

**ENGINEERING STANDARD**

**FOR**

**INSTRUMENT WORKSHOP, LAYOUTS,**

**TEST AND CALIBRATION TOOLS**

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## 1. SCOPE

This Engineering Standard is intended as a guide for the design, selection of layouts, equipment and tools required for the instrument workshop and on the plant, to cover a normal range of maintenance work on new and existing Petroleum Industries of Iran.

## 2. GENERAL REQUIREMENTS

**2.1** Building and layouts of an instrument repair, test and calibration workshop shall be the users' particular needs and shall be furnished with necessary tools and equipment.

As an example, an instrument workshop has been sized and illustrated in the Appendices to house the tool and equipment inventory considered necessary for the calibration and maintenance of the instruments and instrument systems, installed in a medium sized refinery or chemical and petrochemical plants carrying out their own maintenance. The estimated size required approximates to an area of 360 m<sup>2</sup> for the instrument section of such workshop complex.

**2.2** The engineering contractor shall develop a tool and equipment inventory and a workshop layout, based on the actual requirements of the operating Company concerned using this procedural specification. The proposal shall then be presented for the user (owner) for his approval in writing.

## 3. INSTRUMENT TECHNICAL CENTER AND WORKSHOP

### 3.1 General

It is necessary to provide engineering maintenance with well equipped and efficiently organized instrument technical centers and/or workshop facilities.

The following facilities described in this Standard are typical min. requirements necessary for the Contractors design of:

- Pneumatic instrumentation,
- electronic instrumentation,
- digital systems, including process computers,
- Distributed Control System (DCS),
- Programmable Logic Controller (PLC),
- analyzer systems.

#### Notes:

**1) Computer maintenance should include hardware and when applicable peripheral equipment and storage of software packages.**

**2) The accommodation inside the building(s) shall include offices, storage, calibration and light machining facilities.**

For the small plants, the central/main instrument technical center and workshop may form part of a larger maintenance complex together with the mechanical and electrical engineering disciplines, see Appendix A of this Standard. However, for large plants a dedicated instrument technical center should be considered.

Whatever the arrangement, facilities should also be provided in control rooms and analyzer houses, together with the equipment necessary for carrying out certain local maintenance activities.

#### Note:

**The mechanical maintenance of items, such as control valves, could be carried out in the mechanical workshop, as mutually agreed by instrument and mechanical engineering.**

### 3.2 Central/Main Instrument Technical Center and Workshop

A small plant should operate a centralized maintenance system from a central workshop, with a certain flow pattern of equipment and materials between workshop and plant. The larger plants may require a decentralized maintenance system for closer control and economy, with the minimum number and size of 'satellite' workshops necessary for handling urgent day-to-day maintenance, in conjunction with a main workshop(s) for larger equipment and the long-term planned repairs.

#### Notes:

- 1) The internal design of the building should be based on a central corridor providing access to individual offices and work areas.
- 2) The standards equipment room should be located away from machining areas or other sources of vibration, and preferably have an 'air lock' type entrance.
- 3) Special attention shall be given to provide acceptable 'noise levels' inside offices, computer and standard equipment rooms.
- 4) The internal partition walls, between rooms, should be removable to allow re-arrangements for future developments.
- 5) Inside walls should be partially glazed where necessary, to provide a clear view.

Apart from variations in size and layout of the buildings, the equipment to be installed in central/main and 'satellite' instrument technical centers and workshops, will ultimately depend on the type and size of the process installations and the number of installed instruments.

### 3.3 'Satellite' Instrument Workshops

**3.3.1** The number and size of these workshops will be determined by the size and needs of each location. They may be located independently but should wherever possible also be combined with similar mechanical/ electrical 'satellite' workshops.

**3.3.2** A typical layout of a 'satellite' workshop is included as Appendix D.

### 3.4 The Offshore Platform-Instrument Workshop

Workshop accommodation should be provided for the maintenance of the platform instrumentation together with storage for the necessary test equipment and tools, in accordance with the size of the platform and the extent and type of instrumentation installed.

### 3.5 The Sizing of Instrument Technical Centers and Workshops

**3.5.1** The minimum size required for work areas and offices should be based on an area of 9.5 m<sup>2</sup> as a minimum for each person.

**3.5.2** The size of the central or main instrument workshop envisaged for the medium sized refinery or chemical plant described in this Standard and as applied for the layout drawings of Appendix B, covers an area of 360 m<sup>2</sup>.

**3.5.3** For exploration and production platforms, where space is at a premium, the 'instrument workshop' could consist of two relatively small areas of say 3 m × 6 m.

### 3.6 Typical Internal Layout for an Instrument Technical Center and Workshop

#### 3.6.1 General

The instrument technical center and workshop building, as illustrated in Appendix B, should typically comprise the following:

**1) Office accommodation for:**

- engineers,
- supervisors/foremen.

Provisional offices inside the workshop should be allowed to direct supervisory personnel.

- planning personnel.

This office should be of an adequate size to accommodate day-to-day planning/meetings.

**2) Workshop facilities for:**

- receipt and despatch.

This Section of the workshop should have direct access from outside and be divided into:

- receipts, for incoming instruments/material,
  - despatch, for repaired instruments/components,
  - cleaning and painting,
  - heavy duty area (handling large control valves, etc.),
  - pneumatic instrumentation
  - electronic instrumentation
  - Distributed Control System (DCS)
  - Programmable Logic Controller (PLC)
  - industrial analyzers,
  - machining operations.
- Includes,  
inspection, repairs, testing,  
and calibration,

Depending on layout and space available, this area for handling large instruments such as control valves and for the carrying out of general mechanical work on them, can either be separate from, or combined with the machine shop as shown in Appendix B, with sufficient access way to facilitate transportation.

**Note:**

**When the instrument workshop is part of a mechanical/electrical workshop complex, the sharing of facilities such as machining, welding, cleaning and painting, etc., should be considered to avoid duplication.**

**3) Storage facilities for:**

- instrument spare parts,
- consumable items (gaskets bolts and nuts, etc.),
- chemical products,
- portable analyzers,
- computer spare parts (including disks, etc.).

**4) Special workshop facilities for:**

- standards equipment (of measuring and calibration, etc.),
- high-precision (machining and instrument fitting, etc.),
- electronic instrument testing,
- analyzer-type instrument testing.

This room should be located so that it has an outside wall to accommodate:

- an analyzer sample conditioning system,
- a compressed gas cylinder storage rack.

**Note:**

See also Section 6 and Appendix E, for alternative arrangements for chemical and petrochemical plants and crude production areas.

### 3.7 Utilities

**3.7.1** The relevant workshops of the technical center shall be provided with steam, water and tool air, etc., from the plant for workshop utilities system, and an instrument air supply, as appropriate

**3.7.2** Electricity for power and lighting shall be installed in accordance with the requirements. Voltages that may be required are for example, 110 V, 220 Volts AC at 50 Hz, 24 Volts DC. The voltages required shall be indicated in the project specification and the requisitions.

**Note:**

The level of lighting required in the analyzer, electronic, computer and standards equipment rooms may be as high as 1000 lux.

### 3.8 Workshop Buildings

#### 3.8.1 Construction

The building shall be designed in accordance with the general requirements of Standard Drawings IPS-D-CE-210 to 222.

#### 3.8.2 Floor finish

The floors in the workshop building should be finished in accordance with the requirements of the above standard and with the following exceptions:

- All rooms with concrete finish shall be sealed with a dust proof epoxy resin.
- The floors of analyzer rooms shall be finished with acid-resistant tiles, in the same way as Analyzer Houses.

**Note:**

An oil contaminated drainage system will also be required in the analyzer room.

#### 3.8.3 Heating ventilating and air conditioning

**3.8.3.1** Depending on the installed equipment and the requirements for the comfort of personnel, Heating, Ventilating and Air Conditioning (HVAC) may be considered for the following:

- standards equipment room.

This room should be protected against ingress of dust with an entrance preferably of the air lock-type. The room should also be insulated against the effects of vibration.

- electronic 'shop',
- analyzer test and calibration room,
- other offices, 'shops' and rooms as appropriate.

The HVAC System will then be in accordance with the requirements of:

IPS-E-AR-120	"Building Air Conditioning System" and,
IPS-E-AR-160	"Venting, Ventilation and Pressurization System".

**3.8.3.2** Ventilation is particularly required for the following rooms:

- cleaning and painting,
- analyzer test and calibration room.

**Notes:**

1) Chemical cleaning and painting areas shall comply with national and/or local regulations with regards to ventilation, which should typically give a minimum of 30 to 50 air changes per hour, and static electricity/electrical safety in explosive gas atmospheres.

2) When forming part of a building complex, analyzer workshops and test rooms, etc., should have induced ventilation to maintain a pressure below that of the other rooms, in order to prevent escape of gases. There should also be a minimum of 30 to 50 air changes per hour.

### **3.8.4 Fire and gas detection and fire protection**

**3.8.4.1** The sections of the workshop building shall be protected in accordance with the following standards:

IPS-G-IN-270	"Instruments of Fire-Fighting and Detection Equipment".
IPS-G-SF-126	"Hand and Wheel Type Fire Extinguishers".
IPS-E-SF-380	"Fire Protection in Buildings".

**3.8.4.2** In addition, analyzer rooms shall be protected with gas detection systems, incorporating the automatic isolation of electric power and ventilation systems in the event of a gas leak, refer to IPS-G-IN-230 "Analytical Instruments (On Line Process Stream Analyzers)".

## **4. EQUIPMENT FOR THE TECHNICAL CENTER AND INSTRUMENT WORKSHOP**

### **4.1 General**

**4.1.1** The equipment contained in a modern instrument workshop shall be of sufficient quality to ensure that all repaired and re-calibrated instruments will meet the original manufacture's specifications.

**4.1.2** The offices, 'shops' and rooms of the technical center and workshop considered in this Standard are provided with a proposed inventory of furniture, equipment, machines and tools and which is shown on the drawings of Appendix C.

### **4.2 Central/Main Technical Center and Workshop**

#### **4.2.1 Office accommodation**

The offices will be equipped with normal office furniture.

##### **4.2.1.1 Planning office**

This office will be provided with normal office furniture and specialized planning equipment as required:

- a) If computer facilities are available, a terminal should be located in this office to provide:
  - maintenance assistance,
  - storage of instrument inspection and maintenance records,
  - availability and requisitioning details for instruments, parts and spares, etc.
- b) Where such facilities are not available, a small stand alone computer system should be considered.

