

**ELECTRICAL WORKS**



ELECTRICAL WORKS

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PART I

GENERAL ELECTRICAL REQUIREMENTS

## PART I

### CHAPTER 1

#### GENERAL ELECTRICAL REQUIREMENTS

##### I.1.01 PURPOSE OF THE TENDER

The purpose of this tender is the supply and installation of all materials and execution of all works necessary for the Electrical Installations of the laboratory building and R.O. research building to be constructed in the research center of desalination technology of the YANBU and MEDINA Power and Desalination Plant, Saudi Arabia.

The first Part of the tender deals with the general electrical requirements for all the project.

The second Part of the tender deals with the electrical works in the buildings, namely :

- The Laboratory Building
- The R.O. Research Building

The third Part deals with the Electrical works of Low Voltage Distribution.

The fourth Part deals with the Extra-Low Voltage Systems in all the project.

The supply shall include all the equipment, accessories and other materials not enumerated in these Specifications but found necessary for the completion and perfect functioning of the installations.

Works shall be executed in a first-class workmanlike manner in accordance with these Specifications, the drawings and notes indicated therein, the instructions of the Engineer, the provisions of the Bill of Quantities delivered in place and tested to the full satisfaction of the Engineer.

#### **I.1.02 SCOPE OF WORK**

Work described hereunder shall apply to the supply and installation of the following listed, but not limited to, items :

- a - The general low voltage distribution switchboard.
- b - The secondary low voltage distribution switchboards.
- c - The complete circuits for lighting, socket outlets, power supply outlets and all other electric loads in the project including all switchgear, socket outlets, fittings, connectors, and all accessories. The circuits shall be drawn inside rigid galvanized steel conduits and/ or cable tray. Plastic conduits shall be used for the housing units.
- d - The lighting fixtures.
- e - The earthing system.
- f - The extra low voltage systems.

**I.1.03 CONCEPT OF DESIGN**

- a - The laboratory building and R.O. Research building shall be supplied through the existing facilities.
- b - The characteristics of the electric supply in the laboratory building and R.O. research building shall be as follows.

SERVICE			
The laboratory building	Phase	Wire	Voltage
- existing facilities	3	4	230 - 133 V
- labo. equipment	3	4	220 - 127 V
"	3	4	190 - 110 V
The R.O. Research building			
- existing facilities			
- power	3	3	480 V
- lighting/receptacle	3	4	208 - 120 V
- labo. equipment	3	4	220 - 127 V
"	3	4	190 - 110 V
"	1	2	110 V
- lighting/receptacle (newly)	3	4	208 - 120 V

- Note 1. Frequency shall be 60HZ.  
 2. Neutral shall be solid-grounded.

- c - The new wiring from the existing panels and/or new ones shall be routed through existing cable trays using cables suitable for cable tray installation. The cables and/or wires from the cable tray to the equipment or receptacle shall be protected by suitable means such as conduit and/or race way channels.
- d - All the equipment shall be fit for continuous work under the heaviest conditons in YANBU.

#### 1.1.04 CODES AND TESTS

The equipment, materials and installation shall satisfy the followings :

- a - The specifications and technical conditions described in the present book of Specifications.
- b - One of the following standard Specifications :
  - National Electrical Code,
  - I.E.C. Recommendations.

Tests after the completion of the installation shall satisfy the requirements of the standards mentioned above.

#### 1.1.05 ACTUAL ROUTE OF CABLES AND CONDUITS

The location of conduits, cables, switchboards, etc... is shown on the drawings approximately, therefore the actual route of cable and conduits may differ from the plans according to the details of the building construction and the conditions of execution of the installation.

The Contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to apply the modifications on the route of cables and conduits that are found necessary during the work to the complete satisfaction of the Engineer.

#### I.1.06 DRILLING AND CUTTING

The Contractor shall have to do all drillings and cutting of walls or other parts of the building for the complete proper installation of the conduits, cables, switchboards and other parts of equipment.

Beams, girders and other principal structural members shall not be cut or drilled unless permission has been granted by the Engineer.

If such drilling and cutting is made on finished surfaces, any marring of the surfaces shall be made good by repair or replacement at the Contractor's expense.

#### I.1.07 DRAWINGS

Before starting the work, the Contractor shall submit to the Engineer for his approval, the execution drawings for the entire installation, especially the main connections and junctions, the final route of cables and conduits and the details of the switchboards and any other part of the installation required by the Engineer. The Engineer reserves the right to alter or modify these plans if they are found to be insufficient or not complying with the established technical standards, or if they do not afford the most satisfactory performance or accessibility for repairs.

At the end of the work, the Contractor shall present three sets of as-built drawings of the whole installation, with all details required by the Engineer, and with the technical data of all installed equipment.

#### I.1.08 MATERIALS OF THE SAME KIND

All materials of the same kind of service shall be identical and made by the same Manufacturer. Any exception to this rule shall be approved by the Engineer.

#### I.1.09 TEST CERTIFICATE

The supplier shall submit test certificates where required. These shall be issued by an internationally recognized inspection office certifying that all equipment materials, construction and functions are in agreement with the requirements of these Specifications and accepted Standards.

#### I.1.10 CHECKING OF THE INSTALLATION AND GUARANTEE

At the moment of the preliminary reception, a closed and detailed inspection of the method of installation of all the equipment and networks shall be undertaken. Any part of the installation found to have been neglected or which fixing is considered insufficient shall be automatically rejected.

##### a - Tests

The tests shall comprise :

- Quality test : before the commencement of any works
- Checking tests : They shall be carried out according to the program of the Contractor works and at his own expense. He shall supply all the labour needed for the adjustment and testing of the installation. He shall also supply the measuring instruments necessary for the checking. These instruments shall remain as a part of the installation.

##### b - Acceptance

Upon completion of the works, the acceptance procedure shall comprise :

- A checking of the overall good functioning of the installation.
- A checking of the conditions prescribed by the present Specifications.

Any defects found out should be immediately repaired by the Contractor. All drilling, cutting and marring of finished surfaces as a consequence of the repairing shall be made good by repair or replacement at the Contractor's expense.

The results of the tests and checking shall be stated in a detailed report. One year after the preliminary acceptance, the final acceptance shall take place following the same procedure of the preliminary acceptance.

c - Guarantee of a First Class Installation

The Contractor must guarantee that the installation object of the present Specifications have been carried out in a first class manner according to the rules and applicable regulations.

d - Performance Guarantee

The material such as has been specified should offer the maximum safety for continuous working of the entire installation.

All materials supplied must be new and guaranteed for one year as from the date of putting in operation.

This guarantee shall cover all defects or faults whether visible or not concerning the materials used, the method of construction, the conception as well as the good functioning of the installation as a whole and in its different details.

The responsibility of the Contractor shall cover also and to the same degree all the supplies of his sub-Contractors.

e - Guarantee Covering the Material

The Contractor shall be bound to replace, repair or modify at his own expense, all items or elements considered faulty as a result of their inspection, the materials used or the construction and that during one year as from the date of putting in operation.



#### **I.1.11 INSTRUCTION MANUALS**

The Supplier shall prepare and produce instruction manuals in both Arabic and English languages for the use, operation and the maintenance of the supplied equipment and installations

PART II

ELECTRICAL WORKS

## PART II

### CHAPTER 1

#### DESCRIPTION OF THE INSTALLATION

##### II.1.01 SCOPE OF WORK

Work described hereunder shall apply to the supply and installation of the following listed, but not limited to, items :

- a - The secondary L.V. distribution switchboards to be installed as shown on the drawings.
- b - The L.V. cables for connecting the existing general switchboard to all the secondary distribution switchboards.

Every secondary distribution switchboard shall have an independent cable connecting it directly to the general distribution switchboard or to the corresponding equipment.

- c - The complete circuits for lighting, socket outlets, power supply outlets and all other electric loads in the project including all switchgear, socket outlets, fittings, connectors, and all accessories. The circuits shall be drawn inside rigid galvanized steel conduits and/or cable tray.
- d - The lighting fixtures for R.O. research building to be newly constructed.
- e - Lighting system to be modified at existing R.O. research building.
- f - The expanded earthing systems.

#### II.1.02 DISTRIBUTION SYSTEM

- The existing general switchboard shall supply the secondary distribution switchboards.
- The distribution circuits supplying the light points, socket outlets and all the other utilities fed from the secondary distribution switchboards shall be drawn inside rigid galvanized steel conduits.  
These conduits shall be concealed or surface mounted above the false ceiling up to the derivation boxes of every room.  
Inside the rooms, generally the conduits shall be concealed in the walls, the concrete ceilings or in the floor screed.

