PROCEDURAL SPECIFICATION

EQUIPMENT AND TOOLS FOR MAINTENANCE AND INSPECTION

Part 5 - Instrument Technical Centre and Workshop - Equipment and Tools

DEP 70.08.10.14-Gen.

April 1987
(DEP Circular 52/95 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

The right to use DEPs is granted by SIOP, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from SIOP, SIEP or SIC. Consequently, three categories of users of DEPs can be distinguished:

1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, SIOP, SIEP and SIC disclaim any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof. The benefit of this disclaimer shall inure in all respects to SIOP, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

1.1 GENERAL

This procedural specification is intended as a guide for determination of the optimum arrangement for an instrument technical centre, workshop(s) and other relevant areas. It also gives guidance for the selection of equipment and tools required for the centre/workshop and on the plant, to cover a normal range of maintenance work on new and existing oil, chemical and gas installations and certain facilities for exploration and production.

This publication is Part 5 of a series of DEP publications, under the subject heading of:

Amended per Circular 52/95

Part 2	-	Mechanical Workshop	-	Equipment
Part 3	-	Mechanical Maintenance	-	Tools
Part 4	-	Electrical Workshop	-	Test equipment and tools
Part 5	-	Instrument Technical Centre and Workshop	-	Equipment and tools

It is intended for use by companies belonging to or managed by the Royal Dutch/Shell Group and engineering contractors nominated by them.

Where cross references are made in this publication, the number of the section or sub-section referred to is shown in brackets.

All publications referred to are listed in Section 8.

1.2 DEFINITIONS

For the purpose of this publication the following definitions shall hold:

Shall and **Should** - the word 'shall' is to be understood as mandatory and the word 'should' as strongly recommended to comply with the requirements of this procedural specification.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction.
The Principal will generally specify the technical requirements.
The Principal may also include an agent or consultant, authorized to act for the Principal.

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project.
The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment to perform the duties specified by the Contractor.

Pipe sizes: The international nomenclature - **Diameter Nominal** - written as DN 15, 25, 40, 50, etc., has been used for pipe sizes in this publication.

2. GENERAL INFORMATION

This procedural specification, although primarily developed to meet the needs of oil refineries, chemical plants and gas plants, etc., also gives some guidance on the provision of workshop facilities for offshore platforms.

It is intended to assist the organization concerned in deciding on the optimum arrangement/layout of an instrument technical centre and/or workshop(s) to suit its particular needs and in furnishing the technical centre and/or workshops with the necessary tools and equipment.

IMPORTANT NOTE:

This publication is intended to cover the facilities which may be required for the small, medium and large size refinery, plant or installation, etc., applying instrumentation that may be only basic or highly complex. The final arrangement depends on many factors which are generally indicated in this publication. However, as an example, a technical centre and workshop have been sized and illustrated in the Appendices, to house a 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 plant carrying out its own maintenance. The estimated size required approximates to an area of 360 m^2 as previously envisaged for the instrument section of such a workshop complex in DEP 70.08.10.11-Gen., in addition, this publication considers the application of 'satellite' workshops.

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 for guidance only. The proposal shall then be presented to the principal for his approval in writing.

The various sections and appendices which make up this publication are summarized as follows:

- The requirements for sizing and the arrangement of the centre and/or workshops are given in Section 3, while Section 4 indicates the type of equipment that could be located in the various sections of the centre/workshops. Appendices 1 to 4 illustrate both the arrangement of the building and layout of equipment.
- Sections 5 indicates equipment and tools required for the field maintenance of instruments and instrument systems.
- Section 6 gives special attention to the testing and maintenance of the instrumentation of on-line process stream analysis. While Appendix 5 gives alternative workshop arrangements for chemical plants, the location of sampling handling and sample conditioning systems, together with background information on sample conditioning and sample analysis.

  Section 6 also considers the effects of the maintenance of certain other processes on the technical centre and workshop, and for completion of the subject only, the effect of certain procedural considerations on the organization of the centre/workshop, i.e. 'spare parts' and 'custody transfer or trade requirements' for instrument maintenance, while Section 7 gives the duties and responsibilities of the 'instrument inspection team.'
- Requirements and illustrations of the work benches and specific instrument test benches referred to in this publication are given in Appendix 6, while Appendices 7, and 8 are lists of small tools from which a selection can be made for use in the workshop and for use on the plant by instrument technicians. Finally Appendix 9 is a list of typical laboratory glassware which is referred to in various sections of this publication.

NOTE: Instrument workshop equipment and tools should be ordered using the relevant MESC specifications and DEP requisition sheets. Where such specifications and requisition sheets do not exist and in case of doubt, the principal should be consulted.

3. INSTRUMENT TECHNICAL CENTRE AND WORKSHOP

3.1 GENERAL

As a consequence of the ever advancing technology of process instrumentation and the complexity of systems such as digital control, process analysers, process computers, etc., it is necessary to provide engineering maintenance with well equipped and efficiently organized instrument technical centres and/or workshop facilities.

The extent of these facilities will depend on the type of organization concerned, i.e. oil refinery, chemical plant or offshore platform, etc., its size and complexity and whether maintenance is to be carried out by:

- company personnel only
- company personnel assisted by a contractor
- contractor only.

Accommodation required may range from an office and certain specialized test equipment located in a standards room when maintenance is carried out by a contractor, to fully equipped workshops for maintenance by company personnel.

The facilities described in this publication are typical requirements necessary for the maintenance of:

- pneumatic instrumentation
- electronic instrumentation
- digital systems, including process computers
- telecommunication systems, including CCTV
- analyser systems.

NOTES: 1) Computer maintenance should include hardware and when applicable revisions, extensions to, and storage of software packages.

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

For the small refinery or chemical plant, the central/main instrument technical centre and workshop may form part of a larger maintenance complex together with the mechanical and electrical engineering disciplines, see Appendix 1 of this publication and DEP 70.08.10.11-Gen. However, for large plants a dedicated instrument technical centre should be considered.

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

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

The requirements for Exploration and Production locations are not as readily defined as those for refinery operations, they are dependent on factors such as:

- the inventory and complexity of the equipment installed
- the physical environment
- the proximity to existing workshop facilities
- the transportation available.

This publication indicates the facilities required to maintain and test each group of instruments. Workshop requirements can be identified by selecting the appropriate facilities necessary for the groups of instruments which have been installed.

3.2 CENTRAL/MAIN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP

Both the size and the layout of the building may vary depending on the size of the refinery or chemical plant, etc., concerned. Typical arrangements of an instrument technical centre and workshop are given in Appendix 2.

A small refinery or chemical 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 refineries and 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 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 providing acceptable 'noise levels' inside offices, computer and standards rooms, see DEP 31.10.00.31-Gen., and DEP 34.17.00.32-Gen.

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 centres 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

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.

A typical layout of a 'satellite' workshop is included as Appendix 4.

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 CENTRES AND WORKSHOPS

The minimum size required for work areas and offices should be based on an area of 9.5 m^2 as a minimum for each person.

Refer also to DEP 34.17.00.32-Gen., 'Minimum requirements for the design and engineering of buildings'.

The size of the central or main instrument workshop envisaged for the medium sized refinery or chemical plant described in this publication and as applied for the layout drawings of Appendix 2, covers an area of 360 m^2.

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 x 6 m.

3.6 TYPICAL INTERNAL LAYOUT FOR AN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP

3.6.1 General

The instrument technical centre and workshop building, as illustrated in Layouts 1 and 2 of Appendix 2, should typically comprise the following:

1) Office accommodation for:
   - engineers

- supervisors/foremen

Offices inside the workshop should be restricted to direct supervisory personnel.

- planning functions

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
    and
  - despatch, for repaired instruments/components

- cleaning and painting

- heavy duty area (handling large control valves, etc.)
- machining operations

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 2, 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.

- pneumatic instrumentation
- electronic instrumentation
- data and telecommunication
- industrial analysers

} Includes inspection, repairs, testing and calibration

3) Storage facilities for:

- working spare parts
- consumable items (gaskets bolts and nuts, etc.)
- chemical products
- analysers
- computer spare parts (including disks, etc.).

4) Special workshop facilities for:

- standards (of measuring and calibration, etc.)
- high-precision (machining and instrument fitting, etc.)
- electronic instrument testing
- computer operations
- analyser-type instrument testing

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

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

NOTE: See also Section 6 and Appendix 5, for alternative arrangements for chemical plants and for background information on sample conditioning and sample analysis.

3.7 UTILITIES

The relevant workshops of the technical centre shall be provided with steam, water and tool air, etc., from the plant or workshop utilities system, see DEP 34.17.00.32-Gen., and an 'instrument air' supply, see DEP 31.37.00.11-Gen., as appropriate.

Electricity for power and lighting shall be installed in accordance with the requirements of DEP 33.64.10.10-Gen. 'Electrical engineering guidelines'. Voltages that may be required are

for example, 220 volts AC at 50 Hz, 48 and 24 volts DC, or they shall be adapted to suit local conditions, for example, 240 volts AC at 60 Hz, etc. The voltages required shall be indicated in the project specification and the requisitions.

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

3.8 WORKSHOP BUILDINGS

3.8.1 Construction

The building shall be constructed in accordance with the general requirements of DEP 34.17.00.32-Gen.

3.8.2 Floor finish

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

- all rooms with concrete finish shall be sealed with a dust proof Epoxy resin.
- the floors of analyser rooms shall be finished with acid-resistant tiles, in the same way as Analyser Houses see Appendix 1 of DEP 34.17.00.32-Gen.

  NOTE: An oil contaminated drainage system will also be required, see Section 7 of the above DEP.

3.8.3 Heating ventilating and air conditioning

Ventilation is particularly required for the following rooms:

- cleaning and painting (4.2.2.2)

  NOTE: 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.

- analyser test and calibration room (4.2.4.4)

  NOTE: When forming part of a building complex, analyser 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.

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 room (4.2.4.1)

  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' (4.2.4.3)
- analyser test and calibration room (4.2.4.4)
- other offices, 'shops' and rooms as appropriate.

The HVAC system should then be in accordance with the requirements of Section 4 of DEP 34.17.00.32-Gen.

NOTES: If a stand alone HVAC system is to be installed, then a stand by unit should also be provided.

3.8.4 Fire and gas detection and fire protection

The sections of the workshop building shall be protected in accordance with the publications, DEP 34.17.00.32-Gen., 'Minimum requirements for the design of buildings', DEP 80.47.10.30-Gen., 'Requirements for fire protection in onshore oil and gas processing and petrochemical plants' and DEP 80.47.10.32-Gen., 'Portable and mobile equipment for fire fighting'.

In addition, analyser 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, see Section 8 of the DEP 32.31.50.13-Gen. 'On-line process stream analysis - Part 4 Analyser houses'.

4. EQUIPMENT FOR THE TECHNICAL CENTRE AND WORKSHOP

4.1 GENERAL

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 manufacturer's specifications. This is particularly important when measurements have to comply with 'Trade and Customs' or fiscal requirements.

The offices, 'shops' and rooms of the technical centre and workshop considered in this manual are provided with a proposed inventory (4.5) of furniture, equipment, machines and tools and which is shown on the drawings of Appendix 3.

4.2 CENTRAL/MAIN TECHNICAL CENTRE AND WORKSHOP

4.2.1 Office accommodation

The offices shall be equipped with normal office furniture.

4.2.1.1 Planning Office

This office should be provided with normal office furniture and specialized planning equipment as required.

NOTES: 1) 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.

2) 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.

NOTE: This 'shop' should also allow the entry of vehicles such as the one used for pipeline instrumentation checking (6.2), and those requiring maintenance of their communication equipment.

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 Electronic shop

As above, but for electrically operated instruments.

4.2.2.6 Analyser shop

As above, but for industrial analysers. See also Section 6 and Appendix 5.

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 analyser testing, etc.)
- analysers
- computer spare parts (including discs and software, etc.).

4.2.4 Special workshop facilities

4.2.4.1 Standards 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 specifically 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 Electronic instrument test room

This room should house the special electronic test equipment and contain facilities for carrying out specific tests.

4.2.4.4 Analyser test room

This room will be used for the testing and calibrating of industrial analysers and for development work.

4.2.4.5 Analyser sample conditioning system

A system for preparing samples of the process stream with which to test and calibrate the analysers, shall be positioned against the outside wall of the analyser 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 6 and Appendix 5 for alternative arrangements for chemical plants and background information on sample conditioning and sample analysis.

4.2.4.6 Computer room

Because of the growing application of the computer a room should be dedicated in the instrument technical centre 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 gauges, 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
- a test chassis for ICS systems,

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, using MESC Group 83 as a guide, see Appendices 7, and 8.

DEP 70.08.10.12-Gen. gives guidance on the selection of small tools for 'mechanical maintenance' and should be referred to for this aspect. 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 3 shows proposed items of equipment and their suggested location in the instrument technical centre and workshop, superimposed on the layout drawings of Appendix 2.

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 4.5.9).

4.5.2 Furniture

	Item
- 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

	Item
- 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.

4.5.6 Machine tools

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

4.5.7 Work- and test-benches

1. Standard work-benches

	Item
- general duty	30
- heavy duty.	31.

2. Non standard work-benches

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

3. Standard test-benches

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

4. Non-standard test-benches

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

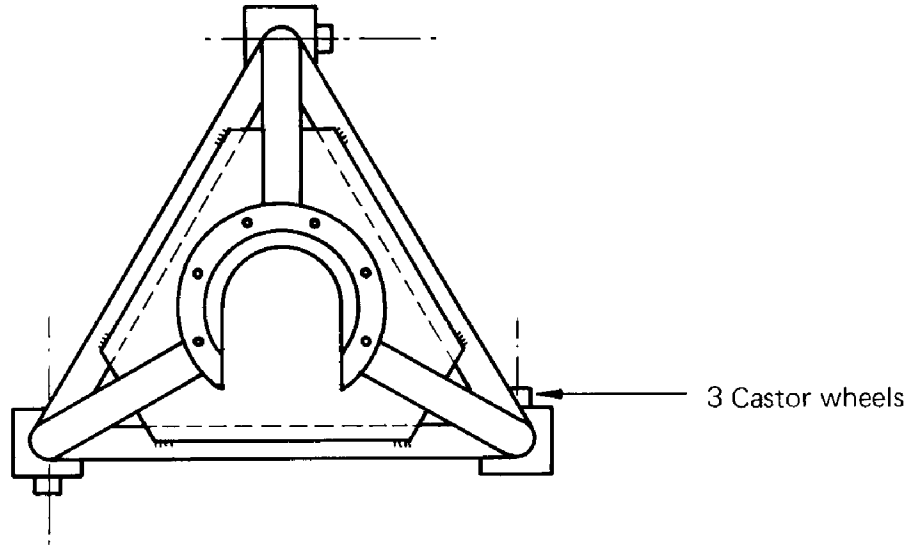
4.5.8 Miscellaneous instrument workshop equipment

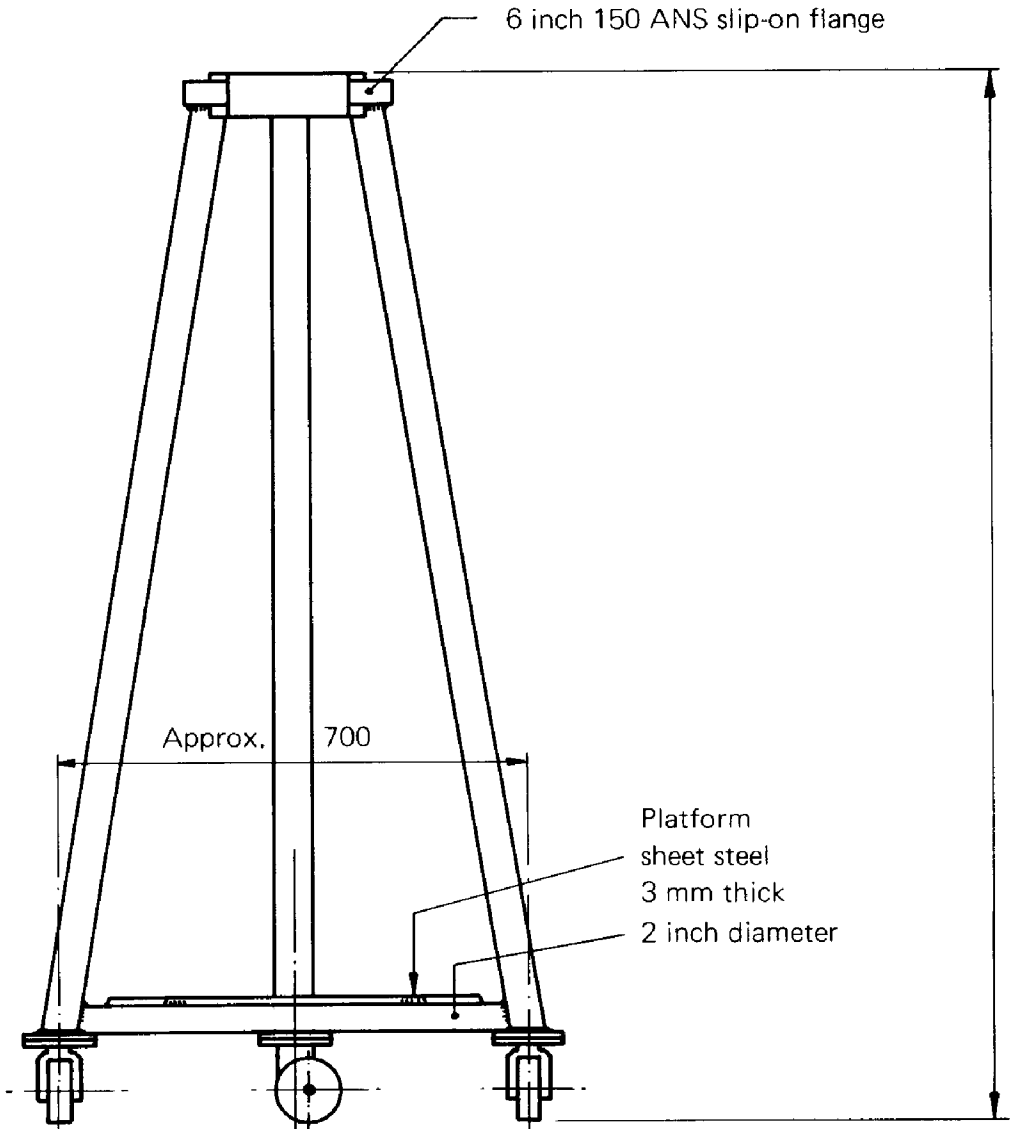
		Item
-	hoisting facilities (electric or pneumatic)	47
-	painting booth	48
-	small welding booth	49
-	mobile hand volume pump	50
-	portable vice (with folding tripod stand)	51
-	pipe bending machine	52
-	cutting shears (hand lever operated)	53
-	magnifying glass (with light source)	54
-	ultra violet light facilities	55
-	test rig for storage tank gauges,	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 (see Appendix 9)	65
-	a Faraday cage	66
-	rack for PLC and GLC equipment	67
-	deep freeze (laboratory type)	68
-	trailer (low loader type)	69
-	mobile crane (3 tonne max. capacity).	70.

NOTE: Typical specifications for some machine tools and items of miscellaneous workshop equipment are given in DEP 70.08.10.11-Gen., 'Mechanical workshop equipment'. Where specifications for particular items have not been covered and further information is required, the principal should be consulted.

TEST RIG FOR TANK LEVEL GAUGES - ITEM 56

Scale 1:10

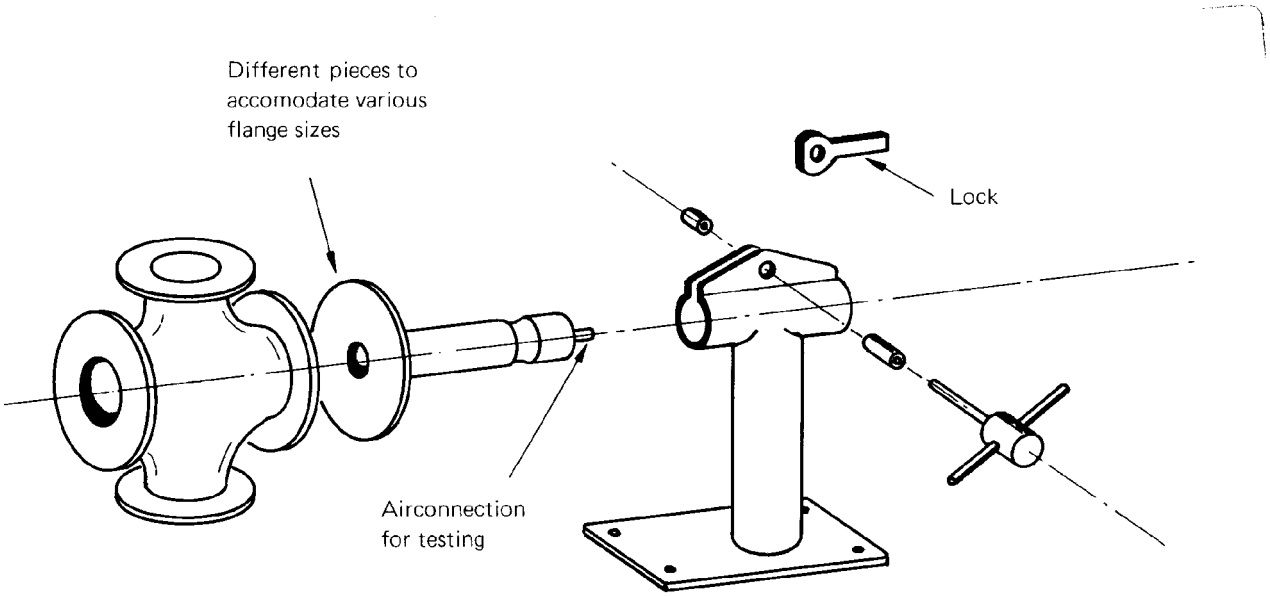


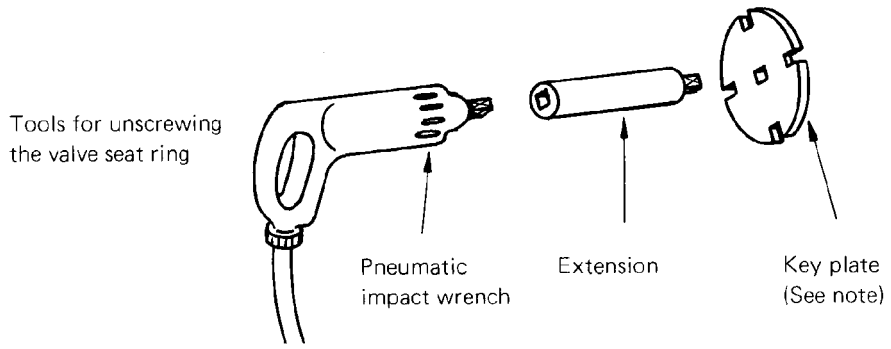


TEST STAND FOR CONTROL VALVES - ITEM 57

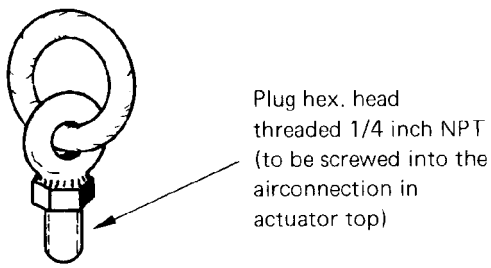
(4.5.8)

TEST STAND FOR CONTROL VALVES - ITEM 57





Hoisting ring for lifting control valves



Note: A complete set of key-plates shall be available, suitable for all sizes and makes of control valves in use in the plant.