## **4.2.2 Workshop facilities**

### **4.2.2.1 Receipt and despatch**

These areas should be suitably equipped for the handling and storage of components and materials.

### **4.2.2.2 Cleaning and painting**

This 'shop' should be equipped as required with chemical cleaning bath(s), grit blast cleaning and painting booths.

### **4.2.2.3 Heavy duty mechanical/machine shop**

This area(s) should be provided with the appropriate equipment and machines to suit the envisaged applications.

This 'shop' should also allow the entry of vehicles such as the one used for pipeline instrumentation.

### **4.2.2.4 Pneumatic shop**

To be provided with tools and equipment necessary for the general repair, testing and calibration of pneumatically operated instruments.

### **4.2.2.5 Electric shop and Electronic instruments test room**

As above, but for electrically operated instruments. This room should house the special electronic test equipment and contain facilities for carrying out specific tests.

### **4.2.2.6 Analyzer shop and test room**

As above, but for industrial analyzers. See also Section 6 and Appendix E. This room will be used for testing and calibrating of industrial analyzers and for development work.

## **4.2.3 Storage facilities**

Storage rooms and/or areas should be furnished as required for the storage of items such as:

- working spare parts,
- consumable items (such as gaskets, bolts and nuts, etc.),
- chemical products (for analyzer testing, etc.),
- analyzers,
- computer spare parts (including discs and software, etc.),
- DCS spare parts (including diskettes and software, etc.).

## **4.2.4 Special workshop facilities**

### **4.2.4.1 Standards equipment room**

This room should house all special test, measuring equipment and calibration standards. This equipment should never leave the room, all measurements and calibrations made with the equipment to be carried out in the standards room.

#### 4.2.4.2 High precision shop (only when specially required)

This facility will only be required when 'in house repair of fine' instrumentation is to be undertaken. The equipment may then include:

- a watchmaker's -type lathe, with the necessary machine tools,
- a light duty test bench.

#### 4.2.4.3 Analyzer sample conditioning system

A system for preparing samples of the process stream with which to test and calibrate the analyzers, shall be positioned against the outside wall of the analyzer test room. A mobile blending drum and a storage rack containing test and carrier gases for the process stream samples should also be provided. See also Section 7 and Appendix E for alternative arrangements for chemical plants and background information on sample conditioning and sample analysis.

#### 4.2.4.4 Computer room

Because of the growing application of the computer a room should be dedicated in the instrument technical center for computer maintenance, development and for the training of personnel.

**Note:**

**The computer room will require air conditioning.**

### 4.3 The Exploration and Production-Offshore Instrument Workshop

#### 4.3.1 General work area

This area should be provided with the tools and equipment necessary for the maintenance and calibration of control valves, transmitters and gages, etc.

#### 4.3.2 Electronic/pneumatic work area

This area should be provided with the tools and equipment necessary for the repair and calibration of electronic instruments, computer circuit boards and pneumatic panel instruments.

Test equipment for electronic instruments, stored in this room should include:

- an oscilloscope,
- a chart recorder,
- a signal generator,
- a variable power supply unit,

together with equipment specifically selected for the particular platform.

Test equipment for pneumatic instruments can be selected from (Sub-sections 4.5) to suit the particular requirements. However, special test equipment for the particular platform will also be required.

**Notes:**

- 1) Calibration equipment for 'fiscal' metering should also be located in this area.
- 2) This area should be free from the effects of vibration.

**4.4 Small Tools for the Instrument Workshop**

The selection of type and quantity of small tools should be made locally to suit requirements. Machine tools should be kept in the appropriate cabinets in the machine rooms, and craftsmen’s hand tools in bench drawers and cabinets located in the various rooms of the workshop.

**4.5 Equipment Inventory**

**4.5.1 General**

Appendix C shows proposed items of equipment and their suggested location in the instrument technical center and workshop, superimposed on the layout drawings of Appendix B.

The equipment is identified by the item number of the following inventory which is sub-divided according to type. It also includes normal items of office furniture and specific test equipment (see also 4.5.8).

**4.5.2 Furniture**

	<u>Item</u>
- work desk	1
- chairs	2
- work table	3
- blackboard	4
- shelves	5
- filing cabinet	6
- high cabinet (with hinged doors)	7
- high cabinet (for machine tools)	8
- low cabinet (for machine tools)	9
- low cabinet (with sliding doors)	10
- table(for computer)	11
- computer equipment storage facilities	12
- planning board, etc.	13

**4.5.3 Utilities equipment**

- acid resistant sink	14
- acid resistant sink (combined with a fume hood)	15
- rack for sample bottles	16
- sample conditioning system	17
- storage facilities complete with gas cylinders	18
- safety shower with eye bath.	19

**4.5.4 Cleaning equipment**

- cleaning table	20
- grit blasting facilities	21
- chemical bath	22
- ultrasonic bath-small size.	23

**4.5.5 Machine tools**

	<u>Item</u>
- lathe (instrument type)	24
- drilling machine (pedestal type)	25
- grinding machine	26
- polishing machine	27
- engraving machine	28
- mobile pipe threading machine.	29

**4.5.6 Work-and test-benches**

**1) Standard work-benches**

- general duty	30
- heavy duty	31

**2) Special work-benches**

- extra heavy duty	32
- mechanical	33
- laboratory.	34

**3) Standard test-benches**

- light duty	35
- pneumatic	36
- electronic	37
- DCS and PLC	38
- analyzer (general duty)	39
- analyzer (specific duty)	40
- vacuum	41
- medium/high pressure	42
- electro/pneumatic.	43

**4) Special test-benches**

- control valve	44
- hydraulic (portable type)	45
- temperature.	46

**4.5.7 Miscellaneous instrument workshop equipment**

- hoisting facilities (electric or pneumatic)	47
- painting booth	48
- small welding booth	49
- mobile hand volume pump	50
- portable vice (with folding tripod stand)	51
- pipe bending machine	52
- cutting shears (hand lever operated)	53
- magnifying glass (with light sources)	54

	<u>Item</u>
- ultra violet light facilities	55
- test rig for storage tank gages	56
- test stand for control valves	57
- trolley for oscilloscope	58
- portable oxy-acetylene welding set	59
- arc welding set	60
- heating oven	61
- electrical heating plate	62
- pipe vice (chain type)	63
- portable pipe vice (with folding tripod stand)	64
- set of laboratory glass ware	65
- a Faraday cage	66
- rack for PLC and DCS equipment	67
- deep freeze (laboratory type)	68
- trailer (low loader type)	69
- mobile crane (3 tonne max. capacity).	70

**4.5.8 Test equipment**

The following sub-sections list test equipment which should be available, as applicable, in certain sections of an instrument technical center. This equipment is not shown on the layout drawings but should be stored in the room or 'shop' to which it belongs, when not in use.

**4.5.8.1 Standards equipment room**

- high precision dead weight tester (customs design)
- high precision voltmeter
- general purpose oscilloscope
- stabilized power supply (high precision-high and low voltage)
- high precision weighing balance
- precision resistance thermometers
- one set of glass thermometers (-5 to +250°C)
- precision variable resistance (Decade box)
- whetstone bridge
- high precision barometer
- high precision dew point hygrometer
- standard platinum resistance
- precision current source
- flat bed recorder
- standard thermocouples
- standards for Voltage/frequency

**Notes:**

- 1) **Voltage** - Two standard cells to be checked every 6 months (derived from stancell/current resistance with high accuracy requirement i.e. 10<sup>-8</sup> V).
- 2) **Frequency** - Check frequently if necessary.
- 3) **All testing equipment in this room shall be certified as primary testing equipment and should not be taken outside the room.**

**4.5.8.2 Pneumatic 'shop'**

- precision pressure regulator
- pneumatic test rig for controllers (depending on manufacturer)
- set of precision gages
- low pressure/vacuum calibration system
- pneumatic calibration unit
- digital pressure calibrator (300 mbar)
- digital pressure calibrator (1.6 bar)
- digital pressure calibrator (10 bar)
- high pressure test kit (200 bar)
- portable low pressure pump
- portable calibrator
- pneumatic calibrator- electro
- pneumatic calibrator
- absolute pressure unit
- deadweight tester system (0 to 10 bar)
- deadweight tester system (0 to 200 bar).

**4.5.8.3 Electronic 'shop'**

- portable temperature indicator (6½ digits)
- portable multivolt meter (6½ digits)
- whetstone bridge
- variable resistance (decade box)
- analogic voltmeter multi-function
- logic analyzer
- electronic voltmeter
- digital counter frequency meter
- universal impedance measuring bridge
- adjustable and portable power supply (high + low voltage)
- function generator
- programmable pulse generator
- general purpose oscillator
- transistometer
- stroboscopic tachometer
- calibration set for vibration monitor
- digital circuit tester
- milli-ohm meter (in 0.001 ohm steps)
- high resistance meter (500 kohms)
- PT 100 simulator
- flat bed recorder (dual bed)
- portable tachometer
- XY recorder (dual bed)
- set of standard resistors (10 000 to 1 000 ohm)
- set of standard platinum resistances
- test oscilloscope microprocessor (to be kept in the control room, for integrated control systems)
- digital oscilloscope with memory
- low-voltage megger (50 Volts)
- high-voltage megger (500 Volts)
- earth fault detector
- specific 'manufacturers' calibrator
- cold junction reference
- computer peripherals.

#### 4.5.8.4 Analyzer 'shop'

- trace moisture generator
- trace moisture analyzer
- H<sub>2</sub>S detector
- H<sub>2</sub>S generator- portable oxygen analyzer
- hydrogen purifier
- conductivity meter box
- portable pH/MV meter (0.01 pH reading)
- flowmeter kit
- mass flow meter (suitable for H<sub>2</sub>)
- de-oxo cell purifier
- DC power supply unit (24V, 2A)
- capacitor (Decade box)
- digital circuit tester
- logic clips
- master flex pump set (Peristaltic)
- set of universal thermometers (-200 to 1200°C)
- portable explosimeters
- turbidity meter (laboratory equipment)
- 'Methrom' titroton and burettes
- digital weighing balance (accuracy 0.1 gr.)
- portable numeric thermometer
- digital thermistor thermometer
- set of low range manometers.

#### 4.5.8.5 Analyzer calibration and test 'shop'

- gas pump
- pressure reducer (MP to LP gas)
- test box for pH simulation
- portable oscilloscope
- flowmeter kit
- decade box
- set of precision thermometers
- flat bed recorder (2 pens)
- recorder XY.

