TECHNICAL SPECIFICATION

REINFORCED CONTROL BUILDINGS/FIELD AUXILIARY ROOMS

DEP 34.17.10.30-Gen.

January 1990

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 DEP aims at describing the appropriate precautions that have to be taken in the design, siting and construction of new control buildings and field auxiliary rooms (FAR's) in order to minimise the damage in the event of an explosion of a vapour cloud, caused by equipment failure or due to incorrect operation of a plant.

It is a revision of the previous publication of the same number dated August 1981

This DEP provides additional requirements for these buildings, over and above the general requirements for buildings as stated in DEP 34.17.00.32-Gen.

This specification is intended for use by civil engineers and/or architects involved in the design and engineering of new control buildings in onshore oil, gas and chemical production facilities. It is not applicable to offshore facilities.

For control buildings, it is important that sufficient protection for operators and electronic equipment (1.2) is provided so that in case of a calamity they remain able to function and emergency actions can be taken to minimise the spread of danger and secondary damage.

For FAR's, it is only essential to protect the electronic equipment as such. These buildings are normally unmanned.

Unless otherwise authorized by SIPM, the distribution of this technical specification is confined to companies forming part of or managed by the Royal Dutch/Shell Group, and to contractors nominated by them.

As a general rule, the requirements of the national and/or local regulations shall be adhered to, but if these are less stringent than the requirements of this specification, the latter shall prevail. Where regulations are more stringent than the requirements of this specification, the supplier and/or contractor shall inform the principal, who may negotiate with the authorities concerned, in order to obtain agreement to follow this specification as closely as possible.

Where cross references are made, the number of the section or subsection referred to is shown in brackets.

All publications referred to in this document are listed in Section 10.

1.2 DEFINITIONS

For the purpose of this specification, 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 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.

Electronic equipment includes (processor based) digital control systems, telecommunication facilities, process computer systems, safety systems including gas and fire detection systems.

2. LOCATION OF THE CONTROL BUILDING/FAR

The location of the building shall comply as far as practicable with the considerations listed below in order of importance.

Deviations from these considerations, and the final decision on the control building location, shall be discussed with the Principal.

DEP 34.17.00.32-Gen. gives guidance on the safety distances to be considered when siting buildings.

The control building for a new plant (grass roots plant) shall preferably be situated in the main office block in the administration area combined with common facilities such as canteen/toilets/showers/offices and laboratory which are located at a safe distance of at least 200 m away from process plants, and more than 100 m away from storage areas/ transfer operation sites. The design shall be in accordance with DEP 34.17.00.32-Gen.

If the above applies, the control room shall be interconnected via data transmission cables to FAR's (Field Auxiliary Rooms), which shall be constructed as a reinforced concrete building in accordance with this DEP manual.

In case the control building is not situated in the main office block, the building, including possible future extensions, shall be located in an area classified as non-hazardous by the IP Model Code of Safe Practice, Part 1, Electrical Safety Code, and shall be designed in accordance with this DEP.
The location shall be at the periphery of the processing plant and at least one side (preferably the back) shall be adjacent to a road or a parking area, see Appendix 1. The control building shall not be enclosed by equipment on all four sides. The above requirements also apply to FAR's.

The following common requirements apply to both the control building and the FAR:

- The distance between the building and equipment containing flammable substance shall be at least 15 m. Depending on size, pressure and contents of this equipment, the minimum distance can be up to 30 m, i.e. installations handling light hydrocarbons under elevated pressure. The distance between the building and any pipe track shall be at least 6 m. Sufficient emergency exit routes shall be designed. For control buildings only such routes shall provide for exit at least in three directions.
- Where there are prevailing winds, the building shall be located upwind of the prevailing wind direction. Special attention shall be paid to the distance between bitumen blowing facilities and the building to avoid any fouling due to spraying bitumen.
- The building shall not be located on a lower level than surrounding plants and tank farms. It shall be located away from vibrating or noise-producing equipment, for example controlled steam vents, heavy-duty pumps and compressors.
- The building shall preferably be located close to centres of major operational importance, and where appropriate, central with regard to future extensions. In that case, space shall be reserved for possible extension of the building itself. The building shall preferably be located close to activities requiring regular local supervision.
- For those plants where operating personnel also act as fire-fighting crew, reserved parking spots next to the control building shall be provided.

3. GENERAL CONSIDERATIONS

3.1 SIZE OF THE CONTROL BUILDING/FAR

The building shall be as compact as possible. The control building shall only accommodate personnel and equipment directly related to safe and reliable plant operations whereas FAR's shall only accommodate the essential (electrical and instrument) equipment, where applicable.

The height of the building shall be limited to one storey above grade. As a consequence the air-conditioning unit shall be located either on the ground floor or in the basement of the control centre.

FAR's shall be built as a one storey building, without basement.

If, for certain chemical plants, e.g. polymerization plants, the control building has to be located on the first floor of the plant structure for optimal supervision, this exceptional requirement shall be mentioned specifically by the principal and a design shall be developed in close consultation with their civil engineering division.

3.2 STRENGTH OF THE BUILDING

The building shall be designed as a reinforced monolithic concrete, rectangular box-type structure, in such a way that a large plastic deformation can occur under the loadings as specified in (5.3) without total collapse. If there is a possibility that gas, smoke, fire, heat, etc., can enter the control building through damaged windows after an explosion, no windows shall be provided in the outer walls of rooms which are considered as essential for controlling the operation of the plant, see (5.5). No windows shall be provided in FAR's.

If the omission of windows in control buildings is contrary to local regulations, the architect or the engineering contractor, in close contact with the principal, shall endeavour to obtain a formal exemption from the local authorities for the restriction of daylight into the building.

NOTE : Closed circuit television (CCTV) facilities shall be considered as a means to maintain visual communication with vital parts of the surrounding plants.

3.3 NOISE LEVELS

If noise-generating equipment is installed in the control building, DEP 31.10.00.31-Gen. shall be followed. For noise limits reference is made to DEP 34.17.00.32-Gen. - Buildings.

The level of reflected noise shall be reduced by installing an acoustic ceiling and acoustic material on the upper part of the walls.

When the noise level generated in the computer room is high, double-glazed (sealed) windows shall be used, to attenuate the transmission of noise to other areas in the building, whilst still allowing visual communication with the control room.

3.4 VIBRATION LEVELS FOR THE COMPUTER ROOM

Vibrations in the control room shall be limited in order to ensure continuously reliable operation of the (process) computer equipment.

The maximum allowable vibration intensities as applied to the equipment are :

- sustained vibration (5 s or longer) at frequencies less than 14 Hz : 0.25 mm peak to peak;
- sustained vibration at frequencies of 14 Hz or higher : 0.1 G peak (0.07 G root mean square);
- intermittent vibration (less than 5 s) at frequencies less than 7 Hz : 2.5 mm peak to peak;
- intermittent vibration of 7 Hz and higher : 0.25 G peak (0.18 G root mean square).

These limits are not usually exceeded for :

- sustained vibrations that are perceptible, but not annoying or distracting;

- intermittent vibrations that are annoying or distracting but not intolerable.

