

**DIVISION 15**  
**MECHANICAL**

**BUILDING WORK**

**DIVISION 15**

**MECHANICAL**

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## **SECTION 15010**

### **BASIC MECHANICAL REQUIREMENTS**

#### **PART 1: GENERAL**

##### **1.01 SCOPE OF WORK**

- A. This Section covers the basic general requirements applicable to all Division 15 works that shall be provided for by the Contractor. These requirements also apply to Section 13806 Automatic Controls.

##### **1.02 CALCULATIONS**

- A. The Contractor shall acquaint himself with the constructional details of the buildings and exterior works both before and during the course of erection and shall take his own particulars with regard to the installation of mechanical equipment. The Contractor shall check the sizes of all mechanical equipment taking into account any additions or deletions required to ensure the installations fit into the room or other spaces allocated and in relation to other plant and equipment being provided.
- B. The Contractor shall undertake and prepare all necessary calculations and drawings relating to the mechanical equipment and for all associated foundation, structural and builder's and services work, except where specifically defined otherwise in the Specification and/or on the Drawing.
- C. The Contractor shall provide and submit to the Engineer all calculations, drawings and supporting data for the mechanical equipment.
- D. The Contractor shall provide calculations, details, drawings and technical data to enable the Engineer to ascertain the correctness of the specialist designs of the associated foundations, supports, bases and fixings.

##### **1.03 WORKING DRAWINGS**

- A. The Contractor shall provide for approval working drawings of the whole mechanical works. The drawings shall include, but not necessarily be limited to the followings:
  - 1. Co-ordinate general arrangements of all services to a scale of not less than 1:100
  - 2. Co-ordinate detailed layouts of plant rooms and similar spaces to a scale of not less than 1:50.
  - 3. Schedules of all equipment to be installed, together with start and running power consumption.
  - 4. Indicate with accurate dimension sizes and positions of all plant, equipment, pipes, conduits, trunk, under floor ducting, cable tray, cables together with all inspection points and cable joints.

5. Fully indicate all ductwork, pipe work, sizes and positions of all plant equipment and valves together with all inspection points and test positions.
  6. Fully indicate all builders' work requirements inclusive of all foundations, bases, plinths, sumps and holes together with the overall sizes and masses of the plant concerned.
  7. Show the disposition and depth of all cables, pipes, ducts, buried direct in the ground and taken at intervals where change of direction occur and where cables increase or decrease in number/size and at every point where the services enter into or depart from ducts or buildings.
  8. Indicate the number, size and services for every cable, ducts, pipes for every service within the building. Circuit lists for every distribution board shall be entered onto the relevant drawings and such lists shall agree with the lists fixed within the distribution board door.
  9. Indicate all equipment and control wiring diagrams together with all specialist systems. Generators, Public Address, Fire Alarm, etc. Diagrams must be co-ordinate and show all required interlocks etc between systems or components.
  10. Show all cables in pits and ducts on drawings to a scale of 1:50 or larger.
  11. Show clearly on site drawing all the new buildings together with all other existing buildings and other permanent features and dimensions between such buildings and cables, pipes, ducts, etc. clearly marked.
  12. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes, both within the building and throughout.
  13. The site, together with intended drainage pipe work backfill, or surround in each location, schedule to be included to indicate manhole, and cover size, etc.
- B. The symbols used for each service for all working drawings shall be shown on separate drawings.
- C. In addition to the working drawings, the Contractor shall obtain and provide at the request of the Engineer, two sets of all manufacturers' detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawings references number added. Specific requirements are given in the individual specification Sections.
- D. All drawings, diagrams and schedules called for in this clause shall be submitted to the Engineer for examination and approval.

- E. The Contractor shall make due allowance for an approval/comment period and it must be clearly understood that the correctness of the submitted information will directly affect this comment/approval period
- F. The Contractor shall be responsible for co-ordinate all mechanical, electrical, lift, fire protection plumbing, drainage and irrigation works, and engineering systems such that each may be installed in a proper manner, ensuring correct performance and allowing adequate maintenance access. All services shall be installed such that the positioning of ducts pipes, cables, and all items of equipment avoid conflict. The Contractor's working drawings shall indicate any services co-ordination needs prior to submission to the Engineer for approval, tender drawing shall not be reissued as working drawings.

#### 1.04 CONSTRUCTION DRAWINGS

- A. Following approval of the Contractor's drawings by the Engineer, they shall constitute "Construction Drawings" and the E and M equipment shall be manufactured and installed in accordance with those approved drawings. The acceptance by the Engineer of any such drawing shall not relieve the Contractor of his responsibility under the Contract and shall not commit the Engineer or make the Engineer liable for any mistake of the manufacturer's deficiencies in strength or efficiency in operation of any part of any item for its specified purpose.
- B. The Engineer reserves the right subsequently to amend or add to the Construction Drawings as may be necessary or expedient.
- C. The Contractor shall provide to the Engineer, immediately after approval of each detailed drawing, one copy on transparent plastic film and two dye-line prints.

