

**Section 15000**  
**Mechanical Specifications**  
**Table of Contents**

## 15000 Mechanical Specifications

### Table of Contents

Section 15000 :	Table Of Contents
Section 15050 :	General Conditions
Section 15100 :	Pipe Works Specifications
Section 15241 :	Vibration and Acoustic Control Specifications
Section 15250 :	Thermal Insulation Specifications
Section 15410 :	Drainage System specifications
Section 15430 :	Plumbing Systems Specifications
Section 15440 :	Sanitary Fixtures Specifications
Section 15665 :	DX Split Units
Section 15855 :	Diffusers, Registers, & Grilles Specifications
Section 15891 :	Duct Work Installations
Section 15910 :	Duct Accessories
Section 15950 :	Testing And Commissioning Specifications
Section 15990 :	Painting, Tags & Labeling Specifications

**Section 15050**  
**General Conditions**

## General Conditions

### Table Of Contents

#### Contents

1.1	General Conditions.....	4
1.2	Standard of Work.....	4
1.3	Data to be Supplied with Tender.....	5
1.4	External Design Conditions.....	5
1.4.1	DESIGN STANDARDS .....	5
1.5	Equipment .....	6
1.6	Equipment Ratings .....	6
1.7	Pretender Requirements .....	7
1.7.1	Familiarization .....	7
1.7.2	Clarification.....	7
1.7.3	Interpretation .....	7
1.8	Co-Ordination with Other Trades .....	8
1.9	Co-Ordination with Other Subcontractors.....	8
1.10	Hand Over Works from Other Subcontractors.....	8
1.11	Tender Drawings .....	8
1.12	Drawings and Technical Data .....	9
1.12.1	DRAWING MATERIAL AND SIZE .....	9
1.12.2	DRAWING FORMAT:.....	9
1.12.3	SIZE AND SCALE:.....	9
1.12.4	TITLE BLOCK .....	9
1.12.5	GENERAL INFORMATION .....	9
1.12.6	IDENTIFICATION OF DRAWINGS .....	10
1.12.7	Shop DRAWINGS .....	11
1.13	Complete & Finished Work.....	13
1.14	Changes and Variations .....	13
1.15	Record Drawings and Manuals .....	13
1.16	Operations & Instructions Boards .....	15

<b>1.17</b>	<b>Operation and Maintenance Manuals</b> .....	<b>15</b>
<b>1.18</b>	<b>Workmanship</b> .....	<b>16</b>
<b>1.18.1</b>	<b>Cleaning</b> .....	<b>16</b>
<b>1.18.2</b>	<b>Accessibility</b> .....	<b>16</b>
<b>1.18.3</b>	<b>Construction Loads</b> .....	<b>17</b>
<b>1.18.4</b>	<b>Fixings</b> 17	
<b>1.18.5</b>	<b>Cutting and Patching</b> .....	<b>17</b>
<b>1.18.6</b>	<b>Inserts, Sleeves, Escutcheons and Curbs</b> .....	<b>17</b>
<b>1.18.7</b>	<b>Access Panels and Doors</b> .....	<b>19</b>
<b>1.18.8</b>	<b>Flashing</b> .....	<b>20</b>
<b>1.19</b>	<b>Warranty</b> .....	<b>21</b>
<b>1.20</b>	<b>Preventative Maintenance</b> .....	<b>21</b>
<b>1.21</b>	<b>Inspection Testing and Maintenance</b> .....	<b>21</b>
<b>1.22</b>	<b>Services for Testing</b> .....	<b>21</b>
<b>1.23</b>	<b>Spare Parts and Tools</b> .....	<b>21</b>
<b>1.24</b>	<b>Spare Parts Information &amp; Tools</b> .....	<b>22</b>
<b>1.25</b>	<b>Special tool and test Equipment List:</b> .....	<b>23</b>
<b>1.26</b>	<b>Factory Witnessing Tests and Certificates</b> .....	<b>24</b>
<b>1.27</b>	<b>Training of Engineering Staff</b> .....	<b>24</b>

## **1.1 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 MEW 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.

## **1.2 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 subcontractors 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.

### 1.3 Data to be Supplied with Tender

1. Initial technical submissions are to accompany the bid including full technical details of every item of equipment proposed for the Project, with the appropriate figures and details highlighted in marker pen or similar in standard manufacturer's catalogues.
2. After final checking of sizing after award of contract, re-submission shall be made with any changes specifically noted.
3. Technical submissions shall be submitted for all equipment as specified in the Project Documentation.
4. 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.

### 1.4 External Design Conditions

The design environmental conditions for Amman - Jordan are as follows:

<b><u>Summer</u></b>	
Month	August
Dry Bulb Temperature	38 °C
Wet Bulb Temperature	24 °C
Average daily range	17.8 °C
<b><u>Winter</u></b>	
Dry Bulb Temperature	0.0 °C
Rainfall	75 mm/hour

#### 1.4.1 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 Standards Specifications
- c. **BSI:** British Standards Institute - CP.: Code of Practice
- d. **NFPA:** National Fire Protection Association- Life Safety Code
- e. **CIBSE:** The Chartered Institution of Building Services Engineers - U.K.
- f. **AMCA:** Air Movement and Control Association.
- g. **ANSI:** American National Standards Institute.
- h. **ASME:** The American Society of Mechanical Engineers.
- i. **SMACNA** Sheet Metal and Air Conditioning Contractor's National association
- j. **NPC :** Sheet Metal and Air Conditioning Contractor's National association
- k. **IBC :** International Building Code
- l. **IMC:** International Mechanical Code
- m. **IPC:** International Plumbing Code
- n. Local Codes, standards and Specifications.
- o. Water Authority Regulations

In case of any contradictions among the above codes and standards, the local codes and standards shall supersede and prevail

### **1.5 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. The Engineer reserve the right to reject any equipment in favour of his choice, and with no obligation for justification of his selection

### **1.6 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 wind-blown sand and other matter. All equipment shall be suitable for operation over the ambient temperature range 0 °C to 55 °C.

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.

- (a) Maximum ambient temperature of 45 °C
- (b) Maximum relative humidity of 80 %
- (c) Altitude 800 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.

## **1.7 Pretender Requirements**

### **1.7.1 Familiarization**

Visit the site, acquaint to the site conditions to familiarize with the status and progress of the construction of 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.

### **1.7.2 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.

### **1.7.3 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.

#### **1.8 Co-Ordination with Other Trades**

Co-ordinate the layout with the Main Contractor and 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.

#### **1.9 Co-Ordination with Other Subcontractors**

Co-ordinate and liaise with other contractors and subcontractors. This shall include but not limited to the HVAC, plumbing and fire fighting supplier equipment suppliers. As well as building management and control system, utility billing systems, landscape, irrigation, kitchen and laundry, water features, interior & lighting, fixed furniture and equipment, spas & pools, and the tenants subcontractors. The coordination shall include the verification of the equipment specifications and their requirement based on the actual site conditions,

Set up the tie in connections of all required services, and liaise with the engineer to consider the impact of such the service requirement on the main services and plants.

#### **1.10 Hand Over Works from Other Subcontractors**

Where the scope of works includes continuation of works, which were carried by other contractors, such as first fix pipes, below ground drainage, puddle flanges, sleeves... etc. the contractors shall , in coordination with the engineer, test inspect and report all defects and damages as he shall take over the other completed works before commencement his works.

It is considered the contractor's responsibility to hand over the complete operational and sound system upon the taking over the other submitted works.

#### **1.11 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 Main Contractor's schedule and sufficiently in advance of Building work to allow sufficient time for checking and possible amendment and re-submission.

## **1.12 Drawings and Technical Data**

### **1.12.1 DRAWING MATERIAL AND SIZE**

- a. Prepare drawings for review submittals, bidding and construction in accordance with instructions of the engineer. Submit record drawings on bond paper, full size one copy and on standard format DVD, two copies. Each of the two electronic copies shall contain .dwg and .pdf files of each drawing, and .doc and .pdf files of each project manual document. Each DVD will be labelled as to station #, project #, date, etc.
- b. Standard sheets are size A0, 1069 mm (42 in.) long by 762 mm (30 in.) wide.
- c. Electronic files shall conform to ISO CAD and Guidelines.

### **1.12.2 DRAWING FORMAT:**

Computer aided design and drafting (CAD) is required for presenting drawings. The format to be used in creating the CAD drawings (i.e. layer/level structure, fonts, font sizes, file naming conventions, etc.) shall be the latest edition of the ISO I CAD Standard.

### **1.12.3 SIZE AND SCALE:**

Use minimum lettering height of 3 mm. Computer generated or typewritten notes are a must. Hold screening, shading, crosshatching and other indications of materials or locations to a minimum. Place symbols and lettering so that they are not confused with dimension lines, arrowheads, or other indications.

### **1.12.4 TITLE BLOCK**

- a. Use the Standard design Title Block for CAD drawings.
- b. Identify drawings above the title block in large font stating as appropriate either "Schematics ONLY" or "Design Development ONLY", and in small font "NOT for Construction".

### **1.12.5 GENERAL INFORMATION**

- a. Organize and number drawings into technical classifications as listed in the design drawings
- b. Indicate scales by note for each plan, section and detail on each drawing. Provide graphic scales.
- c. Show north arrow indicators on plan sheets.
- d. Orient plans with North toward the top of the drawing.
- e. Note section symbol on the referenced sheet location.

- f. Indicate the relationship of details, plans, elevations, and sections, other than standard details, by cross-reference. Note the sheet number and drawing location of detailed feature on details and sections. Provide key plans on stair-section sheets to indicate the location of the stairs in the buildings.
- g. Provide a key plan to show the location of a portion of a plan or elevation with respect to the total project.
- h. Use legends, abbreviations, and symbols that conform to the design standard.
- i. Do not write specification information on contract drawings. Show notes or dimension information on the 1:100 (1/8 in.) scale drawings or 1:50 (1/4 in.) scale drawings, but not on both. Do not repeat drawing information on plans, elevations or details.
- j. Clearly distinguish between new, existing, and replacement items of work.
- k. Locate room names and room numbers within the spaces to which they apply and locate equipment symbols or names adjacent to the equipment shown on the floor plans.
- l. Indicate all smoke barriers and fire-rated partitions on architectural, heating, ventilating, and air-conditioning (HVAC), plumbing, and electrical 1:100 (1/8 in.) scale floor plans.
- m. Show future expansions (both vertical and horizontal) by dotted lines on site plans, architectural floor plans, engineering floor plans, and in elevations and sections.
- n. For buildings which are to be fully sprinklered, place the note "FULLY SPRINKLERED" above the title block, close to the right margin, on each architectural, structural, HVAC, plumbing, and electrical floor plan.

#### **1.12.6 IDENTIFICATION OF DRAWINGS**

- a. General. Bind all drawings into sets and identify drawing classification, relative order of issue, amendment, and change order by symbols placed on drawing title blocks as described below:
  - i. Building number shall precede the classification identification (Building No. 20 as example) 20-BI 1, 20-GS 1, 20-AS 1, 20-SS 1. When a drawing reflects work that is associated with several buildings or the station in general, such as details sheets and exterior utility distributions systems, no building number will precede the symbol which identifies the classification.
  - ii. Number the drawings in sequence within each classification, for example 1-SS 1, first structural sheet Building No. 1; 1-SS 2, second structural sheet, etc. Directly below the drawing number, show the position within the series that each drawing occupies, for example, sheet 1 of 30 (structural sheets), sheet 2 of 30 (structural sheets), etc.
  - iii. Drawings for each new project shall begin with number one. Distinguish the drawings by their project titles and dates.
  - iv. The preferred method for classifying drawings is by identification of technical information shown on drawing, for example, Architectural or Electrical. However, an exception is made when one design discipline has limited work. Show this limited work on a drawing with another classification. The drawing number shall show the symbol for the major work classification; indicate that other work is shown on the same drawing by a description, such as "Plumbing", above the title block.
  - v. When work including two or more buildings is described on a single drawing, the sheet shall bear the number of the building involving the work of the major magnitude;

indicate that work on other buildings is shown on the same drawing by a note above the title block.

- vi.
- b. Amendment Construction Drawings
  - i. Issue a drawing which is produced to supersede an original working drawing as a corrected plot of the CAD file or as a photocopy reproduction of the original drawing, on vellum or mylar. Identify the number of this amendment drawing with the number of the sheet it replaces plus the suffix "R". Identify additional replacements of the same drawing as - "R2"- "R3", etc. Note the revisions dates. Place the words "Amendment Drawing" above the Title block with a statement of the original drawing which it supersedes.
  - ii. Give a drawing, which supersedes a portion of an original working drawing, a new number in sequence with other drawing numbers. Place the notation "Amendment Drawing" above the title block with a statement of the drawing number of the original drawing it modifies. Insert the date of the amendment on the drawing. Place a cross reference note, on the superseded drawing, calling attention to the amendments.
- c. Reissue Construction Drawings
  - i. When a complete set of working drawings is to be reissued without change, remove the original date and insert the new date of the reissue.
  - ii. When a complete set of working drawings is to be reissued with changes, replot the changed drawings, or provide a photocopy vellum or mylar reproduction of the original drawings, where feasible, with changes incorporated. These reproductions (or drawings) shall retain original dates and drawing numbers with the suffix - "R", but the reissue date shall appear in the Revision column.
  - iii. When some drawings only of an entire set are changed, the entire set shall retain original dates and drawing numbers with the suffix "R" added; and the reissue date shall appear in Revision column of the changed drawings only.
- d. Completion Item Construction Drawings. Completion Items are additional work required beyond the original contract and after its completion.
  - iv. Provide drawings prepared to describe Completion Items with drawing numbers in sequence with last working drawing of a series.
  - v. In the title blocks of Completion Item drawings, show the same project titles and project numbers as the original working drawings

### **1.12.7 Shop DRAWINGS**

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.

Make all adjustments to the design as are necessary to accommodate the technical and physical, requirements of the selected equipment in the preparation of the shop drawings. Such adjustments shall at all times ensure that the final performance of the completed installations is achieved as intended.

Check and coordinate 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.

Ensure that equipment offered are compatible (e.g. 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 consultant should be considered for information purposes only and 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 Consultant's attention for resolution.

Specific requirements for a piece of equipment will govern over general requirements for a type of equipment.

### **1.13 Complete & 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.

### **1.14 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.

### **1.15 Record Drawings and Manuals**

Within thirty days of the Certificate of Completion, the Contractor shall provide 3 sets of fully detailed "as installed record drawings" of the whole Contract Works together with full installation operating and maintenance instructions to be checked and approved by the Engineer. Temporary manuals and

record drawings shall be made available at least one month before to enable the Employer's staff to familiarize themselves with the installation. These should preferably be the final manuals with temporary insertions for the items which cannot be finalized until the Works are completed and tested.

The drawings shall comprise general arrangement drawings of all installations; detail drawings of plant rooms and similar areas; single line diagrams of all services; line diagrams of control systems and electrical circuit diagrams.

The drawings shall indicate the colour coding, labelling and identification of all the services as previously described, and shall give full working details of size, load, duty and capacity of each item of plant. The drawings shall also clearly indicate the location of all vents, drains, dampers, valves and test points. The line diagram shall indicate the type, location and function of each component and, together with the interconnecting wiring and piping, the terminal connection reference numbers or letters on the actual equipment.

The drawings shall:

- a) Indicate sizes and positions of all plant, equipment pipes conduits.
- b) Indicate the circuit reference for all equipment and each outlet shown. All references shall agree with the chart and labels in distribution boards fixed to the switchgear.

In addition to the Record Drawings, the Contractor shall obtain and provide two sets of the manufacturer's detailed drawings of all items of plant, suitably titled and with drawing reference numbers added.

The Record Drawings shall be specially prepared and shall not be modified Working Drawings. The preparation of these drawings shall be processed during the installation of the Contract Works, as each section is completed. To ensure that this requirement is met, the Engineer shall be all to inspect the drawings on request.

The operating and maintenance instructions shall be prepared as soon as the working drawings are in hand and shall take the form of a manual in which is described the layout and function of the system, schedules of components comprising each and every item of equipment including manufacturer's name, reference and serial number and operating maintenance instructions based on the manufacturer's standard amplified where necessary. An overall maintenance schedule shall be prepared by the Contractor on a system basis, listing out in simple terms the plant, nature of attention and intervals due. This shall be cross-referenced with the manufacturer's standard instructions.

Drawings shall be arranged to fold out from their position and be entirely visible when any part of the manual read. They shall be printed on linen backed paper.

The manuals shall be encased in loose leaf binders.

The Contractor shall include for the preparation and supply of four copies of the manuals and drawings after all details have been approved by the Engineer. Also the supply of two sets of reproducible, one set to be handed to the Client and one set to be kept with the Engineer.

### **1.16 Operations & 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 each and every 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.

### **1.17 Operation and Maintenance Manuals**

The Operation and Maintenance manuals shall be prepared by a specialised, third party firm, with a minimum of (5) years' experience in this field, and on similar projects.

The Operation and Maintenance (O&M) Manuals shall be of standard formats and bound in eight volumes as following:

- a- Vol. (1) Register including manufacturer's name and address ,trade or brand name, local supplier's name and address
- b- Vol. (2) Factory Inspection and test certificates
- c- Vol. (3) Testing and Commissioning Reports
- d- Vol. (4) Statutory approvals, guaranties and warranties
- e- Vol. (5) Operation Manuals, Instruction / System Start up and shutdown Procedures
- f- Vol. (6) Maintenance Instructions
- g- Vol. (7) Supplementary information regarding trouble shooting, spare parts and tools
- h- Vol. (8) As Built Drawings

These specifications are applicable for all the relevant plant systems and equipment, especially the mechanical and electrical disciplines.

The Contractor shall submit instruction manuals covering all mechanical and plumbing and fire fighting equipment and machinery installed in the Works as specified under sections dealing with mechanical and electrical work.

The Contractor shall prepare and submit two (2) copies of Operation and Maintenance Manuals to the Engineer for review. The Engineer will mark up one copy and return it to the Contractor for correction if necessary.

The Contractor shall submit six (6) copies of approved manuals in hard cover bind incorporating all of Engineer's comments and corrections.

The Contractor shall submit two copies of each CD, one marked "Master" the other marked "Back-up". Drawing files shall not be compressed. Each CD shall carry a manufacturer's lifetime warranty and be virus checked before submission.

The Manuals in CD contents format shall be prepared as a "Portable Document Format" (PDF) using Adobe Software. Non electronic documents shall be scanned and converted to PDF image files. The CD shall be self-executing and the software for the operation of the CD is Adobe Acrobat Reader which shall be delivered as part of the CD operating system. The Adobe Acrobat Reader shall allow the PDF files to be viewed, printed and navigated.

A table of contents shall be incorporated on the CD and shall open automatically upon the insertion of the CD and this shall be the key documents for the structure of the CD. All volumes, sections and chapters of the Manuals shall be addressed from this document and every entry in the table of contents shall contain hypertext links to the corresponding volume, section or chapter of the Manuals. The user shall be able by one keystroke to return to the table of contents from any page of the Manuals. The index system shall be based on the list of contents and its sub-division and link to a master index and search facility.

The electronic Manuals on CD shall be an exact copy of the hard copy version and once a section is opened it must be capable of being read or printed page by page. Each CD shall include an electronic database index listing all the files. The Contractor shall also submit a hard copy of the database index with the CD's.

The contractor shall also submit an index binder for referencing all documents.

