TECHNICAL SPECIFICATION

LABORATORIES

DEP 34.17.10.31-Gen.

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DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

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Shell International Oil Products B.V. (SIOP)
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Shell International Exploration and Production B.V. (SIEP)
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The Hague, The Netherlands,

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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.

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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.

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of laboratories.

This DEP is a revision of the DEP with the same title and number dated June 1983.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors nominated by them (i.e. the distribution code is "C" as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

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

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, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

2. GENERAL

Laboratories shall comply with BS 7789 or CP 16-1.

Normally, there are two types of laboratories in an oil refinery, chemical plant or gas plant:

- A main laboratory (sometimes called a general site laboratory) which is a separate building and shall be located at least 200 m away from any plant containing hydrocarbons or hazardous chemicals, and which should be located in the administration area.
- A plant laboratory as part of the control building.

The main laboratory building shall be designed in accordance with DEP 34.17.00.32-Gen.

The illumination level in laboratories shall be at least 400 lux.

Ambient noise within the laboratory, with equipment running but without personnel present, shall be 50 dBA maximum.

The plant laboratory shall comply with DEP 34.17.10.30-Gen. and DEP 34.17.00.32-Gen.

For research laboratories the requirements for a main laboratory shall apply.

Heating, ventilating and air conditioning of a main laboratory shall be in accordance with the principles laid down in the ASHRAE Handbooks and Product Directory.

Temperatures in laboratories shall be maintained between 20 °C and 26 °C and a relative humidity of between 30 and 70%.

For heating, ventilating and air conditioning of a plant laboratory in a control building, see DEP 31.76.10.10-Gen.

3. LOCATION AND LAY-OUT

3.1 MAIN LABORATORY

The laboratory building and any adjacent area reserved for extension shall be located in a non-hazardous area as defined in IEC 79-14.

General design drawings shall be prepared by the Principal, showing laboratory rooms, offices, chemical and glass stores, sample receiving area, bottle wash room, CFR engine room, air conditioning, machine room, gas cylinder area, instrument/maintenance workshop, pantry, wash/locker room, toilets, cleaners' cupboard, etc.

The CFR engine room (8.) shall be located such that noise and vibrations are kept outside the laboratory rooms. Separation shall be achieved by means of fire resistant walls and doors. If located in a separate building next to the laboratory and if there is a corridor connecting the two buildings then the corridor shall have an air lock.

Gas supply bottles shall be located outside the building (5.3.8).

In order to minimize the risk of fire flash-over and to minimize the extent of explosion damage, retained samples, bulk solvents, chemicals and fuels should be stored in a separate building at least 15 m from the laboratory. This store shall be adequately ventilated near the ceiling and the floor to prevent accumulation of toxic or flammable vapours. Ventilation and spillage containment facilities shall be provided where chemicals, solvents or fuels are poured.

4. ARCHITECTURAL DESIGN

4.1 WALLS, CEILINGS AND FLOORS

All walls, ceilings and floors of rooms where flammable products are stored or used shall have a fire resistance of at least one hour. Doors in these walls shall be self-closing and shall have a fire resistance of at least 60 minutes.

If spaces above ceilings are unavoidable (pitched roofs) these spaces shall be ventilated to prevent an accumulation of gases.

If there is a flat concrete roof, the acoustic and fireproof ceiling panels may be glued to the underside of the concrete ceiling. The underside shall be flat to prevent dead corners where light gases could collect.

If a perforated ceiling is required for an evenly distributed supply of air from the air-conditioning system then the ceiling panels shall be acid-proof and alkyd-proof finished.

In sample storage areas, ventilation shall be such that gases lighter than air cannot accumulate near the ceiling (i.e. extraction shall take place at the highest point of the room) and gases heavier than air cannot accumulate on the floor (i.e. extraction shall take place at the lowest point of the room). See also the ventilation arrangement in a typical analyser house (Standard Drawing S 17.001).

4.2 DOORS

Each laboratory room containing flammable or explosive products shall have at least two doors located as far as possible from each other and should have one door opening directly to the outside of the building.

Access to the laboratory shall be such that easy transport of samples is possible through a separate entrance. Equipment doors shall be sized such that the largest piece of anticipated equipment can enter the building and the room in which it will be installed.

The outside door (emergency exit door) in the plant laboratory in a pressurized control building shall be protected against opening from the outside and shall be self-closing, to prevent loss of over-pressure in the control building.