#### 1.05 REGULATIONS

- A. The installation materials and components shall comply with all relevant statutory instructions and regulations current at the date of tender whether so detailed or not. In particular, the following departments must be consulted.
  - 1. Standards issued by Jordan Standards
  - 2. British Standard Specifications
  - 3. British Standard Code of Practice
  - 4. UK IEE Regulations for Electrical Installation
  - 5. US National Electrical Code
  - 6. US National Electrical Safety Code
  - 7. UK Chartered Institution of Building Services Engineers (CIBSE)
  - 8. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - 9. Safety Health and Welfare Regulations issued by Jordan
  - 10. Water Regulations issued by the Jordan Water .
  - 11. US Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
  - 12. UK HVCA DW142 Ductwork specification.

13. US National Fire Protection Association Standards
14. IEE Regulations for Electrical Equipment of Buildings
15. Local Laws, Rules and Regulations
16. U.K BSRIA code for pipe work flushing.

#### 1.06 WORKMANSHIP AND MATERIALS

- A. The Contractor shall be responsible for ensuring that the components or each system are mutually compatible and integrated to form fully efficient systems complying with the Drawings and Specification. Corresponding parts throughout the Works shall be made to gauge and be interchangeable wherever possible. The Contractor shall, when required by the Engineer, prove interchangeability by the actual interchange of the various parts.
- B. All articles and materials specified to conform to Jordan, British and other standards shall be clearly and indelibly marked with the appropriate standard number specified except where marking is impracticable when relevant documents shall include this information.
- C. All materials and workmanship shall be to the satisfaction of the Engineer. The Contractor shall maintain a competent supervising engineer and supervisors for each specification and for each section of the work on Site throughout the whole of the time to the completion of the works. The Engineer shall give prior approval to the appointment of this supervising engineer and shall have the authority to withdraw this approval at any time. No person shall be allowed to execute any type of work, which is normally carried out by a skilled tradesman unless he is thoroughly experienced and proficient in the trade concerned. The Engineer shall have the authority to require any tradesman to demonstrate his proficiency to the satisfaction of the Engineer.
- D. Where "stainless steel" is specified or used it shall have resistance to atmospheric corrosion and be of a grade to suit its particular use. Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the applications of lubricants. Where bronze is specified or used it shall be zinc free.
- E. All cast iron shall be of standard gray close-grained quality to BS 1452 Grade 14 or better. The structure of the casting shall be homogenous and free from non-metallic inclusions and other injurious defects. All surfaces of casting that are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.
- F. Minor defects not exceeding 12.5% of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of larger defects and no repair welding of such defects shall be carried out without prior approval.

- G. If the removal of metal for repair will reduce the stress-resisting cross-section of the casting by more than 25%, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then that casting may be rejected.
- H. Castings repaired by welding for major defects shall be stressed-relieved after such welding.
- I. Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judge, or to determine that repair welds have been properly made.
- J. All major stress-bearing forging shall be made to a standard specification, which shall be submitted to the Engineer for approval before work, is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws and shall be heat treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may arrange for such forging to be inspected at the place of manufacture with a representative of the Contractor.
- K. Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, they shall be selected so that the bimetallic corrosion is as low as possible. The publication by the UK H.M. Stationary Office entitled "Corrosion and its Prevention at Bimetallic Contacts" shall be used as a guide.
- L. The use of iron and steel shall be avoided in instruments and electrical relays wherever possible. Steel screws, when used, shall be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. All woodscrews shall be of dull nickel-plated brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Spring shall be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible. Pivots and other parts of which non-ferrous material is unsuitable shall be of approved rustle steel where possible.

#### 1.07 INSPECTION AND TESTS AT MANUFACTURER'S WORK

- A. The Engineer and his duly authority representative shall have at all reasonable times access to the Contractor's premises to inspect and examine the materials and workmanship of mechanical equipment being manufactured there, and if part of such equipment is being manufactured on other premises, the Contractors shall obtain for the Engineer and for his duly authority representative permission to inspect as if that equipment was manufactured on the Contractor's own premises. Such inspection, examination or testing, if made, shall not relieve the Contractor from any obligation under the Contract.
- B. All works, materials and the like rejected shall be corrected or replaced as necessary at the Contractor's own expense to the satisfaction of the Engineer.

- C. Where the mechanical equipment is composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer's works, to the relevant test or tests required.
- D. The Contractor shall submit his proposed program of tests for the Engineer' approval six weeks before the commencement of testing.
- E. The aforementioned works tests carried out before delivery to the Site shall not in any way relieve the Contractor of completing satisfactory Site tests after erection as specified.
- F. The Contractor shall give the Engineer reasonable notice, at least ten clear days in writing, of the date and the place at which any mechanical Equipment will be ready for testing as provided in the Contract and the Engineer shall thereupon at his discretion notify the Contractor of his intention either to release such part upon receipt of works tests certificates or of his intention to inspect such part. The Contractor shall forward to the Engineer six duly certified copies of all relevant test readings.
- G. The Contractor shall provide, free of charge, such labor, materials, electricity, fuel, water, stores, apparatus, instruments and other things as may be reasonably demanded to carry out efficiently such tests of the mechanical equipment in accordance with the Contract, and shall provide facilities to the Engineer or to his authority representative to accomplish such testing. Where inspection or testing is to be carried out at a Sub-contractor's works, a representative of the Contractor shall be present.
- H. Works tests shall also be carried out such that due consideration is given to the Site conditions under which the mechanical equipment is required to function. The test certificates shall give all details of such tests.
- I. Specific performance works tests are described in the relevant Sections of Division 15, and include:
  - a) Sample performance testing of air handling units for airflow, heating and cooling and noise emission.
  - b) Sample type-performance testing of fan assisted and non fan assisted Variable Air Volume boxes coupled to proposed diffusers, in a test room at the manufacturers works for heating and cooling airflow, air distribution and noise emission.