3.5 PLANNING OF ACTIVITIES

The control room, instrument basement, computer room/basement in the control building and instrument room in a FAR shall be completed and the air conditioning system operating, before any microprocessor-based computer system is installed. In particular, no concrete work shall be done after the installation of this equipment, and pile driving operations shall not take place in the neighbourhood of such equipment after the installation of the computer. This could cause the limits of (3.4) to be exceeded and lead to damage.

When the microprocessor-based computer rooms are ready and cleaned, the air-conditioning installation shall be in operation at least one week before the computer equipment is installed. During this period the performance of the air-conditioning equipment shall be checked by means of electric heaters, simulating the heat dissipation of the computer equipment to be installed. The results of this test shall be satisfactory before the installation of the computer equipment can proceed.

After unpacking the microprocessor-based computer equipment, the relevant rooms shall be made dust-free again and stay so. During the installation and testing period, cleaning shall be carried out in close operation with the responsible computer specialist. Dust-producing activities shall be restricted to a minimum. If the plant is not yet commissioned, special attention shall be paid to the availability of utility supplies for the air-conditioning system, during the period in which the computer is being installed, tested and commissioned.

4. LAY-OUT OF THE BUILDINGS

4.1 LAY-OUT OF THE CONTROL BUILDING

4.1.1 General

The control building will normally comprise :

- the control room
- the computer room
- a training/conference room is normally required
- a supervisory area should be provided adjacent to the control room
- the instrument and computer room
- the electrical equipment and battery room
- the heating, ventilating and air-conditioning machine room
- the first aid compartment (provision of a separate room for first aid depends on other first- aid facilities, e.g. medical centre/staffed during office hours/ permanent)
- the operators laboratory (if necessary)
- the offices and social amenities (mess room, wash-, locker- and toilet rooms) (it is not always necessary to provide locker and washing facilities as part of the control building).

NOTES:
1) To minimise the number of people near potential hazards, and to reduce the size of control buildings, a general site laboratory shall not be part of the control building but shall be located, if possible, near the administration area, in principle and if possible at least 200 m from the plant area. This laboratory can be built in accordance with DEP 34.17.00.32-Gen.

2) Provision of office space in the control building should be determined per project, taking into account the local organization (including future plans) and local needs. Office space can vary from provision only for shift personnel (supervisors) to all operations personnel (day assistants, plant manager, engineering and technology personnel, involved with plant operation on at least a daily basis).

3) Where sufficient space is available, the control building shall be designed as a one-storey high building without a basement. In that case all the above rooms will be at grade level.

For a typical lay-out, see Appendix 2.

4.1.2 Control room

The control room is that section of the control building in which the instrument consoles and the operator computer facilities are accommodated.

The control room shall be designed such that sufficient space for installation of equipment for future extensions is incorporated without need for extending the reinforced concrete building.

4.1.3 Computer room

A separate room for the accommodation of digital process computers etc. shall be incorporated in the control building. This computer room shall be in such a location that the risk of exposure to fire, water, smoke and dust from adjoining areas and activities is kept to a minimum. This room shall not be located in the basement (if applicable).

The computer room shall not be located next to rooms with equipment which could cause electrical interference, such as rotating electrical machinery, transformers or electrical switchgear, unless special precautions have been taken to safeguard the proper functioning of the computer equipment.

A removable partition shall be provided in the computer room for creating a separate storage area for discs, tapes, documentation and spare parts, etc. This storage area shall also serve as an air lock to the computer room.

4.1.4 Instrument basement and computer basement

In case a basement is required due to space limitations, auxiliary instrument and computer equipment shall be installed under the control room and the computer room.

See Appendix 2.

The basement shall have sufficient space to accommodate all auxiliary instrument and computer equipment required, with sufficient free working space around this equipment. A reasonable amount of spare space shall be included for future extension.

See also Note 3 of (4.A.1).

4.1.5 Electrical equipment (battery room)

If batteries for emergency power supply are located in separate rooms in the basement, these rooms shall have separate exhaust facilities. The rooms shall not be located under wash and toilet areas because of possible plumbing leakages.

4.1.6 Heating, ventilating and air-conditioning machine room

The machine room for heating, ventilating and air-conditioning equipment shall be located in the basement (if applicable) or on the ground floor. This machine room shall be at least two metres from the computer room and from electronic instrumentation located in the control room and control room basement, or shall be separated by a 300-mm thick reinforced concrete wall, to reduce mechanical and electrical interference from power cables/switchgear, to control and computer cables/equipment. No windows shall be installed in this machine room. To avoid large space requirements for HVAC duct work and/or air distribution problems, the HVAC machine room shall be located as centrally as possible in relation to the vital rooms served.

The entrance to the machine room shall be located in such a way that the HVAC maintenance personnel can reach the machine room without having to pass through the instrument, computer or electrical areas.

4.1.7 First-aid compartment

A closed compartment shall be provided in the control building for first aid equipment. Generally, local medical policy determines what shall be provided in the first aid kit, for example whether or not oxygen equipment shall be included. The facilities will also depend on the location of the control building (local or remote from the process plant), and on the existence of other medical facilities (medical centre and/or manning). As a minimum the compartment shall include a collapsible stretcher for removing injured personnel to a point where they can be collected by ambulance, and spare safety equipment such as helmets, gloves and spectacles.
Portable breathing apparatus shall be installed at a convenient height inside the control building, at the exits, for immediate use should the need arise. Each air mask shall be contained in a plastic bag. Canister-type masks are not recommended for rescue work but can be used for personal protection (escape masks).

The booklet "Office Safety" gives some general guidelines for the provision of first-aid equipment.

4.1.8 Interconnections

The shift supervisor shall have a view from his office into the control room and equally the operators shall be able to see the control room from the mess room, thus affording quick visual communication, whenever necessary.

The operators laboratory shall be visible from the control room through windows, to allow visual communication between the operators and laboratory personnel.

There shall be no direct connection between the control room and the basement and the other rooms in the building by direct doors, by slots in walls, or via the drainage system with exception of the following rooms:

- office (for shift supervisor);
- mess room;
- computer auxiliary room (computer office).

All other rooms shall be connected with the control room and its basement via air locks or corridors (min. 2 doors to pass).

Each room in which people work, and where there is a chance of fire or gas accumulation,

shall have two exits, located such that the chance of being trapped is minimal. The width of doors and passages shall comply with the applicable regulations, permitting free and easy exit in emergencies.

The operators laboratory, where provided, shall have no direct communication with the rest of the building through doors, movable windows or hatches, to prevent gases from entering the control room. The laboratory shall have two doors, one entrance door to a corridor or air lock of the control building, and one emergency exit door direct to the outside.

Gas cylinders which may be required for the laboratory shall be kept outside the building.

4.2 LAY-OUT OF THE FAR

4.2.1 General

The building will normally comprise:

- the process control and safeguarding room
- the electrical equipment and battery room (if necessary)
- the heating, ventilating and air-conditioning machine room (if necessary)
- the room for Uninterrupted Power Supply (UPS) equipment (if necessary).

NOTES :
1) The building shall normally be unmanned and therefore no offices shall be designed to accommodate personnel.

2) When the FAR is also used as facilities for field operators in case of remote control rooms, a central access by means of an air lock shall be provided to maintain the required overpressure inside the building.

3) The building shall have no basement.

4.2.2 Process control and safeguarding room

For the installation of such equipment, sufficient space to accommodate the latter shall be designed, taking into account sufficient free working space around this equipment.

