Scottish Health Technical Memorandum 2023

(Part 2 of 2)

Good practice guide

Access and accommodation for engineering services

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Contents

1. Introduction

1.1 This part of Scottish Health Technical Memorandum (SHTM) 2023 gives general guidance on the space requirements for mechanical, electrical and public health engineering services in hospitals and provides data to assist in the planning of those requirements. It relates services areas to hospital total floor areas, and assesses the space requirements and clearances of pipework and ventilation ductwork. Zoning principles are illustrated for a typical hospital services installation.

1.2 Maintenance of building services can only be carried out satisfactorily if adequate space for access is provided. This document establishes some basic rules and principles for the allocation of space and engineering service distribution in a hospital, and illustrates how a systematic approach can improve design coordination and service installation on site.

1.3 The data given is intended to assist in ensuring that space provision for future schemes is adequate to enable easy installation and allow convenient access and sufficient working space for maintenance, renewal and possible extension of the services.

1.4 The guidance in this SHTM is based on information obtained from engineers in the NHS, NHS Estates and consulting engineers, and is specially intended for use during the initial stages of design when specific dimensional details of plant may not be available.

1.5 Variations in the structural system, department layout and engineering services provision will influence the extent to which this guidance can be applied. Individual project solutions may differ, although most should be able to adopt the principles of zoning and spacing for the services outlined in this document.

2. General considerations

2.1 A modern hospital may require 50 or more different engineering services, and others may be added later as new techniques are developed. Hospital buildings can be expected to have a useful life of at least 60 years and during this period engineering services will have to be renewed. Unless adequate space is provided initially, the cost of renewing services will be excessive and their extension may be impossible.

Development planning

2.2 With the increasing complexity of modern hospital services, it is more than ever essential that the engineering and architectural aspects of a project are developed simultaneously from its inception.

2.3 The purpose of early collaboration is to ensure that the planning of medical requirements and communications is properly integrated with the following engineering aspects:

a. services distribution;

b. plant location;

c. future development.

2.4 At the earliest stages of planning, designs should be based on an overall conception of the complete scheme. It is essential to foresee as far as possible what provisions should be made for the passage of services, through different parts of the structure, not only for present requirements but also for possible future developments. It is important to ensure that any construction does not preclude the accommodation of further services in the future.

2.5 Engineering services are necessarily continuous, and must not be obstructed by structural design which might restrict such continuity. The effect of any such obstruction will be felt far beyond its own locality, and may effectively isolate large areas of buildings from services.

2.6 It is therefore most important that the basic structural design should permit sufficient space for the services, and all such space must be regarded as inviolable. Difficulties in this area will be minimised if the services engineer is responsible for public health engineering.

2.7 The provision of extra space for future plant and services should be related to the probable requirements. If there is little likelihood of an increase the extra space allowed should be minimal, but a margin of up to one third above the net basic requirement may well be justified. Possible developments in the remote future should be dealt with at the time of their design.

2.8 The development of detailed engineering drawings will produce accurate information on service space requirements, but these will not be available until a later stage. If a satisfactory estimate of space requirements can be made during the preparation of the sketch plans, serious and costly revisions will be avoided.

2.9 Component data is not included in this document due to the wide variation in sizes between manufacturers. The designer should make reference to actual manufacturers' data including drawings of the specific components or assembly of components, for example air handling units, boilers, switchgear. Reference may also be made to British Standards for specific components and BSRIA technical note TN10/02 which provides space requirements for a number of common service components.

2.10 Plant requirements will depend upon the design solution for the type, design and function of the building. Consideration should be given to the following points:

a. services and plant to be accommodated;
b. optimum siting, in terms of distribution and the effect on adjacent accommodation;
c. optimum size;
d. floor loading when plant is fixed and during installation;
e. space and access requirements for installation and possible subsequent renewal;
f. space and access requirements for proper and safe operation and maintenance;
g. ventilation and combustion air;
h. adequate lighting and heating;
i. fire precautions;
j. safety requirements;
k. the possibility of noise nuisance;
l. heat insulation;
m. minimum heights;
n. drainage;
o. surface finishes.

Working in confined spaces

2.11 Working within confined spaces should be covered by a "permit-to-work system" covering safe working practices in accordance with the "permit-to-work". Reference should be made to Health and Safety Guidance Note GS5, 'Entry to Confined Spaces'. The guidance note covers spaces where there is

a possibility of a build-up of gas or vapour, or where there is likely to be a deficiency of oxygen.

2.12 The presence of asbestos products within a site will require implementation of following approved codes of practice: 'The Control of Asbestos at Work Regulations 1987' and 'Work with asbestos insulation, asbestos coating and asbestos insulating board, 1988'.

2.13 Where no "permit-to-work" system is in operation, it is important to ensure the work is undertaken only after a full investigation and resolution of the following matters has been completed, and the engineer has been informed in writing of the proposals:

a. assessment of the task to be undertaken;
b. identification of the hazards of the task;
c. decision on methods of working to avoid hazards;
d. implementation of a system of work to incorporate these methods;
e. monitoring of the operation of the system of work.

2.14 Prior to the entry of personnel into the space and the commencement of work, the space must be demonstrated to be safe by testing that no toxic or asphyxiant gases are present and that oxygen levels are adequate.

Fire

2.15 Guidance on fire precautions is contained in NHS in Scotland Fire Safety Management. Fire safety requirements should be established prior to commencement of any services design work as the particular disposition of sub-compartment walls, cavity barriers and other physical fire precautions may influence the service distribution and routing.

3. Preliminary plan areas for engineering platforms

General

3.1 This section provides guidance on initial plan areas for engineering services.

3.2 The information is based on data obtained from existing sites and new hospital schemes. Measured service areas have been discussed with the design engineers and confirmed or revised in the light of experience, and where possible an inspection of the accommodation was made. The data given is intended to be used during the early planning stages in conjunction with schedules of accommodation. Figure 1 may be used before drawings are available, and Figures 2 to 8 will assist during more detailed planning.

Total engineering plan area (Figure 1)

3.3 The plan areas shown are for complete hospitals and the point of selection within the band should be related to:

a. the number and complexity of services;

b. the shape and layout of buildings, which largely determines the amount of ventilation required;

c. the basic design of services, for example central or decentralised calorifiers; electrical HV or MV distribution.

3.4 The gross area referred to on Figure 1 is the sum of basic and additional accommodation plus the circulation and communication areas, but does not include engineering service areas.

3.5 Selection within the band will depend on the number of services to be provided, and any special requirements for each service. The value obtained from the graph should be checked against the sum of the areas required by the separate services.

Calorifier room plan area (Figure 2)

3.6 It should be noted that several decentralised plantrooms require considerably more space than one central room (but there may be some savings in distribution services). The most appropriate policy for a particular hospital can be determined by a financial appraisal of each option.

Ventilation plantroom plan area (Figure 3)

3.7 Ventilation requirements will depend upon the type of building, for example the number of internal rooms and the extent to which full air conditioning is to be provided.

3.8 The plan area for low level buildings with little mechanical ventilation will fall well below the band shown on Figure 3, and the area required for a hospital wholly or largely air conditioned will be well above it. An individual assessment will be necessary in such instances.

Lift wells and motor rooms plan area (Figures 4 and 5)

3.9 The area required for lift wells and motor rooms is related to the number of floors served. The band width indicates the variation due to service requirements. For example, office accommodation does not require a bed lift, but a block with a number of operating theatres may require several. Reference should be made to SHTM 2024; *Lifts* for further details on the design of lifts.

Vertical ducts plan area (Figure 6)

3.10 The requirement for vertical ducts will depend upon the number and size of ventilation ducts and piped services to be accommodated, but shows no appreciable relationship to building height.

Water storage plan area (Figure 7)

3.11 Figure 7 is based on examples where nearly all of the storage is internal. The band width is attributable to variation in cistern depth and the estimated daily consumption.

Switchroom plan area (Figure 8)

3.12 Figure 8 does not include accommodation for HV switch gear and transformers (for which SHTM 2007; *Electrical services: supply and distribution* shows dimensioned layouts). The graph shows the approximate area required when space is specifically allocated for switchrooms.

4. Engineering distribution principles

4.1 The main engineering distribution principles, which are illustrated on the exemplar hospital layout in Figures 9 and 10, are as follows:

a. each block may be serviced from the hospital street/corridor unless internal ducts are appropriate for a specialist department, for example pathology or operating theatres;

b. services (except drainage) will be contained within the particular floor they serve, to minimise penetrations of the building structure between floors;

c. services to each department floor will have the means of isolation at the hospital street interface;

d. the routing of the main engineering services to the departments and plantrooms will be within or above the hospital street;

e. major items of plant may be located:

   (i) as a separate enclosure off the hospital street or service street (but not part of, or combine with, a life risk department);

   (ii) in a discreet enclosure remote from the main building block;

   (iii) above the hospital street;

   (iv) at roof level above a block;

f. access to plantrooms will be achieved via general access stairways and a covered walkway above the hospital street.

5. Common distribution requirements

General

5.1 The assessment of requirements must be considered with respect to communication, areas, plant and distribution, and be related to the site, size and shape of buildings. Accommodation for vertical services will be decided during the preparation of the development plan. This information will be in the form of total areas required, to be sub-divided later as design work proceeds.

Distribution

5.2 As far as is practicable, departments that impose a heavy load on the engineering services should be grouped and located near to the main distribution centres to avoid long runs of large capacity mains. It will generally be found advantageous for services to follow the main communication routes.

Distribution to plantrooms

5.3 Generally, the first plantroom to be sited is the energy centre, so that the main services routes can be determined. Energy centres are usually sited in a service centre complex for the hospital, located centrally to the primary energy users, although consideration may be given to siting at roof level.

5.4 The next step will be to decide the areas required for other plantrooms.

5.5 Consideration should be given to the degree of flexibility that is necessary to allow for possible changes in the use of hospital departments.

5.6 In multi-storey buildings, a smaller number of large vertical ducts with adequate provision for horizontal distribution above ceiling level and below structural members may give the most flexible arrangement. A large number of smaller vertical ducts with ceiling spaces for horizontal distribution as necessary, will generally be less flexible.

5.7 The omission of space above ceilings produces the least flexible arrangement.

5.8 Convenient access should be provided to all service spaces.

General access

5.9 Access to services, excluding requirements for initial installation, should be considered for operation, maintenance and replacement.

Frequent access

5.10 Plant, valves, switchgear, and all equipment requiring frequent attention for operation of the system or for maintenance, need immediate access. If enclosed, access should be by hinged doors and adequate clearance should be provided for ease of working on the equipment.

Intermittent access

5.11 Items not in frequent use or requiring maintenance only at intervals of some months, need ready access, which may be by means of floor traps or removable panels in walls, partitions and false ceilings. It is recommended that access panels be fixed by means of quick-release fasteners, such as carriage locks, rather than by screws and cups.

5.12 Access should be arranged, as far as possible, to enable work to be carried out without affecting hospital routine. Access points should be convenient to items requiring attention, and in the case of rodding eyes sufficient space provided to facilitate rodding of the pipework.

Renewal of services

5.13 Some services may have to be renewed once or twice during the useful life of a building. Accommodation should be planned to allow for this and take into account both weight and size of major items. Where emergency renewals are not envisaged the removal of door frames, windows, and even partitions and non structural walls may be considered. The renewal of minor items does not usually create problems, except for pipe lengths and allowance should be made for passing pipe lengths into the ducts at a later date.

5.14 The destruction of finishes to open up a trench or vertical duct or to increase the size of an existing means of access could be more economical than the provision of expensive, rarely used permanent access. The saving must be considered with regard to the cost and inconvenience incurred at the time of replacement.

6. Site primary service distribution space requirements

General

6.1 This section presents, in tabular and diagrammatic form, information on the space requirements for the distribution of site services, with suggested arrangements.

6.2 Dimensions given will allow sufficient access to services for inspection, adjustment or replacement. Where applicable, British Standards or British Standard Codes of Practice should be complied with.

6.3 Dimensional allowances for lighting, drainage, wash down, ventilation, power supply, access points and finishes are to be made as additions to the spaces required for the services.

6.4 Detailed dimensions of access traps, doors, etc. are not given as these will vary considerably with circumstances, but access clearances should not be less than 450 mm square.

6.5 The main requirements are:

a. adequate space to operate valve controls;
b. unobstructed access to rodding eyes, etc;
c. easy access for inspection and maintenance;
d. sufficient space to enable repairs and replacements to be carried out;
e. entry points large enough for the passage of equipment, materials and tools likely to be required during replacement and extension work, for example pipes, valves, pumps, welding equipment, etc.

6.6 Where pipes, ducts, etc, are placed behind fully demountable ceilings, walls, partitions etc, the provision for working space given here need not be allowed. However, services in such positions should have access doors or traps for valves, rodding eyes, etc.

Ducts showing accommodation space for services, access and working space

6.7 Figure 11 illustrates four possible arrangements for installing services in horizontal ducts. Dimensions will depend on the number and size of pipes and fittings to be accommodated, and on ease of access for jointing, installation, branches and maintenance.

6.8 All four spaces may be combined in any permutation conducive to economy, good engineering practice, efficient distribution and access. The sizes of the service areas can be calculated from Figures 15 to 20.

6.9 Consideration should be given to leaving a space or part of a space free to allow for future increases in service loadings.

6.10 The clear space should allow convenient access to install and maintain services (see Figures 12 to 14).

6.11 The above arrangements are suitable for service corridors. It is preferable to locate services to sides rather than overhead to allow access to the pipework and cables.

Subways

6.12 Figure 12 shows engineering services accommodated on either side or overhead as required. Figures 15 to 20 give the dimensions of service spaces which are additional to the clearance space values listed in Table 1.

Table 1: Clear space dimensions

Dimensions of free space	Pedestrian use only	Pedestrians and trolleys	Pedestrians and powered vehicles
A	2.0 m	2.0 m	*2.0 m
B	1.1 m	1.2 m	*1.4 m

* These dimensions and turning radii to suit type of powered vehicles.

6.13 Allowances must be made for any services which cross the subway. Extra width in lay-bys must be included when the subway has to provide for two-way traffic.

Crawlways

6.14 Figure 13 shows engineering services provided on either or both sides of a duct, allowing minimum working space. Reference should be made to Figures 15 to 20 for the dimensions of service spaces, which should be added to the dimensions shown.

6.15 Access should be provided at each end of the crawlway, for example from plantrooms, and access openings with removable covers provided at intervals. The distance between access points should be decided by consideration of the particular circumstances and the installed services. When making provision for access, consideration should be given to the removal and replacement of lengths of pipe where this is practicable. The crawlway should be ventilated to provide fresh air and prevent possible toxic gas build up or excessive ambient temperatures.