4.3 WINDOWS

All internal doors and all internal windows in laboratory rooms shall have transparent Georgian wired glazing with a maximum pane size of 0.25 m^2 and 1 m^2, respectively. See also DEP 34.17.00.32-Gen.

The number of outer windows shall be limited for safety and insulation reasons. These windows shall have a maximum pane size of 1 m^2 in main laboratories and 0.25 m^2 in plant laboratories. See also DEP 34.17.00.32-Gen. and DEP 34.17.10.30-Gen.

The sills of all windows shall be at least 250 mm above the laboratory benches.

The laboratory windows shall be protected from direct sunlight. This can best be achieved by locating the laboratory in such a way that direct sunlight cannot reach the windows. If this is not possible a solar-reflecting film shall be affixed to the glass panes or sun blinds shall be installed.

4.4 LOCATION OF BENCHES

Benches and tables shall be located such that from any point in the laboratory the emergency exits can be reached in two different directions. Therefore, only wall-type benches and island-type benches shall be installed, not finger-type benches.

There shall be at least 1 500 mm free space between benches and tables, and there shall be at least 800 mm free space between a bench or table and a wall. The central corridor in a laboratory room shall be at least 2 000 mm wide.

5. PIPING

5.1 GENERAL

Except for drain pipes and piping in benches and fume cupboards, all piping for the systems mentioned in (5.2) shall be surface-mounted along the walls and ceiling, or shall be mounted in service ducts along the wall or along the centre of island-type benches.

The service ducts above the benches should follow the same route as the electrical service ducts. There shall be one duct for gases and water and a separate duct for electricity and telephone cabling.

All incoming supply piping shall be provided with emergency valves which shall be located in an easily accessible main valve pit outside the building.

All incoming gas supply piping shall be provided with block valves at an operable height of 1.60 m. These valves shall be located outside every laboratory hall or room in order to block off a complete hall or room in case of an emergency.

For each floor, motorised emergency valves actuated simultaneously by central push buttons shall be installed in all piping carrying flammable, toxic and oxygen-suppressing gases.

In the laboratory room the main supply piping to fume cupboards and benches shall be provided with valves within easy reach. Also, each branch to a bench shall have a valve for isolating individual benches.

All fittings in piping systems of benches, fume cupboards, etc. shall be chrome-plated or plastic-coated.

Piping shall be provided for the safe venting and draining of samples. Disposal systems for these samples shall meet the local regulations for clean air, water and soil.

All piping and ancillaries shall be suitable for the fluids with which they will come into contact.

5.2 MATERIALS

The following materials shall be used (Note 1):

SERVICE	PIPING MATERIAL						
	Seamless copper tubing with soldered fittings	Seamless steel pipe, threaded, galvanized internally and externally	Seamless steel pipe, threaded and insulated 2)	Stainless steel pipe with welded fittings	Cast iron	ABS 3)	Poly-ethylene
Hydrogen	X			X			
Helium	X			X			
Argon	X			X			
Oxygen	X			X			
Nitrogen	X			X			
Carbon dioxide	X			X			
Acetylene				X			
Nitrous oxide	X			X			
Propane	X			X			
Butane	X			X			
Natural gas	X			X			
Hot water	X						
Cold water	X						
Distilled or demineralized water						X	X
Compressed air	X						
Steam			X				
Vacuum	X (branch)		X (mains)				
Drain piping in fume cupboards and benches							X
Disposal drain for hydrocarbons				X			
Steam Condensate		X					

NOTES:
1. The use of other materials is subject to the approval of the Principal.
2. Seamless steel pipe shall pass through walls in a pipe sleeve to prevent corrosion in these areas.
3. ABS = acrylonitrile butadiene styrene.

5.3 PIPING SYSTEMS

5.3.1 Cold and hot water

Water supply lines shall be provided with a non-return valve with air vent (valve) or a no-break installation to prevent contamination of drinking water.

The water supply piping to the emergency showers and the eye wash units shall be branched off upstream of the main stop valve of the water supply piping for laboratory and sanitary purposes, and shall be provided with a separate stop valve.

Emergency showers and eye wash units shall be installed at locations indicated by the Principal. Showers shall not be installed above the door opening but next to the door to keep the exit route free. Each shower shall be capable of delivering water at a minimum rate of 1.5 l/s.

