



Schools for Knowledge Economy Project (SKEP)

Funded by United States Agency for International Development (USAID)

Phase (3)/Package (2)

- Thahr Al Sarow Basic School for Boys-Jerash
- Jumana Bint Abi Taleb Basic Mixed School- Amman
- Hay Al Iskan Basic Mixed School- Jerash

Special Tender No.:
9 /2019/USAID/SKEP/3/2

Tender Documents

Vol.2 of 4 -Technical Specifications

August 2019

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CIVIL WORKS

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01010**SCOPE OF WORK****PART 1. GENERAL**

1.1. DESCRIPTION

- A. Work to be performed under these Contract Documents consists of: the construction, servicing, and finishing of schools.

1.2. WORK BY OTHERS

- A. The Employer reserves the right to let other separate contracts in connection with this work, under similar conditions, in association with the project after signature of the Contract.
- B. The Contractor shall allow other Contractors and Suppliers reasonable opportunity for the introduction of their materials and the execution of their work, and shall properly connect and coordinate his work with theirs.
- C. The Contractor shall allow other Contractors and Suppliers a separate secure storage area for their equipment and maintain rigid security at all times

1.3. REFERENCES

- A. Abbreviations and Symbols. The following abbreviations as referenced in the Contract Documents are defined to mean the associated names. Both the names and addresses are subject to change, and are believed to be, but are not assured to be, accurate and up-to-date as of the date of the Contract Documents.

AASHTO American Assoc. of State Highway and Transportation Officials
444 North Capitol Street, N.W.
Washington, D.C.

ACI American Concrete Institute
Box 19150 Redford Station
Detroit, Michigan 48219
313/532-2600

ADAAG American Disability Act Access Guidelines for Buildings and
Facilities

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning
Engineers

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103
212/644-7722

FED. SPEC.	United States of America Federal Specifications General Services Administration Specification Unit 7th and D Streets, S.W. Washington, DC 20406 202/472-2205
ISO	International Organization for Standardization 1 Rue de Vermbe, Case Postale 56 Geneva 20, Switzerland
NEMA	National Electrical Association (American) 2101 L Street, N.W. Washington, DC 20037 202/457-8400
NFPA	National Forest Products Association 1250 Connecticut Avenue, N.W. Washington, DC 20036 202/463-2700
OSHA	Occupational Safety and Health Association U.S. Department of Labor Francis Perkins Building 200 Constitution Avenue, N.W. Washington DC 20210 202/523-8165
TCA	Tile Council of America, Inc. P.O. Box 326 Princeton, New Jersey 08540 609/921-7050
UL	Underwriters Laboratories Inc. 333 Plingisten Road Northbrook, Illinois 60602

- B. Where reference is made in the Contract Documents to one of the above organizations or other associations, comply with the standard or trade association which is in effect at the date of the Contract Documents, except where specifically indicated to comply with a publication of another date.
- C. In general, American standard specifications are quoted throughout the Contract Documents, but the use of alternative equivalent standards may be substituted at the discretion of the Engineer upon the written request of the Contractor following award of the Contract. Demonstration to Engineer's satisfaction the suitability and equivalence of

the substituted codes and standards is the responsibility of the Contractor

- D. The General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 shall be deemed to be the specifications that govern the civil and architectural works under this Contract unless otherwise specified in separate sections.
- E. The Specifications for Highway and Bridge Construction, 1991 issued by the Ministry of Public Works and Housing shall be deemed to be the specifications that govern the pavement and sidewalks works under this Contract.
- F. The following abbreviations as referenced in the Contract documents are defined to mean the following:

%	Percent
ac	Alternating current
AWG	American Wire Gauge
°C	Degrees Centigrade
C/C	Center to Center
CIF	Cost, Insurance and Freight
cm	Centimeter
cu	Cubic
ctrs	Centers
d	Day
dia or Φ	Diameter
g	Gram
ga , GA	Gauge
g/cu cm	Grams per cubic centimeter
h or hr	hour
ha	Hectare
I.L. OR Inv	invert (level)
IPS	Iron pipe size
Kg	Kilogram
Kg/cm ²	Kilogram per square centimeter
kg/cm ³	Kilogram per cubic centimeter
K j	Kilo joule
kn	Kilo newton
kn/m ²	Kilo newton per square meter
Kpa	Kilopascal
kw	Kilowatt
kwh	Kilowatt-hour
L	Liter
l / m	Liters per minute
l/s	Liters per second
LM	Linear Meter
m	Meter
M.R.	Linear Meter
m ² or M ²	Square meter
m ³ or M ³	Cubic meter
m ³ /d	Cubic meters per day
mm	Millimeter

mm ²	Square Millimeter
mN	Mega Newton
mpa	Mega Pascal
max	Maximum
min	Minute or minimum
mg/l	Milligrams per liter
ML/d	Mega Liters per day
NPT	National Pipe Thread
N	Newton
No.	Number
RCP	Reinforced Concrete Pipe
RL	Reduced Level
rpm	Revolutions per minute
Req'd	Required
T	Tonne
TWL	Top Water Level
typ	Typical
VA	Volt Ampere

END OF SECTION

SECTION 01035**CONTROL OF WORK****PART 1. GENERAL****1.1. PLANT**

- A. Furnish plant and equipment which will be efficient, appropriate and sufficient to secure a satisfactory quality of Work and a rate of progress which will insure the completion of the Work within the time stipulated in the Form of Tender. If, at any time, such plant and/or equipment appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Engineer may order the Contractor to increase the plant and/or equipment, and the Contractor shall conform to such order at its own expenses. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the Work, and rate of progress required. All components of plant and equipment including but not limited to, mufflers, exhausts, lights, signals and warning and safety devices shall be maintained in proper working order.

1.2. PRIVATE & PUBLIC LAND

- A. Private or public lands outside of limits of Working Site shall not be entered or occupied by the Contractor, except by permission of the landowners.

1.3. LOCATION OF WORKS

- A. The Works shall be located substantially as indicated on the drawings but the Engineer reserves the right to make modifications in locations as may be found desirable during construction to avoid interference with existing structures or for other valid reasons.

1.4. WORKING SITES

- A. The Working Site indicated on the drawings will be provided by the Employer for the Contractor's use.
- B. Confine the operations, plant, equipment and stores necessary for Execution of the Works to the Working Site indicated on the drawings and any additional working areas secured solely by the Contractor. Provide reasonable facilities for access to the Site and any additional Working Site for any person or vehicle authorized by the Engineer.
- C. Acquire all additional working areas in the vicinity of the Works or Elsewhere for the Contractor's site compound, offices, for offices for the Engineer's Representative, and for any additional lands required for construction purposes and access, apart from access along public streets.
- D. Apart from transport to and from these areas, confine all local operations under the Contract to these areas.
- E. Restrict access to the Working Site to public rights of way. Access to the Site shall be obtained only by such routes as are acceptable to the Engineer. Ensure that persons employed by Contractor or any subcontractor on the Site do not trespass beyond the Site

and the routes so utilized.

- F. Take sufficient precautions to minimize the run-off of polluting substances Such as fuels, oils, or other polluting materials harmful to humans, fish, or other life, into the supplies and surface waters and any agricultural land.

1.5. SITE CONDITIONS

- A. All levels shown on the Drawings refer to mean sea level unless otherwise indicated and are related to bench marks in the Project area. A list of the bench marks has been prepared including their description and reduced levels relative to this datum. Copies of the list will be given to the Contractor following award of the Contract.
- B. Before commencing setting out, check all survey stations and bench marks to be used to determine that each survey station and bench mark is in its original position and condition.
- C. Check the accuracy of bench marks in the vicinity of the Site to ensure that they conform with at least two other listed bench marks. The leveling loop closing error shall be within 3mm/km before adjustment.
- D. Inform the Engineer in writing of the result of these survey checks and whether such bench marks and survey stations are in agreement or not. Should the bench marks or survey station coordinates not be in agreement, the Engineer may direct the Contractor to undertake further survey checks and, thereafter which bench mark values and survey station coordinates to adopt. Reset or replace any stations or bench marks found missing and survey the coordinates and elevations to the standards stated above and adjusted.
- E. Provide all survey and measuring instruments and equipment of every kind necessary for the execution of the Works including the requirements specified in the special conditions of contract.
- F. Furnish and properly install Safety barriers, caution tapes, construction signs and other means to alert the public of the construction ongoing on site and to prevent public entry to site during construction.
- G. Continued occupancy of school: Contractor shall take all precautions and make all arrangements necessary to accommodate and facilitate the continued occupancy of schools during construction.

1.6. OPEN EXCAVATIONS

- A. Safeguard all open excavations by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by workmen and public and private vehicles. Remove bridges provided for access during construction when no longer required. The length or size of excavation shall be controlled by the particular surrounding conditions. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures.
- B. Do not open or excavate any street, way or public or private place until all necessary permits have been obtained and existing underground utilities have been located by the

Contractor.

1.7. TEST PITS

- A. Dig test pits, by hand if necessary, for the purpose of locating underground utilities or structures in advance of the construction. Pits shall be excavated with the knowledge of the Engineer. Backfill test pits immediately after their purpose has been satisfied and restore the surface in a manner satisfactory to the governing authority and Engineer.

1.8. NUISANCE CAUSED BY THE LITTERING IN PUBLIC AREAS

- A. Be responsible for, and do not create any nuisance by littering the Site with earth, mud, debris, and the like, falling off vehicles used for the purpose of this Contract. Failure to comply with this requirement will permit the Engineer to employ laborers or take other necessary action to comply with anti-littering requirements, and the cost incurred thereby will be deducted from any monies due or to become due to the Contractor.

1.9. INSPECTION OF CONSTRUCTION & EQUIPMENT

- A. Provide all watchmen as required for the protection and security of the Work during the period of this Contract.
- B. Carefully protect all Work from damage in any way. Reconstruct all Damaged Works to the satisfaction of the Engineer.
- C. Protect all Works in a manner satisfactory to the Engineer. Should any pipeline, equipment, underground structure, any floors or other parts of structures become heaved, cracked, or otherwise damaged, repair all such damaged portions to the satisfaction of the Engineer.

1.10. CLEAN UP

- A. During the course of the Work, keep the Site of operations in as clean and neat a condition as possible. Do not dump unwanted debris on the Site, access roads or open channels and tanks. Remove and dispose of Site, at dumping grounds acceptable to the appropriate authorities, all unwanted debris from the Site. Do not leave empty containers or receptacles in the open that are capable of forming breeding places for insects and attracting rodents. Take all necessary steps to prevent the breeding of insects in the areas of the Work.
- B. At the conclusion of the Work, leave the entire Site of the Work in a neat, orderly and clean condition. Protect all finished exterior and interior surfaces, fixtures and equipment from stains, marks, dirt or damage of any kind, from time of their construction, finishing, or installation, until its final completion and acceptance. Perform all necessary cleaning, making good, and touching up that may be required to leave all finished surfaces, fixtures and equipment in acceptable condition in accordance with the full intent and meaning of these Specifications.

1.11. COOPERATION WITH OTHER CONTRACTORS

- A. Other construction may be carried out during the same period as Construction under this Contract as described under Paragraph 1.02 of the Scope of Work Section. Plan the Work

and cooperate with other contractors to prevent any interference and delay. Delays due to a failure to coordinate such work will not constitute valid claims for extension of time or additional compensation.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

3.1. GENERAL COORDINATION PROVISIONS

- A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.2. CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.
- B. Execute cutting, fitting, and patching to complete Work, and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- C. Execute work by methods to avoid damage to other Work, and to provide proper surfaces to receive patching and finishing.
- D. Cut masonry and concrete materials using masonry saw or core drill.
- E. Restore Work with new products in accordance with requirements of Contract Documents.
- F. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- G. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire stopping material in accordance with Section 07840, to full thickness of penetrated element.
- I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.

- J. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

3.3. CLEANING AND PROTECTION

- A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.
- B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.
- C. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:
1. Excessive static or dynamic loading.
 2. Excessive internal or external pressure.
 3. Excessively high or low temperatures.
 4. Thermal shock.
 5. Excessively high or low humidity.
 6. Air contamination or pollution
 7. Water.
 8. Solvents.
 9. Chemicals
 10. Light.
 11. Puncture.
 12. Abrasion.
 13. Heavy traffic.
 14. Soiling, staining, and corrosion.
 15. Bacteria.
 16. Rodent and insect infestation.
 17. Combustion.
 18. Electrical current.
 19. High-speed operation.
 20. Improper lubrication.
 21. Unusual wear or other misuse.
 22. Contact between incompatible materials.
 23. Destructive testing.
 24. Misalignment.
 25. Excessive weathering.
 26. Unprotected storage.
 27. Improper shipping or handling.
 28. Theft.
 29. Vandalism.

END OF SECTION

SECTION 01323**NETWORK ANALYSIS SCHEDULES****PART 1. GENERAL**

1.1. SECTION INCLUDES:

- A. References
- B. Quality assurance
- C. Format
- D. Schedules
- E. Submittals
- F. Review and evaluation
- G. Updating schedules
- H. Distribution

1.2. REFERENCES

- A. The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry, Washington, D.C., The Associated General Contractors of America (AGC).

OR

- B. CPM in Construction Management - Project Management with CPM, O'Brien, McGraw-Hill Book Company, New York.

1.3. QUALITY ASSURANCE

- A. Scheduler: Contractor's personnel specializing in CPM scheduling with five years minimum experience in scheduling construction work of complexity comparable to this Project, and having use of computer facilities capable of delivering detailed graphic printout within 48 hours of request.
- B. Contractor's Administrative Personnel: 7 years minimum experience in using and monitoring CPM schedules on comparable projects.

1.4. FORMAT

- A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.
- B. Diagram Sheet Size: 600 high x 900 mm wide or as required.
- C. Scale and Spacing: To allow for notations and revisions.

1.5. SCHEDULES

- A. Prepare network analysis diagrams and supporting mathematical analyses using Critical Path Method, under concepts and methods outlined in AGC's "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".
- B. Illustrate order and interdependence of activities and sequence of work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.
- C. Illustrate complete sequence of construction by activity, identifying work of separate stages. Indicate dates for submittals, including dates for Owner furnished items and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.
- D. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
 1. Preceding and following activity numbers
 2. Activity description
 3. Estimated duration of activity, in maximum 15 day intervals with not more than 2% exceeding these limits
 4. Earliest start date
 5. Earliest finish date
 6. Actual start date
 7. Actual finish date
 8. Latest start date
 9. Latest finish date
 10. Total and free float; accrue float time to Owner and to Owner's benefit
 11. Monetary value of activity, keyed to Schedule of Values
 12. Percentage of activity completed
 13. Responsibility
- E. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, of accepting revised completion dates, and re-computation of scheduled dates and float,
- F. Required Sorts: List activities in sorts or groups:
 1. By preceding work item or event number from lowest to highest.
 2. By longest float, then in order of early start.
 3. By responsibility in order of earliest possible start date.
 4. In order of latest allowable start dates.
 5. In order of latest allowable finish dates.
 6. Listing of basic input data generating report.
 7. Listing of activities on critical path.

1.6. SUBMITTALS

- A. Within 28 days after the receipt of the Letter of Acceptance, submit detailed Programme. Include a detailed critical path construction schedule showing starting dates, progress and

completion dates for all component parts of the work including testing and start-up, a list of major equipment, extent of the construction plant and operations, the extent of subcontracting proposed, and the procurement and delivery schedule for all plant and materials to be incorporated into the Works.

- B. Submit updated network schedules every 28 days.
- C. Submit six copies of submittals required in this section .
- D. The Contractor has to submit the following reports:
 - 1. Monthly status report which shows detailed activities, actual start and completion dates, percent complete or remaining duration, and any other requirement by the Engineer.
 - 2. Material monthly status report which includes material description, unit, material delivered (during the month and the accum.), material planned (during the month and the accum.), adjusted by V.O., variance (quantity, %) and any other requirements requested by the Engineer.
 - 3. Weekly Manpower Report that includes the following in accordance with the approval of the Engineer:
 - a. Profession/Trade
 - b. Average Number
 - c. Average working days
 - d. Average working hours
 - e. Total man-hours
 - f. Total man-days
 - 4. Weekly production report which includes the following:
 - a. Description of major work items
 - b. Contract quantity
 - c. Quantity installed during the week
 - d. Quantity installed to-date
 - e. Percent of the above
 - f. The number and type of the description of the work items shall be as required by the Engineer.
- E. Submit under transmittal letter form specified in Section 01330.

1.7. REVIEW AND EVALUATION

- A. Participate in joint review and evaluation of network diagrams and analysis with Engineer at each submittal.
- B. Evaluate project status to determine work behind schedule and work ahead of schedule.
- C. After review, revise network diagrams and analysis incorporating results of review, and resubmit within 10 days.

1.8. UPDATING SCHEDULES

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update diagrams to graphically depict current status of Work.
- C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- D. Indicate changes required to maintain Date of Completion.
- E. Submit sorts required to support recommended changes.
- F. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate Subcontractors.

1.9. DISTRIBUTION

- A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Engineer, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION

Not Used

END OF SECTION

SECTION 01330**SUBMITTALS****PART 1. GENERAL****1.1. SECTION INCLUDES**

- A. Submittal procedures
- B. Construction progress schedules
- C. Proposed products list
- D. Product data
- E. Shop drawings
- F. Samples
- G. Design data
- H. Test reports
- I. Certificates
- J. Manufacturer's instructions
- K. Manufacturer's field reports
- L. Erection drawings
- M. Construction photographs

1.2. SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer accepted form.
- B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- C. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite Project, and deliver to Engineer. Coordinate submission of related items.
- F. Processing Time: Allow enough time for submittal review, including time for re-submittals, as follows. Time for review shall commence on Engineer's Project and / or Manager's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including re-submittals.
- G. Re-submittal Review: Allow enough time for review of each re-submittal, for submittal's substitution.
- H. Submittals or resubmittals will be reviewed by the Engineer two times only for each submittals, otherwise the Contractor shall bear all costs related to such review .

- I. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- J. Allow space on submittals for Contractor and Engineer review stamps.
- K. When revised for resubmission, identify changes made since previous submission.
- L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- M. Submittals not requested will not be recognized or processed.

1.3. CONSTRUCTION PROGRESS SCHEDULES

- 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.
- C. Submit computer generated network analysis diagram as specified in Section 01323,
- D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate early and late start, early and late finish, float dates, and duration.
- E. Indicate estimated percentage of completion for each item of Work at each submission.
- F. Submit separate schedule of submittal dates for shop drawings, product data, and samples, including Owner furnished, and dates reviewed submittals will be required from Engineer. Indicate decision dates for selection of finishes.
- G. Indicate delivery dates for Owner furnished products.
- H. Revisions To Schedules:
 - 1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
 - 2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
 - 3. Prepare narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including effect of changes on schedules of separate contractors/Sub-Contractors.

1.4. PROPOSED PRODUCTS LIST

- A. Within 30 days of the Notice to Proceed, 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.

1.5. PRODUCT DATA

- A. Product Data: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract

Documents.

- B. Submit number of copies Contractor requires, plus two copies Engineer will retain.
- C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

1.6. SHOP DRAWINGS

- A. Shop Drawings: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
 - 1. Include signed and sealed calculations to support design.
 - 2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 - 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- D. Submit in form of one reproducible transparency and one opaque reproduction.
- E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

1.7. SAMPLES

- A. Samples: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Samples For Selection as Specified in Product Sections:
 - 1. Submit to Engineer for aesthetic, color, or finish selection.
 - 2. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for Engineer selection
- C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- D. Include identification on each sample, with full Project information.
- E. Submit number of samples specified in individual specification sections; Engineer will retain one sample.
- F. Reviewed samples which may be used in the Work are indicated in individual

specification sections.

- G. Samples will not be used for testing purposes unless specifically stated in specification section.
- H. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes described in Section 01700.

1.8. DESIGN DATA

- A. Submit for Engineer's knowledge as contract administrator or for Owner.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.9. TEST REPORTS

- A. Submit for Engineer's knowledge as contract administrator or for Owner.
- B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10. CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to 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 Engineer.

1.11. MANUFACTURER'S INSTRUCTIONS

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

1.12. MANUFACTURER'S FIELD REPORTS

- A. Submit reports for Engineer's benefit as contract administrator or for Owner.
- B. Submit report in duplicate within 3 days of observation to Engineer for information.
- C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.13. ERECTION DRAWINGS

- A. Submit drawings for Engineer's benefit as contract administrator or for Owner.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
- C. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

1.14. CONSTRUCTION PHOTOGRAPHS

- A. Provide photographs of site and construction throughout progress of Work produced by an experienced photographer, acceptable to Engineer.
- B. Twice monthly submit photographs.
- C. Photographs: two prints; color, glossy; 200 x 250 mm size; mounted on 216 x 280 mm soft card stock, with left edge binding margin for three whole punches.
- D. Electronic Media: With each submittal, include three (3) Compact Disks (CD), in protective cases, identified by date photographs were taken.
- E. Take two site photographs from differing directions and five interior photographs of indicating relative progress of the Work.
- F. All expenses in connection with the photographs shall be born by the Contractor.
- G. Copy Right: All photographs shall become the property of the Employer and copyright shall be rested in him. Photographs may only be reproduced after written permission has been authorized.
- H. Identify each print on back. 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.
- I. Deliver negatives to Owner with project record documents. Catalog and index negatives in chronological sequence; include typed table of contents.

PART 2. PRODUCTS

2.1. PHOTOGRAPHIC COPIES

- A. Electronic Media: Digital photographs taken with a suitable digital camera complying to the following specification:
 - 1. Minimum 5 Mega Pixels resolution
 - 2. File format Jpeg or Tiff
 - 3. Monitor LCD for viewing
 - 4. Built-in flash for illumination
 - 5. SD Card compatible
 - 6. Non-Digital zoom (minimum 5X)

PART 3. EXECUTION

Not Used.

END OF SECTION

SECTION 01400**QUALITY REQUIREMENTS****PART 1. GENERAL****1.1. SECTION INCLUDES**

- A. Quality control and control of installation.
- B. Tolerances
- C. References
- D. Mock-up requirements
- E. Testing and inspection services
- F. Manufacturers' field services
- G. Examination
- H. Preparation

1.2. QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3. TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.4. REFERENCES

- A. For products or workmanship specified by association, trade, or by other applicable entity, comply with requirements of standard, except when more rigid requirements are specified

or are required by applicable codes.

- B. Conform to reference standard current on the date for receiving bids, except where specific date is established by specifications or code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of the Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5. MOCK-UP REQUIREMENTS

- A. When required by individual specification section, erect complete full scale mock-up of assembly at project site.
- B. Tests will be performed under provisions identified in this section and identified in respective product specification sections.
- C. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- D. Accepted mock-ups shall be comparison standard for remaining Work.
- E. Mock-up may remain as finished work if so indicated in specification section and approved.
- F. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.6. TESTING AND INSPECTION SERVICES

- A. Employment and payment for services of an independent testing laboratory to perform specified inspecting and testing shall be at the Contractor's expense.
- B. All materials and work will be tested as required in the Specifications, testing and inspection shall be carried out at the Contractor's own expense.
- C. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time specialist and responsible officer.
- D. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by Engineer
 - 1. Laboratory: Authorized to operate at Project location.
 - 2. Laboratory Staff: Maintain full time specialist on staff to review services.
 - 3. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to Royal Scientific Society or accepted values of natural physical constants.
- E. Testing, inspections and source quality control may occur on or off project site. Perform offsite testing as required by Engineer or Owner.
- F. Reports will be submitted by independent firm to Engineer, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

- G. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
 2. Make arrangements with independent firm for additional samples and tests required for Contractor's use.
- H. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by the Engineer. Payment for re-testing or re-inspection will be the full responsibility of the Contractor and at no extra cost to the Contract Price. Any re-inspection cost incurred by the Employer will be deducted from the Contract Price
- J. Laboratory Responsibilities:
1. Test samples of mixes submitted by Contractor.
 2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
 6. Perform additional tests required by Engineer.
 7. Attend preconstruction meetings and progress meetings.
- K. Laboratory Reports: After each test, promptly submit 3 copies of report to Engineer and to Contractor. When requested by Engineer, provide interpretation of test results. Include the following:
1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Results of tests.
 10. Conformance with Contract Documents.
- L. Limits On Testing Laboratory Authority:
1. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Laboratory may not approve or accept any portion of the Work.
 3. Laboratory may not assume duties of Contractor.
 4. Laboratory has no authority to stop the Work.

1.7. MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to approval of Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 01330 - SUBMITTAL PROCEDURES, MANUFACTURERS' FIELD REPORTS article.

1.8. CONTRACTOR RESPONSIBILITIES

- A. Deliver to laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
- B. The Contractor shall allow for all necessary labor, containers, wrappings and labeling in connection with the samples for testing and for all transport charges.
- C. Cooperate with laboratory personnel, and provide access to the Work.
- D. Provide incidental labor and facilities to undertake the following:
 - 1. Provide access to Work to be tested.
 - 2. Obtain and handle samples at the site or at source of Products to be tested,
 - 3. Facilitate tests and inspections,
 - 4. Provide storage and curing of test samples.
- E. Employ services of an independent qualified testing laboratory and pay for additional samples and tests required by Engineer beyond specified requirements.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION

3.1. EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2. PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.

- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 01500
TEMPORARY FACILITIES AND CONTROLS

PART 1. GENERAL

1.1. SECTION INCLUDES:

A. Temporary Utilities at all construction sites:

1. Temporary electricity and lighting for construction purposes
2. Temporary heating
3. Temporary cooling
4. Temporary ventilation
5. Telephone service
6. Temporary water service
7. Temporary sanitary facilities
8. Engineer's Vehicles

B. Construction Facilities at all construction sites:

1. Field offices and sheds
2. Vehicular access
3. Parking
4. Progress cleaning and waste removal
5. Project identification
6. Traffic regulation
7. Fire prevention facilities

C. Temporary Controls at all construction sites:

1. Barriers
2. Enclosures and fencing
3. Security
4. Water control
5. Dust control
6. Erosion and sediment control
7. Pollution control
8. Rodent control

D. Removal of utilities, facilities, and controls

1.2. TEMPORARY ELECTRICITY AND LIGHTING FOR CONSTRUCTION PURPOSES

- A. Make all arrangements with the local electric company for temporary electrical service to each construction site, pay all expenses, and provide all equipment necessary for temporary power and lighting. The electrical service shall be of adequate capacity for all construction tools and equipment without overloading the temporary facilities and shall be made available for power, lighting and construction operations of all trades. If temporary

supply is not granted by the local electric company, then the Contractor must make his own arrangements for providing supply of electricity in order to complete the Works.

- B. Provide power distribution as required throughout the Works for power tools of all kinds. Termination of power distribution shall be at locations approved by the Engineer. Termination shall be provided complete with circuit breakers, disconnect switches and other electrical devices as required to protect the power supply system,
- C. Temporary site electrical network including power and light system shall be furnished, installed and maintained by the Contractor as required to satisfy the requirements of safety and security. Temporary lighting system shall be adequate day and night for illumination in all areas of the building. Where work is being performed at night, increase the illumination level. The Contractor shall provide adequate outdoor lighting to illuminate staging, stockpiles, trenches, projections, etc., to the satisfaction of the Engineer and general illumination throughout, adequate for watchmen and emergency personnel. Temporary electrical works shall be according to latest local electric company regulations. Temporary electrical distribution system design should be submitted by the Contractor to the Engineer for approval with all electrical data of used equipment (cranes, lift, fire pump, welding machine, workshop units, domestic power and light, etc.)
- D. Temporary equipment and wiring for power and lighting shall be in accordance with the applicable provisions of the governing codes. Temporary wiring shall be maintained in a safe manner and utilized so as not to constitute a hazard to persons or property.
- E. At the completion of the Works remove all temporary electrical equipment and wiring.

1.3. TEMPORARY HEATING

- A. Provide and pay for heating devices and heat as needed to maintain specified conditions for construction operations.
- B. Prior to operation of permanent equipment for temporary heating purposes, verify installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.
- C. Maintain minimum ambient temperature of 10 degrees C in areas where construction is in progress, unless indicated otherwise in product sections.

1.4. TEMPORARY COOLING

- A. Provide and pay for cooling devices and cooling as needed to maintain specified conditions for construction operations.
- B. Prior to operation of permanent equipment for temporary cooling purposes, verify installation is approved for operation, equipment is lubricated and filters are in place.
- C. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.
- D. Maintain maximum ambient temperature of 32 degrees C in areas where construction is in progress, unless indicated otherwise in specifications.

1.5. TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to

prevent accumulation of dust, fumes, vapors, or gases.

1.6. TELEPHONE AND INTERNET SERVICE

- A. For each school site : Install two private telephone lines in the field office for the Engineer's exclusive use; one voice grade line with caller ID and call waiting features and a second line for a computer modem. Provide and maintain six suitable push button phone instruments. Pay all bills charged against the telephone, including installation charges and all monthly charges throughout the construction period. Monthly charges to be paid by the Contractor shall not exceed JD 200.
- B. Provide in conjunction with the telephone, an automatic telephone answering device to record messages when the office is not manned.
- C. Provide in conjunction with the telephone a fax plain paper machine for sending and receiving correspondence. The fax plain paper machine shall be HP Office Jet 7400 All-in-One. The Contractor shall provide all paper and ink for the fax machine for the duration of the contract.
- D. If the Contractor cannot provide phone service as specified in paragraphs A, B and C above within one month after the Notice to Proceed, he shall provide three mobile phones for the Owner's Engineer's use at the project site and pay all costs thereof.
- E. For each school site: Provide ADSL internet/e-mail connection services by an approved Internet service provider in Jordan for the period of the Contract. Pay all related monthly charges up to a maximum of JD 75 per month in addition to the connection initial costs.
- F. For the package: Provide **ten (10)** mobile telephones of price not to exceed 50 JD with subscription to mobile Telecommunication Company for the duration of the contract. Provide all related monthly charges up to a maximum of JD 30 per telephone per month excluding sign-up and flat fees. Pay all sign-up flat fees.

1.7. TEMPORARY WATER SERVICE

- A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations. Connect to existing water source.
- B. Extend branch piping with outlets located so water is available by hoses with threaded connections.

1.8. TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide facilities at time of project mobilization. Existing facility may be used during construction operations.
- B. At end of construction, return existing facilities used for construction operations to same or better condition than the original condition.
- C. Where there is existing toilets rehabilitation the contractor shall work on his construction staging to prevent operating the school without sanitary unit, else the Contractor shall provide temporary sanitary facilities on his own cost.

1.9. ENGINEER'S VEHICLES

Non required.

1.10. FIELD OFFICES AND SHEDS

A. Maintenance of Site Accommodations During Construction Period

1. The Contractor shall provide full maintenance for all items to be provided under these requirements in accordance with the Project Construction Schedule. This shall include, but not be limited to, normal and preventative maintenance, remedial maintenance, replacements, spares and consumables.
2. The Contractor shall provide full time **three (3)** office boys (one for each site of the three sites). The said office boys shall be employed by the Contractor in accordance with the Project Construction Schedule.
3. The office boys mentioned above shall be available at all times in accordance with the project Construction Schedule or such extended periods as may be instructed by the Engineer. In the event that the said office boys are not available then the Contractor shall pay a penalty in the sum of JD. 15 (Jordanian Dinars Fifteen) per person, per day or part thereof for each period of non-availability, such period to be determined by the Engineer.
4. Provide all necessary consumables, i.e. tea, coffee, milk, etc., all fuel for heating and cooking, electrical bills, cleaning materials for offices, kitchen and toilets, toilet paper, hand towels, etc., in connection with kitchen, toilet, Engineers and Engineer staff and janitorial services in accordance with the Project Construction Schedule.
5. Provide bottled mineral water for complete offices with suitable disposable cups, all running water for general use and sanitary fixtures.

B. Office: Weather tight, with lighting, electrical outlets, heating, cooling equipment, and Equipped with sturdy furniture.

C. Provide space for Project meetings, with table and chairs to accommodate 10 persons.

D. Locate offices and sheds minimum distance of 10 m from and new structures.

E. When permanent facilities are enclosed with operable utilities, relocate offices and Storage into building, with written agreement of Owner, and remove temporary buildings.

F. Construction of Site Offices:

1. Serviceable, new, adequate for required purpose.
2. Prefabricated building units, or buildings constructed at site with floors raised 200 mm above ground, securely fixed to foundations, with steps and landings at entrance doors.
3. Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work and until removal is authorized.
4. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
5. Exterior Materials: Weather-resistant, and heat insulated finished in one color acceptable to Engineer's Representative.
6. Interior Materials in Offices: Sheet type materials for walls and ceilings, heat and sound insulated pre-finished or painted; resilient floors and bases. Provide false ceiling and recessed type light fittings in all rooms.
7. Lighting for Offices: Fluorescent to all rooms, 500 Lux at desktop height, exterior lighting at entrance doors.

8. Fire Extinguishers: Fire extinguisher with mounting bracket shall be 10 kg capacity dry chemical type, ULS rated for 20A-80 B:C. Extinguisher shall be red enameled steel cylinder with indicating gauge.
9. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.
10. Interior Flooring: PVC in all rooms including corridors.
11. Windows: Minimum of size approx. 10% of floor area with operable sash and insect screens. Locate according to approved shop drawings to provide views of construction area wherever practical. All windows shall be provided with Venetian blinds.
12. Electrical Distribution Panel: MCB and number of ways as required.
13. Minimum four, 13A, 240 volt single convenience outlets, one on each wall of each room.
14. Sanitary and Kitchen Facilities: as specified,
15. Furniture and equipment: New furniture as specified including maintenance.
16. 500 Jordanian Dinars/day shall be deducted from the Contractor's payments if he doesn't execute the sign board within 30 days from the date of site handing over.

G. Environmental Control:

1. Heating, Cooling and Ventilating for Offices: Automatic equipment to maintain comfortable conditions of 25° C heating and of 20° C cooling by A/C system with built-in heating element.
2. Storage Spaces: Ventilation as needed to maintain products in accordance with Contract Documents; adequate lighting for maintenance and inspection of products.
3. Exhaust fan with automatic shutter, one per W.C. (fitting) and kitchen.

H. Site Offices:

1. All facilities as detailed herein for the use of the Employer, Engineer and their staff must be provided by the Contractor at his own expense and at an approved location. These facilities will remain on Site or near the Sites and will be maintained by the Contractor.
2. Provide, equip, furnish and maintain suitable and adequate air-conditioned temporary prefab site office accommodation for the sole use of the Employer, Construction Manager, Engineer and their staff with electric lighting and back-up power, water supply, drainage and firefighting equipment. Provide one sign board (1.80 m X 2.825 m) with English and Arabic lettering at each site to indicate Site offices.
3. Submit for approval, prior to fabrication and erection, site office design and layouts with following accommodations:

Accommodations	Size (m ²)	No.
A. Site Office: main office site (at the school site where the Project Manager and the package key staff will		
Employer's Office including Private Toilet	15+3	1
Resident Engineer's Office	15	1
Engineer's Offices (2Nos)	30	1
Foreman/Surveyor/Quantity Surveyor Office	20	1

Conference Room	15	1
Sample Room	10	1
Kitchen	6	1
Toilet	4	2
TOTAL	120	

Accommodations	Size (m ²)	No.
B. Site Office: (at each of school sites) / (other than the main office site)		
Resident Engineer's Office	15	1
Engineer's Office	15	1
Foreman/Surveyor/Quantity Surveyor Office	15	1
Conference Room	15	1
Sample Room	10	1
Kitchen	5	1
Toilet	5	1
TOTAL	80	

4. Offices must be constructed with a vinyl covered concrete floor, painted walls and a galvanized steel roof sheeting with thermal insulation and painted ceilings.
 5. All rooms shall be supplied with windows, adequate for natural light and complete with burglar bars. Opening sections shall be supplied with fly screens. All rooms shall be provided with wooden flush panel doors with 4 lever locks. The main entrance door shall be a framed, ledged and braced batten door with a deadlock and a steel security gate with a dead lock.
- I. Site Office Furniture (To become the Employer's property at the end of the project)
1. Employer and Resident Engineer's Offices (Main Office):
 - 2x L- shaped desk with lockable drawers, swivel chair & 2 visitor's chairs
 - 2 x lockable steel filing cabinets
 - 1 x plan chest with a minimum of five drawers
 - 1 x drawing table with stool
 - 1 x shelf unit
 - 2 x pin boards
 - 2 x waste paper basket
 - 2 x Telephone set Executive
 2. Engineer's and Foreman/Surveyor/Quantity Surveyor Offices (each site) :
 - 6 x desks with lockable drawers, swivel chair and 2 visitor's chairs
 - 2 x lockable steel filing cabinet
 - 1 x drawing hanger with racks
 - 1 x drawing table with stool
 - 1 x shelf unit
 - 1 x pin board
 - 6 x waste paper basket
 - 2 x Telephone set normal type
 3. Conference Room (Main Office):

- Conference Table 200 x 120 cm
- 12 swivel chair
- 1 x pin boards
- 1 x drawing table with stool
- 1 x waste paper basket
- 1 x Telephone set normal type
- Air Condition

4. Kitchen area (each site):

- 1 x 14 cu. ft. refrigerator
- 1 x water filter and cooler
- 1 x electric kettle
- 1 x coffee percolator
- 1 x stainless steel sink
- 1 x storage cupboard
- 1 x Telephone set normal type

5. Toilet facilities (each toilet):

- 1 x W.C. suite
- 1 x toilet paper holder
- 1 x wash hand basin
- 1 x mirror
- 1 x towel rail
- 1 x soap dispenser

J. Site Office Equipment: (To become the Employer's property at the end of the project)

The following office equipment must be provided and maintained by the Contractor. All equipment must be serviced in accordance with the Manufacturer's recommendations to ensure the proper functioning of all equipment:

- A. Computers: Nine (9) Nos. Desktop for the main office (at the school site where the Project Manager and the package key staff will) and Four (4) Nos. Desktop for each site of the other two sites:
1. Processor: Intel Core™ i7-7800 CPU@3200 GHz
 2. Operating System: Windows 10 pro 64 bit Licence
 3. Hard Drive: 500 GB SSD For Operating System & 1TB HDD Sata For Data Storage
 4. Memory: 16 GB DDR4
 5. Display: Not less than 24" LED Monitor
 6. Graphics: 4 GB GDDR5/ Memory Interface width 128 bit / Bus Support/ PCIe 3.0/ Open GL :4.5
 7. Audio: Integrated JBL® stereo speakers with Waves Audio certification
 8. Ports : 2 USB 3.0, 1 DC-in with USB 2.0 function, 4-in-1 reader(SD, MMC, SDXC, SDHC out, audio combo jack
 9. Security : Antivirus
 10. All necessary drivers for HDD, CD-Rom, Audio, MC, and Ethernet adapter, etc are delivered with the system
 11. Un-interruptible Power Supply unit for each desktop PC

Software:

1. Windows (windows 10)Professional

2. Latest Microsoft Office 365
3. AutoCAD
4. Virus Protection Software with updates during the project duration. (yearly subscribe)
5. The version of the Software provided shall be the latest version at the time the Engineers Facilities are provided. All software shall be licensed to, and provided to, the Engineer when the Computer Equipment is delivered. Original software CDs, diskettes and documentation shall be provided to the Engineer.

2. Printers & Scanners:

The Contractor shall provide for each of the three site offices the following:

- A. One Black and White Printer capable of printing on A3 paper.
- B. One A3 color printer with all paper and ink required for the duration of the project.
- C. One color scanner.
- D. Approved computer hardware and software support shall be provided for the duration of the project. All systems must be installed and configured by the Contractor to the satisfaction of the Engineer. Contractor shall have all computer equipment assembled on site and connected.
3. One (1) plan table, 0.9 m x 1.8 m and one stool
4. UPS Equipment, UPS shall be provided for each PC/laptop 600VA for five minutes duration, full load.
5. Three (3) Digital Cameras/ one for each site of the three sites with the following specifications:
 - A. Free Memory 8 GB + CASE
 - B. Minimum 20 MP
 - C. Min 25x Optical Zoom
 - D. Minimum 3-inch Screen
 - E. Continuous Shooting Speed minimum of: 10fps
 - F. Expanded ISO Maximum: 12800
 - G. Lithium Battery
 - H. Video Capture resolution 1080P

After completion of project the cameras will become the property of the Contractor.
6. Twelve (12) plastic safety helmets, confirming to ASTM 01 ISO Standards
7. Three battery powered (ID size, 1.5 V) flash lights.
8. First aid kit suitable for 12 people with instruction manual, similar to American White Cross No. K10 .
9. One cross-cut shredder with basket, Fellowes Model No. P6000O2, or equal
10. Electronic equipment must be provided with protective covers supplied by the original manufacturer.

K. Survey Equipment Assistance

The Contractor shall make available on Site suitable surveying equipment, in good condition, to enable the Engineer's assistants to check setting out, etc. and shall provide chainmen and other assistants if required.

L. Thermometers

Furnish Maximum and minimum thermometer for measurement of atmospheric temperature and Thermometer for measurement of concrete and ground temperature.

M. Inspection Facilities

The Contractor shall provide all ladders, access lighting facilities and assistance as required by the Engineer's assistants to inspect any part of the Works.

N. The Contractor must also provide all consumables, stationery and paper supplies.

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

1.11. VEHICULAR ACCESS

A. Construct temporary access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.

B. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.

C. Location approved by Engineer.

1.12. PARKING

A. Construct shaded temporary surface parking areas for the following cars:

1. Engineer's Staff: 4 spaces

2. Visitors: 2 spaces

B. Locate as approved by Engineer.

C. When site space is not adequate, provide additional off-site parking.

D. Do not allow heavy vehicles or construction equipment in parking areas.

E. Maintenance: Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, and ice.

F. Removal, Repair:

1. Remove temporary materials and construction at Substantial Completion.

2. Repair existing facilities damaged by use, to original condition.

1.13. PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing spaces.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

- D. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site.

1.14. PROJECT IDENTIFICATION

A. Project Identification Sign:

1. One painted sign for each project site of construction, design, and content shown on Drawings, location designated.
2. Project identification sign board shall be 180 cm X 282.5 cm. In addition to the sign erection, the Contractor shall be responsible for the complete design, graphics, foundations, and structural support.
3. Project identification sign board shall be illuminated.
4. Content:
 - a. Project title, logo and name of Owner as indicated on Contract Documents.
 - b. Names and titles of authorities.
 - c. Names and titles of Engineer and Consultants.
 - d. Name of Prime Contractor and major Subcontractors.

B. Project Informational Signs:

1. Painted informational signs of same colors and lettering as Project Identification sign, or standard products; size lettering for legibility at 30 m distance.
2. No other signs are allowed without Owner permission except those required by law.

C. Design sign and structure to withstand 140 km/hr wind velocity.

D. Sign Painter: Experienced as professional sign painter for minimum three years.

E. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

F. Sign Materials:

1. Structure and Framing: New metal, structurally adequate.
2. Sign Surfaces: 0.5mm Thick metal plate.
3. Rough Hardware: Steel.
4. Paint and Primers: Exterior quality, two coats. Colors designated by Engineer.
5. Lettering: Exterior quality paint, contrasting colors designated by the Engineer. Languages: Arabic and English.

G. Installation:

1. Install project identification sign within 15 days after date fixed by Letter of Acceptance.
2. Erect at designated location.
3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
4. Install sign surface plumb and level, with butt joints. Anchor securely.
5. Paint exposed surfaces of sign, supports, and framing.

- H. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- I. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.15. TRAFFIC REGULATION

A. Signs, Signals, and Devices:

1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.
2. Traffic Control Signals: As approved by local jurisdictions.
3. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
4. Flag person Equipment: As required by authority having jurisdiction.

B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

C. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

D. Haul Routes:

1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
2. Confine construction traffic to designated haul routes.
3. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

E. Removal:

1. Remove equipment and devices when no longer required.
2. Repair damage caused by installation.
3. Remove post settings to depth of 600 mm minimum.

1.16. FIRE PREVENTION FACILITIES

A. Prohibit smoking with buildings under construction. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.

1. Provide one fire extinguisher at each stair on each floor of buildings under construction.
2. Provide minimum one fire extinguisher in every construction trailer and storage shed.
3. Provide minimum one fire extinguisher on roof during roofing operations using heat

producing equipment.

1.17. BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way.
- C. Provide protection for plants designated to remain. Replace damaged plants at contractor's expense.

1.18. ENCLOSURES AND FENCING

- A. Construction: Galvanized corrugated steel sheets 0.5 mm thick with steel transoms.
- B. Provide 2 m high fence around construction site; equip with vehicular gates with locks.

1.19. SECURITY

A. Security Program:

- 1. Protect Work from theft, vandalism, and unauthorized entry.
- 2. Initiate program at project mobilization.
- 3. Maintain program throughout construction period until directed by Engineer.

B. Entry Control:

- 1. Restrict entrance of persons and vehicles into Project site.
- 2. Allow entrance only to authorized persons with proper identification.
- 3. Maintain log of workers and visitors, make available to Owner on request.

C. Personnel Identification:

- 1. Provide identification badge to each person authorized to enter premises.
- 2. Badge To Include: Personal photograph, name and employer.
- 3. Maintain list of accredited persons, submit copy to Owner on request.
- 4. Require return of badges at expiration of their employment on the Work.

D. Security Service:

- 1. Employ uniformed guard service to provide watchpersons at site during non- working hours.

1.20. 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.

1.21. 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.

1.22. 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 surface area of bare soil exposed at one time.
- C. Provide temporary measures including berms, dikes, and drains, and other devices 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.

1.23. POLLUTION CONTROL

- A. 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.
- B. Comply with pollution and environmental control requirements of related authorities.

1.24. RODENT CONTROL

- A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.25. REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials, prior to Substantial Completion inspection.
- B. Remove underground installations to minimum depth of 600 mm.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION

Not Used.

END OF SECTION

SECTION 01580 PROJECT IDENTIFICATION AND SIGNS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Project identification signs only three (3) required, with each in both English and Arabic.
 - 1. Installation.
 - 2. Maintenance.
 - 3. Removal.

1.02 SYSTEM DESCRIPTION

- A. Project identification sign board shall be of sufficient size and construction to incorporate subcontractors name plates.
- B. Project identification sign board shall be illuminated.
- C. Project informational Signs.

1.03 SUBMITTALS

- A. Submit to the Engineer shop drawings under provisions of Section 01330.
- B. Show content, layout, lettering, colors, foundation, structure, sizes, and grades of members.
- C. Obtain Engineer approval and approvals of local Authorities.

1.04 QUALITY ASSURANCE

- A. Design in accordance with the Employer's requirements and instruction of the Engineer.
- B. Design sign and structure to withstand 140km/hr wind velocity.
- C. Sign Painter: engage a professional sign painter with sufficient experience in similar kind of work.
- D. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of project.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. In accordance with section 01500.

PART 3 – EXECUTION

3.01 LOCATION AND INSTALLATION

- A. To be agreed with the engineer.

3.02 MAINTENANCE

- A. Maintain signs and supports clean and repair where deterioration of damages have occurred to the satisfaction of the Engineer at no additional cost.
- B. Repaint as necessary.

3.03 PROJECT INFORMATIONAL SIGNS

- A. To be painted sign of sizes, colored and lettering as approved by the Engineer. Size of lettering to provide legibility at (30m) distance, 2.5m high from the ground.
- B. Provide at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as work progress required and/or as directed by the Engineer.

3.04 REMOVAL

- A. Remove signs, framing, supports and foundations at completion of project, and restore the area.

3.05 Schedule :

	
SCHOOLS FOR A KNOWLEDGE ECONOMY PROJECT Phase 3/ Package 2 School Name	مشروع مدارس الاقتصاد المعرفي المرحلة الثالثة/العزمة الثانية اسم المدرسة
Owner: Ministry of Education	المالك: وزارة التربية والتعليم
Employer: Ministry of Public Works and Housing	صاحب العمل: وزارة الأشغال العامة والإسكان
Funded by: United States Agency for International Development (USAID)	تمويل: الوكالة الأمريكية للتنمية الدولية (USAID)
Consultant: Design and Supervision Engicon	الاستشاري: تصميم وإشراف شركة المستشار للهندسة
Contractor: Contractor's Name	المقاول: اسم المقاول
Contract Number: (0/0000/USAID/SKEP/3/2) Duration of Contract: 000 Days	رقم العطاء: مدة المشروع: ... يوماً

180.0 cm x 282.5 cm

END OF SECTION

SECTION 01600**PRODUCT REQUIREMENTS****PART 1. GENERAL****1.1. SECTION INCLUDES:**

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options.
- E. Product substitution procedures.
- F. Equipment electrical characteristics and components.

1.2. PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.3. PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4. PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5. PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting

those standards or description.

- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.6. PRODUCT SUBSTITUTION PROCEDURES

- A. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 - 2. Will provide same warranty for Substitution as for specified product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.
- D. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.
- E. Substitution Submittal Procedure:
 - 1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
 - 2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
 - 3. Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2. PRODUCTS

2.1. EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.
- B. Cord and Plug: Furnish minimum 2 m cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

PART 3. EXECUTION

Not Used.

END OF SECTION

SECTION 01615

PACKING, SHIPPING, RECEIVING AND STORAGE

PART 1 GENERAL

1.1 SCOPE

- A. This section covers packing, shipping, delivery, receiving, storage, and handling of materials and equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXPORT, PACKING, AND MARKING INSTRUCTION

3.1.1 Preparation

The export packing and marking instructions specified herein are minimum requirements. All equipment, component parts, tools, spare parts and miscellaneous items shall be suitably packaged to facilitate handling and storage and to protect against damage or deterioration during transit to and short term storage in Host Country. All items shall be boxed or crated.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage.

Grease and lubricating oil shall be applied to all bearings and similar items.

Articles subject to damage or deterioration during shipment, handling, or storage due to defective or inadequate packaging shall be repaired or replaced by Contractor at no expense to the Employer.

3.1.2 Subassemblies

The number of subassemblies shall be kept to a minimum. Disassembled units shall be match-marked for easy reassembly, crated for adequate protection against exposure or damage in transit or storage, with markings for identification. Uncrating, inspection, and installation instructions shall be included with each crate.

3.1.3 Separate Crating

Spare parts, special tools, and fragile, vulnerable, loose, or small parts shall be crated separately with necessary identification and instructions included.

3.1.4 Packing Material

Material used for packaging, packing, and wrapping; moisture-resistant barriers; and corrosion preventives shall be recognized brands and grades and shall conform to the best commercial standards in the areas in which articles are packed and shall provide sufficient protection for transport to and storage in Host Country.

3.1.5 Workmanship

Workmanship shall be in accordance with the best commercial practice. There shall be no defects, imperfections, or omissions which impair the protection afforded by the package as a whole.

3.1.6 Preservation

Articles fabricated of metals subject to corrosion will be exposed to severe conditions of moisture and heat in Host Country. All metal subject to corrosion shall be processed with a suitable preservative. Iron and steel articles not having highly finished surfaces shall be protected by the application of a suitable thin film preservative (hard drying, cold application) that permits removal of the preservative with a petroleum base solvent. Steel articles having highly finished surfaces of simple design shall be protected by the application of a suitable heavy preservative (hot-dip) that permits removal of preservative with a petroleum base solvent.

3.1.7 Miscellaneous Requirements

3.1.7.1 Waterproof caste liners in bag form or an over wrap fabricated of asphalt laminated Kraft paper and sealed with waterproof adhesive shall be used if the goods are susceptible to damage from moisture.

3.1.7.2 Articles shall be nested or packed to reduce the volume of each container as much as possible. Article shall be closely but not tightly arranged.

3.1.7.3 Fragile articles shall be wrapped in crepe-cellulose wadding such as Kimpak or equally efficient cushioning material and floated in a suitable cushioning material having physical properties which are not harmful to the article.

3.1.7.4 Sufficient air space shall be allowed when filling liquid containers to provide space for expansion and minimize internal pressure. Liquid containers shall be capable of withstanding prolonged exposure to temperatures of 55 C without rupturing or leaking.

3.1.7.5 Equipment such as precision instruments, etc. shall be packed in an interior moisture vapor proof barrier with silica gel or a comparable desiccant to absorb moisture within the package. The presence of a desiccant will be shown on the external surface of the container.

3.1.7.6 Openings in electric motors and other electrical equipment shall be sealed with water proof tape or in some equally efficient manner.

3.1.7.7 Screw cap closures on glass or metal containers must be tight, with a suitable seal to prevent loss of contents.

3.1.7.8 Fiberboard boxes are not acceptable for use as an outer container except for air freight. When used in this manner, the material will be weather-resistant and all seams and joints reinforced by the use of waterproof pressure-sensitive tape.

3.1.8 Material for Boxes and Crates

Lumber shall be sound and well seasoned Douglas fir or equal and shall be free from defects which materially weaken members or interfere with nailing. Knots shall be sound. Knots shall not have a diameter in excess of 1/3 of the board width. Knots shall be so located as not to cause nailing interference which would result in structural weakness. All nails shall be cement-coated wire box nails. For maximum strength, nails shall be driven into side grain of lumber.

3.1.9 Open Crates

Crates shall be diagonally braced on all faces and all 3 way corner joints shall be constructed as illustrated in Figure 1-01615. The crate shall be constructed to support its own gross weight when supported by grab hooks at the top or by slings around the end or base and to withstand crushing action when pushed or moved by drag lines.

3.1.10 Palletizing

Items impervious to damage from exposure to moisture, weather, or handling and which can be conveniently secured to a pallet to facilitate handling shall be packed in this manner. Refer to attached Figure 1-01615.

3.1.11 Type of Wooden Boxes

<u>Gross Weight</u> <u>890 microns)</u>	<u>Style</u>	<u>Lumber Dimension</u> <u>Strapping</u> <u>Nominal Thickness</u>	<u>Steel</u> <u>(HD</u>
Up to 100 lbs straps-19 mm (45 kg)	4	25 mm ends, 12 mm sides, top, and bottom	2

100 - 300 Ibs (45-135 kg)	2 or 4	25 mm throughout, minimum width cleats 82 mm	2 straps-32 mm
300 -600 I bs (135 - 270 kg)	2 (banded) X (palletized)	25 mm throughout, minimum width cleats	2 straps-32 mm
	modified-2 3 (palletized)	8 mm throughout 50 mm x 100 mm skids; with corner commensurate with	1 strap-32 mm
600 - 1000 Ibs (270 - 450			

3.1.12 Metal Strapping

Metal strapping shall be unannealed steel of 890 micron thickness and 19mm minimum width applied with a stretching tool and secured with crimped steel seals. Metal strap shall be cut evenly at seal without leaving a sharp edge. Strap shall be applied one-sixth the distance from each end of boxes.

3.1.13 Bundling

All items shall be segregated to length and size and bundled into unites not to exceed 2240 Ibs (100 kilograms). Apply 32 mm steel strap with a stretching tool and secure with crimped steel seals spaced up to one meter apart.

3.1.14 Hazardous Cargo

All hazardous materials containers and packing shall conform to the rules and regulations of applicable governmental agencies for packing of hazardous materials such as poisons, poison gas, flammable solids and liquids, oxidizing materials, and nonflammable compressed gases, as applicable.

3.1.15 Export Marking

Each package shall be marked as indicated under Figure 2-01615. A marking stencil of not less than 50 mm lettering shall be used. In addition, a 50 mm band of yellow paint shall be painted around each package or bundle. Packages shall be numbered consecutively, as indicated, starting with No. 1. Each box shall contain a copy of the packing list. A duplicate copy of the packing list shall be placed in a waterproof envelope securely fastened to the outside of the box. NOTE: Contents of each box must match packing list.

In addition to the marking as specified herein, the following special marking to aid in handling shall be applied. Easily damaged material shall be marked "FRAGILE"; also, when required, "HANDLE WITH CARE", "COOL STORAGE", and/or "USE NO HOOKS". Material that must be kept upright to prevent damage such as machinery, motors, engines, etc. shall be marked "THIS SIDE UP" with arrows on all sides of box pointing to top. When required, due to length or unbalanced weight, crates or boxes shall have a

center of balance indicated by a painted or stenciled black stripe 25 mm wide on each side extending upwards from the lower side of sheathing; the words "CENTER OF BALANCE" shall appear in letters 25 mm high adjacent to stripes.

No advertising or mark indicating contents may appear on the package unless authorized.

3.2 DELIVERY

3.2.1 General

The Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the jobsite and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Contract. These requirements also apply to any sub suppliers making direct shipments to the jobsite or the port of entry into the Host Country.

The Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Contract before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, placed in operation and found to comply with all the specified requirements.

All items shall be checked against packing lists immediately on delivery to the Works for damage and checked for shortages. Damaged and shortages shall be remedied with the minimum of delay.

Delivery of portions of the equipment in several individual shipments shall be subject to review of the Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation and to facilitate eventual installation.

3.2.2 Packing

The Contractor shall comply with standard export packing instructions contained herein. When a prospective vendor's standard export packing methods are considered adequate but conflict with requirements of the instructions, an exception may be required.

3.2.3 International Shipment Planning Information

The port of entry into the Host Country for ocean shipments will be Aqaba. The port of entry for air freight shipments will be the Host Country International Airport located in Amman. As soon as possible following receipt of Letter of Acceptance, the Contractor shall submit the following information:

- a. Total estimated weight and volume of each general type of

- cargo expressed in metric tons and cubic meters.
- b. Point(s) of origin.
- c. Routing of shipment(s) including off-loading or transfer points en route.
- d. Planned use of out-of-country staging areas, if any, and the locations (city and country).
- e. Special handling requirements such as heavy lift or oversize pieces.
- f. Estimated shipping date(s).
- g. Estimated arrival date(s).
- h. Procedure for tracking in-transit shipments.
- i. Approximate shipping rate(s) and estimated total shipping cost.
- j. Plans for use of premium air shipping (if used).
- k. Manner of satisfying export control requirements of the country of origin.
- l. Manner of satisfying import control requirements of Host Country, including name(s) of proposed customs clearance brokers.

3.2.4 Shipping Information and Documentation

At the time items are released for shipment, the vendor shall provide the following information to the Contractor, Employer, Engineer and the Engineer's Representative.

- a. By telex or fax

(1) For Ocean Shipment:

- (a) Project number and Contract number.
- (b) Line item number(s) shipped and brief description.
- (c) Quantity by line item shipped.
- (d) Number of packages/containers shipped.
- (e) Total weight shipped.
- (f) Total cubic dimensions.
- (g) Name of shipping line and destination ship's agent.
- (h) Name of vessel and type (Sea Van, Container, Gen, Cargo, etc.)
- (i) Date vessel sailed.
- (j) Port of exit.
- (k) Port of discharge.
- (l) Estimated date of arrival.

(2) For Air Freight Shipments:

- (a) Project number and Contract number.
- (b) Line item number(s) shipped and brief description.
- (c) Quantity shipped by line item number.
- (d) Number of packages/containers shipped.
- (e) Gross weight shipped.
- (f) Airway bill number.
- (g) Origin airport.

- (h) Routing (flight numbers).
- (i) Date of shipment.
- (j) Estimated date of arrival.

b. By Air Mail, Pouch, or Courier service.

(1) For Ocean Shipments:

- (a) One copy of non-negotiable ocean bill of lading (consularized).
- (b) One copy of packing list (tag number to be shown, if applicable).
- (c) One copy of proforma invoice.

(2) For Air Freight Shipments:

- (a) One copy of airway bill.
- (b) One copy of packing list (tag numbers to be shown, if applicable).
- (c) Once copy of proforma invoice.

3.2.6 In-transit Status Reports

As a minimum, the following information will be furnished by telex weekly or when there is a change in status, whichever occurs first:

- (a) Project and Contract number.
- (b) Line item number(s) and quantity.
- (c) Event status; to include any off-loading, missed connections, confirmed arrival, in customs, out of customs, inland movement, etc.

3.2.7

Notification

Address Original

Name of
Contractor
Contractor'
s address

Attn: *
Project Manager

FAX
Telex:
Answerback:

* Name to be provided at time of award.

3.3 INVOICING INSTRUCTIONS

3.3.1 Consignment

The project name, project number and the name of the Employer must be clearly indicated on the airway bill or bill of lading. The bill of lading or airway bill shall contain instructions to notify the Employer or a clearing agent but the consignee must be the Contractor.

For this project, shipping categories will be as follows:

- a. Project, plant, materials and vehicles.
- b. Contractor's equipment (including vehicles), materials, and owned commodities.
- c. Contractor's employees personal household commodities, including vehicles.

These categories of shipments shall not be combined on a single bill of lading. Shipments from different categories may be combined in one container providing that each category has a separate bill of lading.

3.3.2 Bill of Lading

Invoicing and packing list information may be combined on a single document or may be shown separately. In either case, all of the following information must be provided.

- a. Name and address of Contractor.
- b. Name and address of shipper and date of shipment.
- c. Item number, quantity, unit and COMPLETE description.
- d. Net unit prices and extensions for each line item and total amount.
- e. Marks, numbers, quantities, and kinds of packages.
- f. Gross, tare, and net weight in pounds and kilos and the three dimensions of each package.
- g. Invoices, including transportation charges, shall be supported by carrier's original receipted freight bills.
- h. Invoices shall cover only items or portions thereof actually shipped. Any additional duties, penalties, fines or other costs resulting from incorrect invoicing will be for the account of the Contractor.
- i. Itemize additional costs, i.e., taxes, duties, packing, cartage, inland freight, etc. in accordance with the shipping terms, the Conditions of Contract, and any other terms of the Contract.
- j. All invoices must bear the following signed and dated certificate:
"We hereby certify that materials listed herein are of the country of origin and/or manufacturer in accordance with Article 51 of the Conditions of Contract, Part I-General Conditions and the amounts and prices as quoted are true and correct". *
- k. The required number of copies of invoices and packing lists as specified herein.

- l. Forward all correctly prepared documents promptly to avoid delay in payment.

* Not applicable to Host .

3.3.3 Country companies

Document Submittal Instructions

- A. Invoicing. The following documents shall be forwarded by Contractor to the address listed below.

Invoice - original plus 3 copies

Inland Bill of Lading or Dock Receipt - signed

original plus 2 copies Packing List - 1 copy

Forward the above listed documents to:

Construction Management Consultant
- "Engineer" Address in Host Country
to be supplied later.

Attention: (Name to be provided at the time of award.)

It is imperative that a signed copy of Bill of Lading or Dock Receipt be included with Invoice and Packing Lists.

3.4 STORAGE

Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

Stored items shall be laid out to facilitate their retrieval for use in the programmed order. Care shall be taken in drawing the equipment for use to ensure the precise piece of equipment is removed.

Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged.

No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground.

Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum.

Cement, lime and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times.

Pipe fittings and valves may be stored out of doors but must be placed on

wooden blocking.

PVC pipe, geomembranes, plastic liner and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 16 C. Electrical equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be carefully followed by the Contractor.

Moving parts shall be rotated a minimum of twice a month to ensure proper lubrication and to avoid metal to metal "welding". Upon installation of the equipment, the Contractor shall, at the discretion of the Engineer, start the equipment at one half load, for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment by the Contractor at the time of acceptance.

Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

In addition to the protection specified for prolonged storage, the packaging of spare units and spare parts shall be for export packing and shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

Instructions for the servicing of equipment while in long-term or prolonged storage shall accompany each item of equipment. Advertisement of enclosed instructions with each package shall be noted on the exterior of the package in the Host Country and English language.

3.4.1 Off-Site Storage

Off-site storage arrangements shall be acceptable to the Engineer for all materials and equipment not incorporated into the work but included in applications for payments. Such off-site storage arrangements shall be presented in writing, and shall afford adequate and satisfactory security and protection. Off-site storage facilities shall be accessible to Engineer.

END OF SECTION

**SECTION 01625
SOURCE AND ORIGIN**

PART 1 GENERAL

1.1 SCOPE

- A. This section covers the approved source and origin waiver.

PART 2 PRODUCTS

	Submittal Description	Approved Geo Code for Source	Approved Geo Code for Origin
A1	Fluid applied waterproofing and joint sealer	278	935
A2	Joint sealers	278	935
A3	Vapor retarders	278	935
A4	Door & window hardware	278	935
A5	Ceramic & Porcelain tiles & skirting	935	935
A6	PVC tiles & skirting	935	935
A7	Special Paint Coatings	278	935
A8	Special Cement Adhesives & Additives	278	935
A9	Acoustical False Ceiling System	278	935
	Electrical Items		935
E1	PVC Conduit fittings & accessories	278	935
E2	Distribution boards (DB)	278	935
E	UPVC Conduit fittings & accessories	278	935
E4	Isolator, different current & phases	278	935
E5	Electrical identification	278	935
E6	Wiring devices different type & size	278	935
E7	Wiring communications	278	935
E8	Under carpet cable & accessories	278	935
E9	Communication circuit & accessories	278	935
E10	Fire alarm & Evacuation system with accessories for fire alarm cable	278	935
E11	Emergency lighting	278	935
E12	Grounding for low voltage system	278	935
E13	Socket outlets	278	935

E14	Flex outlet	278	935
E15	PBX for MDF	278	935
E16	Data cabinets, cabling & accessories	278	935
E17	Digital telephone exchange	278	935
E18	Motor control center (MCC)	278	935
E19	Control Panels	935	935
E20	Floor boxes	935	935
E21	Interior Luminaries	935	935
E22	Exterior Luminaries	935	935
E23	Main distribution boxes, sub-distribution boxes and accessories including grounding	935	935
E24	Public addresses & Music Equipment	935	935
E25	Hand Dryer	935	935
E26	Electro- magnetic Door Lock System	935	935
	Mechanical Items		935
M1	Water distribution box with brass manifolds, valves, automatic air vent	278	935
M2	Package terminal air conditioning units	278	935
M3	Eastern WC with flush valve	278	935
M4	Floor drains & covers	278	935
M5	Floor cleanouts & covers	278	935
M6	Submersible pump set 2 pumps with control panel	278	935
M7	Glass lined electrical water heater	278	935
M8	Hand spray	278	935
M9	Multistage cold water domestic water pump set consist at 3 pumps	935	935
M10	Air jet nozzle	935	935
M11	Hot water feeding tank	935	935
M12	Fire pump & fittings	935	935
M13	Wall mounted DX coils split units	935	935
M14	Solar panels for space heating	935	935
M15	Electric Water cooler	935	935
M16	Boiler	935	935
M17	G.S.P fire tank	278	935
M18	Elevators & Components	935	935
M19	Steel Radiators	935	935

M20	Cast- Iron Radiators	935	935
M21	Valves & Strainers for heating, domestic potable water, and fire fighting systems	935	935
M22	XLPE Multi-layer Aluminum Domestic Water Pipes, fittings & accessories	935	935
M23	CPVC Water Pipes, fittings & accessories	278	935
M24	Exhaust Fans	935	935

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01700**EXECUTION REQUIREMENTS****PART 1. GENERAL****1.1. SECTION INCLUDES**

- A. Closeout procedures.
- B. Final cleaning.
- C. Starting of systems.
- D. Demonstration and instructions.
- E. Testing, adjusting and balancing.
- F. Protecting installed construction.
- G. Project record documents.
- H. Operation and maintenance data.
- I. Manual for materials and finishes.
- J. Manual for equipment and systems.
- K. Spare parts and maintenance products.
- L. Product warranties and product bonds.
- M. Maintenance service.

1.2. CLOSEOUT PROCEDURES

- A. 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 Engineer's review.
- B. Provide submittals to Engineer required by authorities having jurisdiction.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.3. FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Clean interior and exterior class, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- D. Clean filters of operating equipment.
- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean site; sweep paved areas, rake clean landscaped surfaces.

- G. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.4. STARTING OF SYSTEMS

- 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 each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable manufacturer's representative and 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 01330 that equipment or system has been properly installed and is functioning correctly.

1.5. DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- F. Required instruction time for each item of equipment and system is specified in individual sections.

1.6. TESTING, ADJUSTING AND BALANCING

- A. Contractor shall appoint, employ, and pay for services of an independent firm to perform testing, adjusting, and balancing.
- B. Independent firm will perform services specified in Division 15.
- C. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of

Contract Documents.

1.7. PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.8. PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract,
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record daily "as -built" information on a set of blue or black line opaque drawings.
- G. Provide felt tip marking pens, maintaining separate colors for each major system, for recording information.
- H. Record daily information concurrently with construction progress. Do not conceal any work until required information is recorded.
- I. Record Drawings and Shop Drawings: Legibly mark each item to record actual

construction including:

1. Measured depths of elements of foundations in relation to finish first floor datum.
 2. Measured horizontal and vertical locations and sizes of underground utilities and appurtenances, referenced to permanent surface elements.
 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
 4. Site changes of dimension and detail.
 5. Changes made by Modifications.
 6. Details not on original Contract Drawings.
 7. References to related Shop Drawings and Modifications.
- J. Other Documents: Maintain manufacturer's instruction manuals and certifications, inspection certifications, filed test records, and other Documents required by individual Specifications sections.
- K. Plant Record: Provide a daily record to the Engineer in a format to be approved by the Engineer, showing the type, model and capacity of all mechanical and power operated plant employed on the works. The Contractor will not be permitted to remove any plant or material unless written approval is obtained from the Engineer. This record shall be incorporated in to the Daily Construction Report in Section 01330 "Submittal Procedures".
- L. Labor Record: Provide a daily record to the Engineer in a format to be approved by the Engineer showing the number and description of craftsmen, laborers and other persons employed on or in connection with the works, including those employed by sub-contractors. This record shall be incorporated in to the Daily Construction Report in Section 01330 "Submittal Procedures".
- M. Visitors Record: Maintain a record of visitors to the Site and submit at monthly intervals to the Engineer.
- N. Weather Records:
1. Keep an accurate record of:
 - a. Daily maximum and minimum air temperatures (including overnight).
 - b. Number of hours per day in which work is prevented by inclement Weather.
 2. Provide at least two thermometers at agreed locations inside a building.

1.9. OPERATION AND MAINTENANCE DATA

- A. Submit data bound in A4 three-ring binders with hardback, cleanable, plastic covers; 50mm maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project and subject matter of binder when multiple binders are required.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger

drawings to size of text pages.

- E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
 2. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Originals of warranties.

1.10. MANUAL FOR MATERIALS AND FINISHES

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy be reviewed and returned after final inspection, with Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes in final form within 10 days after final inspection. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations.
- E. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- F. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- G. Additional Requirements: As specified in individual product specification sections.
- H. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.11. MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy be reviewed and returned after final inspection, with Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes in final form within 10 days after final inspection.
- E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- F. Panel board Circuit Directories: Provide electrical service characteristics, controls, and communications.
- G. Include color coded wiring diagrams as installed.
- H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.
- I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- J. Include servicing and lubrication schedule, and list of lubricants required.
- K. Include manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by controls manufacturer.
- M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Include control diagrams by controls manufacturer as installed.
- O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.
- P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Include test and balancing reports as specified in Section 01400.
- S. Additional Requirements: As specified in individual product specification sections.
- T. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.12. SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver spare parts and products required for maintenance to a location designated by the

Engineer. Obtain receipt for the delivery of the said parts and products prior to issuance of final payment certificate.

1.13. PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Include Table of Contents and assemble in three-ring binders with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time Of Submittals:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
 - 2. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.14. MAINTENANCE SERVICE

- A. Furnish service and maintenance of components as indicated in individual specification sections other project documents.
- B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.
- D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of the Owner/Employer.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION

Not Used

END OF SECTION

CIVIL WORKS

DIVISION 2
SITE CONSTRUCTION

SECTION 02222
DEMOLITION AND REMODELING

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Selective Demolishing, removal and subsequent disposal of utilities, pavements, portions of buildings, and other items indicated to be removed.
- B. Related Sections:
 - 1. Section 02300 Earthwork

1.02 REFERENCES

- A. Code of Federal Regulations (CFR)
 - 29 CFR Part 19 10 Occupational Safety and Health Standards
 - 29 CFR Part 1926 Safety and Health Regulations for Construction
- B. Uniform Federal Accessibility Standards (UFAS) FED-STD-795

1.03 DEFINITIONS

Competent Person: Capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

1.04 SUBMITTALS

- A. Provide Submittals in accordance with section 01330
 - 1. Demolition Survey, according to 29CFR 1926.850(a), whenever structural integrity of building components may be compromised or when structure is to be completely demolished.

1.05 QUALITY ASSURANCE

- 1. Obtain all permits for demolition, conform to applicable codes for demolition and perform work in accordance with the ministry of public works & Housing (MPWH).

PART 2 – PRODUCTS

Not used

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Survey existing conditions prior to beginning on-site demolition operations.
 - 1. Provide written pre-demolition survey to the Engineer that includes the following:
 - a. Determination of condition of framing, floors, and walls, and possibility of unplanned collapse of any portion of structure or adjacent structure where

employees may be exposed.

- b. Various phases of demolition and description of how employees will be protected from unplanned contact with active utilities, exposure to toxic materials and gases, falling objects, structural collapse, and any other hazards routinely associated with demolition activities.
- B. Verify that utilities have been disconnected and capped.
 - C. If unanticipated mechanical, electrical or structural elements that conflict with intended function or design are encountered, investigate and measure nature and extent of conflict.
 1. Promptly submit written report to the Engineer.

3.02 SITE CONDICTION

1. Occupancy: School may continuously occupy areas of site immediately adjacent to areas of selective demolition. Code compliance of the existing facility must be maintained throughout construction, while existing facility is occupied.

3.03 UTILITY SERVICES

- A. Maintain existing utilities indicated to remain in service and protect against damage during demolition operations. Extent of electrical and mechanical utilities to be removed is shown on Drawings.

3.04 PREPARATION

- A. Conduct demolition operations and remove debris in manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- B. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities designated to remain.
 1. Provide protective measures as required to provide free and safe passage to and from occupied portions of buildings and for the handicapped that meet UFAS.
 2. Provide temporary barricades and other forms of protection as required for safety and security.
 3. Provide barriers and appropriate signs meeting requirements of 29 CFR 1910 for size and color where necessary to restrict pedestrians from wandering into construction areas.
 4. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure no water leakage or damage occurs to structure or interior areas of existing building.
 5. Protect walls, ceilings, floors, and existing finish work that are to remain in place and are exposed during demolition operations.
 6. Cover and protect furniture, equipment, and fixtures that are to remain from soiling or damage.
- C. Erect and maintain dust-proof partitions and temporary enclosures to limit dust or dust migration, and to separate areas from fumes and noise.

- D. Provide and maintain interior and exterior shoring, bracing or structural support to preserve stability and prevent movement, settlement, or collapse of structures and adjacent facilities that are not part of demolition.
- E. Provide acceptable temporary security barriers where physical security of buildings or fences is compromised due to demolition work.
- F. Notify affected utility companies before work and comply with their requirements and mark location and termination of utilities.

3.05 DEMOLITION

- A. General: Perform demolition work in accordance with 29 CFR 1926, with particular attention to requirements set forth in Subpart T, "Demolition".
 - 1. Perform work in safe and systematic manner.
- B. Demolish and remove existing construction only to extent required, and as indicated in Contract documents.
- C. Should the owner wishes to take any of the materials/items from the existing site before demolishing, Tenderer shall hand over the selected material/item to the owner at the site location.
- D. The contractor shall remove the product and dispose of contaminated soil to the places permitted by the competent authorities and according to their instructions.
- E. Wear proper personal protective equipment at all times.
- F. Use water as necessary to lay dust when chipping, coring, or sawing concrete, masonry or similar materials. Water must be controlled inside buildings by damming, mopping or vacuuming. Prevent water from entering under floor electrical ducts.
- G. Completely backfill below-grade areas and voids resulting from utility removal and other demolition work.
- H. Remove debris from roof or other above-grade location through enclosed chute or bundle, and lower by hand or with hoisting device.

3.06 BASKETBALL HOOP POLES

- A. Removing basketball hoop poles with care to the new site indicated on the drawings and approved by the Engineer.
- B. Do necessary maintenance for basketball hoop poles, re-welding, repainting, etc...
- C. Fixing the basketball hoop poles to new site indicated on drawings, including excavation, concrete base, steel bars, fixing bolts, and all necessary to complete the work.

3.07 REPAIRS

- A. Repair demolition performed in excess of that required.
- B. Return structures and surfaces not part of demolition, to conditions existing prior to commencement of demolition work.
- C. Promptly repair adjacent construction or surfaces soiled or damaged by demolition work at no cost to the Employer.
- D. Relocating, installing and connecting any impeded pipes, cables and connections raised during the demolish works.

3.08 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of debris, rubbish, and other materials resulting from

building site demolition operations.

- B. If Contractor encounters material during removal that is suspected to be potential hazard, stop work immediately and notify the Engineer.
- C. The Engineer shall determine salvageable items, if not indicated in Contract documents.

3.09 REMODELING

- A. General: Perform remodeling work in accordance with Contract documents, drawings and as directed by the Engineer.

3.10 CLEANING

- A. Remove tools, equipment and demolished materials from site upon completion of demolition work.
- B. Remove protections as approved by the Engineer and leave interior areas broom clean.

END OF SECTION

SECTION 02240

GEOTEXTILE

To be read in conjunction with General Requirements and other related sections of the Specifications and Conditions of Contract.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextile under planting soils.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02920 – Planting Soil.

1.3 SUBMITTALS

A. Manufacturer's product data sheet.

B. Samples: Submit physical samples of the types of Geotextile required.

1.4 MATERIALS

A. Geotextile shall be comprised of polymeric yarns, or fibers, oriented into stable network which retains its structure during handling and placement.

B. Geotextiles shall be stock products (i.e., geotextile shall not be specifically manufactured to meet this Project).

1.5 SOURCE QUALITY CONTROL

A. Tests:

1. Geotextiles shall be tested by geotextile manufacturer to evaluate characteristics for quality control. At minimum, the tests indicated in Part 1.5.B of this Specification shall be performed for quality control in accordance with the test methods specified. Unless otherwise noted, the values provided in Part 1.5.B are minimum average roll values.
2. At geotextile manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non complying rolls and to qualify individual rolls.

B. Material Minimum Specifications: Geotextile protection and slip membrane shall be manufactured from polypropylene base of minimum 200 gr/m² applied on both sides of the membrane.

Property	Test Procedure	MARV Value (unless indicated)
Mass/Unit Area (weight) (g/m ²)	ASTM D5261	200
Grab Tensile Strength (kN)	ASTM D4632	0.7
Grab Elongation (%)	ASTM D4632	50
Trapezoidal Tear Strength (kN)	ASTM D4533	0.25

1.6 INSTALLATION

A. Preparation:

1. Areas on which geotextile is to be placed shall be graded and dressed to lines and grades shown on the Contract Drawings or as required by Engineer. Repair eroded or washed out areas prior to placement of material.

B. Geotextile Placement:

1. During placement of geotextiles, care shall be taken not to entrap excessive dust or moisture in or beneath the geotextile, that could damage the geotextile, and/or cause clogging of drains or filters.
2. Place and secure geotextile products per manufacturer's recommendations and specifications.

END OF SECTION

SECTION 02300 EARTHWORK

PART1 – GENERAL

1.01 SUMMARY

- A. General: Perform earthwork necessary to complete all site clearing excavating, filling, grading and compacting of soils including preparation of subgrade for slabs and pavement as shown on the drawings or inferable therefrom and/or as specified in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
1. Excavation for isolated and continuous footings.
 2. Excavation for paved areas and curbs.
 3. Trench excavation.
 4. Back filling for buildings and structure
 5. Filling grading and compaction.
 6. Testing.
 7. Clearing away surplus excavated materials.
 8. Excavation of mechanical / electrical works.

1.02 RELATED SECTIONS

- | | |
|------------------|---------------------------------|
| 1. Section 02222 | Minor Demolition And Remodeling |
| 2. Section 02720 | Aggregate Base Course |
| 3. Section 02770 | Stone Curbs. |
| 4. Section 03300 | Cast-in-Place Concrete. |

1.03 REFERENCES

- A. American Society of Testing and Materials (ASTM):
1. ASTM C 33: "Specification for Concrete Aggregates"
 2. ASTM D 422: "Method for Particle - size Analysis"
 3. ASTM D 1556: "Test Method for Density of Soil in place by the Sand-cone Method"
 4. ASTM D 1557 : "Test Methods for Moisture - Density Relations of Soils and Soil Aggregate Mixtures"
 5. ASTM D 2167: "Test Method for Density of Soil in place by the Rubber Balloon Method"
 6. ASTM D 4318: "Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils"
- B. American Association of State Highway and Transportation Officials (AASHTO) .
1. AASHTO T27: "Sieve Analysis of Fine and Coarse Aggregate"
 2. AASHTO T96: "Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine"
 3. AASHTO T-89: "Determining the Liquid Limit of Soils"
 4. AASHTO T-90: "Determining the Plastic Limit and Plasticity Index of Soils"
- C. British Standard (BS)
1. BS 812: "Testing aggregates. Method for determination of particle size distribution. Sieve tests"
- D. Occupational Safety and Health Administration (OSHA):

1. Part 1926. Subpart P: "Excavation, Trenching and Shoring, Construction Safety and Health Regulations".

1.04 SUBMITTALS

- A. Submit full details, calculations and shop drawings showing the method of excavation, temporary protection, any other details pertinent to excavation for the review and approval of the Engineer before commencing the excavations.
- B. Test Reports:
 1. Submit the following reports to Engineer from the testing laboratory:
 - a. Report and Certification of granular fill and drainage fill.
 - b. Test reports on borrow materials.
 - c. Report on the actual unconfined compressive strength.
 - d. Field density test reports.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
- B. Testing and Inspection:
 1. Submit proposed name of independent Testing Agency qualified by MPWH grade 1 for the approval of the Engineer. Employ, at no extra cost to the Employer, the approved Testing Agency to perform all tests and submit reports specified in this Section. Approval may be withdrawn at the discretion of the Engineer and an alternative Testing Agency approved.
 2. The independent Testing Agency shall be responsible for conducting and interpreting the tests, shall state in each report whether or not the test specimens comply with all requirements of the Contract Documents and shall specifically note any deviations therefrom.

1.06 PROJECT CONDITIONS

- A. Examine the Site, record of test borings, and the subsurface exploration reports to determine all conditions under which the Work will be performed. Obstructions or underground service may be encountered during the construction stage for which no records or data available. The Contractor shall be responsible for investigating the type of obstructions and allow in his Tender Sum.
- B. Pumping and Drainage: Excavate areas so as to afford adequate drainage. Control grading to prevent water running into the excavated areas. Until the work is completed, remove water that may interfere with the proper performance of the work or cause ponding.
- C. Perform all work in such manner as to ensure the safety of the Works, the public and adjoining sites and so as to cause as little inconvenience as possible to the public and adjoining Owners, and allow in the Tender for all necessary precautions to that end.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Structural Fill

1. Sound, clean, durable, granular materials free from deleterious matter and in accordance with the following gradations:

(a) Grading Limits					
ASTM Test Sieve	Nominal Size of Aggregates				
	3/4"	1/2"	3/8"	1/4"	No. 6
1" (25.0 mm)	100	--	--	--	--
3/4" (19.0 mm)	85-100	100	--	--	--
1/2" (12.5mm)	0-40	85-100	100	--	--
3/8" (9.50 mm)	0-7	0-40	85-100	100	--
1/4" (6.30 mm)	--	0-7	0-35	85-100	100
No. 4 (4.75 mm)	--	--	0-10	--	--
No. 6 (3.35 mm)	--	--	--	0-35	85-100
No. 8 (2.36 mm)	0-2	0-2	0-2	0-10	--
No. 12 (1.70 mm)	--	--	--	--	0-35
No. 16 (1.18 mm)	--	--	--	--	0-10
No. 200 (0.075 mm)	--	--	--	0-2	0-3
(b) Specified Size;					
• Passing Sieve No.:	3/4"	1/2"	3/8"	1/4"	No. 6
• Retained on Sieve No.:	1/2"	3/8"	1/4"	No. 6	No. 12
• Minimum Percentage:	60	60	65	65	65

2. Gradations in the table above represent the limits which shall determine suitability of aggregate for use from the sources of supply.
3. Structural fill is classified as Single Size Aggregate.
4. Use structural fill under concrete slabs, sidewalks, paving, under utility pipes, and at other soil bearing situations and as approved by the Engineer.
5. Backfill by single size aggregate to be used at locations as directed by the Engineer and shall meet the following requirements:
- a. Single size backfill shall not be used in the uppermost 20 cm below topping (sub grade) layer and the areas of single size backfill shall be confined from all sides. For unconfined sides, confinement shall be undertaken using compacted common backfill of a width of not less than 1.0 meter.
 - b. Single size aggregate shall be composed of crushed clean and hard particles free from noticeable amounts of organic matters, clay lumps, friable particles, or any other deleterious materials. Sieve analysis test of the intended aggregate size to be used shall be tested according to AASHTO T 27, and it shall satisfy the gradation limits. The Flakiness Index determined according to BS 812, if applicable, shall be less than 35. The percent loss at 500 revolutions in L.A Abrasion test (AASHTO T 96), if applicable, shall be less than 40. The sand size (No. 6 nominal size), when used, shall be Non-Plastic according to

- AASHTO T 89 and T 90.
- c. The single size aggregate shall be properly pre-wetted and laid in lifts of not more than 300 mm in thickness. Each layer shall be properly vibrated and tamped at wet condition to the satisfaction of the Engineer.
6. Fine sand of 500 mm thick layer (similar to Sweileh sand) to be used in sand pits as per drawings.

PART 3 – EXECUTION

3.01 EXCAVATION

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.2 “Excavation Works”.

3.02 FILLING AND COMPACTING

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.2 “Excavation Works”.

3.03 FIELD QUALITY CONTROL

- A. Testing of Materials: The independent Testing Agency shall perform all tests herein specified and any additional tests as may be required and submit test reports to the Engineer, including the following:
 1. One optimum moisture - maximum density curve for each type of soil encountered in subgrades and fills under isolated and continuous footings, slabs on grade and paved areas. Determine maximum densities in accordance with ASTM D1557.
 2. Each type of borrow material shall receive:
 - a. Mechanical Analysis. ASTM D422.
 - b. Plasticity Index Determination. ASTM D4318.
 - c. Moisture-Density Curve Determination. ASTM D1557.
 - d. CBR test as a measure for bearing capacity when required.
 3. The independent Testing Agency shall determine the suitability of materials to be used for fills and to the approval of the Engineer.
- C. Cooperate with the independent Testing Agency in every respect in the performance of the required tests.
- D. If, based on reports of the independent Testing Agency and inspection, the subgrade or backfills are found to be below the specified density, the Engineer may require additional compaction and testing and all this shall be carried out at the expense of the Contractor.

3.04 STORAGE AND DISPOSAL OF EXCAVATED MATERIALS

- A. The following material shall be disposed of legally off the site unless otherwise directed by the Engineer.
 1. Unsuitable excavated materials.
 2. Excess excavated material.
- B. Storage on site of suitable excavated material for later reuse on site, in temporary spoil heaps, is subject to approval by the Engineer for location, quantity and quality of fill material stored. Approval can be rescinded at any time. No claim for additional

compensation will be allowed if site storage is not approved.

- C. Material resulting from clearing and grubbing operations must not be burnt on the site. Dispose of all such material legally off the Employer's property and surrounding areas.

3.05 PROTECTION

A. Safety:

1. Provide a temporary and strong barrier on the edges of the trench excavation as a safety measure.
2. Keep stores and material away from the edge of the trench excavation so as to allow free movement of labourers and staff around the excavations.
3. Use sturdy steel or timber stairs to climb up and down the excavated trenches. Do not use ladders.

B. Pumping and Drainage: Excavate areas so as to afford adequate drainage. Control grading to prevent water running into the excavated areas. Until the work is completed, remove water that may interfere with the proper performance of the work or cause ponding.

- A. Perform all work in such manner as to ensure the safety of the Works, the public and adjoining sites and so as to cause as little inconvenience as possible to the public and adjoining owners, and allow in the Tender for all necessary precautions to that end.

END OF SECTION

SECTION 02700

PAVEMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

Work in this section includes:

This work shall consist of furnishing, placing and applying sub base, bases, bituminous materials, hot poured joint sealers, prime and tack coats, bituminous concrete and Composition and compaction testing in accordance with the Specification, in conformity with the lines, grades, thickness and typical cross sections shown on the Drawings.

1.2 RELATED SECTIONS

1. Section 02300 Earthwork

PART 2 - PRODUCTS

- A. Refer to the Specifications for Highway and Bridge Construction, 1991 issued by the Ministry of Public Works and Housing.

PART 3 - EXECUTION

- A. Refer to the Specifications for Highway and Bridge Construction, 1991 issued by the Ministry of Public Works and Housing.

END OF SECTION

SECTION 02720

AGGREGATE BASE COURSE

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Work provided under this specification shall include the furnishing, placement and compaction of aggregate base course, providing fine granule on top of sheet waterproofing for roofs.
- B. Related Sections: Refer to the following sections for related work:
1. Section 02300 Earthwork.
 2. Section 03300 Cast-in-Place Concrete.
 3. Section 07130 Sheet Waterproofing

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. ASTM C88 : Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 2. ASTM C131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 3. ASTM C136 Method for Sieve Analysis of Fine and Coarse Aggregates
 4. ASTM D75 Practice for Sampling Aggregates
 5. ASTM D422 Test Method for Particle-Size Analysis of Soils
 6. ASTM D1557 Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb(4.54-kg) Rammer and 18-in.(457mm) Drop
 7. ASTM D2419 Test for Sand Equivalent Value of Soils and Fine Aggregate
 8. ASTM D2844 Test Methods for Resistance R-Value and Expansion Pressure of Compacted Soils
 9. ASTM D2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 10. ASTM D2940 Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
 11. ASTM D3017 Test Method for Water Content of Soil and Rock in-place by Nuclear Methods (Shallow Depth)
 12. ASTM D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Section 01330, "Submittal".
- B. Product Data: Submit product data for each base course material.
- C. Test Reports: Provide laboratory test reports to show that materials comply with requirements specified in 2.01 "Materials" of this specification.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protection: Base course shall be transported in suitable vehicles with a cover. A load shall be covered immediately after loading and remain covered until unloading.

1.05 PROJECT CONDITIONS

Environmental Requirement: In the event of temporary suspension of the Work or inclement weather, or as directed by the Engineer, all of the Work, materials and equipment incorporated therein shall be protected against damage, injury or loss from the weather, whether in storage on or off the site.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Provide base course material consisting of fine and coarse aggregate, the combination of materials conforming to the requirements of ASTM D2940.
Base course shall have a resistance value (R-value) not less than 76 as determined by ASTM D2844.
- B. Coarse Aggregate: Durable crushed particles of either stone, gravel, asphalt concrete pavement, or Portland cement concrete.
 1. Aggregates retained on the No. 4 (4.75 mm) sieve shall be capable of withstanding the effects of handling, spreading, and compacting without degradation production or deleterious fines.
 2. Coarse aggregates shall comply with the requirements shown in TABLE 02232.B.
- C. Fine Aggregate: Aggregates retained on the No. 4 (4.75 mm) sieve shall consist of fines from the operation of crushing coarse aggregate.
 1. Natural sand, or finer mineral matter, or both, may be added where available and suitable.
 2. Fine aggregate shall comply with the requirements shown in TABLE 02232.B.

ENGINEERING REQUIREMENTS TABLE 02232.B		
CHARACTERISTIC	Fine	Course
Los Angeles Abrasion Wear (ASTM C 13 1)		40% max.
Soundness (5 cycles ASTM C88)	15% max.	15% max.

Crushed Aggregate (% Material Retained on 3/8 inch sieve (9.5 mm) by wt., having at least two (2) fractured faces)		50% max.
Maximum % passing No. 200 (75 pm)	60% of No. 30 (600 pm)	
Plasticity Index (Material finer than No. 40 sieve) (425 pm)	4.0 max.	
Sand Equivalent Value	35 min.	

- D. Fine Granule: Provide fine granule on top of waterproof sheets for roofs.

2.02 SOURCE QUALITY CONTROL

- A. Tests: A sample of material delivered to the project shall be taken for each 300 tons (270 metric tons) placed or each day's placement, whichever is greater, and tested for gradation and moisture density relationship.
- B. Testing of Materials: The independent Testing Agency shall perform all tests herein specified and any additional tests as may be required and submit test reports to the Engineer.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Preparing the site related to irregularities in substrate gradient correction, elevation by scarifying, reshaping and recompaction.

3.02 INSTALLATION

- A. General: Each base course shall be placed in lifts which will provide 200mm compacted thickness.
- B. Leveling and contouring surfaces to elevations and gradients as indicated.
- C. Compaction as described.

3.03 FIELD QUALITY CONTROL

- a. The independent Testing Agency shall perform compaction testing and any additional tests as may be required and submit test reports to the Engineer.
- b. Testing for compaction density ration under asphalt pavements and under concrete SOG.
- c. Crushed aggregate base/sub-base course, compacted to 95% modified AASHTO density CBR \geq 80%.

3.03 CLEANING

Contractor shall keep the premises free from accumulations of waste materials, rubbish,

and other debris resulting from the Work.

- A. Remove all waste materials, rubbish, and debris from and about the premises.
- B. Remove all tools, construction equipment and machinery, and surplus materials.
- C. Contractor shall restore to their original condition those portions of the site not designated for alteration by the Contract documents.

END OF SECTION

SECTION 02761 PAVEMENT MARKING

PART 1 GENERAL

1.01 SUMMARY

A. **Section Includes:** Pavement marking, which require paint finish in accordance with the requirement of the Contract Document. Work includes but is not limited to the following:

1. Car park areas.
2. Access ramps.
3. Driveways.
4. Parking lot striping and disabled symbol marking.
5. Play yards (Football and basket ball yards).

B. Related Sections

- | | |
|------------------|------------------------|
| 1. Section 02770 | Stone Curbs |
| 2. Section 03300 | Cast-in-place-concrete |
| 3. Section 03530 | Concrete Topping |

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D868-81 Method of Evaluating Degree or Bleeding of Traffic Paint
2. ASTM D869-78 Method of Evaluating Degree of Settling of Traffic Paint.
3. ASTM D913-83 Method of Evaluating Degree of Chipping of Traffic Paint
4. ASTM D969-81 Method of Laboratory Test for Degree of Bleeding of Traffic Paint. .

B. Australian Standard (AS)

1. AS 1428 - Design for access and mobility Set.

1.03 SUBMITTALS

A. **Product Data:** Submit to The Engineer for review, the manufacturer's specifications and installation instructions for paint materials and systems, including certifications, verification of mil thickness specified and other data to show compliance with these Specifications.

B. **Sample:** Furnish to the Engineer a five (5) liter sample of the paint for approval. Paint shall be fresh and furnished to the proper density and consistency for application without thinning.

1.04 QUALITY ASSURANCE

A. **Applicator Qualifications:** Painting work shall be executed by an approved Specialist.

1.05 PROJECT CONDITIONS

A. **Environmental Conditions**

1. Paint shall not be applied in rain, fog or mist, or when the air is dust laden, or when the relative humidity exceeds 85%. Paint,

other than water-thinned coatings, shall be applied only to surfaces that are completely free of surface moisture as determined by sight, touch and moisture meter, as specified.

2. Paint shall not be applied when the temperature of the surfaces to be painted and the surrounding atmosphere is below 10°C for water-thinned coatings. Maintain temperatures within the building at a minimum of 16°C during painting and drying periods.
3. During periods of inclement weather, painting may be continued if the areas and surfaces to be painted are enclosed and artificial heat is supplied, provided that temperature and humidity conditions prescribed above are maintained.
4. Where the paint manufacturer's specifications or instructions differ from the above specifications, the more stringent requirements shall apply to this work.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver paint materials to the job site in sealed original labeled containers, bearing manufacturer's labels, indicating name type, brand and batch number. Unless otherwise directed by The Engineer, deliver paints ready mixed. Order in advance in large enough quantities and in ample time to facilitate the work.
- B. Store materials and equipment in a designated storage space on the site. Keep storage space neat, clean and accessible at all times. Protect floors from paint spillage.

1.07 WARRANTY

- A. Manufacturers shall provide their standard warranties for products furnished under this Section of the Specification.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURE.

- A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 MATERIALS

- A. for parking marking refer to the Specifications for Highway and Bridge Construction, 1991 issued by the Ministry of Public Works and Housing.
- B. For other surfaces use material consisting with the substrate layers from a qualified manufacturer according to the Engineer's approval.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Examine the substrates and adjoining construction, and the conditions under which the work is to be installed. Do not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.02 PREPARATION

- A. Clean pavement surfaces which are to be painted, by appropriate methods to ensure the removal of all loose particles, dust and other contaminants. Test for alkali, using red litmus paper, and be sure the surfaces are thoroughly dry before painting.
- B. Inspect all surfaces in regard to their suitability to receive a finish. In the event that imperfections due to materials or workmanship appear on any surfaces after the application of paint or coating, the cost of any correction shall be borne by the Contractor.
- C. Remove manhole covers and similar items placed prior to painting, set aside and refix on completion of painting work. Protect items where not practicable to remove and upon completion of painting work remove protection.
- D. Clean all surfaces to be painted as required to remove dust and dirt. Properly prepare surfaces to receive paint or natural finish.
- E. Before applying succeeding coats, primers and undercoats shall be completely integral and shall perform the function for which they are specified. Remove any foreign matter before proceeding with the following coat.
- F. Do not apply final coats until after other trades whose operations would be detrimental to finish painting have finished their work in the area to be painted, and the areas have been released for painting.

3.03 APPLICATION

- 1. Paint shall be applied by a brush, roller or spray in accordance with the manufacturer's instructions. All materials, when brushed, shall be evenly flowed on with brushes best suited for the type of material being applied. When using a roller, the covers shall be carpet, velvet back or high pile ships wool best suited for material and texture selected by The Engineer. Sprayed paint shall be uniformly applied with suitable equipment.
- 2. Spread all materials evenly and smoothly without runs, or other defects. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Allow sufficient time between coats to ensure proper drying.

3.04 CLEANING

- A. On completion of the work, thoroughly clean the areas affected by painting works. Remove all paint splashes and smears and surplus construction materials and debris resulting from the work and dispose of same legally off the site.

3.05 PROTECTION

- A. Place paint or solvent soaked rags, waste, or other materials which might constitute a fire hazard in metal containers and remove from premises at the close of each day's work. Take every precaution to avoid damage by fire.
- B. Protect the work of all other trades against damage, marking or injury by suitable covering during the progress of the painting and finishing work. Repair any damage done.

- C. Refinish any work made necessary by defective workmanship or materials, or carelessness as directed by The Engineer.

3.06 PAINTING SCHEDULE

- A. Submit a "Detailed Painting Schedule" for review by the Engineer.
- B. **Material:** New painted line marking in car park areas, access ramps and drive ways and the like. To be install at end of construction period prior practical completion.

Fixing : Apply clear chlorinated rubber sealer and two coats acrylic resin topcoat which is water, resistant and quick drying as per manufacturer recommendations.

Mark all lines straight, with uniform width except as noted on drawings.

Finish: Color and line widths to be selected and approved by The Engineer.

End of Section

SECTION 02770 STONE CURBS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Precast concrete curbs in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
1. Stone Curbs
 2. Edge curb
 3. Concrete base and Haunching
 4. Joint filler
- B. Related Sections:
1. Section 02300 Earthwork
 2. Section 03300 Cast-in-Place Concrete

1.02 REFERENCES

- A. British Standards Institute (BSI)
1. BS 12 - Portland cement
 2. BS 882 - Aggregates from Natural Stone
 3. BS 4027 - Specifications for Sulphates-Resisting Portland Cement
- B. American Society for Testing and Materials (ASTM)
1. ASTM C33 Concrete Aggregates
 2. ASTM C150 Portland cement

1.03 SUBMITTALS

- A. Provide Data: Submit manufacturer's technical data for the types of manufactured units, including certification that the types of manufactured units comply with specified requirements.
- B. Shop Drawing: Submit shop drawings indicating the dimension of units, details of special shapes, installation details showing foundations, conditions at curve setting, butting with adjacent paving, etc.
- C. Samples: Submit full size samples using the materials, finishes and shapes as specified for each type. Sample acceptance will be for color, finish and appearance only. Compliance with other requirements is the responsibility of the Contractor.

1.04 QUALITY ASSURANCE

- A. Qualifications: Manufacturer shall have a minimum of two (2) years successful experience in the fabrication of concrete curbs units of the sizes, shapes and finishes to the units required for this project and shall have adequate facilities to provide the units.
- B. Visual Mock-Up: Following approval of samples of concrete Curb units construct visual mock-up. Coordinate construction of mock-up with that of concrete pavers so that the mock-up construction for both concrete curb and pavers shall be fully representative of the final work in all respect. Mock-up, if approved, may be used in the final work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle concrete curbs units in a manner to avoid undue cracks, staining or other damage.

PART 2 PRODUCTS

2.01 MATERIALS

General: Curb Stone.

Description: Typical 500 mm length x300mm high x(120-150mm) wide curb stones.

Compressive strength: 25N/mm²

A. Concrete curb Units

1. Cement Generally: Cement used shall be from the same mill and manufacturer to ensure uniform color for the concrete curb units required for the project.
2. Sulphate Resisting Cement: BS 4027, or ASTM C150, Type V; for grey concrete curbs units.
3. Ordinary Portland cement: BS 12 or ASTM C150.
4. Aggregates
 - a. ASTM C33 or BS 882.
 - b. Provide aggregates from a single source, for concrete curb units, to ensure uniformity of color, size and shape.
5. Water: Potable clean water.
6. Admixture: ASTM C260, air-entraining type.
7. Formwork: Comply with Section 03300 "Cast-in-Place Concrete".
8. Mix Design
 - a. Properties of Mix: Adjust design mix (mixes) as required to obtain the strength specified.
 - i. Compressive strength: 250 kg/sq.cm. Characteristic cube strength minimum at 28 days.
 - ii. Slump: 75mm maximum.
 - iii. Air Entrainment: 3% minimum, 5% maximum.

B. Concrete Base and Haunching: Provide plain concrete for base and haunching for curb units, where laid on grade, all as shown:

1. Sulphate Resisting Cement: BS 4027 or ASTM C150, Type V.
2. Aggregate: ASTM C33 or BS 882.
3. Water: Potable clean water.
4. Compressive Strength of Mix: 150 kg/sq.cm characteristic cube strength minimum 28 days.

C. Size: varying size

D. Setting and Jointing Mortar:

1. Cement: BS 4027 or ASTM C150, Type V, for setting mortar generally and joint mortar for sulphate resisting grey units. BS12 or ASTM C150, Type I or KSS 36; for setting mortar and joint mortar for ordinary grey concrete units.
2. Sand: Clean, natural sand complying with ASTM C144.
3. Water: Potable clean water.
4. Mix: One part cement to two parts sand by volume with water as required to produce a workable homogeneous mix.

- E. Expansion Joint Filler: comply with Section 07900 "Joint Sealant".
- F. Shims: Hardwood of approved type; shape and size as shown and as required.

2.02 FABRICATION OF CURB UNITS

- A. Forming: Cast-in-forms to produce accurately formed, finished units of the shapes and dimensions shown, true to line, plane and finish.
- B. Color and Finish: Maintain a uniformity of color and finish within the range established by the approved samples. Provide units with smooth, hard finish, on exposed surfaces.
- C. Curing: Cure units by steam or water (no curing compound) for a sufficient length of time to permit handling without damage
- D. Cleaning: After removal of forms and after concrete is thoroughly dry, clean the surfaces of units to remove all loose particles and foreign materials and protect units from damage.

PART 3 EXECUTIONS

3.01 INSTALLATION

- A. Set curb units on full bed of cement and sand mortar, on foundation or on hardwood shims on concrete deck slab, properly aligned, true in level and elevations with abutting paving as shown. Form neat and smooth curves, where units are set to curve, using special units. Provide custom made one piece curbs for internal and external angles where required.
- B. Install temporary curb units as shown on Drawings.
- C. Provide cement and sand mortar joint between units. Maintain uniform joint width wherever possible. Haunch or support units laid on grade as shown, in cast-in-place plain concrete.
- D. Provide expansion joint, with compressible joint filler, at every 12.0m length of curb or as approved by The Engineer.
- E. Provide complete installations using appropriate curb units and jointing mortars as shown and specified, true in line, elevation, slopes, curves, etc. and matching with adjacent paving abutting with curb units.

3.02 PROTECTION

- A. Protect finished work from damage due to subsequent building operation.

End of Section

SECTION 02780 UNIT PAVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Perform all work necessary to complete the Unit Pavers in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Interlock tiles
2. Concrete tiles.
3. Cast in place concrete pavers.
4. Bedding
5. Jointing.

B. Related Sections:

1. Section 03300 Cast in place concrete.
2. Section 04450 Natural Stone Works.
3. Section 07900 Joint Sealant.
2. Section 09300 Tiles.

1.02 REFERENCES

A. British Standards Institute (BSI)

1. BS 12 Portland cement
2. BS 882 Aggregates from Natural Stone

B. American Society for Testing and Materials (ASTM)

1. ASTM C33 Concrete Aggregates
2. ASTM C144 Specification for Aggregate for Masonry Mortar
3. ASTM C150 Portland cement
4. ASTM C260 Air Entraining Admixtures for Concrete
5. ASTM C936 Specification for Solid Concrete Interlocking Paving Units.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for the various types of manufactured units, including certification states that the types of manufactured units comply with the requirements of the Specifications.

B. Shop Drawings: Submit shop drawings indicating the dimensions of units, details of special shapes and reinforcing for each unit.

C. Samples: Submit full size samples using the materials, and finish specified. Sample acceptance will be for color, finish and appearance. Compliance with other requirements is the responsibility of the Contractor.

1.04 QUALITY ASSURANCE

A. Qualifications: The manufacturer shall have a minimum of two (2) years successful experience in the fabrication of units finishes and shall have adequate facilities to provide the units at the required quality.

B. Visual Mock-Up: Following approval of samples of unit pavers, construct a visual mock-up of 15m² or each type of unit pavers on a location

approved by the Engineer. The Mock-up shall be representative of the final work in all respects, including setting bed and joint grout. The mock-up, if approved, may be used in the final work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Transport, store and handle pavers units in a manner to avoid undue strains, cracks, staining or other damage. Store units above the ground and protect from mud or rain splashes.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

- A. A manufacturer with experience in producing similar materials specified herein.

2.02 MATERIALS

Note: Concrete strength 25N/mm² at 28 days.

A. Interlock Tiles.

Description: Min. 65 mm thick, interlock tiles as shown in drawings and directed by the Engineer.

Profile: as indicated in drawings and approved by the Engineer.

B. Concrete Pavers.

Description: 10x20x6.5 cm or 20x20x6.5 cm thick concrete tiles as shown in drawings and directed by the Engineer.

Profile: as indicated in drawings and approved by the Engineer.

C. Cement Tiles.

Description: 40x40x4cm thick cement tiles as shown in drawings and directed by the Engineer.

Profile: as indicated in drawings and approved by the Engineer.

PART 3 EXECUTIONS

3.01 PREPARATION

A. Pavers:

1. Subgrade: Grade and compact the subgrade to the required elevation. Reduce high spots and raise low spots to grade with approved compacted materials and compaction to the required density.
2. Setting Bed: Spread bedding sand, fine aggregates, on compacted subgrade, and compact to the thickness shown to achieve an even, accurate surface, at proper elevation, for the pavers and cobbles.

3.02 INSTALLATION

A. Pavers:

1. Set the pavers on the setting bed and work into place so as to provide total bearing of the setting bed, without voids under the pavers.
2. Set the pavers in pattern shown with uniform open joints of the size shown. If joint width is not shown provide 5mm wide joints. Set tiles then level to required slope and level, using a wood or rubber hammer to tap surface or sides of tiles to place-in position. If not determined a suitable slope of paving surface is 30mm for each 3mt. (1% min. slope) to allow flow out of rain water.
3. Cut unit pavers with motor-driven masonry sand equipment to provide clean sharp, unshipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer or any other means of cutting are not acceptable.

3.03 PROTECTION

- A. Clean and protect finished work from damage due to subsequent building operations. Do not permit vehicular traffic on finished work.

End of Section

SECTION 02820 FENCES AND GATES

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Design, supply and install custom made Sliding/Hinged gates in accordance with the requirements of the Contract Documents. Works includes:
1. Ornamental steel gates.
 2. Fabrication.
 3. Foundations.
 4. Installation complete with accessories & hardware.
 5. Painting
- B. Related Sections:
- | | | |
|----|---------------|-------------------------|
| 1. | Section 03300 | Cast-in-Place Concrete. |
| 2. | Section 05500 | Metal Fabrication |
| 3. | Section 08110 | Steel Doors And Frames |
| 4. | Section 09900 | Painting. |

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
1. ASTM A 366-91(93): “Steel, Sheet, Carbon Cold-Rolled, Commercial Quality”.
 2. ASTM A 513-94: “Electric-Resistance-Welded Carbon and Alloy Steel Tubing”.
 3. ASTM A 570-92(93): “Steel Sheet and Strip, Carbon, Hot-Rolled Structural A Quality”.
 4. ASTM F 626-84: “Specification for Fence Fittings”.
 5. ASTM F 900-84: “Specification for Industrial and Commercial Swing Gates”.
- B. Steel Structure Painting Council (SSPC):
- 1 Printing Manual, Vol. 1 & 2.

1.03 SUBMITTALS

- A. Shop Drawings: Submit to the Engineer, in accordance with the requirements of the Contract Documents, shop drawings, including plan layout and details illustrating fence height, location and sizes of posts, rails, footings, accessories, hardware and erection procedure.
- B. Product data in the form of manufacturer's technical data, specifications and installation instructions for gate posts, fabric, gates and accessories.
- C. Samples: Submit samples as requested by the Engineer of all materials specified herein in accordance with requirements of the conditions of the contract and before ordering materials, obtain approval from the Engineer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualification: Provide metal sliding gates as complete unit produced by a single manufacturer with a minimum of five (5) years of experience in similar works.
- B. Installer Qualification: Employ only experienced tradesman for both fabrication and installation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store materials in a manner to prevent any damage to elements.
- B. Items which become rusted or damaged because of non-compliance with these conditions will be liable for rejection, and such items shall be replaced without any additional cost to the Employer.
- C. Pre-Installation Meetings: The work of this section shall be completely coordinated with work of other sections. Verify dimensions and work of other trades which adjoin materials of this section before the installation of items herein specified.

1.06 WARRANTY

- A. Special Product Warranty: Submit a written warranty, executed by the Contractor, agreeing to repair or replace components or entire units which fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to, structural failure including excessive deflection, faulty operation of gates, deterioration of metals, metal finishes, and other materials beyond normal weathering and defects in hardware, and other components of work.
- B. Warranty period for Gate works shall be Five (5) years after the end of defects liability period.
- C. This warranty shall be in addition to and not a limitation of other rights the Employer may have against the Contractor under the Contract Documents

PART2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

- A. A firm with experience in similar product and approved by the engineer.

2.02 MATERIALS

Refer to drawings for materials and details.

2.03 FABRICATION

- A. Fabricate perimeter frames of gates from metal. Assemble gate frames by welding. Provide horizontal and vertical members to ensure proper gate operation and attachment of panels hardware and accessories.
- B. Sliding Gates: Comply with ASTM F 900.

PART3 – EXECUTION

3.01 PREPARATION

- A. Job site shall be cleared of excess spillage of concrete, packaging and other debris. No work is to begin prior to final grading, unless otherwise permitted by the Engineer.

3.02 WORKMANSHIP

- A. All items shall be installed plumb, straight, square, level and proper elevation, location and alignment with other work. All work shall be designed for adjustment to field variation, fitted with proper joints and intersections, adequately anchored in place.
- B. Provide necessary holes for attaching hardware, other items and anchorage for

attachment to adjoining construction.

- C. Drill or punch holes of correct size required for anchor bolts or connections.
- D. Burned holes will not be acceptable.
- E. Holes must be correctly located to permit bolts to be placed squarely and without offset.

