floor by hosing the floor with liberal amounts of water, to provide a reliable key for the screed topping.

2.03 Mixing

- A. The mortar is generally made up in accordance with the following formulations, the Engineer's instructions and recommendations should be strictly adhered to:-
 - 10 parts by weight ordinary Portland cement.
 - 20 parts by weight basalt sand 0 - 3 mm grain size.
 - 40 parts by weight chippings of basalt quartz or some other hard stone or gravel 5 - 7 mm grain size.
 - 0 - 1 part by weight water, depending on the moisture in the sand.
- B. Minimum cement content shall be 300 kg/m³ and the compressive strength shall be 25MPa after 28 days.
- C. Contractor shall use super plasticizer as approved by the Engineer's.
- D. The Mortar shall be mixed on site.

2.04 Laying

- A. Prepare adequate forms to meet the Engineer's approval and in accordance with the Engineer's recommendations and instructions.
- B. Prime the cleaned sub-floor with a mixture of bonding agent and water in the ratio of 1:4 apply with a brush type (S.B.R.)
- C. Set the forms to the required thickness of 50mm, taking into consideration slopes, falls and crossfalls.
- D. Lay cold rolled continuous wire mesh, covered with 25 mm of cement screed.
- E. Observe expansion joint 6/10mm and follow through into the screed the joints shall be filled with the polysulphide material as instructed by the Engineer's.
- F. Lay the concrete screed between the forms alternately and spread with a rake, and draw-off surplus mortar.
- G. Lay an approved aluminum tamper across the forms at an oblique angle, not at right angle. Remove surplus mortar by moving the tamper to and fro with a sawing action. While this is being done, a ridge of mortar about 3cm thick should be maintained along the front edge of the tamper in the customary manner. Wood tampers are not allowed.
- H. All mixtures should be used up within one hour. Mixtures aging more than one hour should be discarded, and a fresh mixture used to finish the Job.
- I. Spread the quartz material over the surface before the screed dry type (master top 100) as manufactured by FEB or approved equal color as selected by the Engineer's, then trowel the screed mechanically.
- J. Ramp areas top surfaces shall have rough texture epoxy finish as approved by the Engineer's, the other areas shall have trowel smooth top surface with a machine.
- K. Sprinkle over the surface water with a brush. The mixture has to be stirred carefully whilst being made up and then at frequent intervals when being applied in order to prevent spotting, which occurs if water is sprinkled over the mortar.
- L. If the smoothing is carried out by hand, knee boards must be used. Should the smoothing be carried out with a machine, boards or sheets of hardboard should be employed in order to prevent foot marks.

2.05 Curing

- A. Avoid draughts and direct sun light.
- B. Cover the screed with overlapping 20 millimetre thick polyethylene film and spray with water.
- C. Leave the polyethylene film in position for 8 days.
- D. Avoid water to come in contact with the freshly laid screed.
- E. Foot traffic over the laid screed is possible after only 3 days, but the floor should not be subjected to maximum loads for one week. These periods should be appropriately extended if temperatures are low and/or humidity is high.

2.06 Tolerances

- A. Maximum Variation of surfaces flatness for the screened areas 3mm in 3 meters.
- B. Correct defects in the floor by grinding or removal and replacement of the defective work.

2.07 Warranty

- A. provide written warranties in the name of the Employer.
- B. Warranty shall provide for making good within a period of five (5) years, at no cost to the Employer; repair and make good screening and pay for repair or replace all affected or damaged surfaces at no cost to the Employer.

END OF SECTION

SECTION 03370
CONCRETE CURING

PART 1 GENERAL

1.01 Work Included

- A. Initial and final curing.
- B. Curing materials.

1.02 Related Work

- A. Section 03100: Form work.
- B. Section 03300: Cast-in-Place Concrete.

PART 2 PRODUCTS

2.01 Materials

- A. Water: Potable
- B. Absorptive Mats Burlap: cloth made of JUTE or KENAF minimum weight 0.29 Kg/m².
- C. Membrane Curing Compound: acrylic or chlorinated rubber type, pigmented.
- D. Polyethylene Film: 0.1-mm thick, clear color.

PART 3 EXECUTION

- 3.01** Curing water should be of a temperature compatible with concrete temperature and not more than 11 degree C cooler than concrete surface.

3.02 Curing of Concrete

- A. Use one of the following methods as approved by ENGINEER:
 - 1. Walls:
 - a. General: Where walls are to receive coatings, painting, cementitious material, or other similar finishes, or where solvent-based coatings are not permitted, use only water curing procedures.
 - b. Method (1): Leave concrete forms in place and keep entire surfaces of forms and concrete wet for 7 days.
 - c. Method (2): Apply curing compound, where allowed, immediately after removal of forms.
 - d. Method (3): Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
 - 2. Slabs and Curbs:
 - a. Method (1): Pounding
Maintain 100% coverage of water over slabs continuously for 7 days, starting immediately after removal of forms.
 - b. Method (2): Spraying
Spray water over slabs and maintain wet for 7 days.
 - c. Method (3): Absorptive Mat
Saturate burlap and place over exposed areas, lapping ends and sides minimum 50% over lap, and maintain in place saturated for 7 days.
 - d. Method (4): Membrane Curing Compound
Apply curing compound in strict accordance with manufacturer's instructions.
 - e. Other agreed upon method that will keep moisture present and uniform at all times on surface of slabs. Do not use curing compounds.
 - f. Where water curing for slabs during cold weather is not possible, use and ENGINEER-approved curing compound at manufacturer's recommended coverage per gallon.
 - g. Where curing compound cannot be used, special methods using moisture shall be agreed upon prior to placing the concrete slabs.
 - h. Protect slabs during cold weather with plastic sheets or other material inside required heated enclosure if foot traffic is permitted on slabs.

3.03 Manufacturer's Services

Provide manufacturer's representative at site for installation assistance, inspections, and certification of proper installation for products specified.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 References

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Society for Testing and Materials (ASTM):
 - a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - b. C1018, Standard Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading) .
 - c. C1107, Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).
 - d. C1116, Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
 - e. D4580, Measuring Delaminations in Concrete Bridge Decks by Sounding, Practice for.
 - 2. Corps of Engineer (COE):
 - a. CRD-C611, Flow of Grout for Preplaced Aggregate Concrete.
 - b. CRD-C621, Specification for Nonshrink Grout.

1.02 Submittals

- A. Shop Drawings:
 - 1. Product data of grouts.
 - 2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
 - 3. Forming method for fluid grout placements.
 - 4. Curing method for grout.
- B. Quality Control Submittals:
 - 1. Manufacturer's Written Instructions:
 - a. Adding fiber reinforcing to batching.
 - b. Cement-water ratio of grout topping.
 - c. Mixing of grout.
 - 2. Manufacturer's proposed training schedule for grout work.
 - 3. Manufacturer's Certificate of Compliance.
 - a. Grout free from chlorides and other corrosion-causing chemicals.
 - b. Nonshrink grout properties of Categories II and III, verifying expansion at 3 or 14 days will not exceed the 28 day expansion and nonshrink properties are not based on gas or gypsum expansion.
 - 4. Manufacturer's Certificate of Proper Installation.
 - 5. Statements of Qualification: grout manufacturer's representative.
 - 6. Test Reports:
 - a. Test report for 24-hour evaluation of nonshrink grout. Independent testing laboratory to certify that testing was conducted within the past 18 months.
 - b. Test results and service report from the demonstration and training session, and from field tests.
 - c. Field test reports and laboratory test results for field-drawn samples.

1.03 Qualifications

- A. Nonshrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1 year experience that has resulted in successful installation of grouts similar to those for this Project.

1.04 Guarantee

- A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.
- B. Manufacturer guarantees participation with CONTRACTOR in replacing or repairing grout found defective due to faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.01 Nonshrink Grout Schedule

- A. Furnish nonshrink grout for applications in grout category in the following schedule:

| Application | Temperature Range | Max. Placing Time | |
|---|-------------------|-------------------|---------------------|
| | 5 to 38 deg C | 20 min. | Greater than 20 min |
| Filling tie holes | I | I | I |
| Blockouts for gate guides | I or II | | II |
| Precast joints | I or II | | II |
| Column baseplates single-story | I or II | | II |
| Machine bases 25 hp or less | II | II | II |
| Bases for precast wall sections | II | II | II |
| Baseplates for columns over one story | II | II | II |
| Precast base joints higher than one story | II | II | II |
| Through-bolt openings | II | II | II |
| Patching concrete walls | II | II | II |
| Machine bases 26 hp and up | III | III | III |
| Baseplates and/ or soleplates with vibration, thermal movements, etc. | III | III | III |

2.02 Nonshrink Grout

- A. Category I:
- Nonmetallic and nongas-liberating flowable fluid.
 - Prepackaged natural aggregate grout requiring only the addition of water.
 - Test in accordance with ASTM C1107:
 - Flowable consistency 140 percent, five drops in 30 seconds, in accordance with ASTM C230.
 - Flowable for 15 minutes.
 - Grout shall not bleed at maximum allowed water.
 - Minimum strength of grout, 20 Mpa at 3 days, 35 Mpa at 7 days, and 48 Mpa at 28 days.
 - Manufacturers and Products:
 - Master Builders Co., Cleveland, OH; SET GROUT.
 - Euclid Chemical Co., Cleveland, OH; NS Grout.
 - Dayton Superior Corp., Miamisburg, OH; Sure-Grip High Performance Grout.
- B. Category II:
- Nonmetallic, nongas-liberating flowable fluid.
 - Prepackaged natural aggregate grout requiring only the addition of water.
 - Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
 - Test in accordance with COE CRD-C621 and ASTM C1107, Grade B:
 - Fluid consistency 20 to 30 seconds in accordance with COE CRD-C611.
 - Temperatures of 5, 27, and 38 degrees C.
 - 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 - Minimum strength of grout, 17 Kpa at 1 day, 31 Kpa at 3 days, and 48 Kpa at 28 days.
 - Maintain fluid consistency when mixed in 1 to 6 metre loads in ready-mix truck.
 - Manufacturers and Products:
 - Master Builders Co., Cleveland, OH; Master Flow 928.
 - Five Star Products Inc., Fairfield, CT; Five Star 100.
 - Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
- C. Category III:
- Metallic and nongas-liberating flowable fluid.
 - Prepackaged aggregate grout requiring only the addition of water.

3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with COE CRD-C621 and ASTM C1007, Grade B:
 - a. Fluid consistency 20 to 30 seconds in accordance with COE CRD-C611.
 - b. Temperatures of 5 and 38 degrees C.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of grout, 28 Kpa at 1 day, 35 Kpa at 3 days, and 62 Kpa at 28 days.
7. Maintain fluid consistency when mixed in 1 to meter loads in ready-mix truck.
8. Manufacturers and products: Master Builders Co., Cleveland, OH; EMBECO 885.

PART 3 EXECUTION

3.01 Nonshrink Grout

- A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative training instructions.
- B. Form Tie or Through-Bolt Holes: Provide nonshrink grout, Category I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes, coordinate dry pack dense grout application with vinyl plug in Section 03100, CONCRETE FORMWORK and bonding agent in Section 03300, CAST-IN-PLACE CONCRETE.
- C. Grouting Machinery Foundations:
 1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
 2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
 3. Form with watertight forms at least 50 mm higher than bottom of plate.
 4. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative training instructions.

3.02 Field Quality Control

- A. Evaluation and Acceptance of Nonshrink Grout:
 1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
 2. Perform flow cone and bleed tests, and make three 50mm by 50mm cubes for each 25 cubic feet of each type of nonshrink grout used. Restraining caps for cube molds in accordance with COE CRD-C621.
 3. For large grout applications make three more cubes, one more flow cone test, including bleed test for each additional 0.75 cubic meters of nonshrink grout placed.
 4. Consistency: As specified in Article NONSHRINK GROUTS. Reject grout with consistencies outside range requirements.
 5. Segregation: As specified in Article NONSHRINK GROUTS. Reject grout when aggregate separates.
 6. Nonshrink grout cubes shall test equal to or greater than minimum strength.
 7. Strength Test Failures: Reject nonshrink grout work failing strength tests, remove and replace grout.
 8. Perform bleeding test to demonstrate grout will not bleed.
 9. Store cubes at 70 degrees C.
 10. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with COE CRD-C621.

3.03 Manufacturer's Services

- A. General:
 1. Coordinate demonstrations, training sessions, and applicable site visits with grout manufacturer's representative.
 2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of nonshrink grout.
 3. Coordinate necessary equipment and materials are available for demonstration.

END OF SECTION

SECTION 04100
MORTAR

PART 1 GENERAL

1.01 Work Included

- A. Mortar for concrete masonry units.
- B. Mortar for natural stone floor tiling.
- C. Mortar for natural marble works and tiling.

1.02 Related Work

- A. Section 04220 Concrete Masonry Unit.
- B. Section 04450 Natural Stone.
- C. Section 04455 Natural Marble.

1.03 Quality Assurance

Perform work in accordance with requirements of Engineer's instructions.

1.04 Reference Standards

- A. BS 12 - Ordinary Portland Cement.
- B. BS 5224 - Masonry Cement.
- C. BS 890 - Building limes.
- D. BS 882 - Aggregates from natural sources for concrete.
- E. BS 4551 - Methods of testing mortars.
- F. BS 4721 - Specification for ready-mixed building mortars.

1.05 Testing

- A. Testing of mortar mix(es) will be performed by a firm appointed and paid for by the Contractor, in accordance with Section 01410.
- B. Provide free access to all portions of work and cooperate with appointed firm.
- C. Submit proposed mortar mix design to testing firm for approval prior to commencement of work.
- D. Tests of mortar mix(es) will be performed to ensure conformance with requirements stated herein and to ensure mortar will not produce efflorescence.
- E. If mortar mix(es) do not conform with requirements stated herein, re-establish and re-submit for further testing. Pay costs for required re-testing.

1.06 Submittals

Submit manufacturer's recommendations and product data in accordance with Section 01340.

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 the Engineer's Instructions.

2.02 Mortar Materials

- A. Portland Cement BS12 Ordinary Portland Cement; gray color.
- B. Masonry Cement BS 5224 for general use.
- C. Aggregates standard masonry type, BS 882, clean, dry and protected against dampness, freezing and foreign matter.
- D. Water clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.

2.03 Admixtures

Plasticizer water reducing type which reduces porosity and absorption to increase bond strength; as approved by the Engineer.

PART 3 EXECUTION

3.01 Mixing Mortar

- A. Thoroughly mix mortar ingredients, in quantities needed for immediate use.
- B. Add mortar color and admixtures in accordance with manufacturer's recommendations. Ensure uniformity of mix and coloration.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. Use mortar within two hours of mixing at temperatures over (26 deg. C), and two and one half hours at temperatures under 10 degrees C.
- E. If necessary, re-temper mortar within two hours of mixing to replace water lost by evaporation. Do not re-temper mortar after two hours of mixing.

END OF SECTION

SECTION 04220
CONCRETE MASONRY UNIT

PART 1 GENERAL

1.01 Work Included

- A. Concrete masonry unit walls; back-up for cavity walls, and interior partitions, complete with reinforcement and anchorage's.
- B. Concrete Lintels.
- C. Form control joints.
- D. Build-in items supplied by other Sections.
- E. Cut and fit for other sections of work.

1.02 Related Work

Section 04100: Mortar

1.03 Quality Assurance

- A. Perform concrete masonry unit work in accordance with Engineer's Instructions.
- B. When requested by the Engineer, provide evidence and test data confirming that concrete masonry units conform to standards stated herein.

1.04 Environmental Requirements

- A. Maintain materials and surrounding air temperature to minimum (10 deg. C) prior to, during and 48 hours after completion of masonry work.
- B. During freezing or near freezing weather, provide adequate equipment or cover to maintain a minimum temperature of (10 deg. C) and to protect masonry work completed or in progress

1.05 Protection

- A. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.
- B. Keep expansion joint voids clear of mortar.
- C. Provide temporary bracing during erection of masonry work. Maintain in place until building structure provides permanent bracing.

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 Masonry Units

- A. Concrete blocks shall be hard, sound, durable, sharp, rectangular shape, clean with well define arises free from racks and flaws or other defects.
- B. Concrete blocks shall be obtained form an approved local factory. Proportion of mix for a solid block is (1:3:6) and for hollow blocks is (1:2.5:5).
- C. Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as to produce homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than five (5) standard bags (each weighing 50 kgs) per cubic meter of concrete.
- D. Concrete Block: modular size(s) complete with corners, bases, bond beams, lintels and fillers to match and compliment block units, standard weight.
- E. Hollow concrete blocks shall comply with the following requirements: -
 - 1. Compressive Strength at Twenty-Eight (28) Days Over Cross-Sectional Area: -
 - a. Load-Bearing Walls
 - 70 kgs/cm² average of 12 blocks
 - 60 kgs/cm² minimum for any block
 - b. Non-Load-Bearing Walls and Slabs
 - 35 kgs/cm² average of 12 blocks
 - 30 kgs/cm² minimum for any block
 - 2. Water Absorption 20% or less of dry weight

2.02 Masonry Units (Cont'd)

3. The design of cavities and webs of the hollow concrete blocks shall be submitted to the Supervisor prior to manufacture. The thickness of the face shell and of the membrane of solid portions shall be nowhere less than forty (40 mm). The combined thickness of the solid portions shall be not less than one fourth (1/4) of the width and length of the block.

F. Testing

1. Blocks shall be tested for density and compressive strength whenever required by the Supervisor. For each test the Supervisor shall select 10 blocks. The blocks selected shall be immersed in water for 24 hours before compressive testing and shall not absorb more than 15% of their own weight of water during this period.
2. Should a test not meet these requirements the batch of blocks from which the samples were taken shall not be used in the Works and shall be removed from the site.

2.03 Reinforcement And Anchorage's

- A. Reinforcing Steel for Bond Beams Lintels and piers type as indicated by the Engineer and as specified.
- B. Cavity Wall Horizontal Reinforcing: ladder type without moisture drip; galvanized steel construction; (5 mm) side rods with 5mm cross ties at 400 mm centers as approved by the Engineer.
- C. Anchors: Contractor to submit details for approval before start working.
- D. Wall Ties: Contractor to submit details for approval before start working.

2.04 Concrete

- A. Bond Beams Lintels and Piers 25 MPa concrete at 28 days, 100mm slump.
- B. Cement: Ordinary Portland cement gray color.
- C. Coarse Aggregate: maximum (10 mm) size; 25% percent by volume.
- D. Fine Aggregate: minimum .02mm size; 75% percent by volume.

2.05 Accessories

- A. Control Joints: preformed neoprene material; as approved by the Engineer.
- B. Joint Filler: closed cell polyethylene oversized 50%; self expanding; (25mm) wide x maximum lengths; as approved by the Engineer.

PART 3 EXECUTION

3.01 Preparation

- A. Supply metals anchors for placement. Provide in sufficient quantity, and direct their correct placement.
- B. Ensure items built-in by other trades for this work is properly located and sized.
- C. Establish all lines, levels and coursing. Protect from disturbance.

3.02 Workmanship And Installation

- A. Place concrete blocks in accordance with lines and levels indicated on drawings.
- B. Fully bond external and internal corners and intersections.
- C. Buttering corners of joints, deep or excessive furrowing of mortar joints is not permitted.
- D. Do not shift or tap masonry units after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- E. Perform job site cutting with proper power tools to provide straight and true, unshipped edges.
- F. Where non-bearing partitions extend to underside of floor, roof deck or structural system, stop masonry short 10 mm to 13 mm to allow for live load deflection. Fill gap with joint filler. Provide structural anchorage in accordance with General Specifications
- G. Ensure masonry courses are of uniform height. Make vertical and horizontal joints equal and of uniform thickness.
- H. All blocks shall be well buttered with mortar before being laid and properly jointed with other work. All joints shall be in uniform manner and shall not be less than 6 mm and shall not exceed 15mm, no one portion being raised more than 1.00 m above another at one time, and wall of partition necessarily left at different levels, must be racked back.
- I. Remove excess mortar and projections. Take care to prevent breaking block corners.
- J. Lay concrete unit masonry in common bond. Course one(1) block unit and one (1) mortar joint to equal 200 mm.
- K. Form concave mortar joints.
- L. Cut mortar joints flush where damp proofing and waterproofing is scheduled.

- M. All walls and partitions shall be properly cured by sprinkling water for a period not less than three (3) days after completion of laying the course.

3.03 Tolerances

- A. Maximum variation from masonry unit to adjacent masonry unit to be (1 mm).
- B. Maintain flush face on interior masonry surfaces.

3.04 Reinforcement And Anchorage's

- A. Place masonry reinforcing and anchorage's for concrete unit masonry as follows:
 - 1. Provide cavity walls with horizontal masonry reinforcing in every second block joint.
 - 2. Place horizontal masonry reinforcing in first and second joints above and below openings. Place continuous in first and second joint below top of walls.
 - 3. Fully reinforce corners and intersections.
 - 4. Lap masonry reinforcing splices minimum 150mm. Extend minimum 400 mm each side of openings.

3.05 Lintels

- A. Provide reinforced masonry lintels over openings, where steel lintels are not scheduled.
- B. Construct lintels, using concrete and reinforcement specified. Maintain minimum 200 mm bearing on each side of opening. Contractor to submit details for approval.
- C. Use reinforcing bars of full lengths only.
- D. Place and consolidate concrete without disturbing reinforcement.
- E. Allow lintels to reach maximum strength before removing temporary supports.
- F. Unless otherwise shown on the drawings, the lintels shall be reinforced as follows:
 - 2 Nos. 14mm diameter bottom bars.
 - 2 Nos. 10mm diameter top bars.
 - Stirrups, 6mm diameter at 200mm spacing.

3.06 Bond Beams

- A. Reinforce with 2 Nos. 12mm diameter top and bottom bars, and stirrups, 8mm diameter at 200mm spacing Lap splices 55 bars diameters.
- B. Place and consolidate concrete without disturbing reinforcement.

3.07 Control Joints

Do not continue horizontal masonry reinforcing across control joints.

3.08 Built-in Work

- A. As work progresses, build-in nailing strips, anchor bolts, plates, and other items supplied by other trades.
- B. Build-in items plumb and true.
- C. Bed anchors of timber and metal door frames in mortar joints. Fill masonry cores with grout minimum 300 mm from framed openings.
- D. Do not build-in organic materials which will be subjected to rot or deterioration.

3.09 Cutting And Fitting

- A. Cut and fit for chases, pipes, conduit sleeves and grounding. Cooperate fully with other sections of work to ensure correct size, shape and location.
- B. Obtain the Engineer's approval prior to cutting or fitting any area which is not indicated on drawings, or which may impair appearance or strength of masonry work.

3.10 Cleaning

- A. Remove excess mortar and smears upon completion of masonry work.
- B. Point or replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces using a non-acidic solution, which will not harm masonry or adjacent materials. Use non-metallic tools in cleaning operations.
- D. Leave surfaces designated to receive plaster, clean and ready to receive plaster work.

END OF SECTION

SECTION 04450
NATURAL STONE WORK

PART 1 GENERAL

1.01 Work Included

- A. Natural stone for exterior and interior walls.
- B. Mortar and joint grouting.
- C. Joint sealant.

1.02 Related Work

Section 03300 Cast-in-place concrete.

1.03 References

ASTM A36 Structural Steel.

1.04 Submittals

- A. General:
Refer to Section 01340 - Shop Drawings, Product Data and Samples, for submittals provisions and procedures.
- B. Shop Drawings And Product Data:
 - 1. Submit shop drawings and product in accordance with Section 01340. Shop drawings shall clearly indicate expansion joints dimensions and locations.
 - 2. Indicate pertinent dimensioning, layout, construction details, method of installation and adjacent construction.
 - 3. Indicate all units of stone, i.e. sills, lintels, copings, etc.
 - 4. Submit stone field erection drawings.
 - 5. Submit manufacturer's instructions for use of pointing color and admixtures.
- C. Design Calculations:
Submit 2 copies of stone design calculations with The Engineer's Instructions.
- D. Samples:
 - 1. Submit two sets of each type of stone, full size units as selected by the Engineer to the project site, in sufficient number to indicate the full range of color, texture and each type of finish. One of each of the duplicate samples approved by the Engineer will be retained by him at the project site, the other being returned to the stone supplier for his guidance. Colors and types of stone-dressings are as mentioned under Part 2 - Products, paragraph B, "Stone Schedule".
 - 2. The following physical data on all proposed stone shall be submitted by the Supplier:
 - a. Analysis of mineral composition.
 - b. Analysis of chemical composition.
 - c. Thermal sufficient of expansion.
 - d. Absorption
 - e. Specific Gravity.
 - f. Modulus of Rupture
 - g. Abrasion Resistance.
 - 3. Submit samples of other materials specified herein upon request by the Engineer.
- E. Mock Up:
 - 1. Furnish and install a typical stone wall, application required for the project at area designated by the Engineer. The panel shall be constructed for Engineer's approval showing 2.0m long x 1.5m high for wall installation. Wall installation shall include a corner condition indicating a jamb, sill, lintel and coping stones, etc., as shall be instructed by the Engineer.
 - 2. All work shall include setting and jointing of all stone including final cleaning as specified herein for the actual work and as required for approval. Construct as many mock-ups until approval by the Engineer has been obtained.
 - 3. The approved mock-up shall constitute the quality of work to be expected throughout the entire project, and shall remain in place for visual inspection until no longer needed as directed by the Engineer. The removal and disposition of the mock-ups shall be done by the Contractor at his expense without additional cost to the Employer.

1.05 Guarantee/Warranty

- A. Attention is directed to the provisions of the CONDITIONS OF THE CONTRACT regarding guarantees/warranties for the Work.
- B. All warranties/guarantees to be issued by the Supplier, Manufacturers and sub-contractors shall be counter-signed by Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

1.06 Standards

Applicable provisions of the following standard publications shall apply throughout the work:

- A. American Welding Society (AWS): AWS D1.1 Structural Welding Code.
- B. Industrial Fasteners Institute (IFI): Handbook of Bolt, Nut and Rivet Standards.

1.07 References

National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Engineer.

1.08 Qualifications

- A. Supplier/Fabricator: A firm having an adequate supply of the specified type of stone and an annual rated production capacity to deliver the stone to the project site on schedule within a time limit established by the Engineer, as required, to assure no delay in the progress and completion of the Work.
- B. Installer: A qualified stone layer with a minimum of five years successful experience in the erection of stone work.

1.09 Design Criteria

The method of erecting, installing and anchoring of all stone work shown on the Drawings is diagrammatic only, and is not to be used for the purpose of bidding or construction. It shall be the responsibility of the Contractor to design and guarantee the watertight sealing of all stone work. The installation shall be designed to allow for expansion, contraction and differential deflection of supporting floors of the building structure.

1.10 Delivery, Storage & Handling

- A. PACKING AND LOADING: Finished stone shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discolouration shall be used for blocking or packing.
- B. SITE STORAGE: Upon receipt at the building site or storage yard, the stone shall be stacked on timber or platforms at least 100mm above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering. Salt shall not be used for melting of ice formed on pieces, or for any purpose involving its contact with the stone.
- C. DEFECTIVE STONE: Any piece of stone showing flaws, cracks, or imperfections such as vents, sand and clay holes, Shelly bars, shakes, mottle, seams or starts upon receipt at the storage yard, or at the building site, shall be discarded and removed from the work site, and at the contractor's own expense.

1.11 Environmental Requirements

The following environmental requirements are applicable to stone set in mortar, and when caulking stone joints with sealant.

- A. During freezing or near freezing weather provide equipment and cover to maintain a minimum of 4 degrees C and to protect stone work completed or in progress.
- B. At end of working day, or during rainy weather, cover stone work exposed to weather with waterproof coverings, securely anchored.
- C. Maintain materials and surrounding air to a minimum 10 degrees C prior to, during and 48 hours after completion of work.

PART 2 PRODUCTS

2.01 Stone Materials and Fabrication

- A. General:
 - 1. Stone shall be of good quality (Grade A Stone), sound, free from cracks and defects, seams or starts which may impair its structural integrity, durability, appearance or function. Colour, texture and finish shall be within the range of samples approved by the Engineer.

2.01 Stone Materials and Fabrication (Cont'd)

2. All stone shall be obtained from quarries having adequate capacity and facility to meet the specified requirements. Cutting and finishing shall be performed by using approved equipment to process the material promptly on order and in strict accordance with the specifications. Evidence to this effect shall be provided by the contractor's.
 3. Stone rejected for noncompliance with the submitted samples or the requirements of this Specification shall be replaced with material acceptable to the Engineer. Replacement shall be prompt and at the Contractor's own expense. Inspection of stone by the Engineer shall not relieve the Contractor of his responsibilities to perform all work in accordance with the Contract Documents.
- B. Stone Schedule:
- Refer to the Drawings for locations, sizes and thickness of the various types of stone specified herein. All stone work shall be carried out and executed in accordance with the classifications of Class "Special" refer to clause 1.06, item A/1.Stone_Type Application/Thickness/Finish
1. First quality (local type) - Application: Exterior (cladding) with stainless steel anchors, brackets, anchors, bolts, shelves, angles and all needed fixing materials.

| | |
|--------------------|-----------------------|
| Thickness: | As shown on drawings |
| Height of courses: | As shown on drawings. |
| Finish: | As shown on drawings. |
 2. First quality (local type) - Application: Exterior (composite) with all necessary concrete backing.

| | |
|--------------------|--|
| Thickness: | As noted on the relevant details/drawings. |
| Height of courses: | As shown on drawings. |
| Finish: | As shown on drawings |
- C. Finish:
1. The finish, of exposed to view surfaces of stone, shall be as specified above. The concealed from view surfaces of all stone types shall be sawn, hacked and/or roughened to allow key for the backing mortar/concrete, all as more particularly instructed by the Engineer.
 2. End match the texture in the face of stone elements that abut one another to assure continuity in surface appearance.
- D. Stone Fabrication - General:
1. Fabrication of stone shall be in strict accordance with approved shop drawings for fabrication, and with this specification.
 2. To the maximum extent possible, fabrication and assembly of stone shall be executed in the shop. Work that is not shop assembled shall be shop fitted.
 3. All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All materials and workmanship shall conform to the highest industry standards, including the BSI Recommended Practices for the Use of Natural Stone in Building Construction.
 4. Use no materials, equipment, or practices that may adversely affect the functioning, appearance, or durability of the stone work or work of other trades.
- E. Dimensions:
1. Cut all stone work accurately to shape and dimensions shown on the final approved shop drawings. Exposed plane surfaces shall be true. Bed and joint surfaces shall be dressed straight and at right angles to the faces, unless otherwise shown. Exposed arris lines shall be sharp and true. Patching of stone will not be permitted.
 2. Do all necessary cutting for anchors, support plates, shelf angles, and dowels, etc.
- F. Beds and Joints:
- Stone beds and joints surfaces shall be cut square from the face for the entire thickness of stones. Stone shall be bedded and jointed including the various expansion joints dimensions as shown on the approved shop drawings.
- G. Backs Of Pieces:
- Backs of all pieces of stone receiving reinforced concrete backing, shall be roughered.
- H. Exterior Special Shapes:
- All specially shaped pieces of stones shall be constant in profile throughout their length, in strict conformity with details shown on approved shop drawings.
- I. Incidental Cutting & Drilling:
1. Provide holes, grooves, sinkages and recesses, etc., as applicable, for inserts, etc. other cutting and drilling shall be provided only when specifically shown on the approved shop drawings.
 2. Lewis holes for lifting will not be permitted on any stone element with a thickness of 51mm or less.
 3. No cutting or drilling will be permitted on exposed surfaces.

2.02 Mortar Materials and Accessories

- A. Cement:
 - 1. Cement for Setting Mortar: Non-staining Portland Cement conforming to ASTM C150, Type I, except containing not more than 0.03% water soluble alkali.
 - 2. Cement for Pointing Mortar: Non-staining white Portland Cement conforming to ASTM C150. Grey nonstaining cement may be used for pointing mortar if the colour of pointing mortar, as selected by the Engineer, does not require White Portland Cement.
- B. Water : Water shall be potable, clean and fresh from public water system.
- C. Sand:- Well graded non-staining masonry sand conforming to ASTM C144. Use white Silica sand for pointing mortar. No other sand shall be permitted for mortar or grout unless otherwise tested and approved by the Engineer.
- D. Lime:- Approved brand of plastic hydrated, such as New England 4X, conforming to ASTM C207, Type "S".
- E. Integral Waterproofing:- "FEBPROOF" Integral liquid wataerproofer for concrete and mortar, manufactured by Feb Construction Chemicals, or approved equal.
- F. Integral Color:- "FEBTONE' Super permanent, manufactured by Feb Construction Chemicals, or approved equal.
- G. Mortar Plasticiser:- "FEBMIX ADMIX" as manufactured by Feb Construction Chemicals, OR CEBEX 112 or approved equal.

PART 3 EXECUTION

3.01 Conditions At Site

- A. The Contractor shall, prior to proceeding with the stone installation, examine all surfaces and parts of the structure to receive stone work, and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until such conditions have been corrected and are acceptable to the Engineer.
- B. Verify all measurements and dimensions, coordinate the installation of inserts for this work and coordinate and schedule this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the reviewed shop drawings for such trade.

3.02 Stone Installation

- A. Preparation For Stone Installation: Clean stone prior to setting, leaving edges and surfaces free from dirt and foreign material. Do not use wire brushes or implements which mark or damage exposed surfaces, unless otherwise approved by the Engineer.
- B. Mortar and Grout Proportioning - By Volume:-
 - 1. General: Mortar and Grout proportioning shall be prepared and tested by the Contractor, all in accordance with Section 04100 and 01410 respectively, and in addition the Contractor shall allow for preparing and testing the mortar and grout mixes included within this section to meet the Engineer's satisfaction and approval.
 - 2. Setting Mortar for Stone:
 - a. Portland Cement - 1 part
 - b. Hydrated Lime - 0-0.25 part
 - c. Sand - 4 parts
 - d. Plasticiser
 - e. Integral water proofer
 - 3. Pointing Mortar:
 - a. White Portland Cement - 1 part
 - b. Sand - 1-1/2 parts
 - c. Add color additive to acquire the color of mortar approved by the Engineer.
 - d. Add water proofer
 - 4. NOTE: Add integral waterproofing admixture to setting and pointing mortar in the quantity and manner recommended by the manufacturer. Generally, Febmix Admix or Cebex 112 or approved equal, mortar plasticiser shall be used in all mortars, unless otherwise instructed by the Engineer.
 - 5. Wall Grout
 - a. Fine grout shall be mixed in the following proportions by volume all in accordance with ASTM C476:
 - 1) Portland Cement - 1 part
 - 2) Hydrated Lime - 0.1 part
 - 3) Sand - 2.25-3 parts

3.02 Stone Installation (Cont'd)

- b. Coarse grout, where required, shall be mixed in the following proportions by volume, all in accordance with ASTM C476:
 - 1) Portland Cement - 1 part
 - 2) Hydrated Lime - 0.1 part
 - 3) Fine Aggregate - 2.25 parts
 - 4) Coarse Aggregate - 1-2 parts

Use sufficient water to produce a fluid, pourable consistency.
 - C. Mortar and Grout Mixing:-
 1. Mortar and grout shall be machine mixed. Cement and hydrated lime may be batched by the bag. Sand preferably shall be batched by weight, but subject to the approval of the Engineer may on certain small operations be batched by volume in suitably calibrated containers, provided proper allowance is made for weight per cubic foot, contained moisture, bulking and consolidation. Shovel measurement shall not be used.
 2. Workability or consistency of mortar on the board shall be sufficiently wet to be worked under the trowel. Water for tempering shall be available on the scaffold at all times. Mortar and grout which has begun to "set" shall be discarded. Mortar and grout which has stiffened due to evaporation shall be retempered to restore its workability. Retempering of mortar and grout at the mixer shall not be permitted.
 - D. Setting Of Exterior Wall Stone:
 1. All setting shall be done in accordance with the approved shop drawings. All work shall be set in a rigid and substantial manner, straight and plumb, with all horizontal lines level and all vertical lines plumb, unless otherwise shown on the Drawings. Similar abutting profiles shall accurately intersect and be in true alignment. All joints shall be uniform and shall be of the size and detail shown on the approved Shop Drawings.
 2. All exterior stone joints shall be 5mm wide unless otherwise indicated. Refer to the approved Shop Drawings for stone joint dimensions.
 3. As setting progresses, the work shall be fastened securely to take care of all dead loads, wind loads and forces, and erection stresses. All units of stones shall have suitable temporary braces, shores, and stays to hold them in position until permanently secured.
 4. The definitions of all terms herein related to welds, welding, and oxygen cutting shall be interpreted in accordance with the "Standard Definitions, Welding, and Cutting", of the current edition of the American Welding Society.
 5. Cavities behind facing stones shall be filled with fine and /or course grout, as specifically shown on the approved shop drawings and as specified herein.
 6. Stone elements indicated to be set with mortar joints shall be set with two cushions per stone in every horizontal joint. Stone shall be set in full horizontal mortar beds and joints raked out to a depth of 19 mm before mortar has set. The face surfaces shall not be smeared with the mortar forced out of joints or that used in pointing. No hammering, rolling or turning of stones will be allowed on the wall. Precautions shall be taken to prevent seepage of moisture, through or from the beds and joints, which may cause discoloration of the exposed surfaces.
 7. Allow stone units to set overnight and then completely fill joints with pointing mortar. Joints shall be tooled flush. During the tooling of the joints, enlarge any voids or holes and completely fill with mortar. Surfaces of stone shall be cleaned using sponge and water to remove mortar spills from face of stone.
 8. The setting of patched, chipped, cracked, broken, stained or defective stones shall not be permitted.

3.03 Protection

Stone shall at all times be protected from drippings, welding spatter and damage by other trades during construction. Where necessary or directed, substantial non-staining wooden or other approved covering shall be placed to protect the work. Heavy polyethylene film shall be used between stone and wood. Maintain all protection until removed to permit final cleaning of stone work.

3.04 Cleaning

- A. Clean soiled surfaces using non-acidic solution of type which will not harm stone, mortar joint materials, or adjacent surfaces.
- B. Use non-metallic tools in cleaning operations.

3.05 Final Inspection

- A. Finished surfaces shall show no objectionable visual distinction in jointing, bedding, plane, colour, texture, pattern, and finish. All stones which in the opinion of the Engineer do not provide the required uniformity shall be relocated, or removed and replaced with new stone units to the satisfaction of the Engineer and at the Contractor's own expense.
- B. All defective stone shall be replaced with new stone units, except that minor damages may be repaired when approved by the Engineer. Repairs, when approved, shall be completed to the satisfaction of the Engineer. When the repairs to stone are unsatisfactory to the Engineer, the stone shall be replaced with new stone. All repairs and all replacements of defective and unsatisfactorily repaired stone shall be performed at the Contractor's own expense.

END OF SECTION

SECTION 04455
NATURAL MARBLE

PART 1 GENERAL

1.01 Work Included

- A. Marble for floors, using both, standard and cut to size tiles.
- B. Skirting, Sills.
- C. Treads and Risers.
- D. Threshold.
- E. Metal anchors.
- F. Vanity units.
- G. Mortar and Joint Grouting.
- H. Joint Sealant.

1.02 Related Work

Sealant for control and expansion joints, including back-up materials in conjunction with interior and marble works.

1.03 Submittal

- A. General Refer to Section 01340, Shop drawings, Product Data and Samples for submittal provisions and procedures.
- B. Shop Drawings and Product Data
 - 1) Submit shop drawings and product data in accordance with Section 01340.
 - 2) Indicate Pertinent dimensioning, layout, anchorages, construction details, method of installation and adjacent construction.
 - 3) Indicate all units of marble configuration and size, materials and types of anchorage items and their locations.
 - 4) Submit marble supplier's installation instructions, and field erection drawings.
 - 5) Submit manufacturer's instructions for use of pointing colour and admixtures.
- C. Design Calculations

Submit two copies of marble anchorage assemblies as specified.
- D. Samples
 - 1) Submit two sets of each type of marble including thresholds, paving slabs, sills, skirtings, treads and risers, etc. of sizes and thicknesses as indicated on the drawings, to the project site, in sufficient number to indicate the full range of specified marble colours, and the type of finish. One of each of the duplicate samples approved by the Engineer will be retained by him at the project site, the other being returned to the marble supplier for his guidance.
 - 2) The material type and colour of the marble items shall be as selected and approved by the Employer or his representative.
 - 3) The following physical data on all proposed marble shall be submitted by the marble supplier
 - a. Analysis of mineral composition.
 - b. Analysis of chemical composition.
 - c. Thermal coefficient of expansion.
 - d. Permeability.
 - e. Methods of cleaning.
 - f. History of colour change.
 - g. Abrasion resistance.
 - 4) Anchors Two of each type to be incorporated in the work.
 - 5) Manufacturer's recommended marble cleaning agent and application procedure.
 - 6) Submit samples of colour mortar, indicating varying shades of colour closely matching the colour of each type of marble.
 - 7) Submit samples of other materials specified herein upon request by the Engineer.

1.04 Guarantee/Warranty

- A. Attention is directed to the provisions of the Conditions of Contract regarding guarantees/warranties for the Work.
- B. Manufacturers shall provide their standard guarantees for work under this Section. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and Contractor may have by law or by other provisions of the Contract Documents.
- C. All warranties/guarantees to be issued by the Supplier, Manufacturers and Sub contractors shall be counter-signed by Main Contractor and both of them will be liable for repair/replace the items/works, etc. during the warrantee guarantee period.

1.05 Standards

Applicable provisions of the following standard publication shall apply throughout the work:

- A. Building Stone Institute "Recommended Practices for the Use of Natural Stones in Building Construction".

- B. Marble Institute of America (MIA) incorporated American Standards Specifications for Interior and Exterior Marble, latest revision.
- C. American Welding Society (AWS) AWS D1.1 Structural Welding Code.
- D. Industrial Fasteners Institute (IFI) Handbook of Bolt, Nut and Rivet Standards.

1.06 References

- A. National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Engineer.
- B. Refer to SECTION 01090 - REFERENCE STANDARDS for references.

1.07 Qualifications

- A. **Fabricator** A firm having an adequate supply of the specified types of marble and an annual rated production capacity to deliver the marble to the project site on schedule, within a time limit established by the Engineer as required to assure no delay to the progress or completion of the Work.
- B. **Installer** A Firm with a minimum of five years successful experience in the erection and laying of marble works.

1.08 Design Criteria

- A. The method of installation of all marble work shown on the Drawings is diagrammatic only and is not to be used for the purpose of bidding or construction. It shall be the responsibility of the Contractor to design and guarantee the structural support and the permanent water-tight sealing of all marble work. The installation shall be designed to allow for expansion, contraction and differential deflection of supporting floors of the building structure. All fastenings into marble such as plates, bolts, anchors, shelf angles, inserts, etc. are to be stainless steel.
- B. Design and calculations for marble anchor system design shall be based on a minimum safety factor of five for aspects related to marble strength and anchor strength in masonry or concrete.
- C. Allowable stresses in stainless steel anchor elements shall not exceed the following

| | |
|---------------------|-------------------------------|
| 1. Tension, bending | 0.6 Fy |
| 2. Shear | 0.4 Fy |
| 3. Compression | Follow AISC Spec Requirements |

1.09 Delivery, Storage & Handling

- A. Packing and Loading: Finished marble shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discoloration shall be used for blocking or packing.
- B. Site Storage: Upon receipt at the building site or storage yard, the marble shall be stacked on timber or platforms at least 100 mm. above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering. Salt shall not be used for melting of ice formed on pieces, or for any purpose involving its contact with the marble.
- C. Defective Marble: Any piece of marble showing flaws, cracks, or imperfections such as vents, Shelly bars, shakes and starts upon receipt at the storage yard, or at the building site, shall be discarded and removed from the work site, and at the supplier's own expense.

1.10 Environmental Requirements

- A. The following environmental requirements are applicable to marble set in mortar, and when caulking marble joints with sealant.
- B. During freezing or near freezing weather, provide equipment and cover to maintain a minimum of 4 degrees C⁰ and to protect marble work completed or in progress.
- C. At the end of working day, or during rainy weather, cover marble work exposed to weather with waterproof coverings, securely anchored.
- D. Maintain materials and surrounding air to a minimum 10 degrees Co prior to, during and 48 hours after completion of work.

PART 2 PRODUCTS

2.01 Marble Materials And Fabrication

- A. General

- 1) All marble slabs shall be sound, free from cracks, earth veins, objectionable discolouration, structural weaknesses and other defects that would impair their strength, durability, and appearance. The texture grain and colour variations shall be established by approved samples by the Engineer.
- 2) Marble shall be of the thickness and dimensions shown on the approved Shop Drawings. All marble slabs shall be obtained from approved quarries having adequate capacity and facilities to meet the specified requirements.
- 3) Cutting and finishing shall be performed by a firm equipped to process the material promptly on order and in strict accordance with the specifications. Evidence to this effect shall be provided by the Marble Supplier.
- 4) The fabricator must pay attention during the process of cutting to insure that the marble block orientation will yield finished material with visual characteristics complying with the approved samples.
- 5) Marble rejected for non-compliance with the submitted samples or the requirements of this Specification shall be replaced with material acceptable to the Engineer. Replacement shall be prompt and at the Supplier's own cost. Inspection of marble by the Engineer shall not relieve the Contractor of his responsibility to perform all work in accordance with the Contract Documents.

B. Marble Schedule

Refer to the Drawings for locations, sizes and thickness of the various types of marble specified herein

| Application | Thickness | Polished | Textured |
|----------------|-----------|----------|----------|
| Vanity Counter | 30mm | * | - |
| Floors | 30mm | * | - |
| Skirtings | 10mm | * | - |
| Sills | 30mm | * | - |
| Treads | 30mm | * | - |
| Risers | 20mm | * | - |
| Threshold | 30mm | * | - |

The material type and colour of the marble items shall be approved by the Engineer, and shall be

Local Marble

Floors

Treads

Risers

Skirting

Threshold

Sills

Imported Marble

Vanity Counters

C. Marble Finish

- 1) Generally, marble utilized for paving shall be polished with high gloss finish on all exposed surfaces, unless otherwise indicated on the drawings or specified herein.
- 2) Sanded or gritted finish may be used, obtained by light sand blasting to obtain a non-slip finish where required by the Engineer.
- 3) All exposed surfaces shall be free from scratches, chipping or hollows and other defects.

D. Marble Fabrication

- 1) Fabrication of marble shall be in strict accordance with approved shop drawings for manufacture, and with this specification.
- 2) The Contractor shall be responsible for all measurements at the job site that may be required for the fabrication.
- 3) All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All materials and workmanship shall conform to the highest industrial standards.

2.01 Marble Materials And Fabrication (cont'd)

- 4) Use no materials, equipment, or practices that may adversely affect the functioning, or durability of marble work, or work of other trades.
- 5) Marble tile paving, marble facing, marble skirtings, treads and risers etc. shall be of the shapes, sizes and thicknesses shown on the approved shop drawings, and no variation shall

be permitted. All tread nosings shall be slightly rounded; riser heads shall be as shown on the detailed drawings and approved by the Engineer.

- 6) Arrises in all marble work shall be cut perfectly true, even and sharp, and of the full thickness, with exposed edges slightly rounded to prevent snipping.
- 7) The dimension of all marble individuals shall be worked to within plus or minus 1mm from those shown on the drawings and/or the approved Shop Drawings.
- 8) All bed and joint surfaces shall be straight and at right angles to the faces, unless otherwise shown.
- 9) All cuttings to marble items shall be performed properly to form close joints. The marble setter shall cooperate fully with other trades to do all cutting, drilling and fitting to accommodate work of others.
- 10) All drilling, cutting including cut outs to receive anchors, etc. shall be carefully drilled or cut to avoid stunning or fracture of the material adjacent to the hole or mortice. The cutting and drilling work shall be done at the plant.
- 11) All marble works shall be based on requirements established under the American Standards Specifications for Interior and Exterior Marble, of the Marble Institute of America Incorporated (MIA) latest revision.

2.02 Mortar Materials and Accessories

A. Cement

- 1) Cement for Setting Mortar Non staining Portland Cement conforming to ASTM C150, (BS 12) Type I, except containing not more than 0.03% water soluble alkali.
- 2) Cement for Pointing Mortar Non staining white Portland Cement conforming to ASTM C150 (BS 12). NOTE Grey non staining cement may be used for pointing mortar if the colour of pointing mortar, as selected by the Engineer, does not require White Portland Cement.

B. Water Shall be potable, clean and fresh from Public Water System.

C. Sand Well graded non staining masonry sand conforming to ASTM C144 (BS 882). Use white Silica sand for pointing mortar. Other sand shall be approved by the Engineer.

D. Lime Approved brand of plastic hydrated, such as New England 4X, conforming to ASTM C207, Type "S", or BS 890.

E. Integral Waterproofing "FEBPROOF" or approved equal integral liquid waterproofer, as manufactured by Feb Ltd., UK.

F. Integral Color "FEBTONE", as manufactured by Feb Ltd., UK or approved equal.

G. Grout for Marble Pagers "FEBTILE RAINBOW GROUT" as manufactured by Feb Ltd., UK. and or FEBTILE LP GROUT, all as approved by the Engineer, or any others equal and approved.

2.03 Marble Anchorage Materials - Generally

Anchors, dowels, cramps, relieving angles and the like, as shown on the approved Shop Drawings, or as may be required at special conditions for fastening standing marble work shall be fabricated from type 302 or 304 stainless steel.

The type, location and number of anchors shall be determined by calculations, applicable codes, and recommended practices of the BSI and the MIA for placement of anchors.

PART 3 EXECUTION

3.01 Conditions at Site

- A. Examine all surfaces and parts of the structure to receive marble work and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until such conditions have been corrected and are acceptable to the Engineer.
- B. Verify all measurements and dimensions, coordinate the installation of this work, and coordinate and schedule this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the reviewed shop drawings for such trade.
- C. The marble tile setter shall install all work using lighting conditions that will represent the proposed lighting required in the areas involved. This requirement will be insisted upon in order to achieve uniformity in laying out work.

3.02 Marble Installation

A. Marble Floor Installation (Conventional Set)

- 1) Setting bed for floors shall be composed of one- part Portland Cement, four parts damp sand by volume with integral waterproofing admixture in the quantity and manner recommended by the manufacturer.

- 2) The setting bed, when mixed with water, the mortar mix shall be of such consistency or workability as to promote maximum density, determined by stroking the mortar surface with a trowel. When of correct consistency, the trowelled surface readily assumes a smooth slickened appearance. Screed and tamp setting bed firmly.
 - 3) The setting bed shall be 30mm thick on an appropriate thickness of white sand bed underlay.
 - 4) Once the setting bed is applied and tamped to a true and even surface, set the marble tile in place and tamp with a mallet until firmly bedded, then remove. Trowel or brush a thin layer, 1/32 in. (.8mm) to 1/16 in. (1.6 mm) in thickness, of neat Portland Cement paste over the back of marble. A thin layer of dry Portland Cement, 1/32 in. (.08 mm) to 1/16 in. (1.6mm) thick over the setting bed and working lightly with a trowel may be permitted. These areas (setting bed and cement paste) shall be limited to what can be covered with tile before the mortar sets. Marble shall be pressed back firmly into the bed tamping with wood blocks to obtain smooth surface.
 - 5) All tiles shall be aligned properly with straight closed joints 1/32 in. (.8mm) wide. All edges of tiles shall be buttered with coloured cement before closing joints, wipe off excess immediately with sponge and clear water.
 - 6) Tamping shall be completed within one (1) hour after placing tile.
Adjusting work out of line, shall be done within the one (1) hour period.
 - 7) All expansion joints shall be left clear of grout to receive sealant.
 - 8) Lay tiles to pattern as indicated on the drawings.
 - 9) Thresholds shall be set by marble tile setter.
- B. Sealant Application
- 1) Apply approved sealants to joints, expansion joints and other areas where shown on the drawings.
 - 2) Where marble terminates at floor drains, or joints, these joints shall be sealed with approved sealant; coordinate with trades affecting these items.

3.03 Cleaning And Protection - Generally

- A. After marble work has thoroughly set, sponge and wash thoroughly. Remove all surface cement and take care not to damage marble or adjacent materials.
- B. Do not use acid or abrasive cleaners. The type of cleaner shall be approved by the Engineer prior to application.
- C. Marble surfaces shall be dried using soft, dry cloths.
- D. Protect marble work as the work proceeds, with non-staining heavy kraft paper or other approved coverage for both paved or cladded areas.
- E. All pavings including treads shall be properly protected by covering the entire areas with gypsum at least five (5) centimeters thick on top of the kraft paper. This gypsum protective layer shall be removed prior to polishing.
Protect nosings of all treads, edges of skirtings liable to damage by protective boarding or other means.
- F. Protect all facings against the weather or damage and staining by other trades, taking special precautions against staining by timbers, wet straw, oil, washings from steel work or scaffoldings, or other injurious substances.

3.04 Final Cleaning And Polishing

- A. On completion of all building operations, the Contractor shall remove all kraft paper and gypsum layer and dispose of the site, thoroughly clean down the completed marble work and attend to any defects in the finished marble work. All damage shall be made good to the satisfaction of the Engineer at the Contractor's own expense.
- B. All surfaces shall be polished with silicone wax polish (either liquid or paste). When the wax has dried, it shall be polished with a mechanical buffer to a lustrous finish free from tackiness.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.01 Work Included

- A. Metal fabrications include items made from aluminum and/or iron and steel shapes, plates, bars, and strips which are not a part of structural steel or other metal systems specified elsewhere.
- B. Types of work, in this section include metal fabrications for the following, some of which are detailed on the structural and/or architectural drawings
 - 1) Rough Hardware.
 - 2) Brass Strip.
 - 3) Steel Gutter and Frame
 - 4) Chimney Stack Cover
 - 5) Sliding Gates
 - 6) Vertical steel ladders.

1.02 Related Work

Section 05520 Handrails and Railings.

1.03 Quality Assurances

- A. Field Measurements Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for timing and fitting where taking field measurements before fabrication might delay work.
- B. Shop Assembly Preamble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassemble and coordinated installation.

1.04 References

Applicable Publications. The following publications of the issues listed below, but referred to thereafter by basic designation only form a part of this Section

- 1. Federal Specifications, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120, USA
 - FF-W-92B Washers, Flat (Plain).
 - RR-G-661E Grating, Metal, Bar Type (Floor, Except for Naval Vessels).
- 2. American National Standards Institute (ANSI), 1430 Broadway, New York, New York 10018, USA
 - A14.3-1984 Fixed Ladders, Safety Requirements for.
- 3. American Society for Testing and Materials (ASTM) Standards, 1916 Race Street, Philadelphia, Pennsylvania 19103, USA
 - A27-83 Specifications for Steel Castings, Carbon, for General Application.
 - A36-81a Specification for Structural Steel.
 - A47-77 Specification for Malleable Iron Castings.
 - A53-82 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - A123-78 Specification of Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
 - A153-82 Specification of Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - A307-83a Specification for Carbon Steel Externally Threaded Standard Fasteners.
 - A386-78 Specification for Zinc Coating (Hot-Dip) on assembled Steel Products.
 - A569-72(1979) Specification of Steel, Carbon (0.15 Maximum, Percent), Hot Rolled Sheet and Strip, Commercial Quality.
 - F593-82 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- 4. American Welding Society, Inc., (AWS), 2501 N.W. 7th Street, Miami, Florida 33125, USA
 - D1.1-85 Structural Welding Code - Steel.
- 5. Military Specifications, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120, USA
 - MIL-P-21035A Paint, High Zinc Content, Galvanizing Repair (Metric).
- 6. National Association of Architectural Metal Manufacturers (NAAMM), 221N. La Salle, Chicago, Illinois 60601, USA
 - Metal Bar Grating Manual - October 1979

1.04 References (cont'd)

7. Steel Structures Painting Council (SSPC) ; 440Fifth Avenue, Pittsburgh, Pennsylvania 15213, USA
PA1 Shop, Field & Maintenance Painting, November 1, 1982.
Paint 20 Zinc-Rich Primers (Type I-Inorganic and Type II - organic), November 1, 1982.
SP3 Power Tool Cleaning, November 1, 1982.

1.05 SUBMITTALS

- A. Submit items in accordance with the SPECIAL PROVISIONS.
- B. Product Data Submit Manufacturer's specifications, anchor details and installation instructions for products used in miscellaneous metal fabrications, including paint products.
- C. Shop Drawings Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plan, elevations and details of sections and connections, Show anchorage and accessory items. Provide templates for anchor and bolt installation in critical area.
 1. Where materials or fabrications are indicated to comply with certain requirement for design loading, include structural computations, material properties and other information needed for structural analysis.
- D. Samples Submit the following samples
 - 1) Fasteners Threaded ; standard fasteners; or wedged type.
 - 2) Bolts, nuts and washers Regular Hexagon head type washers, round, carbon steel .
 - 3) Welding Materials AWS D1.1; type required for materials being welded.

PART 2 PRODUCTS

2.01 Materials

- A. Ferrous Metals
 - 1) Metal Surfaces, General For fabrication of miscellaneous metal work which will be exposed-to-view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
 - 2) Steel Plates, (Shapes) ASTM A36.
 - 3) Stainless Steel Bolts, Hex Cap Screws and Studs ASTM F593.
 - 4) Steel pipe ASTM A53; type and grade and as required for design loading; standards weight (Schedule 20), unless otherwise indicated.
 - 5) Brackets, flanges and Anchors Cast or Formed metal of the same type material and finish as supported rails, unless otherwise indicated.
 - 6) Concrete Inserts Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. provide bolts, washers and shims as required , hot -dip galvanized, ASTM A153.
- B. Fasteners
 - 1) Bolts and Nuts Regular hexagon head type, ASTM A307, Grade A.
Plain Washers Round, Carbon Steel, Federal Specification FF-W092.
- C. Paint
 - 1) Shop Primer for Ferrous Metal Manufacturer's or fabricator's standard, fast-curing, lead-free, "Coppers" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability of obtaining a sound foundation for field-applied topcoats despite prolonged exposure.
 - 2) Galvanizing Repair Paint High zinc dust content paint for re galvanizing welds in galvanized steel, complying with the Military Specification MIL-P-21035 (Ships) or SSPC-Paint 20.

2.02 Fabrication, General

- A. Workmanship
 - 1) Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
- 3) Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1 mm (1/32 inch), unless otherwise shown. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

4) **2.02 Fabrication, General (cont'd)**

Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces. Welding to or on structural steel shall be in accordance with the Structural Welding Code of the American Welding Society.

- 4) Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, Phillips flat-head (counter sunk) screws or bolts.
- 5) Prepare for anchorage of type indicated, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- 6) Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
- 7) Galvanizing Furnish a zinc coating for those items shown or specified to be galvanized, as follows
 - a- ASTM A153 for galvanizing iron and steel hardware.
 - b- ASTM A123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 3mm (1/8-inch) thick and heavier.
 - c- ASTM A386 for galvanizing assembled steel products.
- B. Shop Painting Apply shop primer to surfaces of metal fabrications except those which are galvanized, stainless steel or as indicated to be embedded in concrete or masonry, unless otherwise indicated, and in compliance with requirements of SSPC-PA1 "Paint Application Specification No. 1" for shop painting.
- C. Surface Preparation Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications
Interiors (SSPC Zone 1A) SSPC-SP3 "Power Tool Cleaning"

2.03 Rough Hardware

- A. Furnish bent or otherwise custom-fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for supporting miscellaneous metal.
- B. Fabricate items to sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.04 Brass Strip

Install and fix brass strip in position including cut to size and all needed fixing material as manufacturer's instructions.

2.05 Steel Gutter and Frames

Steel Gutters shall, unless otherwise indicated, conform to Federal Specification RR-G661. Edges of gutters shall be banded with bars 3mm (1/8 inch) less in depth than the bearing bars. Banding bars shall be flush with top of bearing bars. Furnish frames of steel shapes and all-welded construction finished to match gutter. Frames shall be anchored to structural members with bolts or toggles bolts. Floor grating and frames shall be galvanized.

2.06 Chimney Stack Cover

- A. Furnish all requisite materials, fabricate and install chimney stack over complete with hood, all as detailed on the detail drawings.
- B. All work shall be carried out in strict accordance with approved shop drawings.
- C. Clean all surfaces which are in direct contact with concrete shall be treated with an anti-corrosion paint.

2.07 Balustrade Steel Handrail

- A. Fabricate and install steel balustrade and handrails, for the location shown with dimensions, spacing, details and anchorage as indicated on the approved shop drawings.
- B. Support each balustrade/hand rail using brackets as details.
- B. Clean all surfaces down to bare metal obtain the Engineer approval and apply oil paint comprising primer, under coat and finish coats, touch up paint as deemed necessary after installation.

2.8 Vertical steel ladders

- A. Fabricate and install vertical steel ladders for the locations shown, with dimensions, spacing, details and anchorages as indicated. Comply with the spacings, details and anchorages as indicated on the approved Shop Drawings.
- B. Fit rugs in centerline of side rails, plug revit and grind smooth on outer rail faces.
- C. Support each ladder using brackets as detailed.
- D. Fit platforms revised to angle framing below.
- E. Make good to other trades affected by the installation of the aluminium ladders and finish off to the Engineer / Employer's representative's approval.

PART 3 EXECUTION

3.01 Preparation

- A. Field Measurements. Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.
- C. Coordinate and furnish anchorage, setting drawings, diagrams, templates, instructions, and directions for installation of anchorage, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete construction. Coordinate delivery of such items to project site.

3.02 Installation

General:

- 1) Fastening to In-Place Construction Install anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for connectors as required.
- 2) Cutting, Fitting and Placement:
 - a- Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Use temporary bracing or anchors in form work for items which are to be built into concrete, masonry or similar construction.
 - b- Fit exposed connections accurately together to form tight hairline joints. Weld Connections which are not to be left as exposed joints, but cannot be shop-welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat.
- 3) Field welding Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

3.03 Adjust and Clean

- A. Touch-Up Painting Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry-film thickness of .05 mm (2.0 mils).
- B. For Galvanized Surfaces Clean field welds, bolted connections and abraded areas and apply two coats of galvanizing repair paint.

END OF SECTION

SECTION 05520
HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 Section Includes

- A. Steel pipe handrails, balusters, and fittings; complete with all requisite accessories.
- B. Powder coated and finish handrailing.

1.02 Related Sections

- A. Section 05500: Attachment plates, hold-down bolts, angles, including anchorage, etc.
- B. Section 09900 - Painting: Paint finish.

1.03 References

- A. ASTM A53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
- B. ASTM A123 - Zinc (Hot-Dip Galvanised) Coatings on Iron and Steel Products.
- C. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
- D. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- E. ASTM B211 - Aluminium-Alloy Bars, Rods, and Wire.
- F. ASTM B221 - Aluminium-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
- G. ASTM B241 - Aluminium-Alloy Seamless Pipe and Seamless Extruded Tube.
- H. ASTM B483 - Aluminium and Aluminium-Alloy Drawn Tubes For General Purpose Applications.
- I. ASTM E935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
- J. ASTM E985 - Permanent Metal Railing Systems and Rails for Buildings.
- K. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.04 Design Requirements

Railing assembly, steps rails, and attachments to resist lateral force of 35 Kg. at any point without damage or permanent set. Test in accordance with ASTM A935.

1.05 Submittals For Review

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
- B. Samples: Submit long samples of handrail. Submit samples, of elbow, Tee, wall bracket, escutcheon and end stop.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

The Contractor shall submit to the Engineer / Employer's Representative 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 Steel Railings And Handrails

- A. Fabricate Steel railings, posts and handrails to design, dimensions, and details indicated. Furnish railings and handrail members formed of the sized indicated conforming to ASTM A53, standard weight.
- B. Fabrication : Jointing of post, rail, and corners shall be by one of the following methods
 - 1) Flush-type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 10mm (3/8 inch) hexagonal-recessed-head setscrews.
 - 2) Mitred and welded joints made by fitting post to top rail and intermediate rail to post, mitring corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight-fitting interior sleeve not less than 152 mm (6 inches) long.
 - 3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and that the pipe is not crushed.
 - 4) Furnish wall returns at ends of wall-mounted handrails.
 - 5) Close exposed ends of rails by welding 5mm (3/16-inch) thick steel plate in place or by use of prefabricated fittings.

2.02 Steel Railings And Handrails (cont'd)

- 6) Furnish removable railing where indicated.
- 7) Railings and handrails shall be capable of withstanding a concentrated load of 91 Kg. (200 pounds) applied at any point in any direction.

2.03 Steel Railing System

- A. Pipe: ASTM A53, Grade (B) Schedule 20.
- B. Rails and Posts: of sizes as shown on the drawings; posts and/or supports; welded joints.
- C. Fittings: Elbows, T-shapes, wall brackets, escutcheons, and caps; steel.
- D. Mounting: Adjustable brackets and flanges, with steel inserts for casting in concrete; with steel brackets for embedding in masonry. Prepare backing plate for mounting in floor construction.
- E. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- F. Splice Connectors: Steel welding collars.
- G. Shop Refinishing: Powder coated to color as selected.

2.04 Fabrication

- A. Fit and shop assemble components in largest practical sizes for delivery to site.
- B. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- C. Provide anchors, plates and angles, etc.; as required for connecting railings to structure.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
- G. Interior Components: Continuously seal joined pieces by continuous welds.
- H. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- I. Accurately form components, to each other and to building structure.
- J. Accommodate for expansion and contraction of members and building movement without damage to connections or members.

PART 3 EXECUTION

3.1 Examination

Verify that field conditions are acceptable and are ready to receive work.

3.2 Preparation

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete and/or embedded in masonry with setting templates, to appropriate sections.

3.03 Installation

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects.
- C. Anchor railings to structure with anchors, plates, angles, etc. as approved by the Engineer.
- D. Field weld anchors as indicated on approved shop drawings. Touch-up welds with primer. Grind welds smooth.
- E. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.4 Erection Tolerances

- A. Maximum Variation From Plumb: 3 mm per storey, non-cumulative.
- B. Maximum Offset From True Alignment: 3 mm.
- C. Maximum Out-of-Position: 3 mm.

3.5 Schedule

Refer to the Drawings and Book of Details for Detail Nos. and locations.

END OF SECTION

SECTION 06200
FINISH CARPENTRY

PART 1 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. Prime paint contact surfaces of items and assemblies in contact with cementitious materials.
- D. 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 07111
BITUMINOUS MEMBRANE WATERPROOFING
FOR UNDERGROUND WORKS

PART 1 GENERAL

1.01 Work Included

- A. Prepare, clean and repair surfaces.
- B. Supply and apply water proofing.
- C. Supply and fix Protective coverings.