#### 1.08 CERTIFIED DRAWINGS

- A. The Contractor shall be responsible for providing all "Certified" drawings from manufacturers of mechanical equipment, prior to their manufacture and installation. A "Certified" manufacturer's drawing shall mean a drawing which is prepared by a manufacturer as showing the exact dimensions and details of items of the mechanical equipment, as they will be supplied and installed in the Works.

## 1.9 SAMPLES

- A. The Contractors shall provided a sample properly labeled of all fittings, valves, insulation, cocks, unions, grilles, dampers, switch gear, cables and other like accessories described in the Specification or as required by the Engineer.

## 1.10 PROTECTION AND CARE OF PLANT AND EQUIPMENT

- A. All mechanical equipment shall be packed in robust containers to prevent damage and mishandling during transport to Site. Before dispatch from works all mechanical equipment shall be thoroughly cleaned, protected against damage, deterioration, corrosion and ingress of dirt and packed and protected suitable for prolonged storage in a humid and saline atmosphere.

During storage and erection at the Site, the mechanical equipment shall be kept clean and free from dirt and debris, and water shall not be allowed to remain in any pockets of the equipment. All items of mechanical equipment shall be stored clear to the ground on suitable timbers to the approval of the Engineer.

All mechanical equipment, particularly electrical and other sensitive instrumentation shall at all times be protected so that it is not subject to damage by rainwater, moisture, dust, etc., from any source. Mechanical equipment, which may be damaged by heat or sun, shall be protected accordingly. All open piped ends and duct ends whether installed or in store shall be fitted with plastic caps or suitable protective covering.

## 1.11 GUARDS

- A. A guard shall be provided for all open unprotected intakes to axial fans, centrifugal flow fans, for V-belt drives or in any position required by the UK Factories Act.

Fan guards shall be manufactured by the fan maker, of galvanized steel wire mesh, not greater than 25mm attached to a rigid galvanized steel rod framework.

Guards to V-belt drives shall be made of galvanized steel wire at least 12 gauge with a mesh not greater than 12.5mm attached to a rigid galvanized framework of rods not less than 10mm. The guard shall be readily removable to permit the belts to be changed. Adequate access panels shall be provided in the side of the guard to allow tachometer readings of the two shafts to be taken and belt tension tested. Allowances shall be made for the adjustment of the motor on its slide rails.

Cleaning: The Contractor shall be responsible for cleaning all mechanical equipment at all times to the satisfaction of the Engineer. The cleaning shall be carried out notwithstanding the fact that the installation or any part thereof may be in use of partial use within the premises in occupation by others. A Certificate of Completion will not be issued until the Engineer is satisfied that all dirt, jointing materials and other extraneous and injurious materials have been removed.

### 1.12 AIR CONDITIONED STORES

- A. The Contractor shall provide air conditioned site stores for all goods which deteriorate when subjected to the site climatic conditions detailed. The contractor will adhere strictly to the Manufacturer's instructions with regard to storage temperatures for all materials being used for the construction of this project.

### 1.13 PAINTING

- A. The preparation, painting and treatment of mechanical equipment surfaces shall be in accordance with relevant items in Division 15 and Division 9.
- B. Full details of the manufacturer's standard finishes shall be given to the Engineer for his approval prior to manufacturer. Special care shall be taken to ensure standard finishes are suitable for the particular conditions applicable to the individual items of plant.
- C. Any damage to paint work which occurs shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.
- D. The interiors of control panels shall be finished white enamel paint (two coats) and shall comply with the appropriate BS for enamel finish and the exteriors of such panels shall be of BS Specification color as specified by the Engineer to give a minimum reflection value of 42 %. Instruments shall be finished dull black and control handles push button and similar fittings shall be chromium plated or otherwise durably finished to the approval of the Engineer.
- E. All bright metal parts shall be covered before dispatch with an approved protective compound and protected adequately during delivery to Site. After erection these parts shall be cleaned with a correct solvent and polished bright where required.
- F. Machined mating surfaces such as gear teeth, etc., shall be coated with a thick layer of grease. Other machined surfaces shall be given a coat of rust-preventing paint, which shall be readily removable when required.
- G. Where it is the usual practice of the manufacturer of special items such as pumps, compressors, electric motors, gear boxes, switch gear, etc., to apply a high standard of protective enamel paint work in the shops before dispatch, this will be acceptable provided any subsequent damage to the paint work is made good by the Contractor, at his own cost. The preferred finish is light gray.
- H. The inside of outdoor control cubicles, cabinets, etc., where condensation is liable to occur, shall be coated with an approved anti-condensation composition.
- I. The Contractor shall obtain the paint manufacturer's guarantee that each coat of paint is compatible with the previous and subsequent coats so that peeling, flaking and other faults do not occur.