3.03 ERECTION

- A. Frames, Pickets and Rails: Frames and pickets shall be installed truly vertical and all rails shall be truly horizontal.
- B. Steel Column Attachment: Attachment to steel columns shall be made by means of welding the panel securely to the column.

3.04 CLEANING

- A. Retouching: After installation the complete fence or gate shall be retouched wherever paint has been scratched, abraded or removed. Retouching paint shall be of the same formulation and color as that used for the original painting.

END OF SECTION

SECTION 02840 PARKING BUMPERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast Concrete Parking bumpers.
- B. Fixing accessories.

1.02 RELATED SECTIONS

- A. Section 00330 Cast in Place Concrete.
- B. Section 03350 Concrete Finishing.
- C. Section 05500 Metal Fabrications.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C31-91 Methods of Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33-93 Concrete Aggregates.
 - 3. ASTM C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - 4. ASTM C125 Definitions of Terms Relating to Concrete and Concrete Aggregates.
 - 5. ASTM C127 Test Method for Specific Gravity and Absorption of Coarse Aggregates.
 - 6. ASTM C128 Test Method for Specific Gravity and Absorption of Fine Aggregates.
 - 7. ASTM C131 Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 8. ASTM C128 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.

- A. American Concrete Institute (ACI)
 - 1. ACI 211.1 Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
 - 2. ACI 301 Specifications for structural Concrete for buildings.
 - 4. ACI 304 Recommended Practice for Measuring Mixing Transporting and Placing Concrete.
 - 5. ACI 305 Hot Weather Concreting.
 - 6. ACI 309 Consolidation of Concrete.
 - 7. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - 8. ACI 318 Building Code Requirement for Reinforced Concrete and Commenting.
 - 9. ACI 347 Recommended Practice for Concrete Formwork.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: Manufacturer's data sheets on each product. To be used , including:

1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings:
1. Show in-place location, fabrication details, plans, elevations, anchorages, reinforcement, connection details and methods, dimensions, finishes, relationships to adjacent materials, and erection and placement.
 2. Show identification marks, coordinated to Shop Drawings, and date of manufacture on all units to facilitate hauling and erection.
 3. Setting diagrams, templates, instructions and directions as required for installation.
- D. Selection Samples: For the finish product. Two (2) complete sets representing manufacturer's available patterns.
- E. Mix Design(s): Proposed concrete mix design for each type and color of concrete mix required including backup mix.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver units to the Project site in such quantities and at such times to ensure continuity of installation.
- B. Avoid job site storage. When job site storage is required store in a manner to prevent physical damage and so that markings are visible.
- C. Lift and support only at designated lifting or supporting points as shown on reviewed Shop Drawings.
- D. Provide anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions and directions as required for installation.

1.06 WARRANTY

- A. Warranty: provide manufacturer's five (5) years warranty for the precast concrete bumpers, unless otherwise specified.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience in producing similar products and as approved by the Engineer.

2.02 MATERIALS

General – Refer to section 03300 -" Cast-In-Place Concrete" for concrete specifications.

Formwork:

1. Provide forms with acceptable form facing materials that are non-reactive with concrete or form release agents and will produce required finish surfaces.
2. Construct and maintain forms to produce precast concrete units of shapes, lines, and dimensions indicated, within specified tolerances.

A. Precast Concrete Parking Bumpers(Car Wheel Stop)

Description	Precast Concrete Parking bumpers (stops),
Size	As indicated on drawings 1700mm length, 150-250mm width, 170mm height. Chamfered at top with 20mm at both edges. Holes are placed at each end of the piece so that anchor bolt can be inserted to concrete or asphalt surfaces.
Strength	250Kg/cm ² (25N/mm ²)
Finish	fair face finish.
Reinforcing	using reinforcing bars as per manufacturer's design and approved by the Engineer.
Fixing	3 fixing holes of 20mm dia. and as per drawings.
Details	Refer to drawings for the details.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Position bumpers, spaced as indicated on drawings.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before end of defects liability period.

END OF SECTION

SECTION 02920 PLANTING SOIL

PART-1 -GENERAL

1.01 SUMMARY

A. Section Includes

Planting soil in accordance with the requirements of the Contract Documents, work includes but is not limited to the following:

1. Procurement of materials.
2. Stockpiling of materials.
3. Mixing planting soil.
4. Testing of the soil.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM) Standards

1. ASTM C136 Sieve or Screen Analysis of Fine and Coarse Aggregates.
2. ASTM D422 Particle-Size Analysis of Soils.
3. ASTM D2607.69 Standard Clarification of Peats, Mosses, Humus and related Products.
4. ASTM D2974 Standard method of test for moisture, ash, and organic matter of peat materials.
5. ASTM D2976 Standard Method of Test of PH Peat Material.

B. Official Methods of Analysis (11th Edition and Supply, 1st October 1970).

1.03 SUBMITTALS

A. For agricultural soil submit 5 kg sample and an analysis of the following items conducted by a laboratory approved by the Engineer:

1. Soil Fertility:
 - a. Half Saturation (%)
 - b. Nitrate Nitrogen (ppm)
 - c. Ammonium Nitrogen (ppm)
 - d. Phosphate Phosphorous (ppm)
 - e. Potassium (ppm)
 - f. Magnesium (ppm)
 - g. Calcium (ppm)
2. Agricultural Suitability:
 - a. Salinity (Ece)
 - b. pH
 - c. Calcium (Me/I)
 - d. Magnesium (Me/I)
 - e. Sodium (Me/I)
 - f. Potassium (Me/I)
 - g. SAR (Sodium Absorption Ratio)
 - h. Boron (ppm) (by hot water extraction)
 - i. Lime content (% equivalent CaCO₃)
 - j. Percent Organic Matter

1.04 QUALITY ASSURANCE

1. Perform work with personnel experienced in the work required of this section. Laborers shall be qualified in similar type of landscape work.

PART 2 - PRODUCTS

2.01 PLANTING SOIL COMPONENTS

A. Agricultural Soil: Agricultural soil shall be obtained from the excavated materials passing the requirements listed in this section otherwise it shall be obtained from source approved by the Engineer. It shall conform to the following physical and chemical characteristics:

1. Physical Characteristics
 - a. Material passing a sieve size 5.00mm 100%
 - b. Material passing a sieve size 1.25mm 85-100%
 - c. Material passing a sieve size .50mm 35-100%
2. Chemical Characteristics
 - a. Salinity (ECE x 1000) Less than 6
 - b. Sar (Sodium Absorption Ratio) Less than 4
 - c. Boron (Saturation Extract) Less than 1.25PPM
 - d. PH Less than 8.5

PART 3 - EXECUTION

3.01 PREPARATION

Planting medium shall be well mixed free of decomposed colloidal residue, wood, sulfur and iron, brown, finely shredded with no particles over 5 mm. and with an acidity range from 6.5 to 7.5 pH.

- A. Planting soil mix shall conform to the following requirements:
 1. Salinity (ECe x 1000) Less than 4.0
 2. SAR Less than 4.0
 3. pH 6.5 to 7.5
 4. Boron (by saturation extract) Less than 2.0 ppm
 5. Saturated Weight Less than 960 kg/m³
- B. Planting soil shall be mixed in the quantities or proportions as follows: (80%) local Topsoil, (10%) organic decomposed manure with 10% imported moss peat and 1 kg/m³ compound fertilizer.
- C. Mixing procedure: Mix physical ingredients (as specified in Clause 3.01 item B) to a uniform mixture. Mixing method shall be by wind-rowing/tilling or other approved technique. The organic amendment portion should be moist. Add controlled release fertilizer at the rate of 2.5 kg/cubic meter.
- D. The resultant mix shall be moistened to about 5-10% prior to back filling in designated areas.

END OF SECTION

SECTION 02950 PLANTING

1.01 SUMMARY

A. Section Includes

All planting works in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Transporting plant material from sources to holding nursery of project site.
2. Excavation as required and removal of excavated materials off site.
3. Installation of sub drainage material and soil separator.
4. Placing, compacting and leveling planting soil.
5. Planting of all required material.
6. Supplying and installing tree staking materials.
7. Aluminum edging strip in specified planting area.
8. Maintaining plant material during planting, and throughout maintenance and guarantee period.
9. Testing as required by the Engineer's representative.

B. Related Sections

1. Section 02920 Planting Soil

1.02 SUBMITTALS

A. Samples shall be submitted on the approved form to the Engineer's Representative for review/approval. No materials shall be used until they are approved in writing by the Engineer's Representative. Samples shall be retained by the Engineer's Representative and all subsequent delivery of materials shall conform to the approved samples:

1. Planting soil mix (1 kg) with laboratory test report.
2. Soil separator 300 x 300mm.
3. Fertilizer (1 kg).
4. Tree stakes.
5. Aluminum edging strip in planting area.

1.03 QUALITY ASSURANCE

A. All testing as required by the Engineer's Representative shall be performed by the Contractor at no additional expense to the Employer.

- B. Planting Season: All plant material shall be installed during favorable weather conditions. The preferred planting period is during the month of March and October for all planting except palms. The palms may be installed during the month of April and September provided that the air temperature is not excessive. The seasonal flowers shall be planted during the month appropriate for specified types. Planting outside the specified season shall be at Contractors own risk and responsibility.
- C. Procedures
1. Waste materials shall be removed from the site.
 2. The Contractor shall protect plants from injury during installation and through the duration of the contract.
 3. Adjacent concrete paved surfaces and roads shall be kept clean during the installation of plants and maintenance period.

1.04 DELIVERY, STORAGE AND HANDLING

- A. All plant material shall be packed to provide adequate protection against climatic, seasonal, or breakage injuries during transit.
- B. All plant materials must be transported to the Project Site from the on-site project holding nursery in vehicles covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury to the plants. Closed vehicles shall be adequately ventilated or climate controlled to prevent injury to the plants.
- C. Evidence of inadequate protection due to carelessness while in transit or improper handling shall be cause for rejection. All plants shall be kept moist, fresh and protected at all times. Such protection shall encompass the entire period during which the plants are in transit, stored, handled or planted.
- D. Upon arrival at the site of the work, plants may be inspected for proper transit procedures. Should the roots be dried out, large branches be broken, balls of earth be broken, or loosened, or areas of bark be torn, the Engineer's Representative will reject the injured plant. When a plant has been so rejected, the Contractor shall at once remove it from the site and replace it.

1.05 MAINTENANCE

- A. The maintenance of plants shall commence immediately after planting and continue through to the end of the Defects Liability Period. It shall be the Contractor's responsibility to keep all plants in a good, healthy, and flourishing condition throughout this period.

- B. The Contractor shall immediately remove from the project site and replace, without cost to the Employer all dead plants and all plants not in a vigorous, thriving condition. The plants shall be free of dead or dying branches and branch tips, and shall bear foliage of a normal density, size and color. Replacements shall match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Specification.
- C. The Contractor shall make all necessary repairs due to plant replacements. Such repairs shall be done immediately, at no extra cost to the Employer.
- D. The necessity for replacement of all plants shall extend until the end of the Defects Liability Period.
 - 1. Watering: The Contractor shall maintain an adequate supply of water to ensure root zone moisture and leaching of salts. This shall involve watering by tanker and manual watering if planting installation is commenced before irrigation system becomes operative or if the irrigation system is not functioning for whatever reason. The Contractor shall ensure that watering by hose or any other applicator shall not erode soil, leach out fertilizer or dislocate plants.

2 PRODUCTS

2.01 MATERIALS

A. Plant Materials

Refer to drawings and Bills of Quantities..

2.02 ACCESSORIES

- A. Fertilizer: Controlled Release Fertilizer shall be shall be organic resin coated complete fertilizer with an analysis of 16-17-5Fe and a release longevity of 12-14 months at 21°C soil temperature.
- B. Fungicide: Fungicide shall be as required and shall be reviewed and approved by the Engineer's Representative.
- C. Anti-desiccant: Anti-desiccant shall be an emulsion which provides a protective film over plant surface and permeable enough to permit transpiration. It should be delivered in containers of the manufacturer, mixed according to the manufacturer's directions.
- D. Herbicide: Herbicide shall be as approved by the Engineer's Representative.
- E. Insecticide

1. Malathion or deazinon-contact insecticide. Use according to manufacturer's recommendation.
2. Metasystox-R (2-(ethisalfinyl) etholl) 0, 0-dimethyl phosphorothioate leaf applied insecticide.
3. Soil Separator/Geotextile: Soil separator shall be non-woven fabric, needle punched and heat fused 100% polypropylene staple, fiber freely permeable to moisture transmittal, co-efficient of permeability K, cm/sec 5×10^2 . The material should not be exposed to sunlight in storage. Nominal weight 0.15 Kg/m²

F. Test Stakes and Ties

1. Stakes shall be 50x50 seasoned wood, 3500mm length minimum and painted black all over.
2. Tree ties shall be galvanized wire/hose-tie as approved by the Engineer's Representative.
3. Eye Bolt
 - a. Stainless steel eye bolt
 - b. 6mm diameter, 50mm long
 - c. Expandable plug

G. Yard Edge

- | | |
|-------------|---|
| 1. Material | Aluminum to confirm 6063 T6 alloy |
| 2. Size | 3.2mm x 102mm |
| 3. Stake | 2Nos. 305mm high in every 6 meter length |
| 4. Finish | National aluminum (Mill Finish), finished with electrostatically applied backed as acrylic paint. |

3 EXECUTION

3.01 PREPARATION

- A. The Contractor shall review all applicable architectural or engineering Drawings and shall be familiar with the alignment of utility lines ducts, irrigation lines and buried cables existing in the area. The Contractor shall field check the location of utilities shown on the drawings before any installation of material or plants. The contractor shall protect the water proofing membrane on the raised planters. The Contractor shall be responsible for all damage resulting from any neglect or failure to comply with this requirement.

3.02 PREPARATION OF PLANTING AREAS

- A. Planting pits shall be excavated to required size and level as shown on Drawings.

- B. Each pit shall be tested for percolation prior to backfilling. The period of the percolation test shall not exceed (24) hours.
 - 1. Testing the drainage of the pit shall be done by the auger hole percolation test procedure which shall be reviewed with and approved by the Engineer's Representative. Planting shall not proceed until the Engineer's Representative has reviewed test pit results.
 - 2. If remedial action is required because of unsatisfactory drainage, the Engineer's Representative will require the Contractor to construct a drainage chimney.
 - 3. The Contractor shall not undertake remedial action until approved by the Engineer's Representative.

- C. Place planting soil and compact using water saturation to eliminate air pockets. Fill to the required level as shown on Drawing. Moisten the soil evenly to a depth of 300mm.

3.03 PLANTING

- A. Excavation soil from planters as required.
- B. Set container grown, plants at the same relationship to the soil level as they were in their container.
- C. Move and handle plants by container only.
- D. Set all planting true and plumb.
- E. Remove containers prior to planting. Do not break or disturb root ball while planting.
- F. Fertilizer tablets shall be placed in accordance with the Manufacturer's recommendations and as directed by the Engineer's Representative.
- G. Water all plants immediately after planting.
- H. Spray all plant material immediately after planting with anti-desiccant, applying an adequate film over trunks, branches, twigs, and/or foliage.
- I. Each tree shall be staked, immediately following planting and spraying. Plants shall stand plumb after staking.
- J. Cut ropes or strings prior to spraying with anti-desiccant.
- K. Contractor shall take extreme care in the handling of plant material to avoid breaking branches, scraping off bark, disturbing the roots or damaging the root ball. Plants that have been damaged by poor handling may be rejected.

3.04 PRUNING

- A. Pruning shall be done after planting and staking operations are complete.
- B. Pruning shall be done only by an experienced horticulturist or arborist, with a degree in BS ornamental horticulture and five (5) years experience minimum in an arid climate after graduation. Do not prune until guidelines for pruning have been established in the field with the Engineer's Representative. The Engineer's Representative shall require that several shrubs be pruned in his presence, such pruning being prototypical for the entire job.
- C. Plants shall be pruned according to standard horticultural practice to preserve the natural character of the plant.
- D. Remove all dead wood, suckers and broken or badly bruised branches.
- E. Only clean sharp proper tools shall be used. Do not use pruning shears where loppers are required or loppers where a pruning saw is required.

Plant Materials

Plant Type	Plant Name	Basic data		
		Soil Pit dimensions (m) width x length x depth or diameter x depth	Height of plant at start	Recommended Planting Distance (m)
Canopy Trees	Carop	Diameter 2.0m x1.2 depth m	2- 2.5 m	2.5-5.5 m
	Acacia nilotica	Diameter 2.0m x1.2 depth m	Trunk height (2m); Trunk circumference (18x20 cm), standard Tree	
	Washingtoni a Felifera	Diameter 1.8x1.5 depth m	3 -3.5 m	
Wind Breaker Trees	Italian Cypress	Diameter1.2mx Depth 1.5m	1.8-2.2 m	2.0m-5.0m
	Leyland Cypress	Diameter1.2mx Depth 1.5m	1.8-2.2 m	
Shrubs	Rosemary		Plant height 20cm); Plant diameter (30cm)	1.5-2.5 m
	Lemon grass		Plant height (10cm); Plant diameter (20cm).	
	Bulbine			
	Blue Jasmine		Plant height 20cm); Plant diameter (30cm)	
Climbers	English Ivy	Holes in soil about (30 cm) apart and about (15 cm) deep. The depth of the hole just enough to accommodate the root of the new plant.	-	about 30-35cm apart

DIVISION 3

CONCRETE

SECTION 031500

CONCRETE ACCESSORIES

To be read in conjunction with General Requirements and other related sections of the Specifications and Conditions of Contract.

PART 4. GENERAL

1.01 DESCRIPTION

- A. Forming expansion joints in concrete.
- B. Furnish and install preformed expansion joint filler.
- C. Furnish and Install PVC water stops.

1.02 RELATED WORK

- A. Section 032000: Concrete Reinforcing
- B. Section 033000: Cast-In-Place Concrete
- C. Section 034100: Precast Structural Concrete

1.03 REFERENCES

- A. General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.3” Concrete Works”

1.04 SUBMITTALS

- D. Product Data
 - 1. Submit manufacturer's technical data.
 - 2. Submit manufacturers recommended mixing and placing instructions.
- E. Methods
 - 1. Prior to commencing work submit details of methods and techniques proposed for execution of the work.

PART 5. PRODUCTS

2.01 MATERIALS

- A. Refer to the drawings and Bills of Quantities.
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- - Bill No. 3 and Bill No.17”.

PART 6. EXECUTION**3.01 INSTALLATION AND WORKMANSHIP**

- A. Locate and form expansion and construction joints.
- B. Install expansion and construction joint cover anchorage in accordance with manufacturer's printed instructions. Maintain correct elevation to allow cover to be flush with floor and wall finish.
- C. Install joint fillers in accordance with manufacturer's printed instructions. Use primers of type recommended by joint filler manufacturer.
- D. Install water stops in accordance with the Manufacture Recommendations

END OF SECTION

SECTION 03200 CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Reinforcing steel bars for cast-in-place concrete, complete with tie wire.
 - 2. Support chairs, bars supports, spacers for reinforcing. Concrete.
- B. Related Section:
 - 1. Section 03300 Cast-in-place concrete.

1.02 REFERENCE STANDARDS

- A. Design, detailing and workmanship shall be according to:
 - 1. The Jordanian National Building Code for plain and reinforced concrete JBC-95
 - 2. ACI (American Concrete Institute)
 - 3. General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996

1.03 QUALITY ASSURANCE

- B. Perform concrete reinforcing work in accordance with the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996

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

Deformed High strength Steel 420 Mpa

- A. Reinforcing Steel: Deformed High yield weldable steel bars shall comply with ACI and Jordanian Code.
- B. Reinforcing Fabric shall comply with ACI and Jordanian National Building Code.
- C. Accessories Materials.
 - 1. Chairs, bolsters bar supports, spacers, sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor barrier puncture.

2.02 QUALITY REQUIREMENTS

- D. Steel reinforcement shall be hot rolled, high strength and high bond. Grade

420Mpa complying with requirements of ACI and Jordanian National Building Code.

2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with the applied standards and codes.
- 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 the Engineer.
- B. Chairs, Bolsters, Bar Supports, and 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 - EXECUTIONS

3.01 PLACEMENT AND FIXING OF REINFORCEMENT

- A. Place reinforcing bar supported and secured against displacement. Do not deviate from true alignment.
- B. Before placing concrete, ensure reinforcing bars are 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.
- E. Reinforcement shall be fixed in the positions shown on the drawings within a tolerance of 5mm or 5% of the lowest dimension of the cross-section of the member, whichever is greater.
- F. The concrete cover to the reinforcement shall be carefully maintained utilizing approved spacers where necessary and Conforms to ACI 318 for Concrete cover over reinforcement. The minimum concrete cover to all steel shall be as shown on drawings.
- 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 block 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 one rectangle or 55 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.
- N. Do not displace or damage vapor barrier. Accommodate placement for formed openings.

3.02 MEASUREMENTS AND RATES

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

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

END OF SECTION

SECTION 03300 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: All cast-in-place concrete work shown on the drawings or inferable there from and/or as specified in accordance with the requirements of the Contract Documents. Work includes but is not limited to following:

1. Formworks
2. PVC or rubber water stops
3. All general concrete works and related finishes but is not limited to the following:
 - a. Foundations
 - b. Slab on grade.
 - c. Suspended slab.
 - d. All concrete topping.
4. Testing

B. Related Section

- | | |
|------------------|-----------------------------------|
| 1. Section 02770 | Stone Curbs. |
| 2. Section 03350 | Concrete Finishing. |
| 3. Section 03530 | Concrete Topping. |
| 4. Section 07130 | Sheet Waterproofing. |
| 5. Section 07140 | Cold Fluid Applied Waterproofing. |

1.02 REFERENCES

- A. Design, detailing and workmanship shall be according to:
1. The Jordanian National Building Code for plain and reinforced concrete JBC-95
 2. ACI (American Concrete Institute)
- B. General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.3” Concrete Works”

1.03 SYSTEM DESCRIPTION

A. Performance

1. This specification Section shall govern all cast-in-place concrete work for the complete project except where more stringent or specialized requirements are required. All work shall be performed to secure for the entire project homogeneous concrete having the required strength, surface finish, materials, durability, and weathering resistance, without planes of weakness or other structural defects, and free of honeycombs, air pockets, voids, projections, offsets of plane and other defacements of concrete. The Contractor will be fully responsible for any defects or damage in the building arising from faulty materials or workmanship and the costs of remedial measures in order to ensure that the completed work complies with the Contract Documents.

B. Design Requirements:

1. Base construction methodology on the construction indicated in the Contract Documents. No alterations or substitutions of the structural systems shown on the Drawings will be permitted.
2. Supervise and coordinate all phases of the concrete construction process and be responsible for the complete manufacturing process for all concrete work. All methods of manufacture and practices of handling raw materials and manufactured concrete shall be submitted for review by The Engineer prior to execution of the concrete work.
3. Only materials of known quality shall be incorporated in the work. All materials shall be properly selected, reviewed with The Engineer before use, and maintained during shipment, storage and use. Construction systems and techniques shall be properly selected, reviewed with The Engineer before use, and maintained throughout the complete concrete construction phase. Adequate spare equipment, parts, additional components and repair facilities shall be available for all tools and equipment.

1.04 SUBMITTALS

- A. Shop Drawings: Submit detail fabrication and placement drawings for all formwork and reinforcing steel which are correlated with forming and concrete placement techniques and requirements.
 1. Reinforcing shall be detailed on shop drawings reviewed and approved by The Engineer.
 2. The drawings shall be in such detail as to assure that difficulties in execution of the work in the field are minimized.
 3. The drawings shall consist of sections, plan and details clearly showing locations sizes and spacing of all reinforcing steel, supporting bars and accessories. Include on the shop drawings, schedules and diagrams to indicate bends, sizes and lengths of all reinforcing steel bars.
 4. A separate set of shop drawings, which shows the construction joint locations, shall show all floor openings, wall openings and edges of concrete. Floor, wall openings and sleeves for all mechanical, plumbing and electrical work shall be coordinated with the respective trades and shown on these shop drawings in accordance with the criteria indicated on the Contract Drawings and contained in the various applicable Sections of the Specification.
 5. No work shall be fabricated until all shop drawings have been reviewed and approved by the Engineer (with corrections and resubmittals as required by the Contract Documents). After review and approval by the Engineer, furnish all copies needed for fabrication and erection, and for use of other trades.
 6. The Contractor shall be fully responsible for furnishing and installing all materials called for or required by the Contract Documents even though these materials may have been omitted from the reviewed shop drawings.
 7. Submit shop drawings for all formwork showing locations of joints, tie bolts, cones, dummy cones, openings, chamfers, inserts,

fittings and accessories for the approval of the Engineer before fabrication of formwork.

8. Submit design calculations in accordance with ACI Standard 301, Chapter 4, Para.4.2, wherever required for the supporting system of the formwork along with the shop drawings for the supporting system, for approval of the Engineer.

B. Samples

1. Provide cut lengths of reinforcing bars for testing or evaluation by an approved Testing Agency. The independent Test Agency shall be responsible for conducting and interpreting the tests, shall state in each report whether or not the test specimens comply with all requirements of the Contract Documents and shall specifically note any deviation there from. The Contractor shall not fabricate any reinforcing bars prior to the approval of The Engineer.
2. Provide samples of all concrete materials of every type proposed for use including component parts of prefabricated formwork systems and manufacturer's technical literature relating thereto. Prepare mock-ups and carry out such tests on the proposed prefabricated formwork systems as may be required by The Engineer in order that he may be satisfied as to the system's suitability.
3. Furnish reinforcement and accessories for sample panels and mock-up portions of the structure as required using all materials and techniques as they will be used in actual construction.

C. Mill Tests:

Furnish the Engineer with certified mill test reports for cement, steel reinforcement strands.

D. Certifications for Admixtures. As specified under admixtures.

E. Test Reports:

Submit preliminary test results for The Engineer's approval at least three weeks prior to the beginning of the work. In addition to the test reports specified under "Quality Control", submit the following directly to the Engineer:

1. Preliminary Design Mix Reports (BS 8110 Section 6).
2. Aggregate Soundness Test Reports (ASTM C88).
3. Aggregate Staining Test Reports (ASTM C641).
4. Air Entrainment Test Reports (ASTM C260).3

1.05 QUALIT ASSURANCE

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.3” Concrete Works”

PART 2 PRODUCTS

2.01 MATERIALS

- A. Refer to the drawings and Bills of Quantities.
- B. Refer to the General Technical Specifications for Buildings, the First

Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- - Bill No.3” Concrete Works”.

C. Cyclopean Concrete:

Cyclopean concrete shall consist of concrete with compressive strength 200 kg/cm² containing large embedded stones. The stones shall be 15 cm, dia., carefully placed and shall not be dropped into place. They shall be cast to avoid damage to the forms or to the partially set adjacent masonry. Stones shall be washed and saturated with water before placing. The percentage of the total volume of stone to the total volume of cyclopean concrete shall be determined by the designer.

For retaining walls or piers greater than 60 cm thickness, stone having a maximum size of 25 cm may be used. Each stone shall be surrounded by at least 15 cm of concrete and no stone shall be closer than 30 cm to any top surface nor closer than 15 cm to any coping.

PART 3 EXECUTIONS

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- - Bill No.3” Concrete Works”.

END OF SECTION

SECTION 03350 CONCRETE FINISHING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Concrete surface preparation and finishes shown on the drawings or inferable there from and / or as specified in accordance with the requirements of the Contract Documents.

B. Related Sections:

- | | | |
|---|---------------|-------------------------|
| 1 | Section 03300 | Cast-in-Place Concrete. |
| 2 | Section 03530 | Concrete Topping. |

1.02 REFERENCES

- B. General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.3” Concrete Works”

1.03 SYSTEM DESCRIPTION

- A. Only materials of known quality shall be incorporated in the work. All materials shall be properly selected, reviewed with the Engineer before use and maintained during shipment, storage and use.
- B. Regardless of reviews by the Engineer, the Contractor shall be responsible for all materials, methods and the work. If any work does not satisfy the Contract Documents, implement the removal, replacement or remedial work and revise procedures or materials to prevent recurrence of unacceptable work.

1.04 SUBMITTALS

- A. Product Samples: Submit to the Engineer in accordance with the requirements of the Contract Document samples of concrete accessories of every type to be used.
- B. Mill Tests: Furnish the Engineer with certified mill test reports for cement.
- C. Pre-installation meeting: Four weeks prior to pouring of finished concrete slabs, arrange for an on site pre-installation meeting of the manufacturers of the concrete curing compound, seal and hardener manufacturer, together with Contractor and Engineer to finalize application procedure and site conditions.
- D.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Flooring finishes shall be executed by trained and qualified workman.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver all packaged materials to the site in original unopened containers clearly indicating manufacturers name, brand name and other identifying information.
- B. Store materials in a dry, well ventilated location, off the ground and in such manner as

to prevent damage or intrusion of foreign matter. All materials had become damaged or otherwise unfit for use during delivery or storage shall be replaced.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience and as approved by the engineer.

2.02 MATERIALS

A. Epoxy paint.

Description: Concrete Floor sealer similar to Aqua epoxy or equivalent and approved, is a two-pack Epoxy floor sealer, dispersed in water and solvent-free, non-flammable and provides high chemical, oil, petrol, water and abrasion resistance, superior hardness, wear and hot-tyre resistance

1. 1st. Coat floor seal.
2. 2nd.Coat final seal.

As per manufacturer's documentations and recommendations.

Location: as indicated on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the substrate, adjoining construction and the conditions under which the work is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Clean the substrates to remove grease Latinate and other substances which may adversely affect the adhesion of the work. Use dilute solution of monistic acid, chipping of the surface, or any other method of cleaning required including light grit blasting surface grinding like similar methods. Leave the surfaces thoroughly clean and wet with as much water as it will absorb.
- B. Keep the substrates wet continuously overnight, but in no case for less than 6 hours, before work is applied.

3.03 APPLICATION

1. Apply in accordance with the manufacturer's recommendations.
2. Sprays apply as evenly as possible to the concrete.
3. Apply as soon as the initial surface sleeve has disappeared from the concrete surface.
4. Apply at the rate specified by the manufacturer's recommendation.

3.05 CURING AND PROTECTION

- A. Work may be cured in lieu of moist spraying by covering with waterproof paper, polyethylene sheeting or other approved opaque waterproof covering for at least 7 days after finishing.
- B. After curing keep the work covered to protect it from damage during the progress of other work.

END OF SECTION

SECTION 03530 CONCRETE TOPPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Concrete topping and accessories in accordance with the requirements of the Contract Documents, work includes but is not limited to the following:
1. Drive area.
 2. Water Tanks floors.
 3. play yard
 4. Workshop.
- B. Related Section:
1. Section 03300 Cast-in-Place Concrete.
 2. Section 03350 Concrete Finishing.

1.02 REFERENCES

- A. British Standards Institute (BSI)
1. BS 12 Portland cement
 2. BS 410 Test Sieves
 3. BS 882 Aggregate from Natural Sources
 4. BS 1881 Methods of Testing Concrete
 5. BS 3148 Tests for Water for Making Concrete
 6. BS 4550 Methods of Testing Cement
 7. BS 4483 Steel Fabric for Reinforcement of Concrete
 8. BS 5328 Methods for Specifying Concrete, Including Ready-Mixed Concrete
- B. American Society for Testing and Materials (ASTM)
1. ASTM A185 Welded Steel Wire Fabric for Concrete Reinforcement.
 2. ASTM C33 Concrete Aggregates
 3. ASTM C94 Ready Mixed Concrete
 4. ASTM C150 Portland cement
 5. ASTM C171 Sheet Materials for curing Concrete
 6. ASTM C979 Specification for Pigments for Integral Colored Concrete
- C. The applicable provisions of the following standard publications, codes and specifications shall apply throughout the concrete finishes works:
1. AASH to M182 Burlap cloth made from Jute or Kenaf
 2. ACI 304 Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
- D. Only materials of known quality shall be incorporated in the work. All materials shall be selected, reviewed with the Engineer before use and maintained during shipment, storage and use.
- E. The Contractor shall be responsible for all materials, methods and the work, and if any work does not satisfy the Contract Documents, implement removal, replacement of remedial work and revise procedures or materials to prevent recurrence of unacceptable work.

1.03 SUBMITTALS

- A. Samples: Submit to the Engineer, in accordance with the requirements of the Contract Documents, samples of concrete accessories of every type to be used.
- B. Mill Tests: Furnish the Engineer with certified mill test reports for cement.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver all packaged materials to the site in original unopened containers, indicating manufacturer's name, brand name and other identifying information.
- B. Store materials in a dry, well-ventilated location, off the ground and in such manner as to prevent damage or intrusion of foreign matter. All materials which, in the opinion of the Engineer have become damaged or otherwise unfit for use during delivery or storage shall be replaced.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portland cement: BS 12 or ASTM C150, Type I, non-staining. Use only one brand of cement from one mill throughout the work. Unless otherwise approved by the Engineer.
- B. Coarse Aggregate: BSI 882 or ASTM C33, evenly graded gravel, crushed gravel or stone, or a combination thereof passing a 9.5mm sieve and retained on a 4.5mm sieve.
- C. Fine Aggregate: BS 882 or ASTM C33, natural sand.
- D. Water: Clean, fresh and free of harmful matter such as oil, salts, acids, alkali, sewage, deleterious minerals or organic matter. Water shall conform to BSI 5328 and shall be tested in accordance with BS 3148.
- E. Curing Material
 - 1. Polyethylene Sheeting: ASTM C171, 0.10mm thick, opaque black.
 - 2. Reinforced Waterproof Building Paper: ASTM C171, opaque.
 - 3. Burlap: AASHTO M 182.
- F. Bonding Agent: Polyvinyl acetate or acrylic base.
 - 1. Superior concrete bonder, Dayton Superior Corp.
 - 2. Sonnocrete, Sonneborn-Chemrex.
 - 3. Strongbond, Conspec Marketing and Mfg. Co.
- G. Mixes
 - 1. Grout: 1 Part cement to 1 part sand, with sufficient water to make stiff slurry.
 - 2. Bond Coat: 1 Part cement to 1¼ parts sand to 2 parts coarse aggregate mixed with bonding agent as approved by the Engineer. The amount of water shall not exceed 19 liters per 50kg bag of cement or as recommended by manufacturers.
 - 3. Top Coat: Same mix as specified for the bond coat.
 - 4. Class of Concrete: Grade 350 kg/cm² characteristic cube strength (28 days) as specified in Section 03300 "Cast-in-Place Concrete" to produce heavy-duty topping material.
- H. Hardener:

Cement sand screed topping of 350kg/cm² compressive strength with non-metallic floor Hardener of high impact, non-slip, non rusting and oil, grease resistances for workshops, type to selected and approved by the Engineer.

- I. Mesh Reinforcement: Shall conform to BSI or to ASTM A185.
- J. Bar Reinforcement: Conforming to Section 03300 requirements.

2.02 MIXING

- A. Provide batch type mechanical mixer for mixing topping material at project site. Equip batch mixer with a suitable charging hopper, water storage tank and a water measuring device. Use only mixers which are capable of mixing aggregates, cement and water into a uniform mix within specified time and of discharging mix without segregation.
- B. Ready mix topping may be used when acceptable to the Engineer. When acceptable, furnish ready-mixed topping complying with requirements of ASTM C94.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Examine the substrate, adjoining construction and the conditions under which the work is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean the substrates to remove grease, laitance and other substances which may adversely affect the adhesion of the work. Use diluted solution of muriatic acid, chipping of the surface, or any other method of cleaning required. Leave the surfaces clean and wet with as much water as will be absorbed.
- B. Keep the substrates wet continuously overnight, but in no case for less than 6 hours, before work is applied.

3.03 APPLICATION

- A. Cover the wet substrate surfaces with grout, applied with force and brushed in to assure full coverage.
- B. Apply bond coat not less than 16mm thick immediately after application of grout and bring to true lines, levels and profiles. Compact and roughen the bond coat to form a key for the top coat.
- C. Before the bond coat has set, apply the top coat to such thickness that the total of the work measured from substrate to finished surface will be as shown, less only thickness of finish covering.
- D. Reinforcement in accordance with requirements of Section 03300 "Cast-in-Place Concrete".

3.04 FINISHING

- A. General Requirements for Flatwork: Strike off top surfaces of finished fill and monolithic slabs true and level within a tolerance of 3mm in 3 meters

and measured with a 3 meter straight edge placed in any direction at any location.

- B. **Monolithic Floor Finish:** Level surface and remove excess laitance by tamping, screening, and running the wood float in one direction of the slab. When the slab has hardened sufficiently so that water and fine material will not be worked to the top, compact the surface with motor-driven floats of the disc type and trowel smooth with two steel troweling operations. Do the second troweling after the concrete has become so hard that no mortar will adhere to the edge of the trowel. Leave floors with a smooth, hard finish free of blemishes and true to a maximum tolerance of 3mm in 3 meters.
- C. **Wood Float Finish:** Tamp the concrete using special tools to force aggregate away from the surface, then screed with straight edges to bring surfaces to the required lines. While the concrete is still green, wood float to a 3mm tolerance with no coarse aggregate visible and apply a medium stiff broom finish to receive the specified finishes.

3.05 CURING AND PROTECTION

- A. Work shall be cured by covering with polyethylene sheeting and flooding for at least (7) days after finishing.
- B. After curing keep the work covered to protect it from damage during the progress of other work.

3.06 SCHEDULE:

- A. **Concrete screed for floors of water tanks.**
Description: Minimum 70mm sloping concrete Screed with compressive strength of 20N/mm² mixed with waterproof admixture (if required).
- B. **Concrete Screed for Roofs**
Description: Minimum 50mm sloping concrete Screed with compressive strength of 20N/mm² for roofs.
- C. **Concrete Screed for play yards**
Description: Minimum 50mm concrete Screed troweled finish with compressive strength of 25N/mm² for play yards.

END OF SECTION

DIVISION 4

MASONRY

SECTION 04220

CONCRETE BLOCKS

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Concrete Blocks.
 - 2. Autoclaved Aerated Concrete (Thermal) blocks.
 - 3. Cavity walls.
 - 4. Ribbed blocks.
 - 5. Metal ties, anchors and reinforcement.
- B. Related Sections:
 - 1. Section 03300 Cast in Place Concrete.
 - 2. Section 09206 Metal Furring and Lathing.
 - 3. Section 09220 Cement Plaster.

3.02 REFERENCES

- A. Refer to General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.6” Masonry Works”

PART 2 – PRODUCTS

- A. Refer to General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.6” Masonry Works”

PART 3 - EXECUTION

- A. Refer to General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.6” Masonry Works

END OF SECTION

SECTION 04450 NATURAL STONE WORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Natural stone for exterior walls.
- B. Natural stone for boundary wall coping.
- C. Natural stone for internal and external flooring.
- D. Granite/marble for stairs.
- E. Marble for skirting.
- F. Sand Cement Mortar and approved Joint Grouting materials.

1.02 RELATED WORK

- A. Section 03300 Cast-in-place concrete.
- B. Section 04220 Concrete Blocks.
- C. Section 07130 Sheet Waterproofing.
- D. Section 07140 Cold Fluid Applied
- E. Section 07210 Building Insulation.
- F. Section 09900 Painting.

1.03 REFERENCES

- A. AMERICAN Society for Testing and Materials (ASTM).
 1. ASTM A 36/A 36M-94 Specification for structural steel.
 2. ASTM A 123-89a Specification for zinc (hot-dip galvanized) coating on iron and steel products.
 3. ASTM A 153-82 Zinc coating (hot-dip) on iron and steel hardware.
 4. ASTM A 307-94 Specification for carbon steel bolts and nuts 60,000 PSI tensile strength.
 5. ASTM A 500-93 Specification for cold formed welded and seamless carbon steel structural tubing in rounds arc shapes.
 6. ASTM A 653/A653M-94 Specification for steel sheet, zinc coated galvanized) zinc-iron alloy coated (galvanized) by hot-dip process.
 7. ASTM A 666-94 Specification for Austenitic stainless steel sheet, strip, plate and flat bar
 8. ASTM A 780-93a Practice for repair of damaged and uncoated areas of hot-dip galvanized coatings.
 9. ASTM C 97 Test methods for absorption and bulk specific gravity of natural building stone.
 10. ASTM C 99 Test methods for modulus of rupture of natural building stone.
 11. ASTM C 114-88 Test methods for chemical analysis of hydraulic cement.
 12. ASTM C 119 Definitions of terms relating to natural building stone

13.	ASTM C 150-92	Specification for Portland cement
14.	ASTM C 170 - 09	Standard Test Method for Compressive Strength of Dimension Stone
15.	ASTM C 207-91	Specification for hydrated lime for masonry purposes.
16.	ASTM C 241	Test method for abrasion resistance of stone subjected to foot traffic.
17.	ASTM C 503-89	Specification for marble dimension stone .
18.	ASTM C 568-89	Specification for limestone dimension stone.
19.	ASTM C 615-92	Specification for granite dimension stone.
20.	ASTM C 880-92	Test method for flexural strength of dimension stone.
21.	ASTM C1201-91	Test method for structural performance of exterior dimension stone cladding system by uniform static pressure difference.
22	ASTM E 72-80	Methods for conducting strength test of panels for building construction.
23	ASTM E 283-91	Test method for determining the rate of air leakage through exterior windows. Curtain walls and doors under specified pressure difference across the specimen.
24	ASTM E 331-93	Test method for water penetration of exterior windows, curtain walls, and doors by uniform static air pressure difference.
25	ASTM E 488-90	Test methods for strength of anchors in c concrete and masonry elements.
26	ASTM E 699-79	Criteria for evaluation of agencies involved in testing quality assurance and evaluating building components, in accordance with test methods promulgated by ASTM committee E- 6.
27	ASTM F 436M-93	Specification for hardened steel washers (metric).
28	ASTM F 568-93a	Specification for carbon and alloy steel externally threaded metric fasteners.
29	ASTM F593-91	Specification for stainless steel bolts, hex cap screws and studs.
30	ASTM F 594-91	Specification for stainless steel nuts.
31	ASTM F738	Specification for stainless steel metric bolts, screws and studs.

1.04 SUBMITTALS

A. General: Refer to Section 01330 Submittal Procedures

B. Shop Drawing and Product Data.

1. Shop drawings shall clearly indicate dimensions and locations of joints.
2. Indicate pertinent dimensioning, layout, anchorages construction details, method of installation and adjacent construction.
3. Indicate all units of stone, i.e. sills, lintels, copings, etc. their configurations and size; materials and types anchorage items and their locations.

4. Submit stone field erection drawings.
 5. Submit manufacturer's instructions for use of pointing color and admixtures.
- C. Design Calculations
1. Submit two (2) copies of stone anchorages assemblies including design calculations for mechanical fixing and thickness of stone required for the Engineer's Instructions review and approval.
- D. Samples
1. Submit two (2) 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 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. Anchors: Two (2) of each type to be incorporated in the work.
 4. Submit samples of other materials specified herein upon request by the Engineer.
- E. Mock Up
1. Furnish and install a typical stone wall and a floor application required for the project, at an area designated by the Engineer. The panel shall be constructed for the Engineer's approval showing 1.5m x 1.5m for floor installation and 4.5m x 4.5 high for wall installation. The 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.

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 Contractor and will be liable for repair/replace the items/works, etc., during the warrantee/guarantee, period of three (3) years after defects liability period.

1.06 QUALIFICATIONS

- A. Supplier/Fabricator: A firm having an adequate supply of the specified type of stone and a capacity to deliver the stone to the project site on schedule within a time limit established by the Engineer, as required, ensuring no delay in the progress and completion of the Work. The supplier/fabricator shall be approved by The Engineer.
- B. Installer: A minimum of five (5) years projects, successful experience in the erection of stone work to the approval of The Engineer.

1.07 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 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 and 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 flows, 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.

PART 2 PROUDCTS

2.01 ACCEPTABLE MANUFACTURERS.

- A. Manufacturer with experience in similar products and work and as approved by the engineer.

2.02 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 and/or function, Color, texture and finish shall be within the range of samples approved by and the engineer.
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.

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.
4. Technical Specification for Stone shall be according to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.5” Stone Works:

B. Dimensions

1. Cut all stone work accurately to shape and dimensions shown on the final approved shop drawings.
2. Do all necessary cutting for anchors, support plates, shelf angles, and dowels, etc.

C. Beds and joints

Stone beds and joints surfaces shall be cut square from the face for the entire thickness of stones. Stone joints dimensions as shown on the approved drawings.

D. Backs of pieces

Backs of all pieces of stone shall be sawn to approximately true planes with maximum variation of 1.5mm in thickness from that indicated on the approved shop drawings.

E. Exterior & interior 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.

F. Incidental Cutting & Drilling

1. No cutting or drilling will be permitted on exposed surfaces.

2.03 MORTAR MATERIALS AND ACCESSORIES

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.5” Stone Works:

PART 3 EXECUTIONS

3.01 CONDITIONS AT SITE

- A. The Contractor shall, prior to proceeding with the stone units 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. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.5” Stone Works:

A.01 FIELD QUALITY CONTROL

1. Test mortar and grout in accordance with specification specified in this section.
2. Check completed surfaces that are to receive covering to ascertain units are accurately placed and not damaged.
3. Repair or replace defects prior to application of covering.

A.02 PROTECTION

A. Stone shall at all times be protected from drippings, welding spatter and damage 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.

A.03 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.

A.04 FINAL INSPECTION

- A. Finished surfaces shall show no objectionable visual distinction in jointing, bedding, plane color, 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 units 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

DIVISION 5

METALS

SECTION 05500 METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal window Screens.
- B. Aluminum ladder.
- C. Shop fabricated ferrous metal items, galvanized, prim painted and Aluminum.

1.02 RELATED SECTIONS

- A. Section 03300 – Cast in place concrete.
- B. Section 02874 – Metal Bollards.
- C. Section 05520 – Hand rails and railings.
- D. Section 08110 – Steel Doors and Frames.

1.03 REFERENCES

- A. ASTM (American Society of Testing Materials)
 - 1. ASTM A 36 – Carbon Structural Steel.
 - 2. ASTM A 53 – Pipe, Steel, Black and Hot-dipped, Zinc-Coated Welded and Seamless.
 - 3. ASTM A 123 – Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A 153 – Zinc (Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A 283 – Carbon Steel Plates, Shapes and Bars.
 - 6. ASTM A 325 – High Strength Bolts for Structural Steel Joints.
 - 7. ASTM A 307 – Carbon Steel Bolts and Studs.
 - 8. ASTM A 924 – General requirements for Steel Sheet, Metallic-Coated by the Hot-Dip process.
 - 9. ASTM A 501 – Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 10. ASTM B 221/B 221 – Standard specification for Aluminum and Aluminum-Alloy, extended Bars, Rods, Wire, Profiles and Tubes; 2005.
- B. AWS (American Welding Society)
 - 1. AWS A 2.0 – Standard Welding Symbols.
 - 2. AWS D 1.1 – Structural Welding Code.
 - 3. AWS D 1.2 – Aluminum
- C. SSPC - Steel Structures Painting Council (USA).
- D. CBC – California Building Code, 2007 Edition.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
- C. Indicate welded connections using standard AWS A 2.0 welding symbols. Indicate net weld lengths.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in successfully producing metal fabrications similar to that shown on the drawings, with sufficient production capacity to produce required units without causing delay in work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.
- B. Storage on Site: Store materials in a location and in a manner to avoid damage. Stacking shall be done in a way which will prevent bending.
- C. Store metal components and materials in a clean, dry location. Cover with waterproof paper, tarpaulin or polyethylene sheeting in a manner that will permit circulation of air inside the cover.
- D. Keep handling on-site to a minimum. Exercise care to avoid damage to finishes of material.

1.07 PROJECT CONDITIONS

Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

1.08 SEQUENCING AND SCHEDULING

Sequence and coordinate installation of wall handrails as follows:

- A. Mount handrails only on complete walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.
- B. Mount handrails according to drawings for stairs, reinforced to receive anchors, and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. General: All materials that will be exposed must be smooth and free of surface blemishes including pitting, seam marks, roller marks, trade names and irregularities.
- B. Steel Sections to: ASTM A 36.
- C. Steel Tubing to: ASTM A 501.
- D. Pipe and Downspouts to: ASTM A 53, Type E, Grade B.
- E. Plates to: ASTM A 283.
- F. Bolts, Nuts, and Washers to: ASTM A 307.
- G. Welding Materials to: AWS D 1.1; type required for materials being welded.
- H. Touch-Up Primer for Galvanized Surfaces: Zinc rich type.

- I. Metal Framing Channels: Channel members shall be fabricated from structural grade steel conforming to ASTM A 924; Finish shall be hot-dip galvanized coating unless otherwise indicated.
- J. Pipe/Conduit Clamps: Punch-press made from hot-rolled, pickled and oiled steel plates, strip or coil and conform to ASTM A 36; Finish shall be hot-dip galvanized coating unless otherwise indicated.
- K. Extrude shapes and tubes: (Aluminum) to ASTM B 221, 6061-T6, 6205-75

2.02 FABRICATION GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
Temperature change (Range): 40 deg C.
- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 0.8mm, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Remove sharp or rough areas on exposed traffic surfaces.
- G. Weld corners and seams continuously to comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and welded surface matched those adjacent.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- J. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- K. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

- L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.03 FINISHES

- A. Prepare surfaces to be primed in accordance with SSPC SP 2 - (Hand tool cleaning).
- B. Prime all surfaces that are not scheduled to receive galvanization, except, do not prime surfaces embedded in concrete nor in areas of field welds until welds are completed and inspected.
- C. Prime paint items with one coat.
- D. Galvanized in accordance with ASTM A 123, designated steel items. Provide minimum 380g/m² galvanized coating.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.
- C. Contractor shall conform all existing downspouts to remain fully functional.

3.02 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 or embedded in masonry with setting templates, to appropriate sections.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Perform field welding in accordance with AWS D 1.1. .
- D. Obtain the Engineer's approval prior to site cutting or making adjustments not scheduled.
- E. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.04 PROTECTION AND CLEAN-UP

Protect work of other sections from damage resulting from work of this section, especially welding and cutting sparks. As work proceeds at completion remove surplus materials and deposit debris in containers provided or removes from site as directed.

END OF SECTION

SECTION 05513 ACCESS LADDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

1. Steel Access Ladders.

1.2 RELATED SECTIONS

- | | |
|------------------|-------------------------|
| 1. Section 03300 | Cast-In-Place Concrete. |
| 2. Section 04220 | Concrete Unit Masonry. |
| 3. Section 05500 | Metal Fabrication. |
| 4. Section 05520 | Handrails and Railings. |
| 5. Section 09900 | Painting. |

1.3 REFERENCES

1. OSHA 29 Code of Federal Regulations (CFR) 1910.27 - Fixed Ladders; Occupational Safety and Health Standards; current edition.
2. ANSI A14.3 - American National Standard for Ladders - Fixed - Safety Requirements.
3. American Society for Testing and Materials
 1. ASTM A123/123M, Standard Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products
 2. ASTM A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 3. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 4. ASTM A325M-97, Specification for High-Strength Bolts for Structural Steel Joints.
 5. ASTM A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

1.4 SUBMITTALS

1. Submit under provisions of Section 01330.
2. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Storage and handling requirements and recommendations.
 2. Installation methods.
3. Shop Drawings: Detailed drawings showing relationship of ladders to other construction and methods of anchorage.

1.5 QUALITY ASSURANCE

1. Manufacturer Qualifications: Minimum 10 years experience manufacturing similar products.
2. Installer Qualifications: Experience with ladder assemblies and regulatory

requirements of installation and operation.

1.6 DELIVERY, STORAGE, AND HANDLING

1. Store products in manufacturer's unopened packaging until ready for installation.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

1. Manufacturer with experience in production of similar products.

2.2 APPLICATIONS

1. Drawings: Refer to drawings for size, length, accessories and supporting structure.

2.3 PRODUCTS

A. Steel Access Ladder

1. Ladder Sections, accessories and finish: refer to drawings

PART 3 EXECUTION

3.1 EXAMINATION

1. Do not begin installation until supporting structure and inserts have been properly prepared.
2. Notify The Engineer of unsatisfactory condition before proceeding.

3.2 INSTALLATION

1. Install in accordance with manufacturer's instructions.
2. Installation shall comply with regulations, codes and ordinances for ladder installation and operation.

3.3 PROTECTION

1. Protect installed products until completion of project.
2. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 05520 HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stair Balustrade and Hand rail
- B. Ramp handrail.
- C. Roof handrail.
- D. Wall mounted handrail.

1.02 RELATED SECTIONS

- A. Section 03300 Cast in Place Concrete.
- B. Section 04420 Concrete Blocks.
- C. Section 04450 Natural Stone Work.
- D. Section 05500 Metal Fabrication
- E. Section 09900 Painting

1.03 REFERENCES

- A. Australian Standards
 - 1. AS 1170 – Minimum Design loads on structure.
 - 2. AS 1288 – Glass in building.
 - 3. AS 1428.1 – General Requirement for Access.
- B. ASTM (American Society of Testing Materials)
 - 1. ASTM A 53 , Standard Specification for Pipe, Black, and Hot-Dipped, Zinc- coated Welded and Seamless.
 - 2. ASTM A 1530A 153 M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. ASTM A 283/ A 283 M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - 4. ASTM A 307, Standard Specification for Carbon Steel Bolts and Studs.
 - 5. ASTM A 325, Standard Specification for Structural Bolts, Steel, Heat Treated,
 - 6. ASTM A 500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 7. ASTM A 501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 8. ASTM A 653/A 653 M, Standard Specification for Steel Sheet, zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated by the Hot-Dip Process.
 - 9. ASTM A 1011/A 1011 M, Standard Specification for Steel, Sheet and Strip, Hot- Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - 10. ASTM E 935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for buildings.
 - 11. ASTM C 1107, Standard Specification for Packaged dry, Hydraulic-Cement Granite (non-shrink)
 - 12. ASTM E 985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.

- C. AWS (American Welding Society)
 - 1. AWS A 2.4, Standard Symbols Welding, Brazing, Nondestructive Examination.
 - 2. AWS D 1.1/D 1.1M, Structural Welding Code Steel Bundled Set B.
- D. SSPC (Steel Structures Painting Council), Steel structures Painting Manual in U.S.A.
- E. American with Disabilities Act (ADA) and Architectural Barriers Act Accessibility Guidelines-United States Access Board. .
- F. International Code council (ICC) /ANSI A117.1- (American National Standard Institute): International Building Code.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: Manufacturer's data sheets on each product to be used. Including
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Submit plan, section, elevation and perspective drawings as necessary to depict the proper configuration, assembly and installation and termination of each product specified in this section.
- D. Verification Samples: For each finish product specified, two samples representing actual product, color and finish.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of five (5) years experience.
- B. Installer Qualifications: All products listed in this section are to be installed by a single installer with a minimum of five (5) years demonstrated experience in installing products of the same type and scope as specified.
- C. Field Sample: Provide field sample for evaluation of surface preparation techniques and application workmanship.
 - 1. Do not proceed with remaining work until workmanship, color, and sheen are approved by the Engineer.
 - 2. Refinish field sample area as required to produce acceptable work.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.
- C. Store products indoors in temperature controlled facility.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A. At project closeout, provide to owner representative an executed copy of the manufacturer's standard limited warranty against manufacturing defect, out lining its items, conditions and exclusions from coverage.

PART 2 PROUDCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience in the specified product and approved by the Engineer.

202 MATERIALS

- A. For types, details, colors, accessories and finish: refer to drawings.

203 FASTENERS

- A. Handrail Anchors: Select fasteners of type, grade and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.
- B. Handrail and Railing Component Anchors: Use fasteners fabricated from same basic metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are a standard fastening method for handrail and railing indicated.

204 GROUT AND ANCHORING CEMENT

- A. Non-shrink, Nonmetallic grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- B. Interior Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching and grouting compound. Use for interior application only

205 FABRICATION

- A. Assemble handrails and railings in shop to greatest extent possible to minimize filed splicing and assembly.
- B. Form changes in direction of railing members as shown in the Drawings.

- C. Mechanical Connections: Fabricate handrails and railings by connecting members with railing manufacturer's standard concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- D. Brackets, Flanges, Fittings and Anchors: Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings and anchors to connect handrail and railing members to other construction.
- E. Provide inserts and other anchorage devices to connect handrails and railings to concrete or masonry. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
- F. Shear and punch metals clearly and accurately. Remove burrs from exposed cut edges.
- G. Cut, reinforce, drill and tap components as indicated on drawings to receive finish hardware, screws and similar items.
- H. Close exposed ends of railing members with prefabricated end fittings.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Notify the Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with approved shop drawings and instructions.
- B. Set post plumb within a tolerance of 2mm in 1000mm.
- C. Hard rails variations from parallel with the nosing line of steps or slope of ramps shall not exceed 6mm in 4000mm.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before end of defects liability period.

3.05 CLEANUP

- A. Upon completion of installing the handrails and railings, cleanup all waste materials and debris resulting from this operation and dispose of such waste materials and debris off site.

END OF SECTION

DIVISION 6
WOOD AND PLASTICS

SECTION 06100 ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Provide rough carpentry as shown on the drawings or inferable there from and/or specified and in accordance with the requirements of the Contract Documents.
- B. Related Sections:
 - 1. Section 06200 Finish Carpentry.
 - 2. Section 08210 Wood Doors
 - 3. Section 09900 Painting.

1.02 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI A199.1 Specification for Plywood Grading
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A153 Specification for zinc coating (hot dip) on iron and steel hardware.
- C. The applicable provisions of the following standards publications and codes shall apply throughout the rough carpentry works:
 - 1. EWA The Engineered Wood Association.
 - 2. WWPA Western Wood Products Association.
 - 3. AFPA American Forest and Paper Association.
 - 4. AWWPA American Wood Preservers Association and with the applicable lumbermen's association rules under which each species of lumber is produced.
 - 5. PS Product Standards.

1.03 SUBMITTALS

- A. Wood Treatment Data: Submit to the Engineer details of chemical treatment manufacturer's instructions for handling, storing, installation and finishing of treated material:
 - 1. Preservative Treatment: For each type specified, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservations retained and conformance with applicable standards.
 - 2. For water-borne treatment include statement that moisture content of treatment materials was reduced to levels indicated prior to shipment to project sit.
- B. Fire Retardant Treatments Data: Include certification by treating plant that treated material complies with specified standard and other requirements.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Keep tough carpentry work dry during delivery, storage and installation, and until finish is applied and building is enclosed. Prove for air circulation in stacks of lumber and plywood.

PART 2 PRODUCTS

2.01 LUMBER

- A. General: Lumber species equivalent to those specified and having equivalent appearance and fiber bending stresses, will be considered as acceptable.
- B. General Framing: 1200f (8.3 MPa); any species, unless otherwise shown and described.
- C. Grounds, Nailers, Blocking, Furring: Softwood No.1 Common; Douglas fir, southern Pine or Cedar. Hardwood; economy grade teak.
- D. Lumber Grading: Comply with "Simplified Practice Recommendations PS-20, American Softwood Lumber Standards, by J.S. Department of Commerce, and with applicable lumbermen's association rules under which each species of lumber is produced.
- E. Grade Marking: Each piece of lumber shall be grade marked identifying mill and grading agency and signifying that lumber conforms to type, size, grade and seasoning provisions of the rules under which it was graded.
- F. Sizes and Patterns: Provide lumber which is dressed and surfaced four sides (S4S) and worked to such patterns as shown or specified. Dimensions designate the finished dress size of the item.
- G. Moisture Content: Provide lumber which has been seasoned by air drying or kiln drying to a moisture content no to exceed 18%.

2.02 PLYWOOD

- A. Backing and Flooring: Interior type, Standard Grade C-D (Plugged); Douglas Fir.
- B. Plywood Grading: Comply with Product Standard PS.1, "Construction and Industrial Plywood", or ANSI A199.1 .
- C. Certification and Marking: The producer shall include a Certificate of Inspection with each shipment. Grade mark each panel in compliance with applicable standards of Product Standards PS.1 .
- D. Moisture Content: Provide plywood which has been seasoned by air drying or kiln drying to a moisture content not to exceed 18%.

2.03 MISCELLANEOUS MATERIALS

- A. Fasteners and Anchorages: Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommended nails.
 - 1. Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A153).

2.04 PRESERVATIVE TREATMENT

- A. Wood to be treated: Members embedded in or in contact with concrete, masonry and plaster and as shown or noted on the Drawings.
- B. Preservative Material: Water-borne preservative material as listed in AWPAC Standard C-1 and C-2 for moderate leaching conditions which is not corrosive to metal and is paintable.

- C. Treatment: Pressure treat in a closed retort by vacuum-pressure process in compliance with AWWA C-2 and AWWA C-9 for plywood.
- D. Do not use creosote preservative.

2.05 FIRE RETARDANT TREATMENT

- A. Where fire-retardant treated wood (FRTW) is indicated, pressure impregnate lumber and plywood with fire-retardant chemicals to comply with AWWA C-20 and C-27, respectively, identify "FRTW" lumber with appropriate classification marking of Underwriters Laboratories, Inc., U.S Testing, Timber Products Inspection or other testing and inspection agency acceptable to authorities having jurisdiction.
- B. Size wood before treatment so that minimum cutting will be required after treatment.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, adjoining construction, and conditions under which the work is to be installed and do not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.
- B. Whenever rough carpentry is fitted to other work, obtain measurements of such other work; verify dimensions shown and the shop drawing details.

3.02 ROUGH FRAMING

- A. Frame to fit closely, and set accurately to required lines and levels; secure rigidly in place in accordance with details and good practice.
- B. Use plastic shims for leveling wood members on concrete or masonry, unless otherwise described.
- C. Cut and fit to accommodate other work as required and in neat workmanlike manner.
- D. Provide framing members of sizes and spacing shown or comply with recommendations of "Manual for House Framing" of National Forest Products Association (NFPA).

3.03 BLOCKING AND NAILERS

- A. Provide blocking and nailers between framing members and at masonry, concrete or steel as shown or required for fastening work of other trades.

3.04 GROUNDS

- A. Provide grounds for securing wood trim and other items form to shapes as shown and cut as required for true line level of work to be attached.
- B. Size: 38mm wide and of thickness required to finish flush with surface of finishes or as shown or required.
- C. Install rigidly, true to line, and dimension.

3.05 BACKING

- A. Apply plywood backing in accordance with the recommendations of the Engineered Wood Association.

3.06 REPAIR OF TREATED WOOD SURFACES

- A. Apply heavy brush coat of same wood preservative material to surface exposed by sawing, cutting or drilling.
- B. Apply heavy brush coat of same fire retardant chemicals to any surface which are cut after treatment.

3.07 PAINTING

- A. Refer to Section 09900 "Painting" for finish painting of rough hardware and ferrous metal.
- B. Paint fireproofed wood as per painting schedule immediately after installation (at least first coat).

END OF SECTION

SECTION 06200 FINISH CARPENTRY

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install finish and architectural carpentry work which is exposed to view non-structural, and not specified as part of other sections.

1.02 RELATED WORK

- A. Section 06100 Rough Carpentry
- B. Section 06410 Custom Cabinets
- C. Section 06420 Wood Veneer
- D. Section 08210 Wood Doors
- E. Section 09900 Painting

1.03 REFERENCES

- A. American National Standards Institute
 - 1. ANSI A135.4 Basic Hardboard
 - 2. ANSI A208.1 Mat Formed Wood Particleboard
- B. ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.
- C. AWP (American Wood Preservers Association) C2 – Lumber, Timbers, Bridge Ties and Mine Ties – Preservative Treatment by Pressure Processes.
- D. AWP (American Wood Preservers Association) C20 – Structural Lumber Fire Retardant Treatment by Pressure Process.
- E. HPM (Hardwood Plywood Manufacturer's Association) HP – American Standard for Hardwood and Decorative Plywood.
- F. NEMA (National Electric Manufacturer's Association) LD3 – High Pressure Decorative Laminates.
- G. NHLA (National Hardwood Lumber Association)
- H. NWWDA (National Wood Window and door Association) I.S.4 – Water Repellant Preservative Treatment for Millwork.
- I. AWI (Architectural Woodwork Institute)
- J. American Softwood Lumber Standard – Voluntary Product Standard - PS 1 – Construction and Industrial Hardwood
- K. American Softwood Lumber Standard – Voluntary Product Standard -PS 20 - PS 20 – American Softwood Lumber Standard.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, fixing location of each item, dimensioned plans and elevations to a minimum scale of (1.5).
- C. Wood Treatment Data: Submit chemical treatment manufacturer's instructions for handling, storage, installation, and finish of treated material.
- D. Fire – retardant treatment data for wood material: Submit fire retardant treatment impregnated by pressure process to reduce combustibility

includes certification by the treatment plant that treated wood materials in compliance with requirements.

- E. Provide instructions for attachment hardware, and finish hardware.
- F. Samples: Submit two (2) samples of finish plywood, (200x150mm) in size illustrating wood grain and specified finish.
- G. Submit two (2) samples of wood trim (300mm) long.
- H. Submit two (2) samples of wood veneer faced panel products (200x150mm).

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with AWI (Architectural Woodwork Institute), Premium quality.
- B. Factory-mark each piece of lumber and plywood with type, grade, mill and grading agency identification, except omit marking from surfaces to receive transparent finish, and submit mill certificate that materials has been inspected and graded in accordance with requirements if it cannot be marked on a concealed surface.
- C. Fire-retardant marking: Mark each unit of fire-retardant treated lumber and plywood with classification marking of Underwriters Laboratory Inc., or other testing and inspecting agency acceptable to authorities having jurisdiction. Place marking on surfaces, which will not be exposed after installation.

1.06 QUALIFICATIONS

- A. Manufacturer Qualifications: Firms with ten years experience in successfully producing finishes woodwork similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.
- B. Installer Qualifications: Arrange for installation of finishes wood works by a firm having (10) ten years experience and that can demonstrate successfully an experience in installing finishes woodwork items similar in type and quality to those required for this project.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Protect finish carpentry materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Do not deliver finish carpentry materials until painting, wet work, grinding and similar operations which could damage carpentry material, and that, soil or deteriorated woodwork have been completed in installation areas. If, due to unforeseen circumstances, finish carpentry materials must be stored in other than installation areas, store only in areas meeting requirements specified for installation areas.
- C. Protect work from moisture damage.

1.08 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

1.09 COORDINATION

- A. Coordinate the work with plumbing and electrical rough-in, installation of associated and adjacent components.

1.10 WARRANTY

- A. Submit a written warranty executed by the Contractor and Supplier/installer against failure occurring in woodworks. Upon notification of any failure within the warranty period, make the necessary repairs and replacements including the removal and replacement of work superimposed over the woodworks, at the convenience of the Employer and to complete works in accordance with the Contract Documents and approval of the Engineer.
- B. The warranty period for woodworks shall be four (4) years after the date of defects liability period.

PART 2 - PRODUCTS

2.01 LUMBER MATERIALS

- A. Softwood Lumber: Comply with PS20, and with applicable grading rules of the respective grading and inspecting agency for the species and product indicated, maximum moisture content of eight (8) percent.
- B. Hardwood Lumber: Graded in accordance with AWI Premium maximum moisture content of eight (8) percent, with vertical grain, of quality suitable for transparent finish.

2.02 SHEET MATERIALS

- A. Softwood Plywood: Comply with PS 1 Grade C-D, Graded in accordance with AWI Custom, lumber core.
- B. Block board : comply with specification.
- C. Hardwood plywood: Graded in accordance with AWI Premium, lumber core, type of glue recommended for application.
- D. Wood Particleboard: Comply with AWI standard, composed of wood chips, medium density, made with high waterproof resin binders, of grade to suit application, sanded faces.
- E. Hardboard: Pressed wood fiber with resin binder, standard grade, and smooth two sides.

2.03 PLASTIC LAMINATE MATERIALS

- A. Plastic Laminate: comply with AWI, color and surface texture as selected by The Engineer.
- B. Laminate Backing Sheet: Solid core high pressure decorative laminated sheets, matching in color and pattern selected by the Engineer, produced under trade names of Formica Corp., Laminex Group or equal and approved and comply with NEMA LD-3 BK20 backing grade, undecorated plastic laminate.

2.04 ADHESIVE

- A. Adhesive: Type recommended by AWI to suit application.

2.05 FASTENERS

- A. Fasteners and anchorages: Provide nails, screws and other anchoring devices of the type, size, material and finish required for application indicated to provide secure attachment, concealed where possible.
 - 1. Where finish carpentry is exposed on exterior or in areas of high relative humidity, provide fasteners and anchorages with a hot dipped zinc coating (ASTM A153).
- B. Concealed Joint Fasteners: Threaded steel.

2.06 ACCESSORIES

- A. Lumber for Shimming, and Blocking: Softwood lumber.
- B. Plastic Edge Trim: Extruded flat shaped, smooth finish, self locking serrated tongue, of width to match component thickness, color as selected.
- C. Float Glass: Clear, top quality: (6mm) thick minimum.
- D. Primer: alkyd primer sealer type.
- E. Wood Filler: solvent or Oil base as suitable, tinted to match surface finish color.

2.07 WOOD TREATMENT PROCESSES

- A. Preservative treatment: Following basic fabrication, provide 3 minute dip treatment of finish carpentry items indicated to receive preservative treatment in five (5) percent solution of pentachlorophenol, with vehicle which will not interfere with finish application and will produce minimum effect upon appearance. Apply brush coat on surfaces cut after treatment.
- B. Fire-retardant treated wood (FRTW): Where wood is indicated as FRTW, provide materials complying with applicable standards for pressure impregnation with fire-retardant chemicals and with following requirements.
 - 1. AWWA standard for lumber: AWWA C20 except as otherwise indicated.
 - 2. Surface burning characteristics: Provide materials with surface burning characteristics not exceeding those indicated below when tested in accordance with ASTM E84 for not less than standard time period (10 minutes).
Flame spread Index :25

2.08 FABRICATION

- A. Fabricate to AWI Premium.
- B. Fabricate woodwork to dimensions, profiles and details indicated.
- C. Shop assembles work for delivery to site, permitting passage through building openings.
- D. Fit exposed sheet material edges with (9.5mm) matching hardwood edging. Use one piece for full length only.
- E. Cap exposed plastic laminate finish edges with plastic trim.
- F. Shop prepares and identifies components for book match grain matching during site erection.
- G. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

- H. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline, secure with concealed fasteners.
- I. Apply laminate backing sheet to reserve side of plastic laminate finished surfaces.

2.09 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler which matches surrounding surfaces and of types recommended for applied finishes.
- D. Finish work in accordance with AWI – Section 1500 Applicable System.
- E. Seal, and varnish semi-exposed to view surfaces. Brush apply only.
- F. Seal surfaces in contact with cementitious materials.

2.10 FORMING PATTERNS

- A. Form patterns for indicated items as shown on the drawing.
- B. Wood to be engraved and burned to form patterns as detailed on drawings by qualified and approved man.
- C. Provide polished brass nails and sheets to form patterns as shown on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install work in accordance with AWI Premium Quality Standard.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of (1mm). Do not use additional overlay trim to conceal larger gaps.
- D. Install hardware in accordance with manufacturer's instructions.

3.03 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush applies two coats of preservative treatment on wood in contact with cementitious materials.
- C. Allow preservative to dry prior to erecting members.

3.04 ADJUSTING

- A. Replace finish carpentry that is damaged or does not comply with requirements. Finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.05 CLEANING

- A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION

SECTION 06410 CUSTOM CABINETS/TABLES

PART 1 – GENERAL

1-01 SUMMARY.

A. Section Includes:

1. Custom cabinetwork
2. Cabinet hardware
3. Counter tops
4. La. Benches.
5. Under benches cabinets
6. Fume cupboards.
7. Laboratory Tables.

B. Related sections

1. Section 05500 Metal Fabrication.
2. Section 06100 Rough Carpentry.
3. Section 06200 Finish Carpentry.
4. Section 06420 Wood Veneer
5. Section 09900 Painting.

1-02 QUALITY ASSURANCE

A. Standards

1. Unless otherwise specified on drawings, manufacture millwork in accordance with W.I.C. Custom Grade, per the "Woodwork Institute of California Manual" of Millwork, latest edition.
2. Each unit of casework shall bear the WIC Certified Compliance Grade Stamp indicating specified grade and, by completion of the job, WIC Certified Compliance Certificates shall have been issued by a WIC licensee certifying that the products furnished fully meet the requirements for the specified grade.

B. Acceptable fabricators and installers with minimum 5 years experience in similar works.

C. References

Comply with applicable provisions of the following:

1. FS MM-L-736 - Lumber, Hardwood
2. FS M M M-A- 130 - Adhesive, Contact
3. NEMA LD3 - High Pressure Decorative Laminates
4. PS 1 - Construction and Industrial Plywood
5. PS 20 - American Softwood Lumber Standard
6. PS 51 - Hardwood and Decorative Plywood
7. PS 58 - Basic Hardboard

1-03 SUBMITTALS

A. Make submittals for approval in accordance with the provisions of Section 01330.

1. Shop drawings :Include materials, component plans, profiles and elevations, fastening methods, assembly methods, joint details, accessory listings, hardware schedule and schedule of finishes.
2. Samples Submit samples of materials and finish.
3. Certification Submit WIC certified compliance certificates prior to installation.

1-04 PRODUCT DELIVERY

Deliver materials under cover and store in dry, clean area as directed. Do not store materials in damp, unheated spaces.

1-05 MOCKUP

Prepare a mockup when called for in the contract documents. Provide full size base cabinet and upper cabinet of each counter type indicated, in specified finish with hardware installed. Units will be examined to ascertain quality and conformity to WIC standards and will establish a minimum standard of quality for this work. Approved units may be used as part of the work.

1-06 GUARANTEE/WARRANTY

- A. Provide a written guarantee in the name of the Owner.
- B. Guarantee shall provide for making good or replacing, at no cost to the Owner, cabinetwork, and finish carpentry items specified herein which exhibit defects in material and workmanship within a minimum period of 2 years from end of defects liability period.

PART 2 – PRODUCTS**2-01 ACCEPTABLE MANUFACTURERES**

A Manufacturer with experience in similar products and approved by the Engineer.

2-02 WOOD

- A. Exposed woods
 - 1. Exposed solid wood members, face frames, and like items.
Species called for on drawings.
 - 2. Exposed shelving Furnish with face plys in species and type of wood trim as called for on drawings.
 - 3. block board for cabinets of 22mm thickness .
- B. Unexposed woods For enclosed shelving and backs of cabinets, furnish rotary cut Douglas Fir A-A or A-B grade. Edge band shelves..
Refer to schedule at the end of this specification

2-03 LAMINATED PLASTIC WORK

- A. Plastic laminate for exposed faces and edges 1.6mm. general purpose (standardgrade)
 - 1. Color and finish
Solid color, patterned or woodgrain, as called out in the contract documents, or if not called out, as selected by LMMS.
- B. Plastic laminate panel construction
 - 1. Core Flakeboard, U.S. Plywood Novoply, Weyerhauser Timblend, or approved equivalent particle board,18 mm thick.
 - 2. Backing sheet 5mm. standard backing/balancing sheet.
 - 3. Adhesive As approved by laminated plastic manufacturer for veneering

plastic sheet to core.

C. Interior finish of plastic laminate cabinets

Provide Refinished particle board with finished edges at all exposed interior surfaces of the cabinets and shelves.

1 . Acceptable products

Kortron - Champagne Melamine - Almond

D. Countertops

No-drip bullnose edge and integral coved splash

2-04 ACCESSORIES

- A. Adhesive: Contact adhesive to suit application.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application.
- D. Concealed Joint Fasteners: Threaded steel.
- E. Grommets: Metal material for cut-outs.

2-05 FINISH HARDWARE

A. Provide finished hardware for casework and cabinets as shown on drawings and as required to fully complete the work. Use commercial quality hardware suitable for the purpose intended. The hardware listed below is to be used unless otherwise called out on the drawings or supplemental specifications. The finish of all cabinet hardware should harmonize and be uniform in appearance.

- 1. Concealed cabinet door hinges
- 2. Pulls
Finish: as called out on the drawings or as selected from available finishes (use two pulls for drawers over 600mm wide)
- 3. Drawer slides : As required for drawer depth
Finish: (use two slides for doors over 600mm. wide).
- 4. Shelf standards and brackets
Shelf span not to exceed 760mm Mount shelf standard flush with exposed face of cabinet interior surface.

2-06 FABRICATION

A. Design

All cabinets shall be flush overlay construction.

B. Wood casework fabrication

- 1. Fit shelves, doors, and exposed edges with 10mm matching hardwood edging. Use full length pieces only.
- 2. Door and drawer fronts shall be 18mm thick.
- 3. Accurately machine materials in all of their parts and perform as much work as may be necessary to secure accurate and tight fit and smooth finish in accordance with specified standards. Form joints tight to conceal shrinkage. Set up frames under pressure for at least 12 hours. Use hardwood dowels. Conceal all fastenings.
- 4. Machine sand and scrape exposed surfaces. Material showing burns, plane marks, sander waves, rough or raised grain, or other defects will be rejected. Ease exposed edges.

- C. Laminated plastic casework fabrication
 - 1. Apply plastic to cores with adhesive under pressure, and keep in press until adhesive has set. Contact methods without pressure will not be accepted. Apply edge laminates first. Provide backing laminate plastic work.
 - 2. Apply plastic laminate finish in full uninterrupted sheets. Make corners and joints hairline, slightly beveling arises. Locate counter butt joints a minimum of two ft. from sink cutouts.
 - 3. Cap exposed plastic laminate edges with material of the same finish and pattern.
 - 4. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - D. Metal countertop fabrication
 - 1. Pressure glue metal countertop surfaces to the plywood core backing with invisible butt joints.
 - 2. Make cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures and fittings in the shop. Verify locations of cutouts from onsite dimensions. Seal contact surfaces of cut edges.
 - E. Hardware installation
 - 1. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings. Assemble as fully as possible at the mill.
 - 2. When it is necessary to cut and fit casework on site, fabricate with ample allowance for cutting. Provide trim for scribing and site cutting.
- E. Countertops:
If countertops used in lab. counters, it should be anti-acid .

PART 3 – EXECUTION

3-01 INSPECTION

Verify adequacy of backing and support framing in the field prior to installation.

3-02 INSTALLATION

- A. Set and secure casework in place rigid, plumb, and level.
- B. Use fixture attachments designed for concealed mounting for wall mounted components.
- C. Use threaded steel concealed joint fasteners to align and secure adjoining cabinet units.
- D. Carefully scribe casework that is against other building materials, leaving gaps of 0.8mm. maximum. Do not use additional overlay trim for this purpose.
- E. Secure counter bases to floor using appropriate angles and anchorages.
- F. Counter-sink anchorage devices used to wall mount components at exposed locations, and conceal with solid plugs of species to match surrounding wood. Finish flush with surrounding surfaces.

3-03 ADJUSTING AND CLEANING

- A. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly and correctly.

B. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 06420 WOOD VENEER

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes shop fabricated a finished wood veneer skirting.
- B. Related sections:
 - 1. Section 06200 - Finish Carpentry.
 - 2. Section 09900 - painting.

1.02 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI A208 – Mat-formed wood particleboard.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM E84 – Standard test method for surface burning characteristics of building materials.
 - 2. ASTM C475 – Standard specification for joint compound and joint tape for finishing Gypsum Board.
- C. Architecture Woodwork Institute (AWI)
 - 1. AWI – Quality standards illustrated.
- D. Hardwood Plywood and Veneer Association (HPVA) – North America
 - 1. HPVA HP-1 – American national standard for hardwood and decorative plywood.
- E. APA - The engineered wood association (The leading resource for information about engineered wood product)
 - 1. APA/EWA PS1 – Volunteer product standard for construction and industrial plywood.
- F. Woodwork Institute for California
 - 1. WIC manual of millwork.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Shop drawings: submit detailed shop drawings indicated materials, surface graining elevations of sheet paneling, fastening methods, joining method, and interruptions to other work, to minimum scale of 1:5.
- C. Product data: Submit data on fire retardant treatment materials and application instructions by item and location when specified in this section.
- D. Samples:
 - 1. Submit two sample of finished paneling 500x 500mm in size illustrating wood grain and specified finish.
 - 2. Submit two sample of wood trim 250 x 150mm.

1.04 QUALITY ASSURANCE

- A. Paneling: In accordance with AWI architectural woodwork quality standards, premium grade.

1.05 QUALIFICATIONS

- A. Fabricator: Company specializing in fabricating products specified in this section with minimum five (5) years experience.

1.06 PRE-INSTALLATION MEETINGS

- A. Section 01315 – project meetings.
- B. Convene minimum two weeks prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 – Materials and equipments.
- B. Protect work from moisture damage.

1.08 ENVIRONMENTAL REQUIREMENT

- A. Section 01600 – Materials and equipments.
- B. Do not install paneling when temperature or humidity conditions may have a detrimental affect on paneling.
- C. Maintain temperature humidity conditions within ranges recommended by AWI.
- D. Allow materials to acclimate to temperature and humidity conditions recommended by AWI for minimum of 48 hours prior to installation. Maintain same conditions during and after installation.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 01310 Project coordination.
- B. Coordinate locations and requirement for blocking and backing for supports and attachment of work of this section.

PART 2 PRODUCTS**2.01 WOOD VENEER FACED PANELING**

- A. Fabricator:
 - 1. The Contractor shall submit to the Engineer the names of two 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 COMPONENT

- A. Provide materials that comply with requirements of the AWI and WIC, quality standards for quality grade specified, unless otherwise indicated.
- B. Softwood lumber: NIST PS20: Graded in accordance with AWI III premium: maximum moisture content of 6 percent.
- C. Hardwood lumber: Graded in accordance with AWI premium: maximum moisture content 6 percent.
- D. Softwood plywood APA/EWA PS1 Grade C-D: Graded in accordance with AWI premium.
- E. Hardwood plywood: HPVA HP-1 Grade: Graded in accordance with AWI premium.
- F. Joint sealant: shall be comply with ASTM C475, reinforcing tape, joint compound adhesive and water.

- G. Medium Density Fiberboard (MDF): Graded in accordance with ANSI A208.2, Grade MD.

2.03 ACCESSORIES

- A. Adhesive: Type recommended by AWI manufacturer to suit application.
- B. Wall adhesive: Solvent release, cartridge type, compatible with wall substrate, capable of achieving durable bond.
- C. Fasteners: Of size and type suit application: Finish in concealed application.
- D. Concealed joint fasteners: Threaded steel.
- E. Primer: Alkyd primer sealer type.
- F. Wood filler: Solvent base, tinted to match surface finish color.
- G. Fire retardant treatment: chemical treated and pressure impregnated; capable of providing maximum flame spread/smoke development in accordance with ASTM E48.

2.04 FABRICATION

- A. Fabrication to AWI premium standard, of flush design.
- B. Shop prepares and identifies sheets for grain matching during site erection.
- C. Prepare panels for delivery to site, permitting passage through building openings.
- D. Fit exposed sheet material edges with matching veneer edging. Use one piece for full length only.
- E. Wood Moisture Content: Comply with requirements of the referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

2.05 WOOD TREATMENT PROCESSES

- A. Fire retardant (FR-S Type): Chemically treated and pressure impregnated; capable of providing a maximum flame spread/smoke development rating in accordance with ASTM E84.

2.06 SHOP TREATMENT OF WOOD MATERIALS

- A. Shop pressure treat: Wood materials requiring UL fire rating, preservatives to concealed wood blocking.
- B. Provide UL approved identification on fire retardant treated material.
- C. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.07 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. Seal and varnish internal exposed to view and semi-concealed surfaces. Brush applies only.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

- A. Install work in accordance with AW1 custom quality standard.
- B. Set and secure materials and components in place, plumb and level.
- C. Scribe work abutting other component to AW1 tolerance with maximum and consistent gaps of 1mm, do not use additional overlay trim to conceal larger gaps.
- D. Coordinate installation of blocking behind paneling.
- E. Install component trim with screws.
- F. Install paneling with screws with blind fasteners.
- G. Preparation for site finishing.
 - 1. Site finishing: Refer to section 09900.
 - 2. Before installation, prime paints surface of items or assemblies to be in contact with cementitious materials.

3.03 SCHEDULES

- A. Walnut Skirting:
 - 1. Description: Porcelain skirting.
 - 2. Size: 100mm high x 5mm thickness American walnut for skirting.
 - 3. Length: variable size.
 - 4. Skirting fixings: adhesive type.

END OF SECTION

SECTION 06610 SOLID SURFACING COUNTERTOPS - WASH TROUGH

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Acrylic solid surfacing countertops.

The solid surface wash trough is designed for wall mounting and in a range of standard or special lengths.

1.2 RELATED SECTIONS

- A. Section 06100 – Rough Carpentry
- B. Section 06615 – Solid Surfacing Fabrications
- C. Section 07920 – Joint Sealants

1.3 REFERENCES

- A. ANSI Z124 – Plastic Fixtures
- B. ANSI/ICPA SS-1 – Performance Standard for Solid Surface Materials
- C. ANSI/NEMA LD 3 – High Pressure Decorative Laminates
- D. ASTM D 256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- E. ASTM D 570 – Standard Test Method for Water Absorption of Plastics
- F. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics

1.4 SUBMITTALS

- A. Comply with Section 01330– Submittal Procedures
- B. Product Data: Submit manufacturer’s product data, including fabrication and installation instructions
- C. Shop Drawings: Submit fabricator/installer’s shop drawings, including plans, elevations, sections, and details, indicating:
 - 1. Dimensions, tolerances, materials, components, attachments, fabrication, edge treatment, corners, location of seams, overhangs, backsplashes, and inlays
 - 2. Locations and sizes of cutouts and holes for items to be installed in countertops
 - 3. Locations and sizes of blocking, supports, and reinforcements to support countertops

- D. Samples: Submit manufacturer's samples of solid surfacing material in each color and finish.
- E. Manufacturer's Certification: Submit manufacturer's certification that solid surfacing material and adhesives comply with specified requirements.
- F. Fabricator/Installer's Certification: Submit fabricator/installer's certification by manufacturer.
- G. Care and Maintenance Instructions: Submit manufacturer's care and maintenance instructions, including cleaning and repairing instructions.
- G. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- A. Fabricator/Installer's Qualifications:
 - 1. Fabricator/installer regularly engaged, for preceding 5 years, in fabrication and installation of solid surfacing countertops of similar type to that specified.
- B. Pre-installation Meeting:
 - 1. Schedule pre-installation meeting before start of installation of solid surfacing countertops.
 - 2. Require attendance of parties directly affecting work of this section, including contractor, architect, fabricator/installer, and manufacturer's representative.
 - 3. Review examination, installation, adjusting, cleaning, protection, and coordination with other work.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver solid surfacing countertops to site in accordance with manufacturer's instructions.

PART 2 PRODUCTS

- A. refer to drawings for details.

2.3 ACCESSORIES

- A. Adhesives: Compatible with solid surfacing countertops

2.4 FABRICATION

- A. Follow instructions in manufacturer's Fabrication and Installation Manual.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive solid surfacing Wash Trough.
- B. Verify surfaces to support Wash Trough are clean, dry, flat, level, plumb, stable, rigid, and capable of handling the weight.
- C. Notify Architect of conditions that would adversely affect installation or subsequent use.
- D. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

- A. Install Wash Trough in accordance with manufacturer's instructions at locations indicated on the drawings.
- B. Acclimate solid surfacing Wash Trough to room temperature before installation.
- C. Install Wash Trough level, plumb, square, true to line, and without warp.
- D. To install the wash trough first locate the supplied metal wall mounting brackets. The brackets should be fixed to the wall so that the trough is mounted at the required height.
- E. Fixings for the brackets should be heavy duty and suitable for the wall construction to which the wash trough is being mounted. The brackets should be fixed one at either end. Depending on the length of the trough, there may be more than two brackets supplied. Additional brackets, if supplied, should be placed off-centre to the trough so as to avoid the waste outlet.
- F. The underside of the wash trough is bonded to 18mm thick plywood.
- G. After fixing the brackets the trough should be mounted to the brackets and secured to the underside of the wash trough using wood screws, into the plywood.
- H. The length of the woodscrews does not exceed the thickness of the metal bracket plus the 18mm thickness of the plywood.
- I. Apply "grip-fill" or another similar building adhesive to the back of the trough so as to provide additional strength to the mounting. After installation the joint between the trough and the wall should be sealed with a waterproof sealant.
- J. Install solid surfacing countertops with 2.5mm gap for every 3m of material when surface is enclosed between 2 walls or other obstructions.

- K. Do not install mechanical fasteners directly into solid surfacing countertops.
- L. Install joint sealants as specified in Section 07920.

3.3 Adjusting

- A. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
- B. Remove and replace damaged solid surfacing countertops that cannot be successfully repaired, as determined by Architect.

3.4 Cleaning

- A. Clean solid surfacing countertops promptly after installation in accordance with manufacturer's instructions.

3.5 Protection

- A. Protect installed solid surfacing countertops from dirt, stains, scratches, and damage during construction.
- B. Do not use installed solid surfacing countertops as work surfaces during construction.

End of Section

DIVISION 7
THERMAL AND MOISTURE PROTECTION

SECTION 07130 SHEET WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Membrane waterproofing associated with work in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:
1. Basement and water tank walls.
 2. Roofs.
 3. Round Gravel.
- B. Related Section
1. Section 03300 Cast-in-Place Concrete
 2. Section 02720 Aggregate Base Coarse.
 3. Section 07210 Building Insulation

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
1. ASTM D146-90 Test Method for Sampling and Testing Bitumen- Saturated Belts and Woven. Fabrics for Roofing and Waterproofing.
 2. ASTM D4258-83(R92) Practice for Surface Cleaning Concrete for Coating.
 3. ASTM D5385-93 Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
 4. ASTM D3767-03 Practice for Rubber/MMeasurement of dimensions.
 5. ASTM D412-98 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers/ MTension.
 6. ASTM D882-02 Test Methods for Tensile properties of Thin Plastic Sheeting.
 7. ASTM D570-98 Test Method for Water absorption of plastics.
 8. ASTM D903-98 Test Method for peel stripping strength of Adhesive Bonds.
 9. ASTM E154-99 Test Methods for water vapor Retarders used in Contact with Earth under Concrete Slabs, on walls, or as Ground Cover.
- B. National Roofing Contractors Association (NRCA) (U.S.A.)
1. Roofing and Waterproofing Manual 3rd Edition, NRCA 1990.
 2. Waterproofing and Dampproofing Manual NRCA 1990.

1.03 SUBMITTALS

- A. Product Data: Submit to the Engineer for his approval in accordance with the requirements of the Contract Documents, manufacturer's specifications and installation instructions for the membrane waterproofing system and other data to show compliance with the Contract Documents.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualification
 - 1. The manufacturer shall provide evidence indicating that the specified materials have been successfully utilized on work of a similar scope to that shown and specified for this Project. The system examples cited shall have been completed and in use for minimum five (5) years without any evidence of failure.
- B. Installer Qualification:
 - 1. Membrane waterproofing shall be executed by an approved Specialist with minimum of five (5) years experience in similar Projects.
- C. Contractor's Review: Before commencing work submit written statement signed by the Contractor, stating that the Contract Documents for the membrane waterproofing system have been reviewed with a qualified representative of the waterproofing materials manufacturer and that he is in agreement that the selected materials for membrane waterproofing system are proper, compatible and adequate for the application shown.
- D. Pre-installation Meeting: Prior to the installation of membrane waterproofing, meet at the Project Site to review the material selections, installation procedures and coordination of the work with other trades. Meeting shall include the Contractor, the Engineer, Manufacturer's Representatives and any other whose work requires coordination with this work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's unopened containers identified with name brand, type, grade, class and all other qualifying information.
- B. Deliver bulk materials with a certification from the manufacturer stating the name, type and grade of each product used. Furnish certificate accompanying each load (or furnish manufacturer's blanket certificate) for each bulk product used in the Work.
- C. Store materials in a dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have once been wet or damaged and remove from the job site.

1.06 PROJECT CONDITIONS

- A. Do not apply membrane waterproofing during inclement weather or when air temperature is outside the range recommended by the manufacturer.

1.07 WARRANTY

- A. Special Project Warranty: Submit a written notarized warranty executed by the Contractor against leaks occurring in membrane waterproofing work. Upon notification of any leak within the warranty period, make the necessary repairs and replacements including the removal and replacement of work superimposed over the membrane waterproofing, and to the complete works in accordance with Contract Documents and approval of the Engineer.
- B. The Warranty period for Membrane Waterproofing shall be five (5) years after the end of defects liability period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A manufacturer with experience in similar products and approved by the Engineer.

2.02 MATERIALS

- A. Refer to drawings and Bills of Quantities.
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.9” waterproofing and damp proofing”

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine all surfaces to which the membrane waterproofing is to be installed. Do not proceed with the installation until unsatisfactory conditions have been corrected and approved by the Engineer.

3.02 PREPARATION

- A. Clean substrate of debris and deleterious material which would impair the Work.
- B. Do not proceed with membrane waterproofing until all drains, piping, conduit, vents, ducts and other projections through the substrate have been installed and protected.
- C. Treat external and internal corners of substrate as shown and in accordance with manufacturer's recommendations.

3.03 INSTALLATION

- A. Install membrane in accordance with manufacturer's printed instructions except as hereinafter specified for all installation procedure.
- B. Prime surfaces in accordance with manufacturer's instructions.
- C. Follow the recommended technique of the membrane manufacturer for cleaning, seam, lap and splice areas, for the method and sequence of forming field joints in the membrane.
- D. Flash all pipes, conduits, sleeves, and other projections passing through membrane waterproofing and provide tight construction throughout. Use prefabricated boots or field-fabricated boots, fitted coverings, and other accessories as required.
- E. Provide water cut-off's in accordance with the approved membrane manufacturer's recommendations.
- F. Install protection board in accordance with manufacturer's instructions.
- G. Upon completion of any portion of waterproofing, immediately cover that portion with protective covering.

3.04 PROTECTION

- A. Protect membrane waterproofing from damage during construction period so that it will be without any indication of abuse or damage at time of completion or covering with other materials.
- B. Protect the building from damage resulting from spillage, dripping and dropping of materials. Repair and restore other work damaged during membrane waterproofing operations.
- C. Prevent materials from running into and clogging drains.

- D. Take all necessary precautions against fire and other hazards during delivery, storage and installation of flammable materials specified herein. Comply with local ordinances and fire regulations in the installation of hazardous materials specified or required under this Section.

3.05 Field Quality Control

- A. Testing: Fill water in an area selected by the Engineer to a minimum depth of 50mm. Plug any drains in the area and maintain water level for a period of 48 hours.

END OF SECTION

SECTION 07140 COLD FLUID APPLIED WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

A. General:

Provide cold fluid applied waterproofing in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Wet areas.
2. External concrete, block walls.
3. Under all structural elements below grade.

B. Related Section

- | | |
|------------------|------------------------|
| 1. Section 03300 | Cast-in-place Concrete |
| 2. Section 09300 | Tiles |

1.02 REFERENCES

A. American Society of Testing and Materials:

- | | |
|------------------|--|
| 1. ASTM C836-89a | Specification for High Solid Content, cold Liquid Elastomeric Waterproofing Membrane. |
| 2. ASTM D412-92 | Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers. |
| 3. ASTM D4258-83 | Practice for Surface Cleaning Concrete for Coatings. |
| 4. ASTM E96-94 | Test Methods for Water Vapor Transmission or Materials |
| 5. ASTM D1475 | Test Method for density of liquid coatings, Ink and related products. |
| 6. ASTM C661-83 | Test Method for Indentation Hardness of Elastomeric – Type sealant by Means of Drometer. |
| 7. ASTM C794 | Test Method for Adhesion-in-Peel of Elastomeric Joint sealants. |
| 8. ASTM D1640 | Test Methods for drying, curing, or film formation of Organic Coatings and Room temperature. |
| 9. ASTM D903 | Test Method for peel or stripping strength of Adhesive Bands. |
| 10. ASTM D1970 | Specification for self-Adhering Polymer modified Bituminous sheet Materials used as sleep resting underlayment for Ice Dam Protection. |
| 11. ASTM D3767 | Practice for Rubber/Measurement of Dimensions. |
| 12. ASTM D5295 | Guide for preparation of concrete surface for Adhered (Bonded) membrane water proofing systems. |

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit to the Engineer manufacturer's specifications, installation instructions and other data to show compliance with the Contract Documents.
- B. Samples: Submit samples of cold fluid applied waterproofing. Samples shall be 300mm square, on plywood.

1.04 QUALITY ASSURANCE

- A. Qualifications
 - 1. The manufacturer shall provide evidence indicating that the specified materials to be used have been successfully utilized on work of similar scope to that shown and specified for this Project. The waterproofing system examples cited shall have been completed and in use for minimum five (5) years without evidence of failure.
 - 2. Installer: Cold fluid applied waterproofing shall be executed by an approved specialist having a minimum of five (5) years successful experience in the installation of the specified material. Employ only tradesmen experienced with the installation of the materials specified.
- B. Before commencing Work submit written statement signed by the Contractor, stating that the Contract Documents for the cold fluid applied waterproofing materials manufacturer and that he is in agreement that the selected materials for membrane waterproofing system are proper, compatible and adequate for the application shown.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver material in manufacturer's standard unopened packaging, fully identified.
- B. Store materials above grade and protected from the weather, soiling or damage. Store in accordance with manufacturer's instructions.

1.06 PROJECT CONDITIONS

- A. Do not apply Waterproofing during inclement weather or when air temperature is outside the range recommended by manufacturer.

1.07 WARRANTY

- A. Special Project Warranty: Submit written warranty executed by the Contractor and installer stating that the waterproofing system installed will be waterproof and free from defects. Upon notification of any leaks occurring within the period stipulated, the Contractor shall, repair and/or replace all defected works and shall carry out all necessary remedies to such works in accordance with Contract Documents and the approval of the Engineer .
- B. The warranty period for the cold fluid applied waterproofing shall be ten (10) years after end of defects liability period.
- C. The warranty shall be supported by a bank guarantee of the same duration obtained from a bank approved by the Employer and shall be for the minimum amount of the value of the works established by a final

measurement of the same at the Unit Rates contained in the Bills of Quantities.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 MATERIALS

- A. Refer to drawings and Bills of Quantities.
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.9” waterproofing and damp proofing”

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the substrates, adjoining construction and the conditions under which the Work is to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and prepare the substrate in accordance with the manufacturer's instructions. Grind and fill concrete surfaces as required to meet tolerances specified by the manufacturer.
- B. Apply waterproofing to substrate in accordance with the manufacturers instructions.
- C. Coordinate the installation of waterproofing with floor drains, equipment bases and other adjacent work. Mask adjacent work to prevent soil marks.

3.03 INSTALLATION

- A. Comply with the waterproofing manufacturer's directions for the mixing, placing, and finishing.
- B. Install and complete the system to assure that no water leakage through the system occurs.
- C. At the start of the installation and periodically as work progresses provide the services of the manufacturer's technical representative at the job site as often as deemed necessary by the manufacturer to advise on all phases of this work.
- D. Install the system in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified.
- E. Install cant strips where shown or recommended by the waterproofing materials manufacturer.
- F. Allow waterproofing to cure properly. During this period block off traffic and protect waterproofing from physical damage.

3.04 CLEANING AND PROTECTION

- A. Protect clean and leave waterproofing to receive subsequent construction.

3.05 FIELD QUALITY CONTROL

A. Testing:

Fill water in an area selected by the Engineer to a minimum depth of 50mm. Plug any drains in the area and maintain water level for a period of 48 hours.

END OF SECTION

SECTION 07210 BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Building insulation in accordance with the requirements of the contract Documents. Work includes but is not limited to the following:
1. Extruded polystyrene Insulation exterior walls, soffits, and roof insulation.
 2. Impregnated fiber board.
 3. Accessories.
- B. Related Sections
1. Section 04220 Concrete Blocks.
 2. Section 04450 Natural Stone Work.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. ASTM C518-76 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter
 2. ASTM C558-92 Specification for Mineral Fiber Blanket and Felt Insulation for Commercial and Industrial Applications.
 3. ASTM C578-92 Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 4. ASTM C612-93 Specification for Mineral Fiber Block and Board Thermal Insulation.
 5. ASTM C653-83 Guide for Determination of Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation.
 6. ASTM C665-91 Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 7. ASTM D1621 Test Method for Compressive Properties of Rigid Cellular Plastics.
 8. ASTM D1622 Test Method for Apparent Density of Rigid Cellular Plastics.
 9. ASTM D2842 Test method for Water Absorption of Rigid Cellular Plastics.
 10. ASTM E84-91a Test Method for Surface Burning Characteristics of Building Materials.
 11. ASTM E96-94 Test Method for Water Vapor Transmission of Materials.
- B. BS (British Standard)
1. BS 3837: Part 2-1990 Expanded polystyrene boards. Specification for extruded boards.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's specifications, standard details and installation instructions for the types of insulation required.
- B. Samples: Submit 300 x 300mm square samples of the types of insulation required.

1.04 SYSTEM DESCRIPTION

- A. The insulation shall have a minimum K value of 0.027 W/mat 10°C to ASTM C518.
- B. The insulation shall be vermin proof and contain sufficient fire inhibitors to achieve a class 1 resistance to surface spread of flame when tested.
- C. The insulation shall be water proof and vapor proof.
- D. The insulation shall have a minimum compressive strength of 300 Kpa (3kg/cm²) when tested to ASTM D1621.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualification: The products shall be manufactured by a firm that has specialized in the manufacture of such items of the type specified for a continuous period of at least five (5) years.
- B. Installer Qualification: A firm which has specialized for not less than five (5) continuous years in applicable type of work. The Contractor shall submit evidence of compliance with the above requirements to the Engineer for approval.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation materials in manufacturer's unopened containers or packages, fully identified with trade name, type, class and other identifying information. Store above grade and protect from weather and damage from any source.

1.07 PROJECT CONDITIONS

- A. Do not allow building insulation to become wet or soiled. Comply with other precautions and recommendations of the manufacturer to protect insulation from deterioration.
- B. Examine all parts of the supporting structure or substrate and the conditions under which the insulation work is to be performed. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

1.08 WARRANTY

- A. Manufacturers shall provide their standard warranties for products furnished under this Section of the specification.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- 1. A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 MATERIALS

- A. High Density Rigid Plastic Insulation.

1. Extruded or injected rigid closed-cell polystyrene foam board with ship lapped or rebated edges with aluminum foil facing or other approved vapor barrier where shown, and having the following properties:
 - a. Minimum Density: (32-35) kg/m³ according to ASTM D - 1622.
 - b. 50 mm thick insulation.
 - c. Five (5) years aged average thermal conductivity of 0.032 W/m. k., when tested at 24°C in accordance with ASTM C518 .
 - d. Compressive Strength: 300 KPa (3 kg/cm²). average, when tested according to ASTM D1621
 - e. Water Absorption: 0.2% average, when tested according to ASTM D2842.
 - f. Water Vapor Permeability: 0.79 perm-cm average, when tested in accordance with ASTM E96.

B. Miscellaneous Materials/Accessories

1. Adhesive for Bonding Insulation: An adhesive of the type recommended by the insulation manufacturer.
2. Mastic Sealer: Type recommended by insulation manufacturer for filling voids in insulation work.
3. Anchors for Insulation: For mineral insulation slabs use special clips or adhesive as recommended by insulation manufacturer.

2.03 BUILDING PAPER

- A. Sealing Tape: Type recommended by insulation manufacturer for ensuring tight, sealed joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The installer must examine the substrate and the conditions under which the insulation is to be installed, and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 INSTALLATION

- A. Comply with manufacturers' instructions for the particular condition of use and type of insulation in each case. If printed instructions are not applicable to the condition of use, consult the Engineer for specific recommendations before proceeding with installation.
- B. Extend insulation full thickness over entire area to be covered. Unless otherwise shown. Cut and fit insulation tightly around all obstructions so that no voids exist in the insulation course. Seal in accordance with manufacturer's instructions.
- C. Mechanical Attachment: provide type and spacing of mechanical anchoring devices as shown and as recommended by the insulation manufacturer for the thickness and condition of use shown.

1. For adhesively applied insulation clips, adhesive and spacing of clips shall be that recommended by the manufacturer for the condition and substrate indicated.

3.03 LOCATION :

As per drawings.

END OF SECTION

SECTION 07260 VAPOR RETARDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Reinforced vapor retarders.
- B. Tape to seal joints
- C. Liquid Mastic to repair and patch vapor retarders.
- D. Pipe boots for sealing penetrations.

1.2 RELATED SECTIONS

- A. Section 03300 Cast-In-Place Concrete.
- B. Section 07130 Sheet Waterproofing.
- C. Section 07210 Building Insulation.
- D. Section 07900 Joint Sealant.

1.3 REFERENCES

1. American Society for Testing and Materials (ASTM):
 - A. ASTM D 882 - Tensile Properties of Thin Plastic Sheeting; 2001.
 - B. ASTM D 1709 - Impact Resistance of Plastic Film by the Free-Falling Dart Method; 2001.
 - C. ASTM D 2582 - Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting; 2000.
 - D. ASTM D 3776 - Mass Per Unit Area (Weight) of Woven Fabric; 1996.
 - E. ASTM D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products; 2000.
 - F. ASTM E 96 - Water Vapor Transmission of Materials; 2000.
 - G. ASTM E 1643 - Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 1998.
 - H. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 1997.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Samples: Submit manufacturer's samples of reinforced vapor retarders.
- D. Verification Samples: For each product specified, two samples, minimum size 150 mm square, representing actual product, color, and patterns.

1.5 QUALITY ASSURANCE

- A. Pre-installation Meeting: Conduct a pre-installation meeting two weeks before start of installation of reinforced vapor retarders. Require attendance of parties directly affecting work of this section, including Contractor, Architect, and installer. Review installation, protection, and coordination with other work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers

and packaging, with labels clearly identifying product name and manufacturer.

B. Storage:

1. Store products in manufacturer's unopened packaging until ready for installation.
2. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Handling: Protect materials during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Manufacturer with experience in the specified product and approved by The Engineer.

2.2 MATERIAL

Description: Vapour barrier (separation layer polyethylene sheets) 250 micron, including over lapping at joints, taping of joints, complete as per drawings.

Location : for Roofs, over Extruded polystyrene Insulation and as per drawings.

2.3 ACCESSORIES

A. General: Ensure accessories are from same manufacturer as reinforced vapor retarders.

B. Mastic Tape: ECC STRIP Tape.

1. Description: Black, double-sided, asphaltic, pressure-sensitive, mastic tape.
2. Width: 50 mm
3. Thickness: 1.0 mm

C. Liquid Mastic Sealant: ECC Mastic Liquid Patch.

D. Pipe Boots: ECC Pipe SEALS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas to receive reinforced vapor retarders. Notify Architect in writing defects of work and other unsatisfactory site conditions that would cause defective installation of vapor retarders. Do not begin installation until unacceptable conditions have been corrected.

B. Field-verify dimensions of site.

C. Commencement of work will imply acceptance of substrate.

3.2 INSTALLATION

A. Install vapor retarders in accordance with manufacturer's instructions and ASTM E 1643 for concrete slabs.

B. Install vapor retarders continuously at locations as indicated on the drawings. Ensure there are no discontinuities in vapor retarders at seams and penetrations.

C. Install vapor retarders in largest practical widths. Membrane to be unrolled with the longest dimension parallel to the direction of the pour.

D. Ensure surface beneath vapor retarders is smooth with no sharp projections.

E. Join sections of vapor retarders and seal penetrations in vapor retarders with

mastic tape with a minimum 6-inch overlap. Ensure vapor retarders surfaces to receive mastic tape are clean and dry.

- F. Immediately repair holes in vapor retarders with liquid mastic or vapor barrier section with mastic tape.
- G. Seal around pipes and other penetrations in vapor retarders with pipe boots in accordance with manufacturer's instructions.

3.3 PROTECTION

- A. Protect reinforced vapor retarders from damage until covered by wall finish.
- B. Protect reinforced vapor retarders from damage during installation of reinforcing steel and utilities and during placement of granular materials or concrete slab.
- C. Immediately repair damaged vapor retarders in accordance with manufacturer's instructions.

END OF SECTION

SECTION 07900 JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

- A. General: This section includes furnishing and installing all joint sealers, construction sealants, backers and related materials, as schedule d and/or as called for on Contract documents. It includes sealants for glazing, roof systems and fire stop systems.
- B. Related Section: Refer to the following sections for related work:
 - 1. Section 03300 Cast-In-Place Concrete.
 - 2. Section 04220 Concrete Blocks.
 - 3. Section 07130 Sheet Waterproofing.
 - 4. Section 08110 Steel Doors and Frames.
 - 5. Section 09511 Acoustical Ceiling.
 - 6. Section 09300 Tiles.
 - 7. Section 09900 Painting.

1.02 REFERENCES

- A. General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996- Bill No.3” Concrete Works”

1.03 DEFINITIONS

- A. Sealant Products: Any material with adhesive properties that is used to fill, seal, waterproof gaps or joints between two surfaces. Sealant products include sealant, primers and caulk.
- B. Type: Defines whether products are premixed or require mixing at job site.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Section 01330.
- B. Product Data Sheet: Submit manufacturer's catalog data and application instructions for each material proposed for use.
- C. Manufacturer's Certifications: Submit manufacturer's representative certification that the proposed products are recommended and compatible with each other and substrates for the intended applications.
- D. Material Safety Data Sheets (MSDS): Submit MSDS for joint sealant products.
- E. Sealant Schedule: List type, grade, class, use classification and joint sealant backing for each proposed sealant system in project.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed joint sealant applications similar in material, design and extent to that indicated for project that have resulted in construction with a record of successful in-service performance.

- B. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.06 DELIVERY, STORAGE, AND HANDLING

Deliver and store packaged materials in manufacturer's original unopened containers with seals unbroken and labels intact until time of use. Store materials off ground and under cover to prevent damage or contamination to materials by water, freezing, foreign matter or other causes. Promptly remove from site any materials which show evidence of damage and immediately make all replacements necessary.

1.07 PROJECT CONDITIONS

Environmental Conditions: Do not proceed with installation of joint sealers under the following conditions.

- A. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 4.0 degrees C.
- B. When joint substrates are wet due to rain, frost, condensation, or other causes.
- C. When cementitious substrates are not thoroughly cured and dry.
- D. When joint substrates contain contaminants or other material which may interfere with adhesion.
- E. When Joint Widths are less than those allowed by joint-sealant manufacturer for applications indicated.

1.08 WARRANTY

- A. Installer: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within two (2) years from end of defects liability period.
- B. Manufacturer: Manufacturer's standard form in which manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within five (5) years from end of defects liability period.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A Manufacturer with experience in similar products and approved by the Engineer.

2.02 MATERIALS

- A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application.
- B. Colors: If not otherwise indicated, or chosen at time of submittals, provide color of exposed joint sealers to closely match finish color of adjacent surfaces.
- C. Joint Sealer : Polysulphide sealant (One Components) Colour to match adjacent surfaces, including closed backing cord, water barriers and all necessary fixing.

2.03 MISCELLANEOUS MATERIALS

- A. Primer: Provide material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant-substrate tests and field tests.
- B. Cleaners for Nonporous surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 PREPARATION

General: Comply with manufacturer's recommendations and with the following:

- A. Remove all foreign materials from joint substrates which could interfere with adhesion of joint sealer, including oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Clean concrete, masonry, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, acid washing, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers.
- C. Remove laitance and form release agents from concrete prior to installation of sealants.
- D. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
- E. Prime or seal joint surfaces where recommended by the sealant manufacturer. Confine primer/sealer to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.02 INSTALLATION OF JOINT SEALS

- A. General: Comply with joint sealer manufacturer's printed installation instructions applicable to products and applications indicated, and with ASTM C 1193 and ASTM C 919.
- B. Backing: Provide backing material in the joint recess whenever necessary to control the depth of the sealant. One backer rod shall be a minimum of 33% oversized for closed cell and a minimum of 50% oversized for open cell backer rod.
- C. Set joint filler units at depth or position in joint as indicated to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.
- D. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted by the sealant manufacturer for application indicated.