1.02 Related Work

Section 03300 : Cast-in-place concrete.

1.03 Shop Drawings And Product Data

- A. Submit manufacturers instructions for the Engineer's review.
- B. Submit shop drawings indicating water proofing materials, protective covering, surface preparation and method of application for the Engineer's review and approval.
- C. Indicated jointing details to large scale.

1.04 Warranty

- A. Provide written warranties in the name of the Employer.
- B. Warranty shall provide for making good, within a period of five (5) years, at no cost to Employer, failures of waterproofing to resist penetration of water, except where such failures are result of structural failures of building. Hairline cracking due to temperature of shrinkage is not considered as structural failure. Repair and make good waterproofing membrane and pay for and repair or replace all affected or damaged materials surfaces at no cost to Employer.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

The contractors- shall submit to the Engineer the names of three manufactures and their products which shall be acceptable under this section. Approval of the manufacturer or product must be obtained before proceeding with associated work.

2.02 Materials

- A. Modified bitumen torchable membrane, 4mm thick, reinforced with 180 gm/m2 non-woven polyester with 50 gm/m2 glass fiber.
- B. Primer compatible with waterproofing and recommended by waterproofing manufacturer and approved by the Engineer.
- C. Protective cover, 10cm thick pre-cast hollow concrete blocks.

PART 3 EXECUTION

3.01 Surface Preparation

Clean and prepare surfaces to receive waterproofing in accordance with manufacturers recommendations and the Engineer's acceptance and approved.

3.02 Application

- A. The names of the application firm shall be approved by both the Engineer and the manufacturer prior to proceeding with the works.
 - A. All prepared surfaces shall when dry, be painted with a coat of primer at a rate recommended by waterproofing manufacturer. All blinding surfaces must be finished fair-faced or trowel smooth to receive the waterproofing membrane.
 - B. Apply the waterproof membrane surface against prepared surfaces, in accordance with manufacturers recommendations, ensuring that air is excluded from under membrane.
 - C. Adjacent rolls of waterproof membrane should be provided with a minimum 100 mm lap and complete adhesion must be achieved between both layers to ensure complete waterproofing.
- D. All external and internal angles and corners shall be reinforced with an extra strip of waterproof membrane, minimum 300 mm wide.

3.02 Application (cont'd)

- E. All internal corners should be provided with a 50 mm X 50 mm minimum fillet.
- F. Where waterproof membrane is to be terminated above ground level (150mm from G.L. or as instructed by the Engineer) a chase should be provided of minimum dimension 25 mm x 25 mm. The waterproof membrane should be dressed into the chase and immediately sealed as per the approved Shop Drawings.
- G. Pipes and other projections through waterproof membrane should be properly treated with reinforcing strips, collars etc. as per manufacturer's recommendations to ensure complete waterproofing.
- H. Where waterproof membrane is expected to be left exposed for any length of time the top edge should be batten-fixed to secure edge. The perimeter should be left with an extended edge for later continuity and the free edge shall be adequately protected while exposed. The free edge of the membrane should be carefully cleaned before further laying is commenced.
- I. Before covering, inspect to ensure no damage. Any damaged area should be cleaned and patched in accordance with manufacturer's recommendations to ensure complete waterproofing.
- J. On horizontal applications where steel reinforcement is to be fixed prior to concreting, the waterproof membrane should be protected with a minimum of 25 mm concrete topping "C15" or other approved protection in accordance with manufacturer's recommendations at the Contractor's own expense.
- K. . The area of waterproof membrane laid in a working day should not exceed that which can be protected in the same working day, in order to ensure that membrane is not subjected to site traffic or damage.
- L. Material having limited shelf life are to be supplied with labels indicating batch number and dates of manufacture and expiry. Materials not properly stored or which have exceeded their expiry date will not be permitted to be used in the work and are to be removed from the site.
- M. Submit five years guarantee covering materials and workmanship of waterproofing system. The guarantee should be substantiated with a certified copy of the material guarantee provided by the manufacturer.

END OF SECTION

SECTION 07120
FLUID APPLIED WATERPROOFING

PART 1 GENERAL

1.01 Work Included

- A. Clean and prepare surfaces to receive waterproofing.
- B. Fluid applied membrane waterproofing.

1.02 Related Work

Division 15: Mechanical items projecting through membrane waterproofing.

1.03 Reference Standards

- A. ASTM C355 Water Vapor Transmission of Thick materials.
- B. ASTM D412 Rubber Properties in Tension.
- C. ASTM D624 Rubber Property - Tear Resistance.
- D. ASTM D2240 Rubber Property - Durometer Hardness

1.04 Product Data

- A. Submit Product data in accordance with Section 01340.
- B. Submit manufacturer's recommendations for surface conditioner compatibility, elastic flashing, joint cover sheet and joint and crack sealants along with temperature range for application of waterproofing membrane for review by the Engineer / Employer Representative .

1.05 Environmental Requirements

- A. Do not apply waterproofing membrane during inclement weather or when air temperature is below 40 degrees F (5 degrees C).
- B. Do not apply waterproofing membrane to damp, frozen, dirty, dusty, or unsuitable deck surfaces. Concrete surfaces must be cured for 28 days.

C. Provide positive ventilation when waterproofing membrane is applied in enclosed areas, to remove toxic fumes.

1.06 Warranty

- A. Provide written warranties in the name of the Employer.
- B. Warranty shall provide for making good, within period of five (5) years, at no cost to Employer, failures of waterproofing to resist penetration of water, except where such failures are result of structural failures of building. Hairline cracking due to temperature or shrinkage is not considered as structural failure. Repair and make good waterproofing membrane and pay for and repair or replace all affected or damaged materials or surfaces at no cost to Employer.

1.07 Inspection And Testing

- A. Inspection and, when necessary, testing will be performed by a firm appointed in accordance with Section 01400. Provide free unobstructed access to all portions of work and cooperate with appointed firm.
- B. Perform inspection of membrane waterproofing to ensure conformance with requirements. If defects are revealed, the Engineer may request that waterproof membrane be subject to tests to ascertain full extent of defects. Pay for costs of required testing and inspection.
- C. Correct defects and irregularities as advised by the Manufacturer . Pay for costs incurred including additional inspection and testing of corrected work.

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 Materials

- A. Water Proofing Membrane: Two component elastomeric compound; cold applied; quick setting.
- B. Cured Membrane Characteristics:

| Properties | Test Method |
|---------------------------|--------------------------------------|
| Tensile Strength | ASTM D412 |
| Elongation (Ultimate) | ASTM D412 |
| Hardness | ASTM D2240 |
| Tear Strength | ASTM D624 |
| Water Absorption | 7 days @ 72 degrees F (22 degrees C) |
| Water Vapor Perm Adhesion | ASTM C355 |
- C. Surface Conditioner: Type compatible with membrane compound; as recommended by fluid membrane manufacturer.
- D. Elastic Flashings: 1.19mm thick butyl or neoprene as recommended by the waterproofing membrane manufacturer.
- E. Joint Cover Sheet: Elastic sheet material designed for and compatible with the membrane waterproofing.
- F. Joint and Crack Sealant: As recommended by waterproofing membrane manufacturer.
- G. Back-up Material: PVC membrane or butyl rod or other suitable support material.
- H. Tack-free Surfacers: Normal Portland cement or stone dust.

PART 3 EXECUTION

3.01 Inspection Of Surfaces And Cleaning

- A. Ensure that drains, sleeves and curbs which pass through surfaces to receive waterproofing are properly and rigidly installed.
- B. Ensure surfaces are free of cracks, depressions, waves or projections which may be detrimental to proper installation of waterproofing membrane. Repair surfaces as required.
- C. Seal cracks and expansion joints with recommended backup material and sealant. Ensure proper depth-width ratio as recommended by sealant manufacture
- D. Ensure expansion joints are sharply formed, free of broken edges or loose aggregates.
- E. Clean surfaces of dust, dirt and other foreign matter detrimental to proper installation of waterproofing membrane.

3.02 Preparation

- A. Apply surface conditioner at a rate not exceeding 1 liter per 10 square meters nor less than 1 liter per 5 square meters depending on concrete surface. Protect surface conditioner from rain or frost until dry.
- B. Apply 300 mm wide strip of joint cover sheet over cracks, non-working joints, and expansion joints, over 1.6 mm but not exceeding 12.7 mm in width.
- C. At expansion joints from 12.7 mm to 25 mm in width, loop cover sheet down into joint between 1-1/4 and 1-3/4 inch 31.4 and 44.1 mm. Sheet is to extend at least 6 inches 152 mm on either side of the expansion joint.
- D. Center cover sheet over crack or joints. Roll sheet into 3.2 mm coating of waterproofing membrane. Apply second coat over sheet extending minimum of 152 mm, beyond sheet edges.
- E. Procedure stated above shall also apply to expansion joints between horizontal and vertical surfaces.

3.03 Application

- A. Apply waterproofing membrane in accordance with manufacturer's recommendations.
- B. Temperature of poured waterproof membrane is to be within minimum and maximum range recommended by membrane product manufacturer.
- C. Apply and spread membrane to a minimum 3.2 mm thickness and averaging 4.8 mm thickness.
- D. Continue membrane up vertical surfaces to a minimum of 152 mm unless otherwise noted.
- E. Seal items projecting through membrane.
- F. Install membrane flashings and seal into membrane.
- G. Reinforce membrane over joints, whether they be static or moving.
- H. Immediately after cooling, dust membrane with Portland Cement at rate of approximately 65 kilograms per 10 square meters.

END OF SECTION

SECTION 07181
ELASTOMERIC WATERPROOFING SYSTEM

PART 1 GENERAL

1.01 Section Includes

Elastomeric waterproofing coating.

1.02 Related Sections

Section 07900 : Sealants.

1.03 Reference

- A. Palestinian General Specifications.
- B. Manufacturers instructions.

1.04 System Description

To component cement acrylic elastomeric waterproofing system.

1.05 Submittals

- A. Submit samples with the Engineer instructions.
- B. Product Data Provide details of product description, tests performed, limitations to coating, cautionary procedures required during application, and chemical properties including percentage of solids.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.06 Qualifications

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three experience.

1.07 Mockup

- A. Provide mockup of surface to be coated as per the Engineer instructions.
- B. Prepare coated surface 1000 x 1000 mm in size.

1.08 Delivery, Storage, and Handling

- A. Deliver, store, protect and handle products to site with the Engineer Instructions.
- B. Protect coating liquid from freezing.

1.09 Environmental Requirements

Do not apply coating when surface temperature is lower than 15 degrees C or higher than 40 degrees C.

PART 2 PRODUCTS

2.01 Manufacturers

"Weathercoat" or approved equal.

2.02 Materials

Acrylic elastomeric waterproofing materials.

PART 3 EXECUTION

3.01 Examination

Verify joint sealants are installed and cured.

Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of coating.

3.02 Preparation

- A. Ensure that dust, dirt and foreign matter are brushed away, Ridges and form oil must be removed. If the surface shows signs of flaking or dusting, clean thoroughly and primes with Terrabond A or a solution of Weathercoat Resin/Water (1:1).
- B. Scrub and rinse surfaces with water and let dry.

3.03 Application

- A. Apply coating in accordance with manufacturer's instructions.
- B. Weathercoat is supplied as cement powder and acrylic resin, mixed in quantities as the manufacturer recommendations. Add the powder to the resin. Mix with either a high-speed mixer or a power agitator until the mix is homogenous (approx. 5-10 min). If spraying, add water until the mix is of the correct consistency.
Apply first coat using brush, roller or spray. Further coats can be applied allowing 3 hours between coats to dry.
Mixed Weathercoat must be used within 1 hour of mixing.

3.04 Protection to Finished and Adjacent Work

- A. Protect adjacent surfaces not scheduled to receive coating.
- B. If applied to unscheduled surfaces, remove immediately by a method instructed by coating manufacturer.

3.05 Schedules

To floor & walls : As shown on drawings.

END OF SECTION

SECTION 07212
ROCKWOOL INSULATION

PART 1 GENERAL

1.01 Work included in the Unit Rate

- A. Prepare surfaces to receive insulation.
- B. Rockwool insulation and where applicable as required to provide thermal barrier for building elements and spaces.

1.02 Reference Standards

Palestinian General Specifications.

1.03 Product Data

Submit manufacturers installation instructions for review by the Engineer.

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 Insulation Materials

Rockwool Insulation.

2.03 Accessories

Vapor Barrier: Bituminous paint in two coats.

PART 3 EXECUTION

3.01 Workmanship

- A. Install insulation and vapor barrier to maintain continuous and complete thermal vapor protection for building spaces and elements.
- B. Ensure surfaces which are to receive insulation are clean, free of deleterious matter and are sufficiently level to allow proper installation of insulation.
- C. Cut and trim insulation neatly to fit spaces. Butt edges and ends tight. Fit insulation tight against mechanical, electrical and other items, which protrude through plane of insulation.
- D. Use insulation free of broken or chipped edges and undamaged integral vapor barrier.

END OF SECTION

SECTION 07535
MODIFIED BITUMEN ROOFING MEMBRANE

PART 1 GENERAL

1.01 Work Included

- A. Cleaning substrate, preparing and applying light weight concrete including forming rain water drains and outlets; application of primer coat.
- B. Modified bitumen sheet roofing, installation.
- C. Counter flashing and sealing sheet at termination.
- D. Sealants.

1.02 Related Work

- A. Section 07900 - Sealants.
- B. Section 03300 - Light weight concrete roof screeds.

1.03 Reference Standards

Materials shall have the characteristics specified by current international regulations or failing these shall meet the conditions specified by current standards in countries of origin. Acceptable Standards of reference are as follows:

- 1. UEATC (European Union for Technical Agreement in Construction).
 - General Directives for the Assessment of Roof Waterproofing Systems MOAT 27, January 83.
 - Special Directives for the Assessment of SBS Elastomer bitumen MOAT31, August 84.
 - UEATc, c/o BBA, P.O. Box 195, Bucknalls Lane, Watford, WD2 7NG, U.K.
- 2. ASTM (American Society for Testing Materials) ASTM C869, ASTM 1227D type 4.
- 3. CSTB (Scientific and Technical Center for Construction) 4 Av. du Recteur Poincare 75016 Paris.
 - DTU 20-12- Code of Practice- Concrete roofs to receive waterproofing.
 - DTU 43-1 - Code of Practice - Roofing over concrete deck
 - FIT Classification for roof waterproofing - Sept. 89.
- 4. DIN (Deutsche Institute Fur Normung) Unter den Eichen 87 D 1000 Berlin 45 Germany.
 - Sealing and Insulating Roofing materials testing and design Standards.

1.04 Shop Drawings And Product Data:

- A. Submittals :
 - 1. Shop Drawings
 - Indicated layout of sheets including side and end laps, mechanical equipment, counter flashing, drains and penetrations details.
 - 2. Product Data :
 - Submit manufacturer's printed specification and installation instructions, including procedures and materials for terminations, penetrations, flashings compatibility and bonding. The Contractor shall provide with his submittals all the relevant Standards documentation.
 - 3. Samples :

| | |
|-------------------|--|
| Membranes | : Three 115mm x 75mm samples |
| Flashing Membrane | : Three 115mm x 78mm samples |
| Insulation | : Three 600mm x 600mm samples |
| Metal Flashing | : Three 300mm sample in the required color |
| Primer | : 1 Liter |

Accepted samples will be retained to serve as a basis for checking at the time of delivery of materials to site. The manufacturer shall furnish, when requested, proof of origin and quality of the materials that will be used or where it has been applied.. Only materials specified or approved by the Engineer will be permitted to be used. The Engineer will stipulate acceptance tests and their mode of operation to be carried out on materials supplied by the contractor. The Contractor will carry out these tests in his own laboratory under the control of the Engineer, Rejected materials will be immediately isolated and labeled to avoid any risk of confusion. They will be removed from the site by the Contractor within 48 hours following their rejection.

B) Contractor Certification

The Contractor is required to :-

Submit manufacturer's certification standing materials ordered and supplied are compatible with each other, suited for locations and purpose intended and shipped in sufficient quantity to ensure proper timely installation.

Submit manufacturer's approval of applicator.

Submit a certificate signed by the manufacturer for the materials specified which states materials installed on the project manufacturer's published performance standards and the requirements.

Submit Complete details about the contractor's company : company's profile, list of specialized staff with their respective qualification and experience in the Palestine climatic conditions, references (minimum 5 years), evidence of their ability to handle projects of a similar volume and list of equipment.

C. Manufacturer Approval

- 1) For uniformity of the efficiency and future maintenance, all the products proposed for waterproofing shall be from the same manufacturer or approved by the waterproofing membrane Manufacturer. Furthermore, a guarantee of 10 years availability of the approved materials shall be submitted by the manufacturer.
- 2) The manufacturer shall have an in house quality control set up complying with UEAtc directives and/or with latest version of ISO series standards : manufacturer quality control manual shall be available for the Engineer / Employer's Representative checking at time of submission.
- 3) The manufacturer in house quality control shall be periodically audited by an independent technical control office for compliance with the Q.C. manual and standard recommendations. Certificates from the technical control office shall be available for The Engineer checking.

1.05 Warranty

Provide warranty in the name of the Owner for materials and workmanship of water proofing. This warranty shall clearly include the following:

1. All materials in the waterproofing systems shall be free from manufacturing defects and comply with manufacturer's published technical specifications.
2. All workmanship in waterproofing systems shall be free from any defects and comply with all respect to the manufacturer's technical instructions and control.
3. This warranty becomes operative from the date of issue of the preliminary handing over certificate of the contract and shall be valid for a period of ten (10) calendar years.
 - * Within this warranty the Contractor is liable for the cost of :
 - * Repair of defected materials or installation of replacement materials or system.
 - * Damages to the building and/or the building contents due to such materials.
 - * Financial loss and/or physical injury due to such materials.The text of the warranty shall be to the Engineer / Employer's Representative approval.

PART 2 PRODUCTS

2.01 Materials

A. Basic Materials:

Waterproofing Membranes: The membranes to be used shall comply with the specification as detailed below, Test reports shall be made available to the Engineer / Employer's Representative upon request:-

| | |
|-----------------------------|-------------------|
| Softening Point | >130 °C(ASTM D36) |
| Penetration at 25 C | 20 -40 (ASTM D5) |
| Cold Flexibility | -20 °C |
| Tensile Strength | (L)900 N/5; cm |
| Dimensional Stability | <0.2% |
| Elongation At Break | 50% |
| Static Puncture Resistance | >25Kg |
| Dynamic Puncture Resistance | >20 Joules |
| Tearing Resistance | 270 N |

B) Miscellaneous Materials

- 1) Primer: The primer to be used shall comply with all respect to ASTM D 41 and shall be applied at a minimum rate of 0.250-0.300 kg/Sq.m. As recommended by the manufacturer and approved by the Engineer / Employer's Representative.
- 2) Corner reinforcing strip: A 3mm thick SBS elastomeric bitumen membrane finished on both sides with a macro perforated torch-off film allowing laying by torch or hot bitumen, glass-grid reinforced for a tensile strength of at least 900 N/5 cm. The bitumen compound shall have the same characteristics than the main waterproofing membrane.
- 3) Metal Flashing: 1.5mm minimum thick anodized aluminum, color at the Consultant request.
- 4) Mastic Sealant: Plysulphide, silicone or polyurethane rubber sealant.
- 5) Drain Water Outlets: They shall consist of a prefabricated flange and a welded pipe, flange dimension exceeding 120mm from edge of pipe opening. Pipe shall be of a diameter and a length adapted to the roof condition. Outlets can be metal made (lead, zinc, copper of similar approved) or bitumen-compatible rubber such as EPDM. All flanges shall be primed on both faces before insertion in the waterproofing built-up, Bottom of the pipe shall be sealed to the down pipe entry.

2.02 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 the product must be obtained before proceeding with associated work.

PART 3 EXECUTION

3.01 Inspection

After proper cleaning of the roof area, a complete level survey shall be carried out by the Contractor, including identification of hollow or debonded areas by tapping with a steel rod (these areas will produce a hollow sound). The extent of debonding must be clearly marked. Slope and planeity survey shall be carried out with the following tolerances :

- 1) **Slope:**
 - * Minimum slope requirement : 0.75%
 - * Water pounding area shall be identified clearly.
- 2) **Planeity:**
 - * Tolerances for planeity shall be :
 - 5mm with a 2 meters straight edge.
 - 3mm with a 200mm straight edge.
- 3) **Surface :**

The surface shall be smooth, clean, dry and free of dust, grease, oil, foreign chemicals curing compound. Complete survey report shall be submitted to the Engineer.
- 4) **Details :**
 - * All details shall be finalized before waterproofing works to start :
 - * Rainwater drains shall be well located, inn sufficient number and ready to receive waterproofing membranes.
 - * Expansion joints shall be located at highest roof points, on reinforced concrete curbs chamfered as shown on drawings.
 - * All pipes, cables and other penetrations shall be in place. Provision for proper waterproofing at Chillers and Machinery shall be made.
 - * All parapets shall be in place, with provision for groove or counter flashing at and acceptable height (150mm above finished roof level).

3.02 Preparatory Work

- A. Before commencing installation of the roof waterproofing and insulation system all construction work and installations above roof level shall be completed as far as possible. Particular care shall be taken to ensure:
 1. All rainwater, plumbing, air-conditioning and ventilation duct outlets have been fixed in position and are protected against blockage or accidental damage.
 2. Supports to ductwork, pipework, cable tray and the like have been installed.
 3. All curbs to roof lights, access doors, plant and water tanks have been installed.
 4. All chases for Skirtings, etc., have been prepared.
- B. The surface of the substrate shall be clean and dry, free from ridges or indentations, laid to fall as required and not contaminated with oil or other deleterious matter.

3.02 Preparatory Work (cont'd)

- C. No waterproof membrane shall be applied until the substrate has been inspected and approved by the Engineer.
- D. The Contractor shall abide by all means to National and International Labor and health regulations. Safety precautions on Site shall incorporate, but are not limited to :
 - 1) All ladders and temporary stairs to be well secured at top and bottom.
 - 2) Sufficient number of fire extinguishers to be available.
 - 3) Safety helmet for every worker.
 - 4) All materials shall be stored in dry area, out of direct sunlight and according to manufacturer's instructions (correct rolls position, maximum load and stacking allowed,..)
 - 5) It is not permitted to store material on the building in such concentrations as to impose excessive stress and strain on deck or structural members.
 - 6) In the event that any materials for use in this section deteriorate and become unusable due to inadequate and poor storage they shall be removed from site as instructed by the Consultant / Department and replaced at the contractor's expense.

3.03 Lightweight Concrete Roof Screeds

- A. The roof screeds shall be formed of lightweight foamed concrete as section 03300, clause 2.03, item B herein. The screeds shall be laid in bays, square where possible, of maximum 10 m2. Each bay shall be formed between stop boards of the correct height and cut on each side to indicate the slope required in the roofing. The screed shall be trowelled with a wood float to true and accurate falls or cross falls up to the stop boards. A 10mm wide gap shall be left between each screed bay for the full depth of the screed.
- B. The screeds shall be allowed to cure thoroughly to attain maximum shrinkage. Any cracks which appear due to shrinkage shall be made good.
- C. The gaps between the screed bays shall be filled as follows:
 - 1) Brush or blow out joints to remove dirt, dust, etc., and prime the sides of the joints using a piece of sponge or similar dipped in a mixture, of equal volume of "Flintkote" Type 1 or Type 3 emulsion and water. Allow to dry.
 - 2) Fill up joints slightly poured of the surface using an approved mastic filler. This mastic shall be thoroughly mixed as necessary until it is a uniform brown colour. Allow to set and dry. The screed joints shall then be covered with a 200mm wide strip of building paper not bonded to the screed joint and well lapped at angles and junctions before the application of the roof covering.
- D. The dry density shall be 450 kg/cu. m, and the characteristics compressive strength as defined employing a standard cube at age of 28days shall be 1.4 Mpa using an appropriate material mix proportions, all in accordance with manufacturer's Instructions, Laboratory certified mixes, and approval of the Engineer / Employer's Representative.
Finish surface trowel smooth to receive waterproofing membrane with a protective topping of 20mm minimum thickness of cement sand screed. (1:6) applied on top employing bonding agent.

3.04 Installation

- A. Install materials in accordance with instructions officially issued by the Manufacturer. Manufacturer's technical representative shall be present as necessary to ensure proper installation.
- B. As specified leveling/sloping screed for a minimum 1% slope.
- C. 100g slipsheet layer loosely laid.
- D. Modified bitumen to torchable membrane, 4mm thick reinforced with 180gm/m2 non-woven polyester fabric with 50gm/m2 non woven glass fiber, fully bonded to substrate..
- E. 100g slipsheet layer loosely laid.
- F. Install sheet roofing in accordance with the manufacturer's instructions, and the following requirements : - .
 - 1- The waterproofing membrane shall be fully bonded with a rich hot bitumen coating.
 - 2- The flame welding process shall not be used unless specifically ordered by the Engineer as complementary to the full and proper execution of the works, at the contractor's own expense.
- Gl. Work out air bubbles, wrinkles, and fishmouths. Roll sheet into place, without stretching.
- H. Seal ends and edges to each other and to adjoining surfaces with uniform fillet bead of sealant.
- I. Seal watertight items projecting through membrane with counter flashing membrane material.
- J. Adjacent rolls of waterproofing membrane should be provided with a minimum 150mm lap and complete adhesion must be achieved between both layers to ensure complete waterproofing.

3.04 Installation (cont'd)

- K. All external and internal angles and corners shall be reinforced with an extra strip of waterproofing membrane minimum 300mm wide.
- L. Where waterproofing membrane is to be terminated at a certain height of the wall, the waterproofing membrane should be turned and dressed into the recess formed in the concrete wall and sealed off with an approved sealing compound.
- M. Pipes and other projections through waterproofing membrane should be properly treated with reinforcing strips, collars etc. as per manufacturer's recommendations to ensure complete waterproofing.
- N. Where waterproof membrane is to be left exposed for any length of time the top edge should be batten fixed to secure edge. The perimeter should be left and an extended edge of layer continuity, and the free edge be adequately protected while exposed.
- O. Before laying the protective covers, inspect to ensure no damage. Any damaged areas should be cleaned and patched in accordance with manufacturer's recommendations to ensure complete waterproofing.

3.05 Testing

- A) Flood test 72 hours minimum after completion of the waterproofing works.
- B) Restrict water run-off from membrane area by plugging drains and creating dams or dikes. Flood restricted area to depth of about 100mm and maintain at this depth for 48 hours.
- C) Repair any leaks which develop and retest
- D) At completion of flood test, drain plugs will be removed.
- E) Water supply will be given main contractor from the existing network at no cost to the Contractor, the latter being responsible for the necessary equipment and labour.

3.06 Protective Covering

- A. Where shown on the drawings provide an appropriate layer of approved washed wadi sand bed underlay, cement or terrazzo tiles on sand cement mortar, to falls and cross falls
- B. Lay approved layer of smooth rounded wadi pebbles of size not exceeding 5 cm, on all exposed untiled flat surfaces.
- C. Adequate protection against damage to the roof water proofing system shall be provided where further construction work is necessary in the area.

END OF SECTION

SECTION 07600
FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 Work Included

Top of dressed in recess water proofing flashings.

1.02 Related Work

Section 07900: Sealants.

1.03 Reference Standards

- A. ASTM B209 - Aluminum Alloy Sheet and Plate.
- B. FS TT-S-00230C - Sealing Compound: Elastomeric Type, Single Component.
- C. ASTM A176 - Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip.
- D. BS 729 - "Hot - dip galvanized coatings on iron and steel articles".

1.04 Shop Drawings

- A. Submit shop drawings in accordance with Conditions of Contract.
- B. Clearly detail shaping, jointing, length of sections, fastening, and installation details.

1.05 Samples

- A. Submit samples in accordance with Conditions of Contract.
- B. Samples are to clearly indicate all fixing and sealing methods.

1.06 Existing Conditions/Protection

- A. Exercise care when working on or about roof surfaces to avoid damaging or puncturing membrane or flexible flashings.

B. Place plywood panels on roof surfaces adjacent to work of this Section and on access routes. Keep in place until completion of work.

1.07 Guarantee/Warranty

Provide Employer with a written guarantee stating that metal flashings will properly shed water and protect finish from physical damage for a minimum period of 10 years from date of Completion of Performance of Work, as certified by the Engineer / Employer's Representative, and that damage resulting from failure to provide above stated performances will be repaired or replaced to satisfaction of Owner at no additional cost.

PART 2 PRODUCTS

2.01 Sheet Metals

Aluminum Sheet: ASTM B209; minimum 1.25 mm thick utility sheet of plain finish.

2.02 Accessory Materials And Components

- A. Fasteners: Concealed clip double seal type; of same material as flashings; sized to suit application.
- B. Solder and Flux: Type recommended for materials being used.
- C. Bituminous Paint: Acid and alkali resistant type; black color.
- D. Sealant: Two component polysulphide, non-staining; non-bleeding; non-sagging; of color selected by the Engineer / Employer's Representative.
- E. Backing Rod : closed Cell polyethylene foam with a tough non-porous skin. Over size to 50% of joint size.

2.03 Fabrication

- A. Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- B. Form sections in approved lengths. Make allowances for expansion at joints.
- C. Seams are to be flat lock type except corners. Fabricate corners minimum 455 mm x 455 mm mitered, soldered or welded, and sealed as one piece.
- D. Wipe and wash clean soldered joints to remove traces of flux immediately after soldering.
- E. Backpaint flashings with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals.

PART 3 EXECUTION

3.01 Installation

- A. Secure flashings in place using specified type fasteners. Use exposed fastener in locations approved by the Engineer / Employer's Representative. When using exposed fasteners, they are to be of same finish as flashings.
- B. Fix metal flashings to form tight fit.
- C. Apply sealing compound at junction of metal flashings and concrete and/or plastered surfaces.
- D. Lock seams and end joints. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

END OF SECTION

SECTION 07900
SEALANTS

PART 1 GENERAL

1.01 Work Included

- A. Clean and prepare surfaces to receive sealant materials.
- B. Install sealant and backing materials in exterior concrete and masonry joints around perimeter of exterior located windows and door frames, exterior and interior joints between dissimilar materials and expansion joints.

1.02 Related Work

Section 01340: Shop Drawings, product Data and Samples

1.03 Product Data

- A. Submit Product Data in accordance with Section 01340.
- B. Submit manufacturers descriptive literature; including surface preparation and installation instructions.

1.04 Warranty

- A. Provide written warranty in accordance with "Conditions of Contract".

B. Warranty is to provide for repairing and replacing, at no cost to the Owner, sealants used for joints in Concrete which fails to perform as intended, because of either leaking, crumbling, hardening, shrinkage, bleeding, sagging, staining or loss of adhesion, within a minimum period of ten years from date of Substantial Performance of Work as certified by the Engineer

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 Sealants Materials

- A. Sealant: Polysulphide base, one component, chemical curing; conforming to Shore "A" hardness of minimum 15 and maximum 50 non-staining and non-bleeding; color selected by the Engineer.
- B. Sealant: Polysulfide base, two component, chemical curing; type 1 - self levelling, 2 - non-sagging, conforming to Shore "A" hardness of minimum 15 and maximum 50 non-staining and color selected by the Engineer.
- C. Sealant: Polysulphide base, one component, air curing; conforming to Shore "A": hardness of minimum 15 and maximum 50; non-staining and non-bleeding; color selected by the Engineer.
- D. Sealant: Terpolymer base, multi-component, chemical curing; Type 1 - self levelling, Type 2 - non-sagging, conforming to Shore "A" hardness of minimum 15 and maximum 50; non- staining and non-bleeding; colors selected by the Engineer.
- E. Sealant: Silicone base, one component, solvent curing; conforming to requirements of class A; indicating an instantaneous Shore "A" hardness of maximum 50; non- staining; color selected by the Engineer.
- F. Sealant: Silicone base, one component, chemical curing; conforming to requirements of class A; indicating an instantaneous Shore "A" hardness of maximum 50; non- staining; color selected by the Engineer.

G. Sealant: Silicone base, two component, chemical curing; conforming to requirements of class A; indicating an instantaneous Shore "A" hardness of minimum 12 and maximum 25; non-staining; color selected by the Engineer.

2.03 Reparatory Materials

- A. Primers: Non-staining types recommended by sealant manufacturer to suit applications.
- B. Joint Cleaners: Non-corrosive types recommended by sealant manufacturer; compatible with joint forming materials.

PART 3 EXECUTION

3.01 Preparation/Installation

- A. Maintain workmanship of the highest quality in accordance with best trade practice. Perform all work in accordance with General Specifications.
- B. Clean and prepare joints in accordance with manufacturer's recommendations. Remove any loose materials and other foreign matter which might impair adhesion of sealant.
- C. Ensure that joint forming materials are compatible with sealant.
- D. Examine joint dimensions and size materials to achieve required width/depth ratios. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
- E. Install sealant in accordance with manufacturer's recommendations. Use one part type sealant for up to 20mm joints. Use two part type sealant for over 20mm joints.
- F. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.
- G. Form joints concave, free of air pockets, embedded matter, ridges and sags.

END OF SECTION

SECTION 08110

STEEL DOORS

PART 1 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

PART 1 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 08210
WOOD DOOR AND FRAMES

PART 1 GENERAL

1.01 Work Included

- A. Standard, fire rated and "X" ray Protection type wood doors, with flush faces as indicated on the relevant detailed drawings.
- B. Frames - in Hard Wood (pinewood) as indicated on the drawings.
- C. Metallic sub-frames.
- D. Install door hardware.
- E. Glazing (glass should be 6mm thick laminated glass for medium and heavy duty grades for fire resisting grades the glass should be 6mm Georgian wired clear glass).

1.02 Related Work

- A. Section 06200 : Finish Carpentry.
- B. Section 08700 : Hardware.

1.03 Reference Standards

AWI Quality Standards of Architectural Woodwork Institute.

1.04 Shop Drawings And Product Data

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

1.05 Guarantee/Warranty

- A. Provide written guarantee in accordance with "Conditions of Contract".
- B. Guarantee: Provide for replacing (including cost of rechanging and refinishing), at no cost to Owner, wood doors, frames and architraves exhibiting defects in materials or workmanship including warp and delamination within minimum period of 5 years from date of substantial completion of the work. Solid core doors guarantee: extended to life of installation and include cost of rechanging and refinishing.
- C. All guarantees/warranties to be issued by the Supplier, Manufacturers and Sub-Contractors shall be countersigned by the Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

The Contractor shall submit to the Supervising Engineer\Owner's Representative 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 Door Type

Flush faced, rebated type wood doors of semisolid wood ,veneer, plywood master board, high density chipboard, stabilizer. Thicknesses and finishes are as per doors schedule of finishings, details, and wood work general notes.

2.03 Doors

Wood doors shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer.

2.04 Fabrication

- A. Fabricate doors, frames and subframes in accordance with requirements of AWI Quality Standards.
- B. Fabricate fire rated doors in accordance with requirements of Underwriters' Laboratories (UL).
- C. Provide doors with minimum 25 mm thick edge strips, of wood species to match face veneers.
- D. Make cut-outs and provide stops for glass.
- E. Bevel strike edge of single acting doors 3 mm in 5 mm.
- F. Prepare doors to receive hardware. Refer to Section 08700 for hardware requirements.

PART 3 EXECUTION

3.01 Installation

Install wood doors, frames plumb and square, and with maximum diagonal distortion of 1.6 mm.
Install hardware in accordance with requirements of Section 08700.

END OF SECTION

SECTION 08305
ACCESS DOORS

PART 1 GENERAL

1.1 Section Includes

- A. Fire rated and non-rated access door and frame units.
- B. Wall and ceiling locations.

1.2 Related Sections

- A. Section 03300: Cast-in-place concrete
- B. Section 05500: Miscellaneous Metals.
- C. Section 09310: Ceramic Tiles.
- D. Section 09900: Painting.
- E. Section 15910: Ductwork Accessories: Access doors in ductwork.
- F. Electrical components requiring access.

1.2 References

UL - Fire Resistance Directory.

1.3 Submittals For Review

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work in accordance with section 01340: shop drawings product data and samples.
- C. Shop Drawings: Indicate exact position of all access door units.
- D. Samples: Submit two samples of access units, (600 x600 mm) in size illustrating frame configuration, anchors and all accessories.

1.4 Submittals For Information

- A. Section 01300 - Submittals: Procedures for submittals.
- B. Manufacturer's Installation Instructions: Indicate installation requirements, rough-in dimensions.

1.5 Submittals At Project Close-out

- A. Section 01700 - Contract Close-out: 01730 - Operation and Maintenance Data: Procedures for submittals.
- B. Record actual locations of all access units.

1.6 Regulatory Requirements

- A. Conform to UL REQUIREMENTS code for fire rated access doors.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of fire rated doors.

1.7 Project Conditions

- A. Section 01039 - Coordination and Meetings.
- B. Coordinate the work with other work requiring access doors.

PART 2 PRODUCTS

2.1 Manufacturers

- A. the contractor shall submit to Engineer review and approval the names of three manufacturers and their products which will be acceptable under this section. The approval of the manufacturer and products must be obtained before proceeding with associated work..
- B. Section 01630 - substitutions of same functions are acceptable in accordance with this section

2.2 Fabrication - Wall And Ceiling Units

- A. Fabricate louvered wooden openings comprising 50x35mm pine wood edging 50x30mm soft wood stile.
- B. Hardware:
 - 1. Hinge: 175 degree stainless steel piano hinge with removable pin concealed constant force closure spring type.
 - 2. Lock: Screw driver slot for quarter turn cam lock Cylinder lock with touch latch, chrome finish two keys for each unit .

2.3 Finishes

Finish: as approved by the engineer.

PART 3 EXECUTION

3.1 Examination

- A. Section 01039 - Coordination and Meetings: Verification of existing conditions before starting work.
- B. Verify that rough openings for door and frame are correctly sized and located.

3.2 Installation

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in opening. Secure rigidly in place.
- C. Position unit to provide convenient access to concealed work requiring access.

END OF SECTION

SECTION 08520
ALUMINUM WINDOWS, DOORS AND SCREENS

PART 1 GENERAL

1.01 Work Included

- A. Thermal braked extruded aluminum windows, doors, screens & curtain walls complete with glass and glazing hardware, and fly-screens of aluminum woven mesh in aluminum frame of same material and color as windows.
- B. Install perimeter sealant.
- C. Install hardware as indicated.
- D. All Aluminum windows, doors, screens & curtain walls shall be powder coated heavy duty of not less than (50) micron, of color as selected by the Engineer.

1.02 Related Work

- A. Section 07900: Joint Sealant.
- B. Section 08800: Glazing.
- C. Section 08700: Supply of finish hardware, other than specified in this Section.

1.03 Reference Standards

- A. ANSIO A134.1 Specifications for Aluminum Windows.
- B. ASTM A36 Structural Steel.
- C. ASTM B209 Aluminum-Alloy Sheet and Plate.
- D. ASTM B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

1.04 Shop Drawings And Product Data

- A. Submit shop drawings and product data in accordance with Section 01340.
- B. Indicate pertinent dimensioning, general construction, component connections and locations, anchorage methods and locations, hardware locations, installation details.

1.05 Delivery Of Materials

Deliver windows in Manufacturer's packaging complete with installation instructions.

1.06 Samples

- A. Submit in accordance with Section 01340, full size sample of window corner construction, including opening section, indicating profile, size and jointing method. Also submit sample of each type of operable hardware, indicated style and finish.
- B. Submit color samples for color selection, powder coated finish for the Engineer's approval.

1.07 Guarantee/Warranty

- A. Attention is directed to the provisions of the conditions of contract regarding guarantees/warranties..
- B. Provide written Guarantee in the name of the Employer in accordance with the Conditions of Contract, covering all materials and workmanship used in the installation of the aluminum windows, for a period of ten(10) years from the date of final acceptance of this Project.
- C. Manufacturer's shall provide their standard Guarantee for the work under this section. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the Manufacturer and contractor may have by law or by other provisions of the Contract Documents.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

- A. The Contractor shall submit to the Engineer's 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 the same function and performance are acceptable in conformance with Section 01630.

2.02 Windows and Doors

- A. Type: Thermal Braked extruded aluminum; ASTM B221 alloy, with fixed lights and weather-stripping.
- B. Finish: Factory apply powder coating to exposed surfaces of color as selected by the Engineer's.

2.03 Components And Materials

- A. Frames Sections will be designed to suit the installation with due allowance for wind loads, heights and location, of minimum 2.50mm thick extruded aluminum.
- B. Operable Frames sized and profiled to suit frames, complete with Manufacturer's standard type glass stops of size and profile to suit.
- C. Glass Stops Manufacturer's standard (fixed lights) screw-applied type, of size and profile to suit frames.
- D. Tempered single or double glazed as indicated on detailed drawings and approved on shop drawings.
- E. Glazing Materials Manufacturer's standard type, to suit locations and applications.
- F. Bituminous Paint Acid and alkali resistant type, color as approved.

2.04 Fabrication

- A. Fabricate window units in conformance with ANSI A134.1.
- B. Fabricate aluminum windows to allow for adequate clearances and shim spacing around perimeter of assemblies to enable proper installation. Allow for thermal movement within window construction.
- C. Provide expansion joints where required.
- D. Provide sufficient corrosion resistant anchorage devices to securely and rigidly fit windows in place.
- E. Accurately and rigidly fit together joints and corners. Match components carefully ensuring continuity of line and design. Ensure joints and connections are flush, hair line and weatherproof.
- F. Provide internal reinforcing, with steel members; ASTM A36 galvanized where required to maintain rigidity.
- G. Provide for moisture entering joints, and condensation occurring within frame construction to drain to exterior.
- H. Apply coat of bituminous paint on concealed aluminum surfaces in contact with cementitious or dissimilar materials.

PART 3 EXECUTION

3.01 Installation

- A. Install aluminum windows in accordance with Manufacturer's recommendations, to achieve weather tight installations. Ensure assemblies are plumb, level and free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- B. Install sufficient corrosion resistant anchorage devices to securely and rigidly fasten windows to building, without causing detrimental effects to shape or performance.
- C. Set window sills level and uniform. Accurately and rigidly fit together joints. Ensure joints are flush, hairline and weatherproof.
- D. Place batt insulation in shim spaces around perimeter to maintain continuity of thermal barrier.
- E. Install sealant and related backing materials around perimeter of windows in accordance with workmanship and installation requirements indicated in Section 07900.

END OF SECTION

SECTION 08700

HARDWARE

PART 1 GENERAL

1.01 Work Included

Hardware for interior and exterior doors, windows and other items shall be first quality, imported type.

1.02 Related Work

- A. Section 06200: Finish Carpentry.
- B. Section 08110: Steel Doors.
- C. Section 08210: Wood Doors and Frames.
- D. Section 08305: Access Doors.
- E. Section 08520: Aluminum Windows.

1.03 Reference Standards

- A. ANSI A115.1 - Door and Frame Preparation for Mortise Door Locks for 45mm Doors.
- B. ANSI A115.2 - Door and Frame Preparation for Bored or Cylindrical Locks for 45mm Doors.
- C. ANSI A115.5 - Frame Preparation for 181 & 190 Series Deadlock Strikes.
- D. ANSI A115.7 - Door and Frame Preparation for Floor Closers, or Double Acting.
- E. ANSI A115.8 - Door and Frame Preparation for Floor Closer, Single or Double Acting.
- F. ANSI A156.1 - Butts and Hinges.
- G. ANSI A156.2 - Locks and Lock Trim.
- H. ANSI A156.3 - Exit Devices.
- I. ANSI A156.4 - Door Controls (Closers).

1.04 Samples

- A. Submit samples of each type of hardware required for job, in accordance with Section 01340.
- B. Indicate style and finish.

1.05 Shop Drawings And Product Data

Submit shop drawings and product data in accordance with Section 01340.

1.06 Hardware Schedule

- A. Upon award of the contract the successful Contractor shall submit a hardware schedule for approval by the Engineer in accordance with Section 01340. Items shall be identified by:
 - Manufacturer - Catalogue Number - Size
 - Fastening - Finish
- B. Handing of door and window opening shall be as Hardware Schedule.

1.07 Keying

- A. Door locks Master: submit schedule for the Engineer approval.
- B. Supply 3 keys for each lock.

1.08 Operation and Maintenance Data

Provide the Engineer with manufacturer's parts list and maintenance instructions for each type of hardware supplied and necessary wrenches and tools required for proper maintenance of hardware.

PART 2 PRODUCTS

2.01 Hardware

Provide items in accordance with hardware schedule prepared by hardware supplier, complete to function as intended.

2.02 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 with associated work.
- B. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

PART 3 EXECUTION

3.01 Installation

Install hardware in accordance with manufacturer's recommendations, using proper templates.

END OF SECTION

SECTION 08800
GLAZING

PART 1 GENERAL

1.01 Work Included

- A. Glass and glazing for windows and doors.
- B. Mirror for washrooms.

1.02 Related Work

- A. Section 08110 : Steel Doors.
- B. Section 08210 : Wood Doors.
- C. Section 08520 : Aluminum Windows and Doors.

1.03 Reference Standards

- A. FS DD-G-451C - Glass, Plate, Sheet, Figured (Flat, for Glazing, Mirrors and Other Uses).
- B. FS TT-S-230A - Sealing Compound, Synthetic Rubber Base, Single Component, Chemical Curing For Caulking, Sealing and Glazing in Building Construction.
- C. FS TT-S-001543 - Sealing Compound, Silicon Base (For Caulking and Glazing in Buildings and Other Structures).

1.04 Guarantee/Warranty

- A. Provide written guarantee in accordance with Conditions of Contract, in the name of the Owner.
- B. Provide Ten (10) years warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.
- C. Provide Ten (10) year warranty to include coverage for delamination of reflective glass and replacement of same.

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 Specifications

- A. All single glazed units, other than those specified to be glazed with tempered glass, shall be glazed with 6mm clear float glass.
- B. Mirrors: float glass recommended for high humidity use sheet glass with silvered backs; arrised edges; minimum 6 mm thick.
- C. Glass for wood and steel doors: 6mm thick laminated safety glass for medium and heavy-duty grades.
- D. Leaded glass, X-Ray resistant and clear vision internal double glazing.
- E. Patch fittings for security glass should be stainless steel of approved manufacture.
- F. Mechanical Connections must be provided, designed to integrate the wall assembly. These must be manufactured from materials wholly compatible with glass and able to cope with and distribute the constant stress applied.

2.03 Glazing Compounds

- A. Glazing Compound: color to match aluminium framing sections.
- B. Silicon compound for all joints of glass walls. FEB SEAL SILLICON HM or approved equal.
- C. Sealants.

2.04 Glazing Accessories

- A. Setting Blocks: Neoprene; 80-90 Shore A durometer hardness; 9.5 mm long x width of glazing rabbet space minus 1.5mm x height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene; 50 to 60 Shore A durometer hardness; 76 mm long x one half the height of the glazing stop x thickness to suit application.
- C. Glazing Splines: Manufacturer's standard dry glazing splines to suit aluminum extrusions.
- D. Glazing Tape: Preformed butyl type; NAMM #SS-1B-68, with integral spacing devices; Manufacturer's Standard size and color; 10-15 shore A durometer hardness.

PART 3 EXECUTION

3.01 Exterior Dry Method (Preformed Glazing Channel)

- A. Clean contact surfaces with solvent and wipe dry.
- B. Cut glazing spline to proper length and install on glass pane. Weld joints by butting channel and dabbing with sealant.
- C. Place setting blocks at 1/4 points with edge block no more than 150mm from corners.
- D. Rest glass on setting blocks, and push against stop with sufficient pressure to ensure full contact and adhesion at perimeter.
- E. Install removable stops, avoid displacement of glazing Spline, exert pressure for full continuous contact.

3.02 Interior Dry Method (Tape and Tape)

- A. Cut glazing tape to length and install against permanent stop, projecting 1.6 mm above sight line.
- B. Place setting blocks at 1/4 points with edge block no more than 150mm from corners.
- C. Rest glass on setting blocks and push against tape for full contact at perimeter of pane or unit.
- D. Place glazing tape on free perimeter of glass in same manner described above.
- E. Install removable stop, avoid displacement of tape, exert pressure on tape for full continuous contact.
- F. Knife trim excess or protruding tape.
- G. Glass walls are a specialist item. Installation must be carried out by trained experts in accordance with approved procedures. The walls must be supplied and installed under one contract accompanied by a ten year warranty for both material and installation.

3.03 Cleaning

- A. After installation mark glass with X by using tape or removable paste.
- B. Immediately remove droppings from finished surfaces. Remove labels after work is completed.

END OF SECTION

SECTION 09220

PORTLAND CEMENT PLASTER

PART 1 GENERAL

1.01 Work Included

- A. Three coat cement plaster with wood float trowel led finish coat.
- B. Two coat cement plaster with rough finish coat to receive wall tiles.

1.02 Related Work

- A. Section 03300: Cast-in-place concrete.
- B. Section 04220: Concrete Masonry Unit .

1.03 Reference Standards

- A. ASTM C150 - "Portland Cement".
- B. ASTM C144 - "Sand for Cement Plaster Work".
- C. ASTM C6 - "Normal Finishing Hydrated Lime".
- D. ASTM C206 - "Special Finishing Hydrated Lime".
- E. ASTM C35 - "Inorganic Aggregates for Use In Gypsum Plaster".
- F. UL - "Underwriters' Laboratories Incorporated".
- G. ASTM C631 - "Bonding Compounds for Interior Plastering".

1.04 Sample Panel

- A. Construct 2000 mm wide x 2000 mm high sample panel with finished surface, using materials and methods specified herein, for review by the Engineer.
- B. Accepted surface finish of sample establishes minimum standard of quality and workmanship of cement plaster work on job.

1.05 Environmental Conditions

Provide sufficient heat and ventilation in areas where work of this Section is being performed, so as to allow cement plaster to properly cure. Take precautionary measures necessary to ensure that excessive temperature changes do not occur.

PART 2 PRODUCTS

2.01 Materials Generally

- A. The cement and water used for plastering shall be as before described in Section - Concrete Work and in Section – Block work.

White (Non-stain) cement for tinted plaster shall conform to the requirements of the Standard Specification for Masonry Cement of the ASTM Designation (C-91) latest edition.

Lime shall be imported and of the hydrated type complying with Class B of BS 890.

Marble chipping shall be irregular in size and roughly cubical in shape. Samples shall be submitted to the Supervisor for approval. Sizes shall be as required by the Supervisor and as selected from the following table:

| B.S. Sieve | Sizes | | Percentage Passing By Weight | | |
|------------|----------------|--------|------------------------------|---|-----|
| | Approximate mm | Inches | | | |
| — | 13.00 | 1/2 | — | | |
| — | 10.00 | 3/8 | 95 | - | 100 |
| — | 5.00 | 3/16 | 25 | - | 60 |
| 7 | 2.40 | 0.095 | 5 | - | 30 |
| 14 | 1.20 | 0.047 | 0 | - | 10 |
| 25 | 0.60 | 0.024 | | — | |
| 52 | 0.30 | 0.012 | | — | |
| 100 | 0.15 | 0.006 | | — | |

Any pigments or coloring materials incorporated in mortar shall comply with B.S. 1014:1961.

Waterproof additives shall be to the approval of the Supervisor. The materials shall be delivered in containers bearing the name of the manufacturer and the instructions for use.

2.02 Metal Accessories

- A. Angle Beads, Corner Mesh and Plaster stops: Minimum 0.50mm thick steel with rust inhibitive coating of longest possible lengths; sized and profiled to suit application. Angle beads to have bull nosed edges.
- B. Metal lath for use in plaster shall be plain expanded metal type complying to B.S. 1369, weighing not less than 1 kg/sq.m All metal lathing shall be zinc coated. Zinc coated chicken wire mesh can also be used with dia less than (15 mm) and (20 cm) wide.

Metal lath shall be secured to the carcass and block work by means of galvanized steel nails. If the wire for securing metal lath is to be used it shall be of zinc coated wire not less than 1.2 mm in diameter.
- C. Expansion Joints: Back to back plaster stops of longest possible lengths.
- D. Anchorage's: Nails, staples, or other metal supports, of type and size to suit application and to rigidly secure metal accessories in place

2.03 Application of Coats

- A. Base-Coat (Rendering)

After the application of the spatterdash "Rasheh" the base coat shall be applied after the spatterdash coat has set but in no case earlier than 4 days after the application of the spatterdash coat. Spatterdash coat shall be kept wet moist for 3 days.

When applied to masonry or to concrete surfaces the base coat shall be applied with sufficient force to prevent air pockets and to secure a good bond.

The base coat shall be lightly scratched in both directions to provide a key for the finishing coat and shall be kept moist with a fog spray for 3 days and then allowed to dry out. Thickness shall be between (10-12 mm).
- B. Finishing Coat

Shall not be applied until the rendering or base coat has seasoned for seven days just before the application of the finish coat, the rendering or base coat shall be wetted evenly with a fog spray, where cement plaster with a smooth trowelled finish is specified or indicated on the drawings, the finish coat shall be first floated to a true even surface, then trowelled in a manner that will force the sand particles down into the plaster and with the final trowelling, leave the surface finished smooth and free from rough areas, trowel marks, checks or other blemishes.

2.04 Cement Plaster Mixes

- A. Mix and proportion cement plaster as follows: (by volume).
 - 1. Spatterdash (Rasheh) coat: 1 part ordinary Portland cement 2 parts salt free sand.
 - 2. Base-coat (Rendering): 1 part ordinary Portland cement 4 parts salt free sand.
- 3. Finishing coat: 1 part ordinary Portland cement 4 parts fine sand.

Plastering shall be applied in two (2) coats in addition to the spatterdash coat unless otherwise specified or indicated on the drawings.

Finishing coat shall have a reasonably uniform thickness of approximately 3-5mm.

Screed shall be laid and rules as necessary to allow for a total thickness of 15 mm for external and internal plaster and the rendering shall be applied to the required thickness.
- B. Mix only as much plaster as can be used in one hour.
- C. Mix materials dry, to uniform color and consistency, before adding water.
- D. Add color pigments in accordance with manufacturer's recommendations. Ensure uniformity of mix and coloration.
- E. Protect mixes from frost, dust and evaporation.
- F. Do not retemper mixes after initial set has occurred.
- G. Where hydrated lime is accepted and approved by the Engineer, the volume of lime must not exceed 0.5 that of cement volume for the base course, and 1.0 that of cement volume for the second and third coats.
- H. For two coats plaster use items 1 and 2 of "A" above.

PART 3 EXECUTION

3.01 Preparation

- A. Prior to application ensure mechanical and electrical services behind surfaces to receive cement plaster have been tested and approved.
- B. Clean concrete and concrete block surfaces of dust, laitance, efflorescence, loose particles, grease or other foreign matter. Thoroughly wet surfaces before using acid solutions, solvents or detergents to perform cleaning. Thoroughly wash surfaces with clean water immediately following their use. Ensure mortar joints are flush.
- C. Roughen smooth concrete surfaces so as to allow adequate adhesion. Use method acceptable to the Engineer.
- D. Apply a bonding agent on concrete and concrete block surfaces which are to receive cement plaster. Apply in accordance with manufacturer's recommendations, ensuring complete coverage.
- E. Ensure metal lath has been properly installed and rigidly secured.
- F. Wet Concrete and Concrete block surfaces to reduce excessive suction.
- G. Place metal accessories true to lines and levels.

3.02 Plastering

- A. Apply cement plaster using two coat system and three coat system respectively.
- B. Evenly dampen each coat, to ensure uniform suction, and apply the following coat. Apply to thickness sufficient to secure required texture but in no case less than 3 mm. Apply finish coat subject to requirements.
- C. Maintain surface flatness, with maximum variation of 3.2mm in 3.000 m.
- D. Provide surfaces receiving paint with a steel trowel finish, to match approved sample pane.
- E. Avoid excessive working of surface. Delay trowelling as long as possible to avoid drawing excess fines to surface.

3.03 Fire Rated Assemblies

Perform cement plaster work for fire rated assemblies in accordance with drawings and as recommended by Underwriter's Laboratories.

PART 4 WATERPROOFING PLASTER TO ALL EXTERNAL WALLS

Mixing of plaster ingredients and preparation of surfaces to be plastered with waterproofing plaster shall be as specified above.

Rendering coat shall contain 450 Kg of ordinary Portland Cement per cubic meter of clean coarse salt free sand and with admixture of waterproofing compound as specified added in accordance with the printed instructions of the manufacture, shall be applied and the surfaces shall be trowelled hard smooth and allowed to dry. All surfaces of plastered areas shall be cured for minimum of 7 days. Proportions of mix is 1:2 for all coats.

PART 5 TYROLEAN PLASTER (FINE GRAIN)

5.01 General

The tyrolean plaster shall be executed to the extent shown on the Drawings and as directed by the Supervisor.

The Contractor shall provide sample (s) of Tyrolean plaster for the approval of the Supervisor prior to commencement of Tyrolean work.

5.02 Mixing

Cement and aggregate for each batch shall be accurately measured and mixed dry until evenly distributed and the mass is uniform in color. All batches shall be of such size that they can be entirely used within half an hour. Mechanical mixers of an approved type shall be used for mixing tyreolean plaster, except when hand mixing of small batches is specifically approved by the Supervisor. Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of tyrolean mortar from previous mixes. Water content shall be maintained at a minimum. Mixing shall be continued until plasticity be maintained at a minimum. Mixing shall be continued until plasticity is obtained.

5.03 Proportions

Proportions of materials for tyrolean, by volume shall be as follows: -

A. Scratch Coat

- 1 part Ordinary Portland Cement
- 3 parts fine aggregate

B. Finish Coat

- 1 part of white Portland Cement
- 3 parts fine selected aggregate (made of fine grinded lime stone)

No lime shall be allowed in either scratch or finishing coat, scratch coat shall be set on spatterdash.

C. Application of Tyrolean

1. Workmanship

Surfaces to receive tyrolean shall be clean, free from dust, dirt, oil, or other particles that might interfere with a satisfactory bond. Surfaces to receive tyrolean shall be evenly dampened (not soaked) with a fog spray before tyrolean is applied. If surfaces become dry in spots, the dry areas shall be dampened again to restore uniform suction. Tyrolean Coats shall be applied continuously in one general direction without allowing mortar to dry at edges. Edges to be joined shall be dampened slightly to produce a smooth confluence. Tyrolean unless otherwise shown or specified shall be two coats work not less than 20 mm thick (i.e. spatterdash, scratch coat and one tyrolean coat). All exterior corners of tyrolean shall be slightly rounded. Tyrolean shall be pitched forward to form a drip.

2. Scratch Coat

Shall be approximately 14 mm thick and shall be applied under sufficient pressure to form good keys and shall be brought to a plumb, true even surface. The scratch coat shall be damp-cured 48 hours before the finish coat is applied under sufficient pressure to form good keys and shall be brought to a plumb, true even surface.

3. Finish Coat

Shall be approximately 6 mm, thick. Surfaces of the scratch coat shall be dampened several hours before the finish coat is to be applied. Additional dampening at time of application shall be by fog spraying. Dampening by brush will not be permitted. When measured with a 2 meter long, straightedge applied in all directions the finish surface shall not vary from a true plane by more than 1.5 mm. The finishing coat shall be applied by means of a proper spraying machine and the degree of the finishing coat shall be determined by the Supervisor. The Contractor shall set up samples of different degrees of fineness for the Supervisor's approval. The Supervisor may choose different degrees of fineness for different parts of the works and the Contractor shall allow for this in his rates.

END OF SECTION

SECTION 09260
GYPSUM BOARD SYSTEMS

PART 1 GENERAL

1.01 Work Included

- A. Metal Framing required for gypsum board suspended ceilings.
- B. Blocking.
- C. Acoustical and sound insulation.
- D. Thermal Insulation for z-furring channel installation.
- E. Gypsum Board, fire rated, sound and thermal insulating.
- F. Radiation Protection Gypsum Board.
- G. Acoustical Sealant.
- H. Taped and sanded joint treatment.

1.02 Related Work

Section 09900: Painting

1.03 Quality Assurance

Perform gypsum board systems work in accordance with ASTM C36.
Or any approved equal.

1.04 Submittals

- A. Submit samples of gypsum board systems and exposed joint covers in accordance with Section 01340. Include a sample of each material, texture, and colour specified.
- B. Submit manufacturer's recommendations for installation of thermal insulation and gypsum board.

1.05 References

- A. GA 216 - Recommended Specifications for installation of thermal insulation and gypsum board.
- B. Complies with ASTM C-36, 0-630 method C-473.
- C. Complies with ASTM C840.

PART 2 PRODUCTS

2.01 Metal Framing

- A. Provide metal framing materials in accordance with GA 216.
- B. Studs: 60 X 60 cm both directions.
- C. Runners: Match studs.

2.02 Materials

- A. Gypsum Boards cladding shall be 15-20 mm thick fire rated.
- B. Gypsum board false ceiling shall be 12.5mm thick concealed system similar to Knauf Gypsum Ceiling System D113.
- C. Gypsum board false ceiling in toilets and kitchenettes' areas shall be moisture resistant type, 12.50 mm thick, and as item "A" above.

PART 3 EXECUTION

3.01 Metal Framing Erection - General

- A. Erect metal framing in accordance with ASTM C764.
- B. Install members true to lines and levels to provide surface flatness with maximum variation of 1/8 inch in 10 feet in any direction.

3.02 Ceiling Framing Installation

- A. Coordinate location of hangers with other work.
- B. Install ceiling framing independent of walls, columns, and above ceiling work.
- C. Space main carrying channels at maximum 600 mm on center, not more than 150 mm from perimeter walls. Lap splices minimum 300 mm and secure together 50 mm from each end of splice.
- D. Place furring channels perpendicular to carrying channels at 600 mm on center not more than 150 mm from perimeter walls. Lap splices minimum 200 mm and secure together 25 mm from each end of splice.
- E. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 600 mm past each end of openings.
- F. Laterally brace entire suspension system where required.

3.03 Gypsum Board Installation

- A. Install gypsum board in accordance with recommendations of GA 216, the manufacturer's recommendations, or both.
- B. Erect single layer standard gypsum board in direction most practical and economical, with ends and edges occurring over firm bearing.
- C. Erect single layer fire rated gypsum board vertically, with edges and ends occurring over firm bearing.
- D. Erect exterior gypsum sheathing board horizontally, with edges butted tight and ends occurring over firm bearing.
- E. Use screws when fastening gypsum board to metal furring or framing. Use nails or screws when fastening gypsum board to wood furring or framing. Staples may only be used when securing the first layer of double layer applications.
- F. Erect patterned gypsum board horizontally/vertically, complete with exposed batten fastening system. Erect in accordance with manufacturer's recommendations.
- G. Treat cut edges and holes in moisture resistant gypsum board with sealant.
- H. Place control joints to be consistent with lines of building spaces and in consistent pattern and as directed by Engineer.
- I. Place corner beads at external corners. Use longest practical lengths. Place edge trim where gypsum board abutts dissimilar materials.
- J. Tape, fill, and sand exposed joints, edges, corners, openings and fixings, to produce surface ready to receive surface finishes.
- K. Remove and re-do defective work.

3.04 Warranty/Guarantee

All warranties/guarantees to be issued by the Supplier, Manufacturers and Sub-Contractors shall be counter- signed by Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

END OF SECTION

SECTION 09310
CERAMIC TILES

PART 1 GENERAL

1.01 Work Included

- A. Ceramic tiles flooring and skirting, installed using approved adhesive material with epoxy grouted joints.
- B. Ceramic tiled walls, installed using adhesive, with epoxy grouted joints.
- C. Approved Adhesive Material.
- D. Fixing of ceramic washroom accessories as supplied under Sanitary Ware.

1.02 Related Work

Section 03251 - Expansion and Contraction Joints.

1.03 Reference Standards

- A. ANSI A108.5 - Ceramic Tile installed in the Dry-Set Portland Cement Mortar on Latex-Portland Cement Mortar.
- B. ANSI A118.4 - Latex-Portland Cement Mortar.
- C. ANSI A136.1 - Organic Adhesives for Installation of Ceramic Tile.
- D. ANSI A42.4 - Interior Latching & Furring.
- E. Tile Council - Handbook for Ceramic Tile Installation. of America
- F. TCA137.1 - Recommended Standard Specifications for Ceramic Tile.

1.04 Samples

Submit a 1000mm X 1000mm sample of ceramic wall and floor tile installation, clearly indicating pattern, coloration and grouted joints. Submit in accordance with Section 01340.

1.05 Environmental Conditions

Provide sufficient heat and ventilation in areas where work of this section is being performed; so as to allow ceramic tile to properly set. Take all precautionary measures necessary to ensure that excessive temperature changes do not occur.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

- A. The Contractor shall submit to the Engineer the name of three manufacturers and their Products which will be acceptable under this Section. Approval of the Manufacturer or the Product must be obtained before proceeding the associated work.
- B. Type:
 - 1) Type and sizes of tiles shall be as indicated in the BOQs and drawings.

2.02 Materials and Components For Floors

- A. Ceramic Floor Tile: Square edges, of approved thickness; smooth surface; unglazed, color selected by Engineer.
- B. Setting Bed: Adhesive as approved by the Engineer and instructed by the manufacturer.
- C. Grout: epoxy type; color selected by the Engineer; uniform in color and resistant to shrinking (preparation, mixing and placing should be as instructed by the manufacturer).
- D. Water: Clean, fresh and free of deleterious substances.

2.03 Materials And Components For Walls

- A. Ceramic Wall Tile: cushioned edges; glazed surfaces, color selected by Engineer.
- B. Scratch Coat and Mortar Bed: Adhesive material as instructed by the manufacturer.
- C. Grout: epoxy type; color selected by the Engineer; uniform in color and resistant to shrinking.

PART 3 EXECUTION

3.01 Installation

- A. Prior to installing floor tile, ensure surfaces are level, with maximum surface variation of 6mm in 3.00 meters, and are steel trowled. Ensure surfaces slope to drains.
- B. Prior to installing wall tile, ensure surfaces are level, with maximum surface variation of 3 mm in 3.00 meters.
- C. Ceramic tiles shall be thoroughly soaked in water for a minimum of twenty four hours (24), before laying, and all surplus water drained off before bedding.
- D. Rough cement and sand plastering in tow coats shall be laid as base for wall tiling. Plaster shall be in accordance with Section 09220; PORTLAND CEMENT PLASTER.
- E. Ensure surfaces are clean and well cured.
- F. Do not commence until surface conditions are within tolerances required for proper installation.
- G. Neatly cut tile around fixtures and drains. Accurately form corners, base, intersections and returns.
- H. Ensure tile joints are uniform in width, subject to normal variance in tolerance allowed in tile size. Ensure joints are watertight, without voids, cracks, excess mortar or grout.
- I. Form internal wall angles square and external angles rounded.
- J. Sound tile after setting. Remove and replace hollow sounding units.
- K. Keep expansion/contraction control joints free of mortar or grout.
- L. Allow tile to set for a minimum of 48 hours prior to grouting.
- M. Completed installation to be free of broken, damaged or faulty tile.