## **1.18 Workmanship**

### **1.18.1 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.

### **1.18.2 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.

### **1.18.3 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.

### **1.18.4 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 manufacturer, 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.

### **1.18.5 Cutting and Patching**

1. The Contractor shall Inform all other Divisions in time concerning required openings. 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 this Contractor. Where finishing work is involved, this will only be reinstated by the Contractor responsible for the original work. 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.

### **1.18.6 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% 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:
  - i- For all horizontal sleeves in through fire rated walls , Use a seal equal or .better fire rated than the wall to be sealed
  - j- For horizontal concealed sleeves through fire walls and through walls separating areas of different air pressure, use a permanently resilient silicone based sealing compound.
  - k- 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- Fibre 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.
- 2- 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 every 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.

#### **1.18.7 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 coordination 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.

#### **1.18.8 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/m<sup>2</sup> 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/m<sup>2</sup> 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 to 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.

### **1.19 Warranty**

**Contractor shall provide a minimum two years manufacturer warrantee for all equipment if not otherwise specified.**

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 parts, 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.

### **1.20 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.

### **1.21 Inspection Testing and Maintenance**

This contract shall also include for all necessary inspection, testing and maintenance of the services, during the Defects Liability Period.

### **1.22 Services for Testing**

All fuel, oil, gas, water and electricity for the purposes of testing and commissioning shall be provided by the Contractor up to the date of the issue of the Certificate of Temporary Acceptance. This shall include the initial charging of all systems and equipment with water, oil and refrigerants, etc.

### **1.23 Spare Parts and Tools**

After completion of the Works and during the specified maintenance period the Contractor shall be responsible for the supply and installation at the fixed time recommended by the manufacturers of all spare parts and components, required for the ideal running of all engineering services installation.

In addition the contractor shall coordinate with the client for the procurement of the following recommended spare parts needed for proper preventive maintenance program. The contractor shall allow enlarging this list based upon the recommendations of the equipment suppliers.

## **EQUIPMENT**

## **RECOMMENDED SPARE PARTS**

Air Conditioning	1 set controls
Fan Coil Units	10% filter replacement
HVAC Control	5% thermostat replacement
All HVAC Starters	1 set contacts each type
Contactors & Relays	1 magnetic coil each type 1% heater replacement 5% pilot light replacement
All Hand-Operated Shut-off Valves Automatic Control Valves	5% complete valves of each size type 10% complete repacking, reseating kits each type One automatic control valve of each size in system
Automatic air-vents	six automatic and manual air vents, for each size in system
Insulation	2% replacement each type and size

#### **1.24 Spare Parts Information & Tools**

1. Spare Parts information: The Contractor shall furnish spare parts information for all equipment furnished under this contract. The information shall be complete, legible, organized, and submitted by system in two (2) copies, and shall include:
  - 1.1 A list of spare parts, special tools, and supplies, for each item of equipment, which are either normally furnished a no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract.
  - 1.2 A complete list of spare parts and supplies recommended by the manufacturer to assure efficient and continuous operation of each item of equipment for a period of two (2) years after completion and acceptance of entire work under this contract.
  - 1.3 The list shall show the recommended minimum stockage level for reordering and shall identify all long lead items. A long lead item is defined as any item of equipment, which cannot be ready for delivery in less than six months after receipt of order. The lists shall include the following information for each recommended spare part:

Manufacturer's Part Name

Manufacturer's Name and Address  
Manufacturer's Part Number  
Manufacturer's Drawing Number Showing Part  
Next Higher Assembly  
Equipment Symbol Keyed to Contract Drawings  
Recommended Number of Spares  
Net Unit Price  
Quantity installed per Assembly  
Lead Time  
Shelf Life  
Peculiar Life  
Peculiar cleaning, calibration, packaging and preservation requirements.  
Name and address of the authorized spare parts representative and spare parts stocking source nearest to the project site.  
Alternate sources of procurement.

**1.25 Special tool and test Equipment List:**

The Contractor shall furnish to the Engineer two (2) copies of recommended list of all special tools and test equipment. The special tools and test equipment shall cover all items required for the successful operation and maintenance during a ten year equipment life.

In compiling the special tools and test equipment list, the Contractor shall indicate all special tools and test equipment items that require calibration, including frequency and method. Necessary standards shall be listed immediately after each item that requires calibration, and they must be traceable to the National Bureau of Standards or other reference satisfactory to the Engineer.

Tool lists shall include all tools required. Test equipment lists shall include all equipment required for acceptance testing and calibration. The Contractor shall supply two (2) copies of all vendor-supplied catalogues and instructions for operation and maintenance of the tools and test equipment furnished under this contract.

**Submission of Preliminary Parts List:**

The Contractor shall submit one (1) copy of his preliminary parts list with recommendations for spares within the time frame set forth above. This list is subject to the Engineer review and written approval.

The Consultant may revise the listing as to quantities of recommended spares as a condition of approval. The Consultant reserves the right to order all, none or any portion of additional spare parts from the manufacturer's complete parts list and the preliminary Parts List.

Re submittals: Any re submittals or additional submittals of equipment lists, spare parts lists or associated information shall be made within thirty (30) calendar days from notice by the Engineer and all costs associated with the submissions shall be borne by the contractor.

Final Parts List: The final list shall be submitted not later than one hundred twenty (120) calendar days prior to contract completion date, in five (5) copies and shall be annotated "Final" on each sheet.

#### **1.26 Factory Witnessing Tests and Certificates**

Contractor shall allow for the Engineer and the Client's representative to witness tests of major items of equipment at manufacturer's works (i.e. Chillers, Air handling Units, DX Package Units, Cooling Towers, Sanitary Fixtures, Water Treatment Equipment, fume hoods, cold store systems, Pumps and fans).

The Engineer will advise the Contractor the list of equipment to be inspected. The Contractor shall give the Engineer the required notice of the date on which the plant will be ready for testing. The Engineer will signify his intention to attend the tests or accept the Contractor's Test sheets.

The Contractor shall supply all the Test certificates in original to the Engineer at the time of handing over the project.

#### **1.27 Training of Engineering Staff**

The Contractor shall provide training for the employees of the employer. Such training shall cover all aspects of using, running, commissioning and maintaining of all Engineering services.

**\*End of Section\***

**SECTION 15100**

**PIPE WORKS SPECIFICATIONS**

# PIPE WORKS SPECIFICATIONS

## Table of Contents

### Contents

<b>1. Pipe Works Fittings.....</b>	<b>4</b>
<b>1.1 Codes and Standards.....</b>	<b>4</b>
<b>1.2 Pipe work And Fittings .....</b>	<b>9</b>
1.2.1 General .....	9
1.2.2 Storage and Protection .....	11
1.2.3 Pipe work Materials .....	12
1.2.4 Mild Steel Pipe work .....	12
1.2.5 Jointing of Mild Steel Pipe work .....	12
1.2.6 Mild Steel Fittings .....	13
1.2.7 Galvanized Steel Fittings .....	13
<b>1.3 Copper Pipes .....</b>	<b>14</b>
1.3.1 Copper Fittings.....	14
<b>1.4 Ductile Iron Pipe work.....</b>	<b>15</b>
<b>1.5 Ductile Iron Fittings .....</b>	<b>15</b>
<b>1.6 CPVC Pipes .....</b>	<b>15</b>
<b>1.7 Polypropylene pipes.....</b>	<b>16</b>
<b>1.8 Pipes and Fittings - Joints .....</b>	<b>16</b>
<b>1.9 Fasteners &amp; Joints .....</b>	<b>16</b>
1.9.1 Screwed Joints .....	16
1.9.2 Welded Joints .....	16
1.9.3 Flanged Joints .....	17
1.9.4 Mechanical Couplings .....	18
1.9.5 Pipe work Supports.....	18
1.9.6 Expansion And Contraction Of Pipe work .....	21
1.9.7 Anchor Points .....	25
1.9.8 Thrust Blocks.....	26
1.9.9 Trench Excavation .....	26
1.9.10 Granular Bedding .....	26
1.9.11 Laying of Pipelines and Fittings .....	27
1.9.12 Backfilling Excavations .....	27
1.9.13 Valve Chambers .....	27
<b>1.10 Pipeline Inspections .....</b>	<b>27</b>
<b>1.11 Testing of Pipe work.....</b>	<b>28</b>
1.11.1 Grading of Pipe work .....	28

1.11.2 Air Venting Of System .....	28
1.11.3 Air Separator.....	28
1.11.4 Pipe Cleaning .....	29
1.11.5 Drainage And Flushing of System .....	29
1.11.6 Pipe Sleeves.....	31
1.11.7 Escutcheons.....	32
1.11.8 Dielectric Fittings .....	32
<b>1.12 VALVES.....</b>	<b>33</b>
1.12.1 SUBMITTALS .....	33
1.12.2 DELIVERY, STORAGE, AND HANDLING .....	33
1.12.3 BASIC, COMMON FEATURES.....	33
1.12.4 DESCRIPTION .....	34
1.12.4.1 Strainers.....	34
1.12.4.2 Isolation And Commissioning Valves .....	34
1.12.4.3 Non Return Valves .....	34
1.12.4.4 Differential Pressure Regulating / Reducing Valves (DPRV) .....	34
1.12.4.5 Pressure Independent Control Valves .....	35
1.12.5 INSTALLATION.....	36
<b>1.13 Miscellaneous .....</b>	<b>36</b>
1.13.1 Floor Plates .....	36
1.13.2 Flashing Flanges / Puddle Flanges .....	36
1.13.3 Safety & Pressure Relieve Valves.....	36
1.13.4 Valves And Stopcocks.....	37
1.13.5 Water Shock Absorbers.....	37
1.13.6 Pressure, Altitude and Temperature Gauges .....	37
<b>1.14 Schedule Of Instrumentation.....</b>	<b>37</b>

## 1. Pipe Works Fittings

### 1.1 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
- 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.)
- 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.
- BS 10 Specification for flanges and bolting for pipes, valves and fittings.
- BS 21 Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).
- BS 143& 1256 Specification for malleable cast iron and cast copper alloy threaded pipe fittings.
- BS 639 Specification for covered carbon and carbon manganese steel electrodes for manual metal-arc welding.
- BS 806 Specification for the design and construction of ferrous piping installations for and in connection with land boilers.
- BS 864 Part 2 : Capillary and compression tube fittings of copper and copper alloy.  
Specification for capillary and compression fittings for copper tubes.
- Part 3 : Compression fittings for polyethylene pipes.
- BS 1387 Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.
- BS 1453 Specification for filler materials for gas welding.
- BS 1560 Circular flanges for pipes valves and fittings (Class designated).  
Part 3 : Steel, cast iron and copper alloy flanges.
- BS 1600 Specification for identification of pipelines and services.
- BS 1710 Specification for identification of pipe for the petroleum industry.
- BS 1873 Specification for steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petro-chemical and allied industries.
- BS 1965 Specification for butt-welding pipe fittings for pressure purposes
- BS 2640 Specification for Class II oxy-acetylene welding of carbon steel pipe work for carrying fluids.

- BS 2871 Specification for copper and copper alloys. Tubes.
- Part 1 : Copper tubes for water, gas and sanitation.
  - Part 2 : Tubes for general purposes.
  - Part 3 : Tubes for heat exchangers.
- BS 2971 Specification for Class II arc welding of carbon steel pipe work for carrying fluids.
- BS 3505 Specification for unplasticized polyvinyl chloride (PVC-U) pressure pipes for cold potable water.
- BS 3506 Specification for unplasticized PVC pipe for industrial uses.
- BS 3600 Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes.
- BS 3601 Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes.
- BS 3974 Specification for pipe supports.
- BS 4127 Specification for light gauge stainless steel tubes
- Part 2 : Metric units.
- BS 4190 Specification for ISO metric black hexagon bolts, screws and nuts.
- BS 4320 Specification for metal washers for general engineering purposes. Metric series.
- BS 4346 Joints and fittings for use with unplasticized PVC pressure pipes.
- Part 1 : Injection molded unplasticized PVC fittings for solvent welding for use with pressure pipes, including potable water supply.
  - Part 2 : Mechanical joints and fittings principally of unplasticized PVC.
  - Part 3 : Specification for solvent cement.
- BS 4504 Circular flanges for pipes, valves and fittings (PN designated).
- Part 3 : Steel, cast iron and copper alloy flanges.
    - \* Section 3.1 : Specification for steel flanges.
    - \* Section 3.2 : Specification for cast iron flanges.
    - \* Section 3.3 : Specification for copper alloy and composite flanges.
- BS 4772 Specification for ductile iron pipes and fittings.
- BS 4865 Dimensions of gaskets for pipe flanges to BS 4504.
- Part 1 : Specification for non-metallic flat gaskets  
(including gaskets for flanges to BS 4772).
  - Part 2 : Specification for metallic spiral wound gaskets for use with steel flanges.
  - Part 3 : Specification for non-metallic envelope gaskets.
  - Part 4 : Specification for corrugated, flat or grooved metallic and filled metallic gaskets for use with steel flanges.
- BS 4991 Specification for polypropylene copolymer pressure pipe.

BS 5292 Specification for jointing materials and compounds for installations using water, low-pressure steam or 1st, 2nd and 3rd family gases.

BS 5391 Specification for acrylonitrile-butadiene-styrene (ABS) pressure pipe.

Part 1 : Pipe for industrial uses.

BS 5392 Specification for acrylonitrile-butadiene-styrene (ABS) fittings for use with ABS pressure pipe.

Part 1 : Fittings for use with pipe for industrial uses.

BS 7572 Code of Practice for thermally insulated underground piping systems.

**VALVES :**

BS 759 Valves, gauges and other safety fittings for application to boilers etc.,

Part 1 : Specification for valves, mountings and fittings.

BS 1010: Specification for draw-off taps and stop valves for water services (screw-down pattern)

Part 2 : Draw-off taps and above - ground stop valves.

BS 1123: Safety valves, gauges and fusible plugs for compressed air or inert gas installations.

Part 1 : Cop for installation.

BS 1212 Float-operated valves.

Part 1 : Specification for piston type.

Part 2 : Specification for diaphragm type float operated valves (copper alloy body) (excluding floats).

Part 3 : Specification for diaphragm type float operated valves (plastics bodied) for cold water services only (excluding floats).

BS 1552 Specification for manual shut-off valves for use with 1st, 2nd and 3rd family gases.

BS 1868 Specification for steel check valves (flanged and butt welded ends) for the petroleum, petro-chemical and allied industries.

BS 2580 Specification for underground plug cocks for cold water services.

BS 2767 Specification for valves and unions for hot water radiators.

BS 2879 Specification for draining taps (screw down pattern).

BS 5041 Fire hydrant systems equipment. (Specifications for landing valves for wet and dry risers etc,).

BS 5150 Specification for cast iron gate valves.

BS 5151 Specification for cast iron gate (parallel slide) valves for general purposes.

BS 5152 Specification for cast iron globe and globe stop and check valves for general purposes.

BS 5153 Specification for cast iron check valves for general purposes.

BS 5154 Specification for copper alloy globe, globe stop and check, check and gate valves.

BS 5155 Specification for butterfly valves.

- BS 5156 Specification for diaphragm valves.
- BS 5157 Specification for steel gate (parallel slide) valves.
- BS 5158 Specification for cast iron plugs valves.
- BS 5159 Specification for cast iron and carbon steel ball valves for general purposes.
- BS 5160 Specification for steel globe valves, globe stop and check valves and lift type check valves.
- BS 5163 Specification for predominantly key-operated cast iron valves for waterworks purposes.
- BS 5353 Specification for steel plug valves.
- BS 5412 Specification for the performance of draw-off taps with metal bodies for water services.
- BS 5433 Specification for underground stop valves for water services.
- BS 5494 Specification for gas taps for domestic and catering appliances.
- BS 5741 Specification for pressure regulators used in welding, cutting and related processes.
- BS 5963 Specification for electrical automatic gas shut-off valves.
- BS 6067 Specification for multifunctional gas controls for domestic, commercial and catering applications.
- BS 6282 Part 1 : Specification for check valves up to DN 54.
- Part 2 : Specification for terminal anti-vacuum valves up to DN 54.
- Part 3 : Specification for in-line anti-vacuum valves up to DN 42.
- Part 4 : Specification for combined check and anti-vacuum valves up to DN 42
- BS 6283 Safety devices for use in hot water systems.
- Part 1 : Specification for expansion valves for pressures up to and including 10 bars.
- Part 2 : Specification for temperature relief valves for pressures up to and including 10 bars.
- Part 3 : Specification for combined temperature and pressure relief valves for pressures up to and including 10 bars.
- Part 4 : Specification for drop-tight pressure reducing valves of nominal size up to and including DN 54 for supply pressure up to 12 bars.
- BS 6284 Specification for thermostatic radiator valves.
- BS 6675 Specification for servicing valves (copper alloy) for water services.
- BS 6759 Specification for stop valves for steam and hot water.
- BS 7350 Specification for double regulating globe valves and flow measurement devices for heating and chilled water systems.
- BS 7461 Specification for electrically operated automatic gas shut-off valves fitted with throughput adjusters, proof of closure switches, closed position indicator switches or gas flow control.

BS 7478 Thermostatic valves for radiators, selection and use.

BS 7556 Thermostatic radiator valves, specification for dimensions and details on connection.

BS EN 215 Thermostatic valves for radiators.

API Std 5B Screw threads (for use with BS 1600 and ANSI B36.10 and ANSI B125.1 pipe)

ANSI B2.1

API Std 5L Line pipe.

API Std 1104 Standard for welding pipelines and related facilities.

ANSI B16.5 Steel pipe flanges, flanged valves and fittings.

ANSI B36.10 Welded and seamless wrought steel pipe.

ANSI B125.1 Welded and seamless steel pipe.

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.

## 1.2 Pipe work And Fittings

### 1.2.1 General

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, who shall be nominated 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.

Where pipe work is not readily accessible, it shall be welded. 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.

No joints shall be formed within the thickness of walls, floors or ceilings.

Unions or flanges shall also be provided generally at a maximum spacing of one per 18 meters in position agreed by the engineer.

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, busses, 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 less than the sum of the outside diameters of the branches.

Where pipe work is routed within false ceilings or sealed service ducts or other encasement where access is difficult, all pipe work shall be welded.

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.

No pipe work shall be chased into floor slabs, roof slabs or walls. During the installation period open ends of pipe work shall be capped off using purpose-made plugs or blank counter flanges.

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.

Swing joints, off-sets, expansion joints etc. shall be provided wherever necessary to accommodate expansion of piping.

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.

#### **1.2.2 Storage and Protection**

- A. All pipe work, fittings and accessories shall be stored in properly ventilated, well-supported racked storage sheds.
- B. All pipe work, fitting and accessories shall be inspected prior to use and damaged material disposed of.

- C. 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.

### **1.2.3 Pipe work Materials**

All pipe work installed by the Contractor shall conform with the specified materials, specified under Appendix "schedule of pipeline".

### **1.2.4 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.

Steel pipe work for welding shall be supplied with plain ends, beveled for butt-welding.

Where pipes are required for screwed joints, they shall be provided with screwed taper threads to B.S.21, Part 1.

Steel pipes, which are to be used 'black', shall be varnished externally throughout their length after manufacturer.

Where steel pipes are to be installed underground, they shall be double wrapped in special tape suitable for the application.

### **1.2.5 Jointing of Mild Steel Pipe work**

Black mild steel pipe work up to and including 50 mm dia. shall be jointed by screwing or by mechanical grooved joints.

