REPUBLIC OF LEBANON

Ministry of Public Health

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

CONSTRUCTION OF AKKAR – ONE DAY SURGERY GOVERNEMENTAL HOSPITAL - SAHLEH

VOLUME 2-2 SPECIFICATIONS

ELECTROMECHANICAL WORKS

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SPECIFICATIONS

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DIVISION 15

MECHANICAL WORKS

DIVISION 15

MECHANICAL WORKS

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Division 15

MECHANICAL WORKS

PROJECT OUTLINE AND DESCRIPTION (15005)

A. General

This Book of Specifications covers the General and Particular Specifications for the Mechanical Systems.

B. Project Outline

The project consists of whole mechanical works as mentioned in drawings specifications and BOQ.

C. General Description of the Works

The following Mechanical Systems are included in the Project:

a. Water Supply.
b. Sanitary Drainage.
c. Rain water and surface drainage.
d. Fire fighting.
e. Domestic fuel oil distribution.
f. Air Conditioning.
g. Heating.
h. Ventilation.
j. Medical gases, vacuum & compressed air.
k. Electrical works related to the Mechanical Works.

as described in the following clauses and/or shown on the relevant Tender Drawings.

D. Soil and waste disposal installation

The system shall be a conventional gravity drained combined soil and waste network, primary and secondary vented for all the floors.

Piping are interconnected to a main collecting manhole and then drained to the municipal sewer network of the region in waste drains

E. Rain water drainage system

The rain water drainage system will be a conventional roof drainage system. A set of roof drains and vertical drain pipes running down to discharge at ground level.

F. Domestic water distribution system

F2. Cold Water Supply

- City water is provided to the Health Center by means of one gauge.
- Chlorination station including chlorine storage tank and feeder are provided to sterilize the city incoming water.
- City water is then stored in the underground (existing) water storage tank.
- Pumping set shall transfer water to a storage tank at upper roof level via a filtration plant including sand filter.
- Treated water (sterilized and filtered) will supply via a booster set sanitary fixtures.
- A separate branch of treated water shall supply hot water storage tanks, laundry, laboratory, pharmacy, sterilization room and surgery via a softening system including 2 softeners.
- Additional branch of treated water by Reverse osmosis shall be provided to feed the medical equipment where required.

F3. Hot Water Supply

- Hot water shall be provided to the project by means of hot water storage plant via two separate circuits :
  a. One circuit providing hot water to kitchen and laundry (60 °C)
  b. One circuit for the other fixtures

G. Irrigation water distribution

A booster shall provide water to irrigation faucets via the basement water storage tank.

H. Fire fighting system

Fire fighting system shall consist of:

- $25m^3$ water reserve in the roof storage tank.
- One hydropneumatic system installed at 1^{rst} basement level to provide fire fighting flow and pressure requirements.
- Hose reels installed in appropriate place at each floor level.
- Fire Siamese connection provided at the entrance to the project.
- Fire extinguisher installed in the cabinet of each hose reel, and in every hazardous place.
- Carbon dioxide fire suppression system in the boiler room.
- Special liquid suppression fire fighting system for the kitchen hoods.
- INERGEN GAZ suppression system in the generator room.

J. HVAC System

J1. Basic Data

The system is designed according to ASHRAE recommendations.

1. Climatic Conditions
   The system is designed to provide the inside conditions below noted, when the outside conditions are as stated:

	Summer		Winter
	DB (°C)	RH (%)	DB (°C)
a. Internal Conditions			
• Surgical	20 - 24	50 - 60	24
• recovery	24	50 - 60	24
• Delivery	20 - 24	50 - 60	
• Radiology	24	50 - 60	24 - 27
• Others :Patient areas	24	50 - 60	24
Non patient areas			21
b. External Conditions			
Dry bulb temperature	33		1
Wet bulb temperature	25		--

2. Lighting 20 W/m²
3. Ventilation

   The main recommended air change per hour shall be as following:

Area	*Minimum air change per hour*
– Surgery	15
– Delivery	15
– Sterilization	2
– Recovery	2
– X Ray	2
– Pharmacy	2
– Laundry	10
– Storage	2
– Laboratory	2
– Emergency	2
– Toilets	10
– Kitchen	12
– Autopsy	12

4. Permissible Sound Level

Private rooms	NC 25-30
Wards	NC 30-35
Laboratories	NC 35-40
Corridors	NC 30-35
Public areas	NC 35-40
Pumps room	NC 60
Generator room:	NC 95 (inside the room)
	NC 60 (outside the room)

J2. System Description

1. Air Conditioning

The chilled and hot water system is of the four pipes system for and operating rooms, and two pipes for other areas. Kitchen ,Laundry ,Autopsy, and X-ray rooms are provided with cooling only Hot water generated by the boilers and chilled water generated by the chillers, are circulated in the piping system (four pipes) simultaneously, hot or chilled water is circulated through the fan coil units depending on whether heating or cooling is required in the relative zone.

This system shall include:

- Chilled water generating station which consists of 2 air cooled chillers, cooling only, 1000T.R. installed on site plan.
- Hot water generating station which consists of 3 boilers, 200 000 kcal/h capacity each.
- 2 central pumping stations (one for cooling, one for heating).
- Piping system including four pipes (two for cooling & two for heating) providing chilled and hot water to the terminals (fan coils units and air handling units with dual coils) installed in air conditioned spaces in the basement and delivery room.
- Piping system including two pipes providing chilled or hot water to the terminals (Fan coil units and air handling units with one coil), for the other air conditioned areas.

Operating room

1. There shall be a variable range of temperature capability of 20 to 24°C.
2. Relative humidity shall be kept between 50 and 60%
3. Outside air shall be provided directly to the correspondent air handling unit. Every AHU shall be operating simultaneously with an extract fan. The system shall maintain a positive air pressure with respect to the adjoining rooms by supplying 15% excess air.
4. Humidity indicator and thermometers shall be located for easy observation.
5. Filter efficiencies shall be 99.9%.
6. All outdoor air system shall be adopted with two speed fans. The low speed shall be selected when the operating room is not occupied.

2. Ventilation

Central fresh air air hanling units with energy recovery units , 2 pipes coils , are provided and installed in the attic to provide treated fresh air for the whole hospital.Related central exhaust system is provided to be exhausted through the energy recovery units.

Special dirty ares such as autopsy, waste treatment , garbage room, medical gases , isolation room and laboratory , are provided with individual exhaust fans , with no energy recovery.

3. Heating system

Heating system consists of the following:

- Hot water generating station which consists of 3 boilers, 200 000 kcal/h capacity each.
- Primary pumping set including one pump on each boiler.
- Secondary pumping set including the following pumps :
  - One set of two pumps for each heating circuit as shown on schematic riser
  - One set of two pumps for domestic hot water heat exchangers.
  - One set of two pumps for fan coil and air handling unit heating coil, one stand by.

GENERAL CONDITIONS (15010)

A. Scope of Work

Works under this Contract shall include, but not be limited to, the supply, installation, testing and delivery in good operating conditions of all systems, equipment, components, etc,... as specified under their respective clauses, relevant drawings and the following general stipulations.

1. Extent of Supply
   a. All necessary components, accessories, manpower, tools, scaffoldings, cutting and patching in walls and slabs, painting, testing, etc..., shall be provided by the Contractor at his own expenses to execute the specified systems complete and in good working conditions.
   b. Accessories and particulars specified with each item are deemed shall be minimum requirements and do not limit the Contractor's supply to them.
   c. All accessories and particulars not specifically listed, but necessary to the satisfactory operation and protection of the installation shall be included in the Contractor's supply at no additional cost.
   d. Easily removable and sturdy construction protective guards on all moving equipment or live components.

2. Drawings
   a. Drawings show the general arrangement of equipment and routings of ducts, pipes, cables or conduits. Minor modifications may be allowed to suit Contractor's equipment and site conditions, subject to the approval of the Engineer.

3. Availability of Materials
   a. At the bid stage, the Contractor shall make sure that he can supply all items specified within the time limit set for the project. Any reservations shall be submitted to the Employer before Tender closing date.
   b. Equipment and material not available on the local market, or temporarily out of stock, shall be ordered at an early date after obtaining the Engineer's approval to avoid delays or stoppage of work.
   c. Contractor shall be the sole responsible for resulting delays and the Engineer reserves himself the right to order equipment and material and air freight them, if need be, at Contractor's expenses and responsibility.

4. Submittals
   a. Prior to ordering and/or installation, the Contractor shall submit to the Engineer's approval samples, technical catalogues, performance curves, shop drawings, construction details, etc..., for equipment, materials and installations specified under this Contract.
   b. The Contractor shall also submit to the Engineer the necessary dimensioned drawings showing all sleeves and openings required by him ahead of time before concrete pouring or execution of masonry structures.
   c. Before taking over the installation, the Contractor shall submit to the Engineer operating and maintenance instructions manuals for the whole works and shall instruct the Engineer or his representative on the method of operation and maintenance of the installed systems.

5. Coordination

   a. The Contractor shall take into consideration that the works specified shall be carried out in conjunction with other trades. He shall therefore be responsible to coordinate the execution of his works with these other trades and at no additional cost to the Employer.

   b. Prior to ordering or installation of electrical systems, equipment, controls and/or components, the Contractor shall ascertain himself with the local power authority of the electric supply characteristics.

   c. The Contractor shall foresee all openings required in walls, slabs or structural members to reduce to a minimum piercing and breaking works.

      All works of cutting, patching, piercing, making good, etc..., as well as all excavation and backfilling, cleaning the site of excess material, debris and dirt resulting therefrom, shall be executed by the Contractor and at his own expense.

   d. Whenever cutting and drilling is made on finished surfaces, the Contractor shall make good these surfaces by returning them to their finished original condition and at no additional costs.

B. Equipment and Items Supplied by the Contractor

All equipment and materials supplied by the Contractor shall be brand new, of the latest model and bearing manufacturer's name and corresponding particulars as deemed necessary.

Unless specifically mentioned otherwise, all equipment and items specified and/or shown on the drawings shall be transported, installed, connected to Mechanical and Electrical Services, finished and tested in good working and operating conditions by the Contractor.

C. Tender Drawings

The Contractor shall be responsible for the execution of the works in accordance with the Tender Drawings. Modifications to these drawings may be allowed to suit equipment supplied by the Contractor and conform site contingencies, subject to the approval of the Engineer.

All drawings accompanying the Specifications are shall be read in conjunction with each others and shall be considered as a whole. Any works indicated on them and not specifically mentioned in the Specifications, and vice-versa, are deemed shall be included in the overall Scope of Work.

Tender Drawings are design and not working drawings; they include general layouts of various systems and equipment shall be provided and installed.

While every effort has been made to produce comprehensive Tender Drawings, and unless specifically indicated otherwise, these drawings show approximate locations of machines, equipment, pipings, valves, ductworks, cables, feeders, etc... Exact locations shall be determined by the Contractor to comply with selected equipment requirements and spaces reservations in full coordination with other trades and subject to the Engineer's approval.

D. Shop Drawings

Before starting works on site or ordering materials and equipment, the Contractor shall submit to the Engineer's approval shop drawings showing the followings:

a. Exact layout of piping and ductworks, double line, with exact distances, and levels in relation to fixed references, and exact location of supports, at a scale not less than 1/50. Toilet areas shall be drawn at a scale 1/20.

b. Exact dimensions, location and clearances of equipment and machines.

c. All accessories with exact location.

d. Exact layout of electric cables, feeders, with exact distance and levels in relation to fixed references.

e. Clearances and accesses required for operation and maintenance.

f. Section details in typical location where necessary.

g. Plans and sections of all the shafts, at each level, showing installation, fixation and supporting details at a scale of 1/10.

h. All installation, fixation and supporting details as recommended by the manufacturer.

j. Particular details pertaining to special conditions that may be required by the Engineer.

k. Composite shop drawings, showing simultaneously all trades to indicate their coordination.

Suppliers' approved shop drawings shall be submitted to the Engineer after ordering. Should it be necessary, working drawings shall be revised accordingly.

The Engineer reserves himself the right to approve, modify, alter or reject shop drawings if found incomplete or not complying with the requirements of the Tender Documents.

E. Codes and Standards

Where equipment, materials, methods of erection and testing are specified to conform with certain International Codes and Standards, they shall conform with their latest edition. A copy of the relevant standard shall be submitted with each submittal for approval.

Electric equipment and material supplied under Mechanical Systems shall conform with the recommendations of the International Electro-Technical Commission.

Unless specifically stated otherwise, all Electrical Installation Works shall be tested in compliance with the Regulations for Electrical Equipment of Buildings.

In addition to the above, Works shall conform with the regulations and ordinances of Local Authorities.

Abbreviations are to mean the following:

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

ASME - American society of Mechanical Engineers
AGA - American Gas Association
NF - Norme Francaise
BS - British Standards
DIN - Deutsches Institut fur Normalisierung
ISO - International Standardization Organization
FM - Factory Mutual
NFPA - National Fire Protection Association
NBS - National Bureau of Standards
SAE - Society of Automotive Engineers
UL - Underwriters' Laboratories Inc.

F. Equipment Capacities and Particulars

Capacities given in the Specifications, Schedules or shown on the drawings are the minimum acceptable capacities; the Contractor shall select, install or construct all equipment and systems to meet at least these values.

All equipment shall be suitable for operation under the severest conditions shall be expected for the Project.

No extra payments shall be given to the Contractor as a result of selection, installation or construction of equipment and systems having capacities or sizes in excess to the specified requirements.

All equipment, panels, cables, control gears, circuit breakers, systems, etc,... shall be derated to the ambient design conditions stated for the project.

G. Omissions from Tender Documents

The Contractor is required to inform the Employer of possible omissions or apparent discrepancies that may be encountered in the Tender Documents (Book of Specifications and Drawings), which, if approved by the Employer, will form the object of an addendum to the Specifications.

Failure of the Contractor to point out possible omissions or discrepancies shall be considered that he has included the effects of these discrepancies in his pricing, and shall not be entitled to any compensations as a result therefrom.

H. Interference and Erroneous Locations

The Contractor shall verify on site all data and final locations of work executed under other trades to coordinate systems interconnections accordingly.

In case of interference or erroneous locations with respect to structures, equipment, etc,... the Contractor shall supply all labor and materials necessary to complete the work in an acceptable manner.

J. Coordination of Trades

The Contractor shall foresee in time all openings required in walls, beams, or slabs to reduce a minimum all works of cutting, piercing and making good. He shall be responsible for dimensioning of sleeves, forms, inserts, access doors, etc... Furthermore, if new concrete pouring is shall be carried out he shall install all drains, pipes, conduits, boxes and sleeves wherever required and/or shown on the drawings before concrete pouring.

The Contractor shall be in constant contact with the Concretor to inform him of above requirements ahead of time and shall submit to him all relevant drawings and details showing locations and sizes of sleeves and openings.

All cutting and patching works in slabs and walls, all preparatory or complementary works required, as well as all labor and material supply in connection with these works, shall be at the Contractor's expenses who shall not be entitled to any payments or claims as a result thereof no matter how difficult or precise they may come out shall be.

The Contractor is advised that the works specified herein shall be carried out in conjunction with other trades and he shall be responsible to coordinate the execution of his works with them and at no additional cost to the Employer.

K. Hook-Ups

Hook-ups to other systems and equipment shall be provided to ensure the satisfactory performance of the overall project.

L. Protection of Electrical Equipment

Electrical equipment shall not be stored outdoors and shall be constantly protected from weather, dripping or splashing water. When installed or stored in moist areas, acceptable means to prevent moisture damage shall be provided.

Should any equipment or material be subjected to possible damage by water, it shall be dried out thoroughly and put through a special dielectric test as directed, at the expenses of the Contractor; if permanently damaged, it shall be replaced at the Contractor's own expenses.

M. Programme of Work

Within four weeks after award of Contract, the Contractor shall submit to the Engineer's approval a detailed programme of work for all phases of the project, showing the proposed dates and periods for material submission for approval, getting approvals, ordering, shipping, preparation of working drawings, equipment arrival on site, start of erection, progress of erection, completion, testing and final taking-over. Within the same period, the Contractor shall submit lists of equipment and materials, with names of proposed manufacturer's, and drawings of inter-related items. Lists and Drawings are to show submission dates.

