

**SECTION 6 - SUB-SECTION D**

**AIR CONDITIONING SYSTEM**

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## **1. Operational Requirements**

- 1.1 The air conditioning and ventilation system shall provide the facility with environmental conditions suitable for the operational regime of the buildings and their equipment.
- 1.2 The designer shall take the following considerations into account:
  - 1.2.1 The total dependence of the core of the inspection site on X-ray operational systems and computer systems on the air conditioning and ventilation systems
  - 1.2.2 Removal of gases emitted from the exhausts of trucks located in closed spaces: pit area and along the tunnel.
  - 1.2.3 The dependence of the people working in all buildings, including radiography, manual site, pits area and Customs house, on the ventilation and air conditioning system.
  - 1.2.4 As part of the proposal the Bidder will describe the preferred air-conditioning method, when taking into account initial cost as well as long time expenses.

## **2. Basic Assumptions**

- 2.1 Redundancy: The systems, of the radiography building and all office buildings, shall be designed with a high redundancy. This feature shall enable the system to work continuously and provide service even when subject to breakdowns such as mechanical failure, power outage, breakdown of an air conditioner or water cooling unit, and it must offer at least one alternative to ensure continued operation.
- 2.2 Backup: The central systems shall have a 100% internal backup capability for critical systems (above and beyond the planned expansion) starting from the cooling units, the compressors, the pumps, the motors, and on to the air handling units in the computer halls and equipment rooms. In case of breakdown rapid or automatic substitution between backup units will be possible in order to avoid putting the facility out of action.

Notwithstanding the foregoing, this approach will be examined before and during the detailed planning with reference to budget and space constraints.

2.3 Maintenance: The system shall be designed to ensure that in certain situations when maintenance operations have to be carried out in the system as a whole or in part of it this shall not interfere with the functional capability of the system or with the efficiency of work at the facility or with the operational capability.

2.4 Control: Effective control over system performance, as result of the climatic conditions in the various parts of the building (temperature, humidity, air purity, etc.) and operation of essential parts of the system will be proposed by the Company.

The Bidder shall propose air-condition monitoring system (including energy efficiency data).

2.5 Pollution: The system shall allow ventilation of the Radiography building and of the pit inspection area and an efficient evacuation of smoke or polluted air accumulated in the buildings as a result of fire, welding works, flooding or any other occurrence.

2.6 Reserve: The system shall be designed with a spare capacity of at least 10%.

2.7 Energy Saving and Conservation: The systems shall be designed so as to operate optimally in an energy saving manner but without impairing the operational requirements, the required backup and the working conditions in the facility.

2.8 The system shall be designed for a service life of at least 20 years, taking into account an expected 2% annual growth. (Preparations will be made for the gradual addition of cooling units, pumps and air conditioners). Note: The expansion shall not be at the expense of backup.

2.9 In case of electrical breakdown the system will not operate, except emergency ventilation and smoke evacuation.

2.10 The materials used in the HVAC system shall have fire rating certification according to IS 1001.

- 2.11 Air conditioning equipment and installation in the building shall be a subject to inspection and approval of Client representative.
- 2.12 The equipment shall be manufactured by Trane, Carrier, Liebert or another manufacturers of equivalent status as an authorized dealer/representative in Israel (must have approved equipment and the ability to provide spare parts and maintenance service).
- 2.13 The air conditioning system and equipment shall comply with GOI General Specifications (Chapter 15) and the requirements hereinafter.
- 2.14 All systems and equipment shall be "heavy duty" type, and withstand the defined atmospheric conditions of the Jordan River area (high temperatures and humidity). All materials and equipment surfaces shall be protected and coated with epoxy type paint.