END OF SECTION

SECTION 09410
PORTLAND CEMENT TERRAZZO

PART 1 GENERAL

1.01 Work Included

- A. Preparation of concrete substrate.
- B. Terrazzo floor, color as selected by the Engineer.
- C. Skirting 70 mm X 20mm thick.
- D. Curing, grinding and sealing.

1.02 Related Work

Section 01340: Shop drawings, Product Data and Samples.

1.03 Reference Standards

- A. BS 882 - Aggregate from natural sources for concrete.
- B. BS 12 - Ordinary Portland Cement
- C. BS 5075 - Concrete Admixtures, Air Entraining for concrete
- D. National Terrazzo and Mosaic Association, Inc. (NTMA), Publication: Terrazzo Design Data Book (1972).

1.04 Product Data & Samples

- A. Product data and samples shall be in accordance with Section 01340.
- B. Prior to delivery of the materials to the site, the following samples shall be submitted for approval to the Engineer:
Terrazzo - Two sample panels of each type finish including abrasive, if required, or color combination. Minimum dimension of tile shall be 200mm thick.
- C. Copies of Manufacturer's Specifications and installation instructions for each type of precast terrazzo and material shall be submitted to the Engineer.

1.05 Shop Drawings

- A. Shop drawings shall be in accordance with Section 01340.
- B. Shop drawings showing location, extent, size, shape, and jointing of each type of precast terrazzo item required. Details of anchorage and other special features required shall be included.

1.06 Delivery, Storage & Handling

Manufacturer's packaged materials shall be delivered and stored in their original containers with seals unbroken and labels intact until time of use. Materials shall be protected against the inclusion of foreign matter and/or water and other damage.

1.07 Environmental Conditions

- A. The substrate and the conditions under which the terrazzo is to be installed shall be carefully examined. The Contractor shall submit notification to the Engineer of any unsatisfactory conditions, which will affect the terrazzo installations. Work shall not proceed until such unsatisfactory conditions have been corrected and the surfaces are acceptable.
- B. The ambient surroundings and temperature of cementitious mixtures shall be not less than 10 degrees C. from the time the setting beds are placed until completely cured.

PART 2 PRODUCTS

2.01 Materials

Shall conform to the respective specifications and other requirements specified below:

- A. Portland cement: BS 12 Cement shall be obtained from a single source for all work of one color.

Non-staining white or gray shall be provided as required for terrazzo matrix.

- B. Sand: BS 882, for fine aggregate.
- C. Water shall be clean, free of oil, soluble salts, or other deleterious substances.
- D. Aggregate shall be natural, sound, crushed marble chips without excessive flats or flakes. Colors and gradation of sizes shall be as required to match approved samples.
- E. Matrix pigments shall be pure mineral or synthetic pigments, resistant to alkalis and nonfading. Pigments shall be mixed with cement, by weight, to provide colors as required to match approved samples.

- F. Cleaner shall be liquid, neutral chemical cleaner, formulated for Portland cement terrazzo, as recommended by the Manufacturer of the sealer.

2.01 Materials (cont'd)

- G. Interior floor sealer shall be colorless, non-slip, stain-resistant penetrating sealer which will not disturb the color or physical properties of the terrazzo surface.
- H. Exterior sealer shall be a colorless, non-yellowing, penetrating, synthetic resin sealer for terrazzo.
- I. Air-entraining admixture: BS 5075.

2.02 Precasting

- A. NTMA specifications and recommendations for fabrication of precast terrazzo shall be complied with.
- B. Units shall be cast accurately to size and profile indicated on approved shop drawings.
- C. Type of Portland cement, amount of pigment, if any, and percentages of aggregate shall be in accordance with approved NTMA color plates.
- D. Exposed edges of precast items shall have 3.2 mm radius unless otherwise indicated.
- E. Tiles are formed of two layers, the wearing (facing) layer and the back layer. The net thickness of the tiles after polishing shall be as follows:-

| Dimensions (cm) | Lowest Limit for the Total Thickness (mm) | Lowest Limit of the Facing (Wearing) Layer (mm) |
|-----------------|---|---|
| 20 X 20 | 25 | 8 |
| 25 X 25 | 25 | 8 |
| 30 X 30 | 27 | 12 |
| 40 X 40 | 30 | 12 |

- F. Abrasive aggregate, approximately 15 percent by volume, shall be provided in both the topping mix aggregate and the aggregate seeded during installation in the non-slip areas shown on the drawings.
- G. All precast members shall be moist-cured in compliance with NTMA specifications.
- H. Cured terrazzo topping shall be grouted and ground in accordance with NTMA specifications. Finishing shall be by fine grinding with abrasive grit of the size specified by NTMA, or as otherwise required to match approved samples.

- I. Terrazzo surfaces to receive rustic finish shall be washed to remove approximately 1.5mm of uncured matrix, without disturbing the aggregate. Curing shall be as specified by NTMA. The terrazzo surface shall be saturated with water and cleaned with a 20 percent solution of muriatic acid (9 parts water to 1 part commercial acid) then rinsed thoroughly with clean water to remove and neutralize the acid wash. The terrazzo surface shall match the approved samples for depth of etch into matrix.

PART 3 EXECUTION

3.01 Installation

- A. Preparation of substrate, proportioning setting bed, and placing, grouting, and finishing shall be in accordance with NTMA specifications and recommendations unless otherwise shown or specified.
- B. Setting bed mortar shall be one part Portland cement and three to four parts clean sharp sand. Only enough water to produce a workable mix shall be added.
- C. Terrazzo installation shall be completed before the application of other items, which might be damaged by this work.
- D. Marble Bases shall be installed after placing floor tile or other terrazzo floor toppings. Base shall be set accurately to wall and floor finish lines.
- E. Floor tile shall be laid out to avoid pieces less than one half-tile size.
- F. Field cutting of precast terrazzo, where required, shall be with high-speed diamond or other abrasive saws.
- G. Joints shall be aligned in floor tile at right angles to each other and straight with walls.
- H. All tiles shall be applied with straight joints each way unless otherwise indicated.

- I. Precast terrazzo shall be installed as shown and in accordance with NTMA specifications. Units shall be tamped into setting bed to achieve a full bond without voids, and leveled at joints. Units shall be finish ground at joints if required to remove any minor discrepancies in level of units. Warped, stained, damaged, and non-matching units shall be replaced as directed. Joints shall be grouted, except those shown to receive sealant, with a mixture of Portland cement, pigment, and water matching the matrix of the units.

3.02 Cleaning and Sealing

- A. Terrazzo shall be cleaned after all installation and finishing operations are completed in accordance with the instructions of the terrazzo sealer Manufacturer.
- B. Sealer shall be applied to cleaned terrazzo surfaces in accordance with Manufacturer's Instructions. The maximum number of coats of sealer recommended by the Manufacturer shall be applied.

3.03 Final Cleaning and Protection

- A. Terrazzo shall be cleaned as recommended by the Manufacturer of the sealer, and machine buff if required when buildings are ready for occupancy.
- B. Protection shall be provided for finished terrazzo work until buildings are ready for occupancy.

3.04 Testing

- A. The Contractor shall test terrazzo tiles whenever so requested by the Supervisor for the following items:
 - 1. Water absorption to be 8% (BS4131)
 - 2. Transverse strength to be 3Mpa (BS4131)
 - 3. Wear resistance to be 2mm (DIN52108)

END OF SECTION

SECTION 09510
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 Work Included

- A. Fire rated suspended metal grid system complete with wall and bulkhead trim.
- B. Lay-in ceiling tiles.
- C. Hangers and Inserts.
- D. Cut-out for ceiling appurtenance and/or access panels.

1.02 Related Work

- A. Section Lighting fixtures within ceiling system.
- B. Section Air Diffusers within ceiling system.

1.03 Shop Drawings

- A. Submit shop drawings of acoustical ceilings in accordance with the Engineer's instructions.
- B. Clearly indicate grid layout and all related dimensioning, junctions with other work or ceiling finishes, inter- relation of mechanical and electrical items related to system.

1.04 Environmental Conditions

- A. Do not install acoustical ceilings until building is enclosed, sufficient heat is provided, dust generating activities have terminated and overhead mechanical work is completed, tested and approved.
- B. Permit wet work to dry prior to commencement of installation.
- C. Maintain uniform temperatures of minimum 16 degrees C. and humidity of 20% to 40% prior to, during and after installation.

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 the Engineer's instructions.

2.02 Suspension System

Type and Manufacture: Heavy duty system as instructed by the manufacturer and approved by the Engineer.

2.03 Lay-In Panels

Acoustic Tiles: (Mineral Fiber Tiles) (600x600)mm

PART 3 - EXECUTION

3.01 Installation

- A. Install acoustical ceiling systems in accordance with manufacturer's recommendations to produce finished ceiling true to lines and levels and free from warped, soiled or damaged grid or lay-in panels.
- B. Install fire rated ceiling systems in accordance with UL requirements.
- C. Install ceiling systems in a manner capable of supporting all superimposed loads, with maximum permissible deflection of 1/360 of span and maximum surface deviation of 1/960.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work. Ensure the layout of hangers and carrying channels are located to accommodate fittings and units of equipment which are to be placed after the installation of ceiling grid systems.

- E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest adjacent hangers and related carrying channels as required to span the required distance.

3.01 Installation (cont'd)

- F. Supply hangers or inserts for installation to the respective section in ample time and with clear instructions for their correct placement. Provide additional hangers and inserts as required.
- G. Hang independently of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of the longitudinal axis or face plane of adjacent members.
 - H. Center ceiling systems on room axis leaving equal border pieces.
 - I. Do not support fixtures from or on main runners or cross runners if weight of the fixture causes the total dead load to exceed the deflection capability. In such cases, support fixture loads by supplementary hangers located within 150 mm of each corner, or support the fixtures independently.
 - J. Do not install fixtures so that main runners and cross runners will be eccentrically loaded. Where fixture installation would produce rotation of runners, provide stabilizer bars.
 - K. Install edge moldings at intersection of ceiling and vertical surfaces, using maximum lengths, straight, true to line and level. Miter corners. Provide edge moldings at junctions with other ceiling finishes. Where bullnose concrete block corners occur, provide preformed closers to match edge molding.
 - L. Install lay-in panels level, in uniform plane and free from twist, warp and dents.
 - M. Install hold-down clips on all lay-in panels to hold such panels tight to grid system where within 6.0 m of exterior doors.

3.02 Adjustments

Adjust any sags or twists, which develop in the ceiling systems and replace any part which is damaged or defective.

END OF SECTION

SECTION 09513
METAL TILES FALSE CEILING SYSTEM

PART 1 GENERAL

1.01 Work Included

- A. Suspended Metal Grid Ceiling Support System
- B. Formed Metal Laid in Ceiling Tiles
- C. Cut-out for Ceiling Appurtenance
- D. Hangers and Inserts

1.02 Related Work

- A. Section 01340: Shop Drawings, Product Data and Samples
- B. Section 01630: Substitution and Product Options

1.03 Performance

Design and construct suspension system to accommodate wind and suction loads and wind uplift.

1.04 References

- A. ASTM B209 - Aluminum Alloy Sheet and Plate.
- B. ASTM A446 - Steel Sheet, Zinc - coated (galvanized) by the hot dip process structural (physical) quality.

1.05 Shop Drawings And Product Data

- A. Submit shop drawing and product data in accordance with Section 01340.
- B. Indicate extent of suspension system, method of support for system, integration with mechanical and electrical components, component materials and profiles, perimeter trim members, and installation and coordination details.

1.06 Samples

- A. Submit samples in accordance with Section 01340.
- B. Provide sample of metal sections, supporting main and secondary suspension members, and attachment clips; and in color and finish required.

PART 2 PRODUCTS

2.01 Acceptable Manufactures

- 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. Type: Type and Size of tiles shall be as indicated in the Bill of Quantities and instructed by the Manufacturer.
- C. Substitutions: Items of same function and performance are acceptable in accordance with Section 01630.

2.02 Components

System: Preformed aluminum lay in tiles with plain surface offering sound absorption in the low frequency range similar to Messers. (OWA or approved equal type). Complete with galvanized steel suspension system with anchors to structure as recommended by the manufacturer.

2.03 Materials

- A. Suspension Members: Formed steel tees, with adjustment clips, galvanized finish.
- B. Suspension Wire: 8 mm steel wire, annealed, galvanized.
- C. Aluminum Extrusions: ASTM B209.
- D. Splices: of same material, profile, and color as exposed members.
- E. Internal and External Corners: of same material, thickness, and finish as exposed members; of profile to suit system; shop formed to required angles. Back brace internal corners.
- F. Recessed Closures: Formed aluminum tiles, lay in between exposed members.
- G. Accessories: as required to complement system members, same color and finish.
- H. Expansion Joints: of same material, thickness, and finish as exposed members.
- I. End Caps: formed metal of same color and finish as exposed members.

2.04 Fabrication

Shop fabricate exposed components.

PART 3 EXECUTION

3.01 Installation

- A. Install ceiling system in accordance with manufacturer's instructions.
- B. Install ceiling system to support superimposed loads.
- C. Install ceiling after major above-ceiling work is complete. Coordinate the location of hangers and carrying tees with other work.
- D. Install hangers or inserts.
- E. Where ducts or other requirement prevent the regular spacing of hangers, reinforce the nearest adjacent hangers and related carrying tees to span the required distance.
- F. Hang independently of walls, columns, ducts, pipe and conduit.
- G. Design and layout runners and cross runners so that fixtures will not produce eccentric loads.
- H. Install exposed members using maximum lengths.
- I. Install recessed closures between exposed members at interior and exterior locations.
- J. Exercise care when cutting members on site to insure surface finish is not defaced.
- K. Install edge moldings at intersection of ceiling and vertical surfaces using maximum lengths. Field miter corners. Provide edge moldings at junction with other ceiling finishes.
- L. Provide expansion joints to accommodate plus or minus movement and maintain visual closure.
- M. Provide end caps for members exposed to view.

ENG OF SECTION

SECTION 09610

STONE FLOORING

PART 1 GENERAL

1.01 Work Included in the Unit Rate

- A. Stone floor finish (sizes and type as indicated in the Bill of Quantities).
- B. Mortar bed and joint pointing.

1.02 Related Work

- A. Section 04100 - Mortar
- B. Section 07900 - Sealants.

1.03 References:

The Palestinian General Specifications

1.04 Submittal

- A. General: Shop drawings - Product Data and Samples for submittal provisions and procedures.
- B. Shop Drawings and Product Data:
 - 1. Submit shop drawings and product data in accordance with the Engineer's instructions. Shop drawings shall clearly indicate expansion joints' dimensions and locations.
 - 2. Indicate Pertinent dimensioning, layout, construction details, method of installation and adjacent construction.
 - 3. Indicate all units of stone, their configuration and size.
 - 4. Submit stone supplier's installation instructions, and field erection drawings.
 - 5. Submit manufacturer's instructions for use of pointing colour and admixtures.
- C. Samples
 - 1. Submit two sets of each type of stone, full size units as selected by the Engineer to the project site, in sufficient number to indicate the full range of color, texture and each type of finish. One of each of the duplicate samples approved by the Engineer will be retained by him at the project site, the other being returned to the Contractor for his guidance. Colors and types of stone - dressings are as mentioned under Part 2 - Products, paragraph B, "STONE SCHEDULE".
 - 2. The following physical data on all proposed stone shall be submitted by the stone supplier:
 - a. Analysis of mineral composition.
 - b. Analysis of chemical composition.
 - c. Thermal coefficient of expansion.
 - d. Absorption.
 - e. Specific Gravity.
 - f. Abrasion Resistance
 - 3. Submit samples of other materials specified herein upon request by the Engineer.
- D. Mock Up
 - 1. Furnish and install a typical stone floor application required for the project at area designated by the Engineer. The panel shall be constructed for Engineer's approval showing 1.5m x 1.5m for floor installation.
The Contractor shall also be required to install a typical stone stair application, or any offer which in the opinion of the Engineer is required.
 - 2. All work shall include setting and jointing all stone including final cleaning as specified herein for the actual work and as required for approval. Construct as many mock-ups until approval by the Engineer has been obtained.
 - 3. The approved mock-up shall constitute the quality of work to be expected throughout the entire project, and shall remain in place for visual inspection until no longer needed as directed by the Engineer. The removal and disposition of the mock-ups shall be done by the Contractor at his expense without additional cost to the Owner.

1.05 Guarantee/ Warranty

- A. Attention is directed to the provisions of the CONDITIONS OF CONTRACT regarding guarantees/warranties for the Works.
- B. All warranties/guarantees to be issued by the Supplier, Manufacturers and sub-contractors shall be counter-signed by Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

1.06 Standards

Applicable provisions of the following standard publications shall apply throughout the work:

Ministry of Public Works. The General Technical Specifications for buildings, section 5, volume I, STONWORK; "Recommended Practices for the use of Natural Stones in Building Constructions".

1.07 Qualifications

- A. Supplier/Fabricator: A firm having an adequate supply of the specified types of stone and an annual rated production capacity to deliver the stone to the project site on schedule within a time limit established by the Engineer as required to assure no delay in the progress and completion of the Work.
- B. Installer: A Firm with a minimum of five years successful experience in the installation of stone pavers.

1.08 Design Criteria

The method of installation of all stone pavers shown on the Drawings is diagrammatic only and is not to be used for the purpose of bidding or construction. It shall be the responsibility of the Contractor to guarantee the structural support and the permanent watertight sealing of all stone pavers. The installation shall be designed to allow for expansion and contraction of supporting floors of the paved areas.

1.09 Delivery, Storage & Handling

- A. Packing and Loading: Finished stone shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discoloration shall be used for blocking or packing.
- B. Site Storage: Upon receipt at the building site or storage yard, the stone shall be stacked on timber or platforms at least 100 mm above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering.
Salt shall not be used for melting of ice formed on pieces, or for any purpose involving its contact with the stone.
- C. Defective Stone: Any piece of stone showing flaws, cracks, or imperfections such as vents, sand and clay holes, shelly bars, shakes, mottle, seams or starts upon receipt at the storage yard, or at the area to be paved, shall be discarded and removed from the work site, and at the Contractor's own expense.

1.10 Environmental Requirements

- A. The following environmental requirements are applicable to stone set in mortar, and when caulking stone joints with sealant.
- B. During freezing or near freezing weather provide equipment and cover to maintain a minimum of 4 degrees C and to protect stone work completed or in progress.
- C. At end of working day, or during rainy weather, cover stone work exposed to weather with waterproof coverings, securely anchored.
- D. Maintain materials and surrounding air to a minimum 10 degrees C prior to, during and 48 hours after completion of work.

PART 2 PRODUCTS

2.01 Stone Materials And Fabrication

A. General

- 1. Stone shall be of good quality, sound, free from cracks and defects, seams or starts which may impair its structural, integrity, durability, appearance or function colour, texture and finish shall be within the range of samples approved by the Engineer.
- 2. All stone shall be obtained from quarries having adequate capacity and facilities to meet the specified requirements. Cutting and finishing shall be performed by using approved equipment to process the material promptly on order and in strict accordance with specifications. Evidence to this effect shall be provided by the Contractor.
- 3. Stone rejected for noncompliance with the submitted samples or the requirements of this Specification shall be replaced with material acceptable to the Engineer. Replacement shall be prompt and at the Contractor's own expense. Inspection of stone by the Engineer shall not relieve the Contractor of his responsibility to perform all work in accordance with the Contract Documents.

2.01 Stone Materials And Fabrication (cont'd)

- B. Stone Schedule: Refer to the Drawings for locations, sizes and thicknesses of the various types of stone specified herein. All stone work shall be carried out in accordance with the classification of Class "Special" refer to clause 1.06, Item A/1:
- | Stone Type | Application/Thickness/Finish |
|------------|------------------------------|
|------------|------------------------------|
1. **First Quality (Local Type) Stone**
- Application: First quality stone tiles, white and pink stone exterior stone tiling, set in mortar and sand over reinforced concrete slabs.
- Thickness: As noted on the relevant drawings.
- Finish: As shown on relevant drawings.
2. **Stone Application**
- Exterior Stairs treads and risers bedded with mortar and anchored as necessary.
- Thickness: as noted on the relevant drawings.
- Finish: As shown on drawings.
- All stone work to be executed in accordance with approved shop drawings.
- C. Stone
1. The finish of exposed to view surfaces of stone shall be as specified above. The concealed from view surfaces of all stone types shall be sawn, hacked and/or roughened to allow key for the mortar bed.
 2. End match the texture in the face of stone elements that abut one another to assure continuity in surface appearance.
- D. Stone Fabrication - General
1. Fabrication of stone shall be in strict accordance with approved shop drawings for fabrication, and with this specification.
 2. To the maximum extent possible, fabrication and assembly of stone shall be executed on site to maintain the approved pattern and to compensate for field conditions.
 3. All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All materials and workmanship shall conform to the highest industry standards, including the Palestinian General Specifications. Recommended Practices for the Use of Natural Stone in Building Construction.
 4. Use no materials, equipment, or practices that may adversely affect the functioning, appearance, or durability of the stone work or work of other trades.
- E. Dimensions: Cut all stone work accurately to shape and dimensions shown on the final approved shop drawings. Exposed plane surfaces shall be true. Bed and joint surfaces shall be dressed straight and at right angles to the faces, unless otherwise shown. Exposed arris lines shall be sharp and true. Patching of stone will not be permitted.
- F. Beds & Joints: Stone beds and joints surfaces shall be cut square from the face for the entire thickness of stones. Stone shall be bedded and jointed, including the various expansion joints dimensions as shown on the approved drawings.
- G. Backs of Pieces: Backs of all pieces of stone, shall be sawn to approximately true planes with a maximum of 1.5mm in thickness from that indicated on the approved shop drawings.

2.02 Mortar Materials And Accessories

- A. Cement
1. Cement for Setting Mortar: Non staining Portland Cement conforming to Palestinian General Specifications except containing not more than 0.03% water soluble alkali.
 2. Cement for Pointing Mortar: Non staining white Portland Cement conforming to Palestinian General Specifications.
Gray non staining cement may be used for pointing mortar if the colour of pointing mortar, as selected by the Engineer, does not require White Portland Cement.
 3. The specified cement shall fulfill further requirement that it shall exhibit no efflorescence when cast into the form of 51mm X 179mm X 13mm slabs comprising the cement under test.
- B. Water: Shall be potable, clean and fresh from Public Water System.
- C. Sand: Well graded non staining masonry sand conforming to Palestinian General Specifications. Use white Silica sand for pointing mortar. No other sand shall be permitted for mortar or grout unless otherwise tested and approved by the Engineer.
- D. Lime: Approved brand of plastic hydrated, conforming to Palestinian General Specifications.
- E. Integral Water-proofing: As manufactured by "FEB Master Builders or approved equal..
- F. integral Colour: As "FEB Master Builders" or approved equal.
- G. Grout for Stone Pavers: Premixed commercial expanding agent as manufactured by FEB Master Builders or approved equal.

PART 3 EXECUTION

3.01 Conditions At Site

- A. The Contractor shall, prior to proceeding with the stone installation, examine all surfaces and parts of the areas to receive stone work, and notify the Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until such conditions have been corrected and are acceptable to the Engineer.
- B. Verify all measurements and dimensions, coordinate the installation of this work, and coordinate and schedule this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the approved shop drawings for such trade.

3.02 Stone Installation

- A. Preparation For Stone Installation:- Clean stone prior to setting, leaving edges and surfaces free from dirt and foreign material. Do not use wire brushes which mark or damage exposed surfaces, unless otherwise approved by the Engineer.
- B. Mortar and Grout Proportioning
 - 1. General: Mortar grout proportioning shall be prepared and tested by the Contractor, and in addition the Contractor shall allow for preparing and testing the mortar and grout mixes included within this section, to meet the Engineer's satisfaction and approval.
 - 2. Setting Mortar for Stone:
 - a. Portland Cement - 1 part
 - b. Hydrated Lime - 0-0.25 part
 - c. Sand - 3 parts
 - d. Plasticizer
 - e. Integral water proofer
 - 3. Fine Grout: Fine grout shall be mixed in the following proportions by volume all in accordance with Palestinian General Specifications.
 - a. White Portland Cement - 1 part
 - b. Sand - 1.0-1.5 parts (as approved by the Engineer)
 - c. Add color additive to acquire the color of mortar approved by the Engineer.
 - 4. NOTE: Add integral waterproofing admixture to setting and grouting mortar in the quantity and manner recommended by the manufacturer.
 - 5. Generally, febmix admix mortar plasticiser shall be used in all mortars, unless otherwise instructed by the Engineer.
- C. Mortar and Grout Mixing:
 - 1. Mortar and grout shall be machine mixed. Cement and hydrated lime may be batched by the bag. Sand preferably shall be batched by weight, but subject to the approval of the Engineer may on certain small operations be batched by volume in suitably calibrated containers, provided proper allowance is made for weight per cubic foot, contained moisture, bulking and consolidated. Shovel measurement shall not be used.
 - 2. Workability or consistency of mortar on the board shall be sufficiently wet to be worked under the trowel. Water for tempering shall be available at all times. Mortar and grout which has begun to "set" shall be discarded. Mortar and grout which has stiffened due to evaporation shall be re tempered to restore its workability. Re tempering of mortar and grout at the mixer shall not be permitted.
- D. Setting Exterior Stone Pavers: Set stone with mortar setting bed onto concrete substrate in the following manner.
 - 1. Place setting bed mix onto a slightly water dampened concrete substrate surface or onto fluid applied membrane with protection board, as applicable. Setting bed shall be slightly thicker than the required thickness and parallel to the finish stone surface.
 - 2. Lay out stone work in pattern shown on approved shop drawings. Perform field cutting of stone as required to maintain the approved pattern and to compensate for field conditions.
 - 3. Accurately form intersections and returns. Perform cutting and drilling of stone without marring visible surfaces. Carefully grind cut edges of stone abutting trim, finish or built-in items for straight aligned joints. Fit stone closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars, or covers overlap stone.
- 4. Apply a dope coat, consisting of cement and water, to the bottom of each stone unit and place into freshly installed setting bed. Tap stone unit lightly to a true surface. Leveling of stone shall be done as the setting operation proceeds so that it is not necessary to disturb the stone units previously set. Grouting shall not be done until under bed sets and hardens for 24 hours or more.
- 5. Unless otherwise indicated, stone shall be set with 2mm joints. Refer to the approved shop drawings for stone joint dimensions.

3.02 Stone Installation (con't)

6. Allow stone units to set overnight and then completely fill joints with pointing mortar. Surfaces of stone shall be cleaned to remove mortar spills from face of stone.
 7. Remove and replace stone units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
 8. Protect stone from discoloration or damage during construction and until acceptance of the Work.
 9. Allowable Variations in Finished Work: Do not exceed the following deviations from level locations, slopes and alignments shown:
 - a. Floors: Maximum variation from horizontal plane of units to adjacent unit: plus or minus 0.8mm Plus or minus 3mm in 3048mm run, in any direction, at any location.
 - b. Joints: plus or minus 1mm variation in alignment of joints, in 1000mm.
- E. Setting Interior Stone Pavers
 1. All work shall be carried out in conformity with Clause "D" of Part 3.02 stone installation, and the Contractor shall further allow for the following:-
 - a. Neutralize and seal substrates to receive bedding mortar.
 - b. Maintain installation practices and minimum temperature limits.
 - c. Do not commence grouting for at least 24 hours after placing of stone, unless otherwise instructed by the Engineer.
 - d. Apply the specified grout in accordance with the Engineer directions.
 - e. The finished grout shall be uniform in colour, smooth and without voids, pin holes, gaps, strips or low spots.
 - f. Upon completion of setting and grouting, sponge and wash stone thoroughly diagonally across joints.

3.03 Protection

Stone shall at all times be protected from drippings, welding spatter and damage by other trades during construction. Where necessary or directed, substantial non staining wooden or other approved covering shall be placed to protect the work. Heavy polyethylene film shall be used between stone and wood. Maintain all protection until removed to permit final cleaning of stone work.

3.04 Cleaning

- A. Clean soiled surfaces using non-acidic solution of type which will not harm stone, mortar joint materials, or adjacent surfaces.
- B. Use non-metallic tools in cleaning operations.

3.05 Final Inspection

- A. Finished surfaces shall show no objectionable visual distinction in jointing, bedding, plane, colour, texture, pattern, and finish. All units and stones which in the opinion of the Engineer do not provide the required uniformity shall be relocated, or removed and replaced with new stone units to the satisfaction of the Engineer and at the Contractor's own expense.
- B. All defective stone shall be replaced with new stone units, except that minor damages may be repaired when approved by the Engineer. Repairs, when approved, shall be completed to the satisfaction of the Engineer. When the repairs to stone are unsatisfactory to the Engineer, the stone shall be replaced with new stone. All repairs and all replacements of defective and unsatisfactorily repaired stone shall be performed at the Contractor's own expense.

END OF SECTION

SECTION 09695
CARPETING WITH UNDERLAY

PART 1 GENERAL

1.01 Work Included

- A. Prepare surfaces to receive carpeting.
- B. Apply carpeting on floor surfaces where indicated, complete with underlay and required accessories.
- C. Install edge strips where carpeting terminates at other flooring finishes.
- D. Install nosings on stair treads.

1.02 Reference Standards

FS DDD-C-1023 - Cushion, Carpet and Rug (Hair Felt and Rubber Coated Jute and or Fiber).

1.03 Samples

- A. Submit samples in accordance with Section 01340.
- B. Submit two samples of each type of carpet to be used, sufficiently sized to clearly indicate construction. In addition, submit one duplicate sample of each color selected.
- C. Also submit one 150 mm long sample of each type of edge stripping to be used.

1.04 Shop Drawings

- A. Submit shop drawings in accordance with Section 01340.
- B. Clearly indicate the location of seams, method of joining seams, direction of carpet, type of adhesive to be used, method of integrating edge strips with carpet and installation procedures.

1.05 Job Environment

- A. Do not commence with carpet installation until painting and finishing work is complete and ceilings and overhead work has been tested, approved and completed.
- B. Maintain room temperature at minimum 15 degrees C for at least 24 hours prior to installation and relative humidity at approximately that at which the area is to be maintained.
- C. Provide sufficient lighting.

PART 2 PRODUCTS

2.01 Acceptable Manufacturers

The contractor shall submit to the Engineer the names of three manufactures and their products which will be acceptable under this section, approval of the manufacturer or product must be obtained before proceeding with the associated work.

2.02 Materials

- A. PVC semi conductive 160-410 GUM TECHNIKA or equal. Glued to a copper grid with anti static glue.
- B. Anti static 107-400 GUM TECHNIKA or equal glued on copper grid with anti static glue.
- C. PVC paving CONDUCTIVE 10.4-530 GUM TECHNIKA or equal.

PART 3 EXECUTION

3.01 Preparation Of Surfaces

- A. Clean floors of dust, dirt, solvents, oil, grease, paint, plaster and other substances which would be detrimental to the proper performance of adhesive and carpet. Allow floors to thoroughly dry.
- B. Ensure floors are level with maximum surface variation of 1/480, non-cumulative.

3.02 Installation Of Underlay

- A. Install underlay using maximum sized pieces. Securely adhere to sub-floor. Lay out underlay so that carpet seams will not fall directly over seams.
- B. Butt edges firmly together and tight to edge of carpet gripper. Tape all joints.
- C. Remove air pockets and ridges and slightly stretch. Anchor securely around projections and contours.

3.03 Installation Of Carpet

- A. Lay out rolls of carpet full for the Engineer's approval.
- B. Check matching of carpet before cutting and ensure there is no visible variation between dye lots.
- C. Cut carpet, where required, in a manner to allow proper seam and pattern match. Ensure cuts are straight and true and unfrayed.
- D. Where possible and practical, locate seams in areas of least amount of traffic.
- E. Join seams in recommended manner and so as not to detract from the appearance of the carpet installation and decrease its life expectancy. Ensure seams are straight, not overlapped or peaked and free of gaps.
- F. Lay carpet on floors with run of the pile in same direction of anticipated traffic.
- G. Do not change run of pile in any one room or from one room to next.
- H. Cut and fit carpet neatly around projections through floor and to walls and other vertical surfaces. Where wall bases are scheduled, cut carpet 6.4 mm from walls to allow for possible re-stretching. Fit carpet snugly to walls or other vertical surface where no base is scheduled, leaving no gaps.
- I. Do not place heavy objects such as furniture on carpeted surfaces for minimum 24 hours or until adhesive has set.
- J. Entire carpet installation is to be laid tight and flat to sub-floor, well fastened at edges and present a uniform pleasing appearance. Ensure monolithic color, pattern and texture match within any one area.
- K. Install edging strips where carpet terminates at other floor coverings. Use full length pieces only. Butt tight to vertical surfaces. Where splicing cannot be avoided, butt ends tight and flush.

END OF SECTION

SECTION 09900
PAINTING

PART 1 GENERAL

1.01 Work Included

- A. Prepare surfaces which are to receive finish.
- B. Supply and apply paint finish in accordance with the finishing schedule.
- C. Spot priming and painting of materials delivered to the site, factory finished.
- D. Stopping and filling where necessary.
- E. Knotting.
- F. Emulsion paint on rendered/plastered and fair-face concrete surfaces, internally
- G. Oil paint and varnish to woodwork.
- H. Gypsum Boards Paint
- I. Exterior grade finishing to external wall panels and other concrete and masonry surfaces.

1.02 Related Work

- A. Section 05500: Miscellaneous Metals
- B. Section 05520: Hand Rails and railings.
- C. Section 06200: Finish carpentry
- D. Section 08110: Steel Doors & Frames.
- E. Section 08210: Wood Doors and Frames.
- F. Section 09220: Portland Cement Plaster
- G. Section 09260: Gypsum Board System.

1.03 Mock-Up

- A. Before proceeding with paint application, finish one complete surface of each color scheme required, clearly indicating selected colors, finish texture, materials and workmanship.
- B. If approved, sample area will serve as a minimum standard for work throughout building.

1.04 Samples

- A. Prepare 500 mm x 100 mm samples of finishes when requested by Engineer. When possible, apply finishes on identical type materials to which they will be applied on job.
- B. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.
- C. Colors to be selected by Engineer prior to commencement of work.

1.05 Maintenance Materials

- A. Leave on Premises, where directed by Engineer, not less than one can of five liter container for each color used.
- B. Containers to be tightly sealed and clearly labeled for identification.

1.06 Delivery, Storage And Handling

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing and/or reducing.
- B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 7 degrees C in well ventilated area.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.07 Environmental Conditions

- A. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:
 - 1) Plastered surfaces: 12%
 - 2) Masonry, concrete and concrete block: 12%.
- B. Ensure surface temperatures or the surrounding air temperature is above 5 degrees C before applying finishes. Minimum application temperatures for latex paints for interior work is 7 degrees C and 10 degrees C for exterior work.
- C. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 7 degrees C for 24 hours before, during and 48 hours after application of finishes.

1.08 Protection

- A. Before painting is commenced floors shall be swept and washed over; surfaces to be painted

shall be cleaned before applying paint as specified, and all precautions taken to keep down dust whilst work is in progress.

- B. No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation efflorescence, etc. before the application of each coat.

- C. No painting shall be carried out externally during humid, rainy, damp foggy or freezing conditions, or conditions where surfaces have attained excessively high temperatures or during dust storms.
- D. No new, primed or undercoat woodwork and metalwork shall be left in an exposed or unsuitable situation for an undue period before completing the process.
- E. No dilution of paint materials shall be allowed unless stated otherwise and except strictly as detailed by the manufacturer's own direction, either on the containers, or their literature, and with the special permission of the Engineer. For external work dilution of paints will not be allowed whatsoever. For internal work, where permitted by the Engineer, undercoats may be thinned by the addition of not more than 5% thinners. Gloss finish shall not be thinned at all.
- F. Metal fittings such as ironmongery, etc., not required to be painted shall first be fitted and then removed before the preparatory process are commenced. When all painting is completed the fittings shall be cleaned as necessary and refixed in position.
- G. New concrete shall be allowed to age a minimum of 28 days prior to coating application. The surface must then be chemically treated or sweep blasted to remove the laitance layer. The PH of the concrete surface should be within the 6.8 - 8.0 range for safe coating application. If the surface PH is outside this range, the fresh water rinse should be repeated until PH is within the required range.
- H. Plaster work shall be prepared by removing all loose friable materials by wire brushing/sanding. Surfaces are to be cleaned to remove dust, dirt, oil grease, etc.
- I. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.
- J. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.
- K. Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.
- L. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.09 Guarantee/Warranty

All warranties/guarantees to be issued by the Supplier, Manufacturers and Sub-Contractors shall be countersigned by Main Contractor and both of them will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period.

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 the same function and performance are acceptable in accordance with Section 01630.

2.02 Materials

- A. Powder coated paint, Varnish, Stain, Enamel, clear Lacquer, Polyurethane, Dico and Fillers: Type and brand or equivalent products, approved by Engineer.
- B. Paint Accessory Materials: (Linseed oil, shellac, turpentine and other materials not specifically indicated herein but required to achieve the finishes specified) of high quality and approved manufacturer.
- C. Paints: Ready-mixed except field catalysed coatings. Pigments fully ground maintaining a soft paste consistency, capable of readily and uniformly dispersed to a complete homogeneous mixture.
- D. Paints to have good flowing and brushing properties and be capable of dry or curing free of streaks or sags.
- E. Powder coated paint shall be applied as recommended by the manufacturer for metal work.

PART 3 EXECUTION

3.01 Inspection

- A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing to Engineer, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.
- B. Correct defects and deficiencies in surfaces which may adversely affect work of this section.
- C. No priming coats shall be applied until the surface have been inspected and the preparatory work has been approved by the Engineer. No undercoats or finishing coats shall be applied until the previous coat has been similarly inspected and approved.

3.02 Preparation Of Surfaces

- A. Remove mildew, by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.
- B. Remove surface contamination from aluminum surfaces requiring a paint finish by steam, high pressure water or solvent washing. Apply etching primer or acid etch. Apply paint immediately after acid etching.
- C. Remove dirt, oil, grease and sand if necessary to provide adhesion key, when asphalt, creosote or bituminous surfaces require a paint finish. Apply latex based compatible sealer or primer.
- D. Remove dirt, grease and oil from canvas and cotton insulated coverings.
- E. Remove contamination, acid etch and rinse new concrete floors with clear water. Ensure required acid-alkali balance is achieved. Allow to thoroughly dry.
- F. Remove contamination from copper surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply vinyl etch primer or acid etch. Apply paint immediately after acid etching.
- G. Remove surface contamination and oils from galvanized surfaces and wash with solvent. Apply coat of etching type primer.
- H. Remove surface contamination and oils from zinc coated surfaces and prepare for priming in accordance with metal manufacturer's recommendations.
- I. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive a clear seal. Remove oil and grease with a solution of tri-sodium phosphate, rinse well and allow to thoroughly dry.
- J. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with a solution of sodium meta silicate after being thoroughly soaked with water. Allow to thoroughly dry.
- K. Fill hairline cracks, small holes and imperfections on plaster surfaces with patching plaster. Smooth off to match adjacent surfaces. Wash and neutralize high alkali surfaces where they occur.
- L. Remove grease, rust, scale, dirt and dust from steel and iron surfaces. Where heavy coatings of scale are evident, removed by wire brushing, sandblasting or any other necessary method. Ensure steel surfaces are satisfactory before paint finishing.
- M. Clean unprimed steel surfaces by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
- N. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime steel including shop primed steels.
- O. Wipe off dust and grit from miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats. Back prime interior and exterior woodwork.

3.03 Paint Application

- A. Each coat of paint shall be so applied as to produce a film of uniform thickness. All paint shall be applied in accordance with the manufacturer's instructions. Special attention shall be given to ensure that all surfaces including edges, corners, crevices, welds and rivets receive a film thickness equivalent to that of adjacent painted. Surfaces paint to plaster is to brush applied.
- B. Each coat of paint is to be slightly darker than preceding coat unless otherwise approved by Engineer.
- C. Sand lightly between coats to achieve required finish.
- D. Do not apply finishes on surfaces that are not sufficiently dry.
- E. Heated Surfaces :
Heated surfaces such as radiators and pipes shall remain cold until each coat applied is completely dry.

3.03 Paint Application (cont'd)

- F. Drying :
All coats shall be thoroughly dried before succeeding coats are applied. Allow a minimum of 24 hours between application on any one surface, unless otherwise specified by the manufacturer.
- G. Plastered Surfaces :
Plastered surfaces shall be rubbed down smooth and any cracks cut out and filled. The Contractor shall also apply one coat of Tropaline Putty Filler to the plastered surface prior to the application of paint to provide an absolutely smooth surface.
- H. Unprimed Woodwork :

- 1) Unprimed woodwork scheduled to be painted shall be rubbed down with abrasive paper and dusted off. Care shall be taken to prevent 'burnishing' of the surface. All knots and resinous areas shall be coated with two coats of knotting. Pitch on large, open unseasoned knots and all other beads or streaks of pitch shall be scraped off, or if still soft, shall be removed with white spirit, before applying the knotting. Apply one coat priming to all surfaces, two coats grained ends, to all, to be subsequently painted. Backs of all wood frames in contact with concrete, brickwork, blockwork and metal work or similar materials shall be primed before fixing. After priming all joints, holes cracks shall be stopped and filled, rubbed down and dusted off.
- 2) The primer for non-resinous wood shall be low lead oil based primer to B.S 5358 or aluminum wood primer to B.S. 4576.
- 3) The primer for resinous wood shall be aluminum wood primer to B.S. 4576.
 - I. Primed Woodwork:
Woodwork delivered primed shall be lightly rubbed down with abrasive paper, and dusted off. Touch up bare areas with a similar priming including open grained ends. After touch priming all joints, holes, cracks and open grained ends the woodwork shall be stopped and filled, rubbed down and dusted off.
 - J. Plywood And Blockboard :
Edges of exterior plywood and blockboard shall be sealed with two coats of aluminum primer and the backs treated with a lead primer.
 - K. Clear Finished Woodwork :
All woodwork scheduled to receive a clear finish shall be well sanded with the grain removing all dirt, etc., to give as smooth a surface as possible. resinous timber shall be swabbed down with White Spirit and dried thoroughly. Split or end grain shall be filled with suitable filler recommended by the clear lacquer manufacturer, in accordance with their instructions, and of the appropriate shade.
 - L. Colors :
The colour will be selected by the Employer and/or the Engineer from the paint manufacturer's standard colour range.
 - M. Protection:
Proper care must be taken to protect surfaces while still wet by the use of screens, and 'wet paint' signs where necessary.
 - N. Damage:
Care must be taken when preparing surfaces, or painting, etc. not to stain or damage other work. Dust sheets and covers to the satisfaction of the Engineer shall be used to protect adjacent work. Any such stains or damage shall be removed and made good at the Contractor's expense.
 - O. Cleanliness:
All brushes, tools, pails kettles and equipment shall be clean and free from foreign matter. They shall be thoroughly cleaned after use and before being used for different color's types or classes or material. Painting shall not be carried out in the vicinity of other operations that may cause dust. Waste liquids, oil soaked rag, etc., shall be removed from the building each day. Waste liquids shall not be thrown down any sanitary fittings or drains.
 - P. Performance :
 - 1) If, while the work is in progress, the paint appears to be faulty, such as consistency of colour, drying time or quality of finish, the work shall be stopped at once and the manufacturer consulted.
 - 2) The manufacturer of the materials shall be given every facility for inspecting the work during progress in order to ascertain that the materials are being used in accordance to their directions, and to take samples of their products from the site if they so desire for tests.
 - 3) The finishing coats of the various paints or surface finishing shall be free from sags, brush marks, runs, wrinkling, dust, bare of 'starved' patches, variations in colour and texture, and other blemishes.

3.03 Paint Application (cont'd)

- 4) When the work has been completed, the finished surfaces shall not be inferior in quality, colour and finish to the samples approved by the Engineer, and imperfections in

manufacture shall not be apparent through these finished surfaces. In the event the Engineer is not satisfied with the quality of finish (does not comply with the required standards and/or the sample panel) the Contractor will be required to repaint at his own expense, such work to the satisfaction of the Engineer. In the opinion of the Engineer it is necessary to remove completely the unsatisfactory paint work this shall also be done under the direction of the Engineer at the expense of the Contractor.

Q. Emulsion Paints And Undercoats (Based On the approved manufacturer's written instructions and recommendations) :

The internal paint finish to rendered walls and for fair face concrete ceilings and/or gypsum board ceilings shall be as follows and of colour as selected by the Engineer:-

- 1) Apply two coats of primer coat (vinyl primer sealer) at the rate of 40m² per gallon.
- 2) Spot putty and spot prime
- 3) apply two coats of putty filler
- 4) Apply 1st coat of emulsion paint at the rate of 35m² per gallon.
- 5) Apply 2nd coat of emulsion paint at the rate of 30-35 m² per gallon.
- 6) Sand down between coats.

The internal partitions finish to gypsum partitions, shall be of "Special" coat paint and shall be as follows and of color as selected by the Engineer.

- 1) Remove dirt and grease on the surface and the surface should be kept dry.
- 2) Apply two coats of primer coat (Special Paint) at the rate of 11.3 m²/l/coat
- 3) Apply two coats of intermediate coats at the rate of 13.2m³/l/coat
- 4) Apply one coat of top coat (Special) at the rate of 3.3m²/l/coat.

R. Wood Surface:

The gloss finish /eggshell finish oil paint shall be as follows:

- 1) Primer coat pink wood primer or linseed oil.
- 2) Enamel undercoat.
- 3) One full coat of oil based putty.
- 4) Enamel under coat.
- 5) 1st coat eggshell or gloss finish.
- 6) 2nd coat eggshell or gloss finish.

S. Metal Surfaces Other Than Aluminum :

- 1) Primer coat: zinc chromate primer
- 2) Enamel under coat.
- 3) 1st coat eggshell or gloss finish.
- 4) 2nd coat eggshell or gloss finish.

T. Lead Based Paints :

The use of lead based paints will not be permitted.

U. Exterior Concrete Surfaces:

- 1) System "A" Smooth Surfaces.
 - a) Primer coat super cyle paint at the rate of 45 M² per gallon.
 - b) 1st coat Acrylic Emulsion at the rate of 35 M² per gallon.
 - c) 2nd coat Acrylic Emulsion at the rate of 35 M² per gallon.
- 2) System "B" Textured Surfaces
 - a) Primer coat super cyle paint at the rate of 35 M² per gallon.
 - b) Acrylic Textured coating at the rate of 1 to 1.2 Lt. per square meter, type of paint shall be approved by the Engineer before proceeding with associated work..
 - b) The surface to be coated shall be deemed to be in accordance with the manufacturers recommendations and shall be free from agents which may affect the adhesion of the surface coating.
 - c) All fragile or loose matter on surface of concrete is to be removed prior to coating to provide a hard and stable base. All cement burrs, efflorescence, cement powder and the like shall be removed by scraper, sand paper or wire brush.
 - e) The coating shall be applied in accordance with the manufacturers printed instructions.
 - f) Application of paint shall not be carried out when winds or rain.
 - g) Thinners shall only be permitted to be used in accordance with the manufacturers written instructions, and shall be of a type recommended by the manufacturer.
 - h) Sealers, bases and hardeners shall be thoroughly mixed in the exact proportions as specified by the manufacturer, and shall be mixed in clean containers specifically for the sole use of the coating.

V. Varnish :

- 1) The varnish shall be obtained from approved manufacturer.

- 2) The first coat shall be applied by brush to obtain saturation. Final coats may be applied by brush or by spray.
- W. Knotting:
Knotting shall comply with B.S 1336.
- X. White Spirit :
The white spirit shall comply with Bs 245.
- Y. Timber Stain :
Timber stain shall be oil based pigment stain.
- Z. Stopping :
The stopping shall be as follows:
- 1) Fair faced concrete and plaster work shall be external Grade Koppers Acrylic filler at the rate of 45M2 per gallon.
 - 2) Rough faced concrete and blockwork shall be similar material to the background and finished in a similar texture.
 - 3) Internal woodwork, plywood and blockboard shall be putty complying with B.S. 544.
 - 4) External woodwork shall be white lead paste complying with B.S. 2521.
 - 5) Internal clear wood finishes: the stopping shall be that recommended by the varnish manufacturer.
 - 6) Fillers :
 1. The fillers for internal joinery shall be the type recommended by the paint manufacturer for use with his type of paint or lacquer.
 2. Stoppers and fillers shall be tinted to match the undercoat, and shall be compatible with both undercoats and primers.
 3. All materials shall be used strictly in accordance with the manufacturer's instructions.
 - 7) Brushwork:
 1. Unless otherwise specified by the manufacturer all primers and undercoats shall be stopped flush and rubbed down to a smooth surface with an abrasive paper and all dust removed before each succeeding coat is applied. Care shall be taken to prevent burnishing of the surface.
 2. The stopping/filling shall be applied by spatula or putty knife.

3.04 Mechanical And Electrical Equipment

- A. Refer to mechanical and electrical sections with respect to painting and finishing requirements, color coding identification banding of equipment, ducting, piping and conduit.
- B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.
- C. Finish paint primed equipment to color selected.
- D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with a pre-finished coating.
- E. Replace identification markings on mechanical or electrical equipment when painted over or spattered.
- F. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.
- G. Paint exposed conduit and electrical equipment occurring in finished areas. Color and texture to match adjacent surfaces.
- H. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.
- I. Color code equipment, piping, conduit and exposed ductwork in accordance with requirements indicated. Color banding and identification (flow arrows, naming, numbering, etc.)

3.05 Cleaning

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.
- B. During progress of work keep premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Upon completion of work leave premises neat and clean, to the satisfaction of Engineer.

END OF SECTION

SECTION 10105
VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.01

Section Includes

- A. Vinolium finished Notice Board.
- B. Trims and accessories.

1.02 RELATED SECTIONS

Section 09900 – Painting

1.03 REFERENCES

- A. AHA A135.4 - Basic Hardboard.
- B. FS CCC-W-408 - Wall Covering, Vinyl-Coated.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.
- C. Samples: Submit two samples 300x300 mm in size illustrating materials and finish, color and texture of Notice Board

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Maintenance Data: Include data on regular cleaning, stain removal,

1.06 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.07 WARRANTY

- A. Provide five year warranty under provisions of Section 01700.
- B. Warranty: Include coverage of NoticeBoard surface from discoloration due to cleaning, crazing or cracking and staining

PART 2 PRODUCTS

2.01 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 NoticeBoard MATERIAL

NoticeBoard Covering: Vinyl coated fabric roll stock.

2.03 FRAME MATERIALS

Frame : 40x20 mm cross-tongued softWood.

2.04 FINISHES

Finish as approved by the engineer

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install noticeboards in accordance with manufacturer's instructions.
- B. Secure units level and plumb.

3.02 CLEANING

- A. Clean work under provisions of 01700.
- B. Clean noticeboard surfaces in accordance with manufacturer's instructions.
- C. Cover noticeboard surfaces with protective cover, taped to frame.
- D. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION

SECTION 10191
CUBICLE CURTAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Overhead metal curtain track and guides.
- B. Curtains.

1.02 REFERENCES

- A. NFPA 701 - Fire Tests for Flame Resistant Textiles and Films.
- B. UL (Underwriters Laboratories, Inc.) - Flammability Test 214.

1.03 SYSTEM DESCRIPTION

Track: Wall mounted supported with ceiling mounted rods.

1.04 PERFORMANCE REQUIREMENTS

- A. Track: Support vertical test load of 23 kg without visible deflection of track or damage to supports.
- B. Track Size: Safely support moving loads.
- C. Track and Mounting: Sufficiently rigid to resist visible deflection and without permanent set.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate a reflected ceiling plan view of curtain track, hangers and suspension points, attachment details, schedule of curtain sizes.
- C. Product Data: Provide data for curtain fabric characteristics .
- D. Samples: Submit two fabric samples, 300x300 mm in size illustrating fabric color.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.06 MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Maintenance Data: Include recommended cleaning methods and materials and stain removal methods.

1.07 MOCKUP

- A. Provide mockup of curtain, track and accessories under provisions of Section 01400.
- B. Provide one mockup, 2 m long by 1.5 m wide, with curtain track, curtain, cords and accessories.
- C. Locate where directed.
- D. Mockup may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Accept curtain materials on site and inspect for damage.
- C. Store curtain materials on site and deliver to the Owner for installation when requested.

1.09 FIELD MEASUREMENTS

Verify that field measurements are as instructed by the manufacturer.

PART 2 PRODUCTS

2.01 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 TRACK MATERIALS

- A. Track: Extruded aluminum sections; one piece per cubicle track run; I-beam profile.
- B. Track To fit track section.
- C. Suspension Rods: aluminum sections, sized to support loads designed to receive attachment from track and above ceiling support.
- D. Escutcheons to Suspension Rods: Aluminum .
- E. Curtain Carriers: Nylon roller to accurately fit track; designed to eliminate bind when curtain is pulled; fitted to curtain to prevent accidental curtain removal.
- F. Wand: Aluminum hollow section, attached to lead carrier, for pull-to-close action.

2.03

CURTAIN MATERIALS

- A. Curtain: Close weave [nylon] [anti-bacterial, self deodorizing, sanitized, preshrunk, flameproofed to UL 214.
- B. Curtain: color approved by the project Architects
- C. Open Mesh Cloth: Open weave to permit air circulation; flameproof material, same color as curtain.

2.04 FINISHING

Finish as approved by the Engineer

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install curtain track secure and rigid, true to ceiling line.
- B. Install end cap and stop device.
- C. Secure track to ceiling system.
- D. Install curtains on carriers ensuring smooth operation.

END OF SECTION

SECTION 10260
WALL AND CORNER GUARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Bumper rails.
- B. Corner guards.

1.02 REFERENCES

ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People.

1.03 PERFORMANCE REQUIREMENTS

- A. Installed Wall Rail Component Assembly: Support vertical live load of 1 400 N/m with deflection not to exceed 1/50 of span between supports.
- B. Installed Component Assembly: Resist lateral force of 333 N at any point without damage or permanent set.
- C. Corner Guards: Resist lateral impact force of 445 N at any point without damage or permanent set.

1.06 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Samples: Submit two sections of bumper rail 600 mm long, illustrating component design, configuration, color and finish.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.07 FIELD MEASUREMENTS

Verify that field measurements are as instructed by the manufacturer.

PART 2 PRODUCT

2.01 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 COMPONENTS

- A. Bumper Rail: Preformed end caps, internal and external corners:
 - 1. Material: High impact vinyl
 - 2. Mounting: Surface.
- B. Corner Guard - Flush Mounted:
 - Material: High impact vinyl

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

2.04 FINISHES

finishes as approved by engineer

PART 3 EXECUTION

3.01 EXAMINATION

Verify that rough-in for components are correctly sized and located.

3.02 INSTALLATION

Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

3.03 ERECTION TOLERANCES - HORIZONTAL RAILS

- A. Maximum Variation From Required Height: 6 mm.
- B. Maximum Variation From Level or Plane For Visible Length: 6 mm.

END OF SECTION

SECTION 10441

PLASTIC SIGNS

PART 1 GENERAL

1.1 SECTION INCLUDES

Engraved plastic signs.

1.2 n REFERENCES

ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate sign styles, lettering font, foreground and background colors, locations, overall dimensions of each sign.
 - C. Samples: Submit two sample signs, illustrating type, style, letter font, and colors specified; method of attachment.
 - D. Manufacturer's Installation Instructions: Include installation template and attachment devices.

1.4 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section [01600.
- B. Package signs, labeled in name groups.
- C. Store adhesive attachment tape at ambient room temperatures.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install signs when ambient temperature is lower than recommended by manufacturer.
- B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.1 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.

2.2 ENGRAVED SIGNS

Engraved Signs: Laminated colored plastic; lettering engraved through face to expose core color:

- 1. Face Color: Color as selected.
- 2. Core Color: Color as selected.
- 3. Total Thickness: 3 mm.
- 4. Height: As scheduled in BOQ
 - 5. Edges: Square.
 - 6. Character Font: Arial.

2.3 SAND BLASTED SIGNS

Sand Blasted Signs: Acrylic high gloss plastic; letters sand blasted to dull sheen:

- 1. Color: Color as selected.
- 2. Total Thickness: 3 mm.
- 3. Height: As scheduled in BOQ .
- 4. Edges: Square.
- 5. Character Font: Arial.

2.4 INDIVIDUAL GRAPHICS

- A. Material: Solid color acrylic plastic:
 - 1. Thickness: 3 mm.
 - 2. Height: 150 mm.
 - 3. Edges: Square.
- B. Character Style:
 - 1. Character Color: As approved by project Architects
 - 2. Character Font: As approved by project Architects
 - 3. Character Case: As approved by project Architects
- C. Graphic Style: Handicapped type, male symbol type and female symbol type.

2.5 ACCESSORIES

Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install signs after surfaces are finished, in locations as directed.
- C. Locate sign on door surface, level.
- D. Locate sign on wall surface, level.

END OF SECTION

SECTION 10508
METAL WARDROBE LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Locker units with hinged doors.
- B. Metal and filler panels.
- C. Accessories and hardware.

1.02 REFERENCES

- A. ANSI/ASTM A446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
- B. ANSI/ASTM A526 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

1.03 SYSTEM DESCRIPTION

Locker Units:

Width: 300 mm.

Depth: 450 mm.

Height: 1800 mm.

Configuration: Single.

Mounting: Free standing.

Base: Metal base.

Base Height: 100 mm.

Top: Sloped metal with closures.

Locking: For padlock hasps.

Ventilation Method: Louvered top and bottom frame and top and bottom of door.

Class: Conventional

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300
- B. Shop Drawings: Indicate locker plan layout, numbering plan , combination lock code, key codes.
- C. Product Data: Provide data on locker types, sizes and accessories.
- D. Samples: Submit two samples 75 x 150mm in size, of each color selected; applied to specified base metal.
- E. Manufacturer's Installation Instructions: Indicate component installation.

1.05 MOCKUP

- A. Provide mockup of one full size locker, single with sloped top, metal base, in selected colors by project Architects; under provisions of 01400.
- B. Mockup may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Protect locker finish and adjacent surfaces from damage.

1.07 FIELD MEASUREMENTS

Verify that field measurements are as indicated on shop drawings.

PART 2 PRODUCTS

2.01 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 MATERIALS

- A. Sheet Steel: Mild, cold rolled and leveled unfinished steel; to the following minimum thicknesses:
 - 1. Body and Shelf: 0.6 mm.
 - 2. Door Outer Face: 1.2 mm.
 - 3. Door Inner Face: 0.9 mm.
 - 4. Door Frame: 1.5 mm.
 - 5. Hinges: 1.8 mm.
 - 6. Base, Sloping Top, and Trim: 0.9 mm.

2.03 ACCESSORIES

For Each Locker: double prong wall hooks, coat hanger bar, brief case holder, metal plate number, rubber bumper.

2.04 FABRICATION

- A. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.
- B. Frames: Formed channel shape, welded and ground flush, welded to body, resilient and latching for quiet operation.
- C. Doors: Hollow sandwich construction, 30 mm thick; welded construction, channel reinforced top and bottom with intermediate stiffener ribs, acoustic insulation fill, grind and finish edges smooth.
- D. Hinges: Two for doors 1 050 mm high; three for doors over 1 050 mm high; weld securely to locker body and door.
- E. Integral Cylinder Lock: provide two keys per lock and five master keys.
- F. Number Plates: Provide rectangular shaped plastic plates.
- G. Form recess for operating handle and locking device.
- H. Finish edges smooth without burrs.
- I. Fabricate sloped metal tops, ends and closure pieces.
- J. Provide perforated end panels and filler strips.

2.05 FINISHES

- A. Clean, degrease, and neutralize metal; prime and finish with two coats of baked enamel.
- B. Paint locker bodies and doors in contrasting colors.
- C. Color: color as selected by project Architects

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install lockers plumb and square.
- C. Place and secure on prepared base.
- D. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 445 N.
- E. Bolt adjoining locker units together to provide rigid installation.
- F. Install end panels, filler panels, sloped tops, and bases.
- G. Install accessories.

3.02 CLEANING

- A. Clean work under provisions of 01700.
- B. Clean locker interiors and exterior surfaces.

END OF SECTION

SECTION 10800
TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.01 Work Included

- A. Toilet and bath accessories.
- B. Rough-in frames supplied to other sections.
- C. Attachment hardware.

1.02 Related Work

Section 09310 Ceramic tiles.

1.03 Reference Standards

Palestine General Specifications.

1.04 Samples

- A. Submit samples in accordance with the Engineer's instructions.
- B. Provide one sample of each type of fixture specified herein.

1.05 Product Data

- A. Submit manufacturers product data in accordance with the Engineer's instructions.
- B. Data to illustrate each accessory at large scale and show installation method.

1.06 Delivery, Storage And Handling

- A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.
- B. Pack accessories individually in a manner to protect accessory and its finish.

1.07 Protection

Protect adjacent or adjoining finished surfaces and work from damage during installation of work of this section.

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 the Conditions of Contract and as per Engineer's instructions.

2.02 Materials

All Included in the Mechanical Section.

2.03 Fabrication

- A. Weld and grind smooth joints of fabricated components.
- B. Form exposed surfaces from one sheet of stock, free of joints.
- C. Provide steel anchor plates and anchor components for installation on building finishes.
- D. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- E. Back paint components where contact is made with building finishes to prevent electrolysis.
- F. Hot dip galvanised ferrous metal anchors and fastening devices.
- G. Shop assemble components and package complete with anchors and fittings.

2.04 Electrical Connections

Items requiring connection to electric supply shall have characteristics in accordance with the Electrical Drawings and shall be installed in accordance with appropriate paragraphs of Section 16.

PART 3 EXECUTION

3.01 Preparation

- A. Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates and rough-in measurements as required.
- B. Before starting work notify the Engineer in writing of any conflicts detrimental to installation or operation of units.
- C. Verify with the Engineer exact location of accessories.

3.02 Installation

- A. Install fixtures, accessories and items in accordance with manufacturer's printed instructions.
- B. Install true, plumb and level securely and rigidly anchored to substrate.
- C. Use tamper-proof security type fasteners.

END OF SECTION

SECTION 14210

ELECTRICAL ELEVATORS

PART 1 GENERAL

1.01 Related Documents

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Refer to other sections of these specifications for related work which is not part of this section, including electrical service with fused disconnect switch for elevator system, hoistways, pits and machinery rooms with access, lighting, communications, ventilation and services.

1.02 Description Of Work

- A. Extent of electrical elevator work is indicated on drawings in schedules and by provisions of this section.
- B. Types of electrical elevator service required include the following:
 - 1) Electrical elevators
- C. Definitions: Electric elevators are hereby defined to include elevators in which cars are hoisted by ropes over power-driven traction sheaves, complete with components, equipment, machines, controls and devices as indicated and as required for safely operating elevators at rated speed and capacity.
- D. Elevator schedules indicate required performances, controls, capacities, features and finishes for each elevator or group of elevators.

1.03 Quality Assurance

Installer Qualifications:

The elevator manufacturer, who has not less than 5 years' successful experience with the installation of similar elevators.

A quality certificate valid and issued by accredited international standardization authority shall be presented.

A certificate certifies that the manufacturer of lifts has established and applied a quality control system for his products and proof has been furnished that all requirements are fulfilled.

1.04 Applicable Codes and Standards

Elevator Code:

The lift equipment is in full conformity with the European Standard **EN 81- Part 1** "Safety Rules for the construction and installation of Electrical Lifts"

1.05 Submittals

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each principal component or product, and include certified test reports on required testing. List and describe features of control system, performances, and operating characteristics.
- B. Shop Drawings: Submit plans, elevations and details of car enclosures and hoistway entrances. Prepare elevating diagrams to show service to each level.
- C. Samples: Submit samples of exposed finishes of car enclosures, hoistway entrances, and signal equipment. Provide 200mm square samples of sheet materials and 300mm lengths of running trim members.
- D. Maintenance Manuals: Submit 3 copies of the bound manual for each elevator or group of elevators, with operating and maintenance instructions, parts listing, recommended parts inventory listing, purchase source listing for major and critical components, emergency instructions, and similar information.
- E. Certificates and Permits: Provide Owner with copies of all inspection/acceptance certificates and operating permits as required by governing authorities to allow normal, unrestricted use of elevators.

1.06 Initial Maintenance and Warranty

- A. Maintenance Service: Provide full maintenance service by skilled, competent employees of the elevator. Installer for period of 12 months following date of substantial completion. Include monthly preventive maintenance, performed during normal working hours. Include repair/replacement of worn or defective parts or components and lubrication, cleaning and adjusting as required for proper elevator operation in conformance with specified requirements. Include 24 hour/day, 7 days/week emergency callback service. Exclude only repair/replacement due to misuse, abuse, accidents or neglect caused by persons other than Installer's personnel.

1.06 Initial Maintenance and Warranty (cont'd)

- B. Warranty: Provide special project warranty, signed by the Contractor, Installer and Manufacturer, agreeing to replace/repair/restore defective materials and workmanship of elevator work during warranty period. "Defective" is hereby defined to include, but not by way of limitation, operation or control system failures, performances below required minimums, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unusual, unexpected and unsatisfactory conditions.
1) The warranty period is 12 months starting on date of final handover of elevator work.
- C. Warranties: Provide coincidental product warranties where available for major components of elevator work. Submit with maintenance manuals.
- D. Manufacturer should duly guarantee to follow-up the maintenance and After Sale Services through his local agent, and also to supply all technical support and required spare parts for a period of ten years for reasonable prices.