Walkways

6.16 Figure 14 shows engineering services accommodated on either or both sides of a walkway allowing clear space dimensions for movement and working. Reference should be made to Figures 15 to 20 for the dimensions of service spaces which should be added to the dimensions shown.

6.17 Access through removable covers should be provided at intervals to allow for ventilation as well as the entry for materials, etc.

Pipework dimensions

6.18 Figure 13 indicates the clearances for pipes and valves to allow for accommodation, servicing or renewal.

6.19 Table 2 lists the values of A and B (see Figures 15 to 19) for a series of pipes and valves whether insulated (I) or uninsulated (U).

Table 2: Pipes and valves, clearance dimensions

Pipe diameter (d)	Dimension A (mm)						Dimension B (mm)		
mm	Welded or screwed		Flanged		Cast iron		Gas	Water	Steam
	I	U	I	U	I	U			
80	350	300	350	350	350	300	475	600	650
100	375	325	400	375	375	325	550	700	800
150	475	425	475	425	425	400	700	800	950
225	600	_	600	550	550	475	750	1050	1325

Electrical tray and cable trunking

6.20 Figure 16 shows cable trays and trunking of nominal dimensions A and B, and Table 3 indicates the minimum access space required for installation or replacement of cables over the top, C, and at either or both sides, D.

Table 3: Dimensions of space requirements for trays and trunking

Trays (mm)				Trunking (mm)			
A	*B	C	D	A	B	C	D
100	12	225	225	75	50	225	225
150	12	225	225	100	100	225	225
300	18	300	450	150	150	225	225
450	18	300	450	225	100	225	225

* B is a nominal dimension and will vary according to manufacturer

6.21 For installation and replacement cable trays and trunking installed vertically require front access of no less than dimension C. These minimum dimensions are applicable only where a crawlway or walkway access is available.

Ventilation ducts

6.22 Figure 17 shows minimum areas required around ducts for access to dampers and for making slip or flanged joints. See Figure 18 for clearance dimensions C and D, for appropriate duct dimensions A and B.

Method of spacing services

6.23 Figure 19 shows a recommended arrangement for services in ducts.

6.24 Installation areas (taken from Figure 15) may overlap provided there is reasonable access to services. The overlap should not exceed (A - d)/2 where A is the clearance distance and d the diameter of the smaller pipe.

6.25 Double banking should be avoided as it will create difficulties with maintenance or renewal of services.

6.26 If double banking is unavoidable, banked services should be paired (for example flow and return) and the method of support should be such as to facilitate access.

Vertical ducts

6.27 Figure 20 shows typical vertical ducts of dimensions A x B with frontal access for installation, maintenance and replacement of services.

6.28 The dimensions A and B will depend on the number and size of services to be accommodated (allowing the clearance indicated in Figures 15 to 19).

6.29 Dimensions C and D will vary as follows:

a. with arrangement I, C will be equal to the full opening A and no clearance depth D will be required as there is free access from outside the duct;

b. with arrangement II, C should ensure convenient access, and be not less than 0.5 m. D can be the minimum necessary to clear valve projections;

c. with arrangement Ill, C and D should be at least 1.1 m and 0.75 m respectively, and the access opening should have a minimal clearance width E of 0.75 m and a clearance height of 1.8 m.

6.30 Rodding eyes should be easily accessible.

Ha-ha and low-level piperuns - typical arrangement

6.31 Figures 21 and 22 show services carried on supports or hung from cross members. Provision should be made for movement of pipework due to expansion and contraction. The accommodation should allow for original installation, maintenance and replacement of services. Provision should be made for drainage of the ha-ha and for the clearing of fallen leaves, etc.

Trenches

6.32 Figures 23 and 24 show services in trenches. The arrangement of services accommodated in trenches will be dictated by the fact that installation can only be carried out from above.

6.33 Trenches can be finished with cast in-situ concrete covers, or preformed covers bedded in sealant and finished, for example, with screed or tarmac. The exposure of the trench may require destruction of the finish (such as earth and grass) to obtain access and renewal on completion of servicing.

6.34 If there is need for frequent access after installation the covers should be readily removable precast units or filled metal trays.

6.35 When detailing trench runs, special attention should be given to the depth of the trench to allow for cross-over points, falls in pipework and for drainage of the trench floor. The strength of the covers should relate to their span and anticipated traffic loadings.

Chases

6.36 Figure 25 shows services in chases. Chases are mainly used for accommodating electrical conduits and smaller sized piped services, etc.

6.37 The maximum depth of chases will be governed by the thickness and properties of the material being chased. The width of chases will be limited by the need to prevent cracking of plaster cover, etc, and should be mutually agreed by architect and engineer.

6.38 An alternative is to use a trunking with removable covers which allows convenient access for servicing and installing additional services.

7. Plantrooms

General

7.1 The space requirements for the engineering plant and equipment must be identified early in the design planning stage. For guidance on escape routes and escape route lighting, reference should be made to BS 5266:Part 1:1988: 'Code of practice for emergency lighting' with European amendment as introduced; BS 5499: 'Fire safety signs, notices and graphic symbols; NHS in Scotland Firecode – Fire precautions in NHS Premises and Building Standards (Scotland) Regulations.

Ventilation plantrooms

7.2 Ventilation plant can best be accommodated at roof level. The space allocation will depend on the extent to which ventilation is provided in the departments which interface with the particular hospital street section. In the exemplars, the ventilation plant serves only the department interfacing with the hospital street above which it is located.

7.3 As the combinations of departments change to suit project needs so will the space requirements for ventilation plant. It is therefore considered inappropriate to prepare standard detailed plantroom layouts. General space provision for various ventilation plant requirements have therefore been prepared in block diagram format to provide basic planning advice.

7.4 Due consideration needs to be given to those departments which are almost totally air conditioned or mechanically ventilated, and those which have 24-hour or day (9 am to 5 pm) operation. The combinations of these will greatly influence the number and size of the ventilation plants and therefore the space requirements.

7.5 Where 24-hour-a-day departments are located together, and turn down ratios are reasonable, a single ventilation plant may be the best choice. If turn down is impracticable then separate plants will be necessary (see Figures 28, 29 and 31).

7.6 The ventilation plant space requirements for the operating department, where individual plants per theatre suite are necessary and a separate plant is required for the ancillary accommodation, are shown in Figures 34 to 37 inclusive.

7.7 Optional designs of plantrooms may accommodate boilers, calorifiers and other plant (see Figure 42).

Clean and dirty extract plant

7.8 Ventilation plantrooms will also need to house the clean and dirty extract fan units, and these may be floor or duct mounted. Exhausts from these units must be positioned to discharge clear of air intake louvre and department openable windows (see Figures 35 to 37).

7.9 Consideration should be given to the possibility of installing run-around coils and associated equipment where heat recovery from these items is feasible.

7.10 Fans for special extract systems conveying hazardous or toxic products may need to be sited in ventilation plantrooms. The discharge from these systems should be at high level to atmosphere - the height and location is to be determined in consultation with the appropriate authority (Environmental Health Officer, Health and Safety Executive).

7.11 Extract fans for the smoke extract hood systems are also located in these plantrooms and they should discharge to atmosphere above the plantroom roof level (see Figure 29).

High voltage sub-stations

7.12 Sub-stations should be accessible from a road to allow easy access for transformer changing, fire appliances, maintenance vehicles, etc. There are safety restrictions for personnel access to high voltage sub-stations, and emergency exit doors of the approved “crash bar” type must be provided at regular 20 m intervals, and be located in suitable places to prevent entrapment of personnel.

Layout

7.13 The cable trench layout should allow adequate space for pulling in and terminating cables, and wall clearances for servicing switchgear or cubicles. The size of the sub-station should be related to the anticipated total development, either by building an unequipped extension for future additions or by locating and designing the sub-station so that future building extension is possible.

7.14 Headroom should be sufficient to ensure adequate natural cooling and space for luminaires and fire protection equipment; typical layouts are shown in Figures 44 to 47. A work space should be provided at the end of the switchboard for maintenance work on at least one circuit breaker. In the event of an equipment fault it must be possible for the transformer to be moved into the open air and a crane used.

7.15 Ring anchor fixing should be available for hauling transformers into position or out to the open air.

7.16 The cable entries and ducts should be routed to avoid obstructing the installation or removal of the transformer.

7.17 The following minimum clearances are recommended:

a. between transformer and wall – 1.0 m;
b. headroom above transformer tank – 1.6 m;
c. headroom above switchboard – 0.9 m;
d. between rear of HV and LV switchgear wall – 0.8 m;
e. at front of LV switchboard – 1 m vertically, and to the wall 2 m, for horizontally isolated switching devices.

Ducts

7.18 Cable trenches and ducts should be constructed to avoid paths along which surface water, leaking mineral oil or synthetic fluid will flow. If this is unavoidable, or if cable entries or exits occur at or below ground level, then outside cover edges should be sealed with a suitable weather sealant. All outside cable trench covers should be sealed against water penetration.

7.19 Cable trenches and ducts should have fire-resistant barriers provided in accordance with NHS in Scotland Firecode.

Low voltage switchrooms

Siting

7.20 Switchrooms other than those associated with sub-stations should be sited as close as possible to the load centre and arranged to allow convenient direct entry to rising ducts, horizontal ducts, crawlways etc.

Layout

7.21 The layout should allow adequate space around the switchboard for servicing purposes. Suggested minimum clearances between the switchboard and walls are 0.8 m minimum at the rear and 1 m in front, plus additional space recommended by the manufacturer for withdrawing switchgear. Where provision is made for bus-bars to be extended, adequate space should be allowed at one end of the switchboard for this purpose.

Electrical switchgear

Located within roof level plantrooms

7.22 The distribution strategy proposed in Chapter 6 for the routing of the main electrical cables suggests the optimum position of the sub-main switchgear to be within the roof level ventilation plantrooms (see Figures 28 to 39). In this location, good access for maintenance and repair can be provided without disturbing staff or patients. The option to position the switchgear within the hospital street area or another selected location is, however, not ruled out.

Access and maintenance

7.23 Sufficient space should be provided for normal operating access, maintenance and plant inspection and removal. Provision should also be made for the lifting and removal of large or heavy items of plant or equipment. Wherever possible the “line” of the rooftop walkway should continue through the plantroom to ease plant movement and general access.

Calorifier plantrooms

Size

7.24 Figures 48 and 49 show minimum plantroom areas required for the accommodation of calorifiers, associated plant and equipment.

Site

7.25 Calorifier rooms should be located as near as practicable to the load centres or between the load centres and the source of heat supply. They should preferably have direct access to the outer air. Consideration should be given to the effect on adjacent rooms of heat transfer through walls and ceiling.

Shape

7.26 In general the room shape should vary between a square and rectangle with a maximum ratio of 3:1.

Height

7.27 A minimum room height of 2.7 m is recommended for the accommodation of horizontal calorifiers. Vertical calorifiers may require a height of more than one storey to achieve the necessary headroom.

Construction

7.28 The calorifier base should be designed to carry the weight of the calorifier and its contents. The walls and ceiling may be required to support pipework and minor items of plant. Bases for pumps should be designed to minimise

vibration from the pump and motor. It may be necessary to provide sufficient space to allow for lifting equipment to be used during the installation or renewal of the larger items of plant.

Other services in the calorifier plantroom

7.29 Space for general lighting will be required, with suitable electric power points. Adequate provision should be made for the removal of heat losses from plant to prevent an excessive rise in temperature in the plantroom. This should be achieved by natural ventilation wherever possible. Drains will be required for normal drainage and emptying down. If the plantroom is below drain level, space for a sump and sump pumps will be necessary.

Water storage rooms

7.30 The area required to accommodate water storage cisterns is readily calculated from the required storage capacity and the available room height. Additional space may be required for pressurisation plant or circulating pumps. Figure 50 shows the minimum clearance that should be provided around cisterns.

Site

7.31 The most suitable location for internal storage is either the roof or the basement, except in very tall buildings where cisterns may be required on intermediate floors. Water towers or concrete underground reservoirs may be considered for external storage with the capacity of the high level cisterns in buildings reduced accordingly. Siting cisterns over vertical shafts such as staircases may facilitate supporting the weight of the cisterns.

Shape

7.32 The proportions of the cistern may have to suit the available site. The cost/capacity ratio of the cistern increases as its shape departs from square, therefore cisterns should be designed to be as close to square as is practicable.

Height

7.33 The height will generally be governed by standard plate sizes and a clearance space of approximately 1000 mm above and 450 mm below the sectional cisterns.

Construction

7.34 Sectional cisterns using standard flanged pressed plates are most commonly used for water storage. Adequate supports and supporting structure should be provided. Curbs of adequate height should be provided around descending ducts and at doorways to prevent the spread of spilled or leaking water. A tell-tale overflow should be provided from the floor.

Other services in cistern rooms

7.35 Space for adequate lighting will be required around the tanks. A suitable power point may be required in the cistern room. Adequate ventilation is required for internal cistern rooms. Heating for frost protection should be considered.

Storage of medical pathology and industrial gas cylinders

7.36 The following sections provide guidance on the storage of medical pathology and industrial gas cylinders. Figure 51 shows typical layouts of manifold rooms.

7.37 In respect of liquefied petroleum gas storage (LPG), it should be noted that the principles of 'The Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972', should be followed as appropriate. Detailed guidance on the storage of LPG is given in the Health and Safety Executive Guidance Notes CS4 and CS5, and the advice which follows is given without prejudice to that contained in these documents.

Operational considerations

7.38 This guidance represents the minimum standard applicable to all new installations, and the general principles should be followed on existing installations so far as is reasonably practicable. Normally, existing installations will have been designed to comply with the recommendations of NHS in Scotland Firecode and/or SHTM 2022; *Medical gas pipeline systems* as appropriate, that is gas cylinders will have been stored either in a storeroom which is part of a health building or in a separate, specially constructed building, both areas being used exclusively for medical gas cylinders. These installations will usually be satisfactory if adequate ventilation is provided.

7.39 In cases where there are difficulties in meeting the requirements contained in this document for either new or existing installations, for example on a restricted site, the advice of the gas supplier or Property and Environment Forum Executive) should be sought as appropriate. Where significant problems exist, the local inspector of the Health and Safety Executive should be consulted. Overall, the principles contained in this document should be followed as far as is reasonably practicable.

Cylinder store design

7.40 Cylinders should ideally be stored in the open air, but where this is not practicable, the store should be adequately ventilated to minimise the possibility of gas accumulating in the event of a leak. Details of suitable construction for a store are given in paragraphs 7.62 to 7.64.

7.41 Within the storage area, cylinders whose contents are incompatible, those containing flammable and oxidising gases should not be stored together unless there is adequate separation. Details of the storage area layout are given in paragraph 7.62 to 7.64.