### **3. Scope of Work**

- 3.1 The scope of work for supplying and constructing a complete heating, ventilation and air conditioning system, including but not limited to the following:
- A. Air cooling liquid-based chillers
  - B. Chilled water pumps
  - C. Water treating systems
  - D. Fresh air and standard air handling units
  - E. Special air handling units for computer rooms (close control unit)
  - F. Fan and coil units.
  - G. Water piping
  - H. Air distribution system
  - I. Fire/smoke damper
  - J. Ceiling diffusers, supply and return air grilles, extract grilles

- K. Sound and vibration control
- L. Insulation for piping and ducts
- M. Electrical system
- N. Automatic control, alarm system and instruments
- O. Painting and protection
- P. Testing, balancing and commissioning
- Q. Operation and maintenance instructions

#### **4. Required Design Conditions**

- 4.1 The air conditioning system shall meet the planned surrounding environment heat dissipation.
- 4.2 Special-destination rooms: temperature 22 deg. C (+/- 1 deg); relative humidity 50% (+/- 10%).
- 4.3 Office rooms and public areas: temperature 22 deg C (+/- 1 deg); no humidity control.
- 4.4 The calculation of cooling and air conditioning output shall be made with reference to a peak heat load in summer.
- 4.5 The degree of air filtration required for the computer rooms (technical) shall be 65% to ASHREA # 52-76.
- 4.6 The temperature of technical rooms and assemblies shall not drop below 10 deg C when the equipment is not operating.
- 4.7 Clean, filtered and air conditioned air shall be supplied to the buildings at the rate of at least 10 CFM per person.
- 4.8 The minimum and maximum temperatures for the radiography equipment zone shall be determined in accordance with the manufacturer's requirements.

## **5. Noise Level Limits**

Noise level resulting from the air condition operation shall be as follows:

- 5.1 Noise level of air-cooled water chiller shall not exceed 80 dB (Sound Pressure Level) scale A, measured at 1 meter distance from the unit.
- 5.2 Noise level of water circulating pump shall not exceed 65 dB (Sound Pressure Level) scale A, measured at 1 meter distance from the unit.
- 5.3 Noise level of normal vertical or horizontal air handling unit of up to 2500 CFM shall not exceed 50 dB (Sound Pressure Level) scale A, measured at 1 meter distance from the unit
- 5.4 Noise level of computer room air handling unit shall not exceed 50 dB (Sound Pressure Level) scale A, measured at 1 meter distance from the unit. If necessary, the units shall be installed in acoustically insulated masonry built compartments.
- 5.5 Noise level of fan and coil unit shall not exceed 42 dB (Sound Pressure Level) scale A, measured at 1 meter distance from the unit.
- 5.6 All air conditioning equipment shall be mounted using vibration absorbers.
- 5.7 All water chillers and pump pipe connectors shall have flexible multi-layer neoprene rubber joints.
- 5.8 In the event that the specified noise levels are not attained, the Contractor shall add, at his own expense, acoustic isolation elements and vibration absorbers as necessary until the specified noise levels are achieved.

## **6. Specifications of the Air Conditioning System**

- 6.1 The air conditioning system shall be designed for both cooling and heating. It shall provide cold air and cold water for achieving the environmental conditions required for the equipment and for a comfortable environment.

- 6.2 The air conditioning system shall be two-pipe water-cooled type. Wintertime heating and humidity control shall be accomplished using electric heaters installed in the air handling units and end units.
- 6.3 The system of the Radiography building shall be based on a number of water cooling units installed in a central machinery room.
- 6.4 In the other buildings it may consist also of split air conditioning units.
- 6.5 The rooms shall be air conditioned by means of fan & coil units; the units placed in the offices shall be equipped with electrical heating elements (at the discretion of the Designer).
- 6.6 The technical assemblies shall be air conditioned by a number of special air handling units (made by "Liebert" or equivalent) delivering cold air to the floating floor. At least one unit shall serve as backup. In the halls there shall be control over the temperature and humidity.

These special units shall incorporate air humidifiers, drying-heating elements, and precise temperature and humidity controls

- 6.7 Every air conditioner in the special-purpose and computer rooms shall have a redundant output sufficient for maintenance purposes without impairing the work. The unit shall contain a water sensor under the raised floor.
- 6.8 The fresh air shall be delivered to the rooms in quantities consistent with the ASHRAE requirements. The fresh air shall be supplied by means of a separate air conditioner per assembly, to the fan & coil units, and to the air conditioners of the special-purpose rooms.
- 6.9 Each room shall have an individual temperature regulator.
- 6.10 Air handling units shall be by Carrier, Liebert or other U.S. equivalent.
- 6.11 Each equipment room, hall and fire zone shall have at least two air conditioning units installed – operating and backup. The backup unit shall start operation automatically. Service rooms, offices etc shall not have full backup.