The Contractor shall allow in his programme for the time needed by the Engineer for approval of materials and shop drawings which should be between two to three weeks.

No work on site shall be allowed to proceed unless the programme of work is submitted and approved by the Engineer.

N. Submittals

All submittals shall be presented to the Engineer with a covering letter in which the Contractor states the subject and purpose of the submittal.

Each submittal shall conform with the following stipulations:

1. Working Drawings or Shop Drawings & Materials Submittals

   a. Two months prior to commencement, Contractor shall submit for approval detailed shop drawings (working drawings) showing to-scale dimensions of equipment, pipes, ducts etc.. in plan and elevation with clearances and relation of same to space assigned, showing also location, type and spacing of supports to equipment, pipes, ducts, etc.. Scale shall be not less than 1/50 for general plans and 1/20 for toilet areas.

   b. Shop drawings for equipment and materials shall include detailed manufacturer's drawings, detailed catalogues and descriptive literature showing type, performance characteristics, construction, component parts, dimensions, arrangement, operating clearances, capacity, electrical characteristics, power requirements, motor, drive and testing information and all other details as mentioned in paragraph D (general conditions).

   c. Indicate, with reasons any deviations from the Specifications and Drawings. No modification to the Contract Documents is authorized unless issued in writing in a change order by the Engineer.

   d. No equipment or materials shall be purchased or delivered to Site until such equipment, materials have been approved by the Engineer.

   e. Shop Drawings shall be submitted in triplicate with each submittal.

   f. Shop Drawings for equipment and material shall be submitted in triplicate with each submittal. Al least one copy of catalogues shall be original and not photocopied.

   g. Refer to other sections for other requirements of Working or Shop Drawings.

2. As-Built Drawings

   Contractor shall provide As-Built Drawings and submit them for the Engineer's approval. After approval of as-built drawings, the Contractor shall submit the original plus a reproducible mother print of each drawing. Moreover, two sets of blue prints of each drawing shall be submitted with the originals.

3. Samples

   Two samples of each item shall be required with each submittal and three sets of technical literature's or catalogues, with at least one original copy.

P. Consistency of Supplied Items

It is pointed out to the Contractor, that equipment controls, accessories, etc..., falling under the same service, shall be supplied from the same manufacturer unless specifically directed otherwise by the Engineer.

The followings illustrate equipment and accessories considered shall be falling under the same services:

a. Pumps.
b. Pipes and accessories.
c. Valves.
d. Controls.

e. Insulation.
f. Cables and wires.
g. Panel boards.
h. Electric gears (breakers, switches, starters, etc...)

Q. Approved Manufacturers

In specifying and selecting equipment, fixtures or accessories, model numbers of certain manufacturers' catalogues are referred to; this procedure is adopted to describe the type, shape, and/or function of the items specified, and to establish standard of quality and performance.

Other items from approved manufacturers, judged by the Engineer shall be similar in shape and performance to the one specified, will be accepted. Reference to approved manufacturers and model numbers does not imply approval of same. Contractors shall submit all equipment and materials for approval irrespective of whether a model number or approved manufacturer is listed or not.

It is pointed out that the term "or approved equal" shall mean items or equipment approved by the Engineer, whose decision in approving or rejecting shall be final and not subject to any justifications.

R. Samples

Before ordering and starting the works, the Contractor shall submit to the Engineer's approval samples of the various items shall be supplied and installed by him. These shall include namely:

a. Pipes, pipes fittings and pipes supports.
b. Valves and specialties items (i.e. safety valves, strainers, air vents, etc...)
c. Insulation for pipes and equipment.
d. Drains, clean-outs, gates, manholes, covers, etc...
e. Meters, gauges and controls.
f. China ware and chrome fittings.
g. Bathroom accessories.
h. Cables and wires.
j. Conduits, trunkings, trays, boxes, accessories, etc...
k. Sockets, plugs, switches, etc...
l. Circuit breakers, starter, timers, etc...

The above illustrate the main types of samples required, and does not limit the supply of these items only. The Engineer reserves to himself the right to request any sample not specifically mentioned above at any stage of work progress.

All samples are deemed shall be submitted at the Contractor's own expenses and at no additional charges to the Employer.

S. Maintenance Prior to Completion Date

The Contractor shall be responsible for the maintenance of all equipment and systems installed by him until final acceptance by the Engineer. He shall therefore take necessary measures to insure adequate protection of all equipment and materials during delivery, storage, installation and shutdown. This responsibility shall include all provisions required to meet the imperatives incidental to the delays pending final test of systems and equipment under seasonal conditions.

After installation of systems have been completed, the Contractor shall operate them for a period of time sufficient to complete all tests, balance, adjust and demonstrate that performance are in accordance with design.

T. As-Built Drawings

Upon completion of the Works, the Contractor shall submit to the Engineer the original plus a reproducible mother print and two sets of blue prints of the approved as-built drawings showing the final routing, layout and location of equipment, pipes, cables, etc...

These drawings shall be submitted within one month after completion date, and no payment will be effected upon completion unless the drawings have been received by the Engineer.

U. Operation and Maintenance Instruction Manuals

The Contractor shall provide for each system, equipment and accessories, three copies in bound booklet form containing the following information:

1. Brief description of each system and piece of equipment with basic operating features

2. Descriptive literature of equipment and components with manufacturer's name, model number, capacity rating and operating characteristics

3. Service manual prepared by manufacturer for every major piece of equipment giving operating and maintenance instructions, starting and shut-down instructions, lubrication instructions and list of possible breakdown and repairs

4. Manufacturer's list of general spare parts for every piece of equipment, with unit prices.

5. Manufacturer's list of recommended spare parts for one year of operation for every piece of equipment, with unit prices

6. Detailed and simplified one line, color coded flow diagram of each system with tag number, location and function of each valve and instrument

7. Detailed and simplified color coded as-installed wiring diagrams of motor controllers and automatic controls with tag number, location of each instrument and electrical device with description of sequence of operation and interlocks.

Instruction manuals shall be submitted in draft form for review and approval prior to final issue and at least four weeks in advance of completion date of the system. Completion certificate shall not be issued if the above are not submitted and approved.

V. Access Doors and Frames

The Contractor shall install work shall be readily accessible for operation, maintenance and repair. Approved deviations from the Drawings may be made to accomplish this.

The Contractor shall ensure that access doors and frames are provided for easy access to concealed equipment, controls, valves, traps, vents, drains, clean-outs, and other devices requiring periodic operation, inspection and maintenance.

Access doors and frames are shall be provided by others. Provide details, dimensions and locations of access doors required and submit for approval in sufficient time to enable doors shall be installed during normal course of work.

Access doors are shall be identified to indicate location of concealed work. Method and schedule for identification of access doors is shall be approved.

W. Nameplates, Labels, Tags and Charts

Each piece of equipment is shall have a conspicuous certified nameplate permanently attached at factory, printed or stamped clearly with name and address of manufacturer, equipment model number, serial number, date of manufacture, electrical characteristics, performance rating or duty, pressure, temperature or other limitations and other pertinent data.

Equipment, instruments, controls, electrical devices, valves etc. shall be labeled and identified as to duty, service or function. Label controls and electrical devices to indicate clearly what they control.

Labels shall be of laminated Bakelite with black surface and white core with incised lettering nomenclature written in English.

Labels shall be attached to equipment etc. or to adjacent permanent surfaces in an approved permanent manner.

Controls and instruments that cannot be easily identified shall be tagged with Bakelite labels.

All valves and controls except equipment shut-off valves located at equipment, shall be tagged.

Tags shall consist of 5cm diameter by 1.5mm thick aluminum sheet with stamped numbers and letters filled with black paint.

The Contractor shall submit for approval a schedule of equipment and devices shall be labeled and tagged, with suggested nomenclature

Charts are shall be prepared of schematic flow diagrams of each piping system with location and function of each valve and with type and size of each essential feature of the system, and submitted for approval.

Schedules for equipment lubrication and maintenance and essential operating instructions, shall be prepared in chart form and submitted for approval.

Charts shall be mounted on wooden plaques or 6 mm Masonite boards, cover with heat bonded clear plastic laminate or frame under glass and permanently fix with four brass screws at approved locations.

XA. Instruction to Personnel

The Contractor shall be responsible to instruct the personnel team that may be assigned to him by the Employer during execution at no extra charges. Personnel instruction shall include allowing the personnel team to attend installation works, be instructed on the use, operation and maintenance of the various systems, components and equipment.

XB. Spare Parts

Spare parts necessary for the normal running of equipment or items during the Guarantee period shall be supplied by the Contractor as part of his responsibilities under this Contract except oils and greases.

XC. Tools

The Contractor shall supply all standard and special tools needed for routine maintenance, adjustment, operation or normal overhaul of equipment supplied by him.

Tools shall be brand new, high grade quality and shall include general purpose spanners, wrenches, screw drivers, greasing guns, etc,... as well as all specialized and customized tools.

XD. Site Facilities

The Contractor shall be responsible to provide for himself all site offices and covered storage facilities he needs in coordination with the Engineer.

Stored equipment and items shall be kept clear off the floor and protected from dust and other deteriorating agents.

XE. Works Not Included

The contents of this clause shall not relieve the Contractor's responsibility to coordinate his work with other trades to ensure that execution of works not included in his Contract are carried out on time and to his satisfaction. He shall remain responsible for proper functioning of systems connected with other trades for their installation.

a. Concrete, sump pits and concrete pipe trenches.

b. Water supply and sewer and rain water outside property limits.
However, the Contractor shall coordinate connections to municipal mains with the authorities to obtain permits and authorizations for these connections.
He shall pay for expenses related thereto as well as to works shall be executed whether carried out by himself or by a Contractor appointed by the authorities.

c. Close to each equipment control panel, each electrically operated equipment (pumps, etc,...), and motor control centers supplied under Mechanical Works, an adequate power supply outlet will be provided by the Electrical Contractor.
Final extensions and connections between these outlets and the corresponding panel and/or equipment, as well as all associated controls, wirings, etc,... are included in the Mechanical Works.

XF. Coordination With Civil Works

Before pouring, the Contractor shall prepare a template to the exact dimensions of equipment anchor bolts which shall be rigidly secured on the template to the desired depths.

When only openings for anchor bolts are required, the templates shall be made with wood strips rigidly secured on it at the bolts locations.

XG. Design Conditions

Unless stated otherwise the design conditions shall be as follows:

	Summer		Winter
	DB (°C)	RH (%)	DB (°C)
a. Internal Conditions			
• Surgical	20 - 24	50 - 60	24
• recovery	24	50 - 60	24
• Delivery	20 - 24	50 - 60	
• Radiology	24	50 - 60	24 - 27
• Others : Patient areas	24	50 - 60	24
Non patient areas			21
b. External Conditions			
Dry bulb temperature	33		1
Wet bulb temperature	25		--

c. Electric Power — 3 phase, 4 wire, 50 Hz, 380 volts between phases

220 volts between phases and neutral with solidly earthed neutral

All equipment, cables, control gears and systems shall be derated to conform with the above mentioned conditions.

XH. Noise and Vibration

All equipment shall operate under all conditions of load without sound or vibration which in the opinion of the Engineer is objectionable and above the criteria limits set here below.

The noise level resulting from equipment ducts, air outlets, etc.. and heard in the conditioned spaces shall not result in a noise level in such spaces exceeding the sound levels below listed :

Private rooms	NC 25-30
Wards	NC 30-35
Laboratories	NC 35-40
Corridors	NC 30-35
Public areas	NC 35-40
Pumps room	NC 60
Generator room:	NC 95 (inside the room)
	NC 60 (outside the room)

Contractor shall be responsible for achieving the above noise limits and he shall provide all necessary noise attenuation features and accessories such as sound absorbers for equipment, pipes, etc.. whether or not they are indicated on Drawings or specified.

Vibration control shall be provided. Equipment shall not result in any vibration transmitted to the building. Provide vibration isolators, inertia blocks etc.. to achieve the above.

XJ. Guarantee

The Contractor shall guarantee all his works for a period of one year beginning after the issuing of the Completion Certificate of all the works specified herein. The guarantee shall cover all works, manpower, spare parts, replacements, etc.,,, resulting from failure of equipment, systems and accessories supplied by the Contractor. Guarantee shall apply also for perfect mechanical operation of the system and equipment, acceptable noise and vibration levels and reasonable consumption of power, fuel and water.

If during the guarantee period any equipment or material proves defective or any part of system fails to function properly, equipment is shall be replaced and defects and malfunctions corrected as directed by the Engineer.

If during the guarantee period any piece of equipment is replaced or rebuilt, the guarantee period for this equipment is shall be extended for a new period equal to the original guarantee period.

Contractor shall provide necessary skills and labor to assure proper operation and to provide regular and preventive maintenance required for equipment and controls during the guarantee period, on a continuous 24 hour basis.

Act promptly to correct problems arising in operation of equipment or system.

Provide the Employer with monthly inspection certificates of equipment, record findings on a check list and certify that each piece of equipment has been examined, is operating as intended and has been properly maintained as recommended by the manufacturer.

Check all controls monthly to ascertain that they function as designed.

Spare parts for normal wear and tear are shall be provided by the Employer.

PAINTING (15020)

A. Scope

Supply and apply all painting to the various services provided under this Contract.

Painting shall be executed in accordance with the requirements and instructions of this Section.

B. General Requirements

Surfaces requiring prime painting shall be cleaned thoroughly of rust, scale, oil, grease and dirt. Use wire brushing, sand blasting or solution cleaning as needed.

All items that have rusted or corroded shall be cleaned and/or painted to the satisfaction of the Engineer. No painting shall be applied on rusted, damp or dirty surfaces.

The paint shall be evenly and well brushed out to prevent drops, runs or saggings. Care shall be taken not to paint over controls, labels and nameplates.

C. Paint Types

The primer and finishing coats for painting hot surfaces shall be special heat resistant type acrylic base paint.

The primer and finishing coats for painting cold surfaces shall be acrylic base paint.

The above shall not relieve the Contractor to supply specific paint types other than those mentioned herein and which may be necessary shall be used for specific applications.

D. Piping, Frames, Supports and Ductworks

All black steel piping including flanges, bolts, nuts, cast iron valves and accessories, valve wheels and all ferrous parts are shall be painted with two coats of zinc chromate primer whether or not they are shall be insulated. When bare or exposed to view, they are shall be further painted with two coats of approved oil paint.

Ductwork shall be painted inside or outside with one coat dull black fire resistant paint where visible through air outlets or through the false ceilings.

Hangers and supports including clamps, rods, bolts, nuts etc.. shall be painted with two coats of zinc chromate primer and where exposed to view with two additional coats of approved oil paint.

All exposed uninsulated surfaces shall receive two coats of primer and two coats of finishing paint. Special etch primers shall be used for galvanized surfaces (pipes, ducts etc....)

Unless mentioned otherwise, uninsulated and unwrapped pipes, flanges, valves, laid in trenches, wall chases, in fill or underground, shall receive two layers of asphalt solution soaked jute applied as follows:

a. Clean pipe surface as stated here above and apply one coat of asphalt over the bare pipe.

b. Wrap pipe with the first asphalt soaked jute layer and apply one coat of asphalt over the first jute layer.

c. Repeat the above two operations for the second layer.

d. Under tiles, protection may be replaced by embedding pipes in an asphalt cork sawdust cement mixture.

E. Equipment and Panels

Equipment and panels installed under this Contract shall have two shop priming coats of corrosion protective paint and at least two factory applied finishing coats.

All factory painted surfaces shall be cleaned thoroughly and inspected on site for scratches and etchings and shall be retouched where necessary.

F. Color Coding and Identification

The finishing coat colors for exposed metallic surfaces or insulated surfaces shall conform with the schedule:

a. All factory painted equipmentKeep their color

b. Equipment not factory painted Gray

c. Structural frames and supportsBlack

d. Pipe services as per ASME color code.

e. DuctsAluminum

Piping, cables and wires shall be identified at intervals not exceeding four meters and at all crossings through slabs and walls. Identification shall include:

- Type of service.
- Direction of flow where applicable
- Size

Colored cables and wires shall be used and the same color shall be maintained throughout the project for the same circuit or function. A schedule of colors shall be submitted by the Contractor for the Engineer's approval and adoption.