- E. Install bond breaker tape where indicated or where required by manufacturer's recommendations to ensure that liquid-applied sealants will perform as intended.
- F. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surfaces, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- G. Install liquid-applied sealant to depths shown or, if not shown, as recommended by the sealant manufacturer but within the following general limitations, measured at center (thin) section of beads (not applicable to sealants in lapped joints):
 - 1. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width. But nether neither more than 13mm deep nor less than 6.5mm deep.
 - 2. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in range of 75% to 125% of joint width.
- H. Spillage: Do not allow sealants to overflow from confines of joints, or to spill on to adjoining work. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
 - 1. Do not overheat or reheat hot-applied sealants; discard and do not use this material.
 - 2. Recess exposed edges of gaskets and exposed joint fillers slightly behind adjoining surfaces, except as otherwise shown or specified so that compressed units will not protrude from joints.

3.03 CURRING AND PROTECTION

Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Cure and protect sealants in a manner which will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants which are damaged or deteriorated during the construction period.

END OF SECTION

DIVISION 8
DOORS & WINDOWS

SECTION 08110 STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Metal doors and frames in accordance with the requirements of the Contract Documents, work includes but is not limited to the following:
1. Flush metal doors.
 2. Fire rated doors.
 3. Louver doors.
 4. Door metal frames.
 5. Painting.
 6. Installation.
- B. Related Section:
- | | |
|------------------|--------------------------|
| 1. Section 03300 | Casts in Place Concrete. |
| 2. Section 04220 | Concrete Blocks. |
| 4. Section 08210 | Wood Doors |
| 6. Section 08710 | Hardware. |
| 8. Section 09900 | Painting. |

1.02 REFERENCES

- A. American National Standards Institute (ANSI)
1. ANSI A115 Sealer: Specification for Steel Door and Frame Preparation of Hardware.
 2. ANSI A250.3-93 Test Procedure and Acceptance Criteria for Factory applies Finish Painted Steel Surface for Steel Doors and Frames.
- B. American Society for Testing and Materials (ASTM)
1. ASTM A36 Specifications for Structural Steel.
 2. ASTM A153-82 (R87) Specification for Zinc Coating (Hot dip) on Iron on Steel Hardware.
 3. ASTM A307 Specification for Carbon Steel Externally Threaded Standard Fasteners.
 4. ASTM A366/A366M-91 Specification for Steel, Sheet, Carbon Old-rolled, Commercial Quality.
 5. ASTM A525-93 Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-dip Process.
 6. ASTM A526 Specifications for Steel Sheet, Zinc Coated (Galvanized) by Hot-dip Process.
 7. ASTM A568 Specifications for General Requirements for Steel, Carbon and High Strength, Low Alloy Hot Rolled Sheet and Cold Rolled Sheet.
 8. ASTM E90 Method for Laboratory Measurement of Airborne-Sand Transmission Loss of building Partitions.
 9. ASTM E152 Methods for Fire Tests of Door Assemblies.
 10. ASTM E414 Classification for Determination of Sound Transmission Class.

- C. The Applicable provisions of the following standard, publications, codes and specifications shall apply throughout the metal door and frames work:
1. National Association of Architectural Metal Manufacturers
 - a. Metal Finishes Manual for Architectural and Metal Products 1988.
 2. National Fire Protection Association
 - a. NEPA 80-92 Fire Doors and Windows.
 - b. NEPA 105-93 Installation of Smoke Control Door Assembling.
 3. Steel Door Institute
 - a. SDI 105-91 Recommended Erection Instruction for Steel Frames.
 - B SDI 108-90 Recommended Selection and usage Guide for Standard Steel Doors.
 - c. SDI 111 Series IIIA-IIIIF Recommended Details, Steel Doors and Frames.
 - d. SDI 112-89 Galvanized Standard Steel Doors and Frames.
 - e. SDI 117-88 Manufacturing Tolerances Standard Steel Doors and Frames.
 - f. SDI 118-76 Basic Fire Door requirements.

1.03 SUBMITTALS

- A. Product Data: Submit to the Engineer for review in accordance with the requirements of the Contract Documents copies of manufacturer's specifications for fabrication and shop painting, and instructions for installation of hollow metal doors and frames substantiating that products comply with requirements.
- B. Shop Drawings: Submit to the Engineer, in accordance with the requirements of the Contract Documents for the fabrication and installation of metal doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items required for installation. Submit manufacturer's technical product data substantiating that products comply with requirements.
1. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.
 2. Indicate coordinate of glazing frames and stops with glass and glazing requirements.
- C. Sample: Submit to the Engineer, in accordance with the requirements of the Contract Documents, 450 x 600mm cut-away sample doors of each type specified or required, with provisions for lockset and a pair of hinges and corner section of door frame.
- D. Certificate: For door assemblies submit manufacturer's certification stating that each door and frame assembly has been constructed to conform design, materials, fire-rating and construction equivalent to requirements of the specification.

1.04 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** Provide doors and frames manufactured by a firm specializing in the production of hollow metal work.
- B. **Regulatory Requirements for Fire-Rated Assemblies:** Provide fire rated openings where indicated on the intended Contract Drawings, with specified rating doors having appropriate frames of the type of accommodate hardware specified and meet local code requirements. The certificate shall be provided from the local authorities to conform the requirements. Submit manufacturer's certification that each door and frame assembly has been constructed to conform to design, materials and construction equivalent to requirements for the rating assemblies or products or units tested in accordance with ASTM E152 standards.
- C. Provide doors and frames complying with steel door institute "Recommended Specification: Standard steel doors and frames" ANSI/SD1-100 and ANSI/SD1 A151.1-1987 and as herein specified.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect hollow metal units from damage during transit, storage and installation. Tool marks, rust, blemishes and any other damage on exposed surfaces will not be acceptable. Store material in a dry location, off the ground and in such a manner as to prevent deterioration.

1.06 PROTECTION AND CLEANING

- A. Upon completion of installation, clean exposed surfaces as recommended by manufacturer and leave ready for final painting.
- B. Protect units during construction period so that they show no signs of deterioration, use or damage at time of Substantial Completion.

1.07 WARRANTY

- A. **Special Project Warranty:** Submit a written warranty executed by the Contractor, manufacturer and installer, agreeing to repair or replace components or entire units which fail in materials or workmanship within the specified warranty period. Failures include, but are necessarily limited to structural failure including excessive deflection, excessive leakage or air infiltration, deterioration of metals, metal finishes and other materials beyond normal weathering and defects in hardware, weather-stripping and other components of work.
- B. Warranty period for steel doors and frames shall be five (5) years after the end of defects liability period.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- 1. Manufacturer with experience in the specified product and approved by The Engineer.

2.02 MATERIALS

- A. Refer to drawings and Bills of Quantities.
- B. **Cold-rolled Sheet Steel:** ASTM A366 and A568, free from scale, pitting or other defects, stretcher leveled for doors.

- C. Galvanized Sheet Steel: ASTM A526, galvanized in accordance with ASTM A525, Coating Designation G90 (275 g/sq.m) zinc coating, phosphatized, stretcher leveled for doors.
- D. Supports and Anchoring Devices: Structural steel, ASTM A36; or sheet steel, ASTM A366 cold-rolled or ASTM A569 hot rolled and ASTM A153, Class B.
- E. Filler: Sound deadening and heat-retarding mineral fiber insulating material.
- F. Fasteners: Galvanized or cadmium plated steel,
 - 1. Bolts and Nuts: ASTM A307, Grade A
 - 2. Expansion Bolts: FS FF-S-325, Group III, expansion shield (self-drilling tubular expansion shell bolt anchors)> Type I or 2 with galvanized bolts.
 - 3. Machine Screws: FS-FF-S-92, Carbon steel, Type III cross-recessed, design I or II recess, style 2c flat head.
- G. Sheet Steel Primers: One of the following primers compatible with the finish and intended service. Refer to Section 09900- "Painting".
 - 4. FS TT-P-57 Type I (Oil/Alkyd, Zinc Chromate, Iron Oxide base).
 - 5. FS TT-P-57 Type II (Alkyd, Zinc Chromate, Iron Oxide base).
 - 6. FS TT-P-86 Type III (Alkyd, Red Lead base).
 - 7. FS TT-P-664 (Rust-inhabiting, lacquer-resisting, Zinc Chromate, Iron Oxide base).
- H. Galvanized Steel Primer: FS TT-P-641 Type II (Alkyd, Zinc Dust-Zinc Oxide).
- I. Weather/Acoustic Seals: Neoprene.
- J. Smoke Steel: Hot smoke seal of chemically inert highly stable expandable graphic strip of 12.7mm wide x 0.04mm thick with multi-directional expansion.
- K. Hollow Frame Grout: Cement and sand (1:3).

2.03 FABRICATION

- A. Fabricate doors, louver doors and frames to the design and dimensions shown in accordance with the shop practices. Unless otherwise shown, fabricate doors and panels to a thickness of min 45mm. Take field measurements where coordination with adjoining work is necessary.
- B. Make hollow metal work strong, neat in appearance and free from defects. Reinforce corners of doors as required to prevent twisting or sagging.
- C. Form exposed surfaces free from warp, wave and buckle, with all corners square, unless otherwise shown. Form moulded members straight and true, with joints coped or mitered, well formed, and in true alignment. Dress welded joints on exposed surfaces smooth so they are invisible after finishing.
- D. Provide undercuts and clearances for doors as required and for rated doors and panels within the limitations established by the authority having jurisdiction. Prepare doors and frames to receive weather seals and acoustic seals shown on specified. Drop seals to face uniformly across door width. End pivot type not to be use.
- E. Provide a full miter continuously welded on back side at frame corners and stops with edges straight and true. Grind welds smooth and flush on exposed surfaces.

- F. Accurately machine, file and fit exposed connections with hairline joints unless otherwise shown.
- G. Conceal fastenings unless otherwise shown. Countersink exposed screws using flat, Philips head screws.
- H. Conform to the requirements of the "Structural Welding Code" of the American Welding Society for the welding of steel. Provide welds of adequate strength and durability.

2.04 DOOR STEEL FRAME

- Powder coated steel frames, color as approved by the Engineer. Refer to drawings for details.

2.05 FLUSH DOORS

- A. Refer to drawings and Bills of Quantities.
- B. Provide flush closure at the top of exterior doors. Weld inverted steel channels to both outer sheets to form integrally with edge construction of door.
- C. Round stiles for double-swing doors. Provide an overlapped steel astragal welded to the active leaf for pairs of exterior doors and pairs of fire doors, unless otherwise shown.
- D. Mortise, reinforce, drill and tap doors at factory to receive mortise type hardware in accordance with the contract hardware schedule, Fire Alarm System specifications and templates. Provide reinforcing, drill and tap for doors to receive surface applied hardware, except at push plates and kickplates provide reinforcing only. Use steel secured by spot welding as reinforcement. Hardware reinforcement shall be as follows:
 - 1. Hinge reinforcements: 5 x 38 x 225mm.
 - 2. Lock front reinforcement: 5mm thick by size as required by hardware manufacturer.
 - 3. Lock reinforcement units: 12 gauge (2.6mm) by size as required by hardware manufacturer.
 - 4. Closer reinforcement: 12 gauge (2.6mm) one-piece channel by size as required by hardware manufacturer.
 - 5. Other hardware reinforcements: As required for adequate strength and anchorage.
 - 6. In lieu of reinforcement specified, hardware manufacturers recommended reinforcing units may be use.

2.06 DOOR LOUVERS

- A. Provide minimum 20 gauge (0.85mm) steel louvers of type shown with frame.
- B. Where noted or where required for fire rating by codes or by authorities having jurisdiction, provide louvers with operable blades and fusible links.

2.07 METAL DOOR FRAMES

- A. Refer to Drawings for details.

2.08 WEATHER/ACOUSTIC SEALS

- A. Comply with the Specifications for hollow metal door frames, and form to the profiles shown to receive weather seals and acoustic seals.
- B. Install seals in single lengths for each side with uniform exposure of 10mm, using adhesive and other attachments as detailed and as recommended by the seal manufacturer.

2.09 SHOP PAINTING

- A. Clean, treat and paint surfaces of fabricated hollow metal work, inside and out, whether exposed or concealed in the construction.
- B. Thoroughly clean all metal surfaces of loose scale, shavings, fillings, dirt and other deleterious materials by use of wire brushes or other effective means. Remove grease and oil by one of the methods specified in SSPC-SP-1-63 "Solvent Cleaning". Fill as required to seal seams in edges.
- C. Apply two (2) coats of metal primer to all reinforcement and attachment steel and framing which will be in contact with masonry or concrete.
- D. Chemically treat surfaces with phosphate compound to assure maximum paint adhesion. Apply a sufficient number of coats of an approved enamel filler, baked on, to obtain uniformly smooth exposed surfaces. In addition, apply one coat of light-colored primer, baked on, to both inside and outside surfaces. Touch-up surfaces having runs, smears or bare spots.
- E. Provide minimum mil thicknesses of coatings as recommended by the paint manufacturer.

2.10 FINISH HARDWARE

- A. Finish hardware generally for all types of doors is specified in Section 08710 "Hardware".

2.11 SOURCE QUALITY CONTROL

- A. Test: Provide hollow metal doors and frames for fire rated openings manufactured by a firm whose units are inspected and tested for fire rated doors. By a nationally recognized independent testing and inspection agency acceptable to authorities having jurisdiction.

PART 3 EXECUTIONS

3.01 EXAMINATION

- A. Examine all supports for fixing on drawings at actual time of fixing on site and ensure that all are satisfactory and completely adequate. Report any deficiencies to the Engineer.
- B. Assure that frame openings correspond to dimensions of frame furnished.
- C. Check that surfaces to contact frame are free of debris.

3.02 INSTALLATION

- A. Install hollow metal units in accordance with manufacturer's instructions and final shop drawings. Fit doors to frames and floors with proper clearances and to achieve the maximum operational effectiveness and appearance of each unit.
- B. Set hollow metal frames at locations shown, in perfect alignment and elevation, plumb, level, straight, true and free from rack. Brace frames to prevent displacement.

- C. Extend frame anchorages below fills and finishes, except over membrane waterproofed areas. Anchor bottom of frames to floors with anchor bolts or with power driven fasteners. Coordinate the installation of built-in anchors for wall and partition construction as required with other work.
- D. After wall construction has been completed, remove temporary braces, including spreaders at base of 3 sided frames. Leave surfaces smooth and undamaged.
- E. Apply hardware in accordance with hardware manufacturer's instructions and fully co-ordinate with him in making the necessary door and frame preparations for and fixing all hardware. Drill and tap metal door and frames for machine screws as required and do not use self-tapping sheet metal screws. Anchor transom panels in place with concealed fasteners. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Remove and replace doors which are found to be warped, bowed or otherwise damaged and cannot be properly fitted in frames.
- F. Remove hardware before painting and refix after painting of doors is completed. Adjust and lubricate hardware for proper operation at completion and throughout the Contract Defects Liability Period, and instruct Employer's staff in the proper maintenance and adjustment of all hardware supplied.

3.03 TOLERANCES

- A. Maximum Diagonal Distortion: 1.5mm measured with straight edge, corner to corner.

3.04 ADJUSTING AND CLEANING

- A. Adjust hardware to smooth and balanced door movement.
- B. Upon completion of installation clean exposed metal surfaces as recommended by manufacturer and leave ready for final painting.
- C. Protect doors and frames during construction period so that they will be without any indication of deterioration use or damage at time of substantial completion.

3.05 SCHEDULE.

General: Refer to Door Schedule and Drawings.

END OF SECTION

SECTION 08210 WOOD DOORS

PART 1 – GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install flush wood doors, decorative flush doors, interior doors, fire rated doors and wood frames including shop finishing as required and specified herein.

1.02 RELATED WORK

- A. Section 06100 Rough carpentry.
- B. Section 06200 Finish carpentry.
- D. Section 08110 Steel Doors and Frames.
- E. Section 08710 Hardware.
- F. Section 09900 Painting.

1.03 REFERENCES

- A. American National Standards Institute ANSI A135.4 Basic Hardboard.
- B. ASTM E162 Methods of Fire Tests of Door Assemblies
- C. ASTM E413 Classification for Determination of Sound Transmission class
- D. AWI – Quality Standards of the Architectural Woodwork Institute.
- E. HPMA HPHardwood and Decorative Plywood.
- F. MEMA (National electric Manufacturers Association) LD3 – High Pressure Decorative Laminates.
- G. NFPA 80 Fire doors and Windows.
- H. NFPA 252 Standard Method of Fire Tests for Door assemblies.
- I. UL 10B Fire Tests of Door Assemblies.
- J. Wamock Hersey Certification Listings for Fire Doors.

1.04 SUBMITTALS FOR REVIEW

- A. Section 01330 Submittals Procedures for submittals.
- B. Product Data Indicate door core materials and construction; Veneer species, type and characteristics.
- C. Shop Drawing Illustrate door opening criteria, elevations, sizes, types swings, factory machining criteria, factory finishing criteria, identify cutouts of each door elevation of each kind of door, details of construction. Location and extent of hardware blocking, fire rating, and other pertinent data.
- D. Samples : Submit one (1) sample of wooden door for each type of door (120x80cm) in size cut from bottom corner of door, showing finish and color with provisions of lockset and pair of hinges.
- E. Certificate: Submit manufacturer's certification stating that door is in compliance with specified requirements including of those of referenced standards.
- F. Manufacturer's Installation Instructions: Indicate special installation instructions.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with AWI Quality Standard Section 1300. Premium Grade. Maintain one (1) copy on site.
- B. Finish doors in accordance with AWI Quality Standard Section 1500.
- C. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five (5) years experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Accept doors on site in manufacturer's packaging. Inspect for damage.
- B. Protect doors with resilient packaging. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges if stored more than one week. Break seal on site to permit ventilations.

PART 2 – PRODUCTS

2.12 ACCEPTABLE MANUFACTURERS

- 2. Manufacturer with experience in the specified product and approved by The Engineer.

2.01 MATERIALS

- A. Types of doors, sizes, hardware, glazing and details: refer to doors schedule and hardware schedule.

2.02 ADHESIVE

- A. Facing Adhesive should be waterproofed.

2.03 FABRICATION

- A. Fabricate non-rated Doors: in accordance with AWI Quality Standards requirements.
- B. Astragals for Double Doors: Treated wood, T shaped, overlapping and recessed at face edge, specifically for double doors.
- C. Sound Rating for Single door Leaf and Frame Assembly. ASTM E413. Minimum STC 35.
- D. Provide lock blocs edge and top of door for closer for hardware reinforcement.
- E. Vertical Exposed Edge of Stiles: Hardwood for transparent finish.
- F. Fit door edge trim to edge of stiles after applying veneer facing.
- G. Bond edge banding to cores.
- H. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
- I. Factory fit doors for frame opening dimensions identified on shop drawings.
- J. Cut and configure exterior door edge to receive recessed weather stripping devices.
- K. Provide edge clearances in accordance with AWI 1600.

2.04 DOOR FINISH

- A. Doors finish as per doors schedule.

A.01 PRE-FITTING AND PREPARATION FOR HARDWARE

- A. Pre-fit and pre machine wood doors at factory.

- B. Comply with tolerance requirements of the manufacturer's for pre-fitting. Machine doors for hardware requiring cutting of doors.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes and tolerances are acceptable.
- B. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.
- C. Contractor shall verify all dimensions in field & submit shop drawings to the Engineer, showing all such verification for approval.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions.
- B. Trim non-rated door width by cutting equally on both jamb edges.
- C. Trip door height by cutting bottom edges to a maximum of 19mm.
- D. Machine cut for hardware.
- E. Coordinate installation of doors with installation of frames specified in Section 08110 and hardware specified in Section 08710.
- F. Coordinate installation of glass and glazing.
- G. Install door louvers plumb and level.

3.03 INSTALLATION TOLERANCES

- A. Conform to the manufacturer's requirements for fit and clearance tolerances.

3.04 ADJUSTING

- A. Adjust door for smooth and balanced door movement.
- B. Adjust closer for full closure.

END OF SECTION

SECTION 08310 ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Access panels and frames shown on the drawings or inferable there from and/or specified in accordance with the requirements of the contract documents. Work includes but is not limited to the following:
1. Access doors and frames.
 2. Fixing.
- B. Related Sections:
1. Section 05500 – Metal Fabrication
 2. Section 08210 – Wood Doors
 3. Section 08710 – Door Hardware.
 4. Section 09900 – Painting.

1.02 REFERENCES

- A. ASTM (American Society for Testing and Materials).
1. ASTM A36 / A36M - 08 Standard Specification for Carbon Structural Steel.
 2. ASTM A666 - 03 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 3. ASTM B209 - 07 Standard Specifications for Aluminum and Aluminum-Alloy Sheet and Plate.

1.03 SUBMITTALS

- A. Product: Manufacturer's technical data and installations for each type of access door assembly, including setting drawings, templates, instructions and directors for installation of anchorage and devices.
- B. Shop Drawings: Submit shop drawings to the Engineer in accordance with Contract Documents. Include showing joinery details, frames, and installation of customized access doors and frames, including details of each frame type, elevations of door design types, anchorage and accessory items.
- C. Sample: Submit to Engineer sample 600 x 600mm square showing edges, faces, joinery and material qualities of each type.

1.04 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain access door for entire project from one source from a single manufacturer.
- B. Coordination: Furnish inserts and anchoring devices that must be built into other work for installation of access doors. Coordinate delivery with other work to avoid delay.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect access panel units from damage, storage and installation. Tool marks, rust, blemishes and any other damage on exposed surfaces will not be acceptable. Store material in a dry location off the ground and in such a manner as to prevent deterioration.

1.06 PROTECTION AND CLEANING

- A. Upon completion of installation, clean exposed surfaces as recommended by manufacturer and leave ready for final painting.
- B. Protect units during construction period so that they show no signs of deterioration use

or damage at time of substantial completion.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 MATERIALS

- A. Access Door and Frame
 - 1. Steel plates, shapes and bars: ASTM A36/A.
 - 2. Stainless Steel: ASTM A666 Type 304 and 316
 - 3. Aluminum sheet: ASTM B 209
- B. Locking Devices: Provide one locking device per access door and furnish two special keys per lock.
- C. Galvanized steel access panel with frames and hardware, including steel sections supports, ironmongery, fittings and fixings, painting; as shown on drawings 800x800mm for water tank.

2.03 FABRICATION

- A. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
- B. Fabrication: Fabricate frames and doors as per details and dimensions shown on the drawings to match with surrounding finishes.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Coordinate installation with work of other trades.

3.02 INSTALLATION

- A. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
- B. Access panel shall have uniform gap of not more than 3mm on all four sides with the adjoining finished surface.

3.03 ADJUSTING AND CLEANING

- A. Adjust hardware and panels after installation for proper operation.
- B. Remove and replace panels or frames that are warped, bowed or otherwise damaged.

END OF SECTION

SECTION 08333

COILING DOORS AND GRILLES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Overhead coiling door shutters and grills in accordance with the requirements of the Contract Documents. Work includes but is not limited to the following:

1. Electrically operated commercial security Roller Grille.
2. Coordination with the work of other sections.
3. Installation.

B. Related Sections:

1. Section 05500 Metal fabrication
2. Section 08110 Steel Doors And Frames
2. Section 09900 Painting
3. Electrical Section

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM):

1. ASTM A90: Test Method for Weight of Coating on Zinc Coated (Galvanized) Iron or Steel Articles.
2. ASTM A153: Specification for Zinc Coating (hot-dip) on Iron and Steel Hardware.
3. ASTM A446-89: Specification for steel sheet, zinc-coated (Galvanized) by the Hot-dip Process, Structural (Physical) Quality.
4. ASTM A525-83: Specification for General Requirements for steel sheet, zinc coated (Galvanized) by Hot-dip Process.
5. ASTM B221-85: Standard Specification for Aluminum and Aluminum- Alloy Extruded Bars, Rods, Wire, Slopes and Tubes.

1.04 SUBMITTALS

- A. Product Data Submit to the Engineer for information only in accordance with the requirements of the Contract Documents copies of manufacturer's specifications and installation instructions for each type of rolling shutters and grilles to show compliance with these Specifications.
- B. Shop Drawings Submit to the Engineer in accordance with the Contract Documents detailed drawings of special components required for the proper installation including anchoring and supporting systems. Prepare details at 1:5 minimum scale as approved by the Engineer and show details of adjacent wall and ceiling finishes.
- C. Samples: Submit to the Engineer in accordance with the Contract Documents samples of each curtain slat. Engineer's review of samples shall be for design, color, texture and pattern only. Compliance with all other requirements is the exclusive

responsibility of the Contractor.

- D. Operating and Maintenance Manuals: Submit to the Engineer manufacturer's operating and maintenance manuals, including parts lists and all other information needed for proper operation and maintenance of rolling shutters.
- E. Certificate: Submit manufacturer's certification stating that security roller grill comply with specified requirements including of those of referenced door standards.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Rolling grills shall be installed in place and in full operative condition by an installer having a minimum of Five (5) years experience of similar works to those specified in this Project.
- B. Requirements of Regulatory Agencies: All work shall be in accordance with the requirements of the authorities having jurisdiction and all applicable codes, rules and regulations, and ordinances.

1.06 DELIVERY STORAGE AND HANDLING

- A. Deliver rolling grill shutters and accessories completely identified for installation procedure. Use care in handling to prevent damage. Store all equipment clear of ground and protected from damage and deterioration.

1.07 WARRANTY

- A. Special Project Warranty: Submit a written warranty executed by the Contractor agreeing to repair or replace components or entire units which fail in materials or workmanship within the specified warranty period. Failure includes, but is not necessarily limited to, structural failure including excessive deflection, failure of electrical components, deterioration of metals, metal finishes, and other materials beyond normal weathering.
- B. Warranty period for security roller grill units shall be Five (5) years after the date of defect liability period.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to doors schedule for details.

2.02 HARDWARE

- A. All rolling doors shall be lockable with proprietary locking system which shall be

keyed into the buildings master keying system. Submit to Engineer the proposed locking system for approval.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supports provided by others at time of bidding and again before installation and ensure that they are adequate. Report any deficiencies to the Engineer.

3.02 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, equipments and supports all in accordance with final shop drawings and manufacturer's instructions.

3.03 DEMONSTRATION

- A. Upon completion of the roller grille and doors installation and a minimum of one month before substantial completion and as a condition of their acceptance, demonstrate to the Engineer's satisfaction that the doors operate smoothly, lock securely and have been properly installed.

3.04 CLEANING AND PROTECTION

- A. Following complete installation of each rolling grille and door, clean surfaces, joints and bearings of unit in accordance with manufacturer's instructions; lubricate as recommended by manufacturer. Protect each rolling shutter during construction period from weathering, deterioration or damage from any source so that it will be without any indication of use or damage at the time of completion of the Works.

END OF SECTION

SECTION 08520 ALUMINUM WINDOWS

PART 1 – GENERAL

1.1 SECTION INCLUDES

1. Aluminum framed single/double glazed sliding/Hinged /fixed windows system.

RELATED SECTIONS

1. Section 05500 Metal Fabrications.
2. Section 08110 Steel Doors and Frames.
3. Section 08710 Hardware.
4. Section 09300 Tiles.

REFERENCES

1. ASTM E90 – Standard Test Methods for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
2. ASTM E283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Window, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
3. ASTM E 330 – Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
4. ASTM E 547 – Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
5. ASTM F 588 – Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.

SUBMITTALS

1. Submit under provisions of Section 01330.
2. Test Reports: Submit certified independent laboratory test reports verifying compliance with all test requirements and structural calculations prepared by approved structural engineer and indicating adequacy of all installed materials to meet the uniform and structural load requirements.
3. Provide manufacturer's installation instructions, and include maintenance information on regular cleaning and stain removal.
4. Shop Drawings: Submit shop drawings, showing anchors, glazing details, hardware, operators and other components not included in manufacturer's standard data.

QUALITY ASSURANCE

1. Manufacturer Qualifications: Minimum ten (10) years experience producing aluminum windows.
2. Installer Qualifications: Use installers that are experienced and skilled in the installation of aluminum windows of the type specified.
3. Field Sample: Provide a Field Sample for evaluation of surface preparation techniques and application workmanship.
 - A. Do not proceed with remaining work until workmanship, color, and sheen are approved by Engineer.

- B. Test Procedures: Test shall be in accordance with ASTM E 283 and E 330.
1. Air Infiltration (perform before water test).
 2. Uniform load deflection Test.
 3. Uniform load structural Test.

DELIVERY, STORAGE, AND HANDLING

1. Deliver windows to project site in undamaged condition; handle windows to prevent damage to components and to finishes.
2. Store products in manufacturer's unopened package store in an area that is protected from the elements, in a manner recommended by the products manufacturer until ready for installation.

WARRANTY

1. Provide written ten (10) years warranty signed by manufacturer that products are free of material or manufacturing defects. Defects are defined to include uncontrolled leakage of water, corner or joint failure, and abnormal aging or deterioration.
2. Include repair or replacement of defective units for ten (10) years from end of defects liability period.

PART 2 – PRODUCTS

MANUFACTURERS

- A. Manufacturer with experience in the specified product and approved by the Engineer.

MATERIALS

- A. Details: Refer to windows schedule, hardware schedule and detailed drawings for full details.

B. Thermal Insulated Sliding Window System

With 120 mm (double track) basic frame depths

Design features:

Designed as a sliding construction with two guide tracks.

Vent profiles and tandem rollers for vent weights of up to 150 kg / 300kg must be used.

The fixed glazing is fitted in the outer frame / vent frame.

The bottom, replaceable tracks are made of stainless steel. In the joint area, the outer frames have plastic cover profiles.

Vent profiles can have structural reinforcements to suit requirements.

Glass thicknesses from 8 mm to 32 mm can be used.

The frame connections of the outer frame and vent profiles are made with precision corner cleats.

Profile basic depths:

Outer frame	120 mm
Vent frame	50 mm

Profile face widths:

Outer frame, side and top	17
mm Outer frame, bottom	
17 mm	
Vent frame	84 mm
Vent frame (top light)	
41 mm	
Vent sash bar, flush	78 mm
Vent sash bar, rebated	88 mm
Minimum Thickness Of aluminum profile	1.6 mm
Sound reduction index [dB]	40
Air permeability	Class 4
Watertightness	E1200
Burglar resistance	RC2
Wind load resistance	B3

C. Thermally Insulated Self-Supporting Aluminum Façade System

As a mullion/transom construction for multi-storey façades with an internal and external face width of 50 mm.

Design features:

The construction must be sealed from outside using aluminum pressure plates to suit the infill thicknesses.

Load-bearing structure:

The load-bearing structure of the façade construction consists of rectangular multi-chamber hollow profiles.

The load-bearing profiles are on the room side.

All profile edges are rounded.

The transom profiles are notched and overlap the mullions where they intersect, so that any moisture is reliably drained away.

On multi-storey façades, all horizontal joints must be constructed using the joint connectors and joint tolerance seals belonging to the system.

Appropriate system-based aluminum insert profiles and half profiles, as well as expansion joint seals, must be used for vertical expansion and assembly joints.

Glazing / insert units:

All glazing, even in the insert units, lies in the same plane. The glazing gaskets made from weather-resistant, black EPDM on the room side are of different depths in the mullions and transoms (6 mm offset).

Two individual gaskets made from weather-resistant, black EPDM, with a height of 5 mm, are positioned on the outside. Molded gasket intersections made from EPDM must be used where mullions and transoms join.

In principle two individual gaskets and butyl tape must be used on faceted areas and for roof glazing.

Ventilation:

Rebate base ventilation and vapor pressure equalization are achieved at all four corners of each module field into the mullion rebate.

For field drainage and ventilation, appropriate openings must be made in the aluminum pressure plates, cover caps and gaskets.

Profile face widths:

Mullion, assembly mullion, transom 50 mm

Profile basic depths:

Mullion 105 mm

Transom 110 mm

Cover cap (mullion) 20 mm

Cover cap (transom) 15 mm

Aluminum profile thickness:

Million Side and Transom 2.1 mm

Top 5.8 mm

PART 3 – EXECUTION**3.01 EXAMINATION**

1. Do not begin installation until openings have been properly prepared.
2. Notify the Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

1. Clean surfaces thoroughly prior to installation.
2. Prepare the best result for the project conditions.

3.03 INSTALLATION

1. Install windows and related components in accordance with approved shop drawings and manufacturer's requirements.
2. Erect materials plumb, level, and true relative to the building structure, maximum variation from plumb and level not exceeding (3mm in 3m).
3. Apply caulking at all points between masonry concrete elements and aluminum outer frame, apply in a manner to ensure airtight and watertight continuous perimeter seal so as to prohibit seepage of cold air into the insulated cavity.

FIELD QUALITY CONTROL

1. Window manufacturer shall repair or replace window units not meeting specified performance requirements.
2. Windows shall pass the test requirements in the (General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996) for air and water leakage in the site.

CLEANING

1. After installation, remove all sealants, caulking, and other misplaced materials from all surfaces, including adjacent work.

2. Thoroughly clean window frames, casings, and glass using materials and methods recommended by the window and glass manufacturer that do not cause defacement of work.

PROTECTION

1. Protect installed products until completion of project.
2. Touch-up, repair or replace damaged products before end of defects liability period.

END OF SECTION

SECTION 08710 HARDWARE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Finish hardware in accordance with the requirements of the Contract Documents. Work includes architectural hardware for all interior and exterior doors unless otherwise specified elsewhere. Work include but are not limited to:
1. Door handle.
 2. W/C Indicator.
 3. Bolt.
 4. Door stop.
 5. Door closer.
 6. Locks.
 7. Cylinder.
 8. Hinges.
 9. Pull handle.
 10. Push plate.
 11. Kick plates.
- B. Related Sections:
1. Section 08110 Steel Doors and Frames.
 2. Section 08210 Wood Doors.
 3. Section 08520 Aluminum Windows
 8. Section 09900 Painting.

1.02 REFERENCES

- A. American Architectural Manufacturers Association (AAMA)
1. AAMA 70-2-1994 Specification for Pile Weather Strip
- B. American National Standards Institute (ANSI)
1. ANSI/BHMA A117-1-1988 Building and Facilities- Providing Accessibility and Usability for Handicapped People.
 2. ANSI/BHMA A156 1-1988 Butts and Hinges.
 3. ANSI/BHMA A156 2-1989 Bored and Preassembled Locks and Latches.
 4. ANSI/BHMA A156 3-1989 Exit Devices.
 5. ANSI/BHMA A156 4-1986 Door Controls – Closers.
 6. ANSI/BHMA A156 5-1984 Auxiliary Locks and Associated Products.
 7. ANSI/BHMA A156 6-1986 Architectural Door Trim
 8. ANSI/BHMA A156 7-1988 Template Hinge Dimensions.
 9. ANSI/BHMA A156 8-1988 Door Controls – Overhead Holders.
 10. ANSI/BHMA A156 14-1985 Sliding and Folding Door Hardware
 11. ANSI/BHMA A156 15-1986 Closer Holder Release Devices.
 12. ANSI/BHMA A156 16-1989 Auxiliary Hardware.
 13. ANSI/BHMA A156 18-1987 Materials and Finishes.
- C. American Society for Testing and Materials (ASTM)

1. ASTM D 1056-85 Standard Specification for Flexible Cellular Materials
- Sponge or Expanded Rubber
- D. Door and Hardware Institute (DHI)
1. 1990 Edition Recommended locations for Builder's Hardware for Standard Steel Doors and Frames.
 2. 1976 Edition Recommended locations for Builder's Hardware for Custom Steel Doors and Frame.
- E. National Fire Protection Association
1. NFPA Standard No. 80-1990 Fire Doors and Windows.
- F. National Wood Window and Door Association (NWWDA)
1. NWWDA I.S 7-87 Hardware Locations for Wood Flush doors.
- G. British Standard (BS):
1. BS EN 1935:2002 - Building hardware. Single-axis hinges. Requirements and test methods
 2. BS EN 12209:2003 - Building hardware. Locks and latches. Mechanically operated locks, latches and locking plates. Requirements and test methods
 3. BS EN 1154:1997 - Building hardware. Controlled door closing devices. Requirements and test methods
- H. Underwriter's Laboratories Inc. (UL)
1. UL 228 1986 Standard for Door Closers-Holders, with or without Integral Smoke Detectors.
 2. UL 437 1986 Standard for Key locks.

1.03 SUBMITTAL

- A. Manufacturer's Literature Catalogue Cuts: Submit, copies of manufacturer's Specifications, maintenance and keying manuals, and installation instructions (templates to suit each particular installation), for each item of finish hardware. Include photographs, catalogue cuts, marked templates and other data as may be required to show compliance with these Specifications. Only original manufacturer's catalogue will be acceptable.
- B. Sample: In accordance with the requirements of the Contract Documents, one sample of each typical item of exposed hardware. The Engineer review of samples will be for design, pattern, finish and color only. All other requirements are the exclusive responsibility of the Contractor.
- C. Shop Drawings, Finish Hardware Schedule: Submit Engineer for review, in accordance with the requirements of the Contract Documents, copies of finish hardware schedule covering complete identification of all items required for the project. Include manufacturer's name and identification of finishes. Include a separate schedule of key and master key system with final submittal of schedule. Engineer's review of schedules shall neither be construed as a complete check nor shall it relieve the Contractor of responsibility for errors, deviations or omissions from requirement to provide complete hardware for the project.
1. Coordinate hardware schedule with door manufacturers' "Door Schedule". Submit required templates to door manufacturers to enable proper and accurate sizing and location of hardware.

2. Keying Schedule: Separate detailed schedule indicating clearly how the Employer's final instructions on keying of locks has been fulfilled.
 3. Submit to the Engineer future master key system for the complete buildings for approval.
- D. Statement of Application: Submit to the Engineer in accordance with the requirements of the Contract Documents, one copy of a statement confirming that the finish hardware work complies with these Specifications and, that the methods of installation were proper and adequate for the condition of installation and use. The Statement of Application shall be signed by the Contractor.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Obtain each type of hardware from single manufacturer although several may be indicated as offering products complying with requirements. Companies specializing in manufacturing door hardware with minimum five (5) years experience
- B. Installer Qualifications:
1. The hardware installer shall have extensive experience of not less than five (5) years in the installation of similar hardware to large projects and must produce evidence in the form of references from previous jobs.
 2. The hardware installer must provide an experienced qualified architectural hardware consultant who has been with the hardware installer for a minimum of five (5) years. He must be available during the delivery and installation period and must be able to attend the building site at other times as required by Engineer.
- C. Requirements of Regulatory Agencies:
1. Hardware at Fire Rated Openings: Furnish hardware in accordance with NFPA Standard No. 80 for openings specified, shown or scheduled for a fire rated opening to receive specified fire rating. In case of conflict between type of hardware specified and type required for fire protection, furnish type required to meet the local authorities.
 - a. Furnish hardware of type listed for usage with the types and sizes of fire doors and frames required. Unless otherwise shown or specified, arrange doors at fire rated openings to remain in the normally closed position by furnishing each unit with an automatic closing device. Furnish active latch bolts that cannot be held in the retracted position.
- D. Pre-Installation Meetings: After delivery of hardware and prior to its installation, meet with the Engineer and manufacturer's representatives. Compare final samples with actual hardware delivered to assure acceptability. Review catalogues, brochures, templates, installation instructions and the final hardware schedule. Rehearse installation procedures and workmanship, with special emphasis on unusual conditions, so as to ensure correct technique of installation, and coordination with other work.

1. Finish and color of each hardware item is to match sample furnished to, reviewed and selected by The Engineer.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Package and label each item of hardware separately. Tag each item in accordance with the final hardware schedule. Each package shall contain appropriate fastenings, instructions and installation templates. Protect all items from loss or damage in shipment.
- B. All hardware shall be stored in a dry secure area and in a manner to facilitate sorting, checking and unpacking.

1.06 PROJECT CONDITIONS

- A. Coordination: Coordinate work of this section with other directly affected sections..

1.07 WARRANTY

- A. Special Project Warranty: Submit a written warranty, agreeing to repair or replace components or entire units which fail in materials or workmanship within specified warranty period. Failures include, but are not necessarily beyond normal weathering and defects in hardware.
- B. Warranty Period for door hardware shall be five (5) years after end of defects liability period.

1.08 MAINTENANCE

- A. Provide special wrenches and tools applicable to each different or special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A Manufacturer with experience in similar products and approved by the Engineer.

2.02 HARDWARE SCHEDULE

Refer to Doors Schedule, hardware Schedule for hardware specification.

2.03 DOOR CLOSERS

- A. Generally
 - All door closers include well secured satin stainless steel cover boxes with stainless steel arms.
 - All door closers include spring strengths appropriate to the location, size and weight of door arm configuration and the like.
 - All door closers to be adjusted to manufacturer's recommendations to operate faultlessly.
 - Exchange door closers where spring strengths are inappropriate for conditions.
 - Door closers to corridors and foyer spaces shall be concealed from view with selection of the arm/bracket type.

- For 1 + ½ leaf doors use number 3 rated closer to large leaf and number 1 rated closer to small leaf where two door closers are noted.
- Door closers for pivot doors shall include:
 - Double acting closers shall centre the door within the frame.
 - Single acting closers shall retain positive pressure against the stop.

2.04 DOOR STOPS

Generally

- Install spacers under stops to ensure proper contact with the leaf. Note undercut doors.
- Position stops to ensure that door leaves do not strike walls or furniture. locate no closer than 1/3 of the door width from the hinge.
- Stainless steel floor stopper.
- Stainless steel wall type stopper.

2.05 DOOR HANDLES

- Satin stainless steel lever handle on rose & esutcheon.
- Satin stainless steel pull handle.
- Satin stainless steel special long pull handle.
- Stainless steel touch bar.
- Stainless steel small knob handle.

2.06 HINGES

- Stainless steel butt hinges, two ball bearings, with stainless steel pin.

2.07 HARDWARE FINISHES

- A. All ironmongery and Hardware of woodworks to be stainless steel finish & of high quality Union England. And shall be free from manufacturing defects.
- B. All handles and plates to be polished chrome or stainless steel Union England. All sizes of material given in the hardware sets are only for guidance. It is there responsibility of the Contractor to furnish the exact size and weight of hardware items to ensure proper function in each case. All sizes of door hardware given in hardware set are only for guidance.
- C. Hardware shall be fire rated for the specified fire rated doors.
- D. Produce finishes to exactly match with Engineer's selected sample(s). Reduce variance in hue in the color of each finish, as much as possible, whether the base materials is cast, forged or stamped, or when plating is applied over steel, brass or bronze. Finishes of the same designation, that come from 2 or more sources, shall match when the items are viewed at arms length and approximately 600mm apart. Unless otherwise specified, match the finish of each item of hardware with the finish selected for lock sets and latches.

2.08 HARDWARE MOUNTING HEIGHTS

- A. Mounting heights shall generally be in accordance with the "Recommended Locations for Builders Hardware" published by the Doors and Hardware Institute (DHI) and to the approval of the Engineer.

- B. The Following mounting heights shall apply throughout the work, unless otherwise shown.
1. Lock Sets and Latches: 950mm to centre of handle from floor.
 2. Butt Hinges: 295mm to center of lowest hinge from floor, 181mm to center of upper hinge from top of door, space other hinges equally between lower and upper hinges.
 3. Door Pulls: 1120mm finished floor to centre of pull, centre line in 12mm from edge of flush doors, and centered on stile of narrow stile glass doors.
 4. Deadlocks: Centre line of cylinder to align with centre line of cylinder for lock sets, unless indicated otherwise.
 5. Cross-Bar of Exit Device: 950mm finished floor to centre of cross bar.
 6. Push Bar: 10050 mm finished floor to centre of push bar.
 7. Push Plate: 1120 mm finished floor to centre of plate through mounted to pulls.
 8. Bolts: Lever action flush bolt w/floor socket, Central latch panic bolt.
 9. Stainless steel wheels on top & bottom rail.
 10. Aluminum kick plates both sides of 20 cm height as indicated.

2.09 SOURCE QUALITY CONTROL

- A. Coordinate the application of hardware items with door and frame details and with methods of fastening as hereinafter specified.
- B. Adaptation of Hardware Items: Where the type of hardware specified is not adaptable to the finished size of members requiring hardware; submit an item having a similar operation and quality to the engineer for review.
- C. Templates: Make finish hardware to templates, with wood and/or machine screws as applicable to door and frame details. Furnish templates and schedules to door and frame manufacturers and other trades requiring same, so that doors and frames can be cut, reinforced and prepared in the shop to receive hardware. Use template hinges conforming to ANSI standards to establish location of holes for each size of hinge.
- D. No names, designs, or labels will be permitted on the following items: face of cylinders, turn pieces, or operating trim of lock sets or latch sets, push bars, pull handles, plates (any visible parts) and any other item which the Engineer designates.
- E. Single Source: Use only the products of one manufacturer for each type of hardware specified.
- F. The Contractor should be responsible for the accuracy of the quantities, sizes finish and proper hardware to be furnished whether specifically mentioned or not and shall be responsible for determining all details such as hand of doors, type of locks, standards required etc.

2.10 LOCK CYLINDERS AND KEYING SYTEM

- A. Provide 3 change keys per cylinder.
- B. Heavy duty mortice lock with 6-pins rim cylinder, operable from both sides.
- C. Mortice bathroom lock with turn snib & outside indicator bolt.

- D. Panic lock with external handle and lock always free to escape from inside.
- E. Rim cylinder / key access from one side.
- F. Finish of cylinders shall match the hardware finish and in accordance with BHMA and ANSI 156.18.
- G. Provide temporary cylinders for use during construction period only.
- H. Provide a Construction Master key and required construction keys for each building during construction period.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work and dimensions are as indicated on the prepared and reviewed hardware schedule and as instructed by the manufacturer.

3.02 PREPARATION

- A. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrate.

3.03 INSTALLATION

- A. Receive hardware for doors as shown and scheduled, and as specified in the applicable hardware portions of these specifications. Store in a locked space to prevent loss.
- B. Apply to doors as recommended by hardware manufacturer and as required. Fit locks and latch in their respective doors and remove before painting. Reinstall after painting of doors is completed. Upon completion, adjust and lubricate hardware for proper operation.
- C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

3.04 FINAL ADJUSTMENTS AND CHECKING

- A. Adjust and check the installation of finish hardware. Check, test and adjust moving parts to ensure free and smooth operation. Furnish to the Engineer the special tools required to adjust and maintain hardware including instruction sheets and operation manuals.
 - 1. After the building is completed and in use, adjust hardware to compensate for air movement and other conditions, so that all items will operate properly.
 - 2. A factory representative of the lock and latch manufacturer shall examine all hardware furnished with the Engineer six (6) months after the handing over. Adjust the hardware for proper operation.
 - 3. Clean and polish all exposed hardware at the time of handing over to the Employer.

END OF SECTION

SECTION 08810 GLASS AND GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Glass materials.
- B. Insulating glass units.
- C. Glazing accessories.

1.02 RELATED SECTIONS

- 1. Section 06200 Finish Carpentry.
- 2. Section 07900 Joint Sealers.
- 3. Section 08110 Steel Doors and Frames.
- 4. Section 08210 Flush Wood Doors.
- 5. Section 08520 Aluminum Windows.

1.03 REFERENCES

- A. ANSI Z97.1 – American National Standard for Glazing Materials Used in Buildings- Safety Performance Specifications and methods of Test.
- B. ASTM C162 – Standard Terminology of Glass and Glass Products.
- C. ASTM C864 – Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- D. ASTM C1036 – Standard Specification for Flat Glass.
- E. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
- F. ASTM C1172 – Standard Specification for Laminated Architectural Flat Glass.
- G. ASTM C1193 – Standard Guide for Use of Joint Sealants.
- H. ASTM E283 – Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure differences Across the Specimen.
- I. ASTM E330 – Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- J. ASTM E2188 – Standard Test Method for Insulating Glass Unit Performance.
- K. ASTM E2189 – Standard Test Method for Testing Resistance to Fogging in Insulating Glass Units.
- L. ASTM E2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation.
- M. ASTM E1300 – Standard Practice for Determining the Minimum Thickness and Type of Glass Required Resisting a Specified Load.
- N. GANA (GM) – FGMA Glazing Manual; Glass Association of North America.
- O. GANA (SM) – FGMA Sealant Manual; Glass Association of North America.
- P. GANA (LGDG) – Laminated Glass Design Guide, Glass Association of North American.
- Q. SAA Glazing Code: (Australian Standards).
 - 1. AS1288 – Glass in Buildings.

2. AS2376 – Glass Fiber Reinforced Polyester.
3. AS2208 – Safety Glazing materials for use in buildings.
4. AS1170 – Australian Wind Loading Code.

1.04 DEFINITION

- A. Sealed Insulating Glass Unit Surfaces.
1. Side 1 – Exterior surface of outer pane.
 2. Side 2 – Interior surface of outer pane.
 3. Side 3 – Interior surface of inner pane.
 4. Side 4 – Exterior surface of inner pane.

1.05 SYSTEM DESCRIPTION

- A. Design requirements:
1. Size Glass to withstand dead loads and positive and negative live loads acting normal to plane of glass to a design pressure in accordance with ASTM E1300.
 2. Limit glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.

1.06 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. (Product Data): Manufacturer's data sheets on each product to be used, including
1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Selection Samples: For each finish product specified, two complete sets of color samples representing manufacturer's full range of available colors and patterns.
- D. Verification Samples
1. Flat Glass Materials: Two 100 x 100mm samples of each glass type specified.
 2. Sealed insulating glass Units. Two (300 x 300mm) samples representative of unit construction.
 3. Opacifier for Spandrel Glass: Indicated match to Engineer's color selection.
- E. Certificates: Product certificates signed by the manufacturer certifying material compliance with specified performance characteristics and criteria, and physical requirements.
- F. Warranty documents specified herein.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Flat Glass Materials. Minimum five (5) years documented experience producing glass products specified this section.
- B. Fabricator, Sealed Insulating Glass Units.: Minimum five (5) years documented experience producing sealed insulating glass units specified in this section.
- C. Installer Qualifications: Minimum five (5) years documented experience installing products specified in this section, and approved by Te Engineer.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.09 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Environmental Requirements: Installation of Glass products at ambient air temperature below (10 degrees C) is prohibited.
- C. Field Measurements: When construction schedule permits, verify field measurements with drawing dimensions prior to fabrication of glass products.

1.10 WARRANTY

- A. Provide ten (10) years warranty to include replacement of sealed glass units exhibiting seal failure, interpane dusting or misting.
- B. Provide ten (10) years warranty to include replacement for laminated glass exhibiting delamination.

PART 2 PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS**

- A Manufacturer with experience in similar products and approved by the Engineer.

2.02 FABRICATION

- A. Clear Float Glass
 - a.. Cut float glass materials to indicated sized and provide cut-outs and holes, if indicated before heat strengthening.
 - b. Heat strengthen float glass materials in accordance with ASTM C1048, Kind HS.
- B. Tempered Glass
 - b. Cut float glass materials to indicated sizes and provide cut- outs and holes, if indicated, before heat strengthening.
 - c. Fully temper float glass materials in accordance with ASTM C1048, Kind FT.
 - d. Laminate plastic interlayer between glass panes in accordance with ASTM C1172.
 - e. Laminated glass to conform to the requirements of ANSI Z97.1.
- C. Sealed Insulating Glass Units
 - f. Fabricate units in accordance with ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation with components and performance characteristics specified by the architect.

g. Insulating Glass Components double glazed:

1. Refer to drawings for details

h. Insulating Glass Components single glazed:

1. Fully tempered glass of thickness 10mm.
Provide unit edge seals meeting requirements of ASTM E773, with aluminum spacers having mitered and corners, and silicone sealant for glass-to-spacer seals.

D. Monolithic Spandrel Glass Units.

- Heat strengthened float glass material in accordance with ASTM C1048, Kind HS.
- Tempered float glass materials in accordance with ASTM C1048, Kind FT.
- Apply ceramic fused frit to indicated glass surface.
- Apply silicone polyester enamel opacifier coating to indicated glass surface.

E. Sealed Insulating Spandrel Glass Units

- Heat strengthened float glass materials in accordance with ASTM C1048, Kind HS.
- Tempered float glass materials in accordance with ASTM C1048, Kind FT.
- Fabricate units in accordance with specified requirements for sealed insulating glass units.
- Apply ceramic fused frit to indicated glass surface.
- Apply silicone polyester enamel opacifier coating to indicated glass surface.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that openings for glazing are correct size and within tolerance.
- B. Verify that glazing channels and recesses are clean and free of obstructions, that weeps are clear, and that channels and recesses are ready for glazing.

3.02 PREPARATION

- A. Clean contact surfaces to receive sealant with solvent, wipe dry.
- B. Seal porous glazing channels and recesses with primer or sealer compatible with substrate.
- C. Prime surfaces to receive sealant in accordance with sealant manufacturer's instructions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install coated monolithic glass with coated surface to interior (surface 1) for internal pane.
- C. Install coated monolithic glass with coated surface to interior (surface 2) for external pane.
- D. Install sealants in accordance with Section 07900.
- E. Install sealants in accordance with ASTM C804 for solvent release sealants.
- F. Install sealants in accordance with sealant manufacturers' instructions.
- G. Exterior Dry Method (Tape and Gasket Spline)
 1. Apply glazing tape or spline to glass; butt-joint tape edges, seal joints with butyl sealant.

2. Place setting blocks with edge blocks maximum 152mm from glass edges and intermediate blocks at $\frac{1}{4}$ points of glass panel length.
 3. Set glass unit on setting blocks, apply pressure against fixed stop for full contact.
 4. Install removable stops without displacing glazing tape or spline, apply pressure for full continuous contact.
 5. Trim sight-exposed tape flush with stop.
- H. Exterior Wet/dry Method (Formed and Sealant):
1. Apply glazing tape to glass: butt-joint tape edges seal joints with butyl sealant.
 2. Apply glazing tape to permanent stops, 6mm below sight line; butt-joint tape edges seal joints with butyl sealant.
 3. Apply heel bead of butyl sealant along intersection of permanent stop with frame, ensure full perimeter seal between glass and frame for continuity of air and vapor seal.
 4. Place setting blocks with edge blocks maximum 150mm from glass edges and intermediated blocks at $\frac{1}{4}$ points of glass panel length.
 5. Set glass unit on setting blocks; apply pressure against fixed stop for full contact.
 6. Install removable stops without displacing glazing tape, insert spacer strips between glazing and applied stops, terminate spacer strips 6mm below sight line; apply pressure for full continuous contact.
 7. Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing and to 9mm below sight line.
 8. Apply cap bead of sealant along void between stop and glazing to uniform line flush with sight line, tool sealant surface smooth.
- I. Exterior Wet Method (Sealant and Sealant)
1. Place setting blocks at $\frac{1}{4}$ points; install glazing unit.
 2. Install removable stops; center glass unit in space by inserting spacer shims both sides at intervals of 600mm; set spacer shims 6mm below sight line.
 3. Fill gaps between glazing and stops with sealant to depth equal to bite of frame on glazing and to 9mm below sight line; ensure full contact with glazing for continuity of air and vapor seal.
 4. Apply sealant to uniform line flush with sight line. Tool sealant surface smooth.
- J. Exterior Butt Glazed Method (Sealant Only):
1. Brace glass in position for duration of glazing process, mask edges of glass at adjoining glass edges and between glass edges and framing members.
 2. Secure small diameter non-adhering foamed rod on back side of joint.
 3. Apply sealant to open side of joint in continuous operation, completely fill joint without displacing foam rod; tool sealant surface smooth to concave profile.
 4. Allow sealant to cure, then remove foam backer rod.
 5. Apply sealant to opposite side; tool sealant smooth to concave profile.
 6. Remove masking tape.

- K. Interior Dry Method (Tape and Tape):
1. Apply glazing tape to permanent stops, allowing tape edge to project 1.6mm above stop; butt-joint tape edges; seal joints with butyl sealant.
 2. Place setting blocks with edge blocks maximum 150mm from glass edges and intermediate blocks at $\frac{1}{4}$ points of glass panel length.
 3. Set glass unit on setting blocks; apply pressure against fixed stop for full contact.
 4. Apply glazing tape on free perimeter of glazing as described above.
 5. Install removable stops without displacing glazing tape; apply pressure for full continuous contact.
 6. Trim sight-exposed tape flush with stop.
- L. Interior Wet/Dry Method (Tape and Sealant)
1. Apply glazing tape to glass; butt-joint tape edges; seal joints with butyl sealant.
 2. Place setting blocks with edge blocks maximum 150mm from glass edges and intermediate blocks at $\frac{1}{4}$ points of glass panel length.
 3. Set glass unit on setting blocks; apply pressure against fixed stop for full contact.
 4. Install removable stops without displacing glazing tape; insert spacer strips between glazing and applied stops; terminate spacer strips 6mm below sight line; apply pressure for full continuous contact.
 5. Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing and to uniform line flush with sight line; tool sealant surface smooth.
 6. Trim sight-exposed tape flush with stop.
- M. Interior Wet Method (Compound and Compound)
1. Place setting blocks at $\frac{1}{4}$ points; install glazing unit.
 2. Install applied stops; center glass unit in space by inserting spacer shims both sides at intervals of 600mm; set spacer shims 6mm below sight line.
 3. Locate and secure glazing pane using glazers' clips.
 4. Fill gaps between glazing and stops with glazing compound to flush with sight line; tool surface to straight line.
- N. Installation of glazing in wood borrowed-lite partitions is specified in Section 06200.
- O. Installation of glazing in steel doors and borrowed-lite partitions is specified in Section 08110.
- P. Installation of glazing in flush wood doors is specified in Section 08211.
- Q. Installation of glazing in aluminum entrances and storefronts is specified in Section 08410.

3.04 CLEANING

- A. Remove glazing materials from finish surfaces.
- B. Remove labels after glass installation is complete.
- C. Clean glass surfaces and adjacent surfaces.
 - 1. Protect installed products until completion of project.
 - 2. Repair or replace damaged products before end of defects liability period.

END OF SECTION

DIVISION 9
FINISHING

SECTION 09206 METAL FURRING AND LATHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 1 specification sections, apply to work in this section.

1.02 SECTION INCLUDES

- A. Metal Furring and Lathing System.

1.03 RELATED SECTIONS

1. Section 03300 - Cast in Place Concrete.
2. Section 04420 - Concrete blocks.
3. Section 06100 - Rough Carpentry.
4. Section 08110 - Metal Doors and Frames.
5. Section 09220 - Cement Plaster.
6. Section 09300 - Tiles.
7. Section 09511 - Acoustic Ceilings.

1.04 SYSTEM DESCRIPTION

- A. The extent of the use of metal furring and lathing is as indicated on the drawings and/or specified.
- B. Design and install Framing and lath to limit deflection to the following:
1. Maximum deflection of Vertical Assemblies: 1:360 under lateral point load of 445N.
 2. Maximum deflection of Horizontal Assemblies: 1:240 deflection under dead loads.

1.05 REFERENCES

- A. ASTM (American Society of Testing Materials).
1. ASTM C841 – Standard Specification for the Installation of Interior Lathing and Furring.
 2. ASTM C847 – Standard Specification for Metal Lath.
 3. ASTM C933 – Standard Specification for Welded Wire Lath.
 4. ASTM C1002 – Standard Specification for steel self-Piercing Tapping Screws for the application of Gypsum Panel projects or metal Plaster Bases to wood studs or steel studs, 2001.
 5. ASTM C1063 – Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
- B. GA-600 Fire Resistance Design Manual. (Gypsum Association)(U.S.A.).
- C. ML /SFA (Metal Lath/Steel Framing Association)- Specifications for Metal Lathing and Furring.
- D. ASCE 7-98- Minimum Design Loads for Building and other Structures (American Society of Civil Engineering).
- E. Florida Building Code.

1.06 DEFINITIONS

- A. Re-rolled steel – steel that undergoes additional cold reduction after it has been produced by the mill.

1.07 SUBMITTALS

- A. Submit under the provisions of Section 01330.
- B. Product Data: Provide data describing standard framing member material and finish, product criteria, load charts and limitations.
- C. Shop Drawings: Indicate prefabricated work, component details, stud layout, framed opening, anchorage to structure, type and location of fasteners, and accessories or items required of other related work.
- D. Certificate: Submit certification stating materials comply with specification requirements and can support weight of lath, plaster and light fixtures.

1.08 QUALITY ASSURANCE

- A. Re-rolled framing and framing members containing factory welds will not be allowed.
- B. Contractor shall provide effective, full time quality control over all fabrication and erection complying with the pertinent codes and regulations of government agencies having jurisdiction.
- C. Perform work in accordance with GA-600 and ASTM C1063.
- D. Installer Qualifications: Minimum five (5) years documented experience installing furring and lathing.

1.09 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered in their original unopened packages and stored protected from damage by equipment of other trades.
- B. Provide adequate support to prevent damage of the material prior to installation.
- C. Inspect all material prior to installation to determine suitability for the Work.
- D. Do not store any material directly exposed to standing water or on grade. All material should be supported so that materials is not in direct contact with the ground.
- E. Notify the Engineer of damaged materials received prior to installing.

1.10 PROJECT CONDITIONS

- A. Comply with Section 01600 – Materials and equipments.

1.11 COORDINATION / SCHEDULING

- A. Coordinate work with other trades to accommodate installation of materials covered by this Section.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 FRAMING MATERIALS

- A. Suspension System approved by the Engineer with steel Furring channels, primary and secondary Sections, Section joiners, resilient Ceiling mounts, braces as required. Materials for internal use are made of galvanized steel 275 gm of zinc/m² coating for external use 450gm of zinc/m² coating.
1. Furring channels primary sections (Top Cross rails) 38mm height x 21mm width. – 28mm high x 16mm width or as directed by the Engineer, spacing of Furring Channels as recommended by manufacturer of Suspension System and approved by the Engineer.
 2. Junction trim: Stopping angle with 10mm wide shadow line gap – with approximate weight of 0.164kg/lineal meter and of BMT (Base Metal thickness) of 0.4mm.
 3. Expansion joints of control joint with approximate weight of 0.402 kg/lineal meter and BMT of 0.55mm (Base Metal thickness).
 4. Embelton resilient Ceiling mounts.
 5. Corner beads can be attached by nails or a staple gun, at not more than 500mm centers down both edge of the bead, and not more than 100mm from each end.
 6. All other accessories for Suspension System as per manufacturer's instruction.
- B. Tee System
1. 25mm wide x 38mm high runners both ways.
 2. Wall Angle trim: Lipped wall angle – steel angle of 19mm x 22mm high angle.

2.03 LATHING MATERIALS

- A. Metal Lath: ASTM C847, self-furring mesh stamped sheet; 16.5kg/m².
- B. Corner Mesh; Formed sheet steel; minimum 0.5mm thick; expanded flanges shaped to permit complete embedding in plaster; minimum 100mm size.
- C. Strip Mesh; Expanded metal lath, minimum 0.5mm thick; 100mm x 600mm long.

2.04 ACCESSORIES

- A. Anchorage: Ties wire, nails, screws and other metal supports, of type and size to suit application; to rigidly secure materials in place.

2.05 FINISHES

- A. Framing Materials: Galvanized.
- B. Hangers, Anchors and Fastening Devices; Galvanized.
- C. Lath Materials: Galvanized.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are ready to receive work.
- B. Verify field measurements are as shown on drawings.
- C. Beginning of installation means installer accepts existing conditions.

3.02 CEILING AND SOFFIT FRAMING

- A. Install furring to height indicated. Erect after above ceiling or soffit work is complete. Coordinate the location of hangers with other work.
- B. Install furring independent of walls, columns and above ceiling work.

- C. Securely anchor hangers to structural members or embed in structural slab. Space hangers to achieve deflection limits indicated.
- D. Space main carrying channels at maximum 1800mm centers; not more than 150mm from wall surfaces. Lap splice securely.
- E. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- F. Place furring channels perpendicular to carrying channels, not more than 50mm from perimeter walls, and rigidly secure. Lap splice securely.
- G. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 600mm past each opening.
- H. Laterally brace suspension system.

3.03 CONTROL AND EXPANSION JOINTS

- A. Install control and expansion joints with back-to-back casing beads set 6mm apart.
- B. Control Joint Spacing; As indicated on reflected ceiling plan.
- C. Expansion Joint Spacing; As indicated on reflected ceiling plan.

3.04 LATHING

- A. Apply metal lath taut, with long dimension perpendicular to supports.
- B. Lap ends minimum 25mm. Secure end laps with tie wire where they occur between supports.
- C. Lap sides of diamond mesh lath minimum 38mm.
- D. Attach metal lath to metal supports using tie wire at maximum 150mm o. c.
- E. Attach metal lath to concrete and concrete masonry using wirehair pins. Ensure that anchors are securely attached to backup surface and spaced at maximum 600mm o. c.
- F. Continuously reinforce internal angles with corner, mash, except where the metal lath returns 76mm from corner to form the angle reinforcement; fasten at perimeter edges only.
- G. Place corner bead at external wall corners; fasten at outer edges of lath only.
- H. Place base screeds at termination of plaster areas; secure rigidly in place.
- I. Place 100mm wide strips of metal lath centered over junctions of dissimilar backing materials. Secure rigidly in place.
- J. Place lath vertically above each top corner and each side of door and glazed frames to 150mm above ceiling line.
- K. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
- L. Place strip mesh diagonally at corners of lathed openings. Secure rigidly in place.

3.05 TOLERANCES;

- A. Maximum Variation for True Position: 3mm
- B. Maximum Variation of any Member from Plane: 3mm in 3000mm.

END OF SECTION

SECTION 09210

ACOUSTICAL PLASTER

PART 1 – GENERAL

Section includes interior acoustical plaster finish for ceilings and walls.

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and supplementary conditions and Division 1 Specification Sections, apply to this section.

1.02 WORK INCLUDED

- A. This Section includes:

- 1. Field applied premixed Acoustical Plaster as indicated on the drawings.

- B. Related Sections:

Section 05500, Metal Fabrications; structural steel framing system components to support work of this section.

1.03 SUBMITTALS

- A. Product Data: show manufacturer's installation recommendations.
- B. Samples for Verification: samples of finished products showing texture & colour for approval.
- C. Product Test Reports: ASTM-E84 test for flame spread, NRC test per ASTM C-423. Testing performed by laboratory accredited by the National Institute of Standards and Technology NVLAP (National Voluntary Laboratory Accreditation Program).

1.04 SYSTEM PERFORMANCE REQUIREMENTS

- A. Sound absorption at 10 mm thickness shall be 0.50 at 4 KHz frequency.
- B. Average thermal conductivity should be 0.35 W/mK
- C. Thermal Resistance "R value for 15mm thickness: .042 m²k/W.
- D. Heat flow "U value for 15mm thickness: 23.8 W/m²k.
- E. Standard Test Method for compressive strength of Hydraulic cement mortars ASTM C349

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has attended a training seminar by this manufacturer. Provide copy of certificate of training.
- B. Single Source Responsibility; provide only proprietary, factory formulated materials as produced. Substitutes within the system are not permitted.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site in original, unopened packages, and store them in a fully enclosed space where they will be protected against damage from moisture, and other harmful conditions.
- B. Inspect materials upon delivery and immediately report to Architect damaged or defective materials.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: do not install Acoustic Plaster until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use.

1.08 COORDINATION

- A. Coordinate layout and installation of Acoustic Plaster with others including light fixtures, HVAC equipment, fire - suppression system, and partition assemblies.

PART 2 – PRODUCT INFORMATION

2.01 MANUFACTURERS

- A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 PRODUCT

- A. High quality light weight premixed acoustical plaster

2.03 MATERIAL

- A. Acoustic Plaster System provides manufacturer's complete system of proprietary materials specifically formulated for compatibility.
- B. Apply mixed material Lightweight levelling tools are required in conjunction with trowel to fill in holes
- C. Acoustic Plaster is composed of a retarded gypsum, Perlite & selected aggregates and special additives. It is supplied as a dry powder in pre-weighed bags ready to use on site, which requires only addition of clean water to produce cohesive mix.
Acoustic Plaster is generally applied in a single coat method using spray machine or trowel technique to cover the area to desired thickness.

- D. Accessories & Tools: use manufacturer's recommended accessories and tools.
- E. Water: Clean, fresh, potable, and free of mineral or organic matter.

PART 3 – EXECUTION

3.01 MOCKUP

Construct a 2 x 3m mock-up of the acoustical plaster for architectural approval of finish texture and color. Mock-up shall be installed, if possible, as part of the finished walls & ceiling and shall remain intact throughout the project. Actual installation shall not commence until approval has been received.

3.02 EXAMINATION

Verify the suitability of existing conditions before starting work. Do not begin work of this section until unsatisfactory conditions have been corrected.

3.03 PREPARATION

- A. Comply with manufacturer's written instructions for substrate preparation.
 - 1. The surface should be sound, clean, free from loose material, grease, laitance, dirt curing compound, etc.
 - 2. Prior to Acoustic Plaster application, wet the entire surfaces with clean potable water and allow drying prior to Acoustic Plaster application.
- B. Protect adjacent surfaces.

3.04 INSTALLATION

- A. General: Apply Acoustic Plaster system as per manufacturer's recommendations.
- B. Acoustic Plaster is generally applied in a single coat method, use directly on plastered walls, including applying of two coats plastering.
- C. Apply mixed material using spray machine or trowel technique to cover the area to desired thickness. Lightweight levelling tools are required in conjunction with trowel to fill in holes.
- D. When the plaster stiffens lightly, treat the surface to a smooth level to eliminate all traces of protrusions and undulations. Let the plaster set for about 30 min. using wet sponge, wipe the surface to a creamy smooth finish.

SECTION 09220 PORTLAND CEMENT PLASTER

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes: Portland Cement-Based Plaster
- B. Related Sections:
 - 1. Section 03300 - Cast-in-Place Concrete.
 - 2. Section 04420 - Concrete blocks
 - 3. Section 06100 - Rough Carpentry.
 - 4. Section 08110 - Steel Doors and Frames.
 - 5. Section 08210 - Wood Doors
 - 6. Section 08520 - Aluminum Windows.
 - 7. Section 09206 - Metal Furring and Lathing.
 - 8. Section 09300 - Tiles.

1.02 REFERENCES

- A. Florida Building Coder (FBC) (In U.S.A.).
- B. ASTM C 91 - Masonry Cement
- C. ASTM C 150 - Portland Cement
- D. ASTM C 631 - Standard Specification for bonding Compounds.
- E. ASTM C 841 – Standard specification for installation of interior Lathing and Furring
- F. ASTM C 847 - Standard Metal Lath.
- G. ASTM C 897 - Aggregates for Job Mixed Portland Cement-Based Plaster
- H. ASTM C 926 - Standard Specification for Application of Portland Cement-Based Plaster
- I. ASTM C 206 - Standard Specification for Finishing Hydrated Lime.
- J. ASTM C 1063 – Standard Specification for Installation of Lathing And furring to Receive Interior and Exterior Portland Cement-Based Plaster.
- K. ASTM E 119 - Standard Test Methods for Fire tests of building Construction and Materials.
- L. ASTM E494 Standard specification for chemical Admixture for concrete
- M. ACI 524 - Guide to Portland cement Plastering.
- N. BS 4887- Mortar Admixtures, specification for air-entraining (Plasticizing) Admixture.
- O. BS 1369 – Steel lathing for internal plastering and external Specification for expanded metal and ribbed lathing
- P. UL (FRD) – Fire Resistance Directory, Underwriters Lab. Inc.

1.03 SUBMITTALS

- A. Provide product data on plaster materials, characteristics and limitation of product specified, under provisions of Section 1330.
- B. Submit manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

- A. Cement Plaster: Perform work in accordance with ASTM C926.
- B. Where fire-resistance-rated Portland cement plaster assemblies are indicated, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E119.

- C. The Contractor shall make sample panels at the site at least 200cm x 200cm of plaster work
 - 1. The Contractor shall take the approval of the Engineer before start plastering.
 - 2. The accepted panels will be a basis of all work
- D. Provide Engineer with a letter certifying that all materials and mixes conform to Project Specifications.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver manufactured materials in original unopened packages or containers, identified with manufacturer's label intact and legible. Deliver materials in sufficient quantity to assure continuity of work. Select and utilize handling equipment so as to avoid damage to materials handled and damage to other construction.
- B. Keep all materials dry stored above ground, under cover, protect from weather, direct sun light, surface contamination, aging, corrosion and damage from construction traffic and other causes.
- C. Remove wet or deteriorated materials from the Site.

1.06 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application.
- B. Cold Weather Requirements: Do not apply cement plaster when ambient temperature is expected to be less than (4°C)
- C. Hot Weather Conditions:
 - 1. Use damp loose sand.
 - 2. Use cool water for mix water.
 - 3. Pre-dampen masonry walls prior to the application of the scratch coat.
 - 4. Prevent the plaster from drying out by covering with a plastic sheet, or moist cure at least twice daily for the 2 – 3 days.
 - 5. Do not allow fresh plaster to be subject to hot, dry winds.
- D. Ventilation: Provide ventilation for drying of installed cement plaster.
- E. Protection:
 - 1. Protect plaster from uneven and excessive evaporation during hot, dry weather.
 - 2. Protect finished surfaces installed prior plastering by covering with suitable drop cloths.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to drawings and BOQs.
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.7 “Covering of Walls & ceilings Works”.
- C. Internal three coats cement and sand (1:4) plastering, smooth finish, for new walls and ceilings, complete as shown on drawings.

- D. For external walls, three coats cement and sand (1:4) plastering, with waterproof additive, including groove in external plaster as per drawings.

2.02 ACCESSORIES

- A. Expanded-Metal Lath: Comply with ASTM C847, BS 1369 and ASTM C 841 for material, type, configuration and other characteristics indicated below:
1. Refer to Section 09206 – Metal Lath.
 2. Fabricate expandable-metal lath from galvanized steel structural-quality, zinc coated steel sheets.
 3. Diamond-Mesh Lath Self-furring.
 4. Galvanized angle bead, flange bead, corner bend and other accessories complying with ASTM C847 and ASTM C1063.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates to receive plaster conform to the Requirement of ASTM C926.
- B. Masonry: Verify joints are cut flush and surface is ready to receive work of this Section. Verify no bituminous or water repellent coatings exist on masonry surface.
- C. Concrete: Verify surfaces are flat, honeycomb is filled flush, and surface is ready to receive work of this Section. Verify no bituminous, water repellent, or form release agents exist on concrete surface that are detrimental to plaster.
- D. Fairface: Roughen the surface so that it can accept cement plaster using mechanical means such as push hammer.

3.02 PLASTER APPLICATION, GENERAL

- A. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.
- B. Tolerances: as per specifications.
- C. At all internal corners between wall/wall and wall/ceiling and between all concrete, element and block works joints, apply metal lath to surface with appropriate fasteners.
- D. Sequence plaster application with the installation and protection of other work so that neither will be damaged by the installation of the other.
- E. Plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at the junctures with metal.
- F. Apply thicknesses and number of coats of plaster as indicated or as required by referenced standards.
- G. Concealed Plaster: Where plaster application will be concealed by wood paneling, above suspended ceilings and similar locations, finish coat may be omitted; where concealed behind cabinets and similar furnishings and equipment, apply finish coat; where used as a base for adhesive application of tile and similar finishes, omit finish coat and coordinate

thickness with overall dimension as shown and comply with tolerances specified. Omission of finish coat is at the Engineer's discretion.

3.03 INSTALLATION OF PLASTERING ACCESSORIES

- A. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Mitre accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.
- B. Accessories for Portland Cement Plaster
1. Corner Bead: Install at all external corners.
 2. Casing Beads: Install at termination of plaster work unless otherwise indicated.
 3. Control Joints: Install control joints at locations complying with the following criteria and approved by Engineer:-
 - a. Where an expansion or control joint occurs in surface of construction directly behind plaster membrane.
 - b. Internal every 6-9m at intersections of natural breaks, above door jamb frames and at joints in other materials.
 - c. External at 3.5m maximum at natural architectural breaks above door jamb frames and at joints in other materials.
 - d. Where area within Portland cement panels exceed 10m².
 - e. Where Portland cement plaster panels sizes or dimensions change. Extend joints full width or height of plaster membrane.

3.04 PORTLAND CEMENT PLASTER APPLICATION

- A. Portland Cement Plaster Application Standard: Apply Portland cement plaster materials, compositions, and mixes to comply with ASTM C926.
1. Number of Coats: Apply 3 coats of Portland cement plaster
- B. Water Curing:
1. Follow procedures recommended by Portland Cement Association.
 2. Cure minimum of 72 hours after all coats have set.
 3. Prevent premature dry-out.
- C. Moist cure Portland cement plaster base and finish coats to comply with ASTM C926, including recommendations for time between coats and curing in "Annex A2 Design Considerations". Where and when necessary shade backings and plaster from direct sun and mist spray to reduce temperatures and cure plaster.

3.05 CUTTING AND PATCHING

- A. Cut, patch, point-up and repair plaster as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence, sweat-outs and similar defects, and where bond to the substrate has failed.
- B. Sand smooth troweled finishes lightly to remove trowel marks and arises.

3.06 FIELD QUALITY CONTROL

- A. Tolerances:
1. Exposed plaster walls: Finish all plaster work true and even, with 5mm tolerance in 3meter, without imperfections which can be attributed to the plastering work. Plumb, curve or level and square plaster with

adjoining work (which itself is plumb, level and square) and form a proper foundation for wood and metal moldings, trim, paint and other finishing materials.

- B. Unsightly laps and joinings at scaffold locations or elsewhere are not acceptable and shall be corrected at Contractor's expense.

3.07 CLEANING AND PROTECTION

- A. Remove temporary covering and other provisions made to minimize spattering of plaster on other work. Promptly remove plaster from door frames, windows, and other surfaces which are not to be plastered. Repair floors, walls and other surfaces which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean floors of plaster debris.
- B. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures plaster work is without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 09240
PORTLAND CEMENT COLORED PLASTER
Grooved Graffio Finish

PART 1 – GENERAL

1.1 Section Includes

- A. Portland cement, Pre-Mixed grooved decorative finish coat.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 04 20 00 - Unit Masonry.

1.3 REFERENCES

- A. American National Standards Institute (ANSI) / American Hardboard Association (AHA):
 - 1. ANSI/AHA A 194 - Cellulosic Fiber Board.
- B. ASTM International (ASTM):
 - 1. ASTM C 150 - Standard Specification for Portland cement.
 - 2. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.
 - 3. ASTM C 897 - Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters.
 - 4. ASTM C 926 - Standard Specification for Application of Portland Cement-Based Plaster.
 - 5. ASTM C 932 - Standard Specification for Surface-Applied Bonding Agents for Exterior Plastering.
 - 6. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.
- C. ICC Evaluation Service, Inc. Code Report
 - 1. ICC-ES AC11 Cementitious exterior wall coatings.

1.4 SYSTEM DESCRIPTION

- A. For decorative plaster and for all exterior Walls Substrate: 2-coats, Portland cement plaster applied over concrete consisting of the following:**

- 1. Refer for manufacturer's instruction for application
- 2. First layer of premixed decorative coat plaster of 3mm thickness grooved texture Graffio.
- 3. Second layer of premixed decorative coat plaster of 3mm thickness grooved texture Graffio
- 4. Apply High efficiency solvent based non-staining siloxane water repellent as protective coating.
- 5. Item including all substrates plasters layers

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data.
- C. Samples: Submit selection and verification samples of coloured and texture .
- D. Warranty: Submit system warranty.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm specializing in manufacture of pre-blended stucco materials, with minimum 5 years' experience.
- B. Applicator: Firm specializing in the application of pre-blended stucco materials, with minimum 5 years' experience.
- C. Regulatory Requirements: Conform to applicable code requirements for finish system.
- D. Mock-Up: Provide a mock-up of pre-blended stucco plaster installation, using materials and systems specified in this Section; include at least one example of each type of accessory material.
 - 1. Construct mock-up.
 - 2. Indicate texture, colour and workmanship of finished work.
 - 3. Proceed with work only after the mock-up has been approved.
 - 4. Maintain the mock-up on site and remove at the completion of the project.
- E. **Designing and Detailing:**
 - 1. Follow manufacturers written installation instructions, published details, and technical information in the design of the colored finish system systems.
 - 2. Sealants and backer rod are required at dissimilar materials and expansion joints within the system to provide a watertight system.
- F. **Substrate Systems:**
 - 1. Deflection of the substrate systems shall not exceed $L/360$.
 - 2. Acceptable substrates for stucco systems are poured concrete, and masonry units.
 - 3. Unit masonry, stucco and concrete shall be inspected and prepared as manufacturer's instructions and recommendation before application. of the system on surface
 - 4. Applicator to verify that the proposed substrate is acceptable prior to the installation.
- G. **System Joints:**
 - 1. Expansion joints in the system are required at building expansion joints, at prefabricated panel joints, where substrates change and where structural movement is anticipated.
 - 2. Control joints are required at a minimum of every 13 Sqm of wall surface area and where specified by the design professional. The maximum

uncontrolled length or width is 5.5 lineal meters and a maximum uncontrolled length to height ratio of 2-1/2:1.

H. Pre-Installation Meeting:

At least three weeks prior to commencing work conduct a meeting at the project site to discuss contract requirements and job conditions; require the attendance of installation contractor, and installers of related materials; notify Architect in advance of meeting.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle products under provisions of section 01 66 00.
- B. Deliver materials in original unopened packages with manufacturer's labels intact.
- C. Protect materials during transportation and installation to avoid physical damage.
- D. Store materials in cool, dry place protected from freezing.

1.8 PROJECT CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Do not apply materials in ambient temperatures below 4°C Provide supplementary heat during installation and drying period when temperatures less than 4°C prevail.
- C. Do not apply finish materials to frozen surfaces.
- D. Maintain ambient temperature at or above 4°C during and at least 24 hours after installation and until dry.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate and schedule installation of the materials with related work of other sections.
- B. Coordinate and schedule installation of trim, flashing, and joint sealers to prevent water infiltration behind the system.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

Acceptable Manufacturer:

- A. Requests for substitutions will be considered in accordance with provisions of Section 01 25 00 – Substitution Procedures.
- B. Obtain products from a single manufacturer.

2.2 PLASTER MATERIALS

Vetotouch Graviatto

- A. Vetotouch Graviatto is a cement based Pre-Blended decorative finish composed of hydraulic binders, selected aggregates and special additives. It is supplied as a dry powder in a pre-weighed bags ready to use on site, which requires only addition of clean water to produce easily workable mortar, formulated to be used in one to three coat application for internal & external application

2.3 MISCELLANEOUS MATERIALS

- A. Water: Clean and potable without foreign matter.
- B. Bonding Compound: Complying with ASTM C 932 and as recommended by the manufacturer.
- C. Sealant: As specified in Section 07 92 00 - Joint Sealants.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present.
- B. Substrates:
 - 1. Verify that acceptable substrates have been installation. Refer to Quality Assurance Article above.
 - 2. Examine surfaces to receive system and verify that substrate and adjacent materials are dry, clean, and sound. Verify substrate surface is flat, free of fins or planar irregularities greater than 6mm in 3m.
- C. Flashings:
 - 1. Heads, jambs and sills of all openings must be flashed with a minimum 230mm strip of flexible flashing prior to window/door, HVAC, etc. installation.
 - 2. Windows and openings to be flashed according to design and building code requirements.
 - 3. Individual windows that are ganged to make multiple units require continuous head flashing and/or the joints between the units must be fully sealed.
- D. Utilities:
 - 1. The system must be properly terminated (back-wrapped, sealed, flashed) at all lighting fixtures, electrical outlets, hose bibs, vents, etc.
- E. Do not proceed with stucco work until surfaces and conditions comply with requirements indicated in referenced installation standard and manufacturer's printed instructions.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering work.

3.3 INSTALLING ACCESSORIES

- A. General:

1. Install trim in accordance with manufacturer's specifications.
 2. Install trim components in longest piece length possible to minimize joints.
 3. Allow 3mm – 5mm gap between the abutting trim pieces. Do not overlap trim.
 4. Set intersection of trim in a minimum 10cm bed of trim sealant.
 5. Miter all corners at intersections of trim.
 6. Install according to ASTM C 1063 and at locations indicated on Drawings or as follows.
- B. Reinforcement for External Corners:
1. Install corner bead at exterior corner locations.
- C. Control Joints: Install control joints at locations indicated on Drawings and as follows:
1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 13.5 sqm.
 - b. Horizontal and other Non-vertical Surfaces: 10 sqm.
 2. At distances between control joints of not greater than 5.5 sqm o.c.
 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 4. Where control joints occur in surface of construction directly behind plaster.
 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.4 PLASTER MIXING APPLICATION

- A. General:
1. Comply with ASTM C 926 for applications indicated.
- B. Apply plaster materials in accordance with manufacturer's written installation instructions for the specific systems indicated.

3.5 PLASTER REPAIRS

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.6 CLEANING

- A. Clean material from adjacent surfaces as recommended by manufacturer.
- B. Remove surplus material and debris, including field sample, from site.

3.7 PROTECTION

- A. Protect installed Vetotouch Graviatto surfaces from rain, snow and frost for 48–72 hours following application.

END OF SECTION

SECTION 09300 TILES

PART 1 GENERAL

1.01 GENERAL NOTES

Provide Cement Plaster to all block work that is to receive wall tiling. -Refer to drawings for tiling extent.

1.02 SECTION INCLUDES

- A. Ceramic Tile.
- B. Porcelain Tile.
- C. Terrazzo Tile.
- D. Grouting and sealing.
- E. Trim Tiles and Accessories.

1.03 RELATED SECTIONS

- A. Section 03300 Cast-in-Place Concrete
- C. Section 04220 Concrete Blocks.
- D Section 07140 Fluid Applied Waterproofing
- E Section 09220 Cement Plaster.
- F. Related electrical and Mechanical work sections.

1.04 REFERENCE

- A. American National Standards Institute (ANSI)
 - 1. ANSI A108-1, A-2099 – Specifications for Installation of Ceramic Tile in the Wet-Set Method with Portland cement Mortar.
 - 2. ANSI A108-1, B-2099 – Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar.
 - 3. ANSI A108-1, 1C-2099 – Specifications for Contractors Option. Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar-or-Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar.
 - 4. ANSI A108-4, 2099 – Specifications for Ceramic Tile Installed with Organic Adhesives or Water-Cleanable Tile Setting Epoxy Adhesive.
 - 5. ANSI A108-5 , 2099 – Specifications for Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - 6. ANSI A108-6, 2099 – Specifications for Ceramic Tile Installed with chemical-Resistant, Water-Cleanable Tile-Setting and-Grouting Epoxy.
 - 7. ANSI A108-8, 2099 – Specifications for Ceramic Tile Installed with Chemical-Resistant Furan Mortar and Grout.
 - 8. ANSI A108-9, 2099 – Specifications for Ceramic Tile Installed with Modified Epoxy Emulsion Mortar/Grout.
 - 9. ANSI A108-10, 2099 – Specifications for Installation of Grout in Tile work.

10. ANSI A118-1, 2009 – Standard Specification for Dry-Set Portland Cement Mortar.
 11. ANSI A118-3, 2009 – Chemical-Resistant, Water-Cleanable, Tile-Setting and Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
 12. ANSI A118-4, 2009 – Latex-Portland Cement Mortar.
 13. ANSI A118-5, 2009 – Chemical-Resistant. Furan Mortar and Grout.
 14. ANSI A118-6, 2009 – Standard Ceramic Tile Grouts.
 15. ANSI A118-7, 2009 – Polymer Modified Cement Grouts.
 16. ANSI A118-8, 2009 – Modified Epoxy Emulsion Mortar/Grout.
 17. ANSI A118-9, 2009 – Test Methods and Specifications for Cementitious Backer Units.
 18. ANSI A118-10. 2009 – Load bearing, Bonded, Waterproof Membranes for Thin-set Ceramic Tile and Dimensional Stone Insulation.
 19. ANSI A118-11, 2009 – Exterior Grade Plywood (EGP) Latex-Portland Cement Mortar.
 20. ANSI A1361-1, 2009 – Organic Adhesives for Installation of Ceramic Tile.
 21. ANSI A137-1, 2008 – Specifications for Ceramic Tile.
- B. ASTM International
1. ASTM C150 – Standard Specification for Portland Cement.
 2. ASTM C144 – Standard Specification for Aggregate for Masonry Mortar.
 3. ASTM C2-7 – Standard Specification of Hydrated Lime for Masonry Purposes.
 4. ASTM C241 – Test Method for Abrasion Resistance of stone Subjected to Foot Traffic.
 5. ASTM C503 – Specification for Marble Building Stone (Exterior).
 6. ASTM C615 – Specification for Granite Dimension Stone.
 7. ASTM C629 – Specification for State Dimension Stone.
 8. ASTM C847 – Standard Specification for Metal Lath.
 9. ASTM C1008 – Test method for Determining the Static Coefficient of Friction or Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull meter Method.
 10. ASTM D4397 – Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
 11. TCA Handbook for Ceramic Tile Installation by tile Council of America, current edition.
- C. Ceramic Specification
1. DIN 51130 and 51097 – ramp test (ceramic slip resistance).
- D. AS (Australian Standard)
1. AS 4674-2004 – Design, Construction and Fitout of Food Premises.

1.05 SUBMITTALS FOR REVIEW

- A. Submit under provisions of Section 01330.
- B. Manufacturer's data sheets on each product to be used, including preparation instructions; storage and handling and installation methods.

- C. Shop drawings: Indicate tile layout, patterns, color, perimeter conditions and junctions as well as locate and detail expansion and control joints. Take width of edge tiles not less than half width of tile.
- D. Samples of tile, grout, edging and finishing profiles and field sample not less than 2m x 2m.
- E. Material test reports: For each tile-setting and grouting product.
- F. Maintenance data including stain removal methods.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company as skilled tilers specializing in performing the work of this section with minimum five years experience to be approved by The Engineer.
- B. Single source responsibility.
 - 1. Obtain each type and color tile material required from single source.
 - 2. Obtain setting and grouting materials from one manufacturer to ensure compatibility and in compliance with manufacturer's instructions.
 - 3. Obtain prefabricated edge protection, transition, and movement profiles from one manufacturer to ensure compatibility.
- C. Certifications
 - 1. Submit "Master Grade Certificate" for each type of ceramic, porcelain and pavers file in accordance with the requirements of ANSI A137-1.
 - 2. Submit manufacturer's certifications that mortars, adhesives, and grouts are suitable for intended use.

1.07 DELIVERY, STORAGE AND HANDLING

- 1. Deliver materials in manufacturer's unopened containers, fully identified with name, brand, type, and grade.
- 2. Protect materials from contaminations, dampness, freezing, or overheating in accordance with manufacturer's instructions.
- 3. Broken, cracked, chipped, stained, or damaged tile will be rejected, whether built-in or not.
- 4. Protect mortar and grout materials against moisture, soiling or staining.
- 5. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.08 EXTRA MATERIALS

- A. Upon completion of work, deliver extra stock materials of 2% of the installed quantity for each type, color, size, but not less than 4 cartons.(containing at least 4ms)
- B. Store in location as directed by the owner.
- C. Ensure materials one boxed and identified by manufacturer, type, and color.

1.09 MAINTENANCE DATA

- A. Submit maintenance data under premises of Section 01745.
- B. Include cleaning methods, cleaning solutions recommended stain removal methods, and polishes and wax recommended.

PART 2 – PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS****Terrazzo Tiles:**

- A. Manufacturer with experience in the specified product and approved by the Engineer.

Porcelain Tiles:

- A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 MATERIALS

- A. Refer to drawings for details
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.8 “Flooring”

PART 3 EXECUTIONS**3.01 EXAMINATION**

- A. Examine Substrates, areas, and conditions where tile will be installed, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile:
 - 1. Verify that substrates for setting tile are firm, dry, clean, free of oil, waxy film and curing compounds, and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work and similar items located in or behind tile has been completed before installing tile.
 - 3. Verify that joints and cracks in the substrates are coordinated with tile joint locations, if not coordinated, adjust joint locations in consultation with the Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 REPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, oil, or silicone, that are incompatible with tile-setting materials.
- B. Provide concrete substrates for tile floors installed with thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
- C. For tiles exhibition color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved samples. If not factory blended return the tiles to the manufacturer.

3.03 INSTALLATION

- A. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.8 “Flooring”.

3.04 CLEANING AND PROTECTING

- A. On completion of placement and grouting, clean all ceramic tile surfaces in accordance with manufacturer's written instructions so they are free of foreign materials.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven (7) days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION

SECTION 09510 ACOUSTICAL CEILINGS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Work of this Section consists of furnishing all labor, materials, equipment and services necessary to complete but not limited to the following:

1. Mineral Fiber Acoustical Ceiling units coded as in the Finishes Schedule.
2. Cement Board
3. Exposed suspension system.
4. Trim and accessories.
5. Acoustic infill tiles
6. Acoustical lay-in panels with Bulkheads.
7. Acoustic Accessories

B. Related Section

1. Section 05810 Expansion Joint Covers
2. Section 06100 Rough Carpentry.
3. Section 07210 Building insulation
4. Section 07900 Joint Sealant.
5. Section 09206 Metal Furring and lathing.
6. Section 09300 Tiles.
7. Section 09900 Painting.
8. Div 15 HVAC System Grill, Register, Diffuser etc.
9. Div 16 Interior Lighting

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. A641 Standard Specification for Zinc-coated (Galvanized) Carbon Steel Wire
2. C423 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
3. C635 Standard Specification for the Manufacture, Performance, and testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
4. C636 Standard Practice for Installation of Metal ceiling Suspensions Systems for Acoustical Tile and Lay-in Panels.
5. E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
6. E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
7. E413 Standard Classification for Rating Sound Insulation.
8. E580 Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint.
9. E795 Standard Practices for Mounting Test Specimens during Sound Absorption Test.
10. E1264 Standard Classification for Acoustical Ceiling Products.
11. E1414 Standard Test Method for Airborne Sound Attenuation between Rooms Sharing a Common Ceiling Plenum.

- B. Australian Standards (AS)
 - 1. AS 2785 – 1985 Suspended Ceilings- Design and insulation.
 - 2. AS 1397 – 1993 Steel Sheet and Strip.
 - 3. AS 1538 – 1985 Cold Formal Steel Structure Code.
- C. Underwriters laboratory (UL)- Fire Resistance Directory.
- C. Uniform Building Coder (UBC) USA – Section 25-2- Installation Standards for Suspended Ceiling System and Lighting Fixtures.

1.03 DEFINITIONS

- A. NRC (Noise Reduction Coefficient): The weighted average sound absorption coefficient of the ceiling materials when tested in accordance with ASTM C423, with mounting No. E-400 (ASTM E795).
- B. CAC (Ceiling Attenuation Class): The acoustical ceiling rating derived in accordance with ASTM E1414 and classification ASTM E413.
- C. LRC (Light Reflectance Coefficient): As determined by ASTM E1264.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Section 01330 "submittal".
- B. Product Data:
 - 1. Submit data for each distinct suspension system and acoustical unit type indicated.
 - 2. Submit acoustical ceiling panel manufacturer's documentation.
- C. Asbestos-Free and Lead Paint-Free Certification: Submit manufacturer's written certification that all materials are free of asbestos and lead paint.
- D. Manufacturer's Certifications: Submit manufacturer's representative certification that the proposed products are recommended and compatible with each other and substrates for the intended applications.
- E. Samples for Verification: Submit for each component indicated and for each exposed finish required, prepared two sample size indicated below:
 - 1. Acoustical Units: 300 x 300mm square samples of each type, color, pattern, and texture.
 - 2. Exposed suspension and trim elements: 30 cm long samples of each type, finish and color.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed Acoustical Lay-in Ceiling applications similar in material, design and extent to that indicated for this projects that have resulted in construction with a record of successful in-service performance. Qualifications to be submitted to the Engineer for his approval.
- B. Fire-Test Response Characteristics:
 - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E119 or by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Fire-Resistance Rating: Indicated by design designations for underwriters Laboratory's "Fire Resistance Directory", or from the listings of another approved nationally-recognized testing and inspecting agency.

- b. Identify materials with appropriate marking of applicable testing and inspecting agency.
 2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84.
 - a. Maximum Flame Spread Index: 25.
 - b. Maximum Smoke Developed Index: 50.
- C. Source Limitations: Obtain each type of acoustical ceiling and panel and supporting suspension system through one source from a single manufacturer.
- D. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 1. Standard for Ceiling suspension Systems Requiring Seismic Restraint: Comply with ASTM E58.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in manufacturer's original unopened containers with seals unbroken and labels intact until time of use. Store materials off the ground and under cover to prevent damage or contamination to materials by water, freezing, foreign matter or other causes. Promptly remove from site any materials, which show evidence of damage and immediately make all replacements necessary. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.07 PROJECT CONDITIONS

- A. Within each space to receive specified products, do not begin installation until the following conditions are met:
 1. Work above ceilings has been finished, tested and approved.
 2. Space to receive ceiling system is properly enclosed and protected from weather
 3. Any wet work within the space is dry.
- B. Do not begin installation of ceiling system until building's normal operating temperature and humidity levels have been reached and will be maintained. Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.08 WARRANTY

- A. Ceiling System: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failure includes, but is not limited to:
 1. Ceiling Panels and Suspension System: rust and manufacturing defects.
- B. Warranty Period :
 1. Two (2) years from the end of the defects liability period.
- C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties submitted by the

Contractor in accordance with the requirements of the Contract Documents.

1.09 MAINTENANCE

- A. For ceiling areas above 100m², furnish extra materials described below that match products installed, and that are packaged with protective covering for storage and identified with labels describing the contents.
- 1 Acoustical Ceiling Panels: full-size panels equal to 2.0 percent of quantity installed.
 2. Suspension System Components: Quantity of each exposed component equal to 1.0 percent of quantity installed.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience in similar products and as approved by the Engineer.

2.02 MATERIALS

General: Provide units conforming to applicable requirements of ASTM E1264 for Class A materials.

A. ACOUSTICAL TILES: MINERAL FIBER

refer to drawings for details

B. CEMENT BOARD

2.03 METAL SUSPENSION SYSTEM

- A. Grid suspension system for support of mineral fiber acoustical tile.
1. Manufacturer's standard design system complying with ASTM C 635 Structural Classification "**Intermediate duty**".
 3. Flange width: 24mm
 2. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.

2.04 PERIMETER SEAL

- A. Vinyl, polyethylene or polyurethane open cell sponge material having density of 1.3 plus or minus 10 percent, compression set less than 10 percent with pressure sensitive adhesive coating on one side.
- B. Thickness as required to fill voids between back of wall molding and finish wall.
- C. Not less than 9 mm wide strip.

2.05 WIRE

- A. ASTM A641.
- B. For wire hangers: Minimum diameter 2.68 mm.
- C. For bracing wires: Minimum diameter 3.43 mm.

2.06 ANCHORS AND INSERTS

- A. Use anchors or inserts to support twice the loads imposed by hangers attached thereto.
- B. Hanger Inserts:
 - 1. Fabricate inserts from steel, zinc-coated (galvanized after fabrication).
 - 2. Nailing type option for wood forms:
 - a. Upper portion designed for anchorage in concrete and positioning lower portion below surface of concrete approximately 25 mm.
 - b. Lower portion provided with not less than 8 mm hole to permit attachment of hangers.
 - 3. Flush ceiling insert type:
 - a. Designed to provide a shell covered opening over a wire loop to permit attachment of hangers and keep concrete out of insert recess.
 - b. Insert opening inside shell approximately 16 mm (5/8 inch) wide by 9 mm (3/8 inch) high over top of wire.
 - c. Wire 5 mm (3/16 inch) diameter with length to provide positive hooked anchorage in concrete.
- C. Clips:
 - 1. Galvanized steel.
 - 2. Designed to clamp to steel beam or bar joists, or secure framing member together.
 - 3. Designed to rigidly secure framing members together.
 - 4. Designed to sustain twice the loads imposed by hangers or items supported.
- D. Tile Splines: ASTM C635.

2.07 CARRYING CHANNELS FOR SECONDARY FRAMING

- A. Fabricate from cold-rolled or hot-rolled steel, black asphaltic paint finish, free of rust.

- B. Weighing not less than the following, per 300 m

Channel Size (Kg)	Cold-rolled (mm)	Hot-roll (Kg)
38	215.4	508
50	267.6	571.5

2.08 ADHESIVE

- A. ASTM D1779, having flame spread index of 25 or less when tested in accordance with ASTM E84.
- B. Developing minimum strength of 7 kg/m² of contact surface 48 hours after installation in temperature of 21 °C.

PART 3 – EXECUTION

3.01 CEILING TREATMENT

- A. Treatment of ceilings shall include sides and soffits of ceiling beams, furred work 600mm wide and over, and vertical surfaces at changes in ceiling heights unless otherwise shown. Install acoustic tiles after wet finishes have been installed and solvents have cured.
- B. Lay out acoustical units symmetrically about center lines of each room or space unless shown otherwise on reflected ceiling plan.
- C. Moldings:
 - 1. Install metal wall molding at perimeter of room, column, or edge at vertical surfaces.
 - 2. Install special shaped molding at changes in ceiling heights and at other breaks in ceiling construction to support acoustical units and to conceal their edges.
- D. Perimeter Seal:
 - 1. Install perimeter seal between vertical leg of wall molding and finish wall, partition, and other vertical surfaces.
 - 2. Install perimeter seal to finish flush with exposed faces of horizontal legs of wall molding.

3.02 CEILING SUSPENSION SYSTEM INSTALLATION

- A. General:
 - 1. Install metal suspension system for acoustical tile and lay-in panels in accordance with ASTM C636, except as specified otherwise.
 - 2. Use direct or indirect hung intermediate duty suspension system or combination thereof as defined in ASTM C635.
 - 3. Support a maximum area of 1.48 m² of ceiling per hanger.
 - 4. Prevent deflection in excess of 1/360 of span of cross runner and main runner.
 - 5. Provide extra hangers, minimum of one hanger at each corner of each item of mechanical, electrical and miscellaneous equipment supported by ceiling suspension system not having separate support or hangers.
 - 6. Provide not less than 100 mm clearance from the exposed face of the acoustical units to the underside of ducts, pipe, conduit, secondary suspension channels, concrete beams or joists; and steel beam or bar joist unless furred system is shown,

7. Use main runners not less than 1200 mm in length.
8. Install hanger wires vertically. Angled wires are not acceptable except for seismic restraint bracing wires.

B. Direct Hung Suspension System:

1. As illustrated in ASTM C635.
2. Support main runners by hanger wires attached directly to the structure overhead.
3. Maximum spacing of hangers, 1200 mm on centers unless interference occurs by mechanical systems. Use indirect hung suspension system where not possible to maintain hanger spacing.

C. Indirect Hung Suspension System:

1. As illustrated in ASTM C635.
2. Space carrying channels for indirect hung suspension system not more than 1200 mm on center. Space hangers for carrying channels not more than 2400 mm on center.
3. Support main runners by specially designed clips attached to carrying channels.

3.03 ACOUSTICAL UNIT INSTALLATION

- A.** Cut acoustic units for perimeter borders and penetrations to fit tight against penetration for joint not concealed by molding.
- B.** Install lay-in acoustic panels in exposed grid with not less than 6 mm bearing at edges on supports.
1. Install tile to lay level and in full contact with exposed grid.
 2. Replace cracked, broken, stained, dirty, or tile not cut for minimum bearing.
- C. Markers:**
1. Install markers of color code specified to identify the various concealed piping, mechanical, and plumbing systems.
 2. Attach colored markers to exposed grid on opposite sides of the units providing access.
 3. Attach marker on exposed ceiling surface of upward access acoustical unit.

3.04 CLEAN-UP AND COMPLETION

- A.** Replace damaged, discolored, dirty, cracked and broken acoustical units.
- B.** Leave finished work free from defects.

END OF SECTION

SECTION 09510

ACOUSTICAL PANEL

PART 1- GENERAL

SUMMARY

A. Section includes: Work of this Section consists of furnishing all labor, materials, equipment and services necessary to complete but not limited to the following:

- Wood wool acoustical units coded as in the Finishes Schedule
- Adhesive application.

B. Related Sections: The Contractor shall be required to co-ordinate the work of other sections with the work of this section. Related work to be coordinated and used in conjunction with this specification includes but is not limited to:

1. Section 05810 - Expansion Joint covers
2. Division 16 - Electrical Works

SUBMITTAL

A. Submit in accordance with Section 01333, Shop Drawings, Record Documents and As- Built Drawings.

B. Samples:

1. Acoustical units, each type, with label indicating conformance to specification requirements etc.
2. Colored markers for units providing access.

C. Manufacturer's Literature and Data:

1. Ceiling suspension system, each type, showing complete details of installation, including upward access system details for concealed grid systems.
2. Acoustical units, each type

D. Manufacturer's Certificates: Acoustical units, each type, in accordance with specification requirements.

DEFINITIONS

A. Standard definitions as defined in ASTM C634.

B. Terminology as defined in ASTM E1264.

REFERENCES

A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.

B. American Society for Testing and Materials (ASTM):
A641/A641M-03 Zinc-coated (Galvanized) Carbon Steel Wire
A653/A653M-07 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron alloy
coated by the Hot-Dip Process

C423-07 Sound Absorption and Sound Absorption Coefficients by the
Reverberation Room Method
C634-02 (E2007) Standard Terminology Relating to Environmental Acoustics
C635-04 Metal Suspension Systems for Acoustical Tile and Lay-in Panel
Ceilings
C636-06 Installation of Metal Ceiling Suspension Systems for Acoustical
Tile and Lay-in Panels
E84-07 Surface Burning Characteristics of Building Materials
E119-07 Fire Tests of Building Construction and Materials
E413-04 Classification for Rating Sound Insulation
E580-06 Application of Ceiling Suspension Systems for Acoustical Tile
and Lay-in Panels in Areas Requiring Seismic Restraint

E1264-(R2005) Classification for Acoustical Ceiling Products

C. Ceilings and Interior Systems Contractors Association (CISCA): Acoustical
Ceilings: Use and Practice.

Underwriters Laboratories, Inc. (UL)

WARRANTY

A. Furnish a warranty against defects in materials, workmanship etc. including
sagging or disconnection of grid systems or disintegration of Acoustical Units for a
period of Five (5) years from the Date of Substantial Completion.

PART 2- PRODUCTS

2.01 DESIGN BASIS

Manufacturer: Knauf AMF, Heradesign (Made in Austria)
Type: Wood Wool boards, FSC/ PEFC certified
Material: 1mm thick wood wool fiber bonded with Magnesite
Size of tiles: 600 x 1200 x 25mm
Manufacturing tolerance: ± 1 mm
Edge: AK-01 (compressed edges with 5mm bevel)
Surface: Exquisite surface structure
Color: Natural tone 13, other RAL colors as per finishes schedule

2.02 OTHER ACCEPTABLE MANUFACTURERS

The manufacturers against each type of acoustic panel ceiling shown in 2.01 A above,
are specified to reflect the design intent.

Other manufacturers shown below may be acceptable as per Engineer's Approval

Knauf AMF GmbH Co & KG, Germany
 Certain Teed, US
 Durisal, Netherland

2.03 METAL SUBSTRUCTURE

- A. MF / CD channels to screw mount wood wool acoustical boards.
1. Basic section 60/27/0.6mm and load bearing section 60/27/0.6mm
 3. Always position the panel joint in the supporting direction under a MF / CD section.
 2. Screws: recommended Heradesign screws to be used, minimum 6 screws per panel size of 600 x 1200mm, 9 screws for ball impact resistance

2.04 BACK FILL MATERIAL

- A. 25mm thick 50kg density rock wool to be loose laid at the back, pls refer to manufacturer's installation guideline

2.07 CARRYING CHANNELS FOR SECONDARY FRAMING

Fabricate from cold-rolled or hot-rolled steel, black asphaltic paint finish, free of rust.

- B. Weighing not less than the following, per 300 m

Channel Size (Kg)	Cold-rolled (mm)	Hot-roll (Kg)
38	215.4	508
50	267.6	571.5

2.08 ADHESIVE

- A. ASTM D1779, having flame spread index of 25 or less when tested in accordance with ASTM E84.
- B. Developing minimum strength of 7 kg/m² of contact surface 48 hours after installation in temperature of 21 °C.

2.09 WOOD WOOL ACOUSTICAL UNITS

- A. General:
1. ASTM E1264, weighing 11.3 kg/m² minimum for wood wool panels or tiles with magnesite bonding.
 2. Class B, s1, d0 Flame Spread: EN13501-01
 3. Minimum NRC (Noise Reduction Coefficient): up to 0.85 unless on walls and up to 1.00 on ceiling applications, specified otherwise: ASTM C423.
 4. Impact resistant rating: class 1A as per DIN 18 032/Part 3.
 6. Manufacturers standard finish, minimum Light Reflectance (LR) coefficient of 0.75 on the exposed surfaces, except as specified.
 7. Panels: Sizes as shown, with compressed edges / 5mm bevel

8. Moisture resistance panels, 90% RH,
9. Optional BFA additive in swimming pool areas
10. Sustainability: FSC / PEFC certificate, Environmental product declaration (EPD), Blue Angel RAL certificate

2.10 ACCESS IDENTIFICATION

- A. Markers:
1. Use colored markers with pressure sensitive adhesive on one side.
 2. Make colored markers of paper or plastic, 6 to 9 mm in diameter.

Use markers of the same diameter throughout building.

- C. Color Code: Use following color markers for service identification:

Color	Service
Red	Sprinkler System: Valves and Controls
Green	Domestic Water: Valves and Controls
Yellow	Chilled Water and Heating Water
Orange	Ductwork: Fire Dampers
Blue	Ductwork: Dampers and Controls
Black	Gas: Laboratory, Medical, Air and Vacuum

PART 3 EXECUTION

3.01 CEILING TREATMENT

- A. Treatment of ceilings shall include sides and soffits of ceiling beams, furred work 600 mm wide and over, and vertical surfaces at changes in ceiling heights unless otherwise shown. Install acoustic tiles after wet finishes have been installed and solvents have cured.
- B. Lay out acoustical units symmetrically about center lines of each room or space unless shown otherwise on reflected ceiling plan.
- C. Moldings:
1. Install metal wall molding at perimeter of room, column, or edge at vertical surfaces.
 2. Install special shaped molding at changes in ceiling heights and at other breaks in ceiling construction to support acoustical units and to conceal their edges.
- D. Perimeter Seal:
1. Install perimeter seal between vertical leg of wall molding and finish wall, partition, and other vertical surfaces.
 2. Install perimeter seal to finish flush with exposed faces of horizontal legs of wall molding.

3.02 CEILING SUSPENSION SYSTEM INSTALLATION

A. General:

1. Install metal suspension system for acoustical tile and lay-in panels in

accordance with ASTM C636, except as specified otherwise.

2. Use direct or indirect hung intermediate duty suspension system or combination thereof as defined in ASTM C635.
3. Support a maximum area of 1.48 m² of ceiling per hanger.
4. Prevent deflection in excess of 1/360 of span of cross runner and main runner.
5. Provide extra hangers, minimum of one hanger at each corner of each item of mechanical, electrical and miscellaneous equipment supported by ceiling suspension system not having separate support or hangers.
6. Provide not less than 100 mm clearance from the exposed face of the acoustical units to the underside of ducts, pipe, conduit, secondary suspension channels, concrete beams or joists; and steel beam or bar joist unless furred system is shown,
7. Use main runners not less than 1200 mm in length.
8. Install hanger wires vertically. Angled wires are not acceptable except for seismic restraint bracing wires.

B. Direct Hung Suspension System:

1. As illustrated in ASTM C635.
2. Support main runners by hanger wires attached directly to the structure overhead.
3. Maximum spacing of hangers, 1200 mm on centers unless interference occurs by mechanical systems. Use indirect hung suspension system where not possible to maintain hanger spacing.