A reasonable amount of spare space shall be included for future extension.

4.2.3 Electrical Equipment/battery/no break set room

Batteries for emergency power supply shall be located in separate rooms with separate exhaust facilities.

4.2.4 Heating, ventilating and air-conditioning (hvac) machine room

In order to avoid long ducting the HVAC room shall be located as central as possible with respect to the rooms housing vital equipment.

The HVAC machine room shall be separated by a 300 mm thick reinforced concrete wall to reduce mechanical and electrical interference from power cables and equipment to instrumentation cables and electronic equipment.

The entrance to the air-conditioning machine room shall be located in such a way that the air-conditioning maintenance personnel can reach the HVAC machine room without having to pass through the instrument or electrical areas.

5. DESIGN CONSIDERATIONS FOR REINFORCED CONTROL/FAR BUILDING

5.1 GENERAL

The civil engineering of the building shall be in accordance with the requirements of this specification and of DEP 34.17.00.32-Gen. Local building regulations shall be followed where these are more stringent.

A general arrangement drawing showing the internal lay-out of the building shall be prepared in close consultation with the Principal.

A recognized architect shall be engaged to design and coordinate the buildings and their installations. The choice of architect needs prior approval of the Principal.

5.2 BASIC DESIGN

The shape of the building shall be rectangular, with no protruding canopies, etc., no equipment on the roof except for the air intake and exhaust facilities (penthouse), and no re-entrant angles, to prevent a build-up of pressure.

The overall height of the building and the flat span of the roof of that building shall be to a minimum to limit the effects of an explosion.

Since flying glass fragments are one of the greatest dangers to occupants of buildings during an explosion, windows in outer walls require special treatment and shall be restricted to offices, mess room and the operators laboratory in the control building only.

Furthermore, materials with a brittle behaviour, such as masonry, shall not be used in such a way that they are required to have a structural or resistive function during explosion loading. Since, in the case of an explosion, the external walls will be subjected to a sudden movement inwards, the installation of important equipment, such as panels or switchgear, or radio base stations etc. against such walls is not permitted.

The roof shall be well insulated, but shall not be covered with gravel or loose concrete tiles as these will fly in the event of an explosion. On the roof, only the air intake and exhaust facilities (penthouse) of maximum height 1.8 m, fresh air intake stack, aerials, TV cameras and similar equipment are permitted.

5.3 BASIS FOR CALCULATION

5.3.1 Loads

The calculations for the structural elements of a building subject to blast loads shall be based on the following equivalent static loads acting perpendicularly to the surface :

- *external walls* 100 kN/m^2, except loads on doors and windows which may be assumed to be 30 kN/m^2;
- *roof slabs*
  load is dependent on span between supports :

  50 kN/m^2 for span of 3 m
  45 kN/m^2 for span of 4 m
  40 kN/m^2 for span of 5 m
  35 kN/m^2 for span of 6 m
  30 kN/m^2 for span of 7 m
  25 kN/m^2 for span of 8 m and over, together with the applicable dead load.

  It is to be assumed that these loads will act simultaneously on one wall and the roof.
- *suction on walls and roof 50%* of above-mentioned static loads.

  It is to be assumed that these loads will act simultaneously on one wall and the roof and not in combination with above-mentioned loads.

  NOTE: No extra loading for snow or wind.

5.3.2 Design philosophy

The design shall be based on the plastic hinge design philosophy, also referred to as ultimate strength principle, which recognizes the redistribution of internal forces that takes place when complete yielding develops at regions of high bending moment. Applying this philosophy, the factor of safety against collapse, i.e. when the structure develops a sufficient number of plastic hinges to permit unrestrained deformation, shall be 1:1.

5.3.3 Type of reinforcing bars

Hot-rolled steel bars with a yield strength (fy) between 240 and 410 N/mm^2, and a minimum elongation between 24% and 14%, shall be used for reinforcement of the concrete. The design stresses of those structural elements subject to blast loads shall be the yield strength of the applied steel bars and the failure stress of the concrete, i.e. 0.8 times the characteristic cube strength. Independent of steel/ concrete quality the safety coefficient shall be 1:1.

5.3.4 Reinforcing

The concrete walls and slabs shall be reinforced each side in the main direction with a minimum of 1% on both sides of the concrete cross section in the case of steel bars with a yield strength (fy) of 240 N/mm^2, and 0.6% in the case of steel bars with a yield strength of 410 N/mm^2. For steel bars with yield strengths other than aforementioned the minimum percentage shall be :

$$\text{minimum percentage} = \frac{240}{fy}$$

In the other direction on both sides, a distribution reinforcement of at least 20% of that in the main direction shall be applied. Maximum spacing of bars shall be 150 mm centre to centre. It is preferable for the wall and roof thicknesses to be between the limits of 250 and 400 mm in order to facilitate the placing of the required reinforcing bars.

5.3.5 Shear reinforcement

Shear reinforcement shall be applied in beams only and shall be a combination of stirrups and horizontal side bars : web reinforcement.

When the shear stress (V) is less than 1.3 N/mm^2 (V_{c1}) : no web reinforcement is required.

When the shear stress (V) is more than 1.3 N/mm^2 but less than 4.5 N/mm^2 (V_{c2}) : web reinforcement will be required for ($V-V_{c1}$) N/mm^2.

At least 50% of the bottom main reinforcement shall extend over the face of the support providing a good anchorage between the supports.

5.3.6 Continuity of stress

In general, special attention shall be paid to ensure continuity and a minimum of local stress concentration. Adequate lapping of reinforcement is required.

5.3.7 Foundation

The structure shall be firmly embedded in the ground, i.e. the vertical walls extending to at least 1.5 m below High Point of Paving and having the same strength as the wall's above-ground level.

The equivalent static loads for explosion need not be taken into account for the wall below ground level and the foundation.

5.3.8 Prestressed concrete

Prestressed concrete shall not be used.

5.3.9 Control room floor

The floor between the control room and the basement shall preferably be made without beams and supporting columns. See also (5.6.1). For cable passages through this floor, see (5.8.4).

5.3.10 Air intake stack

The stack for fresh air intake on the penthouse shall be designed for wind loading only.

The height of the stack (level of air intake) shall be 12 m above plant level.

5.4 DOORS

As doors are the weakest points in a reinforced building, they shall be kept to a minimum in size and number.

5.4.1 Access doors

Outward opening doors shall be provided at two sides of the control building for ease of access to process areas. Air locks shall be installed to maintain the required overpressure inside the building. The doors shall be provided with automatic door closers.

Means of escape, including emergency exit(s), shall be provided from at least three sides of the control building. The emergency exit(s) shall be installed at the rear side of the building, not facing the process area. If only to be used for emergencies, the exit door does not need an air lock.

The doors, frames and fixtures for all external door openings and the internal door openings of air locks shall be able to resist an external explosion pressure of 30 kN/m^2 and a suction of 15 kN/m^2. These doors shall always be kept closed to maintain the pressure inside the building.

No windows shall be provided in the outer doors.

The outer doors of the air locks only shall be provided with small peepholes to check, in the case of fire, that the area outside the door is safe to permit evacuation of the building.

All doors shall have a good seal between door and frame to maintain the different pressures between the various rooms and the outside of the building.