#### 4.5.8.6 Shop test equipment

- portable hand 'volume pump' (0 to 70 bar as required)
- electro/pneumatic portable calibration unit (4 to 20 mA)
- medium voltage 'Megger' (capacity 500 V)
- set of standard thermometer
- dual pulse generator
- infra-red camera (pyrometer, optional)
- digital infra-red thermometer
- digital thermometer (contact probe set)
- whetstone bridge
- gas detector
- untra violet temperature indication
- sound and vibration meter
- geiger counter (optional)

## 5. FIELD MAINTENANCE EQUIPMENT AND TOOLS

### 5.1 General

In addition to the calibration and maintenance of instruments which is carried out in the various workshops, calibration and maintenance is also necessary for certain instruments or instrument systems 'in situ' on the plant and/or in the instrument auxiliary rooms and control rooms. To facilitate this work, a selection from the tools and equipment given in the following section should be available as applicable.

For complete flexibility, separate tools and equipment for the field maintenance team should be considered, however some expensive and/or infrequently used items could be 'borrowed' from the workshop(s) inventory.

The 'maintenance' tools and equipment should be located in the workshop(s), but for convenience certain items should be available in the 'maintenance room' of control rooms and analyzer houses. However, certain specific and special test equipment should remain in the main instrument workshop.

The quantities of equipment required will depend on the size of the plant, and whether maintenance is to be carried out as a centralized system from a central workshop or independently from 'satellite' workshops in conjunction with a main workshop.

The equipment listed below is typical for the 'in situ' checking of pneumatic and electronic instruments installed in the average plant as considered in this Standard.

#### 5.1.1 Test equipment

- set of precision pressure gages
- low-pressure calibration unit (including vacuum)
- set of digital pressure calibrators (300 mb to 10 bar)
- pneumatic portable calibration unit (0.2 to 1 bar)
- portable temperature indicator (TC simulator)
- one or two electronic digital accurate voltmeters
- variable resistance (decade box)
- portable oscilloscope (general purpose)
- PT 100 simulator calibrator
- portable tachometer
- manufacturer's calibrator(s)
- portable pulse and function generator
- portable variable power supply (amps/volts).

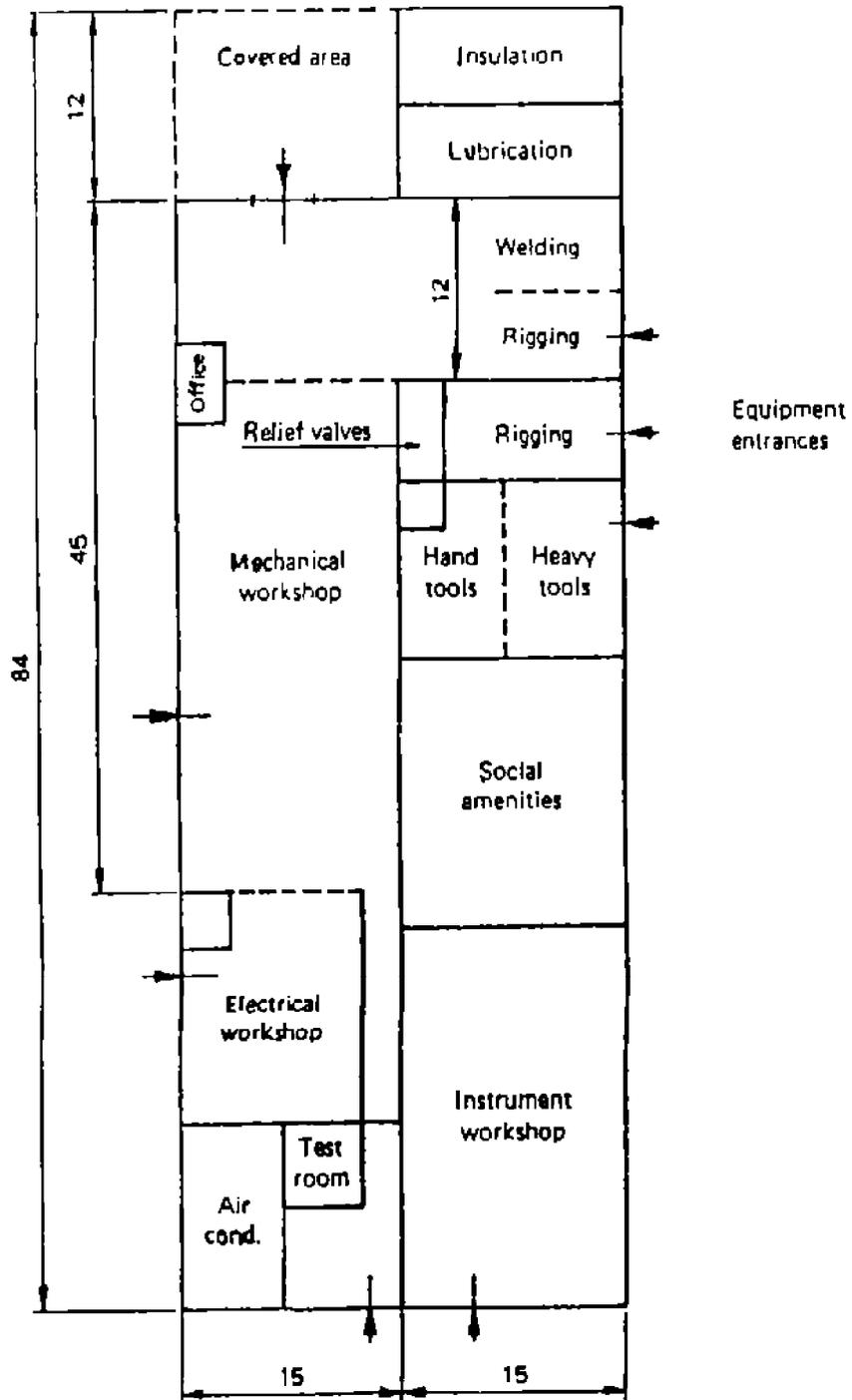
### 5.2 Small Tools for Field Maintenance

Small tools should be selected locally to suit requirements. The tools should be kept in tool boxes preferably in a storage area reserved for 'field maintenance' technicians, when not in use.

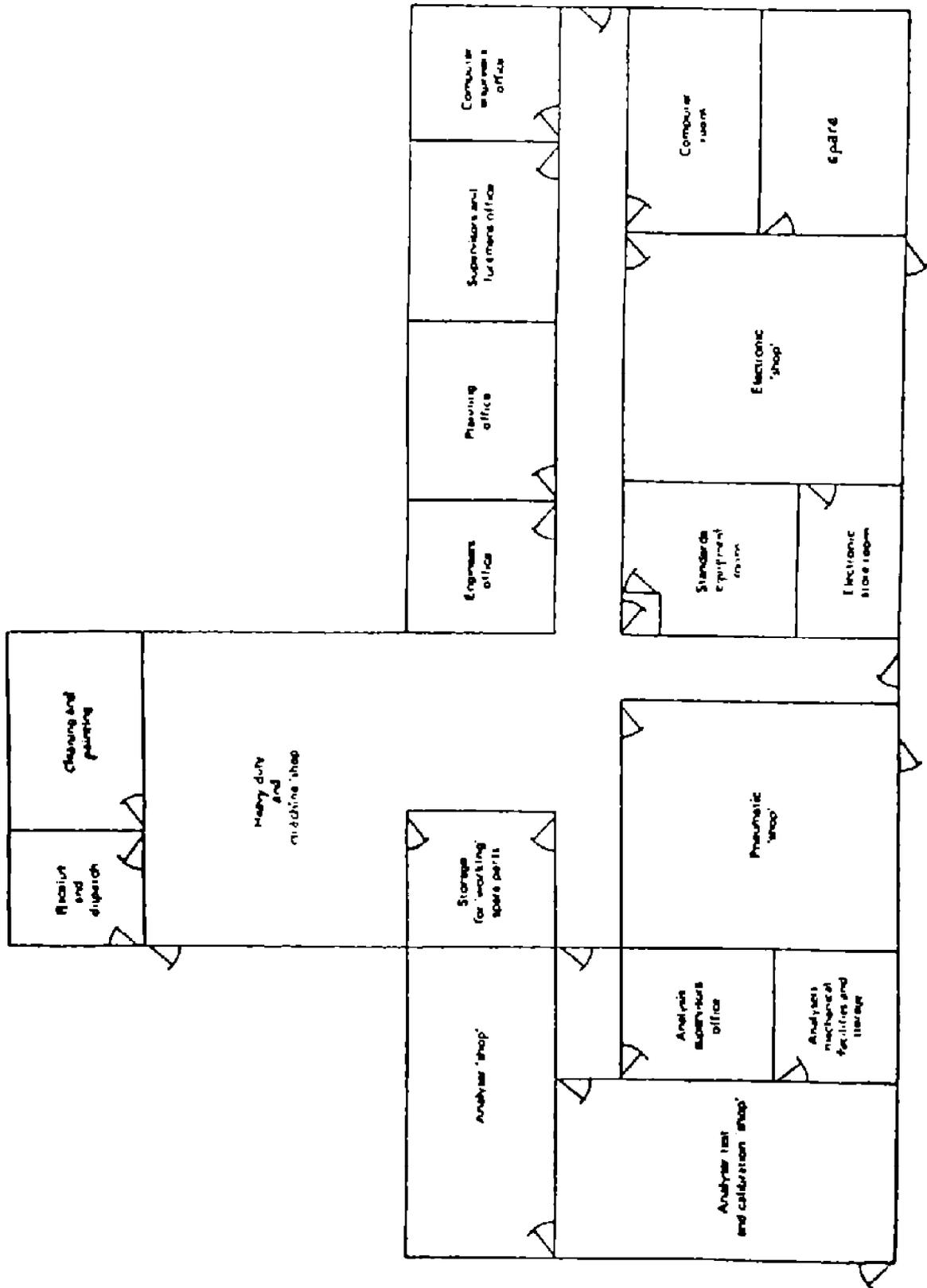
APPENDICES

APPENDIX A

TYPICAL LAYOUT OF A MECHANICAL, ELECTRICAL AND INSTRUMENT WORKSHOP



APPENDIX B  
 TYPICAL LAYOUT OF AN INSTRUMENT TECHNICAL CENTER AND WORKSHOP





**APPENDIX C (continued)**

**EQUIPMENT INVENTORY**

**Furniture**

- 1- Work desk
- 2- Chairs
- 3- Work table
- 4- Blackboard
- 5- Shelves
- 6- Filing cabinet
- 7- High cabinet - with hinged doors
- 8- High cabinet - for machine tools
- 9- Low cabinet - for machine tools
- 10- Low cabinet - with sliding doors
- 11- Table - for computer
- 12- Computer equipment storage facilities
- 13- Planning board, etc.