PART 2 PRODUCTS

2.01 Materials and Components

- A. General: Provide manufacturer's standard pre-engineered elevator systems which will comply with or fulfill the requirements of elevator schedule sheets below, or at manufacturer's option, provide custom manufactured elevator systems which will fulfill requirements. Where components are not otherwise indicated provide standard components, published by manufacturer as included in standard pre-engineered elevator systems, and as required for a complete system.
The product should be E C manufactured Ultra modern reliable microprocessor technology is a must, resulting high availability in conjunction with comfortable drive behavior, short travel and waiting times, substantial energy savings and maintenance- friendly diagnostic system.
- B. Capacity :
Each Elevator shall have a safety-carrying load inclusive of weight of complete car cable and ropes, in accordance with the attached schedule.
- C. Speed :
The rated speed of the elevators shall be as specified in the schedule.
- D. Control Systems:
A very effective close loop control system shall be provided for the elevators. This system shall consist of speed pattern generator, pulse generator, digital regulator, speed feedback system, gate controller, PWM controller, thyristor transistor inverter, etc. The speed pattern generator shall provide slow speed command for hand operation during maintenance work. Optical fiber cables may be used to improve the reliability of signal transmission.
- E. Elevator Operating and Controlling Systems:
All control systems shall be fully automatic passenger operated type. The facility to transfer to independent operation shall also be included. An automatic bypass for land hall calls shall be incorporated in the event the car being loaded to its maximum capacity. Floor calls shall remain registered and shall be served by the next available car. Each elevator group shall be provided with selective collective operating system. In this system, all hall and car calls shall be registered. When the car moving up it shall respond in sequence to both car calls and up hall calls, until it has responded to the highest call.
The direction of travel shall reverse automatically at this point to answer the down calls. The nearest car moving in the appropriate direction shall answer when a hall call is registered. If any hall call is registered behind one car, it shall be answered by the other car. When there are no calls, one car shall return to the main floor to wait further calls.
The central element of the control shall be a computer with minimum 16-bit processor designed and manufactured by the lift manufacturer. The construction of the board shall use fully electronic interfaces with optoisolators between the computer and the high voltage signals.
- F. Elevator Car
The size of the car, interior design and decorations, ceiling and lighting and other facilities shall be as called for in the Schedule and/or in the book of details.
- G. Car and Landing Doors
Two panel center opening, sliding doors. The finish of the doors shall be as specified in the Schedule.

2.01 Materials and Components (cont'd)

Car Door Drive

The door operator shall comprise of an electronic control unit, door gear with AC motor. The motor drive to be solid state, four-quadrant system for very fast controlled direction reversals for high quality door operation.

The control unit has to be capable of communicating with the computer and passenger sensors and independently executing the opening and closing commands, door speed pattern generation, motor speed control and safety supervision. The door closing and opening speeds must be adjustable on site.

Landing Doors

All landing doors to be fire rated for a minimum of 90 minutes and necessary test certificates as per BS/EN-81 to be submitted to the consultant.

Both the landing door panels to be electromechanically lockable for safety and must be provided with release key hold in header trim.

Door Operator

The door operator shall be high-speed heavy duty, with a AC Motor. The opening and closing speeds of the doors shall be adjustable. The landing and car doors shall operate in full synchronism. Advance door opening during approach of the car to a landing could be used to speed passenger transfer.

2.02 Elevators Schedule Sheets

| | |
|---|---|
| TYPE: | BED LIFT (L1) |
| SPEED: | 1.0 M/S |
| CAPACITY: | 1600 KG, 21 PASSENGERS. |
| TRAVEL : | 22.00 M |
| DRIVE: | REGULATED AC - VVVF DRIVE SYSTEM. |
| CONTROL: | MICROPROCESSOR COLLECTIVE WITH DIAGNOSTIC SYSTEM. |
| STOPS: | 4 IN ONE LINE. |
| MACHINERY: | Power supply 3 phase AC 400/230 v, 50 Hz. |
| LEVELING ACCURACY: | +/- 5 mm |
| TYPE OF DOORS: | Fully automatic 2-panel side opening sliding doors, with hard aluminum sill. |
| DOOR DIMENSIONS: | Width: 1300mm, Height: 2100mm |
| CAR DOOR: | Panels covered with stainless steel grain 304. Car door regulated with AC-VVVF drive, door safety device type light curtain opto-electronic door protection system, protection height from 15 mm to 1650 mm. Door open / close time is adjustable. |
| LANDING DOORS: | 4 door in front, 0 door opposite. Door mounted inside the shaft. Door panels and narrows steel frame with stainless steel 304 in finish in all doors. (landing doors are 90 minutes fire resistance) |
| LANDING OPERATION INDICATION PANELS: | &Position indicators, direction arrows and INDICATION PANELS in all floors. Key switch for fireman function in main floor. |
| CAR ENCLOSURE: | Front wall and side walls with stainless steel grain 304 1 car operation panel in side wall. PVC anti bacterial anti-static flooring (local supply), car ceiling in stainless steel with low voltage spot down lighters, tubular handrail at 2 sides stainless steel, exhaust fan emergency light, emergency exit 600 mm x 400 mm. |
| COP: | One COP, Buttons spot led buttons, open, included buttons for landings, alarm, door open, door close button. Digital position indicator and direction arrows, Intercom system for 3 terminals (car, machine room and supervision room), overload protection device with audible and visible signal, key switch for car light, ventilation, car priority and fireman's function. |
| CAR WIDTH: | 1400 mm |
| CAR DEPTH: | 2400 mm |
| CAR HEIGHT: | 2200 mm |
| SAFETY GEAR: | Progressive type for car. |
| Note: | Lift machine, controller and car operating panel should be prepared for a future extension of 2 more stops. |

| | |
|------------------|---|
| TYPE: | BED LIFT (L2) |
| SPEED: | 1.0 M/S |
| CAPACITY: | 1600 KG, 21 PASSENGERS. |
| TRAVEL : | 22.00 M |
| DRIVE: | REGULATED AC - VVVF DRIVE SYSTEM. |
| CONTROL: | MICROPROCESSOR COLLECTIVE WITH DIAGNOSTIC |

| | |
|---|---|
| STOPS: | SYSTEM. 3 IN ONE LINE. |
| MACHINERY: | Power supply 3 phase AC 400/230 v, 50 Hz. |
| LEVELING ACCURACY: | +/- 5 mm |
| TYPE OF DOORS: | Fully automatic 2-panel side opening sliding doors, with hard aluminum sill. |
| DOOR DIMENSIONS: | Width: 1300mm, Height: 2100mm |
| CAR DOOR: | Panels covered with stainless steel grain 304. Car door regulated with AC-VVVF drive, door safety device type light curtain opto-electronic door protection system, protection height from 15 mm to 1650 mm. Door open / close time is adjustable. |
| LANDING DOORS: | 4 door in front, 0 door opposite. Door mounted inside the shaft. Door panels and narrows steel frame with stainless steel 304 in finish in all doors. (landing doors are 90 minutes fire resistance) |
| LANDING OPERATION INDICATION PANELS: | &Position indicators, direction arrows and INDICATION PANELS in all floors. Key switch for fireman function in main floor. |
| CAR ENCLOSURE: | Front wall and side walls with stainless steel grain 304 1 car operation panel in side wall. PVC anti bacterial anti-static flooring (local supply), car ceiling in stainless steel with low voltage spot down lighters, tubular handrail at 2 sides stainless steel, exhaust fan emergency light, emergency exit 600 mm x 400 mm. |
| COP: | One COP, Buttons spot led buttons, open, included buttons for landings, alarm, door open, door close button. Digital position indicator and direction arrows, Intercom system for 3 terminals (car, machine room and supervision room), overload protection device with audible and visible signal, key switch for car light, ventilation, car priority and fireman's function. |
| CAR WIDTH: | 1400 mm |
| CAR DEPTH: | 2400 mm |
| CAR HEIGHT: | 2400 mm |
| SAFETY GEAR: | Progressive type for car. |
| Note: | Lift machine, controller and car operating panel should be prepared for a future extension of 2 more stops. |

PART 3 EXECUTION

3.01 Inspection

Prior to commencing elevator installation, inspect hoistways, hoistway openings, pits and machine rooms, as constructed, verify all critical dimensions, and examine supporting structure and all other conditions under which elevator work is to be installed. Notify Contractor in writing of any dimensional discrepancies or other conditions detrimental to the proper installation or performance of elevator work. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to the Supervising Engineer.

3.02 Installation Of Elevators System

- A. General wiring throughout the installation shall be carried out as specified in the specifications. GI trunking shall be used wherever possible instead of multiple conduits. GI conduits and flexible conduits shall be used between trunking and apparatus. Earthing of all the equipment shall be carried out as specified in Electrical Specification and as per IEE Regulations. Distribution Equipment shall contain all protection equipment for motors and circuits. These shall include overload protection, short-circuit protection, single-phasing protection, etc. as appropriate. Certificate of Origin documented from all authorities will be required at the time of delivery of elevator materials at site.
- B. Welded Construction: Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance and replacement of worn parts. Comply with AWS standards for workmanship and for qualification of welding operators.

3.02 Installation Of Elevators System (cont'd)

- C. Co-ordinations: Coordinate elevator work with work of other trades, for proper time and sequence to avoid construction delays. Use benchmarks, lines and levels designated by Contractor, to ensure dimensional coordination of the work.
- D. Sound Isolation: Mount rotating and vibrating elevator equipment and components on vibration-absorption mounts, designed to effectively prevent transmission of vibrations to structure, and

thereby eliminate sources of structure-borne noise from elevator system.

- E. Lubricate operating parts of system, including ropes, as recommended by manufacturers.
- F. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails, for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing in accordance with standard.
- G. Leveling Tolerance: 3 mm up or down, regardless of load and direction of travel.
- H. Grout sills with non staining, no shrink grout. Set units accurately aligned with and flush with finished floor at landings.

3.03 Field Quality Control

- A. Acceptance Testing: Upon nominal completion of each elevator installation, and before permitting use of elevator (either temporary or permanent), perform acceptance tests as required and recommended by the Code.
The Tests include the following:
 - No load current and voltage readings both on 'Up' and 'Down' Circuits.
 - Full load current and voltage readings both on 'Up' and 'Down' Circuits.
 - One and quarter load current and voltage readings both on 'Up' and 'Down' Circuits.
 - Stalling current and voltage and time taken to operate overload.
 - Overload Protection.
 - Gate sequence relays.
 - All interlocks.
 - Collective control and priority sequence.
 - Safety gear mechanism.
 - Speeds on Up and Down travel with loadings and empty.
 - Door Contacts.
 - Final terminal stopping device.
 - Normal terminal stopping device.
 - Insulation and earth continuity.
- B. Operating Tests: Load each elevator to its rated capacity and operate continuously for 30 minutes over its full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failures of elevator to perform as required.
- C. Advise Contractor, Owner, Architect and Inspection Department of governing agencies, in advance of dates and times tests are to be performed.

3.04 Protection

- A. At time of substantial completion of elevator work (or portion thereof) provide suitable protective coverings, barriers, devices, signs or such other methods or procedures to protect elevator work from damage or deterioration. Maintain protective measures throughout remainder of construction period.
- B. Provide similar protective measures for elevator units which will be placed in temporary service, including inspection and maintenance service during period of temporary service. No additional costs will be paid for temporary service use.

3.05 Instruction and Maintenance

- A. Instruct Owner's personnel in proper use, operations and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at the time of failure in operation and other building emergencies. Train Owner's personnel in normal procedures to be followed in checking for sources of operational failures or malfunctions.
Confer with Owner on requirements for a complete elevator maintenance programme.
- B. Make a final check of each elevator operation, with Owner's personnel present and just prior to date of substantial completion. Determine that control systems and operating devices are functioning properly.
- C. Continuing Maintenance: Installer shall provide a continuing maintenance proposal to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date construction contract maintenance requirements are concluded i.e after two years from final handover. State services, obligations, conditions and terms for agreement period, and for renewal options.

END OF SECTION

Project:

Project: Augusta Victoria Hospital Triage Department

Specifications

Electrical Works

September, 2018

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 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 16130
UNDERGROUND ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Underground Electrical Services including, but not limited to the following:
1. Trenching and backfilling.
 2. Manholes, hand holes and earth rod pits.
 3. Cable warning signs and tapes.

1.02 RELATED SECTIONS

| | |
|-------|---|
| 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) |

1.03 REFERENCES

- A. The IEE Wiring Regulations, 16th Edition (2001).
- B. BS 4568 Rigid Steel Conduits, Zinc Coated.
- C. BS 6099-2.2 / IEC 614-2-2 U.P.V.C. Rigid Conduits.

1.04 SUBMITTAL

- 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. Name and address of agents stating whether any manufacturing or fabrication is carried out locally.
 - 4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
 - 5. Technical performance of the equipment selected.
 - 6. Dimensional details needed for installation and maintenance.
 - 7. Delivery time from the date of orders.
 - 8. Copies of test reports or certificates.
 - 9. Control schematics and wiring diagrams.
- B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.**

1.05 QUALITY ASSURANCE

- A. All items for underground electrical services shall be as per manufacturer's standard construction and materials except civil works such as excavation, backfilling and concreting. Where this contradicts any part of the Specifications, the Contractor shall state so at the time of tender.
- B. Manufacturers: Firms regularly engaged in the manufacture of such items of the types and sizes required, and whose products have been in satisfactory use in similar service for a period not less than 5 years. Preference shall be given to local manufacturers.
- C. All work shall conform to applicable standards of Local Standards Organization and BS.
- D. All underground electrical services for power and communications shall comply with the requirements and standards of Electricity Supply Authority and Telecom Supplier respectively.

1.06 DELIVERY, STORAGE AND HANDLING

- A. During unloading of PVC pipes and other items for underground electrical services, rough handling shall be avoided. Chains or wire ropes may be used, provided they are suitably covered, to protect the pipes and other items from damage.
- B. Unloading by mechanical means such as a crane or fork lift may be used where PVC pipes and other items for underground electrical services are delivered in bundles or in crates. However, consideration shall be given to the total weight and the lifting capacity of the mechanical equipment, and the observance of the statutory safety requirements.
- C. PVC pipes and other items for underground electrical services shall not be dropped or thrown to the ground, knocked against other conduits or against sharp objects that may cause permanent damage.
- D. In preparing for laying the pipes in trenches, the pipes and fittings may be unloaded along the trench direct from the back of a truck. Ducts and fittings should be unloaded on the side opposite to backfill. Fittings including end bells, couplings and other accessories such as solvent cement and lubricant shall be stored at the trench site under cover to prevent loss or damage.
- E. When storing on site, PVC pipes and other similar items shall be placed on a level surface and shall be supported to minimize distortion, and protected from direct sunlight. Horizontal supports of adequate width shall be spaced not more than 1.5 m centre to centre beneath pipes to provide continuous and even support.
- F. Vertical side supports shall be provided at 3 m spacing on rectangular stacks. The maximum free height of such stacks shall not exceed 1.5 m.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Underground Electrical Services for power, lighting, low current systems, control cables and grounding shall comprise manholes and handholes interconnected via concrete encased PVC pipes, direct buried PVC pipes or cable trenching; all as shown on the Drawings and mentioned in the Specifications or required on site for proper installation and maintenance of electrical systems.
- B. Any trenching, backfilling, compaction and general grading required for electrical works shall be carried out in accordance with the requirements given in civil works specs.
- C. Any metal frames, covers, louvers, etc. related to the works described under this Section shall be carried out in accordance with the requirements given in civil works specs.
- D. Any cast in place concrete related to underground electrical services described under this Section shall be carried out in accordance with Section 03300.

2.02 DUCT BANKS

- A. Duct banks shall be either direct buried type or concrete encased type, as applicable and required on site.
- B. Heavy duty rigid PVC conduits shall be used for direct buried or concrete encased underground duct systems. PVC conduits and fittings shall comply with the requirements of Section 16130
- C. PVC conduit shall be suitable for a temperature range of 4 °C to 90 °C. Conduits within the duct bank shall be supported on plastic interlocking spacers, at intervals of approximately 2.4 m. A 25 mm minimum separation, edge to edge, shall be maintained, both horizontally and vertically, between the ducts.
- D. All duct banks shall have a 75 mm concrete cover on the top, sides, and bottom of the PVC ducts. Anchorage shall be used to hold the ducts in place while pouring the concrete encasement.
- E. Where the duct bank enters a building below ground level, the conduit shall terminate in an appropriate fitting. An end bell shall be used on conduits entering manholes.
- F. After completion of the installation of cables in the duct bank, seal the ends of duct banks using special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 °C, and shall not slump up to a temperature of 149 °C. It shall not be harden significantly when exposed to air.
- G. A run of conduit shall not contain more than the equivalent of four quarter bends. Bends in conduit shall be made without reducing the internal diameter of the conduit. The inside radius of the conduit bends shall not be less than one metre.
- H. Matching end bells and plugs, constructed of high impact plastic, shall be provided through out the duct bank at the ends and in manholes.
- I. Each length of conduit shall be provided with one standard coupling. Couplings shall have a center step to ensure proper seating. Joints shall be made with the solvent cement as recommended by the conduit manufacturer.
- J. Concrete encasement shall be class C20 concrete with 13 mm maximum size aggregate for all duct banks. For warning purposes, a red dye shall be towelled into the top surface after pouring the concrete.
- K. An expansion joint of 55 mm per 100 meters maximum shall be provided in the duct banks. Additionally, a construction joint shall be installed if pouring of concrete is commenced any time after initial set of adjacent concrete. Neither expansion nor construction joints shall be installed under a roadway.
- L. For duct banks in stable soils, the soil below the duct bank shall be compacted to 90 % of maximum density to a minimum depth of 300 mm. A dewatering system shall be used to lower the water table below the final excavation depth to eliminate disturbance of in-situ soil densities.

2.03 STUB-UPS

- A. Stubs-up for electrical equipment connections and other requirements shall consist of either 100 mm or 150 mm diameter hot double-dipped galvanized rigid steel conduit entirely encased in concrete.
- B. Rigid steel conduits and bends for stub-ups shall comply with the requirements of Section 16130.
- C. The bends for stub-ups shall be 90 degrees with a minimum radius of 1200 mm.
- D. Bends for stub-ups shall serve as transition between PVC conduits embedded below grade and rigid steel conduit installed exposed on surface. Such bends shall be provided with a PVC steel coupling on one end and a threaded male or female adapter on the other end.

2.04 MANHOLES

- A. Appropriate type and size of manholes shall be provided as shown on the Drawings or required on site in compliance with the requirements of Local Standards Organization, BS and Electricity supply authority or Telecom supplier regulations.
- B. Manholes for communication and low current systems shall be constructed in accordance with the standard practice and requirements of Telecom Supplier Regulations.
- C. A sump pit shall be built into the base slab directly beneath the manhole opening to collect and retain any water present in the manhole. Periodic maintenance may be required since sump pumps will not be permanently installed.
- D. The duct bank manhole/interface shall include an expansion joint to take up longitudinal movement due to expansion and construction of the duct bank. This joint shall also act as water stop to prevent water from seeping inside the manhole.
- E. The exterior of the manhole shall be waterproofed, with a bituminous coating in accordance with Section 03300.
- F. Each manhole shall have two cable pulling irons opposite each duct bank entrance.
- G. Access to deep manholes shall be through a chimney. Permanent ladders or rungs shall be installed, if required by the Engineer on site or shown on the Drawings.
- H. Manholes shall be provided with earth-rods and cable supports as per the requirements of Local Standards Organization, BS or Electricity supply Authority.
- I. The frames and covers of all manholes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.05 HANDHOLES

- A. Handholes may be formed either monolithically or built up to designed sizes by combining several concrete sections cast in various shapes and sizes.
- B. Handholes shall be provided with cast iron covers, sumps, ground-rods, etc. as shown on drawings or required as per the requirements of Local Standards Organization, BS or other applicable standards. Section joints shall be grouted.
- C. The frames and covers of all hand holes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.06 EARTH ROD PITS

- A. Earth rods pits shall be provided for all earth rods in accordance with the requirements of Section 16640.
- B. Earth rod pits shall be precast of either square or round section with cover.
- C. The cover of earth rod pits shall have appropriate marking as approved by the site Engineer.

2.07 CONCRETE PADS

- A. Concrete pads shall be provided for all pad mounted equipment.
- B. Concrete pads shall be 150 mm high, unless otherwise indicated, complete with steel reinforcement and necessary bolts, anchors, etc. required for the proper installation of pad mounted equipment.
- C. Structural calculations for concrete pads supporting heavy equipment shall be submitted for Engineer's approval before commencement of work on site.

2.08 CABLE WARNING SIGNS AND TAPES

- A. Where cables are directly buried, cable warning signs shall be installed to minimize the likelihood of damage to the cables by excavation. These signs shall be suitable for mounting on a riser pole, substation fence or separate stakes to suit the installations.
- B. Posts for cable warning signs shall be placed as close to the cable as practical, but not closer than 900 mm horizontally from the cable.
- C. Cable warning tapes shall be provided in accordance with the requirements given in Section 16120. Tapes shall be placed at least 300 mm above the buried cables, and shall cover full width of the cable trench.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Establish and propose exact routes and requirements of underground electrical services for approval of the Engineer, after co-ordination with all other existing or new underground services, before commencement of the work on site.
- B. Examine the areas and conditions under which the underground electrical services are to be installed, and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. The Contractor shall not proceed with the work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 EXCAVATION AND BACKFILLING

- A. Before commencement of the excavation, check the presence of any existing underground service by means of appropriate tools and equipment. The Contractor shall be penalized for damaging of any existing services in accordance with the rules and regulations set forth by the Owner and described in Section 16050.
- B. Carry out excavation and backfilling in accordance with the requirements of civil works

3.03 DUCT BANKS INSTALLATION

- A. The direct buried PVC ducts shall have a minimum dry sand cushion of 150 mm and a minimum dry sand cover of 300 mm, over which 50 mm thick concrete tiles shall be placed.
- B. Depth for direct buried PVC ducts and PVC coated rigid steel conduits shall not be less than 600 mm from finished grade level to the top of conduits.
- C. Top of concrete encased duct banks shall be installed 600 mm minimum below finished grade and shall connect manholes and handholes as shown and required on site. Where a duct bank connects to a building, adapt the duct bank, at one meter beyond the building exterior wall, to the building conduit with the required couplings.
- D. The concrete encasement surrounding the duct bank shall be rectangular in cross-section, having a minimum concrete thickness of 75 mm beyond any surface of the conduit. Interlocking spacers shall be used to secure a uniform spacing between conduits of not less than 75 mm.
- E. Trenches and duct banks shall be graded so that conduits will have a fall of at least 75 mm per 30 m towards the lower manholes or from the high point of the section towards the manholes or from the building towards a manhole.
- F. Changes in direction of duct bank runs shall be accomplished by using special couplings limited to 5 degrees and/or 45 degrees bends having a 1 m radius sweep with straight sections of ducts between changes of direction and 'S' sweep sections having a minimum of 500 m offset.

- G. Where duct bank enters manholes, conduits shall terminate in end bells. Clean each conduit thoroughly before laying. During construction and after completion of the duct banks, plug the ends of conduits to prevent water washing mud into the conduits. Take particular care to keep the conduits clean of concrete or any other substance during the course of construction.
- H. Securely anchor duct and brace with intermediate and base plastic spacers to prevent movement during the placement of concrete.
- K. After the completion of portion of duct bank, a mandrel not less than 300 mm long, with a diameter of approximately 6 mm less than the inside nominal diameter of the conduits shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand or gravel have been left in the line. This cleaning shall be done one day after the concrete has been poured.
- L. Install a nylon rope in each conduit after cleaning, after which the conduits shall be capped/plugged immediately.
- M. All duct banks shall enter manholes through rectangular openings of suitable dimensions provided in walls. Such holes shall be sized to properly receive the duct, but shall not be too large for proper caulking. The space between duct banks and manhole walls shall be caulked tight with lead wool.

3.04 STUB-UPS INSTALLATION

- A. Comply with relevant requirement of Section 16130.
- B. Exact stub-ups locations and termination requirements for each equipment shall be verified on site, before commencement of laying underground or under floor PVC conduits for required power and control wiring.
- C. Where extensions of PVC conduits above grade are required as stub-ups, a transition bend having PVC/Steel coupling on one end and threaded male or female adapter on the other end shall be used.
- D. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high above the finished floor shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

3.05 CONSTRUCTION OF MANHOLES AND HANDHOLES

- A. Manholes and handholes shall be constructed of precast or cast-in situ concrete to sizes shown on the Drawings. Horizontal concrete surfaces of floors shall have a smooth steel trowel finish.
- B. Frames and covers shall be watertight and covers shall fit the frames without undue play. These shall be free from warp and blow holes that may impair their strength of appearance.

- C. Steel and iron shall be formed to shape and size with sharp lines and angle and shall have a smooth finish.
- D. Provide all necessary lugs and brackets.
- E. Set pulling-in irons and other built-in items in place before pouring concrete.
- F. Provide a 3 m earth rod external to each manhole and handhole. Also provide an earth bar in each manhole and handhole affixed to the wall above the duct bank box-outs. Connect to earth rod using 70 mm² bare copper conductor and bond earth conductors associated with each power cable inside the manhole or handhole.

3.06 CABLE WARNING SIGNS AND TAPES INSTALLATION

- A. Direct buried cables shall be installed in accordance with the requirements for external cable installation given in Section 16120.
- B. Cable warning signs shall mark all direct buried splices and shall be placed at intervals not exceeding 30 m along the cable route.
- C. Cable warning tapes shall be installed 300 mm directly above cable throughout the entire cable route and shall cover the full width of cable trench.

***** 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 & CENELECPREN60669-1 |
| 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 (RED).
- 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

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 (V_{imp}). 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 (I_{cs}) 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 millisecond in steps of 100 millisecond.

- 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 (I_{cs}) 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**
 - a. The relays shall comply with IEC 755
 - b. The relays shall be protected against nuisance tripping caused by switching surges or by lightning surges.
 - c. 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.
 - d. The relays shall be able to operate in the presence of fault currents with DC components.
 - e. 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.
 - f. 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.

- g. The size of the relays shall be compact. They shall be suitable for mounting on symmetrical rail horizontally or vertically.
- h. 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)

- a. Rectangular type for busduct feeders
- b. Circular type for cable feeders
- c. The range of associated toroidal transformer shall be of the closed type with an inside diameter of 30 to 200 mm.
- d. 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 CONTACORS

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, contractors 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 photo electric master control.

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 louvers 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 LUMINARIES - GENERAL

A. Standards

1. IEC Standard 61 - Lamp Caps and Holders.
2. IEC Standard 64 - Tungsten Filament Lamps.
3. IEC Standard 81 - Tubular Fluorescent Lamps.
4. IEC Standard 82 - Ballasts for Tubular Fluorescent lamps.
5. IEC Standard 155 - Starters for Fluorescent Lamps.
6. IEC Standard 188 - High Pressure Mercury Vapor Lamps.
7. IEC Standard 259 - Miscellaneous Lamps & Ballasts.
8. IEC Standard 598 - :luminaires, incorporating:
Part 1: 598-1, General requirements and tests - 1979 including all subsequent amendments.

Part 2: 598-2, Particular requirements including 598-2-1; fixed general purpose luminaires - 1979, 598-2-2; recessed luminaires - 1979, 598-2-5; Floodlighting – 1979, 598-2-19; Air handling luminaires - 1981, chain suspensions - 1982.

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.

C. Fluorescent Luminaires.

1. Fluorescent luminaires shall be constructed of mild steel sheet finished with an approved colour using an electrophoretic dip or electrostatic spray system. The luminaires shall be of a construction which ensures rigidity and a minimum of twisting, distortion, and light leakage.

2. All fluorescent luminaires specified for 26mm diameter fluorescent tubes shall be complete with electronic start type control gear with automatic resetting and RFI suppresser. All control gear shall be suitable for operation in ambient temperatures up to 50 Deg. C.
3. Control gear shall comply with BSI standards and be of the 'silent' type.
4. All fluorescent fitting Ballasts units shall be fitted with power factor correction capacitors which improve the power factor to not less than 0.9 lagging except where are electronic ballasts then no need for capacitor.
Wood chokes for T26 and compact fluorescent lamps.
 - i) Copper wire wound Ballasts with very short magnetic paths, vacuum impregnated and topicalised, suitable for operation from 230V/50Hz single phase AC supply, Class H insulation, maximum winding temperature of 130°C and push in terminals. The ballasts shall be of low loss type, with losses not exceeding the values given below.
 - 18W - 6.5W
 - 36W - 6W
 - 58W - 9W
 - 24W - 6W
 - 36W - 6W
 - 18W - 4W
 - ii) Electronic ballasts for T26 and compact fluorescent lamps.
Ballasts comprising passive electronic components, to run the lamps at a frequency of 35-40kHz.
 - iii) Transformer for LV Halogen lamps.
Transformer operating at high frequency (approximately 35 kHz) with constant secondary voltage, built in overload and short circuit protection and automatic re-set, harmonic filter, RFI suppression clip on terminal covers with strain relief.
5. All luminaires shall be designed for operation from a 230 volt 50 Hz single phase supply, unless specifically indicated otherwise on the Drawings.
6. Luminaires body, housing and reflector shall be of the shape and size as indicated in the Luminaire Data Sheets.
7. Control gear shall be quiet in operation and no part of any luminaire shall rattle when subjected to normal internal building environmental vibrations.
8. Luminaires shall be manufactured to enable simple and efficient cleaning. The external surfaces of all luminaires shall be smooth and devoid of apertures or crevices. Seams and joints shall be continuously welded and ground smooth.
9. luminaires body, reflectors, wiring channels and castings shall be formed so as to prevent buckling or distortion.
10. When aluminium is placed in contact with dissimilar metal, the contact surface shall be separated with a gasket or coating to prevent corrosion.
11. all luminaire latches or other securing means shall be of the captive type.

12. Fluorescent luminaires shall be suppressed for radio interference to recognized international standards.

D. Discharge Luminaires

1. All discharge luminaires used in internal applications shall comply with the requirements of British Standards code of Practice BS 4533: 2.2 and shall conform to the IP rating indicated on the luminaire schedule and the Luminaire Data sheets.
2. All discharge luminaires used in external applications shall comply with the requirements of Standards and shall be minimum of IP 54 unless indicated otherwise in the following Luminaires Data Sheets.
3. All luminaires shall be designed for operation from a 230 volt 50 Hz single phase supply, unless specifically indicated otherwise on the Drawings.
4. all luminaires shall incorporate, within the base, a cable connector suitable for accepting 6.0 sq.mm conductors. Luminaire factory wiring shall be rated at 155°C.
5. Luminaires body, housing and reflector shall be of the shape and size as indicated in g Luminaire Data Sheets.
6. Control gear shall be quiet in operation and no part of any luminaire shall rattle when subjected to normal internal building environmental vibrations. Ballasts shall be high power factor type not less 90%.
7. Luminaires shall be manufactured to enable simple and efficient cleaning. The external surfaces of all luminaires shall be smooth and devoid of apertures of crevices. Seams and joints shall be continuously welded and ground smooth.
8. Luminaires, body, reflectors, wiring channels & castings shall be formed so as to prevent buckling or distortion.
9. When aluminium is placed in contact with dissimilar metal, the contact surface shall be separated with a gasket or coating to prevent corrosion.
10. All luminaires latches or other securing means shall be of captive type and made of stainless steel for luminaires mounted externally.
11. All luminaires shall be suitable for starting, and operating continuously, within the following ambient temperature range.
12. Minimum Temperature -2 Deg. C.
Maximum Internal Temperature 46 Deg. C
Maximum External Temperature 50 Deg. C
13. All discharge luminaires shall incorporate power factor correction to not less than 0.9 lagging.

E. Emergency Conversion Module

Where shown on drawings, emergency lights shall be equipped with emergency conversion modules. The module shall be a 3 hours, maintained type, sealed with rechargeable Nickel - Cadmium battery, rated for use at 50°C ambient. Charger/inverter unit shall have red LED charger monitor.

Mains Voltage - 230V +6% or -10%

| | |
|----------------------|---|
| Mains Frequency | - 50Hz |
| Power consumption | - 7.5W/9VA |
| Insulation Class | - 1 |
| Battery | - 9.66V/4Ah |
| Re-charge Period | - 24 hr. |
| Approvals | - BSI/IEC 598-2-22 |
| Lamps | -Fluorescent lamps-T26-18W,36W & 58W,8w -Compact Fluorescent TCL 24W & 36W Lamp - TCD 18W |
| Ballast Lumen Factor | 18W – 0.46 36W – 0.20 58W – 0.15 24W – 0.26 36W – 0.20 18W – 0.44 |

- F. Emergency conversion modules are to be incorporated inside the luminaires except if luminaire construction does not allow, it may be remotely mounted in a steel box complete with grommets to cable entry and connectors.
- G. Remotely Mounted Control Gear
Provide where shown on drawings, remotely mounted control gear for floodlights illuminating the building facades. Control gear shall be mounted in purpose made enclosures in the low voltage switchgear room. The enclosure shall be fabricated in sheet steel, equipped with lighting control gear and fitted with incoming cable gland plate, contactor control and incoming switchgear with tripple pole MCB circuit protection to each lighting control gear tray.
The tray shall be pre-wired complete with control gear.
- H. Low Voltage Halogen Lamps.
1. All lamps shall be suitable for operation from 12V AC single phase, 50Hz.
 2. They shall have the low-voltage halogen burner optically positioned in an aluminium reflector equipped with an integral protective front glass.
 3. Lamps shall be of BI-PIN cap B15d.

Lamps shall be in accordance with the following schedule.

| <u>Wattage</u> | <u>Base</u> | <u>Intensity</u> | <u>Life (Hrs.)</u> |
|----------------|-------------|------------------|--------------------|
|----------------|-------------|------------------|--------------------|

50W B15d 2000cd 2000

I. Normal Voltage Halogen Lamps

1. They shall be of the single ended, double enveloped type.
2. They shall be suitable for operation from 230V/50Hz, Single Phase AC.
3. They shall be suitable for universal burning positions.
4. They shall be in accordance with the following schedule.

| <u>Wattage</u> | <u>Base</u> | <u>Lumen</u> | <u>Life (Hrs.)</u> |
|----------------|-------------|--------------|--------------------|
| 100W | E27 | 1525 | 2000 |

J. Fluorescent Lamps

1. Fluorescent lamps shall be of 26mm dia., suitable for operation from 200-250V AC, single phase.
2. They shall be of switch start type with daylight appearance.
3. They shall be in accordance with following schedule.

| <u>Wattage</u> | <u>Base</u> | <u>Lumen</u> | <u>Life (Hrs.)</u> |
|----------------|-------------|--------------|--------------------|
| 18W | G13 | 1050 | 7500 |
| 30W | G13 | 2000 | 7500 |
| 36W | G13 | 2500 | 7500 |
| 58W | G13 | 4000 | 7500 |

K. Compact Fluorescent Lamps

1. They shall be single ended, with two or more narrow fluorescent tubes, as shown on luminaire schedule
2. Colour appearance shall be day light.
3. They shall be in accordance with the following schedule.

| <u>Wattage</u> | <u>Base</u> | <u>Lumen</u> | <u>Life (Hrs.)</u> |
|----------------|-------------|--------------|--------------------|
| | | | Output |
| 18W | G24d-2 | 1200 | 5000 |
| 26W | G24d-3 | 1800 | 5000 |
| 24W | 2GII | 1800 | 5000 |
| 36W | 2GII | 2900 | 5000 |

L. Discharge Lamps

1. All discharge lamps shall comply with IEC Standard 188
2. Lamps shall be in accordance with the following schedule:

| <u>Type</u> | <u>Lamp</u> | <u>Wattage</u> | <u>Base</u> | <u>Initial</u> | <u>Life</u> |
|-------------|-------------|----------------|-------------|----------------|-------------|
|-------------|-------------|----------------|-------------|----------------|-------------|

| | | | | <u>Lumens</u> | |
|--------------|--------|------|---|---------------|------|
| Metal Halide | MBI-T | 150 | - | 12000 | 6000 |
| Metal Halide | PAR 64 | 1000 | - | 76000 | 3500 |

M. Luminaire Louvres & Lenses

1. Louvres shall be manufactured from Anodized semi-specular aluminum reflector sheet. Sheilding assembly to be supported by concealed hinges and snap action latches opening from either side with fingertip pressure, to give clean uncluttered appearance to luminous cavity (no visible hardware, rivets etc.).
2. Lenses shall be acrylic with a minimum thickness of 3.175mm.

N. Luminaire Data Sheets

1. The luminaire data sheets define the quality and design/performance of all luminaires which shall be supplied and installed, with locations and quantities as indicated on the Drawings.

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 luminaires 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 16670
LIGHTNING PROTECTION

PART 1 GENERAL

1.01 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 all sections of this Division particularly 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.

1.02 SCOPE OF WORK

- A. This section includes for the complete supply and installation of the lightning protection system specified hereinafter and as detailed on the drawings.
 - 1. The system shall consist of metallic air terminals as shown on the drawings. The down conductors shall drop to the base of the Radome support structure. The structure and all metal objects in the Radome to be bonded to the down conductor, with removable link provided.
 - 2. At the base of the Radome additional air-terminals shall be installed and connected to the down conductors, as shown on the drawings.
 - 3. The down conductors shall continue to drop as shown on the drawings. Additional air terminals shall be installed at roof level and connected to the down conductor network installed around the roof.
 - 4. All curtain wall mullions shall be bonded together at roof level and joined to the copper air terminals by means of bimetallic connectors.

1.03 QUALITY ASSURANCE

- A. Lightning Protection system work shall be performed by one firm specializing in the installation of such systems.

1.04 SUBMITTALS

- A. Reference Applicable Divisions - Submittals.
- B. Reference Applicable Divisions - shop Drawings, Product Data and Samples
- C. Provide a shop drawings riser diagram of the lightning protection system detailing dimensions of all material and equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Air terminals: PVC insulated copper tape not less than 25mm x 3mm and upright copper rods (finials)
- B. Down Conductors: Copper tape not less than 25mm x 3mm PVC sheathed, colour as specified by the Architect./50 mm² CU insulated cable
- C. Fastening and attachment straps, brass.
- D. Test Clamps: Brass and/or gun metal of solid manufacture to accept copper down conductors separated from copper earth electrode conductors.
- E. Electrodes: solid copper rods, extendable type 1.5 metres long x 19mm diameter, phosphor bronze coupling screw, hardened steel tip, hardened steel driving cap.
- F. Flexible Ground Connections: Single core stranded copper conductors PVC sheathed colour green, and yellow, size as indicated.
- G. Test Pit: Concrete test pit with removable cover for periodic testing of earth electrodes.
- H. Connector pit, concrete pit precast with removable granite paver as cover. Provide lamacoid labial inside pits.
- I. Aluminum conductor, may be tape or single flexible cable, to suit mullion detail.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install lightning protection as indicated in accordance with the local codes and BS 6651 :1992.
- B. the down conductor shall be clamped to the Radome support structure and taken to the roof level. All metal materials in the Radome shall be bonded to the down conductor, through removable links.
- C. At the base of the Radome on the concrete structure of the building install additional air terminals as detailed. Down conductors shall be installed and taken to the roof level to be continued down.
- D. where an air termination is installed on the roof, support the tape on raised pads to allow the run of rain water. Weld air termination systems to down conductors.
- E. install air terminals and tape on the parapet walls of the roof structure. Connect all tapes and install down conductors as detailed.
- F. Bond air terminations on roof to steel reinforcement bars by means of bimetallic connectors as shown on drawings.
- G. Down conductors shall terminate at ground level in test pits below pavement.
- H. Install down conductors vertically with fixing clips every 2 meters and terminate at grade level in test clamp.
- I. Install the earth electrodes 4 metres into the ground plus additional sections to obtain the correct readings at each electrode less than 10 Ohms.
- J. Connect and bond all equipment mounted on roof in addition to any metallic installations to the air termination network.
- K. Bond curtain wall vertical mullion sections together by means of an Aluminium connector at a maximum of 10m mullion to mullion horizontal distance. Connect to the nearest lightning pit at grade by means of a bimetallic connector and copper tape.
- L. Test system is accordance with section 16030.

*** 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 CONDITIONS

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 alphanumeric label. In case 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

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.

***** END OF SECTION *****

**SECTION 16771
PUBLIC ADDRESS / VOICE ALARM SYSTEM**

PART 1 GENERAL

1.01 Description Of Work

- A. This section applies to the public address system.
- B. The quantity and location of apparatus comprising a complete system as shown on drawings.

1.02 System Description

- A. Equipment shall be shown with microphones and loudspeaker units positioned where indicated on the drawings to provide the maximum flexibility and coverage for broadcasting.

1.03 Quality Assurance

- A. Equipment shall be purchased only from single manufacturer established and specializing in these types of products.

1.04 Submittals

- A. Manufacturers shall submit drawings and illustrated leaflets of the various types of apparatus offered.
- B. For speakers submit the following:
 - 1. Characteristic curves for defined methods of mounting on ceilings.
 - 2. Suitability for continuous full output power handling.
 - 3. Types recommendations by manufacturer with application and environment considerations. Suitable cabinets for internal loudspeakers to be flushed to ceilings.

1.05 Delivery and Handling

- A. Pack to protect all apparatus during transportation and storage.
- B. Store in dry location.
- C. Do not install equipment until it can be protected from damage during construction.

PART 2 PRODUCTS

2.01 Equipment

- A. To provide high quality reproduction and natural sounding speech/music from a good amplitude modulated amplifier.
- B. Supply:
 - 1. Central rack including all necessary equipment such as Amplifiers, power supply, Radio tuner AM/FM, double deck cassette recorder, DVD player, Zone selections,...etc. as shown on drawings and B.O.Q.
 - 2. Microphone call stations
 - 3. Horn type loudspeaker indoor and outdoor type shall be as shown on the drawings.
 - 4. 6W round type recessed ceiling mounted loudspeakers with tap transformers.
 - 5. Selector switches.
- C. Level of Sound Output: The system shall be designed so that it is capable of providing without the undue distortion the maximum loudness likely to be required taking into account such factors as audience absorption and the maximum ambient noise level.
- D. For internal output a mean sound intensity level of 60dB relative to 5 - 8W/cm²) shall be provided and 20 dB below maximum available from the amplifier and speakers and not after allowance for the loudest passages so as not to create distortion in output quality. The rated power of the amplifier shall not be less than 12.5 m per 13000 m³.

2.02 Microphones

- A. Suitable for omni directional response. Smooth response over range of frequencies for the system. Move coil, ribbon or piezo electric as most suitable for the amplifier.

2.03 Amplifiers

- A. To operate continuously on the environmental conditions stated earlier.
- B. Low voltage to speakers not in excess of 100V. Inputs to the amplifier shall be high enough to produce full power output stated earlier.

2.03 Amplifiers (Cont'd)

- C. Frequency response: With filter inoperative, tone control set for desired response the frequency response shall not vary more than 2 dB over:

100 Hz to 20 KHz at rated output

2.04 Distortion

- A. With same conditions of frequency response the total harmonic content at rated power should not exceed:

2% (-34 dB) at 100 Hz

2.05 Loudspeakers

A. Loudspeakers shall provide close frequency response. Loss of higher frequencies shall not exceed 10 dB at the highest frequency.

B. Line transformers shall also be fitted to loudspeakers where individual outputs require to be adjusted.

2.06 Radio Tuner

- A rack mounted tuner shall be provided. The tuner shall provide for-set selection of 16 FM stations to program individually in the frequency range of 87.5 ~108.0 MHz. Automatically and manual station searching mode. LCD and LED display.

The tuner shall provide the following minimum performance:

| | | |
|-------------------|---|-----------------------|
| Input Sensitivity | : | 1.5 |
| THD | : | 0.5% |
| If Bandwidth | : | 250 KHz |
| Antenna Input | : | 75 |
| Output Signal | : | 0 - 500 mV adjustable |
| Poser Supply | : | 24 VDC |

2.07 Cassette Player

Rack mounted cassette player units of the industrial quality shall be provided for replay of background music.

Each player shall be fully controlled electronically by press of a button, and shall accept standard compact cassettes and shall provide at least 3 hours continuous replay without repeat.

2.07 Cassette Player (Cont'd)

The Cassette Player shall provide the following minimum performance:

| | | |
|---------------------------|---|-----------------------|
| WOW and Flutter | : | <0.15% (DIN) |
| Signal - to - noise ratio | : | > 52 dB (DIN) |
| Frequency response | : | 60 18000 Hz |
| Output voltage (mono) | : | Max. 0 dB, adjustable |
| Output Voltage (Stereo) | : | 2 x 400mV |

Mechanical Features

| | | |
|-----------------|---|--|
| Tape Speed | : | 4.75 cm/sec |
| Rewind time | : | 120 seconds for C 60 Cassettes |
| Motor sound. | : | 2+1 motors with revolving head and no slip clutches |
| Tape monitoring | : | Electronic with air cushioned compartment and auto - reverse function. |
| Material | : | sendust sound head |

Cassette Head Cleaner:

An non - abrasive cassette unit head cleaning cassette shall be obtained within the system manual.

2.08 Disk Player DVD

A rack mounted compact disc (CD) player shall be provided.

The CD Player shall provide the following minimum performance:

1. One control Load and Play
2. Continuous repeat of a pre-programmed track selection.
3. Latching pause control.
4. Visible display of track number and of total playing time in the inserted disc.

The CD player shall include a cartridge for pre-loading of 5 or 6 compact discs, with random track selection facilities.

The CD player shall provide the following minim performance:

1. Frequency response 40 Hz - 20 kHz \pm 0.5 dB.
2. Signal - to - noise ration (S/N) > 100 dB (A).
3. Channel separation > 85 dB

4. Harmonic distortion < 0.01 % @ 1 KHz

2.09 Test Input

An industry standard socket with gain control (female XLR-3 or standard 1/4" jack) shall be obtained for the rack for the insertion of external test sources.

A latching switch shall be provided on the rack for continues broadcast of test message.

2.10 Loudspeakers

1. Distribution Cone Loudspeakers

Distribution ceiling mounted cone loudspeaker shall be provided in all areas within the suspended ceiling. Loudspeakers shall be round, white with metal grid.

Distribution loudspeaker shall be high quality core unit and shall be fitted with bayonet in the mounting ring for rapped and easy fitting.

Ceiling loudspeaker shall be fitted with suitable acoustic enclosure and shall have a built in matching transformer with taps for 100 V @ 6, 3, 1.5 and 0.75 watts.

Distributed cone loudspeaker shall provide the following minimum performance:

1. Power : 6/9 watts
2. Frequency range (-3dB) : 80 ...18000 Hz
3. Sound pressure (1w/1m) : 90 dB
4. Impedance : 4

2. Horn Loudspeakers

Re-Entrant horn loudspeakers shall be provided in plant and high noise level areas.

The loudspeaker horn and driver unit shall be of rugged, impact resistant construction and shall meet the following minimum performance:

1. Handling power : 15 watts
2. frequency range) -3db) : 250 18000 Hz
3. Acoustic pressure (1w/1m) : 118 dB
4. Basic impedance : 8
5. Matching transformer \$@ 100 V : 15, 7.5, and 3.8 watts

The horn loudspeakers shall be provided with rugged brackets which shall permit a minimum of + - 45 o c (horizontal), site adjustment in one plane only shall not be acceptable.

2.10 Loudspeakers (Cont'd)

Miniature re-entrant horn loudspeakers installed within diecast or plastic rectangular assemblies, shall be installed in quiet plant areas ($> 75\text{dB (A)}$) and in service corridors. The assemblies shall be temperature rated (aluminum range - 10°C to $+ 65^{\circ}\text{C}$).

Loudspeakers horn shall be suitable for the environment in which they are installed.

2.12 Cabling

- A. All cables for the sound system are to be twisted 3 core white PVC sheathed - PVC insulated copper cables, not less than 1.5mm^2 .
- B. Microphone cables shall be twisted pairs screened with tinned copper closely lapped or braided. The screening shall be sheathed overall with PVC insulation.
- C. Flexible cables shall be hard service cord high temperature thermoplastic insulated.

PART 3 EXECUTION

3.01 Inspection

- A. The Contractor shall examine the areas and conditions under which the system is to be installed and function.
- B. Correct any unsatisfactory conditions detrimental to the proper and timely completion of the work until unsatisfactory conditions have been corrected in a manner acceptable to the Supervising Engineer.

3.02 Installation

- A. Power supply to be provided adjacent to the amplifier.
- B. All equipment metal enclosures to be grounded.
- C. A separate uninsulated grounding system for connection to cable screens.
- D. Room where amplifier is installed shall be adequately ventilated.
- E. Public address system cable shall not be placed in any raceway or cable trays with conductors for lighting or power cables or cable carrying voltages higher than 100V.
- F. Power supply shall be durably marked to indicate the class of supply.
- G. All non-current carrying metal parts of equipment shall be grounded.
- H. All fixed cabling shall be carried out as a fixed wiring system.
- I. Joints shall not be permitted.
- J. Boxes shall be fitted in dry locations where possible. Boxes fitted in damp locations shall be waterproof pattern.
- K. Wires forming a pair shall not be split. Distribution boxes shall provide separate terminals for all incoming and outgoing wires with cross connection facilities.
- L. One terminal shall contain one wire only. Spare wires shall be left long enough to reach any terminal.
- M. A schedule shall be fixed to the inside face of the box cover showing all connections and giving details of the wiring.
- N. Cables shall not be run externally.
- O. Adequate protection shall be provided for all accidental damage or unauthorized interference.

3.02 Installation (Cont'd)

- P. P/A System shall be connected and interfaced with other sound systems in the project.

3.03 Field Quality Control

- A. The completed installation shall be inspected to ensure the work has been carried out in a satisfactory manner and that the methods, materials and components shall comply with the specification, drawings and manufacturer's recommendation.
- B. A functional test of the installation shall be made to ensure the installation will give satisfactory service under all conditions likely to be experienced.
- C. Earthing connections shall be checked and tested.

*****End of Section*****

Section 16781
SMATV System

PART 1 GENERAL

1.01 WORK INCLUDED:

Furnish, install, connect and test a complete community antenna television (CATV) system.

1.02 RELATED WORK

- A General Provisions for Electrical Work
- B. Conduit
- C. Cabinets
- D. Equipment Identification
- E. Lightning Protection System

1.03 REFERENCE STANDARDS

- A. Verband Deutscher Elektrotechniker (VDE) (Association of German Electrical Engineers).
 - 1. VDE 0855: Specifications for Antenna Installations
 - Part 1: Specifications for the Erection of Antenna Installations
 - Part 2: Functional suitability for receiving Antenna Installations.
 - 2. VDE 0887: Radio Frequency Cable, Coaxial, $Z_0=75\text{ ohm}$, for Television Antenna Systems.
 - Part 1: General Requirements
 - Part 2: Indoor Cables
 - Part 3: Outdoor Cables

1.03 REFERENCE STANDARDS (Cont'd)

- B. British Standards B.S.

B.S. 5063 : Specification for cabled distribution systems for sound and television signals.

1.04 SUBMITTALS

- A. Listing of all component manufacturers.
- B. A detailed technical specification of all equipment and systems.
- C. Shop drawings for all components and equipment.
- D. A detailed drawing of the system with the description of each piece of equipment proposed.
- E. A detailed drawing of the system showing the input and output levels at every amplifier for the highest and lowest channel, as well as the levels maintained at the extremities of each line.
- F. Certified copies of field-strength measurements of all specified stations as determined at the site shall be submitted to the Supervising Engineer for approval.
- G. Test data sheets showing field intensity levels for the specified channels, model and type of field intensity meter and calibrated antenna, height of antenna above ground and the system calibration curves shall be submitted. These data sheets shall also show equipment calibration certification dates and calibration agency.

1.05 DESCRIPTION OF SYSTEM

- A. The system shall receive signals from the television and radio stations which can be received in Saudi Arabia, via a community antenna, amplify the signals and distribute them via coaxial cables to the locations as indicated on the drawings and as described herein.
- B. All equipment shall be designed and rated for 230 volts, 50 Hz supply and shall be rated for continuous duty at the site conditions.

1.06 STATION SIGNALS

Station signals shall be received, amplified and distributed on non-adjacent channels throughout the antenna system from the television stations and all FM radio and AM radio transmissions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All goods and products covered by this specification shall, when available, be procured from a local manufacturer/agent.
- B. Items of same function and performance are acceptable in accordance with the Specifications.

2.02 SYSTEM PERFORMANCE

- A. Any colour or black-and-white television receiver conforming to EIA Standards, when installed at any outlet on the antenna system, shall produce from any required station a picture and sound quality equal to or exceeding the quality obtained with the same receiver connected directly to the properly oriented and tuned channel antenna at the antenna site. The system shall conform to FCC limitations on radiation and shall be effectively shielded against pickup or generation of noise, undesired signals and interference by any components of the system. The delivered signals shall be free from interference, ghosts, noise, reflections, smear, snow and overload distortions. The following shall be demonstrated in acceptance tests.

| | | |
|----|---|----------|
| 1. | Minimum TV signal, all channels | 65 dBuV |
| 2. | Maximum TV signal, all outlet, all channels | 77 dBuV |
| 3. | Maximum difference between adjacent signals at any one outlet | 3.0 dBuV |
| 4. | When measured in 4 MHz bandwidth, overall signal-to-noise ratio for each channel of the system shall not be less than | 37 dB |
| 5. | Frequency drift of converted channels for any condition or temperature of operation not more than | 0.005 % |
| 6. | Maximum variation of outlet signal for 20 dB variation of antenna signal, above minimum signal | 2 dB |
| 7. | Minimum isolation from outlet to outlet | 24 dB |
| 8. | Maximum hum modulation | 5 % |

- B. Phasing characteristics of the antenna system shall not cause ghosts, smears, or double images to appear in receivers used with the system.

2.02 SYSTEM PERFORMANCE (Cont'd)

- C. The FM signal strength at outlets shall equal or exceed the strength of the same signal at the antenna, except that strong signals, greater than 1000 microvolts may be attenuated to prevent television interference. The FM equipment shall be compatible with the TV equipment and the two shall not interfere with one another.

2.03 ANTENNA AND MAST

- A. The antenna shall be mounted on a 6 metre high mast mounted on top of the building as shown on the drawings.
- B. The antenna shall be designed, constructed, installed and oriented such that, when used in conjunction with the system amplification, it will provide the specified signal level, band width, spurious-response rejection and freedom from ghosting caused by undesired radiation. In areas where it is necessary to achieve the required signal characteristics, separate antennae shall be provided and oriented for best reception of each channel so affected. Each antenna shall be designed to match 75 ohm coaxial cable or shall be provided with a matching impedance. Antenna shall be mounted on the mast in accordance with the manufacturer's recommendations. Field strengths tests should be done before offering the system.
- C. Signals in the 88 to 108 MHZ broadcast band shall be received by one broad band antenna and amplified by a broad-band head end amplifier. The antenna shall have a uniform response over the 88-108 MHZ band and shall be oriented to receive the maximum number of FM signals at the most uniform strength.
- D. Obstruction marking and lighting of towers shall comply with local authorities requirements for Defense and Aviation.
- E. The CATV system shall be provided with lightning protection in accordance with the applicable code. Steel masts shall not require air terminals or down conductors but shall be properly grounded. All antenna installed on steel masts shall be bonded directly to the steel mast. All interior equipment, raceways, cabinets, and outlet boxes shall be grounded. Guys shall be continuous without insulators, bonded, and grounded.
- F. The system shall not have radiation in excess of the limits specified by the Code.

2.04 AMPLIFIERS

- A. The amplifier input and output shall be properly matched to the antenna and/or 75 ohm cables.
- B. Single channel amplifiers shall have a noise figure not greater than 10 dB for low band VHF, 12 dB for high band VHF and 14 dB for UHF.
- C. Broadband amplifiers shall have a noise figure not greater than 7 dB for low band VHF, 8 dB for high band VHF and 12 dB for UHF.
- D. Frequency response shall be uniform within plus or minus 1/2 dB over the 6 MHz bandwidths of any channel and within plus or minus 2 dB over all channels of Broadband amplifiers.
- E. Broadband amplifiers shall have separate gain controls or Attenuators shall be provided to balance all channels, or both.
- F. Amplifiers shall comply with VDE0855, shall be inherently stable in operation and shall not require frequent readjustment due to temperature or aging.

2.05 HEADEND UNIT

- A. The headed unit shall have automatic gain control built-in or as separate units and shall have separate manual gain controls for low band VHF, high band UHF and satellite signals.
- B. Headend unit shall include receivers, modulators, amplifiers...etc, to receive signals from satellite dishes, antennas, ASIS signals and local video system.

2.06 FREQUENCY CONVERTERS VIA INTERMEDIATE FREQUENCY

The frequency converters shall have the following features:-

- To convert a CCIR TV channel, standard B/G or standard I or an ORIT TV channel standard D/K.
- Conversion from the VHF1, LSC VHF3, USC or UHF bands to any chosen VHF or UHF channel via the standard intermediate frequency.
- Consisting of two single components, an input converter ... and an output converter.

INPUT CONVERTER

The input converter shall have the following features:

- Converts one input channel to the standard IF band.
- Regulates IF output signal set at the works to 100 dBu V, other IF output levels shall be indicated.
- Level control to reduce input signals.
- 1 connecting jumper 75 ohm shall be included.

OUTPUT CONVERTERS

The output converter shall have the following features:

- Converts from the standard IF band to an output channel in the VHF or UHF band.
- Output level set to the works to 120 dBu V at an IF input level of 100 dBuV.
- For feeding additional video programmes into community antenna systems capable of combination with the TV modulators LMO.
- 1 connecting jumper 75 ohm shall be included.

2.07 TRUNK LINE AMPLIFIERS

- A. Trunk line amplifiers shall be provided where necessary.
- B. The amplifiers shall be routed in corrosion resistant, heavy duty, weather proof enclosures with Glanded cable entries.
- C. The amplifiers shall receive their power supply from the nearest socket outlet.

2.08 SPLITTER UNITS

- A. Splitter units shall be provided in locations as necessary for the project.
- B. Splitter units shall consist of a multiway passive network mounted in corrosion resistant, heavy duty, die- cast, weather proof enclosures with Glanded cable entries.
- C. Unused outlets shall be furnished with 75 ohm terminators.

2.09 TAP-OFF UNITS

- A. Tap-off units shall be provided in locations as indicated on the drawings.
- B. Tap-off units shall consist of a passive network and shall supply a group of outlets as indicated.
- C. Tap-off units shall be mounted in corrosion resistant, heavy duty, die cast, weatherproof enclosures with Glanded cable entries.
- D. Unused outlets shall be furnished with 75ohm terminators.

2.10 COAXIAL CABLE

- A. All coaxial cables used for trunk and distribution lines shall be double screened and shall comply with VDE 0887.

2.11 SATELLITE RECEIVING SYSTEM

- A. The system shall consist of, but not be limited to the following typical equipment for the reception of the channels transmitted, from ARABSAT, (Hot bird), NILESAT.
- B. Typical Equipment for SMATV

10ft mesh dish as described below
Channels to be received (to be selected by the Owner) using demodulators and modulators.
- C. SATELLITE DISH

Satellite dish to be digital type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturers instructions and in accordance with the drawings.
- B. Special care shall be taken with the installation of coaxial cables to avoid damage due to rough handling and short radius bends.

3.02 TESTING AND COMMISSIONING

- A. Acceptance tests shall be performed by the Contractor in the presence of the Supervising Engineer.
- B. The Contractor shall provide all meters, instruments, signal generators, oscilloscope, receivers, and other devices necessary for such tests. The colour receiver used in the tests shall conform to EIA Standards.
- C. The following tests shall be performed in addition to those tests detailed above under the System Performance paragraph.
 - 1. Input Signal: Signal voltages from the antenna shall be measured at the main amplifier input on all required channels. Signals shall be observed on each required channel using any receiver designated by the Contracting Officer. In case of a poor signal, measurements and observations may be required at the antenna terminals on the mast to verify that no improvement of the signal is feasible.
 - 2. Signal at Outlets: Using the field-strength meter, the video level for the highest and lowest frequency channel distributed on the system shall be read at various taps at random. The signal on each channel shall read not less than 1,000 microvolts and not more than 10,000 microvolts. Using the receiver used at the antenna site, the various channels shall be observed at various outlets, to reproduce a signal of equal or better quality than that obtained at the antenna. The Contractor shall demonstrate that the automatic gain control complies with the requirements of paragraph 2.05 above.

3.03 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Four complete bound manuals of operating and maintenance instructions shall be provided. Two copies shall be written in Arabic and two in English language.
- B. The manuals shall include complete data on every component of the system, circuit diagrams, parts lists, alignment procedures, adjustments, signal levels, test points, and troubleshooting procedures using TV receiver, signal generator, oscilloscope, signal strength meter and high-resistance voltmeter.
- C. During the final adjustments and acceptance tests and for a period of not less than two days, the Contractor shall instruct and demonstrate to designated owners staff, all operation, adjustment and test procedures.

3.04 SPARE PARTS SUPPORT

- A. In his tender, the Contractor shall provide full details of the local service organization of the manufacturer of the system.
- B. An individually priced, itemized list of recommended spare parts suitable for one year normal maintenance shall be provided. Spare parts shall be identified as consumable spares, critical for unit operation, or special tasks.

*****End of Section*****

SECTION-16800
APPROVED MANUFACTURER LIST

| <u>Material</u> | | <u>Manufacturer</u> |
|------------------------------|----|-----------------------|
| Main Distribution Boards | a) | Merlin Gerin (France) |
| | b) | Moeller (Germany) |
| | c) | ABB (Europe) |
| Instruments and Meters | a) | Satec (Locally) |
| | b) | ABB (Europe) |
| Sub-main Distribution Boards | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller (Germany) |
| Distribution Boards | a) | Merlin Gerin (France) |
| | b) | ABB (Europe) |
| | c) | Moeller (Germany) |
| Disconnecting Switches | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller |
| Lighting Contactors | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller(Germany) |
| Motor Control Panels | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller(Germany) |
| Relays for Remote Switching | a) | ABB (Europe) |
| | b) | Merlin Gerin (France) |
| | c) | Moeller (Germany) |

| | | |
|--|----|--|
| Wires and Cables Lighting and Power, and Low voltage (FA, PAVA, ...) | a) | Superior (Locally) |
| DATA - Structural Cables and Accessories Sockets and patch panels | a) | CAT7A Superior cables (Locally) |
| | b) | RJ45/3M (USA) |
| | c) | 24PORT P.P/3M (USA) |
| Cable Trays and Ladders | a) | OBO beterman (Germany) |
| | b) | Nidax (Germany) |
| Metallic Cable Trunking | a) | Locally/according to engineer approval |
| Capacitor Banks | a) | EKG (Germany) |
| | b) | Siemens (Germany) |
| Motors and Starters | a) | Moeller (Germany) |
| | b) | Telemecanique (France) |
| PVC Conduits and Fittings | a) | Locally/according to engineer approval |
| PVC Flexible Conduits | a) | Locally/according to engineer approval |
| Boxes | a) | Gewiss (Italy) |
| | b) | Legrand (France) |
| Cable Glands & Accessories | a) | BICC (UK)/or approved equal |
| Lighting Fixtures | a) | as per lighting fixtures schedule or equal |
| Wiring Devices & Accessories | a) | Gewiss (Italy) |
| | b) | Legrand (France) (White) |
| | b) | Merlin Gerin (France) |

| | | |
|--|----|---|
| Fire Alarm System-Analogue/ Addressible | a) | Notifier (USA) |
| | b) | Simplex (USA) |
| | c) | Esser |
| | d) | Telefire |
| Lightning System | a) | Furse (UK) |
| | b) | Helita pulsar (France) |
| Earthing System | a) | Locally/according to engineer approval |
| | b) | Locally/according to local authority approval |
| Builders work | a) | Locally/according to engineer approval |
| Intercom system | a) | Aiphone (Japan) |
| (Public Address & Voice Alarm (PAVA)) | a) | TOA (Japan) |
| | b) | BOSCH (Holland) |

***** END OF SECTION *****

Index

| <u>SECTION</u> | <u>Title</u> |
|-----------------------|---|
| 16000 | Electrical Works |
| 16010 | General Provisions for Electrical Work |
| 16075 | Electric Identification |
| 16110 | Raceways |
| 16120 | Conduits |
| 16130 | Underground Electrical Service |
| 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/ Voice Evacuation System |
| 16781 | SMATV System |
| 16800 | Approved Manufacturer List |

Project:

Project: Augusta Victoria Hospital Triage Department

Specifications

Mechanical Works

September, 2018

MECHANICAL WORKS

TABLE OF CONTENTS

| <u>SECTION</u> | <u>TITLE</u> |
|-----------------------|---|
| 1.00 | General Conditions/Requirements |
| 2.00 | Standards |
| 3.00 | Ventilation & Air Conditioning Installation |
| 4.00 | Chilled Water Installation |
| 7.00 | Cold Water Services |
| 10.00 | Fire Fighting Installations |
| 14.00 | Sanitary Fixtures |
| 15.00 | Above Ground Drainage Installations |

MECHANICAL WORKS

SECTION : 1.00

GENERAL CONDITIONS / REQUIREMENTS

1.01 INTRODUCTION

The following General Conditions and Requirement particularly relate to the Mechanical Engineering aspects of the Contract. They shall be read and interpreted in conjunction with all other Sections of the Specification, the Drawings, the Schedules and all other documents forming part of the Tender Documents.

1.02 EXTERNAL DESIGN CONDITIONS

The design environmental conditions for Jerusalem City are as follows:

| | | |
|------------------------------|---|--------------------------------|
| Summer Design Temperature | : | 35 °C dry bulb, 21 °C wet bulb |
| Absolute Maximum Temperature | : | 37 °C dry bulb |
| Mean Daily Range Temp | : | 13 °C. |
| Winter Design Temperature | : | 0 °C dry bulb |
| Altitude | : | 780 m level |
| Latitude | : | 31 North |

1.03 EQUIPMENT RATINGS

All equipment selected for use on this Contract shall be suitable for continuous and reliable operation under the external design conditions stated. In addition, items of equipment installed in enclosed spaces may be subject to temperatures in excess of those prevailing externally and this shall be taken into account. Where ratings are given in this Specification and/or shown on the Drawings, they are the actual ratings to be achieved after the application of all de-rating factors.

All equipment and enclosures that may be subject to internal condensation shall be fitted with suitably rated electrically operated thermostatically controlled anti-condensation heaters.

1.04 COORDINATION

The Contractor shall be responsible for all aspects of coordination necessary to ensure that the works are properly installed in accordance with the Contract Drawings and Specification. This shall include the inter relationship between Mechanical and Electrical Services, the Building Foundations, Fabrics and Finishes, and all Specialist Equipment contained therein, whether supplied under this Contract or not.