- 6.12 Each room and lab air conditioning unit shall have a 30% output redundancy, for cases of increased load or designation change.
- 6.13 Air ducts, piping and drains installation shall be concealed (inside the ceiling, floor and/or special shafts) but easily accessible for maintenance and alteration purposes.
- 6.14 Duct and pipe passages between fire zones shall be completely sealed. Automatic fire dampers shall be installed in the ducts.
- 6.15 The building sewage system shall collect and drain all air conditioner condensate.

## **7. Water Cooling Units**

- 7.1 The cooling units shall be obtained from a manufacturer well-known / branded in Israel. Maintenance services shall be available from a local agent able to provide service and maintenance.
- 7.2 The condensers or packaged air cooled water chillers shall be mounted outside the building.
- 7.3 The contractor shall supply air cooled chillers manufactured by Carrier, Trane, McQuay or equivalent.
- 7.4 The cooling system shall be divided into a number of water cooling units, each unit containing at least two separate gas circuits (compressor and condenser). A separate water pump shall be installed for every cooling unit.
- 7.5 The backup of the cooling units shall be based on additional water cooling unit, to be connected in parallel to them, including a separate pump and condenser.  
  
The backup unit for critical systems shall enter into operation automatically, when necessary.
- 7.6 Additional space shall be allocated for additional future water chilling unit(s) anticipating future growth or additional backup.
- 7.7 The cooling gas shall be of a modern type, nontoxic and harmless to the environment.

- 7.8 Evaporating inlet/ outlet water temperature 12°C and 7°C and condenser air intake temperature 40°. Each unit shall be microprocessor controlled, air-cooled, liquid chiller utilizing HFC-134a dual refrigeration circuit with electric expansion valves. The units may be factory assembled, single piece, contained within the unit cabinet all factory wiring, piping, controls, charge (HFC-134a) required prior to field start up.
- 7.9 The chillers shall contain all elements as described in Clause 1501 of the GOI General Specification.

### **7.10 Controls**

- A. Unit controls shall include a microprocessor, LOCAL/OFF/REMOTE monitoring system, selector and a 6-digit diagnostic display (scroll-down text) with a keypad.
- B. Shall be capable of executing the following functions:
1. Automatic changeover between the main compressor and the non-active compressor.
  2. Capacity control based on leaving chilled water temperature with return water temperature sensing.
  3. Enable adjustment of leaving chilled water temperature according to the return water temperature or by means of a 0 – 10 V signal.
  4. Control over the chilled water pump.
  5. The unit shall contain communication panel (communication box) designated for transferring unit control data.

### **7.11 Safeties**

Unit shall be equipped with all necessary components and, in conjunction with the control system, shall provide the unit with protection against the following:

- A. Loss of refrigerant charge
- B. Reverse rotation
- C. Low chilled water temperature
- D. Low oil pressure

- E. Current imbalance
- F. Thermal overload
- G. High pressure
- H. Electrical overload
- I. Phase loss
- J. Loss of chilled water
- K. Electrical protection to IP-44C
- L. Compressor soft start
- M. Evaporator freeze protection

## **8. Water Treating System**

- 8.1 The water treating system shall operate a scale removal unit to filter out solid materials from water entering the chillers.
- 8.2 The system shall include a tank for chemical treatment of the re-circulating water.

## **9. Water Circulation Pump**

(Refer to the General spec. clause 15086)

- 9.1 The Contractor shall install pumps made by Taco or Bell & Gossett or KSB.
- 9.2 The pumps shall be vertical split coupled inline type or horizontal frame mounted centrifugal type.

## **10. Cold Water Piping**

- 10.1 The planning of the cold water piping shall be guided by considerations of convenient maintenance and the possibility of opening the piping at a certain place (for repairs, modifications, etc.) without affecting the operation of the system in the other areas.