**Utilities Equipment**

- 14- Acid resistant sink
- 15- Acid resistant sink  
(combined with a fume hood)
- 16- Rack for sample bottles
- 17- Sample conditioning system
- 18- Storage facilities  
(complete with gas cylinders)
- 19- Safety shower with eye bath

**Cleaning Equipment**

- 20- Cleaning table
- 21- Grit blasting facilities
- 22- Chemical
- 23- Ultrasonic bath - small size

**Machine Tools**

- 24- Lathe - instrument type
- 25- Drilling machine - pedestal type
- 26- Grinding machine
- 27- Polishing machine
- 28- Engraving machine
- 29- Mobile pipe threading machine

**Standard Work-Benches**

- 30- Work-bench (general duty)
- 31- Work-bench (heavy duty)

**Non-Standard Work-Benches**

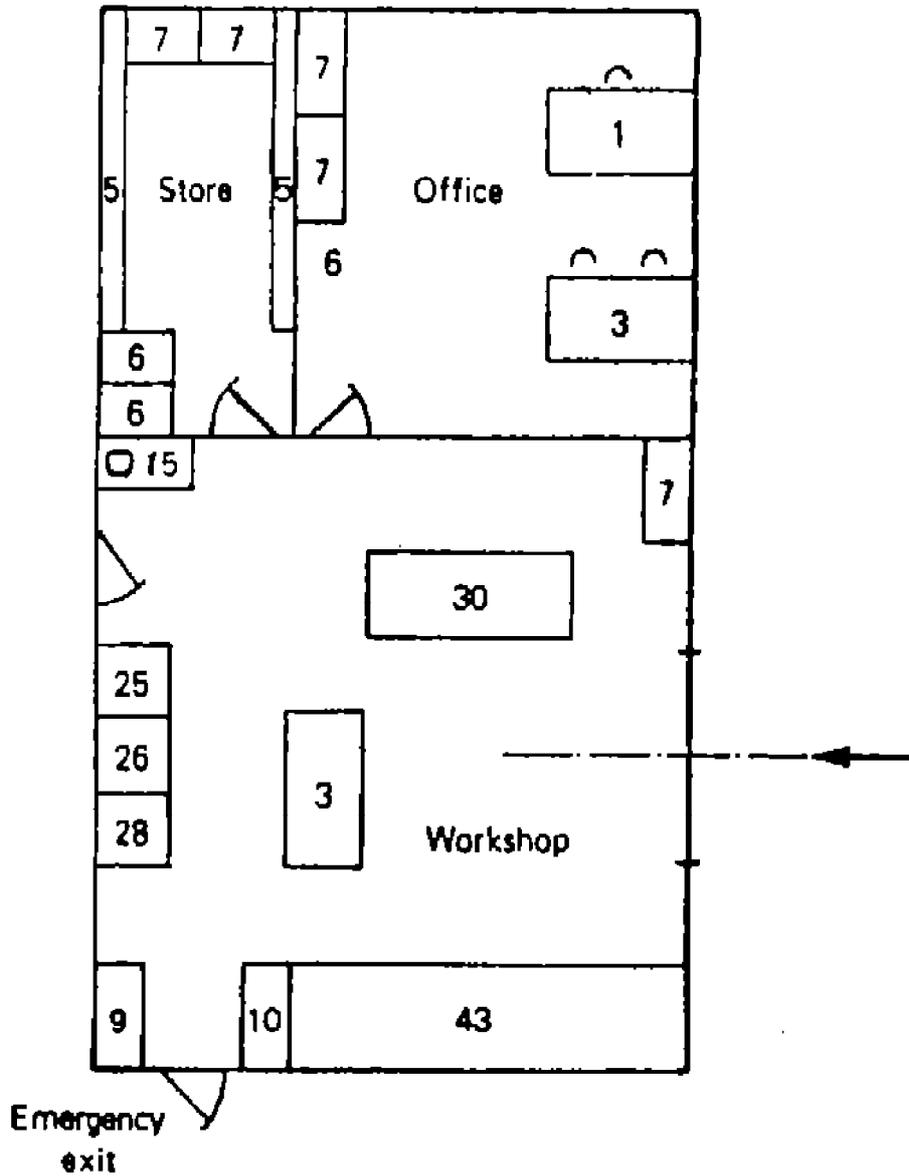
- 32- Extra heavy duty
- 33- Mechanical
- 34- Laboratory
- 35- Light duty
- 36- Pneumatic
- 37- Electronic
- 38- Telecommunication
- 39- Analyzer (general duty)
- 40- Analyzer (specific duty)
- 41- Vacuum
- 42- Medium/high pressure
- 43- Electro/pneumatic
- 44- Control valve
- 45- Hydraulic (portable type)
- 46- Temperature

**Miscellaneous Equipment**

(Note: Only the larger stationary items are shown on the layout.)

- 47- Hoisting facilities (electric or pneumatic)
- 48- Painting booth
- 49- Small welding booth
- 50- Mobile hand volume pump
- 51- Portable vice (with folding tripod stand)
- 52- Pipebending machine
- 53- Cutting shears (hand lever operated)
- 54- Magnifying glass (with electric light)
- 55- Ultra violet light facilities
- 56- Test rig for storage tank gages
- 57- Test stand for control valves
- 58- Trolley for oscilloscope
- 59- Portable oxy-acetylene welding set
- 60- Arc welding set
- 61- Heating oven
- 62- Electrical heating plate
- 63- Pipe vice - chain type
- 64- Portable pipe vice (with floding tripod stand)
- 65- Set of laboratory glass ware
- 66- Rack for PLC and GLC equipment
- 67- Deep freeze - laboratory type
- 68- Trailer - low loader type
- 69- Mobile crane - 3 tonne max. capacity

APPENDIX D  
TYPICAL LAYOUT AND EQUIPMENT LOCATION FOR A  
'SATELLITE' INSTRUMENT WORKSHOP



## APPENDIX E

### TYPICAL WORK-BENCH AND INSTRUMENT TEST-BENCH REQUIREMENTS

#### E.1 General

Work-benches and instrument test-benches can be either to Manufacturer's Standard or of Special Construction.

#### E.2 Standard Work-Benches

These work-benches are manufacturer's standard product, and should be obtained from an approved supplier.

#### E.3 Standard Instrument Test-Benches

##### E.3.1 General concept

The Instrument Test-bench is an item of equipment provided with all the facilities necessary to test and calibrate instruments, which are used to measure and control manufacturing processes.

The test-bench generally consists of a lower unit 'The Bench', which supports a selection of instruments installed in 'The Top Unit'. The type of instruments fitted depends on the duties of the particular test bench.

##### E.3.1.1 The bench

The bench should be based on the commercially available standard product of recommended manufacturer's.

The length of the bench will depend on local circumstances and expected application, but should not be less than 1500 mm.

The work top which will support the 'Top Unit', should be robustly constructed in wood of at least 50 mm thick and plastic faced, e.g. with Melamine.

##### E.3.1.2 The top units

The top units shall consist of 'racks' suitable for sliding (plug-in) units, and/or be based on the '19 Inch System' but they should also be suitable for Euro-Cassette Modules.

Typical details of various top units are illustrated in the following pages of this Standard, however some of the larger technical centers may require other special arrangements.

#### E.4 Special Work and Instrument Test-Benches

For those applications where the standard work and test-benches described in the previous sub-sections are not suitable, special designs may be developed, based as far as possible on the commercially available types.

#### E.5 Typical Work and Test-Benches

This Appendix gives typical requirements and illustrations of the benches generally recommended in this Publication, as listed below:

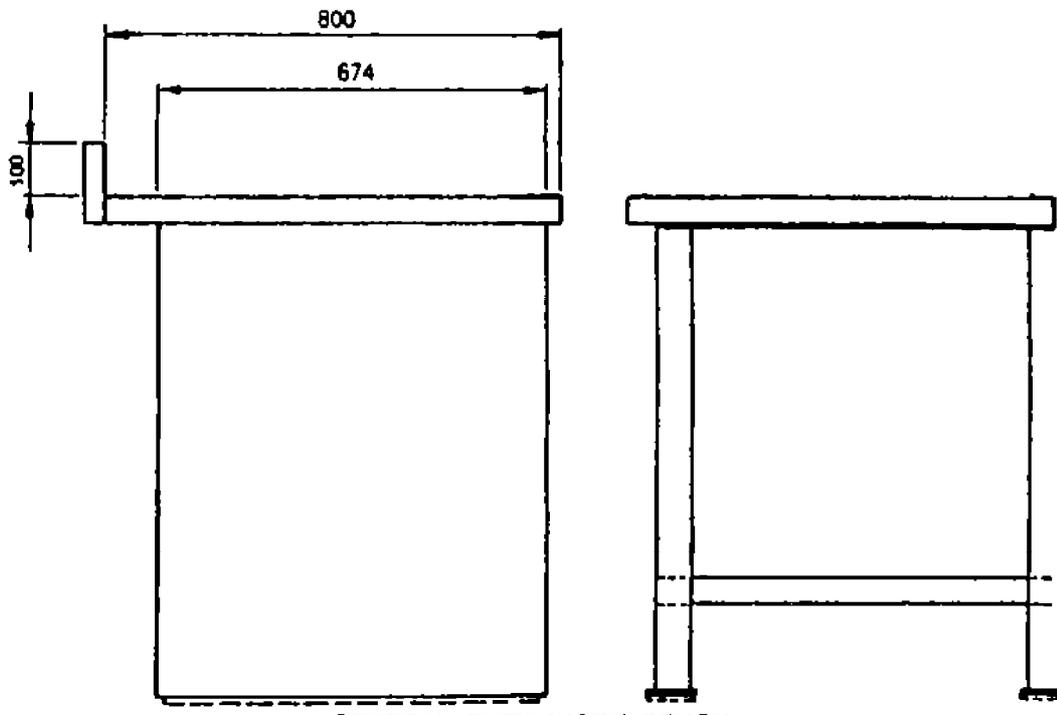
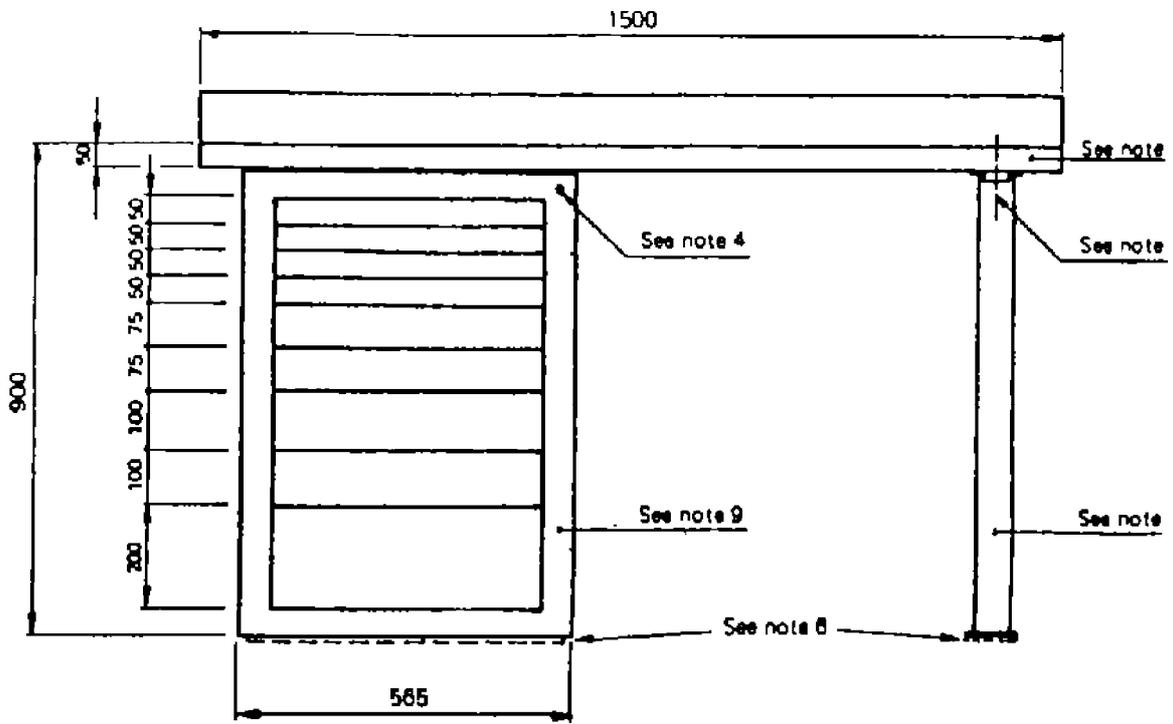
##### E.5.1 Standard Types