The eye wash units shall be connected to a water supply having the minimum water pressure specified by the manufacturer. Eye wash units can conveniently be combined with the water tap at the end of a bench.

In non-tropical climates the eye wash units and emergency showers shall be connected to a warm water system (with an automatic mixing valve to keep the temperature acceptable) or to a separate lukewarm water system.

Each cold and hot water tap on the bench shall be provided with a drip cup mounted in the service zone.

Each island bench provided with hot and/or cold water connections shall have a sink with a drip board.

Drip cups and sinks shall be connected to the laboratory sewer system.

Small electric boilers may be installed in each bench to keep hot water lines as short as possible and provide instant hot water.

The separate taps for drinking water, process water and distilled water shall be clearly marked.

Insulation shall be applied if condensation can occur on cold water piping.

5.3.2 Distilled water

In a small laboratory distilled water may be supplied in bottles or by means of a low capacity laboratory distiller, but in a large laboratory a distilled water system should be considered, with a tap point in each laboratory room.

It should also be considered to make use of demineralized water from the plant utilities system.

An ion exchange unit may be considered for use inside a laboratory.

5.3.3 Compressed air

Dry and oil-free compressed air shall be supplied from an air supply system outside the building or from a compressor in a separate plant room in the laboratory. If the air is not dry and oil-free an air drier and air buffer, both provided with drains, shall be installed. The air system inside the building shall have a safety/relief valve, pressure gauges and pressure-reducing device to maintain a pressure of 2 bar (ga) at the service outlets.

For some special purposes a pressure up to 10 bar (ga) may be required and this shall be specified by the Principal.

For analysers the air required shall have the same specification as instrument air (see DEP 31.37.00.11-Gen.).

5.3.4 Vacuum piping

Vacuum piping shall be designed oversized to prevent blockage.

Buffer vessels and/or liquid catchers shall be installed between the pump and the suction

point.

5.3.5 Steam supply

If steam is required for heating water, a copper-lined heat exchanger shall be provided inside the building. This exchanger shall be equipped with a thermostatic control, a control valve and a safety/relief valve. The hot condensate of the steam supply shall be discharged into a sump located outside the building. The sump shall be connected to the drainage system.

Steam condensate should be collected and routed to the exchanger in order to be reused.

5.3.6 Drain piping

Drain piping shall be taken to the outside of the building along the shortest possible route with sufficient slope and a minimum number of bends.

Drains for flammable liquids shall be closed by a spring-loaded valve.

Drainage shall be designed in accordance with DEP 34.17.00.32-Gen. and DEP 34.14.20.31-Gen.

5.3.7 Gas sample vents

Gas vents shall be connected to a flare line or a vent stack for disposal into the atmosphere at a suitable point, well away from fresh air intakes.

Liquefied gas samples shall be routed to the flare stack.

5.3.8 Hydrogen, oxygen, nitrogen, carbon dioxide, propane, butane, helium, argon, acetylene and nitrous oxide

All gases shall be stored and handled in accordance with applicable national and/or local regulations. Given below are general requirements but it should be noted that certain countries may impose more stringent requirements, such as those for acetylene in the UK. Further details can also be obtained from the gas suppliers.

The gases shall be supplied from cylinders installed outside the building in such a way that free ventilation of air can be maintained. The cylinders shall be adequately protected from direct sunlight and rain by a sloped canopy which shall collapse immediately in the event of an explosion.

Gas cylinders shall be installed in special racks. Cylinders containing oxidising gases shall be physically separated from those containing reducing gases.

The space needed for the cylinders shall be enclosed up to a height of 2 100 mm above the concrete floor slab by a galvanized wire mesh fencing with an access door.

The gas header/manifold for the cylinders shall be provided with isolating valves, pressure regulator, pressure gauges (high-low) and a safety/relief valve, all suitable for the specific gases and all provided with standardized fittings.

Standard pressure at offtake points in bar (ga)*

Butane	0.025
Propane	0.025
Nitrogen	0.1-3.0
Carbon dioxide	4.0-6.0
Oxygen	0.5-5.0
Hydrogen	0.5-5.0
Helium	0.5-5.0
Argon	0.5-5.0
Nitrous oxide	0.5-5.0
Acetylene	max. 1.5

* For special purposes, other pressures may be required as specified by the Principal.