Black mild steel pipe work of 65 mm. dia. and above shall be jointed by mechanical grooved joints or welded unless welding would constitute an unacceptable fire hazard.

All galvanized steel pipe work shall be screwed or jointed by mechanical grooved joints.

Black mild steel pipe work in the following areas shall be welded or jointed by mechanical grooving and couplings regardless of their size:

- a) Pipe work running in ceiling voids, sizes 40mm and above.
- b) Pipe work in boiler room, plant rooms and pump rooms and rooftop plant areas.
- c) Pipe work in ducts, trenches tunnel and other positions not readily accessible.
- d) Pipe work in rooms housing electrical switchgear, telecommunications equipment, computers, control gear, etc. shall be welded only.

Flexible mechanical couplings shall fasten all mechanical grooved joints; unless manufacturer recommends it, to have rigid coupling.

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.

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.

#### **1.2.6 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

#### **1.2.7 Galvanized Steel Fittings**

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, and 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.

### 1.3 Copper Pipes

All pipe work and fittings shall be from the same manufacturer.

Copper tubes to EN 1057 / BS 871: Part 1 Table 'X'. All fittings shall be of the capillary type to British Standard 864: Part 2, manufactured from gunmetal, copper or dezincification resistance brass.

The copper tubes shall comply with the following specification with regard to sizes: -

Nominal Size of tube in mm	Outside Diameter in mm		Nominal Wall Thickness in mm	Thickness of Sheathing in mm
	Max	Min		
15	15.045	14.965	1.0	1.0
22	22.055	21.975	1.2	1.0
28	28.055	27.975	1.2	1.0
42	42.07	41.99	1.5	1.6
54	54.07	53.99	2.0	1.6

#### 1.3.1 Copper Fittings

Capillary fittings shall be to EN 1057/ B.S.864, Part 2, type 'A'. All fittings shall be manufactured from materials being non-dezincifiable, i.e. copper or gunmetal .

Silver brazing fittings shall be manufactured from copper tube to EN 1057/ B.S.2871, Part 1, table X, suitably socket for assembly with silver brazing alloys to EN 1057/ B.S.1845 .

All fittings shall be suitable for the working conditions of the system and purpose-made fittings shall be used throughout. All branch connections shall be by purpose made tees, either square or sweep, to suit the application .

Where practical, fittings shall be of the long sweep pattern. Where standard fittings are not available for the duty and sizes required, reductions shall be made with purpose-made fittings .

Where light gauge copper tubes are pulled on Site to form bends and offsets, the materials used shall be as for adjacent straight lengths. Tubes having nominal bores up to 28 mm. may be bent cold but larger size shall be annealed before manipulation .

In all cases, tubes shall be loaded prior to bending with springs, low melting point alloys or inert sand, care being taken that contamination of the tube material is avoided. Where bending machines are used, these shall have smooth clean guides and formers, any scored or damaged tools being rejected

No pulled bends with any deformity whatsoever resulting in the forming of the bend shall be permitted

Unions shall be manufactured from gunmetal and shall be in accordance with B.S.864 .

Copper pipe work up to and including 67 mm. dia. shall be jointed using capillary fittings or mechanical grooved couplings.

Where necessary due to high temperatures, the capillary fittings shall be high duty type with integral hard solder ring of the silver brazing type .

Copper pipe work of 76.1 mm. and 108 shall be jointed using wedge ring soldered fittings .

Copper pipe work of 159 mm. dia. and above shall be jointed using silver brazing fittings.

All jointing of copper tubes shall be strictly in accordance with the fitting manufacturer's recommendations.

All solder droppings and surplus flux shall be removed on completion of the joint.

During all jointing operations the fitter/plumber shall be accompanied by a competent assistant and suitable non asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the fitters/plumbers with two portable fire extinguishers for use in an emergency .

All copper pipe work up to and including 54 mm. dia. shall have provision made for dismantling using gunmetal unions. All copper pipe work of 67 mm. dia. and above shall have provision made for dismantling using gunmetal silver brazing flanges.

#### **1.4 Ductile Iron Pipe work**

Where the table of pipe work materials requires the use of ductile iron pipe work, this shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws laminations and other defects.

Standard ductile iron pipes, having nominal bores from 80 mm. to 600 mm. shall be in accordance with B.S.4772, Class K9, and shall be provided in standard 5.5 m. lengths of pipe where practical with ends finished for spigot joints.

All ductile iron pipes shall lined sulphate resisting cement and specially graded washed silica sand, all sealed in accordance with B.S.3416

#### **1.5 Ductile Iron Fittings**

All fittings used on ductile iron pipe work shall be concrete lined ductile iron of the flanged joint type as manufactured by Stanton and Staveley or other equal and approved .

#### **1.6 CPVC Pipes**

Pipes shall be manufactured in accordance to ASTM 441 Schd-80 and / or to DIN 8079 PN 20 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 F493 and ASTM F402. This shall include utilizing proper cleaner primer as to ASTM F-656 and solvent cement ASTM 2564, 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 an approved third party lab. Tests shall include the VICAT softening test, compression and burst tests.

### **1.7 Polypropylene pipes.**

Pipes shall be manufactured in accordance to ASTM 441 Schd-80 and / or to DIN 8079 PN 20 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.

### **1.8 Pipes and Fittings - Joints**

The jointing of polypropylene pipe work shall be by means of dezincification resistant threaded fittings for pipe diameter equal to or less than 80mm and flanged joints for larger sizes. All threaded fittings and flanges shall be jointed to pipes by means of thermofusion.

### **1.9 Fasteners & Joints**

#### **1.9.1 Screwed Joints**

Screwed joints shall be tapered to B.S.21.

Steel pipes having screwed joints shall be carefully reamed out before the plain end is screwed .

When making a joint, the screw thread shall be coated with a white jointing compound to B.S.5292 and good quality hemp, all surplus jointing compound being finally cleaned off to leave a surface suitable for painting. P.T.F.E. tape may only be used with the prior agreement of the Engineer.

The joint shall be arranged so that on completion two or three threads are left showing.

Should a screwed joint prove defective under subsequent test, caulking shall not be allowed.

#### **1.9.2 Welded Joints**

Steel pipes, having welded joints on the run, shall be prepared for jointing in a manner suitable for the technique employed. Welding shall be carried out in accordance with R.S.2971 for metal arc welded joints, using covered electrodes and B.S.1821 :1957 and B.S.2640:1955 for oxy-acetylene welded joints.

Pipes shall be prepared for welding with ends swan or cut off by hand, flame cut by hand with subsequent truing up by filing or by grinding to a bevel of 37. 5" as may be required. Welding rods shall in all cases be of good quality copper coated low carbon steel and the manufacturer shall provide test certificates representative of the rods in accordance with B.S.1453: 1972 , Group A.

All pipe work shall be reamed after cutting to ensure it is free from rust, burns, scale and other defects and shall be thoroughly cleaned before erection.

All welded joints, produced by the oxy-acetylene flame process, shall be of best quality, the butt being slightly convex with regular ripples and no undercutting, washing away or surface cavities being resent. Notches at the root indicating incomplete penetration and excessive weld protruding into the pipe bore in excess of 1.5 mm. shall not occur and the external reinforcement shall run out smoothly to the pipe surface on either side.

Welding shall in all cases be carried out by skilled craftsmen, who are in possession of a current certificate of competency issued by an approved authority (which shall be produced at the request of the Engineer and have had a suitable period of experience for the class of work in which they are engaged in accordance with B.S.4871 and B.S.4870.

Highly skilled non-certificated welders may only be used by written permission of the Engineer and test welds, in accordance with R.S.4870, Part I, 1972 with satisfactory laboratory test certificates, shall be submitted before this permission is granted. The Engineer shall determine a suitable independent testing authority and any costs arising from these tests shall be borne by the Contractor.

During all welding or cutting operations, the welder shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the welder with two portable fire extinguishers for use in an emergency .

After cutting or welding, all flashings shall be removed from all pipe work before erection .

All welded joints shall be painted two coats of red oxide on completion of the joint.

### **1.9.3 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.

#### 1.9.4 Mechanical Couplings

All pipe of suitable wall thickness may be jointed by use of mechanical wall grooved pipe and coupling on services with working temperatures not to exceed 85°C. This shall include the following building service piping systems :-

##### HVAC

- Chilled Water
- Condenser Water
- Hot Water Heating
- Glycol
- Air Lines
- Vacuum Lines
- Make-up Water

##### Plumbing

- Domestic Hot and Cold Water
- Roof Drains
- Storm Drains
- Sanitary Drains (DWV)

##### Fire Protection

- Fire Standpipe - Wet and Dry
- Automatic Sprinklers - Wet and Dry
- Water Supply
- Special Hazards
- CO2 and Halon Systems

Installation shall be operative trained by the manufacturer.

Mechanical coupling shall be used for all grooved pipes valves fittings and other grooved component.

All grooved joints shall be jointed by mechanical rigid or flexible couplings.

Couplings shall be of cast ductile iron confirming to ASTM A-536 , BS5750 or BBA certified. The joints shall be self centering and comprise coupling pieces, sealing gaskets, special nuts and bolts.

Grooves shall be formed at the end of the pipe by machine to manufacturer's instructions. Grooves shall be dimensionally compatible with the coupling

Joints shall be made to the manufacturer fitting constructions. Earthing continuity clips shall be fitted at every point.

Supports details and positions shall be to the manufacturer current recommendations. But by any mean shall not be less than the related tables in the appendix.

#### 1.9.5 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 brackets 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 walls: -  
Angle iron with fish tail, minimum size 32 mm. x 32 mm. x 6 mm.
3. Brackets to R.C. Beams:-  
Rag bolt with eye built in, minimum size 15 mm. dia.
4. Brackets to R.S.J.:  
Girder clips .
5. Brackets suspended from flat roofs:  
Rod with eye (minimum size 9 mm. dia.) on underside with back plate and lockout on topside.
6. 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 to be as the tables attached below

All sizes of copper piping 2.0 m. apart.

In addition to the centers given, support shall be provided adjacent all valves, flanged joints and other special components to prevent undue strain on the adjoining 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.

### 1.9.6 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.

#### i) Expansion Loops and Bends

All pipe work shall be installed to accommodate without distortion the linear expansion when heated. Pipe supports shall be of the type, which will allow full movements of the pipes except at fixed points which shall be provided as necessary between expansion bends, or sets. The fixed points shall be secured by anchors of an approved design.

The Contractor shall, provide and fix all the requisite expansion loops formed in the pipe runs by means of long radius welded sweep elbows to the required dimensions. The loops shall be installed in the mains with mild steel flanges and each leg of the loop shall be pulled cold to approximately 50% of the estimated expansion of the leg.

Where expansion fittings become necessary they must be anchored and guided in accordance with the manufacturers recommendations and/or these Specifications.

Where possible, provision for expansion and contraction of pipe work shall be made by changes in direction and it shall be the responsibility of the Contractor to make sufficient allowance for this.

Branch connections are to be taken from the top or bottom of both flow and return mains, depending on the prevailing air venting arrangements. Branches shall have incorporated in them two bends before passing into ducts, trenches, vertical chases, etc. The bends shall be arranged so as to take up the expansion and contraction of the mains without putting any extraneous strain onto the particular branches.

The Contractor shall install piping in a manner so as to permit perfect freedom of its movement during expansion and contraction operations without causing it to become warped. The strain and weight of the piping must not be transmitted to the connected apparatus.

The Contractor shall ensure that adequate provision is made for the expansion and contraction of all pipelines.

Where expansion fittings become necessary they must be anchored and guided in accordance with the manufacturers recommendations and/or these Specifications.

The Contractor shall submit full details of the proposed fittings for approval, together with all calculations and details of loading imposed on the structures.

Where branch connections are made to mains remote from anchor points on the latter, the take off shall be so arranged as to form a radius arms whereby the axial movement of the main is allowed to take place without imposing a bending stress upon the branch.

With a view to reducing strain due to expansion on plant and equipment of any description, whether indicated on Drawings or otherwise, the Contractor shall ensure that the connecting pipes are suitably set and include such expansion fittings as required. The fixed point being taken at the plant or equipment.

The Contractor shall ensure that the required "cold draw" is provided. The jointing of the loops and expansion fittings shall not proceed until it is shown to the satisfaction of the Engineer, that restraint has been correctly applied and that the runs are guided to provide for true axial movement.

Expansion loops or bends shall be of one piece and preferably made at the tube or fitting manufacturer's works. If the total length of the tube or bend is such as to prohibit this, welds may be

made in the long arm as near the centre as possible. No welds will be permitted in the crown of the bend or in the short arms and any seams shall be arranged at the side of the bends. All loops or bends shall be flanged and arranged to vent and drain naturally.

All expansion loops and bends shall be so proportioned to accommodate the total stress set up in the material of the pipe wall, taking into account the stress components due to internal pressure, torsion and bending.

All expansion loops and bends shall be fabricated from similar materials to the pipe work systems in which they are installed, with flanged ends, erected in a horizontal plane and supported at the crest.

All expansion loops and bends of joints shall be erected cold drawn to the extent of one half of the total expansion to be taken up and shall not be assembled before pipes are anchored.

The cold draw shall be pulled by means of long bolts through the flanges. Bolts shall be pulled up diagonally to prevent uneven stressing and after the flanges are tight the bolts shall be replaced one by one with bolts of the correct length.

In the event that the fitting of expansion loops and bends cannot be immediately possible, necessary distance pieces shall be inserted.

#### ii) Expansion Joints

Expansion joints shall be of the straight bellows type and of axial pattern or as otherwise indicated. They shall be provided with screwed union or flanged ends as appropriate to facilitate replacement unless otherwise approved. They shall incorporate internal liners if required and shall be manufactured from 18/8 stainless steel or other approved material appropriate to the duty and shall be designed to withstand the test pressure of the system. Bellows shall be capable of not less than 2,000 complete cycles of movement over the designed working range without failure. Pipe work supports shall be arranged as near as possible to the joints.

Expansion joints shall be selected to accommodate the maximum working temperature and temperature range of the systems. Rods or hangers shall be provided to take imposed end thrusts.

Joints up to 38 mm. shall have screwed ends to B.S.P. and 50 mm. and upwards-flanged ends to B.S. 10/4504. All compensators shall be installed in accordance with the manufacturer's recommendations.

All expansion joints shall be provided with external protection where exposed to damage. For axial joints this shall comprise an external sleeve. Joints shall be installed so that they are not subjected to stresses other than those for which they are designed. Unless otherwise indicated they shall be installed so that they are in their free position at a temperature midway between the high and low limits of normal service.

All connections between bellows and pipe work shall be aligned prior to and during welding by means of welding clamps.

Axial joints shall be installed in line with the axis of the pipe and shall not be subjected to any tension during installation other than that approved by the manufacturers.

Flanged joints shall be pulled up diagonally across the flanges by means of long bolts after the joints are made the long bolts shall be removed diagonally one at a time and replaced with standard bolts, nuts and washers.

Joints with flanged ends shall be installed during the erection of pipe work if possible. Otherwise, temporary distance pieces of accurate dimensions shall be provided. Each such distance piece shall be exactly equal to the "installed" length of the compensators and shall have flanges precisely square

with the pipe and flange bolt holes of the compensator. All expansion joints shall be securely locked in position prior to and during hydraulic testing. Should joints be unable to withstand test pressures they shall be isolated from the piping systems.

End fittings for expansion joints on mild steel pipelines shall be of steel.

Axial expansion joints shall be cold drawn during installation to an agreed amount not exceeding the manufacturer's recommendations.

When installing manufactured expansion loops or bellow joints, the manufacturer's installation recommendation shall be observed in every respect.

When pressure testing pipe work distribution mains, the Contractor shall ensure that the test pressure will not damage the bellows, where the test pressure exceeds the maximum operating pressure.

The Contractor shall supply all cleats, brackets and steel work required for structure, unless stated otherwise elsewhere in the Specifications.

Details of all anchors shall be submitted for approval before manufacture.

The bellows shall be installed with due allowance having been made for cold draw, which will vary according to the type and length of bellows proposed and the temperature of installation. Where "installation bars" or fittings are incorporated with the bellows during delivery and erection, these must be removed before heat is applied.

Care shall be taken when installing flanged end bellows to line up the bolt holes on joint and mating flanges and to ensure that the joint is not twisted in any way or any torsional stress applied.

### iii) Guides

Free guide sleeves shall be fitted on each side of the expansion joint, unless such joint be installed adjacent to an anchor point when guides shall be fitted on the free side only.

Guides shall consist of a tube of diameter not more than 3 mm. greater than the outside diameter of the main and length four and a half times the diameter of the main with a minimum length of 300 mm. unless an alternative design is shown on the Tender Drawings.

Guides shall be installed not more than one and a half pipe diameter from the expansion joint to the first tubular guide and not more than 15-20 pipe diameters between this guide and the next pipe support.

Further pipe guides shall be provided along each pipeline at intervals equivalent to not more than 75 pipe diameters and where shown on the Drawings.

The Contractor shall provide all necessary pipe guides to prevent long pipe spans from buckling and to ensure alignment and linear free movement of pipes from anchor points towards expansion joints constructed to prevent transverse movement and carefully installed so that axial movement is not hampered. Means for lubrication shall be provided where necessary.

Each pipe guide on sections of pipe work incorporating axial joints shall be of the tube type with rods tack welded to the guide, and arranged to locate and restrain the pipe in all planes. Alternatively pipe guides can be made on Site with two roller supports as shown on Drawings.

Special supports and fixing accessories shall be provided at all heavy items of pipeline equipment. i.e. valves, etc. to ensure that no undue strain is placed upon the pipeline at their incidence.

After fabrication, all ferrous fixings and supports shall be thoroughly wire brushed to remove dirt, scale, rust etc. and then given two coats of red oxide primer prior to bolting to structure.

Detailed drawings of pipe guides and supporting frames shall be submitted for written approval prior to manufacture.

### 1.9.7 Anchor Points

Where indicated on the Drawings, or as required, mild steel anchors shall be installed to resist the maximum stresses of the pipe work.

The anchor shall be fixed only to solid structure fabric. The anchors shall consist of heavy section iron 'U' strap, minimum size 50 mm. x 6 mm., welded to the pipe work and attached to minimum 150 mm. x 75 mm. x 6 mm. channel iron supports by H.T. nuts and bolts unless shown otherwise on the Tender Drawings.

On mild steel pipe work, mild steel anchors capable of resisting the maximum stresses shall be welded to the pipe work. Where it is impracticable to weld the anchors to the pipe work, pipes shall be rigidly anchored preferably by flat iron clips and/or 'U' bolts threaded at both ends and pulled tight onto the underside of pipe and butting up to angle and/or channel iron support on each side. The diameter of the rod from which the anchor bolts are made shall be 3 mm. greater than that for 'U' bolt guides. Flat iron clips shall be 38 mm. x 9 mm.

For heavier loading applications, mild steel locking channels shall be welded to the pipe on each side of the supporting channel.

Anchor points shall be provided to resist the axial stress transmitted by the flexure of expansion bellows, of substantial form and suitable for the imposed loads. Such loads shall be assessed upon the assumption that unbalanced forces exist at all anchor points even when such are sited in intermediate positions between two bellows.

The supports for the anchors shall be formed from channel iron or two equal angles back to back, adequately sized to take the maximum thrust load bolted to concrete floor and roof or built into sides of ducts.