##### E.5.1.1 Work-benches

##### E.5.1.2 Test-benches

(to be continued)

APPENDIX E (continued)

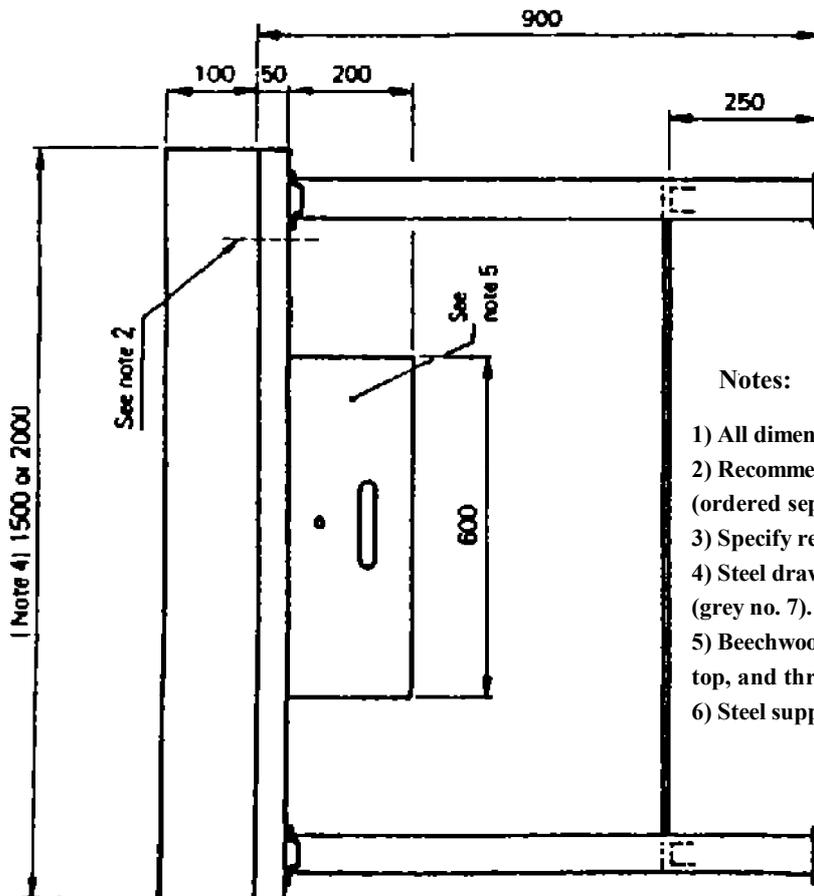
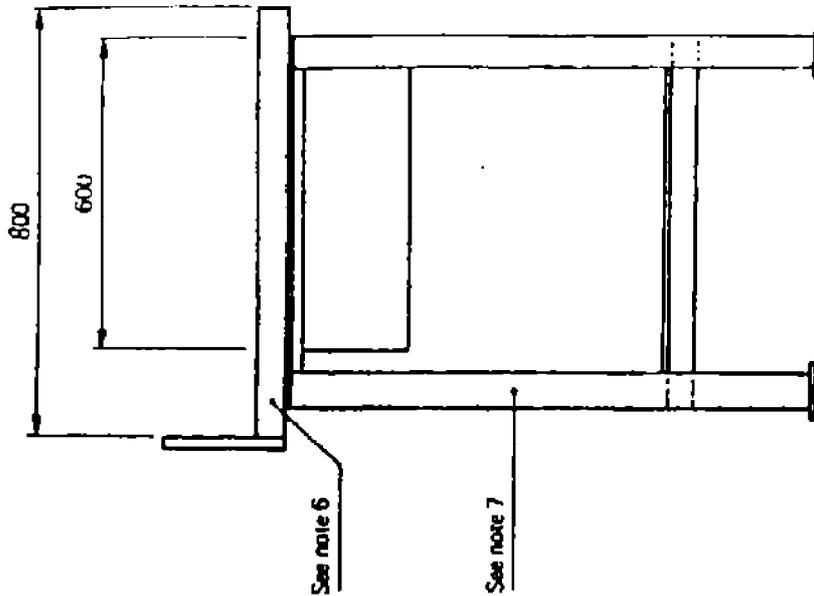


GENERAL DUTY WORK BENCH

Fig. E.1

(to be continued)

APPENDIX E (continued)



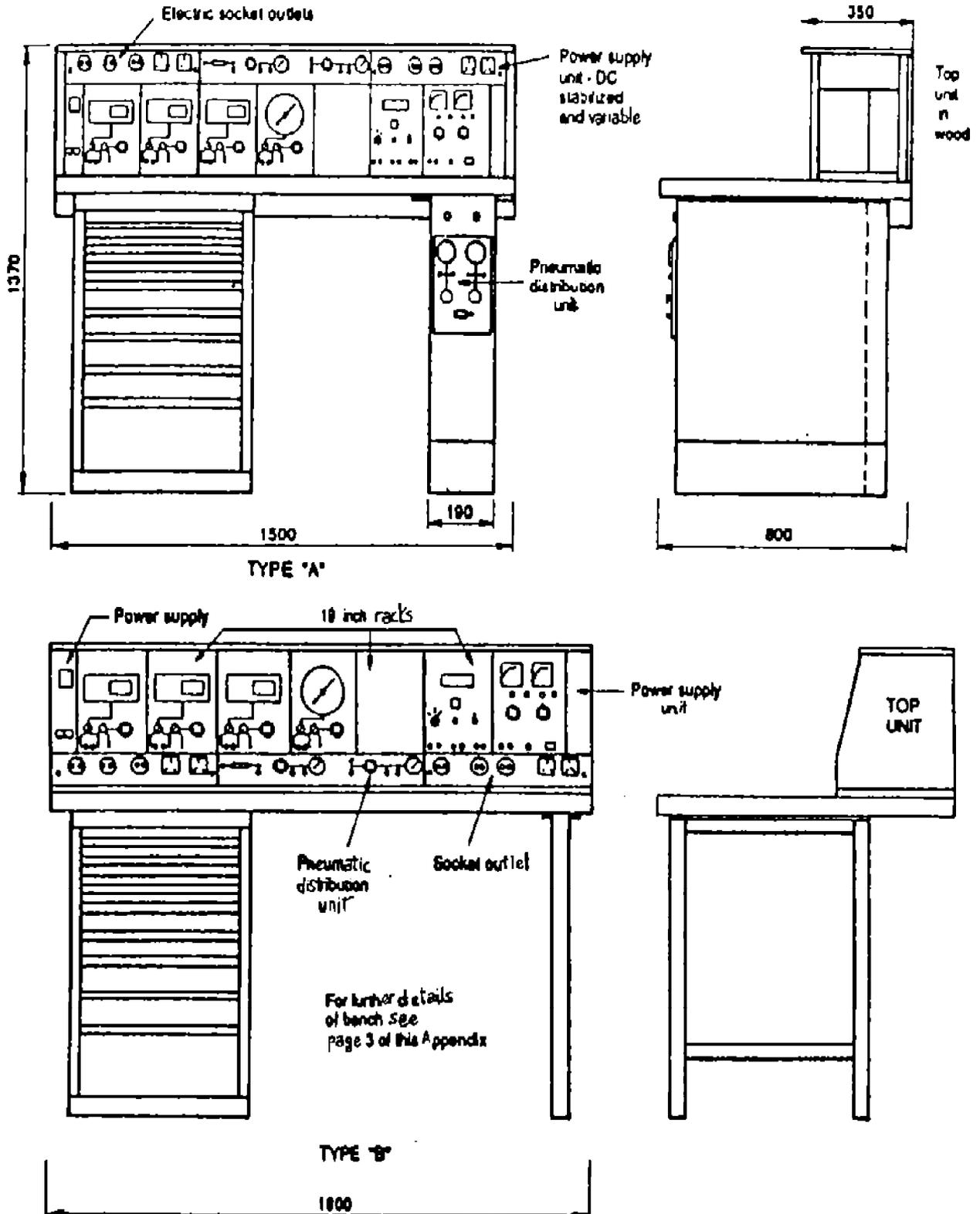
Notes:

- 1) All dimensions in mm.
- 2) Recommended position for bench vice (ordered separately).
- 3) Specify required length when ordering 2000 mm.
- 4) Steel drawing type 7-11 with lock and key (grey no. 7).
- 5) Beechwood with Reuse Urphen (Melamine) grey top, and three steel angle iron side.
- 6) Steel supports (grey no. 7).