To reduce the weight for easy handling the outer doors of air locks can also be constructed of laminated hardwood, as long as the specified strength and fire resistance is maintained. See T-2.229.028.

5.4.2 Equipment doors

(Double) access doors shall be designed such that instrumentation, computer equipment and air-conditioning equipment etc. can be transported into the control room basement and FAR's. The size of these equipment doors will depend on the dimensions of the equipment but they shall be at least 1.8 m x 2.5 m.

In the centre of the equipment doors a vertical removable steel beam shall be mounted to give extra support for these doors against a large overpressure. This beam shall be able to transfer a static load of 30 kN/m^2 over the total door area to the side walling. The design stresses may be equal to the yield stress of the mild steel beam.

When not in use, equipment doors shall be bolted to the steel door frame and the seal shall be air-tight. If the doorway is also to be used as a passageway, a single door shall be installed in the equipment door, and the seal shall be air-tight when the door is closed.

5.4.3 Hoisting area

A travelling crane of sufficient length and lifting capacity shall be installed over the hoisting area, for lowering equipment into the basement of the control building. Free access to the basement shall be maintained to allow for later additions/replacements of equipment.

5.5 WINDOWS

5.5.1 Rooms without windows

The following rooms are considered essential for controlling the operation of the plant, and shall have no windows in the outer walls :

- the control room
- the computer room
- the instrument and computer room
- the electrical equipment and battery room
- the heating, ventilating and air-conditioning machine room
- the shift supervisor's office
- the air locks
- the first aid compartment/room
- the social amenities with exception of the mess room
- all rooms in FAR.

5.5.2 Rooms with small windows

Other offices, operators laboratory and mess room in the control building may have small windows in the outer walls.

These windows shall comply with the requirements described below.

5.5.3 Dimensions of external windows

The total external window area shall not exceed 7% of the wall area, measured inside the building from top of floor to underside of roof. The clear pane area shall be 0.25 m^2 maximum. The windows shall be equi-spaced over the total wall area, in order to maximise the area of concrete between each window.

NOTE : These requirements are to prevent the overpressure, caused by an external explosion and entering the building through shattered windows, from exceeding the limits where people inside could receive permanent hearing damage or lung injuries.

5.5.4 Type of glass in external windows

For external windows, laminated glass panes shall be used consisting of two layers of normal glass, each at least 3 mm thick, with a polyvinyl butyral (PVB) interlayer of at least 1.9 mm thick.

Double-glazing units can be considered for climatic conditions and to prevent condensation on the windows. If double-glazing units are applied, both panes shall be laminated-type glass.

HVAC considerations shall determine if double glazing is required (refer DEP 32.76.10.30-Gen.).

The thick interlayer will keep the two glass sheets together even when the pane has been blown out of its frame and has folded itself around the catch bar described in (5.5.6). This will prevent injuries from flying glass fragments providing the thickness of the interlayer is no less than that specified.

5.5.5 Fixing of glass in external window frames

To keep the glass pane in the window frame for as long as possible after an explosion, the following requirements shall apply :

The window frame shall be made of galvanized steel capable of transferring the explosion pressure on the window pane to the surrounding structure. The normal rebate width of 12 mm shall therefore be increased to at least 30 mm to achieve this requirement.

The glass pane shall be fitted into the window frame using an adhesive compound (polysulphide) that will remain flexible and have maximum adhesive properties.

The pane shall be fixed with steel beads, screwed to the frame.

NOTE: Aluminium or plastic window frames are not allowed because they are not sufficiently strong to cope with forces resulting from explosions. Plastic frames will also produce fumes and harmful gases in the event of fire.

5.5.6 Catch bars for external windows

All external windows shall be provided with a vertically mounted solid steel catch bar, 20 mm dia., securely welded to the inside of the window frame, or built into the concrete structure. The centre line of the catch bar shall be located at least 70 mm behind the glass pane.

NOTE: If the glass pane is blown inwards, it will fold round this bar and will stay there, resting on the window sill.

With a horizontal bar the glass pane will return around the bar and will then fly inwards and can still injure personnel.

5.5.7 Elevation

The underside of external windows in the operators laboratory and offices shall be 1 m above the finished floor level.

5.5.8 Sun protection

Louvres, canopies or venetian blinds are not allowed at the outside of the building. Interior sun protection may be provided. Blinds shall be designed using materials resistant to intense heat.

5.5.9 Windows in partition walls

Partition walls between the control room and the operators laboratory, computer room, office, mess room, etc. shall have fixed windows to allow uninterrupted vision between rooms. These windows shall have a clear pane area of 1 m^2 max.

5.5.10 Type of glass for internal laboratory windows

Transparent, laminated georgian polished wired glass with fire- and explosion-resisting properties shall be used for the internal windows between the control room and the operators laboratory, if applicable. The glass panes shall be fixed in steel frames with screwed metal beads. The laminated glass panes shall consist of one layer of float glass at least 3 mm thick and one layer of wired glass, with a polyvinyl butyral (PVB) interlayer at least 1.9 mm thick.

5.5.11 Type of glass for internal walls

Normal glass with a minimum thickness of 3 mm shall be used for internal windows between the control room and the mess room, office, computer room, etc. The panes shall be fitted in steel frames composed of standard sections, and fixed with a non-hardening, non-staining type of putty. Glass in internal timber doors shall be fixed with screwed hardwood beads.

NOTE : Normal glass can be used for these windows, since the overpressure inside a building without outer windows, or with only a few very small windows, will be low enough during an explosion to prevent fragmented glass flying.

5.6 FLOORS

5.6.1 Cavity floors

The control room, computer room (including storage area), the computer basement, the instrument basement and the electrical equipment room in the control building shall have a cavity floor supported by a recessed reinforced concrete floor.

If the above equipment areas are located on the ground floor level as in a one-storey building and FAR's, they shall also have a cavity floor.

The elevated floor shall be flush with the surrounding floor finishes.

For all other areas, the floor construction and finish shall be in accordance with DEP 34.17.00.32-Gen.

The removable panels shall be 600 x 600 mm and 40 mm thick, constructed of plywood or chipboard, finished with 2 mm thick, factory-applied, anti-static, wearing surface at the top and aluminium foil at the bottom.

The floor panels shall rest on adjustable pedestals manufactured of mild steel with mild steel foot and top plates.

The pedestals shall be glued to the concrete floor, adjustable in height, providing a distance between the top of the cavity floor and the top of the concrete floor of 750 mm. The adjustable part shall have automatic positive locking. Electrical requirements shall be in accordance with IEC 364.

Bracings to be installed to prevent lateral movement of the flooring system.

Separate steel structures to be provided to support electrical equipment and battery benches.

Each floor panel shall be capable of supporting a concentrated load of 4450 N, applied on an area of 650 mm^2 at any point, or 15 kN/m^2 with a maximum deflection of 1 mm.

The size and location of cut-outs in the floor panels will be specified separately. The complete floor system shall be free from vibration, rocking, rattles and squeaks. The system shall ensure that the panels remain in place, even when adjacent panels have been removed.

5.6.2 Channel inserts

Steel channel inserts shall be cast in the concrete basement ceiling for fixing instrument equipment. For type and location, see Appendices 3 and 6.

5.6.3 Plinth for instrument panels

If not otherwise specified by the Principal, the instrument panels in the control room shall be placed on a concrete plinth except where the control room has a cavity floor.