Coordination shall cover the programming and physical requirements of all works. Particular care must be taken in the setting out of works in common ducts, tunnel, false ceiling or similar areas accommodating several services. The disposition of services shall be such that necessary segregation is maintained and that the completed installation affords ready access at a later date for the replacement, maintenance and extension thereof.

1.05 EQUIPMENT

All equipment to be installed under this contract shall be manufactured by a world wide well known manufacturers, and the quality of the product shall be of an approved standard.

The Contractor must give details of type and manufacturer and the manufacturer must have local representative capable of supplying spare parts, and giving technical support throughout the working life span of the equipment.

The Contractor shall name each material or equipment he proposes to supply for the purpose of this project, supported by all details and technical data. The PM and/or the Engineer reserve the right to reject any equipment in favor of their choice.

1.06 SHOP DRAWINGS

The Contractor shall prepare shop drawings for the installation. These shall be based upon the actual equipment to be installed, according to manufacturers subsequently approved by the Engineer.

The Contractor shall make such adjustments to the design as are necessary to accommodate the technical and physical, requirements of the selected equipment in the preparation of the shop drawings .

Such adjustments shall at all times ensure that the final performance of the completed installations is achieved as intended.

Shop drawings shall be checked and coordinated with the work of all trades involved before submission for the approval of the Engineer and shall bear the Contractor's stamp of confirmation as evidence of such checking and coordination. Drawings submitted without this stamp of confirmation will be returned to the Contractor for re-submission.

Drawings shall be initially submitted in 3 sets of prints accompanied by a letter of transmittal. After return of the "Engineer approved for construction" print, the Contractor will furnish the number of additional prints (not to exceed ten in number) specified by the Engineer.

Each drawing shall have a blank area of 18 cm. x 12 cm. located adjacent to the title block and reserved for the comments of the Engineer. The title block shall display the following: -

- a) Number and title of drawing (s),
- b) Date of drawing or revision,
- c) Name of project and employer,
- d) Name of consultant,
- e) Name of contractor and sub-contractor submitting the drawing(s),
- f) Clear identification of contents and location of work,
- g) Specification title and number,
- h) Scale of drawings .

The scale drawings shall be to a minimum scale of 1:50 and in complex areas, such as plant room and service ducts, scales of 1:20 and 1:10 shall be applied.

The Contractor shall submit all drawings sufficiently in advance of construction requirements to permit not less than fifteen working days for the Engineer's checking and appropriate action.

The approval of drawings will be general, but approval shall not be construed as permitting any departure from the Contract requirements, nor relieving the Contractor of the responsibility for any errors, including details, dimensions, materials, etc. and specified performance of equipment.

1.07 RECORD DRAWINGS AND MANUALS

Within thirty days of the Certificate of Completion, the Contractor shall provide 3 sets of fully detailed "as installed record drawings" of the whole Contract Works together with full installation operating and maintenance instructions to be checked and approved by the Engineer. Temporary manuals and record drawings shall be made available at least one month before to enable the Employer's staff to familiarize themselves with the installation. These should preferably be the final manuals with temporary insertions for the items which cannot be finalized until the Works are completed and tested.

The drawings shall comprise general arrangement drawings of all installations; detail drawings of plant rooms and similar areas; single line diagrams of all services; line diagrams of control systems and electrical circuit diagrams.

The drawings shall indicate the color coding, labeling and identification of all the services as previously described, and shall give full working details of size, load, duty and capacity of each item of plant. The drawings shall also clearly indicate the location of all vents, drains, dampers, valves and test points. The line diagram shall indicate the type, location and function of each component and, together with the interconnecting wiring and piping, the terminal connection reference numbers or letters on the actual equipment.

The drawings shall :

- a) Indicate sizes and positions of all plant, equipment pipes conduits .
- b) Indicate the circuit reference for all equipment and each outlet shown. All references shall agree with the chart and labels in distribution boards fixed to the switchgear.

In addition to the Record Drawings, the Contractor shall obtain and provide two sets of the manufacturer's detailed drawings of all items of plant, suitably titled and with drawing reference numbers added .

The Record Drawings shall be specially prepared and shall not be modified Working Drawings The preparation of these drawings shall be processed during the installation of the Contract Works, as each section is completed. To ensure that this requirement is met, the Engineer shall be all to inspect the drawings on request.

The operating and maintenance instructions shall be prepared as soon as the working drawings are in hand and shall take the form of a manual in which is described the layout and function of the system, schedules of components comprising each and every item of equipment including manufacturer's name, reference and serial number and operating maintenance instructions based on the manufacturer's standard amplified where necessary. An overall maintenance schedule shall be prepared by the Contractor on a system basis, listing out in simple terms the plant, nature of attention and intervals due. This shall be cross-referenced with the manufacturer's standard instructions.

Drawings shall be arranged to fold out from their position and be entirely visible when any part of the manual read. They shall be printed on linen backed paper.

The manuals shall be encased in loose leaf binders .

The Contractor shall include for the preparation and supply of four copies of the manuals and drawings after all details have been approved by the Engineer. Also the supply of two sets of reproducible, one set to be handed to the Client and one set to be kept with the Engineer.

1.08 SERVICES FOR TESTING

All fuel, oil, gas, water and electricity for the purposes of testing and commissioning shall be provided by the Contractor up to the date of the issue of the Certificate of Temporary Acceptance. This shall include the initial charging of all systems and equipment with water, oil and refrigerants, etc.

1.10 SPARE PARTS INFORMATION & TOOLS

1. Spare Parts information: The Contractor shall furnish spare parts information for all equipment furnished under this contract. The information shall be complete, legible, organized, and submitted by system in two (2) copies, and shall include:

MECHANICAL SPECIFICATION

- 1.1 A list of spare parts, special tools, and supplies, for each item of equipment, which are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract.
- 1.2 A complete list of spare parts and supplies recommended by the manufacturer to assure efficient and continuous operation of each item of equipment for a period of two (2) years after completion and acceptance of entire work under this contract.
- 1.3 The list shall show the recommended minimum stockage level for reordering and shall identify all long lead items. A long lead item is defined as any item of equipment which cannot be ready for delivery in less than six months after receipt of order. The lists shall include the following information for each recommended spare part:

Manufacturer's Part Name

Manufacturer's Name and Address

Manufacturer's Part Number

Manufacturer's Drawing Number Showing Part

Next Higher Assembly

Equipment Symbol Keyed to Contract Drawings

Recommended Number of Spares

Net Unit Price

Quantity installed per Assembly

Lead Time

Shelf Life

Peculiar Life

Peculiar cleaning, calibration, packaging and preservation requirements.

Name and address of the authorized spare parts representative and spare parts stocking source nearest to the project site.

Alternate sources of procurement.

2. SPECIAL TOOL AND TEST EQUIPMENT LIST:

- 2.1 The Contractor shall furnish to the Engineer two (2) copies of recommended list of all special tools and test equipment. The special tools and test equipment shall cover all items required for the successful operation and maintenance during a ten year equipment life. In compiling the special tools and test equipment list, the Contractor shall indicate all special tools and test equipment items that require calibration, including frequency and method. Necessary standards shall be listed immediately after each item that requires calibration, and they must be traceable to the National Bureau of Standards or other reference satisfactory to the Engineer. Tool lists shall include all tools required. Test equipment lists shall include all equipment required for acceptance testing and calibration. The Contractor shall supply two (2) copies of all vendor-supplied catalogs and instructions for

MECHANICAL SPECIFICATION

operation and maintenance of the tools and test equipment furnished under this contract.

3. SUBMISSION OF PRELIMINARY PARTS LIST:

- 3.1 The Contractor shall submit one (1) copy of his preliminary parts list with recommendations for spares within the time frame set forth above. This list is subject to the Engineer review and written approval. The Consultant may revise the listing as to quantities of recommended spares as a condition of approval. The Consultant reserves the right to order all, none or any portion of additional spare parts from the manufacturer's complete parts list and the preliminary Parts List.
- 3.2 Resubmittals: Any resubmittals or additional submittals of equipment lists, spare parts lists or associated information shall be made within thirty (30) calendar days from notice by the Engineer and all costs associated with the submissions shall be borne by the contractor.
- 3.3 Final Parts List: The final list shall be submitted not later than one hundred twenty (120) calendar days prior to contract completion date, in five (5) copies and shall be annotated "Final" on each sheet.

1.11 TRAINING OF ENGINEERING STAFF

The Contractor shall provide training for the employees of the employer. Such training shall cover all aspects of using, running, commissioning and maintaining of all Engineering services.

END OF SECTION

MECHANICAL WORKS

SECTION: 2.00

STANDARDS

2.01 INTRODUCTION

This General Specification indicates the minimum standard of Work, workmanship and materials necessary for the execution of the Contract to the approval of the Engineer and the true intent of this Specification and associated Drawings.

2.02 DESIGN STANDARDS

The installation shall conform to:

- a) The general and specific requirements of the local water authority, public health officer, local drainage inspectorate and other local statutory authorities.
- b) Local authority by laws and other regulations.
- c) General and specific requirements of the local fire officer.
- d) Relevant codes of practice of the British Standards Institution.
- e) The requirements of the insurance companies concerned.
- f) National Fire Protection Agency (NFPA)
- g) American Society for Heating, Refrigeration, and air Conditioning specifications (ASHRAE).
- h) The regulations for the electrical equipment of buildings, (current edition) published by the Institution of Electrical Engineers, London.
- j) The recommendations of the manufacturers of all materials, plant and equipment.
- i) Department of health and social security (U.K.), (D.H.S.S.) health building system engineering nucleus, Volumes 3 and 4C.
- m) National Plumbing Code.
- n) Guidelines for design and construction of Hospital and health care facilities.

2.03 SAFETY AND FIRE PRECAUTIONS

The Contractor shall ensure that safe methods of working are followed when using any equipment of materials which may involve a danger to life or to property and he is to take all necessary precautions to safeguard against damage by fire or explosion where the execution of the works may involve the presence of flame or sparks.

2.04 CONTRACTOR'S PLANT AND TOOLS

The Contractor, unless otherwise specified, shall provide all materials, tackles, slings, scaffolding, ladders, haulage, labor and apparatus necessary for the supply, delivery and erection of the plant on site.

The Contractor shall be responsible for providing at his own expense, all the requirements such as hand tools, hand lamps, and transformers, where necessary, to carry out the works including all cabling and intermediate connections from supply point to location of work. All wiring, cabling, etc., serving temporary installations are to be designed, installed and operated, as to be safe and in full accordance with the appropriate regulations.

As soon as any part of the Contractor's Site establishment or plant is no longer required for carrying out the Works, the Contractor shall disconnect and remove the same to the satisfaction of the Engineer.

2.05 PIPEWORK CONNECTIONS

The Contract shall include all pipework and connections to all sanitary fittings, basins and equipment as detailed on the Drawings and Architectural Loaded Drawings.

2.06 MATERIALS

All materials, plant and equipment shall comply fully with any relevant British Standard Specification or Code of Practice current at the time of tendering.

The Engineer reserves the right to inspect materials, plant and equipment on Site at reasonable times and to reject any of the same not complying with the Specifications.

The cost of dismantling and re-erection of the installation occasioned by the removal of rejected materials, plant or equipment shall be borne by the Contractor.

2.07 STANDARDS

Corresponding parts of all apparatus shall be interchangeable and where mechanical or electrical details are used or which any part of parts are covered by a British Standard Specification, all such parts are to be made in accordance with such specification as shall be issued at the date at which the parts have been ordered.

Except where otherwise specified, all bolts, nuts and stud screws thread shall be metric and all pipe threads to be to B.S. pipe threads standards.

2.08 TRADE CUSTOMS AND PRACTICE

The Contractor shall be entirely responsible for arranging and ensuring that the various classes of work comply with local trade customs and practice and shall provide accordingly in his Works.

2.09 DIMENSIONS

The Contractor shall take his own dimensions on Site for all plant and material to be supplied by him and shall be entirely responsible for the accuracy, of his measurements.

2.10 SETTING OUT

The Contractor shall set out the Works in accordance with his installation working drawings.

2.11 NAMEPLATES

All plant and apparatus supplied under this Contract shall be provided with brass nameplates, bearing the maker's name shop or reference number, size, type, test and working pressure, speed and other relevant particulars engraved thereon.

2.12 INTERRUPTION OF SERVICES

The Contractor shall not, without permission of the Engineer interrupt or interfere with the operation of existing services such as water, electric lighting and power, buried cables, sewers, drains, etc., nor, in the case of works of statutory authorities or private owners, without the permission of these authorities or owners.

In the event of any such damage, the Contractor shall be responsible for the making good of same to the satisfaction of the Engineer, authorities or owners, as the case may be.

2.13 MISUSE OF MATERIALS

No materials brought on to Site for incorporation in the Works shall be used for scaffolding or any other temporary purpose.

2.14 VOUCHERS

The Contractor, at the request of the Engineer, must produce invoices, paid or unpaid, or accounts if required as proof that the goods are in all respect as herein specified.

2.15 OBSTRUCTIONS

No extra charge shall be made for moving or circumventing any obstruction or other Contractor's equipment that may be laid on the Site and the Contractor must, therefore, allow in his tender for these and any other contingencies likely to arise.

2.16 INSPECTION, TESTING AND REJECTION

The Engineer shall be entitled during manufacture to inspect, examine and test the materials and workmanship for all plant to be supplied under the Contract, whether at the Contractor's or manufacturer's premises or on the Site. Such inspection, examination or testing shall not release the Contractor from any obligation under the Contract. The whole of the installation shall be tested on completion (in the presence of and to the satisfaction of the Engineer or his representative) in the relevant Sections of this Specification as applied to the particular installation concerned.

Certificates of test, in duplicate, must be furnished by the Contractor to the Engineer, for all plant or materials specified to be tested at maker's works.

The tests on Site specified hereinafter are to be carried out in the presence of the Engineer or his Representative. The accuracy of all tests is to be to the satisfaction of the Engineer, whose decision shall be final.

The Contractor shall provide free of charge on the Site at his own expense and/or the manufacturer's works, such labor, materials, apparatus and instruments as the Engineer may consider requisite from time to time and as may reasonably be demanded to efficiently test the plant, materials or works as far as completed, until the plant is accepted as a whole by the Engineer. The Contractor shall at all times give facilities to the Engineer or his authorized representative to accomplish such testing.

The Contractor shall demonstrate, if required, the accuracy of any instrument used for testing.

At least seven days' notice must be given by the Contractor of any test carried out on the Site to enable the Engineer or his authorized representative to be present if they so desire.

Testing of pipes and other apparatus as specified under the various Sections of Specifications may be required to be carried out in parts against testing as a whole and the Contractor must provide accordingly in his tender.

Should the Works on testing not conform to the Specifications, the Contractors must make them so conform at his own expense and, if he fails to do so within a reasonable period, not exceeding fourteen days, the Engineer shall be at liberty to call upon him to remove the defective part and reinstate without cost to the Employer.

2.17 INSPECTION BEFORE CONCEALMENT

Whenever work subsequently to be concealed, requires inspection or testing due notice of at least seven days shall be given to the Engineer so that inspection may be made or tests witnessed before concealment.

Failure to give due notice may necessitate the Contractor uncover the work and re install it at his own expense.

2.18 VALVE LABELS

The Contractor shall supply and fix on all valves and stop cocks throughout the system, white ivory labels with black engraved lettering to provide a clear indication of the precise function of the valve. Each label shall be numbered to agree with the Schedule of Valves and the 'As Fitted' drawings.

2.19 THERMAL INSULATION - GENERAL

All items of thermal insulation work covered by this Specification shall be carried out by an approved specialist thermal insulation contractor. Only skilled operatives in this field of work shall be employed. The Contractor shall be deemed to have included for all works specified to be carried out by the aforementioned specialist.

The Contractor shall ensure that he is acquainted with all of the Conditions of the Works, specifications, hours of working, completion date(s), etc., at tender stage and he shall complete all Works within the program specified. The thermal insulation work shall not be commenced, unless otherwise approved in writing, until the whole or part of the

installation has been completed and tested as set out in the relevant pipework, plant and air distribution Sections of the Specifications.

All thermal insulation shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specifications.

Thermal insulation shall conform with all relevant parts of the building regulations, and to BS 5422,5970.

Insulation materials shall comply with BS 3927 & BS 3958. Thermal insulation of the buried pipes services shall comply with BS 4508.

2.20 THERMAL INSULATION IN AHU PLANT ROOMS

a) Pipework:

All pipework, as specified under this section, shall be individually insulated with plain performed rigid glass fibre sections.

The sections shall be applied in 1,200 mm. lengths, cut longitudinally into halves and securely attached - to the pipework, without gaps, by self-adhesive circumferential bands at 300 mm. centers.

Whenever possible, the longitudinal seams shall be of an interlocking 2 type, to ensure a satisfactory joint. Alternatively chilled water pipework shall be individually insulated with foil backed rigid Nilflam sections with longitudinal and circumferential joints secured with an approved adhesive and then sealed with aluminum tape to provide a continuous vapor seal.

Where the sections are cut and mitered around bends, branches, etc., they shall be fully taped to ensure they are held rigidly on to the pipe.

The thickness of insulation shall be in accordance with the Appendix at the end of this Section of the Specification.

All insulated pipework fittings and valves in Plant Rooms, Main Plant Room, Roof of Main Plant Room and Tunnel shall then be enclosed in fabricated stucco embossed aluminum cladding. The aluminum cladding shall be not less than 1.0 mm. thick on pipes of 150 mm. dia. and above, and not less than 0.8 mm. thick on smaller dia. pipework.

Cladding shall be applied to bends and branch pipe connections prior to straight lengths as follows:

- 1) Bends on pipes up to 50 mm. dia. shall be clad by riveted 45° mitered joints.
- 2) Bends on pipes above 50 mm. dia. but below 100 mm. dia. shall be clad by riveted 3 segment lobster back bends.
- 3) Bends on pipes of 100 mm. dia. and above shall be clad by riveted 5 segment lobster back bends.

- 4) Branch pipe connections shall be clad by cutting a serrated edge opened out against the main pipe. A profiled hole to suit in branch pipe shall then be cut in the main pipe straight cladding.
- 5) Straight pipe cladding shall be rolled to suit the overall insulated pipe dia. and aluminum riveted at 100 mm. centres. The cladding shall be fitted tight to the insulation to ensure a rigid finish. Seams shall be positioned so as not to be generally visible.

All cladding terminations at valves etc., shall be fitted with aluminum end cappings.

b) Pipework Fittings:

All valves, flanges, unions, pump casings and other items requiring access for maintenance on H.W., Steam, Condensate and Chilled Water Pipework, shall be insulated and finished by means of removable 1.0 mm. thick stucco embossed aluminum casings.

The casings shall be fully lined with rigid insulation of the same thickness as that applied to the pipe, securely fixed to the internal surfaces of the box.

The casings shall be split in two halves with one joint suitably hinged and the other securely fixed by quick release toggle fasteners. The casing edges shall be folded so as to give double thickness of aluminum on which to rivet the hinges and fasteners.

Heat bridges between the hot surface and aluminum casings will not be accepted.

For chilled water pipework only, insulation shall be installed to the valve, flange, etc., as detailed under 'Pipework', to give a continuous vapor seal and then fitted with a vapor sealed insulated casing.

Where thermostats, gauges, etc., are fitted the cladding shall be neatly cut and fitted with plain aluminum masking plates.

c) Ductwork:

- Rectangular Ductwork:

All supply and recirculation, ductwork and fittings, etc. shall be insulated with 50 mm. thick rigid glass fiber slabs insulation with a minimum density of 48 kgs per m³, or with Niflam fire resistant foam slabs with aluminum foil faced on both sides, secured with an approved adhesive and having all joints sealed with 100 mm. wide glass fibre reinforced self-adhesive aluminum foil tape to form a continuous vapor seal. All edges shall be reinforced with 0.6 mm. thick 40 x 40 mm. aluminum angle. All flanges shall be covered in 40 mm. thick foil backed half section Niflam of radius to match the flange with mitres on corners secured with an approved adhesive and taped to form a vapor seal.

d) Ductwork Fittings:

Fittings on ductwork shall be insulated as follows:-

1) Supports:

Ductwork supports for insulated ducts shall be as detailed in Section 5.18.6 of DW142, incorporating a rigid insulator between the support and ductwork, with the insulation vapor seal being continuous through the insulator support and NOT over the bracketing.

2) Access Doors:

Access doors shall be of double skin construction incorporating 40mm thick isocyanurate foam insulation, secured into a frame in the duct by hand-operated cam latches seated on a rubber gasket.

The doors shall stand proud from the ductwork with the insulation abutted and secured with 0.8 mm thick aluminum angles with mitered corners.

3) Specialized Fittings:

Where test holes, damper arms, thermostats, etc., are installed in the ductwork, the insulation shall be trimmed to give access and edges shall be vapor sealed and protected from mechanical damage.

4) Flexible Connections:

Ductwork flexible connections to air handling units, fans, Fan Coil Units etc., where a continuation of a vapor seal is required shall be insulated with glass fibre flexible duct insulation, free from short and coarse fibres, bonded with resin and faced with glass fibre reinforced aluminum foil/ kraft paper laminate. The insulation material shall have a thickness of 40 mm. in plant rooms and 40 mm. in ceiling voids etc. The insulation shall be arranged to be easily removable and joints shall be sealed with 100 mm. wide glass reinforced self-adhesive aluminum foil tape to form a vapor seal.

2.21 THERMAL INSULATION IN VOIDS SHAFTS AND DUCTS

Where pipes and ducts are installed in buildings voids, shafts and ducts and in any position otherwise indicated on the tender drawings, they shall be insulated as follows:

a) **Pipework:**

All pipework, carrying fluids as specified under item 2.19, shall be individually insulated with performed glass fibre sections with white lacquered aluminum foil

Kraft laminate covering secured with an approved adhesive and circumferential joints sealed with tape, all to conform with Class '0' spread of flame.

Alternatively chilled water pipework shall be individually insulated with Class '0' foil backed rigid Nilflam sections with all longitudinal and circumferential joints secured with an approved adhesive and then sealed with Class '0' aluminum tape to provide a continuous vapor seal.

Aluminum bands shall be applied to all insulation at approx. 300 mm. centres.

Where bends and offsets occur, the insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with the Appendix at the end of this Section of the Specifications.

Polished aluminum and cappings shall be provided to close all insulation terminations.

b) Pipework Fittings:

All valves, flanges, unions and all other items requiring access for maintenance shall be insulated as follows:

1) Chilled Water Fittings:

Insulated in accordance with (a) above with mitered removable sections to provide a continuous vapor barrier.

2) H.W. Steam and Condensate Fittings on Pipework 40 mm. dia. and above:

Insulated with removable casings as detailed under Plant Rooms, adjoining insulation to be fitted with aluminum end caps.

3) All Other Fittings:

Adjoining pipe insulation to be fitted with aluminum end caps.

c) Ductwork:

All supply, recirculation ductwork and ductwork fittings, shall be insulated with 40 mm. glass fibre, flexible type insulation. The material shall have a minimum density of 24 kg per cubic metre. The insulation shall be secured by means of an approved adhesive and all joints shall be sealed with 100mm wide Class '0' glass fibre reinforced self-adhesive aluminum foil tape to form a continuous vapor seal.

d) Ductwork Fittings:

All ductwork fittings shall be insulated as detailed under Boiler House and Plant Rooms.

2.22 THERMAL INSULATION EXTERNALLY

Where pipes and ducts are installed externally on roof top plant rooms or in external underground trenches or in other wet areas internally, (i.e. showers, bath areas, etc.) and in any other positions otherwise shown on the tender drawings, they shall be insulated as follows:

a) Pipework:

All pipework, carrying hot or cold water and steam and chilled water, shall be individually insulated with plain performed glass fibre sections.

Chilled water pipework shall be individually insulated with rigid fiberglass rigid performed sections or with Nilflam sections with all longitudinal and circumferential joints secured with an approved adhesive.

Self-adhesive tape bands shall be applied to all insulation at approx. 300 mm. centres.

Where bends and offsets occur, insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with the Appendix at the end of this Section of the Specifications.

All insulated pipework shall then be covered with 0.8mm thick Polyiso-butylene (PIB) sheeting with 50 mm. overlaps on all circumferential and longitudinal joints. And shall be finally cladded with 0.8mm stucco embossed aluminum cladding.

b) Pipework Fittings:

All valves, flanges, unions, etc., on all pipework carrying hot or cold water and steam shall be insulated as detailed in (a) above.

c) Ductwork (Air Conditioning):

All externally exposed supply, and recirculation ductwork shall be insulated with 50 mm. thick isocyanurate or 48 kg/m³ glass fibre rigid slabs cut and shaped carefully and secured to the ductwork with an approved adhesive.

On bends, branches and changes of direction, the slabs shall be cut into strips, each strip mitered along its edge and assembled onto the outside and inside contour of the fittings to ensure full coverage of the metal surface. Where flanges or stiffeners are encountered, these shall be covered by 40 mm. thick half sections of suitable radius. The slabs shall be fixed by an approved adhesive and shall be finished with a supercoating of 6 mm. thick cold setting composition, trowelled smooth and uniform to follow the contours of the ductwork, and one layer of galvanized wire netting with two trowelled coats of fibre filled bitumen emulsion.

All externally exposed extract ductwork shall be treated with one layer of galvanized wire netting directly to the ductwork and finished with two trowelled coats of fibre filled bitumen emulsion.

d) Ductwork Fittings:

All ductwork fittings shall be insulated as detailed under Plant Rooms with the exception of flexible connections which shall be insulated as detailed and then covered in 0.8 PIB sheeting as detailed in (a) above.

2.24 THERMAL INSULATION PROTECTION

Any pipework or ductwork, which is insulated but which is likely to be accidentally damaged during maintenance or in gaining access to an area of void or at low level (constrained at 2 meter high from FFL) of plant rooms, shafts (Open in Tunnel) Tunnel and Roofs etc., shall be additionally protected with 0.8 mm. thick stucco embossed GS sheeting. Any damage within the contract period, which may occur as a result of non-compliance with the requirements, shall be made good at no cost to the Employer.

2.25 PAINTING, GENERAL

All items of painting covered by this section of the Specifications shall be carried out by approved specialist painters. Only skilled Operatives in this field of work shall be employed. The Contractor shall be deemed to have included for all works specified to be carried out by the aforementioned specialists.

The contractor shall ensure that the specialist painting contractor is acquainted with all the conditions of the work, specification, hours of working, completion date(s), etc., and he shall complete all Works within the program specified. The painting work shall not be commenced unless otherwise approved in writing, until the whole or part of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution of the Specification.

All painting shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specification.

All painting materials shall be as manufactured by an approved manufacturer and shall be delivered in sealed containers, clearly labeled with type of material and intended use. The following surface treatments shall be applied to all areas detailed under this Section of the Specification unless stated elsewhere in the Specifications.

2.26 TYPES OF SURFACE TREATMENT

a) Method 1:

The surface shall be thoroughly wire brushed, degreased and given one coat of primer as the installation proceeds.

b) Method 2:

The surface shall be hot dip galvanized in accordance with B.5.729. After installation, the surface shall be thoroughly degreased by solvent washing followed by one coat of undercoat/primer to suit the final coat of HIGH BUILD

ALKYD Gloss to suit the Engineer's colour scheme for the B.5.4800 range of colors.

Any damage caused to the galvanizing by burning or cutting shall have all weld splatter and swarf removed and patch primed prior to the paint system detailed above.

c) Method 3:

Shot blast all surfaces to SA 2.5 at manufacturer's works and within 4 hours (or before corrosion sets in, whichever is the sooner) apply one coat of Zinc Phosphate Primer 2-1-10 to 75 micron thickness and one coat of Micaceous Iron Oxide 2-4-01 to 60 micron thickness.

After installation apply one coat of Micaceous Iron Oxide 2-4-01 to 60 microns thickness, followed by one coat of High Build Alkyd Gloss to suit the Engineer's colour scheme from the B.5.4800 range of colors.

d) Method 4:

The surface shall be shot blasted to SA 2.5 to give a minimal profile (maximum profile 50 microns) followed by one coat of HT Silicone Aluminum paint in the manufacturer's works.

Any damage to the treatment caused in transit or installation shall be made good.

e) Method 5:

The surface shall be wire brushed and degreased, painted one coat of primer as installation proceeds, followed by one coat of undercoat/primer to suit the final coat of High Build Alkyd Gloss to suit the Engineer's colour scheme from the B.5.4800 range of colors.

f) Method 6:

The surface shall be painted with one coat of High Build, suitably thinned with thinners, followed by one coat of Spread Valve Undercoat to suit the final coat of High Build Alkyd Gloss to suit the Engineer's colour scheme from the B.S.4800 range of colors.

2.28 PAINTING IN VOIDS, SHAFTS AND DUCTS

- a) All uninsulated pipework shall be treated as Method 5.
- b) All steel pipework to be insulated shall be treated as Method 1.

2.29 PAINTING EXTERNALLY

Painting externally shall be in accordance with that detailed for Plant Rooms with the following exceptions:

- a) Where supports are installed in concealed positions, i.e. underground trenches and tunnels trenches etc., they shall be hot dip galvanized only.
- b) Insulated ductwork shall be treated as detailed under 'insulation'.

2.31 PROTECTIVE PAINTING

Provide a heavy field coat of black asphalt paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction. Kitchen range hood ducts and boiler breeching shall be painted with heat resistant paint.

Coat interior of each outdoor air chamber with two coats of odorless, rust resisting, nonscaling paint.

Coat interior of ducts at register boxes with two coats of black paint, to a dull finish.

All pumps, motors, fans and all other factory manufactured and assembled apparatus shall be factory coated with one coat of primer and one coat of machinery enamel, and after installation shall be cleaned and touched up to repair any damage incurred during construction.

IDENTIFICATION OF SYSTEMS

Provide three sets of charts or diagrams, on cloth, showing outline plans of structures and essential features of the several systems, including all piping, ducts, equipment, valves, dampers and controls.

All valves, dampers, and controls shall be designated by distinguishing numbers on the charts or diagrams. provide stamped brass tags for all designated items with numbers corresponding to those on the charts. The nomenclature to be used on these tags shall be submitted for approval.

The tags shall be not be less than 50mm (2in) in diameter with depressed black numbers of 15mm (1/2 in) height, prefixed by the letters "HVAC". They shall be fastened to valves and controls with approved brass chains and hooks.

Piping identification shall be in conformance with the following:-

- Provide and affix approved adhesive bands identifying the service, by stem and zone, and direction of flow to the various piping systems. Such bands shall be provided in all occupied and unoccupied rooms as well as in all the other spaces (such as shafts) in which piping may be viewed. A set of such bands shall be affixed to each pipe not less frequently than every forty feet and there shall be at least one set of identifying bands per pipe in each space requiring identifying

bands. Identifying bands shall also be provided adjacent to each valve. Valves at equipment and pumps do not require separate identification.

- Each set shall consist of one and on which the name of the service is printed in black letters not less than 50mm (2in) high for pipe 65mm (2 1/2in) and smaller and one band on which is printed a black directional arrow. Bands shall be applied where they can be easily read and with their one dimension parallel to the axis of the pipe. Bands shall have backgrounds of different colors for the various service groups as follows:-

2.32 THERMAL INSULATION IDENTIFICATION

All insulation and exposed pipework installed throughout the Project shall be identified by colour code/safety indication and basic colour identification bands as B.5.1710.

The safety color and color code, indication bands shall be 100 mm. wide, between two basic color identification bands, each of a length of 150 mm., generally as shown on the Appendix II of this Section of the Specifications. The identification shall be at centers of not more than 3 meters and adjacent to all valves, items of plant, changes in direction and point where the pipework passes through walls, floors, etc.

Pipe contents and designation (i.e. HW, Chilled Water Flow, South Side), pipe sizes, flow and return designation and direction flow arrows in black, shall be applied to the basic color identification band as detailed in appendix 'E' of B.5.1710.

Colors for color code/safety indication and basic color identification shall be as detailed in Appendix 'D' of B.S.1710, the main service being shown in Appendix II of this Section of the Specifications.

2.33 CLEANING

Due allowance shall be made for the full and proper protection of all items of plant and equipment, electrical installation and building structure during the whole of the application of the insulation and painting works.

Any damaged insulation/paintwork shall be replaced at no additional cost to the Employer.

2.34 INSTALLATION OF DUCTWORK

The installation of ductwork shall follow the details set out in the accompanying Tender Drawings and be in accordance with the best accepted practice.

The Drawings are diagrammatic and all contractors shop drawings shall be submitted to the Engineer for approval prior to manufacture taking place.

All ductwork shall be adequately supported on hangers and/or brackets, according to position, in order to permit free movement of the ducts due to expansion or contraction and permit application of insulation.

Ducts shall be positioned and spaced in relation to one another, in the building structure so as not to interfere with any other services and to allow for the required thickness of insulation as specified elsewhere.

All ductwork, silencers, dampers, louvers, grilles, diffusers and all other duct mounted equipment and components shall be erected and connected to all equipment as shown on the Air Conditioning Drawings.

All ducting systems shall be installed to a high standard and when complete shall be rigid and free from any sway, true -to- size, accurately lined up and completely sealed to limit air leakage rates to an acceptable minimum as detailed within HVAC DW 142.

MECHANICAL SPECIFICATION

All ducts emerging from the building shall be completely draught proof and watertight with suitable purpose made weathering.

All open ends of ducting left during erection shall be covered to prevent entry of dust and debris by means of hessian or stout bitumen backed paper, securely tied into position.

All ductwork shall be blown through by running the fans prior to finally fitting the grilles, and filters and the interior thoroughly wiped out with damp cloths by reaching as far as possible into all available openings.

All ducts passing through non-fire rated floors, walls or partitions shall have the space around the duct packed and sealed with fiber glass or other material acceptable to the Engineer.

The space between the duct and the buildings element shall not exceed 20 mm. maximum.

Sealing around fire dampers shall be made with materials approved by the relevant department of the local authorities.

Holes in walls and partitions through which ducts pass shall not be used as duct supports. Duct runs shall be erected on the supports provided and aligned, prior to connection to items of equipment to present a neat and workmanlike appearance with allowance made for all clearances for insulation, etc., and other adjacent services.

Ducts shall be installed parallel to the building structure, plumb where vertical and arranged to present a coordinated and neat appearance.

Ducts supports shall be securely anchored to the building construction in an approved manner and installed completely free from vibration under all conditions of operation. Vertical ducts shall be supported at each floor and at intermediate positions as required.

Particular regard must be paid to the prevention of duct movement, with consequent noise, potential leakage and strain upon flexible connections. To this end, separation of metallic surfaces shall be provided by flexible packing material and particular attention shall be paid to the interposition of auxiliary flexible joints and anchoring supports, along duct runs.

2.35 GALVANIZED STEEL DUCTWORK

The duct work shall be constructed from strip mild cold reduced continuously hot dipped galvanized steel sheet to B.S. 2989A in accordance with Specification DW/142, 'Low and High Velocity/Pressure Air Systems for Rectangular, Circular and Spiral Wound Ductwork', as published by the Heating and Ventilating Contractors' Association, with the following exceptions:

The nominal sheet thickness of the ductwork shall be increased to the thickness shown below. No ductwork shall be constructed from sheets less than 0.6 mm.

The sheet metal shall be two sided hot dipped galvanized to BS2989. The minimum zinc coat shall be greater than 275 gram per square meter, based on three surface specimen.

Ductwork connecting kitchen Hoods to Extract Fans shall be of black steel sheets, 2 mm. minimum thickness with all joints welded.

TABLE A: Rectangular Ducts - Low & Medium Pressure
(Modified Table 4 DW/142)

| DUCT SIZE (Longer Side) | NOMINAL SHEET THICKNESS mm. |
|----------------------------|--------------------------------|
| Up to 400 mm. | 0.6 |
| 401 mm. to 600 mm. | 0.8 |
| 601 mm. to 800 mm. | 1.0 |
| 801 mm. to 1000 mm. | 1.0 |
| 1001 mm. to 1500 mm. | 1.0 |
| 1501 mm. to 2500 mm. | 1.2 |
| 2501 mm. to 3000 mm. | 1.6 |

All ducts over 400 mm. longer side shall be stiffened by beading at 300 mm. centers or cross breaking at not more than 1220 mm. spacing. Ducts above 800 mm. longer side to have transverse joints flanged in accordance with DW/142, with maximum spacing of 2000 mm.

Longitudinal joints are to be either lock-seamed (and in all cases the edge of the seam is to be dressed down flush with duct to ensure an airtight joint) or snap lock joints. A suitable compound for sealing should be used during manufacture, where necessary, the ductwork having been cleaned with suitable thinners, beforehand. Seams should not be visible from below. Transverse joints shall be flanged throughout, or jointed in accordance with DW/142.

Mild steel angle flanges shall be not less than 25x25 mm. section, to be solid welded at four corners, galvanized after manufacture or cleaned, primed and painted with zinc rich paint or red oxide and bolted together with sheradised hexagon head bolts and nuts.

The overall length of the galvanized duct should exceed by 13 mm. or 19 mm. the dimension over the angles, thereby allowing the material to be edged over the angle iron flange on each of its four sides 6 mm. or 10 mm.

All ducts through walls shall have an angle iron masking flange attached to each inside of wall. Where ducts terminate in a builders duct in wall, the 'lead in' to terminate shall be a swept branch or bend with wall spigot and angle iron masking flange. Masking flanges shall be screwed to the wall, ceiling or floor, depending on the position of these, with sufficient clearance to allow slight movement of ductwork.

Slip joints shall not be less than 50 mm. long with corners tapered; cutting or notching to achieve this taper shall be made good by welding. All slip joints should be made to lap in the direction of air flow and suitable sealing compound shall be applied in making these joints to prevent air leakage.

Where 'pop' rivets are used (which must always occur if the joint is under tension), these shall be of the 'Imex' sealed type.

MECHANICAL SPECIFICATION

Solid rivets shall be of the type suitably treated to resist corrosion and shall be inserted so that the rivet head is on the inside of the duct. Sharp edges or corners on ductwork and angles will not be permitted. After fabrication, all cut edges and bare metal shall be painted with approved zinc rich paint before being transported to site. Any adjustments or modifications made on Site shall also be similarly treated.

Each length of ducting shall be in one piece i.e. no riveted joints to occur between angle flanges. Ducts to be in 1830 mm. minimum lengths, except where bends or branches occur.

All ductwork throughout shall be adequately stiffened to prevent drumming. Internal stiffening will not be permitted. Mild steel angles used as flanges or stiffeners shall be fixed to the duct by one of the following:

- a) Mechanical closed rivets or bolts at 150 mm. pitch.
- b) Spot welds at 75 mm. pitch.

Angle flanges or joints shall be bolted together at 100 mm. maximum pitch and fixing bolts shall be provided at each corner, angle size in accordance with DW142..Bolt sizes shall be as follows:

| | | | | | | | |
|----|---|----|-----|-------|----|-----|-------|
| 25 | x | 25 | mm. | angle | 8 | mm. | bolts |
| 30 | x | 30 | mm. | angle | 8 | mm. | bolts |
| 40 | x | 40 | mm. | angle | 10 | mm. | bolts |
| 50 | x | 50 | mm. | angle | 10 | mm. | bolts |

The joints shall be made using suitable cord and sealing compound inserted between flanges to ensure air tightness of joint.

High velocity ductwork shall be jointed by using proprietary heat shrink bands.

Provision shall be made in the main and branch ducts and adjacent all items of plant for testing air flow by means of pitot tube or flow meter.

Such provision shall include the forming of a series of holes in the ductwork to suit the test instrument and arranged as shown in B.S.848, 1980, Part 1. The series of holes in each case shall be suitably covered with mild steel cover plates, having rubber gaskets, and fixed to the ductwork with 6mm set screws and wing nuts. The set screws shall be fixed permanently to the ductwork and removal of the cover plate shall be effected by removal of the wing nuts only.

Before any plant is put into commission, the ductwork shall be thoroughly cleaned to the satisfaction of the Engineer.

2.37 DUCTWORK FITTINGS

Fittings shall be constructed of the same material and to the same standard as specified for equivalent size straight ducts.

All radius bends shall have a throat radius equal to not less than the width of the duct. Square and twin bends shall be provided with double skin airfoil section internal air guide vanes, the details to be approved by the Engineer.

The length of transformation and reducing fittings and off-sets shall be such to ensure that the slope of any one side of the fitting does not exceed 20 degrees. Where indicated on Drawing, sloping sides of 30 degrees will have to be fitted, but these should be kept to an absolute minimum. Branch connections with shoes shall have an angle of 45 degrees to the main duct axis. All fittings shall be generally in accordance with DW142 Ductwork Specification, as amended in this Specification.

2.38 REGULATING DAMPERS

These shall be fitted as indicated on the Drawings and generally on all branch duct. They shall be of stainless steel construction.

All ducts shall have dampers of the multi-leaf opposed blade type, the larger ones having blades with maximum unsupported length of 180 mm.

A suitable method of indicating the position of the dampers shall be incorporated.

2.39 FIRE & SMOKE DAMPERS

Fire Dampers shall be fixed in all ducts entering or leaving plant rooms, passing throughout floor slabs, fire walls and zones and elsewhere as indicated on the drawings.

Fire dampers shall be of 1, 1.5, 2, or 3 hours ratings to match the fire walls, slabs or structure ratings.

Fire dampers shall be of the galvanized steel curtain type, having blades not exceeding 50mm in width having rolled edges interlocking to form a continuous hinge upon which the blades pivot when released. The blades shall fold completely upon themselves and be stacked one end of the damper to allow unobstructed opening.

The blades shall be retained by a fusible link set to operate at 68°C. The damper frame shall be a continuous channel enclosing the blades and acting as a continuous stop on both sides of the damper. The dampers shall be suitable for both horizontal and vertical mounting and shall have frames drilled for flange fixing into ductwork. The dampers shall fit within the duct area and shall be suitable for low or medium velocity application.

2.40 ACCESS PANELS

Access panels shall be fixed adjacent to all filters, fans, humidifiers, volume control dampers, fire dampers, cooling and heating coils, on all ductwork bends and at 9 metre centers on straight runs; all generally in accordance with DW142.

The access panels are to be of the hinged type and manufactured from not less than 22 g. galvanized mild steel plate. They shall have rubber door seals.

Where the duct is of sufficient size, access holes shall be not less than 375x300mm. and on small ducts the holes shall be made to the most practical suitable size. Adjacent to

filters fans, humidifiers, dampers, heater coils etc., access doors shall be sized to allow manual access.

2.41 DUCTWORK BRACKETS

Other than specific details being indicated on the Drawing, the bracketing shall be of galvanized steel sections and shall be as follows:

a) Horizontal Ductwork:

All ductwork shall be adequately supported by flat mild, steel band strips or mild steel angle bearers and rods. The rods shall terminate to the structure in one of the following manners.

On a solid structure, channel iron rail bolted to same, including holes to accept threaded rods, which will be attached by nuts and hemispherical washers.

On steelwork, angle iron clips to be fitted across the whole flange and extended beyond the flange. A hole in the extension piece will allow the threaded rod to pass and be attached as above.

On open type steelwork, 2 angle iron sectors placed back to back securely bolted, complete with nuts and washers at maximum spacing of 0.5m with minimum of 2 fixings.

To prevent vibration and drumming, an incompressible insulator shall be sandwiched between the bracket and duct contact face.

Details of spacing for horizontal rectangular ducting shall be as per the tables at the end of this Section of the Specifications.

b) Vertical Ductwork

This shall be supported by cantilever brackets as detailed in DW142.

Where they are fixed to walls, not less than 150 mm. wather plates on the back of the wall and rods shall be fitted. The plates shall be not less than 250 mm. in length and shall be of equal width and thickness to the cantilever bracket material.

2.44 TESTING THE DUCTWORK

In the course of erection, where the ductwork is being insulated, sealed in roof spaces, or where close to walls, etc., and on completion, this shall be tested in accordance to DW 142 specification to ensure the air tightness of all joints or any other method being currently used or as directed by the Engineer. All ductwork shall be tested as detailed in HVCA Specification DW142 together with Method of testing DW143.

All ductwork which are installed prior to VAV boxes and all of those ducts which are of delivers air at 500 Pa or above shall be tested by leak test for medium pressure duct work in accordance to the DW142 specifications. with Method of testing DW143.

The Contractor shall include for balancing all control dampers, grilles, volume dampers, etc., to ensure that the circuit plant or equipment is operating with the correct performance temperature, pressure and flow rates in accordance with the performance schedules and system design.

The Contractor shall include for providing a schedule setting out the design pressures and flow rates and actual final commissioning pressure and flow rates, together with all damper and grille settings.

2.45 FLEXIBLE DUCTING

Flexible ducting shall be formed from neoprene coated glass cloth, spirally jointed by galvanized steel helix, unless specified otherwise elsewhere in this specification. Running lengths of flexible ductwork shall be kept to the absolute minimum to provide flexibility.

2.46 INSTALLATION OF PIPED SERVICES

Installation of all pipework shall follow the detail set out in the accompanying drawings and be in accordance with the best accepted practice.

Details set out in the following Clauses of this Section are generally appropriate to all services except where specifically stated elsewhere in the Specifications and Drawings.

All exposed pipe runs shall be arranged to present a neat appearance and, where practical be parallel both with one another and with the building structure, taking due regard however to the grading, venting and draining requirements. All vertical pipes shall be plumb.

All exposed pipe runs shall be arranged so that the longest length of tube practicable is used between bends, tees and flanges or unions. Short lengths of tube joined together by sockets shall not be permitted.

All pipework, valves, fittings and equipment forming the piping installations shall be erected so that it can be dismantled and is accessible for repair and replacement. In this context, 'accessible' means that the provision for dismantling the flange, union, etc. can be reached and worked upon either in the open or else by removal of a purpose-made duct cover, manhole or similar cover; the fitting is "not accessible" if, as fixed, it cannot be manipulated.

Where pipework is not readily accessible, it shall be welded. Unions or flanges shall be provided at valves and equipment so that they can be dismantled. No pipe shall be installed without a flange or union at a point where it passes through a wall, floor or ceiling and is not readily removable.

No joints shall be formed within the thickness of walls, floors or ceilings.

Unions or flanges shall be provided generally at a maximum spacing of one per 18 meters in position agreed by the Engineer.

MECHANICAL SPECIFICATION

To facilitate routine maintenance, the position of all valves, drains and supports shall be determined with this aspect in mind. Grouping of valves, drains, unions, flanges, etc. shall be preferred to scattered siting.

Clearance between pipework and finished walls, floors, ceiling and other fixtures should be adequate for cleaning purposes and future dismantling, and shall not be less than the distance given below:

Pipework to floor - minimum distance 100 mm.

Pipework to ceilings - minimum distance 100 mm.

Pipework to walls - minimum distance to conform with standard bracket centers

Pipework to pipework - minimum distance 32 mm.

The Contractor shall include for bends in pipes round piers and all other projections and recesses and for all offsets due to varying thickness of plaster, walls, floors, ceilings, and other structural works. It shall be the responsibility of the Contractor to ascertain the skirting heights, sill heights and floor finishes. No pipework offsets shall be allowed on pipework visible in rooms, except as agreed with the Engineer.

Where pipes are held in vices, as when screwing or cutting, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted. Any pipework surface damaged by scoring whilst being installed, shall not be accepted.

The Contractor shall ensure that all pipes, fittings, valves, etc. are free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.

The Contractor shall protect the open ends of all pipework. Suitable caps, plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall not be used.

The Contractor shall not use a valve fitted to the open ends of a disconnected pipe to prevent the entry of dirt.

Failure to comply with the above instructions shall mean that the Engineer shall have the right to order the pipework to be dismantled for as far as considered necessary and the pipework to be thoroughly cleaned internally.

The Contractor shall carry out this work free of cost to the Employer and shall bear all costs incurred by removing, cleaning and replacing the sections of pipework.

Chilled water pipework shall be erected to neatly follow the lines of walls, floors, tunnels and trenches and be correctly graded to ensure venting and draining down can be achieved. Manual valved air vent lines shall be installed at all high points. The clearance between pipework (or if lagged, the lagging) and walls, floors or any other fixtures shall be not less than 100 mm. Pipe drops shall be vertically plum. All horizontal and vertical adjacent pipework shall be installed parallel to walls and floors except where gradients for venting and draining dictate otherwise.

MECHANICAL SPECIFICATION

Headers, where indicated shall be arranged so that each circuit isolating valve is connected direct to a vertical outlet on the top of the header. Circuit connections such as thermometers, flushing valves and circuit isolating valves shall be arranged at common horizontal levels.

Distribution headers up to and including 50 mm. installed on closed circuit recirculation systems shall have the ends terminated with a screwed cap or plug.

Distribution headers above 50 mm. on closed circuits and on open circuits shall have the ends terminated with a flange welded onto the pipe, and a blank flange bolted to it.

Curved or long sweep bends and branches shall be provided as far as is practicable. Square elbows will not be permitted.

Wherever practicable, made bend and sets shall be furnished in preference to short radius fittings. Bends and sets in black pipework above 50 mm. diameter shall be hot formed having a radius not less than four times the pipe diameter. The tubes must remain circular after setting.

Long sweep branches with gradual reductions shall be used for reduced diameters where two mains connect together.

Exceptions to the above shall be used where air pipes or air bottles, drain or dirt pockets, are taken off or air venting requirements dictate, in which case square connections and fittings may be used.

Special care shall be taken where branch joints, welded joints, basses, vents and drain pockets are made, to ensure that there is no obstruction or possible cause of obstruction and to see that full bore is maintained in all directions.

- 1- All branch connections shall be taken from top, side or at a 45° angle from all horizontal piping. Bottom connection shall not be allowed without special flushing provisions being made. When taking side connections from horizontal mains adequate facilities for draining shall be provided.
- 2- The distance between any two adjacent branches shall not less than the sum of the outside diameters of the branches.

Where pipework is routed within false ceilings or sealed service ducts or other encasement where access is difficult, all pipework shall be welded.

Reduction in sizes of pipe lines shall be made by either of the following approved methods:

- 1- by factory made reducing pieces manufactured at the tube or fitting manufacturer's works.
- 2- by properly hot swaging down the larger pipe to the smaller diameter while ensuring that the internal diameter of the reduced pipe is not less than the smaller pipe diameter.

MECHANICAL SPECIFICATION

Reductions on horizontal pipe shall be eccentric, reduction on vertical pipes shall be concentric.

2.47 PIPEWORK MATERIALS

All pipework installed by the Contractor shall conform with the specified materials, specified under Appendix IV “schedule of pipeline”.

2.48 MILD STEEL PIPEWORK

Where the table of pipework materials requires the use of mild steel pipework, this shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, lamination and other defects and shall be free from rust and scale.

Standard steel pipes having nominal bores of up to 150 mm. shall be in accordance with B.S.1387:1967 and shall be provided in random lengths of between 4.5 m. and 7.5 m. Gauge of pipe walls shall be in accordance with the heavy grades of the Standard.

Steel pipework over 150 mm. bore shall be of mild steel manufacture in accordance with B.S.3600:1976. The wall thickness shall be suitable for the pressures of the system in which it is to be installed, and shall be not less than following thickness:

| <u>Size of Pipe</u> | <u>Thickness (inches)</u> | <u>(inches)/mm.</u> |
|---------------------|---------------------------|---------------------|
| 200mm 0.322 | 8. 00 | |
| 250mm 0.365 | 8. 80 | |
| 300mm 0.375 | 10.0 | |
| 350mm 0.375 | 10.0 | |

Steel pipework for welding shall be supplied with plain ends, beveled for butt welding.

Where pipes are required for screwed joints, they shall be provided with screwed taper threads to B.S.21, Part 1.

Steel pipes, which are to be used 'black', shall be varnished externally throughout their length after manufacturer.

Galvanized steel tubes shall be to B.S.1387, heavy grade.

Where steel pipes are to be installed underground, they shall be double wrapped in special tape suitable for the application.

2.51 JOINTING OF MILD STEEL PIPEWORK

Black mild steel pipework up to and including 50 mm dia. shall be jointed by screwing or by mechanical grooved joints.

MECHANICAL SPECIFICATION

Black mild steel pipework of 65 mm. dia. and above shall be jointed by mechanical grooved joints or welded unless welding would constitute an unacceptable fire hazard.

All galvanized steel pipework shall be screwed or jointed by mechanical grooved joints..

Black mild steel pipework in the following areas shall be welded or jointed by mechanical grooving and couplings regardless of their size:

- a) Pipework running in ceiling voids, sizes 40mm and above.
- b) Pipework in boiler room, plant rooms and pump rooms and roof-top plant areas.
- c) All pipework on MPHw or HPHw systems (Only welding is allowed, Grooving and coupling is not accepted)
- d) Pipework in ducts, trenches tunnel and other positions not readily accessible.
- e) Pipework in rooms housing electrical switchgear, telecommunications equipment, computers, control gear, etc.

All mechanical grooved joints shall be fastened by flexible mechanical couplings; unless it is recommended, by manufacturer, to have rigid coupling.

All screwed black steel pipework shall have provision made for dismantling, using Navy Pattern unions.

All welded black steel pipework shall have provision made for dismantling using slip on bossed welding flanges.

Galvanized mild steel pipework up to and including 50 mm. dia. shall have provision made for dismantling using galvanized malleable iron Navy Pattern unions.

Galvanized mild steel pipework of 65- mm. dia. and above shall have provision made for dismantling using galvanized screw-on flanges, faced and drilled BSTe.

2.53 MECHANICAL COUPLINGS

All pipe of suitable wall thickness may be jointed by use of mechanical wall grooved pipe and coupling on services with working temperatures not to exceed 85°C. This shall include the following building service piping systems:-

HVAC

- | | |
|---------------------|-----------------|
| - Chilled Water | - Air Lines |
| - Condenser Water | - Vacuum Lines |
| - Hot Water Heating | - Make-up Water |
| - Glycol | |

MECHANICAL SPECIFICATION

Plumbing

- Domestic Hot and Cold Water
- Roof Drains
- Storm Drains
- Sanitary Drains (DWV)

Fire Protection

- Fire Standpipe - Wet and Dry
- Automatic Sprinklers - Wet and Dry
- Water Supply
- Special Hazards
- CO2 and FM-200 Systems

Installation shall be operative trained by the manufacturer.

Mechanical coupling shall be used for all grooved pipes valves fittings and other grooved component.

All grooved joints shall be jointed by mechanical rigid or flexible couplings.

Couplings shall be of cast ductile iron confirming to ASTM A-536, BS5750 or BBA certified.

The joints shall be self centering and comprise coupling pieces, sealing gaskets, special nuts and bolts.

Grooves shall be formed at the end of the pipe by machine to manufacturer's instructions. Grooves shall be dimensionally compatible with the coupling

Joints shall made to the manufacturer fitting constructions. Earthing continuity clips shall be fitted at every point.

Supports details and positions shall be to the manufacturer current recommendations. But by any mean shall not be less than the related tables in the appendix.

2.54 SCREWED JOINTS

Screwed joints shall be tapered to B.S.21.

Steel pipes having screwed joints shall be carefully reamed out before the plain end is screwed.

When making a joint, the screw thread shall be coated with a white jointing compound to B.S.5292 and good quality hemp, all surplus jointing compound being finally cleaned off

to leave a surface suitable for painting. P.T.F.E. tape may only be used with the prior agreement of the Engineer.

The joint shall be arranged so that on completion two or three threads are left showing.

Should a screwed joint prove defective under subsequent test, caulking shall not be allowed.

2.55 WELDED JOINTS

Steel pipes, having welded joints on the run, shall be prepared for jointing in a manner suitable for the technique employed. Welding shall be carried out in accordance with R.S.2971 for metal arc welded joints, using covered electrodes and B.S.1821:1957 and B.S.2640:1955 for oxy-acetylene welded joints.

Pipes shall be prepared for welding with ends swan or cut off by hand, flame cut by hand with subsequent truing up by filing or by grinding to a bevel of 37. 5" as may be required. Welding rods shall in all cases be of good quality copper coated low carbon steel and the manufacturer shall provide test certificates representative of the rods in accordance with B.S.1453: 1972, Group A.

All pipework shall be reamed after cutting to ensure it is free from rust, burns, scale and other defects and shall be thoroughly cleaned before erection.

All welded joints, produced by the oxy-acetylene flame process, shall be of best quality, the butt being slightly convex with regular ripples and no undercutting, washing away or surface cavities being resent. Notches at the root indicating incomplete penetration and excessive weld protruding into the pipe bore in excess of 1.5 mm. shall not occur and the external reinforcement shall run out smoothly to the pipe surface on either side.

Welding shall in all cases be carried out by skilled craftsmen, who are in possession of a current certificate of competency issued by an approved authority (which shall be produced at the request of the Engineer and have had a suitable period of experience for the class of work in which they are engaged in accordance with B.5.4871 and B.S.4870.

Highly skilled non-certificated welders may only be used by written permission of the Engineer and test welds, in accordance with R.S.4870, Part 1, 1972 with satisfactory laboratory test certificates, shall be submitted before this permission is granted. The Engineer shall determine a suitable independent testing authority and any costs arising from these tests shall be borne by the Contractor.

During all welding or cutting operations, the welder shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the welder with two portable fire extinguishers for use in an emergency.

After cutting or welding, all flashings shall be removed from all pipework before erection.

All welded joints shall be painted two coats of red oxide on completion of the joint.

2.56 FLANGED JOINTS

MECHANICAL SPECIFICATION

All flanges shall be in accordance with B.S.10, or equivalent metric specification suitable for the pressure of the service concerned.

Flanges on black mild steel pipes shall be of the welded slip-on bossed type, secured by welding both the neck and bore of the flange to the pipe, with the tube finished 3 mm. inside the bore, care being taken not to distort the machined face.

Flanges - on galvanized mild steel pipes shall be of the galvanized screw on mild steel faced and drilled type with the threads on the tube arranged to end at a point just inside the bore of the flange so as not to interfere with the joint.

Flanges on copper pipework shall be of the gunmetal silver solder or brazing type.

The joint between flanges on black and galvanized steel pipes shall be made up with a full face Klingerite joint ring graphite Faced on both sides, completed using mild steel bolts having a minimum tensile strength of 431N/sq. mm. (28 tons per sq.in.) with nuts and washers.

The joint between flanges on copper pipework shall be made with a full face Cupro-Nickel Taylor ring and white jointing paste on both sides, completed using mild steel bolts having a minimum tensile strength of 431N/sq.mm. (28 tons per sq.in.) with nuts and washer.

All bolts, nuts and washers shall be manufactured from mild steel to B.S.4504 'Table of Pipe Flanges' to the table appropriate for the pressure specified.

Flanges shall incorporate bolt holes, drilled not punched. Flange faces shall be machined fully across. When the joints are made, the bolt shall project 3 mm. minimum beyond the nut.

2.57 FITTINGS FOR GALVANIZED MILD STEEL PIPEWORK

Fittings for all galvanized mild steel pipework up to and including 50 mm. dia. shall be malleable cast iron pipe fittings to B.S.143, manufactured by the Whiteheart process to Grade 1 of B.S. 309 banded or beaded for reinforcement with the exception of steam pipework on which wrought steel pipe fittings, manufactured from mild steel by seamless or welded process to B.S.1740 shall be used.

Fittings on galvanized pipework shall be galvanized to B.S.729, Part 1.

The screwed ends of the fittings shall be provided with parallel female and tapered male threads to B.S.21, Part 1, the axis of thread being coincident with the true axis of the fittings. Where required, taper threaded fittings shall be provided and shall be in accordance with B.S.143.

Fittings on black mild steel pipework of 42 mm. dia. and above shall be welding fittings heavy weight to B.S.1965 and be manufactured by a forged seamless process from mild steel.

In addition to the fittings set out in the standards, branch bends manufactured to the same details may be used.

MECHANICAL SPECIFICATION

Ends of fittings, which shall have the same wall thickness as that of tube manufactured to the 'heavy' grade of B.S. 1387, shall be beveled for butt welding.

Generally all fittings shall, where practicable, be of the easy sweep type. Branches shall be made using swept tees or branch bends except where an air lock is liable to form i.e. tees on rising mains, etc., where square tees shall be used.

Elbows shall be used only where the use of bends is impracticable and where the Engineer's permission has been obtained.

Where standard fittings are not available for the duty required, reductions on the run and to the branch shall, in all cases, be made with reducing sockets not bushes.

Reducing fittings on horizontal pipework shall be of the eccentric pattern fixed so as to give a smooth run to the crown of the pipe. Concentric pattern reducers shall be used on vertical pipework.

If bends and springs are manufactured on site, then cold bending by a hydraulically operated machine shall be permitted for standard steel pipes having a bore of 50 mm. or less, but larger pipes shall be bent hot. All bends shall be normalized by heat treatment after manipulation.

The diameter shall be maintained; crinkled and scored work will not be accepted.

Where junctions to steel mains are formed by factory or site welding, such work shall be carried out to the above standards for steel tubular. All necessary reinforcement by way of plates, collars or shoes shall be provided. All branch bends, where possible, shall be formed by the use of special welding fittings of the same quality as the pipe and shall conform to B.S.1965:1963 and amendments.

Where branch bends are used, the profile of the hole shall be carefully set out to match the fitting and where the holes are flame-cut all loose scale and oxide shall be removed from the main before the branch is welded into position.

The distance between the centers of two adjacent branch welds shall not be less than twice the diameter of the large branch. All changes in direction shall be proportioned so that the ratio between the centre line radius of the bend and the inside diameter of the pipe is not less than 1.5: 1.

Lobster back and cut and shut bends will not be permitted.

Unions shall, in all instances, be manufactured with double gunmetal seats as the Navy pattern.

2.60 PIPEWORK SUPPORTS

All pipework shall be adequately supported on galvanized steel hangers or on brackets with rollers in order to permit free movement due to expansion and contraction.

Pipework support shall be arranged as near as possible to joints and changes in direction.

MECHANICAL SPECIFICATION

The Contractor shall include for the supply of all necessary supports and brackets complete with all bolts, screws and inserts or plug fastenings.

Particular importance must be attached to the design and method of supports and brackets for pipework and equipment. Care should be exercised regarding strength of material, construction, method of fixing, practicability and appearance when designing brackets. Drawings of all brackets and supports shall be forwarded to the Engineer for approval before manufacture is commenced. Details of all patent fixing to the building fabric shall also be submitted to the Engineer for prior approval.

Softwood plugs will not be permitted.

Vertical pipework shall be adequately supported at the base of the riser and at all intermediate levels. Branch circuit pipes shall not be used as a means of support for the riser main.

Brackets and support shall be set out so that they do not obstruct the access to valve flanges or fittings requiring maintenance.

Pipes shall be spaced in relation to one another and to the building structure so as not to interfere with any other service and to allow for the required thickness of thermal insulation as specified later.

Pipes shall not be supported from each other, but, where there is no alternative, the Engineer's written approval must be obtained. The brackets so installed shall not prevent the removal of any individual pipe where necessary and provision shall be made for any unequal expansion.

Pipes shall not be supported from any item of equipment.

All high level pipework is to be carried on neat galvanized swivel hangers with GM split rings or steel glands suitably spaced to prevent sagging and to allow expansion and contraction.

Brackets, hangers and supports shall be of hot dipped galvanized after manufacture steel sections and are to be as follows:

a) Brackets:

- 1) Brackets to walls:-
Flat iron with fish tail end, minimum size 40 mm.x6 mm.
- 2) Brackets to walls:-
Angle iron with fish tail, minimum size 32 mm. x 32 mm. x 6 mm.
- 3) Brackets to R.C. Beams:-
Rag bolt with eye built in, minimum size 15 mm. dia.
- 4) Brackets to R.S.J.:
Girder clips.
- 5) Brackets suspended from flat roofs:

MECHANICAL SPECIFICATION

Rod with eye (minimum size 9 mm. dia.) on underside with back plate and lockout on top side.

- 6) Brackets in trenches and tunnel:
Channel iron, minimum size 100 mm. x 50 mm. x 6mm.

b) Hangers:

- 1) Rods (minimum size 9 mm. dia.) with purpose-made hook and/or eye.
- 2) Tubes (minimum bore 6 mm.) with chandelier hooks or, ring sockets.

c) Supports:

- 1) Purpose-made mild steel band (minimum size 25 mm. x 3 mm. strap) with nut and bolt or malleable iron split ring with socket for all mild steel pipework.
- 2) Purpose-made heavy gauge brass strip with nut and bolt or gunmetal split ring with socket for all copper pipework.
- 3) Purpose-made mild steel stirrup (minimum size 32 mm. x 3 mm.) with roller and chair sized to manufacturer's recommendation for steel and copper pipework where required to allow for expansion. Bronze rollers shall be used for copper pipework.

Any combination of the above will be allowed, providing that uniformity to type is adopted throughout the various sections of the building.

All hangers and supports, except at necessary fixed points, must be allowed to swing freely to make up expansion and contraction. All low level pipework to be supported by munzening ring and tube secured into walls by brass anchor fixings.

All brackets, hangers and supports, except supports for copper pipework, are to be hot dip galvanized after manufacture to B.S.729.

The spacing distance between brackets and support to be as per Appendix No. III at end of Section 2.00

All sizes of copper piping 2.0 m. apart.

In addition to the centers given, support shall be provided adjacent all valves, flanged joints and other special components to prevent undue strain on the adjoining pipework and so that the equipment or sections of pipework may be removed, leaving the adjoining pipework adequately supported at the ends.

Main walls and partition walls etc. where pipes pass through sleeves, shall not be considered as pipe supports.

2.61 EXPANSION AND CONTRACTION OF PIPEWORK

MECHANICAL SPECIFICATION

Expansion and Contraction of Pipework, expansion joints, guides, and anchor points, as required, whether or not shown on the drawing shall be installed to resist the maximum stresses of the pipework, formed by the Contractor .

a) Expansion Loops and Bends

All pipework shall be installed to accommodate without distortion the linear expansion when heated. Pipe supports shall be of the type, which will allow full movements of the pipes except at fixed points which shall be provided as necessary between expansion bends, or sets. The fixed points shall be secured by anchors of an approved design.

The Contractor shall, provide and fix all the requisite expansion loops formed in the pipe runs by means of long radius welded sweep elbows to the required dimensions. The loops shall be installed in the mains with mild steel flanges and each leg of the loop shall be pulled cold to approximately 50% of the estimated expansion of the leg.

Where no bellows or loops are specified, provision for expansion and contraction of pipework shall be made by changes in direction and it shall be the responsibility of the Contractor to make sufficient allowance for this.