General principles of cylinder storage

Key points

7.42 The cylinder storage area should be:

a. well ventilated;

b. clearly labelled;

c. secure (but with clear access);

d. used exclusively for cylinders;

e. for flammable and oxidising gases, free from naked flames and all sources of ignition, and in a “no smoking” area;

f. provided with barriers for cylinder segregation and to prevent cylinders falling.

7.43 Storage of cylinders containing compressed, liquefied or dissolved gases within unsuitable buildings may increase the risk of fire or explosion. All full and empty cylinders, apart from those in use or required for immediate use, should be kept in specially designed stores, which should be sited away from occupied premises, and used exclusively for the storage of cylinders.

7.44 Wherever possible, cylinders should be stored in the open air.

7.45 Where storerooms have to be used, they should be specially designed and used solely for this purpose. A high standard of natural ventilation to the open air should be provided at high and low level. If used for flammable gases, adequate explosion relief should be incorporated, for example by provision of a roof of lightweight, friable material (see paragraph 6.4 of the British Compressed Gases Association Code of Practice CP8, ‘The safe storage of gaseous hydrogen in seamless cylinders and similar containers’. Automatic fire detection should be installed if appropriate as required by SHTM 82; *Alarm and detection systems*).

7.46 Sources of ignition should be eliminated from all areas where gas cylinders are kept. Smoking and naked lights should be prohibited, and suitable notices

should be posted in prominent positions to this effect in accordance with the EEC directive which came into effect on 1 January 1981. For further guidance see the Health and Safety Sign and Signals Regulations 1996; BS 5499 'Fire Safety Signs, Notices and Graphic Symbols'; and BS 5378 'Safety Signs and Colours'.

7.47 The store should be clearly labelled to indicate the type of cylinders it contains, action to be taken in an emergency and the location of the key(s). The graphic symbols in BS 5499 and BS 5378 may also be used as appropriate.

7.48 If the store contains more than one section, each should be clearly labelled to show which types or classification of cylinders may and may not be stored.

7.49 The store should have adequate means of access to facilitate movement of cylinders on trolleys. The cylinder bays should similarly be arranged to allow the safe loading and manoeuvring of trolleys.

7.50 Industrial and medical gases recognition charts should be displayed, in accordance with BS EN 1089-3 and BS EN 850.

7.51 Cylinders should not be stored in bulk except in specially designated stores. However operational policy may require small quantities of gases to be held outside the main store in ready for use stores. The general considerations outlined in this section will also apply to ready use stores.

7.52 Full cylinders should be stored separately from empty ones in a clearly identified area. Empty cylinders should be stored in the same way as full cylinders.

7.53 The store should normally be locked and access restricted to authorised personnel – see paragraph 7.65.

7.54 Cylinders should be properly secured to prevent toppling or rolling. Vertical storage is recommended for cylinders containing dissolved or liquefied gases and is essential for cylinders fitted with dip tubes.

Location of main cylinder stores

7.55 For guidance on the fire hazards associated with inappropriately located cylinder stores and in buildings adjoining stores, reference should be made to NHS in Scotland Firecode.

7.56 Main cylinder stores should be located at ground level; never underground, for example in basements.

7.57 Where necessary, protection from vehicular damage should be provided for example by a low wall, crash barriers or bollards. This should not significantly restrict the ventilation, and should not create a 'tank' in which gases could accumulate.

7.58 Adequate access should be provided to stores to allow safe delivery and manipulation of cylinders.

7.59 Stores should be located close to the delivery point. Wherever possible, there should be only one delivery supply point on each site.

7.60 No parking should be permitted within the delivery and storage areas, other than for loading and unloading.

7.61 Stores should be located in the shade wherever possible (cylinders of liquid ammonia require special protection from direct sunlight).

Design and construction of main cylinder stores

7.62 Stores should be constructed so as to provide maximum ventilation.

7.63 Where practicable, cylinders should be stored in the open air, with open mesh fences for security. Protection against weather, debris etc. should not reduce the provision for natural ventilation below that given in Table 4 which should be regarded as a minimum standard.

Table 4: Design of main cylinder stores

Classification	Sides	Roof
Medical and non – medical inert and oxidising gases only.	At least one major side open wire mesh (see notes). Remaining sides brick or other non – combustible material. Where the sides are not required to be " fire – resisting" they should incorporate suitably distributed opening (for example air bricks) at high and low level to promote cross – ventilation.	Light, non – combustible material, designed to prevent accumulation of gases in event of leak.
Non – medical including cylinders of flammable, toxic and / or corrosive gases.	At least 2 – sides open wire mesh (wherever possible opposite rather than adjacent sides). Remaining sides as above.	As above.

Notes:

1. The sides should be at least 2 m high.
2. The open wire mesh should be industrial quality, chain link fence or similar material to provide security and free ventilation.

7.64 The floor and hard standing should be level and constructed of concrete or other non-combustible, non-porous material. A concrete finish is preferred and is likely to have a longer life.

NOTE: Bituminous or other similar carbonaceous materials should not be used for surfacing in the vicinity of cryogenic storage installations (especially liquid oxygen), and in any area where spillage of cryogenic liquid may occur (for example tanker delivery areas). (See SHTM 2022; *Medical gas pipeline systems*.) The floor should be laid to a fall, to avoid the accumulation of water in any undrained area of the storeroom.

Security

7.65 Unauthorised access to the store should be prevented. A perimeter fence of industrial quality chain-link or equivalent, at least 2 m high, should be adequate unless protection is otherwise provided (see also Chapter 6).

Requirements for manifolds for non-medical gases

7.66 Wherever possible, manifolds for gases other than medical gases should be located in the open air. If this is not possible, the above guidelines on manifold rooms should be followed, with particular emphasis on good ventilation.

7.67 Explosion relief for flammable gas manifold rooms should be incorporated into the exterior walls or roof of the manifold room. It should be designed so that if an explosion occurs, the pressure would be relieved safely. The area of explosion relief should be equivalent to the area of one of the largest sides or the roof and relief may be achieved by using a roof of lightweight, friable material or via openings in the walls/roof of the store (see also BCGA Code of Practice CP8).

7.68 Manifold control panels for open air service should be suitably constructed and protected against the weather for such a location. Such weather protection should incorporate adequate natural ventilation to prevent the accumulation of any gas leakage.

Ready use stores

7.69 In some areas it will be essential to hold small numbers of spare cylinders for immediate use, for connection to anaesthetic machines, and for sudden unanticipated demands. Such areas would include: operating department, accident and emergency department, coronary care unit, central delivery suite of maternity department, special care baby unit, intensive therapy unit sterilizing and disinfecting unit, etc.

Medical air compressor

Size

7.70 The area required to accommodate a medical air compressor set is shown in Figure 52. Reference should also be made to SHTM 2022; *Medical gas pipeline systems*.

Site

7.71 Ground level or roof level are suitable locations for medical air compressors. Allowance should be made for isolating the noise generated by the plant during operation from adjacent areas. Adequate fresh air intake will be required to the plantroom.

Medical vacuum plant

Size

7.72 The area required to accommodate the medical vacuum plant is shown in Figure 53. Reference should also be made to SHTM 2022; *Medical gas pipeline system*.

Site

7.73 Ground level or roof level are suitable locations for medical vacuum plant. Allowance should be made for isolating noise generated by the plant during operation from adjacent areas.

Liquid oxygen storage

Safety distances

7.74 The area required to accommodate the liquid oxygen storage unit is related to the surrounding buildings. Figures 54 and 55 and Table 5, 6 and 7 show the required clearance for various situations. Reference should be also be made to SHTM 2022; *Medical gas pipeline systems*.

Sterilizers

7.75 The area required for sterilizers is provided in Table 8 and typical layouts for the plant are given in Figure 56. Reference should be made to SHTM 2010; *Sterilization*.

Table 5: Separation distances: liquefied flammable gases, flammable liquids and oxygen storage

a) LPG storage

Size of storage			
Liquid oxygen vessel (tonnes)	LPG vessels		
	Weight capacity (tonnes)	Equivalent liquid capacity (m^3) 15°C	Separation distance metres
Up to 200	0 – 1.1	0 – 2.2	6.0
	1.1 – 4.0	2.2 – 7.8	7.5
	4.0 – 60.0	7.8 – 117.0	15.0
	60.0 – 150.0	117.0 – 124.0	22.5
	150.0 & above	294.0 & above	30.0
	LPG cylinders and other liquefied flammable gas* cylinders above 50 kg total capacity		7.5

See also HS(G)34 'Storage of LPG at Fixed Installations' and LPGITA COP 1 'Code of Practice - Installation and Maintenance of Bulk LPG at Customer Premises'.

b) Other bulk flammable liquids and liquefied flammable gases

The separation distances listed above for LPG should be applied to the same stored volumes (m^3) of other bulk liquefied flammable gases and may be used for the same stored volumes (m^3) of bulk flammable liquids (+). These distances may be reduced depending on the nature of the flammable liquid and any protective measure and in these cases an individual assessment of the proposed location should be carried out.

* Common examples of liquefied flammable gases supplied in cylinders include ammonia, hydrogen sulphide and ethylene oxide.

+ Common examples of bulk flammable liquids include acetone, methanol, diesel, petrol.

Table 6: Separation distances: compressed flammable gases and oxygen storage

Compressed flammable gas cylinders (m^3) (gas volume measured as Nm^3 at 1013 mbar and 15°C)	Liquid oxygen storage up to 200 tonnes separation distance (metres)
Up to 70	5.0
Above 70	8.0

Notes:

1. For liquefied flammable gas cylinders, see Table 1
2. Distances in Table 2 are based on hydrogen cylinders. Reference: BCGA CP8 (1986).

For separation distance for Acetylene, BCGA CP 6 (1986) should be referred to.

Table 7: Separation distances: flammable liquid or gas lines with union flanges etc and oxygen storage.

Flammable liquid or gas line size (nominal)			Liquid oxygen storage up to 200 tonnes separation distance (metres)
	mm bore	inches bore	metres
Up to	25	1	6.0
Up to	50	2	10.0
Above	50	2	15.0

Notes:

1. The above separation distances are intended to provide protection for the LOX storage tank against jet flame impingement from an ignited release from the flammable liquid/gas line.

2. The distances are based on LPG as the contents of the flammable liquid/gas line and are given as a “worst case”.

3. For flammable liquids or gases other than LPG in the line, the above distances should be used, unless it can be shown that smaller distances are adequate to avoid jet flame impingement.

4. If some means of protection from jet flame impingement (such as shielding of the joint by fire resistive material) can be provided between the union/flange on the flammable liquid/gas line and the LOX storage, and this can be shown to provide an equal or greater degree of protection than the separation distances shown, the separation distances may be reduced.

Table 8: Planning Dimensions for preferred sizes of sterilizer

Type of sterilizer	Usable Chamber Space mm H x W x D Minimum (c)	Nominal vessel capacity m^3	Dimensions as Figure 56 mm maximum				Weight (a) Kg Maximum		Portage for Installation and removal (b)	
			A	B	C	Height	Installed	Fully loaded	mm H x W x D maximum	Weight kg maximum
		0.28	Vertical chamber machine – refer to manufacturer							
Porous load and LTS	780x635x635	0.4	1000	1200	1750	2060	1550	1740	2000x1050x1750	1400
LTS and F	780x635x935	0.6	1000	1200	1950	2060	1850	2070	2000x1050x2100	1600
Fluids	780x635x635	0.4	1000	1200	1750	2060	1550	1970	2000x1050x1750	1400
	780x635x935	0.6	1000	1200	1950	2060	1850	2340	2000x1050x2100	1600
	780x635x1250	0.8	1000	1200	2200	2060	1950	2500	2000x1050x2420	1800

a. Weight should be distributed using a minimum of 4 pads each measuring a minimum of 150 mm x 150 mm.

b. Where possible sterilizers should be transported as a whole and not partially stripped.

c. Chamber opening should not be less than 915 mm x 660 mm.

d. Laboratory and EO sterilizers should be sized to suit their particular application. Where a multi-purpose laboratory sterilizer is to be installed it should comply with the data given for the porous load.

8. The zoning and routing of primary services in the hospital street vertical shafts

General

8.1 Engineering services may be distributed to departments via service shafts located within the hospital street. As well as facilitating vertical communication and distribution of services between plantrooms and departments, these shafts form the main vertical distribution zone. It is important, therefore, that sufficient space should be provided within these shafts to accommodate the services provisions for the whole building.

8.2 Where possible, services should be positioned to interface directly with the departmental zoning and spacing principles set down in Chapter 9. Figures 57 and 58 illustrate how space is allocated within the shaft to allow smoke canopy extract ducts on each floor level to be taken up to roof level plantrooms in a separate fire-rated enclosure. A similar enclosure is included for the distribution of the departmental electrical feeder cables and isolators. At each floor level, direct access from the hospital street to the electrical enclosures is recommended. Engineering shafts, apart from those containing electrical services, generally need not be carried below the ground floor ceiling zone down through to the ground floor slab. Access to these shafts for the isolation of services to ground floor and first floor may be accomplished at first floor level (see Figures 57 and 58).

8.3 The space provision for ventilation ductwork in each shaft will be determined by the functional, clinical and fire requirement of particular departments, and also the limitations imposed by the available service void heights inside the building. Piped water services are generally grouped in one shaft, while medical gas services are contained in another.

Standard shaft arrangement

8.4 The standard arrangement shown consists of two rectangular shafts interfacing directly with a department which does not contain a lift or stairway.

Alternative shaft arrangement

8.5 This arrangement is only appropriate where a lift and/or stairway is incorporated within the department entrance. The services provision is similar to the standard arrangement but the shafts are contained within the zone by the lift or stairway.

Drawings

8.6 The drawings depict basic zoning principles for typical departmental accommodation and show how they may be interpreted for typical services routing into engineering shafts positioned at the hospital street interface. These drawings are illustrative only and teams will need to consider local project requirements when designing structural variations and other options for accommodating services not included within this guidance.

9. Service distribution within departments

General

9.1 This chapter provides guidance for all floor levels where a full width ceiling void can be utilised for the distribution of engineering services.

9.2 All the engineering services principles referred to in this section apply to a typical departmental layout. The zoning principles developed and described below have been based on the maximum expected service requirements for a hospital complex containing various departments, each approximately 1400 m^2 in area, and with a minimum ceiling height of 2.7 m (excluding corridors and WCs). For areas requiring a ceiling height of 3 m, such as operating theatres and X-ray departments, these rules may need to be modified accordingly.

9.3 In some departments on the top floor, roof lights may be provided and the routing of the services will need to be coordinated to suit the particular type and application.

9.4 The services provision to each department will dictate the extent to which individual service zones will be utilised. Flexibility is not allowed in the pipe or duct mains zone where services have pre-determined routes dimensioned in the horizontal plane. Branch pipes and ducts should be grouped within the particular zone to provide good access and supports arrangement.