C. Indirect Hung Suspension System:

1. As illustrated in ASTM C635.
2. Space carrying channels for indirect hung suspension system not more than 1200 mm on center. Space hangers for carrying channels not more than 2400 mm on center.
3. Support main runners by specially designed clips attached to carrying channels.

3.03 ACOUSTICAL UNIT INSTALLATION

- A. Cut acoustic units for perimeter borders and penetrations to fit tight against penetration for joint not concealed by molding.
- B. Install lay-in acoustic panels in exposed grid with not less than 6 mm bearing at edges on supports.
 1. Install tile to lay level and in full contact with exposed grid.
 2. Replace cracked, broken, stained, dirty, or tile not cut for minimum bearing.
- C. Markers:
 1. Install markers of color code specified to identify the various concealed piping, mechanical, and plumbing systems.
 2. Attach colored markers to exposed grid on opposite sides of the units providing access.
 3. Attach marker on exposed ceiling surface of upward access acoustical unit.

3.04 CLEAN-UP AND COMPLETION

- A. Replace damaged, discolored, dirty, cracked and broken acoustical units.
- B. Leave finished work free from defects.

END OF SECTION

SECTION 09680 CARPETING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Carpeting as shown on the drawings or inferable there from and/or as specified in accordance with the requirements of the Contract Documents. Work includes but is no limited to the following:
1. Carpet Tiles.
 3. Related accessories.

1.02 RELATED SECTIONS.

1. Section 04450 Natural Stone Work.
2. Section 05500 Metal Fabrications.
3. Section 06100 Rough Carpentry.
4. Section 09300 Tiles.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. ASTM C423-90a "Standard Method of Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method".
 2. ASTM D418-92 "Methods for Testing Woven and Tufted Pile Floor Covering".
 3. ASTM D1335-67 (R72) "Test Method for Tuft Bind of Pile Floor Coverings".
 4. ASTM D2646-87 "Test Method of Testing Backing Fabrics".
 5. ASTM D3574-91 "Standard Test Method Flexible Cellular Materials- Slab, Bonded and Molded Urethane Foams".
 6. ASTM D3936-80 "Test Method of Delamination Strength of Secondary Backing of Pile Floor Coverings".
 7. ASTM E84-91a "Test Method for Surface Burning Characteristics of Pile Floor Coverings".
 8. ASTM E648-93a "Test Method for Critical Radiant Flux of Floor Covering Systems using a Radiant Heat Energy Source".
 9. ASTM D2859 Flammability of Finished Textile Floor Covering".
- B. American Association of Textile Chemists and Colorists (ASTCC)
1. AATCC-16-93 "Colorfastness to light".
 2. AATCC-24-89 "Resistance of Textiles to Insects".
 3. AATCC-134-94 "Electrostatic Propensity of Carpets".
 4. AATCC-165-93 "Colorfastness to Crocking Carpets".
 5. AATCC-174-93 "Antimicrobial Activity Assessment of Carpet".
- C. British Standards Institution (BSI)
1. BS 5805:1991 (1996) "Specification for Underlay for Textile Floor Coverings".
- D. Carpet and Rug Institute (CRI)
1. CRI 104-93 "Standard for Installation Commercial Textile

Floor Covering Materials".

- E. Carpet Cushion Council
 - 1. Traffic Classification 1990.
- F. Federal Standard, Department of Commerce
 - 1. CPSC 16 CFR "Standard for the Surface Flammability of Part 1630-90 Carpets and Rugs (FF1-70)".
- G. National Fire Protection Association (NFPA)
 - 1. NFPA 99-93 "Standard for Health Care Facilities"
- H. AACHEN Test
 - 1. Dimensional Stability 175 Stain Resistance, Pile floor covering (DIN) Standard
- I. Americans with Disabilities Act (ADA)
 - 1. Section 4.5.3 Accessibility Guidelines for Buildings and Facilities.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's printed literature, specifications and written data on physical characteristics, durability, fade resistance and installation instructions for each type of carpeting material specified herein and other data to show compliance with the Contract documents. The product data shall include the following:
 - 1. Construction.
 - 2. Face fiber.
 - 3. Protective treatment.
 - 4. Dye method.
 - 5. Finished face weight.
 - 6. Average density.
 - 7. Backing.
 - 8. Nominal total thickness.
 - 9. Size
- B. Shop Drawings: Submit shop drawings showing carpet layout with design dimensions, seam locations and edge strip locations. Indicate direction of pattern and lay of pile. Show details of the following:
 - 1. Columns, doorways, enclose walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - 2. Carpet type, color, and dye lot.
 - 3. Locations where dye lot changes occur.
 - 4. Seam locations, types, and methods.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern type, repeat size, location, direction, and starting point.
 - 8. Pile direction.
 - 9. Type, color, and location of insets and borders.
 - 10. Type, color, and location of edge, transition, and other accessory strips.
 - 11. Transition details to other flooring materials.
 - 12. Type of cushion.
- C. Samples: Submit samples of each type, color and pattern of carpet required. Samples to be submitted are as follows:

1. Carpet Tile: One standard size carpet tile for each type and color specified.
- D. Test Reports: Submit certified laboratory test reports prepared by an independent testing laboratory for fire hazard classification of carpet and carpet cushion to the Engineer showing conformance to specified performance standards. Test results shall not be over two (2) years old.
- E. Certification: Submit manufacturer's certificate stating that product installed conforms to these specifications.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm (carpet mill) with not less than five (5) years of production experience with carpet similar to types specified in this section and whose published product literature clearly indicates general compliance of products with requirements of this section.
- B. Installer Qualifications: Employ only experienced tradesmen for installation with not less than five (5) years of experience and who are capable of producing work of the highest standards of quality in the industry. The installation of carpet shall be carried out by and approved specialist.
- C. Single Source Responsibility: Provide material produced by a single manufacturer for each carpet type.
- D. Mockups: Before installing carpet, install mockups for each type of carpet installation required to demonstrate aesthetic effects and qualities of materials and execution. Install mockups to comply with the following requirements, using materials indicated for the completed work:
 1. Install mockups in the location and of the size indicated or, if not indicated, as directed by the Engineer.
 2. Notify Engineer seven (7) days in advance of dates and times when mockups will be installed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Engineer approval of mockups before starting work.
 5. Obtain Engineer approval for the underlay type, to be acoustically approved.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Remove mockups when directed.
 8. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original packaging identified with name, brand type, grade, class and all other qualifying information and location of installation.
- B. Store materials in a dry location, in such a manner as to prevent damage.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity

conditions are maintained closely approximate to the interior conditions which will exist when the building is occupied.

- B. Maintain temperature and humidity conditions before, during and after installation. All concrete tiling work (including grinding) shall be complete and dry. Windows and door shall be in place.
- C. Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet manufacturer.
- D. Existing Conditions: Verify all dimensions and installation conditions on site.
- E. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.08 SEQUENCING

- A. Sequence carpet installation with other work to minimize possibility of damage and soiling during remainder of construction period.

1.09 WARRANTY

- A. Special Project Warranty: Submit a written warranty executed by the Contractor, installer and manufacturer, agreeing to repair or replace carpeting which does not comply with requirements or that fails in materials or workmanship within the specified warranty period.
- B. Warranty period shall be five (5) years after end of defects liability period of the project.
- C. Provide certified copies of the following product warranties from the manufacturer:
 - 1. Five (5) years against excessive surface wear.
 - 2. Latent Defect.
 - 3. Pattern Match Warranty (Applicable for patterned products).
 - 4. Lifetime Floor Compatibility Warranty.
 - 5. Lifetime Anti-Static Guarantee.
- D. Warranty shall be sole source responsibility of the manufacturer. Second source warranties that involve parties other than the manufacturer are unacceptable.

1.10 MAINTENANCE

- A. Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed work including methods and frequency recommended for maintaining optimum coordination under anticipated traffic and use conditions. Include precautions against materials and methods which may be detrimental to finishes and performances.
- B. Extra Stock: Provide 2% but not less than one box/bundle extra stock of carpeting of each type, color and pattern. Store where directed by the Engineer completely identified by type, color, carpet code and dimensions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. A Manufacturer with experience in similar products and approved by the Engineer.

2.02 MATERIALS

- A. Carpet Fibers: Types as scheduled and as recommended by the carpet manufacturer for the conditions of installation and use.
- B. Pile Yarn: provide yarn spun in the manner recommended by the yarn manufacturer and the carpet manufacturer, in number of piles and denier indicated or required, to achieve the pile yarn weight, texture and pattern indicated.
- C. Dye: Use dyes and dyeing methods recognized by the industry as successful for the type of fiber being dyed and to achieve the required colors and fade resistance. Achieve the fade resistance established by the Association of Textile Chemists and Colourists for carpet when tested on the Atlas Fedeometer for 40 hours. All carpets of a similar type and color must come from the same dyelot.
- D. All carpets to be antimicrobial and treated for stain repellent.

2.03 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet and carpet cushion manufacturers.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining type to suit products and sub-floor conditions indicated, that complies with flammability requirements for installed carpet and that is recommended by the carpet and carpet cushion manufacturers. Use release type adhesive for carpet tiles.
- C. Tape: Woven fabric impregnated with plastic and coated with adhesive having high-tack adhesion forming a secure bond. Provide water-resisting plastic-coated tape which will unwind without adhesive transfer.
- D. Tackless Stripping: Manufacturer's standard water-resistant wood tackless carpet stripping, arranged for nail anchoring to wood, concrete and other hard floors. Size stripping as required to be compatible with types of carpet and cushions provided.
- E. Seaming Cement: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
- F. Metal Edge Strips: Provide edging profiles, tag trim profiles, capping profiles, and other accessories required to complete the proper installation of carpet. All accessories shall be stainless with polished finish of width and height required to protect exposed edge of carpet and of maximum lengths to minimize running joints.

2.04 CARPETS SCHEDULE

- A. Carpet Tiles:
 - Size: 60x60 cm tiles.
 - Pile height: 8 mm
 - Yarn: 80% Wool and 20% Viscose
 - Underlay: as recommended by manufacture
 - Location: library, carpet lay over terrazzo tiles.
 - Type & Colors to be approved by the Engineer.
- B. Carpet Rugs:

Pile height: 9 mm
Yarn: 80% Wool and 20% Viscose
Underlay: as recommended by manufacture
Type, Size and colors to be approved by the Engineer.
Location: as per drawings.

C. Cut pile carpet:

Roll carpet cut pile 60 ounce color as approved by Engineer,
Pile height:9 mm Yarn 80% Wool and 20% Viscose underlay as recommended by manufacturer
Type, Size and colors to be approved by the Engineer.
Location: as per drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the substrates, adjoining construction and the conditions under which the work is to be installed. Report unsatisfactory conditions to the Engineer. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work complies acceptance from the Engineer.

3.02 PREPARATION

- A. Repair minor holes, cracks, depressions and rough areas using materials recommended by carpet or adhesive manufacturer.
- B. Clear away debris and scrape up cementitious deposits from surfaces to receive carpeting, vacuum clean immediately before installation. Check concrete surfaces access floor to ensure no dusting through installed carpet. Apply sealer where required to prevent dusting.

3.03 INSTALLATION

A. Carpet Tile

1. Carpet tile with release adhesive shall be laid in strict accordance with the manufacturer's latest detailed written installation instructions, copies of which shall be on the job site at all times.
2. Each tile shall be laid in the same direction as identified on the shop drawings and the back of the tile.
3. The installation shall be designed so that all tiles butt as tightly as possible with perimeter units restrained by a reliable vertical surface, to prevent the build-up of any accumulated spaces.
4. The insulation of Ashlar method tiles are led with arrows or tile directions, should all point in the same direction with the tile bond displaced by half a tile in the length direction.

3.04 FIELD QUALITY CONTROL

- A. The carpeting shall be vacuum/cleaned before and after final inspection.
- B. The Contractor shall make written request for inspection at least ten (10) days before completion of carpet installation.
- C. Correct all defects in materials and workmanship listed by the Engineer's Representative during inspection.

- D. Approval of carpet installation will be given only after all such defects have been corrected.

3.05 CLEANING AND PROTECTION

- A. Remove excess adhesive from the floor, base and wall surfaces without any damage.
- B. Vacuum carpet with a commercial vacuum, with rotating agitator or beater in the nozzle. Remove soil spots in accordance with the carpet manufacturer's recommendations.
- C. Protect carpet from damage and soiling. Use non-straining cover material for protection. Tape joints in protective covering. Prohibit traffic on floor finish for 24 hours after installation.

3.06 RESTRECHING

- A. Return to installation after approximately six (6) months of occupancy and use, restretch carpet in each space, repair faults, in seaming, trim and adjust carpeting at edges.

END OF SECTION

SECTION 09705

RESINOUS FLOORING FOR SPORT FLOORING

PART 1 GENERAL

A. Section Includes:

1. Moisture vapor emission testing.
2. Surface preparation.
3. Furnishing and installation of urethane mortar flooring.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-In-Place Concrete:

1. Concrete slabs on or below grade shall be installed over an effective moisture vapor barrier.
2. Concrete slabs shall be cured 30 days, be structurally sound and have a steel trowel finish.
3. Surface shall be well sloped to drains, straight and level with the permissible degree of tolerance of 1cm in 3m in any direction.
4. No curing compounds or surface contaminants shall be used in placing new concrete.

1.03 SUBMITTALS

- A. Submit manufacturer's product data, literature and brochures.
- B. Submit manufacturer's samples showing color choices and texture.
- C. Submit a statement from the manufacturer indicating the installer's certification.
- D. Prior to commencing work, installer shall prepare two 30 x 30cm samples of the resinous flooring chosen for the project showing actual color, thickness and texture. These samples shall serve as a basis for comparison throughout the duration of the work.

1.04 QUALITY ASSURANCE

- A. All materials used in flooring system shall be manufactured by a single manufacturer to ensure compatibility and proper bonding.
- B. Applicator shall have a minimum of 5 years' experience in the installation of resinous flooring and be certified by the manufacturer.
- C. Owner reserves the right to core drill the finished flooring system in 3 locations to verify the thickness of the application. If the specified thickness has not been achieved, the contractor may be directed to pay for testing and reapply flooring materials until the desired thickness is obtained.

1.05 DELIVERY, STORAGE AND HANDLING

- A. All material shall be delivered to the job site in unopened containers clearly labeled by the manufacturer and stored in a dry location at a 18 - 30 degrees Celsius.

1.06 WARRANTY

A. Manufacturer shall warrant that the materials are free from defects and comply with written specifications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Vetonit Co. or other equal approved manufacturer.

2.02 MATERIALS

- A. Versatile Solvent based epoxy primer. Vetoprime EP490,
- B. High performance, chemical, scratch & UV resistant polyester polyurethane floor coating, Vetotop UC371

2.03 SYSTEM DESCRIPTION

A. Flooring system to be a minimum 300 micron thick with colors and texture to match the sample chosen.

B. Finished flooring system shall have the following performance characteristics:

1. Solid Content (% Volume): %50
2. Bond Strength to Concrete ASTM D4541: > 1.5 MPa
3. Taber Abrasion ASTM D4060 CS17 Wheels (mg loss/1000cycles): 20
4. Water Absorption ASTM D413 (maximum): 0.001
5. Porosity with no sealer NACE Sand TM-01-74: 0
6. Skid Resistance ASTM D2394: Pass

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:

1. Inspect surfaces to receive Polyester Polyurethane flooring.
2. Conduct relative humidity probe testing for concrete moisture according to ASTM 2170.
3. Before starting work, report in writing to the Architect any unsatisfactory condition.
4. Application of any material shall signify that surfaces have been inspected and are satisfactory.

3.02 SURFACE PREPARATION

3.03 INSTALLATION

- A. Allow sufficient time for the installation of the flooring system. At no time shall the speed of project completion be allowed to detrimentally affect the application.
- B. Provide sufficient light, power, heat and working conditions to permit proper

materials of the coating. Substrate temperature shall be at a minimum of 45 degrees F during application and for 48 hours thereafter.

1. Apply primer coat @ dry fil thickness (DFT) of 100 micron
2. Apply first coat of Floor Coating (Vetotop UC371) at DFT of 100 micron by using Roller.
3. Apply second coat of Floor Coating (Vetotop UC371) at DFT of 100 micron.
4. Applying Floor Coating (Vetotop UC371) as marking line in the desired colors.

3.04 FIELD QUALITY CONTROL

A. Installer shall monitor the thickness of the system as the work progresses. Areas found to not meet the required thickness shall receive additional material until specified thickness is attained.

3.05 PROTECTION

A. Installation areas must be kept free from traffic and other trades during the application procedure and cure time.

END OF SECTION

SECTION 09900 PAINTING

PART 1 – GENERAL

1.01 SECTION INCLUDES

Surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Use products specified in this section to finish all surfaces exposed to view, unless otherwise indicated, including but not limited to the following:
 - a. Interior wall and ceiling surfaces.
 - b. Interior wood doors and woodwork.
 - c. Opening frames and trim.
 - d. Exterior plaster and stucco.
 - e. Exterior wood.
 - f. Exterior concrete and concrete masonry.
 - g. Stone Façade.
 - h. Exterior metal items.
 - i. Finish aluminum, stainless steel, copper, and bronze only if specifically indicated to receive field finish.
 - j. Roof flashings, trim, roof accessories, rain drainage accessories.
 - k. Roof-mounted equipment, piping, ductwork, brackets, and hangers.
 - l. Access and equipment cabinets.
 - m. Mechanical piping, hangers, and supports.
 - n. Heating, air conditioning, and ventilating ductwork, hangers, supports, louvers, and grilles.
 - o. Electrical conduit, junction boxes, and other equipment.
 - p. All shop-primed items.
2. For colors, to be selected by the Engineer.

1.02 RELATED SECTIONS

- | | |
|-------------------|-------------------------|
| 1. Section 02761 | Paving Marking. |
| 2. Section 04450 | Natural Stone Work |
| 3. Section 05500 | Metal Fabrications. |
| 4. Section 06100 | Rough Carpentry. |
| 5. Section 06200 | Finish Carpentry. |
| 6. Section 06410 | Custom Cabinets. |
| 7. Section 06420 | Wood Veneer. |
| 8. Section 08110 | Steel Doors and Frames. |
| 9. Section 08210 | Wood Doors. |
| 10. Section 08520 | Aluminum Windows. |
| 11. Division 15 | Mechanical. |
| 12. Division 16 | Electrical. |

1.03 REFERENCES

- A. American National Standard Institute (ANSI).
 1. ANSI A13.1 Scheme for the Identification of Piping Systems.
 2. ANSI Z535-1 Safety Color Code.
- B. American Standard for Testing and Materials (ASTM).

1. ASTM D16 Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
 2. ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test.
 3. ASTM D5138-99 A Specification for Liquid Crystal Polymers.
 4. ASTM D4236-94R05 Practice for Labeling Art Materials for Chronic Health Hazards.
- C. Painting and Decorating Contractors of America (PDCA)
1. PDCA P1-92 Touch Up Painting And Damage Repair Financial Responsibility.
 2. PDCA P5-95 Bench Mark Sample Procedure For Paint And Other Decorative Coating Systems.
- D. Steel structure painting council (SSPC).
1. SSPC-SP7 Brush-Off Blast Cleaning.
 2. SSPC SP.10 Near white blast cleaning.
 3. Steel structure painting manual VOP. 1. Good painting practice 2nd.Pittsburgh PA. SSPC. 1983.
- E. Australian Standard (AS)
2. AS 1428 - Design for access and mobility Set.

1.04 DEFINITIONS

Conform to definitions of terms in ASTM D16 in interpreting requirements of this specification section.

1.05 SUBMITTALS

- i. Product Data: For each paint system indicated. Include block fillers and primers.
Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- ii. Samples for Initial Selection: For each finish product specified, two (2) complete sets of color chips representing manufacturer's full range of available colors and finishes.
After color selection, Engineer will furnish color chips for surfaces to be coated.
- iii. Samples for Verification: For each finish product specified, two (2) samples, minimum size (150mm) square representing actual product, color, and finish, on representative Samples of the actual substrate.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: company specializing in manufacture of coatings of quality specified with minimum of 5 years experience.
- B. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance with three years documented experience.

- C. Field Sample: Provide a field sample for evaluation of surface preparation techniques and application workmanship, showing sequence of all coats using same materials of paint to be used.
Finish areas designated by The Engineer.
Do not proceed with remaining work until workmanship, color, and sheen are approved by The Engineer.
- D. Source Limitations: Obtain fillers and primers for each coating system from the same manufacturer as the finish coats.
- E. Performance of Paints: Paints shall be fit for purpose and manufactured specifically for the applications indicated and uses intended, taking into account the type, nature, location, and aesthetic and utility requirements of the project.

1.07 DELIVERY, STORAGE AND HANDLING

Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information.

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture and expiry.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.

Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7°C. Maintain storage containers in a clean condition, free of foreign materials and residue. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.08 PROJECT CONDITIONS

Do not apply paint in rain, fog, or mist, or when relative humidity exceeds 85 percent; or at temperatures less than 3°C above the dew point; or to damp or wet surfaces.

Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

During application of solvent-based materials, post "NO SMOKING" signs.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer with experience in similar products and approved by the Engineer.

2.02 MATERIALS

- A. Refer to drawings and BOQs.
- B. Refer to the General Technical Specifications for Buildings, the First Volume of Civil Works and Architectural issued by the Ministry of Public Works and Housing, Edition 2, 1996 – Bill No.13 “Painting and Decoration Works”.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.
 - 1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the Engineer about anticipated problems when using the materials and specified over substrates primed by others.

3.02 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

3.03 APPLICATION

- A. General: Use only primers and undercoats that are suitable for each surface to be covered and that are compatible with the finish coat required.
 - B. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide exterior doors on tops, bottoms, and side edges the same as exterior faces.
 - C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, comers, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
3. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
 - D. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
 - E. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
 - F. Prime Coats. Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

3.04 CLEANING

Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

END OF SECTION

SECTION 09965 CONCRETE WATER STORAGE PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish all labor, materials, tools and equipment as necessary to perform Acrylic Latex Modified Cement Waterproofing on new and existing structures as shown on drawings and as specified in this section.

Related Sections:

- 1. See section 03300 - Cast-in-Place Concrete
- 2. See section 09220 – Cement Plaster.

1.2 REFERENCES

- A. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
- B. ASTM C 348 - Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
- C. ASTM C 321 - Standard Test Method for Bond Strength of Chemical-Resistant Mortars.
- D. ASTM E 96 - Standard Test Method for Water Vapor Transmission of Materials.
- E. COE CRD-C 48 - Method of Test for Water Permeability of Concrete; U.S. Army Corps of Engineers.

1.3 SUBMITTALS

A. General:

Submit manufacturer's certification that proposed materials, details and systems as indicated and specified fully comply with manufacturer's details and specifications. If any portion of Contract Documents do not conform to manufacturer's standard recommendations, submit notification of portions of design that are at variance with manufacturer's specifications.

B. Product Data:

- 1. Submit manufacturer's literature and installation instructions for each product.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

- 1. Company specializing in marketing or manufacturing products specified in this Section with minimum 10 years documented experience.

B. Installer Qualifications:

- 1. Acceptable to manufacturer with documented experience on at least 5 projects of similar nature in past 5 years and/or training provided by the product manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store in a dry area between 5°C and 32°C. Handle and protect from freezing and direct sun light in accordance with manufacturer's instructions.
- B. Deliver materials in manufacturer's unopened containers, fully identified with brand, type, grade, class and all other qualifying information. Provide Material Safety Data Sheets for each product

- C. Take necessary precautions to keep products clean, dry and free of damage.

1.6 SYSTEM REQUIREMENTS

- A. Coordinate waterproofing installation with other trades.
- B. Provide materials and accessories in timely manner so as not to delay Work.

1.7 PROJECT CONDITIONS

- A. Maintain surfaces to be waterproofed and surrounding air temperature at not less than 5°C. Apply only when temperatures are steady or rising.
- B. Do not apply materials to frozen or frost-filled surfaces.
- C. Exercise caution when temperatures exceed 32°C.

1.8 WARRANTY

- A. Comply with provisions of Section 01700.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A Manufacturer with experience in similar products and approved by the Engineer.

2.2 MATERIALS

- A. refer to drawings

2.3 ACCESSORY MATERIALS

- A. Crack and joint sealing tape: Elastomeric, tear resistant, breathable waterproofing tape.
- B. Sealing Gasket for PVC pipe and other penetrations: Elastomeric, tear resistant, breathable

PART 3 - EXECUTION

3.1

EXAMINATION

- A. Examine all construction substrates and conditions under which waterproofing materials are to be installed. Do not proceed with the waterproofing application until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Protect adjacent surfaces not designated to receive waterproofing.
- B. Substrate preparation:
 - 1. Remove oil, grease, dirt, loose particles, remains of form oils, water repellents, rust or other coatings by high-pressure water blasting (>3000 psi), wet or dry sand blasting, or other mechanical means to produce surfaces suitable for application of waterproofing.
 - 2. Follow manufacturer's instructions to clean and prepare surfaces and seal cracks and joints.
 - 3. Voids in concrete substrates: 6 mm diameter and larger, pre-treat with patching compound. Less than 6 mm diameter can be filled with a scratch coat of one-component waterproofing material.
- C. Rinse surfaces to be waterproofed (excluding drywall or similar) with clean water to saturated surface dry (SSD) condition, with no standing water on horizontal surfaces.

3.3 INSTALLATION

- A. Non toxic solvent free epoxy corrosion (epoxy polysulfide), abrasion resistant, non toxic with 500 micron thickness, according to manufacturer's recommendations and all as per drawings and Engineer's instructions.
- B. Cavity fill, honeycombs & formtie holes:
 - a. Fill voids at cleaned and prepared faulty construction joints, cracks, formtie holes, etc. with patching compound in mortar consistency flush to surface.
 - b. Laminate patching compound in 2 to 3 layers as per manufacturer's instructions for larger spalled or honeycombed areas.

3.4 CURING

- A. Follow manufacturer's general instructions for curing and hardening of waterproofing material. Do not use water for curing. Waterproofing material is self-curing.
- B. Protect surfaces from rain, frost and premature dehydration.

3.5 TESTING OF WATER INCLUDING STRUCTURES

- A. Following application and completion of related work, as required, but well prior to completion of entire project, fill tanks to capacity and allow to stand not less than 3 days. Fill larger structures at a uniform rate not greater than 2 m in 24 hours. The temperature of the fill water shall be plus or minus 10 degrees F of the ambient air and/or the tank structure at the time of filling. Extreme caution is urged if the temperature is greater than 4 degrees. Should leakage occur after this period, drain tanks to perform repairs. Notify Owner prior to draining tanks.

3.6 ACCEPTANCE

- A. Remove left over materials and any foreign material resulting from the work from the site.
- B. Clean adjacent surfaces and materials

END OF SECTION

DIVISION 10
SPECIALITIES

SECTION 10210 LOUVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Shaft louvers.

1.2 RELATED SECTIONS

- A. Section 03300 - Cast-In-Place Concrete.
- B. Section 04420- Concrete Blocks.
- C. Section 05500 - Metal Fabrication.
- D. Section 06100 - Rough Carpentry.
- E. Section 07900 - Joint Sealants.
- F. Section 09220 – Cement Plaster
- G. Section 09900 - Paints.
- H. Mechanical Section.

1.3 REFERENCES

- A. AAMA 2604 – High Performance Organic Coatings on Architectural Extrusions and Panels.
- B. AAMA 2605 - High Performance Organic Coatings on Architectural Extrusions and Panels.
- C. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- D. AMCA 511 - Certified Ratings Program for Air Control Devices.
- E. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- F. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- H. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
- I. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
- J. ASTM D2244 - Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.
- K. ASHRAE 52 – Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Product Data: For each product to be used, including:
 - 1. Manufacturer's product data including performance data.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.

- 4. Installation methods.
- C. Shop Drawings:
 - 1. Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.
- D. Samples: Submit sample of louver to show frame, blades, bird screen, gutters, downspouts, vertical supports, sill, accessories, finish, and color.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. The manufacturer shall have implemented the management of quality objectives, continual improvement, and monitoring of customer satisfaction to assure that customer needs and expectations are met.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.
- C. Handling: Protect materials and finishes during handling and installation to prevent damage.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A Manufacturer with experience in similar products and approved by the Engineer.

2.2 SHAFT LOUVER

General – Refer to drawings for details of sections.

Description: louver windows consist of 3 mm steel plates welded to steel tube (30X30 mm).

Details: Refer to drawings.

2.3 ACCESSORIES

- A. Steel Filter Racks: Formed channel racks to accept standard (25 mm thick filters. Unused bottom portion blanked off with 20 gage (1 mm) galvanized steel sheet.
- B. Steel Filter Racks: Formed channel racks to accept standard 51 mm thick filters. Unused bottom portion blanked off with 20 gage (1 mm) galvanized steel sheet.
- C. Bird Screen:
 - 1. Steel: Galvanized steel, (13 mm mesh by 1.1 mm, intercrimp.

- 2. Frame: Removable, rewirable.
- D. Insect Screens:

2.4 FINISHES

- A. Standard mill finish.
- B. Prime Coat:
 - 1. Apply alkyd prime coat following chemical cleaning and pretreatment.
 - 2. Primer preparation for field painting.
 - 3. Refer to section 09900 - painting

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.
- B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean opening thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.
- B. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
- C. Install joint sealants as specified in Section 07900.
- D. Apply field topcoat within 6 months of application of shop prime coat. Apply field topcoat as specified in Section 09900.

3.4 CLEANING

- A. Clean louver surfaces in accordance with manufacturer's instructions.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 10440 SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outside Wall mounted Signage.
- B. Outside standing Signage.

1.2 RELATED SECTIONS

- A. Section 05500 Metal Fabrication.
- L. Section 09900 Painting.

REFERENCES

- B. Australian Standards (AS).
 - 1. As 1428/1428.1/1428/.2/1428.4 Design for access and mobility.
 - 2. AS2444-2001- Portable fire extinguisher and fire blankets.
 - 3. As 2342 – 1992- Development, testing and implementation of information and safety symbols and symbolic signs
- C. American with Disabilities Act (ADA)
 - 1. ATBCB ADAAG – Americans with Disabilities Act Accessibility Guidelines.
- D. American National Standards Institute (ANSI)
 - 1. ANSI A 117.1 – Accessible and Usable Buildings and Facilities
- E. ASTM (American Society for Testing and Materials)
 - 1. ASTM D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
 - 2. ASTM D 1929 – Standard Test Method for Determining Ignition Temperature of Plastics.
 - 3. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 4. ASTM E 2073 – Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings.
- F. Florida Building Code, Chapter II and Section 423.14.2
- G. Underwriters Laboratory (UL)
 - 1. UL 94 – Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - 2. UL 723 – Surface Burning Characteristics of Interior Finish Materials and Systems.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01330
- B. Product Data: Manufacturer's data sheets on each product to be used, including
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Detail drawings showing sizes lettering, and graphics, construction details of each type of sign, and mounting details with appropriate fasteners for specific project substrates.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each sign type and color specified, two samples minimum size 150mm square, representing actual product, color, and patterns.
- F. Manufacturer's Installation Instructions. Printed Installation Instructions for each signage system.
- G. Signage Report. Signage report indicating signage sizes, lettering and construction.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened factory packing
- B. Inspect materials at delivery to verify.
- C. Store products in manufacturer's original packaging until ready for installation, in climate controlled location away from direct sunlight.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.5 PROJECT CONDITIONS

- A. Install products in an interior climate-controlled environment.
- B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.6 WARRANTY

- A. At project closeout, provide to the owner representative a copy of the manufacturer's standard limited warranty against manufacturing defect outlining the terms, conditions and exclusions from coverage.
 - 1. Duration: Two (2) years.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer with experience in the specified product and approved by the Engineer.

2.02 SIGNAGE-GENERAL (Arabic and English Fonts)
For Details refer to drawings

A. OUTSIDE CONSTRUCTION PROJECT ID SIGNAGE:

Details: Refer to drawings.

Sample:

  	
SCHOOLS FOR A KNOWLEDGE ECONOMY PROJECT Phase 3/ Package 2 School Name	مشروع مدارس الاقتصاد المعرفي المرحلة الثالثة/الجزء الثانية اسم المدرسة
Owner: Ministry of Education	المالك: وزارة التربية والتعليم
Employer: Ministry of Public Works and Housing	صاحب العمل: وزارة الأشغال العامة والإسكان
Funded by: United States Agency for International Development (USAID)	تمويل: الوكالة الأمريكية للتنمية الدولية (USAID)
Consultant: Design and Supervision Engicon	الاستشاري: تصميم وإشراف شركة المستشار للهندسة
Contractor: Contractor's Name	المقاول: اسم المقاول
Contract Number: (0/0000/USAID/SKEP/3/2) Duration of Contract: 000 Days	رقم العطاء: مدة المشروع: ... يوماً

180.0 cm x 282.5 cm

B. WALL MOUNTED PLAQUE:



DETAILS:

- Material:** Brass embedded 1mm in MDF wood (mahogany or similar dark natural wood color) with shaped edges; frame around the brass shall be 2.5cm; brass glued on MDF wood with special adhesive
- Size:** Brass – 70 cm X 40 cm; thickness TBD
MDF wood base – 75x45x1.8 cm
- Font:** Times New Roman (bending final mock-up); Black (matt paint); text at bottom should be approximately 1/3 size of main text
- Placement:** Waiting area directly opposite entrance; hung 1.5 m from floor (bottom edge); fixed on wall with screws

PART 3 EXECUTIONS

3.01 EXAMINATION

- Verify that wall surface is dry and free from dirt, grease, and loose paint.
- Complete all finishing operations, including painting, before beginning installation of signage systems.
- Do not begin installation until substrates have been properly prepared.
- Examine signage for defects prior to installation. Do not install damaged signage.

3.02 PREPARATION

- Verify mounting heights and locations comply with referenced standards.
- Clean surfaces thoroughly prior to installation to remove dust, debris and loose particles.
- Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- Locate the signage system as indicated on drawings for the appropriate substrate and in accordance with manufacturer's installation instructions.
- Install signage systems level and plumb at the height indicated on the drawings.

3.04 CLEANING

A. At completion of installation, clean surfaces in accordance with manufacturer's instructions.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up repair or replace damaged products before and of defects liability period.

END OF SECTION

SECTION 10530 PROTECTIVE COVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial prefabricated and custom shade structures.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-In-Place Concrete: footings.

B. Section 05500 – Metal Fabrication.

1.03 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 1996.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary; American Concrete Institute International; 1999.
- C. ASTM A 135 - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2001.
- D. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 1999.
- E. ASTM E 8 - Test Methods for Tension Testing of Metallic Materials; 2004.
- F. CRSI (DA4) - Manual of Standard Practice; Concrete Reinforcing Steel Institute; 1997, 26th Edition.

1.04 SYSTEM DESCRIPTION

- A. Design and install square shape fabric tensile shade structure system of 4m height, with four powder coated steel posts, including excavation, reinforced concrete works, reinforcement steel bars needed and all according to specification and drawings.
- B. All layers of membrane to be of non-combustible materials.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for specified systems, including all components.
- B. Shop Drawings: Indicate layout heights, component connection details, and details of interface with adjacent construction.
- C. Complete engineering analysis shall be certified and sealed by a Professional Engineer.
- D. Selection Samples: Two sets of color chips representing manufacturer's full range of available colors.
- E. Certificates:
 - 1. Contractor's certification that manufacturer of products of this section meet specified qualifications.
 - 2. Manufacturer's certification that installer of this section is approved.
- G. Manufacturer's printed installation instructions for specified systems, including

removal and re-tensioning procedure.

- H. Provide manufacturers data verifying compliance of the knitted 100% HDPE membrane system in this specification.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum five (5) years of documented experience producing systems of the types specified in this section.
- B. Installer Qualifications: Minimum three (5) years documented experience installing systems of the types specified in this section, and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store system components in accordance with manufacturer's instructions until installation.

1.08 WARRANTY

- A. Warrant that the equipment sold will conform in kind and quality to the specifications listed and will be free of defects in workmanship or materials. Shade manufacturer shall further warrant the following:
 - 1. LIMITED 10 YEAR WARRANTY on all upright posts, and support structure frames against failure due to rust-through corrosion and all other materials supplied.
 - 2. LIMITED 10 YEAR WARRANTY on all fabrics and stitching threads against degradation, cracking or material breakdown resulting from ultra-violet exposure. HDPE fabric will be compliant with NFPA 701 and ASTM E-84 fire standards.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer with experience in similar products and to be approved by the Engineer.

2.02 GENERAL

- A. All materials shall be structurally sound and appropriate for safe use.
- B. Product durability shall be ensured by the use of corrosion-resistant metals such as stainless steel, and coatings such as hot dipped galvanizing and powder-coating on steel parts, subject to the project specific requirements below.
- C. Fabrics used shall include UV-stabilizers and fire retardants as required to meet performance and building code requirements.

2.03 WELDMENTS

- A. All steel structural steel members shall be factory-welded by Certified Welders.
- B. After fabrication all welded areas shall be primed with zinc rich powder coat and oven cured in accordance with the powder coating manufacturers' specification for all materials supplied.

2.04 POSTS, STRUCTURAL FRAME TUBING, AND HARDWARE

- A. All tubing used shall be cold-formed and milled per ASTM A 135 and ASTM A 500.
- B. Material testing shall be in accordance with ASTM E 8.

- C. Minimum yield shall be 275 N/mm² with a minimum tensile strength of 310 N/mm² on all columns.
- D. All tubing shall be pre-cut to appropriate lengths, and all outside surfaces shall be galvanized, with an interior corrosion-resistant zinc-rich coating.
- E. All steel components other than stainless steel and hot dipped galvanized hardware shall be powder coated with specified zinc primer / finish color two coat powder coat system.
- G. All fastening hardware shall be stainless steel or hot dipped galvanized.
- H. Structure shall include an integrated tensioning system to tension and easily remove fabric for storage during winter months.
 - 1. Hardware shall be non-corrosive.
 - 2. All connections shall be designed for assembly with standard hand tools.

2.05 POLYESTER POWDER-COATING PROCESS

- A. The surface preparation shall be in accordance with the powder coat manufactures recommendations for the material being coated. There shall be no more than four hours time lapse between the surface preparation and the application of powder coat.
- B. Minimum dry film thickness for the zinc primer shall be .05 mm and finish color shall be .05 mm.
- C. The individual steel components shall be powder coated with the specified color and heat cured in a batch oven in accordance with the paint manufacturers specification.
- D. The powder coat finish shall be uniform and continuous with no voids or puddles and shall not be broken by scratches or nicks.
- E. Polyester powders shall meet or exceed ASTM standards for Adhesion, Hardness, Impact, Flexibility, Over Bake Resistance, and Salt Spray Resistance.
- F. Color shall be selected by Owner from manufacturers' standard colors.

2.06 FOOTINGS

- A. Footings shall be designed and constructed to local building codes and good construction practices and shall meet the requirements of Section 03300.
- B. Columns shall be provided as direct embedment unless shown otherwise on the Drawings.
- C. Concrete shall meet the requirements of Section 03300.
- D. Reinforcing:
 - 1. Reinforcing shall meet the requirements of Section 03200.
 - 2. All reinforcing steel shall be designed, detailed, fabricated, and place in accordance with ACI 301, ACI 318, and CRSI Manual of Standard Practice.

2.07 SHADE FABRIC

- A. Knitted from 100% virgin HDPE monofilament with slit film fill with Ultra Violet stabilizers and flame retardant as required by the applicable building codes. Fabric with both weft and warp slit film construction is not permitted.
- B. Physical Characteristics: The following indicates minimum physical properties of 100% HDPE monofilament membranes.
 - 1. Weight: 237 gm/sq.m.

2. Breaking Strength:
 - a. Warp 81 Kg.
 - b. Weft 254 Kg.
3. Bursting Strength (ASTM D3787): 215 Kg.
4. UV stability: 10 years.
5. Shade Effect: Angle of Incidence 90% to 95%.
6. Ultraviolet block: Angle of Incidence 90% to 95%.
- C. Colors: Selected from manufacturer's full range of available colors.
- D. Fabric catenary shall include a low-stretch, braided premium HDPE Dyneema or Spectra rope. Steel cables in an edge pocket will not be permitted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are as indicated on shop drawings.
- B. Installer's Examination:
 1. Have installer of this section examine conditions under which construction activities of this section are to be performed, then submit written notification if such conditions are unacceptable.
 2. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.
 3. Beginning construction activities of this section indicates installer's acceptance of conditions.

3.02 PREPARATION

- A. Ensure that adjacent surfaces, structures, and finishes are protected from damage by construction activities of this section.

3.03 INSTALLATION

- A. Install systems specified in accordance with shop drawings and manufacturer's installation instructions.
- B. Placing of concrete for post bases is specified in Section 03300.

3.04 CLEANING

- A. Remove dust or other foreign matter from component surfaces; clean finishes in accordance with manufacturer's instructions.

3.05 PROTECTION OF INSTALLED PRODUCTS

- A. Ensure that finishes and structure of installed systems are not damaged by construction activities.
- B. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Engineer.

END OF SECTION

SECTION 10800

Toilet, Bath and Laundry Specialties

To be read in conjunction with General Requirements and other related sections of the Specifications and Conditions of Contract.

PART 1 GENERAL

1.1 SECTION INCLUDES

1. Sanitary Wares
2. Toilet, Bath and Laundry Accessories

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

The Contractors shall refer to the approved Manufacturer list provided in the Tender Documents.

2.02 PRELIMINARY INFORMATION / REQUIREMENTS

Requirements:

The Sanitary Fittings specification is non-performance designated and contains general materials and workmanship specifications to control the standard of materials and products.

The Contractor should:

- a) Be responsible for the supply and installation of the sanitary fittings to meet the requirements of the Specifications.
- b) Co-ordinate the installation with that for all related works and accommodate the specified movements and tolerances for structural elements as specified in the Structural Engineering Specifications.
- c) Be responsible for ensuring that finishes meet the standards specified herein and have been independently inspected and certified as specified.
- d) Be responsible for ensuring fitness for purpose of all materials and methods of installation to meet the criteria specified herein.

Health & Safety:

- a) The Contractor should ensure that he complies with the latest 'Code of Construction Safety Practice', the Health and Safety requirements of the Contract Documents and ensure that full consideration is given to the health and safety of operatives when manufacturing, handling and installing the Works.

Standards:

- a) Comply with the latest edition of all relevant standards and provide independently certified evidence that all specified variants of components comply with specified requirements.

2.03 TYPE(S) OF SANITARY FITTINGS**Location:**

The location of the Sanitary Fittings is defined on the drawings.

Material shall be first grade stainless steel and subjected to the Engineer's approval.

2.04 PERFORMANCE REQUIREMENTS**Thermal Movement:**

All components shall be designed to resist thermal movement resulting from: the maximum and minimum surface temperature differentials, maximum annual range, and diurnal range, absolute highest and lowest temperature for mid-winter and mid-summer and surface temperature in accordance with the recommendation of applicable standards.

Moisture Movement:

The Sanitary Fittings shall withstand movement without permanent deformation or any reduction in the specified performance:

Due to changes in the moisture content of its components, resulting from variations in the moisture content of the air either inside or outside the building.

PART 3 EXECUTIONS**3.1 INSTALLATION GENERALLY**

- Assembly and fixing: Surfaces designed to falls to drain as intended.
- Fasteners: Nonferrous or stainless steel.
- Supply and discharge pipework: Fix before appliances.
- Fixing: Fix appliances securely to structure. Do not support on pipework.
- Jointing and bedding compounds: Recommended by manufacturers of appliances, accessories and pipes being jointed or bedded.
- Appliances: Do not use. Do not stand on appliances.
- On completion: Components and accessories working correctly with no leaks.
- Labels and stickers: Remove.

Ensure all disciplines and any or all on-site measurements have been properly coordinated prior to procurement and installation.

3.2 COMPATIBILITY OF COMPONENTS

- General: Each sanitary assembly must consist of functionally compatible components obtained from a single manufacturer.
- Exceptions: Nil.

3.3 NOGGINGS AND BEARERS

Noggings, bearers, etc. to support sanitary appliances and fittings: Position accurately. Fix securely.

FRAMING FOR PREPLUMBED PANEL SYSTEM

General: Position accurately. Fix securely.

3.4 TILED BACKGROUNDS OTHER THAN SPLASHBACKS

- Timing: Complete before fixing appliances.
- Fixing appliances: Do not overstress tiles.

3.5 INSTALLING CISTERNS

- Cistern operating components: Obtain from cistern manufacturer.
- Float operated valve: Matched to pressure of water supply.
- Overflow pipe: Fixed to falls and located to give visible warning of discharge.
- Location: Agreed, where not shown on drawings.

3.6 INSTALLING TAPS

- Fixing: Secure against twisting.
- Seal with appliance: Watertight.
- Positioning: Hot tap to left of cold tap as viewed by user of appliance.

3.7 INSTALLING WASTES AND OVERFLOWS

- Bedding: Waterproof jointing compound.
- Fixing: With resilient washer between appliance and back nut.

3.8 SEALANT BEDDING AND POINTING

SUBMITTALS:

Samples (Fabrication Samples) Provide samples including relevant technical literature as follows: Provide representative samples of each of the sanitary fitting and obtain approval before placing orders.

END OF SECTION

DIVISION 11
EQUIPMENT

SECTION 11480 PLAYGROUND EQUIPMENT

PART 1: GENERAL

1.1 SUMMARY: Provide all equipment and materials, and do all work necessary to furnish and install Playground Equipments, the Basketball, football and Volleyball Equipments as indicated on the drawings and as specified herein. It also describes the minimum safety requirements for the Playground Equipments.

1.2 RELATED SECTIONS

- | | |
|------------------|--------------------------|
| 1. Section 02300 | Earthworks. |
| 2. Section 03300 | Casts in Place Concrete. |
| 3. Section 05500 | Metal Fabrications. |
| 4. Section 09300 | Tiles. |
| 5. Section 09900 | Painting. |

1.3 REFERENCES

- A. (AS) Australia standard
1. AS 4685.1-2004 - Playground equipment. Part1:General Safety requirements and test Methods.
 2. As 4685.3-2004 - Playground equipment.Part3:Particular Safety requirements and test Methods for slides.
 3. AS/NZS 4422:1996 - Playground surfacing – Specifications, requirements and test method.
 4. AS/NZS 4486.1:1997 – Playgrounds and Playground equipment. Part1: Development, installation, inspection, maintenance and operation.
- B. Handbook for Public Playground Safety. (1991) U.S. Consumer Product Safety Commission, Washington, D.C. 20207. Pub. No. 325
- C. ERIC Digest Safer Playgrounds for Young Children.. [www.ed.gov/databases/ERIC Digests/ed355206.html](http://www.ed.gov/databases/ERIC_Digests/ed355206.html)
- D. (IPEMA) International Play Equipment Manufacturers Association
www.ipema.org : Use this web site to confirm product certification.
- E. (ASTM) - The American Society for Testing and Materials
1. ASTM F-1487-01 Standard Consumer Safety Performance Specifications for Playground Equipment for Public Use.
 2. ASTM F-1292-99 Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment..
 3. ASTM F-1951-99 Standard Specification for Determination of Accessibility of Surface Systems under and Around Playground Equipment.
- F. (CPSC)_The Consumer Product Safety Commission www.cpsp.gov.
- G. International Amateur Athletic Foundation (I.A.A.F.)

- H. Handbook for Public Playground Safety.
- I. Americans with Disabilities Act (ADA) accessibility standards.
- J. Florida Building Code 2001.

1.4 QUALITY ASSURANCE

- A. Contractor Qualifications: Employ only experienced Installers skilled in the successful installation of the specified materials and assemblies on similar projects for a minimum of five (5) years. Installers shall be certified.
- B. Manufacturer Qualifications: Employ only manufacturers with at least five (5) years experience making the specified materials as a current catalog and regular production item.
- C. Source Limitations: Unless specifically noted otherwise, provide products of the same manufacturer for each type of unit specified.

1.5 WARRANTY

- A. Manufacturer's Warranty: For all metal (steel and aluminum) structural elements against corrosion for a period of (5) five years from the date of end of defects liability period. Warranty slides and panels for a period of five (5) years against structural failure.
- B. Installer's Warranty
- C. Unless otherwise stated in this Guideline, duration of all warranties shall begin on the date of end of defects liability period.
- D. Contractor Statement of Compliance: The Contractor shall provide certification that the specified products or assemblies have been installed in accordance with the Project Construction Documents.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

Manufacturers with experience in similar products and as approved by the Engineer.

2.2 PLAYGROUND STRUCTURE

Note: For steel galvanized tubes, 3 mm min. tube wall thickness.

- A. Basketball:
 - 1. Backboard: 180cmx105cm Wood maple backboard
 - 2. Poles: steel tube 15cm diameter with gooseneck extension.
 - 3. Basket: steel rim 45cm diameter size, with round steel bar of 2cm diameter powder coated.
 - 4. Basket Net: Nylon or Fabric and as approved by the Engineer.

5. Excavation and reinforcement concrete works.
6. All sizes as per drawings.

B. Football goal:

1. Dimension 3m long, 2.2m height, 1.8m depth.
2. Main steel tube frame of 7.5 cm dia. galvanized pipes.
3. Sub steel tubes frame of 5 cm dia. galvanized pipes.
4. Steel Members welded together as per drawings.
5. Oil paint, color to be selected by the engineer.

C. Volleyball post:

1. Steel tube of 10cm dia. of galvanized pipe.
2. oil paint, color to be selected by the engineer.

2.3 DRAWINGS

- A. Contractor shall provide the Playground Equipment as described in this Design Criteria and as shown on the drawings. A scaled drawing of the play structure with all play elements and the surrounding boundary, the ground-surfacing material and depth shall accompany the permit. This applies to both new work and relocated structures.
- B. Drawings shall include a site plan and a plan of the playground equipment.

2.6 MATERIALS

Playground Equipment Components :

- A. Any concrete, reinforced concrete work, formwork needed for fixing the equipment.
- B. Bolts, concealed fixers, paint.
- C. Sand bed suitable for playground Equipment.
- D. Concrete: Refer to Section 03300
- E. Metals: Painted (powder Coated). Refer to Painting
- F. Hardware: Stainless Steel or Zinc Plated steel
- G. Clamps: Aluminum
- H. Plastic: High Density Polyethylene
- I. Steel Tubing: Cold Rolled
- J. Aluminum Tubing: Extruded 6061_T6
- K. Factory electrostatically applied thermosetting powder coating applied with a minimum thickness of 3-5 mils.

PART 3 EXECUTIONS

3.1 EXAMINATION

- A. Examine substrates and existing conditions with the installer for compliance for play court layout, alignment of mounting substrates, electrical availability, tolerances for operational clearances and compliance with the Manufacturers

written installation instructions.

- B. Commencing installation means acceptance of existing conditions by the Installation Contractor.

3.2 INSTALLATION

- A. Installation of the playground equipment, border, ramp and ground surfacing material shall be done by the Manufacturers approved representative.
- B. No installation shall begin before the Contractor has received approved submittals. Submittals are shop-drawings for new work.
- C. Place Footings in accordance with approved shop drawings.
- D. There shall be no exposed bolt ends, sharp edges or protruding points remaining on any surfaces on the play Structure after erection is complete.
- E. The Equipment site shall provide adequate drainage, a minimum of 25.4mm.
- F. All concrete footings for equipment shall be installed as indicated on the drawings and in accordance with Section 03300, Cast-in-Place Concrete.
- G. All equipment shall be installed in strict accordance with the latest rules, regulations and specifications governing that sport or event for which it is being installed.
- H. Fabricate steel tubes of playground equipments as per section 05500 – Metal Fabrication.
- L. Painting, oil paint as per section 09900 – Painting.

3.3 SPECIAL INSTALLATION PROCEDURES/ADJUSTMENT PROCEDURES

- A. Provide all items and accessories as required for a total and complete installation in every respect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Installation of any items indicates all conditions are satisfactory and accepted. This includes all site conditions.
- C. Adjust movable components of equipment to operate safely, smoothly, easily and quietly, free from binding, warp, distortion or malfunction, throughout the entire operational range. Lubricate hardware and moving parts

3.5 CLEANING

After completing the installation of the equipment, inspect all the components for spots, dirt, debris and damaged parts. Clean and remove spots, remove dirt and debris and touch-up damaged shop applied finishes according to the manufacturers written instructions. Damaged equipment will not be accepted by the Owner.

END OF SECTION

SECTION 11600

LABORATORY FURNITURE

PART 1 GENERAL

1.1 SCOPE OF WORK

Supply and installation of School Laboratory Furniture, including under bench cabinets, wall mounted cabinets, tall storage cupboards, Fume cupboards and service fixtures as detailed below.

1.2 SECTION INCLUDES

1. Instructor laboratory counters
2. Octagonal shape working counters
3. Rectangular shape working counters
4. Rectangular shape Preparation counters.
5. Fume Hood Cupboard.
6. Wooden cabinets.

1.3 RELATED SECTIONS

1. Section 06410 Custom Cabinets.
2. Mechanical Section.
3. Electrical Section.

1.4 REFERENCES:

BS EN 438-7:2005 High-pressure decorative laminates (HPL). Sheets based on thermosetting resins (usually called laminates). Compact laminate and HPL composite panels for internal and external wall and ceiling finishes.

BS EN 13792:2002 Colour coding of taps and valves for use in laboratories

BS 1363 Pt 2 Standardized type of power connectors which are standards for household and business power sockets)

TÜV-ISO-9001:2000 Design and manufacture of Laboratory valves
and accessories

DIN-DVGW-NG-4385A000796 (93.01e870) / 4385A00797 (93.02e870).

DIN-DVGW-NG-4385AN0256 / 4385AN0257.

CSA-c-us 1210572 class 3371-13 / 3371-93. Manually Operated Hose End Valves For Laboratory Use.

CAS-c-us 1210576 class 6811-01 / 6811-81. (Plumbing Fittings And Accessories) Fittings Certified to US Standards

1.5 SUBMITTALS

3. Submit under provisions of Section 01330.
4. Product Data: Describes unit construction, size, finish and features, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
5. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
6. Verification Samples: For each finish product specified, two samples, minimum size 150 mm square, represent actual product, color, and patterns.

1.6 QUALITY ASSURANCE

- a. Manufacturer Qualifications: Furniture and Equipments shall be manufactured in a facility with experience in laboratory Furniture not less than ten (10) years.
- b. Mock-Up: Provide a mock-up for evaluation of operation and application workmanship.
 1. Install Furniture/equipment designated by the Engineer.
 2. Do not proceed with remaining work until workmanship and operation are approved by the Engineer.
 3. Correct mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

1. Store products in manufacturer's unopened packaging until ready for installation.
2. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

1. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A manufacturer with experience in specified products and approved by the Engineer.

2.2 BENCH SYSTEM

1. The bench system is supported on heavy-duty steel frames that fully carrying the worktop, series with load capacity of 200kg/m².
2. Under-bench cabinets are suspended on heavy-duty cantilever frame that fully carries the worktop and can be relocated with simple hand tools.
3. Steel frames are constructed from 60x30x2mm rectangular steel section for wall benches and teacher benches, 30x30x1.5mm square steel section for octagonal student benches and metal bases, and 50x25x1.5mm steel section for rectangular student benches.
4. All frames and its connections are coated with epoxy resin based powder coating with excellent resistance to chemicals and high level of surface hardness and resistance to wear and tear.
5. All side and middle frames are constructed without a vertical leg to avoid obstruction to the user. Legs are supplied with end caps and adjustment feet ± 15 mm to correct eventual unevenness of the floor.

2.3 WORKTOP MATERIALS

- C. Refer to drawings for details.

2.4 ACCESSORIES

1. SHELF SUPPORTS

Adjustable shelves are placed on plastic shelf supports with 3mm diameter steel pin. Each 4 shelf supports have a load capacity of 60kg by evenly distributed loading on the shelf.

2.5 ELECTROMECHANICAL FITTINGS (Service Fixtures)

1. SINKS & BOTTLE TRAPS

Laboratory sinks made of black laboratory grade Polypropylene material. Sinks are supplied with polypropylene bottle trap and a PP-strainer.

2. PEGBOARDS:

Pegboards are made of Polypropylene material for easy of clean, structural rigidity, lighter weight and easy assembly. Pegboards are supplied with draining hose, sloping drip tray that makes directing liquid easier and quicker and 55 pegs of lengths 100 & 120mm which fit into molded insert holes that are specially designed to keep pegs in a uniform upright 40° angle for stable glassware storage. Installation and removal can

easily be made with hands.

3. ELECTRICAL SOCKETS

Switching mechanism on switched sockets comply with BS 1363 Pt 2, A.C. only.

2.6 FUME CUPBOARD

1. DIMENSIONS

Width: 1200 mm

Depth: 900mm

Height: 2400mm

2. AIR FOIL

Aerodynamic type airfoil made of 1.2mm thick epoxy powder coated sheet metal fitted on the front edge of the worktop.

3. WORKTOP

Worktops are monolithic, non-porous, and molded from a modified epoxy resin material. These panels contains no asbestos, will not ignite, are non-conductive, and have been engineered to provide resistance to corrosive effects of most laboratory chemicals, moisture, corrosion, stains, impact and stress cracking. These panels are used for chemical, biological and physical laboratories. Fume Cupboard worktop is supplied with Epoxy resin oval cup sink with good resistance to, wear and chemicals. Sink is supplied with laboratory grade polypropylene bottle traps.

4. CHAMBER & BACK BAFFLES

Made of Solid Phenolic Core panels which are high pressure solid composite panels specifically designed for laboratory use and casework. These panels have been engineered to provide resistance to moisture, chemicals, corrosion, stains, impact and stress cracking. Color: Grey, thickness: 16mm for chamber and 6.4mm for back baffles.

5. EXHAUST FAN

Fume Cupboards are supplied with centrifugal extractor fan with IP 55 protection. Fan house is UV resistant, house and wheels are made of polypropylene. Fans are supplied with suitable motor base. Fan capacity: 1500m³/h, Speed: 1450rpm, 0.37kw. Duct is made of round PVC, d: 200mm. Quantities of elbows and flexible duct to be determined as per site requirements and engineer approval.

6. TRANSITION HOOD

Fume cupboard chamber is supplied with epoxy powder coated sheet metal transition hood from rectangular to round fitted on the top and connects the fume cupboard exhaust to duct system.

7. SASH ARRANGEMENT

Sash made of 6mm thick tempered glass, running in guide channels, supplied with a handle made of 1mm thick epoxy powder coated sheet metal on the width of the fume

cupboard. To counter-balance the glass sash, steel cable and a balancing epoxy powder coated metal 40x40mm solid bar are utilized.

8. MECHANICAL FITTINGS

Fume cupboards are supplied with water and gas outlets with their front control valves. These fittings are made of best quality brass which is completely free of ferrous substances (OT85, P-Cu-Zn40-Pb2 certified), partly drawn bars, partly hot forged. The alloy used is free of cadmium (40% silver-alloy), which is also suitable for food industry. Before coating, the taps are cleaned ultra-sonically, externally as well as internally.

Taps are supplied with an epoxy-powder-coating, creating a clean and smooth surface, which withstands aggressive chemicals. All RAL-colors are available, standard color is light-grey (RAL 7035) as **Maryland Metrics** Color Code. Hand-wheels are made of Moplen S30G, a synthetic that is highly resistant to chemical attack and fire. The color-coding for identification of the media is according to EN 13792.

9. ILLUMINATION

A twin fluorescent light fitting is housed in a mild steel white epoxy coated reflector box positioned over a 6mm thick tempered glass panel on the top of the fume chamber. This light assembly is sealed from the internal chamber.

10. ELECTRICAL FITTINGS

Fume cupboards are supplied with the following electrical fittings:

2 no. single electrical sockets with water cover proof.

1 no. fan switch

1 no. light switch.

11. FRAME-WORK

Fume cupboard is mounted on a steel C-frame, made of 60x30x2mm epoxy powder coated rectangular steel section supplied with adjustment feet ± 15 mm.

12. CUP SINK

Fume Cupboard worktop is supplied with black epoxy resin oval cup sink with good resistance to scratch, wear and chemicals. Sink is supplied with laboratory grade polypropylene bottle traps.

13. STORAGE CABINET

Made from 18mm Plywood covered with HPL on all sides with PVC edging strips.

PART 3 EXECUTION

1.1 EXAMINATION

1.7.1 Do not begin installation until substrates have been properly prepared.

1.7.2 Coordinate with mechanical and electrical trades for location, size and type of service required.

1.7.3 If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

1.2 PREPARATION

1.7.4 Clean surfaces thoroughly prior to installation.

1.7.5 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

1.3 INSTALLATION

1.7.6 Install in accordance with manufacturer's instructions.

1.7.7 Plumbing and electrical work shall be performed by licensed professionals and adhere to Local, State and Federal Codes as applicable.

1.4 PROTECTION

1.7.8 Protect installed products until completion of project.

1.7.9 Touch-up, repair or replace damaged products before Substantial Completion.

1.5 DEMONSTRATION

1.7.10 Manufacturer to provide a minimum of one hour of instruction on operation and maintenance of the washer.

END OF SECTION

ARCHITECTURAL LIST OF RECOMMENDED MANUFACTURES

1. Curtain Wall

- Petra Aluminum Co.
- AL-FAQEER INDUSTRIAL Co.
- Ragheb Kalbouneh & Partners Co. - Technical Aluminium & Glass
- Or equivalent.

2. Decorative glass

- Forms + Surfaces.
- Mansour Glass.
- Or equivalent.

3. Porcelain and Ceramic Tiles

- Seasons.
- Marrazi tiles / Salah Shihadeh
- Nabulsi and Amad.
- Or equivalent.

4. Marble and Stone:

- Marbletone
- Quality for marble & granite
- Nassar group
- Al- Jabary Marble
- Amer AL khatib for stone
- Or equivalent.

5. Dry fixation:

- Hilti
- Fischer
- Or equivalent.

6. False ceiling:

- The Knauf group
- AMF –Ceilings systems
- Armstrong–Ceilings systems
- Or equivalent.

7. Signage

- The Engineering Co for signs Khattab
- DOTS PRO industrial advertising solutions & printing
- Or equivalent.

8. Paint

- Jotun
- Dulux
- National Paints
- Sipes
- Or equivalent.

9. Bathroom Accessories

- Bobbrick
- Inda
- Sonia

10. Labs

- Maani
- Protech

DIVISION 14
CONVEYING SYSTEMS

SECTION 14200

CONVEYING SYSTEMS

1.1 GENERAL

The Elevator shall be full package of compact type (all items should be from the same manufacture) and meet requirements for persons with disabilities, have electronic brain/PLC Control that is directly responsible for high performance in an ideally compact structure. The elevator should provide gentle, smooth rides and sure landing accuracy.

The machine should be located inside the elevator shaft (MRL). The Combination of a high-performance VVVF drive / control system and a microprocessor assure system of uniform fine control.

1.2 SUBMITTALS

Each elevator supplier shall submit the following:

- Product data for all elevators including capacities, sizes, performances, operations, sections, safety features, finishes and all similar information.
- Samples of exposed finishes for car, hoist way doors, and signal equipment; 75 mm square samples of sheet materials; and 100 mm length of running trim members.
- Operation and Maintenance Manuals for each different traction elevator, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for the Employer's information at project closeout.
- Inspection and acceptance certificates and operating permits as required by governing authorities for normal, unrestricted elevator use.

1.3 GENERAL TERMS

1.3.1 DRAWINGS, DIAGRAMS AND APPROVALS

Within maximum 10 days of the date of notification of the award of the work, and before work commences, the Contractor shall submit for the engineer's approval all drawings required to accurately complete the shaft and install the lifts, including all their components; Layout of machine room showing size and position of equipment, heat

generated, necessary ventilation and maximum and minimum room temperatures required.

- Shafts layout with guides and other lifts equipment, etc.
- Car and car support framework.
- Car details.
- Doors, door openings and door operators with all switches and devices.
- Signalization.
- Wiring diagrams.
- Buffers and pit details.
- All builders work showing holes, pockets cast in items, scaffolding, etc. The Contractor shall supply details of all load applied to the structure at moments of normal and emergency operation indicating position magnitude and direction.
- Detailed drawings of elevator finish and color samples

As drawings in connection with design work has already been provided to the Contractor, such information shall be confirmed by the Contractor (including confirmation of weight of items of equipment, sizes of access easy. etc.) and incorporated in his own drawings.

All drawings shall be submitted to the Engineer for approval in 3 copies. The Engineer will review the drawings, state his comments, approve them and transfer a copy to the Contractor. Accordingly, the Contractor will amend and submit (3 copies) of the corrected drawings for final approval by the Engineer.

If the correction found necessary by the Engineer are substantive, and the Contractor is compelled to prepare a new Drawing, it shall be submitted to the Engineer again for approval.

The approved drawings shall serve as working drawings. The Contractor shall not execute any work, purchase equipment or execute any other activity prior to approval of drawings.

All parts to be used in the elevators must be approved in writing by the Engineer before they are installed.

1.4 PROGRESS REPORTS

The Contractor shall provide information on the progress of the work to the Engineer upon request. The Contractor shall maintain a log in which he shall record the work, problems and important data relevant to the job. The Engineer is entitled to review the abovementioned log at any time.

1.5 CONSTRUCTION WORK

1.5.1 Dimensions

The Contractor shall check all dimensions on site and shall not rely on the provided drawings only.

1.6 QUALITY OF THE WORK

The Contractor undertakes to implement the work to the highest standard and according to existing and accepted regulations, laws and standards. The work shall be executed by a sufficient number of highly qualified workers suitable for the work.

The Contractor shall supply materials, facilities and instrumentation required for the work.

All materials and parts shall be new and of the highest quality.

No work of any kind shall be assigned to a subcontractor without the prior written approval of the Engineer.

The Engineer is entitled to reject any subcontractor which, in its opinion, does not properly execute the work.

1.7 DAMAGE TO THE BUILDING

The Contractor shall be responsible for any damage that may be caused to the building, the machinery, the facilities and persons by it or by its employees or by a defect in the materials supplied by it or a result of unprofessional or faulty work, either directly or indirectly. The Contractor shall be required to compensate the Employer for the full extent of the above damages.

No cutting into the structure, beams or columns may be implemented without prior written approval by the Engineer. The Contractor shall be required to submit insurance policy as stipulated in Vol I/ Appendix to Tender- reference clause 14.1 which shall constitute full security against damages which may be caused to persons, materials, facilities and equipment, by any cause whatsoever, including earthquake, flood, fire, electrical short or electrical current, etc., within the scope of its work. The Contractor shall also provide insurance for its employees and any third party on site. The Contractor shall submit a copy of the insurance policies to the Engineer.

1.8 GENERALLY, ABOUT THE INSTALLATION

This installation shall include all materials, labor, fixing, connection, commissioning and delivery up clean and in working order as detailed in Elevator Technical Particulars Schedules.

The shaft is cast-in reinforced concrete and the machinery is located inside the shaft.

1.9 CODES AND REGULATIONS

All works & safety requirements must comply with the latest edition of:

- a. BS 5655 (all parts).
- b. EN 81.
- c. American Society of Mechanical Engineer ASME A17.1-2013/CSA B44-13 Safety Code for Elevators and Escalators.
- d. Requirements for persons with disabilities code 2/6/7 of The Jordanian National Building Codes
- e. The Jordan Standards and Metrology Organization.
- f. All related local standards and regulations

1.10 EXTENT OF WORKS

The Contractor shall be responsible for:

1. The complete design and installation of the elevator(s) including the provision of design drawings, contract drawings, and builder's work drawings and all other information required to allow proper integration of the installation within the building.
2. The complete testing, commissioning and setting to work the elevators installation together with the production of As-Built Drawings and Operation and Maintenance Manuals.
3. Three (3) sets of the As-Built Drawings, Operating and Maintenance Manuals shall be issued by the Contractor supplier, when approved.

The following items of Construction works will be carried out by the Contractor in accordance with the approved drawings.

1. Supply and installation of lifting beams in lift and machine rooms including testing and marking for the safe working load.
2. Provision of scaffolding, planks and ladders.
3. Natural smoke ventilation of the lift shafts.
4. Provision of concrete bases including any anti-vibration or insulation blocks shall be supplied by the Contractor.
5. Finishes around the elevators' doors including cutting away and making good of floors, walls and ceilings in the fabric of the building.
6. Back filling and making good around architraves, sills, push buttons and indicators, etc. including adequate shoring to prevent distortion.
7. Provision and fixing of temporary removable screens at each landing entrance.

1.11 MATERIALS AND WORKMANSHIP

a. Operation

Operation of the elevator shall be as mentioned in the schedules of section 1.30- Technical Particulars for Electric Traction Type Elevators. For inspection purposes a manually operated switch connected to "Up" and "Down" direction buttons shall be installed on the top of the car. This switch must permit the car to be operated at slow speed from the top of the car. During this inspection, operation of the car must not respond to any other calls.

b. Machine

The drive unit should be a gearless machine specially made for driving elevators and ensure a smooth and high-quality performance.

Worm rim is to be best quality phosphor bronze or other approved materials, hobbled accurately after fitting to gear spider. Approved means are to be provided for fixing rim to spider and prevent the unit from becoming loose during operation.

The motor shall be squirrel cage induction motor particularly designed for Variable Voltage Variable Frequency drive.

The brake of the machine must be spring applied, magnetically released self-cooling and capable of holding car securely under machine speed and car-load conditions. Brake is to be designed for automatic application immediately after power is interrupted on motor.

The following information on the machinery must be provided:

- Manufacturer
- Size, HP
- Voltage
- Power consumption at full load, KVA
- Revolutions per minute, R.P.M
- Full load current, A
- Starting current, A
- Duration of starting current, sec.
- Power factor
- Winding insulation: should be Class (B)
- Protection degree: should be IP41

The motor must be provided with overload, reversal phase and phase failure cut-out devices.

The machine shall be provided with manually operating turning device in order to bring the car to the nearest landing in case of power failure. The system must prevent engaging of the turning device until the power supply for the motor is switched off.

When not in operation the motor shall start automatically upon registration of a call. The machinery & controller to be placed on vibration dampers inside the shaft. All steel structures for machinery shall be included in this contract. The contractor must produce necessary & sufficient drawings for special concrete foundations for the Machinery, if needed.

The Contractor must provide information to the Engineer on the highest permissible ambient temperature in the machine room and the amount of heat produced by the entire installation.

c. Ropes and Sheaves

The elevator shall be provided with suitable car and counterweight ropes. Sheaves shall be made of best grade iron turned and grooved for the ropes. The sheaves shall be of ample diameter for the ropes used.

Sheaves shall be fixed by means of steel beams which are to be delivered and installed by the contractor. Steel beams must be sound insulated from structural parts. Ropes shall be of high tensile traction steel.

d. Shaft Installation

Guide rails for car & counterweight to be T-steel guide rails planted on three (3) edges. Rails must be placed very accurately and be fixed firmly between brackets. The rails shall be brought totally to the bottom of the shaft.

The fixing of the rails and the connection between two (2) or more sections of rail must be in such a manner that the straight and vertical position is not influenced by changes in temperature or ordinary settlement in the structure.

Guides for car and counterweight to be either rubber roller guides or Teflon (Tufnol) as recommended by (British Standards) B.S. Roller and shoes shall be renewable. Buffers must be provided to bring the car to stop at the extreme limits of travel, should the car for any reason pass the limit switches.

The Contractor must provide sufficient drawings, showing all holes, recesses, fixing devices, and other required components to be cast in the shaft wall & showing all cutting and patching for installation of sills and frames.

The Contractor must supply all fixing devices to be cast in or cut into structural parts. It is the responsibility of the Contractor alone to assure that such parts are cast in or otherwise fixed in the right position in a proper manner.

The Contractor must provide all beams, brackets, spacers, and other required components for fixing of sheaves and guide rails. Contractor must make sure that all holes to be made in concrete in connection with gate, frames, winches, guiderails, switches and controller are provided. The Contractor must furnish drawings for this purpose. The Contractor must provide all steel separation beams inside the shaft as necessary.

e. Controller

The elevator controller shall be of the vertical, totally enclosed, dust proof cubicle type constructed of sheet steel with hinged doors on the front & screwed panels on the back, giving easy access to all components inside the controller. The cubicle enclosure shall be such as not to pose any danger of shock to persons. The cubicle shall be well ventilated by means of louvers or other approved method, such that the temperature inside never exceeds the safe temperature limit of the equipment.

The controller shall house selectors, timing devices, transformers, motor protection, isolation equipment and all components associated with the control of the elevator. All

control circuits shall have silver contacts. Control of the elevators shall be by electronic automatic control circuitry, microprocessor based.

All insulated components of the controller shall be “Class B” or equivalent insulation throughout.

The controller shall provide protection and automatically disconnect motor against the following:

- 1- No-volt and sustained under voltage.
- 2- Over-current in any component.
- 3- Phase reversed of the power supply.
- 4- Overload.
- 5- Earth leakage protection.
- 6- Serious unbalance of phase winding currents.
- 7- Phase failure.

Protection degree of the controller to be IP41.

f. Car

The car frame, which supports the car platform and enclosure shall be made of solid structural steel with bolted, welded or riveted joints. Bolts shall be positioned for easy access and adjustment.

The car leveling shall be within 5mm. by means of an automatic self-leveling feature. The car shall be equipped with a digital floor position indicator above the sliding doors and equipped with illuminated touch buttons in a silver anodized or polished stainless-steel flush mounted operating panel.

The operating panel inside the car must contain:

- Floor buttons, one for each floor served.
- Emergency call button.
- Car top inspection switch.
- Emergency stop button.

- Light switch (key operated).
- Fan switch (key operated).
- Directional arrows.
- Door close button.
- Door open button.

All lamps, buttons and other operating panel components must be changeable from within the car. An alarm shall sound if the car becomes overloaded, interrupting operation and assuring safety. This facility shall include an illuminated flasher. Furthermore, on each floor there shall be a light indicating the presence of a lift on that floor. A buzzer will be operated on arrival of the car.

g. Finishing and Accessories of Car

Ceiling: Stainless steel removable suspended ceiling panels, under galvanized sheet steel 2.5mm thickness. (A choice of at least four (4) options from manufacturer's catalogue of various designs should be provided to the satisfaction of the Engineer).

Lighting: Indirect lighting by using fluorescent tubes.

Ventilation: Concealed vent & silent exhaust fan. Lighting and fan shall be continuously operated and be switched only from the machine room or by key in the car.

Walls: Front, side & rear walls to be made from stainless steel sheet or pressed galvanized steel not less than 2.0mm thickness and covered with brushed silver stainless steel panels. Handrails and kick plates on three (3) sides.

Floor: Floor Finishes shall include a 23 mm recess to accept Granite / Porcelain Flooring to be installed by Contractor

Handrails: Stainless steel rails shall be provided on three (3) sides at a height of 1000mm and chosen from company catalogues.

h. Doors and Frames

The entrance to the car should be provided with automatic (power operated), two-panel metal sliding doors, centre opening, guiding at the sides by non-metallic shoes sliding in suitable grooves. Doors to be installed both in car and elevator shaft.

The doors must be completely provided with electro-mechanical inter-lock & emergency opening key. The car must be stopped & prevented from moving should a door be forced open. The car doors and the shaft doors must open automatically when levelling. The opening to start as the car is approx. 250mm from the landing.

The Elevators doors must be provided with Elevator Door Keys (access switching) to unlock and manually open the landing doors of an elevator for the purposes of Maintenance, or to rescue people trapped inside the elevator, also be used to restrict the use of elevator. Elevator door keys include: Drop Key, Triangle Key, V Key, U Key and any other device used to open elevator landing doors as per manufacturer catalogue.

The car door and hoist way door should move simultaneously when opening and closing, being 5-10 seconds (to be adjustable). In open position the doors shall automatically move back to locked position, even if the car is stationary at the landing. It shall be emphasized that great importance is attached to silent functioning of the doors.

Landing doors to be of automatic (power operated), two-panel, center opening metal sliding doors. All plugs, brackets and other required components. for frame-fixing to be cast in under the supervision of the Contractor. Car and landing doors should be of hair lined stainless steel. Automatic control ensures simultaneous opening / closing of both the car door and the hoist way door, thereby protecting passengers boarding or alighting.

Also, if the doors begin to close during boarding or alighting, they will instantly open again when the safety shoe (curtain type) in the car door edge comes in contact with an object. A retractable safety edge along door side shall be installed that will re-open door when objected. A photocell also should be provided. Doors & door operators shall be of heavy-duty type. Doors shall have a fire rating of 1.0 hr. Door operators shall be of VVVF controlled type.

i. Car Control Panels at Landings

At each landing, a silver anodized or polished stainless-steel flush-mounted metal panel with one or two touch buttons shall be mounted. The buttons must light up when a call is registered. IN USE lamp shall also be fitted in landing control panel.

At terminal landings, one button only is to be installed in the panel. Direction arrow light to be incorporated in button plates, arranged so that the corresponding arrow indicates the direction of the car when in operation (In all floors). At Main Entrance Level and all other floors an illuminated digital car travel position indicator with arrows shall be placed above the door.

Micro-touch buttons with built-in light (LED) shall be fitted in the car operating panel and in the landing button.

1.12 ELECTRICAL INSTALLATION AND EQUIPMENT

The electrical installation shall be carried out according to IEE (17th edition).

The emergency stop button in car shall stop the car completely, even if the button is released. Restarting of the car to take place only by activating the button in the car, not by call from landing. The control devices shall be of such construction that no complications will arise even by simultaneous activation of various buttons.

Buttons in the car must be given preference over buttons at landings. Terminal limit switches stop the car automatically at the terminal landings. Final limit switches must cut off power & apply the brake automatically, should the car pass the terminal landings.

The installation must include all control devices to control starting/stopping, and also apply the brake automatically if any of the safety devices do not operate or the power fails for any reason.

The car safety switch must stop the car whenever excessive descending or ascending speed is attained, by means of cutting off power from motor and activating the brake.

1.13 ALARMS

An alarm button in the car shall simultaneously activate a bell situated on the car and bell positioned in other location agreed by the Engineer. The bell shall be supplied from a dry cell battery to be included.

The Contractor must provide all batteries, wiring and installations for the alarm.

1.14 PAINTING

The Contractor must include all painting of machinery and structural parts required

1.15 OVERLOAD-PROTECTION DEVICE

If the rated load capacity is exceeded by more than a certain amount, an alarm buzzer sounds & the car remains stationary with the doors open until the load is reduced below the rated value. An illuminated flasher shall also be included.

1.16 INTERPHONE FOR OUTSIDE COMMUNICATION

In the event of an emergency, a passenger needs only to initiate two ways communication with the guard room as well as a third station to be selected by the Employer.

1.17 FIREMAN OPERATION

When the fireman switch located at the elevator lobby floor or supervisory panel is activated for fire or other emergency, all other calls are cancelled and the designated elevator returns immediately to the specified floor to rescue the passengers in the car, and then, it goes to the fireman's designated floor for fire-fighting purpose, Landing call does not answer in this case .

1.18 FIRE RETURN CONTROL OPERATION

In case of fire, when the fire officer turns on the fire key-switch, elevator immediately returns to the pre-specified floor and cancels all calls.

If the elevator is moving up, it shall immediately decelerate, stop at a near floor & move in opposite direction to the pre-specified floor and open the door.

If the elevator is waiting with the door open at a floor, it shall immediately close the door and return. If the elevator is moving down, it shall return not-stop. When returning to the pre-specified floor, elevator opens doors and waits for 15 seconds with light off, then closes doors and waits. At this time, door open button on the car control panel is lighted.

1.19 TECHNICAL DATA

Basic	:	Gearless Traction
Location of Machine Room	:	Machine room-less
Drive & Control control, VVVF.	:	Computerized Programable Logic Circuit (PLC)
Door system	:	2- panel, sliding, center opening.
Entrance Dimensions	:	As per schedule.
Sill	:	Extruded hard aluminium.

Kick-plate : As per finishing of car.

Ventilation Equipment : Fan with air diffuser.

1.20 HOISTWAY ENTRANCE

Door frame : Unit frame of stainless steel.

Sill : Extruded hard aluminium.

Main floor : Landing position indicator and button with arrows.

Other floors : Landing button with arrows.

Emergency car light : A battery-operated car light comes on instantly if the power supply for the regular lights fails.

Access for car : One

Pit : As shown on drawings

1.21 CONNECTION TO FIRE ALARM AND DETECTION SYSTEM IN THE BUILDING

Facilities shall be included in the elevator control panel in order to be connected to fire alarm and detection system in the building. During activation of any fire alarm components, a signal should be transferred to the appropriate elevator control panel, and this panel should operate the elevator to its served main floor to evacuate the passengers. No landing calls should be responded to.

1.22 EQUIPMENT AND MATERIALS

The type of elevator equipment offered shall have been in commercial operation for at least five years prior to tender and have a substantiated record of reliability whilst operating on continuous duty.

Each manufacturer shall guarantee the supply of spare parts in a manner consistent with the required effective life span of the installation as a whole. Elevator shall be of the latest design. In case there is any contradiction between general specifications, particular

specifications, technical schedules..... etc, the highest technical, practical, latest design, etc, between these documents should be considered.

The tender shall be based on materials as specified. All materials and equipment shall comply at least with the following norms current at the time of tender:

EUROPEAN STANDARD (EN 81 – 1: 1998)

BRITISH STANDARD (BS 5655)

American Society of Mechanical Engineer ASME A17.1-2013/CSA B44-13 Safety Code for Elevators and Escalators.

Requirements for persons with disabilities code 2/6/7 of The Jordanian National Building Codes.

Standards of The Jordan Standards and Metrology Organization.

The Engineer reserves the right to inspect materials on site or in factory (Manufacturer's country of origin) at reasonable times and to reject any materials not complying with this specification. The cost of inspection visits shall be covered by the Contractor.

The cost of dismantling and re-erection of the installation occasioned by the removal of rejected materials shall be borne by the Contractor.

1.23 SPARE PARTS

The Contractor shall guarantee to provide the Owner with all spare parts needed (against cost) in the future and for at least 15 years starting at the end of the free maintenance period.

1.24 ELECTRICAL INSTALLATIONS

The electrical wiring and connections associated with the elevator equipment; controls & monitoring & shaft services shall be included in the elevator works.

All electrical works shall be carried out in a neat & workmanlike manner in accordance with the specifications, the regulations issued by the Institution of Electrical Engineering (IEE) 17th Edition and/or NFPA 70, and the requirement of the local power supply company. Local regulations & practice shall take precedence where there is a conflict in requirement.

NEC National Electrical Code Article 620; Installation

Earthing and bonding of all non-current carrying metal parts of the elevator installation shall be effectively and safely bonded to the electrical supply earth system in accordance with the regulations.

1.25 TESTING AND COMMISSIONING

The electrical installations & earth bonding shall be tested in accordance with the regulations. The completed elevator installation shall be tested & commissioned in accordance with the procedures detailed in (EN 81 – 1: 1998), (BS 5655) and Jordanian Measurements Standard.

The elevator installer shall provide weights for load tests.

The results of all tests & commissioning procedures shall be recorded & copies of the record sheets signed & included in the service manuals. All commissioning and test procedures shall be demonstrated to the site engineer and his or her signature placed on the record sheet.

1.26 DRAWINGS

A. Shop/Construction Drawings

Detailed drawings specifically for each elevator installation indicating the whole of the installation shall be provided before installation commences. Installation shall not take place until the Engineers' comments on the drawings in writing have been received.

B. As-Fitted Drawings

Prior the practical completion and hand over of the elevator, record drawings of the installations “As-fitted” drawings shall be provided. These drawings shall be paper prints and on computer disc in an approved format.

1.27 MANUALS

Three (3) complete sets of Operation and Maintenance manuals shall be provided prior to completion. These shall include:

- Detailed operating procedures.
- Manual raising and lowering.
- Lubrication – frequency, application and grade of lubricant.
- Wiring diagram.
- Description of each item of equipment and detailed servicing instructions.

- Schedules of spare parts in total and recommendation for spares to be kept on site.
- Test and commissioning records.

1.28 TECHNICAL PARTICULARS FOR ELECTRIC TRACTION TYPE ELEVATORS

1.28.1 Elevator Details

Elevator details are shown in Table 1 below.

Table 1- Elevators Details for Phase 3 / Package 2			
Item	Thar II Sarow Basic School for Boys /Jerash	Hay II Iskan Basic mixed School/Jerash	Jumana Bint Abi Taleb Basic Mixed School/ marka
Lift Origin	One package of one source	One package of one source	One package of one source
Type	Passengers	Passengers	Passengers
Hoist way dimensions /Shaft Size	2200mm (W) x 1850 mm (D)	2200mm (W) x 1850 mm (D)	2200mm (W) x 1850 mm (D)
Travel	10.92 meter	7.28 meter	7.28 meter
Contract Speed	1.0 m/s one speed VVVF type	1.0 m/s one speed VVVF type	1.0 m/s one speed VVVF type
Contract Load/ Capacity	630 kg (8persons)	630 kg (8persons)	630 kg (8persons)
Size of Car (Inside)	1100mm wide, 1400mm depth, 2300mm height.	1100mm wide, 1400mm depth, 2300mm height.	1100mm wide, 1400mm depth, 2300mm height.
Size of doors opening (WxH)	(90x2100) mm	(90x2100) mm	(90x2100) mm
Type of Control	Automatic Collective Selective	Automatic Collective Selective	Automatic Collective Selective
Floors Served	Ground, First Second and Third	Ground, First and Second.	Ground, First and Second.
No. of Stops / Openings	Four (4)	Three (3)	Three (3)
Machine Room Location	NA-inside the elevator shaft (MRL)	NA-inside the elevator shaft (MRL)	NA-inside the elevator shaft (MRL)

Table 1- Elevators Details for Phase 3 / Package 2			
Item	Thar Il Sarow Basic School for Boys /Jerash	Hay Il Iskan Basic mixed School/Jerash	Jumana Bint Abi Taleb Basic Mixed School/ marka
Number of Starts per Hour	180 start per hour	180 start per hour	180 start per hour
Pit	1500mm	1700mm	1700mm
Head Room	4000mm from F.F.L of last floor	4000mm from F.F.L of last floor	4000mm from F.F.L of last floor
Safety Gear	Gradual	Gradual	Gradual
Electric Power Supply	400/230 volts, 3-ph, 50 Hz	400/230 volts, 3-ph, 50 Hz	400/230 volts, 3-ph, 50 Hz

1.29 ELEVATOR CAR FINISH

WALL FINISH:

FRONT WALL MATERIAL: Brushed Stainless Steel in Silver Color (304Grade)

SIDE WALL FINISHES: Brushed Stainless Steel in Silver Color (304Grade)

REAR WALL FINISHES: same as front wall

CAR CEILING MODEL / FINISH: Suspended ceiling. LED lights In Silver Stainless Steel. To be selected from Supplier Standard Range

FAN: Out Blowing Electric type

SKIRTING: Brushed Stainless steel, (304Grade)

MIRROR: Partial Height Full width, clear on the rear side

HANDRAIL: One row of round shape on rear and sides

BUMPRAIL: Not required

Door Design:

- Jamb: Brushed Finished Stainless Steel.
- Door: Brushed Finished Stainless Steel.
- Sill: Extruded hard aluminium.

Additional features required:

1. DC Alarm bell.
2. Door open / close buttons on car operating panel.
3. Hand-winding operation for emergency purposes.
4. Next landing facility

If the hoist way doors become jammed by a pebble, debris etc., the passengers will not be able to alight from the car. In order that the passengers do not get stranded at the affected floor, the elevator will proceed to the next floor for which a call has been registered and the doors will open automatically.

5. Low speed automatic rescue operation:

In the event the elevator should stop between floors, the cause of the malfunction is checked out automatically. When the safety has been confirmed, the elevator will proceed at speed to the nearest floor, so that the passengers can alight from the car.

6. Car arrival chimes:

An electronic chime (mounted on the car top and bottom) sounds to inform waiting passengers of the car arrival.

7. Safety door edge running full height of the door which will reverse door opening in the event of any obstruction to door closing.

8. Overload protective device which will make the elevator inoperative with audible indication and signal lighting in the event the elevator car is overloaded beyond the rated capacity.

9. Emergency landing device: Emergency Evacuation System

Emergency landing device which will bring the elevator to nearest floor by standby batteries, allowing passengers to flight from the car in the event of power failure

10. Emergency lighting in the car.

11. Two-way communications inter phone system.

12. Firemen's emergency operation:

When the firemen's switch located at the elevator lobby is activated during a fire or other emergency, all calls are cancelled, and the designated elevator of the group returns immediately to a specified floor. To facilitate firemen's use afterwards, the elevator responds only to car calls.

13. "VVVF operation" employed to ensure smooth fast and efficient door operation:

The controller will include the data network system. The system will allow for microprocessor at each floor to be connected via a serial transmission for faster and efficient data transmission.

14. Car call cancelling:

When a car responds to the final car call in the ascending or descending direction, the system automatically checks and clears the car calls in opposite direction from memory, thus keeping operating efficiency high.

15. Power-on re-levelling:

If a car stops at a door zone due to the failure of normal power, the car will re level to secure the floor level with the doors open after the normal power has recovered.

16. Click type car/hall call button:

Standard buttons are designed to provide a soft-feel for convenience of vision-impaired persons when pressed.

17. Door sensor self-diagnosis:

If a non-contact door sensor fails, the system will automatically determine the timing of door closing to maintain the elevator service.

18. Automatic door speed control:

The system monitors the actual door load conditions at each floor and automatically adjusts the door speed and torque accordingly.

19. Repeated door-close:

Should an obstacle prevent the doors from closing, the doors will repeatedly open and close until the object is removed.

20. Automatic door open time adjustment:

The system judges the situation of whether the car stops responding to a car call or a hall call and controls the time the doors stay open accordingly. The Time spent waiting for the elevator is shortened, and operating efficiency is increased.

21. Hall & call buttons:

Large square braille type for ease of operation with only 0.2 mm stroke (displacement) button and back light for easy identification.

22. Position indicators:

Dot matrix display with alpha numeric indication for near perfect numbers. Orange when illuminated for higher visibility under all light conditions.

Depth of etching 80 microns & architect to select pattern from manufacturer's etching finish catalogue.

23. Car call erase:

If the wrong floor button is pressed, it can be cancelled by pressing the same button again.

24. Ultrasonic door sensor:

Sound waves are used to scan a 3D area near the open doors to detect passengers boarding or obstructions.

25. Fireman emergency return facility.

26. Handicapped requirements: *Car operating panel horizontal on the side wall for Handicap use*

27. All metal components shall be coated by two layers of anti-rust paint and then with final coats as required.

28. One Fixed Steel Ladder in each elevator pit for easy maintenance and inspection.

27. Other features as per manufacturers' standards.

1.30 ACCEPTABLE SUPPLIERS

The local suppliers/dealers for the following lifts brands are acceptable and approved for completing (installation and commissioning) of the lifts:

- KONE -ITALY

- MITSUBISHI - JAPAN

- THYSENKRUPP - SPAIN

- OTIS -SPAIN

- SANYO- JAPAN

MECHANICAL WORKS

SECTION 15050

GENERAL CONDITIONS

General Conditions

Refer to the Main Contract General Conditions of the specification, together with the additional particular clauses applicable to the Building Services.

The documentation and work under this Section shall be carried out in accordance with codes and procedures defined in the General Conditions and complimented with details in this Section of Particular Specifications, all to the Engineers approval.

Where a particular specification is not defined refer to Ministry Public Work and Housing General Construction Specification, together with the additional particular clauses applicable to the Building Services

It is understood and agreed that the Contractor, has by careful examination of the plans and Specifications, and the site where appropriate, satisfied himself as to the nature and location of the works, and all conditions that must be met in order to carry out the works under this section of the Contract.

Standard of Work

1. The Contractor shall install equipment, air conditioning ducts, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the satisfaction of the Engineer. Air conditioning ducts and pipes shall be installed parallel and perpendicular to the building planes. All piping and ductwork shall be concealed in chases, behind furring, or above ceiling, except in unfinished areas. All exposed systems shall be installed neatly and be grouped to present a neat appearance.
2. All gauges, thermometers, etc., shall be installed in such a way as to facilitate easy observance.
3. All equipment and apparatus, which requires maintenance, adjustment or eventual replacement, shall be installed making due allowance for access.
4. Control sensors shall be installed to guarantee proper sensing. Elements shall be shielded from direct radiation and shall avoid being placed behind obstructions.
5. All panels and boards, etc., shall be installed to remit easy operation.
6. The Contractor shall include in the work all the requirements of the manufacturer's as shown on their drawings.
7. The Contractor shall replace all work not performed to the satisfaction of the Engineer without extra cost and to the standard required by the Engineer. This applies to any item that is found to be defective in service during the maintenance period, or extended maintenance period as appropriate.
8. Where height dimensions are given, the installation shall be reasonably expected to be within 13 mm of actual position.
9. Items displaying a horizontal dimension or edge must be plumbed with a level and must be to the Engineer's satisfaction. Any apparent discrepancy between "level" electrical and mechanical items and adjacent items MUST be reported immediately to the Engineer.
10. All work shall be co-ordinated with other works so as not to obstruct equipment and apparatus which requires maintenance, adjustment or eventual replacement.

11. Manufacturers and Installers shall operate an ISO 9000 approved quality system or equivalent in house system. If requested, details of the quality system shall be submitted to the Engineer.
12. Equipment shall conform to the requirements of the Project Documentation and reference standards.
13. All equipment furnished shall be new, and where feasible shall be a standard product of an experienced or approved manufacturer, and assembled from standard components readily available.

Data to be Supplied with Tender

1. After final checking of sizing after award of contract, re-submission shall be made with any changes specifically noted.
2. Technical submissions shall be submitted for all equipment as specified in the Project Documentation.
3. In the event that the Engineer requires further information on any of the proposed items the Contractor shall arrange visits to similar units that he has installed. In an event, all equipment proposed for the Project shall be currently installed and working satisfactorily locally. The Contractor must be able to provide references of at least three satisfied Owners and Engineer with equipment of the particular size and model proposed.

External Design Conditions

The design environmental conditions for climatic zone 2 are as follows:

The design environmental conditions for climatic zone1 are as follows:

Summer	
Month	August
Average Monthly Maximum Dry Bulb Temperature	42°C
Wet Bulb Temperature	22 °C
Absolute Maximum Temperature	51°C
Average daily range	12°C
Winter	
Average Monthly Minimum Dry Bulb Temperature	5 °C
Rainfall (max)	75 mm in 1 hours

Summer	
Month	August
Average Monthly Maximum Dry Bulb Temperature	38°C
Wet Bulb Temperature	22 °C
Absolute Maximum Temperature	43°C
Average daily range	12°C
Winter	
Average Monthly Minimum Dry Bulb Temperature	0 °C
Rainfall (max)	75 mm in 1 hours

Design Standards

The design of the mechanical work shall generally be in accordance with the following standards, codes, and regulations where applicable: -

- a. **ASHRAE:** American Society of Heating, Refrigeration and Air Conditioning Engineers.
- b. **BSS:** British Standard Specifications
- c. **BSI:** British Standards Institute.
- d. **NFPA:** National Fire Protection Association- Life Safety Code (USA)
- e. **CIBSE:** The Chartered Institution of Building Services Engineers - U.K.
- f. **AMCA:** Air Movement and Control Association (USA).
- g. **ANSI:** American National Standards Institute (USA).
- h. **ASME:** The American Society of Mechanical Engineers (USA).
- j. **NPC:** Sheet Metal and Air Conditioning Contractor's National association (USA)
- k. **IBC:** International Building Code (USA)
- l. **IMC:** International Mechanical Code (USA)
- m. **UPC:** Uniform Plumbing Code (USA)
- n. Local Codes, standards and Specifications.

In case of any contradictions among the above codes and standards The local codes and standards shall supersede and prevail

Equipment

All equipment to be installed under this contract shall be manufactured by worldwide 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 for the approval of the Engineer.

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. Except where otherwise stated, all equipment shall be constructed and sealed as to prevent damage by the ingress of windblown sand and other matter. All equipment shall be suitable for operation over the ambient temperature range 0 °C to 43 °C in climatic zone 2 and 0 °C to 51 °C in climatic zone 1

Except where otherwise stated in the Project Documentation, the declared ratings for all equipment shall be for continuous operation in final service position for the following environmental criteria.

- Climatic Zone 1

- (a) Maximum daily average ambient temperature of 51 °C.
- (b) Maximum Relative humidity of 42 %.
- (c) Altitude 0.0 m above sea level.

- Climatic Zone 2

- (a) Maximum daily average ambient temperature of 43 °C.
- (b) Maximum Relative humidity of 42 %.
- (c) Altitude 773 m above sea level.

All equipment and enclosures that may be subject to internal condensation shall be fitted with suitably rated electrically operated thermostatically controlled anti-condensation heaters.

Pretender Requirements

Familiarization

Visit the site, acquaint to the site conditions to familiarize with the site, review all contract documents, and the documents for other trades, highlight and raise queries with the Engineer for any possible ambiguities as is necessary to accurately price the work. No item, which could have been clarified in this manner, will later form the basis of a variation to the Contract.

Clarification

If interpretation of the Tender Documents is unclear obtain clarification from the Engineer. If clarification is not obtained prior to close of Tenders, the item or arrangement of better quality, greater quantity, or higher cost shall be deemed to be included.

Interpretation

The tender documents are intended to be complimentary and where any items are repeated it is intended to call particular attention to them or to qualify them; it is not intended that any other part shall be assumed to be omitted if not repeated. Items may be covered in the specification or the drawings or both.

If interpretation of the Contract Documents is unclear, obtain clarification from the Consultant, during tendering. Upon awarding the contract any interpretation of specification or other tender documents will be, solely; to the engineer's discretion.

Documents of later date will govern over documents of earlier date. All documents in any set (e.g. Tender Set) will be deemed to be of the date of issue of that set for purposes of establishing precedence.

Within any set, the particular will govern over the general as in the following examples: Specific details will govern over general layout.

Co-Ordination with Other Trades

Co-ordinate the layout with all other trades, and if so directed by the Engineer shall prepare composite working drawings and sections at 1:50 and 1:20 scale clearly showing how his work is

to be installed in relation to the work of other trades. Set out all equipment and services to suit actual space conditions.

Locate all equipment for convenient operation, maintenance and future replacement.

Tender Drawings

Tender drawings show general arrangement but are not fully dimensioned and are in places drawn for clarity of intent rather than dimensional accuracy. Information will not necessarily be shown in both the Specification and Drawings. Any items shown in one or the other forms part of this contract.

Do not scale the tender drawings. Verify all dimensions from the architectural drawings and by site measurement. Obtain formal approval from the Engineer before making any fundamental changes from the conceptual layout.

Submit all shop drawings and technical data in accordance with the approved Contractor's schedule and sufficiently in advance of Building work to allow sufficient time for checking and possible amendment and re-submission.

Shop Drawings and Technical Data

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 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.

Prepare dimensioned construction drawings for the following sections of the installation to a standard at least equal to the tender drawings.

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 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.

- Floor plans 1:50.
- Plant room Layouts (minimum 1:20).
- Duct and equipment layouts including control element locations.
- Pipe work layout and details with all valves clearly shown and numbered.
- Switchboard and control panel diagrams.
- Electrical and control schematics.
- A valve schedule which when read in conjunction with the pipe work layout details the function of each valve.
- Any sections of the installation requiring detailed spatial co-ordination with other trades.
- Any section of the work containing equipment differing from the design base in dimension or configuration.

The purpose of this review is to minimise the likelihood of inconvenience to the Principal which would result from rejection of unsatisfactory equipment or work following installation.

The review is in no way intended to relieve the Contractor's responsibility to check the shop drawings and technical data and to meet the contract requirements especially where some items have been missed out or substituted. In this instance, the Contractor shall be responsible for installing the original items specified.

It is the Contractor's responsibility to ensure that equipment offered are compatible (eg. speed controllers and motors, actuators, control system) and that when combined, such systems meet the noise criteria specified. Generally, checking of technical data by the Engineer does not relieve the Contractor of his responsibility as final lengths, sizes, ratings and any critical factors are the Contractor's responsibility.

Sign all shop drawings and technical data to certify that they have been checked in detail, are fully understood, meet the specification and are considered suitable for the purpose intended. Draw any specific areas of doubt to the Engineer's attention for resolution.

Specific requirements for a piece of equipment will govern over general requirements for a type of equipment.

Complete and Finished Work

Complete and commission all work within the contract.

Provide any incidental materials, components or service, which may be necessary to make the work complete in all respects and ready for operation. All such materials and components shall conform to the same standard and be of the same making as similar items specified herein.

Changes and Variations

Changes resulting from the detailed co-ordination and layout of equipment and services by the Contractor shall not be the basis of a variation to the contract. Offsets of piping and ducts resulting from the Contractor's co-ordination of equipment, services and structure shall not constitute a variation.

Provision of equipment other than the design base shall not lead to a variation. The Contractor shall be responsible for costs to other trades resulting from provision of such equipment.

Record Drawings and Manuals

Within thirty days prior to handing over the works, 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 colour 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.

Operations and Instructions Boards

The operating instructions board shall be prepared & installed at each plant room. The board shall describe the layout and function of the system within the plant room. It shall contain schedules of all equipment within the plant room including operating & maintenance instructions based on the manufacturer's standard.

Another board shall indicate a schematic diagram of the systems within the plant room.

The board shall be plastic with engraved text and drawings.

Workmanship

Cleaning

1. Each day as the work proceeds, and on completion, the Contractor shall clean up and remove from the premises all rubbish, surplus material, equipment, machinery, tools, scaffolds, and other items used in the performance of the work. The Contractor shall clean out dirt and debris and leave the buildings broom clean with no stains and in a condition acceptable to the Engineer.
2. Where electrical items form part of the visible finish in the rooms, the Contractor shall protect them from over-painting, etc. and shall give all items a final cleaning before handing over.

Accessibility

1. Each item of equipment shall be located so as to be accessible for maintenance or repair without removing adjacent structures, equipment, piping, ducts, or other ducts, or other materials. For large air handling units the Contractor shall ensure that these can be assembled on site from components taken into the area.
2. Clean outs shall be located to permit rodding of all drain lines. These shall be located wherever possible external to occupied areas, and to minimise spillage problems during rodding.

Construction Loads

Ensure that movement and installation of equipment and materials under this Contract does not impose loads on the Building, which are either unsafe or likely to damage any part of the Building.

Fixings

Wooden, plastic or fibre plugs will not be permitted as fixings into concrete, masonry and similar construction. Fixings shall be approved metal expansion devices such as Loxen, Hilti or other approved manufacture, installed in strict accordance with the manufacturer's recommendation. Hangers and fixings connected to any metal structure shall be of Caddy manufacture or equal approved.

Cutting and Patching

1. The Contractor Obtain the approval of the Engineer before doing any cutting.
2. In existing work and in work already finished as part of this contract, all cutting and patching will be carried out at the expense of the Contractor. The Contractor shall obtain the approval of the Engineer before doing any cutting. Supporting members of any floor, wall or the building structure shall only be cut and in such a manner as approved by the Engineer. All reinstatement work must be done to the same standard as the original work.

Inserts, Sleeves, Escutcheons and Curbs

A. Inserts

1. Use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. The inserts shall be place only in portions of the main structure and not in any finishing material.
2. Use factory made expansion shields where inserts cannot be placed, but only where approved by the Engineer and for light weights.

3. Do not use powder activated tools except with the written permission of the Engineer.
4. Supply and locate all inserts, holes anchor bolts, and sleeves in good time when walls, floors, and roof are erected.
5. Ensure that insulation is unbroken where pipe or duct is insulated. Size sleeves shall be sized to provide adequate clearance all around.

B. Sleeves

The following materials shall be used for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage (0.70 mm) or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.
 - a. Penetrating Pipe Deflection: 5 percent without leakage.
 - b. Housing: Ductile-iron casting having water stop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
 - c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
 - d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.
5. Cast-Iron Sleeve Fittings: Commercially made sleeve having an integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with set-screws.
6. Pack all sleeves between the insulated pipe and the sleeve or where uninsulated between the pipe and the sleeve with polyurethane insulation. Seal the annular space as follows:
 - a. For all horizontal sleeves in through fire rated walls, Use a seal equal or .better fire rated than the wall to be sealed
 - b. For horizontal concealed sleeves through fire walls and through walls separating areas of different air pressure, use a permanently resilient silicone based sealing compound.
 - c. For all vertical sleeves through roofs, janitor's closets, equipment rooms, use permanently resilient silicone based sealing compound, non-inflammable and waterproof.
7. Ensure that the seal is compatible with the floor and ceiling finishes. The room finishing schedules shall be checked for further details and clarified if necessary with the Engineer.
8. The following sleeving shall be used for ducts:
 - a. The minimum thickness of duct material passing through a sleeve shall be 1.3 mm.

- b. For rectangular duct openings through walls and floors a removable hardwood fare faced box-out shall be provided of the required size, soft wood or plywood will not be acceptable
 - c. Through fire walls, build fire dampers into wall, or make detailed fixing in accordance with Engineer's instruction.
 - d. Through floors where ducts are not furred in or enclosed in a duct shaft, provide 100 mm high and 100 mm wide watertight concrete curbs, with 25 mm chamfered edges all around. Extend sleeves where used flush to top of curb. Concrete works shall be done in accordance with Section Concrete.
 - e. Through floors where duct is enclosed in a duct shaft or furred in, provide the watertight curbs at the extreme top and bottom only. Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finished stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may not be used. Do not use stamped steel friction type split plates.
 - f. Through roofs, provide curbs and sleeves as shown on drawings and to suit flashing requirements.
9. After ducts are installed, the openings shall be packed and sealed as follows:-
- a. Fibreglass insulation for packing except through curbed concrete floors where a fibre proof packing must be used.
 - b. Fire proof packing shall be sealed in openings through floors with permanently resilient silicone base non inflammable waterproof compound; duct supports shall be pressed firmly down into caulking before bolting it down to curb.
 - c. Through all vertical walls, seal the fibreglass packing using permanently resilient silicone based sealant.
10. Duct sleeves and box-outs shall be braced to retain their position and shape during the:
- a. Pouring of concrete and other work.
 - b. Bracing for each duct at ever passage through structure shall be provided to prevent sagging.
 - c. Exposed duct sleeves and openings shall be covered in exposed areas. 100 mm long galvanized steel escutcheons shall be used in the form of a duct collar. Over curbs, the collar shall be extended 30 mm down the side of the curb, similar to counter flashing. The collar shall be fixed in place with Cadmium plated screws.

Access Panels and Doors

- a. The Contractor shall install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on as-built drawings.
- b. The Contractor shall prepare drawings showing the location and type of all access doors in co-ordination with other trades before proceeding with installation and hand these to the Engineer to obtain approval. On smaller Projects, the Contractor shall indicate on the ceiling plans access required at the discretion of the Engineer.
- c. All access doors shall be sized to provide adequate access commensurate with the type of structure and architectural finish. Should it be necessary for persons to enter, a minimum, opening of 600 x 450 mm shall be provided.
- d. Proper fire rating of access doors shall be ensured in fire separations.
- e. Lay-in type ceiling tiles, if properly marked may serve as access panels.

- f. The Contractor shall provide panels in glazed tile walls of 2.6 mm thick 304 alloy stainless steel, with no. 4 finish, with the recessed frame secured with stainless steel, countersunk flush-headed screws.
- g. Panels in plaster surfaces shall be provided with dish shaped door and welded metal lath, ready to take plaster. A plastic grommet shall be provided for door key access.
- h. Details of other types of access doors shall be submitted to the Engineer for approval.

Flashing

- a. The Contractor shall provide flashing to all mechanical and electrical parts passing through or built into a roof, outside wall, or waterproof floor.
- b. 49 kg/m² sheet lead flashing shall be provided for cast iron sleeves passing through roof. Factory manufactured flange plates shall be provided to flash PVC-U pipes passing through roofs.
- c. 7 kg/m² copper flashing shall be provided for copper sleeves passing through roof where copper sleeves are used for copper pipework
- d. All flashing shall suit the roof angle and shall extend a minimum of 400 mm on all sides.
- e. The Contractor shall build the flashing into the roofing system to render a completely watertight connection.
- f. Counter flashing shall be provided on all stacks, ducts, and pipes passing through roofs to fit over the flashing or curb.
- g. Pipes through waterproof floors shall be flashed as per approved details.
- h. Provide pipes and sleeves passing through outside walls with lead or copper flashings and as directed by the Engineer.
All visual aspects of such sleeves shall be approved by the Engineer.
All sleeves shall be installed according to the relevant standard and shall be suitable for local ambient conditions.
- i. The Contractor shall pay special attention to the waterproof conditions of basements and walls and floors that may exist. The Contractor shall ensure co-ordination at all times with the waterproofing trade to prevent damage to any water proofing seal. The Contractor shall provide piping sleeves passing through waterproof walls which shall be sealed to the satisfaction of the Engineer.

Warranty

Contractor shall provide a minimum one year manufacturer warranties for all equipment. All Warrantees for equipment suppliers will be vested in the Owner regardless of whether the Contractor who supplied the equipment is still associated with the Project or not.

Warranty shall be full warranty and shall include all overhead, profit, incidental charges and sundries.

Where damage is caused to any other item by any failure of the item warranted then the warranty shall also include the costs incurred in rectifying the damage.

Preventative Maintenance

Maintain all systems and equipment installed under this contract in accordance with the manufacturers' recommendations, the maintenance manual and this specification. The maintenance period starts after Practical Completion of the facility as a whole and as per contract conditions

Carry out maintenance of each component at least as frequently as recommended by the Manufacturer.

Record and submit details of maintenance to the Principal and the Main Contractor at the end of the maintenance period in a format acceptable to the Engineer.

Inspection Testing and Maintenance

This contract shall also include for all necessary inspection, testing and maintenance of the services, during the Defects Liability Period.

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

END OF SECTION

SECTION 15060

HANGERS, SUPPORTS AND FIRESTOPPING

PART 1: GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mechanical supports and hangers.
 - 2. Expansion slides and compensators.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Equipment curbs.
 - 6. Sleeves.
 - 7. Mechanical sleeve seals.
 - 8. Firestopping relating to mechanical work.

1.2 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code Factory Mutual 'FM' Underwriters Laboratories 'UL' for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.
- C. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- D. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- E. Design seismic-restraint hangers and supports for piping and equipment.
- F. Design and obtain approval from authorities having jurisdiction for seismic-restraint hangers and supports for piping and equipment.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, for hanger and support locations and detail of trapeze hangers.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

- C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple, and riser support hangers. Submit calculations used to determine load carrying capacity of each type of support and hanger for the Engineer's approval.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MECHANICAL SUPPORTS AND HANGERS

- A. All installation material used for supporting and fixing mechanical piping and ducting systems shall be of a modern type that gives tested reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.
- B. The mechanical supporting and hanging system shall consist of the following components:
 - 1. C-Channels shall be used as the main item for supporting all pipes and duct work. C-Channels shall be constructed of rolled galvanized steel strip with galvanization thickness of 65 microns. Contractor must submit mechanical drawing showing all support locations combined with detailed load calculation. Where the channel is cut, suitable end caps shall be used to protect the cut from corrosion. C-Channels of minimum thickness of 2mm and width of 40mm shall be used for all applications, and the height the spacing to be selected according to load calculation.
 - 2. C-Channel accessories as recommended by the channel manufacturer, shall be used to assemble various channel structures as appropriate for the application. These accessories include single-part components for attaching connectors, fixing nuts with serration, angles, brackets and pipe ring saddles. All parts shall be made of galvanized steel.
 - 3. Pipe Ring Clamps: For chilled water pipes and hot, cold domestic pipes; galvanized, pre-engineered pipe ring clamps should be used for fixing all pipes to channel system or directly to the correct structure. The Contractor shall verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by manufacturer.