#### II.1.03 DISTRIBUTION CIRCUITS

- The conductor sizes for the different distribution circuits are shown on the drawings of the distribution switchboards. However, the minimum size used for lighting circuits shall be (2.5) sq. mm. and the minimum size used for socket outlets shall be (4) sq. mm. The calculation of cable sections shall be justified by the Contractor.
- Every circuit shall have an earth continuity conductor.
- The drawings indicate the different circuits. The number of conductors in every conduit shall correspond to the number of circuits plus the extra conductors needed for the control of the circuits (one way, two or three ways switches, etc...).

## CHAPTER 2

### MATERIALS SPECIFICATION

#### II.2.01 SECONDARY DISTRIBUTION SWITCHBOARD

The secondary distribution switchboards are installed inside the buildings, for the lighting circuits, the socket outlets and the small power requirements.

- These switchboards shall be of sheet steel general purpose cabinet type equipped with molded case circuit breakers.
- These switchboards shall be designed for surface or flush wall mounting.
- The cabinet of these switchboards shall consist of a sheet steel box properly jointed, welded and reinforced, and of a sheet steel front having a door with concealed hinged and a flush type combination lock and catch or a multiple point contact.
- The interior of these switchboards shall be assembled as a complete unit to fit the cabinet. This interior shall be composed of bus bars and the branches mounted on them.
- Every switchboard shall be provided with :
  - one neutral bar fully insulated from the cabinet,
  - one earth connector welded to the cabinet.

#### II.2.02 CIRCUIT BREAKERS

##### General Features :

- They shall be suitable for operation on the system which is :  
220 Volts, 3 phase, 4 wire,

190 Volts, 3 phase, 4 wire,

110 Volts, 1 phase, 2 wire,

60 cycles per second, with neutral of the transformer solidly earthed.

- They shall be of the single break type. Three phase circuit breakers shall be designed to break all the poles simultaneously and they shall have a single mechanism.
- Each pole of the circuit breaker shall be equipped with an inverse time delay thermal overcurrent trip device and an electromagnetic instantaneous over-current trip device. The trip device shall be direct-acting.
- They shall be trip free from all positions.
- All the circuit breakers shall be either of the air break or the molded case type. They shall be manually operated.
- They shall have an arc-quenching device on each pole.
- They shall be ambient compensated. All over-load trips of the thermal type shall be compensated for the ambient temperature of the site.
- All three phase circuit breakers shall be three pole.

### II.2.03 BREAKING CAPACITY

- All the circuit breakers used shall have guaranteed breaking capacities sufficient for the maximum short circuit duties that could possibly be imposed on the different breakers.
- In any case the following figures indicate the minimum breaking capacities of the circuit breakers. Lower capacities shall not be offered even if the short circuit currents expected are lower.

- For circuit breakers having a frame size of (400) amp. twenty five thousand (25,000) amp. at the system voltage.
- For circuit breakers having a frame size of (200) amp. twenty two thousand (22,000) amp. at the system voltage.
- For circuit breakers having a frame size of (100) amp. fourteen thousand (14,000) amp. at the system voltage.
- For single pole circuit breakers : ten thousand (10,000) amp. at the system voltage.
- Whenever the short circuit duties are higher, the circuit breakers should ensure a sufficient breaking capacity.

#### II.2.04 CABLES

- The cables used shall be all of standard sizes and satisfy all the requirements of the standard specifications for the type they are used for.
- The conductors shall be composed of stranded copper wires of high conductivity.
- The sizes of cables used shall be sufficient for the maximum load they are liable to carry. The current carrying capacities shall be in strict conformity with the regulations applied after taking into consideration the derating resulting from the prevailing conditions in the project.  
In any case, the size of cables used shall be safely protected by the protection devices used in the different circuits.

- The cables shall be designed to stand the short circuit currents resulting from faulty conditions in the respective circuits until the protective devices interrupt the faulty currents.
- The sizes of the cables shall be sufficient to keep the voltage drop at the end of any circuit within the limits admissible by the standards for the different circuits and duties.
- The cables shall be supplied with all the necessary accessories, terminals and junction boxes, sealing compounds, fixing materials, cable throughs and supports.
- The type of cables used shall be IEC 502 or equivalent.  
Rated voltage one thousand (1,000) volts.  
The conductors shall be insulated by P.V.C. and the core insulation shall be coloured for identification.

#### II.2.05 CONDUITS AND FITTINGS

- a - Conduits shall be galvanized. Plastic conduits shall be used for the Housing Units.
- b - All fittings used with the conduits for their connections shall be of the same series and of the threaded type.
- c - Conduits straps and supports shall be hot dipped galvanized cast iron or steel, and they shall be used with hot dipped galvanized nuts and bolts.
- d - Minimum size of conduits shall be 3/4 inch. (22 mm.) inside diameter. The wiring capacity of the conduits shall be in accordance with the regulations of the standard used.



- e - Expansions fittings : Wherever a conduit run crosses an expansion joint in the structure to which it is attached, an appropriate expansion fitting shall be installed. Same shall be made for each conduit run mechanically attached to separate structures.
- f - All metallic conduits shall be mechanically joined together to form a complete and firm mechanical assembly.
- g - Conduits used for the Housing units shall be super high impact heavy gauge all insulated conduits. The components shall be connected as a push fit and permanently jointed by the application of an adequate adhesive material. Wherever expansion couplers are used, expansion joints shall be made waterproof by the use of a flexible adhesive.

#### II.2.06 WIRES AND CABLES

- a - All the insulated conductors used in the electrical installation inside the steel and plastic conduits shall be made of high conductivity copper conductors insulated with thermosplastic materials (P.V.C.)
- b - Wires and cables shall have a voltage rating sufficient for the operating conditions, and in conformity with the requirements of the regulations for similar installations.
- c - No cable with a conductor smaller than (2.5) sq. mm. shall be used in the installation. The earth continuity conductors shall have the minimum sizes required by the regulations applied.

d - Cables shall be colour coded for identification. Black braiding shall be used for neutral conductor only. Green and yellow shall be for the earth continuity conductor, and red, blue and other colours for phase conductors.

The same colour shall be used for connections on the same phase of the supply throughout the whole installation.

e - Wire and cable connectors shall be of the bolted pressure type, fabricated from a cast non-ferrous material applied to the conductor by crimping. All connectors shall be provided with insulating covers.

#### 11.2.07 BOXES

All boxes and related accessories shall be of the same series of the conduits and shall have the same protective coatings. They shall be provided with galvanized covers and shall have enough openings of the appropriate size for the introduction and securing of conduits. They shall comply with the Standards requirements.

## II.2.08 SWITCHES

- a- Switches shall be single, two way or three way as shown on the drawings. They shall be of the moulded type rated for two hundred fifty (250) V. and of full fifteen (15) amps. capacity. They shall be provided with insulated covers or wall plates. They shall be rocker operated with a quiet operating mechanism enclosed in an arc-resisting chamber. The wall plate shall be supplied with a number of openings corresponding to the corresponding number of switches installed in a single box.
- b- The switches used in the machine rooms and similar type of rooms shall be of a type for surface mounting. They shall be rated as specified hereinabove and shall have a mechanism identical to the flush mounted switches. They shall be enclosed in a drip-proof housing of a moulded insulating compound. The housing shall have tapped holes and sealing bushes.

## II.2.09 SOCKET OUTLETS

- a- All socket outlets shall be single phase as shown on the drawings. They shall have three (3) pin or two (2) pin with earthing contacts. The earth contacts of each socket shall be effectively connected to the earth continuity conductor. The socket outlets shall be rated, in general, for 15 Amps., 250 Volts. The socket outlets installed in outdoors shall be weatherproof.
- b- The socket outlets used with the concealed conduit installation shall be for flush and screw mounting. They shall have insulated wall plates.
- c- The socket outlets used with the surface mounted installation shall be enclosed in a drip-proof housing of a moulded insulating compound. The housing shall have tapped holes and sealing bushes. Every socket outlet shall have a hinged cover.

## II.2.10 LIGHTING FIXTURES

### a - General

- The lighting fixtures covered by these specifications shall be for fluorescent, incandescent lamps and/or mercury vapor lights as shown on the drawings.
- Fixtures shall be supplied complete in every respect. The supply shall include the body of the fixture, the globe, diffuser or louvre, the incandescent lamps or the fluorescent tubes, the lampholders, the ballasts for the fluorescent tubes with incorporated or independent condensers, the inside wiring of the fixture, the accessories needed for securing the fixture to the ceiling, false ceilings or walls, etc...
- The plastic diffusers shall be all acrylic.
- The louvres shall be of anodized aluminium.
- The material of the interior wiring of the light fixtures shall be adequately protected against the heat emitted by the lamps and ballasts.
- All lighting fixtures shall be of a manufacturer's standardized construction and shall fulfil the requirements of the standard applied.

### b - Fluorescent Tubes

- All fluorescent tubes supplied with the lighting fixtures shall be of the rapid-start type with a standard bipin-caps.
- The colour of the fluorescent tubes shall be white.