- J. The Contractor shall include for painting all pipes, ducts, flange edges, etc., prior to their being insulated.
- K. Final decoration of exposed pipe work, brackets and ductwork shall be carried out in accordance with Division 9.

#### 1.14 MANUFACTURER'S NAMEPLATES

- A. Nameplates: Each item of mechanical equipment and plant shall have the manufacturer's name or trademark on a corrosion-resistant nameplate securely affixed in a conspicuous place. The manufacturer's name or trademark may be cast integrally with stamped or otherwise permanently marked upon the item of the equipment. The nameplate shall show the equipment reference number, date of manufacture and the capacity. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplates.

#### 1.15 LABELS

- A. Identification labels of plastic laminate or similar approved materials engraved black on white unless otherwise agreed, with not less than 5mm "line" style letters shall be fixed on or adjacent to all controls, switches and distribution gear, by means of at least two brass screws. Socket outlets of all voltages shall be similarly identified or engraved.
- B. The labels shall bear the identification shown on the Drawings, such as indication, designation, function and, where necessary, phase, voltage, current, frequency, pressure and temperature. All labels shall be in Arabic and English.

#### 1.16 LUBRICATION

- A. A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer for approval before incorporation in the instruction manuals. In the case of grease lubricated roller type bearings for electric motors, a lithium base grease is preferred.
- B. Where lubrication is affected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent for this purpose, means more than once weekly and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility, grease nipples shall be placed at the end of extension piping and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. Button head type nipples shall be of the same size and type for every part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil
- C. Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labeled.

- D. Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practical, with dipsticks. The indicators shall show the level of all temperatures likely to be experienced in service. The normal, maximum and minimum levels at 30<sup>0</sup>C shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant, and they shall be easily dismantled.
- E. All sight glasses shall be firmly held and enclosed in metal protection in such a manner that they cannot be accidentally damaged.
- F. All lubrication systems shall be designed so as not to present a fire hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into current contact with any electrical equipment, heated surfaces or any other potential source of fire.
- G. The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for setting to work and for the commercial operation for one year after the relevant Certification of Completion has been issued.

#### 1.17 SPECIAL TOOLS

- A. The Contractor shall supply two complete sets of any special tools necessary for the operation, maintenance and dismantling of the mechanical equipment. The Contractor shall supply wall-mounted strongboxes, each fitted with a suitable lock and two keys, and located near the item of mechanical equipment for which they will be used. Such tools shall not be used by the Contractor during the erection of the mechanical equipment.

#### 1.18 SUNDRY BUILDERS WORK IN CONNECTION WITH SERVICES

- A. The Contractor shall include in his prices for drilling, raw bolting, plugging, screwing and nailing of all brackets, hangers, for all pipe work, ductwork conduit, cable tray, cable trunk and cable supports. The Contractor shall also include for supplying all brackets, hangers and supports as necessary.

#### 1.19 NOISE

- A. The Contractor shall provide a quiet installation. All items of mechanical equipment shown on the Drawings shall be carefully chosen with a view to silent operation. The recommendations in BS 5720 and BSCP 3 Chapter III shall be followed wherever necessary. The Contractor shall prepare detailed noise level calculations to indicate the anticipated noise levels in all critical areas.
- B. All possible steps shall be taken, (e.g. by the use of sound insulation, anti-vibration mountings, and careful design of pumps, motors, fans, ducts, bends, dampers, grilles and other equipment) to reduce the noise produced by the mechanical equipment.

- C. The Contractor shall determine the noise levels of all primary mechanical equipment before proceeding with manufacture and submit sound power levels of such Equipment to the Engineer for approval before manufacture is commenced.

#### 1.20 ANTI-VIBRATION MOUNTINGS AND SOUND ABSORPTION

- A. The Contractor shall provide and fix all mechanical equipment to prevent noise and the transmission of vibration through the structures.
- B. All fans, motors, pumps and other items, as appropriate, shall be mounted on resilient mountings in such a manner that the plant foundations are isolated from the floor or structure. In addition, all rotating plant shall be statically and dynamically balanced.
- C. Mechanical vibration shall be eliminated by the use of anti-vibration mountings and flexible connections to ensure an isolation efficiency of 95% from the building structure except where defined otherwise on the Drawings or in the Specification.
- D. Spring type anti-vibration mountings shall be the captive partially encased and restrained type to prevent lateral movement.

#### 1.21 AS BUILT DRAWINGS

- A. Thirty days prior to the date of the handing over certificate, the Contractor shall provide for approval "as built" record drawings of the whole works.
- B. The Drawings shall include the following:
  - 1. General arrangements of all services to a scale of not less than 1:50.
  - 2. Detailed layouts of plant rooms and similar spaces to a scale of not less than 1:20.
  - 3. Schedules of all plant and crossed referenced equipment to the maintenance manual.
  - 4. All equipment and control wiring diagrams together with specialist system i.e. public address fire alarms, etc.
  - 5. These may be produced separately or included with the general distribution diagrams.
  - 6. Indicate with accurate dimensions, sizes and positions of all plant, equipment and valves together with all inspection points and test positions. All plants to have indicated manufacturer's name, model and type number also cross-referenced to maintenance manual.
  - 7. Fully indicate all ductwork, pipe work, sizes and positions of all plant equipment and valves together with all inspection points and test