The pipe rings should be of a double screw type. Medium duty pipe rings shall be used for pipes up to 80mm diameter and heavy duty pipe rings shall be used for sizes 100mm and above except for the fire fighting system, the vertical pipes shall be supported by heavy duty double screw pipe rings without rubber and shall be UL listed. All pipe rings used for copper pipes and hot-chilled water steel pipes should be provided with a pre-fitted rubber inlay. Rubber inlay shall be made of Ethylene Propylene Diene Monomer 'EPDM' material inspected for sound insulation with temperature resistance range -40 to 110°C.

4. Threaded rods shall be manufactured of steel grade 4.6. Rods, nuts and flat washers shall be clean threaded and flawless galvanized conditions.
5. Concrete anchors: shall be internally threaded for fixing rods, made of galvanized zinc plated and passivated steel. Anchor shall have FM, VDS and fire resistance approval. Zinc plated and passivated steel bolt anchor with suitable diameter should be used for fixing channels into concrete. Furnish calculations to substantiate selected sizes.
6. Duct work supports: Pre-manufactured C-Channels shall be used as the main item for supporting ducts. Supports for vertical duct shall be located to coincide with the individual floor slabs subject to load calculation.

2.2 EXPANSION SLIDES

- A. Furnish thermal expansion sliding elements and anchors for hot water , chilled water and steam pipes to prevent build-up forces at the pipe clamp and the fixing points. The glider shall provide sufficient slide way distance according to the manufacturer load limit and movement limit. Provide thermal expansion calculations for all net works with selection and installation details for the Engineer's approval.
- B. For pipe risers furnish special fabricated steel arms supported on slabs as cantilever and to be welded on pipe sides to hold the pipe weight. Provide manufacturer's details for the Engineer's approval.

2.3 INSERTS

Furnish inserts with malleable iron case, galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 0.7 mm thick galvanized steel.
- B. Metal Counterflashing: 0.8 mm thick galvanized steel.
- C. Flexible Flashing: 1.2 mm thick sheet compatible with roofing.
- D. Caps: Galvanized steel 0.8 mm minimum; 1.5 mm at fire resistant elements.

2.5 EQUIPMENT CURBS

- A. Concrete curbs are to be provided as recommended by manufacturer of equipment.

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 1.2 mm thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 1.2 mm thick galvanized steel.
- C. Sleeves for Round Ductwork: 1.2 mm thick Galvanized steel.
- D. Sleeves for Rectangular Ductwork: 1.2 mm thick Galvanized steel or 20mm thick wood.

2.7 MECHANICAL SLEEVE SEALS

- A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FIRESTOPPING

- A. Definition: Fire stopping material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, water and hot gases through penetrations in fire rated wall and floor assemblies.
- B. Performance Requirements: Provide firestopping systems which have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.
- C. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- D. Compliance: Comply with manufacturer's product data including product technical bulletins, product catalog installation instructions and product carton instructions.
- E. Application of fire stop systems:
 - 1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical bus ways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
 - 2. Slot gaps between edge of floor slabs and curtain walls.
 - 3. Openings between structurally separate sections of wall or floors.
 - 4. Gaps between the top of walls and ceilings or roof assemblies.
 - 5. Expansion joints in walls and floors.
 - 6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
 - 7. Openings around structural members which penetrate floors or walls.
 - 8. Multiple electrical boxes located within the same stud cavity.
- F. Firestopping materials: The following materials are listed for guidance for the types of firestopping materials required for the installation. The Contractor shall add to the list at no extra charge further materials if found necessary to complete the installation or if required by the fire authority:
 - 1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.

2. Foam Firestopping Compounds: Multiple component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty, collars and sealant compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.
8. Flexible joint spray.
9. Trowelable firestop compound.
10. Cast in-place firestop device.
11. Equivalent products listed in the U.L fire resistance directory.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Obtain permission from Engineer before using powder-actuated anchors.
- D. Do not drill or cut structural members.
- E. Obtain permission from Engineer before drilling or cutting structural members.
- F. Firestopping Surface Preparation: Prepare surface to receive firestop system products in accordance with manufacturer's instructions for surface preparation.
 1. Verify penetrations are properly sized and in suitable condition for application of materials.
 2. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 3. Do not proceed until unsatisfactory conditions have been corrected.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 100 mm and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 13 mm space between finished covering and adjacent work.
- D. Place hangers within 300 mm of each horizontal elbow.
- E. Support horizontal cast iron pipe adjacent to each hub, with 1.5 m maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping .
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 15080.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete as detailed on drawings or a minimum 150 mm thick and shall be 100 mm above finished floor level and extending 150 mm beyond supported equipment.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 15070.

3.6 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 75 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with 600 x 600 mm sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 250 mm clear on sides with minimum 910 x 910 mm sheet size. Fasten flashing to drain clamp device.
- D. Seal floor drains watertight to adjacent materials.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- F. Provide curbs for mechanical roof installations 350 mm minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

- G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 25 mm above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- E. Remove dam material after firestopping material has cured.
- F. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
 - b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, cable bus, conduit, wireway, and trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's printed instructions.
- G. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
 - b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.

2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
4. Interior partitions: Seal pipe penetrations at computer rooms, telecommunication rooms data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

The data listed below shall be compared with the supports load calculations and the lower spacing and the larger threaded diameter shall be installed.

- A.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Galvanized Steel Threaded	15 – 25	8mm	1.2
	32	8mm	1.6
	40 – 50	8mm	1.9
	65– 108	10mm	2.2
	125	10-12mm	2.5
	150	10-12mm	2.6

- B.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
C Black Steel Seamless Welded or Grooved	15	8mm	1.6
	20 – 32	8mm	2.0
	40 – 65	8mm	2.7
	80	10mm	4.5
	100	10mm	5
	125 – 150	10-12mm	6
	200 – 300	12-16mm	7

C.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Copper	8 - 12	8mm	1.0
	15 - 20	8mm	1.3
	25 - 40	8mm	1.7
	50	8mm	2.2
	65 - 80	10mm	3.3
	100	10-12mm	4.0

D.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Cast Iron	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	1.5

E.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
PVC	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	2.0

END OF SECTION

SECTION 15100

PIPE WORKS SPECIFICATIONS

GENERAL

Section Includes:

- 1) Underground pipe markers.
- 2) Bedding and cover materials.
- 3) Gate valves.
- 4) Ball valves.
- 5) Check valves.
- 6) Pressure gages.
- 7) Pressure gage taps.
- 8) Test plugs.
- 9) Flexible connectors.
- 10) Diaphragm-type expansion tanks.
- 11) Air vents.
- 12) Air separator.
- 13) Electronic anti-scale
- 14) Strainers.
- 15) Flow controls.
- 16) Relief valves.
- 17) Flexible pipe connectors.

Installation of all pipe work shall follow the detail set out in the accompanying drawings and shall be in accordance with the best-accepted practice.

All pipe work, fittings and accessories shall be installed strictly in accordance with the manufacturer's recommendations and due allowance made for thermal movement.

Unless necessitated by the site conditions and to the approval of the Engineer, all pipe work, fittings and accessories shall be obtained from one manufacturer only for each system, who shall be submitted by the Contractor in writing and approved by the Engineer prior to ordering any materials. All pipe work, fittings and accessories shall be stored in properly ventilated well-supported racked storage sheds.

All pipe work shall be erected to present a neat and orderly appearance arranged to or at right angle to the structural member of the building, giving maximum headroom and not obstructing window or doorways.

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 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 pipe work, 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.

Unions or flanges shall be provided at valves and equipment so that they can be dismantled. Unions or flanges shall also be provided at all bypasses, tanks, pumps and elsewhere as may be required.

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.

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.

Pipes shall bend round piers, projections and into recessed forming part of the structural works whether so indicated on the drawings or not. Pipe work shall be erected such that there is a minimum of 150mm clear below to the finished floor level and a least 25mm clear to the finished wall face.

Clearance between pipe work 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:

- Pipe work to floor - minimum distance 100 mm.
- Pipe work to ceilings - minimum distance 100 mm.
- Pipe work to walls - minimum distance to conform to standard bracket centers
- Pipe work to pipe work - 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 pipe work offsets shall be allowed on pipe work visible in rooms, except as agreed.

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 pipe work so damaged shall not be fitted. Any pipe work 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 pipe work. 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 have the right to order the pipe work to be dismantled for as far as considered necessary and the pipe work 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 pipe work.

Pipe work shall be erected to neatly follow the lines of walls, floors, 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 pipe work (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 pipe work shall be installed parallel to walls and floors except where gradients for venting and draining dictate otherwise.

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 re-circulation 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 pipe work 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.

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. The distance between any two adjacent branches shall not be less than the sum of the outside diameters of the branches.

Reduction in sizes of pipelines 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.

Reductions on horizontal pipe shall be eccentric; reduction on vertical pipes shall be concentric. All pipe work, which is to be insulated, shall allow space for each pipe to be insulated around its whole circumference. Adequate clearance shall be provided between insulated pipe work running together and adjacent to walls and floors. Clearances between insulation and floor and insulation and wall shall be as for bare pipe work.

All pipe work shall be plumb in the vertical and leveled to the turn of a bubble in the horizontal, except where wall or floor finishes deviate from the vertical or horizontal. All pipe work shall be erected such that it may be vented and drained satisfactorily.

Expansion joints shall be placed in all pipes where they cross building expansion joints. The Contractor shall cross check all plumbing layouts with structural drawings.

Pipe work may be chased into walls only in a vertical plane. Horizontal chases shall not be accepted.

All pipe work, valves and fittings and other components forming the installation shall be erected such that they are accessible for maintenance and repair. Unions and flanges shall be provided as appropriate in order to allow for equipment removal.

SUBMITTALS

Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.

Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used.

Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.

Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.

Submit electrical characteristics and connection requirements.

Maintenance data for valves shall be included in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

CLOSEOUT SUBMITTALS

Project Record Documents:

Record actual locations of valves and components and instrumentation.

Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views, calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

DELIVERY, STORAGE, AND HANDLING

Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

Accept valves on site in shipping containers with labeling in place. Inspect for damage.

Provide temporary protective coating on cast iron and steel valves.

Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

All pipe work, fittings and accessories shall be stored in properly ventilated, well-supported racked storage sheds.

All pipe work, fitting and accessories shall be inspected prior to use and damaged material disposed of.

Protection shall be provided to the complete works as it proceeds to prevent impact damaged from debris. All open ends of all pipes and fittings shall be plugged to prevent the ingress of debris and rubbish using temporary purposes made manufactured plugs or flanges. Plastic sheets or paper bags shall not be used or allowed for plugging pipe work or fittings.

ENVIRONMENTAL REQUIREMENTS

Do not install underground piping when bedding is wet or frozen.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

COORDINATION

Coordinate installation of buried piping with trenching.

CODES AND STANDARDS

Works and materials shall conform to British Standards and Codes of Practice, in addition to the following standards

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
ASME:	American Society of Mechanical Engineers
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
UL:	Underwriter Laboratories (U.S.A.)
NFPA:	National Fire Protection Association

Other International Standards may be considered by the Engineer provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS PIPE WORK AND FITTINGS

Pipe work Materials

All pipe work shall conform to the specified materials, specified under Appendix "schedule of pipeline".

Mild Steel Pipe work

Where the table of pipe work materials requires the use of mild steel pipe work, 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.

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.

Where steel pipes are to be installed underground, they shall be double wrapped in special tape suitable for the application.

Jointing of Mild Steel Pipe work

Black mild steel pipe work up to and including 50 mm dia. shall be jointed by screwing.

Black mild steel pipe work of 65 mm. dia. and above shall be jointed by welded unless welding would constitute an unacceptable fire hazard.

All screwed black steel pipe work shall have provision made for dismantling, using Navy Pattern unions.

All welded black steel pipe work shall have provision made for dismantling using slip on bossed welding flanges.

All galvanized steel pipe work shall be screwed or jointed by mechanical grooved joints.

Galvanized mild steel pipe work up to and including 50 mm. dia. shall have provision made for dismantling using galvanized malleable iron Navy Pattern unions.

Galvanized mild steel pipe work of 65- mm. dia. and above shall have provision made for dismantling using galvanized screw-on flanges, faced and drilled BSTE.

Mild Steel Fittings

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.

Fittings for all mild steel pipe work up to and including 50 mm. dia. shall be malleable cast iron pipe fittings to B.S.143, or to ANSI B16.1 manufactured by the White heart process to Grade 1 of B.S. 309 banded or beaded for reinforcement with the exception of steam pipe work on which wrought steel pipe fittings, manufactured from mild steel by seamless or welded process to B.S.1740 shall be used.

Fittings on black mild steel pipe work 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 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.

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.

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.

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.

Galvanized Steel pipes and Fittings.

All cold and hot water pipes which runs under tiles, in shafts, and exposed at roof shall be galvanized steel pipes to BS 1387, class B

Fittings on galvanized pipe work 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.

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 pipe work shall be of the eccentric pattern fixed so as to give a smooth run to the crown of the pipe. On centric pattern reducers shall be used on vertical pipe work.

The diameter shall be maintained; crinkled and scored work will not be accepted.

Unions shall, in all instances, be manufactured with double gunmetal seats as the Navy pattern. Galvanized milled seamless steel pipes shall be heavy duty and comply with DIN 2441, ISO 65 or BS 1387, standard length 6 m, with threaded ends. The threaded end shall be protected against damage.

Supply and installation shall include for all cutting, threading, jointing and for all fittings and accessories necessary for laying and installation as shown in the Drawings.

Dimensions shall be according to DIN 2441 as follows or according to equivalent standards as indicated on the Drawings or in the Particular Specifications:

GMS Pipes - Dimensions

Nominal Diameter (mm)	External Diameter (mm)	Wall Thickness (mm)
15	21.3	3.2
20	26.9	3.2
25	33.7	4.0
50	60.3	4.5
65	75	5.0
80	90	5.0

The galvanization shall be by hot dip zinc process according to DIN 1706 and shall satisfy the copper sulphate test procedure according to DIN 50952, also prescribed in Appendix C of BS 1387 latest addition.

CPVC PIPES

Pipes shall be manufactured in accordance to ASTM F 441 Schd-80 and / or to DIN 8079 PN 16 and PN 25 (as specified) .Pipes shall be tested in accordance to DIN 8080.

All pipe work and fittings shall be procured from the same manufacturer.

Pipes shall be suitable for potable water use as they shall be NSF approved.

All CPVC fittings shall be assembled by in accordance to ASTM F439 and ASTM F437, or to DIN 8079. This shall include utilizing proper cleaner primer as to ASTM F-656 and solvent cement ASTM F493 or to DIN 8079 and DIN 8080, all in accordance to the manufacturer recommendations.

Pipes shall withstand a continuous elevated temperature and pressure up to 90°C at 5.5 Bar for at least 25 years.

A certificate of the materials resin and the performed tests quality control for the procured batch shall be presented to the Engineer.

A random sample of each size shall be tested by a third party lab. Tests shall include the VICAT softening test, compression and burst tests.

POLYPROPYLENE (PP-R) PIPE AND FITTINGS FOR WATER DISTRIBUTION AND WATER SERVICE

Polypropylene Pipe: ASTM F 2389, pipe pressure rating shall comply with temperature and pressure ratings per the plumbing code requirements for the applicable service (water distribution, water service).

1. Polypropylene Fittings: ASTM F 2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings shall be used for fusion weld joints between pipe and fittings.
2. Mechanical fittings and transition fittings shall be used where transitions are made to other piping materials or to valves and appurtenances.
3. Polypropylene pipe shall not be threaded. Threaded transition fittings per ASTM F 2389 shall be used where a threaded connection is required.

FASTENERS & JOINTS

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 compounds 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.

Flanged Joints

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 pipe work 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 pipe work 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.

Pipe work Supports

- A. All pipe work shall be adequately supported in such a manner as to permit free movement due to expansion, contractions, vibration or other changes in the system.
- B. Supports shall be arranged as near as possible to joints and changes of direction. Spacing of supports shall comply with Table 13 contained in British Standard BS 5572: 1978. Vertical rising pipes particularly in shafts shall be adequately supported at the base to withstand the total weight of the riser. Under no circumstances shall branches from vertical rising pipes be the means of support for the vertical pipe work.
- C. Pipe work up to and including 65mm diameter shall be supported clear of the structure with brackets. Where exposed to view, bright finish brass rackets shall be used with rawl plugs and brass screws.
- D. Where pipe work is concealed, a single pipe ring with BSP female screwed end and back plate with male screwed end shall be used and fixed to wall using brass screws and rawl plugs.
- E. All multi runs of pipe work within false ceilings or service shafts shall be supported on purpose designed proprietary brackets shall be submitted to the Engineer for approval prior to ordering.
- F. Where rollers and chairs are required, these shall be performed as manufactured by a specialist approved by the Engineer, and where used singularly, they shall have restraining "U" bolts formed over the diameter of the pipe and bolted to the base support of the chair. The "U" bolts shall be fitted to allow movement of the pipe without binding.

Pipe work support shall be arranged as near as possible to joints and changes in direction.

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 pipe work 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 patents fixing to the fabric shall also be submitted to the Engineer for prior approval.

Softwood plugs will not be permitted.

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 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 pipe work 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:

i) Brackets:

1. Brackets to walls: -
Flat iron with fish tail end, minimum size 40 mm.x6 mm
2. Brackets to R.C. Beams:-
Rag bolt with eye built in, minimum size 15 mm. dia.
3. Brackets to R.S.J.:
Girder clips.
4. Brackets suspended from flat roofs:
Rod with eye (minimum size 9 mm. dia.) on underside with back plate and lockout on topside
5. Brackets in trenches and tunnel:
Channel iron, minimum size 100 mm. x 50 mm. x 6mm.

ii) 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.

iii) 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 pipe work.

2. Purpose-made heavy gauge brass strip with nut and bolt or gunmetal split ring with socket for all copper pipe work.
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 pipe work where required to allow for expansion. Bronze rollers shall be used for copper pipe work.

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 pipe work to be supported by munzening ring and tube secured into walls by brass anchor fixings.

All brackets, hangers and supports, except supports for copper pipe work, are to be hot dip galvanized after manufacture to B.S.729.

The spacing distance between brackets and support shall be as the tables shown in schedule 3 & 4 below.

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 pipe work and so that the equipment or sections of pipe work may be removed, leaving the adjoining pipe work adequately supported at the ends.

Main walls and partition walls etc. where pipes pass through sleeves, shall not be considered as pipe supports.

All installation material used for supporting and fixing mechanical pipe systems should be of modern flexible type that gives a tested and reliable supporting solution without a need of welding drilling or subsequent galvanizing for corrosion protection.

The system should provide for easy access and disassembly for future maintenance.

The Contractor should provide typical support drawings and load calculation to verify the suitability of the system for the critical load calculation as per the Engineers requirements.

All installation material shall have the name and applicable size stamped in the part itself for identification and shall be designed and manufactured with MSS SP 58 hangers and supports for piping shall conform to NFBA 13 1999 specifications.

Expansion And Contraction of Pipe work

Expansion and Contraction of Pipe work, 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 pipe work, formed by the Contractor.

Trench Excavation

- A. Excavation work shall be executed in whatever ground conditions that may be encountered to the line and levels as detailed on the drawings.
- B. The Contractor shall be responsible for the stability of all excavations and any claim arising from accident or damage to the public, adjoining property or labor on site. The

- Contractor shall provide all necessary steel sheeting, timber supports, strutting and shoring to the complete satisfaction of the Engineer. The Contractor at his own expense shall immediately make any slip or fall good and the Contractor shall take sole responsibility for any claim for damages arising out of inadequate support of excavations.
- C. All excavation shall be maintained dry and free from water. To achieve this Contractor shall, without additional charge, provide all necessary pumping equipment, sumps, and drains and soak ways. The Contractor shall also be responsible for operating, running and maintaining all equipment at all times to ensure excavations are free from water.
 - D. All obstructions shall be broken out with voids and soft spots filled with concrete grade 15 or as otherwise instructed by the Engineer at the Contractor's expense.

Granular Bedding

- A. Pipe work shall be laid on a granular bed with a minimum cover above the crown of the pipe as follows:
 - Pipe lines 600mm cover when there is no traffic on the ground above the pipeline.
 - Pipe lines 1000mm cover when there is traffic on the ground above the pipeline.
- B. The granular bedding shall comprise gravel, stone chippings or crushed stone to pass 12mm sieve and be retained on a 5mm sieve mixed with free draining course sand, in the ratio of two parts crushed stone or gravel to every one part of sand. Bedding material shall not contain more than 0.3% sulphate nor shall it be obtained from locations where 0.1% sulphate is present in the ground water.
- C. Bedding shall be laid 150mm deep along the length of the trench and compacted prior to work commencing on the pipe laying. After pipe laying, inspection and testing, a further 300mm of bedding material shall be compacted by hand above the uppermost crown of the pipeline along its entire length. The bedding material shall span the entire width of the trench and shall be laid in not more than 150mm deep layers, each layer being compacted by hand.

Laying of Pipelines and Fittings

- A. All underground pipelines shall be laid to true levels in straight lines to even gradients shown on the drawings. Pipelines laying shall not commence until the Engineer has inspected and approved the granular bed and trench. All pipes passing through walls and foundations shall have sleeves with puddle flanges. The flange shall be not less than 200mm from the sleeve in all directions. The space between the sleeve and pipe passing through shall be packed with waterproof material and mastic compound.
- B. Where slings are to be used only flat braided steel wire or band slings shall be used.
- C. The cutting of pipes shall be by hacksaw for both copper and ductile iron pipe and all burrs shall be trimmed off by filing.

Backfilling Excavations

- A. After compaction of granular bed and surround, the trench shall be backfilled using selected excavated material free from all rocks, large hard objects and builder's debris of greater than 40mm, and shall be in layers of 150mm, each fully compacted over the full width of the trench. Power rammers and vibrators shall be used to compact backfilling when the cover over the crown of the pipe exceeds 0.5 meters.

Valve Chambers

- A. Generally all valve chambers shall be constructed to British Standard BS 5337: 1976.
- B. All cement shall be sulphate resisting and comply with British Standard BS 4027:1980. All reinforced concrete base slab, walls, cover slab, cover bedding slab and splay shall be formed from grade 25 concrete and comply with British Standard Code of Practice CP 30: Part 1: 1972 and British Standard CP 34: 1969. All internal and external faces of valve chambers shall be finished with two coats of approved bituminous paint.
- C. All valve chambers shall be constructed as described in this Specification and as shown on the drawings in the positions and to the dimensions shown. Valve chamber covers shall be of cast iron complete with frame in accordance with B.S. 497, and be provided with two sets of lifting keys for each type of valve chamber cover installed
- D. The size, depth and valve chamber cover shall be as indicated on the drawings. All frames shall be solidly bedded such that the cover is fair and even with the finished levels. Any cover or frame that allows rocking to occur shall be removed and replaced with an alternative, all at the Contractor's expense. Lightweight valve chamber covers shall be set in cement mortar with their covers in position to avoid distortion of frames.
- E. Valve chambers to be 1 meter away from buildings.

PIPELINE INSPECTIONS

Written notice shall be given for the purpose of inspection, measurement and testing for each of the following cases: -

Setting out complete

Excavations complete

Bedding laid

Pipeline laid and thrust block in position

Pipeline bedding cover complete and compacted between joints and backfilling as necessary complete and compacted between joints, ready for testing.

Joints, bedding cover complete and compacted and backfilling complete and compacted with ground level finish, ready for final testing.

TESTING OF PIPE WORK

- A. refer to Testing and commissioning section

Grading of Pipe work

All pipe work shall be installed with continuous grading to allow for drainage and/or air venting according to the service concerned.

Air Venting of System

Full provision shall be made by the Contractor for air venting of the system at all high points in pipe work 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-corrodible 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.

Air vents shall be manufactured and be in accordance with BS 2879.

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.

Pipe work 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 pipe work 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. Lock shield 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.

All exposed air bottles, automatic vents and drip pipes where required shall be properly insulated.

Pipe 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 pipe insulation and painting works.

Any damaged insulation/paintwork shall be replaced at no additional cost to the Employer.

Drainage and Flushing 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 lock shield 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.

On the dead side of isolating valves, the Contractor shall supply at all low points of pipe work 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 pipe work 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

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.

Pipe work 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 pipe work 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.

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 (The inside diameter of all sleeves shall not be less than 15mm larger than the outside diameter of the pipe passing through.)

Where pipes pass through buried wall or footings, sleeves shall be 25mm larger than the outside diameter of the pipe passing through. The space between the pipe sleeves shall be neatly packed using asbestos string or rope to prevent the passage of noise, vermin or smoke. Sleeves shall not protrude beyond the finished surface. Where pipe work is exposed to view and passes through wall or floor, chromium plated copper pipe flanges of the correct pipe diameter shall be fitted.

The pipe sleeves shall be in new concrete construction before pouring. Sleeves in foundation wall shall make watertight installation. Sleeve through walls, floors and partition walls shall be in galvanized or epoxy painted steel sleeves through outside wall properly canckled to ensure water tight joints

Sleeves in non-load bearing walls, floors ceiling and partitions shall be copper or epoxy painted mild steel to suit the particular pipe materials.

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 steel 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 watertight 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.

Puddle flanges shall be provided on pipe work 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.

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 pipe work sealed with suitable fire rated material.

The Contractor except shall provide external flashing sleeves 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

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.

Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened

VALVES

BASIC, COMMON FEATURES

- A. Pressure and Temperature Ratings: As indicated on the Schedule of this Section and as required to suit system pressures and temperatures.
- B. Sizes: Same size as upstream pipe.
- C. Operators: Use specified operators and hand wheels, except provide the following special operator features:
 - 1. Hand wheels: For valves other than quarter turn.
 - 2. Lever Handles: For quarter-turn valves 4 inches (DN100) and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
 - 3. Gear-Drive Operators: For quarter-turn valves 6 inches (DN150) and larger.
- D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- E. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- F. Threads: To ASME B1.20.1 or BS 21 .
- G. Flanges: To ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves. Or BS 4504

Description

General

- A. Isolation valves shall be installed on the inlet and out let of each equipment, on the main pipes as well as the sub main branches and on each valve chamber,
- B. Regulating valves shall be provided for balancing and regulating flow purposes, this shall include all HVAC equipment and sub mains as shown on the Drawings and as necessarily needed. Double regulation valves shall be provided with measuring orifices.

Gate Valves

- A. Gate Valves to BS 5154 PN 16, series B, Smaller than 2-1/2 Inches (DN65): shall be of bronze body and bonnet, screwed in bonnet, single piece bronze wedge, copper-silicon alloy non- rising stem, teflon-impregnated packing with bronze packing nut, BS 21 threaded end connections; and with aluminium or malleable-iron hand wheel.
- B. Gate Valves to BS 5150 PN 16 (EN 1171) flanged BS 4504, 2-1/2 Inches (DN65) and Larger, rising stem, outside screw and yoke (: shall be of cast-iron body and bonnet, bolted bonnet, solid cast-iron wedge, brass-alloy stem, Teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron hand wheel, internal and external coated with wet epoxy paint.

Ball Valves

- A. Ball Valves, 2 Inches (DN50) and Smaller: shall be of bronze body and bonnet, 2-piece construction; or chrome-plated brass DZR body , standard port for 1 blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: for Sizes 3 Inches (DN75) and Larger Steel hand wheel.
2. Operator: for Sizes 4 Inches (DN100) and Larger Lever operators with lock.
3. Stem Extension: For valves installed in insulated piping.
4. Memory Stop: For operator handles.

Double Regulating Valves

- A. Double Regulating Valves, 2 Inches (DN50) and Smaller: Bronze 'Y' type double regulating valve with threaded nipple type orifice ring carrier 2 No. body bosses fitted sealed test plugs; screwed bonnet; metal plug and seat; ends screwed BS 21 taper

Check Valves

- A. All non-return valves shall be suitable for both vertical and horizontal mounting and shall be fitted in readily accessible positions.
- B. Swing Check Valves to BS 5154 PN 16, series B, 2-1/2 Inches (DN65) and Smaller: horizontal swing, Y-pattern, screwed in cover, bronze body and cap, rotating bronze disc with rubber seat or composition seat, BS 21 threaded end connections.

Air Separator

The separator shall be of micro bubble and Dirt Separator type.

The separator shall be of cylindrical in-line micro bubble deaerator combined with inline dirt separator in the same unit, as to remove and separate air from closed type water circuits (heating), both dissolved air and free air bubbles, as well as dirt particles circulating in the pipes. The inlet and outlet of the unit shall be on the same line (inline).

The unit shall be constructed of Steel internally coated with epoxy and painted externally.

The unit shall have a copper mesh inside which is capable of separating the air and dirt from water.

The unit shall remove the air and dirt in the system by changing flow profile from turbulent to laminar, thus releasing the micro bubbles of air upward, and dirt downwards.

The unit shall be equipped with automatic air vent with non-shutoff valve.

A draining valve at the bottom of the unit shall be used to flush out the dirt accumulated in the unit.

The pressure drop in the unit shall not exceed 5 Kpa at a speed of 1 m/s or 10 Kpa at a speed of 2 m/s.

A high capacity automatic air vent with isolating valve shall be installed at the top of the air separator.

Provide isolating butterfly valves at the inlet and outlets of the vessel.

Provide a Bypass valve for maintenance purposes.

ELECTRONIC ANTI-SCALE

Electronic anti-scale is the eco-friendly water treatment solution – It works without the addition of salt or chemicals. Electronic anti-scale works by changing the physical characteristics of the scale crystals. This treatment removes the adhesive qualities of scale. Electronic anti-scale shall sit outside of the water pipes, and does not need to directly touch the water to function.

Electronic impulses change the crystallization process of the liquid calcium. This way the hard scale loses its adhesive power. The technology works with capacitive electric impulses: no use of any salt or chemicals.

These electronic impulses are transmitted via the two impulse bands, which are wrapped around the pipe. These two bands interact to create an electronic field which alters the liquid calcium crystals in the water.

Electronic anti-scale shall be suitable for all pipe materials and can be installed vertically, horizontally or can also be wall-mounted.

The operating ambient temperature range shall be from -25 to 50oC

Strainers

All strainers shall be fitted in a readily accessible position and adequate access shall be allowed for maintenance and cleaning of strainer basket.

Line size strainers shall be fitted before each item of the equipment and prior to each control valve, and where shown on Drawings.

All strainers shall be manufactured by specialists and have a stainless steel 80 mesh basket

Each strainer shall be provided with drain cock.

- A. Y type strainer, PN 16, threaded ends to BS 21, 2-1/2 Inches (DN65) and Smaller: bronze body and cap, threaded cap, fitted with perforated stainless steel screens with 0.8 mm holes.

Installation

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above the center of the pipe.
- E. Install valves in a position to allow full stem movement.
- F. Installation of Check Valves: Install for proper direction of flow as follows:
 - Swing Check Valves: Horizontal position with hinge pin level.
 - Wafer Check Valves: Horizontal or vertical position, between flanges.

Safety & Pressure Relieve 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 greater.

Valves and Stopcocks

Valves and stopcocks shall conform to the Table Schedule 1 at the end of this Section of the Specifications unless detailed differently in the particular Section of the Specifications.

Pressure, Altitude and Temperature Gauges

Where depicted on the schematics and as generally described here under the Contractor shall supply and install a thermometer, altitude or pressure gauge.

Thermometers shall be fitted on each boiler cylinder on flow and return headers and on each return main prior to connection into the return header, on the secondary side of all calorifiers and on the downstream side of all mixing valves.

Thermometers shall be to BS.1704 dependent upon whether the application calls for a straight or angular pattern'. They shall all be calibrated in both centigrade and Fahrenheit and be supplied with a loose red pointer to be set at the design working temperature. The scale range shall be suitable for a maximum temperature approximately. They shall be supplied with a pocket suitable for insertion into the fluid concerned. All gauges fitted within the Plant Room, Pump Rooms, and Tank Room shall have a 150 mm. dia. dial gauge fitted; elsewhere they shall have a 100 mm. dia. dial.

Pressure Gauges shall be fitted on either side of pumps sets (where duty standby or multiple pump configurations are installed, pressure gauges shall be on the common discharge not a pair per pump set).

Pressure gauges shall be manufactured to B.S.1780. They shall be supplied with a loose red pointer to be set at the design working head and be calibrated in bars gauge. The scale range shall be suitable for a maximum of approximately twice the design head.

All pressure gauges shall be back plate mounted on varnished hardwood panel with chamfered edges. The panel shall have labeling to indicate the pump function and inlet and outlet condition. Pipe work to the pressure gauges shall be in copper and be neatly run to the pump.

SCHEDULE OF INSTRUMENTATION

<u>Item</u>	<u>Location</u>
Pressure Gauges,	inlet and outlet of each pump, domestic hot water cylinder

Note: Gauge cocks only are to be installed at reheat coils in hung ceilings.
Thermometers, manifolds of boiler, domestic hot water cylinder

SCHEDULE 1:**Schedule of Valves and Appliances**

Pressure rating of all valves and appliances shall be suitable for the operating conditions of which they will be installed, and shall not be less than the specified PN rating.

	Size (DN) (mm)	Valve / Fitting Details	Application	BS No.	PN
Heating Water	Up to 50	Bronze gate valve to BS 5154, PN 16 , series B; non-rising extended stem; screwed in Bonnet; single piece wedge; threaded ends BS 21 Taper thread	Isolating	5154	16
Heating Water	Up to 50	Swing check valves to BS 5154 , PN 16, series B; horizontal swing, Y-pattern, screwed in cover, bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded ends BS 21 Taper thread	Check / Non return	5154	16
	Up to 50	Bronze gland pattern drain cock; ends screwed BS 21; male inlet / hose union outlet, wrench operation	Drain off cock	-----	16
	Up to 50	Malleable iron globe valve; renewable nickel alloy disc and seat; inside screw; ends screwed BS 21 taper	Air venting	-----	16
	Up to 50	Bronze 'Y' type double regulating valve with threaded nipple type orifice ring carrier 2 No. body bosses fitted sealed test plugs; screwed bonnet; metal plug and seat; ends screwed BS 21 taper	Flow regulation & Balancing	7350	20
	15 - 50	Y type strainer, PN 16, threaded ends to BS 21, bronze body and cap, threaded cap, fitted with perforated stainless steel screens with 0.8 mm holes.	Pipeline strainer	-----	16
	15-50	Bronze radiator gate valve, casting finish, female/male union , composition hand wheel	Heating Radiators	2767	16

SCHEDULE 1: (Cont.)**Schedule of Valves and Appliances**

Pressure rating of all valves and appliances shall be suitable for the operating conditions of which they will be installed, and shall not be less than the specified PN rating.

	Size (DN) (mm)	Valve / Fitting Details	Application	BS No.	PN
Domestic Water Systems	Up to 50	Bronze gate valve to BS 5154, PN 16 , series B, non-rising extended stem, screwed in Bonnet; single piece wedge, threaded ends BS 21 Taper thread	Isolating	5154	16
	65-300	Gate Valves to BS 5150 PN 16 (EN 1171) flanged BS 4504, rising stem, outside screw and yoke (: shall be of cast-iron body and bonnet, bolted bonnet, solid cast-iron wedge, brass-alloy stem, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron hand wheel, internal and external coated with wet epoxy paint	Isolating	5154	16
Fuel Oil	6-50	Bronze gate valve, single piece wedge, non-rising stem screwed-in bonnet, Viton seals and seats, threaded ends BS 21 Taper thread sealed with approved PTFE tape pipe thread and sealant to BS 3245	Isolating	5154 Series B	16
	15-50	Bronze split wedge disc fire valve, screwed in cap, level and weigh operated with stainless steel cable, pulleys, fusible link, tensioner and warning labels, ends screwed to BS 21 taper. sealed with approved PTFE tape pipe thread and sealant to BS 3245	Fire safely cut-off	-	16

SCHEDULE 1: (Cont.)**Schedule of Valves and Appliances**

Pressure rating of all valves and appliances shall be suitable for the operating conditions of which they will be installed, and shall not be less than the specified PN rating.

	Size (DN) (mm)	Valve / Fitting Details	Application	BS No.	PN
Fire fighting	Up to 50	Bronze gate valve; rising stem; threaded bonnet; single piece wedge; ends screwed To ANSI/ASME B16.3 (O.S & Y)), UL/ FM approved	Isolating	5154	16
	Up to 50	Swing check valves to BS 5154 , PN 16, series B; horizontal swing, Y-pattern, screwed in cover, bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded ends BS 21 Taper thread	Check / Non-return	5154	16
	Up to 32	Bronze gate non-rising stem; screwed-in bonnet; one-piece wedge : to BS-21 or ANSI/ASME16.3	Drain Valves	-----	16
Gas	8-50	Brass body ball plug valve, chrome coated ball plug and valve stem, Viton seals and seats, top entry type with locking plate, quarter turn level operated , ends screwed BS 21 taper sealed with approved PTFE tape pipe thread and sealant to BS 3245 UL approved ,or British Gas approved	Isolating	2789	20

SCHEDULE 2:
Schedule of Pipes & Fittings

Service	Pipe Range (mm)	Pipe Material	Fittings
Buried and Main Feed Water	Up to 80	Galvanized steel pipes to BS 1387, schedule 40.	Fittings on galvanized pipe work shall be galvanized to B.S.729, Part 1.
Main Domestic Cold water on roof	Up to 80	Galvanized steel pipes to BS 1387, schedule 40.	Fittings on galvanized pipe work shall be galvanized to B.S.729, Part 1.
Main Domestic , Cold & hot water	Up to 80	Polypropylene pipes to ASTM F 2389	Fittings on Polypropylene pipe work shall be Polypropylene ASTM F 2389
Cold Water Branch pipes Under tiles	Up to 50	Polypropylene pipes to ASTM F 2389	Fittings on Polypropylene pipe work shall be Polypropylene to ASTM F 2389
Fire Fighting	Up to 50	Black steel to ANSI B 16.3 seamless pipe joined by threading	Black steel, screwed malleable iron , ANSI B16.3
Heating Water	Up To 50mm	Black steel to ASTM-A 53 seamless schedule 40	Malleable iron threaded fittings
	65 - 125	Black steel to ASTM-A 53 seamless schedule 40	Butt welding fittings
Buried LPG & auxiliary Gas	15-& over	Phosphorous de-oxidized non-arsenical copper to BS 2871 manufactured to EN1057, table Y or equivalent ASTM standard protected by polyethylene coating	Phosphorous de-oxidized non-arsenical copper to BS 6017 grade C106. manufactured to 864 , Part 2 or equivalents ASTM standard
HVAC Condensate	Up 100mm Above False Ceiling	CPVC to DIN 8079-8080 - 10 bars CPVC pipes fittings joined by solvent cement adhesives	CPVC to DIN 8079-8080 PN-10 bars solvent cement adhesive
	Embedded in Walls or buried	UPVC to DIN 4660 10 bars 10 bars UPVC pipes fittings joined by solvent cement adhesives.	UPVC to DIN 4660 PN-10 bars UPVC pipes fittings joined by solvent cement adhesives.

SCHEDULE 3:**4.1 Pipe Supports Spacing – Steel Pipes**

The following table indicates the recommended spacing for pipe supports and guides:
Steel Piping (Temperatures up to 100 °C).

Pipe Size	Distance Between Alignment Guide	Distance between Supports			Hanger Rod Dia
		Horizontal		Vertical	
		Bare	Insulated		
in mm	(meters)	(meters)	(meters)	(meters)	in mm
15	3.0	1.8	1.8	2.4	10
20	3.0	2.4	2.4	2.4	10
25	3.0	2.4	2.4	2.4	10
32	3.0	2.7	2.4	3.0	12
40	3.0	3.0	2.4	3.7	12
50	4.0	3.0	2.7	3.7	12
65	4.6	3.4	2.7	3.7	16
80	5.8	3.7	3.0	4.3	16
100	7.6	4.0	3.0	4.6	16
125	9.0	4.6	3.7	5.5	16
150	10.6	4.9	4.5	5.5	16
200	13.7	5.5	6.0	8.5	16
250	18.0	6.0	6.5	9.0	20
300	21.2	6.4	7.0	10.0	24

For temperatures above 100 °C use rod sizes given in Table (8) of BS 3974.

SCHEDULE 4:**4.2 Polymer Pipes including:****CPVC , UPVC , ABS, Polypropylene , Polyethylene Pipes**

The following table indicates the recommended spacing for pipe supports and guides:

Max Temp	Distance between Pipe Support In Meters @		
	20 °C	50 °C	70 °C
Pipe Size			
20 mm	1.3	1.0	0.7
25 mm	1.3	1.0	0.7
32 mm	1.3	1.0	0.7
40 mm	1.3	0.9	0.7
50 mm	1.3	1.0	0.7
63 mm	1.4	1.1	0.8
75 mm	1.5	1.2	0.8
90 mm	1.6	1.2	0.9
110 mm	1.8	1.3	1.0
125mm	1.9	1.4	1.0
140 mm	2.0	1.5	1.1
160 mm	2.1	1.6	1.2
200 mm	2.2	1.7	1.3
225 mm	2.3	1.8	1.5
250 mm	2.5	2.0	1.7

General Notes:

Vertical piping should be supported at each floor and should have a midstory guide, unless thermal expansion design calls for other provisions.

Piping should not be anchored tightly by the support, but secured in a manner to allow for a degree of movement caused by thermal expansion. Hangers or strapping with rough edges should not be used.

END OF SECTION

SECTION 15241

VIBRATION AND ACOUSTIC CONTROL

GENERAL

Section Includes:

- Inertia bases.
- Vibration isolators.
- Duct silencers.
- Cross-talk silencers.
- Ductwork lagging.
- Acoustical louvers.
- Floating Floor.

PROJECT CONDITIONS

Project seismic zone is 1 with a zone factor of 0.075 in accordance with the current Uniform Building Code (UBC).

SEISMIC CONTROLS

1. Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.
 - a. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - e. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.
2. Manufactured Seismic Snubbers: All-directional, double-acting snubbers.
 - a. Construction: Interlocking steel members restrained by a 19-mm-thick, replaceable, shock-absorbing neoprene insert. Maintain 3-mm clearance in all directions between rigid and resilient surfaces.
3. Fabricated Seismic Snubbers: Welded structural-steel shapes designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.
 - a. Construction: Welded steel shapes conforming to ASTM A 36M.
 - b. Resilient Components: 19-mm-thick, replaceable, shock-absorbing neoprene insert.

NOISE CONTROL

General

All 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 under ASHRAE and CIBSE.

All such 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.

The air conditioning system has been designed to achieve a noise level as specified in the design criteria. Particular provisions shall be incorporated into the installations in order not to exceed their level including but not limited to:

- Lead impregnated flexible connections between all fans and ductwork;
- Acoustically sealed duct penetrations
- Internal insulation to ductwork;

Rotating equipment shall be statically and dynamically balanced and installed on bases designed to accommodate vibration isolators. Inertia bases shall be used where specified, or shown on drawings.

The inertia base shall be adequately reinforced 180mm thick concrete in which foundation bolts with pipe sleeve type holders are positioned before the concrete pour. A minimum of 40mm clearance shall be maintained between bottom of inertia base and top of floor slab.

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.

PERFORMANCE REQUIREMENTS

All mechanical electrical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

All piping and ductwork located in mechanical equipment rooms, and for a minimum of 15m, whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration hangers. All isolators shall provide the required static deflection related to the equipment weight or the operational speed as indicated below.

Consider upper floor locations critical unless otherwise indicated.

Use concrete inertia bases for fans having static pressure in excess of 0.85 kPa or motors in excess of 30 kW, and on all base mounted pumps over 7.5 kW.

Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook. HVAC Applications

SUBMITTALS

Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each equipment and system. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

Product Data: Submit schedule of vibration isolator type with location and load. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Furnish calculations to substantiate the selection of vibration and noise isolators and sound attenuators for the Engineer's approval. Indicate spring diameters, free operating and solid height, ratio of horizontal and vertical stiffness and other required data to meet the system requirements.

Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

Manufacturer's Installation Instructions: Submit special procedures and setting dimensions.

Indicate installation requirements maintaining integrity of sound isolation.

Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

Installer: Company specializing in performing Work of this section with minimum three years documented experience.

Design application of duct silencers acoustic housings seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

Acoustic Assessment

The Contractor shall perform an overall acoustic assessment of the plant and equipment, and shall verify that the acoustic measures to maintain noise control within the specified noise level.

The Contractor shall make all necessary steps, as it requires achieving the specified level.

The above shall be performed by acoustical specialist and shall be approved by the Engineer.

CODES AND STANDARDS

Work and materials shall conform to the British Standards and Codes of Practice, and with all local rules and regulations.

Specification shall be to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.)Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
UL:	Underwriter Laboratories (U.S.A.)
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided, they meet with the above standards as a minimum. The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS VIBRATION & ACOUSTIC CONTROL

Vibration Isolation Mountings

For static deflections up to 12mm vibration isolation mountings shall be single or double deflection neoprene mountings incorporating steel top and base plates and a tapped hole to facilitate bolting to equipment.

For static deflections exceeding 12mm vibration isolation mountings shall be housed steel spring mountings incorporating leveling bolts and lock nuts and a 6mm neoprene pad bonded to the base. Steel springs shall have a ratio of mean coil diameter to compressed length at the specified static deflection of not less than 0.8 to 1.0 and shall have an additional travel to solid of at least 50% of the specified static deflection.

Vibration isolation mountings shall be in accordance with the Schedule following.

MINIMUM STATIC DEFLECTIONS FOR ANTI VIBRATION MOUNTINGS

Motor power (kW)	Fan Speed (Revs/sec)	Minimum Static Deflection (mm)		
		Slab On Grade	Up to 10m Span	Over 10m Span
	24	6	12	12
Up to	16	12	12	25
3.5 kW	12	12	25	25
	9	25	40	45
	6	25	67	75
	24	12	25	25
3.5 kW	16	12	25	25
to	12	12	25	40
30 kW	9	25	45	50

Motor power (kW)	Fan Speed (Revs/sec)	Minimum Static Deflection (mm)		
		Slab On Grade	Up to 10m Span	Over 10m Span
	6	25	75	90
Over 30 kW	24	25	25	2
	16	25	25	40
	12	25	25	45
	9	25	65	75
	6	25	90	110

GRILLES, REGISTERS AND DIFFUSERS

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

Octave Bands	NC-35	NC-40	NC-45	NC-50
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
8	42	47	52	57

Manufacturers are required to submit guaranteed sound power level data in octave bands of grilles, register diffusers and fan coil units operated at low, medium and high speeds. Fan coil units noise shall be controlled by installing internal acoustic duct liners along the whole supply duct and not less than a distance of 5 times the narrower cross sectional dimension of supply duct.

In the absence of sufficient length or as a straightforward cleaner alternative to the duct lining, a silencer shall be used low-pressure drop silencer less than 1 m long will do the job.

On the return side of the fan coil system, the return grill into the ceiling shall be located as far from the unit's return opening as possible. Laying a 50 mm layer of batt insulation loosely on top of the ceiling in the area between the return opening in the ceiling and the return opening of the fan coil shall attenuate the return noise without having to add further silencing or lining any ducts.

Grilles, registers, diffusers and fan coil units shall be tested in accordance with ASHRAE Standard 3 6B-63.

Acoustical Treatment of Duct Systems

Acoustically lined with 25mm (1") thick, 0.68 kg (1 1/2 lb) glass fiber duct lining shall be used for the following:-

- All conditioned air ductwork within mechanical equipment spaces, but not less than 7.5 meters, (25 ft.) from fan outlet.
- A minimum distance of 6 meters (20 ft) upstream of all main risers toilets and pantries

exhaust fans.

- A minimum distance of 6 meters (20 ft) downstream of all supply air fans
- Upstream of all exhaust fans, or return air fans, except kitchen systems, a minimum distance of 6 meters (20 ft).
- Supply and return ductwork in function rooms equipped with folding or operable partitions as required controlling sound transmission during simultaneous usage of the divided spaces.
- In certain conditions, packaged factory-built sound traps may provide more effective sound control than acoustical lining, or may be economically advantageous. The acoustical engineer shall make such determination.

Fresh Air Intakes Exhaust Air Plenums

The intake for the fresh air and exhaust air in all mechanical rooms shall have 15 dB of silencing overall. This shall be incorporated into the opening. The silencer shall have 8 dB attenuation at 125 Hz, 15 dB at 250 Hz and 20 dB at 500 Hz.

Pumps Systems' Piping Noise

Since piping system will resonate with the pump and pulsations will be carried much further through the piping system that would normally be the case. Each pump shall include double convolution, rubber, flexible connectors in the suction and discharge of all the pumps at the outset.

Vibration Isolators and Foundations Bases

General

All equipment, piping, etc., shall be mounted on or suspended from approved foundations and supports, all as specified herein.

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 showing the complete details of all foundations, including the necessary concrete and steel work, vibration isolation devices etc.

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. 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.

Mounting systems and components of the isolation mounting shall not be resonant with any of the forcing frequencies of the supported equipment or piping. The mounting manufacturer shall determine mounting sizes and mounting shall be installed in accordance with manufacturer's instructions.

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.

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 breaching - mounting type XT".

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 should be 50% of the rated deflection. The maximum motion of any resiliently supported equipment at start-up 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.

PRODUCTS

Vibration Isolators

- A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.
 - 1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
 - 2. Fiberglass Isolator Pads: Glass fiber not less than 25 mm thick and precompressed through 10 compression cycles at 3 times the rated load. Cork isolator pads are prohibited.
 - 3. Load Range: From 69 to 345 kPa and a deflection not less than 2 mm per 25 mm of thickness. Do not exceed a loading of 345 kPa.
- B. Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top- and base plates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled base plate for bolted connection to structure. Color-code to indicate capacity range.
- C. Spring Isolators: Freestanding, single coil, laterally stable, open-spring-type isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 1.2 times the rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Base plates: Factory drilled for bolting to structure and bonded to a 6-mm-thick, rubber isolator pad attached to the base plate underside. Size base plates to limit floor loading to 690 kPa the use of rubber cups is prohibited.
 - 6. Top Plates: Provide threaded studs for fastening and leveling equipment.
 - 7. Finishes: Manufacturer's standard corrosive-resistant finish.
- D. Restrained Spring Isolators: Vertically restrained, freestanding, single coil, laterally stable, steel open-spring-type isolators.
 - 1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled base plate for bolting to structure and bonded to a 6-mm-thick, rubber isolator pad attached to the base plate underside. Provide adjustable equipment mounting and leveling bolt.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 0.8 times the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.
- E. Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.
- F. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.
1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

Foundations Base

- A. Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.
1. Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36M. Include support brackets to anchor base to isolation units. Include pre located equipment anchor bolts and auxiliary motor slide bases or rails.
 2. Design and fabricate bases to result in the lowest possible mounting height with not less than 50-mm clearance above floor.
 3. Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.
 4. Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.
 5. Configure inertia bases to accommodate equipment supported. Inertia base thickness minimum of 150 mm or 1/12 of longest base dimension unless otherwise specified on the Design Drawings.
 6. Pump Bases: Size to support pump and piping elbows.
 7. Factory Finish: Manufacturer's standard corrosive-resistant finish.

Vibration Isolation Roof Curbs

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 56-m/s wind impinging laterally against the side of the equipment. Design restraints to meet seismic requirements.
- B. Components: Upper support frame; lower support assembly; freestanding, unhoused, laterally stable steel springs; vertical and horizontal restraints.
1. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer stripe for attachment of roof material and 50 mm of rigid

- insulation on the inside of the assembly.
2. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 3. Water Seal: Elastomeric seal conforming to Underwriters Laboratories (UL) Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counterflashed over the roof materials.

INSTALLATION

- A. Install and anchor vibration-, and seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.
- B. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.
- C. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.
- D. Fill concrete inertia bases, after installing base frame, with 20.7 MPa concrete, and trowel to a smooth, hard finish. Cast-in-place concrete is specified in Section 03300, "Cast-in-Place Concrete".
- E. Install pipe connectors at connections for equipment supported on vibration isolators.

Floor Mounting Of Centrifugal Fans - Mounting Type I

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 start up 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 shall be drilled and tapped to receive the fan and motor so that the frame shall act as a template.

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

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 trails, height saving spring mounting brackets, springs and equipment anchor bolt templates shall be provided by the vibration control vendor. Spring supports 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.

Reinforced concrete inertia base thickness shall be in accordance with the following schedules:

Motor Size Thickness Required	Inertia Block
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 should 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

All such units shall be hung by means of vibration isolator hangers consisting of a steel housing or retainer incorporating a steel spring.

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 sub-base shall be installed in the field, which shall support the equipment, to be hung and to which shall be attached the hangers.

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

This equipment shall be mounted as described under mounting type VI.

Diagonal hanger rod isolators shall be provided as required to limit horizontal motion to 1/4 inch maximum under fan operating conditions.

Mounting of Centrifugal Pumps (Greater Than 3 Hp) - Mounting Type VIII

Each pump with its driving motor shall be bolted and grouted to a spring supported concrete inertia base reinforced as required.

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.

Reinforced concrete inertia base thickness shall be in accordance with the following schedule.

Motor Size	Inertia Block Thickness Required
5 hp to 15 hp	6 inches
20 to 50 hp	8 inches
60 hp to 100 hp	10 inches
Greater than 100 hp	12 inches

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

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.

Provide base below supports and structural perimeter frames and reinforcement as described for mounting type VIII.

Mounting Of Packaged Direct Expansion (DX) Units

Resiliently floor support units on mountings providing a minimum static deflection of 3/8 inch
Resiliently suspend units with mountings types providing a minimum static deflection of 1 inch.

Piping Anchors, Guides and Supports - Mounting Type XII

Pipe guides, anchors and supports in all risers, and piping anchors in air conditioning and ventilation 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.

Piping Guides

Steel guides shall be welded to the pipe at 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.

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.

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 attached to the steel guide framing within the shaft.

Anchors

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.

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. The isolation material loading shall not exceed 500 psi.

Supports

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.

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.

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.

VIBRATION ISOLATOR SCHEDULES

Equipment Type	<u>Slab on Grade</u>					<u>Up to 6m Floor Span</u>			<u>6-to-9-m Floor Span</u>			<u>9-to-12-m Floor Span</u>			Reference Notes
	Shaft Powder, Kw and Other	Rpm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	
<u>Refrigeration Machines and Chillers</u>															
Bare compressors	All	All	A	2	6	C	3	20	C	3	45	C	4	65	2,3,12
Reciprocating	All	All	A	2	6	A	4	20	A	3	45	A	4	65	2,3,12
Centrifugal	All	All	A	1	6	A	4	20	A	3	45	A	3	45	2,3,4,12
Open centrifugal	All	All	C	1	6	C	4	20	C	3	45	C	3	45	2,3,12
Absorption	All	All	A	1	6	A	4	20	A	3	45	A	3	45	
<u>Pumps</u>															
Closed Coupled	Up to 5.6	All	B	2	6	C	3	20	C	3	20	C	3	20	16
	7.5 and over	All	C	3	20	C	3	20	C	3	45	C	3	45	16
Large inline	3.7 to 19	All	A	3	20	A	3	45	A	3	45	A	3	45	
	22 and over	All	A	3	45	A	3	45	A	3	45	A	3	65	
End suction and split case	Up to 30	All	C	3		C	3	20	C	3	45	C	3	45	16
	37 to 93	All	C	3	20	C	3	20	C	3	45	C	3	65	10,16
	110 and over	All	C	3	20	C	3	45	C	3	45	C	3	65	10,16

			<u>Slab on Grade</u>			<u>Up to 6m Floor Span</u>			<u>6-to-9-m Floor Span</u>			<u>9-to-12-m Floor Span</u>			
Equipment Type	Shaft Powder, Kw and Other	Rpm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolato Type	Min. Defl. mm	Base Type	Isolato Type	Min. Defl. mm	Base Type	Isolato Type	Min. Defl. mm	Referenc Notes
<u>Boilers-Fire-tube</u>	All	All	A	1	6	B	4	20	B	4	45	B	4	65	4
<u>Axial Fans, Fan Heads, Cabinet Fans, & Fan Section</u>															
Up to 560 mm dia.	All	All	A	2	6	A	3	20	A	3	20	C	3	20	4,9
610 mm dia. And over	Up to 500 Pa s.p.	Up to 300	B	3	65	C	3	90	C	3	90	C	3	90	9
		300 to500	B	3	20	B	3	45	B	3	65	C	3	65	9
		501& over	B	3	20	B	3	45	B	3	45	B	3	45	9
	501 Pa s.p. and	Up to 300	C	3	65	C	3	90	C	3	90	C	3	90	3,9
	over	300 to500	C	3	45	C	3	45	C	3	65	C	3	65	3,8,9
		501& over	C	3	20	C	3	45	C	3	45	C	3	65	3,8,9

			<u>Slab on Grade</u>			<u>Up to 6m Floor Span</u>			<u>6-to-9-m Floor Span</u>			<u>9-to-12-m Floor Span</u>			Reference Notes
Equipment Type	Shaft Powder, Kw and Other	Rpm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	
<u>Centrifugal Fans</u>															
Up to 560mm dia	All	All	B	2	6	B	3	20	B	3	20	C	3	45	9,19
610 mm dia. And over	Up to 30	Up to 300	B	3	65	B	3	90	B	3	90		3	90	8,19
		300 to 500	B	3	45	B	3	45	B	3	65	B	3	65	8,19
		501 & over	B	3	20	B	3	20	B	3	20	B	3	45	8,19
	37 & over	Up to 300	C	3	65	C	3	90	C	3	90	C	3	90	2,3,8,9,19
		300 to 500	C	3	45	C	3	45	C	3	65	C	3	65	2,3,8,9,19
		501 & over	C	3	25	C	3	45	C	3	45	C	3	65	2,3,8,9,19
<u>Propeller Fans</u>															
Wall-mounted	All	All	A	1	6	A	1	6	A	1	6	A	1	6	
Roof-mounted	All	All	A	1	6	A	1	6	A	4	45	D	4	45	
<u>Heat Pumps</u>															
	All	All	A	3	20	A	3	20	A	3	20	A/D	3	45	
<u>Condensing Units</u>															
	All	All	A	1	6	A	4	20	A	4	45	A/D	4	45	
<u>Packaged AHU ,Air Conditioning , H and V Unit</u>															
All	Up to 7.5	All	A	3	20	A	3	20	A	3	20	A	3	20	19
	11 and over	Up to 300	A	3	20	A	3	90	A	3	90	C	3	90	2,4,8,19

			<u>Slab on Grade</u>			<u>Up to 6m Floor Span</u>			<u>6-to-9-m Floor Span</u>			<u>9-to-12-m Floor Span</u>			
Equipment Type	Shaft Powder, Kw and Other	Rpm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Reference Notes
	Up to 1 Kpa s.p.	301 to 500	A	3	20	A	3	65	A	3	65	A	3	65	4,19
		501 and over	A	3	20	A	3	45	A	3	45	A	3	45	4,19
	11 and over	Up to 300	B	3	20	C	3	90	C	3	90	C	3	90	2,3,4,8,9
	1 Kpa s.p and over	301 to 500	B	3	20	C	3	45	C	3	65	C	3	65	2,3,4,9
		501 and over	B	3	20	C	3	45	C	3	45	C	3	65	2,3,4,9
Packaged Rooftop Equipment	All	All	A/D	1	6	D	3	20							5,6,8,17
<u>Ducted Rotating Equipment</u>															
Small fans, fan-Powered Boxes	Up to 283 L/s	All	A	3	13	A	3	13	A	3	13	A	3	13	7
<u>Engine-Driven Generators</u>															
	All	All	A	3	20	C	3	45	C	3	65	C	3	90	2,3,4

Base Type:

- A. No base, isolators attached directly to equipment
- B. Structural steel rails or base
- C. Concrete inertia base
- D. Curb-mounted base

Isolator Type:

- 1. Pad, rubber, or glass fiber
- 2. Rubber floor isolator or hanger
- 3. Spring floor isolator or hanger
- 4. Restrained spring isolator
- 5. Thrust restraint

Notes for Selection Guide for Vibration Isolation

Note 1: Isolator deflections shown are based on reasonably expected floor stiffness according to floor span and class of equipment. Certain spaces may dictate higher levels of isolation. For example, bar joist roofs may require a static deflection of 38 mm over factories, but 64 mm over commercial office buildings.

Note 2: For large equipment capable of generating substantial vibratory forces and structure borne noise, increase isolator deflection, if necessary, so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.

Note 3: For noisy equipment adjoining or near noise sensitive areas, see the section on Mechanical Equipment Room Sound isolation.

Note 4: Contain designs cannot be installed directly on individual isolators (type A), and the equipment manufacturer or a vibration specialist should be consulted on the need for supplemental support (base type).

Note 5: Wind load conditions must be considered. Restraint can be achieved with restrained spring isolators (type 4), supplemental bracing, snubbers, or limit stops.

Note 6: Certain types of equipment require a curb-mounted base (type D). Airborne noise must be considered.

Note 7: See section on Resilient Pipe Hangers and Supports for hanger locations adjoining equipment and in equipment rooms.

Note 8: To avoid isolator resonance problems, select isolator deflection so that resonance frequency is 40% or less of the lowest normal operating speed of equipment (see Chapter 8 in the 2009 ASHRAE Handbook Fundamentals).

Note 9: To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor mounted units operating at 1500 Pa or more total static pressure.

Note 10: Pumps over 55 kW may need extra mass and restraints.

Note 11: See text for full discussion.

Note 12: Refrigeration Machines: Large centrifugal, screw, and reciprocating refrigeration machines may generate very high noise levels; special attention is required when such equipment is installed in upper-story locations or near noise sensitive areas. If equipment is located near extremely noise-sensitive areas, follow the recommendations of an acoustical consultant.

Note 13: Compressors: The two basic reciprocating compressors are duct structures. (1) single- and double cylinder vertical, horizontal or L-head, which are usually air compressors; and (2) Y,

W, and multi-head or multi-cylinder air and refrigeration compressors. Single- and double cylinder compressors generate high vibratory forces requiring large inertia bases (type C) and are generally not suitable for upper-story locations. If this equipment must be installed in an upper-story location or at-grade location near noise-sensitive areas, the expected maximum unbalanced force data must be obtained from the equipment manufacturer and a vibration specialist consulted for design of the isolation system.

Note 14: Compressors: When using Y, W, and multi-head and multi-cylinder compressors, obtain the magnitude of unbalanced forces from the equipment manufacturer so the need for an inertia base can be evaluated.

Note 15: Compressors: Base-mounted compressors through 4 kW and horizontal tank-type air compressors through 8 kW can be installed directly on spring isolators (type 3) with structural bases (type B) if required, and compressors 101075 kW on spring isolators (type 3) with inertia bases (type C) with a mass 1 to 2 times the compressor mass.

Note 16: Pumps: Concrete inertia bases (type C) are preferred for all flexible-coupled pumps and are desirable for most close-coupled pumps, although steel bases (type B) can be used. Close-coupled pumps should not be installed directly on individual isolators (type A) because the impeller usually overhangs the motor support base, causing the rear mounting to be in tension. The primary requirements for type C bases are strength and shape to accommodate base elbow supports. Mass is not usually a factor, except for pumps over 55 kW, where extra mass helps limit excess movement due to starting torque and forces. Concrete bases (type C) should be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 20 kW, 150 mm; (2) for 30 to 55 kW, 200 mm; and (3) for 75 kW and up, 300 mm. Pumps over 55 kW and multistage pumps may exhibit excessive motion at start-up (“heaving”); supplemental restraining devices can be installed if necessary. Pumps over 90 kW may generate high starting forces; a vibration specialist should be consulted.

Note 17: Packaged Rooftop Air-Conditioning Equipment: This equipment is usually installed on low-mass structures that are susceptible to sound and vibration transmission problems. The noise problems are compounded further by curb-mounted equipment, which requires large roof openings for supply and return air.

The table shows type D vibration isolator selections for all spans up to 6 m, but extreme care must be taken for equipment located on spans of over 6 m, especially if construction is open web joists or thin, low-mass slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 6 mm or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 6 mm, supplemental roof stiffening should be installed to bring the roof deflection down below 6 mm, or the unit should be relocated to a stiffer roof position.

For mechanical units capable of generating high noise levels, mount the unit on a platform above the roof deck to provide an air gap (buffer zone) and locate the unit away from the associated

roof penetration to allow acoustical treatment of ducts before they enter the building. Some rooftop equipment has compressors, fans, and other equipment isolated internally. This isolation is not always reliable because of internal short-circuiting, inadequate static deflection, or panel resonances. It is recommended that rooftop equipment over 135 kg be isolated externally, as if internal isolation was not used.

Note 18: Cooling Towers: These are normally isolated with restrained spring isolators (type 4) directly under the tower or lower dunnage. High deflection isolators proposed for use directly under the motor-fan assembly must be used with extreme caution to ensure stability and safety under all weather conditions. See Note 5.

Note 19: Fans and Air-Handling Equipment: Consider the following in selecting isolation systems for fans and air-handling equipment:

1. Fans with wheel diameters of 560 mm and less and all fans operating at speeds up to 300 rpm do not generate large vibratory forces. For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40% or less than the fan speed. For example, for a fan operating at 275 rpm, $0.4 \times 275 = 110$ rpm. Therefore, an isolator natural frequency of 110 rpm or lower is required. This can be accomplished with a 75 mm deflection isolator (type 3).
2. Flexible duct connectors should be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission to air.
3. Inertia bases (type C) are recommended for all class 2 and 3 fans and air-handling equipment because extra mass allows the use of stiffer springs, which limit heaving movements.
4. Thrust restraints (type 5) that incorporate the same deflection as isolators should be used for all fan heads, all suspended fans, and all base-mounted and suspended air-handling equipment operating at 500 Pa or more total static pressure. Restraint movement adjustment must be made under normal operational static pressures.

END OF SECTION

SECTION 15250

MECHANICAL THERMAL INSULATION

GENERAL

Submittals

Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

Samples: Submit two samples of representative size illustrating each insulation type.

Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

Delivery, Storage and Handling

Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

Field Measurements

Verify field measurements prior to fabrication.

PRODUCT THERMAL INSULATION

CODES AND STANDARDS

Work and materials shall conform to the latest edition of the MOPW regulations (Energy saving buildings code and Thermal insulation code) and recommendations for air conditioning equipment and installation. British Standards, Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

The following standards are accepted for HVAC services provided that necessary corrections and provisions are made to suit local climatological and design conditions, power supply system and other required codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
UL:	Underwriter Laboratories (U.S.A.)

SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

INSTALLATION

General

An approved specialist thermal insulation contractor carries out all items of thermal insulation work covered by this Specification. 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. Special care shall be taken in the installation of thermal material and all necessary precaution shall be taken to prevent all cold bridging of surfaces which may produce surface condensation. The Contractor shall be fully responsible for any damage that may be caused as a consequence of condensation due to cold bridging.

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 pipe work, 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.

All metal surfaces shall be thoroughly cleaned and treated with approved corrosion inhibitors before applying insulation.

All pipe works which convey cold fluids, including external pipes, shall be fitted with high density rigid foamed plastics (including metal or glass reinforced plastic sleeved type), hardwood or treated softwood cylindrical form inserts of 70mm minimum length at each support or hanger point before application of pipe insulation. The insert shall match the insulation thickness and pipe outside diameter and shall be suitable for the operating temperature and surrounding environment. Vapour barriers where required shall be carried across pipe inserts.

Thermal insulation shall conform to all relevant parts of the Building regulations.

The following list of items shall be insulated unless otherwise specified. The list shall not be considered as a limitation of the insulation application:-

- Heat exchangers and convectors (including evaporators, water cooled refrigerant condensers and de-aerator.
- Water heaters and storage cylinders
- Refrigerant pipeline, valves and fittings
- Heating water headers, water boxes, pipelines, valves, strainers and all related fittings and

- accessories.
- Condensate water heaters, water boxes, pipelines, valves, strainers and all related fittings and accessories.
 - Domestic Cold water heaters, water boxes, pipe lines, valves, strainers and all related fittings and accessories
 - Domestic hot water heaters, water boxes, pipe lines, valves, strainers and all related fittings and accessories
 - All chilled and heating water circulating pumps valves and trimmings.
 - Other equipment as per the recommendations of the manufacturer or where are specified.

Thermal Insulation in Plant Rooms

i) Pipe work:

All pipe work, as listed above, shall be individually insulated with plain performed rigid sections in accordance with B.S. 5422, as applicable.

The sections shall be applied in 1,200 mm. lengths, cut longitudinally into halves and securely attached - to the pipe work, without gaps, Self-adhesive aluminum foil vapour barrier tape shall be applied to all insulation at approx. 300 mm centers between the circumferential joints and the supporting bands of aluminum foil vapour Barrier tape.

Whenever possible, the longitudinal seams shall be of an interlocking 2 type, to ensure a satisfactory joint.

Where the sections are cut and metered 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 pipe work fittings and valves 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. Pipe work.

Cladding shall be applied to bends and branch pipe connections prior to straight lengths as follows:

- 1- Riveted 45° metered joints shall clothe bends on pipes up to 50 mm. dia.
- 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 centers. 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.
- 6- All cladding terminations at valves etc. shall be fitted with aluminum end cappings.

ii) Pipe work Fittings:

All valves, flanges, unions, pump casings and other items requiring access for maintenance, 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.

Insulation shall be installed to the valve, flange, etc., as detailed under 'Pipe work', to give a continuous vapour seal and then fitted with a vapour sealed insulated casing.

Where thermostats, gauges, etc., are fitted the cladding shall be neatly cut and fitted with plain aluminum masking plates.

Thermal Insulation in Ceiling Voids and Shafts

Where pipes are installed in Buildings voids, shafts and in any position otherwise indicated on the tender drawings, they shall be insulated as follows:

i) Pipe work:

All pipe work, carrying hot or cold water, including chilled and heating water, shall be individually insulated with performed 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.

Self-adhesive aluminum foil vapour barrier tape shall be applied to all insulation at approx. 300 mm centers between the circumferential joints and the supporting bands of aluminum foil vapour barrier tape. 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 capping shall be provided to close all insulation terminations.

ii) Pipe work Fittings:

All valves, flanges, unions and all other items requiring access for maintenance shall be insulated as follows:

1) Heating Water Fittings:

Insulated in accordance with Plant Rooms above with metered removable sections to provide a continuous vapour barrier

2) All Other Fittings:

Adjoining pipe insulation to be fitted with aluminum end caps.

Thermal Insulation Externally

Where pipes are installed and exposed externally on roof tops 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:

i) Pipe work:

All pipe work, carrying hot or cold water and chilled and heating water, shall be individually insulated with plain performed glass fiber sections.

Chilled and heating water pipe work shall be individually insulated with rigid fiberglass rigid performed sections with all longitudinal and circumferential joints secured with an approved adhesive.

Self-adhesive aluminum foil vapour barrier tape shall be applied to all insulation at approx. 300 mm centers between the circumferential joints and the supporting bands of aluminum foil vapour barrier tape. 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 pipe work shall then be covered with 0.8mm thick Polyiso-butylene (PIB) or polyethylene sheeting with 50 mm. overlaps on all circumferential and longitudinal joints. And shall be finally cladded with 1.2 mm stucco embossed aluminum cladding.

ii) Pipe work Fittings:

All valves, flanges, unions, etc., on all pipe work carrying hot or cold water shall be insulated as detailed in Plant Rooms

Thermal Insulation Exposed internally

Where pipes are exposed and run internal and in any other positions otherwise shown on the tender drawings, they shall be insulated as follows:

i) Pipe work:

All pipe work, carrying hot or cold water and heating water, shall be individually insulated with plain performed glass fiber sections.

Heating water pipe work shall be individually insulated with rigid performed sections with all longitudinal and circumferential joints secured with an approved adhesive.

Self-adhesive aluminum foil vapour barrier tape shall be applied to all insulation at approx. 300 mm centers between the circumferential joints and the supporting bands of aluminum foil vapour barrier tape.

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 pipe work shall then be cladded with 0.8mm steel Sheets shall be satin finished. Cladding shall be primed painted with suitable base primer and finished decoratively with glossy spray paint.

ii) Pipe work Fittings:

All valves, flanges, unions, etc., on all pipe work carrying hot or cold water shall be insulated as detailed and in Plant Rooms.

SCHEDULE I:**Schedule of Insulation****Minimum Thickness of HVAC Pipes Insulation**

Item	Inside the Plant Rooms			In Voids, Shafts & Ducts			Exposed		
	Pipes Diameter (mm)	Insulation Material	Insulation Thickness (mm)	Pipes Diameter (mm)	Insulation Material	Insulation Thickness (mm)	Pipes Diameter (mm)	Insulation Materials	Insulation Thickness (mm)
Chilled water	15-25 32-50 65-125 150-350	Preformed rigid fiber glass with a Max. Conductivity of 0.035 W/m.°K	32 32 38 50	15-50 65-80 100-350	Preformed rigid fiber glass with a Max.. Conductivity of 0.035 W/m.°K	32 32 38	15-25 32-50 65-125 150-350	Preformed rigid fiber glass with a Max.. Conductivity of 0.035 W/m.°K	32 32 38 50
Chilled water condensate				All pipes	Preformed rigid fiber glass with a Max.. Conductivity of 0.035 W/m.°K	10			
Refrigerants	All pipes	Preformed rigid fiber glass or closed cell foam with a max. Conductivity of 0.035 W/m.°K	32	All pipes	Preformed rigid fiber glass or closed cell foam with a Max.. Conductivity of 0.035 W/m.°K	32	All pipes	Preformed rigid fiberglass or closed cell foam with a Max.. Conductivity of 0.035 W/m.°K	32
Heating system	15-32 40 50-150 200-350	Preformed rigid fiber glass with a Max. Conductivity of 0.04 W/m.°K	32 38 50 63	15-32 40 50-150 200-350	Preformed rigid fiber glass with a Max.. Conductivity of 0.04 W/m.°K	32 38 50 63	15-32 40 50-150 200-350	Preformed rigid fiber glass with a Max.. Conductivity of 0.04 W/m.°K	32 38 50 63

B. Minimum Thickness of Insulation for Domestic Water Services

	Inside the Plant Rooms or Tunnels			In Voids, Shafts & Ducts		
	Pipes Diameter (mm)	Insulation Material	Insulation Thickness (mm)	Pipes Diameter (mm)	Insulation Material	Insulation Thickness (mm)
Domestic cold water system	All pipes	Preformed rigid fibre glass	10	All pipes	Preformed rigid fiberglass	10
Domestic hot water system	15-32	Preformed rigid fibre glass with a Max.. Conductivity of 0.04 W/m.°K	32	15-32	Preformed rigid fibre glass with a Max.. Conductivity of 0.04 W/m.°K	32
	40		38	40		38
	50-150		50	50-150		50
	200-350		63	200-350		63
	Externally Exposed			Embedded In walls or buried		
	Pipes Diameter (mm)	Insulation Materials	Insulation Thickness (mm)	Pipes Diameter (mm)	Insulation Material	Insulation Thickness (mm)
Domestic cold water system	All pipes	Preformed rigid fibre glass with a Max.. Conductivity of 0.035 W/m.°K	10			
Domestic hot water system	15-32	Preformed rigid fibre glass with a Max. Conductivity of 0.04 W/m.°K	32	15-32	Closed cell elastomer with a Max. Conductivity of 0.04 W/m.°K	10
	40		38	40		15
	50-150		50	50-150		32
	200-350		63	200-350		50

END OF SECTION

SECTION 15340

FIRE FIGHTING SYSTEM SPECIFICATIONS

General Conditions

Refer to the Main Contract General Conditions of the Specification together with the additional particular clauses applicable to the Building Services.

Refer to section (1) of the Local Construction Specification, together with the additional particular clauses applicable to the Building Services.

The documentation and work under this Section shall be carried out in accordance with codes and procedures defined in the General Conditions and complimented with details in this Section of Particular Specifications, all to the ENGINEERS approval.

It is understood and agreed that the Contractor, has by careful examination of the plans and Specifications, and the site where appropriate, satisfied himself as to the nature and location of the works, and all conditions that must be met in order to carry out the works under this section of the Contract.

Extent of Works

Description of Work

The work to be carried out under this contract consists of the design supply, installation, testing, commissioning and maintenance of the following all as specified here within and in Local Construction Specifications.

Portable Fire Extinguisher
Fire hose reels

Portable Fire Extinguishing System

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 by suitable wall bracket or in recessed cabinets as instructed by the Representative Engineer. The bracket and cabinet shall be specifically supplied for the extinguisher type and size concerned.

The fire extinguishers shall be manufactured from robust aluminium cylinder, or from high quality 1.4 mm gauge steel, insert gas welded and finished externally in colour in accordance with the B.S. 5423-1985.

The fire extinguishers shall be operated by pulling the safety pin and squeezing the lever. This action shall open a valve in the head allowing the element of extinguisher to be expelled under its own pressure to the horn through siphon and nozzle.

All the extinguishers shall be clearly marked with the operating instructions.
Fire extinguishers shall be located near escape exits, as marked in drawings and in general as per the requirements of British standards.

Type ABC

ABC dry powder fire extinguisher shall be of the BCF type with a rugged all brass operating valve, large size operating lever, full vision pressure gauge, discharge hose and heavy duty drawn aluminium cylinder with hard, scratch and corrosion resistant finish dry chemical extinguishers.

Type F.EX. (CO2)

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 and corrosion resistant finish carbon dioxide fire extinguishers.

Type Boiler Room

Automatic fire extinguisher shall be with sprinkler head, located above burner of each boiler, BCF type 10 kg capacity

FIRE HOSE REELS (FHR)

General:

The fire hose cabinet shall be of automatic swinging recessed type or exposed type as shown on drawings.

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 kickable 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 meters of hose is withdrawn from the reel.

The hose reel shall be equipped with shutoff valve for connecting with pipe work.

The hose nozzle shall be of high impact plastic, JET/SPRAY/SHUT/OFF nozzle.

Reassessed Hose Reel Cabinet

The reassessed part of the hose cabinet shall be fabricated from mild steel construction with 1.25 mm thick mild steel oil painted.

The reel arm shall be fixed on a strong and movable arm which allows the movement in wide 180° angle to facilitate firefighting from different directions.

The hose shall be rubber and made of double layer of a special synthetic textile, between which there shall be a special strengthening layer made of strong fiber.

The black hose shall have a working pressure of 20 bars and a bursting pressure of 60 bars.

The hose shall be made according to American or European standard No. (En 694) or equivalent.

The branch nozzle shall be attached to the hose's end.

The branch nozzle shall be made of brass.

The nozzle shall provide three positions: jet, spray and complete stop functions.

The cabinet and its doors shall be made of 1.2mm and 1mm steel sheets without any sharp edges or corners.

The Cabinets and doors shall comply with the architectural and decoration requirements.

The cabinets and reels shall be protected against rust.

The door fastening shall be of the recessed style made of modern stainless steel.

The door fastening shall work with a mere push or touch on the knob on which the word (PUSH) shall be written.

The cabinets and the reels shall be painted with special electrostatic powder paint and processed in heat ovens.

The cabinets and reels shall be treated with antirust chemicals.

The valve shall be fixed in the inside wall of the cabinet.

The valve shall be made of brass or steel and shall be connected to a brass reducer (coupling) which is also attached to the hose.

Inside the cabinet there shall be a list of directions comprehensively explaining the hose using instructions step by step in both Arabic and English languages.

The cabinet shall have an additional side compartment with a separate door having the same above specifications containing a 6kg powder or gas extinguisher. The local Civil Defense Department shall approve fire hose cabinets along with all the other firefighting system components.

PIPES AND FITTINGS

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 offsets 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, frost proof 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.

ABOVE GROUND & EXPOSED PIPES

- A. All exposed and above ground fire fighting and drain piping shall be standard weight Black steel seamless pipe to ASTM A53 schedule 40 or equal approved.
- B. Black steel piping shall be used for fire fighting system, and galvanized steel piping shall be used for drainpipe work.
- C. Black steel pipes size 50mm and smaller shall be joined by threading, and pipes size 65 mm and larger shall be joined by grove coupling system.
- D. Galvanised steel pipes shall be joined by threading for all sizes. Welding of galvanised pipes will not be permitted.
- E. Fittings on black steel pipes shall be black, and on galvanised steel pipes shall be galvanised. The use of black fittings on galvanised pipes will not be permitted.
- F. All fittings for black steel pipes size 50 mm and smaller shall be screwed malleable iron fittings, to ANSI B16.3
- G. All fittings for black steel pipes 65mm and larger shall be steel of the seamless but welded type with 37 degree bevelled ends to ANSI B16.5 and ANSI B16.11.
- H. All fittings for galvanised steel pipes shall be screwed malleable iron fittings for all pipe size to ANSI B16.3.
- I. All threaded and welded fittings shall be of 16 bar working pressure rating.
- J. All threaded fittings and pipe shall have threads cut to ANSI/ASTME Standard B1.20.1.
- K. All fittings shall have the same thickness and be the same schedule and rating as the pipe of the corresponding size.
- L. 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.
- M. Elbows shall be of the long radius type.
- N. Branch connection on black steel pipes may be made with forged steel weldolets or thredolets where the branch pipe is not larger than one half the size of main pipe.
- O. 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.
- P. Threads shall be cut with new dies and all burrs and chips formed in the threading operation shall be removed with wire mesh.

- Q. Threaded joints shall be made up tight with approved Teflon tape thread sealant. Lamp wick, cord, wool, or any other similar material will not be permitted in making up threaded joints.
- R. Welded joints on black steel pipes shall be made with electric arc welding.
- S. Care shall be taken that the pipe does not extend into the fittings sufficiently to reduce the water flow.

UNIONS AND FLANGES

- A. 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.
- B. Unions or flanges shall also be provided at adequate intervals, in the piping to permit easy disassembly for alteration and repair.
- C. Disconnecting unions or flanges shall be installed between the equipment and the isolating valves.
- D. Unions used on threaded pipe size 50mm and smaller shall have female threaded ends and ground metal-to-metal seats.
- E. Flanges shall always match the flanges provided on valves and equipment as far as pressure rating, facing, drilling and thickness.
- F. 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.
- G. 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 pushed bolt holes.

END OF SECTION

SECTION 15410

DRAINAGE SYSTEM SPECIFICATIONS

GENERAL

DRAINAGE SYSTEM GENERAL SPECIFICATION

This section covers the supply, installation testing and commissioning of sewage, storm water drainage systems and includes internal and external drainage systems in accordance with this specification and the requirements of the local Construction Specifications

SCOPE OF WORKS

- A. Furnish , installing, test and commission the complete sewage, waste and storm water drainage systems along with all associated manholes, kerb and duct drains and soak ways as indicated on the Contract Drawings.
- B. The Contractor shall provide all supervision, labour, materials, equipment, machinery and any other items necessary to complete the systems in all respects.
- C. The drainage system shall include the following:
 - 1. Floor drains, gullies, traps, rodding eyes, overflows, chrome plated bottle traps.
 - 2. Floor gully and rodding eyes covers with strainer.
 - 3. Other works and materials to make the system complete and functional.

STORAGE AND HANDLING

- A. Storing and handling including taking delivery, loading and unloading of pipes, valves, fittings and other equipment shall be carried out by the Contractor in such a manner as to avoid breakage, distortion, denting or other damage. Stacking of materials shall be done in such a manner as to prevent to the pipe or coatings to the satisfaction of the Engineer.
- B. Plastic pipes and fittings shall be stored under cover and out of direct sunlight at all times. Pipes shall be supported throughout their entire length and free flow of air around them maintained. Generally, all pipes shall be handled using canvas slings not less than 250mm wide. The use of chains or wire slings will not be permitted.
- C. All valves and fittings shall be stored under cover on hard standing until required for fixing. Uncrated valves and fittings shall not be strapped.
- D. Pipes and fittings damaged during handling or storage shall be set aside and the Engineer informed. If in the Engineer's opinion the damage is such that the pipe or fitting has been permanently impaired it shall be removed from site.
- E. No repairs shall be started without the approval of the Engineer.

TRANSPORT AND STACKING OF PIPES ON SITE

- A. The Contractor shall take every care to ensure that no damage whatsoever results to the pipe from transport and stacking. All trucks, wagons, stacking methods and devices shall have the approval of the Engineer but his approval shall in no way relieve the Contractor of his responsibilities under the Contract.
- B. Pipe shall not be allowed to drop or strike objects, which may damage the pipe, but shall be lifted or lowered by suitable approved equipment. Hoister and buildings of approved type shall be used on all vehicles used for the transport of pipe.

- C. The Contractor shall ensure that all pipes with special or of different diameter, wall thickness and manufacture are stacked separately. Successive tiers of spigot and socket pipes shall have sockets protruding at opposite ends of the stack.
- D. All pipes shall be stacked on flat level ground and in such a manner as to prevent damage to the pipe work or coating. Pipes shall not be placed on the ground but raised on timbers with bedding of straw bags or similar approved by the Engineer. The timber shall in no case be less than 200mm wide and 75mm thick.
- E. Pipes shall be stacked in accordance with manufacturer's recommendations but not to a greater height than 4 tiers.
- F. Approved bedding shall also be placed between each tier of pipes.

INSPECTIONS

- A. Written notice on prescribed form shall be given for the purpose of inspection, measurement and testing for each of the following cases:-
 - Setting out completed
 - Excavation complete
 - Beddings laid
 - Drainage laid and ready for testing
 - Drainage bedding cover complete and compacted
 - Backfilling complete and compacted with ground level finish complete ready for final testing.

PRODUCTS

General

Above Ground Soil, Waste, Overflow and Venting Systems.

- A. All above ground Soil, Waste Overflow, Venting and rain water pipe work, complete with all drains, traps, gullies, cleanouts, vents and all accessories, which run inside buildings and located as follows:-
 - Above floor slab
 - Under tiles
 - Chased In walls and through shafts
 - All vertical pipes (risers)
- B. UPVC pipes, traps and fittings shall be manufactured under a BS 4514 - EN1329 -1 Quality system and shall comprise the whole range of integrated system of same manufacturer allowing the easy plumbing of an installation.
- C. The system shall comply with appropriate British Standards and where applicable, bear the Kite mark.
- D. Applicable sub-sections Construction Specification shall be applied to all drainage works.
 - 1) Reference should be made to the following Codes and Standards:-
 - ▶ BS 3943: 1979 Specification for plastic waste traps
 - ▶ BS 4514: 1983 Un plasticised PVC soil and ventilating above ground EN1329-1:1997
 - ▶ Pipe/ fittings and accessories
 - ▶ BS 5254: 1976 Polypropylene waste pipe and fittings.
 - ▶ BS 5255: 1976 Plastic waste pipe and fittings/50 mm and under.
 - ▶ BS 5572: 1978 Code of Practice for sanitary pipe work (formerly CP 304).
 - ▶ CP312: Part 1 & 2: 1973 Plastic pipe work (Thermoplastic material)
 - 2) Materials and Colour: pipes and fittings shall be in UPVC in grey or rustic brown.

- 3) Socketed fittings shall be solvent-welded with plain-ended pipes. Seal ring expansion joints shall be provided where required.
- 4) The system shall be compatible with buried drain system. Weathering Apron (solvent-weld socket) shall be solvent-welded to the soil, waste, vent pipes for weather flashing around pipe at roof.
- 5) Seal ring socket type PVC caulking bush shall be used to connect PVC pipes to sockets of other material if applicable.
- 6) Adjustable, plastic coated steel holder bats shall be used to support pipes or secure fittings. Galvanised mild steel support bracket with packing piece shall be used for horizontal pipes. Smaller pipes and fittings shall be secured to wall by zinc-plated steel brackets.

Below Ground Drainage and Sewerage System

- A. The below ground drainage and Sewerage shall be of UPVC pipes and fittings and shall comply with BS 4660, 5481– EN-1401-1:1998 PN-6, and where appropriate shall bear the Kitemark.
- B. Materials and Colours: buried drain system pipes and fittings shall be UPVC with polypropylene seal retaining caps. Underground fittings shall be coloured golden brown. Seal retaining caps and seal rings are black. Rodding eyes shall be provided where required.
- C. UPVC solvent weld socket seal/lip and lip seal/lip seal shall be used.
- D. Where necessary, lip seal/lip seal slip couplings shall be used.
- E. Transition from higher dia. to lower one shall be made by using level invert taper. Special adaptors and caulking bush shall be used to join UPVC channels in manhole connections to drainage system.
- F. UPVC Puddle flanges shall be provided where pipe work passes through the walls or roofs or structural slabs.
- G. Solvent Cements
- H. Solvent cements should comply with either BS 6209 for non-pressure pipe work or BS 4346: Part 3 for pressure pipe work.
- I. Sealing Rings should be made from natural or synthetic rubber complying with BS2494.

Pumped Drainage and Sewerage System

- A. All pumped drainage and Sewerage system shall be of UPVC pipes and fittings and shall comply with BS 3505 , 3506 class “E” or to DIN 8061, 8062 PN-6, and where appropriate shall bear the Kitemark.
- B. Materials and Colours: buried drain system pipes and fittings shall be UPVC with polypropylene seal retaining caps. Underground fittings shall be coloured golden brown. Seal retaining caps and seal rings are black. Rodding eyes shall be provided where required.
- C. UPVC rubber seal or solvent type.
- D. Where necessary, lip seal/lip seal slip couplings shall be used.
- E. Transition from higher dia. to lower one shall be made by using level invert taper. Special adaptors and caulking bush shall be used to join UPVC channels in manhole connections to drainage system.
- F. UPVC Puddle flanges shall be provided where pipe work passes through the walls or roofs or structural slabs.

G. Solvent Cements

H. Solvent cements should comply with BS 4346: Part 3 for pressure pipe work.

I. Sealing Rings

J. Sealing rings should be made from natural or synthetic rubber complying with BS2494.

Materials

Pipe and fittings made of flame retardant polypropylene joined by electrical fusion coils made of conductive metal wire coated with polypropylene and moulded into a flame retardant polypropylene fusion collar.

Joining

The pipe and fittings shall be joined by use of the electrical fusion collars energized by a low-voltage power supply.

Compound — the PPR compound used in the pipe and fittings covered by this specification shall meet the requirements of Class PP1 10B631.53 material as described in ASTM D 4101. As other compounds are shown to be suitable for these products, such compounds will be added to this specification.

Fittings Design and Dimensions Requirements, fittings design shall be based upon the laying length dimensions in ASTM D 3311 DWV Plastic Fitting Patterns.

Electrical Fusion Collars (1½"- 6") Each coil shall consist of polypropylene jacketed wire, mandrel wound and heat fused on the outer surface and moulded into a self-supporting fusion collar with an integral duplex receptacle. Each collar shall be provided with a ratchet style plastic clamp for sizes up to 3". 4" and 6" fittings will require the use of the steel band clamps that must be ordered separately.

Electrical Fusion Coils 18"-12"1 each coil shall consist of polypropylene jacketed wire, mandrel wound and heat fused on the outer surface. These coils shall be inserted and taped in place within the fusion sockets of all LD fittings at the factory. Properly sized steel band clamps [ordered separately] will be required for proper fusion of fittings to pipe during installation.

Pipe Mark Schedule 40 PPR, Flame Retardant, shall be bluish in color, Group 1-63153, manufactured in 10-foot lengths. Schedule 40 PPRO, Non-Flame Retardant, shall be black in colour Group 1-53653 manufactured in 20-foot lengths. Schedule 80 FPRO, Non-Flame Retardant shall be black in colour, Group 2-53653 manufactured in 20-foot lengths.

All previously listed lengths of pipe shall be marked with NSF-CW-SE, Pipe Size, Schedule, Type, Quality Control Mark and be compatible with the coil fusion method.

Fittings shall be legibly marked with moulded-in letters showing manufacturer's trademark, pipe size of each socket, manufacturer's part number, NSF-CW-SE and symbol PPR indicating the material.

Corrosion Protection of Ferrous Pipelines

A. Ferrous pipelines shall be supplied with factory applied hot dipped bituminous coating.

- B. Upon the completion of the installation, Contractor shall, in addition to any factory applied bituminous paint coating, be required to apply one of the following corrosion protection systems:
- a) Loose polyethylene sleeving system
 - b) Cold applied self-adhesive laminate type system.
 - c) Cold applied self-adhesive laminate tape system and sacrificial magnesium anodes.
- C. All coating manufacturer's instructions shall be strictly adhered to in the application of protective materials. The Contractor shall ensure that there is adequate suitable equipment on site to enable the works to be carried out to the specified standard, as approved by the Engineer or Engineer's Representative.
- D. No pipe with damaged coating shall be incorporated into the works. If damage occurs, the Contractor shall propose repair procedures as recommended by the coating manufacturer and submit them for approval to the Engineer. No repairs will commence until approval is granted.

EXECUTION

Pipes And Fittings - Workmanship

A. Pipe Supports, Brackets and Hangers

All pipe work shall be adequately supported in such a manner as to permit free movement due to expansion contraction, vibration or other changes in the system. Supports shall be arranged as near as possible to joints and changes in direction. Spacings of supports shall be as per manufacturers recommendations.

Vertical stacks shall be adequately supported at the base to stand the total weight of the riser. Under no circumstances shall branches from vertical rising pipes be the means of support for the vertical pipe work.

High temperature PVC waste pipe work 32mm, 40mm and 50mm shall be supported using stand off two piece clips screwed to the wall using round head zinc plated wood screws. Pipe clips shall be plastic coated galvanised mild steel where exposed to view and galvanised mild steel where concealed.

UPVC soil and ventilation pipe work 82mm, 110mm and 160mm shall be supported using two piece holder bats screwed to the wall using round head zinc plated wood screws.

Brackets shall be galvanised steel and be rigid. Where soil and ventilation pipes are suspended from the underside of slab, they shall be held rigid in position. Single angle iron supports may be used for pipe work up to 500mm from underside of slab. Double angle iron supports shall be used for pipe work 500mm-1000mm from the underside of the slab. All supports shall be proprietary brand and manufactured from galvanised steel. Double angle iron braces shall be installed on the both single and double angle iron supports at 6 metre centres for vertical and horizontal runs of pipe work and anchored as necessary.

- a) Rodding Eyes
Rodding and cleaning eyes shall be provided as indicated on the contract drawings and as required. Stainless steel covers to be provided at tiles level.
- b) Roof Termination

All soil ventilation pipes shall terminate 300mm above the point of exit from the services duct.

c) Jointing

Joints of UPVC and high temperature PVC shall be “O” ring and solvent welded. Prior to jointing, all pipe work, fittings and accessories shall be thoroughly cleaned. Pipe work shall be cut square, end chamfered and swarf and dust removed. Prior to jointing, pipes and fitting should be checked for correct position and alignment and marked to ensure accurate assembly.

Where “O” ring joints are to be used pipes shall be marked for insertion depth, “O” ring placed in ring seal prior to application of small quantity of lubricant or petroleum jelly around the chamfered spigot end. The pipe shall then be inserted into the socket joint and finally adjusted to the correct insertion depth.

Where solvent joints are to be used, special care shall be taken to ensure both spigot and socket are free from all dirt, grease and swarf. Solvent cement shall then be applied liberally and evenly to both socket and spigot prior to inserting spigot into socket. The joint shall immediately be cleaned for surplus solvent with a dry cloth around newly formed joint.

Joint UPVC to cast iron shall be by means of cast iron caulking bush with sealed ring joint for expansion. This fitting shall have rubber seal ring for connecting to PVC and spigot for connecting to cast iron.

Jointing of W.C. outlet to UPVC pipe work shall be by means of either a straight or bent connector as required complete with rubber seal ring and suitable connection for W.C. spigot outlet.

d) Laying Rigid Pipe

Each pipe immediately before being laid shall be carefully brushed out and inspected for defects.

Pipe with flexible joints, except where concrete protection is provided as specified hereafter, shall be laid on a well compacted bed of granular bedding material extending for the full width of the trench and with sufficient material at the side to permit the pipes to be worked into the granular material and firmly supported to true line and level. Sufficient space should be left to enable the joints to be made, tested and inspected but the Contractor shall ensure that at least three quarters of the pipe length is fully supported. After the pipeline has been tested and approved by the Engineer the trench shall be carefully filled to 300mm above the crown of the pipe with granular material.

e) Laying Plastic Pipe

All operations involving the laying, bedding, jointing, backfilling etc. of pipes plastic materials shall be strictly in accordance with the manufacturer’s recommendations subject to the approval of the Engineer.

f) Marker Tape

Marker tape shall be laid 150mm above all sewerage and effluent pressure pipelines. The marker tape shall be red, non-biodegradable plastic and inscribed with the words “DANGER-NON POTABLE WATER”, in both English and Arabic and shall be of a type

approved by the Engineer. Where specified in the Contract Documents blue marker tape as above shall be laid above potable water mains and inscribed with the words ‘WATER MAIN’ in both English and Arabic.

g) Setting Out and Pipe Alignment

All pipes and pipelines shall be laid to the lines and depths shown on the drawings or as otherwise directed by the Engineer.

All pipelines shall be laid accurately to line and gradient so that, except where otherwise specified, the finished pipeline is in a straight line in both horizontal and vertical planes. Where shown on the drawings or otherwise permitted by the Engineer shallow changes of direction shall be achieved by deflection at joints within the maximum permitted by the manufacturer. Where the angle of the bend required is greater than that obtainable by joint deflection then manufactured bends of the appropriate degree shall be used. Manufactured bends shall only be used where shown on the drawings or where otherwise permitted by the Engineer.

All pipelines forming part of a drainage system shall be laid to the specified lines and levels so that every pipeline lies in a straight line in both horizontal and vertical planes between successive manholes on the line. No bends will be permitted other than at manholes.

Every pipe shall be placed in position individually and shall be set out accurately to the line and level required. All setting out to line and level of both pipelines and individual pipes shall be achieved by methods approved by the Engineer.

Where pipelines of constant gradient are to be laid, the Contractor shall provide, fix and maintain at such points as may be directed by the Engineer properly painted sight rails and boning rods of pre-determined measurements for the boning in of individual pipes to correct alignment. The sight rails shall be situated vertically over the line of pipes or immediately adjacent to and there shall at no time be less than three sight rails in position on each length of pipeline under construction to any one gradient.

If the Contractor wishes to propose an alternative method of controlling pipeline alignment, he shall submit his proposed method to the Engineer for approval.

h) Concrete Protection to Pipelines

All underground drainage pipe work shall be surrounded with 150mm thick Grade SRC 20 sulphate resisting concrete, along its entire length, in the following locations:

1. All drainage below buildings or structural elements.
2. All drainage with less than 600mm cover
3. Drainage with a cover of between 600mm and 1200mm, where there is vehicular traffic over the ground above the drain line.
4. Elsewhere as indicated on the Contract Drawings.

The required depths of concrete bed and height of concrete backfill shall be as indicated on the Contract Drawings.

Where a concrete bed and surround is specified, a minimum of 75mm blinding of concrete Grade 25 shall first be laid over the full width of the trench.

The pipes shall be laid, jointed and supported on precast concrete blocks, which shall be separated from the barrel by 25mm thick timber packing.

After the pipeline has been tested and approved by the Engineer the top of the concrete bed shall be thoroughly cleaned and additional concrete Grade SRC 20 carefully placed and compacted under and around the pipe to a height of at least 150mm above the crown of the pipe.

Where pipes with flexible joints are to be surrounded, 13mm thick fiber board or polystyrene sheets shall be fixed at the pipe coupling joint extending for the full cross section of the remaining concrete bed and surround and accurately cut to fit the profile of the pipe.

i) Pipelines Protection from Extraneous Material

The pipelines shall at all times be kept free of extraneous material and when work is not in progress the open ends of the pipeline shall be securely plugged with an approved watertight plug or stopper. Claw type plugs or any type liable to damage the pipe will not be approved.

The Contractor shall clear the inside of each fitting and pipe length immediately prior to jointing and shall swab all fittings and pipe lengths to remove all dirt, sand or other matter that may contaminate the pipeline.

The entire absence of foreign matter from the completed line shall be a condition precedent to acceptance.

j) Trenches

All trench excavation shall comply fully with all the relevant clauses of MOPW Construction Specifications and this specification.

Trench depths shall be sufficient to allow the installation of the required pipe bedding, granular or concrete, as specified. Generally the depth of cover shall not be less than 600mm unless otherwise indicated on the Contract Drawings.

Trench width shall be in accordance with the following table:

Nominal Pipe Bore (mm)	Minimum Width (mm)	Maximum Width (mm)
82	400	600
110	430	630
160	490	690
200	560	760

The maximum and minimum widths shall apply from the bottom of the trench to 300mm above the crown of the pipe.

Should the trench be excavated to a depth greater than is required in the opinion of the Engineer, the Contractor shall fill in the bottom of the trench to the required depth with concrete or other such materials as the Engineer may direct.

In the case of trench excavations made in roads, footpaths, verges, central strips or within 5 metres of buildings, the Contractor will be required to execute the works so as to

minimise damage and disturbance. Vertical trench sides will generally require support by timbering or other suitable means. Under-cutting of trench sides will not be permitted.

k) Granular Bedding Material for Pipes

Granular bedding material for pipes shall consist of gravel or broken stone and shall be suitable “all in” ballast or stone.

For pipes up to 1200 millimetres nominal bore the material shall be graded 12 millimetres to 5 millimetres all passing 12 millimetres and not more than 20 percent passing 5 percent millimetres B.S. sieve.

The minimum thickness of granular material below the barrel of the pipe shall be as follows:

- 150 millimetres for pipes up to 600 millimetres nominal bore.
- 200 millimetres for pipes over 600 millimetres nominal bore and up to 1200 millimetres nominal bore
- 300 millimetres for pipes over 1200 millimetres nominal bore
- In rock or mixed soils containing rock, boulders, large flints or stones or other irregular hard sports the thickness of granular fill shall increase by 100 millimetres.

l) Granular Bedding for Plastic Pipes

Granular bedding material for flexible pipes shall consist of coarse graded sand up to 10mm and shall not contain particles with sharp edges, which could cause damage to the pipes. The minimum thickness of sand around the barrel of the pipes shall be 100mm.

m) Backfilling Excavation

After compaction of the granular bed and surround or completion of concrete surround, the trench shall be backfilled using selected excavated material free from all rocks, large hard on objects and builders debris of greater than 40mm. Backfilling shall take place immediately after the specified operations preceding it has been completed and shall be layers of 150mm; each fully compacted over the full width of the trench. Power rammers and vibrators shall be used to compact backfilling when the cover over the crown of the pipe exceeds 0.5 metres.

MANHOLES

Cement and Concrete

a) Cement

All cement used in all classes of concrete for drainage and sewerage works, whether above or below ground level, shall be sulphate resistant cement, complying with BS 4027

b) Granolithic Concrete

Granolithic Concrete shall be mixed using one part by weight of Portland cement to two parts of clean granite chippings graded as Table 1 of BS 882, to one part of sharp siliceous sand graded as Table 2 and clear water sufficient to form a stiff but workable mix and provide a dense concrete.

c) Cement Mortar

Cement mortar shall consist of sulphate-resisting cement and sand gauged by volume in suitable boxes in the proportions as proposed by BS standards

Unless otherwise specified cement mortar shall be SRC Class No.1.

The ingredients of the mortar shall be mixed in an approved mechanical mixer or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added through a rose in sufficient quantity to give no more than stiff workability. The Whole shall then be turned until perfectly mixed.

Mortar shall be used within 30 minutes of mixing and shall not be remixed or worked up again after it has stiffened. Any mortar that has commenced to set shall be removed from the works.

Concrete Classification

Concrete grade		Characteristic strength n/mm^2	Application
SRC	30	30	Precast Concrete
SRC	25	25	Normal reinforced concrete, blinding thrust blocks
SRC	25	25	Mass concrete hard standings
SRC	20	20	Mass concrete, pipeline protection and surrounds protection to tanking and hollowing block infill.
Mix proportion for cement mortar			
Proportion by volume for cement			
Cement	Sulphate Resisting	Sand	Lime
No. 1.	1	2	-
No. 2.	1	3	-
No. 3.	1	5	1

vi) RENDERING TO MANHOLE BEDDING

- Rendering to manhole benching shall comprise a 12mm thick layer of approved epoxy mortar.

Manholes Generally

General

Manholes shall be provided at all changes in direction, gradient or diameter.

The manholes shall be of the sizes and grades indicated on the Contract drawings and fully comply with MOPW regulations and Construction Specification

Block work Manholes

Block work manholes shall be constructed on the drain lines in the positions and to the dimensions indicated on Drawings or as directed on site by the Engineer.

The type of construction for each chamber shall be as indicated on the Contract Drawings.

Concrete blocks used for chamber construction shall be manufactured with sulphate resisting cement and shall comply with the requirements of MOPW Construction Specification

Solid concrete blocks shall be made of concrete Grade SRC 20.

Each manhole shall be built on a minimum of 75mm thick blinding of grade SRC 25 concrete which shall be laid on a dry clean firm foundation free from unsold material. If the bed of the excavation is wet, the top surface of the blinding shall be coated with an approved waterproofing material.

Foundation base slabs shall be cast in-situ. Mass concrete foundation slabs shall be of concrete Grade 20. Reinforced concrete foundation slabs shall be of Grade SRC 30.

Internal and external faces of the block work walls shall be finished with 12mm thick SRC mortar rendering Class 1.

All internal faces of manhole chambers except benching and vitrified clay channel fittings shall be painted with one primer coat and two final coats of black bitumen coating water proofing solution to BS 3416, type 1 or equal and approved.

All exterior faces of manhole chambers shall be protected with 1000-gauge polythene membrane with hardboard protection against damage during backfilling.

Where indicated on the Drainage, manhole cover frames shall be supported on solid precast concrete bricks, manufactured from Grade SRC 30 concrete.

Reinforced cover slabs shall be provided where manhole access openings are less than the internal dimensions of the manhole chamber.

The cover slabs shall be mounted by ductile manhole covers and frames of the quality specified. The covers in roads and paved areas shall be accurately set on precast concrete brickwork to the level and slopes of the roads or pavements.

Manhole inverts shall be constructed of half section vitrified clay channels. Half section vitrified clay channel branch bends shall be used for branch connections. Benching in manholes shall be carefully formed according to the number, diameter and positions of the incoming and outgoing pipes. The benching in the manholes shall have vertical sides extending from the vitrified clay channels at least to the level of the crown of the highest pipe. The benching shall be sloped towards the channels at gradient of 1 in 10 or as otherwise detailed on the drawings. The benching shall be rendered with a 12mm thickness of epoxy mortar rendering. The ends of all pipes entering and leaving the manhole are to carefully cut to shape to suit the internal dimensions of the manholes, and shall project through on the inside, the benching being continued round the pipe to form a fillet.

Precast Concrete Manholes

The base shall be cast in-situ and shall be Grade SRC 20 concrete to the dimensions shown on the drawings.

The whole base including the outside surround to the pipes shall be cast monolithic. Immediately before concreting, lengths of pipes to be built in shall be surrounded with a layer of cement mortar No. 1.

The formwork for all precast concrete rings shall be purpose made in mild steel and shall incorporate surface vibrators of adequate performance to ensure proper compaction of the concrete. The forms must have provisions for allowing the casting in of the step irons. All precast components for manholes shall be made in accordance with BS 5911 or equivalent approved standard. Precast concrete components shall immediately after the removal of forms, be sprayed with an approved curing membrane. Regular spraying with water will not be an acceptable method of curing.

Where the Contractor does not own forms with surface vibrators for the production of precast concrete manhole components he may, with the written approval of the Engineer employ an approved method of hand compaction. If the Engineer gives such written approval, this does not imply acceptance of the quality of the finished work.

The positions of lifting holes or eyes in precast components are to be approved by the Engineer. Lifting holes are to be grouted up after construction of the manhole.

Step Irons

Step irons are to be positioned in the chamber shaft rings in such manner that the step irons are vertically linear. The joints at each step iron shall be made water-tight and strong, free from any crack and if found otherwise the Engineer may reject the precast ring or may instruct the Contractor to take any necessary measures to make the ring watertight.

The first step iron shall be fixed at a maximum of 600mm below the cover level and the last step iron shall be fixed at a maximum of 300mm from the top level of the lowest adjacent benching. Step irons shall be staggered at 300mm centres vertically and horizontally.

All joints between rings or slabs shall be made watertight to the satisfaction of the Engineer with a bituminous mastic strip sealant as approved. The external face of the joint is to be sealed with epoxy mortar.

Chamber Rings

Chamber rings shall be manufactured from concrete Grade SRC 30.

Both internal and external surfaces of the chamber rings shall be coated with a solution of bitumen refined from asphaltic crude oil, the solution having total solids content of approximately 45% and a viscosity corresponding to a No. 4 for cup time of approximately 30 seconds.

Manhole Covers and Frames

In general, manhole covers and frames shall be one of three types, as follows, unless otherwise specified.

- Heavy Duty, to BS 497 Grade A.
- Medium Duty, to BS 497 Grade B1.
- Light Duty, to BS 497 Grade C.

Heavy Duty

All manholes installed in roadways or trafficked areas shall be heavy duty Ductile cover to BS 497 Grade A, Reference MA 60.

The cover and frame shall be made from ductile iron and the cover shall be of the loosely bolted double triangular type with three-point suspension to provide stability under load.

Medium Duty

All manholes installed external to buildings, but not in roadways or trafficked areas, shall be medium duty to BS 497 Grade B1.

The cover and frame shall be of ductile iron and the cover shall be either rectangular or circular as specified in the Manhole Schedule. Such manholes shall incorporate a single seal between cover and frame. Following flushing out and testing of the drainage system, the sealing groove shall be filled with grease to provide an airtight seal.

Light Duty

All manholes installed within buildings and not subject to motor vehicles or industrial trolleys etc. shall be light duty to BS 497 Grade C of the lockable type.

The cover and frame shall be made from grey iron and shall incorporate a double seal between cover and frame. Following flushing out and testing of the drainage system, the sealing grooves shall be filled with grease to provide an airtight seal.

In those areas where it is required to accept a tiled floor finish, the manhole covers shall be of the recessed type. In kitchens, or other areas subject to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

Recessed Covers

Where manholes installed within tiling or decorative floor finish surroundings, a recessed type manhole cover shall be installed.

The cover and frame shall be made from galvanized steel cover and frame and shall incorporate a double seal between cover and frame. Manhole covers shall be fastened to frames by heavy-duty counter sunk screws. Floor finishing shall be rendered continuously within the manhole covers to match the surroundings.

Following flushing out and testing of the drainage system, the sealing grooves shall be filled with neoprene to provide an airtight seal.

In kitchens, or other areas to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

Pipe to Manhole connectors

The manhole connector shall be a watertight flexible pipe-to-manhole connector employed in the connection of the sanitary sewer pipe to precast manholes or other structures

The connector assembly shall be the sole element relied on to assure a flexible watertight seal of the pipe to the structure. The connector shall consist of a rubber gasket, an internal expansion sleeve, and one or more external compression take-up clamps. Approved materials for the connector shall be natural or synthetic rubber and stainless steel

. The rubber gasket element shall be constructed solely of synthetic or natural rubber, and shall meet/exceed the requirements of ASTM C 923, and shall have a minimum tensile strength of 1600 PSI. Minimum thickness of the cross-section shall be 0.275 inches (7 mm).

The internal expansion sleeve components shall be made of stainless steel and shall utilize no welds in their construction.

Installation shall be performed using a calibrated installation tool available from the connector manufacturer. Installation of the sleeve shall require no retightening after the initial installation.

The external compression take-up clamp(s) shall be constructed of stainless steel and shall utilize no welds in its constructions. The clamp(s) shall be installed by torquing the adjusting screw using a torque-setting wrench available from the connector manufacturer.

Selection of the proper size connector for the manhole and pipe requirement, and installation thereof, shall be in strict conformance with the recommendations of the connector manufacturer.

FLOOR DRAIN

Floor Drain Type (F.D.)

Floor drains located in all public toilets and in wet areas (light weight):

Floor drain cover shall be made of stainless steel, and floor drain body shall be made of UPVC to BS Standards with removable shaped odor- trap

The floor drain shall be equipped with:

- Three blanked inlets of 50mm dia. and Side outlet of 80mm dia.
- odor-trap removable by means of O-ring.
- Stainless steel S 316 slotted cover of 150 x 150mm dimensions with stainless steel S 316 setting.
- Body and clamping ring including pressure sealing.
- Maximum height of floor drain body shall be 130mm.