### c - Ballasts

- The ballasts used with the fluorescent tubes shall be designed as follows.
- The laboratory building
  - 1 phase, 127 volts, 60Hz
- The R.O. research building
  - 1 phase 120volts, 60Hz.

The power factor of every light fixture shall be (0.85) or above.

The ballasts shall be made of first class materials and shall have a minimum noise level.

d- Incandescent Lamps

The incandescent lamps used shall be of the inside frosted glass bulb and screw bases type.

e- High Pressure Mercury Vapour lamp

High pressure mercury vapour lamp shall be 250 W. The lamp shall be secured in place by a screw type lampholder and it shall be provided with a ballast and a condenser to keep the power factor above 0.85. The ballast shall be of the cast type, polyester filled having the minimum dimensions.

f- Lampholders

The lampholders used to secure the lamps of tubes in place shall ensure good electrical contact and absorb any vibration. They shall be of the following types :

- Lampholders for fluorescent tubes shall be of the spring loaded type.
- Lampholders for incandescent lamps shall be porcelain with screwed type contact.

## II.2.11 TYPES OF LIGHTING FIXTURES

The following list gives the different types of lighting fixtures, the Contractor may submit to the Engineer for his approval any similar product :

Type A

Fluorescent fixture 2 x 40 watts flush-mounted in sus-pended false ceiling with a louvre of anodised aluminium.

The lighting fixture shall be of the model THORN EMI LIGHTING - FRAV 236 or equivalent.

Type B

Fluorescent fixture 1 x 40 Watts flush-mounted in sus-pended false ceiling with a louvre of anodised aluminium.

The lighting fixture shall be of the model THORN EMI LIGHTING - FRAV 136 or equivalent.

#### TYPE C

Fluorescent fixture 1 x 40 watts ceiling mounted.

The lighting fixture shall be of the model THORN EMI LIGHT - FCLV 36 or equivalent.

#### Type D

Fluorescent fixture with vapour-tight 2 x 40 watts ceiling mounted.

The lighting fixture shall be of the model THORN EMI LIGHT - FNDV 2040 or equivalent.

#### Type E

Fluorescent fixture with vapour-tight 1 x 40 watts ceiling and/or wall mounted.

The lighting fixture shall be of the model THORN EMI LIGHT - FNDV 1040 or equivalent.

#### Type F

Out door fixture with a 20 watts fluorescent tube and acrylic opal diffuser.

The lighting fixture shall be of the model THORN EMI LIGHTING - LUV 118 or equivalent.

#### Type G

Ceiling-mounted fixture with one 250 watts mercury vapour light.

The lighting fixture shall be of the model THORN EMI LIGHTING - DHK 250W or equivalent.

### II.2.12 EARTHING SYSTEMS

#### a - General

The metallic parts of the installation as well as the metallic parts of any other equipment connected to the installation shall be earthed independently.

An earth continuity conductor shall be installed with all the circuits and shall be connected to the metallic parts of the lighting fixtures, to the earthing caps of all the socket outlets and to any metallic wall plates used.

All the enclosures of the motors and pumps shall be also connected to the earthing system.

The armouring of all cables shall be connected to the earthing system.

For that purpose, the following earthing system shall be provided:

- One (1) earthing system for the neutral points of transformers and for the metallic frames of the general distribution switchboard.

The resistance of the earthing system shall not exceed five (5) Ohms (These systems shall be supplied and measured with the underground low voltage distribution network).

b- Materials

- Earthing systems shall be in accordance with the requirements of the Standards and Codes mentioned in these Specifications.

- Earthing electrodes shall consist of rods driven to a depth of at least three (3) meters below the surface of the ground or deeper if required by the Engineer to match the earthing requirements.

Top of electrodes shall be protected against damage but available for inspection in a concrete pit fitted with an inspection cover.

- Connection to the earth continuity conductors shall be made by means of substantial clamps of an approved design.

- Earthing rods shall be composed of steel core copper jacketed rods having a diameter of one (1) inch and a length of three (3) meters per unit.

A pointed end and hardened top shall be provided for each rod.

- Connections shall be made by means of permanently soldered or mechanically clamped joints. "Series" earthing shall not be allowed.

- The minimum size of the earth continuity conductors shall be as follows :

- Main earth continuity conductor (70) sq. mm.  
for general switchboard

- Main earth continuity conductor (70) sq. mm.  
for derivation cabinets

- All circuits Same size as the neutral conductor of each circuit.

- Minimum size of the earth (2.5) sq. mm.

The outside colour of the earth continuity conductors shall be always combined green and yellow. This colour shall not be used for any other service throughout the whole installation.

c- Earthing of the Different Items of the Installation

- Secondary switchboards :

The earthing point for every switchboard shall be connected to the earthing point of the switchboard or derivation cabinet feeding it through the armouring of the supply cables.

- Socket outlets, wall plates and lighting fixtures :

An earth continuity conductor shall be provided for all the earthing caps of the socket outlets, the metallic wall plates whenever they are used and the metallic frames of the lighting fixtures.

This conductor shall run in one continuous line from the farthest point of the installation to the corresponding switchboard.

Connections shall be provided for branch conductors and any other metallic casing housing electrical equipment and/or wires and cables.

The earth continuity conductor shall run in the same conduits as the conductors of the corresponding circuits.

- Motors :

The metallic frames of the motors shall be connected to the earthing bar of the corresponding switchboard by means of an independent conductor. This conductor can be the fourth conductor of the four (4) core cable used to connect the three (3) phase motor to the switchboard.

Whenever the motors are connected to the switchboard by means of insulated conductors installed inside steel conduits, an earth continuity conductor shall be installed inside the conduits.

- Conduits :

The metallic conduits of the distribution circuits shall be mechanically and electrically continuous. They shall be earthed independently through their connections to the metallic frames of the corresponding distribution switchboards.

For that purpose, all conduit connections to junction, derivation and outlet boxes shall be securely done by means of galvanized locknuts and bushings.

Wherever an expansion joint is encountered, an appropriate flexible jumper shall be included to ensure the continuity.

- Metallic water piping in the building :

The metallic water piping in the building shall be connected to the earthing system unless otherwise specified by the Engineer.



## CHAPTER 3

### INSTALLATION REQUIREMENTS

#### II.3.01 MULTI-CORE CABLES

These cables shall be all surface mounted or buried as follows:

- The cables mounted against walls and ceiling shall be fixed by means of cable clamps or racks depending on the number of cables following the same route.
- The buried cables shall be laid in trenches 0.80 meter deep. The bottom of the trench will be covered with a layer of well compacted sand 10 cm. deep, the cable shall then be laid and covered with another layer of sand 10 cm. deep, then protected by precast reinforced concrete blocks. The trench shall then be backfilled with earth and then roads or land restored to their initial state. All sand and backfill will be well compacted.
- Below road crossings and crossings under or above other underground pipes or utilities, the cables shall be drawn inside asbestos cement conduits having a diameter of 150 mm, and protected as above.

#### II.3.02 CONDUITS

- a- The conduits for the electrical installation shall be concealed in walls or surface mounted (exposed) over the false ceilings. They shall be surface mounted in the machine rooms and similar type of rooms.
- b- Floor runs shall be dried thoroughly before wires are pulled in them.
- c- Conduits shall be installed in such a way that the junction, derivation and pull boxes shall always be accessible for repairs and maintenance work.
- d- After cutting, the conduits shall be reamed smooth ends without any blisters or other defects.

- e- All bends shall be of the long radius type, machine made, without kinks, flattenings or crushing.
- f- Concealed conduits shall be fixed with cement mortar free from any plaster or lime.
- g- No running threads are accepted. Only approved threaded couplings shall be used where required.
- h- A separation of two hundred (200) mm. shall be maintained between electrical conduits and hot water lines in the building. When this distance cannot be respected, an approved pipe covering shall be used.
- i- All conduits shall be securely joined together and connected to the electrical boxes, fittings, or cabinets, so as to provide a continuous assembly.
- j- No run of conduit shall exceed ten (10) meters between adjacent draw-in points, nor shall it contain more than two (2) right angle bends, or other deviations from the straight line. Inspection coupling shall be used where found necessary.
- k- All runs of conduits shall be truly vertical or horizontal unless otherwise specified by the Engineer.
- l- Conduits shall generally be saddled to the structure of the building with fifteen (15) cm. of each terminal box, angle box, bend, tee or other conduit fitting, and at intervals not more than one hundred fifty (150) cm.
- m- Boxes, fittings, bends and other accessories shall be protected in the same manner as the conduits.