The number of cylinders depends on the number and type of tests to be carried out and shall be considered separately for each case .

The cylinders shall be connected to the manifold by means of Nyla flow connectors.

The acetylene and hydrogen piping shall include a flashback arrester of a type approved by the Principal.

Nitrous oxide piping shall have a heated reducing vent to prevent freezing.

Hydrogen piping shall include flow-limiting devices and switch-off devices, functioning when greater pressure drops arise.

Piping for flammable and toxic gases shall include excess flow check valves.

Acetylene piping shall be so positioned or protected that it will not be exposed to any source of external heat.

Hydrogen for a gas chromatograph apparatus shall be supplied from cylinders separate from those supplying hydrogen for other purposes.

NOTE: Depending on the local circumstances, nitrogen and other gases may also be supplied from the plant. The general rules given above are also applicable to such systems.

5.3.9 Cleaning and pressure testing of piping systems

The cleaning and pressure testing of piping systems shall be agreed with the Principal. The pressure test shall be performed at 1.5 times the design pressure for 24 hours.

Pressure testing of hot and cold water piping as well as the drainage system are specified in DEP 34.17.00.32-Gen.

5.4 COLOUR CODING

Piping shall be marked in line with local regulations. In the absence of such regulations, the following colour codes shall be used:

MEDIUM IN PIPE	COLOUR
Fire-fighting water	Dark blue (25) (5003) with red band (11) (3002)
	or Dark green (09) (6002) with red band (11) (3002)
Potable water	Dark green (09) (6002) with dark blue band (25) (5003)
Process water	Dark green (09) (6002)
Distilled/Demineralized water	Dark grey (02) (7005)
Warm water and central heating	Buff (06) (8001)
Steam	Red (11) (3002)
Condensate	Red (11) (3002) with dark blue band (25) (5003)
General drains	Black (9005)
Vacuum	Bright blue (27) (5015) with dark grey band (02) (7005)
Compressed air	Chocolate brown (14) (8014)
Instrument air	White (9010)
Argon	Bright blue (27) (5015) + "argon"
Carbon dioxide	Bright blue (27) (5015) + "carbon dioxide"
Nitrogen	Bright blue (27) (5015) + "nitrogen"
Nitrous oxide	Bright blue (27) (5015) + "nitrous oxide"
Flammable gases:	
Propane	Yellow (28) (1018) + "propane"
Butane	Yellow (28) (1018) + "butane"
Hydrogen	Yellow (28) (1018) + "hydrogen"
Oxygen	Yellow (28) (1018) + "oxygen"
Acetylene	Maroon (3009) + "acetylene"
Flare line	Yellow (28) (1018) + "flare gas"

The numbers between brackets refer to the Shell standard colours (2 digits) and the RAL standard colours (4 digits).

If piping is not painted over the full length in these colours, bands shall be applied, visible over the full length of the piping.

Pipes shall be identified with the name of the product, the pressure and the flow direction.

All tap points shall be marked with the name of the product.

6. ELECTRICAL INSTALLATION

6.1 GENERAL

For a laboratory located in a non-hazardous area and where the quantities of flammable gases present inside the building will not constitute a hazard, the electrical installation can be of the normal industrial design.

If either of the above conditions is not fulfilled the electrical installation shall at least conform to the installation practice specified in IEC 79-14 for the relevant hazardous area.

The electrical installation in bottle wash rooms, drying cupboards and fume cupboards, enclosed sample rooms, store rooms for chemicals and inside closed hoods shall at least be adequate for Zone 1 areas.

6.2 STANDARDS

The electrical installation shall be in accordance with DEP 33.64.10.10-Gen. and shall satisfy all statutory regulations of the national and/or local authorities of the country in which the installation is located.

6.3 INSTALLATION PRACTICE

Electrical cables shall be surface-mounted on walls or ceilings. Combined ducts may be used for electrical, earthing and telephone cabling provided that circuits and duties are properly separated.

6.4 SOCKET OUTLETS

Benches, fume cupboards and all other working places where electricity is necessary shall be provided with a sufficient number of single-phase industrial pattern convenience outlets (at least three per working place) having standard supply voltage, i.e. 230 V.

Depending on the local situation a number of 110 V single-phase and earth socket outlets shall be provided.

The rating of the socket outlets shall be at least 10 A.