ROOF VENT COWL (VC)

Roof vent cowl shall be galvanized wire basket to fit snugly inside open end of vent pipes extending above roof.

CLEANOUT (F.C.O)

Cleanouts shall be installed, to provide access to waste and soil pipes for inspection or cleaning.

Cleanouts on horizontal and vertical pipes (not fitted to the fittings), shall be made by access pipe with 100mm. 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.

Cleanout – Type (FCO)

The cleanout is to be installed with 200x200mm square frame with anchor lugs and stainless steel cover plate secured with 316L stainless steel screws.

The CO is for use in conjunction with the standard pipe fittings forming cleanout branch at each change in direction, greater than 45° or near the foot of every vertical stack and on long horizontal pipe runs at 12m intervals.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

Cleanout – Type (H.F.C.O)

Heavy Duty adjustable floor cleanout, with Dura-coated cast iron body with gas and water tight ABS tapered thread plug, and round scoriated secured top and Dura-coated cast iron cover adjustable to finished floor.

The FCO is for use in conjunction with the standard pipe fittings forming cleanout branch at each change in direction, greater than 45° or near the foot of every vertical stack and on long horizontal pipe runs at 12m intervals.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

Gully Trap – Type (G.T)

Gully trap shall be assembled from P- trap and hopper.

The hopper shall be supplied with square sealed cover made of Polypropylene.

Gully hopper shall be with either a spigot or socket tail and shall have two boss sockets of horizontal connections of waste pipes.

P- Trap body shall be made of UPVC.

P- Trap shall be self standing and shall have a ring seal socket for the connection of the hopper.

Trench Drain (T.D):

Supply and install wherever shown on drawings gutter and grates and frames as hereinafter specified.

Gutter (trench) and Grate (Slotted grille) shall be made of heavy rectangular, sectional bar pattern, of cast iron suitable for heavy traffic.

Size shall be (300mm W x 300mm D), Or (300mm W x 2000mm D).

Duplex Submersible Pumps

Submersible pumps shall be of the vortex non clog type. The pump shall have cast iron body, cast iron motor housing, stainless steel shaft and highly wear resistant cast iron impeller.

Pump shall be firmly connected to the discharge connection, guided by not less than two stainless steel guided bars extending from the top of the station to the discharge connection,

Pump motors a squirrel cage non overlading throughout the entire performance induction type, Motors protection shall be IP 68 at (20m). Stators windings shall be F insulated and rated for 150°C. Pumps shall be protected with overload thermistor. Motor shall be suitable for the building electrical supply and submerged operation. The type of starter for motor shall be direct-on-line.

Cables shall be water tight and sealed. Epoxies silicones or other secondary sealing systems shall not be considered.

Each pump shall be provided with an adequately designed cooling system. The cooling system shall provide for continuous pump operation in liquid up to 40°C.

Each set of pumps two vortex impeller 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.

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.

The panel shall be of stainless steel construction of not less than 1.6 mm thick with side hinged opening with key lock. Control panel protection shall be IP 54.

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.

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.

STORM WATER SYSTEM

Pipe work and Fittings

Pipe work and fittings for storm water system shall be UPVC to B.S. 4514 –EN-1329-1. All pipe work, fittings and accessories shall be installed strictly in accordance with manufacture's recommendations. The Contractor shall ensure that the UPVC used is of a sufficiently high temperature rating to withstand the environmental conditions.

Rain Water outlets (RWO)

Scupper drain body shall be made of UPVC with horizontal or vertical outlet.

Pipe work Installations

- A. During installations of the storm water system, the Contractor shall make due allowance for the expansion of the pipe work and fittings during normal working conditions. Further allowance shall be made for solvent weld joining of the above materials with regard to temperature and humidity.
- B. The bores of all pipe work shall be smooth and free from all burns or obstructions; bends wherever possible shall be of the long radius types.
- C. All connections between pipes and Rainwater outlets shall be made with approved connectors.

External Storm Water

- A. The external storm water system consists of underground pipes connected to the soakaway or as indicated on drawings, complete system comprising soakaway, gullies and interconnected pipe work.
- B. Pipe work and fittings used in the external work installation are to be of UPVC to BS. 4514. - EN1329
- C. The bore of the pipe work shall be clear of all obstructions.
- D. The Contractor shall ensure that during backfilling of the excavations required to install the external storm water no damage is caused to this installation.
- E. The pipes and fittings shall be laid on a 150 mm thick granular bed of broken stone rock or gravel retained on a 5 mm sieve and passing through a 15 mm sieve. The bed shall be properly compacted and graded to support the barrel of the pipe to the correct level and fall prior to laying the pipe.
- F. Cover the pipe to a depth of 150 mm to above the top of the pipe with the same granular material carefully compacted by hand. Fill above this point with selected excavated materials free from large objects or builder's debris carefully compacted in 150 mm thick layers.
- G. Pipe work passing through the walls or foundations shall be sleeved with PVC pipe of sufficient size to allow clearance round the drainpipe. The gap between the drainpipe and sleeves shall be caulked with mastic.
- H. Where pipes pass through or below foundations, flexible couplings shall be provided no closer than 150 mm or more than 300 mm from the face of the building.
- I. The whole of the external storm water installation shall be tested in accordance with the requirement of B.S. 5572 - 1978; this shall be to the complete satisfaction of the Engineer.

Protection of Works

The installation shall be adequately protected against damage and deterioration when handed over, the installation shall be in a clean and sound condition. Particular care must be taken during the course of construction to seal all open ends of pipe work, gullies and soak away with a temporary cover. Wood shavings or paper will not be accepted for this purpose.

Painting

- A. The Contractor shall clean and paint all brackets and supports with two coats of red oxide paint.
- B. Exposed pipes in the Kitchen, Bathroom etc. Shall be painted with matching colour of the wall to the satisfaction of the Engineer

TESTING AND COMMISSIONING

General

- A. All drainpipes shall be tested in accordance with the requirements of BS 8301 and the requirements of the local authorities having jurisdictions.
- B. The Engineer shall witness all drainage tests. The Contractor shall give the Engineer a minimum of 24 hours notice of all tests. The Contractor shall also provide test sheets set out in an agreed manner for each drain section to be tested.
- C. The Contractor having ensured that water, electricity and other necessary supplies are available shall set to work the completed works or part thereof, at the instruction of the Engineer, and make the necessary adjustments to ensure correct functioning.
- D. After the installation or part thereof has been set to work and adjusted, the Contractor shall demonstrate its operation at a time selected by and to the satisfaction of the Engineer. Tests shall be in accordance with British Standards BS 6700: 1987.
- E. The test shall demonstrate: -
 - a. That equipment provided complies with the Specification in all particulars and is of adequate capacity for its full rates of duty.
 - b. That all items of plant and equipment operate quite sufficiently to meet the specified requirements.
 - c. That all instruments, protection and control devices, etc., are correctly calibrated and accurate.
 - d. That all drainage runs satisfy the required water tests.
- F. The details of method of carrying out the recording of tests shall be agreed with the Engineer. The Client's representative and the Engineer shall be at liberty to be present at tests and to participate in the tests. This shall not relieve the Contractor of his responsibilities for carrying out the tests satisfactorily.
- G. The Contractor shall make all the records during the tests and on completion thereof shall provide the Engineer with a test report and record, both in triplicate. The Contractor shall also provide all test instruments together with skilled supervision and adequate labour for carrying out the tests.

Proving Tests

- a- All under slab, underground drainage, soil and waste system shall be cleaned down and thoroughly flushed out to remove all dirt within each pipe work system.

- b- After each system has been flushed and each draw off fitting opened and the drainage soil and waste system shall be checked for satisfactory rate flow. And tested by profile test
- c- Particular attention shall be given to groups of sanitary fittings to ensure satisfactory flow when a number of fittings are flushed and air not drawn into the system via any trap.

Water Test

- A. All drains shall be tested before backfilling, immediately after the drain has been properly laid on the correct trench bed and after joining materials has had time to set. A water test pressure of 1.3m head above the soffit of the drain shall be applied at the high end, but not more than 2.4m head at the low end. The test shall be carried out on lengths of drain not less than half the distance between manholes, all to be agreed with the Engineer on site. The lower end of the drain shall be plugged and the higher end shall have a standpipe not less than 1.2m high. The drain shall be filled, taking care to eliminate trapped air. After repair of leakage due to defective pipes, joints and plugs, the drain under test shall be left for one hour to allow water absorption by pipe and fittings.
- B. The loss of water over a period measuring vessel at intervals of ten minutes and noting the quantity of water required maintaining the original level in the standpipe. For drains up to 300mm diameter, the water quantity added shall not exceed 0.06 litre per hour per 100 linear metres per millimetre of nominal bore of the drain under test.
- C. All drains shall be tested for a second time as described above after correct bedding cover and selected backfill have been consolidated and the finished surface complete.

Testing and Commissioning for Drain Pipes

- A. The Contractor shall provide all equipment necessary for testing. Generally, the whole installation shall be tested in accordance with the requirements of the MOPW
- B. Before any test is carried out the Engineer shall be given 24 hours notice. All defects located shall be corrected before further work proceeds and the whole of the section of work affected shall be re-tested.

No section of pipes shall be back-filled before it has been tested.

Test for Storm Water

- A. Testing shall be carried out before any pipes are hunched or surrounded with concrete. All joints shall be exposed.
- B. Storm water should be tested in section. Short branches connected to main runs shall be tested at the same time.
- C. The length to be tested shall be subjected to a static head pressure of not less than 1.5 M at the highest point of the section being tested. After sufficient length of time has been allowed for, the absorption of water into joints, the section under test shall be 'topped-up' and the head maintained without apparent loss for not less than one hour

Profile Test

- A. A hardwood ball, of an approved profile, shall be drawn through all foul drains from manhole to manhole and through branch foul drains before soil pipes, gullies and W.C.'s are filled. The diameter of the ball or profile shall differ from the nominal internal diameter of the pipe by not more than 6mm or by not more than 4% of the nominal internal diameter of the pipe, whichever is the greater difference.

- B. During commissioning, all manhole cover shall be removed and water flow tests shall be carried out to ensure that the drains are flowing at their designed capacity and that they are free of debris.

Manhole Test

- A. All manholes shall be tested in accordance with the requirements of BS 8301 and the requirements of the local authorities having the jurisdictions.
- B. The Engineer shall witness all manhole tests. The Contractor shall give the Engineer a minimum of 24 hours notice of all tests. The Contract shall also provide test sheets set out in an agreed manner for each manhole to be tested.
- C. All concrete manhole cast in situ and precast concrete manholes shall be water tested by plugging all necessary connections and filling the manholes with water to a minimum height of 600mm above the top of the benching. Water shall be added at ten-minute intervals until absorption has ceased. No change of water level shall occur for an uninterrupted period of three hours.

END OF SECTION

SECTION 15430

PLUMBING SYSTEMS SPECIFICATIONS

DOMESTIC WATER SERVICES

EXTENT OF WORKS

The work to be done under or in relation to this Section is as set out below, and as may be further described in this specification.

All work and materials not specifically mentioned in the specification but obviously necessary for the proper and complete installation and operation of the Mechanical Services, as envisaged in this Contract, shall be deemed to have been included in the Tender price.

Unless specified otherwise, all equipment and materials installed under this Contract shall be new.

The work covered by this Section comprises the supply, installation, coordination, commissioning, testing, placing in service and maintenance of the Mechanical Services as per specifications drafted in these sections, local codes and Construction Specifications tender drawings, schedule of drawings and as described elsewhere in the specification/contract documents. The Contractor shall therefore supply, deliver, install, test, commission and set to work the systems and they shall be complete with all necessary ancillary and minor items, whether expressly indicated on the drawings or specification or not. The work shall include but not be limited to the following:

- All water heating equipments, solar panels, and hot water cylinders, complete with insulation controllers, interconnecting pipe works, valves, trimming and accessories.
- All pumps complete with, skids interconnecting pipes valves, fittings, valves, flexible connections, and other accessories.
- All storage tanks complete with, skids interconnecting pipes valves, fittings, valves, floating valves, and other accessories.
- All automatic air vents at top of risers, and drain cocks at bottom of risers of main pipes.
- All pipe hangers, saddles and supports.
- All expansion bellows, loops, vibration & shock absorbers and joints.
- All Fire retardant and protection sealants for all pipes crossing fire rated structures.
- All adapters and dielectric unions for connecting dissimilar materials
- Protection against corrosion, pipe coating, as required per specifications and drawings.
- Vibration isolation for all equipment, fixtures, pipes, as stated in specifications. Disinfections, flushing and water treatment.
- Compliance with all acoustic and vibration control as described in specifications and in accordance to the ASHRAE and British Standards.
- Provision and making good around all openings in structure for all openings needed for pipes, conduits, ducts etc. including all cuttings patching, framing up, furring and making good.
- Trimmed openings in roof for ducts and pipes complete with under flashings.
- All necessary supports, kerbs, and under flashing for all roof equipment.
- Access panels in fixed ceilings for access to valves, balancing and testing taps.
- Over flashing of all roofing penetrations.

- All electrical controllers and services required for the operation of all plumbing and sanitary systems, including:-
 - All wiring between the switch boards and the sanitary fixtures to drive the infrared fixtures
 - All circuit breakers, fuses, starters, relays, switches, timers, pilot lights, and isolating switches, required for the satisfactory operation and maintenance of the systems.
 - All power wiring between the switch boards and motors, starters, heaters, and ancillary equipment including terminating lugs and final connections
- Setting to work, testing and commissioning of the system, including those systems as supplied by the client/ nominated supplier (The Contractor shall make allowance for required coordination etc.)
- All, tools, instruments, electric power supply fuel and water required for installation, testing, balancing, adjusting, disinfections, flushing, operation and commissioning.
- Warranty against defects for a period as noted under general contract conditions.
- Working drawings and as built drawings including permanent reduced scale diagrams as specified.
- Preparation and submission of maintenance and instruction Manuals including those systems as supplied by the client / nominated suppliers (the Contractor shall make allowance for the required coordination etc.)
- Operational maintenance at interval as noted in the special conditions of the contract.
- Instruction of the client's maintenance personnel in the operation and maintenance of all plumbing and sanitary systems including those systems as supplied by the Client/nominated supplier (the Contractor shall make allowance for the required coordination etc.)
- System identifications, tags, labels, nameplates, and charts
- All excavation and back fillings, of all trenches riggings, hoisting, water proofing, cleaning, protection
- Supplying, installation and benching to all frame and covers for concrete storm water and drainage concrete trenches.
- Making good around all openings in the building structure for the penetration of pipes, ducts, grilles and conduits and all cutting, patching, framing up, furring in and making good associated with the building structure.
- Trimmed openings in beams, walls, ceiling and doors for pipe work, ductwork, diffusers, louvers and grilles.
- Positioning and fixing of all pipe sleeves and holding down bolts.
- Permanent access openings for adjustment and maintenance of equipment.
- The removal and replacement of ceiling tiles in each location where necessary to allow access to the concealed services during testing and commissioning of all systems.
- Sealing airtight plant rooms and ceiling voids.
- Fire rated shafts for duct risers and mechanical systems as required.
- The fire rating and retardant sealants around all pipes and conduits penetrating through fire walls.
- Intumescent collars and fire sealants around drainage pipes penetrating slabs and fire walls.
- Access doors in plant rooms where indicated on the drawings and required by mechanical plant. Access doors shall have the same acoustic rating as the plant room.
- Bulkheads.
- All lifting, lowering, handling and scaffolding including cranes as necessary.
- Concrete plinths under all equipment.

CODES AND STANDARDS

The installation, materials and all components shall comply with all statutory instruction and regulations current at the time of tender whether so detailed or not, and shall conform in all respects with the following:

- Safety Health and Welfare regulations issued by the MOPW
- Water Regulations issued by the Local Water Authority
- The Civil Defence Department Regulations
- Uniform Plumbing Code

Should any conflict arise between the codes and standard mentioned above, regulations issued by the local codes shall take precedence.

PIPES AND FITTINGS - MATERIALS

Pipe Works

PEX PIPES

- A. All pipes which run below tiles, from water manifold cabinet to sanitary fixture in toilets shall be of outer diameter 16 mm dia cross linked polyethylene heavy density high pressure type manufactured and listed to ASTM F876 and ASTM F877 or Equivalent.
.Pipes shall run in sleeves of diameter twice the diameter of pipes. Manifolds shall be provided in steel cabinets, for cold and hot water supply. Manifolds shall have special outlets, which can adopt PEX pipes. Cold & hot water inlets to manifolds shall be provided with isolation valves for maintenance. One main isolation valve shall be provided before each manifold inside the cabinets. Cabinets shall be of store enamel steel type, complete with brackets etc.
- B. Manifolds shall be supplied for sanitary ware, adoptable to plastic- copper and iron pipe ball valves in 3/4", female thread, with drain, chrome plated unit, up to DIN standard 1353.

PIPES AND FITTINGS - JOINTS

PEX pipes Fittings shall be of compression or press fittings type, all of gunmetal construction or of dezincification resistant brass

WATER MANIFOLD CABINETS

All components in the cabinet have to be manufactured by the same company.

The cabinet shall be of enamel painted sheet metal of at least 1.5mm thickness and similar to that used for electrical cabinets.

The cabinet's doors shall open and close completely and smoothly.

In case the cabinet was exposed, pipes penetrating the cabinet shall be surrounded with rubber annular escutcheons at the penetration point

Cabinets shall be manufactured of enamel baked painted steel.

The depth of the cabinet shall not exceed be 110 mm, and the dimensions shall be selected according to the length of manifolds required on the water distribution cabinets schedules drawings, and to be sufficient for the installation of all valves and fittings inside the cabinets. The cabinet shall be of enamel painted sheet metal of at least 1.5mm thickness and similar to that used for electrical cabinets.

The cabinets shall include the following:

Cold and Hot Water Manifolds

- Isolating valves on each branch from hot and cold manifolds
- Main isolating vales for both hot and cold water manifolds
- Shall be equipped with an automatic air vent on each collector
- The manifold shall be made from extrusive shaped, lead free dezincification resistant, brass bar with ends female threaded, and supplied with the required outlets: manufactured to BS 864 part 3.

Fittings shall be of non-manipulative compression type to BS 864 Part 3 all resistant to dezincification. And shall incorporate threads to BS 21 shall be made up using by using jointing compound to BS 5292 or PTFE Tape. Care must be taken at joint junctions between manifold and other ferrous pipe. A separation dielectric shall be interposed between the materials to prevent direct contact and subsequent electric action.

The outlet size shall be of the same internal bore as PEX pipes distribution to the sanitary taps. The connection of manifolds and outlets to copper and plastic tubes shall be made properly using adaptors with O-rings. Outlets that are not required, they shall be blanked off with plug and washer.

The manifolds shall be supported on the cabinet with adjustable horizontal brackets.

CONNECTIONS TO SANITARY FITTINGS

- A. All sanitary ware shall be provided on the drawing and approved by Engineer. Bib with mixers, taps, valves or mixer taps shall be bronze or gunmetal castings or hot press brass or manganese bronze and shall be chromium plated. Spindles, glands, crutches, washer plates and nuts shall be of brass or bronze. The taps shall have crutch or capstan head made of metal, being marked hot or cold with tail having external parallel thread. They shall be marked with manufacturer's name or trademark.

The water supply connection to the sanitary fittings shall be in the following sizes:

<u>Fixtures</u>	<u>Size</u>
Lavatory	Outer Diameter of 16mm PEX Pipes
W.C	Outer Diameter of 16mm PEX Pipes
Sink Unit	Outer Diameter of 20mm PEX Pipes
Emergency Shower	40mm polypropylene Pipes
Hand Spray	Outer Diameter of 16mm PEX Pipes

UNDERGROUND COLD WATER PIPE LAYING

General

- A. Underground cold water services shall comply with British Standard Code of Practice CP 310, 1965 and CP 2010: Part 3: 1972.
- B. Each type of pipe work material and associated fittings shall be obtained from one manufacturer only, who shall be nominated by the Contractor in writing and approved by the Engineer prior to ordering any materials.

VALVE CHAMBER

Furnish and install valves chamber for all main water pipe connections to buildings.

Valve chambers and valve boxes shall be constructed from reinforced concrete for valve sizes equal to Ø65mm or greatest and from prefabricated from high density polyethylene for small valve sizes.

Valves chamber and valve box shall be provided with cast iron cover and frame in accordance with B.S.

Valves chamber shall be complete with blinding, base, walls, cover iron steps, plastering, framework, shuttering etc.

FLOAT VALVES

Float valves shall be of all bronze construction including levers and arms, with copper float and shall be suitable for a cold water working pressure of 10 bar. Float valves size 50 mm and smaller shall have screwed inlets and size 65 mm. and larger shall have flanged inlets.

Float valves shall be of the full bore, equilibrium ball type, designed to close tight against maximum pressure when half submerged. They shall have renewable synthetic rubber valve disk and balancing piston bucket.

Float valves shall conform to BS 1212 and BS 1968.

INSULATION OF PIPE WORK

Refer to Pipe insulation specification.

WATER FLOW METER AND TOTALIZER

Furnish and install water meter on the main water supply.

Meters shall be of the turbine type with totaliser. Housed in purpose made galvanised steel cabinet.

Provide all necessary pipework, valves, and fittings

- 2 isolating valves.
- Check Valve.

- Strainer.

WATER SAVERS

Furnish and install water saver on all sanitary fixtures and mixers.

Water savers shall restrict flow rates to 0.2 L/s, independently from the flow pressure . The unit shall operate between pressure ranges 1-8 bars.

Water savers shall be of high quality chrome plated brass, compatible to the used sanitary mixers.

Savers shall be fitted at the discharge of all sanitary mixers, in place of the aerators and shall be vandal proof and of self cleansing features of sediments up to 1mm.

COLD WATER STORAGE GALVANIZED STEEL TANK

- A. Cold water storage tanks shall be manufactured to British Standards and to comply strictly with the local codes and Regulations.
- B. The tanks shall be provided to the capacities, dimensions and locations shown on the drawings.
- D. The Contractor shall submit full specification of the tanks and procedural methods of installation including plans and drawings.
- E. The tank shall be manufactured from galvanized steel metal sheets with a minimum thickness of 2mm.
- F. Stiffeners tube with a diameter not less than 25mm manufactured from galvanizued steel tubes shall be installed in the tank.
- G. Each tank is to be fixed on a base, which will support the whole of the tank. The details of the tank base are to be approved to the Engineer approval before any installation work begins.
- H. Each tank shall be fitted with the following:
 - Ball valve with stopcock
 - Overflow pipe on size larger than the ball valve.
 - Drain valve provided at the bottom of the tank
 - Close fitting openings in cover for water heater vents.
 - Manhole cover adjacent to ball valve.
 - Air vents with gooseneck and wire mesh.
 - Level Switches to control pumps operation when the roof tanks are filled from ground water reservoir by a lifting pump.
- I. After installation, tanks shall be filled with water for testing for 24 hours. No leakage shall be observed at joints.
- J. Tanks shall be guaranteed for minimum 5 years.

FINAL TESTS AND COMMISSIONING

The Contractor shall start-up and operate the whole installation for a period of not less than 48 hours, during which time all valves, pumps, heaters, fixtures, etc., shall be operated as would occur in the normal operation of the installation for the full period of this test. At the conclusion, the whole of the system shall operate to full satisfaction of the Engineer. Testing generally shall be in accordance with BS CP 310:1965.

Pipe Work Pressure Testing

- A. All pipe work services shall be subjected to a test of 10 bar or one and a half times working pressure whichever is the greater, for not less than 12 hours.
- B. Where pipe work is tested in sections, all valves shall be blanked off temporarily using plugs or blank flanges. The valve wedge shall not be used to retain the water. The pipe work services shall be charged with water allowing all air to escape and avoiding shock or water hammer. The test pressure gauge shall be mounted within the pipe work system with a loop and cock and shall be calibrated such that the test pressure falls above its mid-range.
- C. The Contractor shall carry out his own test first to ensure there are no leaks prior to requesting the Engineer to witness the test. The witnessed test shall be maintained for a minimum of one hour without measurable loss and without further pumping.
- D. Pipe work main laid in ground shall be tested for 24 hours and leakage shall be measured by the quantity of water pumped into the main under test. Leakage shall not exceed five litres per 25mm of pipe diameter per 1750 metre length of pipe for 33 metres head pressure in a period of 24 hours.
- E. The Engineer shall witness all pipe work tests. The Contractor shall give the Engineer a minimum of 24 hours notice of all tests. The Contractor shall also provide test sheets set out in an agreed manner for each pipe work section to be tested.

Proving Tests

- A. Prior to fixing on site, all cisterns and storage tanks shall be re-tested for water tightness ensuring damaged equipment is not installed.
- B. Each water service shall be cleaned down and thoroughly flushed out to remove all dirt within the pipe work system.
- C. After the particular water service has been flushed out, refilled and pressure tested, each tap and draw-off fitting shall be checked for satisfactory rate of flow. Particular attention shall be given to groups of sanitary fittings to ensure satisfactory flow with a number of taps open, also that is not drawn into any of the remaining taps or fittings when opened.

Sterilization of Water Services

- A. All pipe work, fittings and storage tanks shall be sterilised starting with the external water supplies storage tanks and finally the water distribution system.
- B. No sterilisation shall be carried out until the system has been flushed out and approval received in writing from the Engineer to commence sterilisation.
- C. The following procedure shall be adopted for sterilisation of the water distribution systems: -
 - a. Flush out all tanks, pipe work, etc
 - b. Recharge all water systems adding sufficient sterilisation chemical at the plant room tank of a concentration shall be confirmed by using a measuring instrument approved by the Water Authority.
 - c. Starting with the draw-off point nearest the cold-water storage tank, each draw-off point shall be opened until chlorine odour is present at each draw-off.
 - d. When all draw-off points have discharged chlorinated water, the cold water storage tanks shall be recharged adding sufficient sterilisation chemical to give the correct concentration of 1-2 parts per million of chlorine. The system shall then remain charged for a minimum period of one hour.
 - e. The water shall then be chemically analysed.

- f. Finally a sample of tank water shall be taken to the third party approved laboratory for testing. The results of these tests shall be forwarded to the Engineer for his approval.

Booster Pump Set Tests

- A. The booster pump set shall be demonstrated to operate satisfactorily and the following shall specifically be carried out for each pump.
- a. That a constant and steady flow without fluctuation occurs
 - b. That the system pressure is maintained during the test period
 - c. That the duty pump cuts in automatically
 - d. That the float switches operate correctly.
- B. After satisfactory completion of the above tests, a fault shall be introduced to the duty pump in order to demonstrate that the standby pump set cuts in automatically and the pump failure indicator lights operate correctly.

Domestic Hot Water System

Electric Water heater (EWH)

Small sizes electrical heaters shall be furnished with residential (EWH). The residential electric water heater shall be of storage type with heating capacity and storage capacity on schedule of equipment. Heater shall be rated at 240 volt single phase, 50 HZ. Heaters shall have a maximum working pressure of 10 bars. And an energy factor of 0.95 or greater.

The tank shall be of double skin injected with insulation foam of R21 insulation value. The jacket shall full size compartments for the performance of service and maintenance through front panel openings and enclose the tank with foam insulation.

The internal surfaces of the cylinder shall be of glass lined with an alkine borosilicate composition fused to steel and guaranteed corrosion proof.

The outer surface shall be treated cleaned and bake enamel paint finished for extra protection against corrosion

The tank shall be provided with 20mm tapping and temperature pressure relief valve and with a sacrificial anode rod for maximum cathodic protection. The tanks shall also be provided with two isolating valves, vacuum breaker, non return valves, drain cock and thermometer.

The controls shall include a thermostat with each element and high temperature cut out switch.

END OF SECTION

SECTION 15440 SANITARY FIXTURES SPECIFICATIONS

GENERAL

SUMMARY

Section Includes:

- Disabled Facility Hand Basin Type
- Semi pedestal Hand Basin Type
- Hand Basin Recessed Type /Drop In
- Tap
- Irrigation Tap Type
- Toilet Pan
- Toilet Eastern Type
- Toilet Pan for handicapped wheel chaired people
- Kinder garten Toilet Pan
- Electric Water Coolers
- Shower
- Cleaner's sink
- Kitchen Sink
- Kinder garten Lavatory
- Wash Trough

SUBMITTALS

- Submittal Procedures: Submittal procedures.
- Product Data: Submit catalog illustrations of fixtures, sizes, utility sizes, trim, and finishes.
- Samples: Submit one of each fixture type for approval before installing.
- Manufacturer's Installation Instructions: Submit installation methods and procedures.
- Manufacturer's Certificate: Certify products meet or exceed specified requirements.

CLOSEOUT SUBMITTALS

- Execution Requirements: Closeout procedures.
- Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

QUALITY ASSURANCE

- Perform Work in accordance with local codes, regulations and standards.
- Maintain one copy of each document on site.

QUALIFICATIONS

- Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- Installer: Company specializing in performing Work of this section with minimum five years documented experience.

DELIVERY, STORAGE, AND HANDLING

- Storing and handling including taking delivery, loading and unloading all fixtures and, fittings and other equipment shall be carried out by the Contractor in such a manner as to avoid breakage, distortion, denting or other damage. Stacking of materials shall be done in such a manner as to prevent to the pipe or coatings to the satisfaction of the Engineer.
- Plastic fittings shall be stored under cover and out of direct sunlight at all times. Pipes shall be supported throughout their entire length and free flow of air around them maintained. Generally, all pipes shall be handled using canvas slings not less than 250mm wide. The use of chains or wire slings will not be permitted.
- All valves and fittings shall be stored under cover on hard standing until required for fixing. Uncrated valves and fittings shall not be strapped.
- Pipes and fittings damaged during handling or storage shall be set aside and the Engineer informed. If in the Engineer's opinion the damage is such that the pipe or fitting has been permanently impaired it shall be removed from site.
- No repairs shall be started without the approval of the Engineer.

TRANSPORT AND HANDLING ON SITE

- a. The Contractor shall take every care to ensure that no damage whatsoever results to the fixture from transport and stacking. All trucks, wagons, stacking methods and devices shall have the approval of the Engineer but his approval shall in no way relieve the Contractor of his responsibilities under the Contract.
- b. Fixtures shall not be allowed to drop or strike objects, which may damage the pipe, but shall be lifted or lowered by suitable approved equipment. Hoister and buildings of approved type shall be used on all vehicles used for the transport of pipe.
- c. All fixtures shall be properly protected in factory assembled timbers with bedding of straw bags or similar approved by the Engineer.
- d. The Contractor shall ensure that all fixtures with special fittings stacked separately. As they should not be stacked. Fixtures shall laid on flat level ground and in such a manner as to prevent damage to other when handled

GENERAL SPECIFICATION

All sanitary fixtures, trim and accessories shall be of approved manufacture and manufacturer's standard.

All vitreous china shall be of first quality, and specified colour, with smooth glazed surface free from warp, cracks, flaws, discolouration or other imperfections.

All vitreous china accessories shall match fixtures.

Exposed piping and trim shall be chrome-plated brass with polished finish guaranteed not to strip or peel off.

Trim and accessories shall be chrome plated unless otherwise stated clearly in the specification. Concealed brackets, hangers and plates shall be painted as directed by the Engineer.

Proper fixture adapters shall of rubber or neoprene rings with ripped wiper seals on the outer face shall be provided on all waste outlets if wash basin sinks, and bidets. The seal shall be

concentric , tight fit inner bore suitable for waste pipe diameter and with the wall plate, The assembly shall cover the pipe externally and enclosed in escutcheon plate if the waste assembly and create an air and water tight sealed joint.

European water closets soil adopters shall be of moulded plastic adopter ring suitable for 100mm diameter soil pipe with ripped wiper seals on the outer face concentric /eccentric inner bore with wiper seals the tail pipe of the tail pipe of water closet and floor wall flange. The assembly shall cover the floor wall pipe externally and create an air and water tight seal joint.

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 to finished walls and floors.

Sanitary fixtures shall be fixed in accordance with the manufacturer's recommendations.

PRODUCTS

Disabled Facility Hand Basin Type

610x 500 mm wash basin. White, vitreous china, wall hung without overflow and with concealed wall trap, specially made for the use of handicapped wheel chaired people complete with the following trim and accessories:

- Self-closing metering mixer shall be a single handle vandal-resistant brass construction with a replaceable valve cartridge and an adjustable timed flow of water. Mixer should include mechanical mixing valve for tempered water. Shall have also feature water conserving of 4.5 l/min, at 3 bar hydraulic pressure without restrictors and with temperature limiter and pop-up waste. Opening time shall be 6-10 seconds. Push button activator shall meet ANSI A117.1 standard.
- 32mm. Dia. Chrome plated adjustable type P-trap with wall tube and wall flange.
- Two 15mm. Dia. Chrome plated angle valves with 300 mm long rigid tube and wall flange blue and red indices

Semi Pedestal Hand Basin Type

600x480 mm Semi pedestal wall hung wash basin. White, vitreous china bowl with overflow and mixer, complete with the following trim and accessories:

- Self-closing metering push button mixer shall be a single handle vandal-resistant brass construction with a replaceable valve cartridge and an adjustable timed flow of water. Mixer should include mechanical mixing valve for tempered water. Shall have also feature water conserving of 4.5 l/min, at 3 bar hydraulic pressure without restrictors and with temperature limiter and pop-up waste. Opening time shall be 6-10 seconds. Push button activator shall meet ANSI A117.1 standard.
- 32mm. Dia. Chrome plated adjustable type P-trap with wall tube and wall flange.
- Two 15mm. Dia. Chrome plated angle valves with 300 mm long rigid tube and wall flange blue and red indices

***Hand Wash Basin Recessed Type (Drop In)**

480x 560 mm recessed wash basin. White, vitreous china with one tap hole and overflow.

Also with Chrome plated single-lever basin Mixer with brass body, flow rate: 4.5 l/min, at 3 bar hydraulic pressure without restrictors and with temperature limiter, dirt strainer, non return valve, flexible connection hose and pop-up waste.

32mm. Dia. Chrome plated adjustable type P-trap with wall tube and wall flange.

Two 15mm. Dia. Chrome plated angle valves with 300 mm long rigid tube and wall flange blue and red indices.

Tap

Self-closing metering push button faucet shall be a single handle vandal-resistant brass construction with a replaceable valve cartridge and an adjustable timed flow of water. Shall have also feature water conserving of 4.5 l/min, at 3 bar hydraulic pressure without restrictors. Opening time shall be 6-10 seconds. Push button activator shall meet ANSI A117.1 standard. Tap for drinking fountain shall be frontal mounted.

Irrigation Tap Type

Metering faucet shall feature a hose-end with lever handle in nickel plated brass ½”.

Toilet Pan

White vitreous china, 550 x 360 mm with back outlet, wall hung WC complete with the following trim and accessories:

- Solid plastic seat and cover of same colour as water closet, with metal chrome hinge, soft closing and rubber washers.
- 6 liter concealed flush cistern without for a floor mounted toilet bowls
Installation height depends on the selected toilet bowl, capacity of 6/3 L dual-flush, complete with stainless steel control panel, U-shaped, galvanised support element with all required fastenings and all parts necessary to fix and connect the product . The cistern shall be connected to water supply at centre back or at the top with protection box for access opening with angle stop valve DZR half inch dia. The cistern shall also be provided with outlet bend 110mm
- Operating plate actuator, for concealed cistern with small access opening front -operated, dual flush 6/3 litres, operating plate shall be stainless steel with security screw, material: stainless steel, clean surface.
- 110mm push fit on to WC plastic outlet connector.
- Heavy Duty Hand spray hose bib complete with chrome plated globe angle valve with integral vacuum breaker male threaded inlet, one-meter metal flexible hose and wall hook.

Toilet Eastern Type

White vitreous china Eastern type with shallow bottom outlet, size of 590mm x 500mm x 157mm Complete with the following trim and accessories:-

- 110mm push fit on to WC plastic outlet connector.
- Heavy Duty Hand spray hose bib complete with chrome plated globe angle valve with integral vacuum breaker male threaded inlet, one-meter metal flexible hose and wall hook.
- liter concealed flush cistern without for a floor mounted toilet bowls
- Installation height shall be suitable to eastern type toilet, capacity of 6/3 L dual-flush, complete with stainless steel control panel, U-shaped, galvanised support element with all required fastenings and all parts necessary to fix and connect the product . The cistern shall

be connected to water supply at centre back or at the top with protection box for access opening with angle stop valve DZR half inch dia. The cistern shall also be provided with outlet bend 110mm

- Operating plate actuator, for concealed cistern with small access opening front -operated, dual flush 6/3 litres, operating plate shall be stainless steel with security screw, material: stainless steel, clean surface.

Toilet Pan for handicapped wheel chaired people

White vitreous china, elongated 520x370 mm bowl with bottom outlet of 480mm height for use of handicapped wheel chaired people, complete with the following trim and accessories or approved equal:-

- Solid plastic seat and cover of same colour as water closet, with metal chrome hinge, and rubber washers.
- Heavy Duty Hand spray hose bib complete with chrome plated globe angle valve with integral vacuum breaker male threaded inlet , one-meter metal flexible hose and wall hook
- All accessories and fitting as per the local codes for the handicapped wheel chaired people.
- 6 liter concealed flush cistern without for a floor mounted toilet bowls
- Installation height depends on the selected toilet bowl, capacity of 6/3 L dual-flush, complete with stainless steel control panel, U-shaped, galvanised support element with all required fastenings and all parts necessary to fix and connect the product . The cistern shall be connected to water supply at centre back or at the top with protection box for access opening with angle stop valve DZR half inch dia. The cistern shall also be provided with outlet bend 110mm
- Operating plate actuator, for concealed cistern with small access opening front -operated, dual flush 6/3 litres, operating plate shall be stainless steel with security screw, material: stainless steel, clean surface.

The following accessories shall be utilized for disabled toilets:

- Two stainless steel grab rails 600mm long (one fixed horizontally and the other vertically as per Detail WAD-04 from the book of details).
- Stainless steel hinged support reversible grab rails.

Kinder Garten Toilet Pan

White vitreous china, 490x315 mm bowl with bottom outlet of 305mm height, for junior application, floor mounted WC completes with the following trim and accessories or approved equal:-

- Solid plastic seat and cover of same colour as water closet, with metal chrome hinge, soft closing and rubber washers.
- 110mm push fit on to WC plastic outlet connector.
- Heavy Duty Hand spray hose bib complete with chrome plated globe angle valve with integral vacuum breaker male threaded inlet , one-meter metal flexible hose and wall hook.
- Installation height shall be suitable to eastern type toilet--, capacity of 6/3 L dual-flush high level, complete with stainless steel control panel, U-shaped, galvanised support element with all required fastenings and all parts necessary to fix and connect the product. The cistern shall be connected to water supply at centre back or at the top with protection box for access opening with angle stop valve DZR half inch dia. The cistern shall also be provided with outlet bend 110mm

***Kinder Garten Lavatory**

- Size (450mmx330mm) Semi Pedestal Hand Wash Basin. White, vitreous china with one tap hole and overflow, at 60 cm height from F.F.L.
- Self-closing metering mixer shall be a single handle vandal-resistant brass construction with a replaceable valve cartridge and an adjustable timed flow of water. Mixer should include mechanical mixing valve for tempered water. Shall have also feature water conserving of 4.5 l/min, at 3 bar hydraulic pressure without restrictors and with temperature limiter and pop-up waste. Opening time shall be 6-10 seconds. Push button activator shall meet ANSI A117.1 standard.
- 32mm. Dia. Chrome plated adjustable type P-trap with wall tube and wall flange.
- Two 15mm. Dia. Chrome plated angle valves with 300 mm long rigid tube and wall flange blue and red indices.

***Wash Trough**

- Acrylic solid surface material wall mounted wash trough, bright white color to total width of 450 mm and 300 mm front facia and 7.5 cm rear upstand. (Lenght of trough as per BOQ and drawings)
- Self-closing metering mixer shall be a single handle vandal-resistant brass construction with a replaceable valve cartridge and an adjustable timed flow of water. Mixer should include mechanical mixing valve for tempered water. Shall have also feature water conserving of 4.5 l/min, at 3 bar hydraulic pressure without restrictors and with temperature limiter and pop-up waste. Opening time shall be 6-10 seconds. Push button activator shall meet ANSI A117.1 standard.
- 32mm. Dia. Chrome plated adjustable type P-trap with wall tube and wall flange.
- Two 15mm. Dia. Chrome plated angle valves with 300 mm long rigid tube and wall flange blue and red indices.

Shower

White vitreous china sunk in receptor, 900x900x145mm deep with high-grade gel coat finish and 50mm corner drain opening, or approved equal, complete with the following trim and accessories:

Chrome plated, adjustable hand shower spray completed with shower bar, hose and soap dish.

Chrome plated brass body thermostatic shower, mixer with integrated volume control, 7.6 l/min, at 3 bar hydraulic pressure without restrictors and with lever for volume control.

Cleaner's sink

Cleaner's sink for wall mounting, Sinks size 520x 390 mm White ceramic heavy duty, with overflow, with rim guard and wall hanger and bracket. Completed with following trim and accessories:

- Chrome plated brass body one-hole single-lever cleaner's sink tap, flow rate: 9 l/min, at 3 bar hydraulic pressure without restrictors and with lever for volume control.
- Stainless steel gratings
- Legs and bearers with sink screwed to wall (if required by the manufacturer)
- 50 mm pop-up waste.
- P-trap with strainer outlet to wall, wall tube and wall flange.

Kitchen Sink

- 304 Stainless steel, 1.6 mm. Thickness kitchen sink, single bowl, size of 1000mm x 600mm. . The sink shall be provided with stainless steel cantilevered with three tap holes for pillar mixer, chain stay hole and overflow and with back splash end.
- The sink shall be complete with the following trim and accessories: -
 - 40 mm. Dia chrome plated waste with stainless steel grating and chain stay and plug.
 - 40-mm. Plastic bottle trap with extension tube.
 - Flexible plastic tube for overflow connection.
 - 15 mm. Dia. Chrome plated angle valves with flexible copper tube and wall flange.
 - 15 mm. Dia. Chrome plated pillar mixer with swivel spout projection 210 mm, or with wall-mounted mixer.

Electric Water Coolers

Two-Level self-contained, heavy-duty, vandal-resistant water cooler shall include:

- 14 gauge stainless steel welded construction for extreme tamper-resistance and curved profile for safety.
- Front pushbutton activation with less than 5 lbs of force (easy to operate) must be self-closing vandal-resistant and not easily removed without special tools
- One-piece, heavy-duty vandal-resistant bubbler and integral drain in basin shall operate on 20-105 psi (1.5-7 bars) supply line pressure with flow regulator to reduce the flow of water by nearly 40%.
- Louvered screens with holes sized to prevent easy tampering.
- Vandal-resistant Drain: Heavy-duty, one-piece construction.
- Cooling system includes: compressor, fan cooled condenser, cooling unit and refrigerant control (Refrigerant R134a is controlled by accurately calibrated capillary tube)
- 1500-gallon (5680 L) capacity activated carbon filter certified to NSF/ANSI 42 and 53 (Lead, Class 1 Particulate, Chlorine, Taste & Odor)

- 32mm P- Trap
- Water Supply copper tube with Shut-off Valve.
- Electrical Supply Wire Recessed Box Duplex Outlet.
- Bolt Holes for fastening to wall.

Electric water cooler shall be lead-free design which is certified to NSF/ANSI 61 and 372.

Electric water cooler shall deliver 8 GPH 30 (l/h) of 50°F (10 degree C) drinking water at 90°F (32 degree C) ambient and 80°F (27 degree C) inlet water.

EXECUTION

Examination

Verify that site conditions are ready to receive work and dimensions are as instructed by the manufacturer.

Verify exact location of accessories for installation.

Preparation

Deliver inserts and rough-in frames to site for timely installation.

Templates: Furnish to the Toilet Partition contractor templates required to locate drilled holes and cutouts for installation of bearing support to all partition mounted accessories.

Provide templates and rough-in measurements as required.

Installation

Install accessories in accordance with manufacturers' instructions and ANSI A117.1.

Install plumb and level, securely and rigidly anchored to substrate.

Toilet Room Accessories: Install where indicated on drawings, as recommended by the manufacturer and as directed by the Engineer, rigidly secured and in perfect alignment with other fixtures.

Metal Trim: Items exposed in the finished work shall be free from buckle, warping and oil-canning effects. Metal to metal contact shall have hairline joints.

Use concealed fastenings wherever possible.

Provide anchors, bolts and other necessary anchorages, and attach accessories securely to walls and partitions in locations as shown or directed.

Install concealed mounting devices and fasteners fabricated of the same material as the accessories, or of galvanized steel, as recommended by the manufacturer.

Install exposed mounting devices and fasteners finished to match the accessories.

Provide theft-resistant fasteners for accessory mountings.

Secure toilet room accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

PROTECTION AND ACCEPTANCE

The Contractor shall suitably protect the work in order to maintain finishes in perfect condition until Substantial completion and acceptance. Any changed or defective work shall be removed and replaced at no additional cost to the Owner.

The finished installation shall be sound and free from defects of materials and workmanship. After the inspection of the installation and its approval by the Engineer, protection, labels, smears and stains shall be removed and mirrors shall be washed clean.

END OF SECTION

SECTION 15480

FUEL SYSTEM SPECIFICATIONS

FUEL INSTALLATIONS

SCOPE OF WORK

The installation of the central fuel oil system and the installation of the LPG system
The work shall be commissioned in accordance with the Jordan Petroleum Refinery Company code of requirements and handed over in a fully reliable working condition.

FUEL OIL PLANT

FUEL OIL STORAGE TANKS

Oil tanks shall be rectangular, above ground, fabricated from 3mm thick high quality black steel plates of welded construction on both the internal and the external seams and to the size as indicated on the Drawings, and according to Jordan Petroleum Refinery Company Standard.

The tanks shall be raised on steel cradles with all necessary level indicators. One-supply lines from the tank to feed the boilers and the fire valve shall be installed on the feed line of each equipment.

Tank shall be provided with the following:

- One 25 mm. screened air vent,
- One 25 mm. sludge drain line from oil tank sump. Outlet to be complete with caps and chains and suitably marked isolation valve to prevent accidental
- Two 25 mm. suction line from oil tank to generator/ Boiler. The outlet to be complete with isolation valve.
- One oil contents gauge with scale calibrated in liters capacity. Gauge mechanism to be housed in a weather- proof "clear vision" enclosure.
- One 600 mm. diameter manholes. The manhole to be fitted with a raised manhole lid securely fixed by bolts and a gasket to provide a liquid and vapor tight joint.
- One copper earthing conductor connected to earthing ground studs.

Filters

Oil filters shall be fitted on the inlet side of the burner.

The filters shall be line size, tested to 20 bar and shall have gunmetal body and covers, stainless steel internals with a stainless steel mesh element and be complete with brass drain plug. The elements shall be capable of filtration down to 100 microns.

Fill Point Cabinet

Fill point cabinet shall be with integral drip tray be wall mounted.

Fill point cabinet shall be made of mild steel, coated with a protective aluminum finish.

Cabinet doors shall be supplied with a grey epoxy powder coating.

Fill point cabinet shall be equipped with 50 mm pipe work, ball valve, check valve, tank gauge, and tanker delivery hose connection complete with its own captive dust cap.

LIQUEFIED PETROLEUM GAS (LPG) PLANT

References

The LPG plant and piping installation shall conform to:-

- American Standard Installation of Gas Appliances and Gas Piping (ASA Z21.30).
- National Fire Protection Association of the U.S. NFPA No. 54,
- ‘National Fuel Gas Code’ & NFPA 58 “Liquefied Petroleum Gas Code” or other approved British or German societies
- Local Civil Defence Department
- Ministry of Energy and Mineral Resources regulations
- All valves and fitting used in the LPG system shall be UL listed and suitable for LPG applications.

System Components

The plant shall mainly comprise of:

- Manifold headers complete with their pig tail pipe connections, valves.
- Pressure Regulators.
- Pressure Gages.
- Safety Relief Valves.
- Solenoid Vales.
- Gas leak detection system.
- Pipe Works and valves.
- Automatic fire valves and seismic shut off valves.

GAS Leak detection control panel (GLDS):

The GAS leak detection control panel shall be UL listed.

The GAS leak detection control panel shall be connected to the GAS leak detection sensors and the solenoid valves on the main gas line shall be commanded to close in case of a confirmed fire alarm signal or if any of the gas detection systems is activated.

The solenoid valve open/closed position shall be monitored by The GAS leak detection control panel.

Vacuum pipelines shall be provided with pressure sensors near area valve service units, which display red indicators on the area alarm panel.

In case of leakage the GAS leak detection control panel shall send an order to the solenoid valve to switched off.

A panic bush bottom shall be mounted in the area of GAS usage and shall be connected to the GAS leak detection control panel which shall also send an order to the solenoid valve to switch off.

Pressure Gauges:

The gauges shall conform to BS.1780 and be of the safety pattern and be graduated in bars and p.s.i.

Gauges shall be degreased and maintained in this condition before and after installation. The dials shall be marked with a blue line at the normal working pressure and a red line at the minimum allowable pressure.

Safety Relief Valve:

The valves shall be of a type which can be locked and sealed and shall be of non-ferrous material.

Each Relief Valve shall be coupled to a copper vent pipe one size larger than the distribution pipe and vented to atmosphere at a 3 meters level above the roof and at a position outside the building. The end of the vent pipe shall terminate in an inverted 'U' bend with wire mesh and a suitable shield. The discharge point shall be finally agreed on Site by the Engineer and Contractor to ensure that there is no danger of fire, injury to personnel, contamination or interference with air intakes or windows. The safety valve and vent pipe shall be supplied and installed in a degreased condition. Weather proof notices shall be fixed at each discharge point stating in English & Arabic:

“Danger keep clear, LPG discharge point”

Pressure Regulating valves and station

The pressure regulators shall be specially manufactured, for LPG use, as they shall be approved and certified by UL or LP gas associates.

Pressure regulators shall be fitted on two stages:

1- The First Stage Regulating Station (PRV-P1)

First stage regulators shall be fitted on the outgoing main, from the gas plant.

Gas regulator shall be installed in duplicate for standby purposes, as to control the pressure of the main pipe and LPG supply.

Regulator shall be designed to reduce LPG pressure from cylinder and main gas pressure down to a maximum of 500mbar as to suite the running distances of the LPG networks.

The valve shall be of die cast aluminum alloy body and spring case, internal relief valve tapped and screened vent on low side

The pressure shall be reduced to a gauge pressure of 550mm WC.

One pressure gauge and one safety relief valve shall be fitted on the outgoing main following the pressure regulating valves. They shall be of the type and size as to suite the running distances of the LPG networks.

Relief valve to be factory set to start to discharge at approximately 710 mm water column.

Regulator seat shall be synthetic rubber, replaceable without disconnecting regulator from the line. Regulator to be complete with mounting brackets

Gas pressure regulator shall be equivalent to Rego, Comap, Fisher Controls C.

2- Second Stage Regulator: (PRV-S1)

The second stage regulator shall be installed for consumer appliances use, Regulator shall be designed to reduce LPG pressure from the first stage regulator pressure outlet to burner pressure. The valve shall be of die cast aluminum alloy body and spring case, internal relief valve tapped and screened vent on low side.

Relief valve to be factory set to start to discharge at approximately 710 mm water column.

Regulator seat to be synthetic rubber, replaceable without disconnecting regulator from the line.

Regulator to be complete with mounting brackets.

Gas pressure regulator shall be as manufactured by Rego, Comap, Fisher Controls Co.

Control Panel Identification

Each panel shall carry in large letters on the front the name of the gas being controlled; the letters shall be embossed, engraved or otherwise marked on so indelible. Painting or adhesive lettering shall not be permitted.

Electricity Supply

The power supply shall be intrinsically safe and suitable for LPG applications

Power Supply shall be operating on 250 volts, single phase, 50 Hertz, A.C. Supply.

Any internal wiring in the panel shall have a flame retarding sheath.

Precautions against leakage

All parts of the Control Panel shall be constructed of materials which will not deteriorate during service and lead to leakage. Diaphragm gaskets of pressure regulators shall not be of fibre but of brass.

PIPES

Pipes extending from regulating valve to appliance shall be manufactured from Phosphorous de-oxidized non-arsenical copper to BS 2871 manufactured to EN1057, table Y protected by polyethylene coating.

Fittings shall be of Brazed or Flared with a material having melting temperature $> 600^{\circ}\text{C}$ and shall be manufactured to Phosphorous de-oxidized non-arsenical copper to BS 6017 grade C106 manufactured to 864, Part 2.

Flared joints shall not be used in concealed locations
Compression fittings shall not be used.

Flanged joints: make with approved gaskets suitable for LPG gas. Do not use rubber, synthetic rubber, lead, compressed ceramic fiber sheet or other material that is combustible, contains organic binder or has melting point below 650 °C.

Components and Accessories

Gaskets: spiral wound, stainless steel, and asbestos filled type, as manufactured by flexitallic.

Drip legs: to comprise a minimum 150 mm long nipple and cap connected to the bottom outlet of tee of same size as riser.

Thread sealant: as manufactured by 3M similar to scotch brand No. 48.

Valves

Isolation valves: Isolation valves shall be to BS 1552, or ASTM B16.1 suitable for LPG use.

50 mm diameter and under shall be screwed. Body shall be of bronze or Dezincification Resistant brass alloy, with PTFE seats and seals. Blow-out Proof stem.

The valves shall be UL approved and certified, as manufactured by British Gas.

Wrapping Tape

Wrapping tapes: 50 mm wide, self adhesive, denso tape, over wrapped with 50 mm self adhesive PVC tape.

Workmanship & System Installation

Execute in strict accordance with the standards of the National Fire Protection Association of the U.S. NFPA No. 54, ‘National Fuel Gas Code’ & NFPA 58 ‘Liquefied Petroleum Gas Code’ and other approved British, German and local societies

Pipe work installations

Install pipe work at slope of not less than 2% with horizontal lines sloping toward risers and from risers to appliances.

Install pipe work overhead and closer to walls.

Copper tubes shall be protected against mechanical damages .

Concealed pipes shall chase in hollow blocks and not in solid partitions.

Do not bury under buildings directly.

The sleeve shall extend through normally usable and accessible portion inside the building and outside the building from the other edge. Sleeves shall be well sealed against gas leak inside building. And shall be vented outside the building in a goose neck connection.

Branch pipes are to be taken off from top or sides of horizontal lines.

Changes in direction: make with fittings only. Do not bend pipes.

Prohibited fittings: do not use unions, bushings, running threads or swing joints made by combination of fittings.

Flanged joints: use new gasket only. If joint is broken and remade, destroy used gasket so that it cannot be re-used.

Damaged pipes and fittings: do not use of threads are stripped, chipped, corroded or otherwise damaged.

Pipe work disassembled after installation: re-use pipes and fittings only after thorough cleaning and inspection to ascertain their equivalence to new material.

Outlets to appliances:

- a) Locate far enough from floor, walls, slabs and ceilings to permit proper use of wrenches without straining piping.
- b) To be securely fastened in place at the outlet.
- c) Close securely gaslight with threaded plug or cap, including valves, until appliance is connected.

Connections to appliances: make with rigid pipe only. Do not use hose of any kind.

Mark valves clearly with metal tag to identify gas piping system.

Testing

Gas tightness:

- a) Test piping by filing with air or inert gas such as carbon dioxide or nitrogen. Do not use water or oxygen. Apply pressure from pressurized cylinder or with air pump. Measure pressure with mercury manometer or inclined gauge calibrated in increments not greater than 0.7 kPa. Isolate pressure source during test.
- b) Test piping to 1.5 times normal working pressure or 70 kPa, whichever is greater. There is to be no drop in shut-in pressure for two hours. Test for leaks by applying soap solution to joints, fittings and valves. Do not use flame to look for leaks.

Commissioning

Check for gas tightness: prior to turning on gas, close all shut-off valves at appliances. Check that all openings are capped or plugged and that pipe work is complete.

Check for gas tightness: turn on gas, attach manometer calibrated in increments of 2.5mm water column to appliance outlet and open main shut-off valve momentarily. No discernible drop in pressure is to occur during 3 minutes. Should pressure drop be noted, identify cause, make necessary repairs and repeat tests until perfectly tight system is assured.

Purge appliances after purging piping and light pilot lights.

Color coding: pipelines to be color coded in accordance with ASME color code.

END OF SECTION

SECTION 15520

PUMPS

GENERAL

SUBMITTALS

The following documents of all pumps shall be submitted to for approval, prior to shipment from the factory.

- A. 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.
- B. Pump cross-sectional drawing showing major components with parts numbers and parts list.
- C. Pumps outline dimensional drawing showing overall dimensions, location of foundations bolts holes and size, location and rating of suction and discharge nozzles of pumps.
- D. Recommended spare parts list for 2 years operation.
- E. Detailed wiring diagrams of pumps controllers, and any other electrical devices of accessories.
- F. Installation, operation and maintenance instruction manuals.

CLOSEOUT SUBMITTALS

Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
Maintain one copy of each document on site.

DELIVERY, STORAGE, AND HANDLING

Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

EXTRA MATERIALS

Furnish one set of mechanical seals for each pump pumps.

Furnish one set of motor bearings for each pump.

CODES AND STANDARDS

Work and materials shall conform to the British Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
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SMACNA:	Sheet Metal and Air conditioning Contractors National Association,.
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PUMPS

GENERAL REQUIREMENTS

- A. All pumps shall be provided from the factory complete with their motors.
- B. 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.
- C. All pumps shall be located in accessible locations for ease of repair and maintenance.
- D. 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.
- E. Each pump shall be tested at the factory to provide detailed performance data and to demonstrate its compliance with the specification.
- F. The manufacturer for pressure not less than 10 bars shall hydrostatically test each pump at 85°C.
- G. Piping shall be supported independent of pumps to prevent piping weight or stresses from bearing on or being transmitted to the pump nozzles.
- H. Drains from base plate, pump, relief valves, etc. shall be piped to the floor drain located in pump room.
- I. All conduits for electrical works in pumps room shall be heavy gauge galvanized steel.

Additional weather proofing and shading to protect all roof exposed pumps against the prevailing weather conditions

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.

Multiple pumps selections shall take in considerations the total system demand and the independent operation of each pump. Consideration shall be given for a single pump operation as to avoid possible over run, and the consequential motors overheats and burns.

PRODUCTS

Pump Motors

- A. The motors of all pumps shall be of squirrel cage induction type and rated for continuous operation to suite maximum ambient temperature and direct sun exposures and by any mean not less than 55°C.
- B. The motors shall be totally enclosed fan cooled type with insulation class F and IP 54 protection. The motor shall be rated -230 volt - single phase and 50 cycles for motor capacities less than 1.5 horsepower.
- C. 415 volt - three phases and 50 cycles for motor capacities greater than or equal 1.5 horsepower.
- D. The motor shall be designed for:
- E. Direct On Line (DOL) starts for motor capacities less than 10 horsepower.
- F. The motor speed shall not exceed 2900 RPM; unless otherwise stated.
- G. 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.
- H. All motor terminals shall be marked in accordance with NEMA Standard MG1-Part 2.
- I. All motors shall be provided with nameplates in accordance with NFPA 70.
- J. Motor power factor shall not be less than 0.85.
- K. 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.

Foundation and Setting

Base Mounted 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.

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 deflecting support. Pump and motor shall be aligned at the factory.

Realignment is required after grouting in of base plate and after connecting piping.

House Keeping pads foundations and Kinetic floating bases shall also be provided for the pump assembly in accordance to ASHRAE recommendations. And as per vibrations and noise control sections

Accessories

- One isolating valve on the Suction Side and the Discharge Side of each pump.

- Check valve
- Strainer
- Two pressure gauges
- 20 mm pressure relief vents
- Air release valves
- Two flexible connections
- Vibration isolators
- Concrete base
- Anti vibration pad
- All interconnecting pipe work and headers and all related power control accessories.

In Line Centrifugal Close Coupled Circulating Pump

- A. for installation in vertical position, capable of being serviced without disturbing piping connections
- B. 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.
- C. The pump motor shall be of squirrel cage induction type rated for continuous operation at ambient temperature not less than 50°C.
- D. The motor shall be totally enclosed fan cooled type with insulation class F and IP54 protection. or it shall meet NEMA specifications
- E. Motor shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed.
- F. The motor shall be rated for 230 volt, 1 phase and 50 cycle.
- G. 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 cap screw.
- H. 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.
- I. Pump shall be rated for minimum of 10 bar working pressure at 85°C.
- J. Volute shall have gauge tapings at the suction and discharge nozzles and vent and drain tapings at the top and bottom.
- K. Impeller sizes shall not exceed 80% of maximum size available for pump casing.
- L. 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.

Water Boosting Pump-Set with Pressure Vessel

- a) The pump set shall be mounted on a chassis complete with suction and delivery manifolds, expansion vessels, valves and factory wired control panel, as approved by engineer. Motors shall have 2900 rpm and shall be TEFC, squirrel cage with class F insulation.
- b) The set shall be operated with the system pressurized and the control panel set to automatic.
- c) To obviate the possibility of the pump-hunting” minimum run timing relays shall be fitted into the control panel, which shall override the pressure switches when the pump-set is meeting relatively small demands. The selector switch on the control panel shall alternate the duty and standby pump.

- d) The control panel cubicle shall be manufactured in mild steel sheet, finished in stove enamel. The panel shall be damp and dust proofed to IP 55 and fitted with Test/Off/Auto switches and run/trip lamps for each pump, selector switch, low water and panel energized lamps, lockable door, door interlocked isolator, HRC fuses for motors and control circuits, motor starters and overloads along with terminals and labels. Motors shall be suitable for operation in ambient temperature of 50 degrees C.
- e) Low-level switch shall be incorporated in the water tank and arranged such that it prevents the pump set operating below the minimum water level.
- f) Each pump shall be vertical multistage of cast iron impeller and SS casing. The booster set shall be held to BS 5306 part 1, directly driven. A strainer shall be fitted on the manifold suction line. Flexible couplings shall be fitted to the inlet and delivery manifold connections.
- g) Each pump shall have isolating valves on the suction and delivery and non-return valves on the delivery.
- h) The pressure vessels shall be of steel with neoprene diaphragm.
- i) **Booster Pump Set Tests**
 - A. The booster pump set shall be demonstrated to operate satisfactorily and the following shall specifically be carried out for each pump.
 - a. That a constant and steady flow without fluctuation occurs
 - b. That the system pressure is maintained during the test period
 - c. That the duty pump cuts in automatically
 - d. That the float switches operate correctly.
 - B. After satisfactory completion of the above tests, a fault shall be introduced to the duty pump in order to demonstrate that the standby pump set cuts in automatically and the pump failure indicator lights operate correctly.

Packaged Variable Speed Booster Pumpset

The booster pumpset shall be completely automatic, factory assembled skid mounted unit.

The pump set shall maintain constant delivery pressure by means of a frequency converter to control speed of pumps. This shall be accomplished by distributing the demand load to all pumps by a microprocessor controller. The processor shall be adjusted for friction loss compensation, a small demand by the system shall be met from the vessel. As the demand increases and the pressure drops, the first pump starts automatically and shall continue to operate whilst there is a demand from the system. When the demand ceases the system and the pressure vessel is primed and reached the set pressure. Pump shall cut out.

The pumps impellers, gaud vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature and direct sun exposures and by any mean not less than 55°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

Pump set shall include the following features:

1. Centrifugal in-line pumps with high efficiency motors and drives, total number as indicated on schedule.
2. Variable frequency invertor driver with set point controller ,digital readout.

3. Galvanized steel frame.
4. Galvanized steel suction and delivery manifolds with flanged connections.
5. Isolating valves and flexible connections on suction and delivery.
6. Check valves on delivery.
7. Strainer on suction.
8. Pressure gauges, pressure switches and pressure relief valves.
9. The pressure vessels shall be of steel with neoprene diaphragm.
10. Low-level switch shall be incorporated in the water tank and arranged such that it prevents the pump set operating below the minimum water level.

11. Control Panel

The control panel shall be constructed of 1.5 mm thickness sheet steel finished in stove enamel. The panel shall be damp and dust proofed to IP 55

The control panel shall include the following features:

1. Door interlocked main fuse switch
2. Contactors, overload thermal protection, and timer
3. Transformer 230/400/110
4. Ammeter
5. Hour meter for each pump
6. Push button start/stop for each pump with indicating lamps
7. Selecting switch hand/off/auto
8. Programmer for sequence operation of the pumps due to the demand, and pressure loss in the system.
9. Automatic shutdown device for dry running protection
10. Separate visible alarms and a common audible alarm for:
 - Power failure
 - Phase failure
 - Low water level in the water supply tank
11. Sets of volt-free changeover contacts for remote alarm monitoring.

Packaged Constant Speed Pump Set

The booster pumpset shall be completely automatic, factory assembled skid mounted unit. Pump set shall include the following features:-

1. Centrifugal in-line pumps with high efficiency motors and drives, total number as indicated on schedule
2. Galvanized steel frame
3. Galvanized steel suction and delivery manifolds with flanged connections
4. Isolating valves and flexible connections on suction and delivery

5. Check valves on delivery
6. Strainer on suction
7. Pressure gauges, pressure switches and pressure relief valves
8. The pressure vessels shall be of steel with neoprene diaphragm.

The pumps impellers, gaud vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature and direct sun exposures and by any mean not less than 55°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be constructed of 1.5 mm thickness sheet steel finished in stove enamel. The panel shall be damp and dust proofed to IP 45.

9. Control panel

The control panel shall include the following features:-

1. Door interlocked main fuse switch
2. Contactors, overload thermal protection, and timer
3. Transformer 230/400/110
4. Ammeter
5. Hour meter for each pump
6. Push button start/stop for each pump with indicating lamps
7. Selecting switch hand/off/auto
8. Automatic shutdown device for dry running protection
9. Separate visible alarms and a common audible alarm for:
 - a. Power failure
 - b. Phase failure
10. Sets of volt-free changeover contacts for remote alarm monitoring.

END OF SECTION

SECTION 15650 HVAC REFRIGERATION EQUIPMENTS

General

Section includes:

- Split DX Units.
- Roof top single packaged air conditioning unit

Definitions

Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions

Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

The acceptable value for the IPLV shall be equal or greater than 4.5 as per ARI 550/590.

Submittals

- Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections.
- Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.
- Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start up instructions.
- Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.
- Manufacturer's Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

Closeout Submittals

Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

Delivery, Storage and Handling

Accept Split DX Units and roof top packaged unit on site in factory packaging. Inspect for damage.

Maintenance Service

Furnish service and maintenance of split units and roof top packaged unit for two years from Date of Substantial Completion and acceptance.

Examine unit components monthly. Clean, adjust, and lubricate equipment.

Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

Perform work without removing units from service during building normal occupied hours.

Provide emergency call back service at all hours for this maintenance period.

Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

Codes and Standards

Work and materials shall conform to the British Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
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ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
UL:	Underwriter Laboratories (U.S.A.)
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor's Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

Split DX Units

General

Provide factory-assembled and tested split D/X units as indicated, designed for roof, slab or floor mounting consisting of compressors, condensers, evaporator fans, refrigeration and temperature control, filters,. Provide capacity and electrical characteristics as scheduled.

Casing of outdoor unit shall be heavy gauge galvanized steel casing with electro-static powder paint of epoxy coating finish for optimum weatherproof protection.

Indoor unit shall be of the same manufacture as the associated outdoor unit.

Indoor unit cabinet shall be of high impact plastic or painted galvanized steel.

Indoor unit shall be fully insulated.

Refrigerant Gas

Refrigerant gas shall be R-410a or R32 and the installation of indoor and outdoor units shall include charging the system with the required amount of refrigerant to the approval of the manufacture and engineer.

Evaporator Fans

Provide tangential, centrifugal, and permanently lubricated motor bearings.

Condenser Fans

Provide propeller-type, direct-driven fans with permanently lubricated bearings.

All condenser fans shall be equipped with wire guards.

Fan blades are made of coated steel, and are statically and dynamically balanced before installation.

Coils

For evaporator and condenser, provide non-ferrous construction with aluminium plate fins mechanically bonded to seamless copper tubes; with brazed tubing joints. Circuit evaporator to provide full active face on minimum cooling step

Compressors

Provide reverse cycled scroll compressors inverter type. Provide vibration isolators, Provide thermal expansion valves, and provide minimum.

Low Ambient Kit

For areas requiring cooling all year round such as but not limited to Electrical rooms. The unit shall be provided with fan-cycling control for low ambient control to 45°F (7°C).

Copper Pipes and Control Cables and Insulation

Copper pipes between indoor and outdoor units shall be approved by the manufacture and Engineer and of size and control cables recommended by the A/C units' manufacture and approved by the Engineer.

Control cables between indoor and outdoor units shall be as recommended and approved by the manufacture and the Engineer.

Safety Controls

Provide the following controls:

1. Low pressure cutout, manual reset.
2. High pressure cutout, manual reset

Refrigerant Piping and Fittings

Refrigerant pipes installed in the field shall consist of copper tubing and recessed solder joint fittings. Tubing shall be in accordance with ASTM Specification B 88-61 type 'k' hard drawn. Fittings shall be wrought copper or tinned cast brass. Where required for connection to gauges and control devices, tubing not larger than 3/8 inch. O.D. may be type 'k' soft (annealed) with flared tube or double ferrule compression fittings suitable for high pressure. On all joints in refrigeration piping flux and solder which is recommended by solder type fittings manufacturer shall be used. Tubing shall be protected against oxidation during silver soldering by use of dry nitrogen flowing through the tubing.

Accessories for field assembled refrigerant piping systems such as oil separators, liquid receivers, heat exchangers, dryers, expansion valves, refrigerant strainers, sight glass etc., shall be in accordance with instructions of the units manufacturers standard practice and specific recommendations.

Drain line shall be of UPVC pipe –6 bar fitted with dielectric fitting to drain pan.

Automatic Temperature Control System

Provide combination thermostat and fan switches to control the room temperature automatically, provide factory fabricated unit of the same manufacturer of DX-\ having sensor,

Electrical

Provide 220-400V convenience outlet, separately fused, with relay, contactors, indicator lamps, overload switches for unit service. Provide means for unit power connection through unit cabinet.

Accessories

Provide the following accessories.

Time Guard

Provide time guards to prevent short cycling of compressors.

Examine areas and conditions under which split D/X cooling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

Roof top single packaged air conditioning unit

Description

- A. Scope: Supply and install Roof top packaged units complete in accordance with the requirements of the Contract Documents. This section relates to the supply and installation of Roof top packaged units for the HVAC installation.
- B. Roof top packaged units shall be one piece air-to-air electric cooling units, each comprising an air-cooled condensing section containing compressors, condenser coil and cooling fans and an economizer section containing return-air/fresh-air dampers, filters, direct-expansion cooling coils, centrifugal fans. The units shall be complete with all internal interconnecting pipework and control equipment and shall be supplied as a single packaged unit suitable for direct site installation.

Quality Assurance

Regulatory Requirements

1. Standard Compliance
Test and rate Roof top packaged units of 135,000 Btu/hr capacity or over in accordance with ARI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment", and provide certified rating or in accordance with related Eurovent standards. Sound test and rate units in accordance with ARI 270 "Standard for sound rating of outdoor unitary equipment", and provide certified rating.
2. ASHRAE Compliance: Construct refrigeration system of Roof top heat pump units in accordance with ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".

Materials:

- A. General: Provide factory-assembled and tested D/X units as indicated, designed for roof, slab or floor mounting consisting of compressors, condensers, evaporator fans, refrigeration and temperature control, filters, and dampers. Provide capacity and electrical characteristics as scheduled.
The units shall be suitable for continuous operation in dusty conditions at ambient shade temperature of up to 50°C.
- B. Casing: Provide manufacturer's standard casing construction, corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts. Insulate casing with 1" thick minimum thermal insulation. Provide knockouts for electrical and piping connections. Provide condensate drain connection, and lifting lugs.
- C. Evaporator Fans: Provide forward -curved, centrifugal, belt-driven fans with adjustable sheaves and permanently lubricated motor bearings.
- D. Return Fans: Provide forward -curved, centrifugal, belt-driven fans with adjustable sheaves and permanently lubricated motor bearings.
- E. Economizer Control: Provide economizer control consisting of return, integral barometric relief, and outside air dampers with low leak dampers designed to meet ASHRAE 90.1, outside air filter, fully modulating electronic control system with reference enthalpy control and adjustable mixed-air thermostat. Design system for 100% outside air capability and adjustable minimum fresh air. Outside air hood shall include aluminium water entrainment filter.

- F. Condenser Fans: Provide propeller-type, direct-driven fans with permanently lubricated bearings.
- G. Refrigerant gas shall be R-410a or R-407C, and the installation of package units shall include charging the system with the required amount of refrigerant to the approval of the manufacture and engineer.
- H. Coils: For evaporator and condenser, provide non-ferrous construction with aluminium plate fins mechanically bonded to seamless copper tubes; with brazed tubing joints. Circuit evaporator to provide full active face on minimum cooling step.
- I. Compressors: Provide serviceable, scroll, semi-hermetic, or hermetic compressors for less 20 KW compressors. Provide vibration isolators, and crankcase heaters, which de-energize during compressor operation.
- J. Safety Controls: Provide the following controls:
 - 1. Provide cylinder unloaders for capacity control, with minimum steps as scheduled.
 - 2. Provide thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; and provide minimum of 2 refrigerant circuits for units having 2 or more compressors. Provide fan-cycling control for low ambient control to 45°F (7°C).
- K. Drain line shall be of copper pipe type "L" fitted with dielectric fitting to drain pan.
- L. Filters: Provide filter section consisting of 2" thick fiberglass throwaway filters in filter rack, with maximum face velocity of 300 fpm.
- M. Dirty Filter Switch - provide this kit includes a differential pressure switch that energizes the fault light on the unit thermostat, indicating that there is an abnormally high pressure drop across the filters
- N. Automatic Temperature Control System
Provide combination thermostat and fan switches to control the room temperature automatically, provide factory fabricated unit of the same manufacturer of DX- unit having sensor, 4-position push button or lever operated manual switch for control of fan compressor interlock and control transformer as an integral part of the unit.
- O. Electrical: Provide 400V convenience outlet, separately fused, with relay, contactors, indicator lamps, overload switches for unit service. Provide means for unit power connection through unit cabinet.
- P. Hot Water Heating Coils: Shall be ARI certified non-freeze type pitched within the ductwork for proper drainage. Headers shall be heavy-gauge galvanized steel. Maximum work pressure limit of coil shall be 175 psig at 400 degrees F. Coil shall be within unit. Piping to coils shall be within unit.
- Q. Accessories: Provide the following accessories;
 - 1. Anti-Recycling Control: Provide controls to automatically prevent compressor restart for 5-minutes after shutdown.
 - 2. Time Guard: Provide time guards to prevent short cycling of compressors.

Execution

Installation of Split D/X Cooling Units

General: Install split D/X cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in approved locations, and maintain manufacturer's recommended clearances.

Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal.

Start - Up

Start-up split D/X cooling units, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

Balance split D/X unit systems to verify its capacity and balanced delivery of air for each space.

Grounding

Provide positive equipment ground for split D/X cooling unit components.

Refrigerant Pipes Tray

The Contactor shall include for the supply of refrigerant pipe tray wherever indicated or as required for the execution of the works. Such tray shall be of the conventional heavy grade perforated pattern with return edges manufactured from a minimum 14 SWG. mild steel. Such tray shall be of galvanised 0.5mm (1/64") thick. Wherever the tray is exposed to weather i.e. laid on the roof, it shall be covered with galvanised sheet steel 0.5mm (1/64") thick covers to protect the pipes from the sun and rain. The tray shall be securely fixed to purpose made brackets with space behind to allow the insertion of tools for the tightening of nuts. The tray shall be of sufficient width to take all pipes without crowding and shall allow for possible future additions to the proportion of 10% of the present requirements.

Each length of tray shall be securely bolted to an adjacent length with sufficient overlap to prevent sagging and twisting. Normal bend of not less than 450mm shall be used. In all instances where tray is supported from the structure of the building, specially fabricated galvanised brackets shall be used. The method of fixing the tray and brackets shall be approved by The Engineer before installation. Where the tray is required to be fixed horizontally the Contractor shall make allowance for providing brackets and supports in positions where steel work is not provided. Where the trays is cut leaving base metal it shall, before installation, be liberally treated by PVC compound from an aerosol type container Wherever Tee or flat bends are required to be used, they shall be factory made. No cutting of the tray shall be permitted. Whenever necessary, the same shall be properly painted with a zinc, rich primer such as 'galvafroid' or similar approved.

All accessories including bends (vertical and horizontal), intersections, tees, risers and reducing sections shall be purpose made by the tray manufacturer.

Sections of tray and accessories shall be joined in accordance with the recommendations of the manufacturer. Nuts, bolts, washers and other fastenings shall be supplied by the manufacturer and shall be of compatible materials. Bolts shall have domed or mushroom heads and shall be installed with the nuts facing away from the pipes.

Trays shall be cut along a line of plain material and not through perforations. Burrs or sharp edges shall be removed prior to the installation of tray sections or accessories. Holes cut in cable tray shall be suitably bushed with grommets.

Where installation conditions necessitate site fabrication, the standards of fabrication and finish shall be not less than that of standard manufacturers' items.

All items shall be installed to the manufacturer's recommendations.

Mid-span joints shall be located as close as practical to one quarter of the span distance away from a support position. Joints at mid span or directly over supports shall be avoided. Supports shall be provided within 150mm of all accessories.

Tray shall not be installed across building or structural expansion joints. On horizontal runs the tray shall be installed with a 20mm gap at the expansion joint. Supports shall be installed within 150mm on either side of the joint.

Covers shall be of the same material and manufacture as the tray. Joints between covers need not coincide with joints in the tray or ladder.

Trays and ladders shall be supported so that the maximum deflection between supports is $1/360$ of the span length.

Any cut or damaged metal shall be made good by first treating the surfaces with a suitable rust-proofing agent, similar to that used in the original manufacture, and then applying finishes comparable to the remainder of the surface.

Refrigerant Trays Supports

Strength of each support including fastening shall be adequate to carry present and future load multiplied by a safety factor of at least four or the calculated load plus 90kg whichever is greater, spacing of supports is not to exceed 1.5m.

Thermal contraction and expansion joints shall be installed for tray runs exceed 52.5m, spacing and gap settings for expansion connectors shall not exceed recommendations of approved applicable standards.

Make changes in direction of tray with standard tray fittings.

Supports shall be constructed from proprietary framing system components. Unless specified otherwise all support system members shall be made of the same material as the tray.

All steel components shall be hot-dip galvanised to BS 729 after manufacture. Where an exposed galvanised surface has been cut or otherwise damaged it shall be repaired by application of a zinc rich epoxy primer.

Plastic end caps shall be fitted to exposed support channel ends in accessible positions and additionally elsewhere as specified.

Full details, with illustrations, of all supports and fixing devices shall be submitted before any orders are placed or manufacturing work put in hand. All supports and fixing devices shall have a factor of safety of not less than four.

The use of rag bolts, indented bolts, foundation bolts or similar fixings requiring grouting shall not be permitted.

Installation of Package Units

1. General: Install Roof top units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in approved locations, and maintain manufacturer's recommended clearances.

2. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. The packaged rooftop unit shall be installed complete with all accessories in accordance with the manufacturer's recommendations, as indicated in the specifications and as shown on the drawings.
3. Two sets of spare filters shall be provided in addition to the set used during construction with each unit. The filters shall be changed after the construction dust has been eliminated and before final inspection. The other set of filters shall be stored in the respective mechanical rooms or spaces.
4. Provide a typed list of all the different units, their filter sizes, and belt sizes to be included in the O & M manuals.

Start – Up

1. Start-up roof top unit, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
2. Balance unit systems to verify its capacity and balanced delivery of air for each space.

Grounding

Provide positive equipment ground for Roof top unit components.

END OF SECTION

SECTION 15670

BOILERS AND CHIMNEY SPECIFICATIONS

GENERAL

SUMMARY

Section Includes:

- Boilers.
- Boiler control panel.
- Radiators.
- Fuel oil fired burner.
- Chimney and Breeching

SUBMITTALS

Product Data: Submit data for capacities and accessories included with boiler, burner and radiators. Include general layout, dimensions, size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.

Test Reports: Indicate boilers and radiators meet or exceed specified performance and efficiency. Submit results of combustion test.

Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

CLOSEOUT SUBMITTALS

Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

DELIVERY, STORAGE, AND HANDLING

Accept boilers, radiators and accessories on site in factory shipping packaging. Inspect for damage.

Protect boilers and radiators from damage by leaving packing in place until installation.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

MAINTENANCE MATERIALS

Furnish wire brush and handle for fire-tube boiler cleaning.

CODES AND STANDARDS

Work and materials shall conform to the British Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

- ASHRAE: American Society of Heating Refrigeration and Air conditioning Engineers (U.S.A.)
- ABMA: American Boilers Manufacturing Associations (USA)
- IHVE: The Institute of Heating and Ventilation Engineers (U.K.)
- ASME: American Society of Mechanical Engineers
- ARI: Air Conditioning Refrigeration Institute (U.S.A.)
- ASTM: American Society for Testing and Materials
- AWS: American Welding Society
- UL: Underwriter Laboratories (U.S.A.)
- SMACNA: Sheet Metal and Air conditioning Contractors National Association, Vienna
- BSI: British Standard Institute – CP: Code of Practice
- NFPA: National Fire Protection Association
- CIBSE: The Chartered Institute of Building Services Engineers - UK
- HVCA: Heating and Ventilation Contractor's Association, U.K.
- TUV: Technischer Uberwachungs-Verein

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS

General description and requirements

The hot water heating boiler shall be of the fully packaged, designed and constructed, approved and certified in accordance with the latest ASME Code , BS or TUV.

The boiler shall be equipped with integral forced draft fuel modulation burning equipment specifically supplied for burning No. 2 light oil, boiler trim and accessories, operating and safety controls, refractory and insulation all assembled, piped and wired at the factory and delivered as a packaged unit ready for installation and operation with simple piping, power and smoke outlet connections.

The completed unit shall be fire tested at the factory prior to shipment and a copy of the test report shall be furnished with the boiler.

The boiler shall be subjected to shop inspection by an authorized. Boiler Inspection and Insurance Co., and stamped with all identifying markings and symbols as required by the ASME to TUV Code. A certified inspection report shall be furnished with the boiler.

The boiler shall be insulated with minimum 75 mm thick with minimum density of 64kgs per m³ mineral wool blanket insulation compacted to 50 mm and covered with heavy gauge steel removable jacket with factory applied heat resisting enamel finish.

The boiler manufacturer shall furnish with the boiler complete shop drawings which shall include but not necessarily be limited to complete boiler piping and wiring diagrams with details of control panel and all controls, interlocks and setting, boiler outline drawing with dimensions, location of connections and flange ratings, complete installation, operation, servicing, care and maintenance instructions, performance test report, inspection report and two years warranty against defects.

The boiler inlet and outlet pipe connections shall be provided with isolating valves and thermometers of glass stem type.

The fuel oil supply pipe connection to the burner shall be provided with isolating valve, oil filter and fire safety valve. Fuel oil supply and return pipes shall be connected to the boiler by heavy duty flexible connections.

The boiler shall be mounted on reinforced concrete base of adequate dimensions to provide 15 cms clearance on each side and above finished floor level.

Boiler

Cast iron sectional boiler of 6 bar working pressure and a maximum temperature of 110 degrees Celsius complete with a suitable 1 stage burner operating on light oil and all necessary controls and an operating thermostat and a limit thermostat. The boiler shall include jacket with 50 mm thick resin bonded mineral wool insulation.

The boiler shall be provided with hinged door access for cleaning and replacement of parts, and will be so designed that one operator can open the access doors for cleaning. Observation opening shall be furnished to provide for visual inspection of combustion conditions. All doors, covers and observation ports shall be reasonably gastight under all conditions of firing.

Burner

The fuel burning equipment shall be of the forced draft type shall comprise but not necessarily limited to: flange mounted oil burner of the mechanical pressure atomizing type for No. 2 light oil, direct driven blower, motor, air damper, oil pump mounted on burner, oil atomizing nozzle, oil solenoid valve, oil supply and return pressure gauges on the lines, fuel suction strainer, ignition transformer, ignition electrodes, electronic flame sensing devices, working temperature controls, high limit temperature controls, all necessary controls and linkage for ON-OFF firing.

Control Panel

The control panel shall contain an electronic programming combustion safeguard control system, magnetic motor starters with thermal overloads and low voltage release, combustion air proving switch, manual potentiometer, manual automatic selector switch, control circuit transformer, necessary switching relays, power on and burner on switches, individual fused circuits for controls, signal lights indicating ignition, flame failure and low water cutout, numbered terminal strip, colour coded wiring and engraved nameplates.

The electronic programming combustion safeguard control system shall provide modulating sequence of enforced low fire start, pre purge, post purge, timed trial for ignition, proof of blower operation prior to opening of fuel valves, and positive response to shut down the burner in the event of flame failure.

RADIATORS

Radiators Generally

Radiators shall be capable of the thermal output specified in tables , determined in accordance with BS 3528 tested at works to a hydraulic pressure of 7.0 bar or twice the working pressure whichever is the greater. Radiators shall be fitted with recessed key operated air vent positioned to ensure maximum evacuation of air, completely derusted and finished one coat of primer paint before leaving Manufacturer's works (except aluminium). Radiators shall be installed with a minimum of 150mm clearance between the underside of the radiator and the finished floor level and 40mm clearance between the radiator and wall surface, unless the specified manufacturer's standard brackets provide otherwise. (Hot pipes serving an LST radiator should be suitably insulated and/or protected from touching).

Radiators shall be supported on bottom brackets and top stays or purpose-designed brackets. Supports to be either built-in or screwed fixing to suit wall construction taken down, connections plugged, and radiators refixed once after initial installation, for the convenience of other trades.

Radiators shall be fitted with the top surface of two or more similar radiators level when on the same or adjacent wall surface.

Radiators shall be generally on the plain panel, finned panel or column type.

Cast Iron Radiators

Cast Iron Radiators shall be grey cast iron, not less than grade 12 of BS 1452, have a minimum thickness of 2.5mm, and be free from scale and sand. Column type being made up with individual nipples.

Radiator Valves

Shall be straight or angle union pattern to BS 2767 with bronze body to BS 1400-LG2, chromium plated finish, with moulded polycarbonate bonnet-handwheel pattern for flow connection and lockshield for return connections on radiators, convectors, radiant panels etc.

SMOKE PIPES AND BREECHING

Chimney

The Contractor shall supply, deliver and erect in the position shown on drawings to 3 meters above the highest level of the building), a slab supported chimney with flue connections, rain caps and clean out openings as shown on drawings.

The chimney shall be of twin wall construction, manufactured in accordance with the latest edition of BS. 5750 part 2 and EN 29002 and shall be connected to the boilers breeching.

The internal wall shall be fabricated of black steel sheet of thickness 3mm, fabricated under the quality control of factory conditions with a continuous vertical seam weld of the inner liner and flanged by 20mm to form a connection end with other pieces on site and shall be provided.

The inner wall of the chimney shall be insulated with 75mm thick mineral wool then cladded by 0.7 mm with aluminised steel or 1.2 aluminium cladding.

The construction of the chimney shall allow for the necessary differential extension movement between the internal flue and the external thermal wall. Such extension shall be compensated by stainless steel expansion bellows.

The chimney shall be complete with access doors for clean out purposes, drain connections and lightning conductor fitted in a boss welded of the top of the stack.

The chimney shall be fastened by Vee bands over all matting flanges of adjacent components, throughout its length, as it shall be sealed internally and on all flanges by appropriate thermal resistant sealant specially manufactured for such purposes.

The chimney shall also be provided with 2 No. brass earthing bolts located on the base plate. The chimney and flue shall be provided with suitable foundations, base plates, gussets and holding down bolts all to the Engineers requirements.

The chimney shall be manufactured from sections which shall be externally flanged; the flanges shall be fastened by channel bands fitted in grooves in the outer casings.

The stack section joints shall be sealed be use of containment bands with captive fasteners and high temperature joint sealant.

The chimney stack shall be supported to structure by galvanized steel and wall guides which shall be fastened on two sides of the slab of each floor or at 3.0 meters intervals (which ever is smaller).

The chimney and breaching assembly shall be manufactured and tested to maintain air tight integrity at pressures up to 60" Wg at room temperature.

BREECHING (FLUE DUCTING)

The Contractor shall supply, deliver and erect in the position shown on the drawings the requisite interconnecting flue ducting between the boilers and the chimney.

The breeching connecting the boilers to the chimney cores shall be fabricated from 3mm black steel plate and shall conform to the sizes indicated on the drawings.

The flue ducting shall be insulated with mineral wool having a minimum thickness of 75mm and the whole shall be enclosed in 0.7 aluminium cladding. The cladding shall be arranged for easy removal of all access doors and to allow for expansion.

2 No. 18mm BSP plugged bosses shall be provided in the horizontal flues prior to the chimney for test procedures.

Clean out doors shall be provided in all horizontal sections of flues at distances not greater than 5 .0m centers.

END OF SECTION

SECTION 15850

FANS

GENERAL

SUMMARY

Section Includes:

- Propeller Fans
- Duct mounted centrifugal fans
- Fume extract system up blast utility

SUBMITTALS

Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, and ductwork and accessory connections.

Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

CLOSEOUT SUBMITTALS

Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

QUALITY ASSURANCE

Performance Ratings: Conform to AMCA 211 and 311 and bear AMCA Certified Rating Seal.

Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

The duty point of the selected fan shall be far away from the surge curve.

Maintain one copy of each document on site.

Motors 1hp and larger shall be totally enclosed fan cooled (TEFC). For smaller power use totally enclosed air over (TEAO) or open drip proof (ODP).

All motors shall have class F insulation as per National Electrical Manufacturers Association "NEMA" Enclosure Standards of Electrical Motors, and suitable for 50°C ambient temperature.

Motor power shall be 25% more than the fan brake horsepower.

DELIVERY, STORAGE, AND HANDLING

Protect motors, shafts, and bearings from weather and construction dust.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

CODES AND STANDARDS

Work and materials shall conform to the British Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
UL:	Underwriter Laboratories (U.S.A.)
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS FANS

GENERAL

- All fans shall be completely factory assembled by a reputable manufacturer who has at least five years experience in this field.
- Each unit shall be sized with at least 10% additional capacity to equipment schedule
- Each unit shall be selected at the lowest available noise, rpm and high efficiency
- Each unit shall incorporate the following: -
- A nameplate fixed permanently on unit, the plate shall list air volume, fan static pressure,
- All bearings shall be supplied fully lubricated.
- All construction and applications shall comply with the requirements of BS8313 with respect of fire precautions against fire.
- All components shall be inherently non-flammable or be made permanently so by suitable treatment.
- Any viscous liquid used shall have a flash point in excess of 177°C.
- All components shall be tested in accordance with the appropriate BS, ARI or Type Test certificated as described in this specification.
- All electrical items of equipment cabling, wiring, and works shall comply with the latest edition of IEE Wiring Regulations & Electricity at Work Regulations or to equivalent UL requirement.

- Test Points shall be provided to enable comprehensive airside and waterside tests to be made on each air-handling unit.
- All Fans shall be selected for slow speed running, low sound level and high efficiency.
- Each motor shall be rated at 130 percent (%) of the fan's rating when running at the duties as designed.
- All 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 or rolled steel channel base frame and belt adjusting bolts.

ACCESSORIES

The Contractor shall provide the following with each fan:

- Aluminum electric shutters.
- Insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.
- Pre lubricated motor bearings. Lubrication shall be suitable for 30,000 hr, or 5 years intermittent use.
- Inlet Galvanized wire mesh guards constructed and fitted to satisfy all relevant safety legislation

Lubrication

An engraved stainless steel plaque shall be mounted beside the fan manufacturer's nameplate. The plaque shall have engraved thereon, in 6 mm upper case, instructions as to type of lubricant and service interval based on normal operating hours.

Efficiency

Fans shall be selected so that the design air quantity is within the range of 0.95 to 1.5 of the fan air quantity at its peak static efficiency for the design static pressure.

PROPELLER FANS

Fans shall include multi blade steel blades with steel hub. Safety guards shall be provided on motor and on fan side. Mounting frames shall be predrilled at Works. Fan panels and frames shall be bonderized and finished in baked enamel.

The wheels shall be precision balanced and die formed. The electric motors shall be totally enclosed with pre-lubricated bearings for long service life. The Units shall be selected by the Contractor for maximum efficiency and low noise levels.

Fans shall be provided with timer to control the operation timer specification shall be as per the electrical specifications.

Fans shall be provided with electric Aluminum low opening sound shutter to keep out rainwater, pressure and dust from outside.

DUCT MOUNTED CENTRIFUGAL FANS

Duct mounted centrifugal fans shall be of backward curved blades design with non overloading operating characteristics and high efficiency. The fan wheel shall be centrifugal backward inclined, constructed of aluminium and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

Fans shall be direct driven in-line type.

Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be sufficient size to permit easy access to all interior components.

Fans shall be selected by the Contractor for slow speed running low sound level and high efficiency. All fans shall be selected by the Contractor to be capable of being operated by at least 10% in capacity over the design volume specified.

Fans shall be provided with motors with Class "F" insulation with protection to IEC 34 5 Group IPW 54 and integral overheat protection.

Fan casings shall be fabricated from heavy gauge galvanized steel plate adequately stiffened and supported. Fan casings shall be rigid and completely free from vibration and drumming and capable of withstanding 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.

Motors shall be permanently lubricated and carefully matched to the fan loads. Motors shall be readily accessible for maintenance.

A NEMA 1 disconnect switch shall be provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring shall be provided from motor to the handy box.

The electric motors shall be totally enclosed fan cooled squirrel cage induction type rated for continuous operation in ambient temperature up to 45°C.

All fan sets shall be tested at Works and installed strictly in accordance with the manufacturer's instructions.

FUME EXTRACT SYSTEM UPBLAST UTILITY

The fume exhaust system shall be compatible with the fume extract cabinets and shall comprise UPVC duct-work.

The exhaust air discharge shall be taken to outside and away from any inlet such that it does not cause any hazard or odor nuisance to residents

The exhaust system shall produce a face velocity of 0.5 m/s. through the sash opening.

The fan shall be of the bifurcated type with coated polypropylene impeller.

Fan housings shall be made of molded fiberglass reinforced polyester or unplasticized PVC.

Impellers shall be of protectively coated polypropylene and shall be bifurcated direct driven. Inlet and discharge connections shall be arranged to receive rigid PVC ducting material. Sheaves shall be of the adjustable type to allow for air volume adjustment.

The discharge terminal shall be adjustable type to allow the direction of the discharge air flow to be selected.

A manual duct damper shall be fitted at the inlet connection of the fan or directly above the fume hood for the fans which are directly connected to their respective motor.

Flexible duct connections shall be supplied with the fan to isolate vibration between the fan and PVC ductwork.

All materials used in construction shall be suitable for the contaminants to be handled. Bearing and lubrication arrangements and electrical equipment shall be suitable for the conditions.

Protectively coated fans shall meet the appropriate requirements of the preceding classes relating to fans generally and to particular types of fans; the form of protection shall be as specified. Where a protective coating is required for use with corrosive gases the coating shall fully cover all parts of the complete fan, motor and casing assembly which will be in contact with the corrosive gases. No fan shall be installed if the protective coating has been damaged in any way. Fans shall be provided with electric chemical resistance low opening sound shutter to keep out rainwater, pressure and dust from outside.

END OF SECTION

SECTION 15855**DIFFUSERS, REGISTERS AND GRILLES****GENERAL****SUMMARY**

- Section Includes:
- Supply and Return Air Diffusers - Ceiling Mounted
- Linear Diffusers
- Air Registers & Grilles
- Door Grilles
- Outlets
- Toilet Exhaust Grilles - Ceiling Mounted

SUBMITTALS

- Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- Samples: Submit two of each required air outlet and inlet type.
- Test Reports: Rating of air outlet and inlet performance.
- Manufacturer's Certificate: Certify products meet or exceed specified requirements.

CLOSEOUT SUBMITTALS

Project Record Documents: Record actual locations of air outlets and inlets.

QUALITY ASSURANCE

- Test and rate diffuser, register, and grille performance shall be in accordance with ASHRAE 70.
- Test and rate louver performance shall be in accordance with AMCA 500.
- Maintain one copy of each document on site.

MOCK-UP

Construct typical interior ceiling module with supply and return air outlets.

Locate where directed by Architect/Engineer.

Incorporate accepted mock-up as part of Work.

CODES AND STANDARDS

Work and materials shall conform to the Standards and Codes of Practice, Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ADC 1062 Air Distribution and Control Device Test Code.
NFPA 90A Installation of Air Conditioning and Ventilation Systems.

UL 181	Factory-Made Air Ducts and Connectors.ASHRAE: American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS

Grilles, Registers & Diffusers

General

Material shall be powder-coated aluminum as approved by the Engineer unless otherwise specified.

All diffusers, registers and grilles shall be provided with Opposed Blade Dampers painted matt black.

Accessories and fittings shall be positioned to allow adjustment without introducing excessive noise or drafts. All diffusers shall be selected to handle the design airflow at a noise level not to exceed NC30.

Concealed fixings shall be used for air grilles, diffusers and registers, fixing through the face flanges shall not be accepted.

Provide Air Diffusion Council "ADC" or equal approved certified performance data for all air diffusion equipment to be installed. Performance data for similar but not identical equipment will not be accepted.

All outlets shall be selected for efficient air distribution and low noise levels and responsibility shall be accepted for selecting and checking neck velocities, horizontal and vertical flow patterns and noise levels. Outlets with poor distribution and excessive noise levels shall not be used.

All outlets selected for variable volume systems shall be suitable for the system and shall be capable of providing adequate distribution without causing draughts at high volume or "dumping" at low volume and shall only be used if manufacturers have specifically tested them for variable volume systems.

All slot diffusers, linear grilles and light air saddle diffusers shall have provision for air pattern adjustments such that air can be deflected in a vertical or horizontal direction or both directions. Approval shall be obtained for each type of outlet, grille and register proposed for use. Samples shall be submitted for this purpose prior to manufacture. All outlets in moist locations shall be of aluminum.

All internal parts of outlets, such as straightening vanes and volume controllers shall be finished matt black. External finishes shall be colored to match adjacent surfaces. Unless otherwise specified aluminum outlets shall be color anodized and steel outlets shall be finished in baked enamel.

Internal duct surfaces visible through any air outlet shall be painted matt black.

Outlets shall be installed with trim gaskets where applicable and in accordance with the manufacturer's recommendation.

Diffusers to be provided with 25 thick acoustically lined and insulated galvanized steel plenum. The plenum shall be integrated with cylindrical air pattern stabilizer and volume control damper.

Supply and Return Air Diffusers - Ceiling Mounted

Diffusers shall be of 4-way blow adjustable core as shown on the drawings and of aluminum construction with drop bevel borders with diffuser cores easily removable and replaceable. All corner miters shall be square true flush. Throw reducing vanes shall be installed where necessary for draft less diffusion. Where neck length is less than one and a half times its width, install equalizing grids.

Each diffuser shall have an opposed blade damper for equalizing of airflow. The diffusers shall be Aerostat DM or equal finished baked enamel of color to be advised during construction.

Noise level is not to exceed 25 NC at specified air quantity measured at vertical position.

Plenum box of Supply Air diffusers to be provided with 25mm thick acoustically lined and insulated galvanized steel plenum. The plenum to be integrated with cylindrical air pattern stabilizer and volume control damper

Each supply air ceiling diffuser connected to flexible ductwork shall be fitted with a sheet metal plenum box on top of the diffuser. Plenum shall be insulated and be supported from the slab above.

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 to be provided with 25mm thick acoustically lined and insulated galvanized steel plenum. The plenum to be integrated with cylindrical air pattern stabilizer and volume control damper

Linear diffusers shall be complete with end caps on end sections and one-piece diffusers, grid pattern air straightness and concealed mounting brackets for easy installation without need for special tools.

Air Registers & Grilles

Supply air registers shall be selected for correct deflection to suit shape of room. Supply registers shall be provided with opposed blade dampers with pin calibrator.

Terminal velocity at end of throw to opposite wall is not to exceed 50 feet per minute at specified air quantity. Voltmeter 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.

Linear bar grilles shall be of double of 0°, 15° single direction or 15° of two directions.

Linear bar shall be manufactured of fixed horizontal straight vanes attached to a frame by means of S clips manufacture from extruded aluminum.

All bar grilles shall be provided with dampers adjusted by setscrew levers.

All grills and registers shall be fixed by concealed retaining spring fixing clips. Fixing by face screws shall not be accepted.

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 concealed screws.

Outlets installed in walls shall be fixed to an appropriate flanged galvanized steel frame provided around the opening. Fixing to frame shall be with chrome plated or cadmium plated, concealed wood screws.

Duct collar shall be flushed 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.

END OF SECTION

SECTION 15891

DUCT WORKS

GENERAL

SUMMARY

Section Includes:

- Duct Materials.
- Insulated flexible ducts.
- Transverse duct connection system.
- Casings.
- Ductwork fabrication.
- Duct cleaning.
- Duct leak testing

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 structure so as not to interfere with any other services and to allow for the required thickness of insulation as specified elsewhere.

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 146.

All ducts emerging from the roof 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 fiberglass or other material acceptable to the Engineer.

The space between the duct and the structural 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 structure, plumb where vertical and arranged to present a coordinated and neat appearance.

Ducts supports shall be securely anchored to the 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.

PERFORMANCE REQUIREMENTS

Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.

Installer: Company specializing in performing Work of this section with minimum five years [documented] experience.

All qualifications documents and samples shall be submitted to the Engineer for approvals.

SUBMITTALS

Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1:50, on drawing sheets same size as Contract Documents, indicating:

- Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
- Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
- Fittings.
- Reinforcing details and spacing.
- Seam and joint construction details.
- Penetrations through fire rated and other walls.
- Terminal unit and coil installations.

- Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

Product Data: Submit data for duct materials duct liner duct connectors.

Samples: Submit two samples of typical shop fabricated duct fittings.

Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

Manufacturer's Certificate: Certify installation of glass fiber ductwork meet or exceed specified requirements.

CLOSEOUT SUBMITTALS

Project Record Documents:

- Record actual locations of ducts and duct fittings
- Record changes in fitting location and type. Show additional fittings used.

QUALITY ASSURANCE

Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

Design pressure for the constant air volume systems and the extract systems is 500 Pa and for the variable air volume systems is 800 Pa.

Construct ductwork to NFPA 90A and NFPA 90B and NFPA 96 standards.
Maintain one copy of each document on site.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

CODES AND STANDARDS

Work and materials shall conform to the Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)
ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
UL:	Underwriter Laboratories (U.S.A.)
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice

NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor's Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUTS DUCT WORK

MATERIALS

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/146, 'Low and High Velocity/Pressure Air Systems for Rectangular, Circular and Spiral Wound Ductwork', as published by the Heating and Ventilating Contractors' Association in USA, 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 in each side, based on three surface specimens.

FLEXIBLE DUCTING

Flexible ducting shall be formed from factory thermally insulated lightweight aluminum laminated duct, with 25mm thick highly efficient fiber glass of $U = .04W/m K$. The insulation shall be protected by scuff resistant outer jacket made of strong and tough spirally reinforced multiple layers of aluminum laminated construction, spirally jointed by galvanized steel helix, unless specified otherwise elsewhere in this specification.

Flexible ducts shall allow airflow up to 25m/sec.

Running lengths of flexible ductwork shall be kept to the absolute minimum to provide flexibility but not to exceed 600mm. Changes in direction shall be limited in long radius. Bends shall be avoided but where necessary shall be limited to radius of twice the diameters.

Kinked and flattened ducts shall be rejected. No test holes to be inserted in flexible ducts. Adequate supports shall be provided to avoid sagging. Ducting shall comply with air tightness requirements for rigid ducts in the same system.

Reinforcement of flexible ducts shall be carried over the terminal and rigid duct branch spigots and secured with worm drive clips and sealant as recommended by the manufacturer.

EXECUTION

CONSTRUCTION

TABLE A: Rectangular Or Round Ducts - Low & Medium Pressure
(Modified Table 4 DW/146)

DUCT SIZE	NOMINAL SHEET THICKNESS
(Longer Side or Diameter)	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 rectangular 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 sides shall have transverse joints flanged in accordance with DW/142, with maximum spacing of 2000 mm.

TABLE B: Within Plant Rooms Connections - All Plant, Roof, Smoke exhaust, and car park exhaust ducts.

DUCTS SIZE	NOMINAL SHEET THICKNESS		
(Longer Side or Diameter)	mm		b.g.
Up to 800mm.	1.6	16	
801 mm. to 1000 mm.	1.6	16	
1001 mm. to 2250 mm.*	1.6	16	
2251 mm. to 3000 mm.*	2.0	14	
* With central tie rod.			

All low velocity ductwork shall generally be rectangular section, except where indicated.

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. Suitable compounds 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/146.

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 steadied 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 airflow 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 'lame' sealed type.

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 shall 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. pitches.
- b) Spot welds at 75 mm. pitches.

Angle flanges or joints shall be bolted together at 100 mm. maximum pitches and fixing bolts shall be provided at each corner, angle size in accordance with DW144. . Bolt sizes shall be as follows:

- The joints shall be made using suitable cord and sealing compound inserted between flanges to ensure air tightness of joint.
- Provision shall be made in the main and branch ducts and adjacent all items of plant for testing air flow by means of picot tube or flow meter.
- 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 setscrews 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.

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 Engineer.

The length of transformation and reducing fittings and offsets 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 DW146 Ductwork Specification, as amended in this Specification.

ACCESS PANELS

Access panels shall be fixed adjacent to all filters, fans, variable air volume terminals, humidifiers, volume control dampers, fire dampers and heating coils, on all ductwork bends and at 9 meter centers on straight runs; all generally in accordance with DW144.

The access panels are to be of the hinged type and manufactured from not less than 22 gage galvanized mild steel plate. They shall have rubber door seals.

Where the duct is of sufficient size, access holes shall be not less than 375 x 300 mm. 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.

DUCTWORK BRACKETS

Other than specific details being indicated on the Drawing, the bracketing shall be of galvanized steel sections and shall be as follows:

Horizontal Ductwork:

Flat mild, steel band strips or mild steel angle bearers and rods shall adequately support all ductwork. The rods shall terminate to the structure in one of the following manners.

On a solid structure, channel iron rawl 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.

ii) Vertical Ductwork

This shall be supported by cantilever brackets as detailed in DW144.

Where they are fixed to walls, not less than 150 mm. water 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.

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 146 specification to ensure the air tightness of all joints or any other method being currently used. All ductwork shall be tested as detailed in HVAC Specification DW146 together with Method of testing DW143. or alternatively, duct works shall be tested in accordance to NEBBO and SMACCNA recommendations

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.

END OF SECTION

SECTION 15910

DUCTS ACCESSORIES

GENERAL

SUMMARY

- A. This Section includes the following:
1. Backdraft dampers.
 2. Manual volume control dampers.
 3. Fire and smoke dampers.
 4. Duct silencers.
 5. Turning vanes.
 6. Duct-mounted access doors and panels.
 7. Flexible connectors.
 8. Flexible ducts.
 9. Accessories hardware.
 10. Air Release Vent.
 11. Overpressure Relief (Pressure relief damper set).

SUBMITTALS

Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers duct access doors and duct test holes.

Product Data: Submit data for shop fabricated assemblies including fire dampers including locations and ratings smoke dampers including locations and ratings backdraft dampers flexible duct connections volume control dampers duct access doors duct test holes and hardware used. Include electrical characteristics and connection requirements.

Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years [documented] experience.

Installer: Company specializing in performing Work of this section with minimum five years [documented] experience.

All qualifications documents and samples shall be submitted to the Engineer for approvals.

DELIVERY, STORAGE, AND HANDLING

Protect dampers from damage to operating linkages and blades.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

COORDINATION

Coordinate Work where appropriate with building control Work.

EXTRA MATERIALS

Furnish five of each size and type of fusible link.

QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."
 - 3. Pressure differential system items shall comply with the BS EN 12101-6:2005
 - 4. DW146 Ductwork Specification
- B. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail the following:
 - 1. Special fittings and volume control damper installation (both manual and automatic) details.
 - 2. Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installations.
- C. Product Certification: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static pressure loss, and dimensions and weights.

EXTRA MATERIALS

- A. Furnish extra materials matching products installed as described below, packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Fusible Links of fire dampers: Furnish quantity equal to 10 percent of amount installed for each type and temperature rating.

CODES AND STANDARDS

Work and materials shall conform to the Standards and Codes of Practice, and with all prevailing rules and regulations pertaining to adequate protection of all moving parts, or otherwise hazardous conditions. Nothing in this Specification shall be construed to permit work not conforming to the most stringent of the applicable codes.

ASHRAE:	American Society of Heating Refrigeration and Air conditioning (U.S.A.) Engineers
IHVE:	The Institute of Heating and Ventilation Engineers (U.K.)
ASME:	American Society of Mechanical Engineers
ARI:	Air Conditioning Refrigeration Institute (U.S.A.)

ASTM:	American Society for Testing and Materials
AWS:	American Welding Society
UL:	Underwriter Laboratories (U.S.A.)
SMACNA:	Sheet Metal and Air conditioning Contractors National Association, Vienna
BSI:	British Standard Institute – CP: Code of Practice
NFPA:	National Fire Protection Association
CIBSE:	The Chartered Institute of Building Services Engineers - UK
HVCA:	Heating and Ventilation Contractor’s Association, U.K.

Other International Standards may be considered provided they meet with the above standards as a minimum.

The Codes and Standards mentioned above are hereby made part of the Contract Specification for the project, and the Contactor accepts full liability for ensuring compliance with the same.

PRODUCTS DUCT ACCESSORIES

Backdraft Dampers

- A. Description: Suitable for horizontal or vertical installation.
- B. Frame: 18-gage galvanized steel, with welded corners and mounting flange.
- C. Frame: 0.063-inch-thick 6063T extruded aluminum, with mounting flange.
- D. Blades: 0.050-inch-thick 6063T extruded aluminum.
- E. Blade Seals: Neoprene.
- F. Blade Axles: Galvanized steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.
- I. Chain Operator: 15-foot-long galvanized-steel sash chain and pulley.
- J. Wing-Nut Operator: Galvanized steel, with 1/4-inch galvanized-steel rod.

Manual Volume Control Dampers

- A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.
- B. Standard Volume Control Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated on drawings, standard leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized-steel channels, minimum of 16 gage, and with mitered and welded corners. Provide frames with flanges where indicated on drawings for attaching to walls. Provide flangeless frames where indicated for installation in ducts.
 - 2. Roll-Formed Steel Blades: 16-gage galvanized steel.
 - 3. Blade Axles: Galvanized steel.
 - 4. Tie Bars and Brackets: Galvanized steel.
- C. Low-Leakage Volume Control Dampers: Multiple- or single-blade, opposed-blade design, low-leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized-steel channels, minimum of 16 gage, and with mitered and welded corners. Provide frames with flanges where indicated for attaching to walls. Provide flangeless frames where indicated for installation in ducts.
 2. Roll-Formed Steel Blades: 16-gage galvanized steel.
 3. Blade Seals: Neoprene.
 4. Blade Axles: Galvanized steel.
 5. Tie Bars and Brackets: Aluminum.
 6. Tie Bars and Brackets: Galvanized steel.
- D. High-Performance Volume Control Dampers: Multiple-blade, opposed-blade design, low-leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized-steel channels, minimum of 16 gage, and with mitered and welded corners. Provide frames with flanges where indicated for attaching to walls. Provide flangeless frames where indicated for installation in ducts.
 2. Steel Blades: 18-gage, airfoil-shaped, galvanized steel.
 3. Blade Seals: Dual-durometer vinyl on blade edges; metallic compression on jambs.
 4. Blade Axles: Galvanized steel.
 5. Tie Bars and Brackets: Galvanized steel.
- E. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within a pipe bearing assembly mounted on supports at each mullion and at each end of multiple damper assemblies. Provide appropriate length and number of mounting to connect linkage of each damper of a multiple damper assembly.
- F. Damper Control Hardware: Zinc-plated, die-cast core with a heavy-gage dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Provide center hole to suit damper operating rod size. Provide elevated platform for insulated duct mounting.