- n- Expansion joints fittings shall be provided for each conduit run independently. The Contractor shall submit, for the Engineer's approval, the method of making this expansion fittings. This expansion fitting shall consist of a sleeve with fittings for installing the conduits on both sides into the sleeve. The movable conduits shall be fitted with insulating bushing and joints. A bonding jumper shall be installed to connect the conduit on both sides of the expansion joint thus ensuring the continuity of the metal work.
- o- Minimum size of conduits and number and size of wires installed in these conduits shall be in conformity with the standards. Maximum number of wires per conduit is six (6) unless the seventh conductor is an earth continuity conductor.
- p- All conduits shall be completely cleaned and dried before the wires are pulled through.

### II.3.03 WIRES AND CABLES

- a- All P.V.C. insulated wires and cables shall be installed inside conduits. They shall be accessible at any time to permit their verification or replacement in case of necessity. They shall be installed in such a way to avoid any mechanical deterioration of the insulation during the operation of pulling or replacing them.
- b- Colour coding shall be respected in all connections.
- c- Where two or more wires or cables are looped into the same terminal, their conductors shall be tightly twisted together before being inserted into the terminal.  
In no case shall a bare conductor be allowed to project beyond any insulated shrouding or mounting of a line terminal.
- d- At all terminations of wires and cables of sizes larger than 10 mm<sup>2</sup>, and where else required by the Engineer, cable lugs shall be used unless other adequate features are accepted by the Engineer.

- e- All wires and cable ends shall be properly tagged or numbered for identification.
- f- Phase and neutral conductors shall always be passing same way and inside same conduit, hole aperture, box knockouts, etc...
- g- Circuits fed from distinct sources of supply, from different distribution boards or through separate isolators shall not be bunched in one conduit.
- h- No oil, grease or compound shall be used to assist the pulling of the wires. Only approved powder soap stone can be used for that purpose.
- i- All connections and spicing of the wires and cables shall be done inside the boxes (junction or derivation boxes). These connections shall be done exclusively by means of solderless connectors as specified hereinabove. The use of insulating tape is not permitted. No joints are permitted in a box housing a socket.
- j- Care shall be taken to connect the phase conductor to the switches. The neutral conductors shall under no circumstances be connected to a switch.
- k- Joints and connectors shall follow requirements set forth in the Specifications and the Local Regulations for Electrical Installation works. The resistance of a joined conductor shall never exceed that of a similar unjoined conductor.

#### II.3.04 BOXES

- a - Outlet boxes for similar equipment shall be mounted at uniform heights within the same or similar areas.

The mounting heights are to be fixed in accordance with the Engineer's requirements and shall match equipment to be fixed with.

- b - Appropriate cover plates shall be installed on the outlet boxes containing no apparatus or containing an apparatus without suitable cover for the box. All junction and derivation boxes are to be provided with cover plates.

- c - All boxes surface mounted shall be properly fixed by approved means of fixing. All other boxes concealed in walls or ceilings shall have their edges flush with the surface of the wall or the ceiling.

#### II.3.05 SWITCHES

- a - Unless otherwise specified, all switches shall be mounted with the dollies at (1.10) meter above the finished floor level. This height shall apply to the lowest sollie level in case of switches grouped in rows.

- b - The switches shall be always connected to the phase conductor. No switch shall be connected to neutral conductor.

- c - In any case, the switches used for the same service in different rooms shall be installed at the same heights and shall be placed at the most adequate point for the service they are provided for.

The approval of the Engineer shall be required before adopting the final places of all the switches.

### II.3.06 SOCKET OUTLETS

- a- The earth contacts of each socket shall be effectively connected to the earth continuity conductor.
- b- Wall mounted socket outlets shall be mounted at 30 cm. above the floor or work bench where apparatus specified by the Engineer. Approval of the Engineer shall be required prior to the final choice of the location of all outlets.
- c- Colour coding and phase connectors mentioned in the standards specified in this Contract shall be strictly respected.
- d- In any case, the socket outlets used for the same service in different rooms shall be installed at the same heights and shall be placed at the most adequate point for the service they are provided for.

### II.3.07 DISTRIBUTION SWITCHBOARDS

- a- Mounting height of the distribution switchboards shall have the center line at (1.50) meter above finished floor level unless otherwise specified by the Engineer.
- b- Distribution switchboards shall be securely fastened and properly aligned and levelled.
- c- Concealed surfaces of the cabinets shall be given a thick coat of asphalt before the installation.  
Circuits breakers shall not be installed inside the cabinets before completion of civil works.
- d- Switchboards and all circuits breakers and circuits shall be properly numbered for identification.  
Name-plates shall be provided for all circuits protection.  
A table indicating the circuits, numbers, references area served, etc... shall be supplied for each switchboard.

- e - All switchboards shall be securely connected to the earthing system of the metallic frames.

#### II.3.08 LIGHTING FIXTURES

- a - All lighting fixtures shall be properly fixed by means of an approved method of fixing. Number of the fixtures supports shall be as recommended by the suppliers. At least two fixing points shall be adopted for fluorescent fixtures.
- b - Fixtures and fixture outlet boxes shall be provided with hangers to support the complete weight of the fixture.  
These cables shall be laid in trenches 0.80 m. deep and shall be protected by two layers of sand and by concrete slabs.

PART III

ELECTRICAL WORKS



PART III

CHAPTER 1

DESCRIPTION OF THE INSTALLATION

III.1.01 SCOPE OF WORK

Work described hereunder shall apply to the supply and installation of the following listed but not limited to, items :

- a- The underground low voltage (220- 127 V) distribution network.
- b- The earthing system.

III.1.02 LOW VOLTAGE DISTRIBUTION NETWORK

The cables shall be laid in trenches 0.80 m. deep and shall be protected by two layers of sand and by concrete slabs.

## CHAPTER 2

### MATERIAL SPECIFICATIONS

#### III.2.01 CABLES FOR LOW VOLTAGE NETWORKS

4 core armoured cables with copper conductors insulated with P.V.C., rated voltage 1000 V. in accordance with the standard SYE 1.

The cable shall be of the type "IEC 502" or equivalent.

#### III.2.02 EARTHING SYSTEMS

##### A- General

- One (1) earthing system shall be provided for the neutral point of each transformer and for the metallic frames of the general distribution switchboard.

The resistance of earthing system shall not exceed five (5) Ohms.

##### B- Materials

Sames as II.2.12.b.

##### C- Earthing of the Different Items of the Installation

- Neutral point of each transformer and the metallic frames of each transformer station :  
the earthing bars or points of these items shall be connected to the earthing electrodes by means of main earth continuity conductors.
- The armouring of all the underground cables shall be connected to the earthing system.

## CHAPTER 3

### INSTALLATIONS REQUIREMENTS

#### III.3.01 GENERAL CONDITIONS - STANDARDS

The works covered by the present Contract include the supply, the transportation to the site, the installation and connection of all the material needed for the good functioning of the medium voltage network, the low voltage network and the street lighting network as described in the present book of Specifications.

The works include also all adjustments, testing and maintenance of the installation during the guarantee period (this include the supply of all the material necessary for that purpose).

##### - Underground low voltage & network

All the installations shall be carried out in accordance with applicable regulations. They shall satisfy the requirements of IEC Recommendations and especially the rules concerning the execution and maintenance of electrical installations of the first and second categories. They shall, as a rule, satisfy all applicable local regulations and standards concerning the electrical installations as well as the requirements of the standard IEC Recommendations.

#### III.3.02 DRAWINGS - PEGGING OUT

##### a - Execution Drawings

Before commencement of the execution of any part of the installation, the Contractor shall submit to the Engineer for approval the execution drawings :

b- Pegging out and coordination Drawings

The exact location on the field of the networks layout according to the coordination drawings and the drawings showing the position of electrical fixtures shall be prepared by the Contractor at his expense.

The Contractor shall supply the site Engineer, after the commissioning of any part of the installation, with one set of transparencies and 6 sets of blue prints showing the as-built works executed in that part and showing the position of all the cables, their reference numbers and their depth.

III.3.03 EXCAVATION OF TRENCHES

The excavation of trenches as well as their refilling are included in the present contract of the electrical work, they shall be executed according to the specifications.

III.3.04 LAYING OF CABLES IN TRENCHES AND BACK FILLING

The cables installation in the trenches shall satisfy the requirements of the standards I.E.C. Recommendations.

The cables shall be laid at a depth of 0.80 m. under the side walks and a depth of 1 m. under road-crossing on a layer of sand 0.10 m. thick.

The minimum radius of bending any cable shall be 20 times the outside diameter of the cable for the M.V. and L.V. networks and shall be 15 times the outside diameter of the cable for other networks.

The pulling of cables shall be carried out on roller wheels spaced at not more than 3 m. from each other.

The use of pulling equipment such as cranes, gears, and other similar systems is strictly forbidden.

Under roadways and parking areas, the cables shall be installed inside asbestos cement conduits having an internal diameter of 150 mm. (or 100 mm.).

At the points where there are many closely situated obstacles (such as manholes for sewage, for telephone and concrete foundations of street lighting poles), the cables shall be installed inside asbestos cement conduits having a diameter of 150 mm. (or 100 mm.).