Special attention shall be paid to a smooth finish and exact level of this plinth.

5.6.4 HVAC machine room

In the HVAC machine room the floor shall be constructed with door thresholds of 100 mm minimum height, to prevent condensate and other leakages from entering other parts of the building. Drain facilities shall be installed in the machine room.

5.6.5 Floor level

The top of the finished floor of the building shall be at least 600 mm above the surrounding ground level. Underground cables entering the basement shall be covered with a layer of sand of 600 mm minimum thickness.

Approaches to the main entrances shall be ramps with a slope of not more than 1 in 8 with a non-slip finish of the top surface.

When the building is located in an area where ice and snow can make the slopes slippery, steps also shall be built in the slopes near the entrances. In some extremely cold temperature areas, heated slopes and/or steps may be considered.

5.7 WALLS AND CEILINGS

5.7.1 Wall tiles

Wall tiles shall be glued to the wall with special tile adhesive, to prevent them from coming loose in the event of an explosion.

5.7.2 Ceilings

The aluminium grid ceiling in the control room shall be constructed in such a way that the panels are secured in position and cannot fall down during an explosion.

This applies also for the lighting fixtures, etc.

5.7.3 Wall and ceiling finishes

All surface finishing materials for walls and ceilings in the control room, the computer room, and the instrument auxiliary/computer basement/room etc. shall be fire-resistant or non-combustible and shall have no loose fibres.

In these spaces, the surface of all walls, ceilings and floors, including the space under the cavity floor, liable to dust formation shall be sealed with epoxy paint or a PVC coating.

5.8 CABLE ENTRIES AND PASSAGES

5.8.1 Entries in basement walls

The cable entries for instrument cables into the building shall preferably be distributed over the longest wall of the instrument basement/room. See Appendix 2.

Cables for electric power and lighting, as well as utility piping, shall preferably enter the building on any other side of the building. See Appendix 2.

No piping for drainage or utility except for instrument air supply, shall be routed through the instrument auxiliary room and computer basement or the electrical equipment and battery room. No electric cables, except for instrument/computer electricity supply and illumination, shall be routed through the instrument auxiliary room.

5.8.2 Level of entries

Entries into the building shall be made below groundlevel and above ground water level at such a level as to exclude any chance of rain water, fire-fighting water, oil, liquefied gas or other liquids, finding its way into the building.

5.8.3 Sealing of entries

The holes for cable entries shall be sealed gas-/watertight, preferably Multi Cable Transit (MCT) blocks shall be used. Unused cable entries shall be closed with spare solid blocks.

All other service entries shall be sealed gas-/water tight. Unused entries shall be closed with watertight brickwork.

5.8.4 Cable passages through floors

Cable passages through the floor from the control room to the basement shall be made of 150 mm dia. plastic pipes. The holes shall have chamfered edges to prevent damaging of the cables during cable pulling. The same type of cable passages between the computer room and the basement shall also be made.

Holes shall also be provided for possible future computer consoles. These holes shall be positioned such as to clear the reinforcement bars in the floor.

6. HEATING, VENTILATING AND AIR CONDITIONING

The building shall be provided with a system for heating, ventilating and air conditioning, as specified in DEP 31.76.10.30-Gen.

Some general aspects of this system in connection with improved safety of the building in the case of external explosions are described below.

The air intake and the air exhaust openings shall be protected by explosion protection valves, mounted in a concrete box on top of the building (penthouse). During an explosion the explosion-proof valves shall close automatically and protect the building against overpressure or suction through the ventilation ducting. These valves shall open automatically when the pressure is back to normal.

Air-cooled condensers shall be located next to the building at grade level and not on top of the building. See Appendix 1.

7. ELECTRICAL INSTALLATION

7.1 GENERAL

The electrical installation for power and lighting, etc., shall be in accordance with DEP 33.64.10.10-Gen.

In addition, the following requirements apply :

7.2 ILLUMINATION

For illumination, including emergency lighting, reference is made to DEP 33.64.10.10-Gen.

7.3 SOCKET OUTLETS

In addition to the usual number of socket outlets required throughout the building, an extra socket outlet shall be provided at each 3 console sections, for maintenance tools. The electrical supply shall be 220/240 V AC and/or as required 110 V AC. The socket outlets are to be mounted on an adjacent wall of the control room and the control room basement.

The computer room may also require a number of additional socket outlets for computer maintenance and testing.

7.4 INSTRUMENT ELECTRICITY SUPPLY

This supply will be designed for each project, depending on instrument and electrical requirements and may require accommodation for batteries, emergency generator, etc.

8. TELECOMMUNICATIONS

The plant telecommunication (radio, telephone, paging and CCTV) system shall be in accordance with DEP 32.71.00.10-Gen.

9. FIRE-FIGHTING FACILITIES/FIRE PROTECTION/FIRE AND GAS DETECTION

9.1 GENERAL

The fire-fighting systems shall be in accordance with DEP 80.47.10.11-Gen. and the requirements specified below.

9.2 FIRE EXTINGUISHERS

Hand-operated fire extinguishers (Halon 1211-6 kg) shall be installed strategically throughout the building and at least close to all exit areas.

Fire-fighting water hose reels shall not be installed in the building.

9.3 FIRE AND GAS DETECTION

The building shall be provided with a sampling-type smoke detection system; see also DEP 32.30.20.11-Gen. This system shall cover as a minimum all normally unmanned areas and enclosed cabinets, e.g. basement in general, cavity floors, cable channels, computer and computer tape room and all cabinets where smoke from hot spots could develop.

The battery room and storage room shall be provided with heat detectors.

The laboratory room shall be provided with combined smoke/heat detectors.

Large central computer systems and tape rooms shall be provided with a sampling-type smoke detection system.

In the unmanned computer room an automatic Halon 1301 (BTM) flooding system may be considered.

9.4 FIRE PROTECTION

9.4.1 General

For explanations of terms used and tests mentioned in this specification, see British Standard 476.

Where ventilation or other ducts or piping/cabling pass through roofs, walls or floors, the surrounding gaps shall be closed air- and water- tight by non-combustible materials and constructed in such a way as to allow essential thermal movements.

The lay-out of the building shall be such that the maximum travel distance from any point of a floor in the building to the nearest exit of that floor is 25 m.

Insulation materials used inside and outside the building shall be e.g. mineral wool blankets with galvanized wire netting and with no flammable materials attached to them (used in wall cladding, ceilings, partition walls, etc.). As an exception to this, built-up bituminous roofing felt, glass fibre based, is allowed but should, where possible, be avoided.

Staircases shall be separated from corridors by automatic closing doors. These doors shall be smoke-tight.

9.4.2 Fire resistance

The minimum fire rating values of the elements of the building shall be as follows :

- Roof, outside walls, including doors and with exception of the windows shall have a smoke and fire resistance period of minimum two hours.
- Doors of air locks only shall have a smoke and fire resistance period of minimum one hour for each door.
- Internal walls of control/computer/instrument aux./UPS/electrical/ battery rooms and plant laboratory shall have a smoke and fire resistance period of minimum one hour.
- Walls of offices and social amenities shall be be designed as partitions with no fire resistance. However, all materials for walls and ceilings shall be of non-combustible type.
- Floors shall have a smoke and fire resistance period of minimum one hour. Raised floors

(computer floors) shall have a smoke and fire resistance period of half an hour.