Anchors shall be positioned to ensure that movement due to expansion and contraction is proportioned throughout the system. Anchors shall, in all cases, be provided complete with the necessary cleats, brackets and steel work section pre-cut to length and drilled, backing plates, holding down bolts, nuts, washers, all for attachments to the Building structure. Each anchor point, shall be set out and lined up accurately into position ready for grouting in.

Prior to manufacture, full details of the propose method at anchorage together with corresponding calculations and details of thrust loading shall be submitted for approval.

### 1.9.8 Thrust Blocks

- A. All pipelines shall be anchored with thrust blocks at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure.
- B. Where pipeline are laid in water logged areas, pipelines shall be weighted to prevent floating. Where pipelines are laid on steep inclines they shall have transverse anchors as detailed in the table below: -

GRADIENT	ANCHOR SPACING
1 in 2 and steeper	5.5.m
below 1 in 2 to 1 in 4	3m
below 1 in 4 to 1 in 5	16.5m
below 1 in 5 to 1 in 6	22m

### 1.9.9 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, 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.

### 1.9.10 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 coarse 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.

### **1.9.11 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.

### **1.9.12 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.

### **1.9.13 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. Valves 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.

## **1.10 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.

## **1.11 Testing of Pipe work**

A. refer to Testing and commissioning section

### **1.11.1 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. Gradients shall be generally as follows for the various services.

- Chilled Water Mains: 1 in 250

- Heating Water Mains 1 in 200

### **1.11.2 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.

### **1.11.3 Air Separator**

A centrifugal type air separator shall be installed for chilled and heating water plants at locations as shown on drawings.

The unit shall have a flanged or grooved inlets and outlets connections tangential to vessel shell . The vessel shell diameter shall be at least three time diameter of the nominal inlet diameter,

The unit shall have an internal stainless steel air collector tube with ) 0.10 mm diameter perforation an open area designed to direct accumulated air to k via an NPT connection at top of the unit.

The unit shall have removable galvanized steel strainer with 0.10 mm perforation and a free area of not less than five times the cross sectional area of not less than five times the cross sectional of the connecting pipe .

A blow down connection and drain with drain cock shall be provided to facilitate routine cleaning of the strainers.

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 .

#### **1.11.4 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.

#### **1.11.5 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.

The branch connections sizes shall be as follows unless practical limitations dictate otherwise:-

Connection Size (mm) Line Size (mm)

Line size	Up to 50 mm.
65	65 to 150 mm.
80	150 to 200 mm.
100	300 to 450 mm.

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.

### 1.11.6 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 cinkled 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/m<sup>2</sup> 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

#### 1.11.7 Escutcheons

Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.
  - a. Finish: Rough brass.
  - b. Finish: Polished chrome plate.
4. Cast Brass: Split casting, with concealed hinge and set-screw.
  - a. Finish: Rough brass.
  - b. Finish: Polished chrome plate.
5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: One-piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Stamped Steel: Split plate, with exposed-rivet hinge, set-screw, and chrome-plated finish.
10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
11. Cast-Iron Floor Plate: One-piece casting.

#### 1.11.8 Dielectric Fittings

Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly for 250-psig (1725 kPa) minimum working pressure at a 180 deg F (82 deg C) temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150- or 300-psig (1035 kPa or 2070 kPa) minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035 kPa or 2070 kPa) minimum working pressure to suit system pressures.

6. Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300-psig (2070 kPa) minimum working pressure at 225 deg F (107 deg C) temperature.
7. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070 kPa) working pressure at 225 deg F (107 deg C) temperature.

## **1.12 VALVES**

### **1.12.1 SUBMITTALS**

- A. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.
- B. Maintenance data for valves to include in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

### **1.12.2 DELIVERY, STORAGE, AND HANDLING**

- A. Prepare valves for shipping as follows:
  1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, grooves, and weld ends.
  3. Set globe and gate valves closed to prevent rattling.
  4. Block check valves in either closed
  5. Set ball and plug valves open to minimize exposure of functional surfaces.
  6. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
  1. Maintain valve end protection.
  2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use hand wheels and stems as lifting or rigging points.

### **1.12.3 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. Chain-Wheel Operators: For valves 4 inches (DN100) and larger, installed 96 inches (2400 mm) or higher above finished floor elevation.
  4. 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: ASME B1.20.1 or BS 21 .
- G. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves. Or BS 4504

#### **1.12.4 DESCRIPTION**

##### **1.12.4.1 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.

##### **1.12.4.2 Isolation And Commissioning Valves**

- A. Isolation valves shall be installed on the inlet and outlet 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.

##### **1.12.4.3 Non Return Valves**

Non-return valves shall be screwed BSPT or flanged BS 4504: Part 2 in accordance with the valve schedule in this specification. All non-return valves shall be suitable for both vertical and horizontal mounting and shall be fitted in readily accessible positions.

##### **1.12.4.4 Differential Pressure Regulating / Reducing Valves (DPRV)**

The differential pressure regulating valves, reducing valves, shall be fitted where shown on the secondary sub-circuits to limit the maximum pump pressure imposed on two port terminal unit valves.

The valve shall be of self acting pilot operated diaphragm type of upstream and downstream pressures as per the control valves manufacturer recommendations

The contractor shall allow for the installation of the required numbers of the DPRV based on the recommendations of the control valves manufacturer. The contractor in coordination with manufacturer shall submit complete schematic drawings showing locations, sizes and upstream and down stream pressure and shall adjust the  $\Delta p$  settings at high load conditions to the ranges of acceptable valve authority as recommended by the two port control valve manufacturers.

#### 1.12.4.5 Pressure Independent Control Valves

Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated manufactured as to BELIMO, oventrop flowcon or approved equal. The manufacturer shall warrant all components for a period of 5 years

##### Valve Body

1. NPS  $\varnothing$ 50 and Smaller: Forged brass body rated at no less than 25 Bar  
chrome plated brass ball and stem, female NPT or BS union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc, with measuring taps, and isolating
2. NPS  $\varnothing$ 65 and above: Cast Iron brass body flanged or groove coupled rated at no less than 16 Bar complete stainless trim; .

##### Accuracy:

The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 0.3 to 4.0 Bar across the valve.

##### Flow Characteristics:

Equal percentage characteristics.

Close-Off Pressure Rating: 14 Bar.

##### Actuator:

All actuators shall be electronically programmed by use of external computer software for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.

Actuators shall fail in place and have a mechanical device inserted between the valve and the actuator for the adjustment of flow.

Actuators shall be provided with an auxiliary switch to prove valve position.

The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted.

Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is not acceptable.

NPS 2" and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer.

The supply side of the coil shall contain an integrated isolation valve/manual air vent strainer/shut-off valve/drain with a P/T port.

The return side shall contain a union fitting with a P/T port, pressure independent control valve, an integrated isolation ball valve/manual air vent with a P/T port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A 300mm long flexible hose set shall be provided for each coil supply and return connection for all pipe packages.

**Balancing:**

Systems installed with pressure independent control valves shall not require hydronic system balancing.

Flow shall be verified and adjusted for the pressure independent valve assembly (valve and actuator combination) for field conditions using the pressure independent control valve manufacturer's documented procedure for 10% and 25% of the total installed product. Exact locations of tested product to be coordinated .

**1.12.5 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. For chain-wheel operators, extend chains to 60 inches (1500 mm) above finished floor elevation.
- G. 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.

**1.13 Miscellaneous**

**1.13.1 Floor Plates**

Where exposed to view, pipes and tubing passing through walls, floors, ceilings, partitions and false ceilings of occupied rooms shall be fitted with a heavy chromium-plated die cast zinc alloy masking plate. Such plates shall be split on the diameter, be a snug fit to the pipe concerned and provided with countersunk holes for setscrews.

**1.13.2 Flashing Flanges / Puddle Flanges**

Where pipes pass through waterproofed membranes, sleeves shall be provided with a flashing flange to which a flashing shield can be clamped or brazed. The shields shall be zinc or copper and shall extend not less than 200mm from the sleeves in all directions. The space between the sleeve and the pipe passing through shall be packed with waterproof material and mastic compound.

**1.13.3 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 the greater.

#### 1.13.4 Valves And Stopcocks

Valves and stopcocks shall conform with the Table Appendix III at the end of this Section of the Specifications unless detailed differently in the particular Section of the Specifications.

#### 1.13.5 Water Shock Absorbers

The shock absorbers shall be fitted to all branch connections to water tanks on pressurized mains and on all connections to equipment with quick action turn off valves. The absorbers shall be constructed from stainless steel as manufactured by a specialist approved by the Engineer.

#### 1.13.6 Pressure, Altitude and Temperature Gauges

Where depicted on the schematics and as generally described hereunder the Contractor shall supply and install a thermometer, altitude or pressure gauge.

Thermometers shall be fitted on each chiller, 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 down stream 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, Chiller Area, Pump Rooms, AHU Rooms and Tank Room shall have a 150 mm. dia. dial gauge fitted; elsewhere they shall have a 100 mm. dia. dial.

Altitude Gauges shall be fitted on each heat exchanger. i.e., calorifier, chiller, etc. Altitude gauges shall be to BS.1780. They shall be supplied with a loose red pointer to be set at the design working head and be calibrated in both meters and feet. The scale range shall be suitable for a maximum of approximately twice the design head.

All gauges shall be supplied with a suitable angle or pigtail siphon and gunmetal gauge cock. All gauges fitted on chillers, chilled water pumps within the Plant Rooms, shall have a 150 mm. dia. dial gauge fitted; elsewhere 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 as 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.

#### 1.14 Schedule Of Instrumentation

<u>Item</u>	<u>Location</u>
Pressure Gauges,	inlet and outlet of each pump
	inlet and outlet of each chiller evaporator
	inlet and outlet of each chiller condenser
	inlet and outlet of each heat exchanger

inlet and outlet of each preheat coil

let and outlet of each cooling coil

inlet and outlet of each reheat coil

upstream and downstream of each pressure reducing valve station

Note: Gauge cocks only are to be installed at reheat coils in hung ceilings.

Thermometers      each pump header  
                         inlet and outlet of each chiller evaporator  
                         inlet and outlet of each chiller condenser  
                         inlet and outlet of each heat exchanger  
                         inlet and outlet of each preheat coil  
                         inlet and outlet of each cooling coil  
                         inlet and outlet of each reheat coil  
                         supply fan discharge duct  
                         return fan intake duct



**SCHEDULE 1:**

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
Chilled & Heating Water Condensor Water System & Machine Cooling	Up to 50	Bronze gate valve; non-rising extended stem; screwed Bonnet; one piece wedge; ends screwed BS 21 Taper thread	Isolating	5154	16
		Or Ball valve DZR copper alloy body, extended stem, with hard chrome plate full bore ball , PTFE seat and stem seal , screwed end to BS 21 r ANSI B2.1 NPT		2874	25
	65 - 200	Cast iron gate valve; inside screw; non rising Stem; bronze trim; bolted bonnet; flanged BS 4504	Isolating	5150	16
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.		5155 or ANSI B16.1 - class125	16
	200 Up to 500	Bronze globe valve; renewable disc; union bonnet; Extended rising stem; ends screwed BS 21 taper	Isolating/ Throttling	5154	16
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.	Isolating/ Throttling	5155 or ANSI B16.1 - class125	16
	50 - 150	Cast iron straight pattern globe valve; bronze trim; Flanged BS 4504	Pump discharge Throttling and	5152	16

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.	Isolating		
	200-300	Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.	Pump discharge Throttling and Isolating	5155	16
	400-600	Cast iron butterfly valve, Fully lugged , through bolts, triple offset; hand wheel and gearbox operated., Capped at end of line service where specified.	Isolating and Coarse throttling	5155	16
Chilled & Heating Water Condensor Water System & Machine Cooling system	Up to 50	Bronze swing check valve; black nitrile rubber faced disc; ends screwed to BS 21 taper.	Check / Non return	5154	16
	65 - 150	Cast iron swing check valve; bronze seat and trim; nitrile rubber faced disc; flanged BS 4504.	Check / Non return	5153	16
	200, 250 & 300	Cast iron swing check; bronze trim; flanged BS 4504.	Check / Non - return	5153	16
	Up to 50	Bronze gland pattern drain cock; ends screwed BS 21; male inlet / hose union outlet, wrench operation	Drain off cock	-----	16
	6 - 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
	65 - 200	Cast iron 'Y' type double regulating valve with flow measurement plate and carrier, with 2 No. body bosses fitted sealed test plugs; outside screw; rising stem; stainless steel trim; bolted bonnet; flanged BS 4504	Flow regulation & Balancing	7350	16

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
	Up to 50	DZR copper alloy auto flow valve. With adjustable stainless steel variable orifice and piston cartridge and opposed springs. Valves body shall be of Universal Y pattern with integral ball valves, measuring pressure taps union connection and extended stem, ends screwed to BS 21 tapered	Automatic Balancing		25
Chilled & Heating Water Condensor Water System & Machine Cooling	65 – 400	Cast Iron auto flow valve flanged type . With adjustable stainless steel variable orifice and piston cartridge and opposed springs. Complete with flanged gear driven butterfly valves and measuring pressure taps	Automatic Balancing		16
	Up to 50	DZR copper alloy independent pressure auto flow valve. With adjustable stainless steel variable orifice and piston cartridge and opposed springs. Valves body shall be of Universal Y pattern with integral ball valves, measuring pressure taps union connection and extended stem, ends screwed to BS 21 tapered	Automatic Balancing and control		25
	65 – 400	Cast Iron auto flow valve flanged type . With adjustable stainless steel variable orifice and piston cartridge and opposed springs. Complete with flanged gear driven butterfly valves and measuring pressure taps	Automatic Balancing		16
	Up to 50	Bronze or DZR alloy 'Y' type diaphragm valve with threaded nipple type orifice ring carrier 2 No. body bosses fitted sealed plugs, two differential pressurecopper conduits ; screwed bonnet; metal plug and seat; ends screwed BS 21 taper	Differential pressure control Valve	7350	16

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
	65 - 200	Cast iron 'Y' type diaphragm valve with flow measurement plate and carrier, with 2 No. body bosses fitted sealed test plugs; two differential pressure copper conduits m; stainless steel trim; bolted bonnet; flanged BS 4504	Differential pressure control Valve	7350	16
	15 - 50	Malleable iron 'Y' Type strainer;, non-ferrous cap; non-asbestos gasket stainless steel screen; ends screwed BS 21 taper.	Pipeline strainer	-----	16
	65 - 200	Cast iron 'Y' type strainer, cast iron cap; non- asbestos gaskets; stainless steel screen; flanged BS 4504.	Pipeline strainer	-----	16
	250 & over	Cast iron or cast steel fabricated pot-type duplex changeover strainer; steel-bolted cap; non-asbestos gaskets; stainless steel screen.	Duplex strainer	-----	16
	15-50	Bronze radiator gate valve, casting finish, female/male union , composition handwheel	Heating Radiators	2767	16
	All sizes	316 stainless steel –Plug and socket quick coupling, with PTFE seal Released by side push buttons. Complete with stainless steel fascia and suitable for high pressure application.	Quick release coupling		50
Domestic And softened water Systems	Up to 50	Bronze gate valve; non-rising extended stem; to 5154 Series 13 screwed (F) screwed Bonnet; one piece wedge; ends screwed BS 21 Taper thread stainless steel trim and spindle. In compliance with NSF or NRC	Isolating	5154	16
		Or Ball valve DZR copper alloy body, extended stem, with hard chrome plate full bore ball , PTFE seat and stem seal , screwed end to BS 21or ANSI B2.1 NPT In compliance with NSF or NRC			

### **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)	Valve / Fitting Details	Application	BS No.	PN
	65 - 200	BS 5154 and BS 5150 (flanged) high-grade cast iron bodes, epoxy painted inside with full way bore, stainless steel trim and spindle. . In compliance with NSF or NRC	Isolating	5150	16
		Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; capped for end of line service where specified. In compliance with NSF or NRC	Isolating/ Throttling	5154	16
	50 - 150	Cast iron straight pattern globe valve; bronze trim; Flanged BS 4504 stainless steel trim and spindle. In compliance with NSF or NRC	Pump discharge Throttling and Isolating	5152	16
	150 - 250	Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; capped for end of line service where specified. In compliance with NSF or NRC	Isolating/ Throttling (High Duty)	1873	16
	200-450	Balancing valve with position indicator drain connection & 2 No. pressure cocks complete with plug type disc with logarithmic characteristic In compliance with NSF or NRC	Regulating valves	5155	16
	80-250	Cast iron butterfly valve; replaceable elastomer seat; 50 - 100mm lever operated, 150- 300mm hand wheel and gearbox operated; 'U' water type, through bolted. Fully lugged, tapped for end of line service where specified. In compliance with NSF or NRC	Isolating and Coarse throttling	5155	16
	All sizes	316 stainless steel –Plug and socket quick coupling, with PTFE seal Released by side push buttons. Complete with stainless steel fascia and suitable for high pressure application.	Quick release coupling		50

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
Purified Water , WFI Distilled Water	Up to 50	Diaphragm Valve. 316 L forged stainless Steel body and trimming, surface machined and polished to 0.2 Micro M to ASTM – A 182 S( and A 351 CF3M. ISO plain ended on main pipes and tri clover trimmed at terminal outlet. Complete with Fluorlastic diaphragm operated by stainless steel or white epoxy coated bonnet	Loop Terminals		16
	65- And above	Diaphragm Valve. 316 L cast stainless Steel body and trimming, surface machined and polished to 0.2 Micro M to ASTM – A 182 S( and A 351 CF3M. triclover on main pipes and at terminal outlet. Complete with Fluorlastic diaphragm operated by stainless steel wheel or white epoxy coated bonnet	Loop Terminals		16
Purified Water , WFI Distilled Water & Pure Steam	Up to 40	Sanitary full bore Ball valve, 316 L forged stainless steel Body to FDA USP class VI . surface machined and Electropolished to 0.375 micron Ra. . Trimmed by triclover clamps Operated by stainless steel Handle or white epoxy coated bonnet	Isolation and Drain valves		16
	50 to 100	Sanitary full bore Ball valve, 316 L cast stainless steel Body to FDA USP class VI . surface machined Electropolished to 0.375 micron Ra. Trimmed with Triclover clamps Operated by stainless steel Handle or white epoxy coated bonnet	Isolation and Drain valves		16
Medical and Lab Gases	12-50	Copper Body, Stem and Ball to BS 2874 CZ121, capable of withdrawal without cutting the pipework. Valves shall be of e ball lever type, with a of key locking in either the open or closed position. Valve ends, copper stub to enable brazing direct to pipe . The fluxless brazing technique with N2 purge	Isolation	BS 739, ISO 5359	32
Compressed Air	Up to 50	Bronze solid wedge disc gate valve; non-rising stem; screwed-in bonnet	Isolating	5154 Series B	16
	65 & over	Cast iron diaphragm valve; flanged	Isolating	5156	32