The type and flow direction of the fluid conveyed in pipes and ducts shall be painted in red at intervals not exceeding four meters and at all crossings through slabs and walls.

ELECTRICAL WORKS FOR MECHANICAL SYSTEMS (15030)

A. Scope

Supply and install all Electrical Works, equipment and accessories specified under the various Mechanical Systems.

Electrical Works shall comply with any of the following standards:

ANSI, NEMA, BS, VDE, DIN, IEC, UTE.

All electrical equipment, materials, accessories, etc,... shall be supplied for the Mechanical Systems, as well as all electrical works and tests shall be done shall conform also with the requirements of the relevant Specifications for the Electrical Systems.

The scope of the Electrical Works under this section includes the supply and installation of the followings:

a. Motor control centers, motor control panels for each item or system and housing all protection gear, switches and controls required for the specified function.

b. All cables and wires between equipment and the corresponding motor control center or motor control panel.

c. All electrical equipment, wiring, cables, conduits, boxes, earth connections, control switches, starters, circuit breakers, isolating switches, relays, contactors, protective gear or equipment, transformers, etc,... and all other necessary item or components required for the satisfactory operation, control and protection of the systems.

B. Works Not Included

The following electrical items are not included and will be supplied by the Electrical Contractor.

a. Power close to each electrically operated equipment not fed from a control panel.

b. Main feeder to the motor control centers and control panels of mechanical equipment.

C. General Requirements

a. Ratings of circuit breakers serving electric motors are design values and must be checked and readjusted, if need be, to conform with motor actual power and rating as recommended by motors Manufacturers.

b. Power supply connections to vibrating or rotating machinery shall be made through adequate metallic flexible conduits or tubings through which cables and wires shall be drawn.

c. Cables shall be color coded for identification. Red, Yellow and Blue shall be used for phase conductors, Black for neutral and Green for earth conductors.

d. Control voltage for starters and control circuits shall not exceed 220 volts.

e. Shop and Installation Drawings are shall be submitted for approval prior to ordering materials and equipment. Drawings to include the following:

i. Complete technical data on all motor starters, motor protection relays, sensing units, control accessories, etc.
ii. Instructional details of equipment, particularly motor control centers and panels
iii. Wiring diagrams of all power and control circuits
iv. Installation details of motor control centres and panels and of control and sensing accessories
v. Exact routing of power and control cables, wiring and conduits
vi. Feeder termination details at motor control centres, starters, motors, isolating switches, control and sensing accessories etc.

f. Power and control wiring to run in conduit unless otherwise specified.

g. Power and control wiring to run in separate conduits.

h. Rigid conduits are not to terminate in nor be fastened to a motor frame or base.

j. Flexible conduits shall be used at motor connections. Allow sufficient slack to permit motor to slide over adjustable length of motor base. Length and radius shall be sufficient to permit bending of feeder cables without damage to conductor or its insulation. Flexible conduits are not shall be used in place of rigid conduit except at motor connections, unless otherwise specified.

k. Conduits are shall be supported with conduit supports in an adequate approved manner.

l. Conduits are not to cross pipe or vent shafts, ducts or openings. They are shall be run a minimum 100 mm away from pipes of non-electrical services.

m. Detailed control wiring diagrams and a list of control equipment with descriptive literature are shall be submitted for approval. Free hand field wiring diagrams or sketches will not be accepted.

n. Circuits shall be arranged to satisfy operating requirements specified for various equipment driven by electricity and other requirements pertaining to proper functioning and operation of equipment.

p. Circuits shall be protected with high rupturing capacity fuses or circuit breakers. Auxiliary supply for controls, other than from main power circuit, shall be effectively isolated by auxiliary contacts on main isolator.

q. Motors shall be earthed by connecting green insulated conductor from earthing bushing in starter to motor frame. Run earth conductor together with circuit wiring and terminate in motor terminal box, provided earth terminal in box is connected to motor frame. If this is not feasible, extend earth conductor through insulated bushed opening in terminal box and connect to motor base.

r. Equipment shall be earthed by connecting non-current carrying metal parts of system to earth source. Non-current carrying metal parts include conduits, cable trays, outlet boxes, cabinets, enclosures, doors, grilles, and barriers protecting or shielding electrical equipment from direct access.

s. Detailed wiring diagram is shall be fixed inside each starter enclosure cover to clearly indicate circuits.

t. Control and power wires are shall be identified either by distinctive colored insulation, engraved tags or other approved method.

u. Circuit breakers earth fault detection and interruption are shall be coordinated with those of main incoming breaker on main distribution panel.

v. Approved Manufacturers: Equipment and accessories shall be obtained from one of the following:

- Westinghouse (U.S.A)
- Square D (U.S.A)
- General Electric (U.S.A)
- Siemens (Germany)
- Klockner - Moeller (U.K.)
- AEI (U.K.)
- GEC (U.K.)
- English Electric (U.K.)
- Merlin Gerin (France)

or approved equal.

D. Conduits

Size is shall be minimum 20 mm unless otherwise specified.

Steel conduits are shall be welded, drawn, heavy gauge, to BS 4568 Part 1 or approved equal, galvanized internally and externally and threaded both ends.

Fittings for steel conduits are shall be threaded, galvanized or cadmium plated malleable iron specifically designed for size and type of conduit.

E. Wires and Cables

Power wires and cables are shall be 600/1000 V grade, to BS 6004. Single conductor wires and multicore cables shall have high conductivity tinned copper wire conductors insulated with PVC compound, with additional PVC sheath for multicore cables.

Control wires and cables are shall have copper conductors tinned annealed, minimum area 1.5 sq mm. Insulation shall be moisture resistant flame retardant PVC compound. Wires and cables shall be rated for 220 V service. Multicore cables for control and signaling shall be PVC insulated copper conductors, PVC sheathed, to BS 6346.

Control wires and cables are shall be provided with special heat resistant insulation or corrosion resistant sheath where required.

Armoured cables shall have the armour as single layer of galvanized steel wire under the PVC sheath.

Connections to motors shall be single conductor wires pulled inside conduits, or multicore cables armoured or non armoured and fixed on cable trays or supports.

Special conditions: where required high temperature resistant cables, silicone rubber, cross linked polyethylene, MICC, or approved equal, corrosion resistant sheath is shall be provided.

F. Electric Motors

Motors are shall be supplied by driven equipment manufacturer, shall be as specified for equipment concerned and specifically supplied for available supply voltage and frequency.

Motors 1/2 horsepower and under shall be single phase and over 1/2 horsepower shall be three phase. Motors shall be totally enclosed, fan cooled type, unless otherwise specified.

Motors are shall have Class B insulation with 80 deg. C continuous temperature rise above average ambient temperature of 40 deg. C, unless otherwise specified.

Motors that will operate outdoors are shall have Class F insulation.

Motors operating in ambient temperatures exceeding 40 deg. C shall be tropicalized and derated for satisfactory operation.

Motors shall be rated for continuous operation.

Power shall be adequate to operate driven equipment without motor overload under all operating conditions and loads and throughout capacity range of equipment. Motor shall be capable of delivering full rated output when operating at voltage deviating by 5% from rated voltage at rated frequency.

Starting and torque characteristics shall be as required by driven equipment.

Speed shall be as specified for equipment concerned.

Conduit terminal box on motor shall be approved model for type of motor enclosure. Motor windings shall be connected to terminals in terminal box at factory. One additional earthing terminal shall be connected to motor frame.

Motor base shall be adjustable where motors are directly connected to driven equipment, unless otherwise specified. Motors connected to equipment through V-belt drive shall have adjustable sliding base. Fractional horsepower motors shall have slotted mounting holes in base.

G. Starters

Starters for three phase motors shall be magnetic type to automatically disconnect motor from power supply in case of supply failure, excessive voltage drop, overcurrent and lack of balance in phases. Overload trips shall be provided for three phases.

Motor data is shall be obtained from equipment supplier before ordering any motor starter, or motor nameplate checked for full load current rating and allowable temperature rise in order to select proper overload thermal element for motor starter.

Short circuit protection device fitted to starter shall be independent of controller and overload protection.

Control for starters and control circuits is not to exceed 220 V.

Step down control circuit transformers shall be two winding isolating type.

Control circuit protection shall be high rupturing capacity fuses or circuit breakers.

Auxiliary supply for controls, other than from main power circuit, shall be effectively isolated by auxiliary contacts on main isolator.

Control devices on starters shall be as follows unless otherwise indicated or required by driven equipment: start stop push buttons, one red pilot light for "running", one group pilot light for "stopped" and one reset push button.

Starter type A for single phase motors not exceeding 1/2 HP shall be surface or flush mounted, manual two pole toggle type, for non reversing across the line starting, fitted with one overload element.

Starter type B for three phase motors not exceeding 10 HP shall be direct on line, non reversing, magnetic type, with manual reset, 3 pole overload relay and low voltage protection, unless otherwise required by local regulations.

Starter type C for three phase motors over 10 HP, but not exceeding 50 HP, shall be automatic star delta magnetic non reversing type, with 3 pole overload relay and adjustable low voltage relay, unless otherwise required by local regulations.

Starter type D for three phase motors over 50 HP shall be multiple step auto transformer non reversing magnetic type, with 3 pole overload relay, adjustable low voltage relay, earth leakage relay and with unbalanced current protection, unless otherwise required by local regulations.

Individually mounted starters shall be totally enclosed in sheet steel enclosure with baked enamel finish. Design is to suit location and application. It is shall be impossible to open enclosure door unless isolator is in open position.

Nameplates: starters and controls shall have engraved nameplates identifying system or defining its function.

H. Isolating Switches

Isolating switches shall be non fusible, single throw type, housed in separate metallic enclosure, with arc quenching devices on each pole capable of interrupting at least six times its rated current. They are to simultaneously interrupt power supply to all line conductors, any neutral and control circuits.

Isolating switches for single phase fractional horsepower motors shall be single pole, dolly operated type, rated 15/20 A at 250 V AC, quick make, quick break, with silver alloy contacts, flush or surface mounted to suit application.

Operating mechanism shall be quick make quick break type, with external operating handle mechanically interlocked with enclosure cover to necessitate disconnecting switch shall be in OFF position for access to inside of enclosure. Means are shall be provided for by passing interlocks. Position of isolating switch shall be clearly indicated on cover.

Enclosure shall be general purpose type, unless otherwise indicated or required, with provision for locking operating handle in OPEN and CLOSED positions.

Enclosures where indicated or required by location shall be weatherproof totally sealed water and dustproof type.

J. Combination Starters Isolating Switches

Components to comprise magnetic starter, isolating switch and short circuit protection devices required by the Standards, in approved sheet metal enclosure to suit application.

Isolating switch operating mechanism quick make, quick break, with external operating handle mechanically interlocked with enclosure cover necessitating disconnecting switch shall be in OFF position for access to inside of enclosure. Means are shall be provided for by passing interlocks. Position of isolating switch shall be clearly indicated on cover.

Short circuit protection gear shall be HRC fused cartridges or moulded case circuit breakers of appropriate current rupturing capacity.

Operation of circuit breaker shall be possible from outside of enclosure. Position of breaker ON/OFF/TRIPPED shall be clearly indicated by position of handle.

K. Push Buttons

Push buttons shall be one unit momentary contact START/STOP with normally open or normally closed contacts as required by wiring diagrams and with lockout attachments. Heads shall be color coded and STOP button shall be protected. Push buttons controlling one piece of equipment shall be housed in separate enclosure.

L. Relays

Relays shall be multipole with normally open or normally closed contacts, electrically operated at 220 V maximum, and magnetically held. Contacts shall be double break, silvered type, interchangeable from normally open to normally closed without additional parts. Relays are shall be rated at 10 A, 600 V.

M. Circuit Breakers

Circuit breakers shall be thermal magnetic type, with moulded case, manually operated for normal switching functions and automatically operated under overload and short circuit conditions.

Circuit breakers to give positive trip free operation on abnormal overloads, with quick make quick break contacts under both manual and automatic operation. Stationary and movable contacts shall be non welding silver alloy adequately protected with effective and rapid arc interruption.

Branch circuit breakers shall be 100 A frame size, unless otherwise shown.

Main circuit breakers shall be 100 A frame size or larger as shown on the Drawings.

Breakers of 225 amp frame size and larger shall have interchangeable trip units and adjustable instantaneous trips unless otherwise shown.

Main incoming breakers shall be current operated, earth leakage type, or suitably equipped to provide earth fault protection. Earth fault detection and interruption shall be time coordinated with those of main incoming breaker on main distribution board.

Multiple pole breakers shall have single handle mechanism. Each pole shall have inverse time delay thermal overcurrent trip element and magnetic instantaneous overcurrent trip element for simultaneous tripping of all poles.

Trip elements shall be ambient temperature compensated type.

N. Motor Control Panels

Motor control panels shall be wall mounted or unit mounted, lockable type.

Construction shall be minimum 1.5 mm thick hot-dip galvanized steel sheet, finished with one coat etch primer and one coat stove enamel internally and externally.

Panels installed outdoors shall have weatherproof totally sealed water and dustproof enclosures.

Panels are to contain necessary breakers, starters, push button switches, selector switches, relays, indicating lights, interconnecting and interlock wiring and all devices and accessories required for automatic or manual operation of equipment as specified under equipment concerned.

Labels starters, switches, electrical devices and accessories shall be clearly labeled in English as to function and number. Labels shall be permanently fixed under each component.

Schematic and wiring diagrams shall be mounted in permanent approved manner on the inside of panel door. Diagrams are to show each component cross referenced with component labels.

P. Switches

Float switches shall be level operated, heavy duty, bracket mounted type, suitable for application in open tanks, complete with 178 mm spun copper float, brass rod, two stops, floor mounting stand, lever and counterweight. Switch shall have oil tight and dust tight enclosure and 2 pole double throw silver contacts that open on liquid rise.

Float switch shall be as manufactured by Square D, Type BW 3, or approved equal.

Pressure switch shall be industrial, heavy duty, bellows actuated type, suitable for water service, with contacts to close on falling pressure. Range shall be 0.1 to 8 kg/cm^2. Switch shall be good for 1720 kPa operating pressure and shall have 6 mm pipe tap bottom connection. It is shall have oil tight and dust tight enclosure, single pole double throw contacts and setting adjustment.

Pressure switch shall be as manufactured by Square D Company Type ACW-1 or approved equal.

Low suction pressure switch shall be industrial, sensitive, low range, diaphragm actuated type, suitable for water service, with range of 2 to 20 kPa of falling pressure, preset at factory to 3 kPa. Switch shall be good for 690 kPa operating pressure and shall have 6 mm pipe tap bottom connection. It is shall have oil tight and dust tight enclosure, single pole double throw contacts, range adjustment knob, sealing cap and range locking nut.

Low suction pressure switch shall be as manufactured by Square D Company Type AMW-1 or approved equal.

PIPE WORKS AND FITTINGS (15060)

A. General Requirements

Supply and install, wherever shown on the drawings and as specified herein, all pipe works and fittings.

All pipes shall carry the Kite Mark of the standard to which they are manufactured, clearly indicated at intervals. Pipes without the above markings shall be rejected.

Pipe works shall be installed in a manner to allow for ease of air escape and system draining. It shall be endeavoured to obtain this naturally by gravity; however, where conditions do not permit it, an automatic air vent shall be supplied and installed at all air pockets locations and a drain valve shall be supplied and installed at all low points and risers legs.

In addition to the stipulations of the above paragraph, cold and hot water pipes supplying bath rooms as well as all vertical risers shall be provided with automatic air vents and associated drain pipes.

Drainage pipes shall be installed with a slope of not less than 1% unless specifically indicated otherwise on the drawings.

Drainage pipes installed underground shall be minimum 2" diameter.

Before installing any pipe, it shall be internally cleaned from dirt, debris, etc,... by passing through it a cleaning cloth.

Pipes shall be installed in a neat manner with runs parallel and branchings or changes in direction at 90 or 45 degrees. Change in direction and size, branching and jointing of pipes shall be made with regular pipe fittings (elbows, tees, reducers etc..). Pipe bending shall not be accepted. All elbows shall be long radius. All drainage fittings shall be long radius sweep type.