Branch connections are to be taken from the top or bottom of both flow and return mains, depending on the prevailing air venting arrangements. Branches shall have incorporated in them two bends before passing into ducts, trenches, vertical chases, etc. The bends shall be arranged so as to take up the expansion and contraction of the mains without putting any extraneous strain onto the particular branches.

The Contractor shall install piping in a manner so as to permit perfect freedom of its movement during expansion and contraction operations without causing it to become warped. The strain and weight of the piping must not be transmitted to the connected apparatus.

The Contractor shall ensure that adequate provision is made for the expansion and contraction of all pipelines.

Where expansion fittings become necessary they must be anchored and guided in accordance with the manufacturers recommendations and/or these Specifications.

The Contractor shall submit full details of the proposed fittings for approval, together with all calculations and details of loading imposed on the structures.

Where branch connections are made to mains remote from anchor points on the latter, the take off shall be so arranged as to form a radius arm whereby the axial movement of the main is allowed to take place without imposing a bending stress upon the branch.

With a view to reducing strain due to expansion on plant and equipment of any description, whether indicated on Drawings or otherwise, the Contractor shall

MECHANICAL SPECIFICATION

ensure that the connecting pipes are suitably set and include such expansion fittings as required. The fixed point being taken at the plant or equipment.

The Contractor shall ensure that the required "cold draw" is provided. The jointing of the loops and expansion fittings shall not proceed until it is shown, to the satisfaction of the Engineer's Representative, that restraint has been correctly applied and that the runs are guided to provide for true axial movement.

Expansion loops or bends shall be of one piece and preferably made at the tube or fitting manufacturer's works. If the total length of the tube or bend is such as to prohibit this, welds may be made in the long arm as near the centre as possible. No welds will be permitted in the crown of the bend or in the short arms and any seams shall be arranged at the side of the bends. All loops or bends shall be flanged and arranged to vent and drain naturally.

All expansion loops and bends shall be so proportioned to accommodate the total stress set up in the material of the pipe wall, taking into account the stress components due to internal pressure, torsion and bending.

All expansion loops and bends shall be fabricated from similar materials to the pipework systems in which they are installed, with flanged ends, erected in a horizontal plane and supported at the crest.

All expansion loops and bends of joints shall be erected cold drawn to the extent of one half of the total expansion to be taken up and shall not be assembled before pipes are anchored.

The cold draw shall be pulled by means of long bolts through the flanges. Bolts shall be pulled up diagonally to prevent uneven stressing and after the flanges are tight the bolts shall be replaced one by one with bolts of the correct length.

In the event that the fitting of expansion loops and bends cannot be immediately possible, necessary distance pieces shall be inserted.

b) Expansion Joints

Expansion joints shall be of the straight bellows type and of axial pattern or as otherwise indicated. They shall be provided with screwed union or flanged ends as appropriate to facilitate replacement unless otherwise approved. They shall incorporate internal liners if required and shall be manufactured from 18/8 stainless steel or other approved material appropriate to the duty and shall be designed to withstand the test pressure of the system. Bellows shall be capable of not less than 2,000 complete cycles of movement over the designed working range without failure. Pipework supports shall be arranged as near as possible to the joints.

Expansion joints shall be selected to accommodate the maximum working temperature and temperature range of the systems. Rods or hangers shall be provided to take imposed end thrusts.

MECHANICAL SPECIFICATION

Joints up to 38 mm. shall have screwed ends to B.S.P. and 50 mm. and upwards flanged ends to B.S. 10/4504. All compensators shall be installed in accordance with the manufacturer's recommendations.

All expansion joints shall be provided with external protection where exposed to damage. For axial joints this shall comprise an external sleeve. Joints shall be installed so that they are not subjected to stresses other than those for which they are designed. Unless otherwise indicated they shall be installed so that they are in their free position at a temperature midway between the high and low limits of normal service.

All connections between bellows and pipework shall be aligned prior to and during welding by means of welding clamps.

Axial joints shall be installed in line with the axis of the pipe and shall not be subjected to any tension during installation other than that approved by the manufacturers.

Flanged joints shall be pulled up diagonally across the flanges by means of long bolts after the joints are made the long bolts shall be removed diagonally one at a time and replaced with standard bolts, nuts and washers.

Joints with flanged ends shall be installed during the erection of pipework if possible. Otherwise, temporary distance pieces of accurate dimensions shall be provided. Each such distance piece shall be exactly equal to the "installed" length of the compensators and shall have flanges precisely square with the pipe and flange bolt holes of the compensator. All expansion joints shall be securely locked in position prior to and during hydraulic testing. Should joints be unable to withstand test pressures they shall be isolated from the piping systems.

End fittings for expansion joints on mild steel pipelines shall be of steel.

Axial expansion joints shall be cold drawn during installation to an agreed amount not exceeding the manufacturer's recommendations.

When installing manufactured expansion loops or bellow joints, the manufacturer's installation recommendation shall be observed in every respect.

When pressure testing pipework distribution mains, the Contractor shall ensure that the test pressure will not damage the bellows, where the test pressure exceeds the maximum operating pressure.

All cleats, brackets and steel work required for building-in shall be supplied by the Contractor, unless stated otherwise elsewhere in the Specifications.

Details of all anchors shall be submitted to the Engineer for approval before manufacture.

The bellows shall be installed with due allowance having been made for cold draw, which will vary according to the type and length of bellows proposed and

the temperature of installation. Where "installation bars" or fittings are incorporated with the bellows during delivery and erection, these must be removed before heat is applied.

Care shall be taken when installing flanged end bellows to line up the bolt holes on joint and mating flanges and to ensure that the joint is not twisted in any way or any torsional stress applied.

c) Guides

Free guide sleeves shall be fitted on each side of the expansion joint, unless such joint be installed adjacent to an anchor point when guides shall be fitted on the free side only.

Guides shall consist of a tube of diameter not more than 3 mm. greater than the outside diameter of the main and length four and a half times the diameter of the main with a minimum length of 300 mm. unless an alternative design is shown on the Tender Drawings.

Guides shall be installed not more than one and a half pipe diameter from the expansion joint to the first tubular guide and not more than 15-20 pipe diameters between this guide and the next pipe support.

Further pipe guides shall be provided along each pipeline at intervals equivalent to not more than 75 pipe diameters and where shown on the Drawings.

The Contractor shall provide all necessary pipe guides to prevent long pipe spans from buckling and to ensure alignment and linear free movement of pipes from anchor points towards expansion joints constructed to prevent transverse movement and carefully installed so that axial movement is not hampered. Means for lubrication shall be provided where necessary.

Each pipe guide on sections of pipework incorporating axial joints shall be of the tube type with rods tack welded to the guide, and arranged to locate and restrain the pipe in all planes. Alternatively pipe guides can be made on Site with two roller supports as shown on Drawings.

Special supports and fixing accessories shall be provided at all heavy items of pipeline equipment. i.e. valves, etc. to ensure that no undue strain is placed upon the pipeline at their incidence.

After fabrication, all ferrous fixings and supports shall be thoroughly wire brushed to remove dirt, scale, rust etc. and then given two coats of red oxide primer prior to bolting to or building into the building structure.

Detailed drawings of pipe guides and supporting frames shall be submitted to the Engineer for written approval prior to manufacture.

2.62 ANCHOR POINTS

Where indicated on the Drawings, or as required, mild steel anchors shall be installed to resist the maximum stresses of the pipework.

MECHANICAL SPECIFICATION

The anchor shall be fixed only to solid building fabric. The anchors shall consist of heavy section iron 'U' strap, minimum size 50 mm. x 6 mm., welded to the pipework and attached to minimum 150 mm. x 75 mm. x 6 mm. channel iron supports by H.T. nuts and bolts unless shown otherwise on the Tender Drawings.

On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be welded to the pipework. Where it is impracticable to weld the anchors to the pipework, pipes shall be rigidly anchored preferably by flat iron clips and/or 'U' bolts threaded at both ends and pulled tight onto the underside of pipe and butting up to angle and/or channel iron support on each side. The diameter of the rod from which the anchor bolts are made shall be 3 mm. greater than that for 'U' bolt guides. Flat iron clips shall be 38 mm.x 9 mm.

For heavier loading applications, mild steel locking channels shall be welded to the pipe on each side of the supporting channel.

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion bellows, of substantial form and suitable for the imposed loads. Such loads shall be assessed upon the assumption that unbalanced forces exist at all anchor points even when such are sited in intermediate positions between two bellows.

The supports for the anchors shall be formed from channel iron or two equal angles back to back, adequately sized to take the maximum thrust load bolted to concrete floor and roof or built into sides of ducts.

Anchors shall be positioned to ensure that movement due to expansion and contraction is proportioned throughout the system. Anchors shall, in all cases, be provided complete with the necessary cleats, brackets and steel work section pre-cut to length and drilled, backing plates, holding down bolts, nuts, washers, all for attachments to the building structure. Each anchor point, shall be set out and lined up accurately into position ready for grouting in.

Prior to manufacture, full details of the proposed method at anchorage together with corresponding calculations and details of thrust loading shall be submitted to the Engineer for approval.

2.63 GRADING OF PIPEWORK

All pipework shall be installed with continuous grading to allow for drainage and/or air venting according to the service concerned. Gradients shall be generally as follows for the various services.

- Chilled Water/

| | | | | |
|------------------|---|----------|------------|--------------|
| Heating Branches | : | I in 250 | Condensate | 1 in 125/250 |
| | | | Steam | 1 in 250 |

- DHWS and all CWS : 1 in 750 Comp. Air 1 in 125

- Chilled Water Mains : 1 in 500 Gas 1 in 250

2.64 AIR VENTING OF SYSTEM

Full provision shall be made by the Contractor for air venting of the system at all high points in pipework formed by the Contractor, whether or not shown on the drawings.

Automatic air vents shall be used where indicated on the Tender Drawings and where necessary and shall have gunmetal bodies with not less than 15 mm. connection copper or stainless steel floats, guides and non-corrodable needle valves. In all cases, the air vent shall be preceded by a lock shield pattern stop valve and a strainer and the discharge from the air vent shall be 10 mm. copper pipe, which shall discharge to outside in a position which shall be agreed in advance with the Engineer.

The automatic air vents shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed.

Pipework shall be arranged as to allow air to be vented out of the system through air handling units, fan coil units, etc. Also at high points, an air bottle with needle valve shall be installed.

Air bottles in pipework up to and including 80 mm. bore shall be manufactured from 50mm bore pipe, 100 mm. bore and over from 100 mm. bore pipe. All bottles shall be 250 mm. long with welded end caps and be complete with 8 mm. bore copper pipe brought down from the top of the air bottle to within reach of ground or floor level and fitted with 8 mm. lockshield needle valve complete with key.

Where required by the Engineer, air bottle vents shall be brought to false ceiling level and shall terminate with an 8 mm. (0.25" BSP) manual air vent projecting neatly through the ceiling.

On MPHWH/HPHW systems the discharge pipe and needle valve shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed and shall be arranged discharge to a safe place.

All exposed air bottles, automatic vents and drip pipes where required shall be properly insulated.

2.65 DRAINING OF SYSTEM

Drain points shall be provided by the Contractor at all accessible low points of water services installations and also on the branch side of all main isolating valves and cocks whether shown or not on the Drawings.

Drain points shall be fitted with a lockshield drain cock of gunmetal construction manufactured to the requirements of B.S.2879:1980, type 'A', complete with hose union and removable key. The base of the pocket shall be drilled and tapped to accept a 15 mm. lever operated plug cock of suitable design.

Drain points on MPHWH/HPHW systems shall be fitted with a bronze needle valve with plugged outlet.

2.66 PIPE SLEEVES

In all cases where pipes pass through walls, floors, ceilings and footings, the Contractor shall provide sleeves which shall be built in and shall be responsible for ensuring that this is performed correctly. Sleeves shall in no case be used as pipe supports, a free annular space always being provided. Puddle flanges shall be provided on pipework passing through walls and trenches intended to be covered by earth, etc., or where passing through bund walls. Sleeves shall be of pipe cuttings properly reamed, cleaned and trimmed at 90° to bore.

Sleeves in non-load bearing walls, floors ceiling and partitions shall be copper or mild steel to suit the particular pipe materials.

Sleeves shall be provided with an inside diameter of not less than 15 mm. larger than the insulated outside diameter of the pipes. Pipes passing through load bearing walls or footings shall be provided with proprietary 'CSD' type pressure tight bulkhead seals suitable for up to a maximum differential water pressures of 138 Kg/m² or alternatively, puddle flanged cast iron sleeves shall be provided with an internal diameter 100 mm. larger than the outside of the pipe. The space between the pipe and sleeve shall be sealed with a water tight mastic or silicon rubber compound. Gland plates not less than 6 mm. thick shall be fitted if necessary to withstand water pressures. Details of all sleeving arrangements through liquid - tight walls shall be submitted for approval.

Where pipes pass through fire barriers proved proprietary approved fire rated 'CSD-F' type mechanical seals shall be provided or alternatively steel sleeves shall be installed with the space between the sleeves and pipework sealed with suitable fire rated material.

External flashing sleeves shall be provided by the Contractor except where indicated otherwise. They shall incorporate an integral flange to which a flashing shield can be clamped or welded. The Contractor shall build the shield into the membrane and fill the space between the sleeves and pipe with waterproof materials or mastic compound.

For pipes which change direction, oversized sleeves, the size larger than normal shall be fitted to allow for expansion. The space between the pipe enclosed and its sleeve shall be caulked with suitable filling material to be approved by the Engineer

Sleeves shall not protrude from the finished face of walls. In toilets, kitchens and all other situation where the floor may be swilled, the sleeve shall project 30 mm. above the finished floor level.

2.67 FLOORPLATES

Where exposed to view, pipes and tubing passing through walls, floors, ceilings, partitions and false ceilings of occupied rooms shall be fitted with a heavy chromium- plated die cast zinc alloy masking plate. Such plates shall be split on the diameter, be a snug fit to the pipe concerned and provided with countersunk holes for set screws.

2.68 SAFETY VALVES

All safety valves shall be to BS.759 and shall be set to discharge at 1.15 times the design pressure, or 5 psig. above the working pressure, whichever is the greater.

2.69 VALVES AND STOPCOCKS

Valves and stopcocks shall conform with the Table Appendix III at the end of this Section of the Specifications unless detailed differently in the particular Section of the Specifications.

2.72 ACOUSTIC STANDARDS FOR MECHANICAL INSTALLATION,

GENERAL

1. All building equipment (plumbing, heating, ventilating, air conditioning, electrical and elevators) including piping and ductwork shall be installed to produce sound pressure levels within occupied spaces not to exceed limits as specified in section 3.
2. All such building equipment, including piping, ductwork, linen and rubbish chutes, shall be so installed that its operation causes no objectionable structure-borne noise or vibration transmission to occupied spaces. Isolation hangers, pads, insulation layers, airspace will all be required in different cases. Each potential source of vibration must be reviewed and means of isolation specified.
3. All building equipment including towers, fresh air intake, spill or exhaust louver faces or gratings shall be so and installed that they result in no objectionable noise transmission to adjoining properties or neighbors, and conform to local codes and regulations.
4. All operating equipment, including mechanical plant and engineering maintenance, shall produce noise levels in their respective areas not to exceed 85 dB, measured on a A scale.

ACOUSTIC STANDARDS

Grilles, Registers, diffusers and Fan Coil Units

1. The maximum permissible sound power levels in octave bands of grilles, registers, diffusers and fan coil units shall be as follows:-
Maximum PWL re 10-12 Watts

| <u>Octave Bands</u> | <u>NC-35</u> | <u>NC-40</u> | <u>NC-45</u> | <u>NC-50</u> |
|---------------------|--------------|--------------|--------------|--------------|
| 1 | 62 | 66 | 68 | 70 |
| 2 | 56 | 60 | 63 | 66 |
| 3 | 49 | 54 | 58 | 62 |
| 4 | 46 | 51 | 56 | 61 |
| 5 | 43 | 48 | 53 | 58 |
| 6 | 42 | 47 | 52 | 57 |
| 7 | 41 | 46 | 51 | 56 |

MECHANICAL SPECIFICATION

8 42 47 52 57

2. Manufacturers shall be required to submit to the engineers representative guaranteed sound power level data in octave bands of grilles, register diffusers and fan coil units operated at low, medium and high speeds.
3. Grilles, registers, diffusers and fan coil units shall be tested in accordance with ASHRAE Standard 3 6B-63.

ACOUSTIC STANDARDS

Acoustical Treatment of Duct Systems

1. Acoustically lined with 25mm (1") thick, 0.68 kg. (1 1/2 lb) glass fibre duct lining the following:-
 - a. All conditioned air ductwork within mechanical equipment spaces, but not less than 7.5 meters, (25 ft.) from fan outlet.
 - b. A minimum distance of 6 meters (20 ft) upstream of all toilet exhaust fans.
 - c. A minimum distance of 6 meters (20 ft) upstream of all supply air fans.
 - d. Downstream of all exhaust fans, or return air fans, except kitchen and laundry systems, a minimum distance of 6 meters (20 ft).
 - e. Supply and return ductwork in function rooms equipped with folding or operable partitions as required to control sound transmission during simultaneous usage of the divided spaces.
2. In certain conditions, packaged factory-built sound traps may provide more effective sound control than acoustical lining, or may be economically advantageous. Such determination shall be made by the acoustical engineer in consultation with the mechanical designer.

FOUNDATION AND VIBRATION ISOLATION

- a. All equipment, piping, etc., shall be mounted on or suspended from approved foundations and supports, all as specified herein.
- b. All concrete foundations and supports (and required reinforcing therefore) shall be provided by the contractor. Furnish shop drawings and templates for all concrete foundations and supports, and furnish for setting all required bolts and other appurtenances necessary for the proper installation of his equipment. All such work shall be shown in detail on the shop drawings, which drawings shall be submitted to the engineer showing the complete details of all foundations, including the necessary concrete and steel work, vibration isolation devices etc.
- c. All floor mounted equipment shall be erected on 4 inch high concrete pads over the complete area of the equipment, unless specified to the contrary herein.

MECHANICAL SPECIFICATION

Wherever hereinafter vibration eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be in turn mounted upon raised concrete pads unless specified to the contrary herein.

- d. Mounting systems and components of the isolation mounting shall not be resonant with any of the forcing frequencies of the supported equipment or piping. Mounting sizes shall be determined by the mounting manufacturer and mounting shall be installed in accordance with manufacturer's instructions.
- e. All mounting systems exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) to be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.
- f. Where supplementary steel is required to support piping and/or ductwork, this steel shall be designed to provide a maximum deflection of 0.08 inch at the mid span under the supported load. The piping shall be rigidly supported from the supplementary steel and the supplementary steel isolated from the building structure by means of isolators described in paragraphs entitled "support of piping and boiler breeching - mounting type XT".
- g. Where steel spring isolation systems are described in the following specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after installation. The spring specified minimum deflection from loaded operating height to spring solid height shall be 50% of the rated deflection. The maximum motion of any resiliently supported equipment at startup or shutdown shall be 1/4 inch. approved resilient lateral restraints shall be provided as required to limit motions in excess of 1/4 inch.

FLOOR MOUNTING OF CENTRIFUGAL FANS - MOUNTING TYPE I

1. Each fan and driving motor shall be mounted on an integral one-piece structural mounting frame, reinforced as necessary to prevent flexure of the frame at startup and during operation of the fan. The utilized structural mounting frame for the fan and motor shall include motor slide rails. The structural steel mounting forms and shall be drilled and tapped to receive the fan and motor so that the frame shall act as a template.
2. The structural steel integral mounting frame shall be supported on steel spring mountings. These mountings shall be positioned in accordance with the weight distribution to insure adequate deflection and vibration isolation. Housing or snubbing devices shall not be used to contain the isolation springs.

FLOOR MOUNTING OF CENTRIFUGAL FANS - MOUNTING TYPE II

1. Each such fan and motor shall be mounted on a reinforced spring supported concrete inertia block. The block shall be poured within structural perimeter frame set on roofing paper. The structural perimeter frame, complete with motor slide rails, height saving spring mounting brackets, springs and equipment anchor bolt templates shall be provided by the vibration control vendor. Spring supports

MECHANICAL SPECIFICATION

shall be located under the brackets and shall incorporate a neoprene acoustical pad and leveling adjustment to raise the entire isolation base 2 inches above the foundation pad.

2. Reinforced concrete inertia base thickness shall be in accordance with the following schedules:-

| <u>Motor Size</u> | <u>Inertia Block Thickness Required</u> |
|--------------------|---|
| Up to 50 hp | 8 inches |
| 60 to 75 hp | 10 inches |
| 100 hp and greater | 12 inches |

FLOOR MOUNTING OF CENTRIFUGAL FANS - MOUNTING TYPE III

This equipment shall be mounted exactly as that described for mounting Type I, except that mountings shall be neoprene-in-shear

MOUNTING OF FACTORY ASSEMBLED FANS, TUBULAR FANS AND BELTED VENT SETS - MOUNTING TYPE IV

Each such equipment shall be mounted on neoprene-in-shear isolators.

MOUNTING OF FACTORY FANS AND AXIAL FLOW FANS - MOUNTING TYPE V

This equipment shall be mounted directly on stable bare steel spring isolators, except that where the units to be mounted are furnished with internal structural frames and external lugs (both of suitable strength and rigidity) or without any severe overhangs, no additional structural frame need be provided beneath the unit. In any event, motor shall be integrally mounted to the unit and shall be mounted on slide rails.

MOUNTING OF CEILING SUPPORTED FACTORY ASSEMBLED FANS, AXIAL FLOW FANS, TUBULAR FANS AND BELTED VENT SETS - MOUNTING TYPE VI

1. All such units shall be hung by means of vibration isolator hangers consisting of a steel housing or retainer incorporating a steel spring.
2. If the equipment to be mounted is not furnished with integral structural mounting frames and external mounting lugs (both of suitable strength and rigidity), approved structural subbase shall be installed in the field which shall support the equipment to be hung and to which shall be attached the hangers.
3. Diagonal hanger rod isolators shall be provided as required to limit horizontal motion to 1/4 inch maximum under fan operating conditions.

MOUNTING OF CEILING SUPPORTED FACTORY ASSEMBLED FANS, AXIAL FLOW FANS, TUBULAR FANS AND BELTED VENT SETS- MOUNTING TYPE VII

1. This equipment shall be mounted as described under mounting type VII.
2. Diagonal hanger rod isolators shall be provided as required to limit horizontal motion to 1/4 inch maximum under fan operating conditions.

MECHANICAL SPECIFICATION

MOUNTING OF CENTRIFUGAL PUMPS (GREATER THAN 3 hp) - MOUNTING TYPE VIII

1. Each pump with its driving motor shall be bolted and grouted to a spring supported concrete inertia base reinforced as required.
2. Each concrete base (rectangular or "T" shape) for horizontally split pumps shall include supports and base elbows for the suction and discharge connections. Base elbow shall be bolted and grouted to the concrete foundation.
3. Reinforced concrete inertia base thickness shall be in accordance with the following schedule:-

| <u>Motor Size</u> | <u>Inertia Block Thickness Required</u> |
|---------------------|---|
| 5 hp to 15 hp | 6 inches |
| 20 hp to 50 hp | 8 inches |
| 60 hp to 100 hp | 10 inches |
| Greater than 100 hp | 12 inches |

4. The spring supported reinforced concrete inertia foundation shall be poured within structural perimeter frame of the required thickness indicated in the above schedule. The structural perimeter frame shall be equipped with height saving brackets and stable bare spring isolators having spring diameters no less than 0.8 of the compressed height of the spring at rated load. The mountings shall provide minimum static deflection of 1 inch unless otherwise noted on the drawings. Structural perimeter frame, mounting templates, saving brackets and spring system shall be provided as an assembly by the vibration control vendor. There shall be a minimum of 2 inch operating clearance between the pump inertia base and the foundation pad.

MOUNTING OF CENTRIFUGAL PUMPS (3 hp OR LESS) - MOUNTING TYPE IX

1. Pumps 3 hp or less shall be bolted and grouted to rubber-in-shear supported reinforced concrete inertia blocks that are a minimum of 6 inches thick. Rubber-in-shear isolators shall provide a minimum static deflection of 3/8 inch and shall be protected against corrosion.
2. Provide base below supports and structural perimeter frames and reinforcement as described for mounting type VIII.

PIPING ANCHORS, GUIDES AND SUPPORTS - MOUNTING TYPE XII

1. Pipe guides, anchors and supports in all risers, and piping anchors in mechanical equipment rooms or occupied spaces shall be isolated from the building structure so that there shall be no direct metal-to-metal or metal-to-structure contact of the piping with the building structure.
2. Piping Guides

MECHANICAL SPECIFICATION

- i. Steel guides shall be welded to the pipe at a maximum spacing of 60 degrees. The outside diameter of the opposing guide bars shall be smaller than the inside diameter of the pipe riser clamps in accordance with standard field construction practice. Each end of pipe anchor shall be rigidly attached to an all directional pipe anchor isolation mounting which, in turn, shall be rigidly fastened to the supplementary steel framing within the shaft in an approved manner.
 - ii. The all directional pipe anchor isolation mountings shall consist of a telescoping arrangement of two sizes of steel tubing separated by a minimum of 1/2 inch thick heavy duty neoprene and canvas duck isolation pad. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The allowable load on the isolation material shall not exceed 500 p.s.i.
 - iii. Low temperature piping guides shall be constructed with a 360 degree 10 gauge metal sleeve around the piping. The thermal insulation requirements for the piping shall be provided between the piping and the sleeve. Heavy duty neoprene and canvas duck isolation pad of thickness equal to thermal insulation requirements shall space the metal sleeve away from the piping with suitable thermal insulation provided in the voids between the pipe sleeve and isolation pad material. The metal sleeve outside diameter shall be smaller than the pipe riser clamp inside diameter in accordance with standard field construction practice. The pipe riser clamp shall be rigidly attach to the steel guide framing within the shaft.
3. Anchors
- i. The pipe clamp at anchor points shall be welded to the pipe and to acoustical pipe anchor mountings which, in turn, shall be rigidly fastened to the steel guide framing.
 - ii. The acoustical pipe anchor mountings shall be capable of safely accepting loads developed by the installed piping and shall consist of a bolted assembly of steel plates with lamination of 1/2 inch thick heavy duty neoprene and canvas duck isolation material. A heat shield of 1/4 inch asbestos transit shall be provided as required. The isolation material loading shall not exceed 500 psi.
4. Supports
- i. Piping supports within shafts shall be provided with suitable bearing plates and two layers of 1/4 inch thick ribbed or waffled neoprene and loaded for 50 psi maximum. The isolation pads shall be separated with 1/4 inch steel plate.
 - ii. Piping isolation supports at the base of risers shall be two layers or 1/2 inch thick heavy duty neoprene and canvas duck isolation pad separated by 1/4 inch thick steel plate. Suitable bearing plates sized to provide a pad loading of 500 psi maximum shall be provided. The stanchion between the pipe and isolation support shall be welded to the pipe and welded or

bolted to the isolation support. The isolation support shall be bolted to the floor slab with resilient sleeves.

5. Piping Penetration of shafts, Floor slabs and/or Partitions

There shall be no direct contact of piping with shaft walls, floor slabs and/or partitions.

2.73 TESTING

The Engineer shall witness all testing and commissioning and shall have access at all reasonable times to such parts of the Contractor's and Suppliers' works as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance.

2.74 NOTICE PRIOR TO TESTING

The Contractor shall give the Engineer seven days' written notice of his intention to carry out a test and shall have carried out all necessary adjustment prior to commencing the test.

2.75 TESTING IN SECTIONS

The Contractor shall allow for testing and commissioning the installation in sections as may be required in order to conform with the program. All pipework and ductwork in these sections shall be sealed and tested as specified below, so that the insulation can be applied and the section completed to assist the program.

2.76 TESTING OF PIPEWORK, WELDS, ETC.

The whole installation shall be hydraulically tested to twice the working pressure of the systems or 4.137 bar, whichever is the greater.

Gas pipework shall be tested as above, but utilizing an inert gas.

The pressure shall be maintained for a period of two hours in each case, and due allowance shall be made for attendance by the Engineer during the progress of such tests. The Contractor shall also be responsible for arranging for the water authority to witness this test should they require to do so. Any equipment fitted not suitable for this pressure shall be adequately protected or isolated from the system during the test.

All leaks are to be immediately repaired and the installations retested until the above requirements are obtained.

The Contractor shall allow for such emptying and refilling and maintenance until all leaks have been satisfactorily stopped.

Upon completion of the final hydraulic test on the system, the Contractor shall apply heat and open all valves and charge the calorifiers.

MECHANICAL SPECIFICATION

All valves and stopcocks throughout the system shall be adjusted and regulated until all circuits are working under normal conditions and to the satisfaction of the Engineer. Joints found to be faulty under heat are to be completely remade.

All tests are to be carried out before application of the paint or insulation and valve adjustments made with the circulating pumps in operation.

The Contractor shall ensure that before informing the Engineer of the proposed tests, all remedial work has been carried out and that there are no leaks. Failure to comply with this Clause could result in a charge being made by the Engineer to the Contractor for the abortive visit.

Each welder shall be assigned a reference, which shall be stamped on each weld and when the general hydraulic tests of the completed systems are carried out, each weld shall be lightly hammered during the time that pressure is maintained.

If any leaks occur at welds, the portion of the weld near the leak shall be cut out and rewelded. Such leaks shall not be repaired by caulking or attempted fusion of the surrounding metal. Should a considerable portion of the welded joints made by a particular operator be found to be defective due to faulty workmanship, all such welds shall be cut out and rewelded by another - operator, whose work has proved satisfactory.

During the progress of the Works, inspection will be made by the Engineer to ensure that all burrs and swarf have been removed from cuts and that the cuts have been made square.

The Engineer reserves the right to instruct the Contractor to cut open any sections of the pipework to inspect cuts or to have welded joints laboratory tests.

If the test and inspection should prove that the welds are to the required standard or that all burrs and swarf have been removed, the Client will pay costs incurred by the Contractor in removing testing and replacing the Sections of pipework. If, however, the inspection and test show that the welds or cuts are below the class of workmanship for this class of work, or if they are found to be faulty in any respect, the Contractor shall make good any such faults free of cost to the Client and shall pay all fees incurred by the tests.

If, in the opinion of the Engineer, this result suggests that the standard of workmanship on the whole of the rest of the work is below that required, the Engineer shall be entitled to instruct the Contractor to remove the remainder of the sections in whole or in part and have these sections renewed to conform with this Specification. The Contractor in this case shall have no claim for the costs involved in removing and renewing these sections of the works, whether such Works are found to be faulty or not.

The Engineer's decision shall be final.

APPENDIX (V)

Materials & Equipment Manufacturers

All materials and equipment specified in this Volume shall be of a quality equivalent

MECHANICAL SPECIFICATION

to/or better than furnished or manufactured by the following:

| <u>Equipment</u> | <u>Trade Mark</u> |
|---|---|
| Chilled Water Installation & Central Air Conditioning : | 1. Trane 2. Carrier |
| Fans : | 1. Wood 2. Flakt. 3. ACME |
| Air Filters : | 1. American Air Filters 3. Cambridge 4. Trox |
| Diffusers and Grills : | 3. Trox 4. Titus |
| Automatic Control : | 1. Honeywell 2. Landis and Staefa 4. Satchwell |
| Chilled water/Heating Pumps : | 1. Aurora 2. PACO 3. ITT 4. Peerless pumps 5. Pullen pumps |
| Sprinkler System Equipment : | 1. Victaulic 2. Grinnel Corporation 3. Central Sprinkler Corp. |
| Sanitary Fixtures & Fittings : | 1. American Standards 2. Twyford Ltd. 3. Vollery – Boch 4. Grohe 5. Hansa |

MECHANICAL SPECIFICATION

| | | |
|---|---|---|
| Valves | : | <ol style="list-style-type: none">1. Spirax Sarco Ltd.2. Hattersley Newman Hender Ltd.3. Victaulic4. Crane5. Holmes |
| UPVC Pipes & Fittings | : | <ol style="list-style-type: none">1. Terrain2. Bartol3. Marley Extrusion Ltd |
| Fire & Smoke Dampers, Volume dampers & Louvers | : | <ol style="list-style-type: none">1. Penn Ventilators2. Trox3. Titus |
| Hangers, Anchors & Supports for pipe & Ducts | : | <ol style="list-style-type: none">1. Hilti or equal approved |

END OF SECTION

MECHANICAL WORKS

SECTION : 3.00

VENTILATION & AIR CONDITIONING INSTALLATION

3.01 GENERAL

This Section of the Specifications covers Air Conditioning and Mechanical Ventilation Systems, comprising air handling units, fan coil units, extract fans, return fans, humidifiers, electric duct heaters, air pressure control valves, air outlets, dampers, attenuates etc. all as shown on the Drawings and as specified hereafter to form a complete installation.

The spaces shall be air-conditioned all the year round by means of central air handling units and fan coil units.

A various air distribution system shall be installed in accordance with the environmental conditions required in the served area.

For areas which require close control of humidity, the AHU's serving them shall be supplied with steam humidifiers.

3.02 BRITISH STANDARD AND CODES OF PRACTICE

Unless otherwise stated, the provisions of the latest revised editions of British Standards and Codes of Practice relevant to the particular installation or part thereof shall be held to be incorporated in the Specifications of materials and workmanship to do with that part of the works as specified herein. Other Standards, national or otherwise and Codes of Practice which are equivalent to the relevant British Standards and Code of Practice may be adopted subject to the approval of the Engineer.

3.03 INTERNAL DESIGN CONDITIONS

All HVAC equipment and plant capacities were based on the following design and performance criteria.

The supplemented data are considered the actual ratings to be achieved after the application of all de-rating factors and shall be adhered by the contractor during the load calculations and revisions.

VENTILATION REQUIREMENTS AND STANDARDS

| Area Designation | Pressure Relationship to adjacent area | Minimum A.C/Hr outdoor | Minimum Total A.C./hr | All Air Exhausted Directly to Outdoor | Recirculated Within Room Units | Relative Humidity % | Design Room Temp dry-bulb Deg. C. | |
|-------------------------------------|--|------------------------|-----------------------|---------------------------------------|--------------------------------|---------------------|-----------------------------------|--------|
| | | | | | | | Summer | Winter |
| Operating Rooms | P | 15 | 15 | YES | NO | 50-60 | 20 | 24 |
| Cath Lab | P | 15 | 15 | YES | NO | 50-60 | 20 | 24 |
| Labour & Delivery Room | P | 15 | 15 | | NO | 50-60 | 20 | 24 |
| Recovery Room | P | 2 | 15 | | NO | 50-60 | 24 | 24 |
| Nursery Unit | P | 5 | 12 | | NO | 30-60 | 24 | 24 |
| Intensive Care | P | 2 | 6 | | NO | 30-60 | 20 | 24 |
| Patient Room | E | 2 | 2 | | | 30-W 50-S | 24 | 24 |
| Patient Room Corridor | E | 2 | 4 | | | 50-60 | 24 | 24 |
| Isolation Room | N or P | 2 | 10 | YES | NO | 30-W 50-S | 24 | 24 |
| Isolation Room - Alcove or Anteroom | P | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Examination Room | E | 2 | 6 | | | 30-60 | 24 | 24 |
| Medication Room | P | 2 | 4 | | | 50-60 | 24 | 24 |
| Pharmacy | P | 2 | 4 | | | 50-60 | 24 | 24 |
| Treatment Room | E | 2 | 6 | | | 30-W 50-S | 24 | 24 |
| X-ray, Fluoroscopy Room | N | 2 | 6 | YES | NO | 40-50 | 27 | 24 |
| X-ray, Treatment Room | E | 2 | 6 | | | 30-60 | 24 | 24 |
| CT-Scan Room | E | 2 | 6 | | | 50-70 | 24 | 24 |
| Endoscopy | E | 2 | 10 | YES | NO | 50-70 | 24 | 24 |

N=Negative

P=Positive

E=Equal

A.C.=Air Change

W=Winter

S=Summer

VENTILATION REQUIREMENTS AND STANDARDS

| Area Designation | Pressure Relationship to adjacent area | Minimum A.C/Hr outdoor | Minimum Total A.C./hr | All Air Exhausted Directly to Outdoor | Recirculated Within Room Units | Relative Humidity % | Design Room Temp dry-bulb Deg. C. | |
|--------------------------------------|--|------------------------|-----------------------|---------------------------------------|--------------------------------|---------------------|-----------------------------------|--------|
| | | | | | | | Summer | Winter |
| Soiled Workroom or Soiled Holding | N | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Clean Workroom or Clean Holding | P | 2 | 4 | | | 50-60 | 24 | 24 |
| Mortuary | N | 2 | 12 | YES | NO | 50-60 | 24 | 24 |
| Dark Room and Process | N | 2 | 10 | | NO | 50-60 | 24 | 24 |
| Non refrigerated body holding room | N | | 10 | YES | NO | 50-60 | 24 | 22 |
| Toilet Room | N | | 10 | YES | NO | 50-60 | 24 | 24 |
| Bedpan Room | N | | 10 | | NO | 50-60 | 24 | 24 |
| Bathroom | N | | 10 | | NO | 50-60 | 24 | 24 |
| Janitors Closet | N | | 10 | | NO | 50-60 | 24 | 24 |
| Sterilizer Equipment Room(Pump Room) | N | | 10 | YES | NO | 50-60 | 24 | 24 |
| Instruments Process rooms | N | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Laboratory Nuclear Medicine | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Pathology | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Cytology | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Haematology & Biochemistry | p | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Histology | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Microbiology | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Blood Bank | P | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Class Ware Wash | N | - | 10 | YES | NO | 50-60 | 24 | 24 |
| Blood Specimen | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Urine Specimen | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |

N=Negative

P=Positive

E=Equal

A.C.=Air Change

W=Winter

S=Summer

VENTILATION REQUIREMENTS AND STANDARDS

| Area Designation | Pressure Relationship to adjacent area | Minimum A.C/Hr outdoor | Minimum Total A.C./hr | All Air Exhausted Directly to Outdoor | Recirculated Within Room Units | Relative Humidity % | Design Room Temp dry-bulb Deg. C. | |
|---------------------------|--|------------------------|-----------------------|---------------------------------------|--------------------------------|---------------------|-----------------------------------|--------|
| | | | | | | | Summer | Winter |
| Sterile supply store | P | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Glass washing sterilizing | N | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Food preparation center | E | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Ware Washing | N | | 10 | YES | NO | 50-60 | 24 | 24 |
| Dietary day storage | E | | 2 | | NO | 50-60 | 24 | 24 |
| Laundry general | E | 2 | 10 | YES | NO | 50-60 | 24 | 24 |
| Soiled linen storage | N | | 10 | YES | NO | 50-60 | 24 | 24 |
| Clean linen storage | P | | 2 | | | 50-60 | 24 | 24 |
| Anaesthesia Storage | E | | 8 | YES | NO | 50-60 | N/A | |
| Central Services | | | | | | 50-60 | N/A | |
| Soiled Room | N | 2 | 6 | YES | NO | 50-60 | 24 | 24 |
| Clean Workroom | P | 2 | 4 | | | 50-60 | 24 | 24 |
| Equipment Storage | E | | 2 | | | 50-60 | N/A | |

N=Negative

P=Positive

E=Equal

A.C.=Air Change

W=Winter

S=Summer

N/A=Not Air Conditioned

3.04 HEPA FILTERS

The filter casing shall be constructed from stove-enamelled sheet steel with a secure, central, sealing and clamping device for the particular air filter cell.

The filter casing shall be complete with anodised aluminium fixed blade diffuser and pre-assembled pressure measuring points, with tubes run to immediately behind the diffuser face.

The diffuser shall be removable and the filter cell accessible from the space served and the casing shall be suitable for a ceiling mounted application.

The particulate air filter frame shall be constructed from a moisture proof fire resistant impregnated board, with fixed neoprene rubber sealing on one side.

The filter media shall be moisture proof glassfiber paper with aluminium corrugated spaces.

The filter unit shall be 99.997% efficient when tested in accordance with BS. 3928 (sodium flame) to meet the class (1) clean room requirements of BS. 5295, (EU-13).

The filter shall be suitable for operation in maximum conditions of 60 deg.C and 100% R.H.

3.05 AIR HANDLING PLANT CASES

3.05.1 General

- 1- A name plate shall be permanently affixed to every unit listing air volume, fan static pressure, coil duties and heat recovery equipment ratings.
- 2- The automatic control equipment required shall be supplied by the controls manufacturer and fitted by the equipment manufacturer, unless otherwise instructed.
- 3- Lifting rings shall be provided on all individual components of 35 kg mass and above for maintenance removal.
- 4- All bearings shall be supplied fully lubricated.
- 5- Spare drive belts shall be provided, in sets where applicable, for each drive in the assembly to a total of one complete change per drive.
- 6- Air Handling Units shall not exceed the overall maximum dimensions specified by $\pm 15\%$.
- 7- Where serpentine averaging thermostat sensors required a full support system shall be provided.

- 8- All access doors shall be insulated to the same standard as the unit casing open towards the high pressure side.
- 9- All components shall be inherently non flammable or be made permanently so by suitable treatment.
- 10- Any viscous liquid used shall have a flash point in excess of 177°C.
- 11- All electrical items of equipment cabling, wiring, and works shall comply with the latest edition of IEE Wiring Regulations & Electricity at Work Regulations 1989 or to equivalent UL requirement.
- 12- Test Points shall be provided to enable comprehensive air side and water side tests to be made on each air handling unit.
- 13- For hazardous or corrosive atmospheric applications, all materials including liners, fixing assemblies and paint schemes shall be selected to meet the detailed requirements and particular conditions. Appropriate IP ratings for electrical enclosures shall be provided.

The unit casings shall be made of (25 mm for inside and 50 mm for outside location) insulated double panels built into a post frame.

Each section of a unit shall have a post framework constructed of anodised aluminium section Bar with 25 mm. seating flange fabricated from 3 mm. thick mild steel for units, handling 9 m³/s to 20 m³/s, 2 mm. thick mild steel on units 2.2 to 9 m³/s and 1.2 mm. thick mild steel on units '0' to 2.2 m³/s. Corners shall be formed from mitred joints welded to form a rigid strong joint cleaned and with cast aluminium corner pieces off smooth.

Frame posts and cross members shall be constructed to incorporate 25 mm. nominal thickness thermal insulation which shall be sealed in position with an additional angle member riveted or spot welded in place.

All framework shall be painted for protection against corrosion after manufacture. Lifting eye bolts shall be provided on the corners of the sections and shall be removed after installation, the holes being plugged off with suitably sized flush fitting brass plugs.

Insulation materials shall be tested to and comply with BS4765 part 7 and achieve class 1 ratings. Fiber glass mentioned.

Insulation shall have a thermal conductivity not greater than 0.04W/mk and have a minimum thickness of 50mm.

Insulates incorporating CFCs in their manufacture, woodwools slabs, polystyrene and urea formaldehyde shall not be used.

If mineral fibers material is used the density shall not be less than 80 kg/m³ and provisions shall be made to ensure that no settling in materials occurs

Panels shall be formed from two sheets of 1.2 mm. thick electronic plated steel having 25 mm. returned edges riveted or spot welded together.

The insulated top and bottom panels of the units shall be designed to withstand the weight of a man and the necessary equipment for maintenance purposes, by forming the inner metal surface in a number of tray pieces which fit inside the complete outer panel section.

Panels shall be adequately stiffened and braced to prevent flexing and drumming and as necessary to maintain rigidity.

All panels shall be of the bolted in removable type: panels fitting flush into frames and corner posts to give smooth external faces.

Joints between panels and framework shall be sealed air tight with non hardening plastic ribbon seal seating strip.

The completed air handling unit casings shall be designed and installed to reduce the fans sound power level radiated into the plant room, or roof level, by the amounts as specified in Schedule S3.01. The density and type of thermal and acoustic insulation to be sandwiched within the panels shall be selected to achieve the panel attenuation specified in Schedule S3.01.

Schedule S3.01

| | | | | | | | | |
|------------|----|------|-----|-----|-----|----|------|----|
| Frequency | HZ | 63 | 125 | 250 | 500 | 1K | 2K | 4K |
| Power Loss | dB | 22.5 | 28 | 27 | 30 | 35 | 27.5 | 29 |

Framework and panels shall be constructed so that bare metal bridges linking inside to outside will not occur as shown on sections and drainages details. The units shall be designed to prevent condensation from occurring from any cool surface of the unit.

Individual panel sizes shall not be greater than 3.5m by 1.75 m. where sections are dimensionally larger, more than one panel shall be used.

All panels and section framework shall be of manageable proportions for transportation and shipment.

The air handling plants shall be painted at the manufacturer's works before dispatch and shipment internally with a complete corrosion resistant paint finish.

The air handling plants shall be decoratively painted externally in accordance with the painting and decorating Clause of the Building Specifications. The final two coats shall be suitable for the weather conditions that prevail in Amman (see Clause 1.02 of this Specification).

Doors in access sections and fan sections shall be suitably sized for man access into and for easy maintenance of the equipment. Each door shall be of double skin construction with an infill of thermal and acoustic insulation to provide acoustic properties equivalent to the unit panels. Doors shall be designed to be an airtight fit and match the unit panels. The doors shall

be double hinged to ensure a good seal onto the gaskets and shall include chromium plated handles, seals and fasteners to hold the neoprene seals in compression. All doors shall be openable from outside or inside the section and shall be provided with door locks, which can be locked from outside the unit but which can still be opened from the inside. Access doors shall be provided on both sides of each unit in access sections and fan sections. (cast aluminium hinges and handles).

3.06 BAG FILTERS

Where indicated in the Equipment Schedules, bag filter sections shall be incorporated.

These can comprise a composite section of the air handling unit and shall be arranged to enable side withdrawal of the filter media from the unit.

Holding frames shall be constructed from galvanised sheet steel with suitable seals provided to prevent air bypass around the filters.

The filter media shall consist of high density glass micro fibre media with individual dust holding compartments, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average arrestance efficiency of not less than 98 % and atmospheric dust spot efficiency 80-90 % on ASHRAE test Standard 52-76 or to EU grade (EU -8) .

The configuration of the dust holding compartments shall be controlled by means of progressive link stitching. The stitching shall be such that it forms a supported compartment resulting in uniform velocities in the passages of the air exit side of the filter.

The dust holding compartments shall be equipped with a minimum of 516 support points per square metre of the filter media.

All stitching points shall be sealed with a hot melt adhesive.

Each filter bank shall be fitted with an inclined tube manometer connected at the works by the manufacturer.

3.07 PANEL FILTERS (PREFILTERS)

The filter media shall be natural, synthetic or glass fibre or fabric fibrous material shall be covered with a final scrim backing. They shall be replaceable filter elements in either mat or pad form, suitable for attachment to the upstream face of the bag filter banks.

They shall be fixed in permanent holding frames, and clips to ensure quick and easy removal of pre filters. The arrangement of the prefilters shall not impair access to and serviceability of the bag filters. All frames and clips shall be galvanised steel or other acceptable corrosion resistant material.

All filter elements shall be bedded firmly into permanent frame seals and pressed firmly and continuously onto face of bag filter frame by a cam operated mechanism or a series of accessible clips for front withdrawal type to prevent air by passing.

Panel filter assemblies shall be 50 mm. thick unless otherwise specified and have efficiencies of not less than those given below for various types of media when tested, to BS 2831 Test Dust No. 2, or ASHRAE 52-76 test.

Typical performance requirements:

| Media Volume Type | Nominal Face Velocity m/s | Initial PD Pa | Arrestance | |
|----------------------|---------------------------------|----------------------|------------|--------------|
| | | | BS2831 | Ashrae 52-76 |
| 1 | 2.0 | 70 | 92 | 83 |
| 2 | 2.0 | 80 | 96 | 86 |

Media

No. Typical Construction

1. Laminated two stage glass filament media.
2. As type 1. followed with a synthetic scrim.

The filter media shall provide a normal servicing frequency of 4 months with a rise in pressure drop from clean to dirty of not more than twice the initial pressure drop.

Each filter bank shall be fitted with an inclined tube manometer connected at the works by the manufacturer.

3.08 PANEL WASHABLE TYPE FILTERS

The filter media shall be combined of expanded and slit aluminium, bonded together in various patterns to form a unique baffle design. This rust-proof aluminium should be easily washed.

Frame, is of aluminium plain mill finish 24 gauge. Construction shall be of aluminium expanded media of 5/8 inch thick in one layer .Average dust arrestance 75% at 1.8 m/s, dust holding 400 Grms at final resistance of 125 Pa. this type of filters shall be used at fresh air inlet side

3.09 DAMPERS

All air regulating dampers shall be installed as indicated on the Drawings and as specified herein.

Air regulating dampers in air handling plant sections shall be assembled from individual dampers bolted together to form a multiple unit. The dampers shall be of the multi leaf opposed blade type. The assembled unit shall be bolted to angle and channel galvanised iron frame work built into the unit casings.

Dampers shall be made of Anodised Aluminium sections geared together by plastic gears.

The multiple damper unit shall be sized for the full air handling unit area, without blanking plates. The face velocities shall be not greater than 5.08 m/sec. (1000 f.p.m.). Closed blade leakage should be $<10 \text{ m}^3/\text{h.m}^2$ with a 100 Pa pressure differential .

Complete damper assemblies shall be operated in vertical banks across the width of the unit. For the adjustment of vertical banks damper regulators with locking quadrants shall be installed inside the unit casing integral with the vertical bank.

Damper regulators shall be marked to indicate the damper position.

Dampers shall be designed, selected and installed such that they do not whistle, whine or produce any recognisable pure tone. The regenerated noise from dampers shall not exceed the induct sound power level at that point of the ductwork system, also the regenerated noise when combined with the induct sound power level at that point must not exceed the criterion in any room over which the duct passes subsequently or in a room which is subsequently served by that ductwork system.

Damper frames shall be fabricated from mild steel channel with all four corners of the frame braced, and shall be Electro galvanised after manufacture.

Damper blades shall not be greater than 250 mm. in width. Blades made from aluminium extruded sections. The blades shall have interlocking edges and cross connecting brackets. Each blade shall have neoprene edging inserted along its length to ensure an airtight seal and whistle free operation.

Damper sections shall be built to size using the lowest practicable number of equal width blades inter-connected on every other blade. Any resulting small air gap top and bottom between blades and channel frame shall be blanked off. Damper blade side stops shall be overlapped and designed to contact blade edges and reach the blade axles.

Damper blade axles and push rods shall be manufactured in stainless steel. Axle bearings shall be of the blind end type with the bearings mounted flush with the inside face of the damper frame. The bearing shall be pre packed with grease and the open end sealed with a rubber 'O' ring seal to prevent air leakage. The opposed blades action only, via gears, made from special anti-static plastic (ABC), temperature resistant to 100 C. Bearing seal achieved using a plastic elastomer on rear of gears between case and gear. Material: Perbunan .

3.11 AIR COOLING COILS

Air cooler batteries contained within air handling plants shall be sectionalised. The whole air cooler battery shall be made up of individual cooler batteries having an overall area not greater than 2.0 square meters.

The coolers shall be bolted onto a steel channel and angle iron framework built inside, and bolted to the unit. The framework shall be protected against corrosion and all nuts and bolts shall be cadmium plated.

Airtight blanking plates shall be provided to seal the remaining portions of the cross sectional area of the air handling unit when the cooler battery is less than the cross sectional area of the unit. Sufficient space shall be left between the battery assembly and the top and bottom of the units for bolting the individual batteries in position in situ.

Each cooler battery flow and return connection shall be extended through the unit side casings with puddle type black steel extension flanges ending to match flange pipe joints within the units. Where two cooler battery sections are mounted end to end across the width of the unit, the primary flow and return connections shall be handed so that the coil can be connected to the service mains at each side of the unit.

Each air cooler battery shall be manufactured in accordance with the following Specification. Cooling battery coils shall be constructed from 16 mm. O/D solid drawn copper tube mechanically expanded into collar spaced ribbed and punched aluminium fins of maximum density 320 fin/meter (10 fins / inch) . The fin and tube matrix shall be treated after manufacturing with corrosion protective layers such as acrylic coatings or other approved materials . Coil's in all AHU's should not contain more than five rows .

Each air cooler battery shall be provided with a galvanised steel drip tray at the base of each section of the battery. Each drip tray shall be tanked and sealed into the assembly. Each drip tray shall be fitted with air deflectors and 25 mm. pipe drain. Each intermediate drain pan shall be connected with a drain pipe feeding into the main air handling unit drain pan as specified in Section 3.13 .

Drain pans shall be designed to minimise the risk of legionella.

The air velocity across the cooling coil shall not exceed 2.5 m/sec.

3.12 AIR HANDLING UNITS FANS

Supply air fans and recalculation air fans mounted within air handling unit sections shall be centrifugal casing type designed and manufactured as specified herein.

Fans shall be double inlet, double width centrifugal back ward curved, or forward blades.

Fans shall be suitable for indirect drive by matched vee belts and pulleys. Where the system allows low flow, multi vane forward curved bladed fans may be used.

Fans shall be selected for slow speed running low sound level and high efficiency. All fans shall be selected to be capable of being operated by at least 10% in capacity over the design volume specified.

Fan casings and scrolls shall be fabricated from heavy gauge mild steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of with standing the pressures involved without leakage or distortion. Fan casings shall be continuously welded construction split as required to pass through available unit access doors.

Fan casings shall be bolted construction for ease of installation, the number of sections being dependent upon the size of the fan and access available for future removal and replacement.

Bearing blocks shall be carried on opposite sides of the fan casing on bearer bars forming a part of a rigid fabricated steel structure integral with the casing.

Ceiling hung fans shall be supported on spring hangers to eliminate vibration to the building structure.

3.13 FAN DRIVES

Fan drives for centrifugal fans shall be multiple vee belts and variable pitch pulleys.

Pulleys of the taper lock type may be used for drives up to 30 KW output. The pulleys shall be keyed to the shafts after commissioning.

Alternatively, and where drives are above 30 KW out-put, the pulleys shall be secured to the fan and motor shafts by fitting into machined keyways. Keys shall be easily accessible so that they can be withdrawn or tightened and shall be accurately fitted so that the gib head does not protrude beyond the end of the shaft.

Each fan set shall be supplied with initial sets of pulleys and drives to give the duties as designed.

Fans with standby motors if require shall be provided with two sets of pulleys, one on each side of the fan.

Vee belt drives shall comply with BS.3790 and shall be capable of transmitting not less than the rated wattage output of the motor with one belt removed.

Machined bolts, nuts and washers shall be used for the assembly of fans: all bearing surfaces for the heads of bolts of washers shall be counterfaced.

All fan casings shall be fitted with bolted on air-tight inspection door and a drain plug.

Fan casing shall be fitted with flanged outlets for duct connections and shall have rigid spigot inlets truly circular and free from dents.

Inlet cones shall be manufactured to close tolerances to avoid turbulence at the air entry to the impeller. all internal and external exposed casing surface shall be zinc sprayed for protection against corrosion.

The fan impeller wheel and blades shall be robustly constructed from mild steel sheet with fabricated steel or cast iron boss with back plate when required. the boss shall be bored and keywayed for the shaft. Impellers shall be zinc sprayed against corrosion.

Impellers shall be rigidly braced to ensure concentricity and eliminate vibration and shall be certified as being statically and dynamically balanced on their shafts at the manufacturers works.

Fan driving shafts, of ample section for the loading, shall be of high tensile mild steel, precision turned, ground and polished.

Keyways shall be provided for securing the impeller and driving pulley.

All fans shall be fitted with permanent type of bearings mounted in cast iron plumber blocks.

All vee belts shall be of the anti static type suitable for operation in temperatures likely to prevail in the plant rooms.

Guards shall be provided for all open unprotected air inlets to centrifugal fans.

Fan and fan motor to be fixed on one steel chassis which is fitted with rubber anti vibration mounting and the fan outlet fitted with flexible canvas connection.

Drive and pulley guards shall be made to be readily removable to permit belts to be changed.

Adequate access panels shall be provided in the guard to allow tachometer readings of the shafts to be taken and the belt tension to be tested.

Allowance shall be made in the dimensions of the guard and the size and position of access panels for the adjustment of the motor on its side rails. Fans with standby motors shall be provided with two guards one on each side of the fan.

3.14 FAN MOTOR

Electric motors shall be continuously rated of metric frame construction and shall comply with BS.5000 and BS.2048.

Each motor shall be rated at 130 percent (%) of the fan's rating when running at the duties as designed. Fan motors shall be squirrel cage, total enclosed, fan cooled type wound for 380 volts, 3 phase, 4 wire, 50 hertz electrical supply. Motors of 5.6 KW and above shall be arranged for star delta starting. Motor insulations shall be to Class F.

Thermistor type overheating cut outs shall be provided in the motor windings.

All motors shall be suitable for horizontal foot mounting and be complete with slide rails and belt adjusting bolts.

Standby motors if required shall be complete as for duty driving motors with slide rails and shall be permanently mounted and wired within the air handling units so that in the event of failure of the duty motor the standby motor can be started without any belt changing, etc.

Each fan and motor assembly including standby motors shall be mounted on a fabricated and welded rolled steel channel iron base frame, suitably drilled for mounting upon antivibration mountings within the air handling unit fan section casing.

3.15 ANTIVIBRATION TREATMENT

All equipment containing moving parts generating noise or vibration shall be mounted or placed upon specially designed isolators. All connections to such equipment shall be fitted

with flexible connectors to prevent transmission of such noise and vibration to the structure or to other areas of the building or to other pieces of equipment.

Each centrifugal fan and motor channel base frame shall be mounted on anti vibration mountings as specified herein.

The resilient material of the anti vibration mounting shall be rubber or neoprene for static deflections of less than 12 mm. and steel for deflection of greater than 12 mm. Steel springs shall contain a series of rubber or neoprene pads to contain and isolate the structural borne noise component. Anti vibration mounting shall be adjustable in height to level the machine foundation except where the static deflection of the mount is less than 6 mm.

Where practicable, anti vibration mountings shall be removed for shipment. Where impracticable anti vibration mountings must be provided with transit bolts and nuts to hold them rigid to the frame of the machine.

Flexible joints shall be provided on fan inlet and outlet connections as required.

Flexible joints and material shall be of, or be protected by, material having a fire penetration time of not less than fifteen minutes when tested in accordance with BS476, Part 1, Section 3.00. The material shall be of the glass fibre cloth type and waterproof. Canvas material will not be permitted.

The width of the joints from metal edge to metal edge shall not be less than 100 mm. and not greater than 250 mm.

All flexible joints shall be between flanged ends. The flexible material flange shall be backed by an angle or flat iron flange and the flexible material held securely between the metal faces of the steel section.

All electrical conduits and connections in contact with fans, bases, motors or supports shall be fitted with flexible sections to avoid nullification of the anti-vibration treatment provided.

Flexible conduit shall be watertight, PVC sheathed, spiralled metal type. The conduit shall be terminated at boxes and equipment with compression glands. An additional PVC insulated stranded tinned copper earthing conductor not less than 6 mm. diameter shall be drawn into flexible conduits and connected to the earth terminals at each end of the flexible run.

3.17 TESTS AND PERFORMANCE CERTIFICATES

The Contractor shall submit for approval before placing his order for the AHU's the following information:

- a) A description of the actual test procedures used by the fan manufacturers.
- b) A laboratory test sheet showing results of a test for fans typical of the types that will be ordered.

- c) A fully documented list of total sound power levels in each of the second octave bands between the frequencies of 63 Hz and 4 KHz for each fan.

The Contractor shall provide the Engineer with fan performance certificates for each fan tested in accordance with the requirements of B.S.848, Parts I & II.

The characteristics of each fan's performance shall include curve relationships of volume, pressure, efficiency and power absorbed at constant speed.

The induct sound power levels shall be determined in accordance with the requirements of B.S.848, Part 11.

The Contractor shall provide the Engineer for approval with performance certificates showing the induct sound power level in the seven octave bands as specified above for each fan before placing his order with the manufacturer.

3.18 TEST HOLES

Tapped holes for testing purposes and for permanent instrumentation shall be provided as indicated on the drawings and Schedule. Suitably sized holes shall be formed in the inner and outer panel skins and steel hank bushes welded onto the inner faces.

Recesses hexagon brass plugs, threaded 15 mm. male shall be supplied and fitted into the female thread of the instrument ferrule.

The panel insulation shall be suitably cut to give a clear way for the instrument ferrule.

3.19 DRAIN PANS

Drain pans shall be fitted below all cooling coils as a continuous unit constructed from 2 mm. thick galvanised steel sheet steel. A 50 mm. galvanised drain complete with trap and clean out plug shall be provided. The drain shall be taken from the pan to terminate external to the unit to a glass trap for extension via a tundish to the nearest floor drain gully.

Secondary drain pans shall be installed under valves and strainers serving FCU's and under all valve stations.

They shall be same as drain pans of AHU's and shall extend via a tundish to the nearest floor drain gully.

3.22 LOUVERS AND PENTHOUSES

GENERAL

Louvres shall be of aluminium manufactured from HE 9th. quality extruded section to BS 1474 or from NS4, H3 or SIC/H quality aluminium sheet to BS 1470 alloy extruded sections.

All louvres shall be provided with an epoxy based powdered coating suitable to resist corrosion.

All louvres and cowls shall be rigid in construction and shall not rattle or flex.

The free area of louvres shall not be less than 45%.

Unless otherwise specified, wall louvers shall be based on the following maximum intake and discharge velocities, provided the specified noise levels are not exceeded.

| <u>Type</u> | <u>Intake</u> | <u>Max.Pr</u> | <u>Exhaust</u> | <u>Max.Pr</u> |
|--------------|-----------------|---------------|-----------------|---------------|
| | <u>Max.Vel.</u> | | <u>Max.Vel.</u> | |
| | <u>m/s</u> | <u>Pa</u> | <u>m/s</u> | <u>Pa</u> |
| Single blade | 2.0 | 35 | 2.5 | 60 |
| Double blade | 2.0 | 50 | 2.0 | 80 |
| Triple blade | 2.3 | 70 | 2.0 | 140 |

The louvers and cowls shall be constructed from aero dynamic designed extruded section to provide low resistance to air flow and maximum resistance to rain penetration.

Before manufacture, the exact size of opening into which louvers and cowls must fit shall be checked by site measurement.

Louvers shall be in multi bank form

a) Wall Louvers

Louvers shall be provided with subframe suitable for bolting into a prepared opening in the building structure.

Special finishes shall be applied to match with the frames of the windows.

Louvers shall have a maximum module size of 2 m.x 2 m. Louvers in excess of this size shall be constructed by bolting modules together. Vertical mullions shall be provided at not more than 1 metre centres.

Box section louver frames shall be provided with all joints and connections.

All louvers shall be provided with flashings, top covers, cills, clips, shims, fastening devices separating panels. anchors and all other items required for a complete installation. All fastenings shall be non-ferrous, or zinc/cadmium plated.

All louvers shall be furnished with bird screens of 12 mm. diamond or square mesh, 2.0 mm. galvanised steel wire in folded frame complete with fixing lugs. All steel parts shall be hot dipped galvanised after manufacture.

Where blank off sections in louvers are indicated, they shall be constructed from two 1.0 mm. thick sheets of galvanised steel with 50 mm. of mineral wool insulation between, then primed and painted matt black on louver side.

3.23 SAND TRAP LOUVRES

Units shall be constructed of aluminium extruded sections. They shall separate sand from intake air and shall include self-emptying sand drain holes. The finish shall be syntha pulvin powder coated M4 L009 (BS 00 A 05) or otherwise to withstand the humidity and temperature conditions. The colour shall be decided by the Engineer at the time of submittal and order.

They shall be provided with aluminium washable filter of 25mm thick and bird screens galvanised 12 x 12 x 1 mm.

The blades shall be 0.9 mm. thick and the casing shall be 2.0 mm. thick.

The units shall be supplied complete with builders cleats.

Sand rejection at 1 m/s. face velocity shall not be less than the following:

| <u>Particle size (in microns)</u> | <u>Efficiency %</u> |
|-----------------------------------|---------------------|
| 150 - 700 | 90 |
| 75 - 700 | 60 |

3.28 CENTRIFUGAL FANS

Supply air fans or exhaust air fans shall be of double inlet, double width centrifugal back ward curved or air foiled for capacities above 1000 L/s and forward curved for lower capacities, non overloading operating characteristics with high efficiency.

Fans shall be suitable for indirect drive by matched vee belts and pulleys. Where the system allows low flow, multi vane forward curved bladed fans may be used.

Fans shall be selected for slow speed running low sound level and high efficiency. All fans shall be selected to be capable of being operated by at least 10% in capacity over the design volume specified.

Fans shall be provided with 1 speed 2 speed or 3 speed motors as indicated on the equipment schedule with Class "F" insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.

Fan casings and scrolls shall be fabricated from heavy gauge mild steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of with standing the pressures involved without leakage or distortion.

Fan casings shall be continuously welded construction split as required to pass through available unit access doors.

Fan casings shall be bolted construction for ease of installation, the number of sections being dependent upon the size of the fan and access available for future removal and replacement.

Bearing blocks shall be carried on opposite sides of the fan casing on bearer bars forming a part of a rigid fabricated steel structure integral with the casing.

Fans shall be complete with :

- a) Backward/ Forward curved blades
- b) Inlet cone
- c) All welded fan casings with reinforced outlets
- d) Side support frames
- e) High grade steel fan shaft on roller bearings
- f) TEFC electric motor rated for continuous operations in ambient temperature up to 50°C
- g) Vee belt drive
- h) Galvanised wire mesh guards constructed and fitted to satisfy all relevant safety legislation
- i) Rolled steel channel base frame
- j) Antivibration mountings
- k) Flexible inlet and outlet flexible connections
- l) Laundry Exhaust fans shall be components shall be constructed to operate continuously at not less than 200°C.

All fan sets shall be finished with one priming coat and two coats of gloss. The impeller shall be finished in a contrasting colour. All fan sets shall be tested at Works and installed strictly in accordance with the manufacturer's instructions.

GUARDS AND DRIVE GUARDS

Guards shall comply with BS 5304 and be provided to all fan open intakes and exhausts and all forms of open power transmission systems including belt drives, drive shafts and drive couplings.

Rigid removable guards shall be installed to full enclose indirect drive systems to prevent inadvertent contact with dangerous parts of machinery. Construction and installation shall ensure strength and rigidity. It shall not be possible to remove any guard or access panel without the use of a tool.

Belt drive guards shall be of galvanised or plastic coated woven steel wire of not less than 2.5mm diameter attached to a rigid galvanised or plastic coated steel rod or angle framework.