- 10.2 Every branch of the cold water piping shall be provided with a disconnect valve on the supply and return pipe.
- 10.3 A supply valve shall be installed at every cold water inlet and outlet to/from the air conditioning units, to allow connection and disconnection of consumers without affecting the other consumers.
- 10.4 The water piping connections inside the technical assemblies shall enable additions to and relocation of the air handling units.
- 10.5 The course of the piping for the special-purpose rooms and office rooms should be in the corridors or in niches but not in the rooms themselves, in order to prevent problems resulting from lack of servicing and maintenance due to inaccessibility.

## **11. Fan & Coil Units**

- 11.1 The units shall be manufactured by Trane, Carrier, Williams or approved equal. The fan coil units shall be of the cooling type with electric heating element. The heating element shall be protected by a high temperature sensor.
- 11.2 Cooling water shall be supplied through a three-way valve, and the heating shall be provided by electrical heating elements controlled by thermostat (in the office rooms).
- 11.3 Air supply shall be horizontal or through air ducts and ceiling diffusers. The fan being - a two-speed type (at least).
- 11.4 Fresh air shall be supplied through the fan & coil unit located at their bottom, in parallel with the returning air, or directly into the room.

## **12. Fans**

(Refer to the General spec. clause 15021)

- 12.1 Fan characteristic curve shall be submitted.
- 12.2 Noise level data, spectrum analysis and dB (sound pressure level – scale A) level shall be submitted.

- 12.3 Fans shall be fitted with protective belt guards, inlet screens required to comply with safety requirements of all authorities.

### **13. Air Ducts and Air Diffusers**

- 13.1 Treated air shall be delivered from the air conditioning unit to the building and back in galvanized metal ducts. The duct will comply with clause 15052 of the General Specification. Duct seams shall be sealed with silicone sealant and checked for tightness and noise, as detailed in the General Specification.
- 13.2 The air ducts shall be insulated on the outside by 25 mm thick fiberglass layer with a vapor barrier. The insulation shall be full, continuous and sealed with aluminum coated fabric adhesive tape.
- 13.3 The exposed ducts shall be insulated on the inside with 1" thick internal thermal and acoustic insulation layer.
- 13.4 Outside exposed ducts shall be primer coated and painted with a topcoat similar in color to the building walls.
- 13.5 Air delivered at the ceiling shall be supplied via insulated ducts to air diffusers installed in the ceilings of the individual rooms. Each air-supplying branch shall be equipped with a damper for manual regulation.

### **14. Air Conditioning in the UPS Rooms**

- 14.1 The UPS rooms shall be air conditioned by means of a number of air handling units with appropriate backup, delivering cold air by means of a duct system with overhead distribution. The water piping shall have space and connections for the addition of more units in future.
- 14.2 The air handling units shall be made by a manufacturer known and represented in Israel, for maintenance purposes.
- 14.3 Cooling shall be achieved by delivery of cold water from the water mains of the building.

- 14.4 Temperature shall be maintained by means of a three-way valve according to the temperature of the return air in the room.
- 14.5 The location of the air diffusers shall be determined in coordination with the Electrical Systems Designer so that the supply of cold air to the equipment shall be as required by the manufacturer.
- 14.6 In principle, the cold air shall be delivered to the front side of the equipment, and the returning air shall flow directly on top of it.
- 14.7 The supply of fresh air through the outside air AHU shall be in accordance with accepted standards and at the filtration level required by the manufacturers of the equipment.

## 15. **Ventilation of the Battery, Machinery, Toilet Rooms and Truck Alleys**

- 15.1 The ventilation of battery rooms shall be based on fans and exhaust ducts made of PVC.
- 15.2 Air suction in the battery rooms shall take place at two levels (at the ceiling and on the floor), at the quantities required according to the accepted standards.
- 15.3 The ventilation of the machinery, transformer and toilet rooms shall be based on a duct system and exhaust fans. Air quantities and their delivery shall be to accepted standards.
- 15.4 Ventilation of truck alleys and tunnels shall be achieved by a number of suspended high capacity tube axial fans.

## 16. **Electric Boards (Power and Control)**

- 16.1 Every cooling unit, including all of its parts (including compressors, condensers, and pumps) shall be installed in the machinery room.
- 16.2 The control of every cooling unit shall be powered from a zone UPS board – per contractor design.