Whenever several cables are laid in the same trench, the spacing between the different cables shall be as required by the standards.

Furthermore, the minimum spacing shall be as follows:

- 0.20 m. between cables and water distribution conduits.
- 0.50 m. between cables and telephone conduits.

Once the cables are laid they shall be covered by a layer of sand 0.10 m. thick which in turn shall be covered by concrete blocks.

The remaining depth of the cable trench shall be backfilled by consecutive well compacted layers 0.10 m. thick of excavation soil.

In no case, shall the filling of trenches be carried out before the Contractor has noted the exact location of the cables and before the Engineer has checked this position.

No matter what precautions the Contractor has taken, he shall remain entirely responsible for any direct or indirect consequences resulting from the eventual existence of other materials left in the trenches.

PART IV

ELECTRICAL WORKS FOR  
EXTRA LOW VOLTAGE SYSTEMS

PART IV

CHAPTER 1

GENERAL ELECTRICAL REQUIREMENTS

IV.1.01 SCOPE OF WORK

Work described hereunder shall apply to the supply and installation of all materials and execution of all works necessary for the extra low voltage systems in the laboratory building and R.O. reserch building.

The supply shall include all the equipment, accessories and other materials not enumerated in these Specifications but found necessary for the completion and perfect functioning of the systems. All to be executed in accordance with these Specifications, the drawings and notes indicated therein, the instructions of the Engineer and the provisions of the Bill of Quantities, delivered complete in place and tested to the full satisfaction of the Engineer.

The Contractor shall coordinate the works of the extra low voltage systems with the other installations to avoid any interference or damage to any of the systems or installations.

The extra low voltage systems covered by these Specifications shall include:

- The telephone system in the R.O. reserch building.
- The public adress system in the R.O. reserch area.

#### **IV.1.02 STUDIES TO BE PREPARED BY THE CONTRACTOR**

These Specifications indicate the operation requirements of all the extra low voltage systems as well as the various types of materials to be used and their main characteristics.

The Contractor shall prepare, according to the systems he is offering, all the wiring diagrams, the number and sizes of wires and cables necessary for the perfect functioning of each system. These distribution circuits shall have enough capacity to fulfil the operation requirements under the heaviest load conditions.

No claim could be formulated by the contractor under pretext of insufficiency of certain choices or Specifications indicated herein for the complete functioning of any of the systems required.

The above mentioned layouts and wiring diagrams shall be presented to the Engineer for approval prior to the ordering of the materials.



## CHAPTER 2

### TELEPHONE NETWORK

#### IV.2.01 SCOPE OF WORK

a - Work described in this Chapter shall be limited to the supply and installation of the distribution circuits of the telephone system.

The telephone exchanges and the telephone instruments are not included in the present Contract.

b - Work shall comprise the following main items :

- The distribution circuits.
- The telephone socket outlets.

#### IV.2.02 CONCEPT OF DESIGN

The Private Automatic Branch Exchange of the Plant shall provide extensions for the R.O. research building.

These extensions shall be connected to the R.O. research Building by means of multipair cables terminating on the distribution boards.

#### IV.2.03 EXTENT OF SUPPLY

Work covered by this section shall start at the following points and end at the telephone socket outlet.

- Works shall start from the above mentioned existing distribution board.

#### IV.2.04 DISTRIBUTION CIRCUITS

- a - The cables used for the telephone installations shall be composed of copper conductors 0.65 mm. insulated by a polyvinyl chloride (PVC) sheathing. The conductors shall be twisted in pairs and the pairs shall be covered with two (2) wax paper tapes and one metallic tape forming an electrostatic shield. A tinned-copper wire placed under the metallic foil shall ensure the longitudinal continuity of the shield. The whole shall be protected by a green PVC sheath. An earth conductor shall be included wherever necessary in each cable. Inside the buildings, the cables shall be of the non-armoured type in accordance with the standard SYT1. They shall be drawn in independent plastic or steel conduits similar to the ones used in the electrical installations. The cross sectional area of the conduit shall be equal to, at least, twice the total area of the cables passing through it. Outside the buildings, the cables drawn in P.V.C. conduits shall be laid in trenches at 80 cm. depth and shall be of the armoured type, in accordance with the standard SYT2. At road crossings, the cables shall be drawn in asbestos cement pipes.

#### IV.2.05 TELEPHONE SOCKET OUTLETS

The telephone socket outlets shall be intended for recessed or surface mounting, they shall be of the same make and design as the electrical socket outlets.

## CHAPTER 3

### PUBLIC ADDRESS SYSTEM

#### IV.3.01 GENERAL

Work under this Chapter shall cover the supply and installation of one (1) complete public address system in the R.O. research area.

#### IV.3.02 SCOPE OF THE SUPPLY

The Public Address system in the R.O. research area shall include the supply and installation of the following items, as well as their connection, testing and commissioning :

- a - Desk top type hand set station with amplifier.
- b - Wall mounted hand set station with amplifier.
- c - The trumpet typed loudspeaker installed exterior.
- d - The loudspeakers wall mounted on the wall.
- e - The distribution circuits and connections between the loudspeakers and the hand set station.
- f - All the accessories and materials not mentioned hereabove but considered necessary for the perfect functioning of the installation.

#### IV.3.03 TYPE OF THE FIXTURES

**Type - A DESK TOP TYPE HAND SET STATION**

This consists of a Desk-Top Subset, remote handset/speaker amplifier and amplifier enclosure.

This station shall be of the model GAI - TRONICS - 7205/005 or equivalent.

**Type - B WALL MOUNT TYPE HAND SET STATION**

This consists of a handset/speaker amplifier and an associated enclosure.

This station shall be of the model GAI - TRONICS - 7005/001 or equivalent.

**Type - C TRAMPET TYPED LOUDSPEAKER**

A compact, low powered reflex speaker.

This speaker shall be of the model GAI - TRONICS - 13321 or equivalent.

**Type - D CONE SPEAKER**

This includes a baffle of heavy molded cyclac with simulated wood grain finish.

This speaker shall be of the model GAI - TRONICS - 801/301 or equivalent.

**LABORATORY FURNITURE**



## LABORATORY FURNITURE

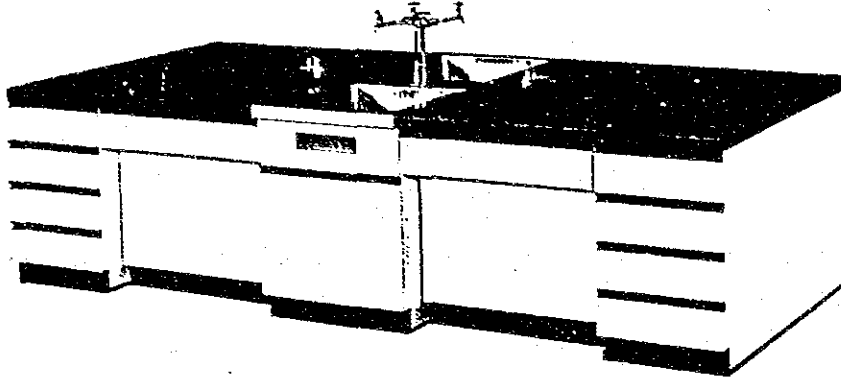
### 1. General

Laboratory furniture to be supplied and installed are shown in the attached lists.

The attached lists of laboratory furniture cover only the basic requirement (e.g. dimensions, necessary function, materials, etc.).

Detailed specifications not covered by the attached lists or deviation from the basic requirement shall be approved by the Engineer.

Furniture No. 5-1 Center table

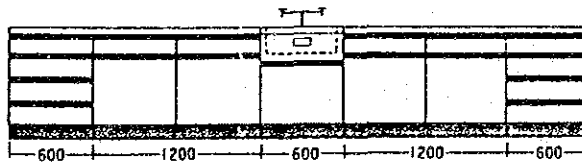
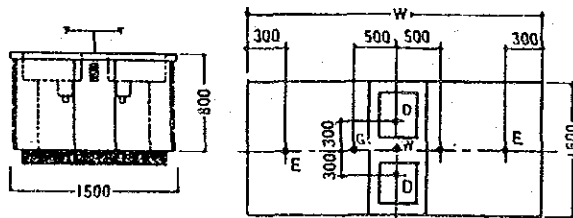


Dimension (W, D, H)	4200, 1500, 800
Sink	2
Faucet	2(triple for table mounting)
Receptacle	4(or 2 doubles)

Material:

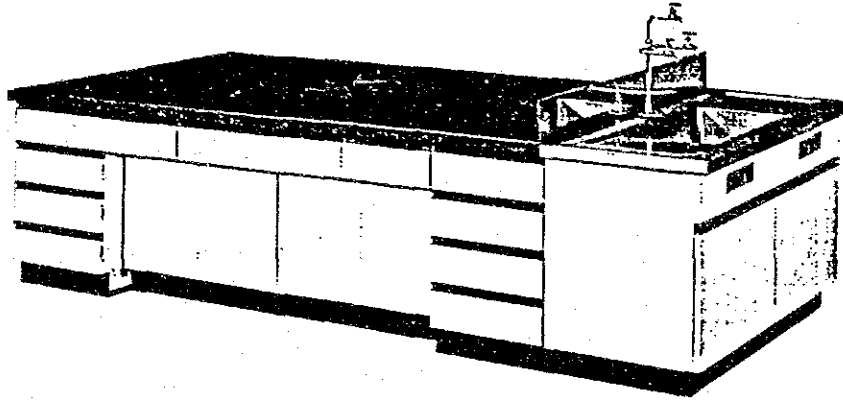
Top board :resistant to heat and chemicals, black or dark grey colored.