NOTE: All penetrations, both inside and outside, shall be well sealed according to the required fire resistance.

9.4.3 Surface spread of flame

Lining materials for walls and ceilings shall be of non-combustible materials with a resistance to surface spread of flame corresponding to class 1, BS 476, part I.

9.4.4 External fire exposure

The roof of the building shall satisfy the classification of BS 476 part III, Class AA, without developing cracks or holes.

10. REFERENCES

In this 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.

DEPs

Noise control	DEP 31.10.00.31-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Plant telecommunication	DEP 32.71.00.10-Gen.
Fire-fighting systems	DEP 80.47.10.11-Gen.
Minimum requirements for design and engineering of buildings	DEP 34.17.00.32-Gen.
Laboratories	DEP 34.17.10.31-Gen.
Heating, ventilating and air-conditioning for plant buildings	DEP 31.76.10.30-Gen.

DRAWINGS

Standard external blastproof doors and frames	T-2.229.028

BRITISH STANDARDS

IP Model Code of Safe Practice in the Petroleum Industry	Part 1 - Electrical Safety Code

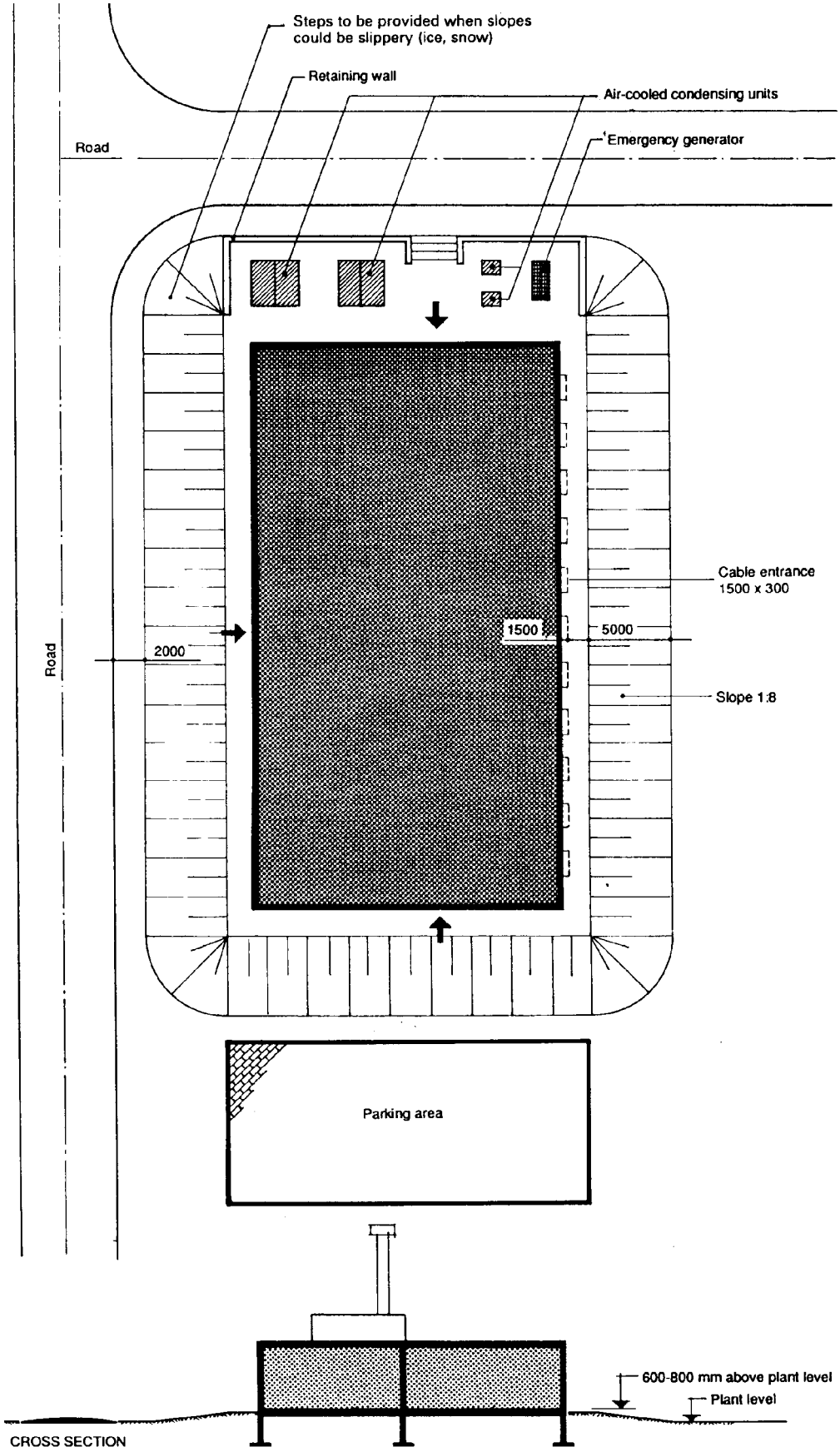
Issued by
Institute of Petroleum,
61 New Cavendish Street,
London W1M 8AR, UK

Fire tests on building materials and structures	BS 476 Part I
External fire exposure roof test	BS 476 Part III

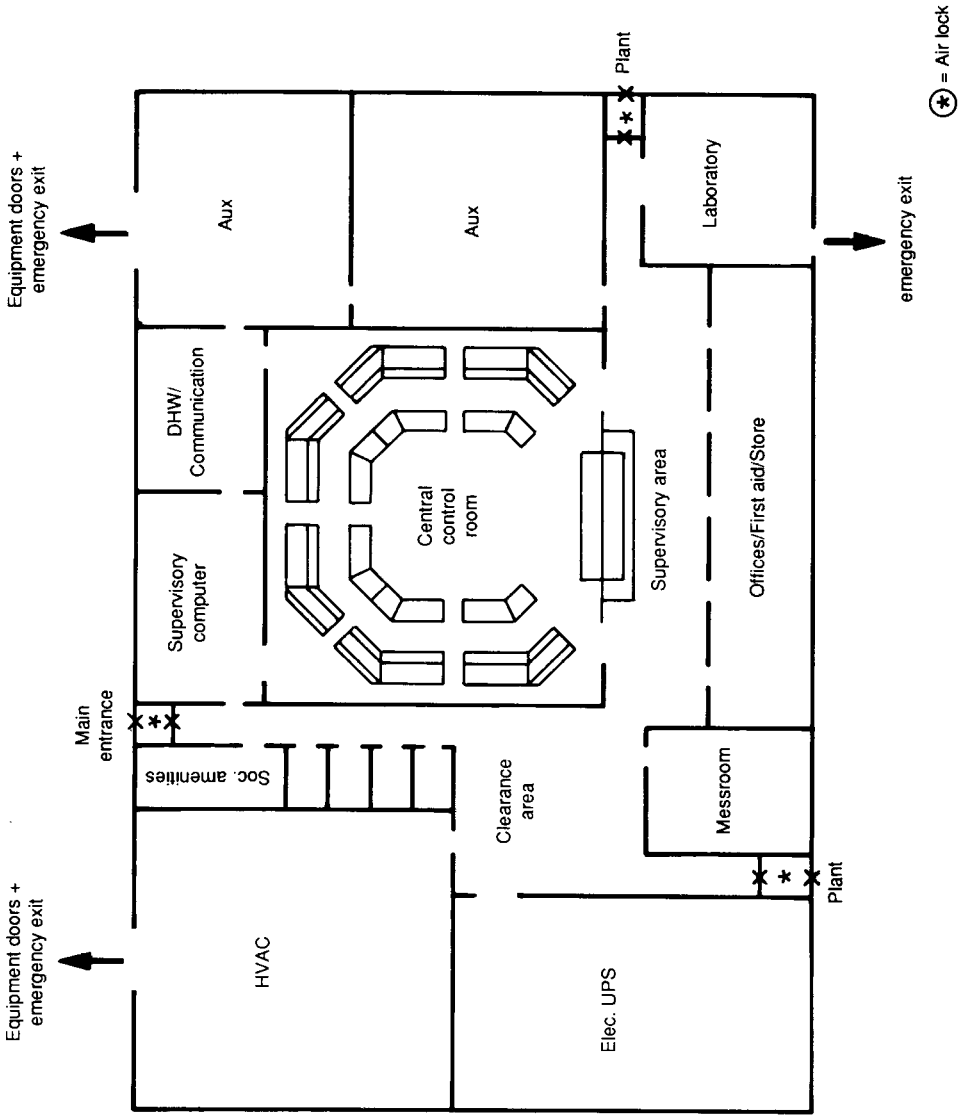
Issued by
British Standards Institution,
2 Park Street, London