Field fabricated fittings, bushings, close nipples and street elbows shall not be allowed.

Sleeves shall be supplied and installed wherever pipes cross slabs, walls, partitions, etc,... Sleeves shall be cuts of galvanized steel pipes having an internal diameter of not less than 1 1/2" (4cms) larger than the outside diameter of the bare sleeved pipe or the insulated sleeved pipe.

Floor sleeves shall protrude about 3/4" (2cms) above finished floor level and shall be flush with finished walls. Gaps between sleeves and pipes shall be filled with non-flowing plastic or waterproof mastic filler or paste.

Escutcheons shall be provided at all sleeves, when exposed to view. Escutcheons shall be chrome-plated.

Cleanouts shall be supplied and installed at all changes in direction of soil, waste and drain and rain water drain pipes.

Unions or flanges shall be provided at adequate intervals in the piping networks, as approved by the Engineer, to permit easy disassembly for alternations and repair.

Unions or flanges shall be provided at connections to equipment, near valves, controls, strainers and other accessories requiring removal.

All pipes shall be supplied and installed complete with the followings:

a. All connections and fixings to equipment and accessories.

b. Unions, flanges, couplings, elbows, crosses, reducers, caps, etc,...

c. Expansion joints wherever specified or indicated on the drawings as well as all passages of pipes at structural expansion joints.
On drain and soil pipes, expansion joints shall be packing type.
Whenever soil and drain pipes are installed with elastomeric joint rings, expansion joints may be omitted after obtaining Engineer's written approval to this effect.

d. Shock absorbers or water hammer arrestors at quick closing valves as well as automatic air vents at high points and drain valves at low points.

e. Dielectric unions or flanges wherever copper pipes connect to ferrous pipes, or wherever dissimilar metals liable to galvanic corrosion are connected together.

f. Metallic supports, saddles, anchors, etc,...

g. All cutting, patching and making good of walls, slabs, partitions, etc,... in connection with fixing, supporting and anchoring of pipes within the building.

h. All works of excavations, trenchings, back filling and making good of roads, green spaces, walkways, etc,... in connection with installing of pipes outside the building.

Buried metallic pipes shall be wrapped with corrosion protection tape or other approved type of protective cover (i.e. Denso tape or equal).

B. Pipes Material

Pipes materials shall be used shall be as follows:

a. Galvanized steel pipe and fittings for domestic and potable water,in exposed application, and PPR random pipes where embedded in walls and under tiles.

b. UPVC non-pressure pipe and fittings for condensate drain.

c. UPVC non-pressure pipe and fittings for rain water drainage system pipes.

d. UPVC non-pressure pipe and fittings for soil, waste and vent pipe systems.

e. High density polypropylene pipes for laboratory waste piping system.

f. Pressure UPVC pipes and fittings for sump pumps discharge pipes.

g. Black seamless steel pipes and fittings for fire fighting water system, heating water pipes, chilled water pipes and fuel oil pipes, and CCSSD sterilizers drainage pipes.

h. Copper pipes for medical gases, vacuum and medical compressed air systems.

C. Black Steel Pipes

Supply and install all black steel pipes as specified herein

Each black steel pipe shall conform with the following requirements:

a. Black steel pipes shall be seamless steel medium weight conforming with DIN 2440, BS 1387 medium class or equivalent international standard for steel pipes.

b. Pipe fittings (tees, elbows, crosses, reducers, unions, flanges, etc,...) shall be of the same weight and quality as the pipe.

c. Pipes and fittings up to 2" shall be black malleable iron suitable for threaded connections.

d. Pipes and fittings larger than 2" shall be black seamless suitable for welded connections.

e. Fittings up to 2" shall be banded with threaded connections.

f. Pipe wall thickness and weight shall be as follows:

Pipe Size (inches)	Thickness (mm)	Weight of Plain End Pipe Kg/m
1/2	2.65	1.22
3/4	2.65	1.58
1	3.25	2.44
1 1/4	3.25	3.14
1 1/2	3.25	3.61
2	3.65	5.10
2 1/2	3.65	6.51
2"	4.00	8.47
4"	4.50	12.10

D. Galvanized Steel Pipes

Supply and install all galvanized steel pipes as specified herein.

Each galvanized steel pipe shall conform with the following requirements:

a. Galvanized steel pipes shall be seamless steel medium weight conforming with DIN 2440, BS 1387 medium class or equivalent international standard for steel pipes.

b. Pipe fittings (tees, elbows, crosses, reducers, unions, flanges, etc,...) shall be galvanized steel of the same weight and quality as the pipe.

c. Pipes and fittings shall be suitable for threaded connections.

d. Polypropylene acid resistant Pipes for laboratory drainage application

e. Fittings shall be banded with threaded connections.

f. Pipe thickness and weight shall be same as those for corresponding black steel pipes.

E. UPVC Non-Pressure Pipes

Supply and install all UPVC pipes as specified herein.

Each UPVC pipe shall conform with the following requirements:

a. Plastic pipes shall be extruded unplasticized PVC (UPVC) conforming to the following British Standards or approved equal, for non-pressure drainage pipes:

- Pipes 32mm to 50mm diameter : to BS 5255. for above and under ground pipes
- Pipes 82mm to 160mm diameter installed above ground: to BS 4514.
- Pipes 110mm and 160mm diameter installed underground : to BS 4660.

- Pipes larger than 160mm diameter : to BS 3506.

b. Pipe fittings shall be UPVC of the same weight and quality as the pipe.

c. All pipes and fittings shall be marked with the Kite Mark of the standard to which they are manufactured.

d. Unless specifically stated otherwise, pipes and fittings for drainage works shall be suitable for rubber ring pressure joint. Sealing rings shall be rubber to BS 2494 Part 2.

e. Alternatively pipes to DIN 8061 are acceptable.

F. Pressure UPVC Pipes and Fittings

Supply and install all pressure UPVC pipes and fittings as specified herein.

a. All pressure UPVC pipes shall be of extruded unplasticized Polyvinyl Chloride to BS 3505 class E or approved equal International Standards. Fittings shall be of same material and pressure as pipe.

b. All joints shall be of the rubber ring pressure joint.

G. Polypropylene Pipes for domestic water

Supply and install all polypropylene pipes as specified herein:

Each polypropylene pipe shall confirm to the following requirements:

- Pipes shall be according to DIN 8078 made of polypropylene type 3. Dimensions of pipes are corresponding to DIN 8077, pipe series 6. Pipes are tested and supervised according to DIN 8075.
- Pipes joint assemblies and fittings shall be welded. Continuous working pressure up to 20 bars, continuous working temperature: up to 90oC.
- The polypropylene pipe system shall correspond to the regulations of the federal public health office.

H. Polypropylene Pipes (laboratory Drainage)

Supply and install all polypropylene pipes as specified herein:

a. Polypropylene pipe, hot water resistant – stabilized light sensitivity durably flame resistant according to DIN standard 4102.

b. Resistant to inorganic salts, concentrated bases and mineral acids as found in laboratory discharges. Organic solvents will not dissolve polypropylene.

c. Color medium gray according to BAL 7037.

d. Pipes shall bear the following permanent marks in red colors: the quality mark, the test marks, the manufacturer logo, the nominal size, the number of the standard specification DIN 19560 and the date of manufacture and the number of the extrusion line.

e. Jointing by push-fit socket.

f. Sealing by pre-fixed lib ring seal.

PIPE HANGERS AND SUPPORTS (15080)

A. General Requirements

a. Supply and install pipe hangers and supports to properly carry weight of pipes and accessories without sagging as specified and required.

b. Hangers and supports shall be designed and tested to sustain a load 8 times the actual supported load, and shall be easily adjustable.

c. Hangers and supports shall be steel with smooth flat bearing surfaces and shall allow free movement of pipes due to expansion and contraction without any deformation. Hangers and supports for UPVC Pipes shall be of material, type and spacing strictly in accordance with manufacturers recommendations.

d. Hangers and supports on insulated pipes shall have galvanized steel sheet protection saddles or shields, 3mm thick, 30cm long to fit outside diameter of insulation and cover 180° of arc.

e. Pipe anchors and guides shall be 3/4" diameter U-bolt.

f. Piping shall be independently supported of equipment and located at adequate intervals to avoid air pockets and dirt traps. All branching shall be directly supported.

g. Spring cushions shall be used where pipe is subject to considerable vertical movement or vibration.

h. Insulated hot pipes shall be supported on a clevis hanger or pipe clamp lined with protection shields.

j. The contractor shall submit shop drawings for all types of supports showing construction details.

k. Hangers and supports locations shall be shown on shop drawings.

B. Steel Pipework

Horizontal steel pipe supports shall be installed at intervals not exceeding the maximum support spacing and by hanger rod of minimum size as follows:

Pipe Diameter	Maximum Support Spacing - M	Minimum Size of Hanger Rod (mm)
1/2"	1.5	10
3/4"	1.8	10
1"	2.0	10
11/4"	2.5	10
11/2"	2.7	10
2"	3.0	10
21/2"	3.3	13
3"	3.6	13
4"	4.2	16
5"	4.8	16
6"	5.2	22
8" and larger	5.8	25

Vertical steel pipe supports shall be installed at a minimum of every storey height.

C. UPVC Pipework

The following shall be used as a guide line. Manufacturer's recommendations shall be strictly followed:

Pipe Diameter	Maximum Support Spacing Horizontal Pipes (cm)	Vertical Pipes(cm)	Minimum Size of Hanger Rod
1/2"	60	120	10 mm
3/4"	70	140	10 mm
1"	75	150	10 mm
11/4"	80	160	10 mm
11/2"	90	180	10 mm
2"	105	210	10 mm
3"	135	270	13 mm
4"	150	300	16 mm
6"	180	360	16 mm
8" and larger	215	360	16 mm

VALVES AND SPECIALTIES (15100)

A. General Requirements

Supply and install, wherever shown on the drawings and as specified herein, all valves and specialties.

In addition to valves proper, this section is applicable to the strainers, safety valves, automatic air vents, float valves, etc,...

The drawings indicate locations of major valves only. This does not limit the Contractor's responsibility to supply and install all valves and specialties specified separately under equipment or systems and in full compliance with the requirements of this section and the following stipulations:

a. Valves shall be designed for a working pressure of not less than 125 psi steam working pressure rating and 200 psi cold water non-shock pressure rating unless otherwise specified.

b. Valves 2" diameter and less for services shall be bronze, threaded ends.

c. Valves 2 1/2" diameter and larger for services shall be cast iron, flanged ends.

d. Unless specifically stated otherwise, valves shall be of the same size as the pipes on which they are installed.

   Whenever the pipe size on which valves are shall be installed is larger or smaller than the equipment connection provided, an enlarger or reducer shall be first installed at the equipment connection to the required pipe size, after which the valves can be installed.

e. A conical union shall be supplied and installed with each threaded valve.

f. Install silent check valves on pump discharge pipes.

B. Gate Valves

Supply and install, wherever shown on the drawings and as specified herein, all gate valves.

Each gate valve shall conform with the following requirements:

a. Bronze gate valves shall have bronze body and trim and shall be non-rising stem, screwed bonnet and solid wedge disc.

b. Cast iron gate valves shall have cast iron body and shall be inside screw, non-rising stem, bolted bonnet, wedge disc and bronze trimmed.

C. Globe Valves

Supply and install, wherever shown on the drawings and as specified herein, all globe valves.

Each globe valve shall conform with the following requirements:

a. Bronze globe valves shall have bronze body and trim and shall be inside screw, rising stem, screwed bonnet and renewable composition disc.

b. Cast iron globe valves shall have cast iron body and shall be outside screw and yoke, rising stem, bolted bonnet, renewable bronze disc and seat ring and bronze trimmed.

D. Check Valves

Supply and install, wherever shown on the drawings and as specified herein, all check valves.

Each check valve shall horizontal or vertical lift, non-slam type and shall conform with the following requirements:

a. Bronze check valves shall have bronze body and bronze trim and shall be screwed bonnet and renewable composition disc.

b. Cast iron check valves shall have cast iron body and shall be bolted bonnet, renewable bronze disc and seat ring and bronze trimmed.

c. Silent check valves 2" diameter and under shall be non-slam, spring loaded, screwed, with bronze body, seat and disc, 18-8 stainless steel spring with body having 300 psi working pressure rating.

d. Silent check valves 2 1/2" diameter and above shall be non-slam, spring loaded, flanged, with cast iron body, bronze seat and disc, 18-8 stainless steel spring, with body having 250 psi working pressure rating.

E. Strainers

Supply and install, wherever shown on the drawings and as specified herein, all strainers.

Each strainer shall conform with the following requirements:

a. Strainers 2" diameter and under shall be bronze body, 150 psi steam working pressure, screwed, "Y" type with 20 mesh stainless steel screen and screwed end-cleaning cap with 1/2" tapped hole for blowdown valve.

b. Strainers 2 1/2" and larger shall be flanged, cast iron body, 125 psi steam working pressure "Y" or basket type with 20 mesh stainless steel screen and bolted end-cleaning cap with 3/4" diameter tapped hole at bottom for blow down valve.

F. Float Valves

Supply and install, wherever shown on the drawings and as specified herein, all float valves.

Each float valve shall conform with the following requirements:

a. All bronze construction including levers and arms suitable for 150 psi cold water working pressure.

b. Balancing piston type flow control mechanism.

c. Adjustable bronze rod.

d. Copper float.

G. Safety Valves

Supply and install, wherever shown on the drawings and as specified herein, all safety valves.

Each safety valve shall conform with the following requirements:

a. Bronze body and trim, suitable for 150 psi steam working pressure.

b. Adjustable, spring loaded relief mechanism testing arm.

c. Spring pressure adjusted locknut.

d. Relief outlet for piped connection.

Setting of safety valves shall be at 125% of the system operating pressure. After adjustment, the adjusting screw shall be locked by an adequate lead sealed wire.

H. Pressure Regulating Valves

Supply and install, wherever shown on the drawings and as specified herein, all pressure regulating valves.

Self contained, spring loaded suitable for inlet pressures up to 300 psi, bronze body with stainless steel springs.

Each pressure regulating valve shall be complete as specified herein:

a. Balanced seat valve with integral strainer.

   Contractor may provide pressure reducing valves with separate strainer if desired.

b. High temperature resisting diaphragm.

c. Spring chamber with regulating knob.

d. Pressure gauge and gauge cock at its outlet and at its inlet.

e. Basket strainer at its water inlet.

f. Isolating gate valves at its inlet and outlet connections.

g. By pass line with one isolating valve and one flow regulating globe valve.

h. Pressure regulating valve shall provide a constant outlet pressure irrespective of variations in inlet pressure.

J. Balancing Valves

Shall be of the double regulating variable orifice, globe pattern type. It shall have a throttling disc and two pressure test points for regulation and measurement of system pressure drop and water flow. Valve handwheel shall have about 8 turns capacity between fully open and fully closed positions.

Valve body is shall be high quality bronze and bronze trim with for sizes up to 2" diameter and cast iron body with bronze trim for sizes larger than 2" diameter. Working pressure is shall be 15 bars at 150°C.

K. Expansion Joints

Supply and install, wherever necessary and as specified herein, all expansion joints.

Expansion joints shall be installed on piping to relieve expansion stresses and shall be located at all structural expansion joints and on all straight runs of pipes at 30 meters intervals.

U-bends expansion joints may be accepted under certain conditions after written Engineer's approval.

Each expansion joint shall conform with the following requirements:

a. Packless bellows type, monel metal for pressure pipes services suitable for 150 psi steam working pressure.

b. Packing type for gravity piped.

c. Expansion joints shall have screwed, flanged or welding ends as required for the pipe size and system served.

L. Automatic Air Vents (AAV)

Supply and install, wherever shown on the drawings and as specified herein, all automatic air vents.

Each automatic air vent shall be completed as specified herein:

a. Cast iron body.
b. Standard float.
c. Single lever orifice vent.
d. Vent test cock.
e. Isolating valve.

M. Hose Bibs (HB)

Supply and install, wherever shown on the drawings and as specified herein, all hose bibs.

Each hose bib shall conform with the following requirements:

a. All brass, chrome plated construction.
b. 3/4" threaded end connection with serrated hose bib nipple for 3/4" hose connection.