9.5 Figures 57 and 58 illustrate typical department services layouts. These plans indicate the routing of services within the department zone and show how services are connected to:

a. the mains distribution system located in the hospital street;

b. rooftop plantrooms via the vertical services shafts.

9.6 Individual services have been allocated a zone or zones through which they may be routed and, apart from vertical penetration by other services, each zone is generally reserved for the assigned service or services. By zoning the services in this manner the difficulties of coordination between them are kept to an absolute minimum. The final design solution for individual services is left to the planning team.

9.7 When dealing with a Whole Hospital design the collection of departments is varied in size and functions and service requirements. A standard arrangement for the services at the hospital street/development interface is therefore essential if the design of the hospital street is not to be over-complicated by different solutions at every interface. This does not mean that a standard arrangement at the interface will solve all problems, but it will

enable standard zoning and spacing arrangements within the hospital street to be workable and easier to apply.

9.8 Drainage has more significant constraints than any other service and, as a consequence, it is more important that its zones are not penetrated by other services. Moreover the services void for a particular department will contain the drainage zone for the department located on the floor above. It is therefore essential that no intrusions into the drainage zone above the false ceiling are made. It is permissible, however, for a department's services to pass through its own drainage zone, that is, below floor level. Such an arrangement should be avoided, however, since it increases costs and the need for coordination.

9.9 The physical integration between services and the components of the building, such as structure, partitions and ceiling support system, are determined in such a way as to suit individual departmental arrangements and service requirements.

9.10 Each department floor may be serviced independently, from its interface with the hospital street. The following basic rules relate to the overall routing of services within the department and should be applied during the early planning stages of the engineering design. The rules aim to simplify the design and routing of services, keep the service loads and therefore sizes to a minimum at departmental entrances, minimise coordination, and lead to the better preparation of engineering drawings.

9.11 Although each block can accommodate a part of one, or a number of individual departments, the basic service routing, illustrated in Figures 57 and 58, remains the same.

Structure

9.12 The zoning and routing of mechanical and electrical engineering services in this document has been set out according to a notional department structural grid. The structural grid may be modified to accommodate the structural variations within hospital developments and the designer will be required to modify the zoning as appropriate. The suggested minimum beam/floor slab depths are assumed to be as illustrated by Figure 59.

9.13 Mechanical and electrical vertical shafts or ducts are located at the department and hospital street interface. These allow vertical communication of services between plantrooms and the main horizontal distribution system into each floor.

Drainage zones

9.14 The drainage branch zone and the perimeter drainage zone contain all drainage pipework. Where a department is single storey or where it constitutes the top floor of a block, this zone may be utilised for rain-water pipework.

9.15 The drainage vent pipe may be routed within the combined pipe and duct branch zone, and will need to be coordinated with the other services using this zone.

9.16 The drainage system should be contained fully within the drainage zones and should not impinge on any other zone. Similarly no other service should impinge on the drainage zone unless it is related to the department to which the drainage design is associated.

Routing drainage systems

Main collection drains (ground level)

9.17 The route of each main collection drain is either towards the hospital street or preferably towards the periphery of the building for connection into the main hospital drain.

9.18 Separate main collection drains convey the soil and waste and surface water drainage from each departmental department into the main hospital drain.

Vertical drainage stacks

9.19 Vertical drainage stacks may rise at the corners of each module of the departmental unit for a vertical drainage duct to accommodate the soil and waste vent stacks, the surface water stack and the drainage vent pipes.

Drainage vents

9.20 Drainage ventilation pipework should be kept to a minimum.

9.21 A 50 mm diameter vent pipe may be required at the high point of all heavily loaded main drains and spine or branch drains of exceptional length.

9.22 For top floor locations having a pitched roof, the drainage vent pipe may be contained solely within the combined duct and pipe branch zone, and routed towards a corner stack location. The connection to the stack may not be possible within the building and in this situation the vent may terminate through the roof adjacent to this position. The service branches will be positioned and routed, and then the vent pipe(s) coordinated with them.

Interfloor drainage

9.23 The drainage system employed for above-ground templates is basically horizontal in concept (shallow gradient). The zones through which the drainage pipework from above-ground floor departments is routed are located in the service void of the department below, and are reserved for drainage systems only.

9.24 Outlets from sanitary appliances may drop vertically through the structural slab into the drainage branch zone below, and connect into collecting spine drains to discharge into the perimeter drainage zone at each side of the module.

9.25 The design should allow blockages to be cleared from above floor level via an access point located either at or adjacent to each sanitary appliance or fitting. Rodding eyes at floor level and access to pipework below the floor slab are not generally acceptable.

Ground floor drainage

9.26 The ground floor does not impose the same restrictions on the penetration and zoning of the drainage pipework. A similar concept may, however, be followed.

9.27 Internal manholes should be provided at the junction between spine and main drains only in areas where they are clinically acceptable.

Pipework service zone

Pipe main zones

9.28 The pipe mains are contained in zones within the services void as follows:

a. **Central pipe main zones –** these zones contain all piped distribution services with the exception of the drainage pipework and the compensated low pressure hot water (LPHW) heating mains (see Figure 60);

b. **Perimeter pipe mains zones –** these zones, which run down the perimeter of each side of the block, contain only the compensated LPHW heating mains. The positions shown should be adhered to since they generally allow for the most economic runs of the services.

Combined duct and pipe branch zone

9.29 To fully utilise the total space requirements of the engineering services void, the duct and pipe branch zones are combined. This will entail a greater degree of coordination of services and therefore will necessitate identification of the ventilation requirements at an early stage.

9.30 When routing the branch ducts in this zone an overall dimensional allowance of 50 mm should be made for flanges, supports and insulation.

Pipe branches

9.31 Branch pipes do not have prescribed routes within the branch zone. They need, therefore, to be coordinated with the branch ventilation ductwork and the electrical services where they pass through the crossover zone or electrical zone.

Low pressure hot water heating

Compensated temperature circuit

9.32 The general pipework arrangement within the service void of each department unit for radiator and convector systems is shown in Figure 60.

9.33 The branch pipework to local low level circuits at the perimeter should drop within a vertical (100 mm min) engineering zone at the perimeter of the block.

9.34 Terminal emitters sited internally within the department can be served via local partitions. In this instance, isolating and regulating valves should not be positioned within the partitioning unless suitable access to them can be arranged.

Constant temperature circuit

9.35 Ceiling mounted fan convectors, and duct mounted heating coils requiring constant temperature low pressure hot water, may have control valves located within the false ceiling. As no alternative is available to the siting of these valves, every effort should be made to ensure that good access to and around these fittings is made available.

Hot and cold water services

Hot water service

9.36 Each department may be served separately from the hospital street by a conventional two-pipe flow and return system. The pipework is routed horizontally in a predetermined position through the service void to dropper positions adjacent to the draw-off points. Careful consideration must be given to the routing of branch flow and return pipework to draw-off points particularly to avoid venting problems.

Cold water service

9.37 Provision has been made within the rules for a single potable cold water service (CWS) pipe. The main enters the department from the hospital street and runs in a predetermined position within the service void. The system design must observe all the necessary precautions against back siphonage as outlined in SHTM 2027; *Hot and cold water supply, storage and main services*.

9.38 The CWS pipework to draw-off points will drop from the high level distribution pipework to draw-off points either within the thickness of the partition or via vertical pipe ducts adjacent to a fitting or range of fittings.

Fire-fighting services

9.39 Reference should be made to NHS in Scotland Firecode.

9.40 Where a sprinkler system is installed, the distribution pipes may be run in the combined duct and pipe branch zones and coordination will be required where the branch pipes pass through the electrical and ceiling zones to connect to the sprinkler heads.

Medical gases

9.41 Consideration should be given to the siting of the main isolation valves at department entrances and nurses' station. The valves will need to be accessed in an emergency and for maintenance; they should therefore be located in a site that is readily accessible and unlikely to be obstructed by equipment. See SHTM 2022 for specific requirements.

Electrical sub-main

Sub-main feeder cables

9.42 The main feeder tray which carries the essential and non-essential sub-main feeder cables to the departmental switchcupboard should have a predetermined route dimensioned in the horizontal plane within the hospital street.

Trunking and conduit

9.43 There is no predetermined horizontal position for the distribution trunking and fire conduit. However, it is recommended these be routed within the main services zone in a readily accessible position above corridor areas, where practical, or in areas where normal departmental routines will not be interrupted.

Ceiling zone

9.44 This zone provides the spatial requirements necessary to accommodate the ceiling and the support members.

9.45 Access will be required through the ceiling zone into the space above for the inspection and maintenance of all plant and equipment located in the ceiling zone.

9.46 Items of equipment which require regular attention should be positioned in areas which will cause minimum disruption to department routines.

Ventilation zones

9.47 An allowance of 50 mm is included in the depth of the ventilation zone for flanges, supports and insulation, and to provide a clearance between adjacent zones.

Duct mains zones

9.48 Supply, clean and dirty extract air ducts may enter the department from the vertical engineering services shafts at the hospital street interface. They then may run horizontally within the duct mains zones which run down each side of the block.

9.49 Duct mains, to serve the side areas of the department, are routed initially into the combined duct and pipe branch zone. Once the perimeter drainage zone within the side module has been cleared, the ducts may then rise back into the main ventilation zone of the side module.

Fire dampers

9.50 Fire dampers are required in ducts which pass through fire compartment floors and walls. Regular access will be required to check and reset all fire and smoke dampers. Adequate space for access to the fire damper should be provided to allow service personnel access to service and reset the damper.

9.51 Further advice and information on the provision of fire dampers is contained in NHS in Scotland Firecode.

Electrical zone

Electrical main zone

9.52 This zone contains both the essential and non-essential sub-main feeder cables which run from the electrical riser switchroom in the hospital street to the department switchcupboard. The department switchcupboard should be located centrally within the department.

Departments with 3 m high ceilings

9.53 Basic spacing and zoning principles can be applied to departments, such as X-ray and operating theatres, which have a ceiling height of 3 m.

9.54 In all cases the drainage zone related to such a department should not be penetrated unless the precise routing of these drains is known.

Departments with 2.4 m high ceilings

9.55 A 2.4 m high ceiling will not normally involve any major engineering routing problems. It will also be possible to maintain the basic zoning and spacing principles for the main through services within the department and where these interface with the hospital street.

9.56 The drawings in this chapter depict, for ground, intermediate and top floor locations, basic zoning principles and how they may be interpreted for typical services provision. These drawings are illustrative only and design teams may need to include local project variations to suit particular needs. In this respect roof profiles, structural systems and roof lights can often impose zoning and routing constraints not included within this guidance.

10. Definitions

10.1 **Chase**: An accommodation for small services cut or formed in the building fabric and covered by the normal finish. Subsequent access is usually obtained by destroying the finish.

10.2 **Crawlway**: An enclosed horizontal space for services large enough to permit a person to crawl along for a reasonable distance or work in cramped conditions for a reasonable period according to circumstances and installed services, when all services have been installed.

10.3 **Duct (horizontal)**: A general term referring to an enclosed space used for the distribution of horizontal services.

10.4 **Duct (vertical)**: An enclosure specifically designed for the controlled movement of air.

10.5 **Ha-ha**: An open trench with one or both sides sloped in which services are run to avoid spoiling the general appearance of the landscape.

10.6 **Lift well**: A vertical space through a building in which lifts will be installed.

10.7 **Plant**: Equipment supplying or served by the engineering services or used for their maintenance.

10.8 **Public health engineering**: The drainage system within the building, including waters, overflows, soil pipes, and rainwater pipes.

10.9 **Service corridor**: A passageway at or above ground level, primarily intended for the use of hospital personnel. Part of such a passageway may be suitably separated for the accommodation of services.

10.10 **Services**: The mechanical, electrical and public health engineering services distributed throughout the hospital.

10.11 **Subway**: An underground traffic route between buildings through or alongside which provision may be made for the installation of services.

10.12 **Trench**: A covered horizontal services space in the floor or ground with access from above.

10.13 **Void**: A space formed in the construction of a building, which can be used for the installation of services, but is not necessarily constructed for that purpose.

10.14 **Walkway**: An enclosed space for horizontal services, large enough to permit a person to walk freely and work comfortably when all services have been installed.

10.15 **Department**: the building envelope containing a department which may be on a single floor or multi-floors.

10.16 **Template**: the floor of a block which can be isolated as a single entry within a hospital development and may contain more than one department.

10.17 **Ready use store**: a local store within a particular department for a limited number of medical gas cylinders - usually one day's supply for reserve purposes, and cylinders for immediate use.

10.18 **Fire Safety Officer**: as defined in NHS in Scotland Firecode.

10.19 **Flammable**: capable of burning with a flame.

10.20 **Main cylinder storage area**: the main area where all cylinders on a site are stored, excluding only those cylinders in use in manifold rooms or in ready use stores.

10.21 **Manifold rooms**: a purpose built room designed to accommodate a cylinder manifold installation, and reserve cylinders as appropriate.

10.22 **Medical gases**: gases used for clinical purposes.