### 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)	Valve / Fitting Details	Application	BS No.	PN
	Up to 50	Bronze lift-type check valve; ends screwed BS 21 taper	Check valve	5154 Series B	16
	65 & over	Cast iron lift check valve; flanged BS 4504	Check valve		
	All sizes	316 stainless steel –Plug and socket quick coupling, with PTFE seal Released by side push buttons. Complete with stainless steel fascia and suitable for high pressure application.	Quick release coupling		50
Steam & Condensate	15 - 200	Cast steel Bellows sealed flanged stop valve; rising stem; renewable nickel alloy plug disc; stainless steel seat, bellows and stem ; steel union bonnet; ends flanged EN 1092 Or ANSI B16.10 graphite gasket	Throttling and Isolating valve	EN 10204 3.1.B	25
	15-50	Flanged Ball valve- full bore rype, Zinc Plate carbon steel body ; extended stem , with stainless steel ball carbon, stainless steel lever and washer , with vinyl cover to lever and graphite seat flanged EN 1092 Or ANSI B16.10 graphite gasket	Throttling and Isolating valve	5351 Series A	40
	100-600	Parallel slide stop valve , cast steel body and cover renewable nickel alloy discs and seat; stainless steel spindle; mild steel pillars and crosshead; bronze gland and bush; cast iron hand wheel with " OPEN" and " SHUT" indication; flanged BS 4504	Isolating valve	5157	20
	40-200	Cast steel body and cover, metal to metal seat and valve; bronze piston and dashpot; mild steel pillars; bronze crosshead and packing gland, cast iron hand wheel ; flanged BS 4504	Combined stop and non-return valve 17.2 bar		20
	350,400 and 450	Cast steel horizontal swing check valve; 13% chrome steel disc and body seat ring; flanged BS 1560.	Check and non-return valve	1868	40
	15 - 200	Flanged 'Y' Type strainer; Carbon steel body , non-ferrous cap; reinforced graphite gaske1.6 mm stainless steel screen; ends Flanged BS 21	Pipeline strainer	EN 10204 2.2	40

### 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)	Valve / Fitting Details	Application	BS No.	PN
Fuel Oil	6-50	Bronze gate valve, one piece wedge, non-rising stem screwed-in bonnet, Viton seals and seats, ends screwed BS 21 taper sealed with approved PTFE tape pipe thread and sealant to BS 3245	Isolating	5154 Series B	16
	15-50	Bronze gate valve, one piece wedge, non-rising stem, screwed-in bonnet, flanged BS 4504	Isolating	5154 Series B	16
	15-50	Cast iron lubricated parallel -plug valve, short pattern ; rectangular port; full bore, ends screwed BS 21 taper, wrench operated.	Isolating	-	16
	50-300	Cast iron lubricated parallel-plug valve, regular pattern , rectangular port; full bore; gear operated; flanged BS 4504	Isolating	-	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
LPG & Natural 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
	65 - 100	Cast iron ball plug valve; details as for brass body type <b>UL approved ,or British Gas approved</b>	Isolating	5159	16
	65 - 300	Cast iron gate valve; broner trim; non-rising stem; wedge disc; inside screw; Flanged to BS 4504 sealed with non organic gasket with above melting point below 650 °C. UL approved ,or British Gas approved	Isolating	5150	16
	50-300	Cast iron wafer type butterfly valve, with lined; quarter - turn operation; for use with BS 4504 flanges UL approved ,or British Gas approved	Isolating	5155	16
	All sizes	316 stainless steel –Plug and socket	Quick release		50

<b>Schedule of Valves and Appliances</b>					
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)	Valve / Fitting Details	Application	BS No.	PN
		quick coupling, with PTFE seal Released by side push buttons. Suitable LPG applications. UL approved Complete with stainless steel fascia and suitable for high pressure application.	coupling		
Waste Drainage	Up to 50	Bronze gate valve; non-rising extended stem; screwed Bonnet; one piece wedge; ends screwed BS 21 Taper thread	Isolating	5154	16
		Or Ball valve DZR copper alloy body, extended stem, with hard chrome plate full bore ball , PTFE seat and stem seal , screwed end to BS 21 r ANSI B2.1 NPT		2874	25
	65 - 200	Cast iron gate valve; inside screw; non rising Stem; bronze trim; bolted bonnet; flanged BS 4504	Isolating	5150	16
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.		5155 or ANSI B16.1 - class125	16
	200 Up to 500	Bronze globe valve; renewable disc; union bonnet; Extended rising stem; ends screwed BS 21 taper	Isolating/ Throttling	5154	16
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.	Isolating/ Throttling	5155 or ANSI B16.1 - class125	16
	50 - 150	Cast iron straight pattern globe valve; bronze trim; Flanged BS 4504	Pump discharge Throttling and Isolating	5152	16
		Or Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and			16

### **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)	Valve / Fitting Details	Application	BS No.	PN
		gearbox operated; Valve capped for end of line service where specified.			
	200-300	Cast iron butterfly valve, Fully lugged through bolted. With replaceable elastomer seat, hand wheel and gearbox operated; Valve capped for end of line service where specified.	Pump discharge Throttling and Isolating	5155	16
	400-600	Cast iron butterfly valve, Fully lugged, through bolts, triple offset; hand wheel and gearbox operated., Capped at end of line service where specified.	Isolating and Coarse throttling	5155	16
Fire fighting	Up to 50	Bronze gate valve; rising stem; screwed-in bonnet; one-piece wedge; ends screwed To ANSI/ASME B16.3 (O.S & Y), UL/ FM approved	Isolating	5154	16
	65 - 300	Cast iron wedge gate valve; inside screw; rising stem; bronze trim; bolted bonnet; flanged GS 4504 O.S. & Y) UL/ FM approved	Isolating	5163	16
	50 - 300	Cast iron body butterfly valve with high nitrile rubber liner molded to form resilient seat and end seals; wafer type between flanges fitting with flange aligning drilled lugs; lever operated. UL/ FM approved	Isolating and Coarse balancing	5155	16
	Up to 50	Bronze swing check valve; renewable nitrile rubber disc; screwed-in cap; ends screwed BS 21 taper.	Check / Non-return	5154	25
	65 - 300	Cast iron swing check valve; zinc-free bronze trim; bolted cover; resilient seated; flanged BS 4504. or ANSI/ASME16.3	Check / Non-return	5153	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



**SCHEDULE 2:****Schedule of Pipes & Fittings**

Service	Pipe Range	Pipe Material	Fittings
Chilled & Heating Water	Up To 50mm	Black steel ASTM A53 Seamless With threaded Joint	Thread Malleable iron fittings to ANSI B 16.3- class 125 (welded where permanently concealed)
	65 - 125	Black steel ASTM A53 Seamless welded or grooved joint	Butt welding fittings to ASME B16.9 & B16.25 (with flanges where required, ASME B16.5 Class 125)
	150- Over	Black steel ASTM A53 Seamless welded or grooved joints	Butt welding fittings to ASME B16.9 & B16.25 (with flanges where required, ASME B16.5 Class 125)
Heating Water	Up To 50mm	PEX type A pipes to BS 3284 type (50) Class (C) , ASTM F876 and F877, or to DIN standards heavy density high pressure type. With Oxygen barrier to DIN 4726	Gun metal or Brass compression , Press Fittings or Quick & easy joints
HVAC Condensate	Up 100mm Above False Ceiling	CPVC to DIN 8079-8080 - 10 bars CPVC pipes fittings jointed 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 jointed by solvent cement adhesives.	UPVC to DIN 4660 PN-10 bars UPVC pipes fittings jointed by solvent cement adhesives.
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
	65-200	Black steel, seamless pipe, joined by welding to ANSI B16.3	Steel of the seamless, but welded type with 37 degree beveled ends to ANSI B16.5 & ANSI B16.11
	Up to 100	Galvanized steel to ANSI B16.3 ( Test & drain pipes)	Galvanized, screwed malleable to ANSI B16.3
FM-200 & CO <sub>2</sub> Fire Suppression Systems	Up to 40	Galvanized mild steel, seamless Cold drawn to Schedule 40 to ASTM A106-77 or BS 1387 class C	Forged Steel , screwed to BS3799 Galvanized inside & outside or to ASME B16.3
	50mm & above	Galvanized mild steel, seamless Cold drawn Schedule 40 to ASTM A106-77 or BS 3601	Forged steel socket weld to BS3799 Galvanized inside & outside or to ASME B16.3

**SCHEDULE 2:**

**Schedule of Pipes & Fittings**

Service	Pipe Range	Pipe Material	Fittings
Steam	Up to 80	Black mild steel to ASTM B36.10 or A-120 seamless , schedule 40	Cast iron pipe to ASME B16.3 Dia. up to 32 cast iron screwed . Dia. 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
	100 to 250	Black mild steel to ASTM B36.10 A-120 seamless schedule	Cast iron pipe to ASME B16.3 Dia up to 32 cast iron screwed . Dia 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
	300 & over	Black mild steel to ASTM B36.10 A-120 seamless schedule	Cast iron pipe to ASME B16.3 up to 32 cast iron screwed. 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
Condensate	Up to 80	Black mild steel to ASTM B36.10 A-120, seamless, schedule 40	Cast iron pipe to ASME B16.3 Dia up to 32 cast iron screwed . Dia 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
	100 to 250	Black mild steel to ASTM B36.10 A-120 seamless, schedule 40	Cast iron pipe to ASME B16.3 Dia up to 32 cast iron screwed . Dia 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
	300 & over	Black mild steel to ASTM B36.10 A-120 seamless schedule 40	Cast iron pipe to ASME B16.3 Dia up to 32 cast iron screwed . Dia 40 and over, seamless, malleable, steel, schedule 40 to ASME B16.3
Main Feed Water	80-350	Ductile cast iron to BS 4772 Class K 9	Ductile iron pipe concrete lined socket and spigot with neoprene o ring
Compressed Air Pipes	All	Un pigmented Polypropylene Random copolymer type manufactured DIN 8077-DIN 8078 – PN25	Socket fusion type fusion with embedded coils.

**SCHEDULE 2:**

**Schedule of Pipes & Fittings**

Service	Pipe Range	Pipe Material	Fittings
Main Domestic & softened hot water	up to Ø32mm	CPVC pipes to Din 8079 – 8080 PN-25 Bar	Solvent cement joints to ASTM-F493 or threaded fittings to ASTM-F437
	Ø32mm & Above	CPVC pipes to Din 8079 – 8080 PN-20 Bar	Solvent cement joints to ASTM-F493 , flanged at valves, equipment and 20m intervals
	up to Ø90mm	PEX-AL –PEX to manufactured DIN 4726	Press fittings to DIN 4726
Cold Water Branch pipes Emebded in Walls Under tiles	All	Cross linked polyethylene plastic pipes type PEX-A , manufactured to ASTM F 876 -84 , ASTM F877-84 a. or DIN standard Pressure rating 20 bar.	Gun metal or DZR Brass compression , Press Fittings or Quick & easy joints
Purified Water Distilled Water Pure Steam	Up - 100	Stainless Steel to AISI 316L manufactured to ASTM A269/A270. pharmaceutical grade surface roughness 0.30 micro meter	Plain ended , orbitally welded fitting - Joints to be checked by x-ray & Ultrasound NDT tests Or 316 L stainless steel trilover clamp pharmaceutical grade or FDA approved grooved joints
Irrigation	Up - 50	UPVC to BS 3505 Heavy weight Or UPVC pipe to Din 8062 - 16 Bar	UPVC to BS 3505 with solvent joints Or UPVC solvent cement
	65- Up	UPVC to BS 3505 Heavy weight Or UPVC pipe to Din 8062 - 16 Bar	UPVC to BS 3505 with threaded joints Or UPVC solvent cement joints
Fuel Pipes	Up To 50mm	Black mild steel seamless to BS 1387 medium Weight or DIN 2440	Malleable iron pipe to BS 143 and 1256 (welded where permanently concealed)
	65 - 125	Black mild steel seamless to BS 1387 medium Weight or DIN 2440	Butt welding fittings to BS 1965: Part 1 (with flanges where required, to BS 4504 and appropriate pressure rating)
Main Above ground LPG	Up to 50	Black steel to ANSI B 16.3 seamless schedule 40	Black steel, screwed malleable iron , ANSI B16.3
	65-200	Black steel to ANSI B 16.3 seamless schedule 40	Steel of the seamless, butt welded type with 37 degree beveled ends to ANSI B16.5 & ANSI B16.11
Lab Gases Exposed or Concealed in Voids	15-& over	Phosprous de-oxidized non-arsenical copper to BS 6017 grade C106. manufactured to EN1054 , table X	Phosprous de-oxidized non-arsenical copper to BS 6017 grade C106. manufactured to 864 , Part 2 Brazing by copper silver zinc alloy under oxygen free nitrogen gas shield.
Buried LPG & auxiliary Gas	15-& over	Phosphorous de-oxidized non-arsenical copper to BS 2871 manufactured to EN1057 , table Y protected by polyethylene coating	Phosphorous de-oxidized non-arsenical copper to BS 6017 grade C106. manufactured to 864 , Part 2

**SCHEDULE 3:**

**Pipe Supports Spacing – Steel & Copper 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	
in mm	(meters)	Bare	Insulated		in mm
		(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.

The following table indicates the recommended spacing for pipe supports and guides:

Copper Piping (Temperatures up to 100 °C).

Pipe Size	Distance Between Alignment Guide	Distance between Supports			Hanger Rod Dia
		Horizontal		Vertical	
		Bare	Insulated		in mm
in mm	(meters)	(meters)	(meters)	(meters)	in mm
15	2.0	1.8	1.8	2.4	10
20	2.0	2.0	2.0	2.4	10
25	3.0	2.0	2.0	2.4	10
32	3.0	2.0	2.0	3.0	12
40	3.0	2.5	2.0	3.7	12
50	4.0	2.5	2.5	3.7	12
65	4.6	3.0	2.5	3.7	16
80	5.8	3.0	3.0	4.3	16
100	7.6	3.0	3.0	4.6	16
125	9.0	3.5	3.5	5.5	16
150	10.6	4.0	4.0	5.5	16
200	13.7	5.0	5.0	8.5	16
250	18.0	6.0	6.0	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:**

**Polymer Pipes including:**

**CPVC , UPVC , ABS, Polypropylene , Polyethylene Pipes**

The following table indicates the recommended spacing for pipe supports and guides:

Acrylonitrile Butadiene Styrene (ABS) (Temperatures up to 70 °C).

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 have 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**

# Vibration & Acoustic Control Specifications

## Table of Contents

### Contents

<b>1.</b>	<b>VIBRATION &amp; ACOUSTIC CONTROL.....</b>	<b>3</b>
1.1	CODES AND STANDARDS .....	3
1.2	PROJECT CONDITIONS .....	3
1.3	SEISMIC CONTROLS.....	3
1.4	NOISE CONTROL.....	4
1.4.1	General	4
1.4.2	Acoustic Assessment	5
1.4.3	Vibration Isolation Mountings	5
1.4.4	Acoustical Treatment of Duct Systems	6
1.4.5	Fresh Air Intakes Exhaust Air Plenums	7
1.4.6	Pumps Systems' Piping Noise	7
1.4.7	Vibration Isolators And Foundations Bases	7
1.4.7.1	General .....	7
1.4.7.2	Vibration Isolators .....	8
1.4.7.3	Foundations Bases .....	9
1.4.7.4	VIBRATION ISOLATION ROOF CURBS.....	10
1.5	INSTALLATION .....	10
1.5.1.1	Floor Mounting Of Centrifugal Fans - Mounting Type I.....	11
1.5.1.2	Floor Mounting Of Centrifugal Fans - Mounting Type II.....	11
1.5.1.3	Floor Mounting Of Centrifugal Fans - Mounting Type III.....	12
1.5.1.4	Mounting of Factory Assembled Fans, Tubular Fans And Belted Vent Sets - Mounting Type IV .....	12
1.5.1.5	Mounting Of Factory Fans and Axial Flow Fans - Mounting Type V.....	12
1.5.1.6	Mounting of Ceiling Supported Factory Assembled Fans, Axial Flow Fans, Tubular Fans and Belted Vent Sets - Mounting Type VI .....	12
1.5.1.7	Mounting of Ceiling Supported Factory Assembled Fans, Axial Flow Fans, Tubular Fans and Belted Vent Sets- Mounting Type VII.....	12
1.5.1.8	Mounting of Centrifugal Pumps (Greater Than 3 Hp) - Mounting Type VIII.....	13
1.5.1.9	Mounting of Centrifugal Pumps (3 Hp Or Less) - Mounting Type IX.....	13
1.5.1.10	Mounting Of Packaged DX Units .....	13
1.5.1.11	Piping Anchors, Guides and Supports - Mounting Type XII.....	13
1.5.1.12	Piping Guides .....	14
1.5.1.13	Anchors .....	14
1.5.1.14	Supports .....	14

## **1. VIBRATION & ACOUSTIC CONTROL**

### **1.1 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.

### **1.2 PROJECT CONDITIONS**

Project seismic zone is 1 with a zone factor of 0.075 in accordance with the current UBC .

### **1.3 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.

## **1.4 NOISE CONTROL**

### **1.4.1 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.

### 1.4.2 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.

### 1.4.3 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**

		Minimum Static Deflection		
		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
	6	25	75	90
Over	24	25	25	2
30 kW	16	25	25	40
	12	25	25	45
	9	25	65	75
	6	25	90	110

#### **GRILLES, REGISTERS, DIFFUSERS AND DOOR GRILLES**

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 shall require 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.

#### 1.4.4 Acoustical Treatment of Duct Systems

Acoustically lined with 25mm (1") thick, 0.68 kg. (1 1/2 lb) glass fiber duct lining 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) down stream 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.

#### **1.4.5 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.

#### **1.4.6 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.

#### **1.4.7 Vibration Isolators And Foundations Bases**

##### **1.4.7.1 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

#### **1.4.7.2 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.

#### **1.4.7.3 Foundations Bases**

- 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.

#### **1.4.7.4 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 of authorities having jurisdiction.
- 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 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.

### **1.5 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.

#### **1.5.1.1 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.

#### **1.5.1.2 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: -

<b>Motor Size Thickness Required</b>	<b>Inertia Block</b>
Up to 50 hp	8 inches
60 to 75 hp	10 inches
100 hp and greater	12 inches

#### **1.5.1.3 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

#### **1.5.1.4 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.

#### **1.5.1.5 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.

#### **1.5.1.6 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.

#### **1.5.1.7 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.

#### **1.5.1.8 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

<b>Motor Size</b>	<b>Inertia Block Thickness Required</b>
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.

#### **1.5.1.9 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.

#### **1.5.1.10 Mounting Of Packaged 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.

#### **1.5.1.11 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.

#### **1.5.1.12 Piping Guides**

Steel guides shall be welded to the pipe at a maximum spacing of 60 degrees. The outside diameter of the opposing guide bars shall be smaller than the inside diameter of the pipe riser clamps in accordance with standard field construction practice. Each end of pipe anchor shall be rigidly attached to an all-directional pipe anchor isolation mounting, which, in turn, shall be rigidly fastened to the supplementary steel framing within the shaft in an approved manner.

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.

#### **1.5.1.13 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.

ii. The acoustical pipe anchor mountings shall be capable of safely accepting loads developed by the installed piping and shall consist of a bolted assembly of steel plates with lamination of 1/2 inch thick heavy duty neoprene and canvas duck isolation material. A heat shield of 1/4 inch asbestos transit shall be provided as required. The isolation material loading shall not exceed 500 psi.

#### **1.5.1.14 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.



## **Section 15250**

### **Thermal Insulation Specifications**

# Thermal Insulation Specifications

## Table of Contents

### Contents

1.1	CODES AND STANDARDS .....	3
1.2	INSTALLATION .....	4
1.2.1	General .....	4

## 1.1 CODES AND STANDARDS

Work and materials shall conform to the latest edition of the MOPW regulations and recommendations for air conditioning equipment and installation. 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.

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.

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.