HEAVY DUTY WORK BENCH  
Fig. E.2

(to be continued)

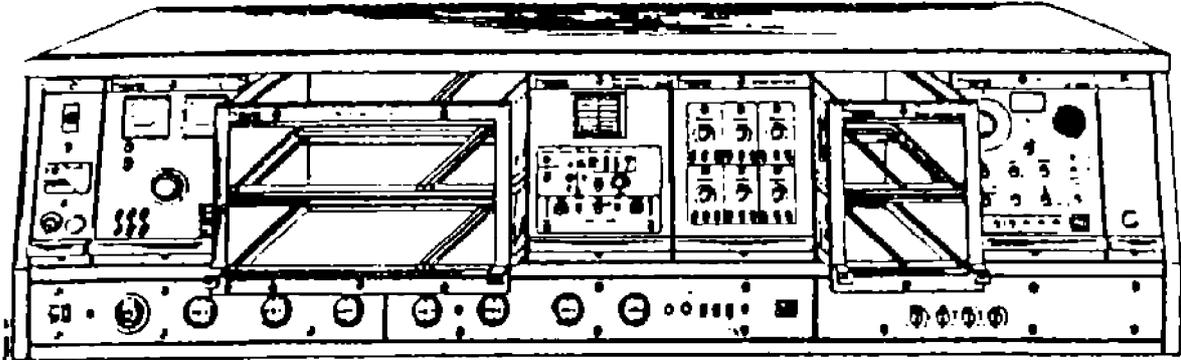
APPENDIX E (continued)



GENERAL CONCEPT OF A TYPICAL TEST-BENCH  
Fig. E.3

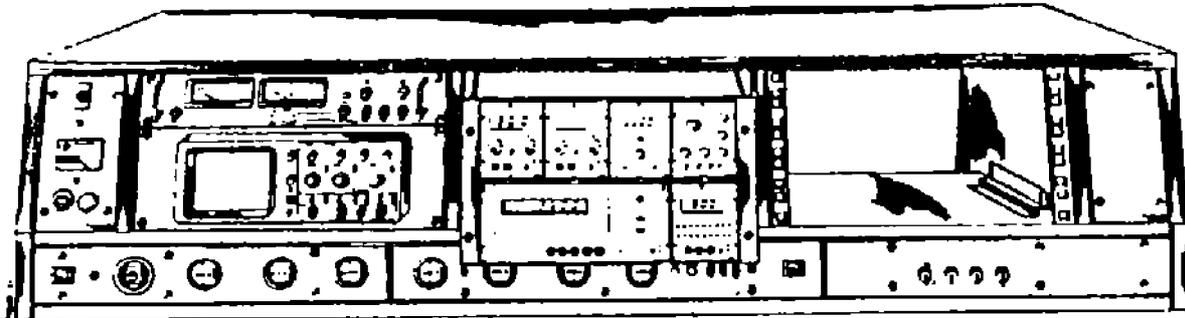
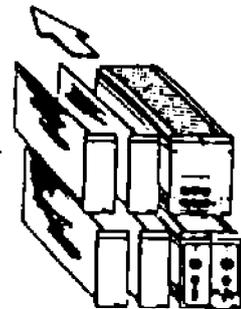
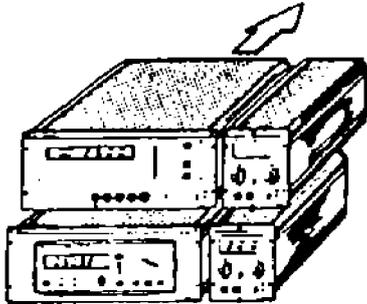
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APPENDIX E (continued)



Combination Possibilities

- 19 inches rack slide units
- Non-standard units
- Euro cassette modules



Power Unit

Electrical Unit

Pneumatic Unit



TYPICAL ARRANGEMENTS OF RACKS AND MODULES

Fig. E.4

(to be continued)

## APPENDIX E (continued)

**E.5.1.2.1 Light duty work/test-bench****1) Bench**

- size, 1500 × 800 × 900 (mm),
- with a Melamine faced top,
- and an insulated steel frame.

**2) Under bench**

- with 9 lockable drawers on roller,
- guides fitted with drawer dividers.

**3) Bench top unit**

- suitable for fitting on the bench as 3 × 19 inch racks complete with Part Nos. 3, 5 & 7.

**4) Power supply unit**

- complete with safety devices.

**5) Pneumatic supply unit**

- with regulators and pressure gages.

**6) Socket outlet panel**

- complete with plugs for:

220 V	50 Hz	or to suit local conditions see Sub-section 3.7
110 V	50 Hz	
24 V	DC	

Each socket should be in a dedicated color

**7) Light source**

- fitted with 2 × 60 W bulbs on an articulated arm.

**8) Magnifying lens**

- for use with Part No. 7.

**E.5.1.2.2 Pneumatic test-bench****1) Bench**

- size 1800 × 1000 × 900 (mm),
- with Melamine faced top,
- and an insulated steel frame.

**2) Under bench**

- with 9 lockable drawers on roller guides fitted with drawer dividers.

**3) Power supply**

- 220 V 50 Hz complete with miniature circuit breaker having overcurrent protection of 16 A, with a combined or separated earth leakage device of 30 mA.

(to be continued)

**APPENDIX E (continued)****4) Bench top unit**

Suitable for fitting on the bench as 3 × 19 inch racks complete with Parts Nos. 3, 5 and 7.

**5) Pneumatic supply unit panel**

- complete with monitor gages 0.2 to 5 bar and 0 to 10 bar,
- 2 test connections,
- and an air supply at 2 to 2.5 bar, with 2 connections for maximum air pressure, controlled by reducing valves.

**6) Socket outlet panel**

- complete with:
  - 2 plugs, for 220 V 50 Hz
  - 1 plug, for 110 V 50 Hz
  - 2 plugs, for 24 V DC.

**Note:**

Socket with different voltages should have different contact arrangements and be in a dedicated color.

**7) Light source**

- fitted with 2 × 60 W bulbs on an articulated arm.

**8) Magnifying lens**

- for use with Part No. 7.

**9) Slide unit with:**

- transmitter calibrator,
- power supply 220 V 50 Hz,
- output 0 to 60 V DC and 0 to 50 mA, to be adjustable by a 10 turn potentiometer,
- a display of 4 to 5 digits,
- and an accuracy of 0.1% of the measured value.

**10) Slide unit with:**

- digital pressure indicator 0 to 300 mbar,
- accuracy 0.1 % of full scale,
- a display of 4 to 5 digits,
- pneumatic adjustable switches,
- leak test and pressure limiting valves.

**11) Slide unit (as 10 above but for 0 to 1.6 bar)****12) Slide unit (as 10 above but for 0 to 6 bar)****13) Slide unit (as 10 above but for 0 to 10 bar)****14) Slide unit (as 10 above but for 0 to 60 bar)****15) DC power supply 0 to 50 mA**

(to be continued)

**APPENDIX E (continued)****16) Analog pressure indicator**

- 0.5 bar with an accuracy of 0.05% of full scale.

**17) Stabilized power supply**

- with variable DC voltage/current 0 to 11 V DC, 0 to 60 mA and 0 to 120 mV.

**18) Slide unit with:**

- earth free variable, stabilized DC power supply 0 to 30 V and 2 A (4 to 5 digit display).

**19) Universal digital voltmeter****20) Universal analog voltmeter****21) Analog pressure indicator**

- 0 to 16 bar, with an accuracy of 0.1% of full scale.

**E.5.1.2.3 Electronic test-bench****1) Power supply unit**

- 220 V 50 Hz complete with miniature circuit breaker having overcurrent protection of 16 A, with a combined of separate earth leakage device of 30 mA.

**2) Oscilloscope (general purpose)****3) Vacuum pump****4) Outlet socket panel**

- complete with plugs for:

220 V	50 Hz
110 V	50 Hz
24 V	DC

- earth connections.

**Note:**

Sockets for different voltages should have different contact arrangements and be in a dedicated color.

**5) Variable AC voltage stabilizer****6) Analog voltmeter****7) Variable DC power stabilizer unit**

- 0 to 12 V and 0 to 120 mA.

**8) Earth free variable DC power unit**

- 0 to 30 V.

**9) Digital voltmeter**

(to be continued)

**APPENDIX E (continued)****10) Pneumatic distributor panel**

- complete with pressure gages and regulators.

**11) Transmitter calibration unit**

- 0 to 50 V DC and 0 to 50 mA,
- with an accuracy of 0.1% of full scale.

**E.5.1.2.4 Analyzer test-bench (general duty)****Note:**

The length of this bench is 4 meters.

**1) Power supply unit**

- 220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, with a combined or separate earth leakage device of 30 mA.

**2) Pneumatic unit**

- with a digital indicator scale 0 to 1.6 bar having an accuracy of 0.5% of full scale.

**3) Special unit with:**

- a vacuum pump,
- digital display,
- and a start/stop switch.

**4) Socket outlet panel**

- complete with plugs for:

220 V	50 Hz
110 V	50 Hz
24 V	DC.

**Note:**

Sockets for different voltages should have different contact arrangements and be in a dedicated color.

**5) Pneumatic distribution panel****6) Analog multimeter****7) Variable stabilized DC and current power supply unit**

- 0 to 12 V and 0 to 120 mA.

**8) Variable stabilized DC power supply unit - 0 to 30 V****9) Digital multimeter****10) Automatic/manual, start/stop timer unit****11) Transmitter calibration unit**

- 0 to 60 V and 0 to 50 mA with an accuracy of 0.1% of full scale.

(to be continued)

## APPENDIX E (continued)

**E.5.1.2.5 Analyzer test-bench (specific duty)****1) Power supply unit**

- 220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, with a combined or separate earth leakage device of 30 mA.

**2) Slide unit with:**

- a vacuum pump,  
- digital indicator,  
- and a start/stop switch.

**3) Pneumatic digital indicator unit-0 to 1.6 bar****4) Digital multimeter unit****5) Oscilloscope (general purpose)****6) Variable DC power supply unit**

- 0 to 12 V and 0 to 120 mA.