N. Water Hammer Arrestors

Supply and install, at all pipe connections to flush valves and as specified herein, all water hammer arrestors.

Each water hammer arrestor shall be complete as specified herein:

a. Stainless steel shell and adapter.
b. Elastomer bellows.
c. Hydraulic displacement fluid.
d. Pressurized insert gas pneumatic displacement chamber.
e. 1/2" NPT threaded connection.

P. Valves Boxes

Supply and install, wherever shown on the drawings and as specified herein, all valve boxes.

Sizes and number of valves in each valve box shall be as shown on the drawings.

Each valve box shall be of masonry wall construction or metallic wall construction encased within masonry.

Each valve box shall conform with the following requirements:

a. Depth shall conform with site conditions and pipes inverts.
b. Valve boxes located outside shall provide a minimum cover of 30cms over pipes passing through.
c. Indoor valve boxes shall have a steel cover matching space internal finish.
d. Outdoor valves boxes shall be provided with a heavy duty cast iron cover, lockable type.

Q. Flexible Connections

Supply and install, wherever shown on the drawings and as specified herein, all flexible connections.

Flexible connections shall be installed on all pipe connections to rotating equipment.

Each flexible connection shall conform with the following requirements:

a. Seamless bronze tubing with annular corrugations covered with high tensile bronze braid suitable for 200 psi cold working pressure.

b. Screwed ends for pipes 2" diameter and smaller and flanged ends for pipes 2 1/2" diameter and larger.

INSULATION AND LAGGING (15260)

A. General Requirements

Supply and install, all insulation and lagging wherever specified in this Book of Specifications in accordance with the requirements of this section.

Insulation material shall be fiberglass.

Insulation types shall be used shall be as follows:

a. Rigid board, fiber glass type shall be used for ducts run outdoors and for kitchen exhaust ducts.

b. Blanket type fiber glass shall be used for equipment, ducts and flat surfaces.

c. Rigid fibreglass pipe insulation for piped services carrying chilled, heating and hot water services.

d. Provide insulation for the following services :
Supply and return air conditioning ducts carrying cooled or heated air,
Refrigerant suction and liquid lines.
Chilled water and heating water pipes.
Condensate drain pipes.
Domestic hot water pipes.

B. Insulation Finish

Insulation finish shall be executed as follows:

a. Finished insulation surface shall present a neat, uniform and straight appearances, whether concealed or exposed to view.

c. All insulation exposed on roof or to weather agents shall be provided over and above the Specification requirements with additional water proofing and weather proofing material in 3 layers, plus a final outer jacket of aluminum construction 0.8mm thick.

d. All pipe insulation shall be finished by a factory applied vapour barrier of aluminum foil laminated on to kraft paper and reinforced with glass yarn mesh. All joints shall be sealed with sealing tape and held in place by adequate number of non-corrodible bands.

C. Acoustic Duct Liner

a. All supply, return and exhaust air ducts shall be lined internally with fiber glass duct liner up to a minimum length of 3 meters from their connections with the air handling units and fans.

b. Duct acoustic liner shall have one surface covered with heavy coating of black pigmented neoprene layer.

c. Whenever acoustic liner is specified for ductworks, the duct dimensions shown on the drawings are understood shall be the net internal dimensions resulting AFTER the liner is installed.

d. Duct lining of the operating rooms should not be used unless 90% efficient minimum terminal filters are used downstream of the linings.

D. Insulation Thicknesses

Thicknesses or insulation shall be supplied and installed for the various systems shall conform with the following table:

a. Conditioned air supply and return: 1 1/2"
ductwork

b. Refrigerant suction and liquid lines: 1"
c. Condensate drain pipes: 1/2"
d. Acoustic duct liner: 1/2"
e. Heating and chilled water pipes up to 2" diameter: 1 1/2"
f. Heating and chilled water pipes 2 1/2" and above: 2"
g. Domestic hot water pipes: 1"

E. Duct Insulation - Type A

Fiberglass rigid board type of minimum density 6 lbs per cu.ft. and an average thermal conductivity not exceeding 0.25 Btu-inch per sq.ft. per degree F per hour at a mean temperature of 75° F faced with aluminum foil and Kraft paper.

F. Duct Insulation - Type B

Fiberglass blanket type of minimum density 2 lbs per cu.ft and an average thermal conductivity not exceeding 0.25 Btu-inch per sq.ft. per degree F per hour at a mean temperature of 75° F faced with aluminum foil and Kraft paper.

G. Pipe Insulation

Performed sectional rigid pipe insulation, with a thermal conductivity not exceeding 0.23 btu-inch per sq.ft. per degree F per hour at a mean temperature of 75° F, specifically supplied for the nominal pipe size. Density shall not be less than 6 lbs per ft^3.

H. Insulation on Cold Equipment

Voids between insulation and equipment shall be filled with blanket insulation and cover with removable 1mm galvanized sheet metal casing panel lined with 50mm thick rigid board insulation. Vapour seal closure joints on metal casing with vapour barrier coating.

J. Insulation on Hot Equipment, Smoke Pipe and Breeching

Material is shall be calcium cilicate blocks suitable for high temperature. Edges of calcium silicate blocks shall be butted tightly and secured with 1.5mm thick galvanized annealed steel wire, or 15mm x 0.04mm galvanized steel bands, at 300mm centres. Cover insulation with 50mm hexagonal mesh wire tightly stretched in place with edges tied together and coat with 6mm thick coat of insulating cement trowelled smooth. Reinforce corners with 50 x 50 x 3mm iron angles. Provide cleanout doors with angle frames and insulate in same manner as equipment.

FIRE FIGHTING SYSTEM (15310)

A. Fire Hose Cabinet type FHC-1

Supply and install fire hose cabinet wherever shown on drawings and as specified herein.

a. Fire Hose Cabinet: Recessed mounted type, with painted steel body, trim and door, finished with baked white enamel on inside and outside. Cabinet is to consist of one compartment to house a portable fire extinguisher type FE-1 and a hose rack and hose. Body and trim shall be 16 gauge and door 20 gauge thickness. Door shall have full panel double strength glass with 'FIRE HOSE' decal. Hose cabinet shall be supplied from factory with the following equipment:

- One 1 1/4" inlet gate valve.
- One 1 " x 1" brass reducer.
- One steel hose rack with rack nipple.
- One 1" unlined linen fire hose, 30m long with brass hose couplings attached.
- 1" brass nozzle.
- One 9 kg ABC nitrogen operated dry chemical fire extinguisher,.

B. Fire Hose Cabinet Type FHC-2

Same as type FHC-1 but suitable for exposed surface mounting.

C. Portable Fire Extinguishers

Supply and install all portable fire extinguishers wherever shown on the Drawings and as specified herein:

1. Portable fire extinguishers, dry chemical type FE-1
   a. Dry chemical "ABC" type of 9 kgs capacity.
   b. Heavy duty drawn steel cylinder with hard, scratch-resistant red enamel finish.
   c. All brass operating valve, large size operating lever, full vision pressure gauge and discharge hose.

Supply and install all portable fire extinguishers wherever shown on the Drawings and as specified herein:

2. Portable fire extinguishers, CO2 type FE-2
   a. Carbon dioxide type of 9 kgs capacity.
   b. Heavy duty drawn steel cylinder with hard scratch-resistant, enamel finish with colour as per International fire regulations colour code for CO2.
   c. Pull-pin, squeeze handle, double braided hose and non-conducting discharge horn.

D. Automatic Fire Extinguishers

Each automatic fire extinguisher shall conform with B.S N.F, ISO 90001 regulations and shall be complete and conform with the following requirements :

a. Extinguishing agent shall be all purpose dry chemical powder or carbon dioxide, suitable for Classes A, B, and C fires, as shown on the drawings and indicated in the specifications.

b. Extinguisher body shall be cylindrical shape of drawn steel and tested at not less than 200kg/cm^2

c. Controllable discharge head valve, safety fracture disc., safety clip, high impact nozzle and pressure indicator gauge.

d. Extinguisher shall be finished with red paint.

e. Supports and/or wall brackets

Capacity of each Automatic Fire extinguisher shall be as given in the bills of quantities and as indicated on the drawings.

Extinguisher shall be ceiling mounted and shall be provided with quartz fuse and sprinklers in brass calibrated at 60°C.

D. CO_2 Automatic Fire Protection System

Supply and install CO2 automatic fire protection system wherever shown on drawings and as specified herein.

Provide fixed total flooding CO2 fire extinguishing system and companion fire detection system for protection of the heating plant room.

- Features
  - Non-corrosive, non-conductive, clean extinguishing agent that leaves no residue
  - Suitable for Class A, B, and C hazards
  - Fixed nozzle and/or hose reel agent distribution
  - UL, ULC, and FM approved
  - In accordance with NFPA-12 – Carbon Dioxide Extinguishing Systems
- Application

  The Carbon Dioxide (CO2) Fire Suppression System shall be an engineered system utilizing either a fixed nozzle agent distribution network, hose reel(s), or a combination of both. The system is listed by Underwriters Laboratories, Inc. (UL) and Underwriters Laboratories of Canada (ULC), and is approved by Factory Mutual (FM). The system is designed in accordance with the latest revision of the National Fire Protection Association (NFPA) Standard 12, "Carbon Dioxide Extinguishing Systems." When properly designed, the carbon dioxide system will suppress fire in Class A, B, and C hazards by displacing the air containing oxygen which supports combustion.
- Description

  The CO2 Fire Suppression System shall be actuated by detection and control equipment for automatic system operation along with providing local and remote manual operation as needed. Accessories are used to provide alarms, delay discharge, ventilation control, door closures, or other auxiliary shutdown or functions.

  Due to the method of extinguishment, personnel occupying areas protected by carbon dioxide systems must be evacuated prior to system discharge. For this reason, discharge time delays and alarms are mandatory for occupied hazards. Two or more hazard areas can be protected with a single group of agent storage containers (cylinders) by means of directional or selector valves.

  The CO2 Fire Suppression System shall be particularly useful for suppressing fires in hazards where an electrically non-conductive medium is essential or desirable; where clean-up of other agents presents a problem; or where the hazard obstructions require the use of a gaseous agent.

  Additional equipment includes: remote manual pull stations, corner pulleys, door closures, pressure trips, bells and sirens, transfer switches, time delays, pneumatic switches, and weighing devices. All or some are required when designing a total system.
- Specifications

Part 1 – General

- Description of work:
    - Design and installation shall be an engineered fire detection and carbon dioxide total flooding, gaseous agent, fire suppression system.
    - Drawings: The contract drawings shall indicate the general arrangements of the areas to receive detection and carbon dioxide protection. Contractor is to review all drawings so that all items affecting the operation of the fire detection/carbon dioxide suppression system (such as equipment location, air diffusers, damper closures, and door openings) are considered in the design of the engineered system.
- References:
    - National Fire Protection Association (NFPA):
        a) NFPA 12 – Standard on Carbon Dioxide Extinguishing Systems
        b) NFPA 70 – National Electrical Code
        c) NFPA 72 – Standard For Protective Signaling Systems
    - Underwriters Laboratories, Inc. (UL) and Underwriters Laboratories of Canada (ULC) – Fire Protection Equipment Directory
    - Factory Mutual (FM) Approval Guide
    - Requirements of the Authority Having Jurisdiction (AHJ)
- Requirements:
    - This installation shall be made in strict accordance with the drawings, specifications and applicable National Fire Protection Association Standards. All equipment and devices used shall be listed in both the UL/ULC Fire Equipment Directory and the Factory Mutual Approval Guide.
    - Design and installation of the fire detection/carbon dioxide suppression system shall be in strict accordance with the following guidelines and regulatory agencies:
        a) NFPA 12 – Carbon Dioxide Extinguishing Systems
        b) NFPA 70 – National Electric Codes
        c) NFPA 72 – National Fire Alarm Code

- General:
    - Furnish all engineering designs and materials for a complete fire detection/carbon dioxide suppression system, including: charged carbon dioxide storage cylinders, nozzles, control panel, detectors, wiring, annunciators, alarms, and all other equipment necessary for a complete operational system.
    - Major system components shall be installed by an authorized distributor certified for the design, installation, and service of carbon dioxide suppression systems.

Part 2 – Products

- System description and operation
    - Design Requirements:
        a) System design shall be total flood providing a minimum of 34% design concentration throughout the entire protected area.

        OR

        Specify the design concentration or the area of coverage if used as a local application.

- Sequence of operation:
    - Activation of any single detector in any detection zone shall:
        a) Cause audio and visual pre-discharge alarms to operate.
        b) Transmit an alarm signal to remote monitoring or building alarm panel.
        c) Operate auxiliary contacts for HVAC shutdowns and automatic dampers
        d) Initiate a mechanical/pneumatic time delay to sound prior to CO2 release.
    - Upon completion of the time delay the carbon dioxide system shall:
        a) Cause a discharge alarm to be activated.
        b) Energize control actuator for carbon dioxide cylinders releasing CO2.

- Control panel – autopulse control system:
    - The control panel shall be an AUTOPULSE system and shall communicate with and control the following types of equipment used to make up the system: heat detectors, manual release, alarm notification appliances, releasing components and other system controlled devices.

- Heat detectors:
    - Rate compensated heat detectors shall be supplied. Maximum spacing shall be 250 ft2 (23.3 m2) per detector.

- Indicating appliances:
    - Explosion-proof horn shall be provided in protected area.

      OR

      Alarm horn strobe shall be provided in protected area.
- Manual pull station:
    - Explosion-proof manual pull station shall be provided at each exit.

      OR

      Manual pull station shall be provided at each exit.
- Carbon Dioxide Storage Cylinders:
    - Cylinder Assembly:
        a) Steel construction with red epoxy finish and equipped with a pressure seat-type CV-98 valve.
        b) Cylinder sizes shall be 35 lb (15.9 kg), 50 lb (22.7 kg), 75 lb (34.0 kg), 100 lb (45.4 kg), or 120 lb (54.4 kg) capacity.
- Pneumatic Time Delay:
    - Pneumatic time delay shall be provided to delay discharge of carbon dioxide.
    - Pneumatic pressure operated siren shall be located in protected space to sound for 30 seconds prior to discharge.
- Supervised Mechanical Lockout:
    - Installer shall provide a supervised mechanical lockout valve installed in the discharge line to prevent discharge of CO2 into the protected space. Control panel must display a supervisory signal when valve is closed.
- Cylinder Bracket:
    - Each cylinder assembly shall be furnished with a bracket made from welded steel. The bracket shall hold the cylinders in a saddle with a front bracket piece that secures the cylinders.

      The brackets shall be modular in design to allow added bracketing or stacking of cylinders depending on installation requirements.
    - Cylinder brackets shall be UL/ULC listed and/or FM approved for use with the carbon dioxide.
- Valve Actuators:
    - Electric valve actuators shall be of brass construction and stackable design with swivel connections to allow removal of actuators for maintenance or testing.
- Discharge Hose/Check Valve:
    - When manifolding, all cylinder assemblies shall include a flexible discharge hose and check valve for connection to the manifold inlet.
    - All hose/check valves shall be UL/ULC listed and/or FM approved for use with the CV-98 carbon dioxide.
- Discharge Nozzles:
    - Designed to direct discharge of carbon dioxide in a liquid or gaseous state.

- Orifice size determined by flow rate and system design required.
- Standard nozzles to be natural brass or painted red.

Part 3 – System Testing

- System Checkout:

- The completed installation shall be inspected by factory authorized and trained personnel. The inspection shall include a full operational test of all components per the equipment manufacturer's recommendations.
- Inspection shall be performed in the presence of the owner's representative, Engineer or engineer's representative, insuring authority and/or the local authority having jurisdiction.
- All mechanical and electrical components shall be tested according to the manufacturers recommended procedure to verify system integrity.
- Inspection shall include a complete checkout of the detection/control system and certification of cylinder contents. A written report shall be filed with the owner.
- As-built drawings shall be provided by the contractor (two copies) indicating the installation details. All routing of piping, electrical conduit, and accessories shall be noted.
- Equipment installation and maintenance manuals shall be provided in addition to the as-built drawings.
- Prior to final acceptance, the contractor shall provide operational training in all concepts of the system to the owner's key personnel. Training shall consist of:
  a) Control system operation
  b) Trouble procedures
  c) Abort procedures
  d) Emergency procedures
  e) Safety requirements
  f) Demonstration of the system (excluding carbon dioxide release)
- The quantity of agent shall reflect the actual design quantity of carbon dioxide agent.
- A functional test shall be completed consisting of detection, release, alarm, accessories related to the system, control unit and a review of the cylinders, piping, fittings, hangers and cylinder pressure.