## 1.2 INSTALLATION

### 1.2.1 General

An approved specialist thermal insulation contractor shall carry 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 Sub-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 other wise specified. The list shall not be considered as a limitation of the insulation application:-

Supply air systems ductworks

Return air systems ductworks

Fresh Air duct works.

Air Handling Units.

Heat exchangers and convectors (including evaporators, water cooled refrigerant condensers and de-aerator.

Chilled / heating / machine cooling buffer tanks and cisterns.

Storage & non-storage calorifiers

Water heaters and storage cylinders.

Refrigerant pipeline, valves and fittings.

Chilled water, heating water and machine cooling headers, water boxes, pipelines, valves, strainers and all related fittings and accessories.

Condensate water headers, water boxes, pipelines, valves, strainers and all related fittings and accessories.

Domestic Cold water headers, water boxes, pipe lines, valves, strainers and all related fittings and accessories

Steam and condensate water headers, pipe lines, valves, strainers, traps, and all related fittings and accessories

Domestic hot water headers, water boxes, pipe lines, valves, strainers and all related fittings and accessories

All chilled water circulating pumps valves and trimmings.

Other equipment as per the recommendations of the manufacturer or where specified.

## **Section 15410**

### **Drainage System Specifications**

# Drainage System Specifications

## Table of Contents

### Contents

<b>1.</b>	<b>DRAINAGE SYSTEM .....</b>	<b>3</b>
1.1	General specification.....	3
1.2	Scope of Works .....	3
1.3	Storage and Handling .....	3
1.4	Transport and Stacking of Pipes on Site.....	4
1.5	Inspections .....	4
1.6	Pipes and Fittings - Materials .....	5
1.6.1	General.....	5
1.6.2	Above Ground Soil, Waste, Overflow and Venting Systems.....	5
1.7	Pipes and Fittings - Workmanship .....	6
1.8	Under Sink Combined Solid & Grease Interceptors (S.I & GI).....	10
1.9	Floor Drain Trap Primer .....	10
1.10	CHANNELS WITH OUTLETS, GULLIES AND GRATINGS (Ky) .....	10
1.11	Roof Vent Cowl (VC) .....	10
1.12	Cleanout.....	10
1.12.1	Painting .....	11
1.13	Testing and Commissioning .....	11
1.13.1	General.....	11
1.13.2	Proving Tests .....	12
1.13.3	Water Test .....	12
1.13.4	Air Test .....	12
1.13.5	Testing and Commissioning for Drain Pipes.....	12
1.13.6	Profile Test.....	13

## **1. DRAINAGE SYSTEM**

### **1.1 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

### **1.2 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. Below ground drainage and sewerage system running below grade and between sewage manholes as shown on drawings and specified elsewhere.
  - 2. Above ground soil, waste, vent, drain system as shown on the drawing and specified elsewhere.
  - 3. Kitchen and Laundry waste drainage system, as shown on the drawing and specified.
  - 4. Laboratory waste drainage and venting system, as shown on the drawing and specified.

Floor drains, gullies , traps, rodding eyes, overflows, chrome plated bottle traps.

- 5. Floor gully and rodding eyes covers with strainer.
- 6. Manholes, ductile covers, gratings, manhole steps as shown on drawings and specified elsewhere.
- 7. Rain water , surface and storm water pipes complete with cast iron rain water outlets as shown on drawings.

Other works and materials to make the system complete and functional.

### **1.3 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.

#### **1.4 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.

#### **1.5 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.

## 1.6 Pipes and Fittings - Materials

### 1.6.1 General

### 1.6.2 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
  - Ceiling Voids
  - High level and low level (exposed or concealed)
  - 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.
- A. 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)
- B. Materials and Colour: pipes and fittings shall be in UPVC in grey or rustic brown.
- C. Socketed fittings shall be solvent-welded with plain-ended pipes. Seal ring expansion joints shall be provided where required.
- D. 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.

- E. Seal ring socket type PVC caulking bush shall be used to connect PVC pipes to sockets of other material if applicable.
- F. 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.
- G. Floor drains shall be P- trapped and shall be provided with 200 x 200 nickel coated brass cover including strainer.

## **1.7 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 75mm, 100mm and 150mm 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.

Copper waste pipe work shall be supported clear of the structure with cast brackets screwed to the wall using brass screws. Where exposed to view, bright finish brass hospital brackets shall be used with rawl plugs and brass screws. Where pipe work is concealed, bright finish brass single pipe ring with BSP female screwed end and bright finish brass back plate with male screwed end shall be used and fixed to wall using brass screws and rawl plugs.

#### **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.

j) 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.

l) 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.

m) 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.

n) 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.

p) Insulation

All drainage pipes run above false ceilings should be insulated by fiber glass insulation of a density of 24 kg/m<sup>3</sup>.

### **1.8 Under Sink Combined Solid & Grease Interceptors (S.I & GI)**

Large capacity Acid resistant coated interior and exterior fabricated steel grease interceptor, rated as shown in the schedule of equipment with internal air relief by pass, bronze cleanout plug and visible double wall trap seal with removable pressure equalizing/flow diffusing baffle and sediment tray. Gasket non-secured cover with covered recessed lift handle complete with flow control fitting. Regularly furnished with inlet and outlet in high position

Solid Interceptor shall be of large capacity Acid resistant epoxy coated interior and exterior fabricated of steel, Solid Interceptor shall be provided with non-skid secured cover, and with ready removable stainless lint intercepting basket assembly and permanent primary straining baffle. Regularly furnished with inlet and outlet in high position.

### **1.9 Floor Drain Trap Primer**

The automatic trap seal primer valve is a precision device used to deliver a metered amount of water to seldom used floor drain. Connected to any cold water line, it shall be automatically activated whenever any fixture is opened in the building. The automatic trap seal primer valve shall serve individual or remote area drains shall be provided with 15mm NPT (Mtof) connections with strainer and integral back flow preventer and vacuum breaker.

### **1.10 CHANNELS WITH OUTLETS, GULLIES AND GRATINGS (Ky)**

Channel outlets shall be provided in kitchen areas, laundry and where shown on drawing. Channels, gullies outlets shall be manufactured from stainless steel. All edges shall be finished to acceptable levels. The channel shall be provided with:-

- End plates to terminate channel units
- Fully welded flanges and neoprene gaskets to provide watertight seal between components.
- Fixing ties and leveling feet to level channels with floor finishing.
- P trap stainless steel outlet 110mm dia.
- Gully tops to provide bottom outlets to P trap fixed to channel unit via invert dependent connector plates.
- Stainless steel non slip ladder shaped grating of 300mm wide and 25mm height.
- The required openings for the channel inlets (factory fabricated).

### **1.11 Roof Vent Cowl (VC)**

Roof vent cowl shall be provided for all vent pipes as shown on the drawings.

Roof vent cowl shall be galvanized wire basket to fit snugly inside open end of vent pipes extending above roof.

### **1.12 Cleanout**

Cleanouts shall be installed, to provide access to waste and soil pipes for inspection or cleaning.

Cleanouts shall be provided as shown on the drawings, at or near the foot of every vertical stack and no long horizontal pipe runs at every 15-meter intervals.

Cleanouts on horizontal 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.

#### **1.12.1 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.

### **1.13 Testing and Commissioning**

#### **1.13.1 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.

#### **1.13.2 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.

#### **1.13.3 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.

#### **1.13.4 Air Test**

- A. A gauge in the form of a "U" tube shall be connected to the plug fixed at one end of the length to be tested and all junctions and connections to the sewer on drain shall be plugged. Air shall then be pumped in from the other end of the drain under test until a pressure equal to 100mm of water is indicated on the gauge. Without further pumping, the pressure shall not fall more than 25mm during a period of five minutes.
- B. Air tests shall be carried out after 3 pm and all pipe work shall be shaded from the sun at all times. Should an air test fail, a water test shall be carried out as described in this Specification.

#### **1.13.5 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.

#### **1.13.6 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.

**\*End of Section\***

## **Section 15430**

### **Plumbing Systems Specifications**

# Plumbing Specifications

## Table of Contents

### Contents

1.1	Extent of Works.....	3
1.2	Codes and Standards.....	5
1.3	Design Criteria.....	5
1.4	Pipes and Fittings - Materials .....	6
1.4.1	Pipe Works .....	6
1.4.2	Pipes and Fittings - Joints.....	6
1.5	Water Manifold Cabinets .....	6
1.6	Connections to Sanitary Fittings.....	7
1.7	Underground Cold Water Pipe Laying.....	7
1.7.1	General.....	7
1.7.2	Jointing.....	8
1.8	Float Valves.....	8
1.9	Insulation of Pipe work .....	8
1.10	Water Flow Meter and totalizer .....	8
1.11	Water Savers.....	8
1.12	Concrete Water Reservoir Accessories .....	9
1.13	Water Cooler Drinking Fountains .....	9
1.14	Electric Water heater (EWH): .....	10
1.15	Final Tests and Commissioning.....	11
1.15.1	Pipe work Pressure Testing .....	11
1.15.2	Proving Tests .....	11
1.15.3	Sterilisation of Water Services .....	11

## 1.1 Extent of Works

The work to be done under or in relation to this Contract 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.

Unless specified otherwise, all equipment and materials installed under this Contract shall be new.

The work covered by this contract 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 else where 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 heaters, and calorifiers, complete with insulation controllers, interconnecting pipe works, valves, trimming and accessories.
- All pumps completes with, skids interconnecting pipes valves, fittings, valves, flexible connections, and other accessories.
- All automatic air vents, drain cocks at bottom of risers and 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 of all drain and water connections for other trades and subcontractors, such as fire fighting, HVAC, kitchen, irrigation, fountains...etc
- Provision and making good around all openings instructor for all openings needed for pipes, conduits , ducts etc. including all cuttings patching, framing up , furring and making good.
- Provision of trimmed openings in roof for ducts and pipes complete with under flashings.
- Provision of all necessary supports, kerbs, and under flashing for all roof equipment.
- Provision of 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 of the all plumbing and sanitary systems, including:-
  - ▶ 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.
  - ▶ All control and interlocking wiring required to form a complete an operating control system as described under “Automatic Control and BMS” sections
- ▶ 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, specification of equipment, or for 400 days, which ever is greater.
- ▶ 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.)
- ▶ Provision of 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 a back fillings, of all trenches riggings, hoisting, water proofing, cleaning, protection
- ▶ Build up and erection of the concrete domestic water reservoirs.
- ▶ All concrete storm water and drainage concrete trenches complete with benching frame anchoring.
- ▶ The provision and 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.
- ▶ The provision of trimmed openings in roof for ducts and pipes complete with under flashings.
- ▶ The provision of all necessary supports, kerbs and under flashing of the roof equipment.
- ▶ The provision of 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.
- ▶ The provision of 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.
- ▶ The provision of 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.
- ▶ The provision of 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.
- ▶ Provision of bulkheads.
- ▶ All lifting, lowering, handling and scaffolding including cranes as necessary.
- ▶ Provision of concrete plinths under all equipment.

## 1.2 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 Fire Department Regulations
- ▶ All relevant British Standards and Code of Practice
  - BSCP 6700 - Water Supply
  - BS 5572 - Code of Practice for Sanitary Pipe work
  - BS 8301 - Code of practice for Building Drainage

Should any conflict arise between the codes and standard mentioned above, regulations issued by the local codes shall take precedence.

## 1.3 Design Criteria

Domestic Water Operating Pressures

Minimum 50 kPa

Maximum 300 kPa

Water Velocity 1.0 m/sec - 1.5 m/sec

## **1.4 Pipes and Fittings - Materials**

### **1.4.1 Pipe Works**

#### **1.4.1.1 Internal Pipe Works**

Domestic cold water main pipes which run in air conditioned areas shall be insulated to protect against condensation in air conditioned areas

Domestic Water pipes which run on roof shall be insulated to protect against frosting.

All domestic hot water pipes shall be insulated to protect against thermal heat dissipation

#### **1.4.1.2 Pipes embedded under tiles and Walls**

- A. All pipes which run below tiles, or embedded in walls shall be of cross linked polythene PEX type PEX – A . Pipes shall be cross linked using peroxide cross linking.
- B. Pipes shall be manufactured to BS 3284 type (50) Class (C) , ASTM F876 and F877, or to DIN standards heavy density high pressure type. Pipes shall run in sleeves of diameter twice the diameter of pipes. Manifolds shall be provided in steel cabinets installed below washbasins 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.
- C. Manifolds shall be supplied for sanitary ware, adoptable to plastic- copper and iron pipe ball valves in  $\frac{3}{4}$ " , female thread, with drain, chrome plated unit, up to DIN standard 1353.

### **1.4.2 Pipes and Fittings - Joints**

- A. The jointing of copper pipe work shall be by means of dezincification resistant integral solder ring or end feed fittings. Bronze welding shall not be permitted.
- B. PEX pipes Fittings shall be of compression or press fittings type, all of gunmetal construction or of dezincification resistant brass

## **1.5 Water Manifold Cabinets**

Cabinet cover and frames shall be of stainless steel 304 decoratively brush finished or painted wood, all as per architect decision. Cabinet shall have full internal cladding of granite or marble.

The depth of the cabinet shall not exceed 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.

Where the cabinets located within walls of ceramic tiles finish, the cabinets shall be provided with heavy-duty hinged type cover. The cover to be fitted with ceramic tiles rendered to match the wall tiles. The cover shall be provided with click in locking mechanism.

The cabinets shall include the following:

A. Cold and Hot Water Manifolds

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.

**1.6 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.

B. The water supply connection to the sanitary fittings shall be in the following sizes:

Fixtures	Size
Lavatory	16mm
W.C	16mm
Sink Unit	22mm
Shower	22mm

**1.7 Underground Cold Water Pipe Laying**

**1.7.1 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.

#### **1.7.2 Jointing**

- A. The jointing of copper pipe work shall be by means of dezincification resistant type fittings. Bronze welding shall not be permitted.

### **1.8 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.

### **1.9 Insulation of Pipe work**

- B. Refer to Pipe insulation specification.

### **1.10 Water Flow Meter and totalizer**

Furnish and install water meter on the main water supply.

Meters shall be of the turbine type with totalizer. Housed in purpose made galvanised steel cabinet.

Provide all necessary pipework, valves, and fittings

- 2 isolating valves
- Check Valve
- Strainer

### **1.11 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.

## 1.12 Concrete Water Reservoir Accessories

Install all fittings and connections reservoirs walls, prior to concrete casting, at their exact required locations , taking the necessary precautions not to have them dislocated when concrete is poured

All fittings shall be galvanized steel pipe, with threaded ends for connecting to threaded fittings and valves and with flanges screwed on to them where it is necessary to connect them to flanged fittings or valves. They shall be of suitable lengths to project 5 cm. within the reservoirs and 15 cm to the outside wall of the reservoirs.

All piping connections embedded in the concrete walls of the reservoirs shall be provided with no-leak puddle flanges which shall consist of a square black steel plate, 6 mm. thick, of dimensions 15 cm. larger than the pipe, with a hole in the center equal to the outside diameter of the pipe. The flange shall be welded all around the pipe at a location as to fit in the centre of the wall to prevent water leakage around the pipes all as detailed on the drawings.

Open ended piping connections into the reservoirs such as vents and overflows shall be properly screened to prevent the entrance of insects, vermin and foreign matter into the reservoirs. The screens shall be of galvanized steel wire mesh not less than 10 mesh per square centimeter and shall be fitted to the open end of the pipe in an approved manner.

The inlet of pump suction pipe in the water reservoir shall be provided with vortex plate.

Each reservoirs shall be provided with access windows with swinging doors and lock, near make-up , supply and overflow piping. A stainless steel cat ladder shall be install for each reservoir in both sides of the access windows.

The make-up pipe shall be connected to the water tank via a float valve of the same size as the pipe connection.

Vent pipes of the water tanks shall be properly screened to prevent the entrance of insects, vermin and foreign matter into the tanks. the screens shall be of galvanized steel wire mesh not less than 10 mesh per cm<sup>2</sup>.

The make-up opening shall be located at a position higher than the overflow opening.

The tanks shall be filled with water and allowed to stand for 48 hours. They shall be examined for leaks and repaired as necessary.

## 1.13 Water Cooler Drinking Fountains

- a) Type: Each electric water cooler shall be of refrigerated, self-contained semi recessed, floor-mounted, of capacity of 20 litres per hour from 27.0 deg C inlet temperature to 7.0 deg C drinking water in room ambient temperature 32 C.

- b) Roughing-in Dimensions: The Contractor shall install the water cooler to the roughing-in dimensions shown on the approved shop drawings.
- c) Connections: The electrical, water supply and waste connections are to be made according to the approved shop drawings. During rough in, plumber and electrician shall check dimensions carefully to prevent any part of the water cooler cabinet or equipment from interfering or partially interfering with any connection.  
  
The cooler shall be provided with cartridge type water filter connected to the water supply.
- d) Top and Cabinet: Water cooler top shall be of highly polished stainless steel with full-length anti-splash ridge and integral strainer. Cabinet shall be of heavy gauge stainless steel. Cooler is to have anti squirt anti bubbler with built-in strainer and pressure regulator.
- e) Condensing Unit and Tank: Condensing unit shall be hermetically sealed and lubricated for life. Cooling tank shall be of brass, tinned, and have a minimum working pressure of 140 lb.
- f) Approval: Water cooler shall bear the Underwriters' Laboratories seal of approval.
- g) Protection: The water cooler shall be protected during the construction and debris or other construction dirt shall not be allowed in the cooler. Excess pipe joint compound shall be wiped off as soon as installation is complete. Any chrome trim with wrench marks shall be removed and new trim installed.
- h) Cleaning: The water cooler shall be cleaned and all construction dirt removed at the completion of the project.

#### **1.14 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 and UL listed and approved. 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.

## **1.15 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.

### **1.15.1 Pipe work Pressure Testing**

- A. All pipe work services shall be subjected to a test of 1000 KN/m<sup>2</sup> 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.

### **1.15.2 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.

### **1.15.3 Sterilisation 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 Department.
  - 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 Ministry of Electricity and Water Department for testing. The results of these tests shall be forwarded to the Engineer for his approval.

## **Section 15440**

### **Sanitary Fixtures Specifications**

## Sanitary Fixtures Specifications

### Table of Contents

#### Contents

<b>1. Sanitary Fixtures .....</b>	<b>3</b>
<b>1.1 General specification .....</b>	<b>3</b>
<b>1.2 Storage and Handling .....</b>	<b>4</b>
<b>1.3 Transport and Handling on Site .....</b>	<b>4</b>
<b>1.4 Selection Sheets .....</b>	<b>5</b>

## 1. Sanitary Fixtures

### 1.1 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

All sanitary fixtures, trim and accessories shall be of approved manufacture and manufacturer's standard, selected from the top half of the product line and shall not be "factory close-out", end of product model", or otherwise discontinued models. Trim and accessories shall be procured from one manufacturer unless specified otherwise.

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 and shall be of the same manufacture and colour unless otherwise specified.

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.

List and catalogues of all proposed plumbing fixtures, trim and accessories, indicating manufacturer, type and mode number shall be submitted for approval.

Samples of all fixtures trim and accessories shall be submitted for approval when asked to do so by the Engineer. The Contractor shall not charge the employer with the cost of such samples nor shall he use any item different from the approved sample.

Sanitary fixtures shall be kept dry, under cover, and separate with clean dustsheets or polythene when not in manufacturers own packing.

Concealed brackets, hangers and plates shall be painted as directed by the Engineer.