11. APPENDICES

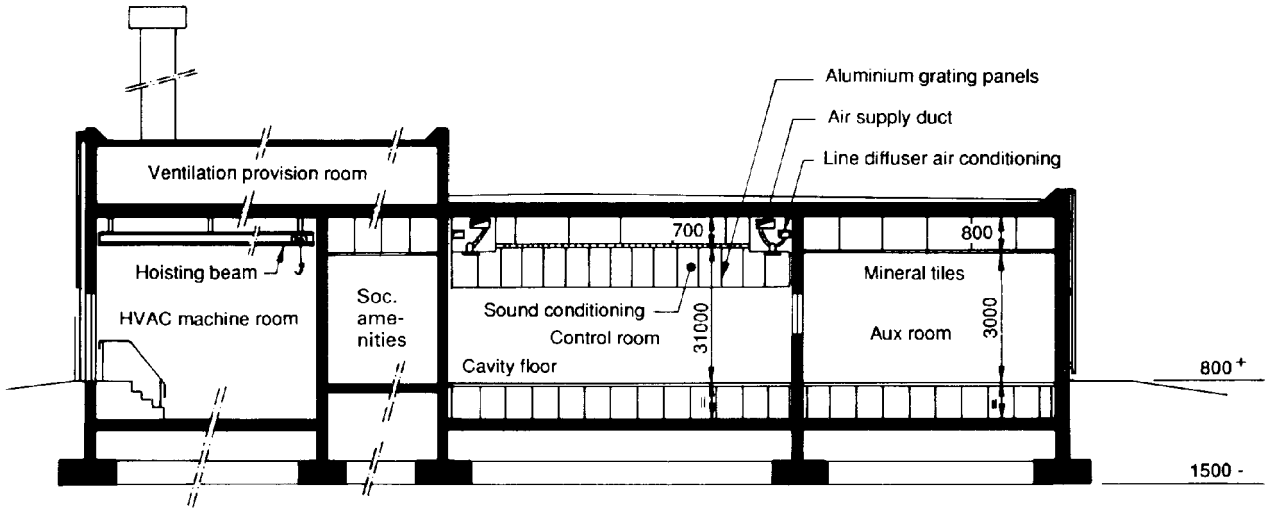
APPENDIX 1 TYPICAL LOCATION OF CONTROL BUILDING