Sink :stainless steel or polyvinylchloride



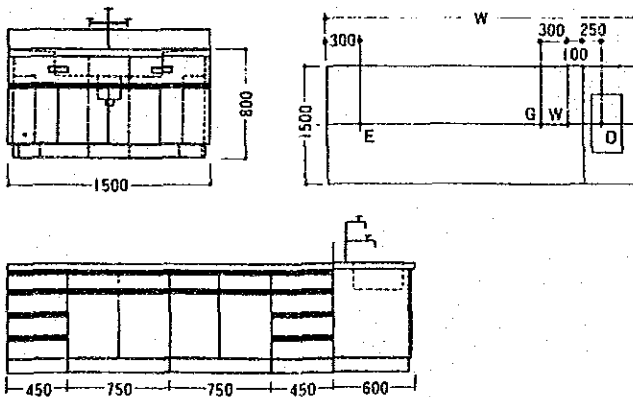


Furniture No. 5-2 Center table

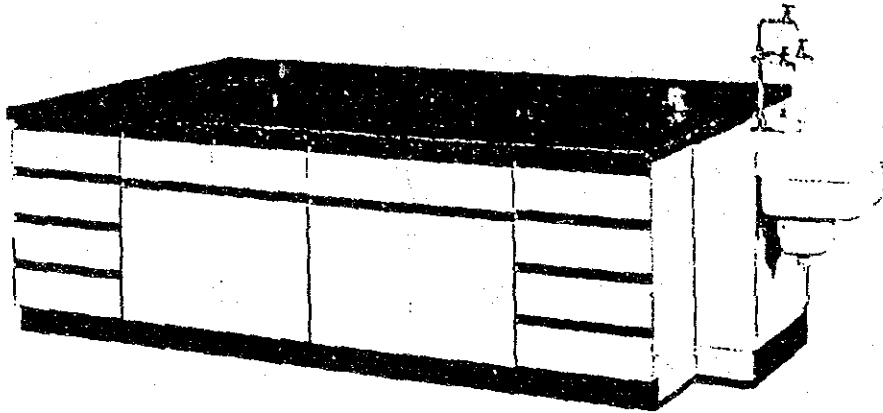


Dimension (W, D, H)	3000, 1500, 800
Sink	1
Faucet	1 (triple for table mounting)
Receptacle	2 (or 1 doubles)

**Material:**  
 Top board : resistant to heat and chemicals, black or dark grey colored.  
 Sink : stainless steel or polyvinylchloride

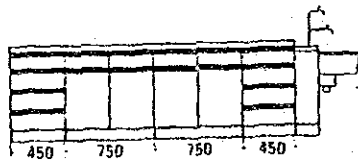
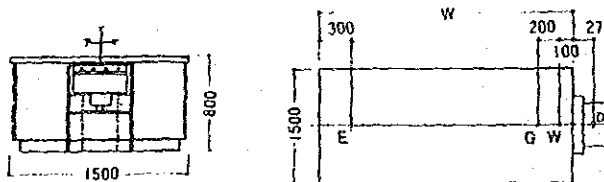


Furniture No. 5-4 Center table



Dimension (W, D, H)	2400, 1500, 800
Sink	1
Faucet	1 (triple for table mounting)
Receptacle	2 (or 1 doubles)

Material:  
 Top board : resistant to heat and chemicals, black or dark grey colored.  
 Sink : stainless steel or polyvinylchloride



Furniture No. 5- 5 Work table

Dimensions (mm)

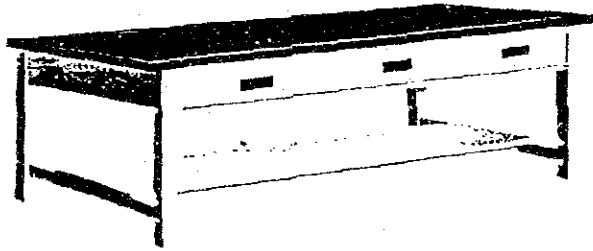
Width 2,400

Depth 750

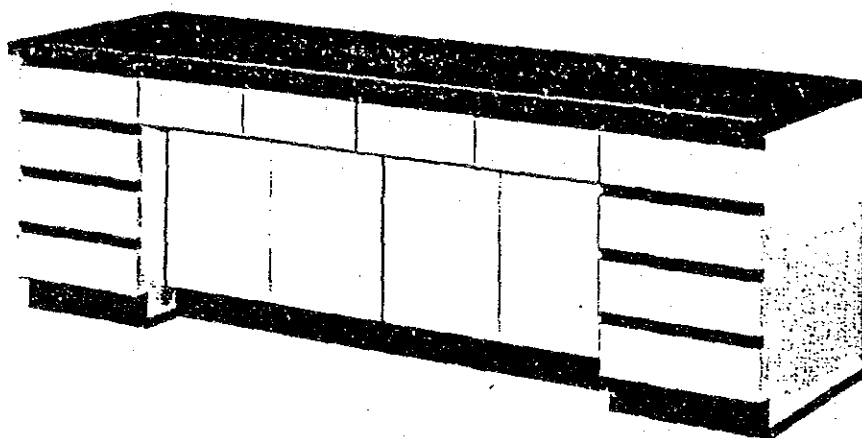
Height 750

Drawers

3

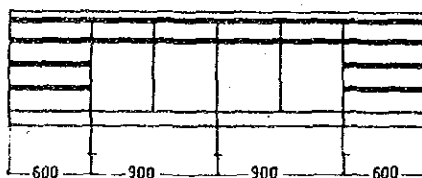


Furniture No.5- 6 Side table

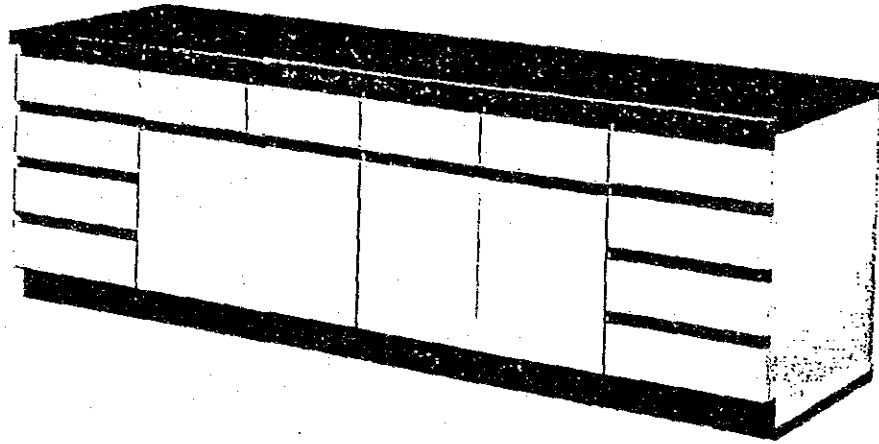


Dimension (W, D, H)	3000, 750, 800
Sink	0
Faucet	0
Receptacle	2

Material;  
 Top board :resistant to heat and chmicals, black or dark grey colored.



Furniture No.5- 7 Side Table

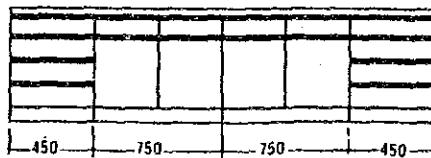


Dimension (W, D, H)	2400, 750, 800
Sink	0
Faucet	0
Receptacle	2

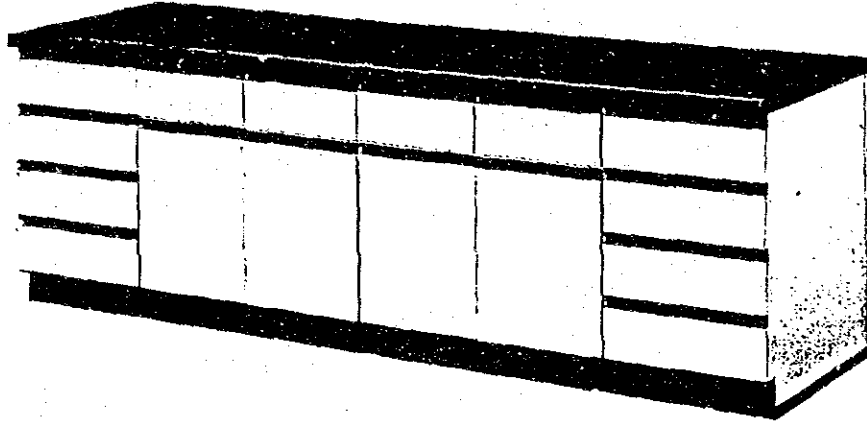
Material;

Top board

:resistant to heat and chmicals,black or dark grey colored.