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. At all branches serving more than 3 Nos. supply and return registers
2. At all branches serving fresh air to spaces
3. At all main fan supply, re-circulation and extract ducts.
4. At all connections to grille and diffuser plenum boxes.

Scribe or indelibly mark the final setting on all dampers and adjusting devices after balancing.

Fire Dampers

- A. General: UL labeled according to UL Standard 555 "Standard for Fire Dampers., 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.
- B. Fire Rating: 1-1/2 or 3 as per the recommended NFPA ratings.
- C. Frame: Type A or Type B; fabricated with roll-formed, 21-gage, galvanized-steel; with mitered and interlocking corners.
- D. Mounting Sleeve: Factory-installed or field-installed galvanized steel.
 1. Minimum Thickness: 0.056-inch (16-gage) or 0.138-inch (10-gage) thick as indicated on drawings, and length to suit application.
 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of the wall or floor, and thickness of damper frame meets sleeve requirements.

- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Blades: Roll-formed, interlocking, 21-gage galvanized steel. In place of interlocking blades, provide full-length, 21-gage, galvanized-steel blade connectors.
- G. Horizontal Dampers: Include a blade lock and stainless steel closure spring.
- H. Fusible Link: Replaceable, 165 deg F rated.

Ceiling Fire Dampers

- A. General: UL listed and labeled; comply with the construction details for the tested floor/roof-ceiling assemblies as by applicable UL Standards.
- B. Frame: 20-gage, rectangular or round, galvanized steel; style to suit ceiling construction.
- C. Blades: 22-gage galvanized steel with nonasbestos refractory insulation.
- D. Volume Control Adjustment: Provide UL-labeled, fusible volume control adjustment.
- E. Fusible Link: Replaceable, 165 deg F rated unless otherwise indicated on drawings and/or required for specific hazards.

Smoke Dampers

Smoke dampers shall be fixed and installed in all ducts entering or leaving smoke areas, escape corridors and routes, and to all air handling units where they are used to provide air during smoke or fire emergency and as depicted on drawings.

Frame shall be aluminum formed into a structural hat channel shape with corner braces for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. The blades shall be airfoil shaped double skin construction. Blade edge seals shall be silicone rubber designed to withstand 450°F and jamb seals shall be aluminum flexible metal compression type. Blade action must be parallel blade or opposed.

Each smoke damper shall be classified by underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S. The leakage rating under UL555S shall be leakage Class I (4 cfm/ft. at 1" w.g.).

Dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressure of at least 4" w.g. in the closed position, and 4000 fpm air velocity in the open position.

In addition to the leakage ratings already specified herein, the smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250°F depending upon the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and alarm.

Blade Position Indicator: Each smoke damper shall be equipped with Switch Package. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

Openings sizes shall be restricted so as to require the minimum of infill material which shall be keyed in to provide a homogeneous construction and maintain the fire resistance integrity of the structure.

Smoke dampers and frames shall not be supported by adjacent ductwork.

Smoke dampers and frames shall always be set parallel to the plane of the wall or floor.

Access doors shall be provided adjacent to smoke dampers for inspection and be of sufficient size for single-handed resetting.

Access to smoke damper assemblies shall also be maintained through builders work elements.

Duct Silencers

- A. General: Provide factory-fabricated and -tested round or rectangular silencer with performance characteristics and physical requirements as indicated on the silencer equipment schedule on drawings.
- B. Fire Performance: Adhesives, sealers, packing material, and accessory materials shall have fire ratings not exceeding 25 for flame spread and 50 for smoke developed when tested according to ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."
- C. Rectangular Units: Fabricate casings with a minimum of 22-gage solid sheet metal for outer casing and 26-gage perforated sheet metal for inner casing.
Round Units: Provide casings with sheet metal thicknesses for the casing diameters as listed below:
 - 1. Up to 24 inches: 22 gage.
 - 2. 26 through 40 inches: 20 gage.
 - 3. 42 through 52 inches: 18 gage.
 - 4. 54 through 60 inches: 16 gage.
 - 5. Casings fabricated of spiral lock seam duct may be 2 gages lighter than that indicated.
 - 6. Interior Partitions and Baffles: At least 22 gage, and designed for minimum aerodynamic losses.
- E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.
- F. Fibrous Acoustic Fill Material: Inert and vermin-proof fibrous material with density to obtain specified acoustic performance. Pack under not less than 5 percent compression to eliminate voids due to vibration and settling.
- G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
 - 1. Do not use nuts, bolts, and sheet metal screws for unit assemblies.
 - 2. Lock form and seal or continuously weld joints.
 - 3. Suspended Units: Provide factory-installed suspension hooks or lugs attached to the frame in quantities and spaced to prevent deflection or distortion.
 - 4. Reinforcement: Provide cross angles or trapeze angles for rigid suspension.
- H. Source Quality Control: Perform the following factory tests:
 - 1. Acoustic Performance: Test silencers with airflow in both directions through silencer, according to ASTM E 477, "Methods of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance."
 - 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with an airflow of at least 2,000 FPM face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of the associated fan static pressure or 6-inch W.G. static pressure, whichever is greater.

Turning Vanes

- A. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.
- B. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

Duct-Mounted Access Doors And Panels

- A. General: Refer to the Access Door Materials Schedule on drawings for frame and door thickness, number of hinges and locks, and location of locks. Provide construction and airtightness suitable for duct pressure class.
- B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- E. Insulation: fiber glass or polystyrene foam board to match the around duct insulations in thickness and density.

Flexible Connectors

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19. or to DW/146
- C. Extra-Wide Metal-Edged Connectors: Factory-fabricated with a strip of fabric 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19. or to DW/146
- D. Transverse Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 4-3/8-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19. or to DW/146.
- E. Conventional, Indoor System Flexible Connectors Fabric: Glass fabric double coated with polychloroprene.
 - 1. Minimum Weight: 26 oz. per sq yd.
 - 2. Tensile Strength: 480 lb per inch in the warp and 360 lb per inch in the filling.Conventional, Outdoor System Flexible Connectors Fabric: Glass fabric double coated with Du Pont's HYPALON or other synthetic-rubber weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.
 - 1. Minimum Weight: 26 oz. per sq yd.
 - 2. Tensile Strength: 530 lb per inch in the warp and 440 lb per inch in the filling.

3. High-Temperature System Flexible Connectors: Glass fabric coated with silicone rubber and having a minimum weight of 16 oz. per sq yd and tensile strength of 285 lb per inch in the warp, and 185 lb per inch in the filling.
4. High-Corrosive-Environment System Flexible Connectors: Glass fabric coated with a chemical-resistant coating.
5. Minimum Weight: 14 oz. per sq yd.
6. Tensile Strength: 450 lb per inch in the warp and 340 lb per inch in the filling.

Flexible Ducts

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts - Uninsulated: Spiral-wound steel spring with flameproof vinyl sheathing.
- C. Flexible Ducts - Uninsulated: Corrugated aluminum.
- D. Flexible Ducts - Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-thick, glass fiber insulation around a continuous inner liner.
 1. Reinforcement: Steel-wire helix encapsulated in the inner liner.
 2. Outer Jacket: Glass-reinforced, silver mylar with a continuous hanging tab, integral fiber glass tape, and nylon hanging cord.
 3. Inner Liner: Polyethylene film.

Accessories Hardware

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

EXECUTION

EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance, operation and maintenance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

INSTALLATION

- A. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
- B. Install Dampers where required for the proper regulation of the ventilation systems. In general, the dampers shall be provided as follows:
 1. At all branches serving more than 3 Nos. supply and return registers
 2. At all branches serving fresh air to spaces
 3. At all main fan supply, re-circulation and extract ducts.
 4. At all connections to grille and diffuser plenum boxes.

- C. Scribe or indelibly mark the final setting on all dampers and adjusting devices after balancing
- D. Provide test holes at fan inlet and outlet and elsewhere as indicated. Scribe or indelibly mark the final setting on all dampers and adjusting devices after balancing
- E. Install fire and smoke dampers according to the manufacturer's printed instructions.
- F. Install fusible links in fire dampers.
- G. Label access doors according, "Mechanical Identification."

ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.

END OF SECTION

SECTION 15950

TESTING AND COMMISSIONING

GENERAL

Testing and Commissioning

Summary

Section Includes:

- Testing, adjusting and balancing of air systems.
- Testing adjusting, and balancing of hydronic and refrigerating systems.
- Measurement of final operating condition of HVAC systems.
- Sound measurement of equipment operating conditions.
- Vibration measurement of equipment operating conditions.

References

Associated Air Balance Council USA:

- AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- American Society of Heating, Refrigerating and Air-Conditioning Engineers:
- ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- Natural Environmental Balancing Bureau USA:
- NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

Submittals

- Prior to commencing Work, submit proof of latest calibration date of each instrument.
- Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms prepared following ASHRAE 111 NEBB Report forms containing information indicated in Schedules. Submit data in S.I. units.
- Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty and Copy of NEBB Certificate of Conformance Certification.
- Submit draft copies of report for review prior to final acceptance of Project.
- Furnish reports in soft cover, letter size, binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

Closeout Submittals

Project Record Documents: Record actual locations of flow measuring stations balancing valves and rough setting.

Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

Quality Assurance

Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance ASHRAE 111 NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

Maintain one copy of each document on site.

Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

Qualifications

Agency: Third party company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience approved by the Engineer.

Sequencing

Sequence balancing between completion of systems tested and Date of Substantial Completion.

EXECUTION

General

Systems and components shall be tested during construction in accordance with the requirements of the relevant clauses of the documents. Adequate time shall be allowed for the stair pressurisation and smoke exhaust systems to be fully tested and commissioned correctly.

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.

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.

Testing in Sections

The Contractor shall allow for testing and commissioning the installation in sections as may be required in order to conform to the program. All pipe work 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.

Compliance Tests

Certificates showing compliance with the requirements of these documents and of any authority having jurisdiction shall be furnished.

Operating Tests

Operating tests shall be carried out prior to Practical Completion and a detailed report shall be furnished at completion showing the preliminary readings and final balance figures for each circulating system, name plate rating and full load operating current for each motor, the settings for each electrical and control element.

Balancing is to be by NATA, BSRIA accredited organization or by NEBBO tested personnel with specialized expertise in air and water balancing.

Off Site Tests

When called for by the Engineer or where British Standards or Codes of Practice stipulate tests on items of equipment to demonstrate compliance, these tests shall be carried out at the manufacturer's works or elsewhere, as appropriate. In certain cases, where appropriate, type test certificates will be accepted as follows:

- a) Fans: Type Test Certificates showing fan characteristic curves, (BS 848, Part 1, test method as appropriate) and Type Test Certificates for sound power levels (BS 848, Part 2).
- b) Pumps: Type Test Certificates for head, discharge, speed and power input (BS 599)
- c) Electric Motors: Type Test Certificates in accordance with BS 5000. For motors of 40 kW output and above, routine (individual) test certificates in accordance with BS 5000.
- d) Starters and control gear: Type Test Certificates BS 587. For control panels as a whole routine (individual) high voltage test in accordance with BS 587.
- e) Other electrical equipment, such as air heaters (but excluding thermostatic control equipment): Test Certificates in accordance with BS 6220.
- f) Refrigeration and A/C plant: Test Certificates for hydraulic and air pressure testing at works in accordance with BS 4434, Part 1.

On Site Tests

Carry out pressure tests on all ductwork and piping systems in accordance with the requirements of this specification, relevant clauses:

Air Systems

Adjustments shall be made at each air terminal to provide an even distribution over the face. Air quantity shall be balanced to within +10 0% of the value shown on the drawings with volume dampers set to achieve the lowest practical fan speed and power consumption.

Blade pitch and fan speed setting to deliver +10% 0% of the design value shall adjust fan air quantity.

Air quantity at pilot traverse stations shall be measured and recorded.

In each system the sum of the individual terminal air quantities shall be within +5% 5% of the upstream pilot traverse quantity.

Fan speed and pitch shall be recorded.

Controls

Pressure, temperature and humidity controllers shall be tested and adjusted to operate at the correct settings.

Pressure and temperature limit controls shall be tested and adjusted to safe operating settings and trip times.

Interlocked and multi-step systems shall be tested for operating sequence.

Thermal overloads and protective cut outs shall be tested and adjusted during a hot day for the operating load.

Generally

Cooling equipment shall be tested for satisfactory operation. Pressures and temperatures for refrigerant and cooling water shall be tested and adjusted to the correct operating settings.

Any abnormalities in terms of vibration and noise shall be corrected. Unusual operation in rotating machinery shall be corrected by testing for alignment and support. Noisy air terminals shall be corrected by rebalancing.

Performance Tests

A detailed report shall be furnished at the completion of performance tests.

Air Cooling Systems

Cooling tests shall be conducted in summer climatic conditions.

Measuring air total heat difference and refrigerant temperatures simultaneously at the balanced flow rates shall test the capacity of each cooling coil.

Refrigeration compressor capacity shall be read from manufacturer's rating information using measured suction and discharge pressures and operating current step by step.

Controls

Operating pressures, temperatures and humidity's shall be tested under operating conditions. The set point and differential operating range of each control element shall be recorded. The recorded readings shall be entered on the "As Built" control drawing. (See "Instruction Manuals").

Three copies of recorded data for final system set up shall be forwarded to the Project Manager after final acceptance tests.

Acceptance Tests

Prior to the Defects Liability period acceptance tests shall be conducted to demonstrate that systems and components are performing in accordance with the requirements.

Final acceptance testing of control systems shall be conducted in the presence of a representative of the Contractor. During testing, the control characteristics, interlocks, and responses of all relevant control systems shall be demonstrated to the satisfaction of the Contractor. Witnessed testing shall not be arranged until the Contractor has assured himself that all systems are functioning correctly and are capable of maintaining reliable and consistent operation.

The acceptance tests shall include a period of two days operation of control systems during which time the performance of the systems shall be carefully observed and important parameters logged or recorded. Where possible, the plants shall be operated under extreme conditions of service by artificially loading if necessary.

Logging and Documentation

During the commissioning and testing period, the settings of all control elements shall be logged and documented for inclusion in Operation and Maintenance Manuals. The logs shall provide a complete record of commissioning data for the plant including final settings, special adjustments or requirements, and other useful data such as recorder charts etc. Three (3) copies of commissioning logs shall be forwarded to the Main Contractor after final acceptance tests.

Where results are inconclusive tests shall be repeated.

If the second test should fail all further witnessing of tests by the Contractor or his representative shall be chargeable at his currently hourly rate and the accumulated sum shall be deducted from the amounts payable under the Contract.

TESTING OF PIPE WORK, WELDS, ETC

The whole installation shall be hydraulically tested to twice the working pressure of the systems or 4.0 bar, whichever is the greater.

Gas pipe work 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. 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.

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 re welded. 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 re welded 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 pipe work 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 pipe work. 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.

TEST CERTIFICATES

The Contractor shall at the time of the test present copies of a test certificate for signature by the Engineer and one to be retained by the Contractor.

Insurance company certificates of hydraulic test held at the Manufacturer's work shall be submitted for boilers calorifiers, cylinders.

Manufacturers' certificates, of test at the specified duties held at the manufacturers' works shall be submitted for pumps and fans. No item of equipment shall be delivered to Site before the Engineer has given his approval of the test certificate.

Where no test pressures at factory are given, the test shall be carried out on Site in accordance with the appropriate British Standard (current edition) and subject to the Engineer's approval.

AIR AND HYDRAULIC SYSTEMS TESTING, BALANCING AND COMMISSIONING

Scope

Inspect, test, commission and monitor all mechanical services systems and equipment included in this contract together with associated control systems and panels.

Provide all personnel and equipment necessary to carry out the required inspections, tests and commissioning operations including the employment of specialists who would provide and operate testing and monitoring facilities.

Related Work under Mechanical Sections

This section shall relate to all sections included in this contract.

Guarantees

Attention is directed to provisions of the General Terms and Conditions and Special Conditions regarding guarantees and warranties for work under this contract.

Commissioning Agency

The Contractor shall employ the services of a company approved by the Engineer regularly engaged in providing a testing and commissioning service and who has been in continuous business for not less than 5 years employing fully trained staff having not less than 2 years dedicated experience. A senior experienced commissioning technician shall be responsible for supervising and directing the activities of the commissioning team.

A fully commissioning team shall be provided throughout the full period of commissioning. Changes to the staffing of the commissioning team shall only be made at the request or approval of the Engineer.

The company shall have no vested interest in Project, such as sales of equipment, services etc. and shall not be partly or wholly an owned subsidiary of any vested or interested party, Contractor or sub-contractor.

Standards

All inspection, testing and commissioning procedures shall conform to the current editions and amendments thereto of the following standards and codes notwithstanding current statutory and legal requirements and any other standards and codes which shall apply.

Chartered Institution of Building Services Engineers (C.I.B.S.E.). Commissioning Codes;

Series A	-	Air Distribution
Series B	-	Boiler Plant
Series C	-	Controls
Series R	-	Refrigerating Systems
Series W	-	Water Distribution systems

- Building Services Research and Information Association (UK). BSRIA Application guides and Technical Notes.
- D.W. 142 Specifications
- British standards and Codes of Practice
- I.E.E. Regulations
- Local Authority Regulations and Bye-Laws
- Government Regulations
- Insurance Company(s) Requirements

Tests

All tests shall be witnessed and test certificates signed by the Engineer upon satisfactory completion of the tests. One copy of the signed certificate shall be immediately handed to the Engineer.

Notice

Clear notice required by the Engineer of testing and commissioning activities.

Off site tests	:	14 days
On site tests and inspection	:	2 days
Start up of major plant	:	7 days
Performance tests	:	14 days

Submittals

Four (4 No.) copies of all testing and commissioning documentation shall be submitted in bound covers indicated as follows:

- A. Certificates:
 1. Equipment test certificates
 2. System(s) test certificates
 3. Welding test certificates if applicable
- B. Data Sheets and record manuals:
 1. Data sheets of test equipment to be used.
 2. Full commissioning and testing data presented on approved record forms for all systems and equipment.
- C. Drawings:
 1. Equipment detail drawings for equipment.
 2. Circuit diagrams for each system with design and actual flow rates and other pertinent data shown.
- D. Record forms:
 1. Specimen copies of all commissioning record forms shall be submitted or approval of their use on this project.
 2. Forms shall be A4 size paper for loose leaf binding, with blanks for listing of the required test ratings and for certification of report.
- E. Program of work:

Fully detailed program of work for inspecting, testing and commissioning the works, shall be submitted for approval.

Instruments

- i) All necessary instruments for commissioning and testing as defined in the C.I.B.S.E codes and this specification shall be included.
 - ii) All instruments shall have been calibrated within a period of six months and carry a certificate of calibration to that effect. The instruments shall be selected to provide an accuracy compatible with the readings to be taken and the tolerances specified.
 - iii) The accuracy of the instruments shall be demonstrated to the Engineer and the use thereof shall be subject to his approval.
- B. Test instruments shall be available for use to obtain the readings and recorded data required, and shall include but not be limited to the following:-
1. Temperature and humidifies:
 - a) Electronic thermometers
 - b) Mercury in glass thermometers
 - c) Aspirated/sling hygrometers
 2. Pressures:
 - a) Manometer gauges
 - b) Magnehelic gauges (diaphragm actuated)
 - c) Pressure gauges
 - d) Test pressuring equipment
 3. Air flow:
 - a) Pitot static gauges
 - b) Hot wire anemometers
 - c) Vane anemometer (analogue or digital) with hoods
 - d) Velometers (grilles and diffusers only)
 4. Liquid Flow
 - a) Manometer gauges across venturies, orifice plates, valves or equipment.
 - b) Anubar (Pitot) gauges
 - c) Flow meters
 - d) Portable pumps
 5. Air Movements
 - a) Smoke pellets
 - b) Smoke aspirator
 6. Rotational Speeds:
 - a) Direct read out electronic digital tachometer
 - b) Revolution counter and stop watch
 7. Sound Levels:
 - a) Sound spectrum analyzer
 8. Electrical:
 - a) Ammeters
 - b) Voltmeters
 - c) Multi-meters
 9. Vibration:
 - a) Accelerometer
 10. Recording Instruments:
 - a) Hydro thermograph
 - b) Multi-point temperature/humidity recorder (plotter)
 - c) Digital pressure recorder (plotter)
 - d) Sound level recorder

General Requirements

- A) Definitions:
1. Commissioning: The advancement of the installation from the static completion to full working order calibrated to design requirements, involving the setting-to-work and regulation of the installation (s).
 2. Testing: The evaluation of the performance of the commissioned works.
NB: Preliminary checks on the static installation will be carried out by the commissioning Engineers to ensure that it is in a satisfactory and safe condition immediately prior to start up.
- B) The Contractor shall apply for, obtain and pay for all permits, tests and inspections that may be required by any of the authorities or agencies having jurisdiction in the performance of the work.
- C) Under the adjudication of the Engineer, the Contractor shall coordinate, supervise and carry out all inspection, testing and commissioning activities within an agreed program period.
- D) The Contractor shall prepare, submit and agree with the Engineer a detailed program of work defining for each stage: activities, sequence of work, time scales, manpower requirements, start and completion dates and working areas of the building to which access will be required.
- E) The Contractor shall allow for carrying out testing and commissioning of the works in phases/stages.
- F) The Contractor shall allow for carrying out activities in an occupied building with premium working out of normal office hours in the evening and at weekends.
- G) All defects of workmanship, materials, performance design of equipment, maladjustment's or other irregularities, which become apparent during tests, shall be rectified and the tests repeated to the Engineer satisfaction and at no cost to the contract.
- H) Where equipment requires inspection or certification by an insurance company during construction adequate notification shall be given of the date when the equipment will be ready for examination. This shall also apply to on site tests to be witnessed by an insurance company.
- I) Before any electrical circuit is energized an "Application for Supply" shall be made. This shall be delivered 24 hours before the supply is required and shall be accompanied by a Test Certificate showing the witnessed values of insulation, resistance and earth fault loop impedance obtained.
- J) Before any installation is subjected to site testing or commissioning it shall be thoroughly cleaned both internally and externally.

Where fire protection systems are installed they shall be installed in stages to suit the program of work, but upon construction of the first 18 meters in height they shall be capped off at this height and hydrostatically tested. This section of the riser shall then be made operative to provide protection to the building. This procedure shall be repeated floor by floor thereafter until the system has been completed after which the entire installation shall be re-tested. AIR SYSTEMS' BALANCING PROCEDURES.

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.

- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.

CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

- A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.
- B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each air-handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Adjust fan speed higher or lower than design with the approval of the Engineer. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes (if applicable) to determine the maximum required brake horsepower.
- C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at design flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

HYDRONIC SYSTEMS' BALANCING PROCEDURES

- A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.

- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.
- E. Adjust balancing stations to within specified tolerances of design flow rate as follow:
 - 1. Determine the balancing station with the highest percentage over design flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
 - 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating if high-efficiency motor.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
 - 1. Entering- and leaving-water temperatures.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperatures of entering and leaving air.
 - 5. Wet-bulb temperatures of entering and leaving air for cooling coils designed for less than 3540 L/s.
 - 6. Airflow.
 - 7. Air pressure drop.

TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

- C. Measure outside-air, wet- and dry-bulb temperatures.

TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Confirm interaction of electrically operated switch transducers.
- H. Confirm interaction of interlock and lockout systems.
- I. Verify main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or non grounded power supply.

COMMISSIONING

Checks and Procedures

- A) Prior to any work being commenced, a thorough inspection of all systems, plant and equipment shall be carried out to check for installation errors, damage, deterioration cleanliness and readiness for testing and commissioning. all defects shall be recorded in detail, which shall be rectified before work can proceed.
- B) When the above procedure has been satisfactorily completed the sequence for each main system shall comprise:
 - i) Mechanical and electrical engineering safety checks.
 - ii) Start up and run machines. Pumps shall not be run until system flushing is complete unless used for dynamic flushing.
 - iii) Regulation calibration or adjustment.
- C) The preferred sequence for commissioning the system is :
 - i) Flushing and pre commissioning cleaning only of water systems.
 - ii) Commissioning of air distribution systems.
 - iii) Filling, venting, water treatment, start up and regulation of water systems.
 - iv) Functional checks on thermal controls associated with water distribution.
 - v) Commissioning of boiler and calorifier plants and associated controls.
 - vi) Commissioning of air conditioning and refrigeration plants including associated controls.
 - vii) Commissioning of controls for air conditioning and ventilation plant.
 - viii) Commissioning of fire and other safety control circuits including instrumentation, sensing and remote indication.
- D) The precise sequence may have to be adjusted for readiness of plant and suitability of weather conditions, subject to the prior approval of the Engineer.
- E) All water systems, air distribution systems, plant and equipment and control systems shall be fully commissioned in accordance with the C.I.B.S.E. Commissioning Codes and this Specification.

Where connections to existing services are required, the existing services shall be thoroughly checked and tested also cleaned and repaired where necessary before connecting into new systems.

The tolerance for adjustment of air flow rates shall be generally as stated in C.I.B.S.E. Commissioning Codes but subject to agreement with the Engineer. Water flow rates shall be adjusted such that volumes to each branch shall be $\pm 10\%$ of design values and pump volumes shall be $+ 10\%$, $- 10\%$ of the design value.

The detailed procedure for preliminary checks, setting to work and regulation of the works shall be carried out strictly in accordance with the relevant C.I.B.S.E. code(s). No deviations to these procedures shall be made without the prior written approval of the Engineer.

Commissioning shall not be considered as complete until the Engineer approval has been obtained.

During the commissioning period of controls arrange for a controls systems engineer to be available on site until the controls systems have been fully commissioned and the witnessing of proving tests have been carried out.

Particular attention shall be paid to the following features:

- Satisfactory operation of any automatic or manually operated sequences to be used in the event of fire.
- Safety in the event of failure and of sudden resumption of electricity supply.
- Satisfactory operation of safety interlocks designed for the protection of personnel, such as those associated with the high voltage side of equipment and with remote electrically operated plant.

The following item shall be checked and/or tested:

- Set desired value of all control devices.
- Satisfactory operation of equipment protection devices.
- The functional correctness of all on/off sequencing interlocks, operations and alternate working selections, automatic or manual change-over of duplicate plant, and modulation ability of all control systems.

The satisfactory operation of all make-up, drain and overflow arrangements shall be checked. Where water treatment is included initial commissioning shall be carried out and then rates of flow, dosing quantities etc. shall be calibrated and set for routine operation. where controlled blow down is included the controlling device shall be calibrated and set for routine operation. Damper setting positions shall be scribed on completion of air system balancing.

Testing and Commissioning of Controls, MCC's

a. General

All control panels and motor control centers when specified shall be pre-tested at works prior to delivery.

Where it is necessary for the Engineer or his Representatives to visit places away from the Works for supervision or inspection in compliance with the Contract, the Contractor shall

pay the traveling, subsistence and accommodation expenses of the Engineer and his Representation.

Commissioning shall be carried out in accordance with these requirements together with the C.I.B.S.E. Commissioning Code 'C' and relevant I.E.E. Codes and British Standards for testing equipment.

The commissioning shall be completed within the time scales laid down by the Engineer of the Engineer.

The Tender shall include for the provision of all equipment and apparatus necessary for carrying out commissioning and testing on site and to certify that the specified commissioning procedures have been carried out.

b. Static Checks

Checks shall be carried out on all control components to ensure proper location and installation. All anomalies shall be corrected.

Checks shall be carried out to ensure that all control circuit wiring is complete and is safely and correctly installed.

Checks shall be carried out on circuit continuity and earth leakage.

Visual inspection shall be made of all associated motors and equipment to ensure conditions are safe prior to start-up and running.

Checks shall be carried out on rating of all fuses and overloads, and on settings of all safety devices to design requirements.

c. Commissioning

All control systems shall be progressed from the completion of the static installation to full working order, calibrated to design requirements.

d. Testing

All control systems shall be fully tested to check:

- 1) Functional correctness
- 2) Modulating ability
- 3) Sequence operation and interlocks
- 4) Operation of safety circuits and devices
- 5) Control ability within design limits

All information relating to controls including set points, control bands limits, pressures, temperatures, etc. The information shall be logged for tabulation and inclusion in the maintenance and operation instructions.

Fault and limit conditions shall be simulated to ensure correct response occurs.

Performance tests shall be carried out to demonstrate that the control systems operate safely and correctly in accordance with the specification and are acceptable to the Engineer of the Engineer.

e. Inspections

Pre-Installation Inspection:

The area and conditions under which the control systems are to be installed shall be examined and any unsatisfactory conditions detrimental to the proper and timely completion of the work shall be corrected. The work shall not proceed until unsatisfactory conditions have been corrected in a manner suitable to the Engineer of the Engineer.

f. Post-Installation Check:

The services of an experienced and competent Engineer/Technician of the manufacturer or supplier of the equipment shall be provided to visit site to inspect, check, adjust if necessary and approve the installations.

The equipment supplier's Engineer/Technician shall be present when equipment is placed in operation.

Commissioning records

1. During the commissioning of the installation(s) the results of all checks and measurements taken for all systems and equipment shall be tabulated and recorded on approved record sheets. System and equipment design data shall also be tabulated on the same from for comparison.
 2. Written records are to be maintained, throughout the commissioning and testing, of all measurements made, and all settings and adjustment imposed on the plant. This shall include precise details of all thermal controls, including sensitivities, proportional bands, integral times and delay times. They shall be submitted to the Engineer for approval as they are prepared at each stage of the works.
 3. All data shall be collated and produced as a single commissioning and testing record manual, enclosed in a loose leaf ringed plastic covered binder. On completion, a draft copy of the manual shall be submitted for approval prior to the production of the three final copies.
 4. The information recorded shall include but not necessarily be limited to the following, and shall also include all plant data including name of manufacturer, type of equipment, model number, system reference, etc.:
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

- Return and Extract Fans

Air flow	L/S
Total and static pressure	mm
Fan speed	Rpm
Fan power (absorbed) / phase	Amp/Amp/Amp
Motor speed	Rpm
Motor Power (name plate) FLA	Amp
- Room Ventilation & Internal Temperatures

Supply air	L/S
Extract air	L/S
Main and sub-main duct	L/S
Internal Temperature	°C
Sound level	dB(A)Hz

•	Single package and split air conditioner	
	Supply air quantity	L/S
	Return air quantity	L/S
	Fresh air quantity	L/S
	Total and static air pressures. (Indoor fan)	mm H2O
	Evaporator fan speed	Rpm
	Fan power (absorbed) / phase	Amp/Amp/Amp
	Motor speed	Rpm
	Motor power (name plate) FLA	Amp
	Room internal temperature DB & WB	°C
	Return air temperature	°C
	Mixed air temperature	°C
	Ambient dry bulb temperature	°C
	Refrigerant suction pressure(s)	bar
	Condensing pressure(s)	bar
	Oil pressure differential pressure(s)	bar
	High pressure cut-out setting	bar
	Low pressure cut-out setting	bar
	Duty	Watt

Note

Single package units shall be tested and commissioned when relevant air compressors and vacuum pumps are operational.

•	Pumping equipment	
	Water flow rate	L/S
	Static pressure	m/water
	Suction pressure	m/water
	Discharge pressure	m/water
	Pump speed	R.P.M.
	Pump power (absorbed)/phase	Amp/Amp/Amp
	Motor speed	R.P.M.
	Motor power (name plate) FLA	Amp
•	Water systems (piping & Control Valves)	
	Flow through main and sub-circuits	L/S
	Flow through control valves	L/S
	Pressure drop through control valves	m/water
	Pressure drop across strainers	m/water
	Supply temperature	°C
	Return temperature (after coil)	°C
	Return temperature (after mixing valve)	°C
•	Motor data:	
	Name plate power (FLA)	Amp
	Voltage	V
	Motor absorbed power/phase	Amp/Amp/Amp
	Cycles	
	Starting current	Amp
•	Controls:	
	Set values of all control devices	

Control bands on all control devices
Set values of all protection devices

- Vibration
Static deflection of mountings mm.
- Sound Levels:
(Free field sound full spectrum) dB(A)Hz
Adjacent to:-
 - Chillers and A/C Split and Packaged Units
 - Fans and air handling plant
 - Air intake and discharge louvers
 - Refrigeration condensing units
- Terminal Units
Damper motor operation
Interlock with hood and extract fan

Performance Tests

- a. Carry out and supervise the operation of the commissioned installations for such a period as necessary to satisfactorily evaluate and demonstrate to the Engineer, the performance of the installations by use of measuring and recording instruments that the installations function correctly and maintain the required conditions within the specified limits.
- b. Provide artificial loads as required for the purpose of simulating internal and external loads.
- c. During the trial period, plant and building conditions shall be checked and monitored, all necessary adjustments made and recorded on final report sheets.
- d. During the trial period, provide training to the clients nominated staff in the operation of the plant.
- e. No test or trial shall be carried out while conditions are abnormal.
- f. Provide the Engineer with 14 days clear notice of proposed commencement

Equipment Cards

Install at each piece of equipment a "Check out" card showing all significant operating temperatures, pressures, amperes, voltages, power consumption flow rates, resistance, etc. Check out cards shall be standard 125 mm. x 200 mm. stiff index card enclosed in a clear film card folder, securely attached to equipment, or wall in immediate areas.

Documentation

The whole of the information requested in this specification including:-

- Plant data.
- test certificates.
- commissioning records.
- Performance test reports.
- Circuit diagrams.

Shall be collated, indexed and assembled into manuals having vinyl covered loose leaf ring binder covers with the project title and then words "Commissioning Data" permanently printed on the front cover. The commissioning companies name, address and telephone number shall be printed on the inside of the front cover.

Four sets of the above manuals shall be handed to the Engineer within ten weeks of the completion of commissioning and performance tests. The installation shall not be accepted until the final approved manuals have been handed over.

END OF SECTION

SECTION 15990

IDENTIFICATION TAGS AND LABELING

GENERAL

SUMMARY

Section Includes:

- Nameplates.
- Tags.
- Stencils.
- Pipe markers.
- Labels.
- Lockout devices.

SUBMITTALS

- Product Data: Submit manufacturers catalog literature for each product required.
- Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- Samples: Submit two tags, labels, pipe markers suitably sized for the project.
- Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- Manufacturer's Certificate: Certify products meet or exceed specified requirements.

CLOSEOUT SUBMITTALS

Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

QUALITY ASSURANCE

Conform to ASME A13.1 for color scheme for identification of piping systems and accessories. Maintain one copy of each document on site.

FIELD MEASUREMENTS

Verify field measurements prior to fabrication.

EXTRA MATERIALS

Furnish six containers of spray-on adhesive.

PRODUCTS

NAMEPLATES

Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

TAGS

Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 38 mm square.

Metal Tags: Brass with stamped letters; tag size minimum 50mm (2in) in diameter with depressed black numbers of 15mm (1/2 in) height, prefixed by the letters indicating the system such as "HVAC", "Water", "Steam"...etc . They shall be fastened to valves and controls with approved brass chains and hooks.

Information Tags: Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 83 x 143 mm with grommet and self-locking nylon ties.

Tag Chart: Diagrams, on cloth, showing outline plans of structures and essential features of the several systems, including all piping, ducts, equipment, valves, dampers and controls.

STENCILS

Stencils: With clean cut symbols and letters of following size:

- Up to 51 mm Outside Diameter of Insulation or Pipe: 13 mm high letters.
- 64-150 mm Outside Diameter of Insulation or Pipe: 25-mm high letters.
- Over 150 mm Outside Diameter of Insulation or Pipe: 44 mm high letters.
- Ductwork and Equipment: 44 mm high letters.

Stencil Paint:, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

PIPE MARKERS

Color and Lettering: Conform to ASME A13.1.

Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

LABELS

Description: Aluminum, size 48 x 19 mm, adhesive backed with printed identification and bar code.

LOCKOUT DEVICES

Lockout Hasps: Anodized aluminum hasp with erasable label surface; size minimum 184 x 76 mm.

Valve Lockout Devices: Steel device preventing access to valve operator, accepting lock shackle.

EXECUTION

PAINTING

Approved specialist painters shall carry out all items of painting covered by this section of the Specifications. 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 pipe work, 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.

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 color 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 2110 to 75 micron thickness and one coat of Micaceous Iron Oxide 2401 to 60 micron thickness.

After installation, apply one coat of Micaceous Iron Oxide 2401 to 60 microns thickness, followed by one coat of High Build Alkyd Gloss color 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 color 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 color scheme from the B.S.4800 range of colors.

PAINTING IN PLANT ROOM

- a) All annulated pipe work, ductwork, flanges, unions, valves, trench covers and handrails shall be treated as Method 5.
- b) All steel pipe work to be insulated shall be treated as Method 1.
- c) All galvanized supports shall be treated as Method 2.
- d) All insulated ductwork shall be treated as Method 6.
- e) All equipment and plant delivered to site in a pre-finished condition shall have all damage made good prior to handover.

PAINTING IN VOIDS, SHAFTS AND DUCTS

- a) All annulated pipe work shall be treated as Method 5.
- b) All steel pipe work to be insulated shall be treated as Method 1.

PAINTING EXTERNALLY

Painting externally shall be in accordance with that detailed for Plant Rooms with the following exceptions:

- Where supports are installed in concealed positions, i.e. underground trenches and tunnels trenches etc., they shall be hot dip galvanized only
- Insulated ductwork shall be treated as detailed under 'insulation'

DECORATIVE PAINTING INTERNALLY EXPOSED

All internally exposed duct work and pipe works shall be carefully, prepared by use of mechanical tools, manual chipping and chamfering, wire brushing and other techniques required to remove rust and scale and to produce a surface compiling with PST 2 quality of BS 7079: Part A.

Steel sheets and pipes shall be degreased by scrubbing with a warm detergent solution (2% Teepol or equivalent) followed by water washing, and by treatment with mordant solution (British Rail "T" wash or equivalent), then followed by water washing once the surfaces has turned black. All areas which do not turn black shall be re cleaned and retreated.

The quality of surface preparation specified must be obtained as per BS7079. at the time of priming.

Duct shall then be painted according to the following:

Primer:	Zinc phosphate oil/alkyd primer. 40 microns DFT
Barrier:	Oil Alkyd MIO barrier coat, 75 microns DFT (Color as per architectural selection)
Undercoat:	Oil Alkyd under coat 40 microns finish (Color as per architectural selection)
Finish:	Lacquered spray finish (Color as per architectural rendering selection)

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 breeching shall be painted with heat resistant paint.

Coat interior of each outdoor air chamber with two coats of odorless, rust resisting, non-scaling 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.

TAGS AND COLOR CODING

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.

Piping identification shall be in conformance with the following:

Provide and affix approved adhesive bands identifying the service, by stem 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:

System	Color	Stripe
Water, Air Cond. Chilled	Blue	Green
Heating	Green	White / Crimson
Refrigerants	Purple	
Fuel Oils No. 3 to 6	Yellow	
Boiler Blow Down	Green	Yellow & White
Domestic Cold Water	Green	White/Blue/White
Hot Water	Green	White/Crimson /White
Fire Protection Service	White	Red
Fire Extinguishing	Green	Safety Red
Compressed Air	Light Blue	White
Fuel Oil, Diesel, Kerosene No. 2	Yellow	Black
Town Gas	Yellow Ochre	Emerald/Green
Steam, Low Pressure (under 137.6 kPa/20 psi)	Orange	White
Steam, Medium Pressure - (137.6-668 kPa/20-100 psi)	Orange	Green
Steam, High Pressure - (over 688 kPa/100 psi)	Orange	Black
Gasoline	Yellow	Orange & Black

THERMAL INSULATION IDENTIFICATION

General

Color code/safety indication and basic color identification bands shall identify all insulation and exposed pipe work installed throughout the Project 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.,. 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 pipe work passes through walls, floors, etc.

Pipe contents and designation (i.e. Chilled Water Flow, 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.S.1710.

Colors for color code/safety indication and basic color identification shall be as detailed in Appendix 'D' of B.S.1710.

Valve Labels

The Contractor shall supply and fix on all valves and stop cocks throughout the system, white ivories 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.

END OF SECTION

APPROVED LIST OF MECHANICAL MATERIAL'S MANUFACTURERS

Item	Product	Manufacturers
1.	UPVC Pipes and Fittings	1. ADASANI 2. NIC 3. TERRAIN 4. MARLEY 5. HEPWORTH 6. OSMA 7. OSTENDROF-NG 8. CONCEPT 9. SAPCO 10. CAFMO 11. COSMOPLAST 12. WORLD PLASTICS
2.	Steel Pipes (Black, Galvanized)	1. NIPPON 2. TUBAS 3. DELAMINI 4. PIETRA 5. HEBEI 6. INTERPIPE 7. BRISTOL 8. SILKTUBE 9. SHIELD
3.	Steel Fittings	1. AFL 2. CRANE 3. ECONOSTO 4. DELAMINI 5. IBS 6. IRC 7. HEBEI 8. SHURJOINT 9. BRISTOL 10. ARMSTRONG 11. SHIELD
4.	Valves	1. CRANE 2. HATTERSLEY 3. ECONOSTO 4. OVENTROP 5. T&A 6. NIPCO 7. HOLMES 8. SHURJOINT 9. BRISTOL 10. SHIELD

Item	Product	Manufacturers
5.	Duct & Pipe Supports	1. FISCHER 2. HILTI 3. FLAMCO 4. MEFA 5. CADDY 6. BRISTOL 7. INKA
6.	Gauges / Thermometers	1. H.O. TERICE 2. ASHCROFT 3. WEISS 4. DWYER 5. TOZEN 6. HOLMES 7. LUXOR
7.	Plumbing Fixtures	1. DURAVIT 2. LAUFEN 3. VILLEROY&BOCH 4. IDEAL STANDARD 5. KEREMAG 6. RAK 7. LAUFEN 8. VITRA 9. PRESSALIT 10. GEBERIT
8.	Faucets & Mixers	1. GROHE 2. HANSGROHE 3. HANSA 4. IDEAL STANDARD 5. DELABIE 6. THG
9.	Pipe & Duct Insulation	1. AFICO 2. KIMCO 3. HEBEI 4. KNAUF 5. IZOCAM 6. K FLEX
10.	All Kind Of pumps (domestic & fire & submersible & Irrigation)	1. KSB 2. ARMSTRONG 3. ITT (XYLEM) 4. HOLDEN BROOKE PULLEN 5. FAIRBANKS MORES 6. PACO 7. NEW HADEN 8. CRANE 9. BIRAL 10. FLYGT 11. ABS

Item	Product	Manufacturers
		12. HOMA 13. JUNG 14. HERBORNER 15. BRISTOL 16. GRUNDFOS 17. WILO 18. SAER 19. AURORA 20. SPP 21. ANDRITZ
11.	Kitchen Sinks	1. ELKAY 2. BLANCO 3. SCHOCK
12.	Dampers / Duct Accessories	1. KBE 2. GREENHECK 3. RUSKIN 4. TROX 5. BSB 6. MAT METROPOLITAN AIR TECH. 7. AIR MASTER 8. BSP 9. SAFID 10. ATAI
13.	Air Outlets / Louvers	1. KBE 2. TITUS 3. TROX 4. AIR MASTER 5. TECHNOSTREAM 6. COOLING INDUSTRIES 7. GOLDEN STAR
14.	Flexible Duct Connectors	1. DURODYNE 2. DYNAIR 3. SAFID
15.	All Kind of Fans	1. ACME 2. TWINCITY 3. ELTA 4. SODECA 5. VENCO 6. PENN 7. SYSTEM AIR 8. GREEN HECK 9. S & P 10. WOODS
16.	Split Air Conditioners	1. DAIKIN 2. PETRA 3. SKM 4. PANASONIC

Item	Product	Manufacturers
		5. MITSUBISHI(MHI) 6. O GENERAL 7. GREE 8. FUJITSU 9. SAMSUNG 10. LG 11. TOSHIBA 12. TRANE
17.	Rooftop packaged units	1. DAIKIN 2. PETRA 3. SKM 4. PANASONIC 5. MITSUBISHI(MHI) 6. O GENERAL 7. FUJITSU 8. SAMSUNG 9. LG 10. YORK 11. CARRIER 12. TRAIN 13. MCQUAY 14. DUNHAM – BUSH 15. TRANE
18-	Pre-insulated duct	1. P3 2. SAKE 3. MPU 4. ALP 5. FIMM
19.	Expansion Tanks	1. FLAMCO 2. ARMSTRONG 3. REFLEX 4. EMIRA - IMAS
20-	Double Regulating Valves	1. CRANE 2. HATTERSLY 3. T&A 4. OVENTROP 5. HOLMES 6. SHIELD 7. ACASO 8. APE
21-	Pipe Flexible Connections	1. MASON 2. MERCER RUBBER 3. KINETICS 4. TOZEN
22.	Fire Hose Reel & Portable Fire Extinguishers	1. NORSEN 2. ANGUS 3. THORN

Item	Product	Manufacturers
		4. COMBAT 5. NAFFCO 6. SUZHOU 7. BRISTOL 8. FULL BLAZE 9. TOTAL 10. KIDDIE 11. NOHA 12. SHIELD
23.	Hot Water Cylinders	1. PATTERSON KELLY 2. REFLEX 3. RYCROFT 4. PACETTI 5. CEMLINE 6. ACE INC 7. HUBBLE 8. LOCHINVAR 9. A.O.SMITH 10. ARISTON 11. CHAPPE 12. DE DIETRICH 13. FERROLI 14. FIORINI INDUSTRIES 15. WAGNER & CO. 16. BAXI 17. ATLANTIC
24.	Galvanized Sheet Metal	1. NIPPON 2. SUMITOMO 3. SABIC
25.	Boiler	1. HURST 2. HOVAL 3. LOOS 4. VIESSMAN 5. CLEAVER BROOKES 6. WELLMAN ROBNEY 7. BURNHAM 8. DE-DIETRICH 9. CHAPPEE 10. SAINT ROCH 11. BIASI 12. IVAR 13. BUDARAES
26.	Chimney & Chimney Breaching	1. RITE VENT 2. SELKIRK 3. RAAB 4. DINAK 5. METALOTERM ONTOP

Item	Product	Manufacturers
		6. DE DIETRICH
27.	Air and Dirt Separators	1. SPIROTECH, 2. FLAMCOVENT 3. REFLEX 4. TACO 5. BELL & GOSSET 6. SIPIROVENT 7. PNEUMATIX 8. T & A
28.	LPG Valves	1. CRANE 2. GIACOMINI 3. COMAP 4. TECOFI
29.	PRV's, Regulators, Pressure Gauges, Safety Valves for LPG System	1. FISHER 2. REGO 3. COMAP 4. HOLMES 5. SHIELD
30.	Cross Linked Polyethylene (XLPE)	1. UPONOR 2. LK 3. REHAU 4. HENCO 5. PIPEX 6. AQUAPIPE
31.	PEX PIPE FITTINGS	1. GIACOMINI 2. EMMETI 3. LUXOR 4. OVENTROP 5. FORNARA 6. APE
32.	Toilets Flushing System	1. GROHE 2. GEBERIET 3. ALCAPLAST
33.	Electric Water Heater	1. ARISTON 2. BAXI 3. FERROLI 4. THEMEX 5. A.O. SMITH
34.	Cast Iron Drains, Gully and Cast Iron Clean outs	1. J R SMITH 2. JOSAM 3. WADE 4. ZURN 5. ACO

GENERAL CONDITIONS:**Submittals from manufacturers not listed above shall not be accepted:**

1. The Approval Of The Manufacturer Does Not Release The Supplier From Full Filling The Specifications Completely; The Deviation From Specifications Will Be Subjected To Rejection.
2. All Grooved Fittings Shall Be From One Manufacturer For All Systems In The Project (Plumbing, Fire Fighting).
3. All Valves (All Sizes) Shall Be From One Manufacturer For All Systems In The Project (Plumbing, Fire Fighting, HVAC).
4. All Mixers Shall Be From One Manufacturer.
5. All Sanitary fixtures Shall Be From One Manufacturer.
6. All Fresh And Exhaust Fans Shall Be From One Manufacturer.
7. All Support System For All Systems (Plumbing, Fire Fighting, Hvac) Shall Be From One

ELECTRICAL WORKS

SECTION 16000 ELECTRICAL WORKS

PART 1 - GENERAL

- A. The 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 Jordan 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.
- B. The name of the electrical engineer details of his experience and his staff qualifications and experience shall be submitted by the Contractor with his tender.

1.1 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.
- B. 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
- C. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The Contractor shall supply install, test and commission all materials (unless otherwise stated), for the following electrical systems:
 - a. Lighting System
 - b. Power system
 - c. Uninterruptible Power Supply UPS.
 - d. Earthing protection systems.
 - e. Fire Detection and alarm System.
 - f. IP Security System (CCTV).
 - g. Program Change Bell/Strobe System
 - h. Structured Cabling Systems (Voice and Data).
 - i. Audio Visual, school Bell / Program Change and Public address systems.
 - j. Intrusion Alarm System
 - k. Private Automatic Branch Exchange (PABX)

The Contractor shall include all parts, materials and services necessary to ensure that the whole of the works is complete and will be handed over in satisfactory working order, so that it will correctly perform for the anticipated lifetime of the work

1.2 STANDARDS

All electrical design works will be done upon the requirements of national technical specifications, in addition to the international codes. These standards are:

- a. General technical specifications for buildings, Electrical Installation, Ministry of Public Works & Housing – Jordan.
- b. Jordanian electrical codes.
- c. Requirements for Electrical Installations for Buildings (IEE Wiring Regulations), published by the Institute of Electrical Engineers –UK.
- d. National Electrical Code (NEC).
- e. International Electrotechnical Commission (IEC).
- f. National Fire Protection Association Standards (NFPA72).
- g. BS 3116 Automatic Fire Alarm Systems in Building.
- h. BS 5445 Specification for Components of Automatic Fire Detection System.
- i. Civil Defence Department Regulations.
- j. Local Electric Power Company Regulations and Requirements.
- k. Requirements of Ministry of Education (MOE).

1.3 CLIMATIC CONDITIONS

- A. 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 Jordan. Generally, the following temperatures shall be made as design criteria:
 1. 40 Deg. C if installed in areas having good heat insulating properties and adequate ventilation.
 2. 45 Dig. C if installed in well ventilated positions and shaded from direct sunlight throughout the day.
 3. 50 Dig. C if exposed to direct sunlight.
- B. The above temperatures do not take into consideration heat generated from the equipment itself or from any other equipment installed in the vicinity.

1.4 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: -

- | | | |
|----|--------------------------|---|
| a. | Nominal voltage
Earth | 400 VAC, 50 Hz, three phase, Neutral and
230 VAC, 50Hz, single Phase (P+N+E) |
| b. | Frequency | 50 Hz |
| c. | Neutral | Solidly Earthed |

B. Abbreviation of Electrical Terms

- L.V Low Voltage (0.4 kV)
- V Volt
- A Ampere
- mA Milli-Ampere
- W Watt
- F Frequency
- T Temperature
- AC Alternating Current
- P Phase
- N Neutral
- E Earthing
- PVC Polyvinylchloride
- XLPE Crossed Link Polyethylene

1.5 FUSING AND PROTECTION

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.

1.6 DIMENSIONS OF EQUIPMENT

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.

1.7 DRAWINGS

- A.** Contractor should refer to all 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.

B. Shop Drawings

1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:
 - a. Exact routes of cables and ducts including sizes and details of installation.
 - b. Cable tray
 - c. s and ladders giving routes, sizes and details of supports and hangers.
 - d. Exact runs of conduits and trunking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.
 - e. Distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.
 - f. Proposed supports and hangers for cable trays, trunking, conduits, cables, and light fittings ...etc. including details of materials, finish, sizes and method of fixing to structure.
 - g. 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. Shop drawings for the electrical room, UPS room shall be made to a scale not less than 1/50 or as required by the engineer.
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.
4. Engineering data covering all equipment and fabricated material to be supplied shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement and operation of component materials and devices.
5. All deviations from the contract documents shall be identified on each submittal and shall be tabulated in the Contractor's letter of transmittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by the Contractor.
6. The Contractor shall accept full responsibility for the completeness of each submission, and, in the case of a resubmission, shall verify that all exceptions previously noted by the Engineer have been taken into account.
7. The Engineer's review of drawings and data submitted by the Contractor will cover only general conformity to the drawings and specifications. The Engineer's review does not indicate a thorough review of all dimensions, quantities and details of the

material, equipment, device or item shown. The Engineer's review of submittals shall not relieve the Contractor from responsibility for errors, omissions, or deviations, nor responsibility for compliance with the contract documents.

8. When the drawings and data are returned marked "NOT APPROVED" or "APPROVED AS NOTED", the corrections shall be made as noted thereon and as instructed by the Engineer and one corrected copy and one corrected reproducible copy shall be resubmitted. Fabrication shall not commence until the final drawings have been returned marked "APPROVED" by the Engineer. When corrected copies are resubmitted, the Contractor shall in writing direct specific attention to all revisions and shall list separately any revision made other than those called for by the Engineer on previous submissions.

C. As Built Drawings

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

D. Approval from Authorities

The contractor shall be responsible for obtaining design and as built approvals from all local authorities, Civil Defense 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.

1.8 DISCREPANCIES

The Contractor shall be responsible for any discrepancies, errors or omissions in the electrical drawings and information supplied by him whether they have been approved or not, provided that such discrepancies, errors or omissions are not due to inaccurate drawing or information given to the Contractor by the Client or the Engineer.

1.9 APPROVED MANUFACTURERS

A. General

1. The design is based upon the equipment under listed in this section.
2. the tender pricing shall be based on any of the under listed acceptable manufactures for each type \ system.
3. the contractor must submit the base tender complying with the under listed manufactures. An alternative offer from alternative manufactures may be submitted in addition to the base tender, provided that full substantiating data of the equipment, and noting of the non-compliant features of the alternative equipment \ system together with the cost implications, is submitted.

All alternative equipment \ system offers may be accepted or rejected at the sole discretion of the engineer as it shall be to the approval and final acceptance of the engineer.

4. submit the compliance for with the tender indicating the proposed manufacturer(s) for major equipment \ system for this purpose.
5. changes from the listed equipment \ system offered during the tender stage will not normally be permitted unless the engineer is satisfied that there is significant advantage in principle.

B. Electrical List of Approved Manufacturers

1. Main and Sub Main distribution panels

- Schneider (Europe).
- Legrand (Europe).
- ABB (Europe).
- Eaton (Europe).
- GE (USA)
- Hager (Europe)

2. Distribution boards

- Schneider (Europe).
- Legrand (Europe).
- ABB (Europe).
- Eaton (Europe).
- GE (USA)
- Hager (Europe)

3. Wiring accessories

- MK (Europe).
- MEM (Europe)
- Legrand (Europe).

4. PVC conduits

- Egatube (UK).

- Decoduct (UAE).
- Marshall Tufflex (UK).
- Gulf Plastic (Jordan).

5. G.I. Trunking

- Davis (UK).
- Swifts (UK).
- OBO Betterman (Germany).

6. Cable trays

- Davis (UK).
- Swifts (UK).
- OBO Bettermann (Germany).
- Cablofil (France)

7. Wiring \ Power Cables

- Jordan New Cables (Jordan).
- CABELCO (Jordan).
- Gulf Cable (Jordan)
- Ducab (UAE).
- Tekab (UAE)
- Top cable (Spain)

8. Isolating Switches Disconnectors

- MK (Europe).
- ABB (Europe).
- Legrand (Europe).
- Eaton (Europe).

9. Earthing/lightning System

- Furse (UK).
- Wallis (UK).
- Kingsmill (UK)

10. Fire alarm system

- SIMPLEX (USA\Canada).
- NOTIFIER (USA).
- EDWARD (UK).
- Sectron (Canada)
- Gent (UK)

11. Lighting Luminaires

- Thorn (UK).
- IGUZZINI (Italy).
- Luce (Italy).
- Targetti (Italy).
- Philips (Netherland)
- EAE (Turkey)

- GE (USA)
- Zumtobel (Europe)
- Leviton (USA)
- RZB (Germany)

12. Lighting Pole

- MITAS (Turkey)
- Babtain (KSA)

13. Service Floor Box

- MK (Europe).
- Legrand (Europe).
- CMD (UK)

14. Uninterruptible Power Supply

- APC (Europe).
- Eaton (Europe).
- GE (USA).
- Legrand (France)
- G-Tec (Italy)
- ABB (Europe)

15. CCTV Cameras

- Bosch(Germany)
- Pelco(USA)
- Axis(Denmark)
- Samsung (Korea).
- GE (USA)

16. Structure cable system

- Leviton (USA)
- AT&T (USA)
- Legrand (France)
- Digitus (Germany)
- R & M (USA)

17. Public Address System

- Toa (Japan)
- ATEIS (Switzerland)
- Bosch (Germany)
- Paso (Italy)
- Inter-M (Korea)

18. Projector

- Sony
- Sanyo
- Hitachi

19. PABX

- Siemens
- Ericson
- Panasonic

20. Elevator

- KONE (Italy)
- MITSUBISHI (Japan)
- THYSSENKRUPP (Germany)
- SCHNEIDER (France)
- OTIS (USA)
- SANYO (Japan)

21. Wall Mounted FAN

- Matthews (USA)

22. Intrusion alarm system

- optima
- Bosch
- Honeywell
- Guardall

PART 2 – PRODUCT

2.1 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 Jordan.
- B. 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.
- C. The details of equipment and materials submittals 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 with the Specification. All these details shall be submitted clearly in Compliance Sheets for each material.
- D. Submit, at the request of the Engineer, a sample of any equipment or material for further study before approval.
 - E. No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained.
 - F. The Contractor is not permitted to change the original tender documents. If he wishes to suggest the use of items, which are different from the description in the tender documents, these must be submitted as separate alternative offers.

Alternative offers will be evaluated only if all requirements of the tendered system are fulfilled, regarding the technical requirements, reliability and safety, compliance with the regulations, availability, space requirements, costs and energy requirements.

Alternative offers will be considered only if the specified products and performances are exactly described with detailed documentation, sufficient to allow the Engineer to verify beyond doubt that the above requirements are fulfilled.

PART 3 – EXECUTION

3.1 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.

3.2 IDENTIFICATION AND LABELLING

- A. The components of main distribution board, 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, 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.

3.3 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 shall comprise of but not be limited to:
 - 1. Verification of polarity.
 - 2. Effectiveness of earthing.
 - 3. Insulation resistance test.
 - 4. Phase rotation.
 - 5. Operation tests of relays, interlocks and any other protective and control device to ensure correct functioning. The results and readings obtained shall be recorded on forms.
- C. Supply all instruments and tools required for carrying out the tests.
- D. Follow-up and make all necessary arrangements with the local authorities for the purpose of providing permanent electricity supply. Also provide all facilities and attendance to the local authorities for any other tests carried out before energizing the installation.
- E. 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.
- F. 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.

- G. Acceptance certificate will not be issued until all testing and commissioning has been carried out to the satisfaction of the Engineer and local authorities.
- H. Following successful site testing of all items of equipment, the Contractor will be responsible for the commissioning of the equipment within the plant.
- I. The commissioning period shall consist of a start-up period and a running period. During the start-up period individual units shall be put into service and any initial operating faults rectified. The start-up period will end when all items of the plant are operating satisfactorily, at which point the running period will commence. The running period shall be a period of not less than 5 days satisfactory fault-free running of the plant at the conclusion of which the Contractor shall give to the Engineer seven days notice that he is ready to carry out the final test of the above works.
- J. The Contractor shall, as the final test of the whole works, demonstrate in the presence of the Engineer that all electrical equipment systems are functioning as an integrated whole according to the requirements of the specification and are capable of being operated satisfactorily.
- K. The final test will be in a form to be agreed between the Engineer and the Contractor but it is envisaged that it will take the form of a systematic check on the functioning of each individual operation that the plant is capable of performing, by all items of the plant, separately and in conjunction with one another.

3.4 OPERATION AND MAINTENANCE MANUALS

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.

3.5 OPERATION AND MAINTENANCE DURING THE MAINTENANCE PERIOD

- A. Include for Operation and Maintenance including Preventive Maintenance during the Maintenance Period.
- B. Include all spare parts for replacements made necessary due to wear and tear of equipment, consumable parts, short life parts, etc. and all maintenance tools and equipment required for proper operation and maintenance of the Works.
- C. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep equipment in perfect operating condition.

- D. Provide all necessary maintenance and operation staff experienced in electrical work such as engineers, foremen, operators, electricians, helpers....etc. for effective maintenance and operation of all systems.
- E. 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.
- F. Contractor shall provide all spare parts required during the maintenance period at NO cost.

3.6 GUARANTEE

- A. 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.
- B. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- C. All warranties/guarantees to be issued by Contractor and will be liable for repair/replace the items/works, etc., during the warrantee/guarantee period of two (2) years after defects liability period.

END OF SECTION

SECTION 16010

GENERAL PROVISIONS FOR ELECTRICAL WORK

PART 1- GENERAL

1.1 QUALITY ASSURANCE

- A. 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.
- B. All items of labor and material required complying with such standards and codes in accordance with the requirements of the Contract Documents shall be included.

1.2 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.

1.3 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.

1.4 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, warp age, or their defects. Energy consuming equipment shall be of the energy saving type, wherever relevant and applicable.

PART 2-PRODUCTS

2.1 GENERAL

All goods and products covered by these specifications shall, when available, be procured from a Jordanian manufacturer. Procurement of all goods and products manufactured out-of-Jordan must be approved by the Supervising Engineer.

PART 3- EXECUTION

3.1 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.

3.2 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.
- B. Concrete pads shall be 200mm 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 200mm beyond the equipment outline on all four sides.
- C. Under no circumstances shall duct work, piping and mechanical equipment be used for supporting electrical facilities.

3.3 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. 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.

3.4 CUTTING AND PATCHING

- A. The Contractor shall provide 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.

3.5 PAINTING

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 site. Under no circumstances, shall the nameplate, label or tag of any equipment be covered with field painting.

3.6 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.

3.7 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.

3.8 EQUIPMENT CONNECTIONS AND MOTOR STARTERS

- A. In addition to electrical work, the Contractor shall make all electrical connections to mechanical equipment furnished under other sections i.e. the Plumbing, Heating, Air Conditioning and Ventilation.
- 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.

- C. 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.

3.9 EQUIPMENT TESTING AND COMMISSIONING

- 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.

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

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.1 GENERAL

- A. Raceways shall include all cable ladders, cable trays and cable trunking with all associated accessories, supports and fixings used for the distribution of electric power in the building.
- B. Raceways shall be of galvanized steel.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

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

1.3 SIZE SELECTION

The size of the raceways shall be selected according to 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

2.1 CABLE TRAYS

- A. Cable trays shall be heavy duty, return flange, of 2mm gauge perforated type formed from sheet steel and hot-dip galvanized after manufacture.
- B. Cable trays shall have a minimum thickness of 1.6mm for trays up to 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.
- 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. 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 40% of the tray space.

2.2 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.

2.3 CABLE LADDERS

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 torsion 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.

2.4 CABLE TRUNKING

Cable trunking shall consist of sections not less than 2000mm long and 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 - up to and including 100mm x 100mm
- 1.6mm thick - up to and including 150mm x 150mm
- 2.0mm thick - up to and including 230mm x 230mm

Where trunking is used to carry various services it shall be sub-divided into three separate compartments for power, telephones and auxiliary services.

2.5 OUTDOOR CABLE TRAYS

- A. Responsibility of supply and installation shall be as indicated on Drawings.
- B. Assemble cable trays, sun shaded 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.

- C. Use mushroom head steel roofing bolts and nuts to fix adjacent sections and cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets, 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.
- E. All supporting materials, angles etc. shall be hot dip galvanized.
- F. All cable trays exposed to sun shall be provided with sun-shade cover. Sun shade shall be galvanized, on-corrosion steel and shall be supported at least 10cm above cable tray, and should have 2 side slope along the cable tray.

2.6 HANGER RODS

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

PART 3 - EXECUTION

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3.1 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.

3.2 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

3.3 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

1.1 GENERAL

1.2 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

1.3 RELATED WORKS SPECIFIED ELSEWHERE

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

1.4 SUBMISSION

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

PART 2 - PRODUCTS

2.1 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 IEC standards. 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. 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. 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 no more than 9000mm centers. Where right angle bends are formed in the circuit, draw-in boxes shall be provided at no more than 7500mm centers and not more than two right angled bends shall be employed in any one run. 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.

2.2 PVC CONDUITS

All rigid PVC conduit and conduit fittings shall be certified as suitable for use at ambient temperatures up to 55 deg. C. Additionally, the material 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.

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.

2.3 CONDUIT (FLEXIBLE CONNECTIONS)

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 corrosion resistant flexible metal tubing with a polyvinyl chloride sheath terminated at each end by a compression gland screwed into the connection boxes.

2.4 CONDUIT (CAPACITY)

The number of polyvinyl chloride single core cables run in any one conduit shall be restricted in accordance with concerned local codes

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

2.5 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

- 3.1** PVC conduits and fittings shall be joined by using sealing material such as (vinyl solvent paint) to ensure a watertight joint. The sealing material 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.
- 3.2** 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.
- 3.3** 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.
- 3.4** 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.
- 3.5** 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.
- 3.6** The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in local codes, 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.
- 3.7** 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.
- 3.9** The conduit system shall, in general, be surface mounted in all plant rooms and electrical rooms.

END OF SECTION

SECTION 16200

CABLES AND WIRES

PART 1 - GENERAL

- 1.1** 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 codes.

1.2 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.

- 1.3** 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 in building structure cable cleats shall be used.
- 1.4** 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.
- 1.5** Proper cable glands of non ferrous material shall be used for cable entries into distribution boards and equipment.
- 1.6** 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.

1.7 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.

1.8 RELATED SECTIONS

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

1.9 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

2.1 PVC INSULATED/PVC SHEATHED CABLES

These shall be 600/1000V, single or multi-core conforming to BS 6346 or IEC 60502 with high conductivity plain annealed stranded copper conductors, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be colored to identify phases and neutral. Armored sheathed cables shall have a single layer of galvanized steel wires for multi-core cables and aluminum wire or tape for single core cables.

2.2 CROSSED LINKED POLYETHYLENE CABLES

These shall be single core or multi-core cables, 600/1000V conforming to BS 5467 or IEC 60502 with high conductivity plain annealed stranded copper conductors, insulated with cross linked polyethylene (XLPE) layer, cables bedded and overall sheathed by a black PVC layer. Armored cables shall have a single layer of galvanized steel wires for multi-core cables and aluminum wire or tape for single core cables.

2.3 WIRES

- A. Single core cables shall be plain annealed copper conductor to BS 6346, insulated with PVC layer 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 color of insulation shall be as specified in IEE regulations for different phases, neutral and earth wires.

PART 3 - EXECUTION

3.1 GENERAL

- A. Every cable shall be installed in accordance with the relevant codes of practice and shall be neatly run in all situations. Cables, which are to run on walls, ceilings or other structures, shall be supported on cable trays or embedded on PVC conduits of a appropriate size.
- B. Where cables are surface run on the external faces of structures or above ground level, suitable protection from the radiation of the sun shall be provided by means of covers or canopies.
- C. Where cables enter or leave structures or panel plinths, the ducts shall be sealed at the point of entry or exit. The Contractor shall be responsible for temporarily sealing all cable ducts into structures during the installation stage to prevent accidental flooding of the structures.
- D. PVC insulated cables shall be terminated with mechanical glands and shall be of the type to provide adequate support to the cable by under and over locking on to the cable armoring, giving a high earth continuity. Each and every mechanical cable gland shall be supplied and installed complete with brass earthing tape and a PVC gland shroud, which shall provide an effective seal on both the cable over sheath and gland.
- E. When a cable is cut from a length on a drum, the drum length shall be immediately sealed. All cables once cut and laid shall be terminated in their final position or effectively sealed. All cables shall be drawn from the top of its drum which shall be jacked and positioned for easy draw off in relation to its final position of installation.
- F. The general routing of cables shall be as generally indicated on the contract drawings but the final routes shall be those agreed with the Engineer before any cable installation work is carried out. All cables shall be installed strictly in accordance with the requirements of this specification.
- G. The laying of all cables shall satisfy the following requirements:
 - Cable depths shall be assessed from the finished ground level unless otherwise directed by the Engineer.
 - Cables shall be laid at a depth of 0.8 meter, less bedding.
 - A layer of soft sand, 10 cm thick shall be laid under and over the cable, and a 7 cm thickness of solid blocks and warning tape shall be placed above the sand along the cable trench.

3.2 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

WIRING DEVICES

PART 1 - GENERAL

1.1 VOLTAGE

All single-phase devices shall be rated for 230V ,50 Hz and all three phase devices shall be rated for 400V, 50Hz.

1.2 DESCRIPTION

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

1.3 RELATED WORKS SPECIFIED ELSEWHERE

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

PART 2 - PRODUCTS

2.1 SOCKETS

- A. Sockets shall be 250V, three pin, 13A switched type to BS 1363 or IEC 60886 . 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.
- C. Sockets shall be fixed inside galvanized stamped steel boxes or heavy gauge PVC type which shall be flush mounted in walls and fixed at 450mm above finishing floor level, unless otherwise indicated on the Drawings.
- 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.
- F. Three phase sockets industrial socket shall be of 5 pin design (3 phase + neutral + earth) according to IEC 60947.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. 13A weatherproof sockets outlets shall have the weather tightness.
- H. The wiring for the sockets shall be of high class, 4mm² stranded copper PVC insulated wires, embedded in PVC conduits.
- I. Sockets may be 1 gang or 2 gangs and protected by 16 amp MCB in the secondary distribution board. For water heaters and air condition units a double pole, 20 Amps switch with indication lamp shall be used, and protected by 20 Amp. MCB at distribution board.
- J. All sockets outlets circuits shall be earthed by a special wire green or yellow and green different from the phase wire. The size of earth wire shall be same as the phase wire. The earth wire shall be taken from the distribution board.

2.2 LIGHTING SWITCHES

- A. Lighting switches shall generally be flush mounted and of grid type and used to control lighting fixtures, in each room as shown on the drawings. These switches will be single phase, 10 Amp., 230V rated.
- B. The function of the switches may be one gang, one way, one gang, 2 way, or 2 gangs, 2 way switches.
- C. These lighting switches will be installed at 1400 above finished floor level, unless otherwise indicated on the Drawings. Wiring terminals shall be of the screw type or solder-less pressure type having suitable conductor release arrangement

2.3 LIGHTING MOTION SENSORS

- A. The lighting motion sensor shall be passive infrared motion detector, for automatic light control. The Sensor shall have 2 channels, 1 for light switching, and 1 free potential output for ventilation, with separate delay time up to 30 minutes for each channel and 10 amp switching Capacity.
- B. The sensor shall cover detection area with diameter 4 meters for walking head on the sensor, and 6 meters walking diagonally on the sensor, and the sensor head shall be capable to be adjusted downwards by 45° in 15° stages thus allowing detection area to be changed to avoid switching the device on unnecessarily .
- C. Its sensitivity can be reduced to limit the detection area. The sensor shall be able to install on ceiling. The mounting height of the sensor is between 2.7 to 3.2m.
- D. The lighting motion detector shall be override by lighting switch, so in case of failure occurred in the lighting motion sensor the lighting fixture should be controlled through the lighting switch.

2.4 DOUBLE POLE SWITCHES

The double pole switches shall be with indication neon lamps and shall be rated 20 amps unless otherwise mentioned.

2.5 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.
- C.** All outdoor isolators and switch fuses shall be in weather proof enclosures with IP-65.

PART 3 - EXECUTION

3.1 MOUNTING HEIGHT

- A.** All devices shall be installed at levels as per the concerned local codes.
- 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 1400mm above finished floor level and sockets shall be fixed at 450mm 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.

END OF SECTION

SECTION 16400

MAIN DISTRIBUTION EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The main distribution equipment shall comprise main low voltage distribution board, distribution boards , isolators, ...etc.
- B. The supply and distribution arrangement shall be as indicated on single line 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. The contractual responsibility for the supply and installation shall be as indicated on drawings.

1.2 RELATED WORKS

- Section 16120 Conduits
- Section 16200 Cables and Wires
- Section 16300 Supporting devices
- Section 16635 Earthing

1.3 SUBMISSION

- A. **Shop Drawings:** Submit dimensional shop drawings including sections and elevations for the main distribution board and the control panels and showing positions of major components and method of fixing and terminating cables.
- B. **Project Data:** Submit full specifications of the enclosure and the components of the main distribution board and the control panels.

PART 2 - PRODUCT

2.1 MAIN DISTRIBUTION BOARDS (MDB)

- A. The main distribution board (MDB) shall be supplied, installed inside the electrical room of the school building.
- B. The 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.
- C. Main distribution boards shall comprise main incoming breaker, busbars, molded case circuit breakers, 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.

- D. The main distribution board shall be metal enclosed self-supporting structure independent of wall supports. It shall be free standing, dust and vermin protected .The sides and rear shall be covered with removable screw-on plates.
- E. Main distribution board shall be assembled according to IEC 61439 standard and shall be three phase with earth and neutral.
- F. Doors, covers and sides shall be made from galvanized sheet metal at least 2 mm thick, painted with two primary coats and two final coats of gray oil paint. The cabinets are to be designed for placing against the wall. Doors must strike in the direction of escape routes and are to complete with locks for double bit keys and central locking system. To avoid earthing problems, internal parts may not be varnished. Doors are locked with double bit keys.
- G. The main distribution board shall consist of the required number of vertical sections bolted together to form one rigid board. All edges of front cover panels shall be formed.
- H. All doors and removable cover plates shall be provided with neoprene gasket so as to obtain degree of protection IP53.
- I. All exterior and interior steel surfaces of the distribution boards shall be properly cleaned and provided with a rust-inhibiting phosphates coating. Color and finish of the main distribution board shall be light gray and approved by the Engineer.
- J. All external bolts or screw heads shall be chrome or cadmium plated.
- K. The equipment in the main distribution board shall be accessible with indicating instruments mounted not higher than 1.8m. and the centerlines of operating devices not higher than 1.8m. above main distribution board base. The distribution board shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.
- L. Cable entries for the main distribution board are assumed to be from the bottom unless otherwise requested.
- M. The main distribution board shall be provided with main incoming and number of outgoing breakers. These breakers will be of MCCB type and have 25 KA high rupturing capacity.
- N. Accidental touch to live parts is prevented by installing of suitable insulation barriers to limit accessibility of live parts.
- O. Main incoming breaker's compartment's door shall be interlocked with the respective circuit breaker so that the door cannot be opened unless the breaker is in the OFF position. Also, It shall not be possible to switch the panel 'ON' when the door is open.
- P. Instruments are supplied with moving coil measuring element for alternating current and voltage. All instruments are to have the basic dimensions of (96x96) mm.

- Q. Internal necessary wiring, fuse blocks and terminal blocks within the main distribution board shall be furnished as required. All groups of control wires leaving the distribution board shall be provided with terminal blocks with suitable numbering strips.
- R. The main distribution board shall be provided with adequate lifting means, and shall be capable of being rolled or moved into installation position.
- S. An empty compartment for the installation of the electricity utility KWh-meter in the main distribution board shall be provided, however, copper bus bars extensions to facilitate the connection of the incoming cables shall be installed. The KWh-meter compartment shall have the provision for tamper proof locking.
- T. The busbars shall be high conductivity copper bars with ratings as indicated on the drawings for the three phases and neutral. The bus bars shall be arranged and marked to the approval of the Engineer.
- U. The earth bus shall have adequate rating and length for connecting the incoming and outgoing earth cables.
- V. 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.

2.2 BUSBARS

- A. The main distribution board shall be provided with fully rated Busbars for the entire width of the board. In addition, each section or panel of the distribution board shall be provided with vertical busbars of adequate rating to provide branch connections to the outgoing breakers.
- B. The busbars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard.
- C. The busbars shall be of sufficient size to limit the temperature rise above ambient temperature and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as estimated at rated voltages.
- D. Busbar system shall provide 3 phases + neutral + earth with colors Red, Yellow, Blue for the three phases, Black for Neutral and Green for Earth.
- E. The busbars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygroscopic glass fiber moldings.

2.3 MOULDED CASE CIRCUIT BREAKERS

- A. The molded case circuit breakers shall comply with IEC 60947-2 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.

- B. They shall be of utilization category 'A' having rated service breaking capacity (Ics) as indicated in the drawings.
- C. The circuit breakers shall be suitable for isolation as per IEC 60947-2 and shall have rated operation voltage of 500V 50 Hz, insulation voltage of 750 V, 50 Hz.
- D. The breaker shall be available in 3 or 4 pole version as per the drawing.
- E. All poles shall operate simultaneously for circuit breaker opening, closing and tripping. The mechanism shall be completely enclosed in the compact molded Bakelite case.
- F. 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.

2.4 CURRENT TRANSFORMERS

- A. Current transformers are to be supplied insulated in resin with either a wound core or a pushing bar with one or two cores, with performances and precision classes.
- B. 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.
- C. Current transformers shall be designed as plug-on transformers through which both busbars and wires can be routed. The power rating shall be established in accordance with the instruments and devices to be connected, the minimum power rating being 10 VA. The precision class shall be determined to be 1.

2.5 INSTRUMENTS

- A. The measuring instruments shall include ammeters, voltmeter, 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 96 x 96mm square. Accuracy shall be one percent of full scale values. Moving elements shall be provided with zero adjustments external to the cases.
- C. The degree of protection is to be IP 54.
- D. Ammeters shall be moving iron type scaled 0-2000 A for main incoming supply.
- E. Voltmeter shall be moving iron type scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.

2.6 SECONDARY DISTRIBUTION BOARDS

- A. Three phase distribution boards will be used for lighting and power.
- B. Secondary 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 drawings.

- C. 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. 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.
- D. Secondary distribution boards 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.
- E. Distribution board shall be fixed flush to the wall at 180 cm above FFL.
- F. Distribution boards shall comply with IEC-61439 standards.
- G. MCB shall comply with IEC60947-2 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 6 kA if not mentioned on the drawings.

PART 3 – EXECUTION

3.1 CIRCUITS AND CONNECTIONS

- A. Connect feeders, for circuits rated up to 63A, to terminal blocks located in separated compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.
- B. For feeders, rated more than 63A, suitably extend copper links rigidly supported and covered with colored PVC sleeves.
- C. Provide all feeders with cable lugs and brass cable glands.
- D. Provide removable gland plates suitable for the glands required for the specified cables.
- E. Provide all small wiring of stranded copper, not less than 2.5mm² with PVC insulation. Small wiring shall be neatly bunched and cleat in harness form, or shall be enclosed in purpose made plastic trunking. Wiring cleat to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommet with suitable grommets.

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

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

The Interior lighting points will comprise the following as a minimum.

- A. Embedded, ceiling mounted lighting points shall be used.
- B. Lighting installations will be of PVC embedded conduits.
- C. PVC conduits will be of heavy gauge type and with size not less than 20mm.
- D. The maximum number of PVC wires inside the PVC conduits will be such that a free space of 40% of the PVC size will be provided.
- E. High class 2.5 mm² stranded copper, PVC insulated, 450/750 Volts wires will be used for lighting circuits (P+ N+E).
- F. Separate protective device (breaker) will be used for each circuit.
- G. Each lighting circuit comprises number of lighting points based upon the rating of the protection miniature circuit breaker (MCB).
- H. Galvanized steel conduits will be used in exposed installation.
- I. MCB's for lighting circuits will be of 10 Amp. rating, 6kA rupturing capacity
- J. It is strictly forbidden to feed lighting circuits from a socket outlet circuit, and vice versa.
- K. Draw boxes and covers, lighting fixtures, distribution boards etc. and anything else is needed to be fixed on the walls or the ceiling will be fixed by plastic sphenoid and zinc plated self tapping hardened steel (zsh) screws. The use of wooden sphenoid or wired is strictly forbidden.
- L. The work of this division shall comply with requirements of Section 16010 electrical General Provisions.

1.2 SCOPE OF WORK

- A. Supply all labor, 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. Internal lighting as shown on drawings.
 - 2. Emergency and Exit lighting as shown on drawings.
 - 3. External Lighting as shown on drawings.

- C. Generally the lighting installation shall be carried out by installing conduits within the building slab and walls
- D. Emergency lighting and Exit signs shall be connected as shown on drawings.

1.3 QUALITY ASSURANCE

A. Acceptable Manufacturers:

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. Shop drawings, data sheets and samples.
- B. For each type of lighting fixtures Contractor shall submit the following details:
 - a. Catalogue illustrations of luminaires proposed for each specified application.
 - b. Installation requirements.
 - c. Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.

PART 2 - PRODUCTS

2.1 LUMINAIRES - GENERAL

A. 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.
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 re lamping.
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 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 cable of adequate size.
7. All luminaires shall be suitable for connection to rigid conduit, and/or flexible circular sheathed cable.

B. LED Luminaires:

1. All luminaires shall be designed for operation from a 230 volt 50 Hz single phase supply.
 2. Luminaires body, housing and reflector shall be of the shape and size as indicated in the Luminaires specifications.
 3. 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.
 4. luminaires body, reflectors, wiring channels and castings shall be formed so as to prevent buckling or distortion.
2. External LED driver.

C. 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
- Mains Frequency - 50Hz
- Battery - 9.66V/4Ah
- Re-charge Period - 24 hr.
- Lamps - LED lamp 5W.

Emergency conversion modules are to be incorporated inside the luminaires.

D. LED Lamps:

1. Colour Temperature 3000-4000 K.
2. CRI > 80
3. Life hour= 50000-hour LT80
4. Minimum efficacy 100 Lumen /Watt.
5. 5-years warranty.

E. Luminaire Data Sheets: The luminaires 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 TYPES OF LIGHTING FIXTURES

The following types of lighting fixtures will be used in different locations of the project:

A. (Type F1) Recessed mounted type LED lighting fixture with the following features:

- LED module type with 40watt and efficacy not less than 100Lumen/watt.
- With slim profile
- Body: steel sheet white.
- Diffuser: UV stabilized.

- Glare protech prismatic optic
 - Dimension 60cm x 60cm.
 - UGR<19.
 - CRI>80
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=20.
 - 5-years warranty.
- B. (Type F2) Recessed type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F1) above in addition to maintained emergency pack of 3 hours duration.
- C. (Type F3) Surface mounted type LED lighting fixture with the following features:
- LED module linear light type with 40watt and efficacy not less than 100Lumen/watt.
 - Body: precoated roll from steel white.
 - Diffuser: extruded opal acrylic.
 - CRI>80
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=20.
 - 5-years warranty.
- D. (Type F4) Surface mounted type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F3) above in addition to maintained emergency pack of 3 hours duration.
- E. (Type F5) Surface mounted type LED lighting fixture with the following features:
- LED module linear light type with 40watt and efficacy not less than 100Lumen/watt.
 - Body: aluminum painted white.
 - Diffuser: polycarbonate with linear prism.
 - Toggles: stainless steel.
 - CRI>80
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=65.
 - 5-years warranty.
- F. (Type F6) Surface type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F5) above in addition to maintained emergency pack of 3 hours duration.
- G. (Type F7) Surface mounted type LED lighting fixture with the following features:
- LED module linear light type with 27watt and efficacy not less than 100Lumen/watt.
 - Body: precoated roll from steel white.

- Diffuser: extruded opal acrylic.
 - CRI>80.
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=20.
 - 5-years warranty.
- H. (Type F8) Surface mounted type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F7) above in addition to maintained emergency pack of 3 hours duration.
- I. (Type F9) Surface mounted type LED lighting fixture with the following features:
- LED module linear light type with 40watt with efficacy not less than 100Lumen/watt.
 - Body: sheet steel painted white.
 - End cap: molded in white polycarbonate.
 - Louver: aluminum precoated white or anodized.
 - CRI>80.
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=44.
 - 5-years warranty.
 -
- J. (Type F10): Recessed mounted downlight, LED lighting fixture with the following features:
- LED module type downlight with 20watt and efficacy not less than 100Lumen/watt.
 - Body: die-cast aluminum.
 - Internal aluminum reflector, white finish.
 - Circular shape.
 - CRI>80.
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=20.
 - 5-years warranty.
- K. (Type F11): Recessed Spot Light mounted type LED lighting fixture with the following features:
- LED module type downlight with 20watt and efficacy not less than 100Lumen/watt.
 - Body die-cast aluminum.
 - White finish
 - Circular shape.
 - CRI>80.
 - Color temperature 4000K.
 - LED Driver.
 - Life hour 50000, LT80.
 - IP=44.
 - 5-years warranty.
- L. (Type F12): Recessed Spot Light mounted type LED lighting fixture with the following

features:

- LED module type downlight with 12watt and efficacy not less than 100Lumen/watt.
- Body: polycarbonate with white bezel.
- Reflector: ripple – faceted specular anodized aluminum..
- Circular shape.
- CRI>80.
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=20
- 5-years warranty.

M. (Type F13) Recessed mounted type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F12) above in addition to maintained emergency pack of 3 hours duration.

N. (Type F14) Surface mounted LED lighting fixture for staircase with the following features:

- LED module type downlight with 11watt and efficacy not less than 100Lumen/watt.
- Body: aluminum white.
- White polycarbonate bezel.
- Reflector: specular.
- CRI>80.
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=44.
- 5-years warranty.

O. (Type F15) Surface mounted type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F14) above in addition to maintained emergency pack of 3 hours duration.

P. (Type F16): Surface mounted LED lighting fixture for Bath Room with the following features:

- LED module type with 10watt and efficacy not less than 100Lumen/watt.
- Body: die-cast aluminum.
- White finish.
- opal Tempered diffuser.
- Circular shape.
- CRI>80
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=44.
- 5-years warranty.

Q. (Type F17) Wall mounted LED lighting fixture with the following features:

- Wall mounted with 20watt LED lamp with efficacy not less than 100Lumen/watt.
- Body made from die-cast aluminum with metallic guard.
- Diffuser: opal polycarbonate.
- Reflector: aluminum.

- Gaskets: extruded silicone rubber sponge
- CRI>80
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=54.
- 5-years warranty.

R. (Type F18) Outdoor wall mounted floodlight fixture with the following features:

- The body of unit from die-cast aluminium.
- Tempered clear glass cover and silicone rubber gaskets.
- (100watt) LED lamp and equipped with LED driver.
- efficacy not less than 125Lumen/watt.
- Colour Temperature: 4000 K.
- Wide beam angle.
- CRI>80.
- Lift time: 65000 hours LT80.
- Fixture shall be mounted on the top of roof and shall be equipped with aluminum adjustable bracket and aluminium arm with 0.5-1.0m length to control the unit direction.
- IP=65.

S. (Type F19): Recessed LED lighting fixture for Bath Room with the following features:

- LED module type with 10watt and efficacy not less than 100Lumen/watt.
- Body: die-cast aluminum.
- White finish.
- opal Tempered diffuser.
- Circular shape.
- CRI>80
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=44.
- 5-years warranty.

T. (Type F20) Surface mounted type LED lighting fixture with emergency kit. Each fixture shall have the same features mentioned in item (Type F9) above in addition to maintained emergency pack of 3 hours duration.

U. (Type F21) Surface mounted LED lighting fixture with the following features:

- LED module type downlight with 20watt and efficacy not less than 100Lumen/watt.
- Body made from die cast aluminum powder coated, white.
- opal Plastic (Poly carbonate) diffuser.
- Circular shape.
- CRI>80.
- Color temperature 4000K.
- LED Driver.
- Life hour 50000, LT80.
- IP=44.
- 5-years warranty.

V. Type E1) Emergency Exit lighting fixture with the following features:

- Self contained, maintained type.

- Pendant from ceiling or wall mounted.
- 5 watt LED lamp
- Single /Double sided EXIT sign.
- IP20.

W. (Type P1,P2 & P3) Street lighting poles with LED lamps shall have the following features:

- Lighting poles shall be one piece, hot dip galvanized octagonal tapered, 4 mm thickness steel and shall be equipped with opening door of (135x600) mm located 450 mm above base with cut-in galvanized steel box, 5A mcb for single arm pole and two numbers 5A mcbs for double arms pole. Pole height shall be as shown on the drawings. Poles tops shall be designed to receive the required arms and luminaires.
- The pole, once installed and fully equipped, shall be able to withstand a wind speed of 160 km/hr blowing in the most unfavorable direction.
- For anti-corrosion purposes the pole shall have prime paint, enamel paint, plastic coated and finally hot-dip galvanization.
- Bracket arms and all steel accessories should be hot-dip galvanized.
- Foundation bolts should be equipped with appropriate nuts and washer.
- The steel wire armored of the cables should be bonded to the pole by means of suitable clamps.
- Each pole should have its own earthing rod in addition to main earthing lead and earthing conductor.
- The foundation of the poles shall be completed with UPVC pipes, and 4 threaded bolts that will pass through the pole mounting steel plate as per the drawings.
- Luminaires for poles types P1 and P2 shall be LED 80 W, and efficacy not less than 125Lumen/watt. 4000K, and protection rating of IP 65 for lamp compartment and IP 23 for control gear.
- Luminaires for poles types P3 shall be LED type floodlight with 180 W, and efficacy not less than 135Lumen/watt. 4000K and protection rating of IP 65 for lamp compartment and IP 23 for control gear.
- The housing shall be of glass-fiber reinforced polyester resin, water and heat repellent flat gasket. All materials are to be chosen for maximum resistance to corrosion. Electrical components and lamp holders are to be integrated into a single unit, which can be unfastened and removed without tools.
- The poles lighting fixtures shall be controlled by a astronomical timer and 3 phase contactors. An override switch shall be provided for manual operation. Contactors and override switch shall be located inside a painted metal sheet weather proof control box with indication lamps and push buttons.
- MCCB for each external lighting circuit
- 3-pole contactor with 2 auxiliary contacts (1 NO+1 NC).
- 3-position selector switch installed on door of the external lighting distribution board (EXDB) with indications for these positions as follows:
 - M - Manual operation.
 - OFF.
 - A - Automatic operation via Astronomical Timer.
 - A red indicating lamp to light when the power is ON.
 - A green indicating lamp to light when the system is OFF.
- 3 copies of the internal control and power diagram with the external lighting units (numbered) shall be put inside the EXDB.
- All wires and components inside and outside the EXDB shall be numbered and labeled. Labels shall be plastic with the name engraved on them and shall be fixed by screws.
- For 8m height pole the concrete base shall be reinforced concrete with dimensions (70x70x100)cm (Length x Width x Depth) while for 12m height pole the base dimensions shall be (70x70x120)cm (Length x Width x Depth).

2.3 EMERGENCY ESCAPE ROUTE LIGHTING

- A. Escape illumination shall be provided along corridors and staircases, escape routes, mechanical and electrical rooms. The luminaries shall be suitable for wall and ceiling mounting and shall be connected to the local lighting circuit and arranged to automatically illuminate when the main lighting power fails.
- B. The escape lighting luminaires shall be installed adjacent to the general lighting luminaires and shall include LED lamps, battery, battery charger and charge normal indicator of the non-maintained type to provide three hours operation after mains failure.
- C. The luminaires shall be equipped with 5-watt LED lamp, body of white stove enameled sheet steel, extruded polycarbonate diffuser, nickel cadmium battery.
- D. Protection grade shall be IP 23.
- E. The main supply for these luminaires will be 230V, 50 Hz, un switched for non-maintained type.
- F. Exit route lighting shall be same as emergency light with single or double sided "EXIT" signs. The "EXIT" lettering shall be viewed at distance of not less than 35 metres. The "EXIT" shall be provided with arrow.

2.4 Wall FANS

- a. Wall mounted fans and their associated switches shall be suitable for operation on an electricity supply of 230V, single phase, 50 Hz.
- b. Fans shall be of the higher power factor; high efficiency type and power factor of the fans shall be 0.85 or better at full speed.
- c. Fans and regulators shall be suitable for continuous operation in an ambient temperature of 40 degree centigrade.
- d. Shall be Hand-balanced metal blades
- e. Supplied with Metal safety cage
- f. Fan head shall be capable positioned vertically and horizontally across 180-degree arcs to provide maximum directional airflow
- g. Averaged High/Low CFM/Airflow: 1181 CFM
- h. Includes variable wall fan speed control switch through a hardwired switch.
- i. Damp location with powder or clear coat only. Neither coastal, saltwater nor chlorine compatible.
- j. Material: Cast Aluminum, Heavy Spun/Stamped Steel
- k. Number of Blades: 3
- l. Blade Pitch: 31 degrees
- m. Motor Type: AC

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING FIXTURES AND LAMPS.

- A. Provide all lighting fixtures and lamps shown on the drawings and mentioned in the bills of quantities.

- 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. 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 required 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.
- F. Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided.
- G. Provide safety chains on all surface mounted or suspended fixtures.
- H. The final connection to all luminaires integrated into suspended ceilings shall be by means of flexible heat resisting cable terminated at a plug and socket 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.
- I. Earthing:
 - a. 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.
 - b. Where luminaires are suspended, a cable protective conductor shall be connected between the fitting and the final sub-circuit wiring installation.
- J. Luminaires Commissioning and Testing:

At the discretion of the Engineer, make-up site test and demonstrate the operation of special application of fixtures such as building floodlights, pole lighting fixtures and other decorative fixtures, and adjust their locations within a reasonable distance to obtain the effects desired. 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.

END OF SECTION

Section 16611

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

This Section includes 3-phase, 5-line, static-type, uninterruptible power supply (UPS) systems, complete with battery and battery circuit breaker.

1.2 DEFINITIONS

A. The UPS shall be capable of being operated in any of the following modes:

Normal Mode

During normal operation, the UPS shall be used to provide precise regulated and transient-free power to the critical load. The primary A.C source shall be used to supply power to the rectifier and battery charger separately via an isolation transformer. The rectifier shall provide regulated D.C power to support the inverter while the separate battery charger is maintaining the battery plant in a fully charged condition. The inverter shall convert the D.C power into regulated A.C power for the load.

Emergency Mode

Upon failure of the normal A.C power input, the input power for the inverter shall automatically be supplied from the battery plant for 15 minutes. When the A.C power is restored, input to the inverter shall automatically be supplied from the rectifier while the battery plant is being recharged by the battery charger. If the input power does not return, the UPS shall automatically shut itself down, while sounding an audible alarm, when the lower limit of the battery plant is reached.

Bypass Mode

If the UPS failure occurs, a static switch shall transfer the load to the A.C main power within 1/4 cycle. Retransfer of the load to the output of the UPS shall be manually accomplished. For maintenance purposes, provide and install make-before-break manually initiated maintenance bypass switches to bypass and isolate the UPS system without interruption of the load.

The UPS shall have built-in protection against under voltage and over current, including voltage and current surges on the output caused by load transfer.

B. THD: Total harmonic distortion.

1.3 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each product specified in this Section.
- B. Shop Drawings: Detail fabrication, internal and interconnecting wiring, and installation of UPS system. Include dimensioned plan, elevation views, and details of control panels. Show access and clearance requirements.
- C. Product Certificates: Signed by manufacturers of UPS system certifying that the products furnished comply with requirements.
- D. Factory Test Reports: Comply with specified requirements.
- E. Maintenance Data: For system and products to include in the maintenance manuals for the following:
 - 1. Lists of spare parts and replacement components recommended to be stored at the Project site for ready access.
 - 2. Detailed operating instructions covering operation under both normal and abnormal conditions.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain UPS, including components, from a single manufacturer with responsibility for entire system.
- B. Listing and Labeling: Provide UPS specified in this Section that is listed and labeled as a factory-assembled unit.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment in fully enclosed vehicle after specified environmental conditions have been permanently established in space where equipment is to be placed.
- B. Store equipment in space with environments that are controlled within manufacture's ambient temperature and humidity tolerances for non-operating equipment.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this article shall not deprive the Client of other rights the Client may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the contract documents.
- B. Special Warranty of Batteries: A written warranty, signed by manufacturer and principal Installer, agreeing to replace UPS system storage batteries that fail in materials or workmanship within the specified warranty period.

Special Warranty Period for Batteries: 3 years from date of Substantial Completion. A full warranty applies to the first year of the period, and a prorated warranty applies to the last 2 years.

Part 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Factory fabricated, in a single modular cabinet. Automatic system operating functions include the following:

1. Normal Conditions: Supply the load with power flowing from the normal A.C power input terminals, through the rectifier / battery charger and inverter, with the battery connected in parallel with the rectifier output.
2. Abnormal Supply Conditions: When the normal A.C supply deviates from specified voltage, waveform or frequency limits, the battery supplies energy to maintain constant inverter output to the load.
3. When normal power fails, energy supplied by the battery through the inverter continues supply to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, the rectifier/battery charger supplies power to the load through the inverter and simultaneously recharges the battery. Synchronize the inverter with the external source before transferring the load.
5. When the battery becomes discharged and normal supply is available, charge the battery by the rectifier/battery charger. On reaching full charge, shift the rectifier/battery charger to a float-charge mode.
6. When any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal source with less than one-quarter-cycle interruption of supply.
7. If a fault occurs in the system supplied by the UPS and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal supply circuit of the UPS system for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

B. Functional Description of Manual Operation: Manual operating functions include the following:

1. Turning the inverter OFF causes the load to be transferred by the static bypass transfer switch directly to the normal A.C input source without interruption.

2. Turning the inverter ON causes the static bypass transfer switch to transfer the load to the inverter.
- C. Maintenance Bypass / Isolation Switch: Interlocked so UPS cannot be operated unless the static bypass transfer switch is in the bypass mode. The device has 3 settings that produce the following conditions without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied bypassing UPS. UPS A.C supply input, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
 2. Maintenance Bypass: Load is supplied UPS. UPS A.C supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 3. Normal: UPS A.C supply terminals are energized and the load is being supplied through either the static bypass transfer switch or the UPS rectifier and inverter.

2.2 SYSTEM SERVICE CONDITIONS

- A. Environmental Conditions: Operate continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Ambient Temperature: 0 to 40 deg. C.
 2. Relative Humidity: 0 to 95 percent, non-condensing.
 3. Altitude: Sea level to 1200 m.

2.3 SYSTEM CHARACTERISTICS

- A. Minimum Duration of Supply: 15 minutes, if rated full load is being supplied solely from the battery.
- B. System Performance When Supplied from Battery: Performance under steady-state and transient-load conditions remains within specified tolerances throughout minimum duration of supply from battery specified.
- C. Input Voltage and Frequency Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state A.C input voltage varies. Plus or minus 10 percent from nominal voltage; when steady-state input frequency varies plus or minus 5 percent from nominal voltage; and when the THD of input voltage is 15 percent, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.

2.4 PERFORMANCE EFFICIENCIES

- A. Maximum Acoustical Noise: 60 dBA weighting, emanating from the system under any condition of normal operation, measured 1200mm from the nearest surface of the enclosure.

- B. Maximum Energizing Inrush: 6 times the full-load current.
- C. Maximum Output-Voltage Regulation for loads up to 50% Unbalance: plus or minus 2% of the full range of battery voltage.
- D. Output Frequency: 50Hz, plus or minus 0.5% of the full range of input voltage, load and battery voltage.
- E. Maximum Harmonic Content of Output-Voltage Waveform: 5% RMS total and 3% RMS for any single harmonic for rated full linear load more than the full range of battery condition and input voltage and frequency.
- F. Overload Capacity of System at Rated Voltage: 125 % of full-load rating for 10 minutes and 150 % for 10 seconds.
- G. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full load, voltage shall remain within the stated percentages of rated value and recover to within plus or minus 2 % of that value within 100 ms:
- H.
 - 1. 50 Percent: Plus or minus 8 percent.
 - 2. 100 Percent: Plus or minus 10 percent.
 - 3. Loss of AC Input Power: Plus or minus 5 percent.
 - 4. Restoration of Input Power: Plus or minus 5 percent.

2.5 SYSTEM COMPONENTS, GENERAL

- A. Description: Solid-state devices using hermetically sealed semiconductor elements. Devices include rectifier/battery charger, inverter, static bypass transfer switch, and system controls.
- B. Control Assemblies: Mount on modular plug-ins, arranged for easy maintenance.
- C. Surge Suppression: Protect UPS system input elements, rectifier/battery charger, inverter, controls, and output components against voltage transients with surge suppressors listed in UL 1449, and tested according to IEEE C62.41, Category B.
- D. Power Assemblies: Mount rectifier and inverter sections and static bypass transfer switch on modular plug-in, arranged for easy maintenance.
- E. Design and fabricate internal supports for assemblies, subassemblies, components, supports, and fastenings for batteries to withstand static and anticipated seismic forces in any direction, with the minimum force value used being equal to the equipment weight.

2.6 RECTIFIER / BATTERY CHARGER

- A. Capacity: Adequate to supply the inverter during full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent

of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

- B. Input Current Distortion: Less than 32 % of THD at rated UPS load.
- C. Rectifier Control Circuits: Immune to frequency variations within the rated frequency range of the system.
- D. Battery float-charging conditions, in terms of voltage and charging current under normal operating conditions, are within battery manufacturer's written instructions for maximum battery life.
- E. Input Power Factor: At least 0.85 lagging when supply voltage and current are at nominal rated values and UPS are supplying rated full load.

2.7 BATTERY

- A. Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, and complete with battery disconnect switch.

2.8 INVERTER

- A. Description: Pulse-width modulated, with sinusoidal output.

2.9 STATIC BYPASS TRANSFER SWITCH

- A. Switch Rating: Continuous duty at rated full load. Switch provides make-before-break transfer. A contactor or electrically operated circuit breaker in the inverter output provides electrical isolation.

2.10 INDICATION AND CONTROL

- A. General: Group displays, indications and basic system controls on a common control panel on the front of UPS enclosure.
- B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays and wiring required to support listed items. An audible signal sounds for alarms as well as the visual indication.
- C. Indications: Labeled LED display.
 - 1. Status Indications : Include the following:
 - a. Normal operation.
 - b. Load on bypass.
 - c. Load on battery
 - d. Inverter off
 - e. Alarm condition exists.
 - 2. Alarm Indications : Include the following:
 - a. Bypass A.C input over-voltage or under-voltage.

- b. Bypass A.C input over-frequency or under-frequency.
 - c. Bypass A.C input and inverter out of synchronization.
 - d. Bypass A.C input wrong-phase rotation.
 - e. Bypass A.C input single-phase condition.
 - f. Bypass A.C input filter fuse blown.
 - g. Battery system alarm.
 - h. Control power failure.
 - i. Fan failure.
 - j. UPS overload.
 - k. Battery-charging control faulty.
 - l. Input over-voltage or under-voltage.
 - m. Input wrong-phase rotation.
 - n. Approaching end of battery operation.
 - o. Battery under-voltage shutdown.
 - p. Inverter over-temperature.
 - q. Static bypass transfer switch over-temperature.
 - r. Inverter power-supply fault.
 - s. Inverter output over-voltage or under-voltage.
 - t. UPS overload shutdown.
 - u. Inverter current sensor fault.
 - v. Inverter output contactor open.
3. Controls: Include the following:
- a. Inverter on-off.
 - b. UPS start.
 - c. Battery test
 - d. Alarm silence/reset.
 - e. Output-voltage adjustment.
- D. Analog Meters: Accurate within 2 percent.
- E. Dry Form "C" Contacts :Available for remote indication of the following conditions:
- 1. UPS on battery
 - 2. UPS on-line.
 - 3. UPS load on bypass.
 - 4. UPS in alarm condition.

2.11 MECHANICAL FEATURES

- A. Ventilation: Redundant fans or blowers draw in ambient air near the bottom of the cabinet and discharge it near the top rear.

2.12 SOURCE QUALITY CONTROL

- A. Factory test complete UPS, including battery, before shipment. Include the following tests:
- 1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - 2. full-load test.

3. Transient-load response test.
4. Overload test.
5. Power failure test.
6. Efficiency test at 50, 75, and 100 percent loads.

Part 3 –EXECUTION

1.1 INSTALLATION

- A. Install system components on 100-mm-high concrete housekeeping pad.
- B. Maintain minimum workspace at equipment according to manufacturer's written instructions.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

1.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Supervision of unit installation, connections, tests, and adjustments by a factory-authorized service representative. Report results in writing.
- B. Supervised Adjusting and Pretesting: Under supervision of a factory-authorized service representative, pretest system functions, operations, and protective features. Adjust to ensure operation complies with specifications. Load the system using a variable-load bank simulating KVA, KW, and power factor of loads for which unit is rated.
- C. Retest: Correct deficiencies and retest until specified requirements are met.

1.3 CLEANING

- A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

1.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Client's maintenance personnel as specified bellow:
 1. Train Client's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 2. Review data in the operation and maintenance manuals.
 3. Schedule training with Client with at least 7 days' advance notice.

1.5 COMMISSIONING

- A. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

END OF SECTION

SECTION 16640

EARTHING

PART 1 - GENERAL

- 1.01** The earthing system shall comply with the requirements of the local codes and standards.
- 1.02** The earthing installations shall provide that all extraneous conducting materials in the buildings are equipotential bonded, so that in the event of an electrical fault potential differences are not present.
- 1.03** All metallic equipment enclosures, steel conduit system, cable trays, trunkings, lighting fixtures, earthing pins of sockets, mechanical services, pipe work and ductwork, tanks, shall be bonded to the electrical earthing system.
- 1.04** The earthing conductor shall be adequately sized and sufficient low resistance to carry the maximum fault current for a period equivalent to the clearing time of the protective equipment without undue temperature rise.
- 1.05** All earth connections shall terminate finally at the main distribution board earth bus and extended from there to earth electrodes as specified hereinafter.
- 1.06** The earthing system of the building shall be an independent system connected to the earth bus on the main distribution board earth bus. The neutral shall not be used for.
- 1.07** In all other cases, a separate earth conductor in addition to the circuit wiring shall be included. The earth conductor shall be installed in the same conduit with the phase and neutral conductors and shall be sized in accordance with the concerned local codes.
- 1.08** The complete earthing system shall be protected against damage by corrosion.

1.09 SUBMITTALS

- A. Submit test reports of electrical resistance to earth.
- B. Provide layout showing system earthing pit and electrodes connections and routing of earthing conductor.

PART 2 - PRODUCTS

- 2.01** Connections between the earthing rod and the main distribution board will be made using copper stranded cable of appropriate cross sectional area with an overall green or green/yellow PVC sheath.
- 2.02** Where armored cables are installed directly in the ground then the armoring must be bonded to earth using suitable glands. The armoring must not be used as the sole earthing conductor. Additional earthing shall be provided by means of a separate insulated PVC-copper cable whose insulation is green/yellow.

2.03 EARTH RODS

Earthing rods should be of 20mm in diameter by 3 meters length power driven vertically in to the ground with heads located at a depth to suit the position of the disconnecting earthing pit.

Earthing rods shall be manufactured from a high tensile strength, low carbon steel core, 99.95% pure electrolytic copper. Earthing rods shall be provided with special hardened tips and caps, to avoid distortion when driven into the ground. Non-ferrous clamps for connecting the rod to the copper conductor will be provided.

The head of the earthing rod will be brought to a concrete chamber to be disconnected for testing purposes.

Concrete disconnecting pit with removable cover and disconnecting link, for location and test purposes, will be provided. The top of the chamber will be at finished ground level.

Joints at the head of the earthing rods shall be easily accessible for periodic inspection.

Disconnecting bolts, nuts, locknuts and washers shall be made from high strength copper alloy, phosphor bronze.

The copper PVC insulated wires connecting the ground rods to the test link shall be exothermically welded at the test link and sweated to the top of the earth rod.

2.05 ACCESSORIES

All accessories associated with the earthing system shall be of high strength and conductivity copper. These accessories are:

- A. Road to Cable Clamp.
- B. Threaded coupling.
- C. Threaded driving head.
- D. Driving spike

PART 3 - EXECUTION

3.01 All distribution boards and isolators shall be provided with an earth bus or earth terminal and these shall be connected to the earth bus in the main distribution board by earth conductors included with the feeders.

3.02 Connection between earth bars and equipment frames and stranded copper cables shall be made with appropriate compression lugs, bolts, nuts and lock washers. Contact surfaces shall be thoroughly cleaned and tinned.

3.03 Lugs, bolts, nuts, washers, screws, clamps, cleats and other items which come into direct contact with copper earth bars, tapes, cables, ...etc. shall be non-ferrous and manufactured from brass, bronze or other suitable conducting material which will not cause electrolytic corrosion. Connection between copper and galvanized structures shall additionally be tinned.

- 3.04** The maximum earth resistance as measured at the earth bus shall be in accordance with the concerned local codes. If this resistance cannot be obtained with two earth rods, additional earth rods or sectional earth rods shall be used to obtain the required resistance. Parallel connected earth rods shall be spaced at a distance of not less than the rod lengths. If approved by the Engineer, earth plates or other earthing means may be used instead of the additional earth rods
- 3.05** The connection between earth conductors and earth rods shall be made by means of high strength corrosion resistant copper alloy connector clamps.
- 3.06** The tops of the electrodes shall be protected from any damage and shall be easily accessible. With a view of this, they shall be enclosed in pits equipped with covers. The presence of the electrode shall be indicated in English and Arabic.
- 3.07** Measurement of the earth resistance will be implemented after erection the earthing system and this resistance will not exceed 2 ohms.

END OF SECTION

SECTION 16670 **LIGHTNING PROTECTION**

PART 1 - GENERAL

1.1 SCOPE

The purpose of the lightning protection system is to minimize the effects of a lightning strike to the building, from above or from the side, and to safely conduct the discharge to earth without side flashing and without danger to personnel.

The system shall consist of an air terminal, copper tape mesh on roof, bonding conductors, earth electrodes, Lightning pits and any other items required to make a complete system, steel reinforcement is used to be as a down conductor. Test joints shall be provided as required to make routine tests of the system.

Full working details including all builders work requirements shall be obtained prior to any excavation work commencing on site.

The entire lightning protection system, apart from natural building elements used as part of the system, shall be the product of one manufacturer. Subject to the requirements of this Specification & architectural considerations, all items shall be installed in accordance with the manufacturer's recommendations, including fixing to the fabric of the building.

Natural conductive elements of the building such as metal roofs, columns and framing, reinforcement, foundations ...etc shall be used as part of the lightning protection system.

Where building elements are to be used as part of the lightning protection system they shall be tested during construction to ensure that the resistance is low enough for the purpose. A formal record shall be kept of the resistance readings taken. If readings are higher than acceptable, suitable measures shall be taken to the approval of the engineer, to reduce the resistance to an acceptable value.

Waterproofing of the building shall not be impaired in any way by fixings or by any part of the lightning protection system. The lightning protection system will encompass air terminal, copper tape mesh on roof, down conductors, earth pits ...etc. The system shall be designed and constructed according to the related IEC standards.

1.2 QUALITY ASSURANCE

A. Standards

Lightning protection system shall comply with the requirements and recommendations of IEC 62305 standard with the relevant parts and sections.

B. Lightning Protection system work shall be performed by one firm specializing in the installation of such systems.

1.3 SUBMITTALS

- A. Detailed design for the lightning protection system according to the latest IEC standards.
- B. Shop Drawing and Product Data: Per requirements in section 16000.
- C. Submit full technical details and conductor size calculations of each type of cable or wire proposed.
- D. Submit exact route of each cable or wire proposed .

PART 2 - PRODUCTS AND MATERIALS

2.1 MATERIALS

- A. The materials of which protection systems are to be made shall be resistant to the corrosive environment of the area. No material shall be used that forms part of an electrolytic couple that will, with the presence of moisture, cause corrosion.
- B. Acceptable materials are:

Copper at 99% conductivity when annealed Copper alloys provided they are equal to copper in resistance to corrosion.
- C. Grade and quality of materials and the dimensions of components shall be as detailed in IEC.