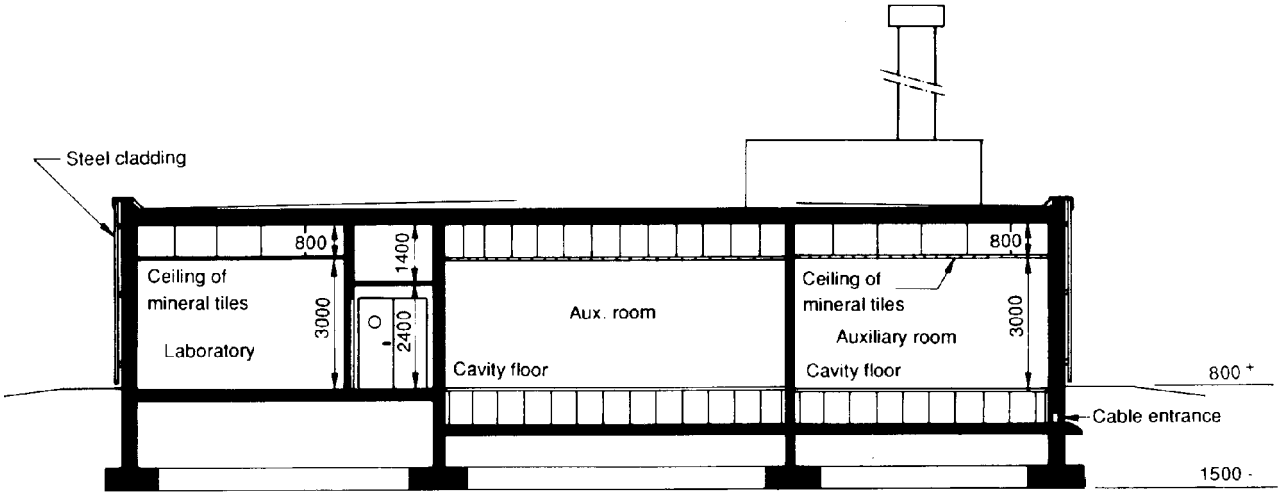


APPENDIX 2 TYPICAL LAY-OUT OF CONTROL BUILDING

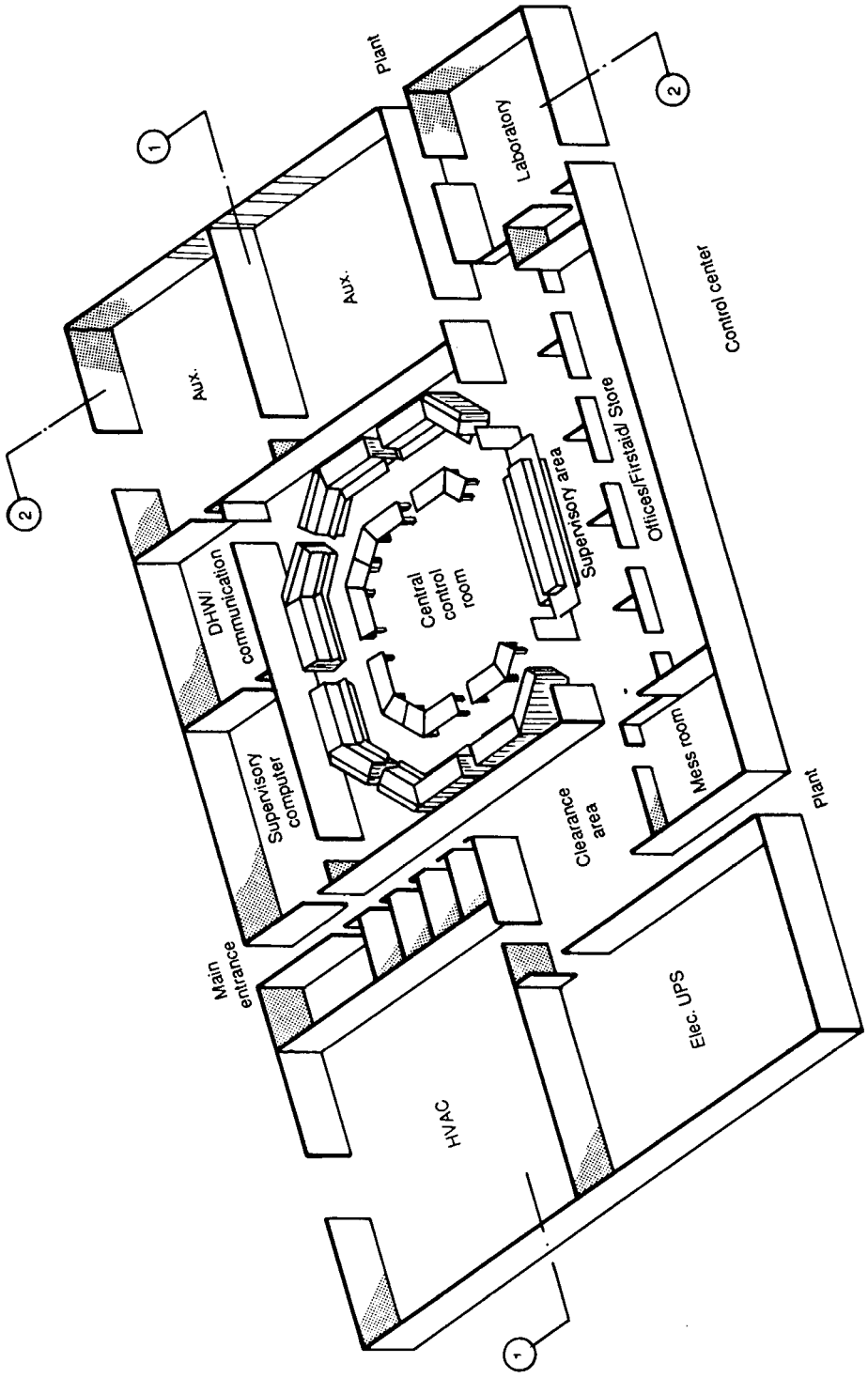


APPENDIX 3 TYPICAL CROSS SECTIONS OF CONTROL BUILDING

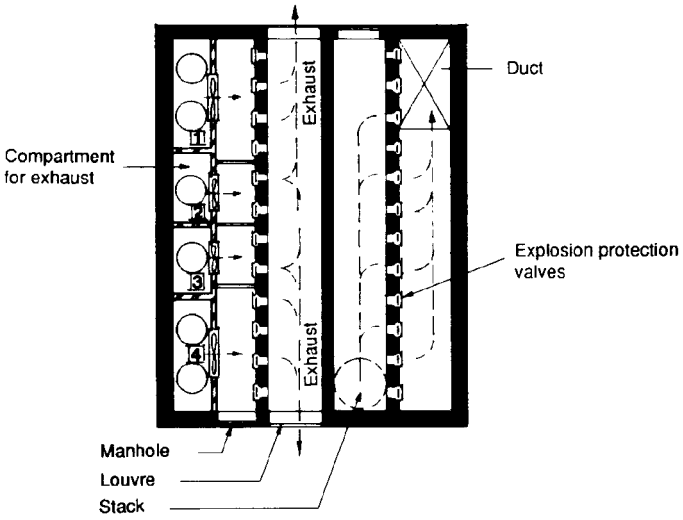


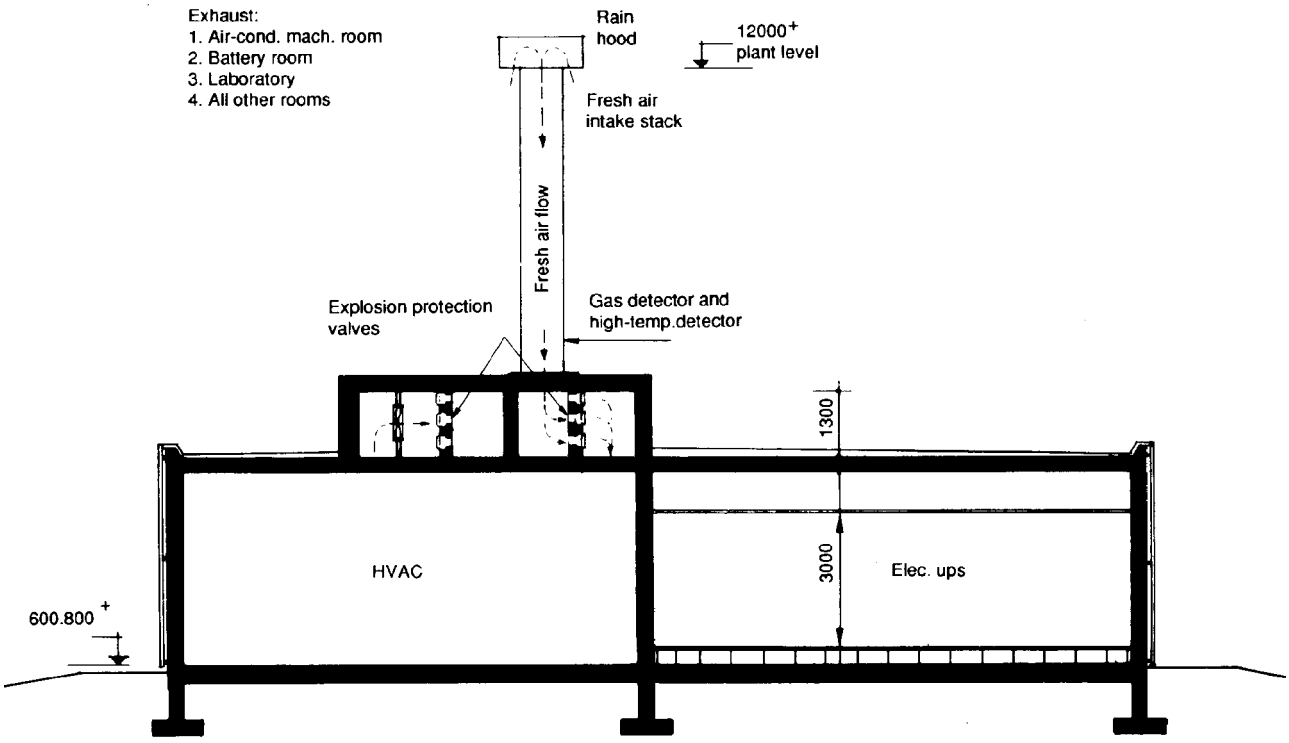


APPENDIX 4 BIRD'S EYE VIEW OF A CONTROL BUILDING



APPENDIX 5 TYPICAL CROSS SECTION OF CONTROL BUILDING WITH VENTILATION PROVISIONS





APPENDIX 6 TYPICAL CROSS SECTION OF CONTROL ROOM