4.5.9 Test equipment

The following sub-sections list test equipment which should be available, as applicable, in certain sections of an instrument technical centre. 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.

4.5.9.1 Standards 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)
- McLeod Gauge
- precision variable resistance (Decade box)
- wheatstone bridge
- high precision barometer
- high precision dew point hygrometer
- standard platinum resistance
- precision current source
- flat bed recorder
- standard thermocouples
- manoscope
- miniscope
- 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^{-8} V).
2) frequency - check atomically if necessary.
3) All testing equipment in this room shall be certified as primary testing equipment and should not be taken outside the room.

4.5.9.2 Pneumatic 'shop'

- precision pressure regulator
- pneumatic test rig for controllers (depending on manufacturer)
- set of precision gauges
- 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 bars)
- portable low pressure pump
- portable calibrator
- pneumatic calibrator
- electro-pneumatic calibrator
- set of Dwyer equipment
- absolute pressure unit
- deadweight tester system (0 to 10 bar)
- deadweight tester system (0 to 200 bar).

4.5.9.3 Electronic 'shop'

- portable temperature indicator ($6\ ^1/_2$ digits)
- portable multivolt meter ($6\ ^1/_2$ digits)
- wheatstone bridge

- variable resistance (Decade box)
- universal meter
- analogic voltmeter multi-function
- logic analyser
- electronic voltmeter
- digital counter frequence 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 such as Foxboro or Honeywell)
- digital oscilloscope with memory
- low-voltage megger (50 Volts)
- high-voltage megger (500 Volts)
- earth fault detector
- specific 'manufacturers' calibrator
  (e.g. Honeywell or Foxborough, etc.)
- cold junction reference
- optic attenuator
  (with local optical power injection and detection, for repairing optic fibre cables.)

4.5.9.4 Analyser 'shop'

- trace moisture generator
- trace moisture analyser
- H_2S detector
- H_2S generator
- portable oxygen analyser
- hydrogen purifier
- conductivity meter box
- portable pH/MV meter (0.01 pH reading)
- flowmeter kit
- mass flow meter (suitable for H_2)
- 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.

4.5.9.5 Analyser 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
- set of peristaltic pumps.

4.5.9.6 Data and telecommunication

Data communication and telecommunication test equipment should be a part of the electronic workshop. The equipment listed below should be considered in addition to the test equipment recommended by the manufacturer's of data and telecommunication equipment.

Test equipment shall be obtained only from approved or well-known suppliers, preferably the suppliers of the data and telecommunication equipment itself.

The type of equipment shall be reviewed and updated for each project.

NOTE: Test equipment shall be in accordance with the recommendations of the International Telegraph and Telephone Consultative Committee (CCITT - Geneva), or for those locations which apply American Standards; with the equivalent Bell Corporation publications.

Telecommunication

- digital multimeter
- analogue multimeter (4 $^{1}/_{2}$ digits)
- desktop digital multimeter
- function generator (0.1 to 13 MHz sinus/square/triangle)
- frequency counter (500MHz)
- portable 100 MHz dual trace storage oscilloscope
- time domain reflectometry cable tester
- EIA (Electronic Instruments Association)/CCITT Interface test box ('break out box')
- datascope (serial data analyser)
- handheld level generator
- hand held level meter
- transmission test set
- RF power meter insertion type
- tranceiver test set
- modulation meter
- logic trouble shooting kit.

Telephone

- portable digital pulse
- ectometer (with charger).

Closed circuit television (CCTV) systems

In general, test equipment should be included as part of the original order for the CCTV system. The test equipment, including a monitor, is normally provided in one cabinet as part of the system, from which all the required signals or functions can be generated.

If monitors and cameras are to be checked and repaired in the instrument workshop, the equipment listed below should also be available, but special equipment is not required for field maintenance.

- test pattern generator

- test slide projector (1 inch)
- test slide projector ($^2/_3$ inch)
- video waveform monitor
- standard lens (50 mm)
- light box (1400 lux).

NOTE: In cases of doubt concerning specifications for the test equipment referred to above, the principal should be consulted.

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 analyser 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 chemical plant or refinery, etc., 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 chemical plant/refinery, etc., as considered in this publication.

5.1.1 Test equipment

- set of precision pressure gauges
- low-pressure calibration unit (including vacuum)
- portable calibration unit (for variable pitch fans)
- set of digital pressure calibrators (300 mb to 10 bar)
- portable hand 'volume pump' (0 to 70 bar as required)
- pneumatic portable calibration unit (0.2 to 1 bar)
- electro/pneumatic portable calibration unit (4 to 20 mA)
- portable temperature indicator (TC simulator)
- high voltage 'Megger' (capacity 500 volts)
- one or two electronic digital voltmeters (HP or similar)
- set of standard thermometers
- variable resistance (Decade box)
- oscilloscope (general purpose)
- PT 100 simulator calibrator
- PT 1000 simulator calibrator
- dual pulse generator
- infra-red camera (optional)
- digital infra-red thermometer
- digital thermometer (contact probe set)
- wheatstone bridge
- earth fault detector
- portable tachometer
- geiger counter
- 'manufacturer's' calibrator(s) (e.g. Foxboro).

5.1.2 Additional items for ICS (Integrated Control Systems)

- digital oscilloscope memory
- flat bed recorder (2 pens)
- portable pulse and function generator
- portable electronic voltmeter
- portable variable power supply (amps/volts).

NOTE: The above equipment should be kept in an area of the control centre reserved for maintenance, inspection and test facilities.

5.2 SMALL TOOLS FOR FIELD MAINTENANCE

Small tools should be selected locally to suit requirements using MESC Group 83 for guidance. A typical listing of such tools is given in Appendix 8, with a classification code to indicate the make up of the various types of instrument fitter/technician tool kits.

NOTE: The tools should be kept in tool boxes preferably in a storage area reserved for 'field maintenance' technicians, when not in use.

6. ADDITIONAL MAINTENANCE FACILITIES

6.1 ON LINE PROCESS STREAM ANALYSERS

6.1.1 In 'situ tests' and maintenance

In general, industrial analysers are grouped and localized in the middle of the plants with which they are concerned, and/or installed in analyser buildings. However, certain analysers are required in specific locations, such as for O_2 for furnaces and pH meters for various items of equipment, etc.

Their installation in buildings is convenient for maintenance purposes and two types of 'in situ' maintenance are distinguished.

1) **Routine checking**

   Consisting only of the checking of flow, pressure, power, temperature, output of instrumentation and, if installed, air-conditioning systems.

2) **Tests and calibrations**

   Where the Analyser (QMI) 'workshop' is located far away from the plant, it may be more advantageous to carry out the following procedures inside the analyser buildings itself, since all utilities and samples are readily available:

   - performance testing
   - the replacing of components/electronics cards
   - changing of scale.

   The test equipment could be installed on a mobile test-bench.

   NOTE: Test Equipment shall be connected to those supply sockets which are switched off when the safety system of the analyser room is activated.

6.1.2 Equipment required

1) An Electronic test rack complete with:

   - an oscilloscope (which could be made available from the Analyser workshop)
   - one or two stablized power supply units
   - a multi-trend recorder
   - a universal meter
   - a flat bed recorder (2 pens).

2) Portable equipment consisting of:

   - a small set of laboratory glassware (see Appendix 9)
   - a set of standard manometers (0.5 to 10 bar)
   - a vacuum tester
   - a bubble meter
   - a hand pump (50 bar max.)*
   - one or two small hand pumps (with vacuum facilities)
   - an electro-pneumatic calibrator
   - air-conditioning test equipment (if required)*
   - a trolley (for electronic equipment)
   - filing cabinets.

   * Common for all analyser houses.

6.1.3 Analyser house facilities and the analyser (QMI) workshop

When facilities allowing 'in situ' inspection, testing and maintenance are included in analyser houses, workshop requirements can be reduced accordingly.

The workshop would then only need to provide facilities for specific tests and calibration, requiring minor chemical preparations and the minimum number of QMI specialists.

6.1.4 Requirements of petrochemical and chemical plants

The analyser requirements of petrochemical and chemical plants in general, differ from those of a normal refinery, especially for chromatography and in rapid product evolution.

NOTE: To meet the above requirements, the instrument technical centre/workshop should be provided with an analytical section generally as indicated on pages 2 and 3 of Appendix 5, equipped as indicated below.

6.1.4.1 Analyser (QMI) 'workshop' layout

The area allocated for an Analyser (QMI) 'workshop' should typically have accommodation for:

- an engineers office
- a chemical room
- a test and development room
- a small mechanical room
- storage.

NOTE: The door between the analyser and instrument workshops should normally be closed and the air-conditioning system, if installed, shall allow a slightly higher pressure in the instrument workshop than in the analyser workshop.

6.1.4.2 Equipment in the Analyser (QMI) 'workshop'

1. **Chemical Room**

   - laboratory work-bench (with an acid-resistant sink fitted with a fume hood)
   - test-bench (Item 39, see Appendix 6)
   - distilled water apparatus
   - set of laboratory glassware
   - cupboards (for drying/storage with side entries for GLC column up to 450°C)
   - weighing balance (High precision, digital reading 0 to 15 kg).

2. **Development, Test and Calibration Room**

   This room should have sufficient working space for QMI specialists and the following equipment, say 25 m^2:

   - air purifying system (active coal)
   - industrial sink (acid-resistant)
   - industrial GLC's (preferably of the same type and mounted for field use)
   - sampling rack (installed outside the building)
   - mobile drum (See Appendix 5 pages 4 and 5).

   NOTES: (1) The GLC's and the mobile drum may also be used in the field for specific performance tests.

   (2) The GLC's should be microprocessor based with serial links to a small or centralized system having printer facilities.

   - sampling gases (such as H_2, N_2, and purified air, stored on the outside of this room)
   - sampling bottles (also stored outside with a connection to the test benches.)

   NOTES: 1) A laboratory type GC such as the Hewlett Packard or Perkins Eleven should also be considered.

   2) The above equipment would also apply for a large refinery with associated chemical plants, if required.

3. **Small mechanical room**

   - drilling machine
   - grinding machine
   - fume hood (industrial type)
   - welding facilities (including 'argon-arc').

   NOTES: 1) Other test equipment requirements are the same as for a refinery QMI workshop, see (4.5.9.4).

2) See also Appendix 5.

6.1.5 Maintenance of analysers in central/plant laboratories

6.1.5.1 Test room

Equipment in the modern laboratory is becoming more complex and many new analysers are equipped with microprocessors or computers. A special room should be available in the laboratory for the testing, maintenance and calibration of analysers.

The size of the test room should not be less than 3 m x 4 m.

The test room should be equipped with the following items:

- an analyser test-bench (including power supply units)
- utilities (such as instrument air, water, steam and electricity)
- acid-resistant sink with a fume hood
- gases such H_2, N_2

NOTES: 1) Test equipment such as oscilloscopes and electronic voltmeters,etc., could be borrowed from the QMI central workshop.

2) Special equipment such as CFR Motors, Spectrometers, etc., may require special maintenance contracts.

3) This room should be equipped with an air ventilation system as a minimum, see (3.8.3).

6.2 PIPELINE INSTRUMENTATION - INCLUDING PUMPSTATIONS

The inspection and testing of such equipment could be carried out using a small vehicle equipped with a test-bench and the appropriate test equipment including a small air compressor and/or hydraulic pump.

NOTE: The vehicle and its equipment should be part of the workshop inventory and be controlled by the responsible instrument workshop engineer.

Alternatively, certain items of test equipment and maintenance spare parts could be kept at the pump station.

6.3 MAINTENANCE OF HYDRAULIC SYSTEMS

No specific instrumentation is installed, other than oil distributors, and high pressure switches, differential pressure cells, and automatic valves with hydraulic actuators, e.g. motor operated valves (MOV's).

The test equipment required is a high pressure hand pump, and/or a small specific test-bench, see Appendix 6 page 28.

6.4 MAINTENANCE OF HEATING VENTILATING AND AIR CONDITIONING SYSTEMS

The following equipment should be available:

- anemometer (direct reading electronic type)
- manometer (inclined type, pressure range to suit fan duties)
- pitot tubes (static, to suit duct sizes)
- pitot tube flow meter
- hygrometer
- thermometers (mercury in steel type)
- dry bulb temperature recorder
- combined temperature and humidity recorder
- ammeters
- tachometers
- portable blower with a flow measuring device
- sound analyser and vibration meter.

6.5 'CUSTODY TRANSFER OR TRADE REQUIREMENTS' FOR INSTRUMENT MAINTENANCE

6.5.1 General

Because certain products carry customs duty, operations concerning such products need to be strictly controlled. These operations include transfer of products, the loading of ships, road and rail cars and the following instrumentation is involved:

- flowmetering, (liquid and gas)
- tank gauging systems
- loading systems
- weighing systems
- packing machines associated with weighing systems
- statistic control systems
- prover loop (if permanently installed).

NOTE: The above equipment requires special attention with regards to accuracy.

6.5.2 Maintenance and the workshop organization

6.5.2.1 Small refineries or chemical plants

Personnel requirements for maintaining the instrumentation for 'custody' transfer should normally be minimal.

The 'standards' room need only be small.

6.5.2.2 Large refineries, petrochemical and chemical plants

The volume of maintenance work will effect both the size and organization of the workshop. Two or three specialists should be specifically assigned as **'The Metrology Team'** for this work and the 'standards' room will need to be sized accordingly.

Standards room equipment

For details refer to sub-section 4.2.4.

NOTE: Authorities such as 'customs', etc., can at any time demand to see the calibration records. A specific filing cabinet should be provided in the standards room for this purpose. The authorities can also insist on checking the primary 'standard equipment' at any time.

6.5.3 Contact with local authorities

The 'Metrology Team' should be approved by local authorities for the carrying out of 'customs' tests and to maintain the equipment used for measurement of product subject to customs duty.

6.6 SPARE PARTS FOR INSTRUMENT MAINTENANCE

General working spares

For efficient day to day maintenance, complete instruments such as:

- differential pressure cells
- controllers (electronic or pneumatic)
- recorders
- electronic printed circuit boards
- manometers, thermometers, TC's and RTD's
- small size Control Valves
- consumables, such as gaskets, various small fittings and small items of electronic equipment

should be available in full working condition in the instrument main workshop. When applicable, it may be advantageous for certain critical items to be kept also in the 'satellite' workshop.

Working spare parts for digital control systems

Spare parts such as printed circuit boards should be stored in a cabinet in the control building maintenance room, to be available for quick replacement.

Other critical spares shall be retained in the instrument technical centre and workshop.

NOTES:
1) Working spare parts shall not be used for planned maintenance or 'shutdowns'.

2) A complete set of working spare parts shall always be part of the initial requisitions.

3) The necessary environmental conditions required for the storage of spare parts shall be provided.

4) The planning section should normally be responsible for 'working spare parts', increasing or decreasing quantities as required and placing orders for new parts in conjunction with the Materials Department.

   A computer terminal or small stand alone computer is recommended to control the necessary administration.

5) Normal spare parts will be automatically controlled by the SPIR/MESC system.

7. INSPECTION OF INSTRUMENTATION

7.1 THE INSPECTION TEAM

The Instrument Inspection Team is generally responsible for instrument inspection, acceptance of new equipment for, and improvements/modifications to, the following systems:

- safeguarding
- fire and gas detection and control systems
- depressuring systems
- (emergency) shutdown systems
- main alarms control.

Their duties include, the compilation of testing procedures and the execution of systematic tests to prove the accuracy and functioning of the instruments.

To carry out the necessary inspection, the team will require access to items of inspection and test equipment such as:

- logic analysers
- flat bed recorders
- infra red cameras
- noise analysis and recording equipment
- sound level meters
- vibration measuring equipment
- optical pyrometers
- geiger counters.

Most of the equipment required by the team should be available from the 'electronic' workshops.

A further important duty of the Inspection Team is the keeping of records for instrument systems. They shall therefore need access to the computer in the 'planning' room.

NOTES:
1) The Team shall also be conversant with the requirements of local authorities, such as for weights and measures, etc., (see sub-section 6.5) and for the required environmental conditions.

2) The Inspection Team for Exploration and Production facilities, both on and offshore, is co-responsible with the Operating Department for instrument inspection. They normally carry out most of the work involved. They are also expected to maintain an acceptable level of reliability and accuracy of the instrument systems.

8. REFERENCES

In this procedural specification, reference is made to the following publications.

NOTE: The latest issue of each publication shall be used together with any amendments/supplements/revisions to such publications.

It is particularly important that the effect of revisions to international, national or other standards shall be considered when they are used in conjunction with DEP's unless the standard referred to has been prescribed by date.

Instrument air supply	DEP 31.37.00.11-Gen.
On-line process stream analysis Part 4 - Analyser houses	DEP 32.31.50.13-Gen.
Electric engineering guidelines	DEP 33.64.10.10-Gen.
Minimum requirements for the design and engineering of buildings	DEP 34.17.00.32-Gen.

Equipment and tools for maintenance and inspection:

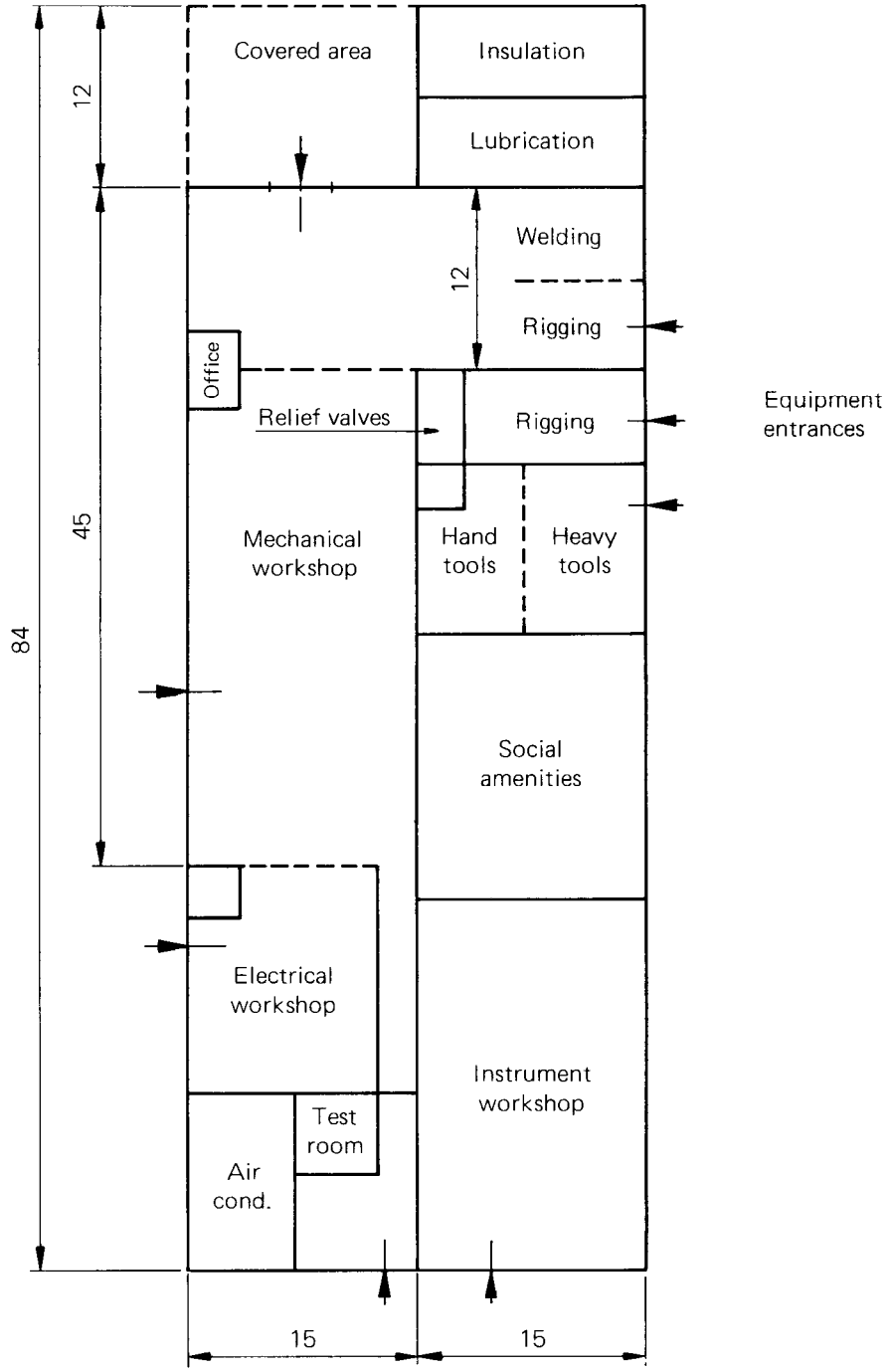
Amended per Circular 52/95

Part 2	-	Mechanical workshop - Equipment	DEP 70.08.10.11-Gen.
Part 3	-	Mechanical maintenance - Tools	DEP 70.08.10.12-Gen.
Part 4	-	Electrical workshop - Test equipment and tools	DEP 70.08.10.13-Gen.