- 16.3 Board for the critical cooling unit and AHU (e.g. Linac accelerator unit etc.) shall be connected to operator's control. The board shall be equipped with a selector switch "local/remote".
- 16.4 The air handling units for the equipment and computer rooms shall be fed from zone electric boards in their vicinity (the Electrical Corporation field), every unit from a separate board.
- 16.5 The fan & coil units shall be fed from local secondary boards with possibility of central cutoff when necessary.
- 16.6 Every air conditioner, pump, fan, etc. serving for backup shall be fed from a board separate from that of the equipment being backed up.
- 16.7 The air handling units for the UPS rooms shall be fed from a local board (the Electrical Corporation field with generator backup).
- 16.8 The operation of the system shall allow automatic restarting, including the required delays, in case of voltage drop.
- 16.9 In case of fire detection, the air conditioning and ventilation shall be stopped in the affected zone.
- 16.10 Ammeters, voltage drop and power outage protection devices shall be mounted on the panel. Feed and control cables shall be routed inside PVC ducts. External exposed cables shall be routed in galvanized steel pipes or ducts.
- 16.11 The complete air conditioning equipment, piping and ducts shall be connected to a grounding circuit according to the Israeli Electricity Law, and shall be subject to approval by an authorized inspector.
- 16.12 The electronic control system shall operate as follows: each room shall be equipped with a temperature sensor. Cooling requirement received from a room shall activate the three-way cold water-mixing valve in the FCU. During winter, room thermostats will activate the FCU heating elements to regulate the room temperature to the desired degree.

- 16.13 The return air ducts shall be equipped with a smoke detector and safety thermostat, which will cut off air conditioner operation and activate the fire detection panel warning light and siren in the event of fire.
- 16.14 All electric panels shall be equipped with an automatic gas type fire extinguishing system.

## **17. Control of the Air Conditioning Systems**

- 17.1 The air conditioning systems shall include all the controls required for automatic operation, in accordance with the order of their units, including the activation of the backup units.
- 17.2 There shall be a possibility of activating every component/assembly of the system manually and locally. For this purpose, the independent control boards shall be equipped with all the switches, indicators and warnings necessary for local operation.
- 17.3 In addition to the above, there shall be central control from the building's systems control room, whose main purpose is to collect information on the operating data and environmental conditions in all parts of the building, and to perform functions that require handling in a general perspective, system operation and disconnection, failure alarms, backup system activation, and the execution of manual functions, as detailed in the chapter on control of the systems in the building.
- 17.4 Apart from the sensors of the electronic/computerized control system, the systems shall be provided with separate mechanical temperature and pressure sensors and gages to be connected in parallel.
- 17.5 Every air conditioned room and hall shall have a separate temperature control. The temperature in every room shall be kept constant regardless of the changes of load imposed by the equipment and persons present.

## **18. Work Plans, Equipment Specifications and Samples**

18.1 Additionally to the General Specification stipulations, the Contractor shall submit work plans and specifications as follows:

- A. Detailed catalog, air conditioning units
- B. Fully detailed production and assembly drawings for all air ducts
- C. Duct thermal insulation sample
- D. Air diffusers together with any additional materials and equipment as required by the inspector
- E. Detailed Bill of Quantities, all system components
- F. Air conditioning unit installation plan, fully detailed
- G. Electrical and control panel plans including detailed equipment list and labels. Detailed electrical and control schematics.
- H. Electric heating elements.
- I. Room thermostats

18.2 Inspector's approval of work drawings and/or equipment items in no way relieves the Contractor from full responsibility for the quality and/or suitability of the equipment, as detailed in the Specifications and plans. The Contractor (or representative of) is obligated to visit the premises and ensure that the conditions thereof conform to the work drawings.

18.3 All Contractors' production drawings shall be furnished using computer magnetic media and standard drawing file formats, to be agreed upon. , After obtaining engineering approval, they shall be submitted to the inspector and shall remain a government property.

## **19. Running-in**

The contractor shall execute a run-in acceptance test of the systems and devices after finishing the assembly and installation works, subject to the inspector's approval. Continuous operation during 5 full consecutive days and nights, without failures shall be considered a successful run-in test pass.