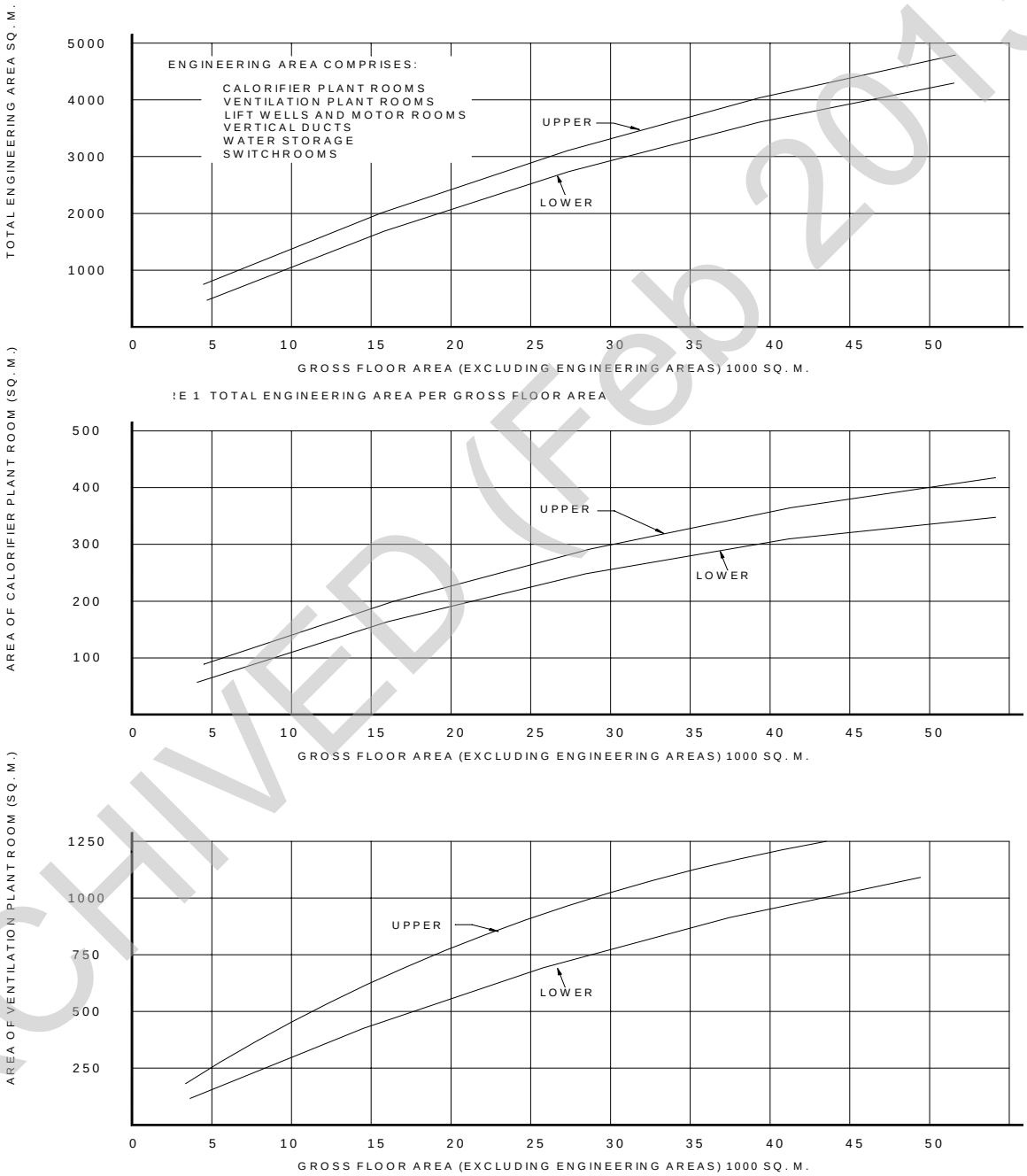
10.23 **Non-medical gases**: all other gases including those used for industrial purposes and in laboratories and pathology departments.

From top:

Figure 1: Total engineering area per gross floor area

Figure 2: Calorifier plantroom/gross floor area

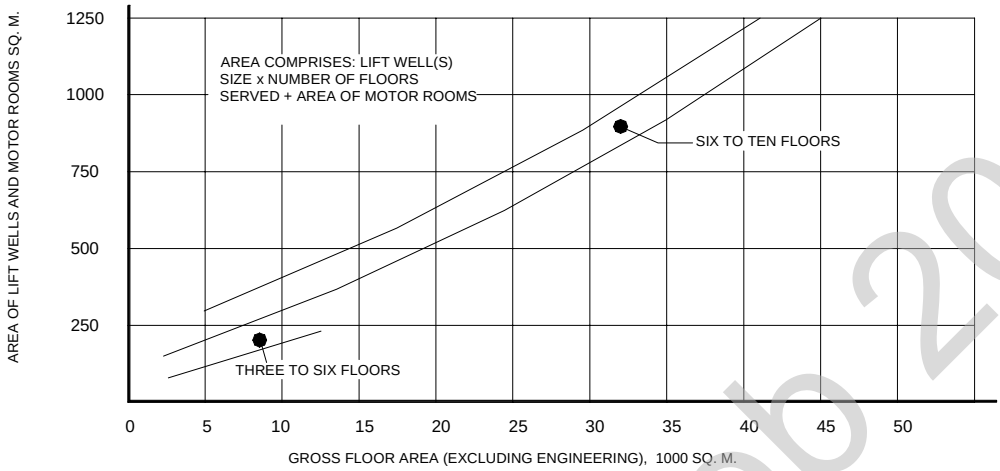
Figure 3: Ventilation plantroom/gross floor area

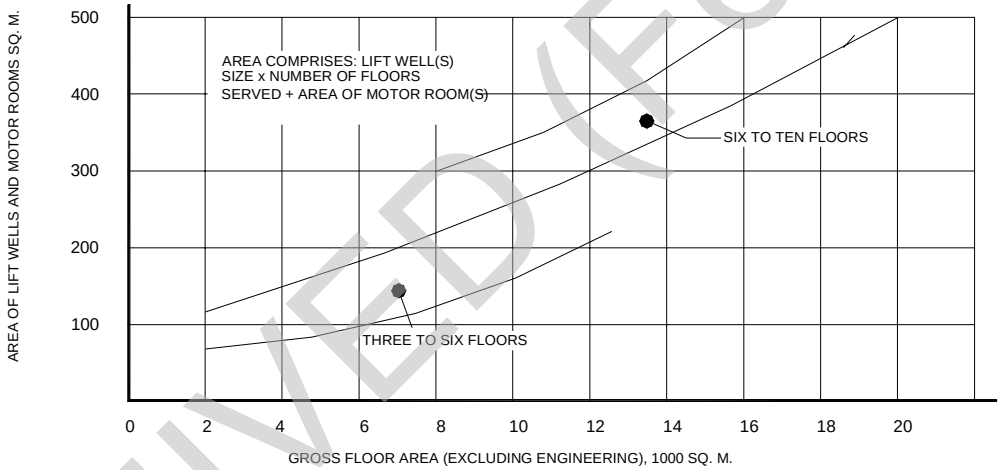


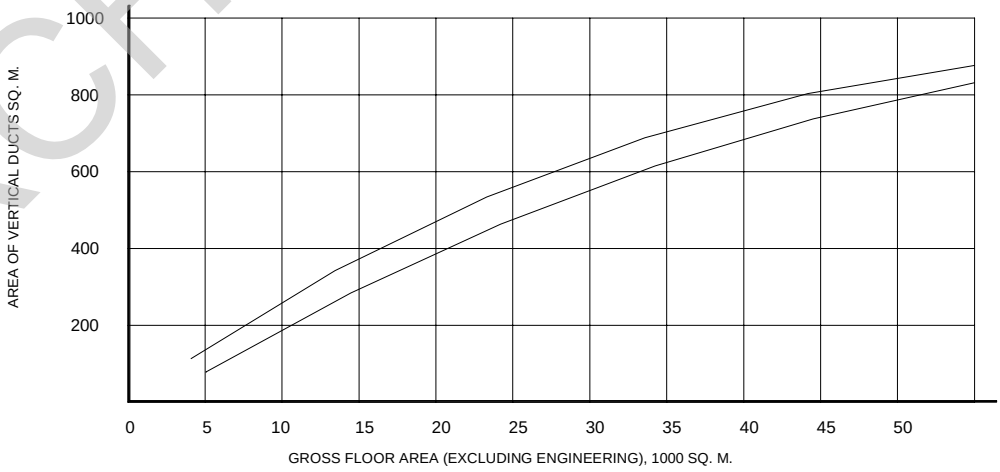
!E 1 TOTAL ENGINEERING AREA PER GROSS FLOOR AREA

From top:

Figure 4: Lift wells and motor rooms/gross floor area.
Figure 5: Lift wells and motor rooms/gross floor area.
Figure 6: Vertical duct area/gross floor area.



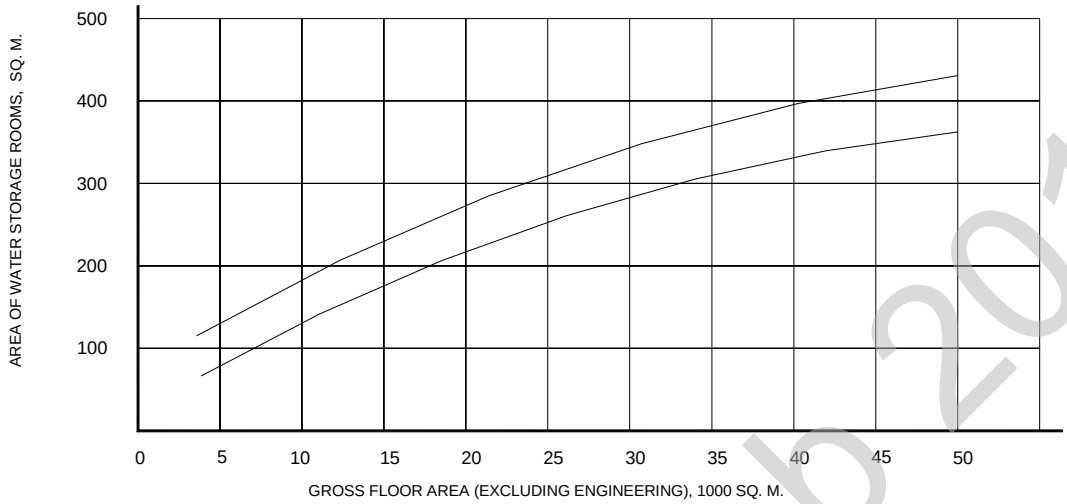




From top:

Figure 7: Water storage room/gross floor area

Figure 8: Switchroom/gross floor area



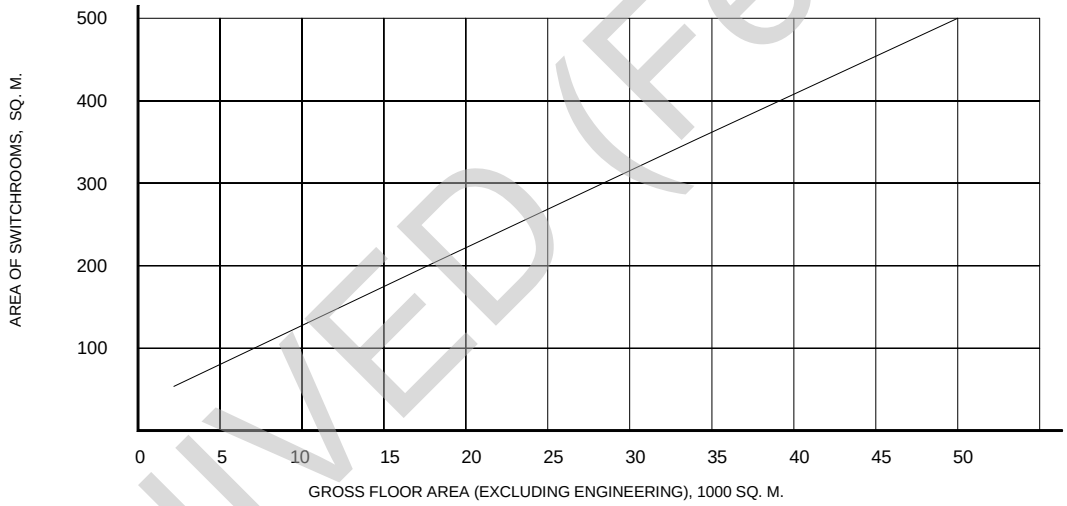


Figure 9: Main engineering distribution within hospital

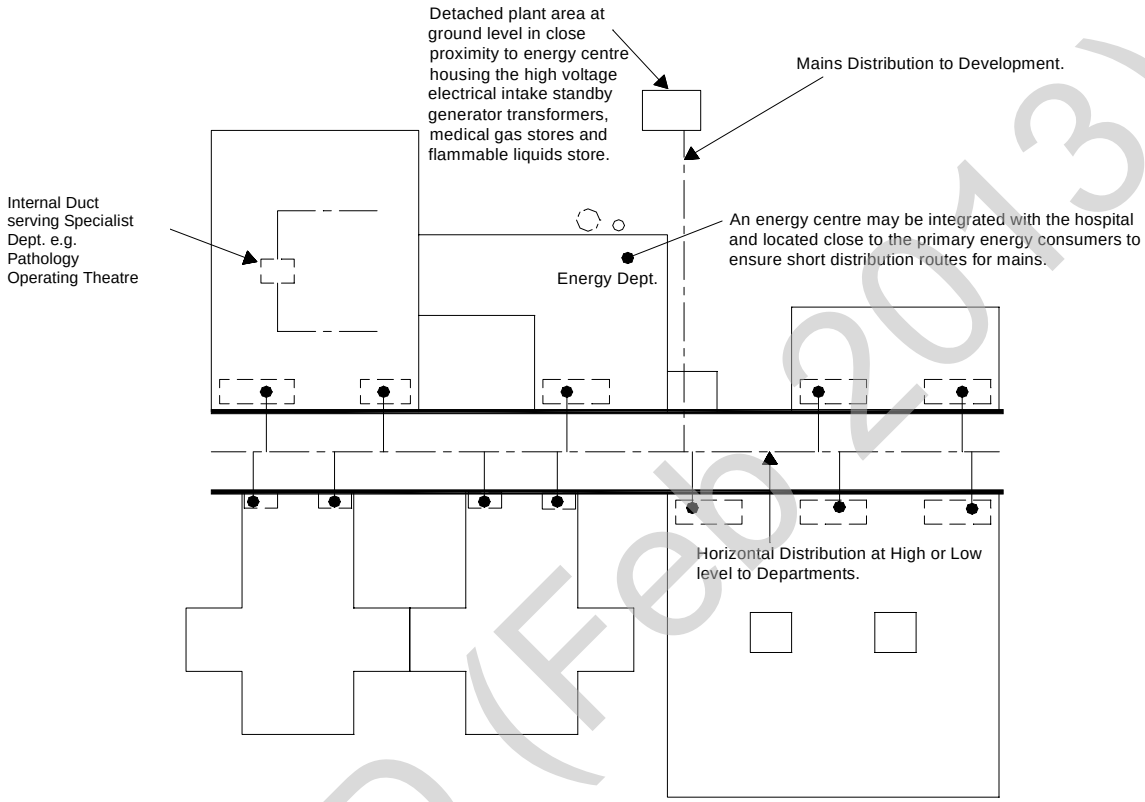


Figure 10

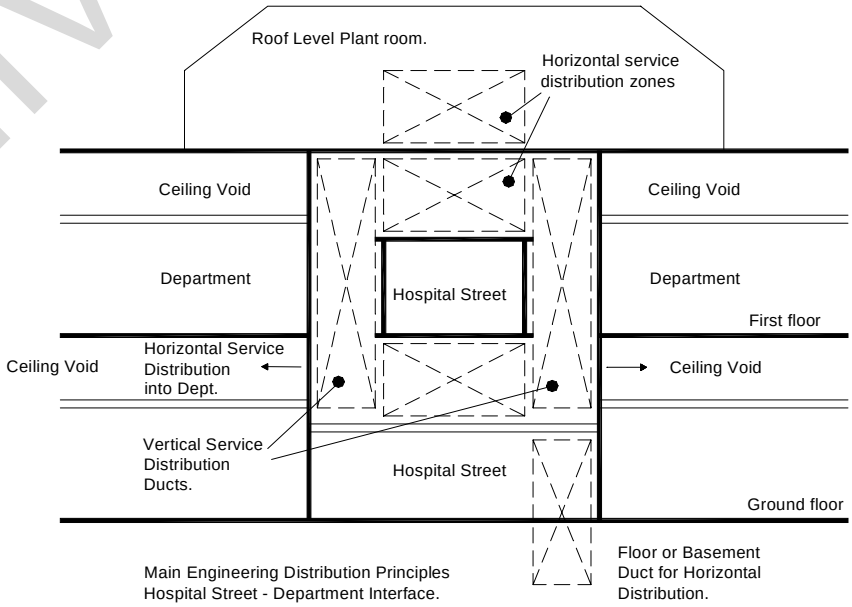
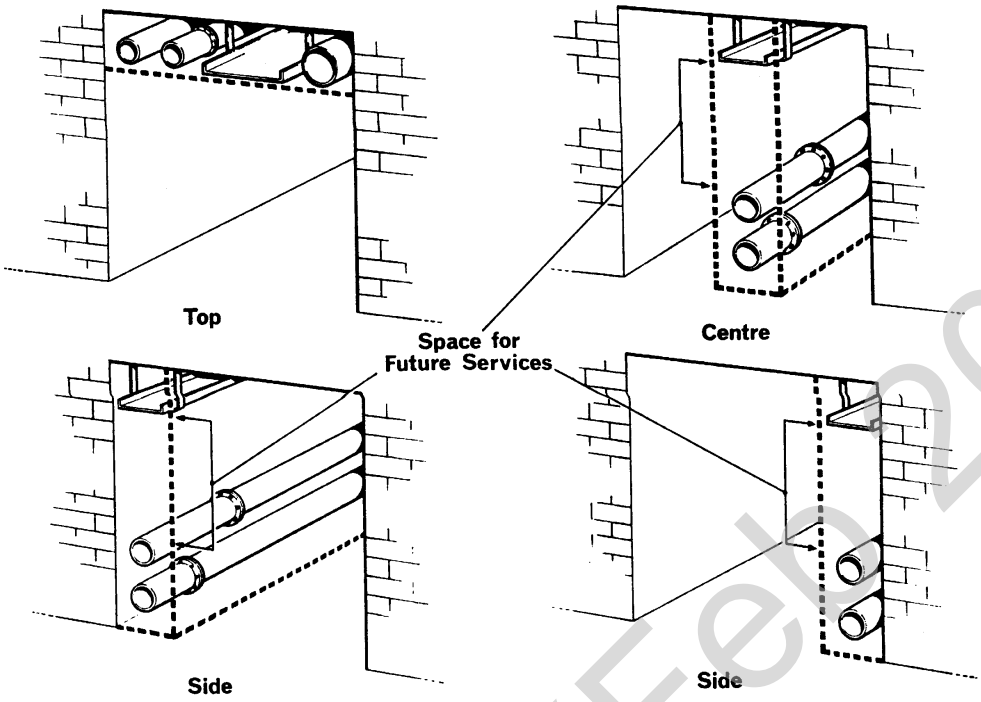


Figure 11: Composite of duct and service spares



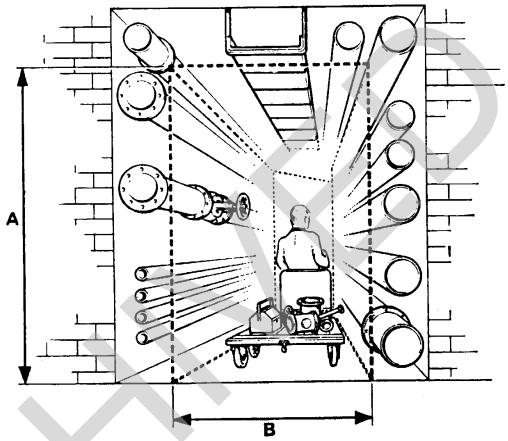


Figure 12: Typical cross-section

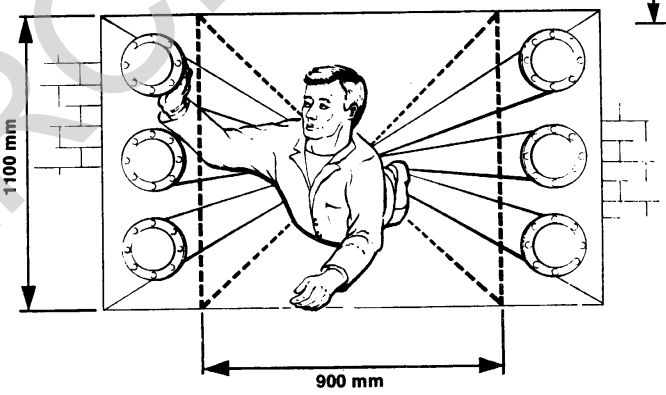


Figure 13: Typical cross-section of crawlway

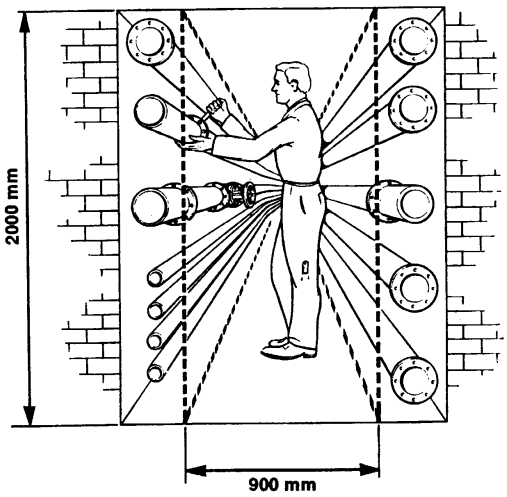


Figure 14: Typical cross-section of walkway

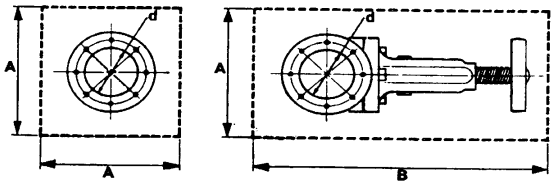


Figure 15: Clearance areas around pipes and valves

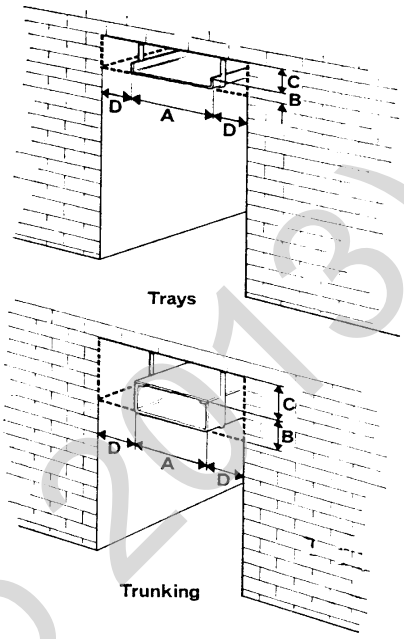


Figure 16: Typical cross-sections

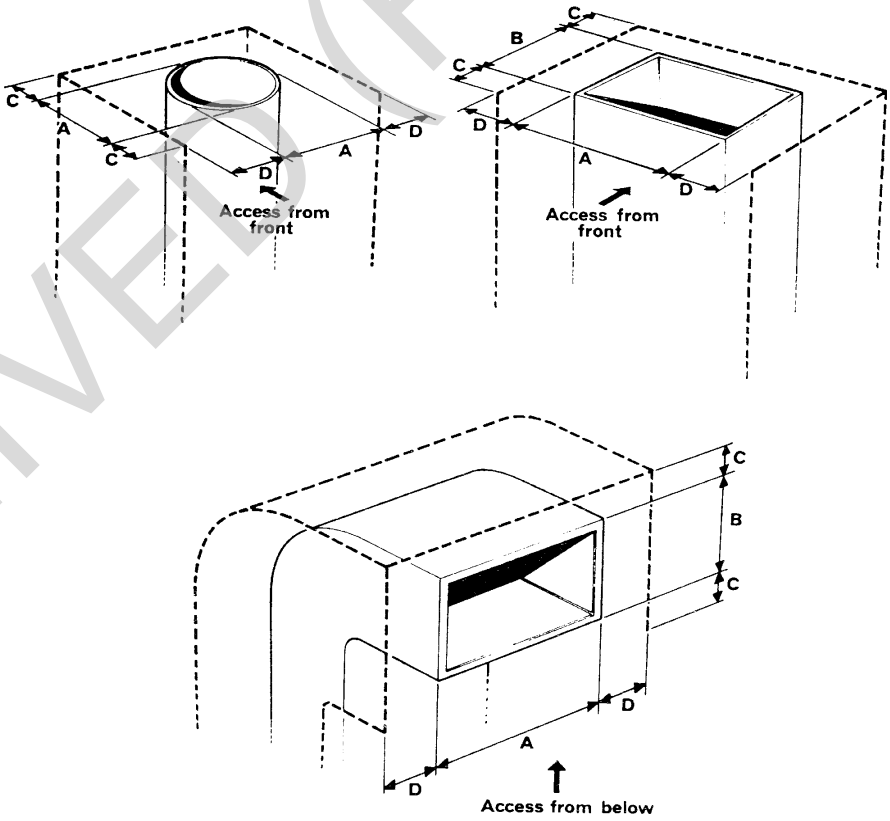


Figure 17: Typical cross-section of ventilation duct areas

Figure 18: Clearance dimension around duct

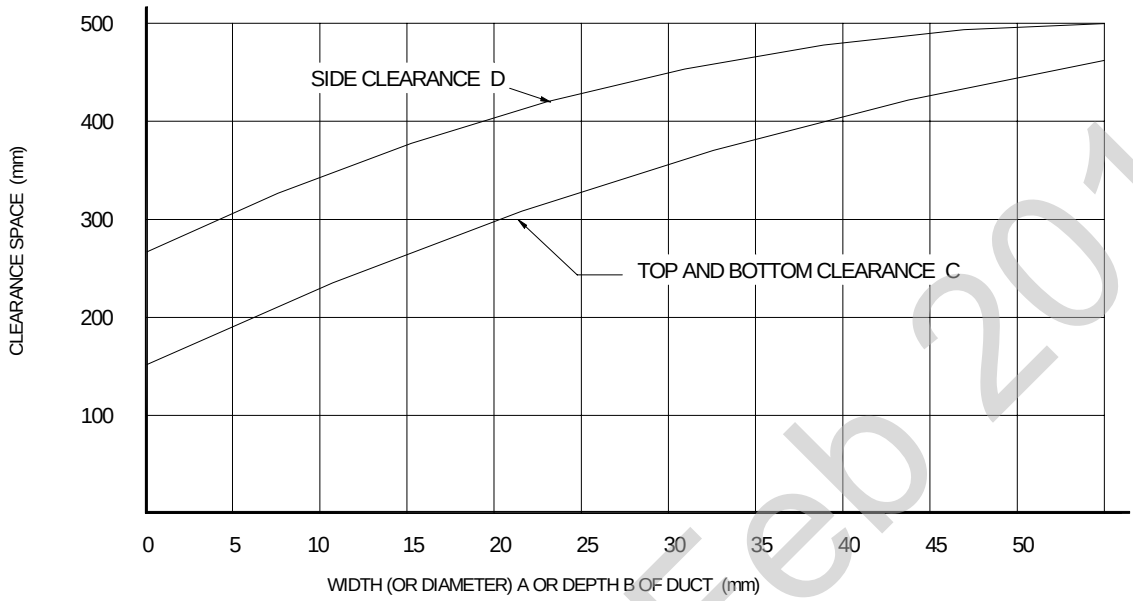


Figure 19: Typical cross-section showing spacing of services

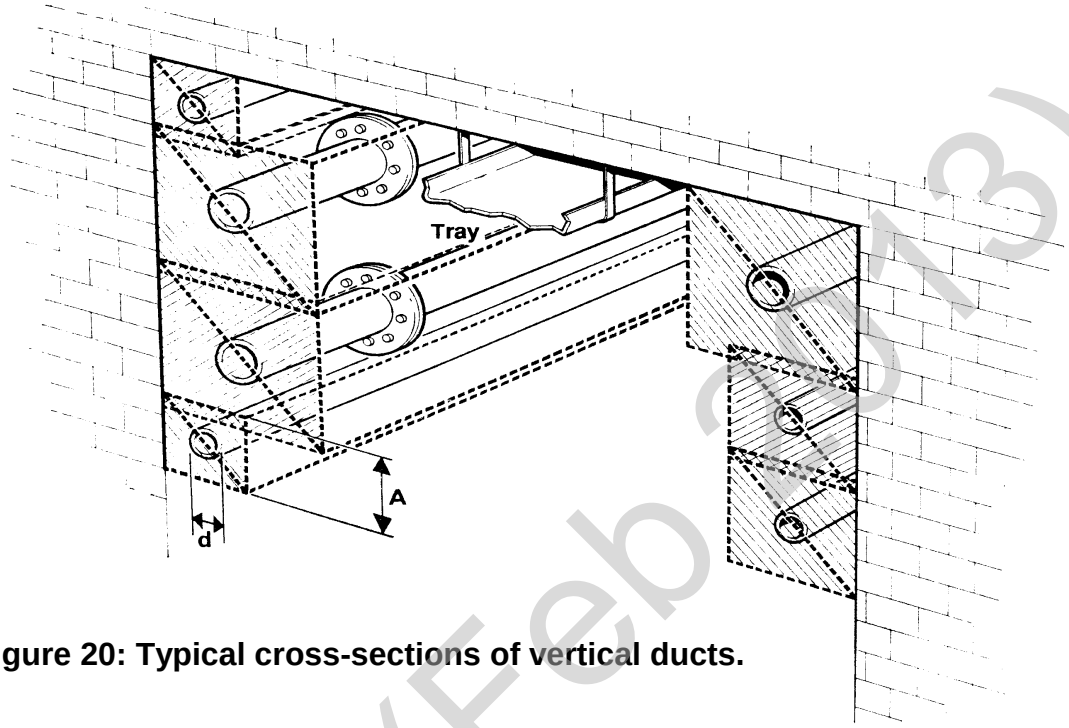


Figure 20: Typical cross-sections of vertical ducts.