The contact configuration of the socket outlets for the various voltage levels shall differ in such a way that associated plugs are not interchangeable.

Outgoing circuits to socket outlets shall be protected against overcurrent with maximum 16 ampere fuses and shall also be provided with earth leakage protection of 30 mA.

Overcurrent and earth leakage protection may be combined by fitting 16 A / 30 mA miniature circuit breakers of sufficient breaking capacity.

To avoid power disturbances at a working place as a result of a fault at another location, each set of socket outlets at each location shall have its own independently protected circuits.

Lighting circuits shall not be combined with socket outlet circuits. The circuit protection for socket outlets shall be within easy reach of the laboratory staff and in this respect sub-distribution per bench should be considered.

Depending on the size and purpose of the laboratory, one or more 3-phase+neutral+earth power outlets of at least 63 A shall be installed. In addition to the short-circuit protection of the power outlet circuit, earth leakage protection of maximum 500 mA shall be provided.

Equipment outlets and power outlets shall be located at a safe distance from sinks, water taps and emergency showers and shall not be positioned underneath shelves from where spillage can be expected.

6.5 EARTHING

Each work bench shall be provided with an earth bar, connected to a common earthing system, having a low resistance to earth (maximum 4 ohm).

6.6 ELECTRICAL SUPPLY SYSTEM VARIATION

Deviations in supply voltage and frequency and variations in supply waveform shall be within the values specified in DEP 33.64.10.10-Gen.

Short high-voltage spikes up to (2 U + 1 000) V super-imposed on the rated voltage may be expected due to HRC fuse blowing or de-energizing of unloaded transformers.

Laboratory equipment using electricity shall be able to cope with the above supply system variations.

Equipment having special requirements with respect to variations in voltage, frequency and/or waveform shall be provided with a power supply that is adequately stabilised and/or filtered.

6.7 EMERGENCY FACILITIES

In case of power failure, part of the lighting shall be supplied automatically from an emergency supply system for at least one hour to provide adequate lighting for the safe termination of work and for leaving the building.

Central push buttons shall be installed to switch off the electricity supply in each laboratory room in the event of fire and shall be located in such a way that they are safely accessible in an emergency situation.

In addition each fume cupboard and laboratory bench should be equipped with an emergency push button to switch off their power supplies separately.

7. FIXED FURNITURE

7.1 GENERAL

The wood used for furniture shall be well-seasoned. The glue used for making joints or laminating chipboard shall be of a water-proof type.

The tops of all benches and tables shall be between 750 and 800 mm or between 900 and 950 mm above the finished floor level, depending on whether laboratory work will be done sitting or standing (this to be specified by the Principal).

For some apparatus the height may be higher or lower depending on the type and height of the apparatus (this to be specified by the Principal). The tops of writing tables shall be approximately 780 mm above the finished floor level.

The work surface of the bench or table shall be made of strong and chemical-resistant material such as:

- teak or other hardwood, such as Iroko or Kambala;
- Trespa-Volkern, a thermosetting melamine or PVC (e.g. Toplab) veneer on a 16 mm solid phenol formaldehyde plastic base;
- ceramic;
- vitreous clay tiles with chemical-resistant joints on laminated wood;
- polypropylene;
- stainless steel.

The type of table top finish depends on the specific use of the bench or table.

Hardwood bench or table tops shall be finished with three coats of epoxy-type varnish. The final finish shall be non-glossy.

All other exposed surfaces of wood, such as the insides of cupboards and drawers, edges of chip-board panels, etc., which are not laminated shall be treated with at least two coats of epoxy-type varnish.

Grips, hinges, runners and flush pulls shall be of a strong and chemical-resistant material.

7.2 LABORATORY BENCHES

The basic construction shall be a rack of rectangular steel tubes carrying the required service piping and electric cables, a bench top and under-bench units. The rack shall be fixed to the floor or wall and shall be provided with a strip for mounting fittings and electrical sockets.

Alternatively, the required service piping and electric cables may be fitted in a service conduit located above the bench top.

Removable under-bench units shall be fitted to this rack.

The under-bench units shall be executed as cupboard and drawer elements. Their sides shall be properly finished on the outside since they may be permanently visible.

The cupboard units shall be provided with sliding doors, or doors that can open at least 180 degrees, and with adjustable shelves.

Bench tops and service strips for fittings, etc. shall be made of strong chemical resistant material as described in (7.1).