Furniture No.5- 8 Side Table

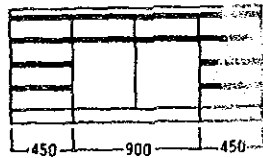


Dimension (W, D, H)	1800, 750, 800
Sink	0
Faucet	0
Receptacle	2

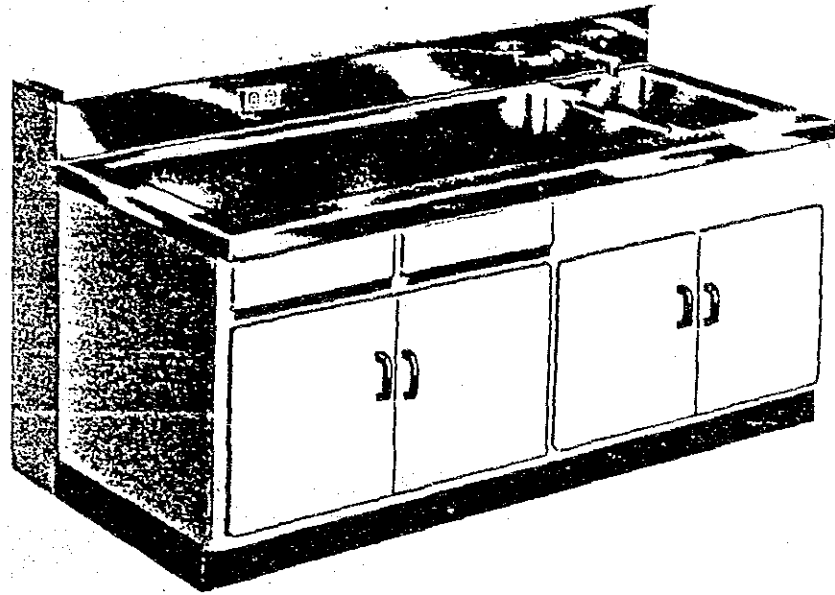
Material:

Top board

:resistant to heat and chmicals,black or dark grey colored.



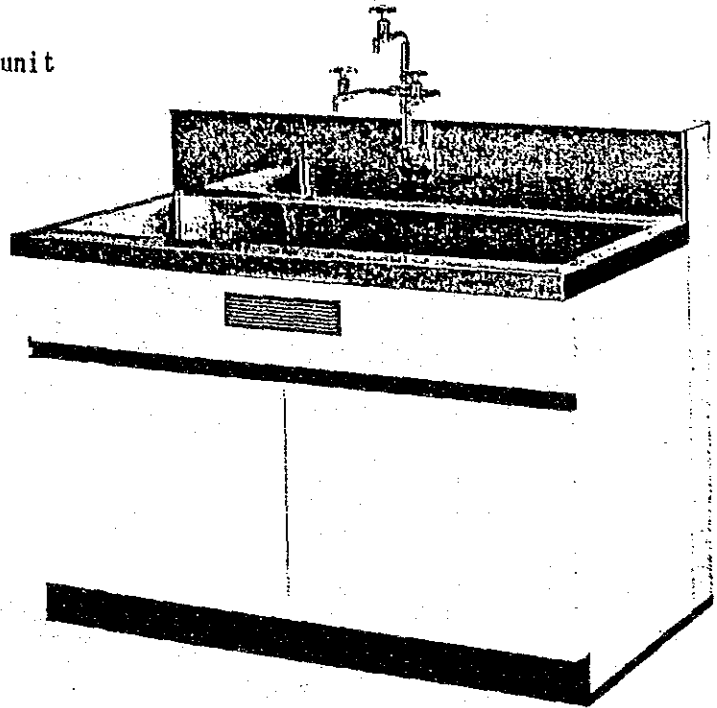
Furniture No. 5-10 Sink for developping



Dimension (W, D, H)	2400, 750, 800
Sink	2 (Large, 500x465x240:small, 300x465x400)
Faucet	1
Receptacle	2

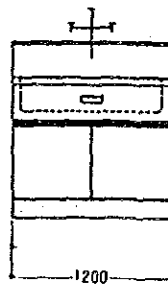
Material;  
Sink :stainless steel

Furniture No. 5-11 Sink unit



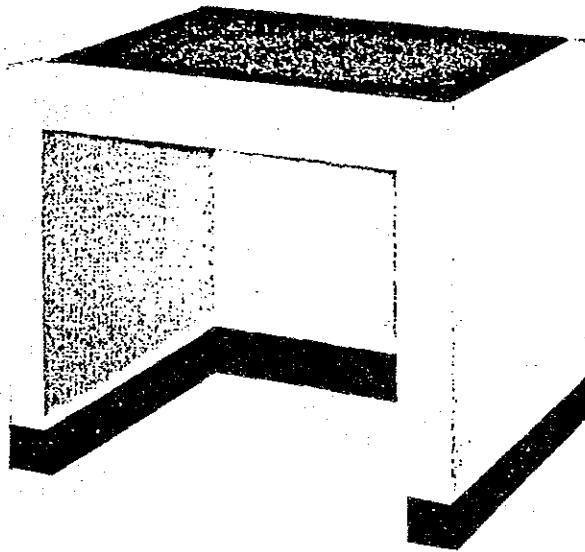
Dimension (W, D, H)	1200, 750, 800
Sink	1 ( 1110x465x200)
Faucet	1 ( 3 outlets)
Receptacle	0

Material;  
Sink :stainless steel





Furniture No. 5-12 Balance table

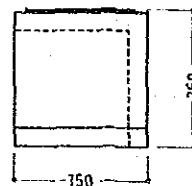
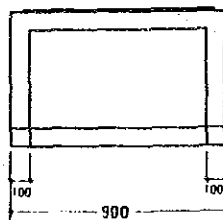


Dimension (W, D, H)	900, 750, 800
Sink	0
Faucet	0
Receptacle	0

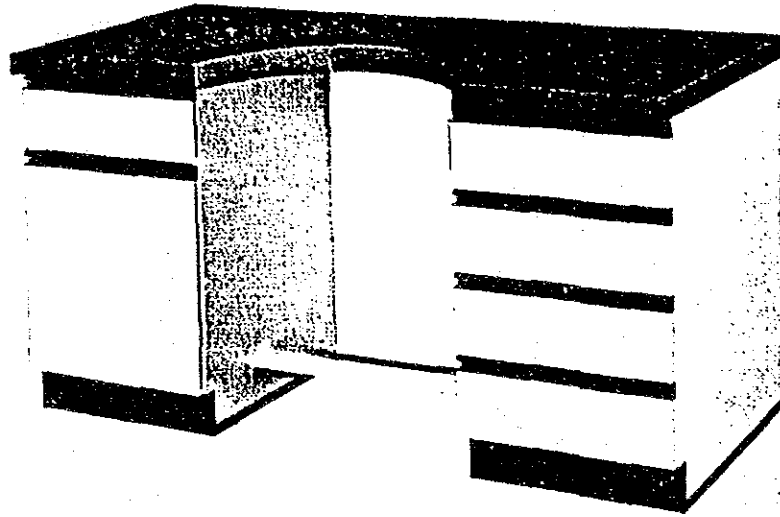
Material:

Top board

:resistant to heat and chmicals, black or dark grey colored.