- positions. All plant to have indicated manufacturer's name model and type number also cross-referenced to maintenance manual.
8. Show the disposition and depth of all cables, pipes, ducts, buried direct in the ground and taken at intervals where cable increase or decrease in number/size and at every point where the services enter into or depart from ducts or buildings.
  9. Indicate the number, sizes and services for every cable, duct, pipe, for every service within each building. Circuit lists for every distribution board shall be entered on to the relevant drawings and such lists shall agree with the list fixed within the distribution board door.
  10. Show clearly on site drawings all the new buildings together with all other existing buildings and other permanent features with dimensions between such buildings and cables, pipes, ducts, etc. clearly marked, together with installed backfill and surround to each services.
  11. Indicate all equipment and control wiring diagrams together with all specialist systems i.e. public address, fire alarm, etc. Diagrams must be co-ordinate and show all required inter blocks etc. between systems or components.
  12. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes both within the building throughout the site, together with drainage pipe work backfill, or surround in each location. A schedule shall be included to indicate each manhole size, cover size, invert level and ground level.
- C. The symbol used for each service for all as built drawings shall be shown on separate drawings.
- D. In order to achieved accurate as built drawings, all relevant information relating to the mechanical works shall be entered onto prints supplied immediately after the work has been carried out. The marked up prints shall be available for inspection at the Contractor's site office at any reasonable time during the progress of the works.
- E. All service routes, intersections and joints shown on the prints and finally recorded shall be actually physically measured from permanent features and accurate distances shall be shown on the Drawings.
- F. In addition to the as built drawings, the Contractor shall obtain and provide two sets of all manufacturer's detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawing reference numbers added.
- G. The Contractor shall provide two copies for all as built drawings for review comments and approval. Upon receiving approval in writing from the Engineer, or his representative, the Contractor shall provide one negative copy of each approved as built drawing and bind one set of prints into each of 6 No. copies of the operating instructions specified in clause 1.23.

## 1.22 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The working, operating and maintenance instruction shall be prepared in draft as soon as the working drawings are in hand and shall take the form of a manual in which fully detailed information relating to the maintenance and operation of the complete installation and its component parts is presented.
- a) Overall general description of the complete equipment installed together with the method of functioning.
  - b) Full technical descriptions of each and every item of equipment, including the electrical circuit details as applicable.
  - c) Operating procedures for each section of the works and each individual item of equipment or plant.
  - d) Planned maintenance schedules for the installation and its component parts to include commissioning performance details and measurements.
  - e) Schedule of components comprising each and every item of equipment including manufacturer's name, description and part number of each component.
  - f) A copy of the manufacturer's literature, describing each item of equipment, plant fittings and accessory type used throughout the installation. This literature shall list the technical data available, together with catalogue list numbers for replacement purposes.
  - g) Generally all drawings must be arranged to flood out from their position and be entirely visible when any part of the manual is being read. They shall be printed on linen backed paper.
  - h) Each section shall be encased in a loose leaf ring binder covered in plastic material of an approved color and of a type which shall be flat when open.
  - i) The Contractor shall include for the preparation and supply of six copies of the above operating and maintenance instructions for each section after all details have been approved by the Engineer.
  - j) Electric transfer of "As Built" drawings shall be provided as required by the Engineer.

## 1.23 INSTRUCTION AND TRAINING

The Contractor shall be responsible for the provision of suitably qualified personnel for the instruction and supervision of the Employer's staff at Site in the operation and routine maintenance of all mechanical equipment and associate works. Unless specified to the contrary in the specific technical clauses in Division 15 and Division 13, instruction and training shall be for periods of six hours daily for twenty days after the satisfactory commissioning of the

installation and as necessary, after each subsequent commissioning of a system or part thereof.

#### 1.24 SPARES AND CONSUMABLES

- A. A list of spares and consumables for 1 year operation for every item of plant and system shall be furnished by the Contractor at the time of tendering.

#### 1.25 MOCK-UPS

- A. The Contractor shall provide mechanical equipment to allow full Architectural Mock-ups to be built as described elsewhere in the specification.

**End of Section**

## **SECTION 15060**

### **PIPE AND PIPE FITTINGS**

#### **PART 1: GENERAL**

##### **1.1 WORK INCLUDED**

- A. Sanitary drainage and vent system piping.
- B. Storm sewer system piping.
- C. Domestic water system piping.
- D. Fire protection system piping.
- E. Refrigeration and air conditioning system piping.

##### **1.2 QUALITY ASSURANCE**

- A. Stand Pipe and Hose System Piping: B.S.5306 Fire Extinguishing installations and equipment on premises.
- B. Domestic Water, Drainage and Vent Piping: National Plumbing Code.