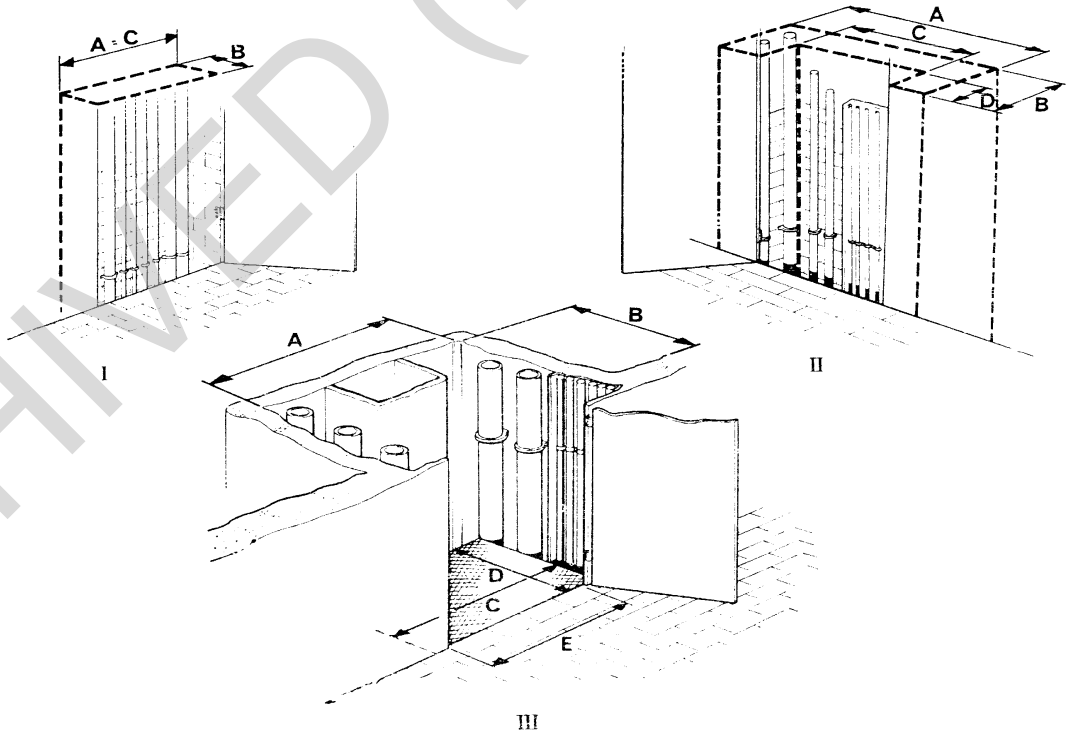


Figure 21: Typical cross-section of ha-ha

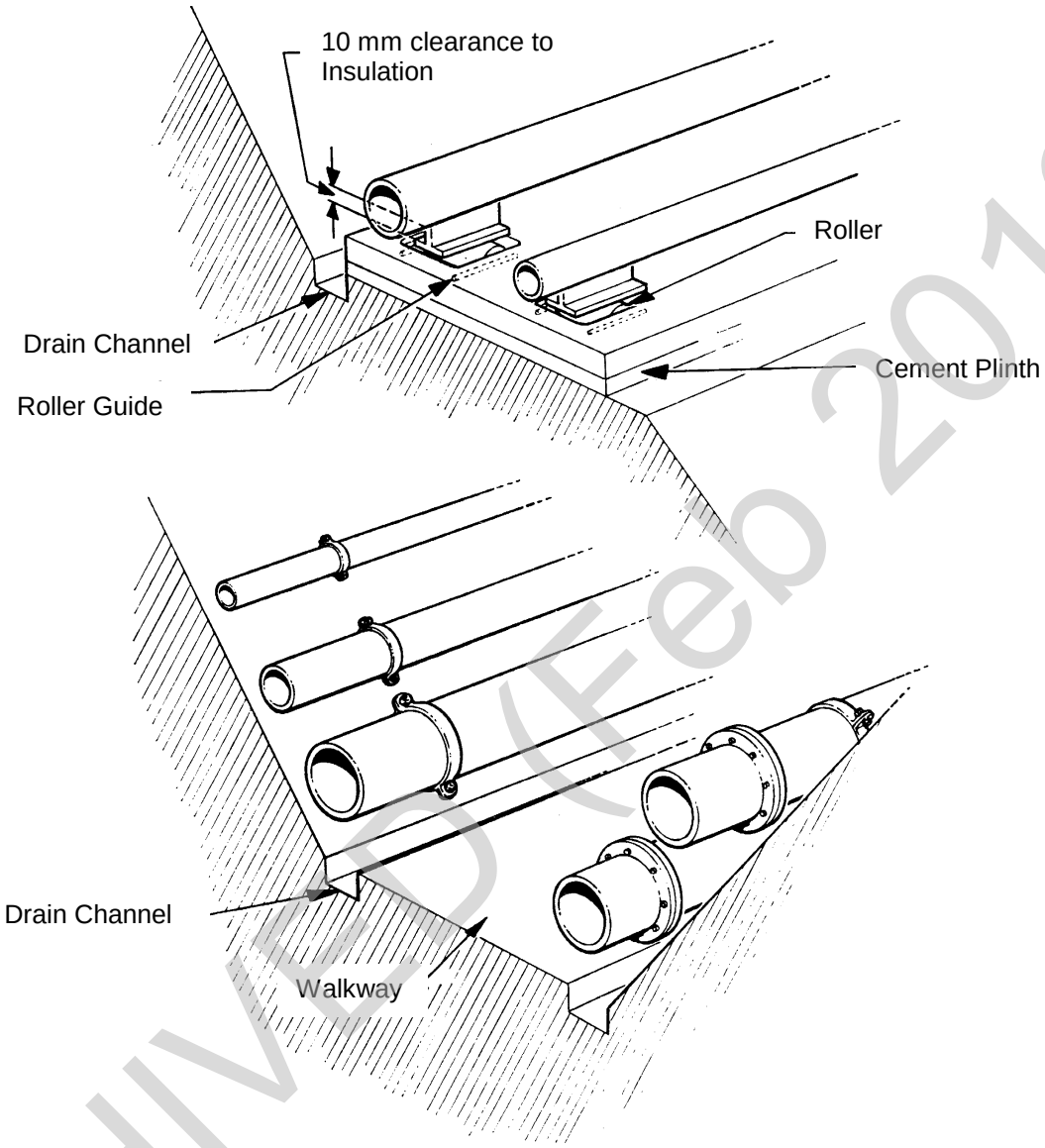


Figure 22: Typical cross-section of ha-ha

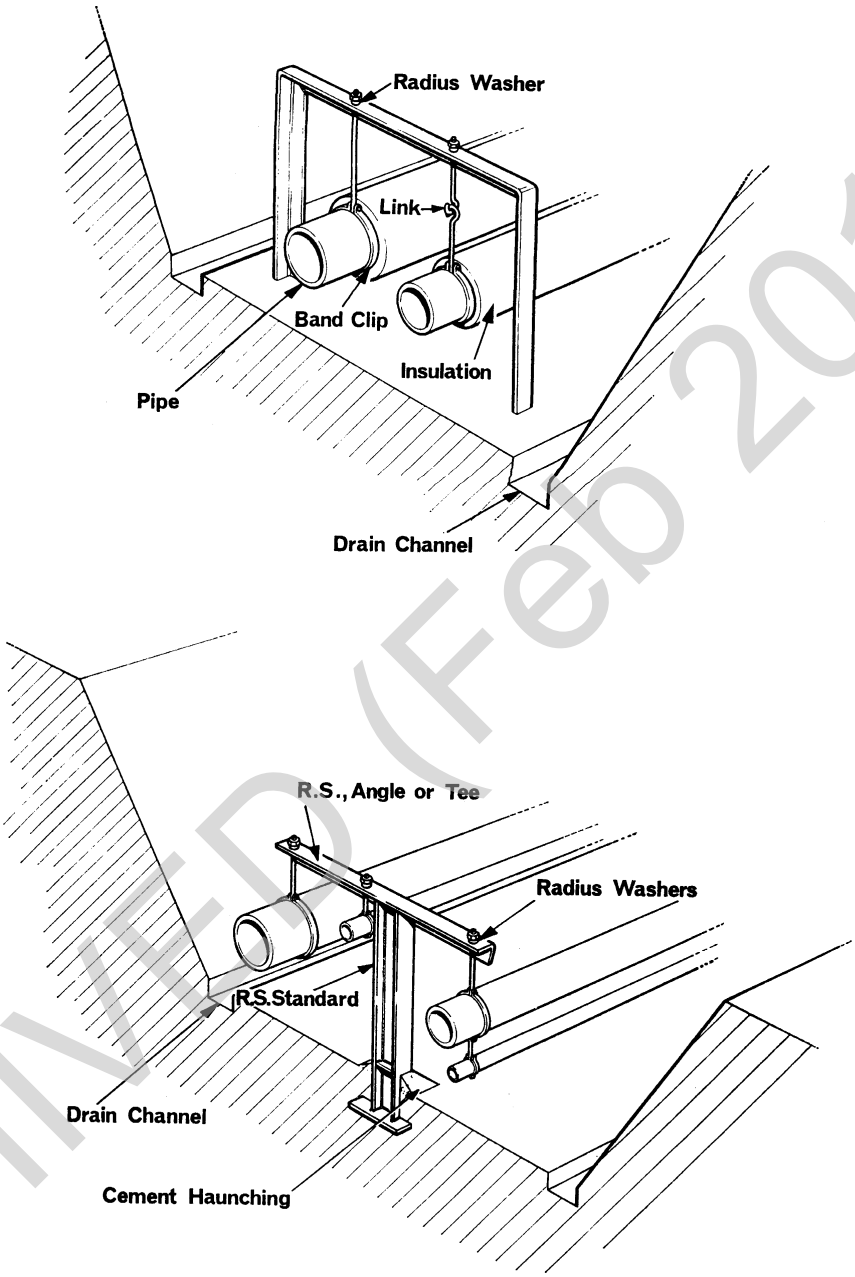


Figure 23: Typical cross section of service trench - internal

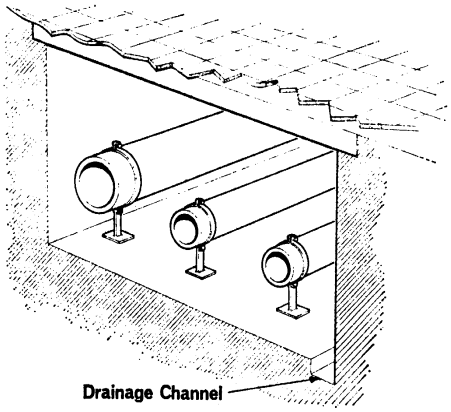
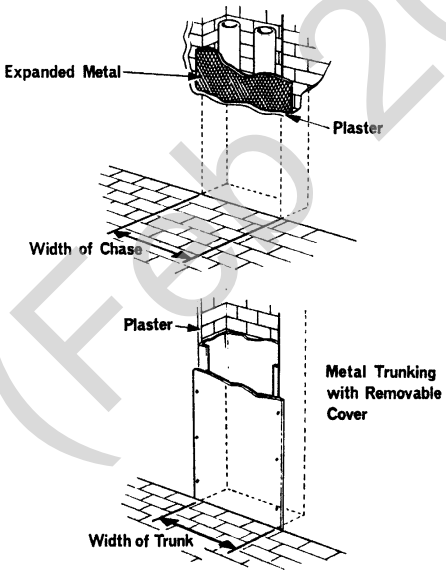


Figure 25: Typical cross-section showing chases in brickwork or concrete



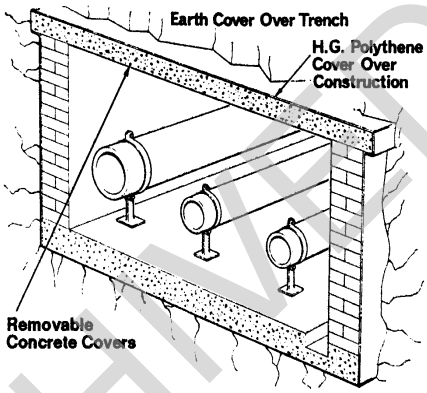


Figure 24: Typical cross-section of service trench – external.