Metal fixtures shall be stored on level surface to prevent twisting, prevent contact with cement and lime and do not pack in straw.

Coordination of fixing sanitary fixtures and accessories supplied by the client shall be as directed by the Engineer.

Self-tapping screws shall conform to BS 4174.

Coordination of fixing accessories for shower tray type SH shall be 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 sea;s 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 with finished walls and floors.

Sanitary fixtures shall be fixed in accordance with the manufacturer's recommendations.

## **1.2 Storage and Handling**

- A. 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.
- B. 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.
- 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.

## **1.3 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

**1.4 Selection Sheets**

## DX Split Units Specifications

### Table of Contents

#### Contents

<b>1. SPLIT DX HEAT PUMP UNITS.....</b>	<b>3</b>
1.1 SUBMITTALS.....	3
1.2 CLOSEOUT SUBMITTALS .....	4
1.3 DELIVERY, STORAGE, AND HANDLING .....	4
1.4 COORDINATION .....	4
1.5 PRODUCTS .....	4
1.5.1 Split DX Heat Pump Units.....	4
1.6 EXECUTION .....	10
1.6.1. EXAMINATION .....	10
1.6.2. INSTALLATION – INDOOR UNIT .....	10
1.6.3. INSTALLATION - CONDENSING UNIT (Outdoor Unit) .....	10
1.7 MANUFACTURER'S FIELD SERVICES .....	11
1.8 CLEANING .....	11
1.9 DEMONSTRATION .....	11

## 1. Split DX Heat Pump Units

Section Includes:

1. Indoor Unit
2. Condensing unit (Outdoor Unit).
3. Refrigerant Pipes

### 1.1 SUBMITTALS

- A. Product Data: Submit data indicating:
1. Certificate of origin for the indoor and outdoor units
  2. Certificate of origin for the compressor and the controllers
  3. Compliance sheet with schedule of equipment
  4. Compliance sheet with specifications
  5. Cooling and heating capacities
  6. Available external static pressure for all indoor units and outdoor units fans
  7. Dimensions of all indoor units and outdoor units
  8. Weights of all indoor units and outdoor units
  9. Sound data for all indoor units and outdoor units
  10. Rough-in connections and connection requirements
  11. C.O.P at design operating conditions
  12. Electrical requirements with electrical characteristics and connection requirements
  13. Room Thermostats Type
  14. Controls
  15. Accessories
- B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- C. Manufacturer's Certificate: Certify Products to meet specified project requirements. Including capacities of all indoor and outdoor units, refrigerant pipes sizing taking in consideration the de-rating of the Cooling and Heating Capacity due:-
1. Height and horizontal run differences between Indoor units and Outer units
  2. Fittings, valves, multi kits accessories
  3. Ambient conditions
  4. Indoor Design Conditions
  5. On Coil Dry and Wet Bulb Conditions
- D. Manufacturer's Field Reports: Submit start-up report for each unit
- E. Supplier Data: Submit list of clients and projects reference list
- F. Warrantee: Submit written **Five years full warranty** from date of commissioning including all parts, refrigerant charge, overhead, profit, incidental charges and sundries.
- G. Maintenance: Submit written **Five years free maintenance** from date of commissioning including two periodical visits per year (summer (cooling mode) and winter (heating mode) change over),

filters cleaning and/or replacement, refrigerant pressure check and any on-call maintenance required

## **1.2 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations of controls installed remotely from units
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

## **1.3 DELIVERY, STORAGE, AND HANDLING**

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

## **1.4 COORDINATION**

- A. Coordinate installation of condensing units with concrete pad and roof structure
- B. Coordinate locations of indoor and outdoor units with architectural discipline
- C. Coordinate weights of indoor and outdoor units and concrete bases with structural discipline
- D. Coordinate electrical data with electrical discipline
- E. Coordinate thermostats' locations and type with architectural discipline. Provide sample for approval
- F. Coordinate thermostats' electrical requirements with electrical discipline

## **1.5 PRODUCTS**

### **1.5.1. Split DX Heat Pump Units**

#### **1.5.1.1. Product Description:**

- A. General Inverter Units should all be Heat Pumps Class A for cooling and heating operations, Single phase (230V ~ 50Hz).
- B. The Units should all be factory-assembled and tested, consists of indoor and outdoor units, each one complete piece, air cooled outdoor unit, designed for roof, slab or floor mounting, Contained with in the unit enclosure shall be all factory wiring, piping, Consisting of DC

- compressors, DC fan motor, condensers, evaporator fans, holding charge of R410 Refrigerant and temperature control, filters and special features required prior to field start up.
- C. Outdoor unit cabinet shall be constructed of galvanized steel; compressor compartment shall be isolated to assure quiet operation.
- D. Condenser fans shall be direct drive Propeller type, and motors shall be totally enclosed.
- E. Compressor shall be Hermetic type, 4 Pole, DC Rotary Inverter motor for all units except the unit with cooling capacity 5 KW which is Scroll DC inverter motor.
- F. Condenser coil shall be constructed of aluminum fins mechanically bonded to internally enhance seamless copper tubes.
- G. The control must be an inverter control with a Vector PAM Inverter technology. (I-PAM +Vector control) to improve the maximum compressor speed and operation efficiency. "I-PAM (Intelligent power module-Pulse Amplitude Modulation)"
- H. Unit will not need low ambient control kit as the operation in the units should be a low ambient operation.
- The heating mode operation temperature should be between (-15~24) °C.
  - The cooling mode operation temperature should be between (-10 ~ 46) °C.
- I. Units should have EER up to 3.8 and a COP up to 4.12.
- J. Operation Sound, low noise by adopting plastic case, Plastic fan and Multi positions airflow volume switch decreases noise to 48dB(A) in the indoor unit.

#### **1.5.1.2. INDOOR UNIT**

A. Configuration:

- Decorative 4-way and 2-way cassette type indoor units
- Decorative wall, ceiling and floor mounted types
- Ducted concealed units

B. Mode Of Operation: All Unit shall Operate on :-

- Heating Mode
- Cooling Mode
- Dehumidification mode.

C. Construction :

##### **1. Ducted Concealed Indoor Unit**

a. Chassis

The chassis shall be fabricated from at least 0.7mm thick galvanized sheet steel to form a rigid unit fully sealed to eliminate extraneous air leakage free from sharp edges and complete with fixing lugs.

Thermal insulation of at least 12.0mm. minimum thicknesses shall be applied to all sides of coil sections, and beneath all cooling coil drip pans.

All insulation must be non-flammable, non-toxic, and possess minimum smoke propagation qualities.

Acoustic treatment shall be supplied to casings as required to meet the room specified sound levels.

Reinforced sheet steel enclosures shall be provided for room-mounted units to form a rigid cabinet that will not flex or vibrate during unit operation. There shall be space within each cabinet for piping connections and valves.

b. Fans & Motors

Fans shall be multi-blade, curved centrifugal type, statically and dynamically balanced, and directly driven by motor. The fan motor bearing shall be permanently lubricated. The fan shall be of three operating positions High, Medium and Low which can be selected according to the required conditions.

Motor design, marking, rating, performance and testing shall be in accordance with Relevant British Standards. Motors shall be designed to have a winding temperature rise to class B requirements and be provided with class F insulation.

The unit shall be pre-wired to relevant British Standards complete with contactors, overloads and control circuit fuses and shall have a terminal including an earth connection for field wiring of both power and controls.

Units shall incorporate thermal overloads for fan motors and compressors, manually reset high pressure cut outs, thermistors with lockout circuiting, low pressure controls with lock out provision, start to start timers (5-10 minutes).

The protection shall be arranged so that an alarm will shut down the affected compressor and trigger an alarm light on the unit but will permit the fan and any other compressors to continue to operate.

Unit casing shall be insulated throughout including the condensate tray by, a minimum 12.0mm thick, closed cell rubber with scrim finish, bonded to the casing.

c. Cooling Coil

Coil shall be the multi-pass, cross-finned tube type, equipped with highly-efficient aluminum fins, mechanically bonded to seamless, oxygen-free copper tubes. The fins shall be spaced at no more than 12 fins per inch (25.4mm). The coil shall be cleaned, dehydrated and tested for leakage at the factory.

d. Drain Pans

Units shall be fitted with a one piece drip pan, extending beyond the cooling coil sections to cover return bends and shall have a second deep flanged drain pan fitted outside of unit chassis having 22mm OD outlet to cover where necessary random condensate from valves, fittings and coil drip pan outlet.

Drip and drain pans shall be zinc coated and treated both sides with a protective coating of mastic.

Both pans shall be reversible for left or right hand location. The outer surface of all condensate drain pans shall be adequately treated/insulated to prevent secondary condensation occurring.

All drip and drain pans shall be designed to reduce to the absolute minimum the formation of Legionella by careful detailing of both pans and pipe work connections.

The protective mastic coating shall be suitable for the frequent application of disinfectant when maintenance engineers flush through drip/drain pans and fan coil drainage pipe work

The condensate drain pan shall be treated to resist corrosion and suitable to catch all condensate and any moisture carry over from the coil shall be provided.

e. Filters

Furnish air filters on the inlet side prior to coil and fan sections.

Filters shall be of throwaway type readily accessible for inspection, removal and replacement.

The media shall be washable aluminum and shall not break up in the air stream.

Filter media shall be non-flammable and shall not produce smoke or large volumes of noxious products when exposed to fire.

f. Access Panel

Furnish Access panel for fan's assembly, coils, filters and electrical connection box.

Access to control switches and coil connections shall be through hinged flaps on the top panel discharge grille. Front panels shall be secured with positive locking tamper proof fasteners, hinged for horizontal units.

When specified or shown on drawings, return air plenums shall be provided to suit particular manufacturer's standard model type

g. Condensate Pump

Furnish condensate pump for the ceiling cassette units. Pump assembly shall be of plastic body and trimmings. The unit shall be motor driven and shall be under the control of float level switch.

A direct alarm signal shall be indicated on the equipment control panel to indicate pump failure

2. **Decorative Indoor Units:**

The decorative ceiling, wall or floor mounted units shall be constructed of heavy duty polymer or finished steel sheet baked with synthetic resin-paint, with a plastic air panel assembly.

3. **Ceiling Cassette Units:**

The ceiling cassette units shall be constructed of heavy duty polymer or finished steel sheet baked with synthetic resin-paint, with a plastic air panel assembly.

#### **1.5.1.3. Outdoor Unit**

- A. The outdoor unit should be air cooled split system .Outdoor section shall be suitable for on the ground/roof top installation.
- B. Units shall consist of Hermetic type, 4 Pole, high efficiency DC Inverter Rotary compressor and a high efficiency DC scroll compressor for the unit with cooling capacity 5KW.
- C. All Units shall consist of air cooled coil, propeller type condenser fan, DC Inverter control box, DC inverter motor and holding refrigerant charge R410A.
- D. The outdoor heat exchanger should be of aluminum fins mechanically bonded to internally enhance seamless copper tubes.
- E. The Outdoor unit's weight should not exceed 61 Kg.
- F. The out door fan should be driven by DC Inverter motor.

#### **1.5.1.4. CONTROLLERS:**

Operation is controlled by a wireless remote controller.

Indoor temperature can be detected accurately by the inclusion of a thermo sensor in the body of the wireless remote controller.

- A. The controller must have a simple operation with Built-In Daily Timer possible to set ON/OFF timer once within a 24 hour period.
- B. The controller must have a simple and sophisticated operations with a choice of 4 daily timers ( On/Off/Program/Sleep)
- C. The controller must have the ability to control up to 16 Indoor units.
- D. The controller must have a sleep timer function that automatically corrects the set temperature to prevent excessive heating or cooling during sleep hours.

#### **1.5.1.5. ACCESSORIES:**

The outdoor units shall be provided with the following features:

- A. Service charging valves.
- B. Pre-charged outdoor unit with Freon.
- C. Expansion device, Muffler & two strainers.
- D. Thermostat with Multi-speed switch wall mounted type.

**1.5.1.6. SAFETY:**

- A. The Indoor Units must have a Circuit protection – Current Fuse (PCB)-and a fan motor thermal protection.
- B. The Indoor Units must have a terminal Protection – Current (Thermal) Fuse.
- C. The Outdoor units must have a Circuit Protection – Current fuse- near the terminals and main PCB, Fan motor protection by a thermal protection program, high pressure protection by a pressure switch for units above 5.3KW and compressor thermal protection.

**1.5.1.7. REFRIGERANT PIPING and Fittings**

- A. Furnish complete pipe network between indoor units and outdoor units.
- B. Refrigerant pipes to be of copper tubing and recessed solder joint fittings. Tubing shall be in accordance with ASTM Specification B 88-61 type 'L' hard drawn. Coiled copper piped are not allowed to be used even for the small sizes.
- C. Fittings shall be wrought copper or tinned cast brass
- D. Furnish fittings from the equipment manufacturer and installed in accordance to their recommendation.
- E. Joint brazing should be carried out with care as to prevent intrusion of foreign matters. Blow all pipes with N2 .Tubing shall be protected against oxidation during silver soldering by use of dry nitrogen flowing through the tubing.
- F. Test all pipes by at twice the maximum operating pressure.
- G. All out door Refrigerant pipes shall run in cable trays or ladder for protection
- H. Furnish thermal insulation for all suction pipes of 13mm closed cell elastomeric rubber. All insulated piped on roof and exposed to sight shall be clad with 0.7mm galvanized sheet metal.
- I. Furnish complete calculations for pipe sizing for the Engineer's approval.
- J. Furnish all piping accessories and specialties required to complete the installation.

**1.5.1.8. Refrigerant Pipes Ladders and trays**

Ladders and 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 galvanized 0.5mm (1/64") thick.

Steel trays shall be manufactured from mild steel in accordance with BS 1449: Part 1 or BS EN 10130/10131/10051 as appropriate. Galvanized components shall be hot-dip galvanized to BS729 after manufacture.

Wherever the tray is exposed to weather i.e. laid on the roof, it shall be covered with galvanized sheet steel covers of 20 gauges to protect the pipes from the sun and rain.

## **1.6 EXECUTION**

### **1.6.1. EXAMINATION**

Verify concrete pad for condensing unit is ready for unit installation.

### **1.6.2. INSTALLATION – INDOOR UNIT**

- A. Install Indoor units with vibration isolators and mounting bracket.
- B. Install floor mounted units on concrete housekeeping pads at least 87 mm high and 150 mm wider than unit.
- C. Install condensate piping with trap and route from drain pan to condensate drainage system.
- D. Install components furnished loose for field mounting.
- E. Install connection to electrical power wiring in accordance with electrical specifications.

### **1.6.3. INSTALLATION - CONDENSING UNIT (Outdoor Unit)**

- F. Install condensing units on vibration isolators.
- G. Install units on concrete foundations.
- H. Install refrigerant piping from units to condensing unit. Install refrigerant specialties furnished with unit. Install thermal insulation on suction piping. All brazed joints shall be accessible for future inspection and leak detection. Provide access doors for this purpose for concealed areas. Access doors shall be marked by the installer and provided by the civil contractor.
- I. Evacuate refrigerant piping and install full charge of refrigerant.
- J. Install electrical devices furnished loose for field mounting.
- K. Install control wiring and cables between air handling unit, condensing unit, and field installed accessories.
- L. Install connection to electrical power wiring in accordance with electrical specifications.
- M. Install the BMS integration network and wiring.

**1.7 MANUFACTURER'S FIELD SERVICES**

- A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.
- B. Provide on site training of Owner's personnel on the operation, maintenance and trouble shooting for the whole system. Training course shall be for full five working days after which the manufacturer shall issue a certificate that the attendees are capable of carrying out the above mentioned tasks.

**1.8 CLEANING**

- A. Vacuum clean coils and inside of unit cabinet.
- B. Install new cleanable filters in units at Substantial Completion.

**1.9 DEMONSTRATION**

- A. Demonstrate Indoor unit operation and maintenance.
- B. Demonstrate starting, maintenance, and operation of condensing unit

## **Section 15855**

### **Diffusers, Registers, & Grilles Specifications**

# Diffusers, Registers, & Grilles Specifications

## Table of Contents

### Contents

<b>1. Diffusers, Registers, &amp; Grilles Specifications .....</b>	<b>3</b>
<b>1.1 Codes and Standards .....</b>	<b>3</b>
<b>1.2 Products .....</b>	<b>3</b>
<b>1.2.1 Grilles, Registers &amp; Diffusers .....</b>	<b>3</b>
<b>1.2.1.1 General .....</b>	<b>3</b>
<b>1.2.1.2 Supply and Return Air Diffusers - Ceiling Mounted.....</b>	<b>4</b>
<b>1.2.1.3 Linear Diffusers .....</b>	<b>5</b>
<b>1.2.1.4 Air Registers &amp; Grilles.....</b>	<b>5</b>
<b>1.2.1.5 Door Grilles .....</b>	<b>5</b>
<b>1.2.1.6 Outlets .....</b>	<b>6</b>
<b>1.2.1.7 Toilet Exhaust Grilles - Ceiling Mounted .....</b>	<b>6</b>

## 1. Diffusers, Registers, & Grilles Specifications

### 1.1 Codes and Standards

Work and materials shall conform to the British 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.

### 1.2 Products

#### 1.2.1 Grilles, Registers & Diffusers

##### 1.2.1.1 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 NATA, 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 to be integrated with cylindrical air pattern stabilizer and volume control damper.

#### **1.2.1.2 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.

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.

### **1.2.1.3 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.

### **1.2.1.4 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

### **1.2.1.5 Door Grilles**

Door grilles no vision, V-shaped louver type. Grille net free area is to be not less than 70% of the gross face area.

Grilles shall be installed in an approved, neat, level, square, tight manner.

#### **1.2.1.6 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.

#### **1.2.1.7 Toilet Exhaust Grilles - Ceiling Mounted**

Grilles shall be of the egg-crate type of flanged, aluminum construction in a baked enamel finish of a color to be directed. Egg-crate shall be on a 12mm grid. Grilles shall have removable core and be fitted with an opposed blade volume damper, painted matt black.

**\*END OF SECTION\***

## **Section 15891**

### **Duct Work Installations**

## Duct Work Installations

### Table of Contents

#### Contents

1.	Duct Work.....	3
1.1	Codes And Standards .....	3
1.2	Submittals .....	4
1.3	Installations.....	4
1.3.1	General.....	4
1.3.2	Materials.....	5
1.3.3	Construction .....	6
1.3.4	Ductwork Fittings.....	8
1.3.5	Kitchen And Cooking Hood System.....	8
1.3.6	Ductwork Brackets.....	9
1.3.7	Flexible Ducting.....	10
1.3.8	Testing The Ductwork .....	10
1.4	Schedule:.....	11

## 1. Duct Work

### 1.1 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 Contractor accepts full liability for ensuring compliance with the same.

## **1.2 SUBMITTALS**

A- Submit in accordance with Section 15050, General Conditions

B- Manufacturer's Literature and Data:

- 1- Rectangular ducts:
  - a. Schedules of duct systems, materials and selected SMACNA or DW construction alternatives for joints, sealing, gage and reinforcement.
  - b. Duct liner.
  - c. Sealants and gaskets.
  - d. Access doors.
- 2- Round and flat oval duct construction details:
  - a. Manufacturer's details for duct fittings.
  - b. Duct liner.
  - c. Sealants and gaskets.
  - d. Access sections.
  - e. Installation instructions.
- 3- Volume dampers, back draft dampers.
- 4- Upper hanger attachments.
- 5- Fire dampers, fire doors, and smoke dampers with installation instructions.
- 6- Sound attenuators, including pressure drop and acoustic performance.
- 7- Flexible ducts and clamps, with manufacturer's installation instructions.
- 8- Flexible connections.
- 9- Instrument test fittings
- 10- Details and design analysis of alternate or optional duct systems.