Furniture No. 5-13 Microscope table



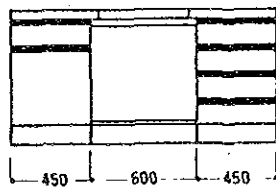
Dimension (W, D, H)	1500, 750, 750
Sink	0
Faucet	0
Receptacle	0

Material:

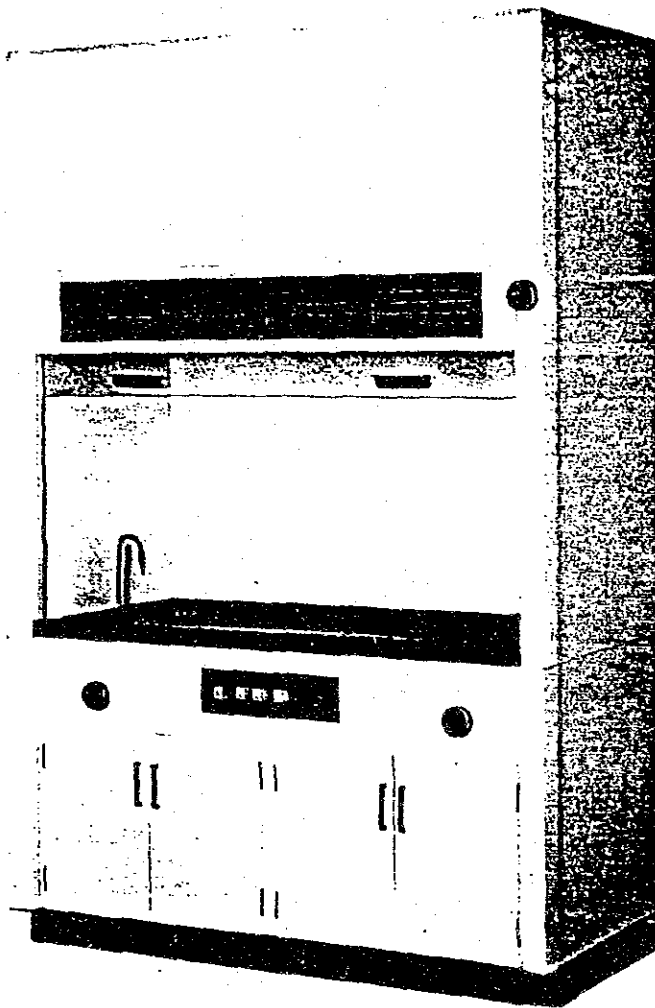
Top board

:resistant to heat and chemicals,black or dark grey colored.

SPA-150



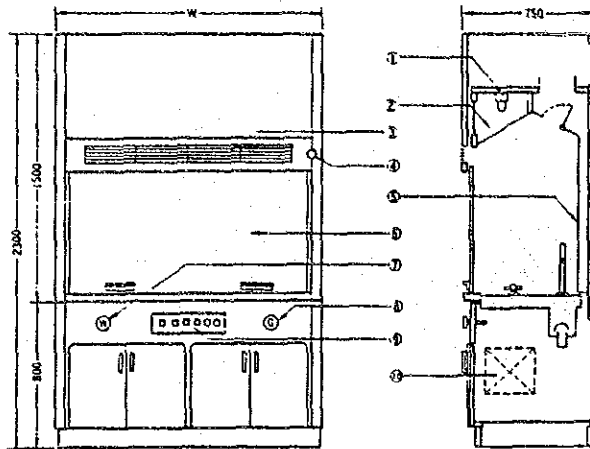
Furniture No. 5-14 Fume hood



Dimension (W, D, H)	1800, 750, 2300
Sink	
Faucet & gascock	Water 1 (swan neck) , gas 1 (double)
Receptacle	2

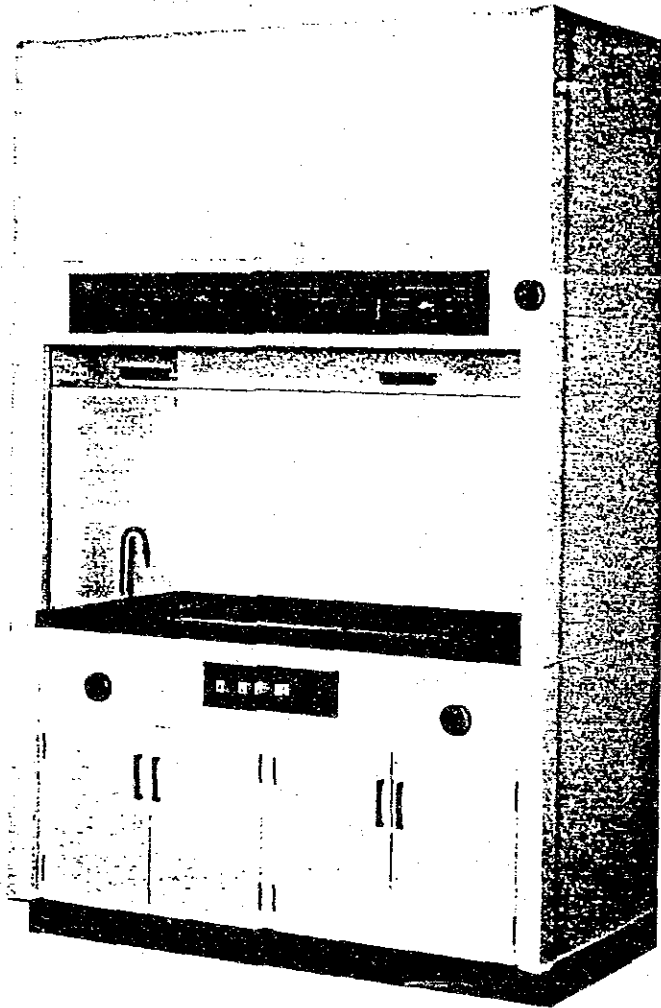
Material:

Exterior : wood, finished with chemical resistant paint  
 Interior : cement board finished with chemical resistant paint  
 Window : reinforced safety glass  
 Bottom surface : lead lining or ceramic tile



1. Fluorescence light
2. Opaline glass
3. Air inlet
4. Handle for damper
5. Buffle board
6. Front door
7. Stop valve for water
8. Stop valve for gas
9. Panel for switches
10. Panelboard
11. Wastewater
12. Water faucet
13. Gas cock
14. Bottom surface

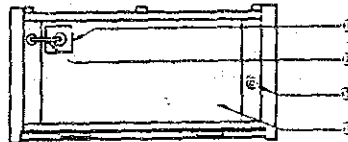
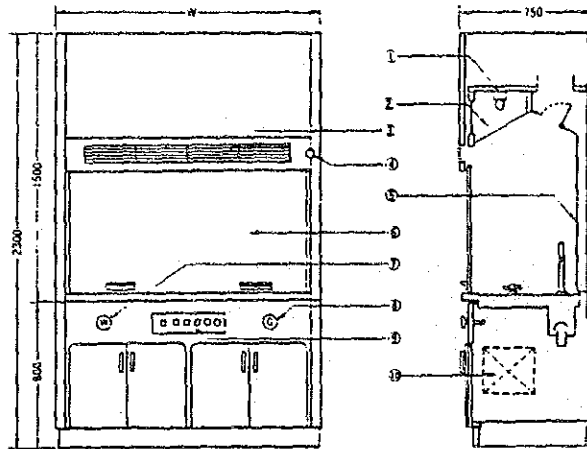
Furniture No. 5-15 Fume hood



Dimension (W, D, H)	1200, 750, 2300
Sink	
Faucet & gascock	Water 1 (swan neck) , gas 1 (double)
Receptacle	2

Material;

Exterior : wood, finished with chemical resistant paint  
 Interior : cement board finished with chemical resistant paint  
 Window : reinforced safety glass  
 Botom surface : lead lining or ceramic tile



1. Fluorescence light
2. Opaline glass
3. Air inlet
4. Handle for damper
5. Baffle board
6. Front door
7. Stop valve for water
8. Stop valve for gas
9. Panel for switches
10. Panelboard
11. Wastewater
12. Water faucet
13. Gas cock
14. Bottom surface

Furniture No. 5-16 Shelf, open type; 1,800x500

Dimensions (mm)

Width	1,800
Depth	500
height	1,800

Material Steel

Furniture No. 5-17 Shelf, open type; 1,500x500

Dimensions (mm)

Width	1,500
Depth	500
Height	1,800

Material Steel

Furniture No. 5-18 Shelf, locked type; 1,500x450

Dimensions (mm)

Width	1,500
Depth	450
Height	1,800

Material Steel

Furniture No. 5-19 Black curtain

Black curtain for Dark room

Dimensions (mm)

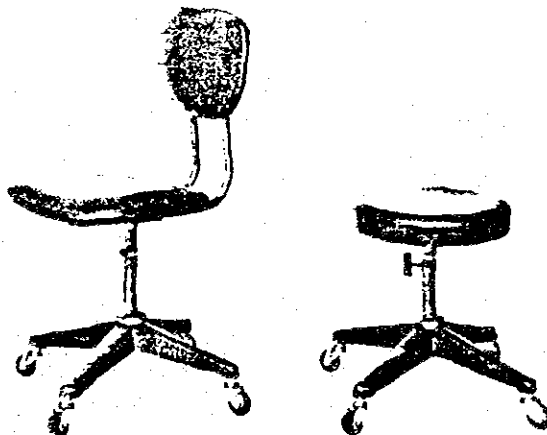
Length	ca. 3,000
Width	3,000

Black curtain for EPMA room

Dimension (mm)

Length	ca. 3,000
Width	6,000 or 3,000x2

Furniture No. 5-20 Laboratory chair









JICA