The mesh size and/or the location of the guard shall prevent finger penetration. alternative construction may be from galvanised sheet steel not less than 0.8mm thick stiffened as necessary to ensure a rigid enclosure.

Removable access panels shall be provided to permit tachometer readings to be made of motor and driven shafts and belt tension to be tested. The sizes of guards including the dimensions and locations of access panels shall provide for the extreme motor position.

For duplicate motor installations the guard provided shall be arranged to protect both drives. All fixings and mountings shall be installed to facility changeover of the drive.

Extended fan shafts shall be protected with a galvanised steel wire mesh or sheet metal guard shaped to suit the components and removable for maintenance. Guard construction shall be as for belt drives.

3.47 AIR OUTLETS

a) General Requirements:

Material : Powder Coated aluminium of ARAL colors as approved by Engineer unless other wise specified.

Size : as indicated on Drawings.

Manufacturer: as far as practicable air outlets are to be the products of one manufacturer.

Approval : Approved manufacturers does not necessarily constitute approval of their products. The Contractor shall submit for approval a complete list of proposed air outlets, indicating manufacturer, catalogue number, details of construction and performance.

Noise level : Size air outlets for minimum noise levels. Not to exceed the allowable noise level at the specified air quantity, as measured on the A scale of a standard noise level meter unless specified otherwise.

Gaskets : To be fitted at factory on all air outlets to prevent air leakage around them and dust streaking of walls and ceilings. To be felt by sponge rubber.

Screws : All screws used in fixing air outlets to be chrome or cadmium plated.

Finish : Shall be powder coated and as agreed upon with Engineer at time of order. They shall be factory coated of colour approved by the Engineer.

b) Ceiling diffusers:

They shall be of the louvred face pattern. Select to give required throw to nearest wall. Terminal velocity is not to exceed 50 feet per minute at specified air quantity. Velometer velocities through diffuser are not to exceed 500 feet per minute.

They shall be flanged suitable for flush mounting to false ceiling and round or square neck sized to fit over the duct. They shall be complete with volume control damper accessible from face of diffuser and equalizing deflectors to provide an even air discharge pattern.

Square and rectangular ceiling diffusers shall be two piece design consisting of mounting frame and removable core attached with spring lock and safety chain.

c) Linear diffusers

Linear diffusers shall be continuous, single or multiple slot type, with individually adjustable supply air pattern and volume control blades on each slot. Air supply pattern is to be adjustable in 6" lengths through 180 degrees from diffuser face with two way incremental capability from multiple slots.

Noise level is not to exceed 25 NC at specified air quantity measured at vertical position.

Linear diffusers to be of total length, number of slots and cfm per linear foot run as indicated on Drawings.

Linear diffusers shall be without face flange screw holes, and shall be suitable for ceiling mounting air supply and for air return. Diffusers shall be supplied in standard lengths up to 60 inches. Where longer lengths are specified, multiple lengths shall be joined with special key strips supplied with the diffusers.

Linear diffusers shall be complete with end caps on end sections and one piece diffusers, grid pattern air straighteners and concealed mounting brackets for easy installation without need for special tools.

d) Air register.

Air register supply and return shall be selected for correct deflection to suit shape of room. Terminal velocity at end of throw to opposite wall is not to exceed 50 feet per minute at specified air quantity. Velometer velocities through register or grille are not to exceed 500 feet per minute.

Return/Extract air grilles, fixed blade type with blades set at 45 degree deflection parallel to long dimension. Grille net free area is to be not less than 70 % of gross face area. They shall include volume dampers of the opposed blade type.

e) Transfer grilles

Transfer grilles to be of the fixed blade type, with blades set at 45 degree deflection parallel to the long dimension. Grille net free area not to be less than 70 per cent of the gross face area. They shall include double frames.

f) Fan Coil Units Return Grilles

FCU access panel with return Grilles. Grille face is to be hinged to provide easy access to filter and have a knurled knob. Area

g) Return /exhaust air registers

Register are to have fixed, 1" wide, horizontal louvers set at 45 degree deflection, spaced at 3/4" centres and equipped with vertical, opposed blade, key operated volume control dampers accessible through the face of the register.

h) Door grilles

Door grilles no vision, V-shaped louver type. Grille net free area is to be not less than 70% of the gross face area.

Grilles shall be installed in an approved, neat, level, square, tight manner.

i) Outlets

Outlets that are installed directly on ducts shall fit to an appropriate sheet metal flange formed integrally from the duct and be fixed with sheet metal screws.

Outlets installed in walls shall be fixed to an appropriate wooden frame provided around the opening. Fixing to frame shall be with chrome plated or cadmium plated wood screws.

Duct collar to finish flush with external surface of frame shall be provided and shall be nailed to the frame to make a tight connection. The frame shall be of a size to be completely concealed by the air outlet flange.

3.48 MANUAL VOLUME CONTROL DAMPER

Provide dampers of a proprietary manufacture mounted in a flanged or folded section galvanised zinc spray coated steel frame.

Construct damper frames and blades to ensure rigidity and prevent distortion and jamming in operation.

Provide for low velocity air systems, single thickness damper blades. Provide for high velocity air systems, double thickness, streamline pattern damper blades. The edges of the blades shall be folded and left smooth. Dampers located inside aluminium duct shall contain blades made from aluminium extruded sections .

Each blade shall be securely bolted to solid spindles mounted in low friction sealed for life ball bearings or self lubricating for life, special plastic bearings (Pocan) suitable to withstand temperatures up to 120 degrees C.

Provide single bladed dampers for ducts up to 150 mm. in height and multi bladed dampers, not more 150 mm. wide generally, for ducts and apertures in excess of 150 mm. in height.

All blades of multileaf dampers shall be rigidly fixed to their spindles and inter linked to ensure that one movement of the operating handle shall move each blade an equal amount and differential blade movement does not occur.

Provide all dampers with external indication of blade position.

Dampers shall be rigid in construction and free from vibration in any position. Casings shall be air tight. Dampers shall be accurately installed in relation to their quadrants so as to permit free movement of 90 degrees.

Dampers greater than 1200 mm. in height or width shall be built up in two or more sections, suitably interconnected with air tight seals between sections, and mounted into a framed casing having additional bracing members as necessary to avoid flexing large installations shall be site assembled.

Provide accessibly located and external to dampers a substantially constructed, rigid mounting bracket to which a cast quadrant with lockable cadmium plated screws, nuts and washers. The quadrant shall be clearly marked "open" and "shut".

Dampers shall be provided where required for the proper regulation of the ventilation systems. In general, the dampers shall be provided as follows, and at such other points indicated on the Drawings:

- 1 In all branches serving more than 3 Nos. supply and return registers
- 2 In all branches serving fresh air to spaces
- 3 In all main fan supply, recirculation and extract ducts.
- 4 In all connections to grille and diffuser plenum boxes.

Scribe or indelibly mark the final setting on all dampers and adjusting devices after balancing.

Standard dampers must always be installed with the blade axles horizontal.

3.49 FIRE DAMPERS

Automatic fire dampers shall be provided at each fire compartment where shown on the building drawings and each slab level and be complete with access doors for maintenance purposes. Fire dampers shall be operated by fusible links actuation with failure indication connected to the indication lamp.

Fire dampers shall be of the shutter type. They shall comprise continuous folded interlock blades contained within and arranged to close the opening of a surrounding frame. The blades frame and component parts shall be constructed from 1.2mm. strip mill cold reduced sheet steel continuously hot dipped galvanised to B.S.2989, Group 2, Class B, with all cut edges protected with zinc chromate prime. The shutter shall be held in the open position out of the airstreams by a fusible link set to release at 72°C. The closing action of all shutter type dampers shall be actuated by means of two constant force coiled band springs. Shutter type fire dampers shall be sized to suit adjacent ductwork sizes and shall be manually reset.

Where fire dampers incorporate short lengths of ductwork between the damper and the protected wall, such short lengths of ductwork shall be constructed to the same fire rating as the fire damper.

Fire damper shall have a minimum fire rating of two hours. Access shall be provided for inspection and testing.

3.52 FAN COIL UNITS

The design construction, materials and finishes of all units shall be suitable for the locations and operating conditions indicated in these Specifications and Drawings.

A customary auxiliaries deemed necessary, shall be provided by the manufacturer for the safe controlled automatic operation of the equipment which shall be pre-wired and tested.

Units shall be of the room cabinet or basic chassis type, suitable for floor or ceiling location as shown on Drawings.

All units shall be provided with easy access to fans, controls, filters, coils, vents, drain and valve connections.

Discharge grilles shall be provided with hinged sections for access to controls on wall or floor mounted furred in or cabinet type units.

Units shall be selected with sound levels at least 3db below required room specified sound levels at design speed.

All units shall be complete with the following basic components:-

- Air filters
- Flexible rubber connectors
- Electrical junction box
- Fan assembly
- Coil section

The chassis shall be fabricated from at 1.6mm thick galvanised sheet steel to form a rigid unit fully sealed to eliminate extraneous air leakage free from sharp edges and complete with fixing lugs.

Thermal insulation of 12 mm. minimum thickness shall be applied to all sides of coil sections, and beneath all cooling coil drip pans.

All insulation must be non flammable, nontoxic, and possess minimum smoke propagation qualities.

Acoustic treatment shall be supplied to casings as required to meet the room specified sound levels.

Reinforced sheet steel enclosures shall be provided for room mounted units to form a rigid cabinet that will not flex or vibrate during unit operation. There shall be space within each cabinet for piping connections and valves.

Panels shall be bonded plastic coating or be treated with corrosion resistant baked on primer and stove enameled or equal finish.

Access shall be provided in cabinets to fans, coils, filters and electrics. Access to control switches and coil connections shall be through hinged flaps on the top panel discharge grille. Front panels shall be secured with positive locking tamper proof fasteners, hinged for horizontal units.

All flow grilles shall have adjustable discharge.

The design of the enclosures shall enable air filters to be serviced without having to remove any of the unit paneling.

When specified or shown on drawings, return air plenums shall be provided to suit particular manufacturer's standard model type.

Resiliently mounted, direct driven centrifugal double width, double inlet fans, shall be used with impellers and scroll made in shockproof material to guarantee maximum stability during transport and installation .

Impellers shall be statically and dynamically balanced for quiet operation.

The fan and motor assembly shall be removable on a slide out arrangement. For changeover systems, the motor shall be positioned below the unit coil to eliminate damages due to excessive heat and air temperature.

Maximum motor speeds shall not to exceed 24 rps.

Coils shall be of copper construction with aluminium fins mechanically bonded to seamless copper tube coils all joints brazed arranged for On Site handling

Each coil water and electrical connections shall be handed to suit Site requirements, but connections shall be adaptable for Site reversal.

Units shall be complete with a one piece drip pan, extending beyond the cooling coil sections to cover return bends and shall have a second deep flanged drain pan fitted outside of unit

chassis having 22 mm. OD outlet to cover where necessary random condensate from valves, fittings and coil drip pan outlet.

Drip and drain pans shall be zinc coated and treated both sides with a protective coating of mastic. Both pans shall be reversible for left or right hand location. The outer surface of all condensate drain pans shall be adequately treated/insulated to prevent secondary condensation occurring.

All drip and drain pans shall be designed to reduce to the absolute minimum the formation of legionella by careful detailing of both pans and pipework connections.

The protective mastic coating shall be suitable for the frequent application of disinfectant when maintenance engineers flush through drip/drain pans and fan coil drainage pipework.

Cooling coil face velocities shall be sufficiently low to prevent moisture carry over beyond the condensate drip tray, and to limit noise generation.

All coils shall be complete with air vent and drain cock.

All units shall have air filters on the inlet side prior to coil and fan sections.

Filters shall be of throw away type readily accessible for inspection, removal and replacement.

The media shall be vermin and rot proof and shall not break up in the air stream.

Filter media shall be non flammable and shall not produce smoke or large volumes of noxious products when exposed to fire.

Bonding agents shall have a flash point of not less than 163°C.

The Contractor shall ensure all control valves can open and close against the maximum system differential operating pressures.

All units shall be provided with manual isolating and commissioning set (double regulating and testing valves, in addition to the proportion three way valve or two way valve and other fitting as shown on the drawings or mentioned in the specs or the BOQ, and required .

Concealed units shall be selected for operation with sufficient fan and motor power to provide the required air flow rates at the operating resistance of the air distribution systems.

Fans and motors shall be resiliently mounted.

Final electrical connections to the units shall be flexible.

The contractor shall provide flexible sleeves, between unit spigots and connected ductwork of heavy quality glass fibre reinforced canvas having a minimum length of 150 mm. securely fixed and sealed to minimize air leakage. Maximum flame spread rating 25.

Support rails and vibration isolators shall be provided for horizontal units.

The Contractor shall select units to ensure that the room sound levels in Specifications are not exceeded.

ROOM THERMOSTAT

The fan coil unit shall be controlled by a wall mounted sensor with recessed housing and overlapping cover plate. The housing shall have conduit entry provision and shall be handed to the electrical Sub Contractor with instructions for fixing at the time that conduits are installed.

Interconnecting cables shall terminate at a fixed terminal strip within the housing and all connections to the components mounted on the fascia.

Facilities on the sensor shall include :

- Fan high, medium and low speed selector
- ON/OFF switch
- Temperature setpoint
- Temperature digital readout
- Power 'ON' indicator
- Set back default setting (economy / normal)

- Reverse auctioning of the temperature controls depending on the temperature of the water supplied to the coil.

DRAWINGS

Detailed drawings of the complete installation including the housing, fans, filters and structural arrangements, together with detailed circuit diagram and control panel arrangement shall be submitted to the Engineer prior to ordering. These drawings are for approval prior to manufacture and similar 'as fitted' details are to be provided in the service manual.

END OF SECTION

MECHANICAL WORKS

SECTION : 4.00

CHILLED WATER INSTALLATION

4.01 GENERAL

The chilled water installation shall comprise the complete installation as depicted on the Drawings. It shall be commissioned in accordance with the manufacturers code of requirements and C.I.B.S.E. Commissioning Code and handed over in a fully reliable working condition.

4.02 CHILLED WATER PLANT

The central chilled water plant shall include air cooled packaged water heat pumps located on the site of the hospital, and enclosed by acoustical damping louvers to minimize noise transmission to the hospital service area. The heat pumps shall be mounted on a floating kinetic slab, to avoid vibration and noise transfer to below.

Screening walls around the heat pumps shall be provided to act as a barrier against direct transmission of noise to terraces below. Acoustic louvers within the screen wall to be provide for more sound breaking.

In order to reduce the transmission of vibration, each heat pump shall be mounted on spring anti vibration mounts selected for a minimum static deflection of 50mm. The contractor shall also count for the compatibility of the multiple mountings systems of all other heat pumps..

Each heat pump shall be provided with a constant flow primary pumps. The primary circulating chilled water pumps shall be of direct driven type. Each pump shall be interlocked with its respective heat pump.

The primary chilled water pumps shall deliver water at supply temperature = 7° and return temperature = 13°

4.03 HEAT PUMP

The design, construction, materials and finishes of all units shall be suitable for outdoor use in the locations, climatic and operating conditions indicated in this specification and drawings. The units shall be started on site by the Manufacturer's qualified technical staff.

The size of the heat pump plant shall be such that it can brought into the position and sufficient space for access and manufacturers recommendations space for serving shall be maintained

The units shall be packaged and fully factory assembled complete with operating and safety controls and all customary auxiliaries deemed necessary by the manufacturer for the safe, controlled automatic operations of the equipment.

Manufacturer shall provide efficiency of their equipment per each refrigerant along with a list showing all requirements needed to replace the R22 by 134a.

Compressors

Compressors shall be of scroll rotary serviceable construction serviceable hermetic construction oil separator system with filter(s), drier(s), crank case heater(s), suction and discharge valves and all necessary auxiliaries, copper flexible connector to be fitted at the discharge of the compressor.

Reciprocating Compressors

Main rotating and reciprocating components shall be statically and dynamically balanced. Crankshafts and eccentric shafts of all open or semi-hermetic compressors over 2.5 kw input power shall run in replaceable bearings,

Liquid line control on each circuit should be installed (Liquid solenoid valve, moisture indicator , filter dryer and thermostatic expansion valve.

Drive motors shall be suction gas cooled direct driven running at a maximum of 24.2 revs. per second sized to operate under all conditions. Motor Full Load Amperes (F.L.A.) at design conditions shall not exceed name plate F.L.A.

Internal pressure relief devices shall be in accordance with ANSI B9.1.

A multi stage capacity control shall be available down to approximately 25% of full load on each heat pump unit.

Oil pump(s) shall be of the reversible type. Spring type vibration isolators (by contactor) shall be specially selected with neoprene base pads for fitting beneath the complete liquid heat pump packages to ensure there is no transmission of discernible vibration to the structure and occupied spaces from the units. Isolation efficiency shall be not less than 98%. The isolators shall be adjusted on site for optimum performance.

a) Controls

The operating and safety controls shall include:

1. Motor temperature winding (Inherent motor protector) protection by embedded ambient insensitive solid state sensor and discharge gas temperature sensor for each motor to open all three phases in the event of overloading on any one phase,
2. High and low refrigerant pressure safety devices.
3. Neciprocating.
4. Antishort cycling timer,
5. Crank case heater control.

MECHANICAL SPECIFICATION

6. Chilled water safety thermostat (antifreeze protection). By Microprocessor.
7. Flow Switch interlock.
8. A command control micro processor which shall be built-in each heat pump and shall control capacity cycling of the compressors and unloaders to satisfy the dictates of a leaving water temperature sensor and a return water temperature compensation sensor. All sensors shall be of the thermistor type providing inputs to the micro processor. The micro processor shall recycle the capacity control to the unloaded condition following plant shut down. The microprocessor controller shall afford simple interface with other control systems such as BMS .

The microprocessor shall be capable to perform self diagnosis of the heat pump and shall report the fault on a built-in LCD .

9. Fan cycling head pressure control,
10. Automatic pump down control on shut down, of heat pump.
11. Sequence selection switch for compressor operation (manual).
12. Abnormal conditions alarm lights.
13. Controlled pull down limits for compressor loading on start up, (Reduced starting load part winding motor or star delta starting).
14. Hours Run Meter.
15. Remote Start Stop Control.
16. Common Alarm Volt Free Control.

A weatherproof and dust tight housing shall be provided with lockable tight sealed door(s) all factory wired controls and instrumentation that will be IP55 rating. The heat pump will be equipped with pressure and temperature gauges for refrigerant, field power and control circuit terminal blocks, circuit breakers, motor starter control relays and disconnect switches.

b) Motor Starting

1. The motor starting equipment shall limit the starting current of each motor/compressor unit to 2 ½- 3 times the full load running current,
2. With multi compressor units each compressor must run up to its full speed before the next compressor can start,
3. Compressor starts shall be limited to (6) per hour,
4. Starters shall incorporate thermal overload devices on each phase with single phasing protection,

5. The units shall be capable of starting under all ambient and water temperature conditions likely to occur.
6. Compressors shall be part winding started .

c) **Evaporator**

The evaporator shall be of the direct expansion shell and tube design with removable heads and multi refrigerant circuits one circuit per each compressor Constructed to ASME and tested to a pressure of 1030 K.P.A. water side and 1800 K.P.A. refrigerant side with a water side fouling factor of 0.00009 m² dec. C/W.

Construction shall be seamless copper tubes expanded into tube sheets.

The evaporator shell shall be insulated to a minimum thickness of 38 mm: (K=0.28 w/m °C) with closed cell insulation suitably protected against weather and mechanical damage.

Gland type drain valve with hose union connection shall be provided.

d) **Air Cooled Condenser**

Air cooled condenser coil(s) shall be of non ferrous construction with fins mechanically bonded to tube to ASME U I standards.

Coils shall be constructed of seamless copper tubes with aluminum fins having a maximum of 470 fins/meter.

Sub cooling circuits and liquid accumulators shall be provided where required.

Provision for purging non condensable shall be made.

Fans shall be direct or belt driven propeller type, statically and dynamically balanced having permanently lubricated ball bearings. Fans shall be aluminum or zinc plated steel with zinc plated steel hubs and the motors shall have inherent over current protection.

Motors shall be weatherproof and protected and all bearings shall be capable of operating in dust laden atmosphere.

All motors shall be selected with service factor to N.E.M.A. standards.

Fans shall be fitted for low noise levels.

Coil(s) and fans shall be fitted with protective safety guards.

All fan/motor assemblies shall be mounted on vibration isolators.

The condenser and sub cooler shall be factory leak tested under water to 1034 k.p.a and pressure test to 3100 k.p.a.

e) Casing

The shassies shall be constructed from 6 mm. thickness weld steel chassies.

Panels and access doors shall be constructed from 2.0 mm. galvanized sheet steel, bonderised and given a special tropicalised (epoxy) heat reflecting, corrosion resistant finish to withstand the climatic temperature, humidity and atmospheric dust conditions indicated in this Specification to provide a fully weatherproof enclosure for components.

Coil panels, safety guards and where necessary top panels shall be removable for inspection.

Coil shall be robust in construction and shall not flex or vibrate during operating of fans and compressors.

Lifting eyes or facilities for lifting tubes in base frames and sling spreaders if necessary shall be provided to avoid damaging the equipment during Site lifting activities.

f) Noise & Vibration

Appropriate measure shall be taken to control the noise and vibration form the heat pumps to the surroundings. The heat pumps shall be located above a services distribution plant room to provide extra isolation form sound transmission.

Based on the selected heat pumps the sound reduction shall be to the following criteria :-

Other Features

Each Heat pump shall also incorporate the following :-

Oil Pressure Gages.

Refrigerant Pressure Gages.

Compressor Isolating Valves

Condenser Coil Wind Baffles

Compressor Muffler.

Condenser Coil Protection Guards

Corrosion Resistant Coated Coils.

Low Noise / High pressure Condenser Fans. 750 RPM.

Compressor Attenuating Enclosures.

Power Supply Isolator.

| Frequency (HZ) | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|----------------------------------|----|-----|-----|-----|------|------|------|------|
| Estimated Heat pump transmission | 99 | 96 | 97 | 97 | 95 | 91 | 87 | 81 |
| Sound Reduction Indices | 5 | 5 | 7 | 12 | 18 | 21 | 16 | 16 |

Structureborne noise from the heat pumps shall be attenuated by constructing a float slab suspended on the resilient material at the upper roof plant level.

To reduce noise levels at source the heat pumps shall be fitted with low noise, high efficiency fan and compressors shall be enclosed in acoustic housings. To reduce the noise each heat pump shall be mounted on spring anti vibration mounts selected for a minimum static deflection of 50mm. If individual compressors are also mounted on springs the compatibility of the two mounting systems shall be verified.

A complete and detailed analysis shall be carried out by the contractor , taking in consideration the adjacent buildings and the close guest rooms.

4.04 HEAT PUMPS PLANT CONTROLLER

The heat pump plant shall include a central microcomputer controller to control and optimize the operation of the heat pumps and the primary pumps through the built-in heat pumps microprocessors and pump modules controllers.

The plant control system shall sense and monitor all control variables that govern the operation of each heat pump, the current draw , evaporator temperature, condenser temperature... etc.

The plant controller shall be able to maintain the operation of the heat pump by making the corrective steps automatically without the need to shut down the heat pump, if one of the variables has reached its limit condition.

The plant controller shall optimize the total heat pumps power consumption.

The plant shall be fully compatible and interfaced to the BMS system via modules, which shall be supplied by the plant manufacturer ready for direct connection to BMS, and shall provide all sensed parameters, such as leaving water temperature, capacity stage, water flow, number of operating compressors and heat pumps...etc.

The plant shall be fully compatible and interfaced to each heat pump microprocessor controller .

The plant controller shall incorporate CRT for monitoring and setting up instructions.

All control points of the heat pumps and primary pumps shall be commanded by the controllers. And only the status of pumps and heat pumps shall be monitored by the BMS.

The Plant Controller shall be capable of rescheduling the chilled water temperature to achieve the required mixed flow temperature under part Load operating conditions.

The Plant controller shall be able to control the following functions of the chilled water system:

- 1- System Start-up
- 2- Heat pumps Start Sequence.
- 3- Primary Chilled water Pumps starting sequence
- 4- Logic control of the set point and actual temperatures.
- 5- Operation scheduling.
- 6- Soft Start of the heat pumps.

- 7- Unloading at starts.
- 8- Failure Detection and Recovery.
- 9- Failure Reset
- 10- Operator Override.
- 11- Electrical Demand Limit Controlling.
- 12- Heat pump Plant Reporting & Logging.

4.10 PUMPS

A) General Requirements

- All pumps shall be provided from the factory complete with their motors.
- Pump and motor base shall be mounted on an isolated reinforced concrete foundation of an adequate construction and dimensions via vibration isolators, as detailed on the drawings.
- All pumps shall be located in accessible locations for ease of repair and maintenance.
- All pumps shall be constructed of materials having a pressure rating not less than 10 bars at 85°C.
- All pumps shall be provided from the factory with plugged connections for casing vent, drain and suction and discharge pressure gauges.
- Each pump shall be tested at the factory to provide detailed performance data and to demonstrate its compliance with the specification.
- Each pump shall be hydrostatically tested by the manufacturer for a pressure not less than 10 bars at 85°C.
- Piping shall be supported independent of pumps nozzles to prevent piping weight or stresses from bearing on or being transmitted to the pump nozzles.
- Drains from base plate, pump, relief valves, etc. shall be piped to the floor drain located in pump room.
- All conduits for electrical works in pumps room shall be heavy gauge galvanized steel.
- All pumps that are installed under shade or in roof plant rooms shall be protected by additional weather proofing for specially considered for exposed pumps.

B) Documents

The following documents of all pumps, shall be submitted to the Engineer for approval, prior to shipment from the factory.

- Certified performance curves showing job number, customer order number, date of manufacture, model number, pump size, impeller diameter, impeller type, rpm, flow-head characteristic curve, consumed horsepower curve and pump efficiency curve.
- Pump cross-sectional drawing showing major components with parts numbers and parts list.
- Pumps outline dimensional drawing showing overall dimensions, location of foundations bolts holes and size, location and rating of suction and discharge nozzles of pumps.
- Recommended spare parts list for 2 years operation.
- Detailed wiring diagrams of pumps controllers, and any other electrical devices of accessories.
- Installation, operation and maintenance instruction manuals.

C) Pump Motors

The motors of all pumps shall be of squirrel cage induction type and rated for continuous operation at ambient temperature not less than 40°C.

The motors shall be totally enclosed fan cooled type with insulation class F and IP 54 protection.

The motor shall be designed for:

- Direct On Line (DOL) start for motor capacities less than 10 horsepower.
- Star-Delta start for motor capacities less grater than or equal 10 horsepower.

The motor speed shall not exceed 1450 RPM ;unless otherwise stated.

The locked rotor current of the motor shall not exceed approximately six times the full load current. The motor shall be sized so that the full load ampere rating will not be exceeded.

All motor terminals shall be marked in accordance with NEMA Standard MG1-Part 2.

All motors shall be provided with nameplates in accordance with NFPA 70.

Motor power factor shall not be less than 0.85.

The horsepower rating of the motor driving the pump shall be of such magnitude as to ensure non-overloading of the motor throughout the capacity range of the pump for the impeller size selected.

D) Split Case And End Suction Centrifugal Pump

1) Foundation and Setting

The pump and motor shall be mounted on a common cast iron or steel base plate adequately reinforced against deflection and provided with drip rim and bolt holes.

The pump shall be directly connected to the motor through a heavy duty flexible coupling and provided with heavy gauge coupling guard from the factory. The base plate shall be securely supported on the foundation in such a way that proper pump and motor shaft alignment will be assured.

Horizontal split pumps shall be of a single stage volute type , with cast iron body, fully bronze fitted, double suction inlet, bronze impeller, flanged suction and discharge connections.

The base plate, with pump and motor mounted on it, shall be set level on the foundation and secured with proper size anchor bolts and completely grouted in to provide a rigid non deflating support. Pump and motor shall be aligned at the factory.

Realignment is required after grouting in of base plate and after connecting piping.

2) Pump Construction

The pump casing shall be of high tensile strength close-grained cast iron fitted with bronze wearing rings.

The impeller shall be bronze of the enclosed type and fitted to the shaft with stainless steel key. The impeller shall be dynamically balanced at the factory.

The shaft shall be stainless steel amply sized to carry all axial and radial thrust. The shaft shall be protected by stainless steel sleeves.

The pump rotating element shall be supported by heavy duty grease lubricated ball bearings mounted in a heavy iron housing. The bearing shall be lubricated by screw type grease cups.

The pump shall be fitted with mechanical shaft seals which shall be easily removable from the stuffing boxes without disturbing motor and pump alignment.

The pump shall be provided with back pull-out casing for maintenance purposes.

MECHANICAL SPECIFICATION

The pump shall be provided from the factory with mating flanges for suction and discharge connections. the pump shall be provided with nameplate.

The pump shall be furnished with grease lubricated outboard bearings provided with drain plugs and fittings suitable for in service lubrication.

Mechanically; sealed condensing and chilled water pumps shall be provided with balanced seals.

Mechanically; sealed heating and hot water pumps shall be provided with John Crane Code Xp1d1 Type 1 unbalanced seals. Pumps provided with seals shall be provided with bronze or stainless steel shaft sleeves and stainless steel Cyclo-clean filters.

Packed pumps shall be fitted with stainless steel shaft sleeves heat treated or metallized to brinell hardness 500.

Stuffing box shall designed to accommodate a minimum five rings of packing plus spacer ring and shall be suitable for conversion to grease or water sealing. Packing shall be suitable for service scheduled in accordance to the pump manufacturer's recommendations.

3) Operating Characteristics

The pump shall be selected so that the operating point of specified flow and head falls near the point of maximum efficiency as obtained from the manufacturer published data. The pump shall never be selected to operate near the end of its curve.

The pump shall deliver not less than 150 percent of rated flow at a pressure not less than 65 percent of rated pressure. The shutoff pressure shall not exceed 120 percent of the rated pressure.

The impeller size shall not exceed 90% of the maximum size available for pump casing.

A pump satisfying the specified flow and head characteristics but with smaller impeller size will be rejected. A large pump with a smaller impeller shall be selected to satisfy the specified flow and head.

4) Pump Instrumentation

a) Relief Valve

The pump shall be provided with a relief valve set below the shutoff pressure to provide circulation of sufficient water to prevent the pump from overheating when operating with no discharge. A 20 mm. relief valve shall be used.

MECHANICAL SPECIFICATION

Provision shall be made for a discharge to drain.

The relief valve shall be located between the pump and pump discharge check valve.

b) Automatic Air Release Valve

Each pump shall be provided with float operated air release valve not less than 15 mm. size, to automatically release air from the pump.

c) Pressure Gauges

A pressure gauge shall be connected to the discharge and suction side of the pump casing.

d) Valves and Fittings

- Gate valves shall be installed on the suction and discharge piping of the pump.
- Globe valve shall be installed on the discharge bypass piping of the pump.
- Check valve shall be installed on the pump discharge piping.
- Strainer Y-type shall be installed on the suction piping of the pump.
- Flexible connections shall be installed on the suction and discharge piping of the pumps.
- All valves, strainers and fittings shall be of the same size as the pipe which they are installed.
- All power cabling, flow switches and the connection to the BMS.

e) In Line Centrifugal Close Coupled Circulating Pump

The Contractor shall supply and install circulating pumps as shown and detailed on the drawings, for installation in vertical position, capable of being serviced without disturbing piping connections

MECHANICAL SPECIFICATION

The pump shall be inline close coupled single suction centrifugal type. The pump shall have suction and discharge flanges of the same diameter and on the same centerline.

The pump motor shall be of squirrel cage induction type rated for continuous operation at ambient temperature not less than 50°C.

The motor shall be totally enclosed fan cooled type with insulation class F and IP54 protection. or it shall meet NEMA specifications

Motor shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed.

Pump volute shall be of Class 30 cast iron or bronze. The impeller shall be of cast bronze, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.

The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 Deg. F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

Pump shall be rated for minimum of 10 Bar working pressure at 85°C.

Volute shall have gauge tapings at the suction and discharge nozzles and vent and drain tapings at the top and bottom.

Impeller sizes shall not exceed 80% of maximum size available for pump casing.

Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

Pump Instrumentation

a) Pressure Gauges

A pressure gauge shall be connected to the discharge and suction side of the pump casing.

b) Valves and Fittings

- Gate valves shall be installed on the suction and discharge piping of the pump.

MECHANICAL SPECIFICATION

- Globe valve shall be installed on the discharge by-pass piping of the pump.
- Check valve shall be installed on the pump discharge piping.
- Strainer Y-type shall be installed on the suction piping of the pump.

Note:-

- All valves, strainers and fittings shall be of the same size as the pipe which they are installed.
- All power cabling , flow switches and the connection to the BMS.

a) Expansion Tank

The expansion tank shall be of the closed type, sealed, pre-charged expansion vessel, steel shell divided into two sections by a flexible removable diaphragm. One section contains system water, the other, air or an inert gas such as nitrogen. All valves and other devices should be connected and included with the tank as mentioned on drawings.

- Isolating valves
- Pressure regulating valve
- Relief valve
- Pressure gauge and Air or Nitrogen filling connection
- Automatic air vent valve
- Working temperature should be up to 165 C

d) Base frame

All components shall be mounted on to a mild steel folded and welded base frame complete with lifting eye bolts.

The base frame shall be primed and undercoated with epoxy paint finish.

e) Vibration isolators

1. The unit shall be mounted on anti vibration isolators.
2. Non ferrous braided flexible pressure hose connections on interfaces with pipework system shall be provided.
3. Final electrical connectors shall be made with armored flexible conduit.

f) Control Panel

The pressurization set shall include control panel to operate the pressurizing pump and monitor the low and high level switches , and low and high level pressure

Final electrical connectors shall be made with armored flexible conduit.

The unit shall be complete with all power cabling , flow switches and sensors and shall be connected to the BMS.

4.13 THREE PORT CONTROL VALVES

The three port valve authority (pressure drop over the valve when it is fully open divided by the pressure drop when it is fully closed) has been designed between 0.3 -0.5 based on the maximum systems pump pressure and based on equal percentage or modified parabolic characteristic .

However; and in order to achieve acceptable levels of the control and to minimize the required pump pressures, the valve authority and sizes shall be determined by contractor in coordination with the control valve manufacturer after the final units selection and based on the pressure drop calculation of the network .

This shall ensure the system operates effectively.

4.15 DRAINAGE AND FLUSHING OF SYSTEM

On the dead side of isolating valves, the Contractor shall supply at all low points of pipework systems, except where pipes dip under floors or doors suitably sized key operated cocks with hose unions to ensure complete drainage. Where pipes dip under floors or doors a suitably sized tee with plugged outlet shall be fitted.

The Contractor shall provide scale or dirt pockets where indicated on piping system at the lowest point, which shall generally be adjacent to the plant or equipment.

Scale or dirt pockets shall be of equal cross section as the connecting pipe, 150 mm. minimum length or depth. For pipe-work 65 mm. and above they shall terminate with welded on flange and bolted down blank companion flange arranged to allow easy removal for cleaning. Companion flange shall be tapped and fitted with a 25 mm., tight shut off valve with hose union connection.

For pipework 50 mm. bore and below the dirt pocket shall terminate by means of a screwed cap unless otherwise indicated.

Capped flushing valves shall be installed in the following positions and additionally where indicated on the Drawings:

- a) At the base of all vertical risers and droppers
- b) At the ends of all horizontal run outs
- c) On the system side of valved connections to equipment located at other than roof plant room level.
- d) At all other low points in systems

MECHANICAL SPECIFICATION

The valves shall be line size up to 40 mm. and not less than 50 mm. for line size 50 mm. and above.

Capped branch connections shall be installed suitable for fitting flexible hoses for dynamic flushing, at the following locations on each system and additionally where indicated on the Drawings.

- a) Inlet and outlet of all strainers and on strainer side of isolating valves.
- b) Suction and discharge side of all pumps and on pump side of isolating valves for system pumps used for flushing system.
- c) System side of system pump discharge valve when portable pumps are used to flush systems.
- d) System side of inlet isolating valves and equipment and system side of all cooling coils of air handling units, evaporators, exchangers.

Isolating valves shall be fitted on branch flushing connections located on the system side of the equipment isolating valves and at other positions where indicated on the drawings.

The branch connections sizes shall be as follows unless practical limitations dictate otherwise:-

Connection Size (mm) Line Size (mm)

| | |
|-----------|----------------|
| Line size | Up to 50 mm. |
| 65 | 65 to 150 mm. |
| 80 | 150 to 200 mm. |
| 100 | 300 to 450 mm. |

Pipework between flushing tanks and system connections may be flexible material, to suit operating pressures.

Overflow and/or warning pipes shall be provided to the feed and expansion tanks and automatic air relief valves.

The guiding principles determining the provision and positioning of drain points shall be that all sections of the pipework installation must be capable of being completely drained with the isolating valves closed on the section to be drained.

The Contractor shall install horizontal drain lines to fall at a rate of not less than 25 mm. in 6 m. (1:240), and provide ample, easy access rodding facilities with union or flanged joints for cleaning, inspection and dismantling.

The following shall be arranged to discharge into tundishes connected to drains lines run to convenient drains or sumps. This shall include where pressure or suction conditions exist, cleanable traps with water seals of the required depth.

Drip points from pumps, one tundish being provided for each pump.

4.16 ANTI VIBRATION PROTECTION

The inlet and outlet from each heat pump and pump shall be provided with a line sized anti vibration flexible connection capable of absorbing all vibration prior to any pipework bracketing.

Heat pumps and pumps should be seated on anti vibration mountings to prevent vibrations being transmitted to the structure.

4.17 STRAINERS

Line size strainers shall be fitted before each item of the equipment and prior to each 3 port control valve, and where shown on Drawings.

4.18 ISOLATING AND COMMISSIONING VALVES

Control regulation and isolation valves shall be installed in the following positions on the chilled water installations, and where shown on Drawings.

Isolation valves shall be provided for each heat pump, pump, three port control valve and air handling plant cooling and heating coils. In addition isolation and regulating valves shall be provided the mains and submains and at valve stations as shown on the Drawings and as necessary whether indicated in Drawings or not. Double regulation and orifice valves shall be installed across all pumps and items of heat exchange equipment.

4.19 PIPE FLEXIBLE CONNECTORS

Shall be of the bellows type and shall be suitable for a minimum working pressure of 10 bars at a maximum temperature of 80 °C. They shall be able to withstand a test pressure of 15 bars at 80 °C.

The bellows and inner sleeves shall be stainless steel to B.S. 1449, 321 S 12 .

The tube ends shall be carbon steel flanged to match connected equipment.

END OF SECTION

MECHANICAL WORKS

SECTION 7.00

COLD WATER SERVICES

7.02 PIPEWORK

A. General

Pipework inside buildings shall follow the lines of walls vertically and horizontally and shall be graded as necessary for draining and venting. Joints in pipework shall not be made within walls, or floors and where pipes pass through these structures they shall be sleeved. Where pipes pass through walls, floors, or ceiling exposed to view, they shall be fitted with chrome plated pipe covers. During the course of construction, open ends of pipework shall be sealed with compression type stop ends. Paper, wood, will not be allowed.

All pipe penetrations of lower and upper deck slabs and planters shall be made with puddle flanges.

All connections of plastic pipes or copper tubes to threaded fittings shall be via adapters. Cut threads shall not be allowed.

For more details refer to section (2).

C. Building Domestic Cold Water Pipework

2. All domestic cold water pipework shall be PPR PN-16 bar supplied in straight lengths.

For more details refer to section (2).

7.04 THERMAL INSULATION

All cold water pipework exposed to view on roof shall be insulated and cladded as called for in section (2) of the specifications.

All other cold water pipework in shafts, voids, in walls, under tile, etc., shall not be insulated.

7.05 FLUSHING

The whole of the pipework installation shall be flushed out as detailed in section (2) of these specifications.

7.06 TESTING AND COMMISSIONING

The testing and commissioning of the cold water services shall be carried out as described in section (2) of these specifications.

7.07 CHLORINATION

After testing of the pipework and prior to making the connection to the new town mains supply all pipework shall be satisfactorily chlorinated in accordance with BS Code of Practice No. 310.

END OF SECTION

MECHANICAL WORKS

SECTION 10.00

FIRE FIGHTING SERVICES

10.01 SCOPE OF WORK

The fire fighting services shall be executed as shown on the drawings. All fire fighting components shall be approved by the Local Civil Defence Department.

10.02 PIPEWORK

10.02.1 General Requirements

- All pipes shall be of sizes and general routing as shown on the contract drawings.
- Valves shall be of the same size as the pipe run in which it is installed.
- Piping material shall be as specified hereafter.
- Pipes shall be installed in a neat manner to present a neat and pleasing appearance.
- Pipes shall be installed in a manner to permit free expansion and contraction without causing damages to piping or construction. Adequate off-sets and change of direction in the piping shall be provided to accomplish this. On long pipe runs expansions loops or expansion joints shall be provided. where expansion joints are used careful consideration shall be given to anchoring and guiding the pipes for controlled expansion and contraction.
- Adequate clearance shall be left between pipes and adjacent surfaces or existing installations for the easy installation of valves and accessories.
- Drain valves shall be provided at all low points and as required to permit draining any part of the system for maintenance and repair irrespective whether they are shown on the Contract drawings or not. Drain valves shall also be provided for alarm valves as shown on the Contract drawings for the purpose of testing the system.
- When water filled supply pipes pass through open areas or other areas exposed to freezing, the pipe shall be protected against freezing by insulating coverings, frostproof casings, or other reliable means capable of maintaining a minimum temperature of 4 c.
- The Contractor shall inspect the site conditions for verifying the required clearance and space necessary for the installation of all pipe work.

10.02.2 Pipes and Fittings

- All fire fighting and drain piping shall be standard weight seamless steel pipe to ASA schedule 40 or equal approved.
- Black steel piping shall be used for fire fighting system, and galvanized steel piping shall be used for drain pipework.
- Black steel pipes size 50mm and smaller shall be joined by threading, and pipes size 65 mm and larger shall be joined by welding.
- Galvanized steel pipes shall be joined by threading for all sizes. welding of galvanized pipes will not be permitted.
- Fittings on black steel pipes shall be black, and on galvanized steel pipes shall be galvanized. The use of black fittings on galvanized pipes will not be permitted.
- All fittings for black steel pipes size 50 mm and smaller shall be screwed malleable iron fittings, to ANSI B16.3
- All fittings for black steel pipes 65mm and larger shall be steel of the seamless but welded type with 37 degree beveled ends to ANSI B16.5 and ANSI B16.11.
- All fittings for galvanized steel pipes shall be screwed malleable iron fittings for all pipe size to ANSI B16.3.
- All threaded and welded fittings shall be of 16 bar working pressure rating.
- All threaded fittings and pipe shall have threads cut to ANSI/ASTME Standard B1.20.1.
- All fittings shall have the same thickness and be the same schedule and rating as the pipe of the corresponding size.
- All changes in direction, change in pipe size, branching and jointing of pipes shall be made with regular pipe fittings such as elbows, reducers, tees, coupling, unions, flanges, etc. Bending of pipes for elbows and field fabricated fittings will not be permitted.
- Elbows shall be of the long radius type.
- Branch connection on black steel pipes may be made with forged steel weldolets or threadolets where the branch pipe is not larger than one half the size of main pipe.
- Pipes shall be cut square and to the exact length with a hacksaw or pipe cutting device and the cut end of the pipe shall be reamed with a special tool to the full inside diameter and all chips shall be removed.
- Threads shall be cut with new dies and all burrs and chips formed in the threading operation shall be removed with wire mesh.

- Threaded joints shall be made up tight with approved teflon tape thread sealant. Lampwick, cord, wool, or any other similar material will not be permitted in making up threaded joints.
- Welded joints on black steel pipes shall be made with electric arc welding.
- Care shall be taken that the pipe does not extend into the fittings sufficiently to reduce the water flow.

10.02.3 Welding

All welding shall be executed by first class certified welders working under skilled supervision. The name of the welder with his full qualification shall be submitted to the Engineer.

- The Engineer shall have the right to request any welder to execute a standard weld in the presence of the Engineer or his representative on site and for this weld to be submitted to any reasonable tests which the Engineer may require, in the event of the test failing to satisfy the Engineer's requirements, the welder who executed the faulty work may be required to leave the site and the contractor shall at once replace him with a competent welder.
- Black steel pipes to be welded shall be cleaned thoroughly from rust, scale and oxide and shall be bevelled for a V-butt weld. Welds shall have a minimum of two and half times the pipe wall thickness and shall be symmetrical with respect to the centre line of the joint. All welds shall be of sound metal and shall be free from laps, gas pockets, slab inclusions, interior protrusions or other imperfections.
- Welds shall be hammer cleaned and piping shall be flushed out after welding to remove scale, welding slag and other debris.
- Welding procedure shall comply with the requirements of American Welding Society Standard AWS D10.9.
- All required and necessary precautions against fire and other damage shall be taken when welding or cutting any part of the site.
- Welding sections of pipework in place inside the building shall not be permitted. Sections of branch lines and pipe mains may be shop welded.
- Sections of shop welded piping shall be joined by means of flanged joints.
- Where branch lines are welded to the pipe mains, the holes in piping for outlets shall be cut to the full inside diameter of fittings prior to welding in place of the fittings. Openings cut into piping shall be smooth bore and all internal slag and welding residue shall be removed.
- Fittings used for welding shall not penetrate the internal diameter of the piping. Steel plates shall not be welded to the ends of piping or fittings. Blind flanges shall be used on the ends of piping or fittings.
- Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings.

10.02.4 Unions and Flanges

- Pipe unions or flanges, depending on size and material of piping, shall be provided at piping connections to equipment and valves, control valves, and other accessories that need to be taken out for replacement, cleaning or repair.
- Unions or flanges shall also be provided at adequate intervals, in the piping to permit easy disassembly for alteration and repair.
- Disconnecting unions or flanges shall be installed between the equipment and the isolating valves.
- Unions used on threaded pipe size 50mm and smaller shall have female threaded ends and ground metal to metal seats.
- Flanges shall always match the flanges provided on valves and equipment as far as pressure rating, facing, drilling and thickness.
- Flanges on black steel piping shall be black, forged steel of the slip-on or welding neck type. Flanges on galvanized steel piping shall be galvanized steel of the threaded types.
- Flanges joints shall be made perfectly square with the pipes and shall be fitted with proper thick rubber ring gaskets and assembled with steel, square head machine bolts and hexagonal nuts. Gaskets for flat face flanges shall be of the full face ring type with punched bolt holes.

10.02.5 Return Bends

Return bends shall be installed for pendent type sprinklers except for dry pendent sprinklers. Return bends shall be connected to the top of branch lines in order to avoid accumulation of sediment in the drop nipples connected to the pendent sprinklers. Return bends shall be installed as detailed on the drawings.

10.02.6 Pipe Hangers and Supports

- All piping shall be supported on steel hangers and supports of adequate strength and design to carry the weight of piping and contents without sagging, swaying, vibrating, failing or deforming. Hangers and supports shall allow free movement of pipes due to expansion and contraction without causing noise or damage to piping or construction. Hanging pipes from other pipes will not be permitted.
- Hangers and supports shall be of a design that permits removal without dismantling the pipes and shall be supplied complete with all required rods, bolts, nuts, turnbuckles, swivels, coupling brackets and all other components and accessories.
- Hangers and supports shall be securely fastened to the building construction by means of expansion bolts without causing overstress to any part of the construction.

- Hangers and supports shall be designed and tested to sustain a load 8 times the actual support load.
- Vertical pipes shall be supported by steel pipe clamp comprising two flat bar yokes formed to fit the pipe and drilled and fastened to the pipe with bolts and nuts. The extended ends of the clamp shall be hung from the underside of the floor slab by two rods fastened to the concrete.
- Vertical pipes shall be supported at their base and at their base and at a minimum of every story height.
- Horizontal pipes shall be hung from the ceiling by individual steel hangers of the adjustable clevis type with rod, nuts and turnbuckle.
- All rods shall be threaded for a sufficient length to allow for vertical adjustment of pipes. Each rod shall be provided with two nuts: one for positioning and one for locking.
- The minimum size of hanger rod for individually supported horizontal pipes shall be : 10mm for pipe size up to 50 mm, 13 mm for pipe size 65mm to 80 mm, 16 mm for pipe size 100mm to 125mm, 20mm for pipe size 150mm and 22 mm for pipe size 200 mm and larger.
- The maximum support spacing for horizontal drainage pipework shall be : 1.5m, 1.8m, 2.0m, 2.5 m, 2.7 m, 3.0 m, 3.3 m, 3.6 m, 4.2 m, 4.8m, 5.2m, for pipe sizes 15mm, 20mm, 25mm, 32mm, 40mm, 50mm, 65mm, 80mm, 100mm, 125mm, 150mm, respectively.
- The maximum support spacing for horizontal sprinkler pipework shall be 4.5m for pipe size 40mm and larger and 3.6m for pipe size less than 40mm.
- At least one hanger shall be provided for each section of branch line and between each two branch lines of sprinkler piping.
- The distance between a hanger and the centerline of an upright sprinkler shall not be less than 0.60m.
- The unsupported length between the end sprinkler and the last hanger on the line shall not be greater than 0.60m when this limit is exceeded additional hanger shall be provided.
- The length of an unsupported armover to a sprinkler shall not exceed 0.60m. The hanger closest to sprinkler shall be of type that prevents upward movement of the piping.
- Wall mounted sidewall sprinklers shall be restrained to prevent movement.
- Types of hangers to be used for pipe support shall be in accordance with NFPA 13.
- The contractor shall submit show drawings of pipe hangers and supports to be used showing the fixation details and location of hangers, for the Engineer approval.

10.03 VALVES

10.03.1 General

- All valves used shall be of 250 psi or 16 bar cold water pressure rating.
- All valves connected to water supply and sprinkler piping shall be of indicating type.
- Gate valves used for drain and shutoff purposes shall be solid wedge disk, non rising stem and bronze trim, and shall be screwed, bronze body with screwed bonnet for valves size 50 mm and smaller, and flanged, cast iron body with bolted bonnet for valves size 65 mm and larger.
- Globe valves where required, shall be screwed, bronze body and trim, integral seat, revolving disk, and screwed bonnet for valves size 50mm and smaller, and flanged, cast iron body, bronze trim, renewable seat and disk and bolted bonnet for valves size 65mm and larger.
- Check valves shall be bronze trim, swing pattern, renewable disk, and shall be screwed, bronze body and screwed cap for valves size 50mm and smaller, and flanged, cast iron body and bolted cap for valves size 65mm and larger.
- All check valves shall be suitable for horizontal or vertical installations.

10.03.2 Indicating Valves

- All indicating valves shall be outside screw and yoke "O.S. & Y" gate valves with rising stem that indicates if the valve is open or closed.
- Indicating valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position to avoid damage to piping by water hammer.
- Indicating valves shall be flanged, bronze trim, solid wedge disk.
- Indicating valves shall be bronze body with screwed bonnet for valves size 50mm and smaller, and cast iron body with bolted bonnets for valve size 65mm and larger.

10.04 FIRE HOSE CABINET (FHC)

A. Fire Hose Cabinet (FHC)

The fire hose cabinet shall be automatic swinging recessed type.

Hose reels shall be in accordance with BS 5274. The hose reel shall have a 30 meters long of 25 mm. internal diameter reinforced non-kinkable rubber hose capable of withstanding a working pressure of 16 bar. The hose shall be wound on a fabricated steel drum with circular side plates.

The hose reel shall turn on automatically when 1.5 - 1.8 meters of hose is withdraw from the reel.

The hose reel shall be equipped with shut-off valve and pressure reducing valve for connecting with pipework.

The hose nozzle shall be of chrome plated brass, JET/SPRAY/SHUT/OFF nozzle, and shall have 6mm orifice

The cabinet shall be heavy steel construction finished with red colour paint labelled "FIRE HOSE REEL" and in Arabic.

The fire hose cabinet shall include a dry chemical fire extinguisher of the ABC type as specified hereafter.

The fire hose cabinet shall be of dimensions sufficient to include the hosereel, the shut-off valve and the fire extinguisher and to fit with the available space as shown on the Drawings.

B. Fire Hose Rack (FHR)

The fire hose rack shall consist of:

- a. Cabinet: Cabinet and door leaf shall be made of 1.5 mm steel sheet with all around folded edges, door leafs hinged flush mounted or door frame.

Cabinet shall be equipped with vertical wired glass window on front door. The cabinet shall be painted red with electrostatic powder paint and labelled fire hose rack.

The door shall be recessed type base with aluminum turn handle chrome plated.

- b. Fire hose, synthetic of 65 mm diameter and 40 mm long equipped with brass male coupling for the connection with the landing valve, and with aluminium alloy nozzle to Civil Defence approval.

The fire hose rack shall be located at 1000 mm above finish floor level.

10.05 PORTABLE FIRE EXTINGUISHERS

a. General

The fire extinguishers shall be of the rechargeable type and shall be supplied complete with the operating charge from the factory.

All portable fire extinguishers shall be mounted on special wall brackets that shall be supplied with the extinguishers from the factory.

The brackets shall be specifically supplied for the extinguisher type and size concerned.

b. Type FE-1

Dry chemical fire extinguishers shall be of the ABC type with a rugged all-brass operating valve, large size operating lever, full vision pressure gauge, discharge hose and heavy duty drawn steel cylinder with hard, scratch resistant finish. The capacity shall be 6 kg.

c. Type FE-2

Carbon dioxide fire extinguishers shall be of the pull-pin, squeeze-handle type with double braided hose, non-conducting discharge horn and heavy duty drawn steel cylinder with hard, scratch resistant finish. The capacity shall be 4.5 kg.

d. Type FE-3

Pressurized water fire extinguishers shall be of the air pressurized type with stainless steel finish. The capacity shall be 9 kg.

e. Type EF-4

Halon type 1211, ceiling mounted, including sprinkler (r.t. 68 °C), BCF, 12kg

10.06 LANDING VALVES

Landing valves shall be installed on the wet risers for the use of Fire Brigade inside buildings as shown on the Drawings.

Landing valve shall be gunmetal globe valves, high pressure type to BS. 5041 with 65 mm. dia. bore fitted with 65 mm. instantaneous female coupling to conform to BS 336 and a brass blank cap secured by a suitable length of chain. The landing valve shall have 65 mm. dia flanged inlet for attachment to the dry riser.

The valve shall be equipped with spindle not less than 22.2 mm dia. and fitted with a gunmetal hand wheel of about 150 mm. dia. marked with OPEN and CLOSED directions. Opening shall be anti-clockwise.

The whole valve fittings shall be sound construction and hydraulically tested to a pressure of 20.7 bar before being connected to the dry riser.

The valve shall be installed about 760 mm. above finished floor level. The valve shall be finished with red colour paint.

10.09 AUTOMATIC SPRINKLER SYSTEM

10.09.1 General Requirements

Sprinklers shall be installed as shown on the drawings and in accordance with the requirements of NFPA 13-1991.

Shop drawings prepared by the Contractor shall show the exact location, spacing and types of sprinklers.

All sprinklers shall be manufactured, tested and approved in accordance with the applicable standards of Underwriters Laboratories and Factory Mutual.

The following limitations and requirements shall be strictly followed:-

- Orifice size of the sprinkler shall be 15mm with 15mm NPT thread type.
- The pipe size supplying one sprinkler shall be 25mm.
- Return bends shall be used for pendent type sprinklers to avoid accumulation of sediment in sprinklers except for dry pendent type sprinklers.
- Type, spacing, and position of sprinklers shall be as specified here under.
- Sprinklers located in skylight area shall be protected with approved sprinkler shield.
- Sprinklers so located as to be subject to mechanical injury shall be protected with approved sprinkler guard.
- All sidewall sprinklers and ceiling mounted pendent sprinklers shall be provided with escutcheons plates of the same colour as of the walls or ceiling on which the sprinklers are mounted.
- Sprinklers shall not be altered in any respect or have any type of ornamentation or coating applied after shipment from the place of sprinklers manufacturer.
- When painting the sprinkler piping or painting in areas near sprinklers, care shall be taken to avoid any coating applied to sprinklers.
- Any sprinklers that have been painted or coated except by the sprinklers manufacturer, or damaged shall be replaced with new approved sprinklers of the same characteristics. Cleaning of painted sprinklers, or repairing damaged sprinklers will not be permitted.
- The protection area per sprinkler shall not exceed 18 m² for light hazard occupancy.
- The protection area per sprinkler shall not exceed 12 m² for ordinary hazard occupancy.
- The protection area per sprinkler shall not exceed 9 m² for extra hazard occupancy.

10.09.2 Spacing, Location, and Position of sprinklers

All sprinklers shall be located and spaced as shown on the Contract drawings and in compliance with the following limitations.

A. Upright and Pendent Sprinklers

- The distance between branch lines and between sprinklers on the branch lines shall not exceed 4.6 m.
- The distance from the walls to the end sprinklers on the branch lines shall not exceed one-half of the allowable distance between sprinklers on the branch lines.
- The distance from the walls to the end branch lines shall not exceed one-half of the allowable distance between the branch lines.
- Sprinklers shall be located a minimum of 100 mm from a wall.
- A minimum clearance of 450 mm shall be maintained between top of storage and sprinkler deflector.
- Deflectors of sprinklers shall be parallel to ceilings and located 25 mm to 300 mm below ceilings.
- Deflectors of sprinklers under beams shall be located 25 mm. to 100 m below beams and not more than 500 mm below roof or floor deck.
- Deflectors of sprinklers in bays shall be at sufficient distance from the beams as shown on Table 4.4.1.3.1.2 and Figure 4.4.1.3.1.2 of NFPA 13-1991 to avoid obstruction to the sprinkler discharge pattern, otherwise the spacing of sprinklers on opposite sides of the beams shall be measured from the centerline of the beam and the distance shall not exceed one-half of the allowable distance between sprinklers.
- The operating elements of all sprinklers shall be located below the ceilings.
- Where sprinklers located in area containing piping, light fixtures, ducts, etc. which are likely to interfere with the proper distribution of water from sprinklers, the sprinklers should be so located or spaced that any interference is held to a minimum.

Sprinklers shall be installed beneath duct over 1.2 m wide unless sprinklers can be spaced in accordance with Table 4.4.1.3.1.2 of NFPA 13-1991.

B. Sidewall Sprinklers

- The distance between sprinklers on the branch lines shall not exceed 4.0 m.
- Deflectors of sprinklers shall be at a distance from walls and ceilings not more than 150 mm or less than 100 mm unless special construction arrangements make a different position advisable for prompt operation and effective distribution.

10.09.3 Sprinklers Specification

- All sprinklers shall be of k-factor 5.3-5.8 unless otherwise specified, and manufactured of brass finish pattern, frame, and deflector, except for dry pendent type which shall have chrome plated components.

- Sprinkler shall be integrated with sensitive glass bulb operated at the required temperature rating. Fusible element will not be accepted.
- Unless otherwise indicated on the drawings, all sprinklers shall have a temperature rating 68 C (155 F) with bulb color Red.
- Sprinklers having a temperature rating 93 C (200 F) shall have bulb color Green and white frame color.
- Corrosion - resistant coated sprinklers shall be installed where required.
- Sprinklers equipped with protection guards or shields shall be installed where required.

10.09.4 Sprinklers Types

A) Standard Pendent Sprinklers:

Sprinklers designed to be installed in such a way that the water stream is directed downwards against the deflector.

Pendent sprinklers shall be installed for all ceiling mounted sprinklers.

Standard Pendent sprinklers shall be marked SSP and shall be installed in Pendent position only.

B) Standard Upright Sprinklers:

Sprinklers designed to be installed in such a way that the water spray is directed Upwards against the deflector.

Upright sprinklers shall be installed in all areas containing exposed sprinklers piping.

Standard Upright sprinklers shall be marked SSU and shall installed in Upright position only.

C) Sidewall sprinklers:

Sprinklers having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling one quarter of a sphere with a small portion of the discharge directed at the wall behind the sprinkler.

All sidewall sprinklers shall be of quick-response extended coverage type with special extended directional and discharge patterns.

Sidewall sprinklers shall be installed horizontally and marked with SIDEWALL-TOP.

D) Dry Pendent Sprinklers:

Sprinklers for use in a pendent position in cold storage rooms. Patten, frame and deflector shall be manufactured of chrome-plated finish.

Return bends shall not be installed for dry pendent sprinklers.

10.10 FIELD ACCEPTANCE TESTS AND MAINTENANCE

10.10.1 General Requirements

The Contractor shall perform all tests including but not necessarily limited to the following:

- Flushing Test
- Hydrostatic testing of pipe network
- Testing of alarm valves
- Testing of sprinklers
- Testing of hose reels, fire hydrants and Siamese connection
- Maintenance inspection test

No part of any piping system shall be painted, covered or enclosed until it has been tested, inspected and accepted.

All tests shall be conducted in the presence of the Engineer, as directed by him and to his entire satisfaction.

The Contractor shall provide all labour, equipment, material, instruments, power and connections required to execute all testing, balancing and adjusting as directed.

All expense incurred by the testing shall be borne by the Contractor including the cost of repair or replacement of defective work, cost of restoring, repairing or replacing damaged work resulting from the tests and the cost of replacing defective or inadequate equipment and material all as directed by the Engineer.

10.10.2 Hydrostatic Testing of Pipe network

All piping systems including drainage piping shall be hydrostatically tested for ensuring complete tightness at not less than 16 bar pressure for 2 hours.

Systems can be tested as a whole or in sections to facilitate the progress of the work.

No part of any piping system shall be tested to a pressure less than the specified test pressure measured at the lowest point of the system.

Care shall be taken not to subject any equipment, apparatus or device to a pressure exceeding its prescribed test pressure as obtained from its name plate data or from manufacturer's published data. Pressure tests shall be applied before connecting piping to equipment. Relief valves, instruments, automatic air vents, and all devices that might be damaged by the test pressure shall be removed, disconnected or blanked off.

No pressure shall be applied against the closed gate of gate valves. All valves shall be in the open position but not completely back seated during testing. End valves shall be capped.

In testing flanged piping, temporary blank flanges shall be installed and firmly anchored to accommodate all developed end thrust.

All piping that can be damaged by end thrust developing from hydrostatic testing shall be properly anchored during testing especially at changes of direction.

The piping system to be tested shall be closed by plugging and blanking all openings in the system and filled slowly with water making sure to vent all entrapped air. Plugs shall be released temporarily to ensure that water has reached all parts of the system.

Pressure shall be applied to the system by means of a hand pump drawing from a water container.

The pump discharge shall be connected to the system through a globe valve, check valve and recently calibrated pressure gauge of suitable range to have the test pressure read in the middle of the range.

After the test pressure is reached, the pump shall be blocked off by closing the globe valve and the variations of pressure in the system monitored on the pressure gauge.

While the system is under pressure, a careful inspection shall be made of all pipes and joints and if any leaks in joints or evidence of defective pipe or fitting is disclosed the defective work shall be corrected immediately by replacing defective parts with new joints and materials. No make shift repairs or application of any repair compound will be permitted.

After the correction is made the pressure test shall be repeated until a completely tight system is ensured.

The test pressure shall be released slowly so as not to produce shocks and sudden contraction that might damage the piping.

10.10.3 Flushing Test

- All provisions shall be made to properly drain all parts of the system. Flushing test shall be performed for the fire fighting system.
- Flushing of each main pipe supplying branch lines of sprinkler system shall be made through the test connection installed at each alarm valve assembly and other test connections installed.

- Flushing of the risers shall be made through the hose reels.
- Additional drain connections shall be provided, where needed to perform the flushing test for all parts of the fire fighting system.

In any case if lines become plugged during the flushing test or flow test, piping must be dismantled and cleaned.

10.10.5 Test of sprinklers

Operating test of automatic sprinklers shall be performed in accordance with Civil Defence Department instructions and requirements.

All automatic sprinklers shall be replaced when the representative samples fail to meet test requirements.

10.10.6 Maintenance

The Contractor shall perform during maintenance period all weekly, monthly quarterly and annual inspections test and maintenance for the sprinkler system, in accordance with the requirements of NFPA 13 A-1987. Records shall be maintained on all work performed.

The Contractor shall submit to the Owner a copy of NFPA 13 A standards.

END OF SECTION

MECHANICAL WORKS

SECTION 11.00

SPECIALIST SERVICES MEDICAL GASES INSTALLATION

11.01 Scope of Works

The Works shall comprise the complete installation and setting to work of the specialist Services for Medical Gases Installations, as indicated on the Drawings and specified hereunder.

11.02 Medical Gases, Air and Vacuum

The medical gases installations shall comply in all respects. with the under mentioned Specifications and Hospital Technical Mararanda Nos. 2022 and standard specification C-11 issued by DHSS and accepted local standards of good health engineering services.

Medical Gases, Air and Vacuum are to be distributed throughout the Hospital complex to the outlets indicated on the Drawings. The Medical Gases Installation shall be installed in accordance with the following specifications.

11.07 Distribution Pipe System

a) **Extent of Pipework:**

The Contractor shall supply, install, connect up and test all the pipework and valves required from the supply source to the distribution terminals for each gas , air and vacuum system.

The pipe size and valve positions shall be as given on the Contract Drawings and test procedure as described later.

b) **Pipework Installation:**

1) **Fixing:**

All pipework shall be fixed without any springing or forcing.

A clearance of 150 mm. shall be maintained between the pipework and other services. Where pipework crosses other services a clearance of 25 mm. minimum shall be maintained.

2) **Gradients**

Gradients are not required on gas, air or vacuum pipelines.

3) **Drainage:**

MECHANICAL SPECIFICATION

A full bore drain cock shall be provided at the bottom of each main vertical run on the air and vacuum pipework and at low points on long horizontal runs.

4) **Diversion Sets**

The use of fittings for diversion sets shall not be permitted and the sets shall be formed from a long length in one piece and cold drawn or hot drawn in a neat manner without buckling or thinning.

5) **Routing to avoid Fire Risk Areas**

The routes of the pipework shall avoid fire risk areas including laundries, boiler houses, generator rooms, incinerator rooms, storage rooms for combustible materials (unless the pipes are to be cased), lift shafts and kitchens.

6) **Pipework Supports**

Pipework shall be supported in accordance to HTM 22, 2022 & C-11 Standards.

Where valves are fitted the pipe shall be supported at both sides of the valve to facilitate valve operation without pipe movement.

Fixing brackets or supports shall be of a suitable non-ferrous material suitably treated to minimize corrosion and prevent electrolytic action.