## **1.3 Installations**

### **1.3.1 General**

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.

### **1.3.2 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, 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 (G90), based on three surface specimens.

### 1.3.3 Construction

TABLE A: Rectangular Or Round Ducts - Low & Medium Pressure

(Modified Table 4 DW/146)

---

DUCT SIZE (Longer Side or Diameter)	NOMINAL SHEET THICKNESS mm.
Up to 400 mm.	0.6
401 mm. to 600 mm	0.8
601 mm. to 800 mm.	1.0
801 mm. to 1000 mm.	1.0
1001 mm. to 1500 mm.	1.0
1501 mm. to 2500 mm.	1.2
2501 mm. to 3000 mm.	1.6

---

All 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 to have transverse joints flanged in accordance with DW/142, with maximum spacing of 2000 mm.

TABLE B: PLANT Connections - All Plant

DUCTS SIZE (Longer Side or Diameter)	NOMINAL SHEET THICKNESS	
	mm	b.g.
Up to 800mm.	1.6	16
801 mm. to 1000 mm.	1.6	16
1001 mm. to 225 mm.*	1.6	16
2251 mm. to 300 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 to be in 1830 mm. minimum lengths, except where bends or branches occur.

All ductwork throughout shall be adequately stiffened to prevent drumming. Internal stiffening will not be permitted. Mild steel angles used as flanges or stiffeners shall be fixed to the duct by one of the following

a) Mechanical closed rivets or bolts at 150 mm. 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:

- ▶ 25 x 25 mm. angle 8 mm. bolts
- ▶ 30 x 30 mm. angle 8 mm. bolts
- ▶ 40 x 40 mm. angle 10 mm. bolts
- ▶ 50 x 50 mm. angle 10 mm. bolts

The joints shall be made using suitable cord and sealing compound inserted between flanges to ensure air tightness of joint.

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.

#### **1.3.4 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.

#### **1.3.5 Kitchen and Cooking Hood System**

Kitchen exhaust ductwork shall be installed in accordance to NFPA 96 (Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations)

Duct works shall be as short and direct as possible with minimum bends and no turning vanes. Ductwork shall be provided with amply sized clean openings (450x450mm) at every change of direction and on horizontal straight run every 4.5 meters.

The duct shall constructed of 2.0 mm black steel, welded and properly reinforced to be completely liquid tight and.

The duct shall be connected to the fan and via a heavy-duty non-asbestos high temperature glass or ceramic fabric

Fire dampers shall only be installed in the duct if the hood uses the gas suppression system such as CO<sub>2</sub>.

Where ducts are interiorly exposed, they shall be clad with satin finished 0.8mm stainless steel cladding.

Range hoods shall be supplied by the kitchen equipment supplier. However it shall be coordinated and arranged with duct manufacturer

#### **1.3.6 Ductwork Brackets**

Other than specific details being indicated on the Drawing, the bracketing shall be of galvanized steel sections and shall be as follows:

##### **i) 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.

### **1.3.7 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.

### **1.3.8 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.

**1.4 SCHEDULE:**

**SCHEDULE 1:**

**Schedule of Approved Manufacturers**

All materials and equipment specified in this Volume shall be of a quality equivalent to/or better than furnished or manufactured by the following

<b>Equipment</b>	<b>Manufacturer</b>	<b>Country Of origin</b>
Sheet Metal Ducts	Tayssen Sheet Metal British Steel Nippon Steel	Germany Belgium UK Japan
Fire Dampers	Trox Anemostat Titus BSP	UK USA UK UK , Jordan
Volume Dampers Sound Attenuators	KBE ATAI Safid BSP	KSA KSA KSA UK , Jordan
	KBE ATAI Safid BSP	KSA KSA KSA UK , Jordan
Ducts Accessories	BSP Dura Dyne Foster	UK USA USA
Supports & Hangers	Hilti Fischer Erico	Liechtenstein Germany USA

**NOTES**

- 1- The tender pricings shall only be based on any of the above listed approved manufacturers.
- 2- Alternative offers from other manufacturers may be submitted, provided that full substantiating data of the compliance with specifications and compliance with the approved manufacturer's features is submitted
- 3- The alternative manufacturers offers may be accepted or rejected at the sole discretion of the Engineer. The engineers decision shall be final with no obligation to explain his decision.
- 4- Submit the compliance form, with the Tender documents, indicating the proposed manufacturers for major equipment. Treat all equipment for which data submissions are required as major equipment for this purpose.
- 5- Changes from the equipment offered at Tender will not be permitted unless the Engineer is satisfied that there is significant advantage in Principle.

**\*END OF SECTION\***

## **Section 15910**

### **Ducts Accessories**

## Duct Work Installations

### Table of Contents

#### Contents

710.1	Duct Accessories .....	3
710.1.1	Codes And Standards .....	3
710.1.2	Summary .....	3
710.1.3	Quality Assurance .....	4
710.1.4	Extra Materials.....	4
710.1.5	Products .....	4
710.1.5.1	Backdraft Dampers .....	4
710.1.5.2	Manual Volume Control Dampers.....	5
710.1.5.3	Fire Dampers.....	5
710.1.5.4	Ceiling Fire Dampers .....	6
710.1.5.5	Smoke Dampers.....	7
710.1.5.6	Duct Silencers .....	8
710.1.5.7	Turning Vanes .....	10
710.1.5.8	Duct-Mounted Access Doors And Panels .....	10
710.1.5.9	Flexible Connectors.....	10
710.1.5.10	Accessories Hardware.....	11
710.1.6	Execution .....	11
710.1.6.1	Examination .....	11
710.1.6.2	Installation .....	12
710.1.6.3	Adjusting.....	12

## **1.00 DUCT ACCESSORIES**

### **1.01 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 Contractor accepts full liability for ensuring compliance with the same.

### **1.02 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.

- 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.

### **1.03 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. DW146 Ductwork Specification

### **1.04 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.

### **1.05 PRODUCTS**

#### **1.05.1.a 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.

### **1.05.1.b 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.

All volume control damper shall be of high performance , opposed-blade design, low-leakage rating, with linkage outside of air stream, suitable for horizontal or vertical applications. The damper shall comprise of :-

- 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.
- 6- 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.
- 7- 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.

Provide for low velocity air systems, single thickness damper blades. Provide for high velocity air systems, double thickness, streamline pattern damper blades. The edges of the blades shall be folded and left smooth. Dampers located inside aluminum duct shall contain blades made from extruded sections.

Provide single bladed dampers for ducts up to 150 mm. in height and multi bladed dampers, not more 150 mm. wide generally, for ducts and apertures in excess of 150 mm. in height.

Dampers shall be rigid in construction and free from vibration in any position. Casings shall be airtight. Dampers shall be accurately installed in relation to their quadrants so as to permit free movement of 90 degrees.

Dampers greater than 1200 mm. in height or width shall be built up in two or more sections, suitably interconnected with air tight seals between sections, and mounted into a framed casing having additional bracing members as necessary to avoid flexing large installations shall be site assembled.

Provide accessible located and external to dampers a substantially constructed, rigid mounting bracket to which a cast quadrant with lockable cadmium plated screws, nuts and washers. The quadrant shall be clearly marked "open" and "shut".

#### **1.05.1.c FIRE DAMPERS**

- A. General: UL labeled according to UL Standard 555 "Standard for Fire Dampers. Or to B.S.2989, Group 2, Class B, with all cut edges protected with zinc chromate prime. The shutter shall be held in the open position out of the airstreams by a fusible link set to release at 72°C.
- 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.

#### **1.05.1.d 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.

### 1.05.1.e SMOKE DAMPERS

- a- General: UL-labeled according to UL Standard 555S, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems." Combination fire and smoke dampers shall also be UL-labeled for 1-1/2 hour rating according to UL Standard 555 "Standard for Fire Dampers." Refer to the Smoke Damper Schedule at the end of this Section for leakage classification, temperature category, and other characteristics.
- b- Fusible Link: Replaceable, 165 deg F rated.
- c- Frame and Blades: 16-gage galvanized steel.
- d- Mounting Sleeve: Factory-installed, 18-gage galvanized steel, length to suit wall or floor application.

### 1.05.1.f COMBINED FIRE SMOKE DAMPER

- e- Combined fire smoke damper shall be installed as depicted on drawings. Frame shall be a minimum of 16 gage (1.52) galvanized steel formed into a structural hat channel shape with tabbed corners 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 with 14 (1.90) gage equivalent thickness. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in blade edge (adhesive or clip fastened seals not acceptable) and shall withstand 450°F. Jamb seals shall be stainless steel flexible metal compression type. Blade action must be parallel blade.
- f- Each combined fire smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 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 no higher than leakage Class I (4 cfm/ft. at 1" w.g. and 8 cfm/ft. at 4" w.g. or .02 m<sup>3</sup>/s/m<sup>2</sup> at 249 Pa or .04 m<sup>3</sup>/s/m<sup>2</sup> at 996 Pa).
- 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. (996 Pa) in the closed position, and 4000 fpm (20.32 m/s) air velocity in the open position.
- h- In addition to the leakage ratings already specified herein, the combination fire smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 121°C 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. Manufacturer shall provide factory assembled sleeve of 16" (406) minimum length. Factory supplied caulked sleeve shall be 20 gage (.91) for dampers through 84" (2134) wide and 18 gage (1.21) above 84" (2134) wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation.
- i- FireStat: Each combination fire smoke damper shall be equipped with a UL classified FireStat. FireStat shall electrically and mechanically lock damper in a closed position when duct temperatures exceed (74°C) and still allow appropriate authority to override FireStat and operate damper as may be required for smoke control functions. Damper must be operable

while temperature is above (121°C) FireStat package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when damper is fully open; the other switch shall close when damper is fully closed. FireStat and position indicator switches shall be capable of interfacing electrically with building fire alarm systems. FireStat shall be equipped with High Limit Temperature Sensor that meets all requirements of NFPA92A by returning damper to fire protection mode when temperatures reach (121°C), which is the operational limit of the damper and actuator assembly.

- j- Electric Fuse Link: Each combination fire smoke damper shall be equipped with an Electric Fuse Link which shall activate at 165°F, (74°C) causing damper to close and lock in a closed position, and can be reset when damper cools to 135°F. Damper shall also be furnished with an EP switch if pneumatic actuator is specified.
- k- Blade position indicator (included with FireStat): Each combination fire 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.
- l- Fusible Link: Each combination fire smoke damper shall be equipped with a fusible link which shall melt at 74°C causing damper to close and lock in a closed position.
- m- 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.
- n- Smoke dampers and frames shall not be supported by adjacent ductwork.
- o- Smoke dampers and frames shall always be set parallel to the plane of the wall or floor.
- p- Access doors shall be provided adjacent to smoke dampers for inspection and be of sufficient size for single-handed resetting.
- q- Access to smoke damper assemblies shall also be maintained through builders work elements

#### **1.05.1.g 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.

### **1.05.1.h 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.

### **1.05.1.i 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:** 1-inch thick fiber glass or polystyrene foam board.

### **1.05.1.j 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.

#### **1.05.1.k 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.

### **1.06 EXECUTION**

#### **1.06.1.a 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.

### **1.06.1.b    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."

### **1.06.1.c    ADJUSTING**

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.

**\*End of Section\***

## **Section 15950**

### **Testing & Commissioning Specifications**

# Testing & Commissioning Specifications

## Table of Contents

### Contents

1.1	Testing and Commissioning .....	3
1.1.1	General .....	3
1.1.2	Notice Prior to Testing .....	3
1.1.3	Testing in Sections.....	3
1.1.4	Compliance Tests .....	3
1.1.5	Operating Tests.....	3
1.1.6	Off Site Tests.....	3
1.1.7	On Site Tests .....	4
1.1.8	Performance Tests .....	4
1.1.9	Acceptance Tests.....	5
1.2	Testing of Pipe work, Welds, Etc. ....	5
1.3	Test Certificates.....	7
1.4	Air and Hydraulic Systems Testing, Balancing and Commissioning .....	7
1.4.1	Scope	7
1.4.2	Related Work under Mechanical Sections .....	7
1.4.3	Guarantees .....	7
1.4.4	Commissioning Agency.....	7
1.4.5	Standards.....	8
1.4.6	Tests	8
1.4.7	Notice	8
1.4.8	Submittals.....	9
1.4.9	Instruments .....	9
1.4.10	General Requirements .....	11
1.4.11	CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES.....	12
1.4.12	FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS .....	14
1.4.13	VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES.....	14
1.5	TEMPERATURE TESTING .....	14
1.6	TEMPERATURE-CONTROL VERIFICATION.....	15
1.7	Commissioning .....	15
1.7.1	Commissioning records .....	17
1.7.2	Performance Tests .....	19
1.7.3	Equipment Cards.....	19
1.7.4	Documentation .....	19

## **1.1 Testing and Commissioning**

### **1.1.1 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 pressurization 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.

### **1.1.2 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.

### **1.1.3 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.

### **1.1.4 Compliance Tests**

Certificates showing compliance with the requirements of these documents and of any authority having jurisdiction shall be furnished.

### **1.1.5 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.

### **1.1.6 Off Site Tests**

When called for by the Authorized Representative 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.

#### **1.1.7 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.

#### **1.1.8 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.

#### **1.1.9 Acceptance Tests**

At the beginning of 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 Main Contractor. During testing, the control characteristics, interlocks, and responses of all relevant control systems shall be demonstrated to the satisfaction of the Main Contractor. Witnessed testing shall not be arranged until the Mechanical 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 Main 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.

## **1.2 Testing of Pipe work, Welds, Etc.**

The whole installation shall be hydraulically tested to twice the working pressure of the systems or 4.137 bar, whichever is the greater.

Gas 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. The Contractor shall also be responsible for arranging for the water authority to witness this test should they require to do so. Any equipment fitted not suitable for this pressure shall be adequately protected or isolated from the system during the test.

All leaks are to be immediately repaired and the installations retested until the above requirements are obtained.

The Contractor shall allow for such emptying and refilling and maintenance until all leaks have been satisfactorily stopped.

Upon completion of the final hydraulic test on the system, the Contractor shall apply heat and open all valves and charge the calorifiers.

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.

### **1.3 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.

### **1.4 Air and Hydraulic Systems Testing, Balancing and Commissioning**

#### **1.4.1 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.

#### **1.4.2 Related Work under Mechanical Sections**

This section shall relate to all sections included in this contract.

#### **1.4.3 Guarantees**

Attention is directed to provisions of the General Terms and Conditions and Special Conditions regarding guarantees and warranties for work under this contract.

#### **1.4.4 Commissioning Agency**

The HVAC and Mechanical 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 Authorized Representative.

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.

#### **1.4.5 Standards**

All inspection, testing and commissioning procedures shall conform to the current editions and amendments thereto of the following standards and codes not withstanding current statutory and legal requirements and any other standards and codes which shall apply.

C.I.B.S. Commissioning Codes;

- Series A - Air Distribution
- Series B - Boiler Plant
- Series C - Controls
- Series R - Refrigerating Systems
- Series W - Water Distribution systems

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

Health and Safety at Work Act

Government Regulations

Insurance Company(s) Requirements

#### **1.4.6 Tests**

All tests shall be witnessed and test certificates signed by the Authorized Representative upon satisfactory completion of the tests. One copy of the signed certificate shall be immediately handed to the Authorized Representative.

#### **1.4.7 Notice**

Clear notice required by the Authorized representative 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

#### **1.4.8 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 for 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.

#### **1.4.9 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 Authorized Representative 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) Anuber (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

#### **1.4.10 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 Authorized Representative, 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 Authorized Representative 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 Authorized Representative's 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.

#### **1.4.11 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.

#### **1.4.12 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.

#### **1.4.13 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES**

- A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### **1.5 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.

## **1.6 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.

## **1.7 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 Authorized Representative.
- 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. 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. Commissioning Codes but subject to agreement with the Authorized Representative. 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. code(s). No deviations to these procedures shall be made without the prior written approval of the Authorized Representative.

Commissioning shall not be considered as complete until the Authorized Representative's 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 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.

#### 1.7.1 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 form 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 Authorized Representative 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.:
  - Return and Extract Fans
 

Air flow	L/S
Total and static pressure	mm
5. Note operation of electric actuators using spring return for proper fail-safe operations.

- |                              |             |
|------------------------------|-------------|
| Fan speed                    | Rpm         |
| Fan power (absorbed) / phase | Amp/Amp/Amp |
| Motor speed                  | Rpm         |
| Motor Power (name plate) FLA | Amp         |
- Fan coil units

Air flow, supply and return	L/S
Air pressure drop across filter	mm H2O
On cooling coil air dry and wet bulb temps.	°C
Off cooling coil air dry and wet bulb temps.	°C
Water flow	L/S
Chilled water temperatures (at medium speed)	°C
Free field sound full spectrum	dB
Room Temp. (during maximum exposure to Sun)	°C
Vibration	OK/Not OK
Speeds of Motor	OK/NOT OK
  
  - 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
  
  - 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 :-

    - Fan Coil Units
    - Fans
  
  - Terminal Units

Damper motor operation  
Interlock with hood and extract fan

### **1.7.2 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 authorized representative, 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 Authorized Representative with 14 days clear notice of proposed commencement

### **1.7.3 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.

### **1.7.4 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 Authorized Representative 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 & Labeling Specifications**

# Tags & Labelling Specifications

## Table of Contents

<b>1. PAINTING .....</b>	<b>3</b>
<b>1.1 General .....</b>	<b>3</b>
<b>1.2 Types of Surface Treatment .....</b>	<b>3</b>
<b>1.3 Decorative Painting Internally Exposed.....</b>	<b>4</b>
<b>1.4 Protective Painting .....</b>	<b>4</b>
<b>1.5 Tags and Color Coding .....</b>	<b>5</b>
<b>1.6 Thermal Insulation Identification .....</b>	<b>6</b>
<b>1.6.1 General.....</b>	<b>6</b>
<b>1.6.2 Valve Labels .....</b>	<b>6</b>

## **1. Painting**

### **1.1 General**

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.

### **1.2 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.

### **1.3 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)

### **1.4 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 breaching 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.

## 1.5 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.

The tags shall be not be less than 50mm (2in) in diameter with depressed black numbers of 15mm (1/2 in) height, prefixed by the letters indicating the system such as "HVAC", "Water", "Steam"...etc . They shall be fastened to valves and controls with approved brass chains and hooks.

Piping identification shall be in conformance with the following:

Provide and affix approved adhesive bands identifying the service, by stem 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:

<b>System</b>	<b>Color</b>	<b>Stripe</b>
Water, Air Cond. Chilled	Blue	Green
Heating	Green	White / Crimson
Domestic Cold Water	Green	White/Blue/White
Hot Water	Green	White/Crimson /White
Fire Protection Service	White	Red
Fire Extinguishing	Green	Safety Red

## **1.6 Thermal Insulation Identification**

### **1.6.1 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., generally as shown on the Appendix of this Section of the Specifications. The identification shall be at centers of not more than 3 meters and adjacent to all valves, items of plant, changes in direction and point where the 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, the main service being shown in Appendix II of this Section of the Specifications.

### **1.6.2 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\***