If radiators are installed underneath the windows, the section of the strip for fittings (between the wall and the rack) above such a radiator shall be provided with removable air grills.

Special benches for gas chromatographs, spectrophotometers, etc. shall be selected, preferably in two halves, separated by an open service space of about 500 mm wide.

7.3 FUME CUPBOARDS

Fume cupboards shall be made of the same material as the laboratory benches, and shall have the same outside finish. The walls and ceiling shall be internally lined with acid-resistant sheeting, e.g. chemical-resistant toughened glass. The worktop shall have vitreous clay tiles or shall be ceramic or polypropylene, or stainless steel plated. Fume cupboards for use in hydrofluoric acid service shall be made from PVC and perspex.

Each fume cupboard shall be at least 1 000 mm wide.

The interior of the fume cupboard and the exhaust ducting to atmosphere shall be such that dead corners are avoided.

In the opening between the window and the bench top an evenly distributed air current, without turbulence, shall be ensured for any position of the sash window. The entrance air velocity shall be 0.30-0.60 m/s. The window shall be glazed with safety glass.

The exhaust of the fume cupboards shall be an integral part of the air-conditioning system. The exhaust fans are therefore always in operation.

Regardless of the position of the fume cupboard window the rate of exhaust shall remain constant.

The capacity of the fan shall be such that under any outside wind conditions a sufficient quantity of air can be displaced from the fume cupboard to the outside of the building.

The fan shall be a centrifugal type and the ducting from the fume cupboard to the extraction fan shall be sized such that there is a negative pressure over its entire length.

Each cupboard shall have its own exhaust ducting and shall be provided with its own acid-resistant non-sparking fan. The explosion-proof motor of this fan shall be mounted outside the ducting. It shall be possible to switch this motor from a safe distance away.

The fume cupboards shall be located such that passing people or opening of doors will not disturb the air flow in front of the cupboard.

The air flow shall as far as possible be perpendicular to the entrance opening of the fume cupboard.

Fume cupboards should be located along the wall and in groups next to each other.

Both the controls of the service points and the electrical fittings such as plug sockets, switches and pilot light shall be mounted outside the fume cupboard on a horizontal service strip in the front, and below the level of the bench top.

If it is unavoidable to have electrical equipment inside the hood it shall be adequate for a Zone 1 area.

At each cupboard there shall be pilot light indicating on/off and an audible alarm activated upon interruption of the extraction fan motor.

7.4 SAMPLE TABLES AND SHELVES

The working surfaces of table tops shall be of the materials specified in (7.1).

The front legs shall be fixed to the floor. Horizontal braces for the legs shall be fixed to horizontal wooden rails fixed on the wall.

The work surface of shelves (which are at about half the height of tables) shall be of the materials specified in (7.1) but if made of solid wood they shall be stainless steel plated or shall be coated with an oil-resistant and chemical-resistant paint (epoxy type).

The shelves shall be designed for a load of 100 kg per metre for a shelf depth of 300 to 400 mm.

7.5 SPECIAL EXHAUSTS AND DRAINS

For the disposal of flammable liquid products, a separate drain shall be connected to the oily drain system of the refinery or to an underground collecting tank to be emptied by a suction truck.

This disposal drain sink shall be made of stainless steel.

The drain pipe of this sink shall be provided with a foot-operated self-closing valve so that no vapours from the drain pit can enter the laboratory when the sink is not in use.

A shelf for solvent bottles shall be constructed above the sink and an exhaust hood shall be mounted above the entire unit.

The Principal shall specify if and where separate spot exhausts shall be installed above specific equipment (e.g. atomic absorption equipment).

If more gas chromatograph apparatus is installed, a separate exhaust system shall also be included.

All exhaust openings shall be protected against the entry of debris, birds, rain, etc. These openings shall be positioned in such a way that the exhaust air cannot enter the fresh air intake opening.

Different types of exhausts shall not be combined.

8. CFR ENGINE ROOM

The combustion fuel reference (CFR) room shall comply with the building requirements specified in ASTM Volume 05.04.

The reinforced concrete foundation of the test unit shall be isolated from the room floor. Asphalt or other vibration damping material shall be used between the foundation and surrounding edges of the flooring.