F. Kitchen Fire Fighting System

Supply and install kitchen fire system as specified

An automatic fire fighting system shall be provided for the kitchen equipment, and shall be complete and conform with the following requirements :

- Part 1 – General
  - References
    - Underwriters Laboratories, Inc. (UL)

a. UL Standard 1254
b. UL Standard 300

- Underwriters Laboratories of Canada (ULC)
  a. ULC/ORD-C 1254.6
- National Fire Protection Association (NFPA)
  a. NFPA 96
  b. NFPA 17A

- Submittals
  - Submit two sets of manufacturer's data sheets
  - Submit two sets of piping design drawings
- System Description
  - The system shall be an automatic fire suppression system using a wet chemical agent for grease related fires.
  - The system shall be capable of suppressing fires in the following areas associated with cooking equipment: ventilating equipment including hoods, ducts, plenums, and filters; fryers; griddles and range tops; upright, natural charcoal, or chain-type broilers; electric, lava rock, mesquite or gas-radiant char-broilers.
  - The system shall be the pre-engineered type having minimum and maximum guidelines established by the manufacturer and listed by Underwriters Laboratories, Inc. (UL).
  - The system shall be installed and serviced by personnel trained by the manufacturer.
  - The system shall be capable of protecting cooking appliances by utilizing either dedicated appliance protection and/or overlapping appliance protection.
- Quality Control
  - Manufacturer: The Kitchen Fire Suppression System shall be manufactured by a company with at least thirty years experience in the design and manufacture of pre-engineered fire suppression systems. The manufacturer shall be ISO 9001 registered.

- Certificates: The wet agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.7 – 8.7, designed for flame knockdown and foam securement of grease-related fires.

- Warranty, Disclaimer, and Limitations
  - The pre-engineered restaurant fire suppression system components shall be warranted for five years from date of delivery against defects in workmanship and material.
- Delivery
  - Packaging: All system components shall be securely packaged to provide protection during shipment.
- Environmental Conditions
  - The R-102 system shall be capable of operating in a temperature range of 32 °F to 130 °F (0 °C to 54 °C).

- Part 2 – Product
  - Components
    - The basic system shall consist of a regulated release assembly which includes a regulated release mechanism and a wet chemical storage tank housed within a single enclosure. Nozzles, blow-off caps, detectors, cartridges, agent, fusible links, and pulley elbows shall be supplied in separate packages in the quantities needed for fire suppression system arrangements. Additional equipment shall include remote manual pull station, mechanical and electrical gas valves, pressure switches, and electrical switches for automatic equipment and gas line shut-off.
    - Wet Chemical Agent: The extinguishing agent shall be a specially formulated, aqueous solution of organic salts with a pH range between 7.8 – 8.2, designed for flame knockdown and foam securement of grease related fires.
    - Agent Tank: The agent tank shall be installed in a stainless steel enclosure or wall bracket. The tank shall be constructed of stainless steel. Tanks shall be available in two sizes; 1.5 gallon (5.7 L) and 3.0 gallon (11.4 L).The tanks shall have a working pressure of 110 psi (7.6 bar), a test pressure of 330 psi (22.8 bar), and a minimum burst pressure of 600 psi (41.4 bar). The tank shall include an adaptor/tube assembly containing a burst disc union.
    - Regulated Release Mechanism: The regulated release mechanism shall be a spring-loaded, mechanical/pneumatic type capable of providing the expellant gas supply to one or two agent tanks depending on the capacity of the gas cartridge used. It shall contain a factory installed regulator deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar). It shall have the following actuation capabilities: automatic actuation by a fusible link detection system and remote manual actuation by a mechanical pull station. The regulated release mechanism shall contain a release assembly, regulator, expellant gas hose, and agent storage tank housed in a stainless steel enclosure with cover. The enclosure shall contain knock-outs for 1/2 in. conduit. The cover shall contain an opening for a visual status indicator. It shall be compatible with mechanical gas shut-off devices; or, when equipped with a field or factory-installed switch, it shall be compatible with electric gas line or appliance shutoff devices.
    - Regulated Actuator Assembly: When more than two agent tanks are required, the regulated actuator shall be available to provide expellant gas for additional tanks. It shall be connected to the cartridge receiver outlet of the regulated release mechanism providing simultaneous agent discharge. The regulator shall be deadset at 110 psi (7.6 bar) with an external relief of approximately 180 psi (12.4 bar).The regulated actuator assembly shall contain a regulated actuator, regulator, expellant gas hose, and agent tank housed in a stainless steel enclosure with cover. The enclosure shall contain knockouts to permit installation of the expellant gas line.
    - Discharge Nozzles: Each discharge nozzle shall be tested and listed with the R-102 system for a specific application. Nozzles tips shall be stamped with the flow number designation (1/2, 1, 2, and 3). Each

nozzle shall have a metal or rubber blow-off cap to keep the nozzle tip orifice free of cooking grease build-up.

- Distribution Piping: Distribution piping shall be Schedule 40 black iron, chrome-plated, or stainless steel pipe conforming to ASTM A120, A53, or A106.
- Detectors: The detectors shall be the fusible link style designed to separate at a specific temperature.
- Cartridges: The cartridge shall be a sealed steel pressure vessel containing either carbon dioxide or nitrogen gas. The cartridge seal shall be designed to be punctured by the releasing device supplying the required pressure to expel wet chemical agent from the storage tank.
- Agent Distribution Hose: Kitchen appliances manufactured with or resting on casters (wheels/rollers), which have the Fire Suppression System hard piped, shall include a UL Listed agent distribution hose as a component of the suppression system. This shall allow the appliance to be moved for cleaning purposes without disconnecting the appliance fire suppression protection. Hose assembly shall include a restraining cable kit to limit the appliance movement within the range (length) of the flexible hose.
- Flexible Conduit: The manufacturer supplying the Restaurant Fire Suppression System shall offer flexible conduit as an option to rigid EMT conduit for the installation of pull stations and/or mechanical gas valves. The flexible conduit shall be UL Listed and include all approved components for proper installation.
- Pull Station Assembly: The Fire Suppression System shall include a remote pull station for manual system actuation. The pull station shall be designed to include a built-in guard to protect the pull handle. The pull station shall also be designed with a pull handle to allow for three finger operation and shall be red in color for quick visibility.

- Part 3 – Implementation
  - Installation
    - The fire suppression system shall be designed, installed, inspected, maintained, and recharged in accordance with the manufacturer's listed instruction manual.
  - Training
    - Training shall be conducted by representatives of the manufacturer.

G. Fire Water Hydro-Pneumatic Pressure Set

Supply and install all fire water hydro-pneumatic pressure sets wherever shown on the drawings and as specified herein.

Fire water pressure set shall be pneumatic, packaged type, duplex type, complete with pneumatic pressure tank, interconnecting piping, fittings, controls, specialties and control panel for duplex operation all mounted on the same steel frame with heavy gauge steel protective casing, and all factory assembled and tested.

The set shall consist of two pumps with one pump as standby.

Fire water pressure set shall be complete as specified in the following clauses:

1. Pumps

Each pump shall be centrifugal, vertical split case, single or multistage, silent type, complete with flexibly coupled electric motor and couplings. The pump and motor assembly shall be mounted on a steel bed plate with an approved vibration isolator.

Pumps construction shall be cast iron body, volute bronze impeller, stainless steel shaft and mechanical seal.

Pumps shall be flexibly coupled to the electric motor thru a flexible coupling. Motor speed not to exceed 2900 rpm.

Each pump shall include:

a. Casing drain and vent plugs.
b. Gauge tappings.
c. Drip Chamber or tray with drain connection.
d. Gate valve and strainer at its suction.
e. Silent check valve and gate valve at its discharge.
f. Pressure switches.
g. Pressure gauge and gauge cock at its discharge.
h. Reinforced type flexible connectors at pump's suction and discharge.

2. Hydro-Pneumatic Pressure Tank

Each pressure tank shall be cylindrical or spherical, closed type, constructed in compliance with an approved international code for unfired pressure vessels.

Each pneumatic pressure tank shall include:

a. An inert gas chamber.
b. Flexible butyl or neoprene membrane separating the inert gas chamber from water.
c. Air recharge valve if tank is not permanently charged at factory.
d. Pressure gauge and gauge cock.
e. Gate shut-off valve.

3. Capacity

Capacity of each Fire water pressure set shall be as given in the schedules of capacities and/or the Bills of Quantities.

H. Fire Water Pressure Set Operation and Control

Supply and install for each Fire water pressure set a system control and control panel which shall include all necessary pressure switches, pressure regulating valves, instruments, operating relays, safety relays as well as cables, wires, etc,... connecting it to the corresponding pump and storage tank or reservoir to obtain the following functions:

a. When line pressure drops, the pump shall operate and remain in operation until flow stops or the pressure switch reaches its high limit setting. A minimum run-time relay, adjustable type shall be provided to prevent frequent on/off operation. If pressure drops below a preset value, the second pump shall operate.
b. When suction water level drops to 10 cms above top of suction pipe, the pump shall stop by the action of a low level float switch; it shall not be able to run even if other controls call for its operation.

After water level rises to 15 cms above suction pipe, controls shall allow pump operation again.

c. If operating pump fails to start the second pump shall operate automatically.

d. An automatic sequencing control shall be provided to operate pumps in a rotational sequence after each cycle.

e. Panel shall be provided with OFF-MANUAL-AUTO selector switch to allow the system shall be stopped and/or put on manual or automatic operation.

f. Panel shall be provided with an alarm buzzer and switch which shall be put in operation in case of fault.

g. For each function specified with the panel, a pilot light shall be provided to indicate the status of the particular function. Pilot lights colours shall be selected in accordance with the function shall be indicated.

h. A delay relay shall be incorporated within the panel to prevent immediate start-up upon re-establishment of power after power failure.

DOMESTIC COLD WATER SUPPLY (15410)

A. Water lifting set

Supply and install water lifting set wherever shown on the drawings and as specified herein.

Water lifting set shall consist of two pumps with one pump as stand-by

1. Pumps

   Each pump shall be of the horizontal multistage centrifugal, silent type, complete with flexible coupled electric motor and couplings. The pump and motor assembly shall be mounted on a steel bed plate with an approved vibration isolator.

   Pumps construction shall be cast iron body, volute bronze impeller, stainless steel shaft and mechanical seal.

   Pumps shall be flexibly coupled to the electric motor through a flexible coupling with coupling guard. Motor shall be of the totally enclosed fan cooled type.

   Each pump shall include:

   a. Casing drain and vent plugs.
   b. Gauge tappings.
   c. Drip chamber or tray with drain connection.
   d. Gate valve and strainer at its suction.
   e. Silent check valve and gate valve at its discharge.
   f. Pressure gauge and gauge cock at its discharge and suction.
   g. Reinforced type flexible connectors at pump's suction and discharge.

2. Capacity
   Capacity shall be as given in the schedules of equipment.

B. Lifting Pumps set Operation and Control

Supply and install for each house lifting pump a system control and control panel which shall include all necessary switches, instruments, operating relays, safety relays as well as cables, wires, etc,... connecting it to the corresponding pump and storage tank or reservoir to obtain the following functions:

a. When water level in the roof tanks drops below a predetermined level, the lead pump shall operate by a signal from float switches in the roof tanks, and remain in operation until the water level resumes its pre-set level.
b. When suction water level drops to 5cms above top of suction pipe, the pump shall stop by the action of a low level float switch; it shall not be able to run even if other controls call for its operation.
   After water level rises to 10 cms above suction pipe, controls shall allow pump operation again.
c. If operating pump fails to start, the second pump shall operate automatically.
d. An automatic alternating switch shall be provided to alternate pumps function after each cycle.
e. Panel shall be provided with OFF-MANUAL-AUTO selector switch to allow the system shall be stopped and/or put on manual or automatic operation.
f. Panel shall be provided with an alarm buzzer and switch which shall be put in operation in case of fault.

g. For each function specified with the panel, a pilot light shall be provided to indicate the status of the particular function. Pilot lights colours shall be selected in accordance with the function shall be indicated.

C. Concrete Water Tanks

Supply and install of the basement reservoir the followings:

a. Balancing piston type float valve with shut-off valve.

b. Low level float switches assemblies as required and as necessary for the control of the relevant systems.

c. High water level alarm float switches.

d. Drain valve.

e. Drain and overflow to nearest drain provision or as shown on the drawings and vent pipes with insect copper mesh screen.

Testing kit : Softener is shall be supplied with one standard water testing kit to enable operator to make determination necessary in controlling operation of softener and with batch of standard soap solution for testing sufficient for one year of operation.

D. Irrigation Water Hydro-Pneumatic Pressure Set

Supply and install all irrigation water hydro-pneumatic pressure sets wherever shown on the drawings and as specified herein.

Irrigation water pressure set shall be pneumatic, packaged type, duplex type, complete with pneumatic pressure tank, interconnecting piping, fittings, controls, specialties and control panel for duplex operation all mounted on the same steel frame with heavy gauge steel protective casing, and all factory assembled and tested.

The set shall consist of two pumps with one pump as standby.

Irrigation water pressure set shall be complete as specified in the following clauses:

1. Pumps

Each pump shall be centrifugal, vertical split case, single or multistage, silent type, complete with flexibly coupled electric motor and couplings. The pump and motor assembly shall be mounted on a steel bed plate with an approved vibration isolator.

Pumps construction shall be cast iron body, volute bronze impeller, stainless steel shaft and mechanical seal.

Pumps shall be flexibly coupled to the electric motor thru a flexible coupling. Motor speed not to exceed 2900 rpm.

Inter connecting pipes within the pumping set shall be copper pipes.
Each pump shall include:

a. Casing drain and vent plugs.

b. Gauge tappings.

c. Drip Chamber or tray with drain connection.

d. Gate valve and strainer at its suction.

e. Silent check valve and gate valve at its discharge.

f. Pressure switches.

g. Pressure gauge and gauge cock at its discharge.

h. Reinforced type flexible connectors at pump's suction and discharge.

2. Hydro-Pneumatic Pressure Tank

   Each pressure tank shall be cylindrical or spherical, closed type, constructed in compliance with an approved international code for unfired pressure vessels.

   Each pneumatic pressure tank shall include:

   a. An inert gas chamber.
   b. Flexible butyl or neoprene membrane separating the inert gas chamber from water.
   c. Air recharge valve if tank is not permanently charged at factory.
   d. Pressure gauge and gauge cock.
   e. Gate shut-off valve.

3. Capacity

   Capacity of each irrigation water pressure set shall be as given in the schedules of capacities and/or the Bills of Quantities.

E. Irrigation Water Pressure Set Operation and Control

Supply and install for each irrigation water pressure set a system control and control panel which shall include all necessary pressure switches, pressure regulating valves, instruments, operating relays, safety relays as well as cables, wires, etc,... connecting it to the corresponding pump and storage tank or reservoir to obtain the following functions:

a. When line pressure drops, the pump shall operate and remain in operation until flow stops or the pressure switch reaches its high limit setting. A minimum run-time relay, adjustable type shall be provided to prevent frequent on/off operation. If pressure drops below a preset value, the second pump shall operate.
b. When suction water level drops to 10 cms above top of suction pipe, the pump shall stop by the action of a low level float switch; it shall not be able to run even if other controls call for its operation.

   After water level rises to 15 cms above suction pipe, controls shall allow pump operation again.
c. If operating pump fails to start the second pump shall operate automatically.
d. An automatic sequencing control shall be provided to operate pumps in a rotational sequence after each cycle.
e. Panel shall be provided with OFF-MANUAL-AUTO selector switch to allow the system shall be stopped and/or put on manual or automatic operation.
f. Panel shall be provided with an alarm buzzer and switch which shall be put in operation in case of fault.
g. For each function specified with the panel, a pilot light shall be provided to indicate the status of the particular function. Pilot lights colours shall be selected in accordance with the function shall be indicated.
h. A delay relay shall be incorporated within the panel to prevent immediate start-up upon re-establishment of power after power failure.