##### **1.3 REFERENCE STANDARDS**

###### **A. Steel/ Copper Piping:**

###### **1- ANSI - American National Standards Institute:**

- I. B16-5-1977 Steel Pipe Flanges and Flanged Fittings
- ii. B16.9-1971 Factory made Wrought Steel Butt Welding Fittings
- iii. B16.11-1973 Forge Steel Fittings Socket Welded and Threaded
- iv. B16.22-1972 Wrought Copper and Bronze Solder-Joint Pressure Fittings
- v. B16.23-1975 Cast Copper Alloy Solder-Joint Drainage Fittings DMV
- vi. B16.26-1975 Cast Copper Alloy Fittings for Flared Copper Tubes
- vii. B31.1-1977 Code for Power Piping

###### **2- ASTM - American Society for Testing and Materials**

- i. A53-72a Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- ii. A120-77 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- iii. A135-73a Electric-Resistance-Welded Steel Pipe.
- iv. A139-71 Electric-Fusion (Arc-Welded Steel Pipe (size=4" and over)
- v. A333-77 Seamless and Welded Steel Pipe for Low Temperature Service.
- vi. A370-77 Standard Methods and Definitions for Mechanical Testing of Steel Products
- vii. A524-76 Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures
- viii. B88.7.6 Seamless Copper Water Tube

###### **3- AWWA American Water Works Association**

- i. C200-75 Standard for Steel Water Pipe 6 inches and larger

- ii. C203 Coal tar enamel protective coatings and lining for steel pipelines enamel and tape hot applied.

4- AWS American Welding Society: B.3.07, Qualification Procedure.

5- ASME American Society of Mechanical Engineers

- i. Boiler and Pressure Vessel Code

B. Cast Iron Soil Pipe:

1- ASTM American Society for Testing and Materials

- i. A74-75 Cast Iron Soil Pipe and Fittings

2- ANSI - American National Standards Institute

- i. A21.6-1975 Cast-iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
- ii. A21.8-1975 Cast-iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids.
- iii. A21.10-1971 Gray-Iron and Ductile-Iron Fittings, 2 in.
- iv. A21.10a-1972 Through 48 in., for Water and Other Liquids.

3- ASME American Society of Mechanical Engineers: A40.8- 1955 National Plumbing Code

C. Cast Iron Pressure Pipe (Gray and Ductile):

1- ANSI American National Standards Institute

- i. B16.1-75 Cast Iron Pipe Flanges and Flanged Fittings
- ii. B31.1-77 Power Piping.

2- ASTM American Society for Testing and Materials

- i. A377.77 Gray Iron and Ductile Iron Pressure Pipe.
- ii. A674-74 Recommended Practice for Polyethylene Encasement for Gray and Ductile Cast Iron Pipe for Water or Other Liquids.

3- AWWA American Water Works Association

- i. C101-67 Thickness Design of Cast Iron Pipe
- ii. C104-80 Cement-Mortar Lining for Cast-Iron and Ductile-Iron pipe and Fittings for Water.
- iii. C105-72 Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids
- iv. C106-75 Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.
- v. C110-82 Gray-Iron and Ductile-Iron Fittings, 3in. through 48in. for Water and Other Liquids
- vi. C111-80 Rubber-Gasket Joints for Cast-Iron Pressure Pipe and Fittings.

- vii. C115-75 Flanged Cast-iron and Ductile-Iron Pipe with Threaded Flanges.
- viii. C150-76 Thickness Design of Ductile-Iron Pipe.
- ix. C151-81 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- x. C600-82 Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances.
- xi. C606-81 Grooved and Shouldered Type Joints.

D. Cast Iron (Ductile Iron) Drainage Piping:

1- ANSI American Standards Institute

- i. A21.5-1972 Polyethylene Encasement for Gray & Ductile Cast-Iron Piping for Water and Other Liquids

2- ASTM American Society for Testing and Materials

- i. A 674-74 Recommended practice for Polyethylene Encasement for Gray and Ductile Cast Iron Pipe for Water or other Liquids.
- ii. A 716-78 Ductile Iron Culvert Pipe.
- iii. A 746-77 Ductile Iron Gravity Sewer Pipe.

3- AWWA American Water Works Association: C600-77 Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances.

E. Plastic Pipe:

1- ASTM American Society for Testing and Materials

- i. D 568-76 Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position.
- ii. D1004-66 Standard Test Method for Tear Resistance of Plastic Film and Sheeting.
- iii. D1248-74 Polyethylene Plastics Molding and Extrusion Materials.
- iv. D1785-76 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- v. D2104-74 Polyethylene (PE) Plastic Pipe, Schedule 40
- vi. D2146-69 Propylene Molding and Extrusion Materials.
- vii. D2241-76 Polyvinyl chloride (PVC) Plastic Pipe (SDR-PR)
- viii. D2665-77 Polyvinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe.
- ix. D2774-72 Underground Installation of Thermoplastic Pressure Piping.

1.4 SUBMITTALS

- A. Certificate of compliance stating that the material used and construction of pipes and fittings conform to all requirements of this Specification.
- B. Certificates of testing of pipes including test data to show that all tests specified have been performed and all requirements have been met.

- C. Catalogue data for all piping accessories, pipes and fittings showing illustrations and schedule of parts to facilitate assembly and disassembly.
- D. Equipment Manufacturer's recommended spare parts and tools list, operation and maintenance information.
- E. Joint detail drawings and joint assembly procedures.
- F. Temperature/pressure ratings of pipings, fittings and piping accessories.
- G. Manufacturer recommended specifications for transporting, handling, loading, unloading, stock piling and storage of materials.
- H. Procedures for qualifying field welder's records for field welder qualification and results of field weld tests.