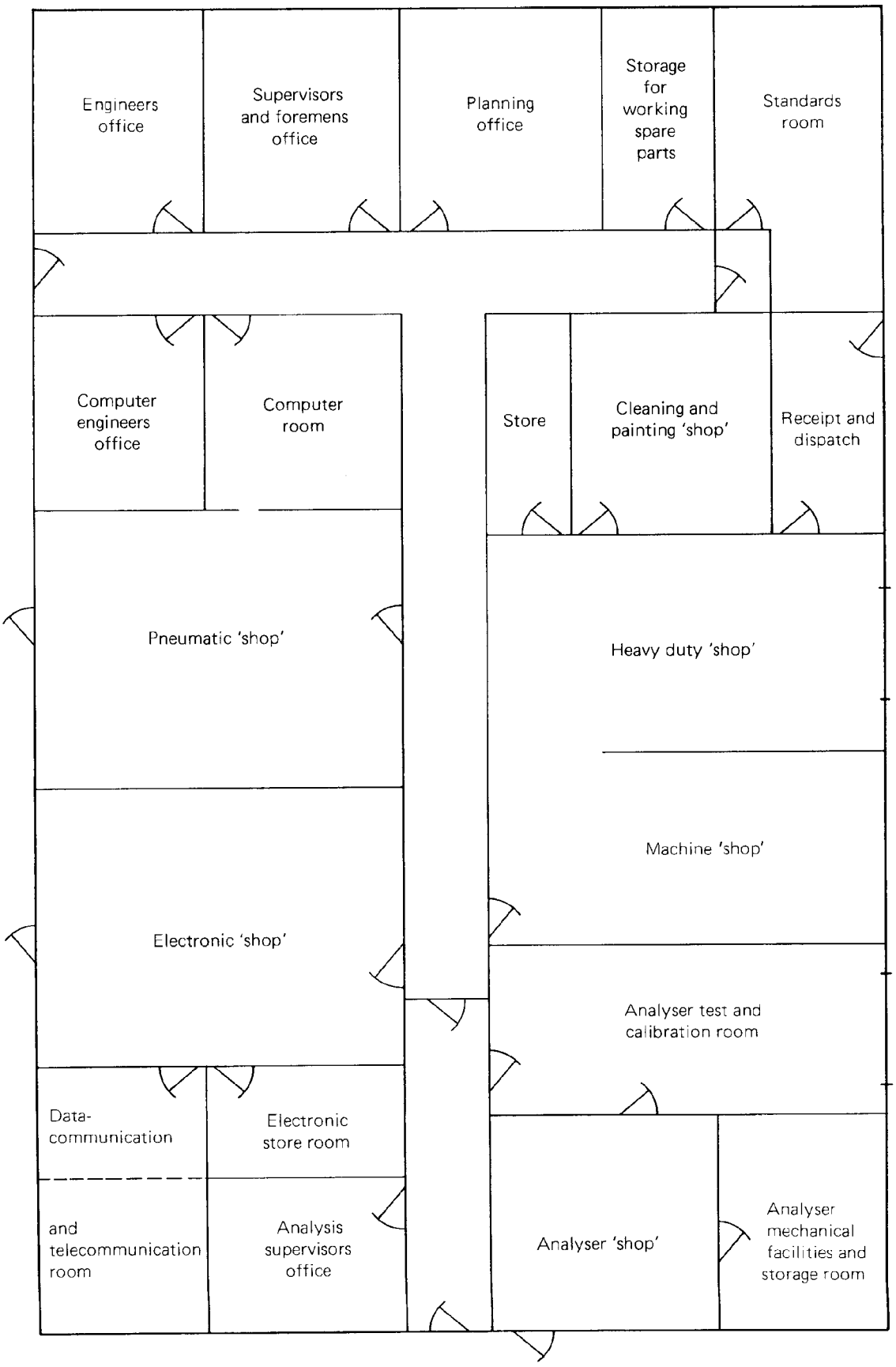
Requirements for fire protection in onshore oil and gas processing and petrochemical installations	DEP 80.47.10.30-Gen.
Portable and mobile equipment for fire fighting.	DEP 80.47.10.32-Gen.

9. APPENDICES

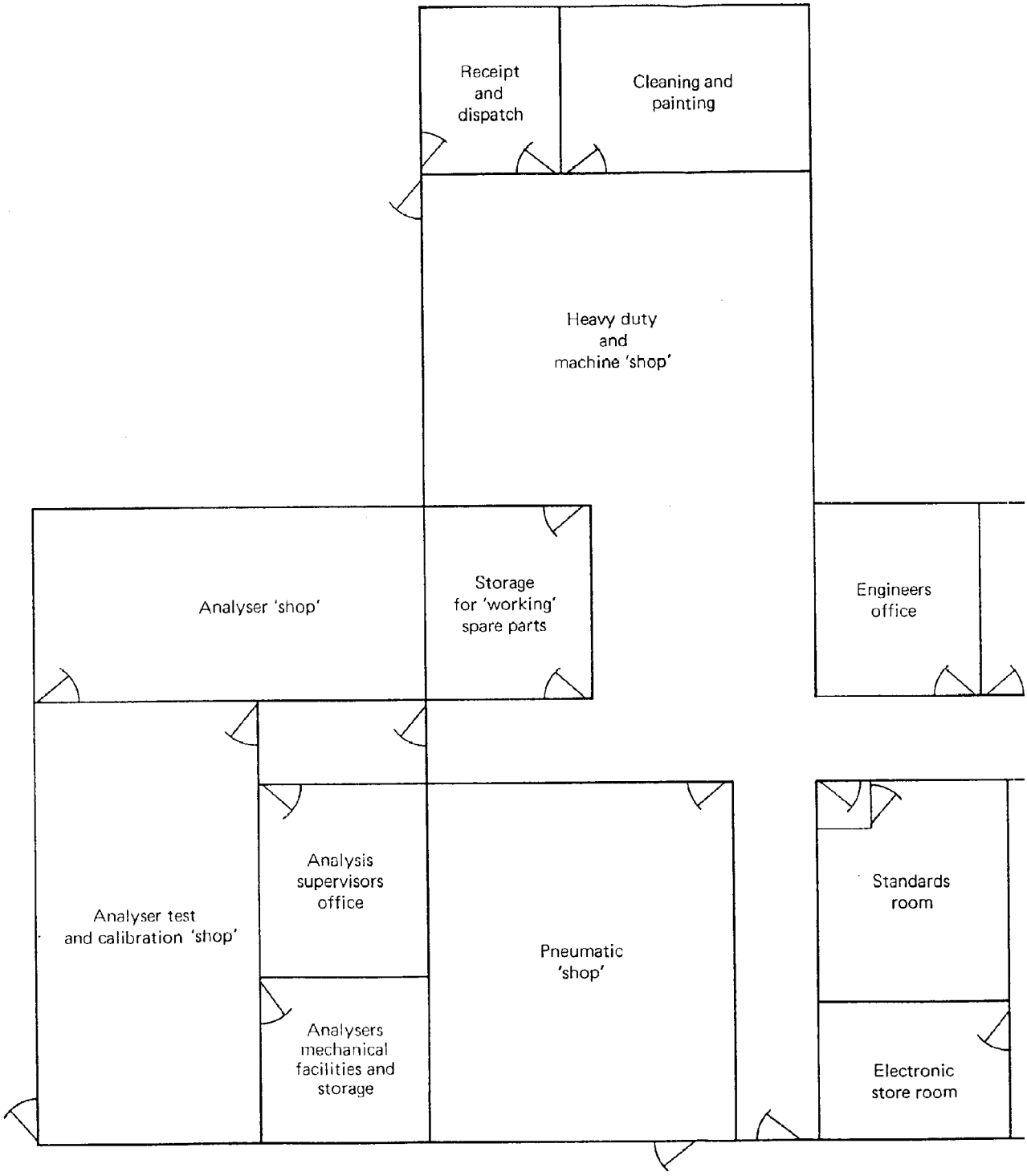
APPENDIX 1 TYPICAL LAYOUT OF A MECHANICAL, ELECTRICAL AND INSTRUMENT WORKSHOP

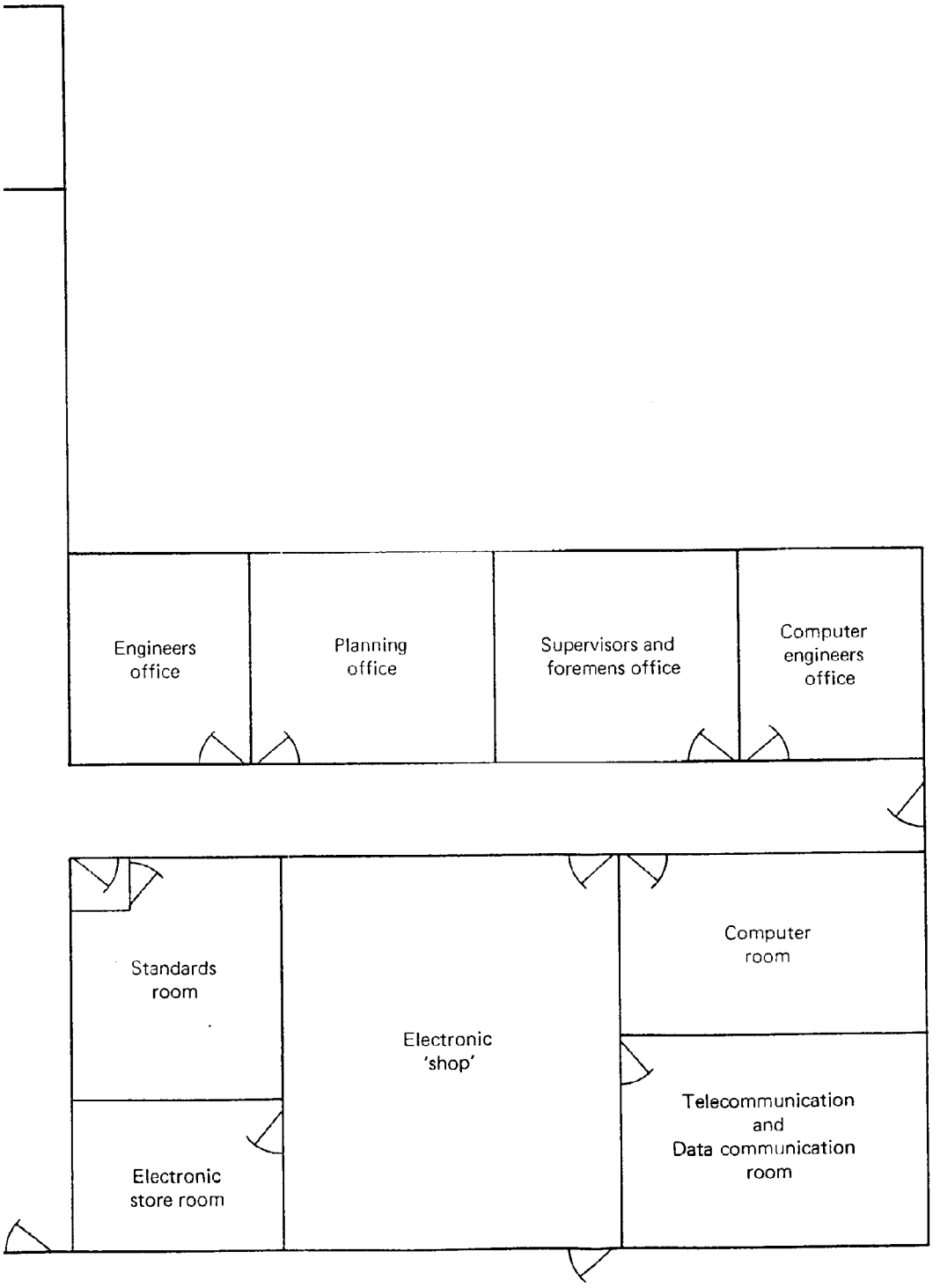


APPENDIX 2 TYPICAL LAYOUT OF AN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP - 1



TYPICAL LAYOUT OF AN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP - 2




Engineers office
Planning office
Supervisors and foremens office
Computer engineers office
Standards room
Electronic 'shop'
Computer room
Electronic store room
Telecommunication and Data communication room

APPENDIX 3 EQUIPMENT LOCATION IN AN INTRUMENT TECHNICAL CENTRE AND WORKSHOP

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 bath
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.

Standard test-benches

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

Non-standard test benches

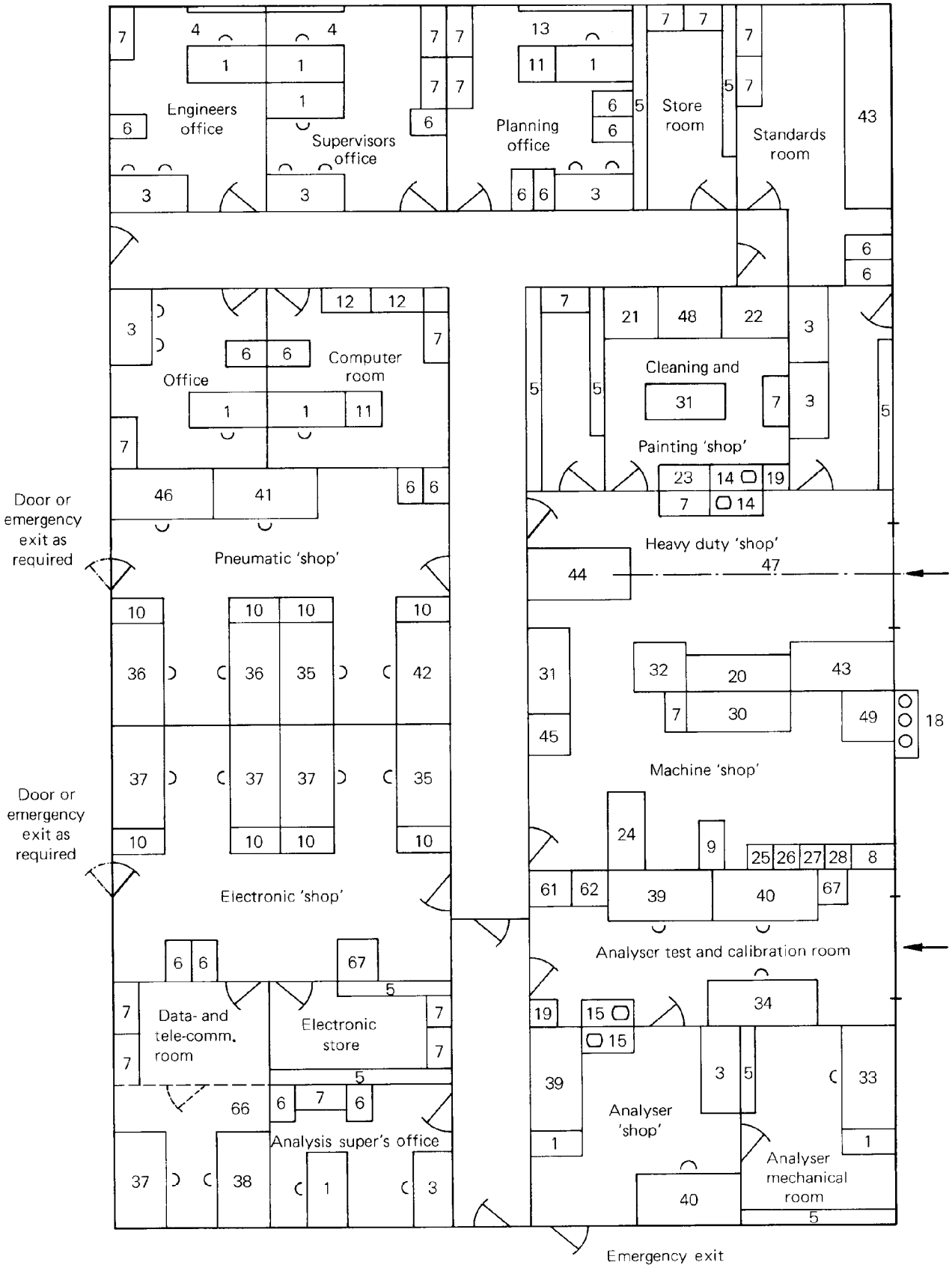
44 - control valve
45 - hydraulic (portable type)
46 - temperature.

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 - pipe bending machine
53 - cutting shears
(hand lever operated)
54 - magnifying glass
(with electric light)
55 - ultra violet light facilities
56 - test rig for storage tank gauges
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 folding tripod stand)
65 - set of laboratory glass ware
(see Appendix 10)
66 - a Faraday cage
67 - rack for PLC and GLC equipment
68 - deep freeze - laboratory type
69 - trailer - low loader type
70 - mobile crane - 3 tonne max. capacity.

TYPICAL LAYOUT OF EQUIPMENT IN AN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP - 1



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 bath
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.

Standard test-benches

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

Non-standard test benches

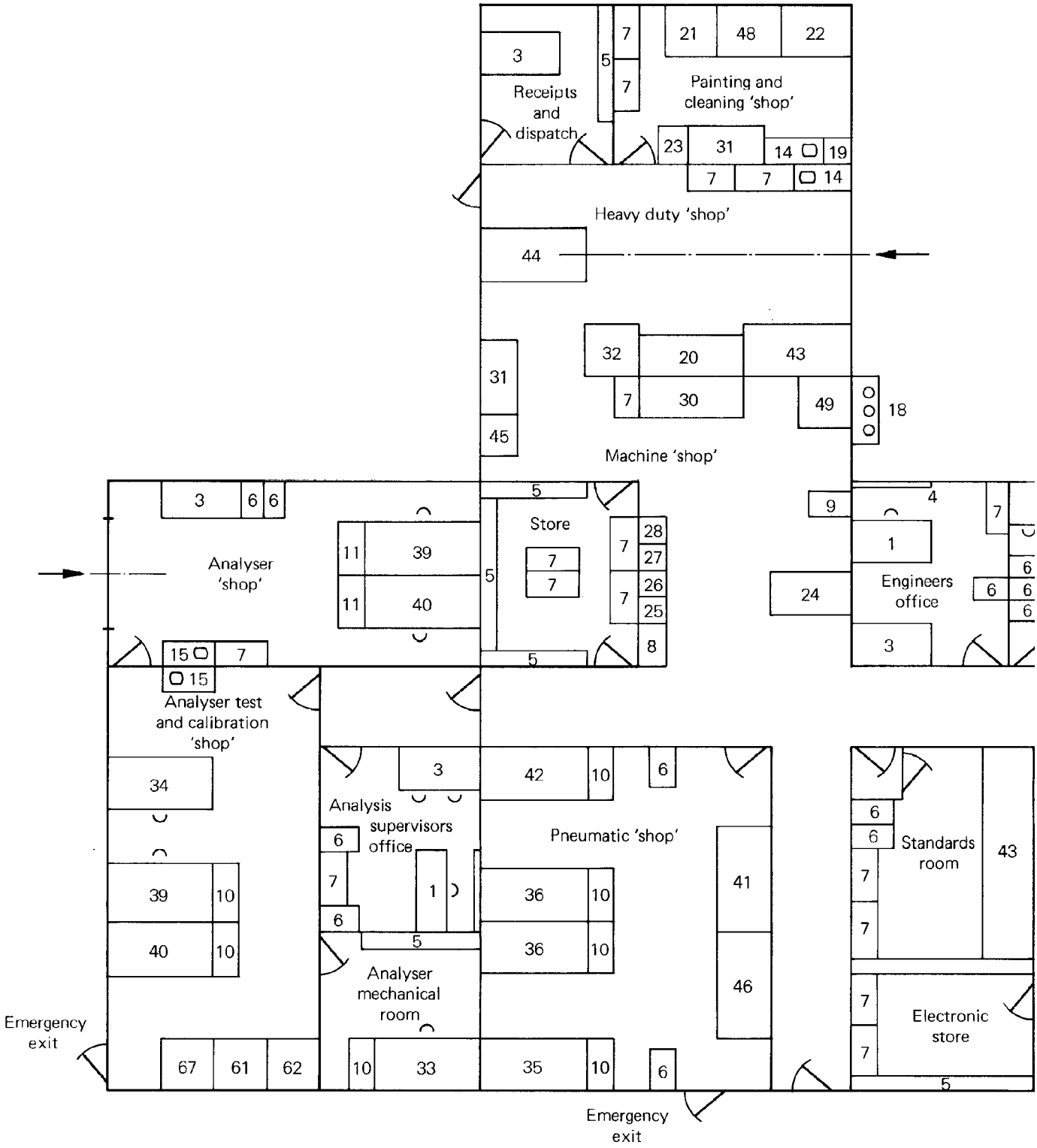
44 - control valve
45 - hydraulic (portable type)
46 - temperature.