**7) Variable stabilized DC power supply unit-0 to 30 V****8) Electronic timer unit**

- with automatic/manual start/stop.

**9) Analog multimeter****10) Analog pressure gage unit-0 to 16 bar****11) Digital pressure gage unit-0 to 25 bar****12) Socket outlet unit**

- with a plug for - 220 V 50 Hz.

**13) Pneumatic unit**

- regulators, pressure gages and connections.

**14) Electrical junction box unit**

- with a safety device for the pumps.

**15) Pneumatic system****16) Transmitter calibration unit**

- with digital gage 0 to 50 mA.

**17) Digital vacuum indicator unit (including connections)**

(to be continued)

## APPENDIX E (continued)

**E.5.1.2.6 Vacuum test-bench****1) Power supply unit (for the bench, and for the pump)**

- 220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, with a combined or separate earth leakage device of 30 mA.

**2) Digital vacuum indicator (with connection)****3) Digital pressure indicator-0 to 1.5 bar****4) Digital pressure indicator-0 to 6 bar****5) Socket outlet panel**

- complete with plugs for:

220 V	50 Hz
110 V	50 Hz
24 V	DC

**Note:**

Sockets for different voltages should have different contact arrangements and be in a dedicated color.

**6) Pneumatic distribution unit****7) Transmitter calibration unit**

- 0 to 60 V DC and 0 to 50 mA with an accuracy of 0.1% of full scale.

**8) Vacuum pump****E.5.1.2.7 Pressure test-bench****1) Power supply unit**

- 220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, with a combined or separate earth leakage device of 30 mA.

**2) Air compressor (high pressure type)****3) Digital pressure gages**

0 to 1.5 bar  
0 to 6 bar  
0 to 25 bar  
0 to 60 bar  
0 to 100 bar  
0 to 200 bar.

**4) Analog pressure gage**

0 to 25 bar.

(to be continued)

**APPENDIX E (continued)****5) Electronic calibrator unit**

- 0 to 60 V DC and 0 to 50 mA output with digital display, having an accuracy of 0.1% of full scale.

**6) Socket outlet panel**

220 V	50 Hz
110 V	50 Hz
24 V	DC

**Note:**

Sockets for different voltages should have different contact arrangements and be in a dedicated color.

**7) Pneumatic distribution unit****8) Oil/gas (nitrogen) separator**

- to allow oil free calibration of transmitters.

**9) Nitrogen supply (high pressure)**

- for cryogenic and O<sub>2</sub> applications.

**E.5.1.2.8 Electro pneumatic test-bench****1) Power supply unit**

- 220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, with a combined or separate earth leakage device 30 mA.

**2) Slide unit (0 to 200 mbar digital)****3) Slide unit (0 to 16 bar digital)****4) Slide unit (0 to 6 bar digital)****5) Slide unit with analog gage (1.6 bar)****6) Slide unit (with digital vacuum indicator)****7) Slide unit (high pressure analog - 0 to 25 bar)****8) Oscilloscope (general purpose)****9) Analog multimeter unit****10) Digital multimeter unit****11) Variable DC power supply unit**

- 0 to 12 V and 0 to 120 mA.

**12) Variable stabilized power supply - 0 to 30 V****13) Slide unit (spare)****14) Pneumatic distribution unit**

(to be continued)

**APPENDIX E (continued)**

**15) Slide unit**

- with plugs for:

220 V      50 Hz  
115 V      50 Hz.

**16) Pneumatic slide unit**

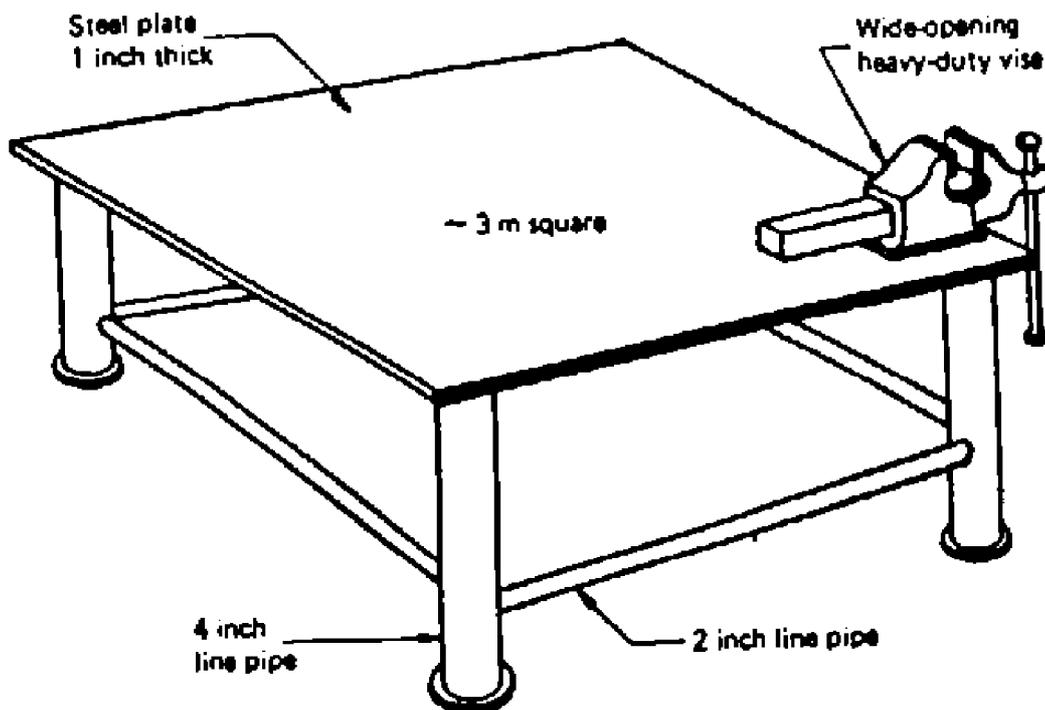
- with regulators and gages.

**17) Electrical junction box**

**E.5.2 Non-Standard Types**

**E.5.2.1 Work-benches**

<b>PART No.</b>	<b>DESCRIPTION</b>	<b>REQUIREMENTS</b>	<b>QUANTITY</b>	<b>SUPPLIER</b>	<b>REMARKS</b>
1	Bench  Size 900 × 900 × 900 mm high with 25 mm thick steel top and steel pipe supports  Complete with wide opening heavy duty vise.		1		To be fabricated in the site workshop, or by local manufacturer.



**EXTRA HEAVY DUTY WORK BENCH**

**Fig. E.5**

(to be continued)

**APPENDIX E ( continued)****E.5.2.1.1 Mechanical work-bench****1) General**

- Typical size 1750 (or 2000) × 750 mm, overall height 1630 mm.

**2) Work top**

- beechwood, plastic faced with aluminum angle sides,
- 50 mm thick.

**3) Drawer-cabinet/supports**

- each cabinet to have 4 large capacity drawers with a locking system,
- 2 drawers to be fitted with compartments,
- constructed in heavy gage sheet steel.

**4) Shelf**

- fitted between the cabinets complete with back cover constructed in heavy gage sheet steel.

**5) Top unit**

- with sliding roller shutter type lockable doors,
- fitted with a tool storage system,
- constructed in heavy gage sheet steel.

**6) Base**

- of hardwood or equivalent.

**7) Accessories**

- a light source,
- a parallel jaw vice.

**E.5.2.2 Test benches****E.5.2.2.1 Control valve test-bench****1) General**

The control valve test-bench should provide all the facilities necessary for the complete testing and calibration of control valves such as:

**2) The bench**

- of welded steel frame complete with:
  - 2 control desks,
  - 1 hydraulic lifting table fitted with safety devices,
  - special connections for 3-way valves,
  - complete set of interchangeable flanges in stainless steel.

**(to be continued)**

**APPENDIX E (continued)****3) Capacity**

- suitable for the testing of control valves up to 16 in nominal bore and 1200 mm between flanges,
- and for calibrating 3-way valves.

**4) Equipment and facilities**

- required to carry out the following tests:

**a) leak tests - in accordance with:**

- ANSI B 16- 106 up to Class VI (Ref. IPS-G-IN-160, "Control Valves"),
- manufacturer's standards.

with: air or water.

The equipment shall include:

- a set of leakage rotameters for 6 l/h up to 30 l/h,
- a manifold for rotameter selection.

**b) pneumatic tests-requiring:**

- air supply variable with variable control to a pressure of 6 bar maximum,
- a complete air manifold with accurate manometers:
  - fixed outputs of: 0.2 bar,
  - 1.0 bar,
- pneumatic connections made with stainless steel tubing and compression fittings,
- variable output.

**c) hydraulic tests-requiring:**

- mechanical protection for the hydraulic tests.

**d) Electronic tests-requiring:**

- electricity supply of 220 V 50 Hz complete with a miniature circuit breaker having over current protection of 16 A, with combined or separate leakage device of 30 mA,
- 24 V DC,
- fixed output 4 mA,
- fixed output 20 mA,
- variable output 0-60 mA with digital indication for input measurement,
- electronic timer for start/stop.

**e) electronic leak test-requiring:**

- electronic leak detection apparatus.

**f) PLC capabilities-requiring**

- automatic clamping with safety features,
- automatic control of clamping pressure,
- automatic sequence procedures,
- configuration via the keyboard.