#### 1.5 PRODUCT HANDLING

- A. All pipe products, fittings and piping accessories shall be delivered in Manufacturers' original protective packaging.
- B. All products, fittings and piping accessories shall be inspected at time of delivery for damage and for compliance with specifications.
- C. Any products that are damaged or found not to be in accordance with the Specifications shall be immediately repaired or replaced.
- D. All products shall be handled and stored as recommended by Manufacturer to prevent damage and deterioration.
- E. The Contractor shall supply handling equipment such as lifting beams, reinforced canvas slings, protective padding, struts, cradles, etc., required to install products without damaging hardware or linings and coatings.
- F. The Contractor shall unload all products singly from trucks or lorries. Unless cranes are used, pipes shall be unloaded by means of skids and check ropes and no pipe shall be dropped or be allowed to roll.
- G. Each pipe unit shall be site stored, stacked and handled into its position only in such manner, and by such means, that affords total protection for it from damage. Site stacking of pipework shall be such that the pipework will not deform or be damaged in any way through storage or retrieval. The Manufacturer's recommendations shall be taken as the minimum requirement. All site storage areas shall be shaded.
- H. Products shall be protected against damage and the ambient conditions both during transport, site storage and immediately up to the time the products are installed.
- I. Full consideration shall be given to safety aspects when locating, planning and constructing stacking areas and whilst stacking pipes.

**PART 2: PRODUCTS**

**2.1 ACCEPTABLE MANUFACTURERS**

Piping, fittings and accessories shall be the product of a Manufacturer regularly engaged in the production of these items issuing complete catalog data for same.

**2.2 PIPES**

	Service	Material
↙	Heating water pipes for exposed pipe	Black steel class B
	Heating water pipes under tile	Pex pipe
↙	Equipment drains overflows pipes and fire fighting drains	UPVC
↙	Sanitary drainage and vent pipes	UPVC
↙	Storm drainage pipes	UPVC
↙	Fire fighting pipes	Black steel seamless Sch. 40
↙	Wet system	
↙	Domestic hot /cold water pipes	Galvanized Steel pipe to ASA "scheduled 40", or Pex pipes*
↙	Fuel pipes	Black steel seamless Sch-40
↙		

**\* PEX PIPES FOR HEATING**

Pipes should be peroxide cross linked polyethylene, with degree of cross linkage not less than 75% according to DIN 16892, pipes should be covered with Oxygen Diffusion Barrier in accordance with DIN 4726.

Dia.(mm)	Thickness (mm)
16	2
20	2.8
25	3.5
32	4.4

**\* PEX PIPES FOR DOMESTIC WATER**

Pipes should be specialized for domestic water supply with approvals for hot and cold water Installations like NSF (USA), KIWA (Netherlands), wrc (Britan), DVGW (germany). These Pipe should be have approvals for hygienic/toxicological approvals. These pipes should be White (no colorants) and totally smooth from th inside with the following diameters and Thicknesses:

Dia.(mm)	Thickness (mm)
16	2.2
20	2.8
25	3.5
32	4.4

### 2.3 FITTINGS

Service	Material	Joint	Size
Heating water & piping	Black steel iron with alkyd enamel paint	Grooved	All sizes
Equipment drains	UPVC	Solvent welded or with rubber joints	All sizes
Sanitary drainage	UPVC	Solvent welded or with rubber joints	All sizes
Storm drainage piping	UPVC	Solvent welded or with rubber joints	All sizes
Domestic cold water and hot water piping	Wrought copper, & galvanized steel	Grooved Grooved	Up to 100mm above 100mm
Fire protection piping	Ductile iron with alkyd enamel paint.	Grooved	All sizes

\* All fittings shall be supplied with grooves or shoulders to permit fast installation without field preparation. Fittings shall include elbows, tees, reducing tees, crosses, wyes, laterals, ... caps, long reduces elbows, reducers and many others, and pressure ratings upto 1000 PSI depending on size.

### 2.4 UNIONS AND COUPLINGS

A. Use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion.

B. Couplings shall consist of the following:

1. Gasket: The optimum gasket shall be used for each specific service, as for water and oil free air service gasket shall be molded of synthetic rubber in a central cavity flush sealing design and shall be grade "E" EPDM compound (green colour coded) conforming to ASTM D-2000 designation with temperature operating range -30 degree F to +230 degree F.

2. Housing: Ductile iron (conforming to ASTM-A-536/DIN 1963) and it shall be:

- 1) Coating with alkyd enamel paints for black steel seamless pipes.
- 2) Coating with hot dip galvanized to ASTM A-153 for galvanized steel pipe.
- 3) Coating with copper colored alkyd enamel for copper pipe.