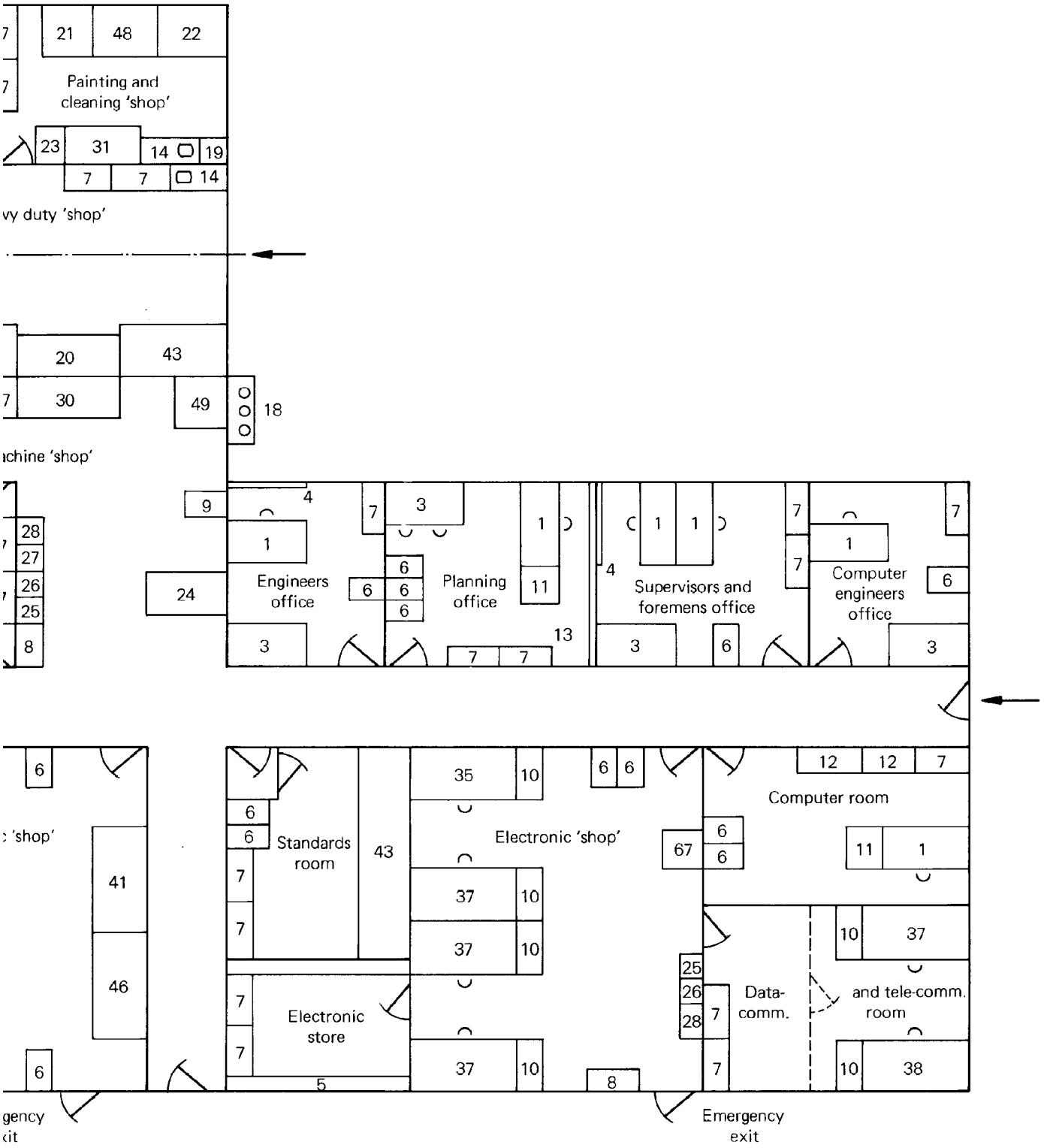
Miscellaneous equipment

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

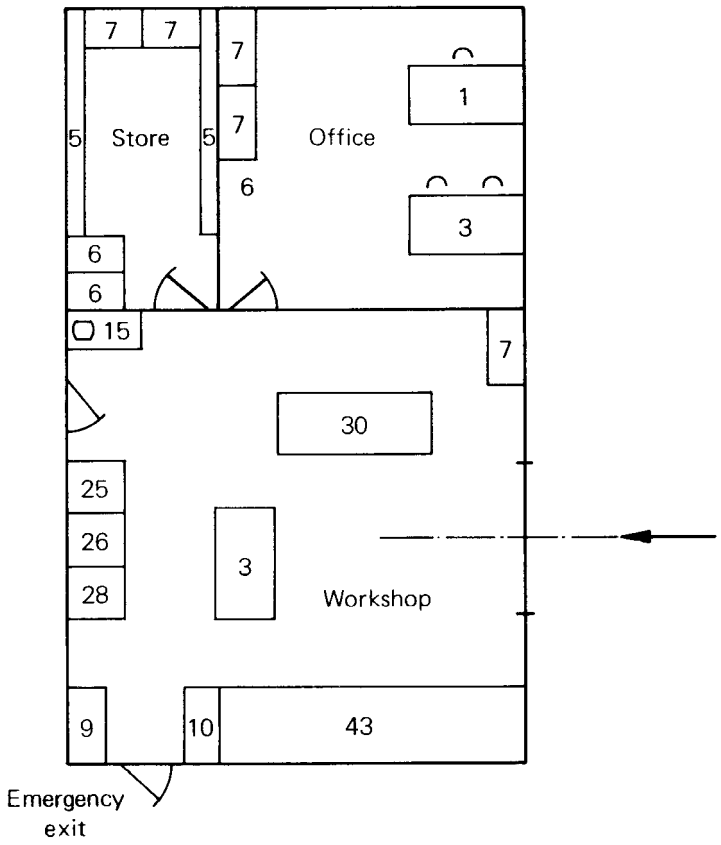
47 - hoisting facilities
(electric or pneumatic)
48 - painting booth
49 - small welding booth
50 - mobile hand volume pump
51 - portable vice
(with folding tripod stand)
52 - pipe bending machine
53 - cutting shears
(hand lever operated)
54 - magnifying glass
(with electric light)
55 - ultra violet light facilities
56 - test rig for storage tank gauges
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 folding tripod stand)
65 - set of laboratory glass ware
(see Appendix 10)
66 - a Faraday cage
67 - rack for PLC and GLC equipment
68 - deep freeze - laboratory type
69 - trailer - low loader type
70 - mobile crane - 3 tonne max. capacity.

TYPICAL LAYOUT OF EQUIPMENT IN AN INSTRUMENT TECHNICAL CENTRE AND WORKSHOP - 2




Painting and cleaning 'shop'
vy duty 'shop'
achine 'shop'
Engineers office
Planning office
Supervisors and foremens office
Computer engineers office
Standards room
Electronic 'shop'
Computer room
Electronic store
Data-comm.
and tele-comm. room
Emergency exit
gency
xit

APPENDIX 4 LAYOUT AND EQUIPMENT LOCATION FOR A 'SATELLITE' INSTRUMENT WORKSHOP



APPENDIX 5 TYPICAL ANALYSER WORKSHOP LAYOUTS AND FLOWSCHEMES

For Chemical and Petrochemical Plants
(Alternative to Layout-1 of Appendix 2 Page 1)

For Chemical and Petrochemical Plants
(Alternative to Layout-2 of Appendix 2 Page 2)

Sampling and Gas Supply Facilities for the Analyser Workshop

Diagram illustrating the Principle of the Analysis of Liquids

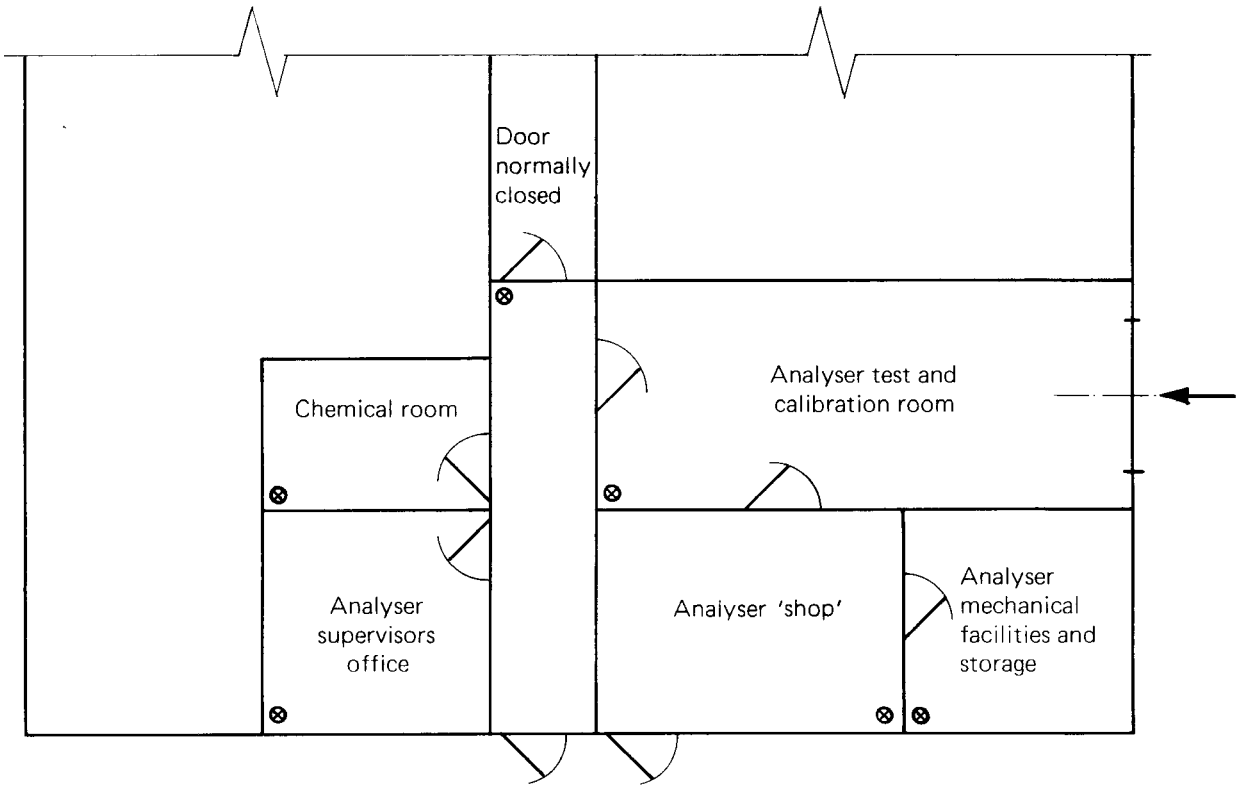
Diagram illustrating the Principle of the Analysis of Gases

Sample Conditioning System - for Heavy Liquids

Sample Conditioning System - for Light Liquids

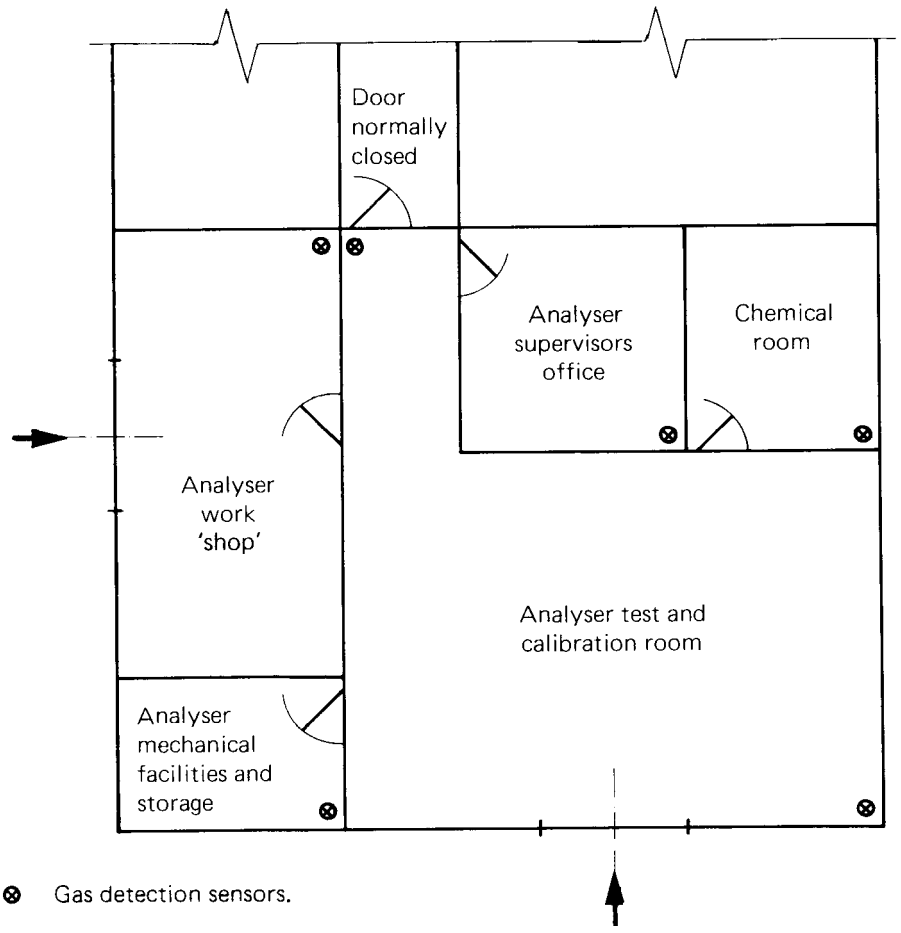
Sample Conditioning System - for Gases

TYPICAL ANALYSER 'WORKSHOP' - FOR CHEMICAL AND PETROCHEMICAL PLANTS (ALTERNATIVE TO LAYOUT - 1, SEE APPENDIX 2 PAGE 1



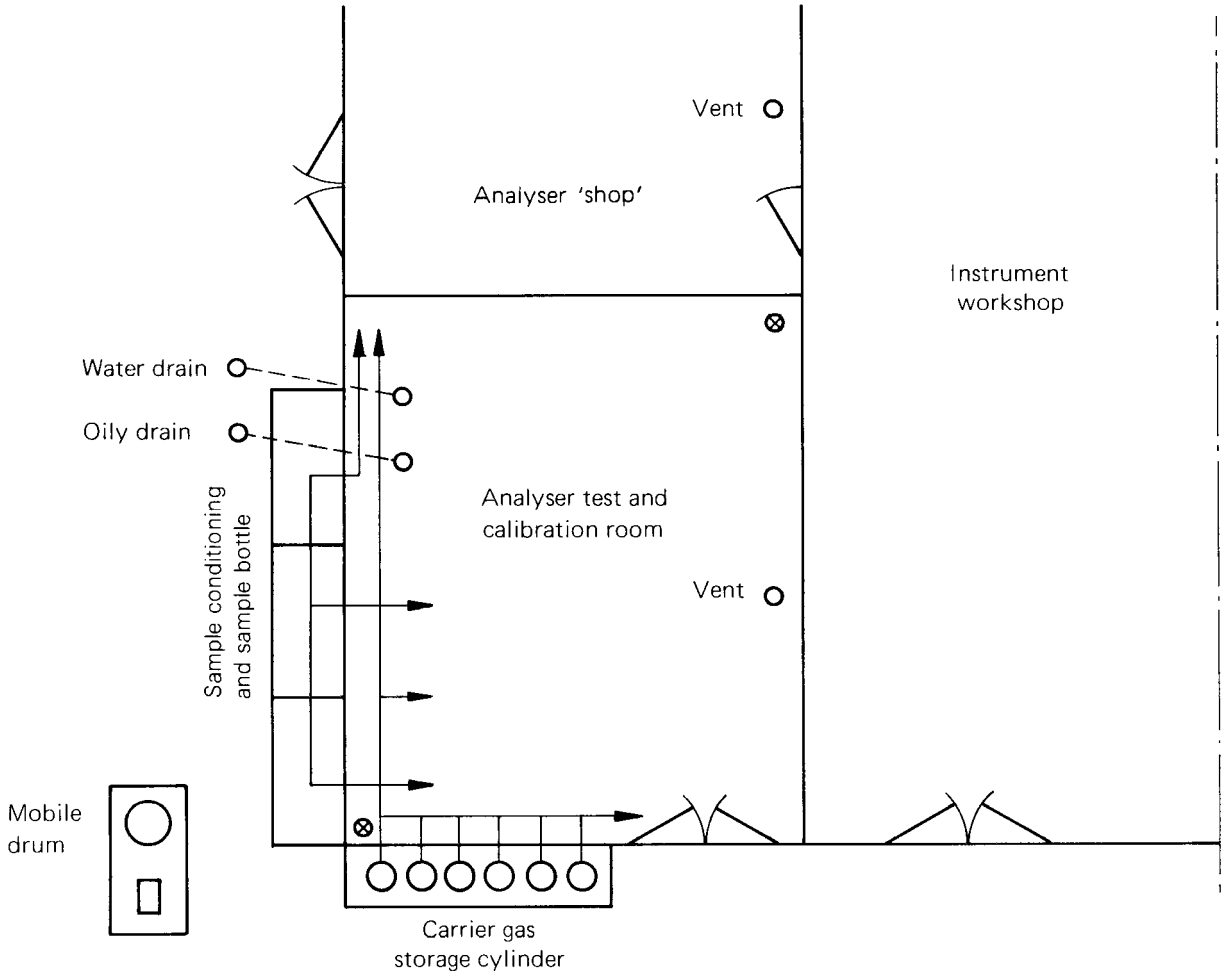
⊗ Gas detection sensors.

TYPICAL ANALYSER 'WORKSHOP' - FOR CHEMICAL AND PETROCHEMICAL PLANTS (ALTERNATIVE TO LAYOUT - 2, SEE APPENDIX 2 PAGE 2)



⊗ Gas detection sensors.

SAMPLING AND GAS SUPPLY FACILITIES FOR THE ANALYSER 'WORKSHOP'



NOTES: 1) For cold climates, sampling facilities for heavy products shall be installed inside insulated cabinets.
A heating system should also be available.

2) ⊗ Gas detection sensors.
O Vent system

3) Gases are not allowed in the analyser work room.

DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE ANALYSIS OF LIQUIDS

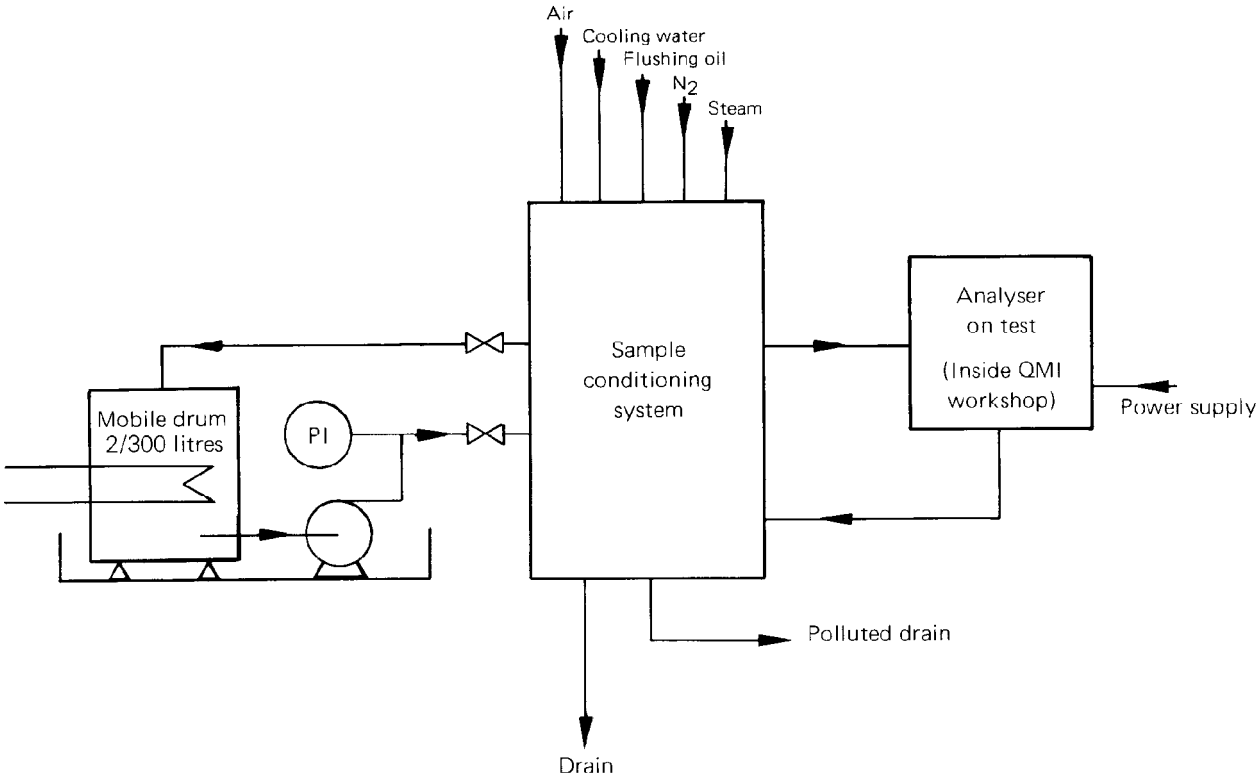
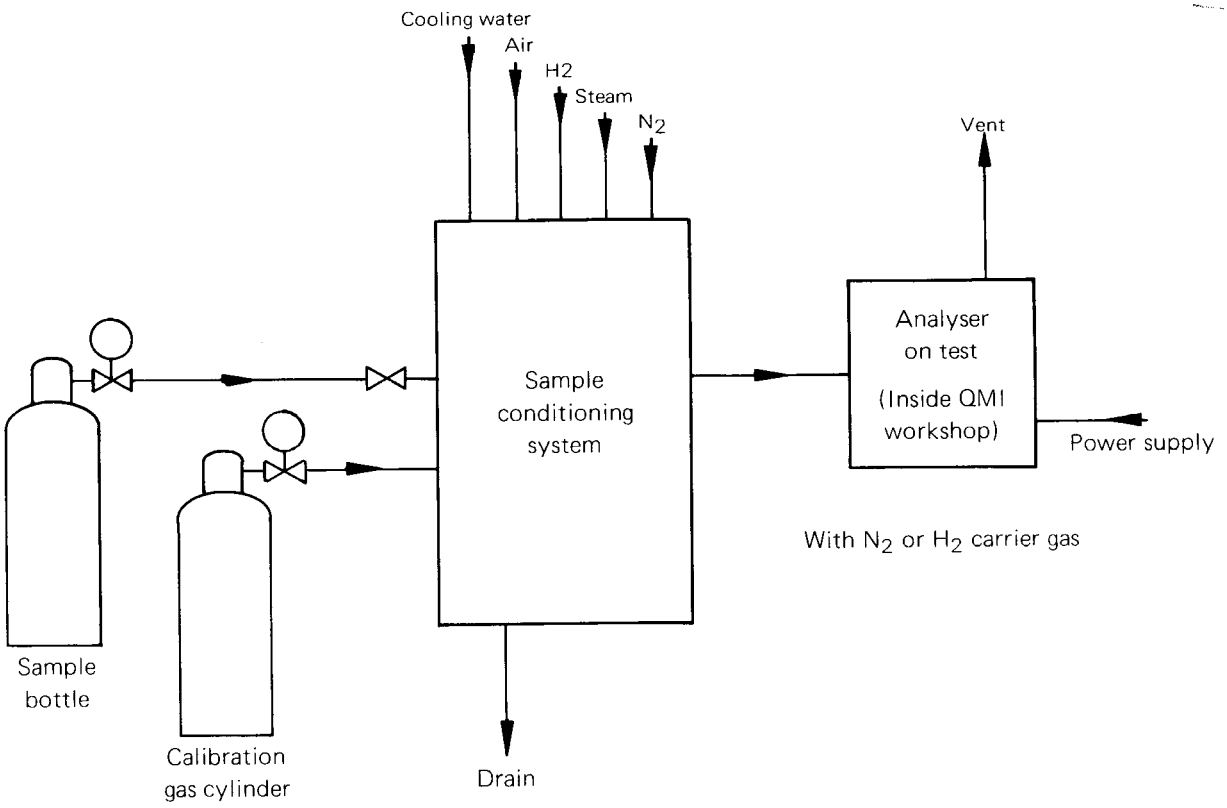
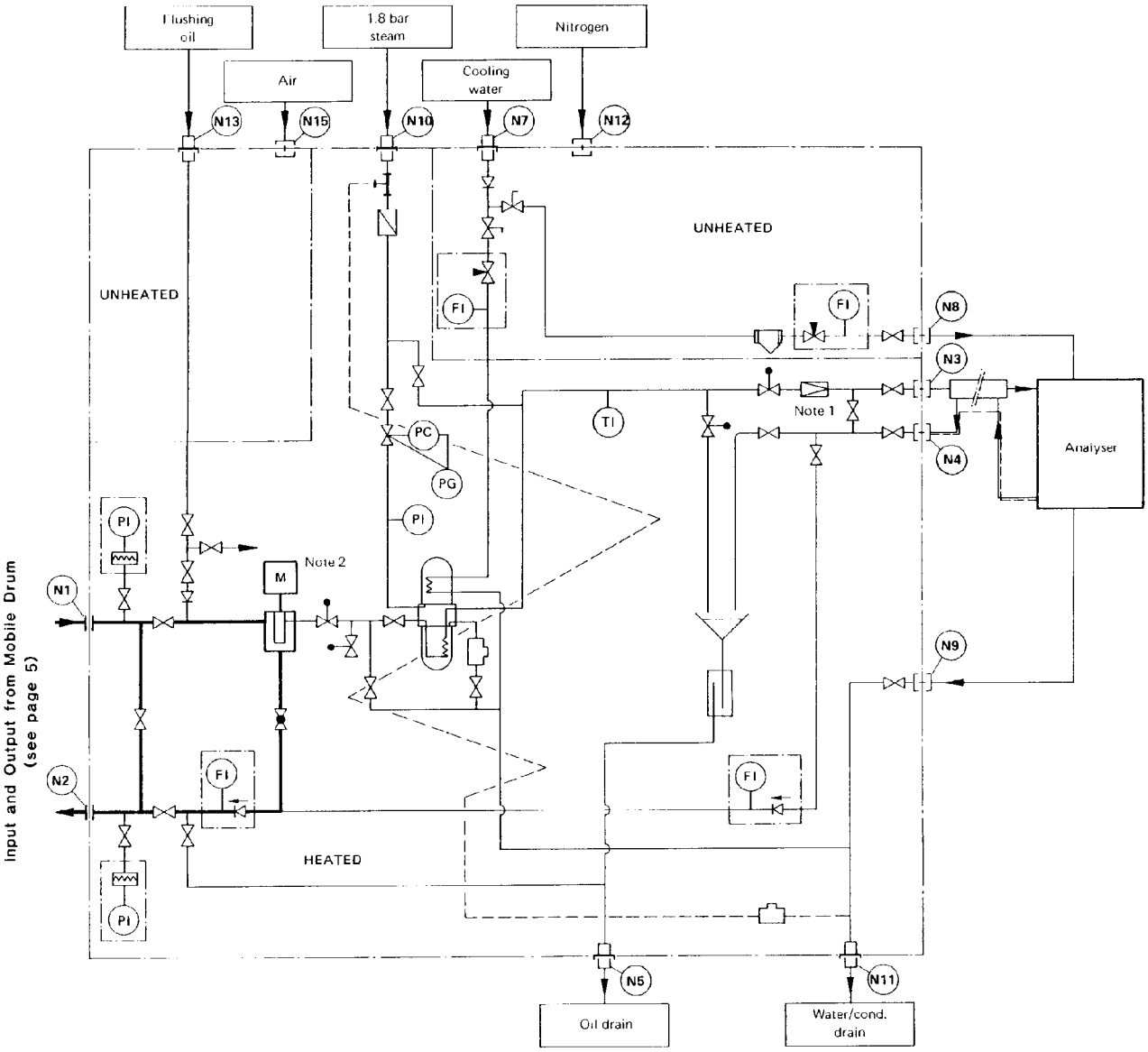


DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE ANALYSIS OF GASES



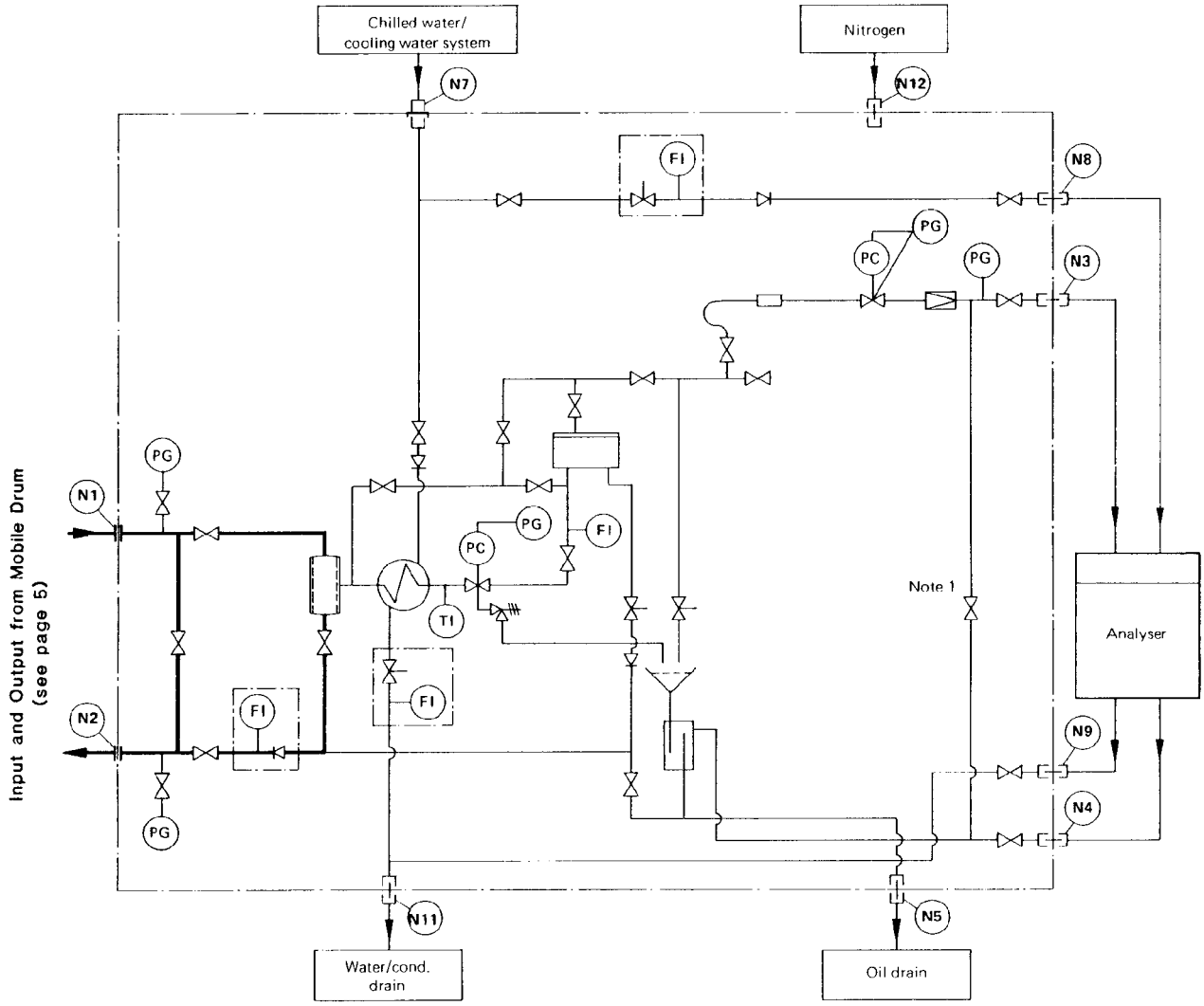
SAMPLE CONDITIONING SYSTEM - FOR HEAVY LIQUIDS



Conn.	Description
N1	Sample inlet
N2	Sample fastloop outlet
N3	Sample outlet to analyser
N4	Sample return from analyser
N5	Oil drain
N7	Cooling water inlet
N8	Cooling water outlet to analyser
N9	Cooling water return from analyser
N10	Steam inlet
N11	Water/condensate drain
N12	Nitrogen inlet
N13	Flushing oil inlet
N15	Air inlet

NOTES: 1) General by-pass.
2) Motorized filter electrically or pneumatically driven
3) For equipment specification, see DEP 32.31.50.11 - Gen.

SAMPLE CONDITIONING SYSTEM - FOR LIGHT LIQUIDS

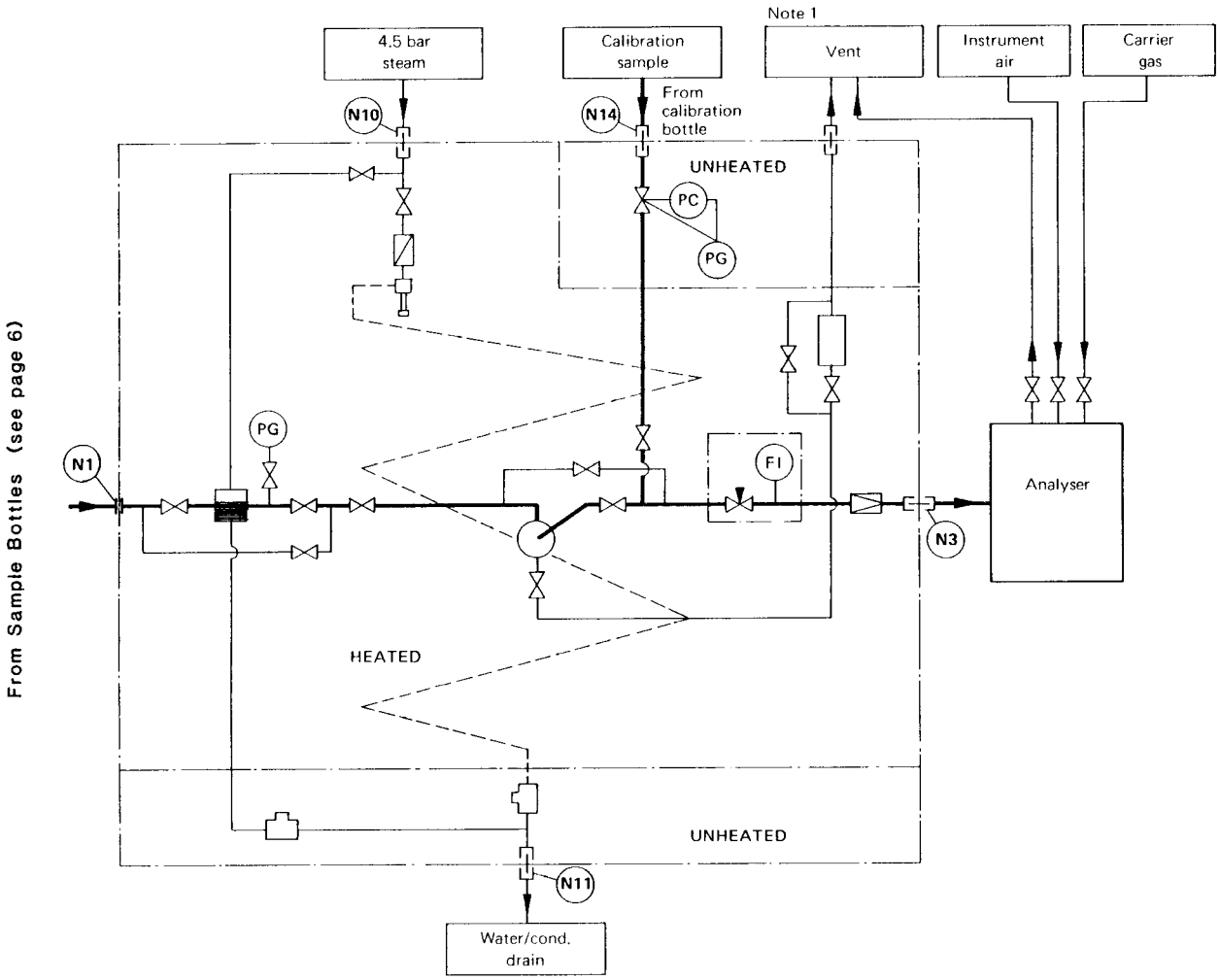


Conn.	Description
N1	Sample inlet
N2	Sample fastloop outlet
N3	Sample outlet to analyser
N4	Sample return from analyser
N5	Oil drain
N7	Cooling water inlet
N8	Cooling water outlet to analyser
N9	Cooling water return from analyser
N11	Water/condensate drain
N12	Nitrogen inlet

NOTES: 1) General circulation by-pass.

2) For specification of components, see DEP 32.31.50.11 - Gen.

SAMPLE CONDITIONING SYSTEM - FOR GASES



Conn.	Description
N1	Sample inlet
N3	Sample outlet to analyser
N10	Steam inlet
N11	Wayer/condensate drain
N14	Calibration sample

NOTES: 1) Vent to be installed with outlet on roof of 'workshop'.
2) For equipment specification , see DEP 32.31.50.11 - Gen.

APPENDIX 6 WORK-BENCH AND INSTRUMENT TEST-BENCH REQUIREMENTS

1. GENERAL

Work-benches and instrument test-benches can be either to **Manufacturers Standard** or **of Special construction.**

2 STANDARD WORK-BENCHES

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

3 STANDARD INSTRUMENT TEST-BENCHES

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.

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, see Appendix 6 pages 3, 6 and 8.

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 Appendices, however some of the larger technical centres may require other arrangements.

4. NON-STANDARD WORK AND INSTRUMENT TEST-BENCHES

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

5. TYPICAL WORK AND TEST-BENCHES

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

5.1 STANDARD TYPES

5.1.1 **Work-benches**

(1) - General Duty

(2) - Heavy Duty

5.1.2 **Test-benches**

(3) - General Concept of a typical test-bench

(4) - Light duty

(5) - Pneumatic

(6) - Electronic

(7) - Telecommunications

(8) - Analyser (General Duty)

(9) - Analyser (Specific)

(10) - Vacuum

(11) - Pressure

(12) - Electro/Pneumatic

5.2 NON-STANDARD TYPES

5.2.1 **Work-Benches**

(1) - Extra-Heavy Duty

(2) - Mechanical

(3) - Laboratory Type

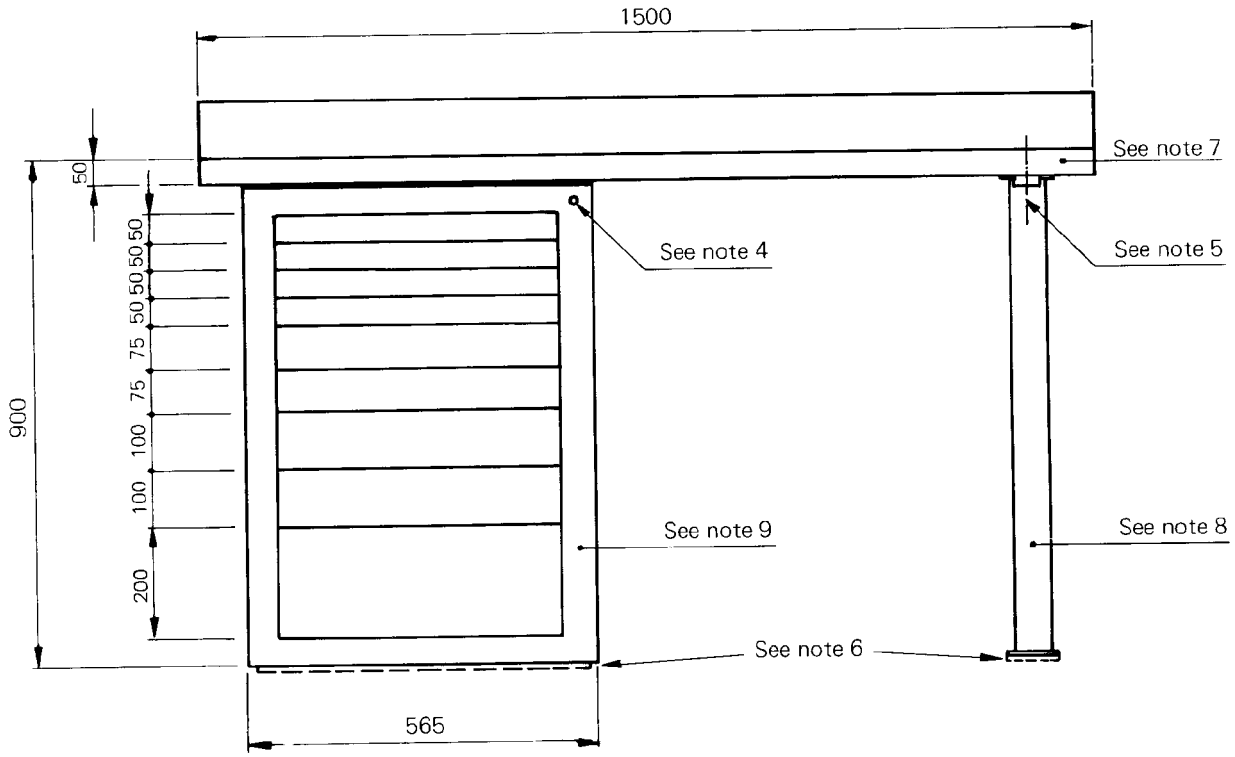
5.2.2 **Test-Benches**

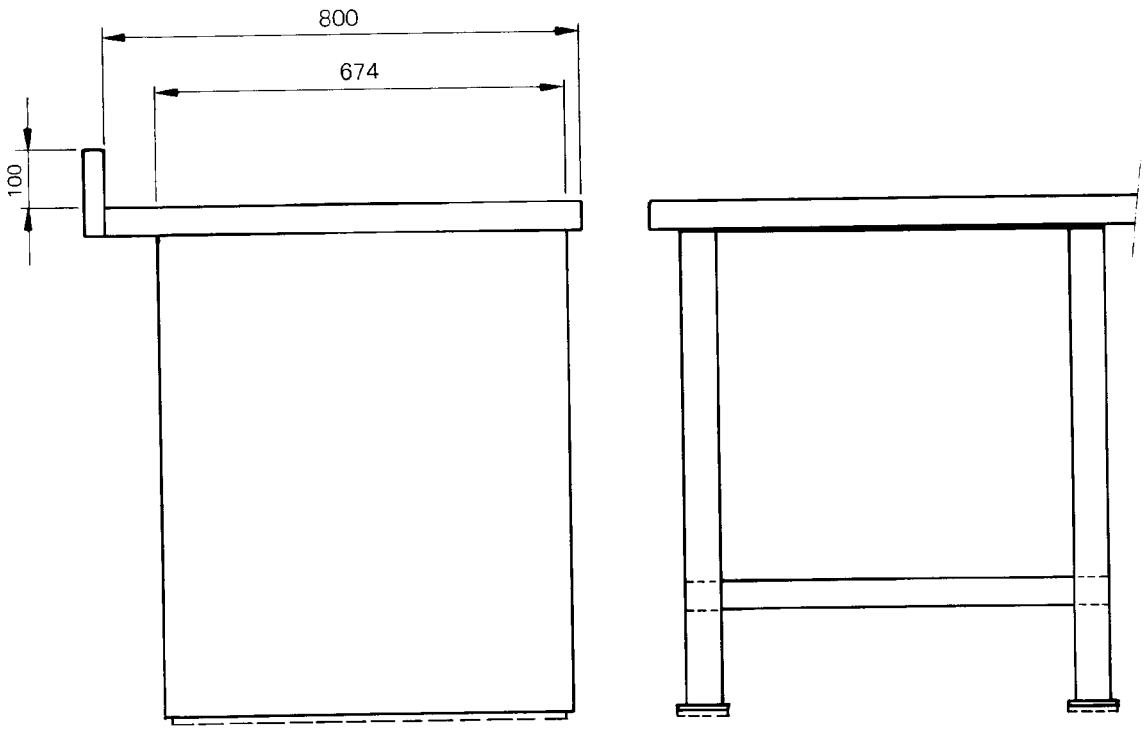
(4) - Control Valve

(5) - Temperature

(6) - Hydraulic (Portable)

(1.) GENERAL DUTY WORK BENCH - Item No. 30





(1.) GENERAL DUTY WORK BENCH - Item No. 30 (Cont.)