The Contractor shall drill and plug walls and ceilings as required to fasten the supports. Where roof decking is encountered, the Contractor shall provide cavity fixing devices to fasten the supports.

7) **Pipework in Floors, Walls, Ceilings:**

Pipework in rooms and corridors shall be concealed either behind ceiling panels, or in walls, ducts or trunking. Removable covers or panels shall be provided to allow access to pipework. Pipework

shall not be buried solidly in floors, walls or ceiling except with the approval of the Engineer. Approval will normally be given only for tail pipes in one piece for terminal unit to service duct or ceiling void and for unjointed pipes from control valve to void. The route of the buried pipe should be clearly and continuously marked by chalk, coloured adhesive tape or otherwise, during construction, discourage the driving of nails etc., into or near the pipe. Where pipes are to be installed in partition walls the tail pipes of terminal units shall be in one piece (without joint) from the terminal unit to the service duct or ceiling void. Service ducts or voids should have adequate ventilation to prevent gas concentration in the event of a leak.

Where pipes pass through floors, walls or partitions, copper pipe sleeves, one size larger, shall be built in by the Contractor. Sleeves shall project

MECHANICAL SPECIFICATION

between 1.5 and 3 mm. beyond finished surfaces and plates shall be fitted. All joints shall be accessible and no joints shall be made so that it is inside the pipe sleeve. In fire compartment walls the space between pipe and sleeve shall be sealed with a flexible fire resisting compound.

Where pipework is to be concealed it shall not be covered over until it has satisfactorily passed all pressure tests.

Pipework in service duct or voids, or in corridors where the pipework is not required to be concealed shall be surface run.

8) **Special Precautions against Corrosion:**

Where pipework is supported by or is liable to come into contact with timber that has been treated with compounds likely to cause corrosion of copper, the pipe shall be protected locally by impermeable materials such as PVC tape or spacers.

9) **Cleanliness during Installation:**

Great care shall be taken during installation to ensure that no extraneous materials are allowed to enter the pipework. Where any section of the pipework is left incomplete shall be sealed immediately with a plastic cap.

10) **Bonding and Earthing:**

Wherever possible, pipelines shall be physically separated from the metal sheath and armour of electric cables and from metal conduits, ducts, trunking and bars and earth continuity conductors associated with any cables which operate at low voltage or above.

Where physical separation is impossible or when pipelines are in metal trunking and bed head units, the pipelines shall be bonded to the metal work in accordance with the I.E.E. Regulations.

The entire pipework system for each service shall be earthed by bonding to the Consumer's Earth Terminal, in accordance with the I.E.E. Regulations.

The pipework at each zone service unit valve box shall be bonded on the downstream side of pressure valves and upstream of vacuum valves to the local electrical earth.

c) **Pipework Material and Size:**

1) **Material:**

Pipework material for gases, air and vacuum shall be phosphorous de-oxidised non-arsenical copper to BS.6017 Grade C106. In addition to BS.

MECHANICAL SPECIFICATION

2871 markings pipes shall be marked 'deg' or 'degreased' to represent compliance with clause 110.OOc).

2) **Sizes:**

Pipework sizes shall be to metric outside diameters in accordance with BS.2871, Part 1, Table X.

3) Pipes shall be cut with circular cutters (not hacksaws) to prevent ingress of particulate matter.

d) **Fittings Joints:**

1) **Fittings:**

All fittings shall be to BS.6017 grade C106 and manufactured to BS.864 Part 2 from phosphorous de-oxidised non arsenical copper.

2) **Fluxless Jointing Technique:**

Fluxless jointing with an inert gas shield shall be used in accordance with the D.H.S.S. Directive No . WKO (82) 1 dated 27/1/82 .

Copper-copper to BS.1845 and no flux

Copper to brass or gunmetal joints at factory shall utilize a silver brazing material type AG132 to AG18 to BS.1845 and flux as recommended by the manufacturer. The completed assembly shall

be cleaned and delivered to site in a sealed bag for compliance with clause 110.OOc).

3) **Inert Gas Shielding:**

On site fluxless jointing and hot forming of bends shall be performed only when the internal bore is charge with carbon dioxide or nitrogen to BS.4105.

Runs of pipework shall be jointed starting at the joint nearest to the cylinder and progressing to the remote end of the run. Cylinders shall be complete with pressure regulator and flow control device for normal use and high flow flush purge cycle.

The Contractor shall ventilate enclosed areas where a gas shield is being used to ensure that safe working is achieved. Where necessary detection and alarm systems shall be used to avoid potential hazards.

Shield gas cylinders delivered to site shall be recorded and the removal from site also recorded.

4) **Fittings:**

MECHANICAL SPECIFICATION

Fittings on moisture eliminators and trap sets for vacuum and compressed air shall be brass compression to fittings, or flanged fittings, as appropriate.

5) **Valve Joints Capillary or Screwed:**

Jointing of valve to the pipelines shall preferably be made with a capillary joint but the end feed method may be used if necessary and approved by the Engineer.

The finished joint will have to be cleaned in accordance with WKO (82)l.

Screwed joints shall be factory made using silver alloy. This shall be done with valves dismantled to avoid damage to internal parts and the same care shall be taken when making the capillary joint to the pipeline to ensure heat from the brazing operation does not damage diaphragms, seatings etc.

All parts of the valves shall be maintained in a degreased condition.

e) **Demonstration Joints:**

Every craftsman working on pipework jointing shall provide a sample joint on two sizes of pipework to demonstrate his competence before any site work is commenced.

Selected joints in the completed installation shall be cut out for checking and the installation reinstated at no extra cost.

Joints will be satisfactory when brazing alloy has penetrated a minimum of 4 mm at any point and the internal surface is clean and free of oxide.

f) **Jointing Methods:**

All site joints shall be brazed except connections to plant and equipment which may be screwed or flanged.

g) **Components Cleanliness and Protection:**

1) **Cleaning, Protection and Labelling:**

All pipework and fittings for Medical Gas, Air and Vacuum shall be cleaned at the manufacturer's works, the pipes shall be individually fitted with purpose made tightly fitting plastic caps or plugs to protect the bores before despatch to Site. Pipes shall be delivered in bundles in protective wrappings and fittings in sealed polythene bags, no capping required. Larger shall be wrapped and package in cartons.

The cartons, bundles and bags shall be securely and clearly labeled:

"Degreased Materials. For use on Medical Gas Installations."

MECHANICAL SPECIFICATION

The Contractor shall take great care in storing these materials and any materials contaminated while on Site shall be returned to the manufacturer for degreasing, at the expense of the Contractor.

2) **Degreasing Processes:**

The pipe shall be degreased internally by steam, then dried, shot-basted and blown through with medical quality air from cylinders. After a visual inspection each pipe shall be capped individually at both ends.

If steam cleaning is not economical, pipes above 54mm outside diameter may be alternatively cleaned using an approved solvent such as methyl chloride, which will leave no poisonous or explosive residues and the fittings may also be cleaned by this method. The pipes and fittings shall be dried out, inspected and capped or sealed, as specified later.

While the degreasing process is primarily concerned with the internal bore of pipes, care shall be taken to avoid oil or grease on the outside, as being a possible source of bore contamination.

h) **Valves on Distribution Pipework:**

The Contractor shall supply and fit valves at the positions shown on the Drawings and any deviation from these positions shall be agreed in writing by the Engineer.

1) **Valve Materials and Types:**

All valves shall be non-ferrous material and of the non-lubricated type, to the following details. They shall be capable of withdrawal without cutting of the pipework.

i) **Medical Gas Valves:**

| | |
|----------------|---------------------|
| Type | Ball - 90° shut-off |
| Bores | To suit line size |
| End Connection | To suit pipework |

ii) **Compressed Air Valves:**

| | |
|----------------|---------------------|
| Type | Ball - 90° shut-off |
| Bores | To suit line size |
| End Connection | To suit pipework |

iii) **Vacuum Valves Type**

| | |
|-------|--|
| Type | Ball/Diaphragm (diaphragm only as main pipeline valves) |
| Bores | To suit line size |

MECHANICAL SPECIFICATION

End Connection To suit pipework

Valves shall carry the manufacturers identification reference and size and be provided with locking facilities in the open or closed position.

2) **Direction of Valve Closure:**

Wheel head screw valves shall close in a clockwise direction. Lever Ball Valves shall close with a 90° clockwise turn. Wheel valves shall have the direction of closing indelibly cast or engraved on the wheel by means of an arrow and the word "CLOSE".

Lever ball valves shall have "ON"/"OFF" cast or engraved on to show when the valve is open or closed.

3) **Maker's Identification**

Each valve shall carry the manufacturer's serial numbers or identification or valve size.

4) **Pressure Testing and Degreasing:**

All valves shall be pneumatically tested by the manufacturers to twice the working pressure and afterwards degreased for medical gas services using a suitable method as given in (110.05) before being individually sealed in polythene bags. Capping or not required.

5) **Certificates:**

A certificate shall be supplied by the manufacturer for each valve or batch stating that pressure test and degreasing has been carried out and that any solvents have been completely removed.

i) **Pressure Regulating Valve Set**

Shall be capable of maintaining the indicated delivery pressure within ± 0.14 Bar of the valve setting up to the maximum flow rate of the system.

The delivery pipe lines shall be fitted with a self closing pressure relief valve to BS 6759: Part 2 of a type that can be locked or sealed and set to lift at a pressure related to the system and to comply with Specification C110.

The valves shall be of brass or bronze and be designed and degreased for medical gas use.

The relief valve shall have a flow of capacity at least equal to that of the pressure regulator immediately upstream of it. The discharge pipe shall be at least one size larger than the main pipe line. The discharge pipe shall be vented to atmosphere in an area where the discharge pipe will not create a hazard and where it is

MECHANICAL SPECIFICATION

not liable to unsure personnel and clear of any opening or air intake. The vent terminal shall be turned down and fitted with a fine gauge filter. A warning label shall be fitted adjacent to each discharge point.

j) **Area Valve and Service Units (AVSU) :**

1) **Location:**

The Contractor shall supply and install lockable special purpose valve boxes for all the medical gas, air and vacuum valves located outside manifold and plant rooms and not contained in ducts or ceiling voids.

2) **Purpose:**

The boxes shall render the valves tamper proof and shall have transparent breakable panels to facilitate emergency operation of the valve. The valve boxes shall incorporate a physical break facility and a gas specific NIST connector on the inlet and outlet side of the valve.

3) **Mounting Height:**

The valves shall serve both emergency and maintenance purposes and because of the former requirement the box and valve shall be mounted at a centre height of 1.22 metres above floor level in a position not obstructed in any way by other equipment. Boxes for different gases grouped together may be fixed one above another in which case the mean height is to be 1.22 m.

4) **Details:**

Valve shall be tested and certified for a working pressure of 18 Bar and shall be cleaned as clause 11 g).

A removable section upstream and downstream of the valve shall allow insertion of a blank plate for isolation of the pipelines. One blank plate for each valve shall be clearly visible when deployed.

N.I.S.T. connectors up and down stream of the blanking plates shall have self sealing check valves and captive screwed caps.

5) **Mounting Depth**

The boxes shall be set into the wall with any projection being kept to a minimum and surface mounted boxes shall be avoided if at all possible. The Contractor shall ascertain the nature of the wall into which the box will fit and shall provide a final fix bezel to conceal the wall joints.

6) **Standardized**

The design of box offered shall be of a standardized pattern throughout the installation and have the following features:

- i) Ease of access for fitting valve or maintenance.

MECHANICAL SPECIFICATION

- ii) Designed so that pipework can be fitted easily either by having a split box or other suitable method.
- iii) Ventilation to obviate a possible build up of gas in case of a leak.
- iv) Non-interchangeable keys so that a maintenance permit to work system is operated .
- v) Keys in duplicate.
- vi) Keys and locks with numbers engraved on.
- vii) Arrows indicating the direction of flow.
- viii) Breakable transparent panel (pull-out panel not acceptable).
- ix) Non-interchangeability of box covers if this could wrongly identify-covers to be highned on.
- x) Boxes shall accommodate one valve only ganging will not be permitted.

7) **Multiple AVSUs :**

Where two or more AVSUs are located together the individual boxes shall be enclosed in a common recessed housing complete with decorative front cover, pre connected pipework, alarm pressure sensors and local alarm panel. Each housing shall have a matching make up section extending to above ceiling level.

k) **Valves in Ducts or Ceiling Voids**

The valves shown on the Drawings in ducts or cupboards are intended for maintenance purposes only and are not required to be in valve boxes, providing the valves are lockable in the open and closed position. Suitable locking arrangements and duplicate non-interchangeable keys shall be provided so that such valves can be included in any permit to work scheme.

Care shall be taken not to install valves in cupboards or ducts which are poorly ventilated or in cupboards used for other materials which could be affected by leakages. Any pipe runs so situated shall be drawn to the attention of the Engineer before proceeding on Site.

j) **Identification of Valves:**

An engraved label of white "Traffolyte" or similar material shall be permanently fixed adjacent to each valve box to indicate the service and give the following information:

In Red letters:

Engraving Required:

1) Service

e.g. "OXYGEN"

MECHANICAL SPECIFICATION

- 2) Area Served e . g . "WARD 1"
- 3) Emergency Instructions e.g. "IN EMERGENCY BREAK AND CLOSE VALVE "

In Black Letters:

Valves e. g. "VALVE ABC 678"

This number is for maintenance purposes and is to be agreed later on Site.

Valves in ducts or cupboards shall be similarly identified except for emergency instructions.

The titles of area served shall be finally agreed on site and the labels shall be installed before the systems are tested and commissioned in order to prove their correctness.

k) **Terminal Units:**

1) **Extent of Work:**

The Contractor shall supply, install and connect to the distribution pipework all the terminal units required at the positions shown approximately on the Drawings.

This excludes rigid pendants which are covered under a separate section. See Section 110.07 110.07 (Sub-Clause a) for location of pendants.

2) **Definition:**

All terminal units shall be defined as a single outlet point for a specific gas and shall be a separate unit for that one gas only. The units shall comply with BS.5682: 1984 .

Each terminal unit shall be identified on a fixed bezel for the service connected.

3) **Fascia Plate:**

Multiple terminal units at one location may be housed under a common fascia plate but it shall not be possible to mount the fascia plate incorrectly and reverse or alter the identification of the services. The units shall be mounted on a common back plate to ensure accurate centering of the units and allow precise fitting of the fascia plate so that the probes enter freely:

Identification of the service shall not appear fascia plate.

4) **Mounting Order:**

The Terminal Units when viewed facing the units shall be mounted in the following order horizontally from left to right:

02. N20. MA4. H.P. AIR VAC. WAGE

5) **Type:**

The terminal units shall be either of the flush mounted type set into the wall or of the type to be mounted in bed head trunking as detailed on the drawings and described hereunder. The Contractor shall ensure proper liaison between the bedhead trunking manufacturer and the medical gases equipment supplier, with particular regard to the installation of tail pipes and outlets, and facia plates.

6) **Mounting Heights:**

The mounting height of the terminal units above floor level shall be as follows:

- i) For Flush Mounted Units 1.3 m. to centre of Unit.
- ii) For "Rail" System 1.5 m. to centre of Unit.

7) **Exact Positioning of Terminal Points:**

The exact positions of the terminal units relative to the beds, operating tables etc., shall be agreed with the engineer before installation commences.

Due regard shall be given to ensure that nursing staff can couple up equipment easily, that short routes for flexible pipes to apparatus can be achieved without obstructing movement of staff or equipment round the patient and that access to the units for maintenance is easy without disruption to patients or other services. Terminal outlets shall be located so that flow meters etc when plugged in are not obstructed other fittings.

8) **Essential Design Features of Units:**

Terminal Units shall be designed to incorporate the following features:

- i) The ability to accept, retain and release the inserted probe by means of a quick release mechanism designed for single-handed operation.
- ii) Valves:
 - A maintenance valve on the inlet to the unit which automatically closes to isolate when the socket assembly check unit is removed.
 - A self-sealing check valve which is opened by the probe and on withdrawal closes before secondary lock engages.

MECHANICAL SPECIFICATION

- iii) Non-swivel type terminal socket to probe connection so that secondary equipment such as a flow meter is not tilted during use. (Only on wall mounted units. Not on ceiling pendants).
- iv) The terminal socket and check valve shall only accept the correct probe for the specific "gas" and not allow interchangeability with or partial operation by probes for any other service.
- v) It shall not be possible to interchange the parts of a unit for one gas with those for a different gas and so enable a probe to be connected to the wrong position.
- vi) Fascia plates which are not marked with the name of the gas shall not be used unless the design is such that interchangeability of fascia plates between the different gas terminal units is impossible.
- vii) The front face round the terminal socket shall be exposed and shall carry "gas" name and colour.
- viii) Identification by shape-incorporation of the probe is not an essential feature but if adapted by the manufacturer the following shapes shall be used:

| Service | Shape |
|-------------------|---------------------|
| Oxygen | Hexagonal |
| Nitrous Oxide | Round |
| Medical Air 4 BAR | Round with one Flat |
| Medical Air 7 Bar | Round with one Flat |
| Medical Vacuum | Square |

- ix) The manufacturers and batch number.

9) **Identification Colours and Wording Units:**

The following names and colours shall apply:

| Service | Colour | Wording |
|--------------------|---------------|--------------------|
| Oxygen | White | Oxygen |
| Nitrous Oxide | French Blue | Nitrous Oxide |
| Medical Air 4 Bar | White & Black | Medical Air 4 Bar |
| Surgical Air 7 Bar | White & Black | Surgical Air 7 Bar |

MECHANICAL SPECIFICATION

| | | |
|----------------|------------------------|--------|
| Quarters | | |
| Medical Vacuum | Primrose BS. 10.E53 | Vacuum |

The name and colour shall be of a permanent method and it shall not be possible to transfer either to a different terminal.

The colour shall be of laminated plastic or other self coloured material and the words engraved in a contrasting colour.

Painting of the colour or wording is not permissible.

10) **Pressure Loss Across Terminal Units:**

The terminal Units shall be capable of passing the following flow rates without exceeding the stated pressure losses across the terminal units. (See following Table).

| Service | Nominal Gauge Pressure at back of Terminal Unit | Maximum Rate of Flow Req'd at This Pressure | | Maximum Permissible Loss across Terminal Unit | |
|--------------------|--|---|-------------------|---|-------|
| | Bar | p.s.i | Litre/min. at STP | Bar | p.s.i |
| Medical Gases | 3.9 | 57 | 40 | 0.034 | 0.5 |
| Nitrous Oxide/Oxy | 3.9 | 57 | 275 | 5.55 | 8 |
| Medical Air 4 Bar | 3.9 | 57 | 50 | 0.04 | 6 |
| Surgical Air 7 Bar | 6.9 | 100 | 350 | 0.34 | 5 |
| Medical Vacuum | Minus 400 mm. 40 | | | ⇐100mm. Hg ⇒ | |
| | Hg Below standard atmospheric pressure of 760 mm Hg. | | | | |

The above figures relate to the performance required of the terminals units.

11.09 Identification of Pipelines

a) **Permanent Identification:**

The Contractor shall carry identification of the installation(s) by colour coding in accordance with Data Sheet 10.11/12 and BS.1710 (1971).

The identification shall comprise:

MECHANICAL SPECIFICATION

- 1) Colour banding applied at valves, junctions, either side of walls, floors and at intervals of about 2 m. on short runs up to 4 m. on long straight runs.
- 2) The name of the service printed on colour band in a contrasting colour.
- 3) An arrow at each colour band showing direction of flow.

Letters to be minimum of 6 mm. high.

Self-adhesive plastic labels or tapes of approved manufacturer may be used as an alternative to painting.

Where valves are in valve boxes and identified by ' Traffolyte' labels, colour banding is not required.

b) **Temporary Identification:**

During installation of piping, individual pipes, valves junction and ends shall be identified as the work progresses. This identification shall be at intervals similar to final identification requirements and may be made with removable labels. These temporary identification labels must be subsequently replaced by the permanent ones at an appropriate stage.

11.10 Warning and Alarm System

a) **Extent of Work:**

The Contractor shall supply, install and commission the following Warning and Alarm System which shall be connected to BMS ,comprising a combination of flashing lights audible Alarm, generally as Listed on Schedule.

b) **Alarm Panel/Indicating Units:**

A Main Indicating Unit shall be installed in the Telephone Exchange to monitor all the services in one chained unit.

Sub-Units shall be installed in the following locations :

Sub-Units in at entrance of the departments are to be 2 lights/gas triggered by pressure switches located downstream of the main area valve.

The alarm panels shall have sheet steel cases with stoved enamel finish and lockable hinged access doors to all components. A fused connection unit (3 amp. fused) shall be provided adjacent to each panel to provide a 240 volts 50 Hz supply.

The panels and remote sensor etc. shall operate at extra low voltage .

Panels shall be designed for easy cleaning with no recesses or ledges to harbour dust and dirt.

MECHANICAL SPECIFICATION

Each panel shall incorporate a power pack comprising transformer, rectifier and battery designed to operate under alarm conditions for a period of not less than 4 hours after mains failure. The battery shall be of a type with average device shall be incorporated to prevent the system operating before the generator starts after power failure (i.e.20 seconds).

Alarm panels shall provide the visual and audible signals indicated on schedules 3/1 and 3/2.

The main alarm panels shall have interface facilities for multiplex signal transmission and reception. An interface unit with common alarm terminals for each services shall be provided to transmit alarm signals to the Building Management System (BMS).

Local alarm panels shall operate independently and shall have a single pair of contacts to transmit an alarm signal to the BMS Local panels, shall be provided as shown on drawings located by the AUSU.

c) **Electrical Power:**

Each alarm unit work on low voltage D.C. current stepped down from a 220 Volt single phase supply via a double wound earth screened transformer.

d) **Essential Features of Flashing Light Units:**

The Main Unit and Sub-Units shall be of similar construction and embody the following features:

- 1) A solid state electronic components .
- 2) Translucent coloured panels for each service engraved with the fault" or normal conditions .
- 3) Two L.E.D.s in duplex on a 'plug in' board behind each panels each panel.
- 4) A green panel to indicate that the unit is normal.
- 5) A standardized size and type of Lamp throughout the system.
- 6) Its suitable for rapid on/off flashing operation with long life.
- 7) A lamp test button on each unit to test the audible Warning and all lamps on the unit simultaneously.
- 8) Audible alarms as indicated in Schedule No. 2.
- 9) An muting switch operation of which will silence the a audible alarm and cause the lights to continue flashing. After 15 minutes the audible alarm shall again sound unless the fault has been rectified. A 'follow' on' alarm after the mute button has been rated shall re activate the alarm. After the 'fault ' has been recified all systems shall automatically return to ' normal'.

e) **Working of Main and Sub-Units- "Flashing" System"**

The units shall indicate the condition of all the monitored service simultaneously and for each service more than one panel may be indicated at a time.

The audible alarm on each unit shall be common to all the services and be arranged to re-set automatically after being muted, or if muting is not carried out, after the fault is rectified.

f) **Arrangement of Panels on Units:**

The order in which the services shall be arranged the panels shall be that adopted for terminal units :

When facing the panels the service shall be in the following order reading left to right:

11.12 Commission and Testing

a) **General Requirements:**

The Contractor shall allow for commissioning and testing of the complete installations generally in accordance with Commissioning Manual No.15 - "Medical Gases and Suction System" published by H.M.S.O. The Manual covers Pre-Commissioning Examinations and Tests, Commissioning Examinations and Tests and Handing Over Procedures. The Contractor shall satisfy himself that the installation is in all respects fit for use and conforms to the Specifications before inviting the Commissioning Engineer to witness the commissioning Tests. He shall do this by carrying out any pressure, flow-rate and anti-confusion tests necessary for that purpose.

b) **Test Equipment:**

The Contractor shall provide all test instruments listed in the commissioning.

Manual Sheet 15.1.7 and any other equipment not specifically listed but obviously necessary to carry out the tests.

In addition to the items listed, male probes shall also be provided for each installed gas, air or vacuum system, to operate the terminal units. The probes shall incorporate the anti-confusion identification shapes as given in Clause (110.06) of the Specifications or alternatively be marked with the "gas" name.

The accuracy of the test instruments shall be checked and certified by the Contractor to the reasonable satisfaction of the Engineer before any commissioning tests are carried out.

The Contractor shall also provide special "Flow Rate and Delivery Pressure Test Units" to check delivery at each terminal unit. The test units are to be as described on Schedules Nos. 3&8 and are calibrated to pass air equivalent to required "gas" flow rates.

MECHANICAL SPECIFICATION

The test units shall remain the property of the Contractor and not be chargeable to the Contract.

c) **Permit-toWork :**

On new installations a permit-to-work procedure will not be required.

d) **Pre-Test Examinations and Purge:**

1) **Pre-Test Examinations:**

In addition to the checks listed in D.H.S.S. Commissioning Manual 15 Sheets 15.2.6. it shall also be confirm that pipe diameters and mounting order of terminal units agree with Drawings and specifications.

2) **Pre-Test Purging of Pipework:**

Purge the pipelines with Medical Quality Cylinder Air at 8 bar (116 p.s.i.) gauge.

Gas used for purging at S.T.P. shall include impurities not in excess of:

Dry particulate - 0.01 mg/m³

Oil - 0.5 mg/m³ liquid aerosol and vapour)

Water - 115 mg/m³ dew points of 40° C at atmospheric pressure

Carbon Monoxide - 5.5 mg/m³ (Sppm) Carbon Dioxide - 900 mg/m³ (500 ppm)

This shall be done before Terminal Units are connected and before connections are made to main folds or plant. On no account shall industrial air be used for purging or tests.

All valves shall be fully open during the purging operations which shall continue for a sufficient length of time to ensure that pipes are clear.

If any excess materials are ejected from the pipework, or blockages are encountered, the pipework shall be dismantled and examined, at the Engineer's discretion.

e) **Pressure Testing of Distribution Pipework Valves:**

Pressure testing of the carcasing should be carried out before manifolds and theatre fittings are connected and before the "working parts" of the terminal unit are fitted:

1) Open fully all valves on distribution pipework.

2) Connect cylinder of Medical Quality Air to the System. Points of connection as in Clause (110.03).

3) All the systems may be under test at the same time if thought expedient and safe, additional cylinders to be provided.

MECHANICAL SPECIFICATION

- 4) The air test pressure to the pipelines shall be controlled as follows:
 - i) For Medical Gases, at 10.5 bars (150 p.s.i.) gauge for systems working at (4.14) bars (60 p.s.i.) gauge.
 - ii) For Compressed Air, at 10.5 bars (150 p.s.i.) gauge for all system.
 - iii) For Vacuum, at 6.9 bars (100 p.s.i.) gauge.
- 5) The system(s) shall be fully charged with air and the cylinder valve then closed and cylinder disconnected.
- 6) The test pressure shall be held for 24 hours.
- 7) Leakage shall be detected by means of soap solution applied to joints, valves etc.
- 8) All leaks shall be rectified and test repeated until the pressure can be held for 24 hours.
- 9) Ultrasonic leak detectors may be used instead of the method described in 7.

f) **Checking Valves for Internal Gas Tightness:**

All valves on the systems shall be checked for internal " gas tightness ".

With the pipeline full of air at the test pressure, commence at the terminal unit end, close each valve in sequence and release the pressure on the downstream side. Leaks should occur during a 15 minute test period on each valve.

g) **Testing of Relief Valve Settings:**

Before pressure tests on the pipelines are started, safety relief valves should be removed and outlets blanked off. After completing pressure tests, re-fit relief valves and test with air at 125% of normal pipe working pressure at which point the valve should discharge.

h) **Pressure Testing of Complete Installation (s):**

On completion of all previous tests, each system shall be finally tested using air at the nominal working pressure of the system and with all terminal units and theatre fittings connected:

- 1) Open main isolating valves between manifold or plant and distribution pipework.
- 2) Open isolating valves on terminal units and special fittings.
- 3) Open all valves on distribution pipework.

MECHANICAL SPECIFICATION

- 4) On Manifold Systems, connect cylinder of medical quality air to the manifold and test at working pressure for 24 hour period during which a leakage of up to 2 p.s.i. is allowed.
 - 5) On Compressed Air Plant installations, use the compressors to charge the system and test for 24 hours as above.
 - 6) On Vacuum System, connect cylinder of medical quality air to position as in Clause (110.03) Sub-Clause in plant room and test at 0.7 bar (10 p.s.i.) gauge for 24 hours as above.
 - 7) The Vacuum System shall then be subjected to a vacuum test using the pumps to exhaust down to 550 mm. Hg gauge (210 Hg absolute). With the pumps switched off and the Vacuum Plant isolated, the pressure shall not rise more than 10 mm. Hg in one hour and the test shall be held for 24 hours. If the pressure rise is exceeded the system shall be checked for leakage and after rectifying re-tested until the pressure loss can be held within the limit specified.
 - 8) The correct operation of any reducing valves on the systems shall be checked during these tests.
 - 9) During the above pressure tests, once the system are fully charged with air the valves at the source of supply shall be closed.
- j) Testing for correct connections throughout the installation (Anti-Confusion Test) and correct valve zoning:
- 1) **Checking for correct Pipework Connection (Anti-Confusion Test):**
 - i) Connect pipework to terminal units and manifolds or plant.
 - ii) Ensure that all valves are fully open at the same time on all the installed pipework and terminal units.
 - iii) Ensure that all valves isolating plant or manifold from pipelines are closed.
 - iv) Connect cylinder of medical quality air regulated to the Oxygen system designed working pressure to the Oxygen system and by means of an oxygen probe check that air is being delivered to every oxygen terminal unit or special fitting. At the same time using probes for the other gases, air and vacuum Prove that air is not being delivered to these positions. The air shall be introduced into the system at the following positions:

or Oxygen connect into standby.

For compressor plant connect into standby manifold.

For vacuum connect into position behind main isolating valve throughout specially provided valve.

MECHANICAL SPECIFICATION

Special adaptors or probes shall be provided by the Contractor as necessary to allow air cylinders to be connected to the different "gas" connections.

- v) The results of these tests shall be recorded for each terminal unit in the form of Schedule 10.

2) **Check for Correct Valve Zone Control:**

On proving that all Oxygen pipelines are connected to correct positions follow by checking that all isolating valves on the oxygen system actually control the department or area specified on the valve label and shown not the Contract Drawings :

- i) Close the valve being checked.
- ii) Release downstream air through oxygen terminal units.
- iii) Check for non delivery of air through each oxygen terminal unit to be isolated the valve.
- iv) Ensure that valves are reopened after these tests.

3) **Repeat Tests for Other "Gases":**

- i) Disconnect air cylinder from Oxygen system.
- ii) Release air from oxygen system.
- iii) Repeat tests in Clause (110.10) Item 1 and 2 for other gases, air and vacuum. In each case a cylinder of medical quality air is connected to the system and regulated to the system working pressure for the pressure gas installations and at a gauge reassurance of 0.7 bar (10 p.s.i.) for vacuum installations.
- iv) During each test, check all other terminal units for non-delivery of air. This shall include checking all include service outlets such as town gas, etc., which follow the same route the medical gas systems.

The Contractor shall ensure that all valves on these services remain fully open during the tests and the supply is cut off or disconnected so that any cross connections to medical gas pipes are discovered.

4) **Rectifying Errors:**

The Contractor shall rectify any cross-connections or wrong valve zoning as soon as discovered, without proceeding any further with tests. At the same time, the Contractor shall ensure that pipe diameters and identification is correct in such cases. The whole test procedure shall then be gone through again commencing at the beginning. All rectification work shall be carried out at no extra cost to the Client.

MECHANICAL SPECIFICATION

During the tests any leakages shall be rectified or noted for future attention, although these tests are not intended to prove soundness.

k) **Checking Flow Rates Delivery Pressures:**

1) **Test Requirements**

Two separate tests, with quite different purposes are involved. Test 1 is to ensure that each terminal unit is capable of providing the flow and pressure for which it is designed. Test 2 is to ensure that the whole installation is capable of providing the flow for which the installation is designed, while at the rate of flow the pressure at the terminal unit should be not less than the design pressure.

Both tests shall be carried out using Test Units described in Clause (110.10) Item 3) and 4).

2) **Test Gasses and Pressures:**

The actual working gases shall not be for these tests. The pressure in the distribution pipework after the reducing valves for these tests shall be as follows:

For manifold systems or oxygen from plant use medical quality air at (4.14) bars (60 p.s.i) gauge +/- 0.14 bar (2 p.s.i)

For compressed airplant use the plant to provide air at 7.2 bars (105 p.s.i.) gauge +/- 0.17 bar (2.5 p.s.i.).

For vacuum use the plant to provide 400 mm. Hg gauge at the back of the terminal units.

The supply of air or vacuum shall not be cut off during the tests.

3) **Test 1 Test of Flow Rate at Each Terminal Unit:**

One test unit, of appropriate rating with pressure gauge attached, shall be connected into each terminal unit in turn and the flows shall not be less than that given in the following Table:

| | | | |
|-------------------|---|-----|-------------|
| Oxygen | : | 40 | litres/min |
| Nitrous Oxide | : | 15 | litres/min. |
| Surgical Air | : | 350 | litres/min. |
| Medical Air 4 Bar | : | 50 | litres.min. |

While this test is being conducted each terminal unit shall be superficially examined for any mechanical defect. No leakage should occur with the probe inserted or removed. It must not be possible to insert any probe other than that for which the terminal unit is designed.

4) **Test 2 Total Flow Rate and Delivery Pressure Test:**

The appropriate total number and size of test units without pressure gauges should be connected simultaneously into representative terminal units distributed over the whole installation.

The Contractor should then check the terminal unit pressure at vulnerable or representative points as directed. This should be done by substituting for the ordinary test unit one incorporating a pressure gauge. The pressure indicated shall not be less than that given in the following table.

All terminal units and special fittings shall be tested as above, to the satisfaction of the Engineer.

Note:

If, during the tests, the test gauge pressure is not below the figures given, the required conditions will normally be met in practice, because of the reservoir capacity of the pipeline itself.

| Service | Flow Rate Litres/min. at Back of at S.T.P. | Maximum Gauge Pressure | | Acceptable Pressure on Gauge of Remarks Test Unit | |
|------------------------|--|------------------------------|-------|--|-------|
| | | Terminal Unit | | | |
| | | bar | p.s.i | bar | p.s.i |
| Medical Gases | 40/20/15 | 3.9 | 57 | 3.9 | 56.5 |
| Medical Compressed Air | 250 | 6.9 | 6.6 | 95 (See note below) | |
| Medical Compressed Air | 65/50 | 6.9 | 100 | 6.8 | 99 |
| Medical Compressed Air | 65/50 | 3.9 | 57 | 3.9 | 56 |
| Medical Vacuum | 40/20 | 40 mm. Hg | | 300mm. Hg mm. | |

n) **Signaling System Tests:**

The whole of the alarm signalling system shall be tested by simulating all the fault conditions appropriate to the system installed.

Check that all items have been correctly installed.

MECHANICAL SPECIFICATION

Check that visual and audible alarms operate correctly at the required positions and can be seen and heard distinctly.

Check that muting switches operate correctly.

Check lamp test system and " system alarm" circuits .

Check that indicating panels and switches are marked up correctly.

Repeat signals to the BMS system shall be checked for correct indication.

o) **Purging Medical Gas System with working gas :**

Upon completion of all tests using air, Medical Gas System shall be charged with "working" gas.

This may be arranged to be done a short while before hand over so that gases are left standing in system which may not be used for some time.

The initial full complement of cylinders for each gas as specified previously shall be connected to the manifolds.

The Contractor shall demonstrate during this stage of commissioning that all tail pipe connections are correct and that the support racks are suitable.

The operation of nonreturn valves on the manifold at the tail pipe connection and flow of gas from each position shall be proved isolating all cylinders but one and checking that gas pressure is maintained by this cylinder. The test shall be repeated for each cylinder in turn.

The systems shall then be purged with the gases and the discharge temporarily piped to a suitable safe position outdoors via flexible lengths of hose with probes to operate the terminal units.

The working gas may be introduced either from the manifold or plant supply, or through the three valve arrangement from cylinders if these valves have been provided.

p) **Checking of gases and air at terminal units:**

The Contractor shall demonstrate to the satisfaction of the Engineer the acceptability of the gases or air delivered from the terminal units or special fittings.

- 1) For medical gases this shall identify that the correct gas is being delivered to the correct terminal positions.
- 2) For medical air supplied from cylinders this shall identify that air is being delivered to the correct terminal positions.
- 3) For medical air supplied by compressor plant this shall identify that air is being delivered to the correct terminal positions and prove that the air is dry to requirements of paragraph 110.03 Sub-Clause f), Item (10) and

MECHANICAL SPECIFICATION

pure to the requirements of 110.03 Sub-Clause f), Item (12). The Contractor shall provide all apparatus or instruments to carry out the above checks.

q) **Witnessing of tests and hand-over meeting:**

All the foregoing tests shall be satisfactorily carried out by the Contractor and witnessed by the Engineer before the systems are demonstrated by the Owner at the handover meeting. When each system has been approved and accepted by the Owner, Schedule 9 should be jointly signed by the Engineer and the Owner, and retained as a permanent record.

r) **Pressure variation during tests:**

It should be noted that variations in temperature will have an effect on the pressure during tests, in accordance with the gas laws.

This should be taken into account when taking pressure readings, for example a pressure drop due to a temperature drop and not a leak and conversely a leak may not be apparent if the temperature has increased.

END OF SECTION

MECHANICAL WORKS

SECTION 14.00

SANITARY FIXTURES

14.01 GENERAL REQUIREMENTS

The Contractor shall furnish and install all the sanitary fixtures as shown on the Drawings and as specified below, complete with all their trim and accessories as specified..

Sanitary fixtures shall be of vitreous china to BS 3402, unless otherwise specified and of colour as specified. Fixtures shall have smooth glazed surface free from warp, cracks, flaws, discolouration or other imperfections. Imperfect fixtures will not be accepted.

Sanitary fixtures shall be supplied complete with all required metal trim and accessories, as specified, including but not necessarily limited to faucets, wastes, traps, supplies, stop valves, wall flanges, hangers, plates, brackets, anchors, supports, soap holders, toilet paper holders, etc.

All exposed piping and metal trim for the sanitary fixtures shall be chrome plated brass to BS 5750 Part(1) with polished finish.

All vitreous china accessories shall match the sanitary fixtures and shall be of the same manufacture and colour.

All sanitary fixtures, trim and accessories shall be the product of a reputable and approved manufacture and as far as practicable shall be procured from one manufacturer unless specified otherwise.

Sanitary fixtures and their trim and accessories shall be installed in a neat, finished and uniform manner as directed by the Engineer. They shall be set straight and true and securely attached to the supporting surfaces. Roughing shall be accurately laid out to conform with finished walls and floors .

The colour of sanitary fixtures shall be white for all fixtures unless other wise directed by the architect.

Sanitary fixtures shall be connected to the drain and water supply pipes in an approved gastight and watertight manner and as detailed on the Drawings.

Strap or padded wrenches shall be used on chrome plated pipe, fittings, valves and other trim.

Sanitary fixtures, metal trim and accessories shall be thoroughly cleaned of labels, plaster, paint droppings and all foreign matter and shall be well polished and tested for perfect working condition before turning them over to the Employer.

Concealed brackets, hangers and plates shall be painted as directed by the Engineer.

The Contractor shall submit to the Engineer a list of all fixtures, trim and accessories that he proposes to use indicating manufacturer, type and model number, with descriptive catalogues clearly marked as to the item proposed.

The Contractor shall submit samples of all fixtures, trim and accessories when asked to do so by the Engineer. The Contractor shall not charge the Employer with the cost of such samples nor shall he use any item different from the approved sample.

14.02 WATER CLOSET

A. Wall Hung-Horizontal Flow

White vitreous china, W.C bowl with horizontal outlet complete with the following trim and accessories:

- Seat and cover with bottom fix stainless steel hinges.
- Supporting brackets and bolts for bowl.
- .
- DAL flushing system for concealed installation including 410 x 510 x 115mm cistem 6-9 liter flush volume interruptible flush cycle of polyethylene with angle stop valve 15mm dia. inlet from top or back insulated against condensation. Complete with fixing brackets, flush pipe and styrofoam protecting block 45mm, and with wall plate.

14.04 SHOWER TRAY

The shower tray shall be made of white vitreous china 700x700 mm. shower tray with anti-slip base and 15 mm. wall height, complete with the following trim and accessories, chrome plated waste, and built-in single lever shower mixer 15 mm. with shower head, shower arm, handspray assembly and Diverter.

14.07 WASH BASIN

A. Normal Wash Basin (Wall Mounted)

White, vitreous china, semi-pedestal with overflow and single hole faucet, dimensions: 600 x 500mm complete with the following trim and accessories or approved equal:

- One hole single lever mixer.
- Pop-up waste fitting.
- Chrome plated trap 32 mm dia.
- Two angle valves with escutcheon and copper tube flexible connections.
- Soap dish of stainless steel.
- Wall brackets.

B. Medical Wash Basin

Medical wash basin shall be wall mounted white vitreous china. The overall dimension shall be 590 mm wide, and 440 mm deep. It shall be complete wall mounted mixer, pedal action 15 mm with swivel nozzle and divided flow, mixer fitting chrome plated grid waste 32 mm and all fixing material.

END OF SECTION

MECHANICAL WORKS

SECTION 15.00

ABOVE GROUND DRAINAGE INSTALLATIONS

15.01 GENERAL DESCRIPTION

The work under this section of the specifications shall include all above ground drainage pipework waste, soil, and rain water, complete with all drains, traps, gullies, clean-outs, vents and all accessories, as shown on the drawings and as specified hereafter.

The above ground drainage pipes shall mean all pipework inside buildings and located as follows:-

- Above floor slab
- Under tiles
- In walls
- At high level or low level exposed or concealed
- All vertical pipes (risers)

15.02 PIPEWORK-GENERAL

The pipes and fittings used for above ground drainage installations shall unplasticised polyvinyl chloride HDPE and shall conform BS 4514 and BS 5255.

All change in direction in drainage pipes shall be gradual and not abrupt.

Long sweep fittings and 45-degree fittings, of solvent weld sockets type shall be used.

All pipes shall be plain ended lengths for solvent weld or seal ring connection to all fittings.

Slope of horizontal pipes shall be not less than 1% and not more than 3%.

All pipe jointing and supporting shall be made as recommended by the pipes manufacturer.

All pipes and fittings including adapters, couplings and connectors shall be supplied by the same manufacturer and marked with the manufacturer name, BS. number and diameter.

All pipes and fittings which serves areas of hot effluent waste water such as kitchens, laundries, and CSSD of cast iron to BS 416 or ANSI/A21 spigot or hubless type.

Hubless cast iron system for waste and soil pipe and fittings shall utilize a sleeve-types coupling device consisting of an internally ripped elastomeric sealing gasket with a protective corrugated stainless steel shield by stainless steel bands with stainless steel tightening devices.

15.03 JOINTS AND CONNECTORS

All joints for above ground drainage pipework, except for expansion joints, shall be made by solvent weld jointing, using the solvent weld cement as recommended by the manufacturer.

Solvent weld socket shall be used to connect two lengths of pipes.

Seal ring coupling (expansion joint) fitted with black rubber seal ring shall be provided for each vertical pipe (not embedded) located between every two floors, and for horizontal pipes (not embedded) at 4.0 m. intervals. The conversion from solvent weld joint pipe to seal ring expansion joints shall be made by adding seal ring adapters.

The connection of HDPE pipes to all water closets shall be made by WC-connector with solvent weld socket and pan seal socket.

Special HDPE connectors and adapters shall be used for connecting the pipes with dissimilar material of other pipes or fittings such as bottle traps, P-traps of plumbing fixtures.

The coupling assembly of cast iron pipes consists of a stainless steel shield, band and tightening device, and a neoprene gasket, assembled at the factory as a complete unit.

All HDPE pipes which penetrate slabs between two different one hour fire zones, shall be fitted with fire protection seals. Such seals shall comprise of sheet metal collars containing an intumescent material which expands rapidly when subjected to intense heat.

The connection between vertical pipes and under-ground pipes shall be made by long radius sockets bend fitted with rubber seal rings.

All hangers and supports shall be of approved types, as recommended by the pipes manufacturer.

15.04 WATER PROOFING

Where HDPE pipes pass through roofs, they shall be provided with HDPE weathering apron and slate to make watertight seal around the pipes at roof level.

The method of water proofing shall be made as per the manufacturer instructions.

15.05 CLEANOUTS

- Cleanouts shall be installed, to provide access to waste and soil pipes for inspection or cleaning. All cleanouts types shall be HDPE.
- Cleanouts shall be provided as shown on the drawings, at or near the foot of every vertical stack and no long horizontal pipe runs at every 15 meter intervals.

- Cleanouts on horizontal pipes (not buried) shall be HDPE access cap solvent weld to any socketed fitting fitted with screw cap and washer complete with PTFE tape to seal thread.
- Cleanouts on horizontal and vertical pipes (not fitted to the fittings), shall be made by access pipe with 75 mm. diameter, opening for access and sealed with screwed cover.
- All fittings used for the connection between horizontal pipe and vertical pipe (not buried) shall be fitted with access doors secured by two zinc plated screws and captive nuts.

15.06 FLOOR DRAIN – TYPE (FD)

The floor drain type (FD) shall be HDPE trapped floor gully with 110mm. dia. top socket, three side inlet sockets, and one 75 mm. dia. outlet socket equipped with screwed plug for rodding.

Each side inlet socket shall be 50 mm. dia. blanked off and must be cut out of inlet used.

The top socket shall be fitted with 110 mm. dia. raising piece with a 150 mm. square top to suit standard floor tiles, together with a snap-in cover that provides channel for disposal of surface water.

15.07 FLOOR DRAIN -TYPE (FD-1)

Floor drains type (FD-1) shall consist of 100 mm. dia. HDPE p-trap, stainless steel strainer size 200 x 200 mm and connecting pipe piece between p-trap and strainer.

15.10 ROOF VENT COWL -TYPE (RVC)

Roof vent cowl shall be provided for all vent pipes as shown on the drawings.

Roof vent cowl shall be HDPE with screened cap and connected to the vent pipe by solvent welding.

15.11 TESTING

The work shall be inspected and tested during installation.

All work which will be concealed shall be tested before it is finally enclosed.

A final test shall be made upon completion of the work for soundness and performance in accordance with BS 5572: 1978 Code of practice for Sanitary Pipework.

END OF SECTION

MECHANICAL WORKS

SECTION 16.00

BELOW GROUND DRAINAGE INSTALLATIONS

16.01 GENERAL DESCRIPTION

The work under this section of the specifications shall include all underground drainage pipework complete with gullies, traps, cleanouts, manholes, and all accessories, as shown on the drawings.

Below ground drainage pipework shall mean all pipework located under ground floor slab inside buildings and all external pipe network.

16.02 PIPEWORK - GENERAL

The pipes and fittings shall be unplasticised polyvinyl chloride UPVC.

Pipe shall conform to Israeli Standard

Pipes and fittings shall be manufactured with polypropylene seal retaining caps.

All joints for below ground pipework shall be made by seal ring expansion joint.

16.03 PIPEWORK - INSTALLATIONS

1. EXCAVATION

All excavations shall be formed with vertical sides and of not greater dimensions than stated in this specifications, with allowance for timbering, shuttering or other necessary temporary work.

Excavation beyond these dimensions for any convenience of the contractor will not be permitted and should any excavation exceed the width or depth stated, to the detriment of the support or foundation of any of the works, the contractor shall refill such extra with C7.5P concrete or as directed at his own cost.

The sides of trenches, manholes and other excavations shall be adequately supported at all times.

Any material excavated in forming pipe drains shall, if found unsuitable, be run to spoil and replaced with suitable approved material. All suitable excavated material shall be used as backfill except in French drains.

Timber, sheeting, piling, struts, wallings and bracings may only be left in the excavations if so directed.

The formations of all excavations are to be cut and trimmed to the exact lines, levels and depths as shown on the drawings, or to such other lines, levels or depths as directed.

MECHANICAL SPECIFICATION

Where a concrete or granular bed or surround is required to the pipeline , manhole etc, the excavation shall be taken out to the overall dimensions of the bed or surround. The sides of the trench shall be vertical with no undercutting.

Where pipelines are to be laid pipe on granular bed the concrete fill to over-excavation shall be shuttered to provide the trench width specified , up to 300mm above the barrel of the pipe.

Where pipes are to be laid at or below existing ground level underfill, and there is less than 1.2m of existing ground above the pipe crown, the fill shall be completed to a depth of 1.2m above the crown of the pipe , and the trenches excavated in fill material for such pipelines and associated structures.

Soft spots shall be removed from the bottom of the trenches and other excavations, which shall then be refilled to formation level with the same material and compaction as the permanent work, which is to rest on their formation. Any void which results from over excavations below formation level shall refilled in the same manner.

All excavations shall be cleared of water both by day and by night, and shall be shaped to prevent any accumulation of water either in or adjoining the excavation or the spoil therefrom.

Sumps shall be constructed and maintained clear of all excavations for permanent works, so that water at all times must be kept below any permanent works in the course of construction.

Ground water and water arising from construction shall be maintained away and not permitted to enter the permanent drainage systems.

Excavated materials which is suitable for use as a backfill shall be adequately protected to maintain its suitability for reuse.

Excavated materials or any other materials shall be placed at as safe distance from the excavation and shall not be placed closer than a horizontal distance equal to the depth of the excavation, unless suitable working and safe arrangements are made.

2. SUPPORTS FOR EXCAVATIONS

All excavations shall be supported and secured to ensure the proper execution of the works and to prevent any settlement of the adjoining ground or structures thereon.

Systems of timbering using poling boards, runner or steel trench sheeting shall be used according to the ground conditions and shall be designed to prevent loss of ground during excavation and to ensure that backfilling can be carried out in accordance with the requirements, leaving no voids.

3. TRENCH WIDTHS (EXCLUDING LAND DRAINS)

From the bottom of the trench to a level 300mm above the crown of the pipe, trench widths shall not be less than the minimum nor greater than the maximum figures shown in the table below.

| Pipe Nominal Diameter | Minimum Trench Width | Maximum Trench Width |
|-----------------------|----------------------|----------------------|
|-----------------------|----------------------|----------------------|

MECHANICAL SPECIFICATION

| (mm) | (mm) | (mm) |
|------|------|------|
| 100 | 450 | 525 |
| 150 | 490 | 600 |
| 225 | 580 | 700 |
| 300 | 680 | 750 |
| 375 | 950 | 1050 |
| 450 | 1030 | 1150 |
| 525 | 1120 | 1200 |
| 600 | 1240 | 1350 |

Irregularities and overbreak shall, unless otherwise agreed prior to the commencement of permanent work, be made good to the correct dimensions with concrete as specified.

4. DRAINAGE PIPE LAYING

A. GENERAL

The installation of pipework shall be carried out in accordance with the requirements and recommendations of Israeli standards unless more stringent requirements are stated in this specifications..

Before the commencement of the pipe layouts, the position and level of the drains or sewer to which it is proposed to make a connection shall be confirmed, if necessary by excavation.

B. LEVELS

All pipes shall be laid truly straight lines in directions and gradient between manholes, rodding eyes access chambers.. etc. Bends shall be provided where shown on drawings and, in the event of any variations in the position of any manhole of the line of the sewer being considered necessary, the works shall be constructed as directed,

The allowance on given invert levels shall be $\pm 5\text{mm}$ provided that the as laid gradient of the pipes runs between successive given invert levels shall not vary by more than 10% from that shown on drawings and provided that the relative level differences between pipes in an individual installation are maintained. The plan setting out shall be within $\pm 5\text{mm}$ of the drawing dimensions.

Pipes shall be laid within the whole of the barrel of the pipes evenly and solidly supported by bedding materials, with shaped holes in the receive the socket. After making the joint, the bedding material shall be carefully packed around the joint to fill the void in the bed left joints.

Hard packings shall not be used as permanent or temporary pipe supports; nor shall pipe spigots be permitted to bear on socket inverts in such a manner as to produce uneven pressure on the joints.

Notwithstanding the flexibility provided in the pipe joints, pipes must be securely positioned to prevent movement during and after the making of the joint.

The space between the end of the spigot and the shoulder of the socket of flexibly jointed pipes when jointed shall as recommended by the manufacturer..

MECHANICAL SPECIFICATION

Joints shall be made strictly in accordance with the manufacturer's instructions, using the technical advisory services offered by the manufacturer for instructing the pipe joiners in the methods of assembling joints. Where manufacturer recommend the use of special jointing tackles, these shall be used for the assembly of all joints to pipes,

C. PROTECTION

Immediately after flexibly jointed socket and spigot pipes have been tested, the gaps between barrels of the pipes and the internal face of the socket shall be sealed with puddle clay or other suitable flexible materials to prevent the ingress of the bedding and fill materials.

All pipe end which are left open during the contract shall be temporarily fitted with propriety end caps as supplied by pipes manufacturer, Where these are not available , expanding stoppers shall be used. Adequate precautions shall be taken to prevent floatation of the pipeline.

Pipes shall not be buried at less than 600 mm. below finished grade for protection against mechanical damage.

Pipes shall not be run closer than 1 m. to building bearing walls and footings for protection against building settlement.

Pipes shall be kept clean until final acceptance of the work. Exposed ends of all incompletd lines shall be closed with wooden plugs and adequately secured at all times when pipe laying is not actually in progress.

Pipes shall be installed on a good foundation and adequate means taken to prevent settlement. Pipes laid in trenches shall be provided with a solid uniform bearing throughout the entire length.

D. DRAINAGE THROUGH STRUCTURE AND MANHOLE WALLS

There shall be two flexible joints at each point, where the pipe lines is built into and supported by the structure or manhole/instructions, positioned at 150mm and 750mm from the face of the structure.

E. DRAINAGE UNDER BUILDING

Where drain trenches are to be excavated beneath foundations or below the level of adjacent foundations, the sides of the excavation shall be supported by such substantial planking and strutting as steel trench sheeting driven plumb in advance of the excavation proceeding. The trench sheeting shall be carefully withdrawn after compaction of the backfill material so as to cause the minimum disturbance to the backfill and adjacent ground.

Where the top of a pipe of equal to or less than 150mm diameter is within 300mm of the underside of a concrete slab or footing, the pipe shall be bedded and surrounded in 200mm of canned concrete.

F. DRAINAGE THROUGH STRUCTURE AND MANHOLE WALLS

MECHANICAL SPECIFICATION

There shall be two flexible joints at each point where the pipe lines is built into and supported by the structure or manhole/instructions, positioned at 150mm and 750mm from the face of the structure.

Where conditions necessitate that the drop would exceed 450 mm. at the maximum slope of 3%, a drop manhole shall be used, of detail as shown on the drawings.

All joints shall be inspected and an inspection of the lines as a whole shall show all pipes to be true to line and grade with full moon circle visible at the manholes.

If an inspection of the completed sewer or any part thereof shows any structures, pipes or joints which are defective, the defective work shall be replaced or repaired as directed.

G. SUB-SOIL DRAINAGE

Subsoil drainage pipe work shall extended around the buildings and in the site green beds to effectively drain the exceeded water tables levels and remove subsoil moisture.

Subsoil drainage shall be made using open jointed, porous, or perforated pipes.

The main pipes should be of 100mm bore and the branch pipes shall be of 75mm bore.

The pipes shall be laid at between 600mm to 900mm in heavy soils, and deeper in light soils and the gradient rather by the fall of the land than by consideration of self cleansing velocity.

Subsoil water shall be discharged into soakaway pit or through a catch basin into the nearest ditch or into a surface water drainage system.

16.04 BEDDING AND SURROUNDING OF PIPES BENEATH BUILDING

- a. All pipes shall be bedded on 20 N/mm. concrete and shall be supported at the concrete cradles placed behind the sockets or on each side of the joint by methods approved by the Engineer. The supports shall be provided with soft contact padding such as roofing felt or other approved material.
- b. The annular gaps in flexible joints shall be sealed with approved means to prevent the intrusion of concrete. The pipes to be in contact with concrete shall be washed clean of any mud or clay.
- c. Concrete shall be gently and evenly placed over the entire width of the trench of bedding as shown on the drawings, and to within 25 mm. of the bottom of the pipe. Then, without stopping, it shall be placed gently on the side of the pipe only and carefully worked under the pipe, ensuring that no voids are left below the pipe. Concrete shall the be brought up equally on each side of the pipe to the required finished height, care being taken not to force the pipes off their supports.
- d. No fill material shall be placed over the concrete until the concrete has reached a crushing strength of 14 N/mm². The concrete and the pipes shall be kept damp and

MECHANICAL SPECIFICATION

protected from sun or frost until the concrete has reached the required strength for filling to take place.

16.05 BEDDING AND LAYING OUT OF DRAIN PIPES - EXTERNAL

- a. Immediately following the trench excavation, the pipes shall be laid and jointed on pipe bedding material.
- b. The pipes shall be laid so that one is in contact with the bed throughout the length of its barrel. Bedding material being scrubbed away at each socket so that the socket does not bear on the bed. Pipes and channels shall be laid with the sockets leading up the gradient. All drainage runs shall be commenced at the point of outfall or at a manhole.

16.06 BEDDING AND SURROUND OF PIPES - GENERALLY

After jointing the pipes, the bedding shall be brought up equally on both sides of the pipe, first to the level of the centre of the pipe line and then up to a height of 300 mm. above the top of the pipe barrel. This material shall be placed in layers not exceeding 150 mm. in thickness and shall be carefully compacted with wooden rammers.

16.07 BACKFILLING OF TRENCHES

- a. All backfilling shall, as far as practicable, be undertaken immediately after the specified operations preceding it have been completed.
- b. The backfilling shall be undertaken only after completion of testing for such pipes as described herein. From 300 mm. above the barrel of the pipe up to the formation level of the road, the filling in the trench shall continue with selected approved material from excavations, in layers not exceeding 150 mm. in thick. Each such layer shall be solidly rammed before the next layer is added.
- c. Where the drain does not run under a road, the backfill material shall be solidly rammed up to the existing ground level in the manner described above.

16.08 MANHOLES - GENERAL

Manholes shall be of precast in place reinforced concrete construction and shall be of details shown on the drawings.

Manholes shall be constructed to the required depth. The manholes top shall have 600 x 600 mm clear opening and shall be shaped to accommodate a standard size manhole frame and cover.

Manhole floors shall be formed with rich cement mortar to the size and shape of the sewer. Inverts shall have a cross section of exact shape as the sewers and all changes in sewer size shall be made gradually and evenly. The floor shall have a gradual slope from the side walls to the central channel.

16.09 BENCHING AND INVERTS OF MANHOLES

The open channel in the bottom of the manholes shall be formed in the benching with half round of pipe. All side branches shall be connected to the main channel so that the discharge is in the

MECHANICAL SPECIFICATION

direction of the flow in the main channel. The benching shall be concrete and shall rise vertically from the edge of the channel pipe to a height not less than the outgoing pipe and be sloped upwards from there to meet the wall of the manhole at a gradient of about 1 in 6. Rendering to benching shall be applied in a coat of cement mortar (1:1) to a final thickness of 20 mm trowelled to a smooth hard finish.

16.10 TEMPORARY COVERS FOR MANHOLES

Temporary covers shall be fitted and retained in position on all manholes from the time the top access is formed or the concrete cover slab installed, until the permanent cover is installed.

16.11 MANHOLE STEP IRONS

All manholes of depth greater than 1200 mm. shall be provided with galvanized steel irons. They shall be staggered in two vertical runs at 300 mm. centers vertically and 225 mm horizontally.

The top iron shall be no more than 350 mm. below the underside of the manhole cover slab and the lowest no more than 300 mm. above the benching. Manhole cover frames shall be bedded in 1:3 sulphate resisting cement sand mortar.

16.12 FRAMES AND COVERS

The Contractor shall provide for each manhole cast iron frame and cover with a 600 mm diameter clear opening. the concrete masonry shall be neatly and accurately brought to the dimensions of the base of the frame. the frame shall be thoroughly embedded in mortar and frame and cover set level and to the proper grade.

All castings for frames and covers shall be of tough grey iron and shall be made accurately to dimensions and machined to provide even bearing surfaces. Covers shall fit the frames in any position and if found to rattle under traffic shall be replaced. No plugging, burning in or filling to obtain tight covers will be allowed. All castings shall be carefully coated inside and outside with coal tar pitch varnish of approved quality.

All frames and covers shall comply with specifications indicated on the manholes schedules.

All manholes covers shall be provided with at least two keyways.

All covers and frames shall have clearly cast thereon the number of compliance standard, the appropriate grade and the weight in kg.

16.14 WET PIT SUBMERSIBLE SUMP PUMPS

MECHANICAL SPECIFICATION

Submersible pumps shall be of the single stage centrifugal type. The pump shall have cast iron body, stainless steel shaft and stainless steel impeller. The squirrel cage motor shall be suitable for the building electrical supply and submerged operation. The type of starter for motor shall be star delta.

Each set of pumps consisted of two number macerating pumps (submersible type / explosion proof) configured as duty/standby. Pumps shall alter in operation sequentially. Standby pumps shall operate by very high level switch.

All studs, bolts, nuts, screws and washers shall be of stainless steel. Each set of pumps shall be complete with adjustable level controller, control panel, non-return valve in each discharge line and lifting handle and chain.

The control panel shall be complete with the following:-

- Normal housing
- Start/stop buttons
- Individual pump run lights
- Individual pump stop lights
- Individual pump trip lights
- Supply on lights
- Minimum run timers
- Hand auto/On/Off switch
- Volt free "fault" contact for BMS

The control panel shall incorporate thermal overload protection with automatic reset provision and connected to the BMS system.

The submersible pumps shall be located within the wet section in the pumping chamber, complete with guide rails for ease of removal for maintenance / repair.

The sump shall be provided with level controls for operation of the pump units as well as at very high and very low level alarms indication relayed to the BMS.

The sump shall be provided with access covers, step cast iron and sump vents.

Local isolators shall be located adjacent to the sump for isolation of units during maintenance.

Pump isolating valves and test points shall be added to each set of pumps

16.15 DRY PIT SUBMERSIBLE PUMPS

Dry pit submersible pumps shall be of the single stage centrifugal type. The pump shall have cast iron body, stainless steel shaft and stainless steel impeller. The squirrel cage motor shall be suitable for the building electrical supply and submerged operation. The type of starter for motor shall be star delta.

Each set of pumps consisted of three number macerating shrouded vane pumps (submersible type / explosion proof) configured as duty/standby. Duty & stand by pumps shall alter in operation sequentially. Standby pumps shall operate by very high level switch.

MECHANICAL SPECIFICATION

All studs, bolts, nuts, screws and washers shall be of stainless steel. Each set of pumps shall be complete with adjustable level controller, control panel, non-return valve in each discharge line and lifting handle and chain.

The control panel shall be complete with the following:-

- Normal housing
- Start/stop buttons
- Individual pump run lights
- Individual pump stop lights
- Individual pump trip lights
- Supply on lights
- Minimum run timers
- Hand auto/On/Off switch
- Volt free "fault" contact

The control panel shall incorporate thermal overload protection with automatic reset provision and connected to the BMS system.

The submersible pumps shall be located within the dry section in the pumping chamber.

The sump shall be provided with level controls for operation of the pump units as well as at very high and very low level alarms indication relayed to the BMS.

The sump shall be provided with access covers, step cast iron and sump vents.

Local isolators shall be located adjacent to the sump for isolation of units during maintenance. Pump isolating valves and test points shall be added to each set of pumps

16.16 TESTING OF DRAINS

General

- a. The Contractor shall provide the necessary labour and equipment and include in his Tender for testing and work to the requirements and satisfaction of the Engineer and all relevant public authorities.
- b. All drains and sewers shall be tested with air after being laid and jointed but before surround and backfilling is commenced to ensure that the jointing is satisfactory. The results of the test must be approved by the Engineer before connecting.

The air test shall be applied at a pressure equivalent to 100mm head of water shall be held for 5 minutes without further pumping; with loss not exceeding 25mm for satisfactory testing. Where gullies or other ground floor appliances are connected, a 50mm test should be applied with a maximum loss of 12mm over a 5 minute period..

A gauge in the form of a glass 'U' tube shall be provided and connected to the drain plug of the length of drain under test.

MECHANICAL SPECIFICATION

- c. A further water test shall be carried out after the completion of the backfilling and manhole construction, the length tested being between manholes. Test shall be carried out in the manner described in the following paragraph.
- d. To facilitate the general building programme, tests shall be made of sections as the work proceeds, such testing however will not absolve the Contractor from his liability for any subsequent or final testing.
- e. Any defects that become apparent during these tests of any part or parts of the installation shall be rectified at the Contractor's expense and the part, or parts, retested to the satisfaction of the Engineer and the relevant public authorities.
- f. For a water test, the drain lines shall be subjected to test pressure of 2.5m. head of water at the highest point of the section under test. Allowance should be made for added water until absorption has ceased, after which the test proper should be commenced and the water level be maintained for a minimum of 30 minutes without the addition of further water.

The same diameter as the drain at end, shall be fitted temporarily, in the socket of the last pipe laid the joints being made water tight. The length under test shall be fitted with water. The length under test shall be filled with water and after allowing for 2 hours absorption and topping up, the water level in the pipe shall be observed for 30 minutes. The test shall be regarded as satisfactory if the loss of water does not exceed:

| Pipe Diameter (mm) | Water Loss (liter per meter run) |
|-----------------------|-------------------------------------|
| 100 | .05 |
| 150 | .08 |
| 225 | .12 |
| 300 | .15 |

- g. Test for straightens and obstruction shall be made to the Engineer's satisfaction and in accordance with the requirements of B.S.C.P. 301, Building Drainage.
- h. The whole of the installation shall be left clean and free from debris.
- i. The Contractor shall keep a record of the tests carried out on the drainage installation throughout the Contract, recording date of test, by whom tested and the result, one copy of the records shall be sent to the Engineer on completion of the Contract.

16.17 TESTING OF MANHOLES

Manholes shall be subjected to a hydraulic test. Pipe stoppers shall be inserted into all pipe ends and the manhole filled with water to a height of 1500 mm above the benching invert. This water shall stand for five minutes for absorption to take place and then be topped up as necessary. The water shall then remain at this level for a further two hours to satisfy the test. If the water level falls, then all defects shall be made good to the satisfaction of the Engineer, and the test shall be repeated as many times as may be necessary until the manhole is satisfactory.

16.18 LOCAL REGULATIONS

All works shall be carried out to comply with the current local public health regulations, and current local by-laws and shall be to the entire satisfaction of the Engineer.

END OF SECTION