3. Bolts and Nuts: It shall conform to ASTM A-183 and shall be heat treated with zinc plated carbon steel track head.
- C. The following variety coupling type shall be used where required as specified before for pipe installation
  1. Flexible coupling: It shall be used to provide noise/vibration attenuation, thermal movement or seismic relief.
  2. Rigid coupling: It shall be used to provide torsional and flexural load resistance for rigidity, and it shall be used for valve connections, fire mains, long straight runs ... etc.
  3. Outlet coupling: It shall be used for reducing tee and couplings by joining grooved pipe and providing a reducing branch outlet.
  4. Reducing coupling: It shall be used to provide direct reduction from one pipe size to another without a special reducing fittings.
  5. Mechanical-T bolted branch outlet: It shall be used to provide a direct branch connection at any location, so as to a hole shall be cut in pipe, and for purpose of installation, Mechanical-T must be installed so that the main and branch connections shall be true 90° angle when permanently attached to the pipeline surface, and it is applicable for fire fighting installation.
  6. Mechanical-T cross assemblies.
  7. Snap-let Outlet:
    - A. It shall be used to provide a convenient method of incorporating 15mm, 20mm, 25mm outlets for directly connecting, drop nipples, sprigs, gauges, drains and other outlet products.
    - B. It shall consist of outlet housing (ductile), strap of zinc electroplated steel, O-Ring of grade "EPDM Gasket, hex washer head screw of zinc plated.
  8. Thermometer Outlet:
    - A. It shall be used to provide, easy connection combining the features of a thermowell and strapless mechanical outlet.
    - B. It shall consist of ductile iron painted, collar, grade "E" EPDM Gasket.

## 2.5 FLANGE ADAPTORS

- A. It shall be used for joining flanged components directly into grooved pipe system, engage into groove and bolts directly to flanged component.
- B. Flange adapters shall be casted from ductile iron conforming to ASTM A-536 with black enamel coating with Grade "E" EPDM Gasket.

### **PART 3: EXECUTION**

#### **3.1 PREPARATION**

- A. Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

#### **3.2 CONNECTION**

- A. Pipes shall be prepared for each specific product style, and preparation shall vary according to pipe material, pipe wall thickness, pipe outside diameters.
- B. Roll grooving: Roll grooving shall remove no metal, cold forming a groove by the action of an upper male roll being forced into pipe as it is rotated by a lower female drive roll, and shall be applied for standard and light wall pipe.
- C. Cut grooving: cut grooving shall remove less metal to less depth than threading, maintaining the designed integrity of the pipe and shall be applied for heavy wall metallic, cast gray and ductile iron or plastic pipe.

#### **3.3 ROUTE AND GRADES**

- A. Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping whenever practical at common elevations. Install concealed pipes close to building structure to keep furring to a minimum.
- B. Slope water piping 1/500 and arrange to drain at low points.
- C. On closed systems, equip low points with 19 mm drain valves and hose nipples. Provide, at high points, collecting chambers and high capacity float operated automatic air vents.
- D. Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.
- E. Grade horizontal drainage and vent piping 1/100 minimum.
- F. Install piping to allow for expansion and contraction without stressing pipe or equipment connected.
- G. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.
- H. Provide protection, i.e. step over access for piping run at low level in plant rooms.
- I. Where hot and cold water ranges run parallel with each other, the cold supply must always be on the bottom to minimize heat transfer from the hot supply.
- J. The configuration of the circuits should be such that clear zones can be individually served, thus making it possible to close down areas of the building.

### 3.4 LAYING OF UNDERGROUND PIPES

#### 3.4.1 General

- A. Place all materials in accordance with the Manufacturers recommendations.
- B. Inspect and clean out all piping carefully before laying. Only material of high quality shall be used. Surface of joints shall be free of cracks or irregularities, which would weaken them, impede the jointing work or cause leakage.
- C. Report minor damages to pipes or fittings already incorporated in the works to the Engineer, who will decide if the damage may be repaired or if the pipe or fittings shall be replaced. Repaired items shall be approved by the Supervising Engineer.
- D. Before jointing the pipes make hollows in the trench bottom to provide sufficient space for the socket and for making the joints.
- E. Place pipes in bedrock or rockfill on beds of sand.
- F. Provide a flexible joint where a stiff pipe or fitting is built in, e.g. fixed in a wall. Check the implication of the bed before laying the pipes, so that settlement will be avoided as far as possible.
- G. After jointing, support the pipes adequately along their whole length by hard packed fill under their lower quadrant.
- H. If work is interrupted, seal the open ends of the pipes properly to prevent the entry of mud or other materials until work is resumed.
- I. Lay pipes to the lines shown on the drawings with a minimum thickness of cover below the finished surface level of 0.8 m over the crown of the pipe, unless otherwise indicated on the drawings.
- J. Jointing of Pipes:
  - 1- Clean and dry the surfaces of all joints immediately before jointing.
  - 2- Equipment for jointing the pipes shall be suited to the relevant pipe dimensions so that the surfaces of the joints will not be damaged.
  - 3- Carry out the jointing so that all joints will withstand the specified test pressures without leaking.

#### 3.4.2 PIPE IDENTIFICATION AND COLOR CODING

- A. Identify and color code pipe by applying plastic markers.
- B. Markers shall follow the color code established by ASHRAE standard. Display the name of the material carried by the pipe, and indicate direction of flow.
- C. Place markers within 1.8m of any equipment connections, close to branch connections and valves in mains, and within 0.91m of wall, floor, roof or ceiling through which pipe passes, do not space markers more than 15m apart on any pipe.

D. Identify and color code all pipes except pipes concealed in vertical masonry chases.

E. In lieu of labels, stenciling and painting of equal quality may be substituted.

### 3.5 PAINTING

A. All painting shall be in conformance with Engineerural and Structural Specifications.

### 3.6 CLEANING

A. Clean all systems in conformance with Engineerural and Structural Specifications.

**End of Section**