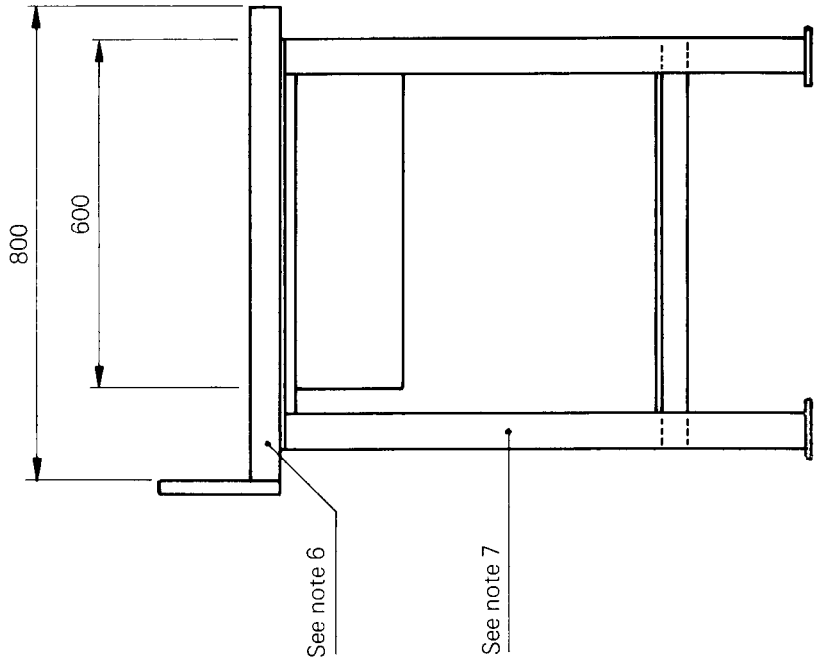
NOTES:
1) Manufacturer: 'Lista' Lienhard Stahlbau, Erlen Switzerland, or approved equivalent.
2) For partitions in drawers, see table below.
3) All dimensions are in mm.
4) All benches shall have different keys. 2 masterkeys shall be supplied fitting all locks or benches on the order.
5) Recommended position of bench vice (ordered separately).
6) Hardwood plinth (10-22 mm high) to be made locally.
7) Beechwood, Reus-Urphen (Melamine) grey top, with aluminium sides (3).
8) Support 7-4 (grey no.7) steel angle.
9) Cabinet B-214 (grey no. 7).

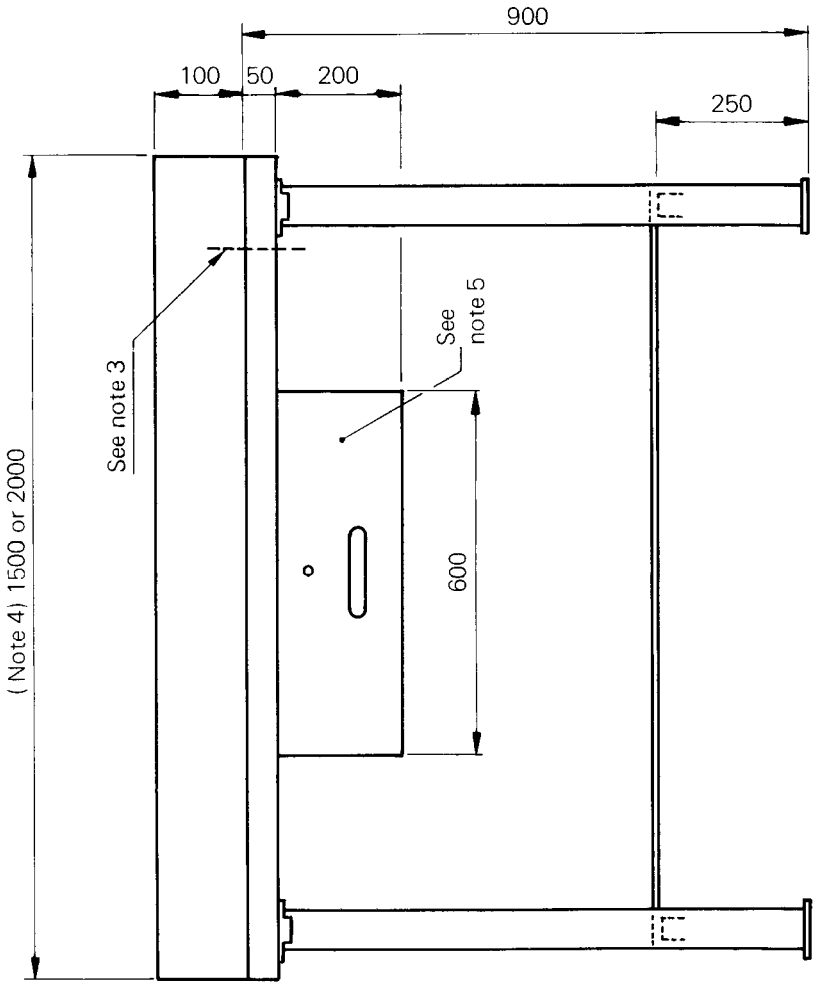
PARTITIONS IN DRAWERS

Drawer no.		1	2	3	4	5	6	7	8	9
Nom. height in mm		50	50	50	50	75	75	100	100	200
Description	Lista No.									
Drawer divider	X-362									2
Drawer divider	X-366				15					
Drawer divider	X-367				15					
Drawer divider	X-375					30	30			
Drawer divider	X-376					10	10			
Drawer divider	X-382							30	30	
Drawer divider	X-383							10	10	
Slotted partition	X-556					6	6			
Slotted partition	X-557							6	6	
Slotted partition	X-707				4					
Drawer divider	X-836				15					
Drawer divider	X-837					20	20			
Drawer divider	X-838							20	20	
Drawer divider	X-1124						20			
Plastic through insert (4)	X-1644	12	12							
Plastic through insert (3)	X-1645			12						
Through partition	X-1647	60	60							
Through partition	X-1648			50						

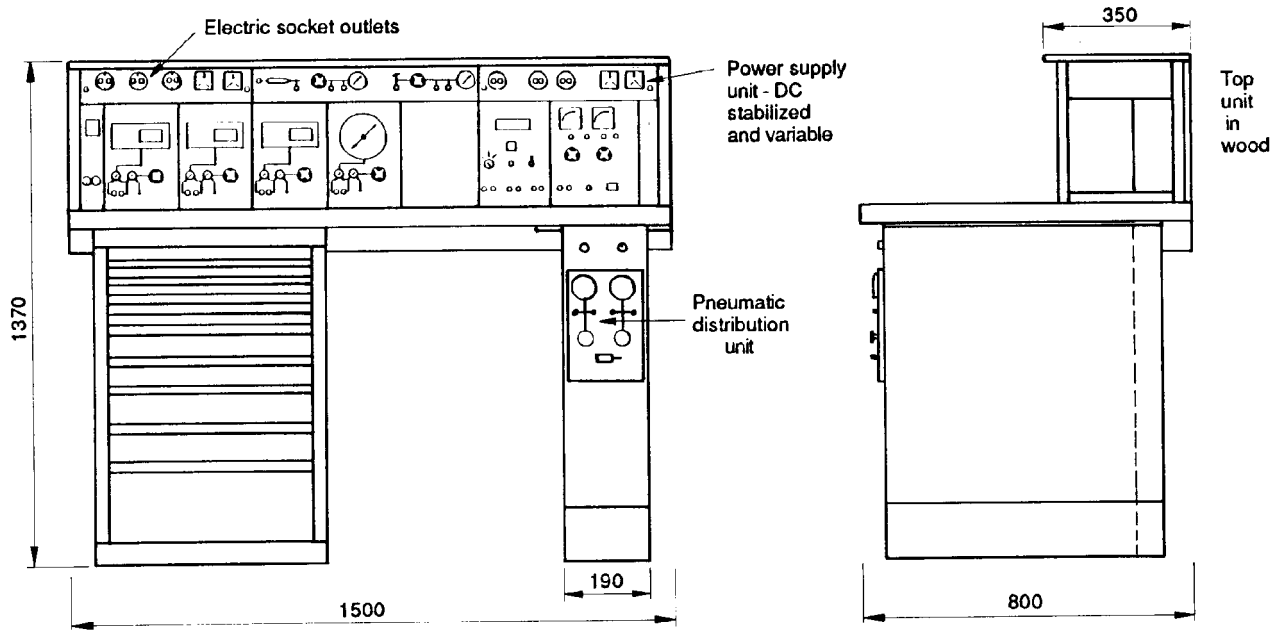
NOTE: Quantities indicated include spare material.

(2.) HEAVY DUTY WORK BENCH - Item No. 31

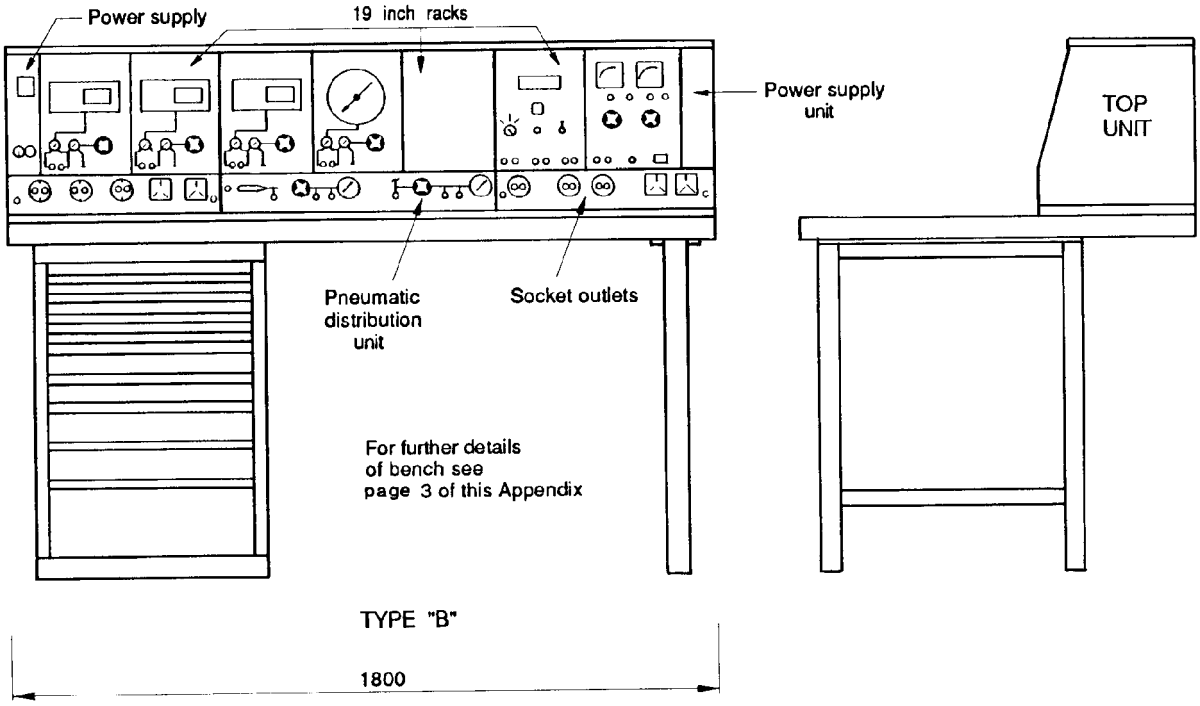




(3.) GENERAL CONCEPT OF A TYPICAL TEST-BENCH

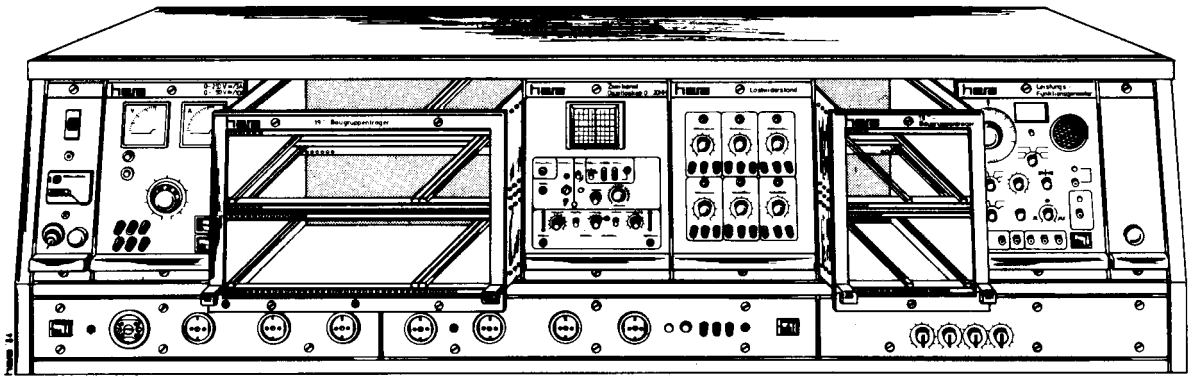


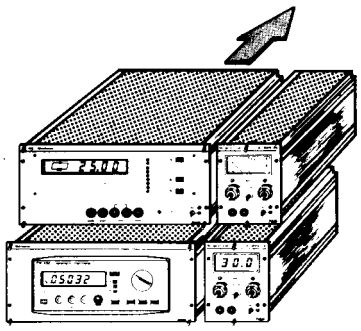
TYPE "A"



TYPE "B"

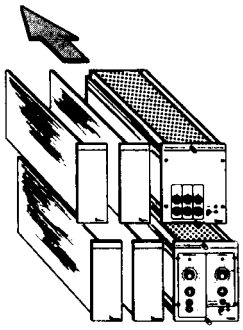
(3.) GENERAL CONCEPT OF A TEST BENCH - (Cont.)

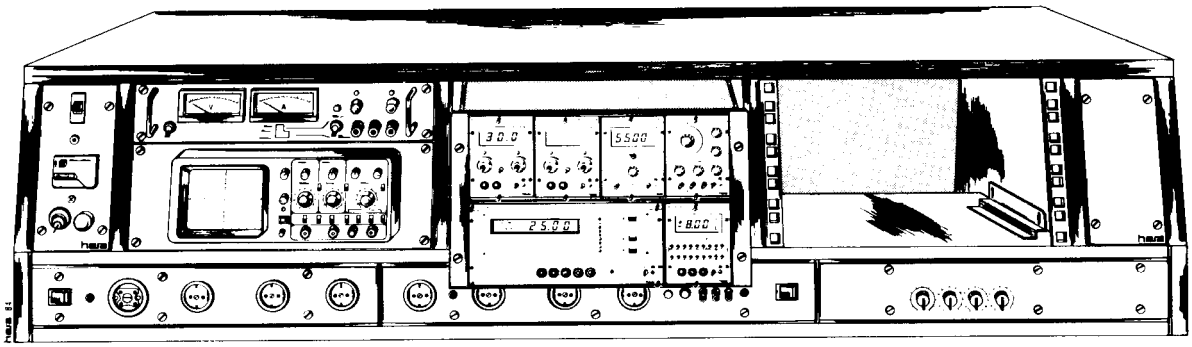




Combination possibilities

- 19 rack slide units
- Non-standard units
- Standard DIN modules
- Euro cassette modules

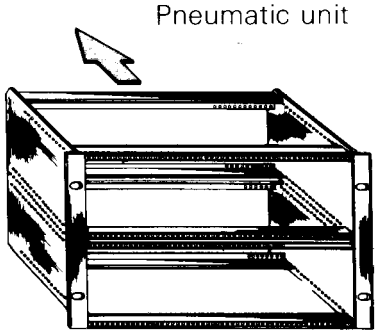




Power unit

Electrical unit

Pneumatic unit



TYPICAL ARRANGEMENTS OF RACKS AND MODULES

(4) **Light duty work/test-bench - Item No. 35**

1 - Bench

- size, 1500 x 800 x 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 x 19 inch racks complete with Part Nos 3, 5 and 7.

4 - Power supply unit

- complete with safety devices.

5 - Pneumatic supply unit

- with regulators and pressure gauges.

6 - Socket outlet panel

- complete with plugs for:
  - 220 V 5O Hz (or to suit local)
  - 110 V 50 Hz (conditions see)
  - 24 V DC. (sub-section 3.7)

Each socket should be in a dedicated colour

7 - Light source

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

8 - Magnifying lens

- for use with Part No. 7.

(5) **Pneumatic test-bench - Item No. 36**

1 - Bench

- size 1800 x 1000 x 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, to curve K of VDE 0660, and a minimum switch capacity of 8 µA with a combined or separate earth leakage device of 30 mA.

4 - Bench top unit

suitable for fitting on the bench as 3 x 19 inch racks complete with Part Nos 3, 5 and 7.

5 - Pneumatic supply unit panel

- complete with monitor gauges 0.2 to 5 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 5O Hz
- 1 plug, for *110 V 50 Hz
- 2 plugs, for 24 V DC.

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Socket with different voltages should have different contact arrangements and be in a dedicated colour.

7 - Light source - fitted with 2 x 60 W bulbs on an articulated arm.

8 - Magnifying lens - for use with Part No. 7.

9 - Slide unit with:

- transmitter and 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 $^1/_2$ digits
- and an accuracy of 0.1 % of the measured value.

NOTE: * Or to suit local conditions, see (3.7).

10 - Slide unit with:

- digital pressure indicator 0 to 300 mbar
- accuracy 0.1 % of full scale
- a display of 4 $^1/_2$ digits
- regulator switches for in/out
- 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

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 $^1/_2$ 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.

(6) Electronic test-bench - Item No.37

1 - Power supply unit

- *220 V 50 Hz complete with miniature circuit breaker having overcurrent protection of 16 A, to curve K of VDE 0660, and a minimum switch capacity of 8 µA with a combined or 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

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Sockets for different voltages should have different contact arrangements and be in a dedicated colour.

5 - Variable AC voltage stabilizer

6 - Analogue 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

10 - Pneumatic distributor panel

- complete with pressure gauges 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.

(7) Telecommunication test-bench - Item No. 38

1 - Power supply unit

- *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, to curve K of VDE 0660, and a minimum switch capacity of 8 µA with a combined or separate earth leakage device of 30 mA.

2 - Oscilloscope (general purpose)

3 - Frequency counter (general purpose)

4 - Socket outlet panel

- complete with plugs for:
  - *220 V 5O Hz
  - *110 V 50 Hz
  - 24 V DC

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Sockets for different voltages should have different contact arrangements and each socket should be in a dedicated colour.

5 - Slide unit

- with a general purpose frequency generator 0.1 Hz to 100 kHz.

6 - Variable DC power supply unit

- 0 to 12 V.

7 - Variable DC power supply unit

- 0 to 30 V.

8 - Function generator (general purpose)

9 - Digital multimeter

10 - Pneumatic distribution unit.

(8) Analyser test-bench (General Duty) - Item No 39.
(NOTE: The length of this bench is 4 metres.)

1 - Power supply unit

- *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, to curve K of VDE 0660, and a minimum switch capacity of 8 µA with a combined or separate earth leakage device of 30 mA.

2 - Pneumatic unit - with a digital indicator scale 0 to 300 mbar 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 5O Hz
- * 110 V 50 Hz
- 24 V DC.

NOTE: 1) Sockets for different voltages should have different contact arrangements and be in a dedicated colour.

NOTE: 2) * Or to suit local conditions, see (3.7).

5 - Pneumatic distribution panel

6 - Analogue 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 - Special unit (11 inch non-standard) with:

- a 'Peristaltic'pump
- process connections
- and a start/stop switch.

11 - Automatic/manual, start/stop timer unit

12 - Transmitter Calibration Unit

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

(9) Analyser test-bench (Specific duty) - Item No. 40

1 - Power supply unit

- *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, to curve K of of VDE 0660, and a minimum switch capacity of 8 µA 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 300 bar.

4 - Special slide unit with:

- a 'Peristaltic' pump
- and a start/stop switch.

5 - Digital multimeter unit

6 - Oscilloscope (general purpose)

7 - Variable DC power supply unit

- 0 to 12 V and 0 to 120 mA.

8 - Variable stabilized DC power supply unit - 0 to 30 V.

9 - Electronic timer unit

- with automatic/manual start/stop.

10 - Analogue multimeter

11 - Analogue pressure gauge unit - 0 to 16 bar.

12 - Digital pressure gauge unit - 0 to 25 bar.

13 - Socket outlet unit

- with a plug for - *220 V 50 Hz.

NOTE: * Or to suit local conditions, see (3.7).

14 - Pneumatic unit

- regulators, pressure gauges and connections.

15 - Electrical junction box unit

- with a safety device for the pumps.

16 - Pneumatic system

17 - Transmitter calibration unit

- with digital gauge 0 to 50 mA.

18 - Digital vacuum indicator unit (including connections)

(10) Vacuum test-bench - Item No. 41

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, to curve K of VDE 0660, and a minimum switch capacity of 8 μA with a combined or separate earth leakage device of 30 mA.

2 - Digital vacuum indicator (with connections)

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 5O Hz
  - *110 V 50 Hz
  - 24 V DC

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Sockets for different voltages should have different contact arrangements and be in a dedicated colour.

6 - Pneumatic distribution unit

7 - Transmitter calibration unit

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

8 - Vacuum pump

9 - Facilities for filling the membrane separator systems.

(11) Pressure test-bench - Item No. 42

1 - Power supply unit

- *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, to curve K of VDE 0660, and a minimum switch capacity of 8 μA with a combined or separate earth leakage device of 30 mA.

2 - Air compressor (high pressure type)

3 - Digital pressure gauges

- 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 - Analogue pressure gauge

- 0 to 25 bar.

5 - Electronic calibrator unit

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

7 - Socket outlet panel

- *220 V 5O Hz
- *110 V 50 Hz
- 24 V DC

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Sockets for different voltages should have different contact arrangements and be in a

dedicated colour.

8 - Pneumatic distribution unit

9 - Oil/gas (Nitrogen) Separator
  - to allow oil free calibration of transmitters.

10 - Nitrogen supply (high pressure)
  - for cryogenic and O_2 applications.

(12) Electro-pneumatic test-bench- Item No. 43

1 - Power supply unit

- *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A, to curve K of VDE 0660, and a minimum switch capacity of 8 µA with a combined or separate earth leakage device 30 mA.

2 - Slide unit (0 to 200 mbar).

3 - Slide unit (0 to 16 bar).

4 - Slide unit (0 to 6 bar).

5 - Slide unit with analogue gauge (1.6 bar).

6 - Slide unit (with digital vacuum indicator).

7 - Slide unit (high pressure - 0 to 25 bar).

9 - Oscilloscope (general purpose)

10 - Analogue multimeter unit

11 - Digital multimeter unit

12 - Variable DC power supply unit

- 0 to 12 V and 0 to 120 mA.