Internal and external doors of the engine room shall be double-sheeted insulated steel doors, each provided with an automatic door closer, and shall be 60 minutes fire-resistant. If visibility is necessary, windows in these doors shall have maximum pane size of 0.25 m^2.

The ceiling and internal surfaces of walls between the ceiling and the tops of door frames shall be covered with acoustic panels. All materials used in the construction of ceiling and wall linings shall be of non-combustible material.

A CFR engine shall never be installed in the control building.

To avoid escalation in case of fire, a CFR engine shall be clearly separated from other laboratory areas by means of fire resistant walls and doors.

An unmanned CFR engine room shall be equipped with fire and gas detection and an extinguishing system.

The ventilation system of a CFR room shall be separate from ventilation of other spaces, to avoid gases originating in the CFR room migrating to other spaces.

There shall be at least 12 air changes per hour and there shall be no stagnant areas, as described in area classification codes. Ventilation shall rely on natural ventilation.

9. FIRE-FIGHTING FACILITIES

9.1 GENERAL

The facilities shall be in accordance with DEP 80.47.10.30-Gen., DEP 80.47.10.31-Gen. and DEP 80.47.10.32-Gen. and NFPA 101.

9.2 FIRE, SMOKE AND GAS DETECTION

The fire safety requirements shall be determined in a comprehensive fire safety assessment considering the plausible fire scenarios, the safety of personnel, the manning of the location and the consequences of loss of the laboratory facilities.

At least the following facilities shall be provided:

- Polyethylene tube-type heat detectors shall be installed on the engines. The CFR room shall be provided with flammable gas detectors alerting personnel inside and outside the room.
- All areas in the building where flammable materials may be present shall be equipped with conventional smoke detectors.
- All detectors shall activate an alarm in a permanently manned location on the premises.

9.3 FIRE CONTROL MEASURES

Switches to trip the engines shall be installed outside the CFR room. Facilities, accessible under fire conditions, shall be provided to cut the fuel supply to the CFR engines.

9.4 FIRE EXTINGUISHERS AND WATER HOSE REELS

Hand-operated carbon dioxide fire extinguishers of 6 kg capacity shall be provided in all work spaces of the building. The extinguishers shall be located near the doors.

Two dry chemical extinguishers shall be installed in the CFR room near the doors.

25 mm reeled water hoses fed from the potable water system shall be installed in the corridors of the building such that all work spaces will be within reach of the nozzle.

10. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Heating, ventilation and air conditioning for plant buildings	DEP 31.76.10.10-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Drainage and primary treatment facilities	DEP 34.14.20.31-Gen.
Minimum requirements for design and engineering of buildings	DEP 34.17.00.32-Gen.
Reinforced control buildings/field auxiliary rooms	DEP 34.17.10.30-Gen.
Assessment of the fire safety of onshore installations	DEP 80.47.10.30-Gen.
Active fire protection systems and equipment for onshore facilities	DEP 80.47.10.31-Gen.
Portable and mobile equipment for fire-fighting	DEP 80.47.10.32-Gen.
Typical analyser house for tropical areas	S 17.001

AMERICAN STANDARDS

Test Methods for Rating Motor, Diesel, and Aviation Fuels — ASTM Volume 05.04

Issued by:
American Society for Testing and Materials
1916 Race Street
Philadelphia
PA 19103
USA.

ASHRAE Handbooks and Product Directory

Issued by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.,
1971 Tullie Circle NE,
Atlanta
GA 30329
USA.

Life Safety Code — NFPA 101

Issued by:
National Fire Protection Association
470 Atlantic Avenue
Boston
MA 02210
USA.

BRITISH STANDARDS

Guide to design of measurement laboratories — BS 7789

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
UK.

DUTCH STANDARDS

Laboratoria, bouw en inrichting — CP 16-1

Issued by:
Sdu
Servicecentrum Uitgeverijen,
Afdeling Verkoop
Postbus 20014
2500 EA Den Haag
Netherlands

GERMAN STANDARDS

RAL Standard Colours

Issued by:
RAL
Bornheimerstraße 180
D-5300 Bonn 1
Germany.

INTERNATIONAL STANDARDS

Electrical installations in explosive gas atmospheres (other than mines) — IEC 79-14

Issued by:
International Electrotechnical Commission
Central Office (Sales Department)
PO Box No. 131
3 Rue de Varembé
1211 Geneva 20
Switzerland.
Copies can also be obtained from national standards organizations