F. Irrigation Box and Tap

Supply and install irrigation box and tap wherever shown on the drawings and as specified herein.

Unit shall be cast bronze with satin finish face and "Nikaloy" box complete with hinged latching cover with lock of vandal proof construction, and with 3/4" bronze tap with standard hose connection, control key, and with an integral extension of suitable length to connect to the buried main pipe.

G. Polyethelene water storage tanks

Supply and install Polyethelene water storage tanks wherever shown on the drawings and as specified herein.

Unit shall be polyethylene cylinder shape, triple layer, as manufactured by NTG or approved equal.The tank shall include the required connectons as shown on the drawings.

POTABLE WATER SUPPLY (15415)

A. Potable Water Hydro-Pneumatic Pressure Set

Supply and install potable water hydro-pneumatic pressure set wherever shown on the drawings and as specified herein.

potable water pressure set shall be pneumatic, packaged type, triplex type, complete with pneumatic pressure tank, interconnecting piping, fittings, controls, specialties and control panel for triplex operation all mounted on the same steel frame with heavy gauge steel protective casing, and all factory assembled and tested.

Potable water pressure set shall be complete as specified in the following clauses:

1. Pumps

   Each pump shall be centrifugal; vertical split case, single or multistage, silent type, complete with flexibly coupled electric motor and couplings. The pump and motor assembly shall be mounted on a steel bed plate with an approved vibration isolator.

   Pumps construction shall be cast iron body, volute bronze impeller, stainless steel shaft and mechanical seal.

   Pumps shall be flexibly coupled to the electric motor thru a flexible coupling. Motor speed not to exceed 2900 rpm.

   Inter connecting pipes within the pumping set shall be copper pipes.

   Each pump shall include:

   a. Casing drain and vent plugs.
   b. Gauge tappings.
   c. Drip Chamber or tray with drain connection.
   d. Gate valve and strainer at its suction.
   e. Silent check valve and gate valve at its discharge.
   f. Pressure switches.
   g. Pressure gauge and gauge cock at its discharge.
   h. Reinforced type flexible connectors at pump's suction and discharge.

2. Hydro-Pneumatic Pressure Tank

   Each pressure tank shall be cylindrical or spherical, closed type, constructed in compliance with an approved international code for unfired pressure vessels.

   Each pneumatic pressure tank shall include:

   a. An inert gas chamber.
   b. Flexible butyl or neoprene membrane separating the inert gas chamber from water, and suitable for drinking water applications.
   c. Air recharge valve if tank is not permanently charged at factory.
   d. Pressure gauge and gauge cock.
   e. Gate shut-off valve.

3. Capacity

   Capacity of each potable water pressure set shall be as given in the schedules of capacities and/or the Bills of Quantities.

B. Potable Water Pressure Set Operation and Control

Supply and install for the potable water pressure set a system control and control panel which shall include all necessary pressure switches, pressure regulating valves, instruments, operating relays, safety relays as well as cables, wires, etc,... connecting it to the corresponding pump and storage tank or reservoir to obtain the following functions:

a. When line pressure drops, the pumps shall operate by cascade and remain in operation until flow stops or the pressure switch reaches its high limit setting. A minimum run-time relay, adjustable type shall be provided to prevent frequent on/off operation. If pressure drops below a preset value, the second pump shall operate, and if the pressure continues to drop, the third pump shall operate.

b. When suction water level drops to 10 cms above top of suction pipe, the pumps shall stop by the action of a low level float switch; it shall not be able to run even if other controls call for its operation.

   After water level rises to 15 cms above suction pipe, controls shall allow pumps operation again.

c. If operating pump fails to start the second pump shall operate automatically.

d. An automatic alternating switch shall be provided to alternate pumps function after each cycle.

e. Panel shall be provided with OFF-MANUAL-AUTO selector switch to allow the system shall be stopped and/or put on manual or automatic operation.

f. Panel shall be provided with an alarm buzzer and switch which shall be put in operation in case of fault.

g. For each function specified with the panel, a pilot light shall be provided to indicate the status of the particular function. Pilot lights colours shall be selected in accordance with the function shall be indicated.

h. A delay relay shall be incorporated within the panel to prevent immediate start-up upon re-establishment of power after power failure.

C. The Electric Panel Board

The Contractor shall supply an electrical panel board including:

- A main disconnecting link
- One circuit breaker and a number of starters for each pump
- All necessary relays
- Protection for the control equipment
- One voltmeter and one ammeter.

D. Hot Water Circulating Pump Set Operation and Control

Supply and install, wherever shown on the drawings and as specified herein, hot Water Circulating Pump Set Operation and Control , composed of duplex pump set

Each pump shall be of the centrifugal, in-line, single stage type, complete with direct coupled electric motor and couplings suitable for handling water at 200°F (93°C).

The pump and motor assembly shall be flexibly coupled with spring-type vibration isolators.

Pump connections may be either threaded or flanged.

Circulators shall be horizontal or vertical all-bronze with stainless steel shaft and water tight mechanical seals. Motor shall be sleeve type bearing, drip proof, with built-in automatic thermal overload protection.

Circulators shall be complete with switch, pilot light and electrical wiring adjustable immersion type thermostats shall be furnished and installed for each pump to start and stop the pump and maintain its thermostat setting.

Pump shall be designed for operation mounted on the pipe and circulating water in any direction up, down or horizontally

Each pump Shall be supplied complete with :

- Casing drain and vent plugs
- Gauge tappings
- Gate valve and strainer at its suction
- Gate valve and check valve at its discharge.
- Reinforced flexible joints at its suction and discharge
- Built-in thermal overload motor protection
- Capacity and type of each central heating water pump shall be as given in the schedules of capacities and/or the bills of quantities.

Supply and install for each Hot Water Circulating Pump set a system control and control panel which shall include all necessary pressure switches, instruments, thermostat, operating relays, safety relays as well as cables, wires, etc,... connecting it to the corresponding pump to obtain the following functions:

- If water return temperature drops below the selected temperature, the circulating pump starts, to reach the stop preset temperature.
- If operating pump fails to start the second pump shall operate automatically.
- An automatic sequencing control shall be provided to operate pumps in a rotational sequence after each cycle.
- Panel shall be provided with OFF-MANUAL-AUTO selector switch to allow the system to be stopped and/or put on manual or automatic operation.
- Panel shall be provided with an alarm buzzer and switch which shall be put in operation in case of fault.
- For each function specified with the panel, a pilot light shall be provided to indicate the status of the particular function. Pilot lights colours shall be selected in accordance with the function to be indicated.

A delay relay shall be incorporated within the panel to prevent immediate start-up upon re-establishment of power after power failure

DRAINAGE (15420)

A. Submersible Sewage Sump Pumps

Supply and install all sewage sump pumps wherever shown on the drawings and as specified herein.

Sump pumps shall be duplex assembly complete as specified in the following clauses:

1. Pumps

   Each pump shall be of the non-clog, centrifugal, submersible, type designed for pumping raw sewage and complete with:

   a. Cast iron casing.

   b. Open type cast iron non-clog impeller able to pass solids up to 3 inches diameter.

   c. Stainless steel shaft.

   d. Mechanical seal.

   e. Water cooled, totally enclosed electric motor, rated for continuous duty. Motor speed shall not exceed 1450 rpm. Motor shall have thermal overload protection and moisture sensing probes, pump and motor bearings shall be heavy duty, permanently lubricated and sealed ball bearings guaranteed for a minimum of 100,000 hours continuous operation.

   f. Oil casing.

   g. Cables and floats fixing frame.

   h. One check valve and one gate valve at pump outlet.

   j. Air tight access cover and frame.

   k. Level regulators of the pear-shaped type.

   Sump pumps shall be installed in a concrete pit shall be constructed by the Concretor.

   The Contractor shall coordinate his piping with the Concretor and shall install all pipes connected to the sumps pit in accordance with the layouts shown on the drawings.

   It shall be his responsibility to coordinate and determine pipes inverts and locations of pipe connections to the pit.

2. Controls

   An automatic operating and control panel shall be provided for sump pumps operation.

   The panel shall be of light alloy construction, perfectly sealed against dust and water and shall house pumps starters, breakers, floats, relays, interlocks, pilot lights, cables, wires, etc,... to obtain to following results:

   a. At low water level in the collecting pit, controls shall be inoperative.

   b. When water level rises to the first normal level in the collecting pit, the lead pump shall start.

   c. When water level rises to the second normal level in the collecting pit, the second pump shall start.

   d. When water level drops to the first level, the last pump to start shall stop. The first pump shall keep on running until water level drops to the low water level setting.

   e. An automatic alternating relay shall alternate pumps lead role after each cycle.

f. Should the water level rise to the alarm preset level, controls shall act to operate an alarm bell which shall remain in operation until put off manually.

3. Capacity

Capacity of each sump pump shall be as shown on the drawings.

B. PVC Floor Drains - Type FD-1

Supply and install all floor drains wherever shown on the drawings and as specified herein.

Each floor drain shall be constructed of heavy duty UPVC and shall conform with the following requirements:

a. Integral trap with cleaning plug.

b. Adjustable level, heavy duty, large grate area, stainless steel or chrome plated bronze strainer, 200mm x 200mm fixed onto the drain body.

C. Cast Iron floor drains

Supply and install wherever shown on the drawings floor drains of sizes and shapes as indicated on the drawings.

Each floor shall be of cast iron with 'S' or 'P' trap complete with chrome plated heavy duty bronze strainer fixed by screwing into the drain body. Drain shall receive two coats of asphaltic paint before installation or shall be asphalt painted at factory.

The open area of the strainer shall be at least two-thirds of the cross section area of the drain line to which it connects.

Each floor drain shall have a minimum water seal of 50mm

All floor drains shall have removable chrome plated covers over their strainers.

D. Roof Drains (RD), Terrace Drains (TD), Trench Drains (TRD), Flower Bed Drains (FBD), Garage Drains (GD) and Balcony Drains (BD)

Supply and install all roof drains, terrace drains and trench drains wherever shown on the drawings and as specified herein.

Drains shall be used on all horizontal surfaces exposed to rain water i.e. roofs, terraces, etc,...

1. Roof Drain - Type RD-1
   Each roof drain shall be constructed of heavy duty UPVC with bottom outlet and shall conform to the following requirements:
   a. Large grate area body with no trap and with gravel guard.
   b. Adjustable heavy duty elevated dome type strainer.
   c. Integral flashing flange.
2. Roof Drain - Type RD-2
   Each roof drain shall be constructed of heavy duty UPVC with side outlet and shall conform to the following requirements:
   a. Large grate area body with no trap and with gravel guard.
   b. Adjustable level, heavy duty elevated dome type strainer.
   c. Side outlet to suit installation in shallow finish height.
   d. Integral flashing flange

E. Clean-Outs

Supply and install all clean-outs wherever shown on the drawings and as specified herein.

Each clean-out shall be of the same material and dimension as the pipe shall conform with the following requirements:

a. For pipes exposed or in false ceilings, clean-outs shall consist of a threaded cap screwed onto pipe end.

b. Floor clean-outs shall consist off capped wide elbows ending under a chrome plated bronze tile 20 x 20cms with screwed cover.

F. Roof Vents and Vent Caps

Supply and install all roof vents and vent caps wherever shown on the drawings and as specified herein.

Each roof vent and vent cap shall be of UPVC and conforming with the following requirements:

a. Vent shall be full size of stack connected to it and provided with cap. Side openings shall be provided with plastic insect mesh screen securely fixed onto body.

b. Vent shall be provided with an extension nipple for fixing onto the vented stack.

G. Grease trap Collector

Supply and install wherever shown on the drawings grease trap of size and capacity as indicated on the drawings.

Grease trap shall be of fabricated steel construction with interior acid resistance epoxy coating and shall be complete with the following :

- Visible double wall trap seal with removable pressure equalizing/flow diffusing baffle and sediment container.
- Bronze cleanout plug
- Internal air relief bypass
- Threaded inlet and outlet pipe connections
- Gas and water tight gasketed cover secured with recess and covered center securing handle.
-

H. Oil Interceptor

Supply and shown wherever shown on the drawings, oil interceptor of size and capacities as indicated on the drawings and/or bill of quantities.

Oil interceptor shall be of fabricated steel construction with interior and exterior acid resistance epoxy coating and shall be complete with the followings:

- Air relief by-pass.
- Bronze cleanout plug and visible double wall trap seal.
- Removable combination pressure equalizing flow diffusing baffle, and sediment bucket, horizontal baffle, adjustable oil drawoff and vent connections either side.
- Secured gasketed non-skid secured cover complete with flow control fitting.
- The oil interceptor must be able to handle a flow rate 95 m^3/h.

I. Manholes Inspection Chambers and Gullies

a. Coatings

- Pitch epoxy coating for internal surfaces of manholes.
- Asphaltic composition coating for external surfaces of manholes.

b. Components

- Precast units : to BS 5911, sections C and D, plain and reinforced concrete class C and B respectively. Cement is shall be ordinary Portland cement.
- Cast in situ units : plain and reinforced concrete as per specifications for "Structural Works".
- Covers and Frames for manholes : to BS 497, coated, locking, solid top. Types shall be heavy duty grade A.
- Road Gully Gratings and sidewalk gullies: to BS 497, coated. Types shall be heavy duty grade D.
- Step Irons : to BS 1247.
- Steel Ladders : to BS 4211, mild steel, galvanized to BS 729.

c. Channels in bottom of manhole are shall be smooth, semi-circular and size equal to diameter of adjacent sewers. For straight through manholes, construct channels of half pipe sections. Make changes in direction of flow with smooth curves as large as manholes permit. Changes in size and grade of channels are shall be gradual and even.

d. Benching shall be formed in sulphate resisting concrete Class B and to rise vertically from top of channels to a height not less than soffit of outlet pipe, then sloped upwards 1 in 10 to walls. Within 3 hours, shall be floated with coat of sulphate resisting cement-sand mortar 1:2 and finished smooth with steel trowel.

e. External Coating: cover faces of manholes and chambers with two coats asphaltic composition applied by brush in accordance with manufacturer's instructions.

f. Internal Coating: cover faces of manholes and chambers with two coats pitch epoxide coating applied by brush in accordance with manufacturer's instructions.

g. Adjustment for level build top courses of brickwork or blockwork after completion of surrounding levels. Adjust as necessary to give accurate and even final levels.

h. Covers and Gratings: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.

j. Testing of Manholes: plug manhole inlets and outlets, fill manhole with water and allow to stand for at least 24 hours or such longer period to allow for complete absorption. Re-top with water. Allowable leakage over 24 hours is not to exceed 1% of total volume of manhole, otherwise make good and retest.

J. Service Connections to Municipal Networks

a. Location : agree location and invert level of connections with the Engineer's Representative before starting construction.

b. Programme connections to follow closely construction of pipeline.

c. Execution Connection to sewer is shall be at manhole where possible, or by T or Y junction.

d. Minimum Grade : lay connections at minimum grade of 20 per 1000 unless otherwise approved.

e. Install, bed and test connections in same manner as main pipelines.

f. Records : maintain accurate records of location of connection to main sewer. Record details of the following:

- connection number
- type of connection
- diameter
- downstream manhole number
- distance from manhole
- position (left or right) when facing upstream of street sewer
- distance from centre line of sewer to end lateral
- invert of street sewer
- lateral invert at end point
- number of inspection chambers
- cover type
- location, description and elevation of obstructions and method of protection.

g. Keep records in an approved survey log book, made available for inspection and handed to the Employer on completion. Transfer information to sketches and tables as agreed with the Engineer's Representative, provide three bound copies and hand to the Employer.

SANITARY FIXTURES (15440)

A. Scope

The scope of the sanitary fixtures and accessories shall be as specified herein and as detailed in the Bills of Quantities.

B. Performance and Standards

The work shall comply with the latest applicable standards and codes and shall be in accordance with the manufacturers recommendations.

C. Related Items

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D. Submittals

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

b. Samples for fixtures, trim and accessories shall be submitted for approval.