**(to be continued)**

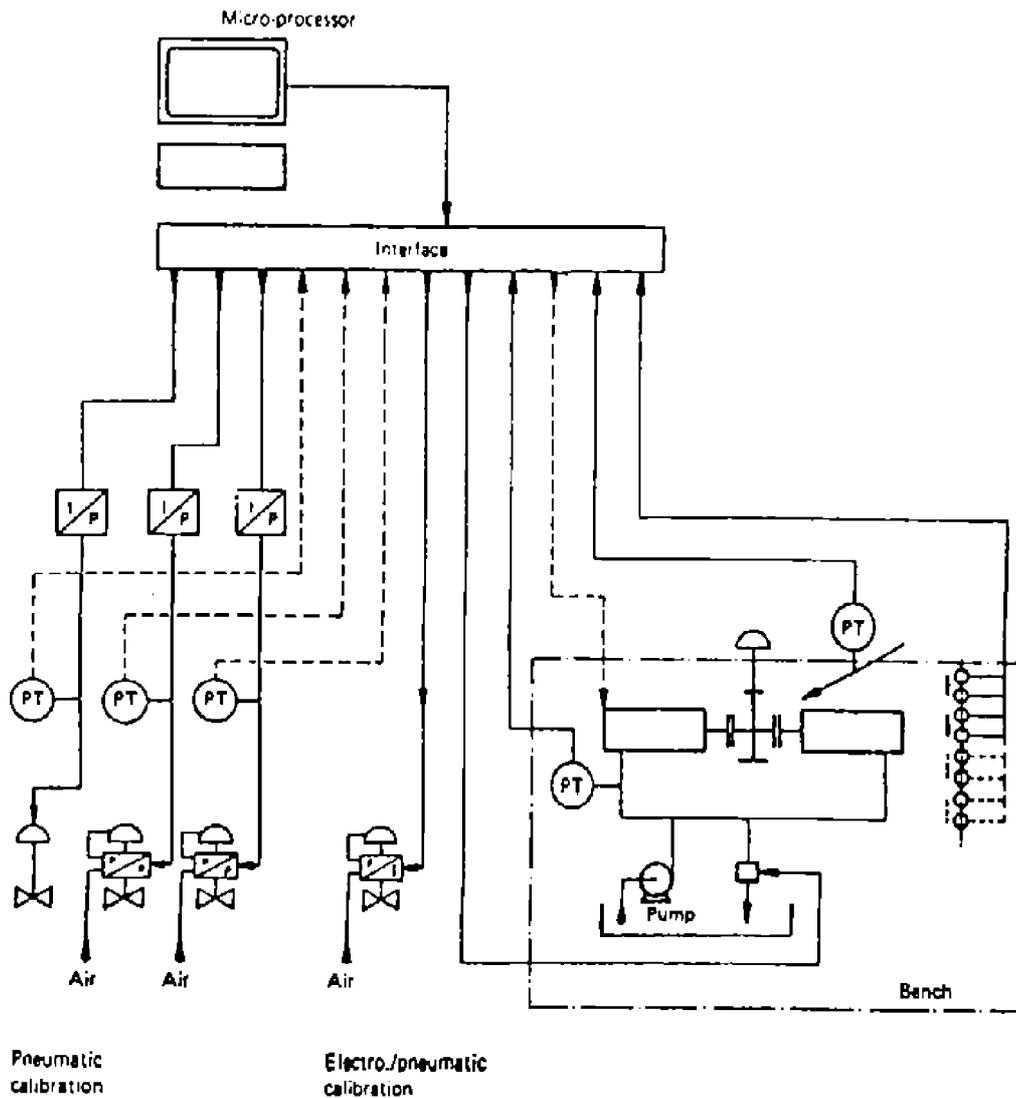
APPENDIX E (continued)

g) micro-computer equipment-comprising:

- bench filing capabilities,
- storage for manufacturer's data,
- filing all test procedures,
- control valve data,
- control valve records,
- calibration via keyboard.

h) printer:

- procedures,
- calibration,
- control valve data and specification,
- control valve records, by tag number.

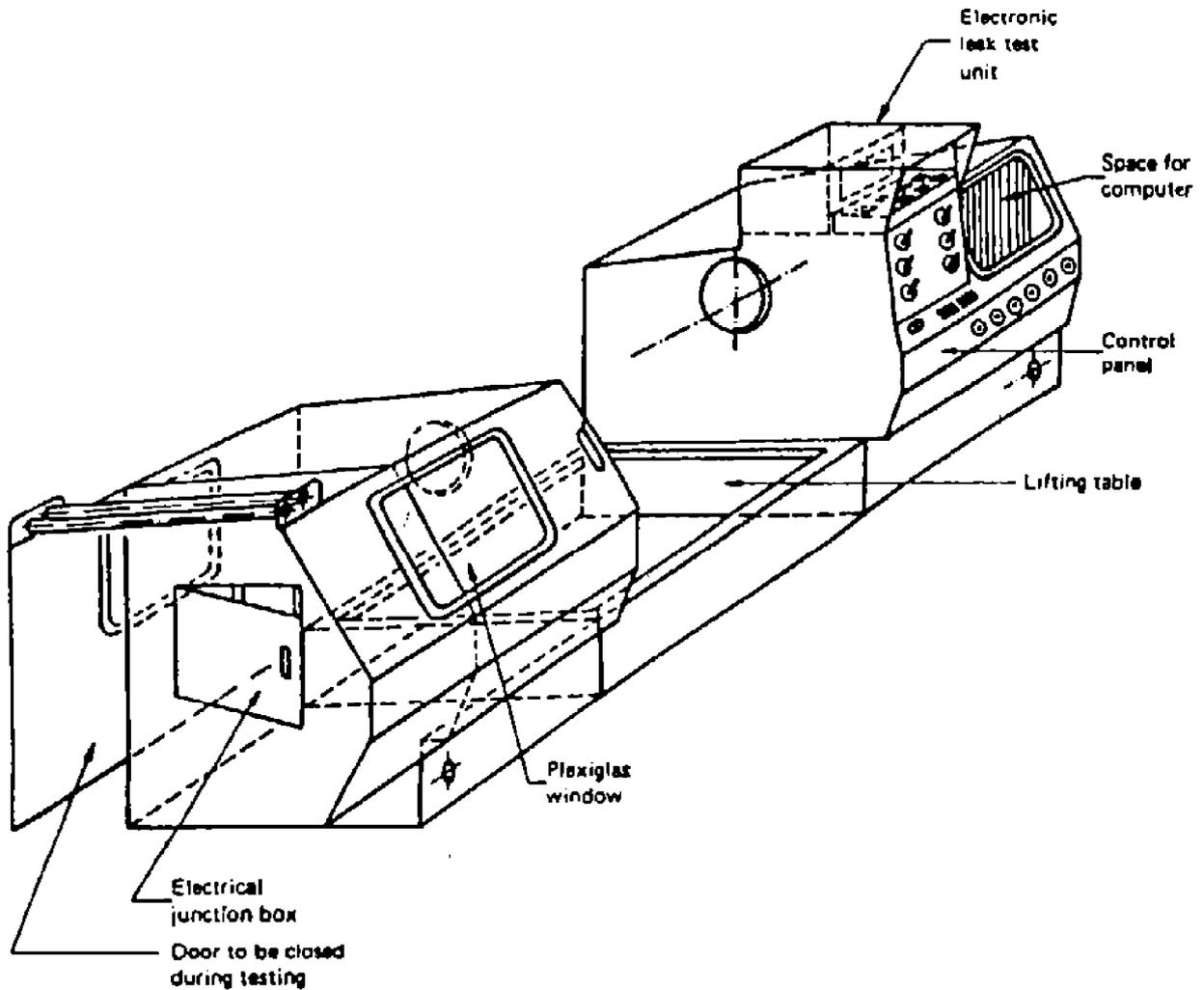


TYPICAL CONTROL VALVES TEST - BENCH

Fig. E.6

(to be continued)

APPENDIX E (continued)



TYPICAL VALVES TEST - BENCH  
Fig. E.7

E.5.2.2.2 Temperature test-bench

1) Construction

- all metal with totally enclosed back and removable doors,
- working surface for the bath to be stainless steel,
- high temperature baths to be insulated,
- with internal forced ventilation,
- all control and visual systems to be mounted in the 'top unit'.

2) Typical temperature range

- from -30°C to +600°C in four baths.

(to be continued)

**APPENDIX E (continued)**

**3) Bath characteristics**

- refer to bath specifications Table E.2 of this Appendix.

**4) Indication and control**

- baths to be continuously monitored by analog (or digital) indicators,
- thermometers to be of the mercury precision type,
- a safety cut out device shall be fitted to prevent overheating and fire damage,
- bath on/off control to be programmable,
- connection for instrument air supply,
- socket outlets for 110/120 V.

**5) Accessories**

- mercury in glass thermometer,
- instrument air filter/reducer,
- set of supports for the instruments under test,
- individual temperature control system for each bath.

**6) Dimensions**

- 2400 × 850 × 1220 mm for a four bath unit.

**7) Power supply**

- normally 380 V 3 phase.

**TABLE E.2 - TEMPERATURE TEST-BENCH BATH SPECIFICATION (TYPICAL)**

<b>SPECIFICATION</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Range (°C)	-30/+80	Ambient/+80	80/230	100/600
Tank Capacity (ltr)	23	20	20	17
Top Hole Size (mm)	210 × 160	210 × 160	210 × 160	230 (diameter)
Max. Depth (mm)	355	355	355	420
Media Height (mm)	270	270	270	406
Recommended Media (supplied only on request)	Kerosene, Water/Industrial Alcohol, Water	Distilled Water, Polyethylene Glycol 200	Silicone Oil, Polyethylene Glycol 1400	—
Media Supplied as Standard	—	—	—	Specially Treated Aluminum Oxide
Temperature Controller	Solid State, High Accuracy	Solid State, High Accuracy	Solid State, High Accuracy	Solid State, P + I + D
Control Sensitivity (°C)	from ±0.15 to 0.05	from ±0.15 to ±0.05	from ±0.3 to ±0.05	±0.25 at 600°C
Uniformity (°C)	±0.05	±0.05	±0.25	±0.5
Power (watt)	1200	750	1500	3000
Cooling Rate (°C)/hour	7.5	—	—	—
Heating Rate (°C)/hour	50	60	100	250
Refrigeration	Continuous Below +35°C	Cooling Coil for Tap Water	—	—
Protection from Over Temperature (variable)	Reset from Front	Reset from Front	Reset from Front	—
Ditto (fixed)	Factory Set at 80°C	Factory Set at 80°C	Factory Set at 230°C	—
Precision Thermometer (mercury-in-glass)	-38/+50°C -5/+100°C	-5/+100°C —	-10/+360°C —	-10/+480°C 200/610°C
Temperature Read-out	digital	analogue	analogue	analogue
Air Supply (with flowmeters)	—	—	—	125 litres/min. at 50
Programmer	Yes	Yes	Yes	No

**APPENDIX E (continued)****E.5.2.2.3 Hydraulic test bench (portable)****1) General**

To be suitable for the liquid testing of equipment with hand operated pumps of 300 bar max. capacity.

**2) Hydraulic oil reservoir**

- capacity 20 liters, constructed from heavy gage steel plate.

**3) Hand pump**

- built into the reservoir and fitted with a release valve.

**4) Strainer plate****5) Test stand****6) Deflector/safety guard**

- of transparent material.

**7) Pressure gages-for setting and control**

0 to 10 bar

0 to 60 bar

0 to 100 bar

0 to 300 bar.

**8) Selection valve for each gage****9) Control panel-for gages etc.****10) Dimensions**

- 660 × 555 × 350 mm.

**11) Weight 70 kg approx.**