## **20. Demonstration and Training**

- 20.1 The Contractor shall demonstrate the operation, control and maintenance of the system components and functions.
- 20.2 Each demonstration shall include an operator training including troubleshooting and servicing of the demonstrated component.

## **21. System Delivery**

The terms of delivery are as follows:

- 21.1 Contractor completed all works on the system.
- 21.2 Contractor completed all system tests and adjustments, and prepared suitable test reports.
- 21.3 Contractor shall carry out a system run-in test.
- 21.4 Contractor completed all demonstration and training obligations.
- 21.5 Contractor prepared and delivered all installation manuals,.
- 21.6 The systems shall be delivered in the presence of Contractor's technicians who participated in the installation and running-in of these systems / components.

## **22. Documents and Plans**

The Contractor shall supply the following documents:

- 22.1 List of motors and electrical elements with relevant data including but not limited to manufacture, type, model, current and voltage rating, isolation, overload adjustment etc.

- 22.2 Clearly worded operating instructions including a troubleshooting section.
- 22.3 Maintenance instruction with periodic maintenance sections, as required.
- 22.4 Recommended spare parts list.
- 22.5 After making necessary corrections in accordance with the inspector's remarks and after obtaining engineering approval, the Contractor shall submit five copies of the complete documentation, with a set of CD media, hereinafter the "Installation Manual", to the inspector.
- 22.6 As stated, submittal of the Installation Manual shall be a condition for delivery. During the delivery/acceptance process the team shall carry out part of the inspections described in the Installation Manual, in particular the operation and maintenance instructions.
- 22.7 All production drawings shall be included "as made" in the Installation Manual.

### **23. Important Points**

- 23.1 The air conditioning system shall provide a continuous reliable service 24 hours a day, 365 days a year. In any event of failure resulting in non-delivery of conditioned air, the backup system shall instantly take over.
- 23.2 The planning shall include a comprehensive solution for dust filtering, deposits and corrosion problems in all system components.
- 23.3 All air conditioning equipment, including spare parts, shall be purchased in suitable quantities and models, according to manufacturer and designer recommendations to ensure continuous work and minimum of downtime for repairs.
- 23.4 The equipment shall be designed for easy maintenance of all components. During maintenance period, the system shall continue to provide service though the use of backup units.
- 23.5 The equipment chosen shall ensure maximum reliability in long-term continuous operation, as well as withstanding to frequent stops and starts.

- 23.6 Location of the air conditioning equipment shall be planned so as to occupy minimum space, and minimize the effects of noise, vibration, voltage drop etc.
- 23.7 During operation or when being turned on/off, the air conditioning system shall not cause any disturbances on the mains or RFI/EMI effects.
- 23.8 The Contractor shall supply a full-set of spare parts for two years of operation. The minimal spare parts kit shall include (but not limited to) two spare air filter kits and one spare set of fan and condenser belts.
- 23.9 The Contractor shall connect the air conditioning unit, the ducts, piping etc. to grounding plates, as required by the Israeli Electricity Law.
- 23.10 Suction points for the fresh air fans shall be installed so as to prevent suction of odors and gases emitted from the lavatories, the accumulator rooms, and the generators.
- 23.11 The air conditioning system shall be designed in accordance with the "fire zones" and with arrangements regarding security compartmentalization. The air duct passages between fire zones shall be provided with automatic fire dampers integrated with the detection and warning systems.
- 23.12 In case of fire detection, the air conditioning and ventilation system shall switch to a different mode of operation: stoppage of fans in the affected zone, closure of the fire doors and smoke flaps, formation of overpressure areas for escape, activation of a smoke exhaust system, etc.
- 23.13 The air conditioning systems shall not raise the noise level in the special-purpose rooms above 50 dB, scale A.

## **24. Central Control**

- 24.1 All electromechanical components of the air conditioning and ventilation systems shall be automatically controlled by state-of-the art computerized control system.
- 24.2 All system parameters that are involved in operation, adjustment, regulation, measurement, protection, alarm, maintenance periods etc. shall be transmitted to control system and shall operate from there.

24.3 The Contractor shall be responsible for submitting all these parameters to the designer of the central control system. It is the Contractor's responsibility to ensure that the computerized system interfaces with the central control system of the building.