All fittings, fixings, supports etc, shall be purpose made for lightning protection.

Joints in conductors shall be kept to a minimum and shall be both electrically and mechanically sound and constructed to prevent the ingress of moisture.

All contact between dissimilar metals or between a metal and a material with which it might react shall be avoided, except as permitted in IEC and provided all the precautionary measures recommended are employed. If necessary to prevent long-term corrosion, additional precautions shall be taken such as separation or the insertion of an intermediate material with which neither of the dissimilar metals/ materials reacts, or by changing the metal or material.

2.2 EQUIPMENT

- A. Air terminal and copper tape mesh shall be made of copper as mentioned above and the distribution of the air terminal and copper tape mesh shall be according to the detailed design provided by the contractor.

All steel and metallic equipment located on roof such as AC conditions, tanks, towers, steel structure...etc. shall be connected to the copper mesh on roof via joint clips according to IEC standards.

B. Down Conductors:

Steel reinforcement of the concrete structure is used as down conductors, the connection to the copper tape shall be carried out by either using exothermic welding or suitable clamps and this job shall be carried out by CONTRACTOR. The electrical continuity of the welded reinforcing bars shall be tested prior and after each pour of concrete is completed.

Using reinforcing bars as down conductors shall achieve the requirements of BS EN 62305-3 regarding continuity of reinforced concrete steel bars (0.2 Ohm) measured from the top of the reinforcement bars down to their bottom ends.

C. Joints

1. Joints in conductors shall be kept to a minimum.
2. All contact surfaces shall be thoroughly cleaned and coated with an anti-corrosive electrical jointing compound suitable for the conductor material. For bi-metallic joints a separate abrasive shall be used to clean metal.
3. Joints between conductors of the same metal, other than at test points, shall be made by thermal welding process or by riveting and sweating. Overlap of conductors shall be not less than 100mm.
4. Bonding connections to other metal parts of the building shall be electrically compatible with those metal parts.
5. Screws and rivets shall be manufactured of phosphor bronze, naval brass or high tensile manganese brass.
6. Joint connections shall be protected by a coating which will form a seal and exclude moisture in all weather conditions. At connections to earth electrodes the coating shall cover all exposed conductors and, in the case of earth pipes, the top surface of the flanges. Protective coatings shall be of waterproof, inert, tenacious material and of one of the following forms: Solvent cutback thixotropic corrosion preventative forming a film of resilient matt petroleum wax.
7. A fast drying durable rubberized sprayed coating.
8. A heat-shrink clear sheathing.

D. Conductors

1. Earthing conductors, main earthing rods and main bonding conductors shall be of the type, size and conductor materials as detailed or approved by CLIENT/ENGINEER.
2. Tapes shall comply with IEC where used to interconnect copper electrodes. The tape may be bare for interconnecting pipe electrodes and for all other purpose the tape shall have an extruded PVC sheath.
3. Main earthing bars shall comply with IEC and shall be bare.
4. Cables shall comply with BS 6004, Table 1, without sheath, unless specified otherwise.
5. Generally, roof conductors shall be of PVC sheathed 3 x 25 mm minimum) copper tape. PVC color to be approved by the Engineer. However, bare copper tape may be unless indicated otherwise on the Project Drawings or Specification.
6. Air termination rods shall be securely anchored and welded.
7. Anchoring bolts shall be used to hold roof conductors and in firm position.
8. Lightning conductor connectors shall be provided for conductor splice

connections and conductor terminal connections.

9. The connectors shall be heavy duty, cast metal and shall have hex-head screws in the bodies and holes in the tongues for bolts.
10. TV antenna, HVAC equipment, handrails and structures in the vicinity of the lightning protection system, if any, shall be bonded to the system by 3x25 sq. mm (minimum) PVC sheathed copper tape .

E. Earth Electrodes

1. The earth electrodes shall be of the earth rod type.
2. The type and number of each electrodes shall be as indicated.
3. Unless otherwise indicated, earth rods shall be 16mm normal diameter extensible copper rods connected together. Driving heads shall be of high-tensile steel. Rods shall be connected by screwed joints by one of the following methods.
4. Threads shall be roll-formed with a minimum thickness of 0.05 mm copper in the roots of the thread; couplers shall be of high strength silicon-aluminum bronze alloy and threads shall be counter bored at the ends so that the couplers completely enclose the threads on the rods.
5. The ends of the rods shall be internally threaded; couplers shall comprise a copper ferrule with the phosphor - bronze coupler screw, a corrosion inhibiting paste shall be applied to the threads on rods and couplers.
6. Where the earth electrodes are formed with tape shall be to BS 1432, of the size, length depth below ground level and layout as indicated.

F. Fixing

1. Client/Engineer's approval of the tape clips, saddles and holdfasts used shall be obtained before work is commenced. The maximum spacing of fixings shall not exceed 600mm. No fixing shall be made into joints in masonry.
2. For copper conductors or gunmetal, aluminum-silicon bronze or naval brass.
3. Clips shall be either of metal as above or of outdoor grade polycarbonate or polypropylenes with snap-on lids which cannot be inadvertently removed. Clips and saddles shall have rounded edges and countersunk screws. Brass components shall not be used.
4. For general areas inside the building screws and nuts shall be of cadmium electroplated steel or stainless steel; outside building, in plant rooms or other locations they shall be of stainless steel.
5. No shot firing shall be used and no drilling or welding of structural steelwork shall be carried out without the approval of CLIENT/ENGINEER. Drilling and cutting of the outside fabric of the building shall be carried out only after approval has been given by CLIENT/ENGINEER.

G. Inspection (Lightning) Pits

1. Unless otherwise indicated, connection between an earth conductor and its associated earth electrode system shall be in an enclosure.
2. Every connection of an earthing lead to an earth shall be made in an

inspection pit measuring 300mm x 300mm and the connection shall be either welded or clamped. The pit shall be filled with sand and a removable cover placed on each pit.

3. The enclosure shall have a removable top cover which shall be flush with finished ground level. The enclosure shall be purpose made concrete inspection pit, a galvanized steel inspection pit embedded in concrete, an earth electrode connection shall be just below the lid of the inspection pit with adequate access for testing purpose.
4. Backfill immediately surrounding electrodes shall be of low specific resistivity and good water retention properties and it shall be well compacted and watered.
5. Where earth electrodes are to be installed through the base slab of a building, electrode seals shall be provided. As indicated, either the rods shall be driven, and the seals fitted before the concrete is poured or the seals handed to the CONTRACTOR for him to incorporate them in the slab and the rods driven at a later date. Harmful ingress of water shall be avoided when driving the rods.
6. Electrodes shall be installed vertically in an excavated hole, with a minimum depth of 2000 mm below finished ground level.
7. Earth Pit Cover shall be of heavy duty construction.
8. Earth Pit Cover shall have a recessed lifting hook.
9. Earth Pit Cover shall have a brass plate, engraved "Electrical Earth Below ."

PART 3 - EXECUTION

3.1 INSPECTION

- A. The Contractor shall examine the areas and conditions under which lightning protection systems are to be installed and correct any manufacturing conditions detrimental to the timely and proper completion of work. He shall not proceed with the work until conditions are satisfactory and in a manner acceptable to the Owner.

3.2 LOCATION OF TERMINALS

- A. 25mm x 3mm copper tapes shall be provided for any parts of the building that are likely to be damaged by lightning and are not protected by adjacent structural steel work. This generally refers to roof mounted mechanical equipment which requires bonding to adjacent steel work.

3.3 CONDUCTORS

- A. Conductors sizing shall be as indicated on the drawings.
- B. Gradual Bends. Any bend in a conductor shall not form an included angle of less than 90 degrees nor shall it have a bending radius of less than 203mm.
- C. Supports. Conductors may be coursed through air without support for a distance of 0.9m or less. With a 15.00mm rod or its equivalent as a support, securely fastened at each end, a conductor may be coursed through air for a distance not to exceed 1.8m.

- D. Steel reinforcement is used to be as down conductors, the electrical continuity shall be ascertained from the air termination system to the Earthing system.

3.4 EARTHING

- A. Earthing shall be carried out at lowest floor finish; earth conductor shall be installed to external earth pits.
- B. Earth Terminals (Rods). Ground terminals (rods) shall be as previously indicated.
- C. Earth Rod Clamps. Clamps shall make contact with the 'earth rod for a distance of 38mm measured parallel to the axis of the ground rod and with the cable itself for a distance of at least 38mm. Clamps shall be secured with at least two bolts or cap screws.
- D. Common Earth. All earthing mediums shall be bonded together. This shall include electric, telephone and antenna system earths and other underground metallic piping systems, which enter the structure. Such piping systems include water services, underground conduits, etc.
- E. Overall resistance to earth of the completed lightning protection system shall not exceed 10.0 ohms.

3.5 BONDING OF METAL MASSES

- A. Certain metal bodies of conductance or inductance contribute to lightning hazards outside or inside a building and shall be bonded to the conductor system.
- B. Metal bodies. Metal bodies of conductance shall be protected.
- C. Bonding Requirements for Metal Bodies of conductance. Metal bodies of conductance shall be bonded to the system using main size conductors and a bonding plate having a surface contact area of not less than 1900mm². Provisions shall be made to guard against the corrosive effect introduced by dissimilar metals at points of bonding.
- D. Bonding Requirements for Metal Bodies of Inductance. Metal bodies of inductance shall be bonded at their closest point to the system using secondary bonding conductors and fittings. It is possible that some metal bodies may be bodies of both inductance and conductance. In such cases, the requirements (as to size of conductor) covering bodies of conductance shall apply.

Connections to metal bodies of inductance are required if such bodies fall within 1.8m of the main conductor or other bonded metal body.

- E. Water Pipe Bond. If a metal water pipe system is present and the lightning conductor has been bonded to the water pipe, the metal bodies shall be connected either to the metal water pipe system, the nearest lightning conductor, or to another metal body already connected to the system. Where other metal bodies are bonded through their structural connection to the metal water pipe system no additional bonding is required.

- F. Antennas, Radio and Television masts of metal, located on a protected building, shall be bonded to the lightning protection system with a main-size conductor and fittings.

Lightning arresters, protectors or antenna discharge units shall be installed on electric and telephone service entrances and on radio and television antenna lead-ins.

- G. Where metal bodies are required to be bonded elsewhere, they need not be separately bonded if they are electrically continuous with the lightning protection system throughout the steel framework.

3.6 FASTENERS

- A. Conductors shall be securely attached to the building or other object upon which they are placed. Fasteners shall not be subject to breakage. They shall be fixed with the screws, and bolts of the same material as the conductor or of such materials that will ensure no serious electrolytic corrosion in the presence of moisture, because of contact between the different parts. Fasteners shall be spaced less than 0.9m apart on all conductors.
- B. Masonry anchors shall have a diameter of not less than 6.5mm and shall be set with care.
- C. Holes to receive the shank of the fastener or fitting shall be of the correct size, made with proper tools, and preferably made in the brick or stone rather than in the mortar joints. When set, the fit shall be tight against moisture and the effect of frost and capable of withstanding a pull test of 100 pounds (445N).
- D. Connector fittings shall be used on all lightning conductors at "end-to-end" "tee" or "Y" splices. They shall be attached so as to withstand a pull test of 200 pounds (890N). Fittings, for connection to metal tracks, gutters, downspouts, ventilators, chimney extensions, or other metal parts about the structure shall be made tight to the object by compression under bolt heads. Both crimp type and bolted clamps and splices of stamped or cast metal are acceptable.
- E. Disconnectors. Where future testing of a system may be required, disconnectors may be installed on all but one ground terminal of the system.
- F. No shot firing shall be used and no drilling or welding of structural steelwork shall be done without the approval of the Contract Administrator. Drilling and cutting of the outside fabric of the building shall not be carried out without the approval of the Contract Administrator.

3.7 CONCEALED SYSTEMS

- A. All requirements covering exposed systems apply to concealed installations. Conductors are coursed the same, expect that they may be coursed under the roofing material, under the roof framing, behind the exterior wall facing, between the studding of partitions or outside walls, in concealed or embedded conduit, or embedded directly in concrete.

- B. Concealment in concrete. In a concealed installation, where conductors are embedded in concrete, the reinforcing steel shall be bonded to the cable with a main size conductor. Reinforcing steel shall be bonded at the top and bottom of each embedded downspout if roof conductors are similarly embedded, connections to reinforcing steel shall be made at intervals not exceeding 10m.

3.8 FIELD QUALITY CONTROL

- A. The completed installation shall be tested to ensure the resistance between the ground terminals and earth is not more than 10 ohm.
- B. Additional ground terminals shall be installed if necessary to achieve this value.
- C. The installation shall be inspected for sound installation and workmanship.
- D. Testing of Earthing systems shall be carried out by the earth megger test.

END OF SECTION

SECTION 16710

STRUCTURED CABLING SYSTEM

1. REFERENCE STANDARDS

A. The rules and standards that apply to the techniques for projects and industrial installations for data transmission networks are:

- ANSI/EIA/TIA-568-B and addenda (Electronic Industries Alliance / Telecommunication Industries Association: Commercial Building Telecommunications Cabling Standard).
- ISO/IEC 11801 2nd edition 2002 and addenda (International Organization for Standardization / International Electrotechnical Commission).
- ANSI/EIA/TIA-606-A (Administration standard for commercial communications infrastructure).
- ANSI/EIA/TIA-569 (Commercial Building Standard for Telecommunications Pathways and Spaces).
- ANSI-J-STD 607-A (Commercial building grounding and bonding requirements for telecommunications). If a datacenter is part of the project, it will comply with: ANSI/TIA-942 (Telecommunications infrastructure standard for datacenters).
- The cabling system shall also be compatible with a series of standards, products and protocols, i.e., at least:
 - IEEE 802.3-2002 (Ethernet, Fast Ethernet, Gigabit Ethernet).
 - IEEE 802.3-2002 (10 Gigabit Ethernet for fiber).
 - IEEE 802.5 (Token Ring).
 - ANSI FDDI.
 - ATM at 155, 622 and 1.2Giga.
 - ANSI/TIA/EIA 854 (1000 Base TX).
 - ISO/IEC 8802.3 (all equivalents to IEEE 802.3).

2. COMPLIANCE WITH SAFETY STANDARDS

All cables used shall comply with the safety specifications established by IEC-322-1 standard, in particular for buildings with a high-density population and fire protection within buildings.

In contact with flames, cables can become a vehicle for propagating fire and substances produced by combustion can, in turn, have a harmful effect on both Persons and equipment.

Fire propagation shall be deemed the main risk factor and, therefore, the main item to be considered when setting up protective measures.

The results obtained from research on the most advanced production-related technologies and materials have enabled the development of cables that are specially suited for use in installations where it is essential to eliminate, or at least limit, the risks for both persons and equipment.

Among the types of cable having characteristics likely to reduce fire-related risks, groups with flame retardant cable jacket and reduced emissions of smoke and toxic gases stand out called as Low Smoke Zero Halogen (LSZH). The composite

materials used to make them must limit the production of smoke (which reduces visibility) and the release of halogen gases (which lead to asphyxia).

3. NETWORK ARCHITECTURE

The cabling infrastructure will be:

- A. Systematic: presence of outlets at all user access points to enable the connection or moving of any equipment without need for re-cabling.
- B. Standard: outlets and connected cables shall be identical in order to support any type of network and equipment.
- C. The computer and VoIP cabling system will have a star-type topology. As regards computers, there will be main cross-connect (DC-M), and cross-connect cabinets in different floors.
- D. Cabling architecture is based on the following principles:
 - Horizontal distribution from the cross-connect facilities to the workstations will be done with a four-twisted-pairs cable wired to a RJ45 outlet (both VoIP and Data).
 - Horizontal Distribution from telephone boxes facilities to the telephone outlets done with 2Px0.6mm tel. cable wired to RJ11 outlets (this system cover few offices only as per drawings).

4. COMPONENTS

4.1 General

All system components of the entire cabling system will be of the same manufacturer in order to ensure efficient operation, component compatibility and a single warranty covering the entire installation. This includes but is not limited to:

- Horizontal distribution.
- Cabinets and Racks.

All components will provide identification markings that meet the requirements of standard ANSI/TIA/EIA 606-A.

All system components shall be manufactured by ISO 9001:2000 certified companies and all packaging shall carry clear product identification (catalogue number, quality control number, etc.), possibly in the form of a barcode.

All products must met European directive 2005/95/EC concerning restricted use of hazardous materials (RoHS).

4.2 Horizontal distribution

The proposed horizontal distribution cabling system is Category 6 UTP (Data and VoIP except for limited RJ11 telephone outlets, which will connect by 2Px0.6mm telephone cable and as indicated on the drawings.

All single outlets will consist of an RJ45 Cat6 port and/or RJ11 port.

All dual outlets will consist of 2 (two) RJ45 Cat6 ports 2X4P UTP CAT.6 cables.

All copper components used in the horizontal system will be of the same manufacturer, and will all be third party TESTED & VERIFIED to Cat.6 components (except RJ11 outlet port will be 2x0.6mm telephone cable), permanent link & channel, complying with ANSI / TIA / EIA, ISO / IEC & CENELEC EN standards.

(Component verified means that each component has been quarterly or half yearly tested by the independent laboratory at the manufacturer assembly plant). The entire link will be certified by an independent laboratory to meet Cat.6 according to ANSI/TIA/EIA 568 B.2-1 and ISO/IEC 11801.ed.2: 2002 and Amended 2008.

4.3 Copper

Data & VoIP

Outlets are to be used to connect the user equipment to the network through a patch cord. The RJ45 modules shall meet the following criteria:

- Category 6 RJ45, third party component verified to Cat.6 ANSI/TIA/EIA 568 B 2.1 of 20 June 2002.
- Center tuned to Cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1. of 20 June 2002.)
- Rated 750 insertions
- Compliant to FCC part 68, subpart F and UL1863, dealing with the interface's Physical dimensions, including the 1.27µm gilding on the contacts, the traction force that has to be borne by the RJ45 socket, the plug (100 grams) and the maximum force authorized for connecting the plug in the jack (2.2 kg).
- Support T568A and T568B wiring.
- Available in various colors, and be icon compatible.
- Accept 22 to 24 AWG cable.
- Enable maximum untwisting of ½ inch (12mm) of the pairs.
- Connection of the cable will be done through rear IDC contacts with use of a standard 110 impact tool. Tool less connectors are not acceptable.
- Modular contacts must be plated with minimum 50 micro-inches of gold.
- Modules that cannot be re-connected in case of error are not acceptable.

Telephone (RJ11) port wired

- Conductor: Annealed tinned electrolytic copper conductor.
- Insulation: insulated and sheathed with PVC compound.
- Twining: twisted pairs bunched together in concentric layers so as to minimize cross-talk and wrapped with melanics or PVC tape.

4.4 Faceplates

The modules will be integrated in faceplates with either of the following methods:

- A single faceplate accepting one or two RJ45 modules each. The faceplates will be matched to the electrical outlets, and must have label holders. (a transparent cover that allows the placement of a machine printed label)
- An adaptor in either the "6c" 45mm formats that allows placing the modules in standard faceplates of the same brand and modeling as the electrical outlets, or in floor boxes. Each adaptor MUST also have a label holder.
- For counter outlets refer to architectural enlarge drawings for exact location, as well as, how the cable will pass through the counter from floor.

4.7 Patching Connectivity for Copper Horizontal Distribution

4.7.1 For Copper Horizontal Distribution

Patch panels shall be used in the cross-connect facilities to connect the four-twisted pair cables and their related outlet, to the active devices via patch cords. They shall meet the following criteria:

- Category 6 RJ45, third party component verified to cat.6 ANSI/TIA/EIA 568 B 2.1 of 20 June 2002.
- Support T568A and T568B wiring.
- Compliant to FCC part 68500, section F and UL1863, dealing with the interface's physical dimensions, including the 1.27.m gilding on the contacts, the traction force that has to be borne by the RJ45 socket, the plug (100 grams) and the maximum force authorized for connecting the plug in the jack (2.2 kg).
- Durable black powder coat finish with flame retardant UL 94V-0.
- Connection of the cable will be done through rear IDC contacts with use of a standard 110 impact tool.
- Support 24 ports on one unit of space and / or 48 ports availability with same one unit of space (as per BOQ).
- Recessed Curved Patch Panels are recommended as they directs cords more easily to vertical cable management and save rack space eliminating the need of horizontal cable managers.
- Have a rear-side cable support bracket far enough away from the panel to comply with the cable bend radius.
- Have slots in the front face for the insertion of designation tabs (icons for Voice-Data) for the ports and a label designation system in the front and in the back to provide identification marking that meets the requirements of standard ANSI/TIA/EIA –606-A.
- Have a metal structure enabling it to be durably fixed to the uprights of the 19"chassis assuring ground continuity with the metal frames.
- Modular contacts must be plated with minimum 50 micro inches of gold.

- If angled panels are to be used, they must be recessed from the 19" rails, and meet all requirements above. However, curved panels are recommended because of their better recessed capability and aesthetics.

4.8 Horizontal Copper Cable

Whether for computers or VoIP, copper cables shall be used on each floor for the horizontal distribution between the end sockets and the intermediate cross-connect (DC-). They shall meet the following criteria:

- Third party component verified to the standard for Category 6 ANSI/TIA/EIA 568 B 2.1 of 20 June 2002.
- Four twisted pairs of 22 or 23 AWG wire per cable.
- Impedance 100 Ohms.
- U/UTP according to the last edition of ISO/IEC 11801ed2: 2002.
- Low Smoke Zero Halogen jacket, meeting IEC 332-1 Fire resistance.

4.9 Cat.6 Copper Patch Cords (Wherever Mentioned in BOQ)

Cat.6 copper patch cords are to be used to connect the workstations to RJ45 outlets, and allow for patching in the enclosures between patch panels and active devices.

They shall meet the following criteria:

- Factory made. (hand crimping of cable is not acceptable)
- Minimum length of 3 ft or 0.97 m, and maximum length of 5m.
- Third party component verified to the standard for Category 6 ANSI/TIA/EIA 568 B 2.1 of 20 June 2002.
- Center tuned to cat.6 test specifications. (Perfectly centered in relation to the limit values set by standard ANSI/TIA/EIA-568-B.2.1. of 20 June 2002.)
- Manufactured from stranded wire cable for longer flex-life.
- Have a “snag-less” design to protect the latch from damage during moves and installs. (Plastic protection over the latch). This must not add width to the plug so that it can still be used with high density switches.
- Be available in various colors and allow the use of color icons.
- Rated for at least 750 plug insertions.
- Meet requirements of IEC 60603-7 for plug and termination.
- Modular contacts must be plated with 50 micro inches of gold.

Note: Cat.6 Patch cords will be tested by the Engineer and / or owner representative before approval of the solution. (See Samples)

4.10 Racks

4.10.1 Free Standing Cabinets

Free standing cabinets can be used to house the patch panels and the active devices in rooms where persons other than IT technicians have access. They shall meet the following criteria:

- 19”format.
- Height of 42 units.
- Width of 800 mm, and depth of 800 mm.
- Fitted with 2 sets of 19” rails, front and back.
- Fitted with vertical cable management on both sides. (Left and right, front only)
- Fitted with lateral cable support on both sides. (i.e. Cable tray or bars on the inside so that cables are never fixed to the 19” rails but on proper support)
- Have key lockable front door, back door, and side panels. The side panels must be removable without tools.
- Fitted with a grounding kit.
- Include 3 fans connected to a thermostat.
- Fitted with a 5 way power strip. (or more as per power requirements, without exceeding the power rating of the cabinet)
- Fitted with a curved safety glass front door.

All Free standing cabinets must have the following ratings:

- Rated IP 20 according to IEC 60529.
- Rated IK 08 according to IEC 62262.
- EIA 310-D.
- Loading of 10kg per unit of space. (i.e.: 420kg for a 42u cabinet)
- Tested for corrosion resistance: Maximum 6mm of cross around a scratch after 1000 hours of continuous salt spray.

4.10.2 Wall Mounted Cabinets

Wall mounted cabinets can be used to house the patch panels and the active devices where less than 16 units of space is required. They shall meet the following criteria:

- 19"format.
- Height of minimum 15 units.
- Width of 600 mm, and depth of 600 mm.
- Pivoting to allow easy access to the rear of the cabling.
- Fitted with one set of 19"rails in the front.
- Fitted with lateral cable support on both sides.
- Have key lockable front door.
- Fitted with a grounding kit.
- Include 2 fans connected to a thermostat.
- Fitted with a 5 way power strip.(or more as per power requirements, without exceeding the power rating of the cabinet)
- Fitted with a curved safety glass front door.

All wall mounted cabinets must have the following ratings:

- Rated IP 20 according to IEC 60529.
- Rated IK 08 according to IEC 62262.
- EIA 310-D.
- Loading of 3kg per unit of space. (ie: 45kg for a 15u cabinet)
- Tested for corrosion resistance: Maximum 6mm of cross around a scratch after 1000 hours of continuous salt spray.

4.11 Horizontal Cable Management Panels

4.11.1 Inside Cabinets

Horizontal management panels inside cabinets will meet the following criteria:

- 19"format, metal structure.
- 1 or 2 units.
- 4 cutouts
- 5 plastic rings of minimum depth 90mm. Rings must be durable, flexible, and must protect the bend radius of the patch cords.

5. EXECUTION

5.1 Distribution and Location of Workstation Outlets

The workstation outlet is the access point that houses all the connecting devices enabling a user to connect to the cabling system. This can also be isolated outlets in a corridor used to connect a network printer or a phone, for example. Outlets shall be located in the rooms in such a way as to preserve the aesthetic quality. Their exact location is determined by the indications of the works manager during the execution phase. For counter location refer to architectural enlargement drawings.

5.2 Enclosure Components

Enclosure configuration (cable entry, cable management, etc.) shall be the same for each intermediate cross-connect facilities (floor cabinets).

An intermediate cross-connection comprises:

- Backbone cable entry.
- Outgoing cables corresponding to user need:
- A minimum of 20% of spare space is to be provided for future extensions.

Each switch and each copper patch panel will be backed up by cable management panels that enable clean patching. (Only angled panels used in a rack do not require one horizontal cable management panel each.) Dimensioning will be 1u of management panel for every 24 ports.

Cable management panels are to be dimensioned to comply with the bend radius of the patch cords, even when all the patch panel ports are used, and will be fitted on standardized 19" structures.

5.3 Horizontal Distribution

A Category 6 four-twisted-pair cable will be assigned to each RJ45 connector in the user outlets.

Pair assignment shall be that according to T568-B method. From the intermediate cross-connect facilities IC, cables are routed either:

- In surface-mounting raceways for workstations or in sleeves installed for this purpose between cross-connect and raceways (or as per drawings details).
- In metal conduits (if any) for fewer than 5 cables. Interior diameter to be 27mm for 4 and 5 cables, 21mm for 3 cables or less (Cat.6 UTP). The bend radius of any portion of the conduit pathway must be at least six times the diameter of the conduit. Conduit bends should be smooth and even and should not contain kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation. All conduits to be equipped with a plastic or nylon line (also called a pull cord) that has a minimum test rating of 90 kg (200 lb).
- Back boxes must be minimum 40mm deep.

The horizontal distribution network has uniform characteristics, whatever the type of floor, the only specific parameters being the number and location of the user outlets.

Maximum cable length is 90 meters between the end outlet and the IC.

Avoid as far as possible transition or consolidation points. The project Engineer shall be notified if any are required.

To enable several re-cabling operations, each RJ45 outlet shall have 30 (thirty) centimeters cable slack.

An additional cable slack of about 3 (three) meters shall be planned for the cabling in all the enclosures in the technical rooms, also to enable eventual re-cabling operations.

These additional lengths of cable shall be organized so as to avoid creating loops that are too small and that degrade link performance. Recommended procedure is to make a "detour" with the cable tray so that cable length is increased while keeping cables organized. If space is unavailable for the detour, then slack will be kept in a figure of eight.

5.4 Cable Management

- All fitted cables shall be routed through trunking installed by the "Electromechanical contractor" work section.
- All cable trays will be designed for 40% usage with all cables installed.
- In any case, the Contractor is to notify the project Engineer of any close installation that may cause problems such as: circulation of fluids, neon tubes, etc.
- The contractor will also inform the project Engineer if any of the cable management solutions are insufficient or non compliant with standards (cables tray too small, back boxes or floor boxes with insufficient depth), and must specify if the issue may affect the performance of the system.
- On cable trays, cables are to be fixed in bundles of maximum of 48 cables using removable cable clips with clamp control of minimum 12mm width, at distances of about 60 cm, avoiding, where possible intervals that are too regular so as to prevent the generation of harmonics.
- Vertically in the racks and cabinets, cables will be fixed with Velcro type straps of minimum width 19mm, in bundles of maximum of 48 cables.
- On the rear cable support bar of the patch panels, cables will be fixed with Reusable hook-and-loop straps Type such as Velcro type straps of minimum width 10mm.
- Care must be always taken that the ties are not too tight as to avoid deforming the outer jacket and damaging the cables' internal structure.
- The "thin white" plastic cable ties are always prohibited.

5.5 Grounding

- There shall be only one grounding network, and therefore no distinction between the computer ground and the electric ground. This requires a maximum meshing of all the metal parts (e.g. cable trays) such as indicated in standard ANSI-J-STD-607.A and IEEE 142.
- The Contractor is to ensure the connection to earth in compliance with good engineering practice: this will cover every installed metal structure.
- Cross-connect facilities and 19 inch enclosures are to be earthed, and at the time of installing systems.
- During the installation, special attention shall be paid to strict compliance with grounding rules. The building grounding installation shall ensure a maximum potential difference of 1 V RMS between any two connection points.
- The rules mentioned above shall also be complied with as regards metal ducts.
- Grounding must be done in accordance with all applicable codes and regulations.

5.6 Electromagnetic Compatibility

At the time of installed a structured cabling system, it is essential to take account of issues of protection against electromagnetic emission and immunity. Cabling is considered a passive system and it is therefore impossible to test its electromagnetic compatibility (EMC) on an individual basis. Devices that have been designed for these applications shall comply with the standards on electromagnetic compatibility, in order to avoid degradation of the characteristics of the system. When developing the project, it is necessary to pay special attention to this factor, so as to best protect the integrity of the signals against interference and disturbances that are internal and, in particular, external to the transmission lines. The minimum distance between Low voltage (LV) and Low Current (LC) shall comply with ISO/IEC 11801 ed2:2002 and ISO/IEC 18010, and to all applicable codes and regulations.

5.7 Drilling

The Contractor is to drill all the necessary holes and shall be responsible for filling in these holes. No cable is to be flush-mounted directly across wall or floor feed-through. Any feed-through shall include a protection comprising a sleeve or conduit with a protection.

The contractor is reminded that the making of any holes in the ceiling shall require the project Engineer approval.

5.8 Connections

Connection of the cables to the cross-connect facilities is to be carried out according to good engineering practice, and as to guarantee highest performance of the system.

5.9 Marking

Marking labels shall be created using a dedicated software program in order to ensure that the marking complies with standard ANSI/TIA/EIA 606-A. Labels enabling easy marking shall be inserted. The Contractor is to ensure marking of all the installed equipment:

- The RJ45 outlets.
- Each end of each cable (horizontal and vertical distribution), on the technical room side and the outlet side.
- The RJ45 patch panels (Data, VoIP)
- The rack mounts fiber patch cabinets

The method for labeling and marking is to be submitted to the project Engineer for approval at the time of the execution studies.

Labels on the outlets and patch panels must be either printed paper inside the clear plastic cover designed for it, or engraved adhesive plastic. Adhesive paper (type "Brady") will not be accepted as it can be removed to easily while cleaning. Cables are to be labeled at both ends using self-laminating wrap around labels.

For horizontal distribution, labeling will include (when relevant): Building, floor, enclosure, outlet number.

For fiber vertical distributions, an identification label fixed inside the glass door of the fiber cabinet will enable identification of the origin and type of the cables when looking from the outside, and of all individual cores when opening the door (back side of the label). These shall be repeated at both ends of the cable.

6. WORK ACCEPTANCE

6.1 Principle

Acceptance tests will take place at the end of the work project.

The installation compliance is checked in relation to the specifications of this document as per the following criteria:

- Certification tests compliance with standard ANSI/TIA/EIA.
- Compliance with the technical file submitted at the start of the work, with the drawings for cable management and outlets layout.
- Cable connection.
- Marking of the distributed outlets and the distribution enclosures.
- Systematic grounding.
- Quality of the fitting.
- Filling in of all the holes.
- Equipment: layout, quantities.
- Testing and inspection files.
- Test validity.

During the testing phase (as well as during the execution phase), if the project engineer records one or several deteriorations in the locations made available to the Contractor at the start of the work, the Contractor shall be responsible for any renovation work.

6.2 Testing the cabling system

The contract giver may reserve the right to be present at any time during the tests and, once the test phase is over, to select at random up to five (5) percent of the total of the copper and optical links in order to re-test them and compare them with the results given in the technical certification tests.

Any test that has not been carried out according to the methods described in this document shall be repeated and will not be invoiced. If more than two (2) percent of the total of the tests fail, the whole cabling system shall be re-tested at no additional cost.

The Contractor shall be responsible for providing the test equipment during the acceptance tests.

6.3 Copper Cables

6.3.1 Visual Tests for Cat.6 Cables

As regards an installation with twisted pairs, among other things the test shall verify the following:

- Environmental limitations.
- Cable bend radius.
- Maximum jacket removal of 25 mm.
- Untwisting lengths less than or equal to a half-twist.
- Absence of unpaired parallel wires
- Marking labels.
- The connections are correctly made.
- Continuity is ensured along the whole length of the link.
- Free of any short circuits
- Maximum lengths are respected.
- Each pair is properly insulated with respect to the other pairs and with respect to the earth.

6.3.2 Measurements

Cat.6:100% of links will be tested for compliance with standard ANSI/TIA/EIA 568 B.2-1 which shall result in:

- The name of the certification company.
- The name of the operator.
- The type, serial number and software version of the instrument used.
- The identification number of the tested link system.
- The type of test carried out (class E link).
- The connection (including earth continuity for FTP cables).
- The length of each permanent link.
- The length of each channel.
- The results of all the tests carried out with the tester with the version of the software used.
 - The cable's NVP (Nominal Velocity Propagation) shall be taken into account for accurate length measurements.
 - The test method will be "Permanent Link", except if 110 connectors are used in which case "Channel" will be tolerated.
 - "Basic Link" is never acceptable as it is obsolete.
 - All test devices of the same type shall be supplied by the same manufacturer and the results produced shall have a consistent format.
 - Approved devices for Cat.6 testing: Fluke Networks testers of Level III or better, with latest software version, and with calibration up to date.

6.3.3 Results

In order to insure proper performance of the cabling, the results for NEXT (Near-end Crosstalk) and for the RL (Return Loss) obtained shall be 3 dB better (double the performance) than the limit values stated in standard ANSI/TIA/EIA 568 B.2-1, for 100% of the links installed and for the entire frequency range tested.

6.5 Cabling Certification

In compliance with standard ISO/IEC 11801 2nd edition 2002/09 or ANSI/TIA/EIA 568-B.2, each CAT 6 twisted-pair cable section or each fiber optic cable section shall be certified to proof its compliance with the minimum characteristics required by the standard mentioned above. It is mandatory for the network administrator to receive the original certification together with the calibration certificate for the instruments that have been used, and all test results of the concerned links.

6.6 Documentation

Full documentation shall be provided in both printed and electronic format.

At the start of the work, the Contractor is to deliver the execution drawings to the project Engineer.

The Contractor is to provide, in the form of tables, a technical acceptance test report that shall guarantee that the whole cabling infrastructure has been tested and validated as per the standards in force. The information required is:

- The reference number with the departure and arrival point for each cable, the type of cable and its identifier.

- Results of the tests relating to the standards used.
- For the fiber optic cables, overall optical budget for each link
- Date and time of the tests.
- Final result of each test: Pass/Fail.

The results of each test (graphs and values) given by the measuring instruments shall be supplied on an electronics support such as CD-ROM, along with any proprietary software (other than Excel, Access, CSV files, etc.) required. A certificate signed by an authorized person from your company shall accompany these electronic reports guaranteeing the authenticity of the information.

The documentation delivered at the end of the service will also comprise:

- A set of "as built" drawings with the locations of the outlets for the cross-connect facilities, cable routing systems and cable duct insertion points
- The "as built" drawings for the technical rooms (with enclosure drawings): The distribution diagrams and details of the connection blocks.
- The technical data sheets for each item of installed equipment.
- The reports on the tests carried out.

As part of its offer, the Contractor is to provide a standard example of the acceptance test report that is to be used. The Contractor is also to provide the parts list for any equipment implemented with the operating instructions and the delivery notes.

7. CALL FOR TENDER'S REGULATION

7.1 The Offers

The contractor is invited to take account of the difficulties of work execution on site. No supplementary price may be requested for work that may have been underestimated through lack of knowledge that may or may not be attributed to the contract giver as regards the entire conditions of execution.

7.2 Conformity

A cabling system is intended to provide an integrated communication system, independent from the transmission equipment (computer, printers, network equipment, etc.), as well as from the protocols used (Ethernet, Token Ring, TCP/IP, etc.), while taking account of the future developments and uses for which the bandwidth shall always require further extension. Therefore, the cabling system shall perfectly comply with the standards and shall be characterized by an open architecture, as indicated in standard ISO/IEC.

Cabling shall comply with international standards and the regulations in force. If, during the execution of the work, new regulations or standards come into force, the Contractor shall make the required modifications to ensure that the installations delivered at the time of acceptance are compliant with the latest provisions.

7.3 Samples

All installed equipment shall be submitted to the project engineer for approval for each equipment, the contractor is to indicate in its offer the type, supplier and catalogue number as a list classified by equipment type.

7.4 Execution of the work

The worksite Engineer will be responsible for checking the conformity of the work with the requirements defined in this specification and for carrying out the work acceptance tests.

A weekly worksite or work progress meeting is to be scheduled to keep the Building, Project Engineer or Owner representative informed of work progress.

The Contractor also agrees to make every effort to maintain the worksite in as clean a state as possible. The project engineer requests that the Contractor should carry out systematically full cleaning of the worksite every week. In case of non-execution, the project Engineer will entrust the mission to another company, whose invoice shall be forwarded to the contractor.

7.5 Warranties

The contractor shall submit detailed documentation on the components used, using photos or graphics taken from the manufacturer's documentation. The contractor shall be able to provide proof of a significant similar installation demonstrating real experience in the implementation of the manufacturer's cabling solutions.

The contractor shall include the approved installer certificate evidencing its qualification.

The system is subject to 24 month warranty, where contractor to provide the labor, equipment and 5% of total installed cable ,connecters and patch cord the price of spare part is included in the structure cabling system BOQ

END OF SECTION

SECTION 16730

FIRE ALARM SYSTEM

PSRT 1: GENERAL

- A. The contractor shall be responsible for the supply, installation, commissioning and servicing of the conventional fire alarm system.
- B. The contractor must review the consultant's proposal for suitability to his system. All deviations should be brought to the notice of the engineer.
- C. The contractor or his representative must have, at least 5 years experience in installing, commissioning and servicing fire detection and alarm systems.
- D. All equipment central to the operation of the conventional systems shall be designed and manufactured by the company installing and commissioning the system. As a minimum requirement, this clause covers the following:
 - a. Fire Alarm Control Panel
 - b. conventional ancillary equipment
 - c. Power supplies and automatic point detection equipment
- E. 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).
- F. The main equipment proposed for use shall be approved by at least one of the following:
 - a. Loss prevention Council (LPC)
 - b. Underwriters Laboratories (UL)
- G. 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.
- H. 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.
- I. 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.
- J. Applicable Standards and Specifications
Where applicable, the fire detection and alarm system and installation shall comply fully with the British Standards (BS) or NFPA rules and regulations, as well as , the local Authority has the jurisdiction (Civil Defense) .

1.01 APPROVALS FROM THE CONCERNED LOCAL AUTHORITIES (I.E. CIVIL DEFENSE)

- 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 (Civil Defense) during and after the installation as deemed necessary and as required.

1.02 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 (Civil Defense).
- B. The electronically operated conventional system including but not limited to the following items:
 - 1. Fire Alarm Control Panel (Number of zones as indicated on BOQ)
 - 2. Fire Alarm Repeater panels (when indicated in drawings and BOQ)
 - 3. Power supply and standby batteries with charger
 - 4. Smoke sensors
 - 5. Heat sensors
 - 6. Manual call points
 - 7. Visual / Sounder alarms
- C. 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.

1.03 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 departments (Civil Defense) and obtain necessary approvals.

1.14 SYSTEM OF WIRING

Fire alarm wiring shall be completely segregated from any other system.

All internal wiring between bells, push buttons....etc. master alarm panel and local junction boxes shall be in PVC insulated cable enclosed in conduit.

For the surface installations, the interior wiring generally in exposed galvanized steel heavy gauge Class (B).

For recessed installations, the interior wiring shall generally be concealed in PVC conduits, rigid heavy gauge, and super high impact type.

1.15 SYSTEM OF OPERATION

Under normal condition the front panel shall display a system, normal message and the current time and date.

Should an abnormal condition be detected by an automatic detector or break glass contact the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steadily for trouble and supervisory conditions. Operation of an automatic detector or break glass contact shall signal to the main panel and indicate the zone, detector etc. in which the signal originated.

Upon receipt of an alarm signal the sounders through the system shall sound for 5 seconds and in the zone where the call originated shall sound continuously. In other zones the processor shall be programmable so that for each alarm signal the sounder shall remain silent (after the first 5 second pulse) or shall sound intermittently one second ON five seconds OFF.

The panel shall display the following information relative to the abnormal condition of a point in the system:

- Zone number.
- Type of device (i.e. smoke, Break Glass).
- Point status (i.e. alarm, trouble).

Pressing the appropriate acknowledge button shall acknowledge the alarm or trouble condition.

After all the points have been acknowledged, the LED shall glow steady and the panel audible signal will be silenced.

Provision shall be made at the main panel to silence the alarms siren but the visual indication shall remain until the system is reset. A further call shall not be inhibited whilst the sounders have been silenced.

System Reset shall be used to return the system to its normal state.

Provision shall also be provided at the main panel to operate the alarm siren/flasher in any zone to indicate that the area should be evacuated.

In the event of an alarm, call output signals shall be provided to release the automatic doors closers, unlock fire escape exit doors(if any) etc.

In addition to any required printer output, the control panel shall have the ability to store a minimum of three hundred (300) events in alarm log and (600) events in a trouble log stored in (RAM).

PART 2: PRODUCT

2.1 MAIN FIRE ALARM CONTROL PANEL (FACP)

Fire alarm control panel shall be microprocessor based, housed in an all metal cabinet suitable for wall mounting and be conventional type.

Digital codes shall be incorporated to allow on site reprogramming and isolation of inputs and outputs. All programming shall be possible on site.

The control panel shall receive 230 VAC power and shall be provided with a battery and battery charger unit. The battery shall be maintenance free, heavy, sealed lead acid with sufficient capacity to maintain the system for 24 hours followed by an alarm condition for 30 minutes.

The charger shall be the static type, compatible with the battery and capable of recharging the battery whilst maintaining the system.

2.2 PULL STATION

Conventional type Pull stations shall comply with the requirements of BS 5839: part 2: 1983 or NFPA-72 and will contain electronics that communicate the station status (alarm, normal) to the control panel over two wires which also provide power to the Pull station, the station requires a firm downward pull to activate the alarm switch completing the action breaks an internal plastic break-rod.

The Pull station shall be flush-mounted at 1350 mm. AFFL (at light switch level).

2.3 AUTOMATIC DETECTORS

All detectors shall be of conventional type suitable for mounting to a common back plate and connected to two wire circuit

Each sensor output shall be digitized and transmitted to control panel (every 4 seconds), integral LED for power on (Pulsing) or alarm or trouble (steady on).

Conventional Heat detectors 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. Generally, be designed to operate on "rate of rise" and a fixed temperature 60 C. A temperature increase at the sensor of 9°C or more per a minute activates the rate of rise feature.

Conventional Smoke detectors shall be complying with BS 5445: part 7 and shall be LPCB approved or comply with NFPA -72 and shall be UL approved. Photoelectric type, seven levels of sensitivity for each individual sensor, ranging from 0.2% to 3.7% per foot of smoke obscuration, 360 smoke entry for optimum response and almost dirty detection peak value reporting and automatic sensor self test. They shall incorporate green LED's to indicate that the unit is operational.

Photoelectric and heat detectors shall incorporate red LED's to indicate when the unit is in "alarm" state

2.4 ALARM SIREN/FLASHER

Alarm siren/flasher shall be multi tone type and Operated by 24 VDC, each device assembly shall include separate wire leads for in/out to the associated signal circuit.

Alarm siren/flasher shall be mounted directly over a flush box at 2.2m AFFL & below ceiling level and clearly labeled "Fire Alarm".

Technical specification

- Combined flashing high intensity LED beacon and sounder

- Wall mount
- Two part plug-in construction , no locking screw required
- First fix base for easy and safe installation
- Operation voltage: 24Vdc non-polarized
- Operating temperature: -10 °C to +50°C
- Flashing frequency: 20x180 per min.
- Alarm volume(SPL): 90 dB @1 m
- Relative Humidity : 95%
- Application: indoor use
- Material: ABS
- Wiring: I pair 24Vdc supply

PART 3: EXECUTIONS

3.1 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 1.35m heights above finished floor (or as per lighting switch level).
- C. Automatic smoke and heat sensors. Ceiling mounted/surface mounted/above ceiling mounted
- D. Alarm Siren/Flasher. 2.20m above finished floor
- E. Outdoors alarms fix where indicated by the concerned local authorities fire department (Civil Defense) and/or indicated on the drawings, and approved by the engineer.

3.2 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 (Civil Defense) approval and requirements.
- B. The Fire Alarm Systems shall be complete programmed in accordance with the concerned local authorities fire department requirements and as a 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 extra payment even in time.
- D. Drawing and specification are complimentary 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.

- 3.3 Shall co-ordinate with other trades for the installation of the system.
- 3.4 The contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.
- 3.5 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.
- 3.6 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.
- 3.7 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 16750

IP CCTV SYSTEM

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. Examine all other sections of the Specification for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.
- C. This section shall be read in conjunction with section 16710 "Structured Cabling system"

1.02 DESCRIPTION OF WORK

- A. This section applies to the IP Based CCTV.
- B. The quantity and location of apparatus comprising a complete system as shown on drawings.

1.03 SYSTEM DESCRIPTION

- A. Equipment shall be shown with IP cameras, PC, servers units positioned where indicated on the drawings to provide the maximum flexibility and coverage.

1.04 REFERNCES

Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the work of this Section:

- Canadian ICES-003
- Canadian Standards Association (CSA)
- Conformity for Europe (CE)
- Consultative Committee for International Radio (CCIR)
- Electronic Industry Association (EIA)
- Electrical Testing Laboratories (ETL)
- Federal Communications Commission (FCC)
- Joint Photographic Experts Group (JPEG)
- Moving Picture Experts Group (MPEG)
- National Television Systems Committee (NTSC)
- Phase Alternating by Line (PAL)
- Underwriters Laboratories Inc. (UL)
- NFPA 70 and /or IET17th edition (BS 7671:2008)

1.05 QUALITY ASSURANCE

- A. Equipment shall be purchased only from manufacturers established and specializing in these types of products.

1.06 SUBMITTALS

- A. contractor shall submit drawings and illustrated leaflets of the various types of apparatus offered.
- B. For cameras, submit the following:
 1. Methods of mounting on ceilings or on wall.
 2. Types recommendations by manufacturer with application and environment considerations especially for external units.
 3. Samples of all types of camera.

1.07 DELIVERY, STORAGE AND HANDLING OF MATERIALS

- A. Pack to protect all apparatus during transportation.
- B. Store in a dry clean place.
- C. Do not install equipment until it can be protected from damage during construction.

PART 2 - PRODUCT

1. Daynight Dome Camera (Recessed ceiling type/Surface ceiling type)

- A. General Characteristics:
 - The day/night HD camera shall deliver true 1080p HD resolution in 16:9 formats.
 - The day/night HD camera shall be capable of operating as an indoor/outdoor camera.
 - The day/night HD camera shall be rated to IP67 (NEMA 4X) standard against water and dust ingress.
 - The day/night HD camera shall be rated to IK10 vandal resistance.
 - The day/night HD camera shall provide direct network connection using H.264 and JPEG compression and bandwidth throttling to efficiently manage bandwidth and storage requirements while delivering outstanding image quality.
 - The day/night HD camera shall support Auto-MDIX (a medium dependent interface crossover).
 - The day/night HD camera shall conform to the ONVIF standard (ONVIF is an open industry forum for the development of a global standard for the interface of IP-based physical security products).
 - A user shall be able to view video on a PC using a Web browser.
 - The day/night HD camera shall be capable of integration with third-party video management software.
 - The day/night HD camera shall provide MOTION video motion detection analysis system that provides basic video content analysis.
 - The day/night HD camera shall offer Intelligent Video Analysis (IVA) in a hardware-enhanced version.
 - The day/night HD camera shall provide four (4) independent, fully programmable privacy mask areas.
 - The day/night HD camera shall provide an on-screen display to simplify the camera/lens back focus and network configuration settings.

B. Imaging

- The day/night HD camera shall utilize a 1/2.7-inch day/night CMOS image sensor.
- [The day/night HD camera shall utilize a 3.8 to 13 mm optically corrected wide angle lens.]
- The day/night HD camera shall produce a resolution of 1920 x 1080 pixels (HD 1080p) at 30 IPS (Image per Second) with 16:9 aspect ratios.
- The day/night HD camera shall provide a frame integration mode that can increase the integration time up to 10 times on the CCD.
- The day/night HD camera shall produce a color image with a minimum scene illumination of 0.22 lux (0.022 fc) and a monochrome image, when in the night mode, with a minimum illumination of 0.05 lux (0.005 fc) at 30 IRE.
- The day/night HD camera shall provide enhanced night viewing through the increase of IR sensitivity by automatically switching a motorized IR filter from color to monochrome operation in low-light or IR illuminated applications. Allow the IR filter to be switched manually via the alarm input, preprogrammed in a camera mode or profile.
- The day/night HD camera shall utilize pixel-by-pixel analysis to automatically compensate for bright areas of a high contrast scene (Back light) without having to define a window or area.
- The day/night HD camera shall offer 76 dB digital wide dynamic ranges (92 dB with iAE).

C. Housing

- The day/night HD camera shall come fully assembled with an integral varifocal lens inside cast-aluminum housing with a polycarbonate window and a hardened inner liner.
- The day/night HD camera shall be able to withstand the equivalent of 55 kg (120 lbs) of force.
- The day/night HD camera shall be protected against water and dust to IP67 (NEMA 4X) standard.

D. HD Characteristics

- The day/night HD camera shall generate full HD 1080p resolution and 720p resolution using H.264 compression.
- The camera shall generate multiple simultaneous video streams:
 - a. Two Independently Configurable H.264 Streams:
 - 1) Stream 1:
 - a) H.264 Main Profile (MP) 1080p 25/30,
 - b) H.264 Main Profile (MP) 720p 25/30
 - Or H.264 MP Standard Definition (SD)
 - 2) Stream 2:
 - a) Copy of stream 1 (when 1080p),
 - b) H.264 Main Profile (MP) 720p 25/30 (when stream 1 is 720p)
 - Or H.264 MP Standard Definition (SD)
 - b. Two Additional Streams
 - 1) M-JPEG stream
 - 2) High Definition (HD) stream
- The day/night HD camera shall offer G.711 audio standard at an 8 kHz sampling rate AAC.

- E. Installation Requirements
- The day/night HD camera shall be capable of operating in an outdoor environment.
 - The day/night HD camera shall contain a manual pan/tilt/zoom mechanism that allows selecting the exact field of view.
 - The day/night HD camera shall offer surface, wall, and suspended ceiling mounting options.
 - The day/night HD camera shall provide power, video, and control via an Ethernet connection.
 - The day/night IP camera shall be capable of simultaneous connection to PoE and 12 VDC / 24 VAC power supplies.
 - The day/night HD camera shall provide a multi-language on-screen display.
- F. Storage Management
- The day/night HD camera shall support iSCSI devices to allow video stream to be recorded directly to an iSCSI RAID array.
 - The day/night IP camera shall support iSCSI storage targets to enable the camera to function as a conventional DVR.
 - The day/night IP camera shall have a micro-SD card slot that uses standard, off-the-shelf micro-SD SDHC or SDXC cards for local storage (up to 2 TB).
 - The local storage feature shall be capable of storage for Automatic Network Replenishment (ANR).
- G. Alarm Handling Features:
- The day/night HD camera shall provide an alarm input that may be triggered by either a normally opened or normally closed contact.
 - The day/night HD camera shall provide the capability on alarm to display up to a 17 character, programmable alarm message.
 - The day/night HD camera shall provide a relay output that may be selected for normally opened or normally closed operation. The relay can be activated from an external alarm input to the camera, manual activation from the browser, upon video motion detection, or video loss.
- H. IP Connectivity
- The day/night HD camera shall allow full camera control and configuration capabilities over the network.
 - The day/night HD camera shall offer Power over Ethernet (IEEE 802.3at Class 3) for indoor applications.
 - The day/night HD camera shall deliver 1080p HD video, at rates up to 25/30 images per second, via TCP/IP over Cat5/Cat6 cable.
 - The day/night HD camera shall conform to the ONVIF (open industry forum for the development of a global standard for the interface of IP-based physical security products) standard.
 - The day/night HD camera shall offer Embedded Intelligent Video Analytics (IVA) as a hardware-enhanced version.
- I. Embedded Video Content Analysis
- The day/night HD camera shall be VCA (Video content analysis) enabled.
 - The day/night HD camera shall offer MOTION video motion analysis that uses an algorithm based on pixel change.
 - The day/night HD camera MOTION feature shall include object size filtering and tamper-detection capabilities.

- J. Intelligent Video Analysis
- The day/night HD camera shall be capable of processing and analyzing video within the camera itself, with no extra hardware required.
 - The day/night HD camera shall be capable of detecting and sending alarms for abnormal events.
 - The day/night HD camera shall allow users to set up to 10 separate profiles and switch profiles based on a day/night or holiday schedules.
- K. Access Security
- The day/night HD camera shall offer three levels of password protection.
 - The day/night HD camera shall support 802.1 x authentications using a RADIUS (Remote Authentication Dial In User Service) server.
 - The day/night HD camera shall store a SSL certificate for use with HTTPS.
 - [The day/night HD camera shall be capable of being independently AES encrypted with 128-bit keys.
- L. Electrical: Power Supply:
- PoE (Power over Ethernet)
 - 12 VDC \pm 10% and/or
 - 24 VAC \pm 10%, 50Hz
- M. Sensor:
- Type: 1/2.7-inch CMOS
 - Active Pixels: 1920 x 1080
- N. Video:
- Video Compression: H.264 (ISO/IEC 14496-10), M-JPEG, JPEG.
 - Streaming: Four (4) individually configurable streams in H.264 and M-JPEG, configurable frame rate and bandwidth Two Independently Configurable H.264 Streams:
- Stream 1:
- a) H.264 Main Profile (MP) 1080p 25/30,
 - b) H.264 Main Profile (MP) 720p 25/30
Or H.264 MP Standard Definition (SD)
- Stream 2:
- a) Copy of stream 1 (when 1080p),
 - b) H.264 Main Profile (MP) 720p 25/30 (when stream 1 is 720p)
Or H.264 MP Standard Definition (SD)
- Two Additional Streams:
- a) M-JPEG stream
 - b) High Definition (HD stream).

- HD Resolution (H x V):
 - a. 1080p: 1920 x 1080
 - b. 720p: 1280 x 720
 - 480p Resolution (H x V)
 - a. Encoding: 704 x 480
 - b. Displayed: 854 x 480
 - 240p Resolution (H x V)
 - a. Encoding: 352 x 240
 - b. Displayed: 432 x 240
 - Overall IP Delay:
 - a. Minimum: 120 ms
 - b. Maximum: 240 ms
 - GOP Structure: IP, IBP, IBBP,
 - Sensitivity (3200K, Scene Reflectivity 89%, F1.2)
 - a. Minimum Illumination (30 IRE):
 - 1) Color: 0.22 lx (0.022 fc)
 - 2) Monochrome: 0.05 lx (0.005 fc)
 - Day/Night: Color, Mono, Auto
 - White Balance:
 - a. ATW (2500 to 10000K)
 - b. ATW hold and manual
 - Shutter: Auto (1/50 [1/60] to 1/50000) automatic fixed selectable
 - Backlight Compensation: On/Off
 - Contrast Enhancement: On/Off
 - Sharpness: Level selectable
 - Privacy Masking: Four (4) independent areas, fully programmable
 - Video Motion Analysis: MOTION or IVA (Intelligent Video Analytics)
- O. Audio
- Standard: G.711, 8 kHz sampling rate AAC
 - Signal-to-Noise Ratio: >50 dB
 - Audio Streaming: Full duplex / Half duplex
- P. Input/output
- Audio: 1 x mono line in, 1 x mono line out
 - a. Connector: 3.5 mm stereo jack
 - b. Signal Line In: 12 k Ohm typical, 1 V rms max.
 - c. Signal Line Out: 1 V rms at 1.5 k Ohm, typical
 - Alarms: 2 inputs

- a. Activation Voltage: +5 VDC to +40 VDC (+3.3 VDC with DC-coupled 22 k Ohm pull-up resistor)
 - Relay: 1 output
Voltage: 30 VAC or +40 VDC Max 0.5 A continuous, 10 VA
 - Data Port: RS-232/422/485
- Q. Local Storage
 - Memory Card Slot: Supports SDHC and SDXC micro-SD cards up to 2 TB
 - Recording: Continuous recording, ring recording, alarm/events/schedule recording
- R. Software Control
 - Unit Configuration: Via Web browser or Configuration Manager
 - Software Update: Flash ROM, remote programmable
- S. Network
 - Protocols: RTP, RTSP, Telnet, UDP, TCP, IP, HTTP, HTTPS, FTP, DHCP, IGMP V2/V3, ICMP, ARP, SMTP, SNTP, SNMP, 802.1x, UPnP
 - Encryption: TLS 1.0, SSL, AES (optional)
 - Ethernet: STP, 10/100 Base-T, auto-sensing, half/full duplex, RJ45
 - PoE Supply: IEEE 802.3at compliant
- T. Environmental:
 - Operating Temperature Range : -50°C to +55°C
 - Operating Humidity: 20% to 93% relative humidity
 - Storage Humidity: up to 98% relative humidity
 - Vandal Resistance: IK10
 - Ingress Resistance: IP67, NEMA 4X

2. IP 66 Outdoor wall mount (Pre-backed Housing) camera

- A. General Characteristics:
 - The product specified shall be a prepackaged camera and lens built into a housing designed for indoor/outdoor operation.
 - The camera housing shall be constructed of an aluminum casing, neoprene gaskets, UV-resistant polymer end caps, and all stainless steel hardware. The viewing window shall be 3 mm thick glass.
 - The housing kit shall be equipped with a heater, blower, and sunshield to protect against environmental extremes.
 - A compatible feed-through wall mount shall be provided by the manufacturer to support a maximum load of 20 lbs (9 kg). The mount shall have a swivel head that rotates 360° and tilts 180°. To ensure neatness of installation, the mount shall be designed to allow feed through wiring.
 - The kit shall meet IP66 and NEMA-4X enclosure protection standards.
 - The prepackaged camera shall be a true day/night camera with a mechanical filter for truly outstanding nighttime performance. The filter can be switched remotely, or automatically via a light level sensor or contact input.

- The camera shall offer Content-based Imaging Technology (CBIT).
 - The camera shall utilize Intelligent Dynamic Noise Reduction (IDNR) technology to reduce the bit rate and storage requirements by removing noise artifacts.
 - The camera shall offer 1080 HD resolution.
 - The camera shall accept power via Power-over-Ethernet (IEEE 802.3af compliant).
 - The camera shall offer latest generation Intelligent Video Analysis (IVA).
 - The camera shall provide four independent, fully programmable privacy mask areas.
 - The camera shall provide an on-screen display to simplify the camera/lens back focus and network configuration settings.
 - The camera shall utilize pixel-by-pixel analysis to automatically compensate for bright areas of a high contrast scene (Back light) without having to define a window or area.
 - The camera shall provide intelligent Auto Exposure (IAE) to improve visibility of high contrast scenes (dark objects against a light background and the reverse).
 - The camera kit shall be easy to install.
 - The camera shall have six configurable user modes with the best settings for a variety of applications.
 - The camera shall allow users to set up to 10 separate recording profiles based on day/night or holiday schedules.
- B. Image processing and compression
- The camera shall offer a 1/3-inch CMOS image sensor.
 - The camera shall offer 3MP sensor pixels.
 - The camera shall offer the following minimum sensitivity:
 - a. Color: 0.25 lx
 - b. Mono: 0.08 lx
 - The camera shall use intelligent Dynamic Noise Reduction (IDNR) to actively analyze the contents of a scene and reduce noise artifacts accordingly.
 - The low-noise image and efficient H.264 compression technology shall provide clear images while reducing bandwidth and storage by up to 30% compared to other H.264 cameras.
 - The camera shall provide the most usable image possible by cleverly optimizing the detail-to-bandwidth ratio.
 - The camera shall use C-BIT to improve image quality in all lighting conditions.
- C. Network Video
- The camera shall provide direct network connection.
 - The camera shall allow full camera control and configuration capabilities over the network.
 - The camera shall be capable of capturing and storing images using the following compression standards:
 - a. H.264 MP (Main Profile)
 - b. M-JPEG
 - The camera shall deliver video, at rates up to 30 images per second, over a 10/100 Base-T, auto-sensing, half/full duplex, RJ45 Ethernet connection.
 - The camera shall comply with the IEEE 802.3af Power over Ethernet standard.

- The camera shall conform to the ONVIF standard (ONVIF is an open industry forum for the development of a global standard for the interface of IP-based physical security products).
- D. Video Motion Analysis
- The camera shall be capable of processing and analyzing video within the camera itself, with no extra hardware required.
 - The camera shall be capable of detecting and sending alarms for abnormal events.
 - The camera shall offer Intelligent Video Analysis (IVA) that uses an intelligent tracker to follow objects within the defined regions of interest.
- E. Surveillance Software
- The camera shall be accessible from a web browser, and using the Bosch Video software.
 - The camera shall be accessible from the mobile App. The App shall allow complete camera control and shall display images over low bandwidth connections.
- F. Access Security
- The camera shall offer three levels of password protection.
 - The camera shall support 802.1x authentications using a RADIUS (Remote Authentication Dial in User Service) server.
 - The camera shall store a SSL certificate for use with HTTPS.
 - [The camera shall be capable of being independently AES encrypted with 128-bit keys.]
- G. Image Posting
- The camera shall offer periodic JPEG image posting to an FTP server or a Dropbox account.
 - The camera shall offer best face detection and JPEG best face image posting to an FTP server or to a Dropbox account.
- H. Alarm Handling Features:
- The camera shall provide an alarm input that may be triggered by either a normally opened or normally closed contact.
 - The camera shall provide the capability on alarm to display up to a 31 character, programmable alarm message.
 - The camera shall provide a relay output that may be selected for normally opened or normally closed operation. The relay can be activated from an external alarm input to the camera, manual activation from the browser, upon video motion detection, an alarm task script or video loss.
 - The camera shall provide email alarm messaging with optional JPEG posting.
- I. Storage Management
- The camera shall support iSCSI devices to allow video stream to be recorded directly to an iSCSI RAID array.
 - The camera shall support iSCSI storage targets to enable the camera to function as a conventional DVR.
 - The camera shall have a micro-SD card slot that uses standard; off-the-shelf microSD (SDHC and SDXC) cards for local storage (up to 2 TB).
 - The local storage feature shall be capable of storage for Automatic Network Replenishment (ANR).

- J. Electrical
- The housing shall accept 230VAC, 50Hz.
 - The camera shall accept either 12 VDC, 24 VAC, or Power over Ethernet (IEEE 802.3af compliant).
- K. Lens
- The pre-packaged cameras shall be available with a choice of factory installed super resolution megapixel lens:3.8-13 mm varifocal lens
- L. Audio
- The camera shall offer one (1) line in jack connector and one (1) line out jack connector.
 - The camera shall offer two-way, full/half duplex audio communication.
 - The camera shall offer G.711, AAC and L16 audio compression (live and recording).
- M. Environmental
- The housing kit shall operate in -40°C to +50°C temperature range, and can be stored in -40°C to +70°C range.

3. Wall mounted indoor camera

- A. General Characteristics:
- The camera shall be a true day/night camera with a mechanical filter for truly outstanding nighttime performance. The filter can be switched remotely, or automatically via a light level sensor or contact input.
 - The camera shall offer Content-based Imaging Technology (C-BIT).
 - The camera shall utilize Intelligent Dynamic Noise Reduction (iDNR) technology to reduce the bit rate and storage requirements by removing noise artifacts.
 - The camera shall offer 1080 HD resolution.
 - The camera shall accept power via Power-over-Ethernet (IEEE 802.3af compliant).
 - The camera shall offer latest generation Intelligent Video Analysis (IVA).
 - The camera shall provide four independent, fully programmable privacy mask areas.
 - The camera shall provide an on-screen display to simplify the camera/lens back focus and network configuration settings.
 - The camera shall utilize pixel-by-pixel analysis to automatically compensate for bright areas of a high contrast scene (Back light) without having to define a window or area.
 - The camera shall provide intelligent Auto Exposure (iAE) to improve visibility of high contrast scenes (dark objects against a light background and the reverse).
 - The camera shall be easy to install.
 - The camera shall have six configurable user modes with the best settings for a variety of applications.
 - The camera shall allow users to set up to 10 separate recording profiles based on day/night or holiday schedules.
- B. Image processing and compression
- The camera shall offer a 1/3-inch CMOS image sensor.
 - The camera shall offer 3MP sensor pixels.

- The camera shall offer the following minimum sensitivity:
 - a. Color: 0.25 lx
 - b. Mono: 0.08 lx
 - The camera shall use intelligent Dynamic Noise Reduction (iDNR) to actively analyze the contents of a scene and reduce noise artifacts accordingly.
 - The low-noise image and efficient H.264 compression technology shall provide clear images while reducing bandwidth and storage by up to 30% compared to other H.264 cameras.
 - The camera shall provide the most usable image possible by cleverly optimizing the detail-to-bandwidth ratio.
 - The camera shall use C-BIT to improve image quality in all lighting conditions.
- C. Network Video
- The camera shall provide direct network connection.
 - The camera shall allow full camera control and configuration capabilities over the network.
 - The camera shall be capable of capturing and storing images using the following compression standards:
 - a. H.264 MP (Main Profile)
 - b. M-JPEG
 - The camera shall deliver video, at rates up to 30 images per second, over a 10/100 Base-T, auto-sensing, half/full duplex, RJ45 Ethernet connection.
 - The camera shall comply with the IEEE 802.3af Power over Ethernet standard.
 - The camera shall conform to the ONVIF standard.
- D. Video Motion Analysis
- The camera shall be capable of processing and analyzing video within the camera itself, with no extra hardware required.
 - The camera shall be capable of detecting and sending alarms for abnormal events.
 - The camera shall offer Intelligent Video Analysis (IVA) that uses an intelligent tracker to follow objects within the defined regions of interest.
- E. Surveillance Software
- The camera shall be accessible from a web browser, and using the Bosch Video software.
 - The camera shall be accessible from mobile App. The App shall allow complete camera control and shall display images over low bandwidth connections.
- F. Access Security
- The camera shall offer three levels of password protection.
 - The camera shall support 802.1x authentications using a RADIUS (Remote Authentication Dial In User Service) server.
 - The camera shall store a SSL certificate for use with HTTPS.
 - [The camera shall be capable of being independently AES encrypted with 128-bit keys.]
- G. Image Posting
1. The camera shall offer periodic JPEG image posting to an FTP server or a Dropbox account.

2. The camera shall offer best face detection and JPEG best face image posting to an FTP server or to a Dropbox account.
- H. Alarm Handling Features:
- The camera shall provide an alarm input that may be triggered by either a normally opened or normally closed contact.
 - The camera shall provide the capability on alarm to display up to a 31 character, programmable alarm message.
 - The camera shall provide a relay output that may be selected for normally opened or normally closed operation. The relay can be activated from an external alarm input to the camera, manual activation from the browser, upon video motion detection, an alarm task script or video loss.
 - The camera shall provide email alarm messaging with optional JPEG posting.
- I. Storage Management
- The camera shall support iSCSI devices to allow video stream to be recorded directly to an iSCSI RAID array.
 - The camera shall support iSCSI storage targets to enable the camera to function as a conventional DVR.
 - The camera shall have a micro-SD card slot that uses standard; off-the-shelf microSD (SDHC and SDXC) cards for local storage (up to 2 TB).
 - The local storage feature shall be capable of storage for Automatic Network Replenishment (ANR).
- J. Electrical
- The camera shall accept 12 VDC, 230 VAC, 50 Hz or Power-over-Ethernet.
- K. Audio
- The camera shall offer one (1) line in jack connector and one (1) line out jack connector.
 - The camera shall offer two-way, full/half duplex audio communication.
 - The camera shall offer G.711, AAC and L16 audio compression (live and recording).
- L. Environmental
- The camera shall operate in -20°C to +50°C temperature range.

4. Video Surveillance Control and Management System

1.05 REFERENCES

- International Organization for Standardization (ISO)9001 – Quality System

1.06 DEFINITIONS

- H.264: a video encoding and compression standard that uses block-oriented motion-compensation-based codec standard to significantly reduce the size of the video stream being transmitted. This often provides substantial compression because in many motion sequences, only a small percentage of the pixels are actually different from one frame to another.
- IPS: images per second; describes the frame rate of a video in a numerical value. The frame rate is the reciprocal value of an image interval. Example: A video streams every 0.2s a new image, $IPS = 1/0.2 = 5$

- LDAP: Lightweight Directory Access Protocol; an application protocol for querying and modifying data of directory services implemented in Internet Protocol (IP) networks.
- MPEG4: a patented collection of methods defining compression of audio and visual (AV) digital data.
- OPC: Object Linking and Embedding (OLE) for process control, a standard that specifies the communication between control devices of different manufacturers.

1.07 SYSTEM DESCRIPTION

- The video management system (VMS) specified is an IP video security solution that provides seamless management of digital video, audio and data across an IP network. The video management system to work with 3rd party cameras. The VMS shall consists of the following software modules:
 - The job server (central event and trigger handling), recording services, configuration and the application for the operator. Video from other sites may be viewed from single or numerous stations simultaneously at any time. Cameras, recording stations, and receiver stations for viewing only may be placed anywhere in the IP network.
- The software components of the VMS shall capable of running together on a single PC with one of the following operating systems:
 - Windows 2003 Server
 - Windows 2008 Server
 - Windows XP
 - Windows 7

1.08 Recording Station, Video Management and Recording Software

1.08.1 **Architecture:**

- A single PC loaded with the VMS shall be called a station. There are “recording stations” and “receiver stations”.
- A “remote station” is a recording station that a receiver or another recording station can connect to.
- The operator can manually connect or disconnect a remote station that is configured on his local station.
- A recording station shall:
 - Record video.
 - Show and control live video from the local and from remote stations.
 - Playback recorded video from the local and from remote stations.
 - Trigger jobs like alarm recording or sending notifications.
 - Forward alarm video to remote stations.
- A receiver station, which does not record and manage video locally, shall:
 - Show and control live video from remote recording stations.
 - Playback and export recorded video from remote recording stations.
 - On one station it must be possible to configure up to 200 different remote stations.
 - On one station it must be possible to connect up 32 remote stations simultaneously.

1.08.2 General Requirements:

- The VMS shall allow live, recording and playback for up to 64 camera channels per station.
- The VMS shall allow live, recording and playback functionality of the following IP devices:
 - MPEG-4 devices
 - H.264 devices (incl. HD devices)
 - JPEG IP devices that support the HTTP/TFTP protocol and provide a fixed HTTP/TFTP-Link to the generated image
- The VMS shall auto-detect devices of category of above IP devices with a device scan that scans the subnet of the station.
- The VMS shall allow live, recording and playback functionality of image IP devices with video image resolutions up to 2048x1536 pixels (3 Megapixel)
- The VMS can integrate analog cameras via encoding IP devices
- The VMS shall support login of users in LDAP (Lightweight Directory Access Protocol) groups.

1.08.3 Live Surveillance Requirements:

- The VMS shall offer different display modes to optimize display under the following conditions:
 - Standard Definition (SD) Video (e.g. CIF) on SD Monitor (e.g. 1024 x 768 pixel resolution)
 - SD Video on widescreen Monitors (e.g. WUXGA: 1920 x 1200 pixels)
 - High Definition (HD) Video on widescreen monitors
- The VMS shall offer widescreen image windows that display HD video without black bars.
- The VMS shall be capable of showing live video from different IP devices connected to different stations on one monitor.
- The VMS shall be capable of showing all live image windows in full screen mode, without the additional user interface controls like event list or tree control.
- For all applicable resolutions the VMS must not distort the video image when displaying it in an image window or in full screen mode.
- The VMS shall have an instant playback function that allows instant recall of recorded images from 2 to 300 seconds in the past to be replayed at the same rate the images were recorded. Live images continue to be simultaneously displayed along with the recorded images.
- The VMS shall sequence through all displayed cameras in full screen mode with a configurable dwell time.

1.08.4 Playback Requirements:

- The VMS shall allow playback of the stored video in the forward or reverse direction, frame by frame, and from beginning or end of the clip using standard VCR-like buttons.

- The VMS shall provide a graphical representation of the recorded video using a timeline with different tracks for each recorded devices.
- The VMS shall playback up to 16 recorded tracks simultaneously and synchronously.
- The VMS shall allow zooming of reviewed video clips or still images.
- The VMS shall allow the images to be sent to a printer connected to the parallel port of the local station or to a network printer.
- The VMS shall allow an image displayed in the image window to be saved as a single JPEG, BMP, or HTML file.

1.08.5 Exporting Video Images:

- The VMS shall be capable of exporting video clips to the CD/DVD drive or network drive.
 - Images shall be exported along with a stand-alone player. Playback of the exported images with the player will be possible from any Windows based PC. This proprietary format provides video authentication to assure that images are not altered in any way.
 - Images shall also be exported in a format that can be played back with a default software program such as Windows Media Player.
- The VMS shall provide an export video scheduler function that allows previous days recorded video to be exported for back up to a designated target drive. Images from the current day can also be exported up to the time that the export program job is activated.

1.08.6 Remote Access via Web Browser

- The VMS shall provide embedded Internet Web browser access that allows up to five (5) remote PCs using Windows Explorer 6.0 or higher to communicate with the VMS via a network.
- The browser shall use a secure connection using log-on and authorization levels during transmission.
- The remote site using the browser shall,
 - Display live video images in single or multi-screen format.
 - Display video as a single screen sequences.
 - Display status of the inputs will be displayed
 - Control remote relays.
 - Control compatible PTZ cameras.

1.08.7 Remote Access from another station (receiver or recording station)

- The remote receiver station shall have the ability to display live and recorded video from any configured remote station.
- The remote receiver station shall have the ability to display the database information from a remote station.
- The remote receiver station shall be able to receive and record alarm video from the VMS to its local drive

- The access by another remote station in the network can be blocked by a connection password
- The connection and the communication between different stations shall work in WAN (wide area network) low bandwidth environments (e.g. stable 1 Mbit/s DSL connection)
- The VMS shall provide bandwidth throttling which limits the traffic to and from another station. Reception rate and transmission rate can be set individually to values reaching from 32 Kbit/s to 1 Gbit/s. (Only on Windows XP platforms)

1.08.8 Alarm and Trigger Input Capability

- The VMS shall be capable of automatically displaying incoming camera alarms, with the option of displaying alarms when in playback mode.
- The VMS shall allow the option to manually acknowledge an alarm to silence, or to delete an alarm. All alarm acknowledgements and deletions shall be saved to a log file.
- The VMS shall be capable of hiding a camera during normal operation, only to display the camera during an alarm when the camera is part of the alarm.
- The VMS shall have the capability to send an e-mail notification on the following events: an alarm, motion detection, video loss, or a reference image check failure.
- The VMS shall be capable of handling all N/O or N/C alarm inputs and relay outputs available in the network where 1 of those relays will be designated as a malfunction relay. The physical inputs and relays shall be part of the available IP devices.
- The VMS shall be capable of recording pre-alarm video on an alarm or motion detection for a time period from 0 to 120 seconds. Post alarm recording time shall be selectable from 0 to 999 seconds. The VMS shall be capable of having pre- and post-alarm video recorded from all IP cameras.
- The VMS shall be capable of transmitting live video images via a network upon an alarm or triggered event to a remote station that is running the specified manufacturer's VMS remote software program (receiver station).
 - The VMS shall maintain a list of remote sites in order of priority so that an attempt is made to establish communication with the first site on the list.
 - If the attempt fails, the VMS shall move to the next remote site on the list to establish connection.
 - Once communication is established, the VMS shall initially alert the operator at the remote station via a flashing icon and audible tone (or selected wav file) that an alarm has occurred.
 - The operator shall then have the option to acknowledge the alarm and display the live video at the workstation. The VMS shall also have the capability to be programmed to establish communication with multiple remote sites upon an alarm.
- The VMS shall provide motion detection sensing of the connected IP cameras and encoders that have been programmed to detect video motion.

- The VMS shall be capable of automatically commanding Auto Dome pan/tilt/zoom cameras to move to pre programmed preset positions.
- The VMS shall provide 32 virtual alarm inputs that can be controlled via the browser interface to execute pre programmed jobs within the VMS such as controlling relay outputs, camera sequences, alarm recording, etc.

1.08.9 VMS Setup and Configuration

- The VMS shall provide the following two methods of system setup and configuration:
 - A Quick Configuration Wizard for users who want to create a basic system configuration in a minimum amount of time. The quick configuration shall allow the setup of the following system parameters:
 - Selection Receiver or Recorder software and activation of the software
 - Authorization levels and users
 - Setup of connections between local station and remote stations
 - Detect IP devices (H.264 and MPEG-4 cameras) automatically in the subnet of the Recording Station
 - Select the devices that shall be added to the configuration
 - A graphical schedule planner to allow different recording qualities (resolution, frame rate, compression) to be assigned to different schedules up to a granularity of 15 minutes.
 - Assign basic recording settings for all IP devices to all schedules.
- The VMS shall provide a default (customized) configuration to allow for programming of more complex applications of the specified VMS. A configuration menu shall be displayed in a Windows tree format to allow the user to create the system configuration setup by going from top to bottom of the menu and making the corresponding entries in the dialog boxes. The Default Configuration shall provide, but not be limited to, the following configuration selections:
 - Connection and disconnection of local and network hard drives. Displays total storage capacity, used storage capacity, and available storage.
 - Provide an overview of the IP devices managed by the local station including cameras and encoders. Allows addition, deletion, editing of IP devices, including H.264, MPEG-4 and JPEG IP cameras. Editing includes setup of pre-position scenes, motion detection, alarm inputs, relays and audio inputs.
 - Recording setup – On a camera by camera basis, allows setup of IPS rate and type of recording such as continuous, motion, or alarm. Schedules can be assigned to these setups.
 - A graphical schedule planner provides eight schedules

- that can be assigned to any day of the week, holiday, or special day.
- One controllable IP relay can be configured to act as the malfunction relay. All internal error events will trigger this relay
- Four alarm inputs can be used for alarm simulation purposes.
- Jobs may be created that are started by alarm input triggers, cameras using motion detection or reference image check, or a virtual input. Jobs can be assigned a schedule. Jobs created can 1) control up to 4 dome cameras 2) control relay outputs 3) start alarm recording.
- Setup of connections between local station and remote stations.
- The VMS specified will transmit images and/or messages to other locations upon an alarm or trigger event.
- Video authentication.
- The VMS shall support an optional feature that allows the VMS to: Connect to an IP server that sends data (for example a POS server) and to record this data as metadata along with the camera image.

1.08.10 Camera Control (PTZ)

- The VMS shall provide camera control from local or remote recorders or via PC workstations running remote receiver software and /or using the Internet Explorer 6.0 or higher, Web Browser.
- The VMS shall provide an RS 232 port that supports wide surveillance systems manufacturer.
- The VMS shall provide manual or automatic call-up to preset positions stored within Dome cameras.

1.08.11 System Administration

- After initial installation of the VMS, three (3) standard user authorization levels shall be automatically created.
 - The first standard authorization level (Administrator) allows the user all the rights of the system including configuration and operation.
 - The second standard authorization level (Extended User) allows the user all operational rights - but no configuration capabilities except assigning new users to lower authorization levels.
 - The third standard authorization level (Normal User) has operational rights only, but cannot configure the VMS.
- The VMS allows creating more (custom) authorization levels with detailed permissions to each configuration page and each camera during operation.
- To each authorization levels new users can be assigned.
- The VMS shall provide a dual authorization feature where one user may only login to the system in conjunction with a second user.

- The VMS shall log events of who starts up or shuts down the system, who logs in or off, status changes, and images transmitted.

1.08.12 External Archive

- The VMS shall be able to use an optional SCSI adapter port to connect a recommended external hard disk array with up to 16TB capacity.
- For exports the VMS shall allow to select a NAS (network attached storage) as a target drive.

1.08.13 Integration with 3rd party systems

- The VMS shall provide an OPC server to integrate it into 3rd party management systems that use the OPC standard.
- The VMS shall provide an SDK that allows 3rd party applications to access basic functions, e.g. get live and playback images of all connected cameras.

PART 3 EXECUTIONS

3.01 INSPECTION

- A. The Contractor shall examine the areas and conditions under which the CCTV 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 Engineer.

3.02 INSTALLATION

- A. Power supply shall be durably marked to indicate the class of supply.
- B. All non-current carrying metal parts of equipment shall be earthed.
- C. All fixed cabling shall be carried out as a fixed wiring system.
- D. Joints shall not be permitted.

END OF SECTION

SECTION 16760

AUDIO-VISUAL, SCHOOL BELL /PROGRAM CHANGE & PUBLIC ADDRESS SYSTEMS

PART I – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and specification sections. Apply to this section

1.2 SUMMARY

- A. This section includes Video Systems, Audio System, presentation facilities , Public Address and School Radio Broadcast Systems

1.3 REFERNCES

Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the work of this Section:

- NEC Article 640: Audio Signal processing, Amplification, and Reproduction Equipment.
- AS1127: sound system Equipments
- IEC118-4: Electro acoustics-hearing Aids-Part 4 introduction loop systems for hearing aid purposes-Magnetic Field strength.
- NFPA 70 and/or IET 17th. Edition (BS7671:2008)

1.4 DEFINITIONS

Not applied.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the conditions of the contract and specification sections.
- B. Product data for each type of product specified
- C. Shop drawings detailing Video System, Audio System, presentation facilities, Public address & School Broadcast system, including, but are not limited to the following:
1. Rack arrangements
 2. Panel board for A/V equipment
 3. Details of Radio room
 4. Schematic diagrams of all system with type and number of cable and connectors.
 5. Plans with conducting layout for all systems with location of all equipment and item A/V and PA systems
- D. Wiring diagrams detailing wiring for power, AV & PA systems and differentiating clearly between manufacturers installed and field installed wiring.

Identify terminals to facilitate installation, operation, and maintenance.

- E. Report of field tests and observations, including record of final tap settings of speaker line matching transformers and signal ground-resistance measurement certified by installer.
- F. Maintenance data for system to include in the operation and maintenance manual.

1.6 TESTING AND COMMISSIONING

The Contractor shall provide test and commissioning procedures to the Engineer. The contractor shall be responsible for testing all equipment including load tests where appropriate.

1.7 TRAINING

The Contractor shall provide at site a program of operational training and basic maintenance training for at least 2 working days (for at least 2 persons) to satisfy the needs of the owner / operator and their technicians.

1.8 WARRANTY

The contractor shall provide a warranty cover for a period of 24 months from handover of the equipment .During this period; the contractor shall be wholly responsible for all costs including labor and parts necessary to ensure that all systems covered by this specification are in full working order.

PART II - PRODUCTS

2.1 MANUFACTURES

- A. Manufacturers: Subject to compliance with requirements, the manufacturers shall be approved by the Engineer after submitting technical qualification for each item submitted.

2.2 SYSTEM REQUIREMENTS

- A. Coordinate the features of materials and equipments to form an integrated system Match components and interconnections for optimum performance of specified functions.

2.3 EQUIPMENTS

- A. General: Use all solid state components, fully rated for continuous duty at all rating indicated. Select equipment for normal operation on input power at 230V, 50 Hz (unless otherwise mentioned).

2.4 EQUIPMENT SPECIFICATIONS

1. **4000 ANSI Lumen LCD Projector**
 - 3-color LCD shutter projection system, 3000 ANSI Lumen brightness with suitable lens
 - Dichroic mirror separation / prism synthesis optic system
 - 0.59-inch TFT p-Si x 3 LCD panel size

- Polysilicon active matrix TFT LCD panel drive system
- 2,880,000 pixels: 960,000 (1200 x 800) x 3 LCD panel pixels
- 300 W lamp
- 30" – 300" screen size
- Full color (1,070 million colors)
- Contrast ratio 20000:1
- H-sync: 15-120 kHz, V-sync: 48-120 Hz, Dot clock: 230 MHz scanning frequency
- HDMI (HDCP compliant) / RGB (D-Sub15pin), RGBHV/Y/VIDEO, Pb/Cb, Pr/Cr (BNCx5), S-Video (mini DIN4) input signals
- RS232C In / Out (D-Sub9x2), Wired / Wireless I / R Remote Control (mini Jack) control terminal
- UXGA / SXGA+ / SXGA / WXGA / XGA / SVGA / VGA / MAC computer compatibility
- PAL / SECAM / NTSC / NTSC4.43 / PAL-M / N color system
- Networkable (RJ45 Connector)
- 230VAC, 50 Hz power supply

2. **Projector Mounting Poles**

- Extends distance between ceiling mount and projector mount
- Cable cutout provides convenient cable access –
- 1.5" NPT pipe in fixed lengths of 2" (5 cm), 4" (10 cm), 6" (15 cm), 10" (25 cm), 12" (30 cm), 18" (45 cm) and 24" (60 cm), threaded at each end

3. **Universal Projector Mounting Bracket**

- Universal projector mount compatible with every projector up to 25 pounds (11 kg). features independent adjustment of roll, plus or minus 4 degrees of horizontal tilt, pitch, plus or minus 25 degrees of vertical angle, and yaw, 360 degrees of rotation on a pole mount or 10 degrees when mounted flush to the ceiling, for precise control of each axis and exact alignment of the projector. Locking mechanisms
- Universal projector mount compatible with every projector up to 25 pounds (11.34 kg)
- Independent adjustments of horizontal tilt or roll, vertical angle or pitch, and rotation or yaw — The universal mount feature independent adjustment of roll, plus or minus 4 degrees of horizontal tilt, pitch, plus or minus 25 degrees of vertical angle, and yaw, 360 degrees of rotation on a pole mount or 10 degrees when mounted flush to the ceiling, for precise control of each axis and exact alignment of the projector.
- Precise positioning adjustments are maintained even if projector is removed for service — Locking mechanisms maintain the original positioning settings when servicing requires that the projector with attached bracket arm assembly be disengaged from the mounting assembly.
- Built-in security tabs to prevent theft

4. **Motorized Screen**

- Heavy Duty Motorized Projection screen
- Suitable extra black drop
- Equipped with internal thermal overload protector and electric brake
- Controllable by IR and/or RF up & down switch
- Lifetime lubricated
- White matte 1.0 gain surface
- Extruded aluminum housing including white powder coated finish

- Standard 12" black leader
- Ceiling/wall mounted
- Service door and trap doors
- Quiet motor-in-roller design
- Size as per BOQ

5. **DVD Player**

- Professional DVD Player
- Outputs :Optical Digital Audio , S- Video and Component
- Playable Discs: DVD Video, DVD-R, DVD+R, DVD-RW, DVD+RW, Video CD, CD-R,CD-RW, CCCD, Super Video CD, CD-DA
- Control RS232
- 19" Rack mountable

6. **6 Watt Wall Mounted Speaker**

Full range wall mounted made of plastic material with front metal grille:

- Sensitivity 1W/1m : 90 dB
- Max.SPL/1m : 97 dB
- Frequency response : 100-15000Hz
- Rated Power : 6 W
- Adjustable Power : 6/3/1.5W
- Dispersion angle @2KHz : 120 deg.

7. **20 Watt Wall Mounted Outdoor Horn Speaker**

Full range wall mounted weatherproof IP66 Horn speaker, die-cast aluminum body with stainless steel screw and bracket.

- Sensitivity 1W/1m : 110 dB
- Max.SPL/1m : 123 dB
- Frequency response : 160-10000Hz
- Rated Power : 20 W
- Adjustable Power : 20/10/5/2.5W
- Dispersion angle @2KHz : 80 deg.
- Protectio degree (IP) : 66

8. **Full range wall mounted professional speaker**

- Frequency response(-3dB) : 60-20000Hz
- Frequency response(-10dB) : 48-20000Hz
- Sensitivity 1W/1m : 94dB
- Max.SPL/1m : 117 dB
- Coverage (nominal -6dB) H°xV° : 100°
- Rotatable horn
- System power handling : 200W
- LF Transducer : 8"
- HF Transducer : 1"
- Internal crossover
- 4-pin detachable input connectors
- Fullrange, Mid-High & Two-way speaker type

9. **2X180W Power Amplifier**

- 19" rack mountable
- Class AB output stage topology

- Transformerless, switchable output characteristic for each individual channel.
- 2x200W 8Ω Maximum mid band output power
- 55.3V maximum RMS Voltage swing
- THD @ rated output power MBW=80KHz, 1 KHz <0.03%
- +21dBu maximum input level
- Crosstalk <80dB
- 10Hz-40KHz frequency response
- 20KΩ input impedance , active balanced
- Damping factor >300
- 25 V/μs slew rate
- <-71dBu output noise(A-weighted)
- 230VAC ,50Hz power supply
- Audio limiter, Temperature , DC,HF short circuit ,peak current limiters, inrush current limiters & turn delay protection
- Front to rear continuously variable fans cooling
- I safety class

10. 240/360Watt Booster Power Amplifier

- Protection circuit for speakers against overload and short circuit
- LED power indicator
- LED level indicator
- Main volume control
- Spate volume control for inputs from 1 to 5
- Low and high tone control
- Ground connection screw
- Four mic/line microphone with XLR and Jack 6.3mm (phantom 24V)
- Three AUX inputs (switchable)
- Main IN/OUT function
- Four outputs amongst which one at 4 ohm constant impedance and the other three at a constant voltage (25, 50,100V)
- Tape out output on RCA
- Universal power input 110/230VAC
- 24VDC emergency input
- Rack mountable

11. 40Watt Compact Mixer Amplifier with MP3/CD and Digital Tuner

- 40W rms amplifier
- Compact MP3/CD and digital tuner AM/FM
- 2XLR Microphone
- 1 line Aux input
- Tone and volume control
- CD player with program and repeat functions
- 100/70/50V out voltage & 4/8/16 Ohm
- 60-17000Hz frequency response
- Universal power input 110/230VAC
- 24VDC emergency input
- Rack mountable

12. Desktop Microphone

- High sensitivity back electret condenser phantom powered gooseneck flexible microphone

- Unidirectional element
- Ring light to indicate operation condition
- 100-16000Hz frequency response
- -37dB±3dB sensitivity
- 400mm gooseneck length
- Metal base with XLR connector

13. Cardioids microphone type

- Element : Dynamic
- Polar Pattern : Cardioid
- Impedance, Low-Z balanced :300 Ohms
- Connector Type :3-pin XLR
- Open Circuit Voltage :2.9 mV/Pascal
- Audio Frequency Response :45 - 15,000 Hz Near Field 100 - 15,000 Hz Far Field
- Mic Type : Instrumental
- Finish : Non-reflecting Black
- Case Material : Metal

Complete with floor stand with telescopic rod and folding tripod with adjustable height and microphone boom height 90-150cm.

14. Wireless microphone type

I) Professional UHF handheld Microphone

Controls	Power On/Off, Gain, Tx Power, Menu, Set, Up, Down
Displays	Group/Channel, Frequency or Battery Level
Antennas	Internal 1/2 wave
Battery Life	Minimum 8 hours with 9V Alkaline typical
Mic Type	Handheld
Power Requirement	9V Battery
RF Output	5 or 50 mW selectable
Finish	Non-reflecting Black
Case Material	Overmolded High-Impact ABS

II) UHF Single Wireless Receiver unit

Controls	Front: On/Off, Menu, Set, Up, Down Rear: Output Level, Mic/Line
Displays	Group/Channel, Frequency, Label, Diversity, AF meter, RF meter
Connector Type	1/4" unbalanced
Connector Type	3-pin XLR
Antennas	External 1/4 wave detachable
Audio Frequency Response	30 - 15kHz +/- 2dB

Balanced Line Level Output (RMS Adjustable)	10 - 100 mV
Diversity	DSP Secure Phase True Diversity
FCC Type Acceptance	Approved under Part 15
Number of channels	950 possible (programmable in 25kHz steps) per band
Power Requirement	External 12 VAC 750mA in-line supply
Squelch	Tone Code plus Amplitude
Case Material	Steel

15. **4 Channel professional Mixer DJ**

- DJ mixer with phono/USB/line inputs
- Four full-featured channels plus a fifth mic/line input channel for convenience
- 8-in/8-out USB audio interface makes it easy to DJ with digital tracks and record your set
- Ultra-smooth faders.
- Outstanding LP, BP and HP filters with resonance that ranges from mild to wild
- External effects loop with per-channel dry/wet blend controls
- Channels: 4 + mic
- Analog Inputs: 1 x XLR, 1 x stereo RCA (Aux), 4 x stereo RCA (Line), 4 x stereo RCA (Phono), 1 x stereo RCA (Return)
- Analog Outputs: 2 x XLR, 1 x stereo RCA (Booth), 1 x stereo RCA (Record), 1 x stereo RCA (Send)
- Headphones: 1 x 1/4" (Headphones), 1 x 1/8" (Headphones)
- MIDI I/O: USB
- USB: 1 x Type B
- Faders: 4 x 45mm
- Crossfader: 45mm VCA Replaceable
- EQs: 3-band with kills

16. **54-Channel DMX Controller**

- For a maximum of 9 spotlights or spotlight groups
- Suitable for all RGB, RGBW, RGBWA, and RGBWA + UV spotlights
- 6 Smooth-running faders for mixing red, green, blue, white, amber and UV
- 9 Color presets with quick-access buttons
- Quick selection of automatic or manual mode
- Blackout
- Color jump
- Color fade
- Strobe and sound control with adjustable microphone sensitivity
- DMX output: XLR 3-pin female

17. **Parcan 64 LED Lighting 12x12 RGBWA+UV**

professional PAR64 spotlight with 25° beam angle in a stable white cast metal

housing and 12 bright 12 Watt 6-in-1 LEDs.

The RGBWA+UV system enables a lively lighting design with discreet pastel shades such as brilliant, rich colors.

- LED Type: 12 x 12 W 6-in-1 RGBWA+UV
- Beam angle: 25°
- Repetition rate: 3000 Hz
- DMX Mode: 2, 3-1, 3-2, 6, 9-Channel
- 3-Pin XLR DMX Input/output
- DMX Function: color fade, master dimmer, RGBWA+UV, sound control color jump& strobe
- Double bracket with non-slip locking screws offers numerous mounting options
- Controls: enter, mode, value up & value down.
- Operating voltage: 230 V AC / 50 Hz
- Power supply connection: Neutrik Power Twist input and output
- Housing cooling: Fan
- Includes mains cable with safety plug (type E/CEE 7/7)

18. **Triangular Aluminum Truss**

- Triangular Aluminum Truss.
- 3.0m Straight Segment.
- 290mm Overall Truss Width.
- Main Tubing: 50mm Outer Diameter Tubing, 2mm Wall Thickness.
- Brace Tubing: 20mm Diagonal Bracing, 2mm Wall Thickness.
- Material: Aluminum Alloy EN AW-6082 T6.
- Connecting Hardware Included.
- Aluminum Brush Finish.
- TUV Certified.

19. **19" Metal Rack**

- Width: 19 inch
 - Height: As per BOQ
 - Construction: Steel
 - Glazed or Plexiglas's Door with key lock
 - Includes: Power distribution for equipment with On//Off switch, lamp, Thermostat, Clock and ventilation panels
1. Complete with socket strips (number of socket as per rack equipment numbers) the socket strips shall be as follows
 - With lit switch,2 pole switching
 - Socket rotation : 45°
 - Cable feed : 1.5mm²
 - Moulded right angle plug
 - Casing: closed sheet-steel extrusion, zinc plated, powder coated texture.
 - Plastic parts: polyamide PA6 (UL94VO), recyclable.
 - Internal Conductor: full-length busbar , brass
 - Cable feed :PVC
 - Approval: CE label in accordance with low potential guideline 73/23/EWG,EMC guideline 89/336/EWG
 - Loading rate 250 VAC,16A
 - 2 mounting brackets

20. School bells/ Program change

- 8" electrical 230VAC, 50Hz bell.
- Silver color to discriminate from fire alarm bell in color and sound.
- Sound level 95dB.
- For outdoor shall be IP 66.

For Deaf Schools the program change shall be flasher with following features:

Program Change flasher shall be multi tone type and Operated by 24 VDC, each device assembly shall include separate wire leads for in/out to the associated signal circuit.

Technical specification

- Flashing high intensity LED beacon
- Wall mount
- Operation voltage: 24Vdc non-polarized
- Operating temperature: -10 °C to +50°C
- Flashing frequency: 20x180 per min.
- Material: ABS
- Wiring: 1 pair 24Vdc supply
- For outdoor shall be IP 66

21. School Program Change Controller

- Shall automatically switch on and switch off the school bell/strobe.
- Circuit output power of controller shall be enough to feed all installed bells/strobe.
- Programmable number shall be 8 groups for 2 independent circuits.
- Timing error less than or equal 2 second
- Desktop/wall mounts type.

22. AV Cables**a) Microphone cable**

- 2X0.5mm 42X40 bare copper (0.024") conductor
- Foam density polyethylene (0.58") insulation material
- Tinned copper French braid type covered 95% outer shield material
- 0.5mm stranded bare copper outer shield drain wire
- Polyvinyl chloride (PVC) outer jacket material
- -20°C to +60°C operating temperature range
- EU&CE approval
- UL 1666 flame test certificate

b) Speaker cable (1.5mm)

- 2X1.5mm, 104X34 stranded bare copper conductor
- Polyvinyl chloride-PVC (0.04" wall thickness) insulation material
- Polyvinyl chloride-PVC outer jacket material
- Polypropylene overall cabling fillers
- Paper tape overall cabling separator material
- 0.002" overall cabling separator thickness
- CE/UL approval
- 0.0610μH/m conductor inductance
- 4.8 DCR@20° C (Ω/1000 ft) conductor resistance

- 300Vrms operating voltage
- c) Speaker cable (2.5mm)**
- 2X2.5mm, 259X34 stranded bare copper conductor
 - Polyolefin-PO (0.17") insulation material
 - Polyvinyl chloride-PVC outer jacket material
 - CE/UL approval
 - 0.0457 μ H/m conductor inductance
 - 1.0 DCR@20° C (Ω /1000 ft) conductor resistance
 - 300Vrms operating voltage
- d) S-Video cable**
- 2X1.0mm solid bare copper with anti-corrosion treatment – BCAC (0.403") conductor
 - Gas-injected Foam polyethylene (0.180") insulation material
 - Bonded aluminum foil-polyester tape-aluminum foil covered 100% first layer and braid aluminum second layer of outer shield material
 - PVC outer jacket material
 - CE/UL approval
 - 75 Ω conductor impedance
 - 0.0296 μ H/m conductor inductance
 - 53pF/m conductor capacitance
 - 28.0 DCR@20° C (Ω /1000 ft) conductor resistance
 - 300Vrms operating voltage
- e) DMX Cable**
- DMX lighting control cable based on RS485 data cable.
 - 120Ohm impedance
 - 24AWG (7x32) strand
 - Shielded cable
 - 42Pf/m capacitance
 - PE insulation
 - PVC Jacket

PART 3 EXECUTION

3.01 INSPECTION

- A. The Contractor shall examine the areas and conditions under which the AV and PA systems are 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 Engineer.

3.02 INSTALLATION

- A. Power supply to be provided adjacent to the equipment rack and AV devices.
- B. All equipment metal enclosures to be earthed.
- C. Room where amplifier is installed shall be adequately ventilated.
- D. AV 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.
- E. Power supply is durably marked to indicate the class of supply.
- F. All non-current carrying metal parts of equipment shall be earthed.
- G. All fixed cabling shall be carried out as a fixed wiring system.

- H. Joints shall not be permitted.
- I. Boxes shall be fitted in dry locations where possible. Boxes fitted in damp locations shall be waterproof pattern.
- J. Wires forming a pair shall not be split. Distribution boxes shall provide separate terminals for all incoming and outgoing wires with cross connection facilities.
- K. One terminal shall contain one wire only. Spare wires shall be left long enough to reach any terminal.
- L. A schedule shall be fixed to the inside face of the box cover showing all connections and giving details of the wiring.
- M. Adequate protection shall be provided for all accidental damage or unauthorized interference.

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 manufacturers recommendations.
- 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.

3.04 FIELD TESTS

- A. The Contractor shall carry out field tests within the building after the fabric and finishes are complete to determine the acoustic characteristics of the various areas.
- B. The Contractor shall carry out acoustic characteristics field tests in internal and external circulation areas after completion of all elements relevant to the acoustic performance.
- C. Upon completion of the installation and all relevant acoustic finishes, all areas shall be tested for acoustic performance to the satisfaction of the Engineer.

END OF SECTION

SECTION 16770

INTRUSION ALARM SYSTEM

PART I – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and specification sections. Apply to this section

1.2 SUMMARY

- B. This section includes Intrusion Alarm System

1.3 REFERENCES

Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the work of this Section:

- IEC118-4 : Electro acoustics-hearing Aids-Part 4 introduction loop systems for hearing aid purposes-Magnetic Field strength.
- NFPA 70 and/or IET 17th. Edition (BS7671:2008)

1.4 DEFINITIONS

Not applied.

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the conditions of the contract and specification sections.
- B. Product data for each type of product specified
- C. Shop drawings detailing intrusion alarm System, including, but are not limited to the following:
6. Metal magnetic contact at exit door installation
 7. Intrusion alarm Panel
 8. Indoor siren and outdoor siren with flasher
- D. Wiring diagrams detailing wiring for power, intrusion system and differentiating clearly between manufacturers installed and field installed wiring. Identify terminals to facilitate installation, operation, and maintenance.
- E. Maintenance data for system to include in the operation and maintenance manual.

1.6 TESTING AND COMMISSIONING

The Contractor shall provide test and commissioning procedures to the Engineer. The contractor shall be responsible for testing all equipment including load tests where appropriate.

1.7 TRAINING

The Contractor shall provide at site a program of operational training and basic maintenance training for at least 2 working days (for at least 2 persons) to satisfy the needs of the owner / operator and their technicians.

1.8 WARRANTY

The contractor shall provide a warranty cover for a period of 24 months from handover of the equipment .During this period; the contractor shall be wholly responsible for all costs including labor and parts necessary to ensure that all systems covered by this specification are in full working order.

PART II - PRODUCTS

2.1. SYSTEM REQUIREMENTS

- B. Coordinate the features of materials and equipment to form an integrated system Match components and interconnections for optimum performance of specified functions.

2.2. EQUIPMENTS

2.2.1. 8 ZONES INTRUDER ALARM SYSTE

- A. System shall incorporate a fully functional intruder alarm system. Any Inputs globally within the system can utilize as intrusion alarm inputs and be connecting to Intruder detection sensors. Likewise any outputs anywhere within the system can be used for intruder alarm purposes such as sounding remote sirens etc. Arming and disarming the intrusion detection system is to be by integrated keypad. A fundamental requirement is that it when exit door opened by un authorized person (school principle or other authorized personal) this system active and showing which door opened.
- B. Input circuit shall be monitored by end of line resistors to provide detection of the following 4 states.
- Alarm
 - Tamper
 - Open circuit
 - Short Circuit
- C. Multiple inputs from detection devices covering the same region for control purposes are to be grouped into alarm zones. Alarm zones can be in any one of four states and shall handle alarms differently depending of the state. The first two shall be defined as set (armed) and unset (disarmed). The names of the other states shall be able to be defined at the central control for other purposes such as maintenance testing.
- D. Alarm priorities can be assigned to any of the four input states.
- E. The system shall provide entry and exit delays for the setting and unsetting of alarms.

- F. The entry delay shall be configurable from 0 to 5 minutes in steps of one second.
- G. An audible warning must sound during the entry delay (from the time that the alarm occurs to the time that the Zone state is changed). Selected output relays should also be able to be operated during the entry delay period allowing suitable sounders to be connected at required locations.
- H. An exit delay is to be provided to groups of inputs so that a change of state of an exit delayed zone is delayed by the exit delay period, which can be adjusted, from 5 seconds to 5 minutes in steps of one second.
- I. It shall be possible to have automatic time based setting and unsetting of alarms.
- J. Multiple alarm zones can be set and unset from keypad.
- K. All alarm events arriving at the control panel shall be "time stamped" with the time they occur and the time they were logged at the control panel.
- L. Operators shall have a 2-stage alarm processing mechanism available to them, being:
 - 1. Acknowledge Alarm.
 - 2. Process Alarm.
- M. The system shall provide relay output facilities that are system activated in response to alarm activations.

2.2.2. Outdoor siren with flasher/ indoor siren

the outdoor/indoor siren shall be made of strong plastic material, IP66, rated voltage 12VDC supply from intrusion panel, SPL 112dB. the location of the siren shall be opposite to guard house.

Highly resistant ABS (white) housing and UV prevention
Piezo siren with strobe
SPL: 112±3dB (at 12V DC/1m)
Flasher time: 70 to 90 times/minute
Lens colors: red, blue, and orange
Certification: CE approved

2.2.3. Metal Magnetic door contact

Heavy Duty door Contact
Sturdy Polished Aluminium Die-cast Housing
Wide Operating Gap 2" min. (50mm)
1m Long Stainless Steel Armoured Cable

PART 3 EXECUTION

3.01 INSPECTION

- A. The Contractor shall examine the areas and conditions under which the burglar / intrusion system are 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 Engineer.

3.02 INSTALLATION

- A. Power supply to be provided adjacent to the equipment control panel.
- B. All equipment metal enclosures to be earthed.
- C. Power supply is durably marked to indicate the class of supply.
- F. All non-current carrying metal parts of equipment shall be earthed.
- G. All fixed cabling shall be carried out as a fixed wiring system.
- H. Joints shall not be permitted.
- I. Boxes shall be fitted in dry locations where possible. Boxes fitted in damp locations shall be waterproof pattern.
- J. Wires forming a pair shall not be split. Distribution boxes shall provide separate terminals for all incoming and outgoing wires with cross connection facilities.
- K. One terminal shall contain one wire only. Spare wires shall be left long enough to reach any terminal.
- L. A schedule shall be fixed to the inside face of the box cover showing all connections and giving details of the wiring.
- M. Adequate protection shall be provided for all accidental damage or unauthorized interference.

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 manufacturers recommendations.
- 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 16780

PABX & SWITCH System

PART I – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Examine all other sections of the Specification for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.
- C. This section shall be read in conjunction with section of “Structured Cabling system”

1.2 DESCRIPTION OF WORK

- A. This section applies to the PABX system.
- B. The quantity and location of apparatus comprising a complete system as shown on drawings.

1.3 REFERENCES & Standards

- 1. ITU-T Recommendation
- 2. Jordan TRC Approval

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer’s data, user and installation manuals for all equipment and software and any requirements may needs.
- B. Shop Drawings; include
 - 1. System device locations on architectural floor plans.
 - 2. Full Schematic of system, including wiring information for all devices.
- C. Closeout Submittals
 - 1. User manual.
 - 2. Parts list.
 - 3. System device locations on architectural floor plans.
 - 4. Wiring and connection diagram.
 - 5. Maintenance requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Minimum of 10 years experience in manufacture and design PABX Devices.
- B. PABX System:
 - 1. This product shall be manufactured by a firm whose quality system is in compliance with the I.S. /ISO 9001/EN 29001, QUALITY

SYSTEM. For design, developments, manufacturing, sales, services and support for networking solutions.

- C. Installer:
1. Minimum of 5 years experience installing of PABX System.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacture's original, unopened, undamaged containers; and unharmed original identification labels.
- B. Protect store materials from environmental and temperature conditions following manufacturer's instructions.
- C. Handle and operate products and systems according to manufacturer's instructions.

1.7 WARRANTY

- A. Provide manufacturer's warranty covering 2 years for replacement and repair of defective equipment.

PART II PRODUCTS

2.1 PAXB SYSTEM DESCRIPTION:

Hybrid Telephone System - up to 24 Hybrid extensions (Analogue, Digital & IP)

- Configured to 3 exchange lines (Expandable to 8 exchange lines) and 24 Hybrid extensions.
- The system shall built-in DISA (Direct Inward System Access) which allows outside callers to access any extension without going through an operator
- Message on busy
- Call forwards
- Message waiting when extension busy
- Party conference (up to Five extension and Two CO)
- Details calling activity report
- Extension Caller ID compatibility displays the incoming caller's phone number or name
- Built-in voice message
- Built-in voice mail APT or DTMF
- The system shall detect an incoming fax transmission - routing the call automatically to a designated fax extension.
- Remote Modem and USB Port for PC Programming.

2.2 POWER EQUIPMENT

The system shall operate from a primary power source subject to the following:

- Voltage limits – 48 VDC and Nominal voltage range: 230 VAC+or-15 Volt
- The rectifier charger capacity shall be sufficient for feeding the ultimate capacity of the system and simultaneously re-charge the batteries when they are fully depleted.

- The batteries should be of sealed maintenance free type of standby capacity sufficient for (4) hour's operation in case of power failure.
- The battery shall preferably have a nominal D.C (-48) volts

2.3 MAIN DISTRIBUTION FRAME (analogue line)

- Modern quick connect Punch Blocks type.
- C.O. lines to be protected against over-voltage.

2.4 ENVIRONMENT:

The PABX associated equipment shall be suitable for normal operation under the following environmental conditions:

- Temperature: 5 to 40 deg C
- Relative Humidity: 20 to 80 %

2.5 ACCESS SWITCH:

Note: PoE the same specification but with all port are PoE.

- 24/48 port 10/100/1000 switched RJ-45 ports deliver up to 200 Mbps of throughput per port
- Two 10/100/1000 switched RJ-45 Gigabit uplink ports with two shared SFP ports (combo ports)
- 13.6-Gbps non blocking, store-and-forward switching mechanism
- Simplified QoS management enabled by advanced queuing techniques using 802.1p, IPv4/v6 Differentiated Services (DiffServ)/DSCP traffic prioritization specifications
- Configuration and monitoring from a standard web browser with a simplified management interface
- 802.1Q-based VLANs enable segmentation of networks for improved performance and security
- Port-level security via 802.1X authentication and MAC-based filtering
- Increased bandwidth (up to 8x) and added link redundancy with Link Aggregation Control Protocol (LACP)
- Multicast and broadcast storm control
- Port mirroring for noninvasive monitoring of switch traffic
- Fully rack mountable using the included rack-mounting hardware

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.
- B. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Protect devices from damage during construction.

3.3 INSTALLATION

- A. Install devices in accordance with manufacturer's instruction at locations indicated on the floor drawings plans.
- B. Perform installation with certified qualified service personnel.
- C. Install devices in accordance with the National Electrical Code or applicable local codes.
- D. Ensure selected location is secure and offers protection from accidental damage.
- E. Location must provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

END OF SECTION