13 - Variable stabilized power supply - 0 to 30 V.

14 - Slide unit (spare)

15 - Pneumatic distribution unit

16 - Slide unit

- with plugs for:
  - *220 V 50 Hz
  - *115 V 50 Hz.

NOTE: * Or to suit local conditions, see (3.7).

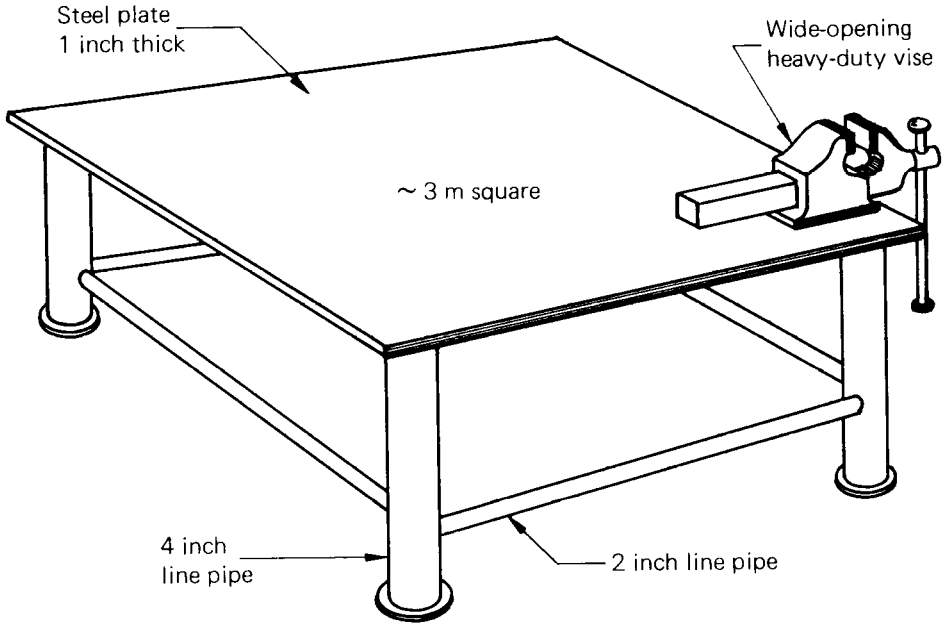
17 - Pneumatic slide unit

- with regulators and gauges.

18 - Electrical junction box.

(1.) EXTRA HEAVY DUTY WORK BENCH - Item No. 32

Part No.	Description	Require-ments	Quan-tity	Supplier	Remarks
1	Bench Size 900 x 900 x 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 manu-facturer.



(2) Mechanical work-bench - Item No. 33

1 - General

- 'FACON' type 2110B or an approved equivalent
- Typical size 1750 (or 2000) x 750 mm, overall height 1630 mm.

2 - Work top

- beechwood, plastic faced with aluminium 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 gauge sheet steel.

4 - Shelf

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

5 - Top unit

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

6 - Base

- of hardwood or equivalent

7 - Accessories

- a light source
- a parallel jaw vise.

(3) Laboratory-type work-bench - Item No. 34

1 - General

- based on manufacturer's standards comprising the following items:

2 - Sink unit

- acid-resistant and fitted with a fume hood.

3 - Work top

- of wood, covered with acid-resistant material
- 30 mm minimum thickness
- fitted with additional acid resistant sink(s).

4 - Under bench

- supporting arrangement
- and with 3, 6 or more lockable drawers on roller guides fitted with drawer dividers.

5 - Top unit - of acid-resistant material.

6 - Utilities

- electricity supply of *220 V 50 Hz complete with a miniature circuit breaker having overcurrent protection of 16 A to curve K of VDE 0660, and a minimum switch capacity of 8 μA with a combined or separate earth leakage device of 30 mA.
- socket outlet panel complete with plugs for:
  - *220 V 5O Hz
  - *110 V 50 Hz
  - 24 V DC

NOTES: 1) * Or to suit local conditions, see (3.7).

2) Sockets for different voltages should have different contact arrangements and be in a dedicated colour.

- distribution systems for:
  - compressed air
  - nitrogen
  - water (hot and cold.)

NOTE: The systems should be colour coded for identification purposes.

5.2.2 **Test-benches**

(4) **Control valve test-bench - Item No. 44**

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.

3 - Capacity

- suitable for the testing of control valves up to DN 400 (16 in. n.b.) and 1200 mm between flanges
- and for calibrating 3-way valves.

4 - Equipment and facilities

- required to carry out the following tests:

1) leak tests - in accordance with:

- ANSI B16-106 up to Class VI
- 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.

2) 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 (3 psi)
  - 1.0 bar (15 psi)
- pneumatic connections made with stainless steel tubing and compression fittings
- variable output.

4) Hydraulic tests - requiring:

- test pressure up to 60 bar via a hydraulic pump
- a hydraulic cylinder double acting, max load 1000 kg
- mechanical protection for the hydraulic tests.

5) Electronic tests - requiring:

- electricity supply of *220 V 50 Hz complete with a miniature circuit breaker having over current protection of 16 A, to curve K of VDE 0660,

and a minimum switch capacity 8 µA with combined or separate leakage device of 30 mA

- 24 V DC
- fixed output 4 mA
- fixed output 20 mA
- variable output 0-60mA
  with digital indication for input measurement.
- electronic timer for start/stop.

NOTE: * Or to suit local conditions, see (3.7).

6) Electronic leak test - requiring:

- electronic leak detection apparatus.

7) PLC Capabilities - requiring

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

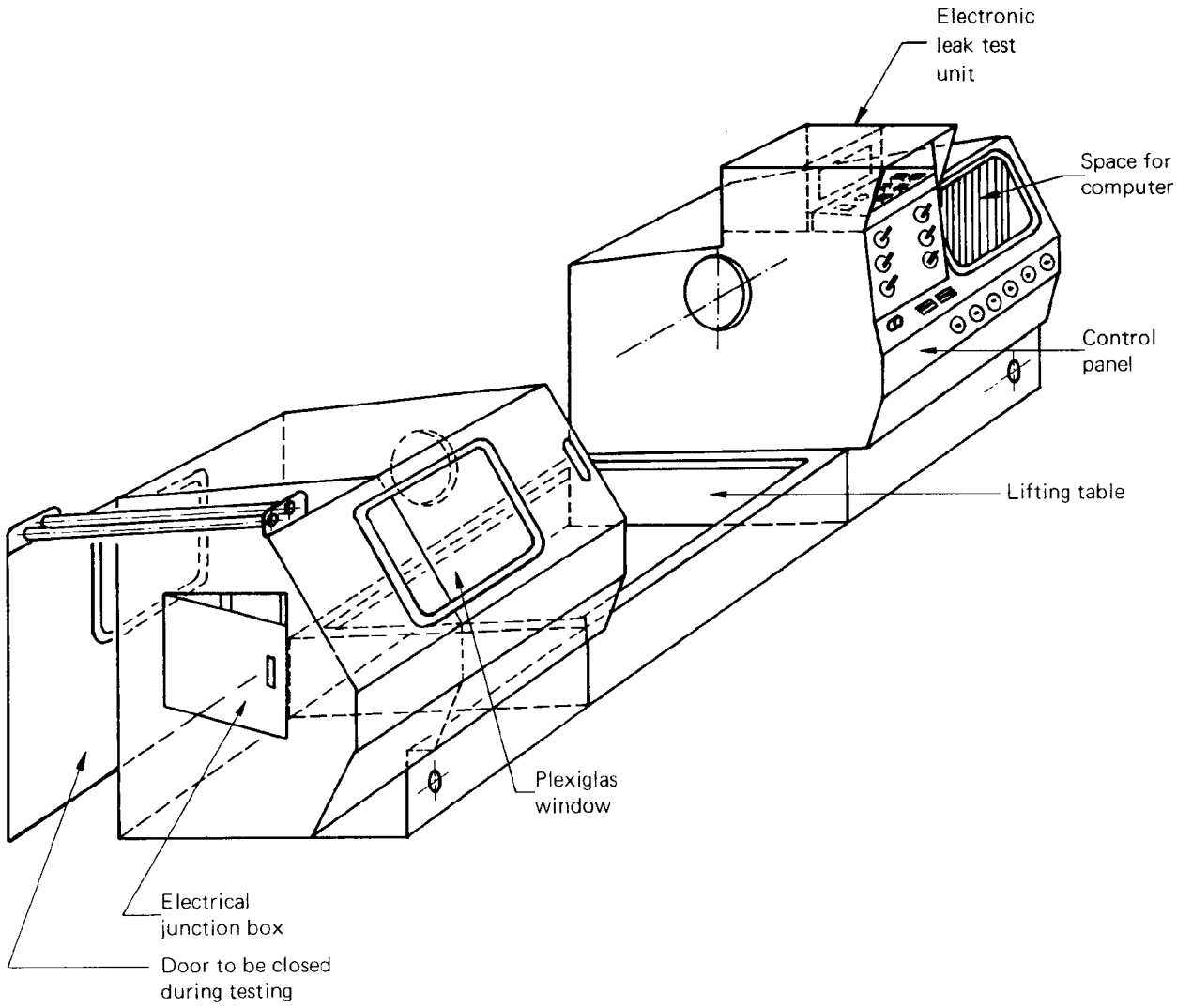
8) Micro-computer equipment - comprising:

- bench filing capabilities
- storage for manufacturer's data
- filing all test procedures
- Control valve data
- Control valve records
- Calibration via keyboard.

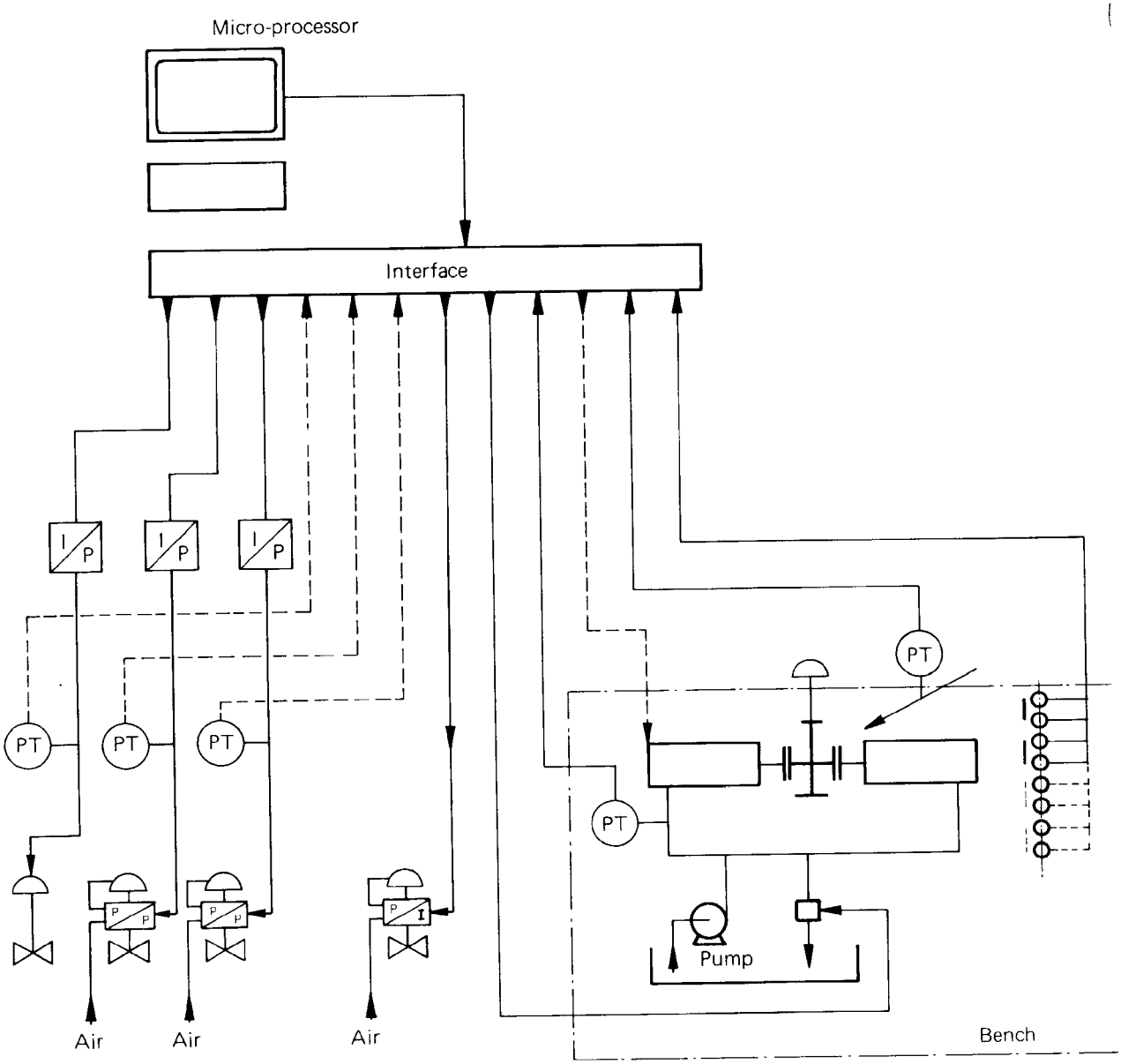
9) Printer

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

(4.) CONTROL VALVES TEST-BENCH - Item No. 44 (Cont.)



(4.) CONTROL VALVES TEST-BENCH - Item No. 14 (Cont.)



Pneumatic calibration

Electro./pneumatic calibration

(5) **Temperature test-bench - Item No. 46**

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.

3) Bath characteristics

- refer to page 27 of this appendix.

4) Indication and control

- baths to be continuously monitored by analogue (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 *110/220 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 x 850 x 1220 mm for a four bath unit

7) Power supply

- normally *380 V 3 phase

NOTE: * Or to suit local conditions, see (3.7).

(5.) TEMPERATURE TEST-BENCH - Item No. 22 (Cont.)

BATH SPECIFICATIONS (TYPICAL)

SPECIFICATION	1	2	3	4
Range (°C)	-30/+80	Ambient/+80	80/230	100/600
Tank capacity (ltr)	23	20	20	17
Top hole size (mm)	210 x 160	210 x 160	210 x 160	230 (diameter)
Max. depth (mm)	355	355	355	420
Media height (mm)	270	270	270	406
Recommended media	kerosene, water/ industrial	distilled water, Polyethylene	Silicone oil, Polyethylene	-
(supplied only on request)	alcohol, water	glycol 200	glycol 1400	
Media supplied as standard	-	-	-	Specially treated aluminium 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 (built-in compressor)	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	-38/+50 °C	-5/+100 °C	-10/+360 °C	-10/+480 °C
(mercury-in-glass)	-5/ +100 °C	-	-	200/610 °C
Temperature readout	digital	analogue	analogue	analogue
Air supply (with flowmeters)	-	-	-	125 litres/min. at 50 psi
Programmer	yes	yes	yes	no

(6) **Hydraulic test-bench (portable) - Item No. 45**

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 litres, constructed from heavy gauge 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 gauges - 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 gauge

9) Control panel - for gauges etc.

10) Dimensions

- 660 x 555 x 530 mm

11) Weight 70 kg approx.

APPENDIX 7 SMALL TOOLS FOR THE INSTRUMENT WORKSHOP

The following tools, listed in sequence of MESC number, are recommended for use in the instrument workshop. The list is not restrictive, it depends on size and application of the workshop.

MESC	DESCRIPTION
56.27.35.xxx.9	Magneto spanners (set)
58.67.42.xxx.9	Spark plug brush
83.11.60.xxx.9	Pointer extractor
67.85.14.070.1	Multirange test meters, analogue
67.87.35.010.1	Voltage tester
69.55.30.xxx.9	Hand torch hazardous areas
81.82.25.006.1	Brush, flat, 35 mm
81.82.25.212.1	Brush, round, 19 mm diameter
81.82.25.216.1	Brush, round, 26 mm diameter
81.82.90.230.1	Wire brush (for welding), 3 rows
81.86.58.xxx.9	Oil dropper, pocket type
81.86.58.xxx.9	Oilers bench
81.86.62.010.1	Padlocks, cyclindrical type, brass
83.01.80.xxx.9	Fire tong (Blacksmith) 375 mm (15 inch)
83.04.72.158.1	Saw dove tail
83.10.99.310.1	Trimming tool kit Philips
83.11.70.216.1	Piercing saw frame 0 to 150 mm (6 inch)
83.11.70.252.1	Saw blades, piercing saw 125 mm
83.11.70.276.1	Hack saw frame 150 mm (6 inch)
83.11.70.286.1	Saw blades hacksaw 150 mm (6 inch)
83.11.99.050.1	Tool kit 'Leeds and Northrup'
83.11.99.112.1	Tool kit 'Foxboro'
83.19.27.050.1	Glass cutter sheet glass
83.19.27.054.1	Glass cutter plate glass
83.29.63.016.1	Prying bar
64.20.50.701.1	Soldering outfit, propane portable
83.39.30.008.1	Cold chisel cross-cut, cut 3 mm
83.39.30.016.1	Cold chisel cross-cut, cut 6.4 mm
83.39.30.140.1	Cold chisel flat, cut 15.9 mm
83.39.30.164.1	Cold chisel flat, cut 25.4 mm
83.41.68.802.1	Punches metal workers, set of 4 pcs
83.41.68.812.1	Punches metal workers, set of 4 pcs
83.41.82.108.1	Breast drill

MESC	DESCRIPTION
83.45.41.204.1	Pocket knife
83.45.41.300.1	Trimming knife
83.45.49.012.1	Scissors 300 mm (12 inch)
83.45.49.106.1	Brass foil shears
83.45.49.430.1	Tinman shears circular cutting
83.46.75.110.1	Electric soldering iron 75 W
83.46.75.114.1	Electric soldering iron 150 W
83.46.75.xxx.9	Electric soldering iron
83.46.45.008.1	Portable electric drill 8 mm
83.46.45.063.1	Portable electric drill 13 mm
83.10.38.050.1	Wire stripping pliers, 0.2 to 0.9 mm
83.10.38.051.1	Wire stripping pliers, 0.75 to 6 mm
83.48.20.000.1	Figure stamps, 3 mm (for marking metal)
83.48.20.003.1	Figure stamps, 10 mm
83.48.21.000.1	Letter stamps, 3 mm
83.48.21.003.1	Letter stamps, 10 mm
83.49.12.012.1	Flat files 300 mm (12 inch) bastard
83.49.12.212.1	Flat files 300 mm (12 inch) smooth
83.49.16.012.1	Half-round files 300 mm (12 inch) bastard
83.49.16.212.1	Half-round files 300 mm (12 inch) smooth
83.49.20.012.1	Round files 300 mm (12 inch) bastard
83.49.20.212.1	Round files 300 mm (12 inch) smooth
83.49.80.904.1	Instrument makers file set 100 mm (4 in)
83.49.80.906.1	Instrument makers file set 150 mm (6 in)
83.49.85.072.1	Needle file set 140 mm
83.52.08.201.1	Outside micrometer (0 to 1 inch)
83.52.08.251.1	Outside micrometer 0 to 25 mm
83.52.08.666.1	Vernier caliper 150 mm
83.52.14.020.1	Adjustable square 300 mm
83.52.60.312.1	Screw pitch gauge metric thread
83.52.60.322.1	Screw pitch gauge unified thread
83.52.76.074.1	Thickness gauge (feeler inch size)
83.52.76.084.1	Thickness gauge (feeler) metric size
83.52.82.090.1	Twist drill gauge metric, 0.5 to 10 mm
83.53.04.370.1	Hacksaw blades 300 mm 24 teeth/inch
83.53.04.378.1	Hacksaw blades 300 mm 32 teeth/inch

MESC	DESCRIPTION
83.53.08.005.1	Hammer pall pein 225 g
83.53.08.360.1	Hammer engineers cross pein 450 g
83.53.08.403.1	Hammers ball pein pein 100 g approx.
83.53.08.508.1	Hammer hard rubber, head 50 mm dia
83.53.08.690.1	Hammer plastic faces, head 25 mm dia
83.53.14.221.1	File handles 75 mm
83.53.14.223.1	File handles 115 mm
83.53.14.225.1	File handles 150 mm
83.60.15.001.1	Inspection mirror, plastic, length 250 mm
83.61.92.xxx.9	Wheel dresser
83.62.11.328.1	Inside caliper spring type 200 mm
83.62.11.408.1	Outside caliper firm joint type 200 mm
83.62.14.xxx.9	Divider firm joint 300 mm (12 inch)
83.62.14.xxx.9	Divider toolmakers 150 mm (6 inch)
83.62.46.012.1	Bench level cast iron, 300 mm
83.62.14.112.1	Bench level hard wood, 600 mm
83.62.66.202.1	Centre punch $^{1}/_{8}$ inch
83.62.66.204.1	Centre punch $^{1}/_{4}$ inch
83.62.70.012.1	Straight steel rule 300 mm (12 inch)
83.60.05.030.1	Pocket magnet
83.62.70.250.1	Steel folding rule, metric 1000 mm
83.62.70.302.1	Steel pocket rule, met/imp. 2000 mm
83.62.73.008.1	Engineers scribers
83.62.73.104.1	Pocket scribers
83.62.75.406.1	Engineers try squares 150 mm
83.62.75.412.1	Engineers try squares 300 mm
83.62.88.200.1	V-blocks and clamps
83.64.32.104.1	Cutting nippers, diagonal 115 mm
83.64.32.206.1	End cutting nippers, 150 mm
83.64.36.001.1	Combinations pliers, 150 mm
83.64.36.070.1	Short chain nose pliers, 200 mm
83.64.36.140.1	Short flat nose pliers, 100 mm
83.64.36.160.1	Flat nose pliers, parallel jaw 160 mm
83.64.36.306.1	Long flat nose pliers, 150 mm
83.64.36.366.1	Long bent snipe pliers, 170 mm
83.64.36.434.1	Short round nose pliers, 100 mm