E. Product Handling

The Contractor shall store all products in a clean and workmanable manner under cover in weatherproof sheds and kept dry.

F. Materials

1. General
   a. Plumbing fixtures, trim and accessories shall be obtained from one approved manufacturer unless otherwise specified.
   b. Vitreous china : first quality, of specified colour, with smooth glazed surfaces free from warps, cracks, checks, flaws, discolouration or other imperfections.
   c. Vitreous china accessories: to match fixtures and of same manufacture and colour.
   d. Exposed piping and metal trim : chrome plated brass with polished finish guaranteed not to strip or peel off.
   e. Black bitumen coating solution for cold application to BS 3416 Type 1.
   f. Waterproof jointing compound for wastes : type recommended by waste manufacturer.

2. Lavatories
   a- White, vitreous china LECICO CLINIC SET for special needs persons toilets.
   b. White, vitreous china, with overflow, Lecico LAGUNA or approved equal, complete with accessories for all other areas.

3. Water Closets

a- White, vitreous china LECICO CLINIC SET for special needs persons toilets.

b. White, vitreous china, Lecico- delta S. without reservoirs, suitable for flush valve installation, complete with the accessories (for public toilets) :
   - White solid plastic seat and cover with metal hinge, rubber washers and plastic screws and nuts,
   - 3/8" angle valve with 300mm long tube,
   - Stainless steel toilet paper holder, with hood and plastic roller exposed surface mounted type, polished finish Bobrick B-66997.

c. Idem LAGUNA with reservoir or approved equal (for patients Bedroom).

4. Shower tray

   a- Similar to MUREX 80x80 for all areas.with Shower rose and support similar to GROHE RELAX PLUS shower system..

5. Sinks (Refer to architectural specifications,Corean or Resin as specified according to the area of application) except janitor room.

   a. Janitor Sink : Stainless steel similar to IDEAL STANDARD Janitorial sink reference S6509MY, with related mixer.

   b. Kitchen Sink (Refer to the kitchen equipment specifications and bill of quantities)

   c. Scrub-up sink

   Stainless steel, single bowl, single drainer, 16 gauge thickness, with splash back, of sizes as shown on drawings,as manufactured by Franke.

6. Liquid soap dispenser
   Wall mounted heavy gauge stainless steel with concealed fixing wall plate similar to Bobrick model B2113 or approved equal.

7. Towel Paper Dispenser
   Stainless steel, surface mounted with sloping top, refill indicator slots, and a pivot type door hinge, 290 x 375 x 100mm, Bobrick No. 26212 or approved equal.

8. Towel Holder
   Similar to BOBRICK B-530x24

9. Towel Hooks
   Similar to BOBRICK B-2116

10. Sanitary Mixer

a.Sanitary mixers, tabs and accessories for all toilets,shall be similar to GROHE EUROSMART or approved equal.

b.Sanitary mixer for Scrub-up shall be special mixer elbow operated similar to GROHE ERGOMIX 34018000.

HEATING PLANT (15450)

A. Oil fired boiler (Cast iron)

supply and install cast iron boilers wherever shown on the drawings and as specified herein :

Boiler shall be of the cast iron sectional type rated for 88.5 psi (610kpa). Each boiler shall be complete with the following :

- Automatic, high pressure, gun type burner suitable for light oil No.2 atomatization.
- Fuel oil solenoid valve.
- Burner plate
- Insulated and enameled steel jacket and fire bricks.
- 4mm thick steel breaching with 2" (50mm) insulation, connecting the boiler with the chimney.
- Draft control damper
- Thermometer
- Pressure gauge
- Aquastat
- Pyrostat or photocell
- Safety relief valve
- Electric control panel complete with switches and pilot lights and all electrical wiring.

The aquastat shall control burner operation to maintain water leaving the boiler at 180°F (82°C) and the pyrostat or the photocell shall monitor burner operation and stop it in the event of flame failure or if combustion does not take place.

B. Domestic hot water tank (heat exchanger)

Suuply and install domestic hot water tank wherever shown on the drawings and as specified herein :

- Tank shall be constructed of welded sheet steel galvanised after fabrication. Tank shall be of the tube in shell storage type for vertical mounting, built for indirect heating with large heating surfaces.
- Tank shall be tested for 177 psi (1220 kpa) and suitable for 88.5 psi (610 kpa) working pressure.
- Each tank shall be complete with the following :
  - Gate valves at each inlet and outlet.
  - Automatic air vent
  - 2" (50mm) thick fiberglass insulation with wire mesh and two coats of starch soaked heavy cloth
  - Steel saddles and frames necessary for installation
  - All motorized valves, control panel, wires, and accessories required for proper operation.

C. Central heating water pumps

Supply and install, wherever shown on the drawings and as specified herein, all central heating water pumps.

Each pump shall be of the centrifugal, in-line, single stage type, complete with direct coupled electric motor and couplings suitable for handling water at 200°F (93°C).

The pump and motor assembly shall be flexibly coupled with spring-type vibration isolators.

Pump connections may be either threaded or flanged.

Circulators shall be horizontal or vertical all-bronze with stainless steel shaft and water tight mechanical seals. Motor shall be sleeve type bearing, drip proof, with built-in automatic thermal overload protection.

Circulators shall be complete with switch, pilot light and electrical wiring adjustable immersion type thermostats shall be furnished and installed for each pump to start and stop the pump and maintain its thermostat setting.

Pump shall be designed for operation mounted on the pipe and circulating water in any direction up, down or horizontally

Each pump Shall be supplied complete with :

- Casing drain and vent plugs
- Gauge tappings
- Gate valve and strainer at its suction
- Gate valve at its discharge
- Reinforced flexible joints at its suction and discharge
- Built-in thermal overload motor protection
- Capacity and type of each central heating water pump shall be as given in the schedules of capacities and/or the bills of quantities.

D. Main Fuel Tank

Supply and install main fuel tank wherever shown on the drawings and as specified herein:

Tank shall be cylindrical, fabricated from 6mm thick high quality black steel plate welded on both internal and external seams.

Hydrostatically test tank at factory to pressure of one atmosphere held for 24 hours. All welds shall be proven sound.

Manhole shall be 500 mm diameter on top of tank, constructed from 6 mm thick side, flange and cover welded to tank. Cover shall be fixed to flange with 1.5 mm thick asbestos composition ring gasket and 20 mm diameter machine bolts 40 mm long with nuts equally spaced around 600 mm diameter bolt circle.

Connections: tank shall have necessary female threaded connections comprised of black forged steel pipe couplings fitted through holes cut in tank and welded all around inside and outside tank.

Connections made to top of tank, except vent connection, are shall be extended down to within 150 mm of tank bottom with seamless black steel pipes of same size as connections and well braced to tank inside walls. Vent connection is not to extend more than 20 mm into tank.

Fill and sounding line connections shall have hinged lockable caps with 50 mm female threaded bottom inlets as manufactured by Buckeye, or approved equal.

Local tank level gauge: 20mm gauge glass of correct length, complete with 20mm gauge cocks, drain cock, and gauge glass protector as manufactured by Hatterseley.

Paint finish: tank, manhole and connections shall be thoroughly cleaned of rust, scale, slag, oil, grease and all foreign matter by sand blasting or wire brushing down to base metal and painted on outside only with two coats of zinc chromate primer and two coats of emulsified asphalt.

Tank shall be built in accordance with UL standard for steel under ground tanks for flammable and combustible liquids UL. 58-1972.

Tank shall be equipped with the following :

- Remote reading, oil level gauge
- Fill and vent pipes
- Fuel supply and return lines
- Earthing connection

Tank should never be installed in, or covered with cinders to avoid rapid steel corrosion due to wet sulphur action.

Tank should be located outside the building with the top of the tank below the level of all piping to which the tank is connected. Tank should be buried so that the top of the tank is at least 600mm below grade. Otherwise, the top of the tank shall be covered with not less than 300mm of earth on top of which shall be placed a slab or reinforced concrete not less than 100mm thick. The slab should be set on a firm, well tamped earth foundation and should extend at least 300mm beyond the tank in all directions.

E. Expansion Tank

Supply and install expansion tank wherever shown on the drawings and as specified herein:

Closed type, including an interchangeable nitrogen bag tested to 7 bars at 110°C.

Horizontal or vertical closed vessel. One piece Butyl moduled bladder, fixed inside the vessel in one or two points. Bladder provides a complete separation between air and water, and is protected by filter.

Internal and external anti-corrosion paint.

F. Fuel Oil Circulating Pump

Supply and install fuel oil circulating pump set with two pumps wherever shown on the drawings and as specified herein:

The fuel oil circulating pump shall be centrifugal end suction type, Pedrollo or approved equal, and shall include :

- Cast iron casing
- Bronze impeller
- Carbon steel shaft
- Mechanical shaft seals
- The pump shall be bolted and grouted to a concrete base

The Contractor shall supply and install an electric panelboard for fuel oil circulating pump set including :

- The main disconnecting switches
- All necessary starters and controllers with alternate operation for pumps
- On/off default light
- Auto manual switch
- Magneto-Thermal protection for each pump

G. Fuel Oil daily tank

Supply and install fuel oil daily tank wherever shown on the drawings and as specified herein:

Fuel tank shall be rectangular shape fabricated from 4mm thick high quality black steel. The tank shall be reinforced and hydrostatically tested at factory after fabrication to a pressure of one atmosphere for 24 hours.

The tank shall be provided with steel legs at its bottom

The tank shall be complete provided with :

Fill connections ¾" diameter

One inch vent pipe.

H. Boiler breaching

Supply and install boiler breaching wherever shown on the drawings and as specified herein:
Boiler breaching and chimney shall be black metal sheet not less than 5mm thick, painted with two coats of fire resisting paint, insulated with 5cm fire resisting insulation (rockwool), and covered with 0.6mm galvanised jacket.
Clean up tight caps and doors shall be installed at every change of direction.

G. Raditor

Supply and install radiators wherever shown on the drawings and as specified herein:

Radiators shall be aluminum as manufactured by chappee, de dietrich or approved equal ,complete with all necessary accessories.

WATER TREATMENT SYSTEM (15482)

A. Sand filter

Supply and install sand filter wherever shown on drawings and as specified herein :

The filter shall be factory assembled :

- The casing shall be made of heavy gauge galvanised to resist to 9 bars operating pressure and shall be protected internally and externally by a thick epoxy coating.
- The media shall be made of calibrated gravel and silica materials.
- The filter shall be equipped with set of a butterfly valves and manometers on inlet and outlet.

The filtration velocity shall be less than 12m/h.

The service flow rate shall be $5m^3/h$

B. Chemical feeding system

Supply and install chemical feeding system wherever shown on drawings and as specified herein :

This system shall include :

- One pump to inject chlorine to sterilize the water

The pumps shall be similar to PULSAFEEDER, Electronic feeder type, capacity up to 30 gallons per day, pressure up to 80psi.

The metering pumps shall be supplied with four feet vinyl section tubing, and eight feet polyethylene discharge tubing. The digital timing circuit is highly reliable and by design, virtually unaffected by temperature.

The pump shall be internally dampened to reduce noise.

C. Water softener

Supply and install water softener wherevr shown on drawings and as specified herein:

Type : twin tank, fully automatic, package type, complete with brine tank, water meters, automatic controls and piping, completely assembled, wired and tested at factory, ready for installation and operation with simple water and electrical connections and of size and capacity to soften available water to zero hardness.

Brine tank : Shall be adequate size to provide minimum four regenerations of softener at maximum salt dosages and of fibreglass, rigid, sturdy, one piece open type construction with cover, designed to serve as combination salt storage and brine measuring tank. Perforated platform is to divide tank into sections with area above platform for dry salt storage and that below for brine generation.

Softener tanks : electric welded low carbon steel with dished ends double hot-dip galvanised after fabrication, designed and built for 6.9 bars (100 psi) operating pressure and tested at 10 bars (150 psi) hydrostatic pressure. Tanks are shall have access handhole at top with cover, steel structural legs, necessary female threaded connections and non-clogging stainless steel underdrain distribution systems designed for efficient flow distribution and requiring only one grade of supporting gravel. Each tank shall have multiport cast iron valve containing five integral diaphragm valves hydraulically operated by cycle controller in a smooth and water-hammer free manner and complete with self-adjusting brine injector.

Cycle controller : fully automatic, operated from automatic reset water meter to operate multiport valve and sequence the following regeneration operations on a gallonage basis

: backwash, brine, slow rinse, down-flow flush and return to service. Position dial on controller is to indicate various steps of regeneration.

Electric alternator is shall be provided for the two softener tanks and is to comprise sequencing pilot and pressure switch integrated with multiport valve cycle controller to allow automatic alternate operation of softener tanks : one unit in service and second on standby. Signal source to actuate alternator is shall be supplied by automatic reset water meter.

Water meter : Shall be provided with each softener tank for installation on water outlet pipe from each tank. Meter is shall have automatic reset controller and electrical lockout device to prevent more than one softener tank from regeneration at one time and is to signal the regeneration cycle controller at a preset gallonage of softened water and then automatically reset for next service run.

Flow controller : each softener tank is shall have special factory-set flow controller to maintain proper backwash flowrate automatically over wide variations in operating pressures to prevent resin from being washed away during regeneration.

Automatic brine valve controlling brine withdrawal and fresh water refill is shall be provided in brine tank and housed in a tube sealed at bottom. Brine valve body shall be galvanized cast iron and other critical parts tough plastic. Brine valve shall have at least three steps of adjustment to allow operator to select salt dosage for most efficient and satisfactory operation for particular water condition.

D. Potable Water cartridge Filters

Supply and install a potable water filter at the discharge of the potable water pressure set as specified herein.

Cartridge water filter shall be single or multiple cartridge type elements designed to remove sand, dirt and rust color, odor taste and chlorine, and shall be complete as specified herein:

a. Stainless steel housing

b. Cellulose cartridge elements designed for cold water application.
The catridge is constructed of carbon-impregnated cellulose media, which is spirally wound around a polypropylene core polyester reinforcement backing, polyethylene outer sheath.
Filter elements shall have a nominal degree of filtration of five microns.

c. Unless specifically stated otherwise, filter shall be rated for 175 psi (12.3kg/cm²) working pressure.

d. Isolating valves, pressure gauges and cocks at inlet and outlet connections.

e. A bypass connection with gate valve.
Capacity and type of each cartridge water filter shall be as shown on the drawings and/or given in the Bills of Quantities.

E. Reverse Osmosis System

Supply and install reverse osmosis treatment system wherever shown on drawings and as specified herein.

E.1 Reverse Osmosis Unit

a. Packaged automatic reverse osmosis system mounted on steel frame, designed for project conditions. Equipment arranged on the frame to allow easy access for operating, maintenance and repair.

b. Performance Requirements:
   1. Membrane reject ratio: 98% minimum. TDS of product is 2% maximum of input TDS.
   2. Capture rate: 70% minimum. Maximum amount of water to drain 30% of input.

c. RO Membrane Elements:
   Thin-film composite with FRP over-wrap, anti-telescoping device, u-cup brine seal. The design salt rejection shall be 98% based on 2000 ppm water at 225 psig at 77 degrees F.

d. RO Element Housings:
   Type 304 stainless steel with PVC end caps held in place with stainless steel bands. Each housing assembly complete with one set of O-rings and O-ring lubricant. Housings for systems over 9000 gallons per day shall be constructed of fiberglass reinforced polyester (FRP). Provide cleaning connections.

e. High Pressure Pumps and Motors:
   Vertical multistage high efficiency centrifugal type with Type 304 stainless steel casing, shaft, impellers. Tungsten carbide and ceramic shaft seals. Cast iron frame with flanged piping connections. Premium efficiency TEFC motor selected to be non-overloading on the entire performance curve.

f. Manual Valves:
   1. Pump Throttle Valve: Type 316 stainless steel ball valve, socket welded.
   2. Concentrate Throttle Valve, Recycle Throttle Valve: In-line needle style, stainless steel, rated for 300 psi minimum.
   3. Inlet Isolation Valve, Product and Concentrate Check Valves: PVC with EPDM seats and seals.
   4. Feedwater Sample Valve, Product Water Sample Valve: PVC plug valve with EPDM seats and seals.
   5. High Pressure Sample Valve: Type 316 stainless steel plug valve.