MESC	DESCRIPTION
83.64.36.466.1	Long round nose pliers, 100 mm
83.64.36.761.1	Water pump pliers, 240 mm
83.64.36.810.1	Circlip pliers bent nose internal 180 mm
83.64.36.815.1	Circlip pliers straight nose internal
83.64.36.820.1	Circlip pliers bent nose external
83.64.36.825.1	Circlip pliers straight nose external
83.64.38.050.1	Tweezers straight 130 mm
83.64.38.052.1	Tweezers straight 150 mm
83.64.38.xxx.9	Tweezers curved
83.68.03.106.1	Packing removers No. 1
83.68.03.110.1	Packing removers No. 2
83.68.03.706.1	Gasket cutter up to 150 mm
83.68.03.720.1	Gasket cutter up to 500 mm
83.73.10.230.1	Engineers scrapers (set)
83.73.12.106.1	Screw drivers 150 mm
83.73.12.108.1	Screw drivers 200 mm
83.73.12.170.1	Screw drivers 250 mm square blade
83.73.12.202.1	Screw drivers 75 mm, parallel tip
83.73.12.208.1	Screw drivers 150 mm, parallel tip
83.73.12.310.1	Screw drivers 150 mm insulated
83.73.12.400.1	Instrument makers screwdriver set
83.73.12.504.1	Screwdriver 100 mm offset type
83.73.12.603.1	Philips screwdriver 80 mm
83.73.12.604.1	Philips screwdriver 100 mm
83.73.12.606.1	Philips screwdriver 150 mm
83.73.12.608.1	Philips screwdriver 200 mm
83.73.12.xxx.9	Screwdriver with screw holder 80 mm
83.73.12.xxx.9	Screwdriver with screw holder 112 mm
83.73.14.255.1	Screw extractor set, $^{3}/_{16}$ to $^{3}/_{4}$ inch
83.73.14.310.1	Stud extractor set, $^{1}/_{4}$ to $^{3}/_{4}$ inch
83.68.76.xxx.9	Mechanics Puller
83.79.12.032.1	Adjustable spanners 100 mm (4 inch)
83.79.12.048.1	Adjustable spanners 150 mm (6 inch)
83.79.12.064.1	Adjustable spanners 200 mm (8 inch)
83.79.12.084.1	Adjustable spanners 300 mm (12 inch)
83.79.40.060.1	Key wrenches unified, set

MESC	DESCRIPTION
83.79.40.100.1	Key wrenches metric, set
upto and inc	Key wrenches metric, set
83.79.40.119.1	Key wrenches metric, set
83.80.30.xxx.9	Pipe wrench adjustable 150 mm (6 inch)
83.80.30.100.1	Pipe wrench adjustable 200 mm (8 inch)
83.80.30.101.1	Pipe wrench adjustable 250 mm (10 inch)
83.80.30.102.1	Pipe wrench adjustable 350 mm (14 inch)
83.80.30.103.1	Pipe wrench adjustable 450 mm (18 inch)
83.80.76.401.1	Socket sets ($^1/_4$ inch) drive, unified $^3/_{16}$ to $^7/_{16}$ inch
83.80.76.501.1	Socket sets ($^1/_2$ inch) drive, unified 3/8 to 1 $^1/_4$ inch
83.80.75.401.1	Socket sets ($^1/_4$ inch) drive, metric from 4 mm upto and inc. 12 mm
83.80.75.501.1	Socket sets ($^1/_2$ inch) drive, metric from 10 mm upto and inc. 32 mm
83.82.36.240.1	Tool kit collapsible, 3 partitions
83.82.36.250.1	Tool kit collapsible, 5 partitions
83.82.68.033.1	Tube bender lever type $^3/_{16}$ inch OD
83.82.68.034.1	Tube bender lever type $^1/_4$ inch OD
83.82.68.035.1	Tube bender lever type $^5/_{16}$ inch OD
83.82.68.036.1	Tube bender lever type $^3/_8$ inch OD
83.82.68.038.1	Tube bender lever type $^1/_2$ inch OD
83.82.68.102.1	Tube cutter, 3 to 30 mm $^1/_8$ to 1 $^1/_8$ in
83.82.68.402.1	Tube flarer, $^3/_{16}$ to $^5/_8$ inch
83.86.30.304.1	Hand vice, 100 mm
83.86.30.415.1	Instrument makers vice, 65 mm
83.86.30.430.1	Instrument makers pin vices, set 0 to 5 mm
88.76.15.120	Oil stone, 25 x 50 x 200 mm
88.76.40.083	Oil Whetstone, 25 x 50 x 200 mm
83.10.38.xxx.9	Wire stripping tool (type stripwright)
83.46.75.xxx.9	Solder retractor
	Double head open end spanners 15° angle
83.79.32.190.1	Nominal A/F size $^7/_{16}$ x $^1/_2$ inch
83.79.32.193.1	Nominal A/F size $^9/_{16}$ x $^5/_8$ inch
83.79.32.196.1	Nominal A/F size $^{11}/_{16}$ x $^3/_4$ inch
83.79.32.199.1	Nominal A/F size $^{13}/_{16}$ x $^7/_8$ inch

MESC	DESCRIPTION
83.79.32.202.1	Nominal A/F size $^{7}/_{8}$ x $^{11}/_{16}$ inch
83.79.32.205.1	Nominal A/F size $^{15}/_{16}$ x $^{11}/_{8}$ inch
	Double head open end spanners 15° angle
83.79.32.652.1	Nominal A/F size 6 x 7 mm
83.79.32.656.1	Nominal A/F size 8 x 9 mm
83.79.32.660.1	Nominal A/F size 10 x 11 mm
83.79.32.662.1	Nominal A/F size 12 x 13 mm
83.79.32.664.1	Nominal A/F size 14 x 15 mm
83.79.32.668.1	Nominal A/F size 16 x 17 mm
83.79.32.669.1	Nominal A/F size 17 x 19 mm
83.79.32.670.1	Nominal A/F size 18 x 19 mm
83.79.32.672.1	Nominal A/F size 20 x 22 mm
83.79.32.673.1	Nominal A/F size 21 x 23 mm
83.79.32.675.1	Nominal A/F size 24 x 26 mm
83.79.32.676.1	Nominal A/F size 25 x 28 mm
83.79.32.677.1	Nominal A/F size 27 x 32 mm
	Ring spanners, double ended (12 point)
	deep offset
83.79.32.772.1	Nominal A/F size $^{5}/_{16}$ x $^{3}/_{8}$ inch
83.79.32.774.1	Nominal A/F size $^{7}/_{16}$ x $^{1}/_{2}$ inch
83.79.32.777.1	Nominal A/F size $^{9}/_{16}$ x $^{5}/_{8}$ inch
83.79.32.780.1	Nominal A/F size $^{11}/_{16}$ x $^{3}/_{4}$ inch
83.79.32.783.1	Nominal A/F size $^{13}/_{16}$ x $^{7}/_{8}$ inch
83.79.32.786.1	Nominal A/F size $^{7}/_{8}$ x $^{11}/_{16}$ inch
83.79.32.789.1	Nominal A/F size $^{15}/_{16}$ x $^{11}/_{8}$ inch
	Ring spanners, double ended (12 point)
	deep offset type
83.79.32.802.1	Nominal A/F size 6 x 7 mm
83.79.32.804.1	Nominal A/F size 8 x 9 mm
83.79.32.806.1	Nominal A/F size 10 x 11 mm
83.79.32.810.1	Nominal A/F size 12 x 13 mm
83.79.32.812.1	Nominal A/F size 14 x 15 mm
83.79.32.814.1	Nominal A/F size 16 x 17 mm

MESC	DESCRIPTION
83.79.32.816.1	Nominal A/F size 17 x 19 mm
83.79.32.818.1	Nominal A/F size 18 x 19 mm
83.79.32.824.1	Nominal A/F size 20 x 22 mm
83.79.32.826.1	Nominal A/F size 21 x 23 mm
83.79.32.830.1	Nominal A/F size 24 x 26 mm
83.79.32.832.1	Nominal A/F size 25 x 28 mm
83.79.32.834.1	Nominal A/F size 27 x 32 mm
	Twist drills metric, parallel shank
83.42.56.050.1	0.5 mm Diameter
83.42.56.070.1	0.7 mm Diameter
83.42.56.110.1	1.0 mm Diameter
83.42.56.111.1	1.1 mm Diameter
83.42.56.112.1	1.2 mm Diameter
83.42.56.113.1	1.3 mm Diameter
83.42.56.115.1	1.5 mm Diameter
83.42.56.118.1	1.8 mm Diameter
83.42.56.120.1	2.0 mm Diameter
83.42.56.122.1	2.2 mm Diameter
83.42.56.124.1	2.4 mm Diameter
83.42.56.125.1	2.5 mm Diameter
83.42.56.126.1	2.6 mm Diameter
83.42.56.128.1	2.8 mm Diameter
83.42.56.130.1	3.0 mm Diameter
83.42.56.132.1	3.2 mm Diameter
83.42.56.135.1	3.5 mm Diameter
83.42.56.137.1	3.7 mm Diameter
83.42.56.140.1	4.0 mm Diameter
83.42.56.142.1	4.2 mm Diameter
83.42.56.145.1	4.5 mm Diameter
83.42.56.147.1	4.7 mm Diameter
83.42.56.150.1	5.0 mm Diameter
83.42.56.155.1	5.5 mm Diameter
83.42.56.160.1	6.0 mm Diameter
83.42.56.165.1	6.5 mm Diameter
83.42.56.170.1	7.0 mm Diameter

MESC	DESCRIPTION
83.42.56.175.1	7.5 mm Diameter
83.42.56.180.1	8.0 mm Diameter
83.42.56.185.1	8.5 mm Diameter
83.42.56.190.1	9.0 mm Diameter
83.42.56.195.1	9.5 mm Diameter
83.42.56.200.1	10.0 mm Diameter
83.42.56.205.1	10.5 mm Diameter
83.42.56.210.1	11.0 mm Diameter
83.42.56.215.1	11.5 mm Diameter
83.42.56.220.1	12.0 mm Diameter
83.42.56.225.1	12.5 mm Diameter
83.42.56.230.1	13.0 mm Diameter
	Taps, B.S. Conduit set of 2 (1st and 3rd)
83.78.13.648.1	$^{3}/_{4}$ inch 16 threads/inch
83.78.13.664.1	1 inch 16 threads/inch
83.78.13.680.1	1 $^{1}/_{4}$ inch 16 threads/inch
83.78.13.696.1	1 $^{1}/_{2}$ inch 14 threads/inch
	Complete set of taps and dies in box with wrenches, for BSW and Whitworth thread
83.76.10.xxx.9	$^{1}/_{8}$ inch up to $^{1}/_{4}$ inch
	Complete set of taps and dies in box with wrenches, for metric thread
83.76.10.xxx.9	3 mm up to 12 mm
	Complete set of taps and dies in box with wrenches, for NPT thread
83.76.25.xxx.9	$^{1}/_{8}$ inch up to 1 inch
	Hand reamers, parallel driving squares Helical flutes, taper lead, metric
83.43.48.050.1	Nominal diameter 5.0 mm
83.43.48.055.1	Nominal diameter 5.5 mm
83.43.48.060.1	Nominal diameter 6.0 mm
83.43.48.070.1	Nominal diameter 7.0 mm
83.43.48.080.1	Nominal diameter 8.0 mm
83.43.48.090.1	Nominal diameter 9.0 mm
83.43.48.100.1	Nominal diameter 10.0 mm
83.43.48.110.1	Nominal diameter 11.0 mm

MESC	DESCRIPTION
83.43.48.120.1	Nominal diameter 12.0 mm
83.43.48.140.1	Nominal diameter 14.0 mm
83.43.48.160.1	Nominal diameter 16.0 mm
83.43.48.180.1	Nominal diameter 18.0 mm
83.43.48.200.1	Nominal diameter 20.0 mm
83.43.48.220.1	Nominal diameter 22.0 mm
83.43.48.240.1	Nominal diameter 24.0 mm
	Straight wrench for taps and reamers
83.78.32.012.1	No. 5 11 inch long, sizes 4 to 13 mm
	Wrench T-handle for taps and reamers
83.78.32.210.1	No.328, 70mm long, sizes 1 to 6 mm

APPENDIX 8 SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS

The following item numbers are used as a code in the lists to indicate the make up of the various fitters/technicians kits:

1. Instrument pipe fitter - Field
2. Instrument Technician - Field - General (Pneumatic and Electronic)
3. Instrument Technician - Field - Analyser
4. Instrument Technician - Shop - Analyser
5. Instrument Technician - Shop - Electronic
6. Instrument Technician - Shop - Pneumatic

NOTE: Materials are listed in sequence of MESC number.

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.11.60.xxx.9	Pointer extractor						x
69.55.30.xxx.9	Hand torch hazardous areas		x	x		x	
81.82.25.006.1	Brush flat, 35 mm		x	x	x	x	x
81.82.90.230.1	Wire brush (for welding)	x					
81.86.58.xxx.9	Oil dropper, pocket type		x	x	x	x	x
81.86.58.xxx.9	Oiler bench	x					
81.86.62.010.1	Padlocks, cylinder type brass	x	x	x	x	x	x
83.11.70.276.1	Hack saw frame 150 mm (6 inch)		x	x	x	x	x
83.11.70.286.1	Saw blades hacksaw 150 mm		x	x	x	x	x
83.29.63.016.1	Prying bar	x					
83.39.30.008.1	Cold chisel cross-cut, 3 mm		x	x	x	x	x
83.39.30.016.1	Cold chisel cross-cut, 6.4 mm	x					
83.39.30.140.1	Cold chisel flat, 15.9 mm		x	x	x	x	x
83.39.30.164.1	Cold chisel flat, 25.4 mm	x					

SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS (contd)

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.45.41.204.1	Pocket knife	x	x	x	x	x	x
83.45.49.106.1	Brass foil shears		x			x	x
83.46.75.xxx.9	Electric soldering iron					x	
83.49.12.012.1	Flat files 300 mm (12 in)	x	x	x	x	x	x
83.49.12.212.1	Flat files 300 mm (12 in)		x	x	x	x	x
83.49.16.012.1	Half-round files 300 mm (12 in)	x	x	x	x	x	x
83.49.16.212.1	Half-round files 300 mm (12 in)		x	x	x	x	x
83.49.20.012.1	Round files 300 mm (12 in)	x	x	x	x	x	x
83.49.20.212.1	Round files 300 mm (12 in)		x	x	x	x	x
83.49.80.906.1	Instrument makers file set			x		x	x
83.49.85.072.1	Needle files set, 140 mm		x			x	
83.52.08.666.1	Vernier caliper, 150 mm		x			x	x
83.53.08.005.1	Hammer 225 g ($^1/_2$ lb)	x	x	x	x		
83.53.08.360.1	Hammer engineers 450 g (1 lb)	x					
83.53.08.403.1	Hammers ball pein pin 100 g					x	x
83.53.08.690.1	Hammers plastic faced	x					x
83.53.14.221.1	File handles 75 mm	x	x	x	x	x	x
83.53.14.223.1	File handles 115 mm	x	x	x	x	x	x
83.53.14.225.1	File handles 150 mm	x	x	x	x	x	x
83.60.15.001.1	Inspection mirror				x	x	
83.62.11.408.1	Outside caliper firm joint 200 mm (8 inch)	x					
83.62.14.xxx.9	Divider firm joint 12 inch	x	x				x
83.62.14.xxx.9	Divider tool makers 6 inch	x	x				x

SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS (contd)

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.62.46.012.1	Bench level, cast iron	x					
83.62.66.202.1	Centre punch $^1/_8$ inch		x	x	x	x	x
83.62.66.204.1	Centre punch $^1/_4$ inch	x					
83.62.70.012.1	Straight steel rule 300 mm	x	x	x	x	x	x
83.62.70.250.1	Steel folding rule, 1 m	x	x	x	x	x	x
83.62.73.008.1	Engineers scribers	x					
83.62.73.104.1	Pocket scribers		x		x	x	x
83.62.75.406.1	Engineers try squares 150 mm		x		x	x	x
83.62.75.412.1	Engineers try squares 300 mm	x					
83.64.32.xxx.9	Cutting nipper diagonal 150 mm	x					
83.64.32.206.1	Cutting nipper end 150 mm		x	x	x	x	x
83.64.32.104.1	Cutting nipper instrument makers, diagonal 115 mm		x	x	x	x	x
83.64.36.001.1	Combinations pliers 150 mm	x	x	x	x	x	x
83.64.36.070.1	Short chain nose pliers 200 mm				x	x	
83.64.36.140.1	Short flat nose pliers		x		x		x
83.64.36.160.1	Flat nose pliers, parallel jaw						x
83.64.36.306.1	Long flat nose pliers		x	x	x	x	x
83.64.36.366.1	Long bent snipe pliers			x	x	x	
83.64.36.434.1	Short round nose pliers		x	x	x		x
83.64.36.466.1	Long round nose pliers					x	
83.64.36.761.1	Water pump pliers	x	x	x			
83.64.36.810.1	Circlip pliers bent nose internal, 100 mm				x		

SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS (contd)

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.64.36.815.1	Circlip pliers straight nose internal, 180 mm				x		
83.64.36.820.1	Circlip pliers bent nose external				x		
83.64.38.052.1	Tweezers straight 150 mm		x	x	x	x	x
83.64.38.xxx.9	Tweezers curve		x			x	x
83.73.12.106.1	Screwdriver 150 mm		x	x	x	x	x
83.73.12.108.1	Screwdriver 200 mm		x	x	x	x	x
83.73.12.170.1	Screwdriver 250 square blade	x	x	x	x		x
83.73.12.202.1	Screwdriver 75 mm spindle bl.				x	x	
83.73.12.208.1	Screwdriver 150 mm spindle bl.		x	x	x	x	x
83.73.12.310.1	Screwdriver 150 mm insul.		x	x	x	x	x
83.73.12.400.1	Instrument makers screwdriver (set)		x	x	x	x	x
83.73.12.504.1	Offset screwdriver		x	x	x	x	x
83.73.12.603.1	Philips screwdriver 75 mm		x	x	x	x	x
83.73.12.606.1	Philips screwdriver 150 mm		x	x	x	x	x
83.73.12.xxx.9	Screwdriver with screw holder		x	x	x	x	x
83.73.12.xxx.9	Screwdriver with screw holder		x	x	x	x	x
83.79.12.032.1	Adjustable spanner 100 mm		x	x	x	x	x
83.79.12.048.1	Adjustable spanner 150 mm	x	x	x	x	x	x
83.79.12.064.1	Adjustable spanner 200 mm	x	x			x	x
83.79.12.084.1	Adjustable spanner 300 mm	x					

SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS (contd)

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.79.32.652.1 to 83.79.32.680.1	Double head open ended spanners (set) metric	x	x	x	x	x	x
83.79.32.802.1 to 83.79.32.848.1	Double head ring spanners (set) metric	x	x	x	x	x	x
83.79.40.060.1	Key wrench set A/F sizes		x	x	x	x	x
83.79.40.100.1 to 83.79.32.119.1	Key wrench metric set		x	x	x	x	x
83.80.30.xxx.9	Pipe wrenches 150 mm (6 in)						
83.80.30.100.1	Pipe wrenches 200 mm (8 in)						
83.80.30.101.1	Pipe wrenches 250 mm (10 in)	x	x	x	x		x
83.80.30.102.1	Pipe wrenches 350 mm (14 in)						
83.80.30.103.1	Pipe wrenches 450 mm (18 in)		x				
83.80.76.401.1	Socket sets $^1/_4$ in drive A/F		x	x	x	x	x
83.80.75.401.1	Socket sets $^1/_4$ drive, from 4 mm up to 11mm (metric)		x	x	x	x	x
83.82.36.240.1	Toolkit collapsible 3 partitions	x					
83.82.36.250.1	Toolkit collapsible 5 partitions		x	x			
83.82.68.034.1	Tube bender $^1/_4$ inch OD	x	x	x	x		
83.82.68.038.1	Tube bender $^1/_2$ inch OD	x					

SUGGESTED TOOL KITS FOR INSTRUMENT FITTERS/TECHNICIANS (contd)

MESC No.	DESCRIPTION	CODE					
		1	2	3	4	5	6
83.82.68.102.1	Tube cutters, 3 to 30 mm	x	x	x	x		
83.10.38.xxx.9	Wire stripping tool (type stripwright)		x			x	
83.46.75.xxx.9	Solder retractor		x			x	
67.85.14.xxx.9	Portable multimeter (digit readout)		x	x	x	x	
83.60.10.xxx.9	Low pressure manometers (Dwyer type)			x			
83.10.99.240.1	Electronic engineering Tool kit (*x for the electronic technician only)		*x	x	x	x	
83.10.99.310.1	Philips trimming toolkit						x

APPENDIX 9 TYPICAL LABORATORY GLASSWARE SET

MESC	DESCRIPTION	SIZE	QUANTITY
90.04.42.025.1	Beakers, squat form, with spout	250 ml	4
90.04.42.070.1	Beakers, squat form with spout	1 l	4
90.04.42.110.1	Beakers, tall form without spout	50 ml	2
90.63.18.645.1	Dewar vessels	4 l	4
90.10.90.002.1	Cylinders, graduated, glass	5 ml	4
90.10.90.008.1	Cylinders, graduated, glass	50 ml	4
90.10.90.010.1	Cylinders, graduated, glass	100 ml	4
90.10.90.025.1	Cylinders, graduated, glass	250 ml	4
(Also available with interchangeable stoppers)			
90.20.20.105.1	Funnels, glass	55 mm	4
90.20.20.110.1	Funnels, glass	100 mm	4
90.20.20.511.1	Funnels, polyethylene	115 mm	4
90.19.55.190.1	Flask, washing, polyethylene	1 l	4
90.44.78.101.1	Pipettes, class A	2 ml	4
90.44.78.105.1	Pipettes, class A	5 ml	4
90.44.78.110.1	Pipettes, class A	10 ml	4
90.23.75.xxx.9	Gas flow meters soap-type	0 - 10 cc/min	2
90.23.75.xxx.9	Gas flow meters soap-type	0 - 50 cc/min	2
90.23.75.xxx.9	Gas flow meters soap-type	0 - 100 cc/min	2
90.23.75.xxx.9	Gas flow meters soap-type	0 - 500 cc/min	2