Figure 26: Anthropometric data – body dimensions

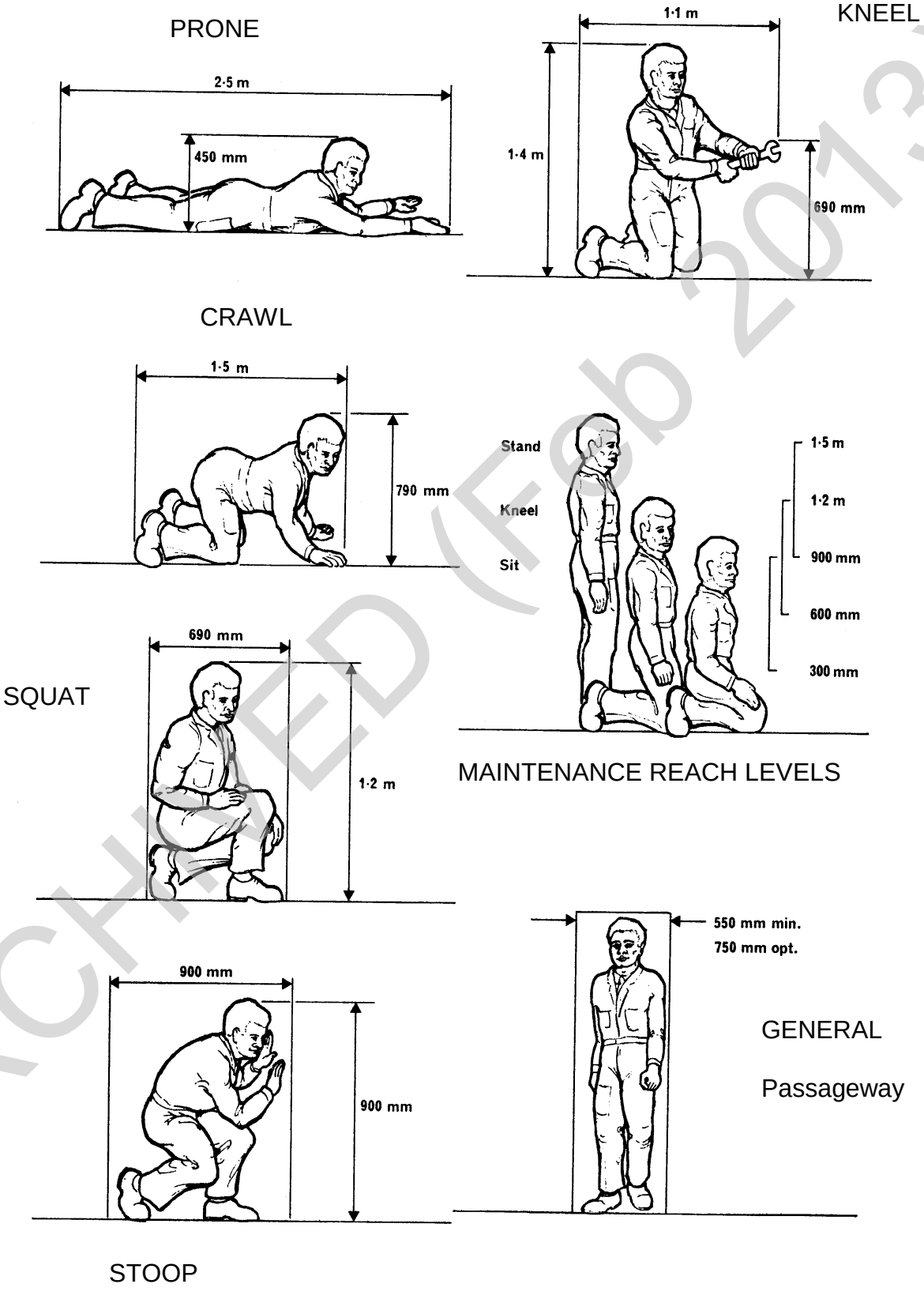
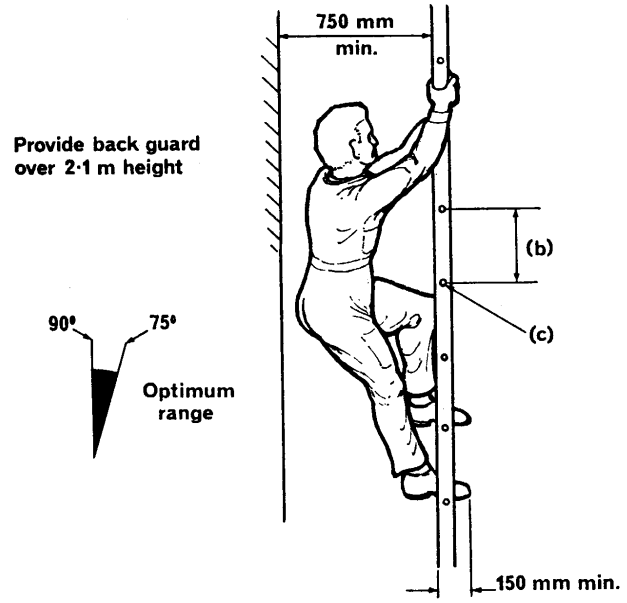
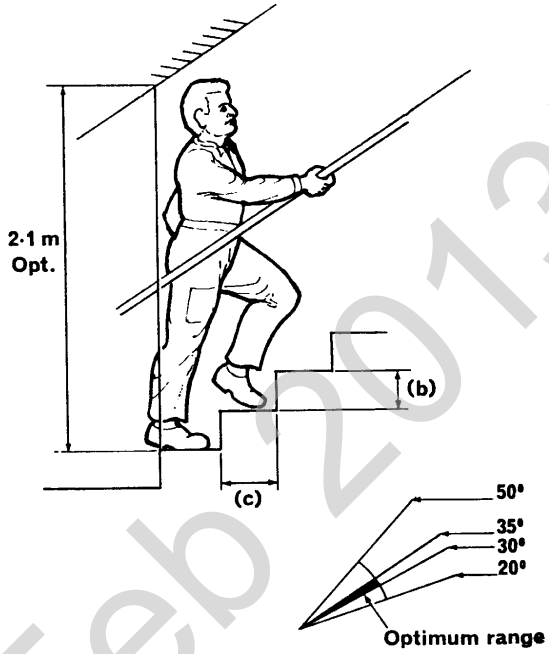


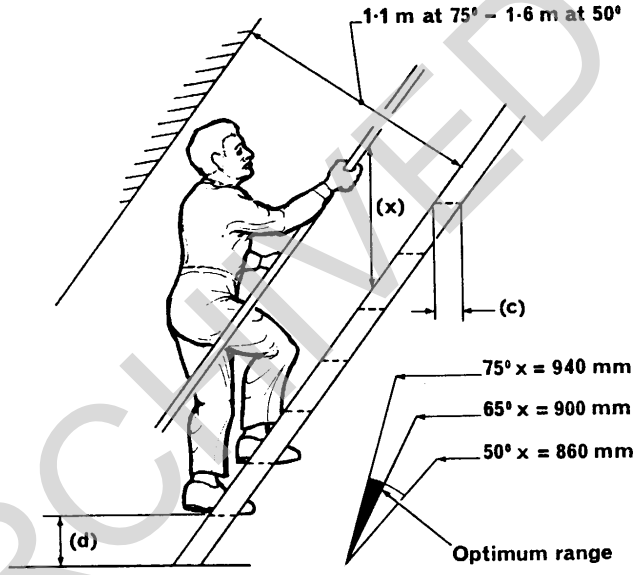
Figure 27: Anthropometric data – climbing dimensions



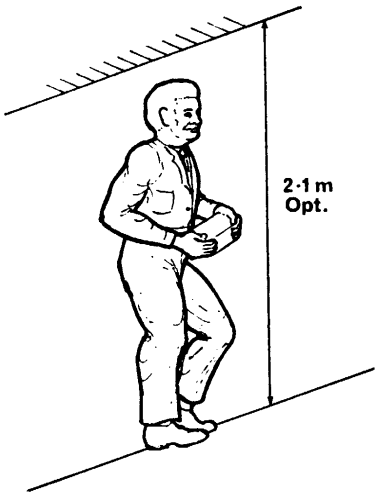
(a) Width 380 mm min. 450 mm optimum. 600 mm min. between side walls
(b) 180 mm – 406 mm – 300 mm optimum
(c) 20 mm – 40 mm dia. rung



(a) Width 600 mm to 760 mm one man – 1·1 m min. two men
(b) 184 mm optimum
(c) 240 mm – optimum tread



(a) Width 530 mm to 600 mm with handrails
(b) 600 mm min. between side walls
(c) 80 mm – 150 mm tread
(d) 250 mm riser maximum



(a) Width 750 mm min. – 1·1 m optimum

Figure 28: Typical plantroom 1 serving a combination of 24 hr and 9-5 accommodation departments. End location

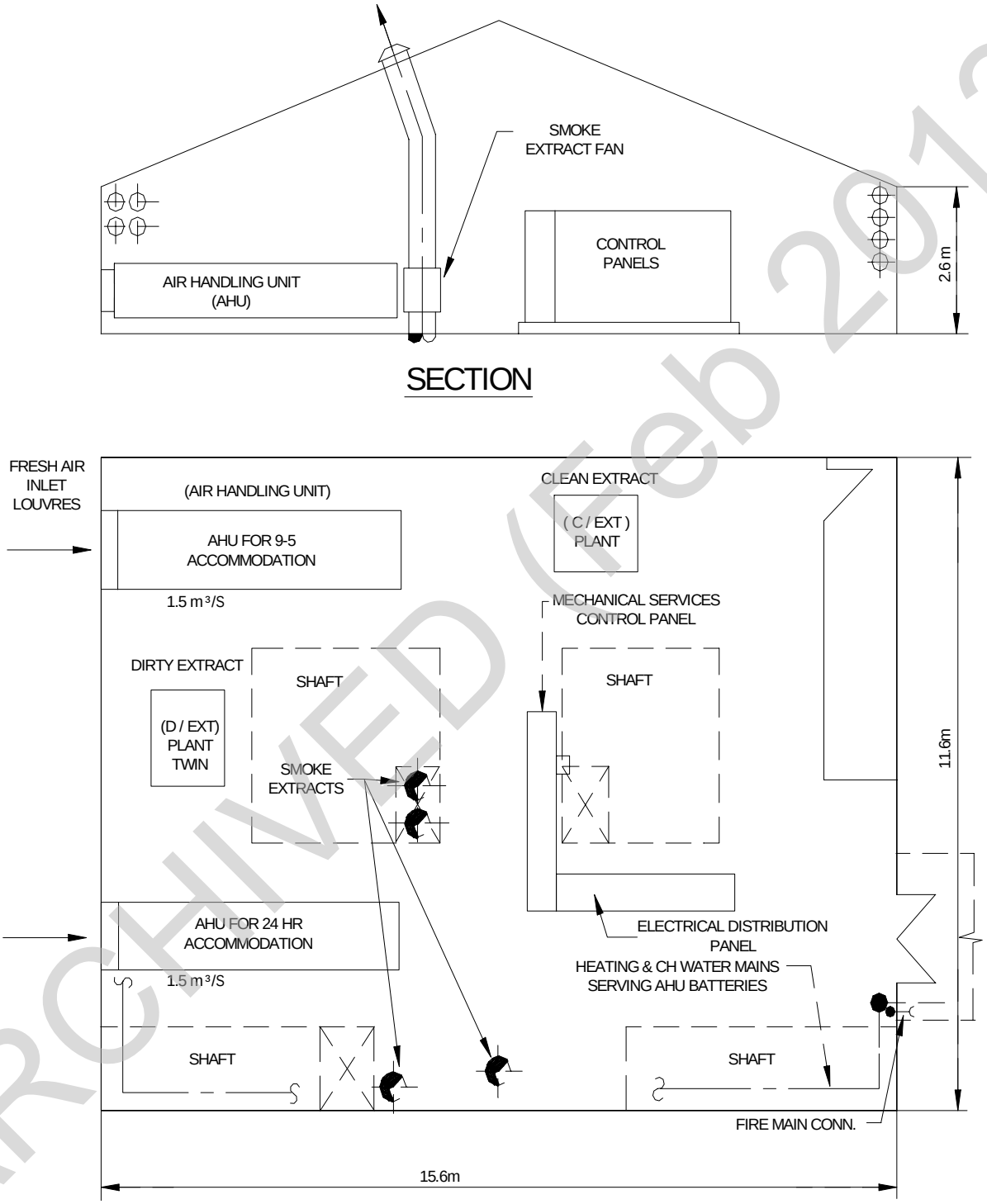


Figure 29: Typical plantroom 2 serving a combination of 24 hr and 9-5 accommodation departments

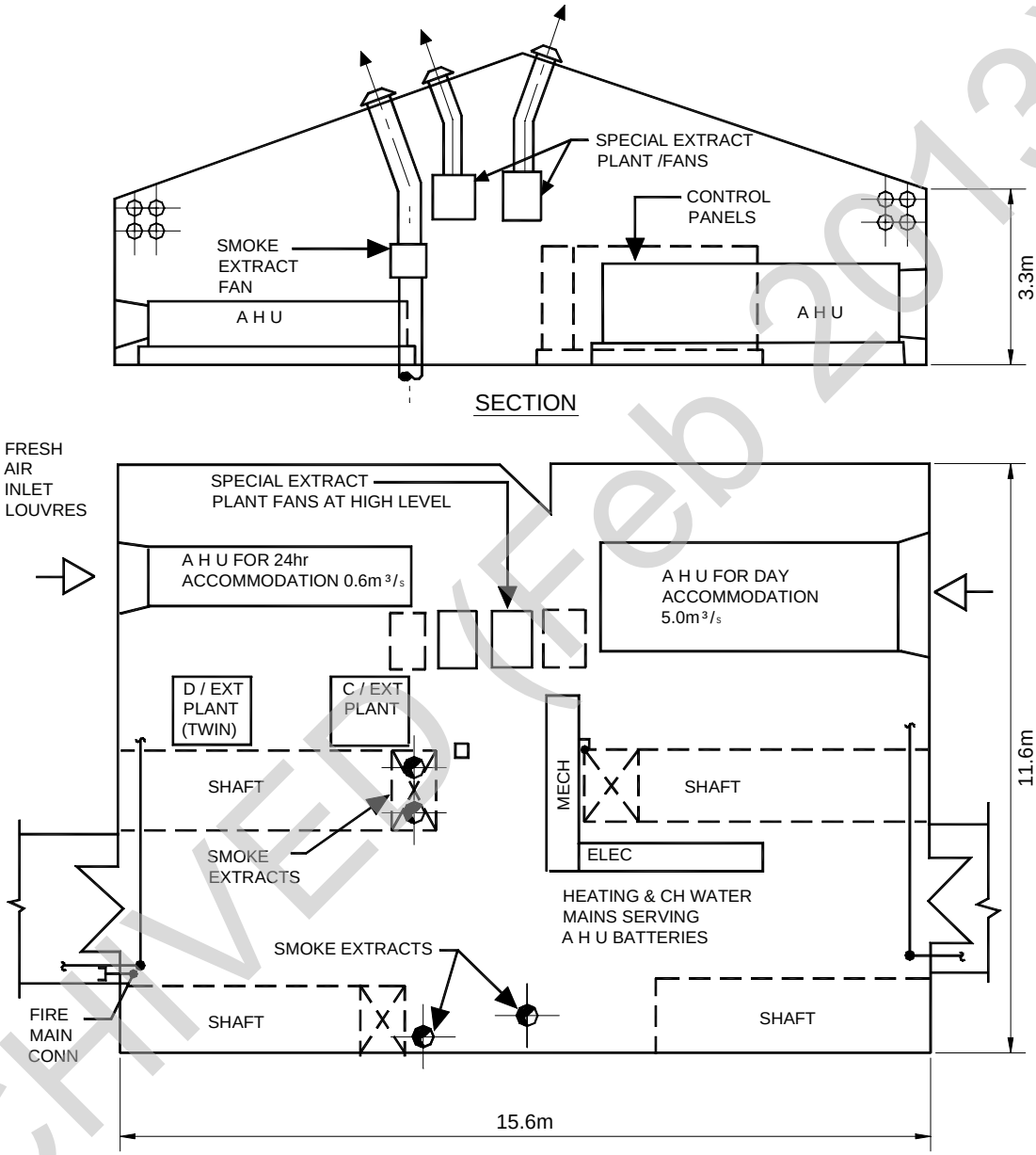
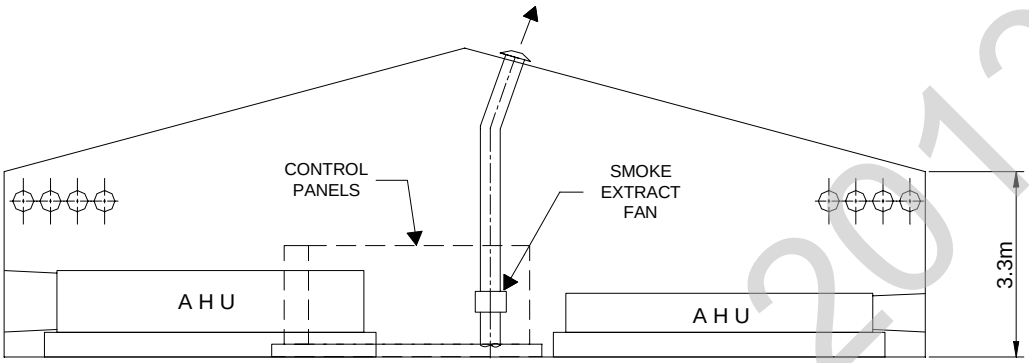


Figure 30: Typical plantroom 3 serving a combination of 24 hr and 9-5 accommodation departments



SECTION

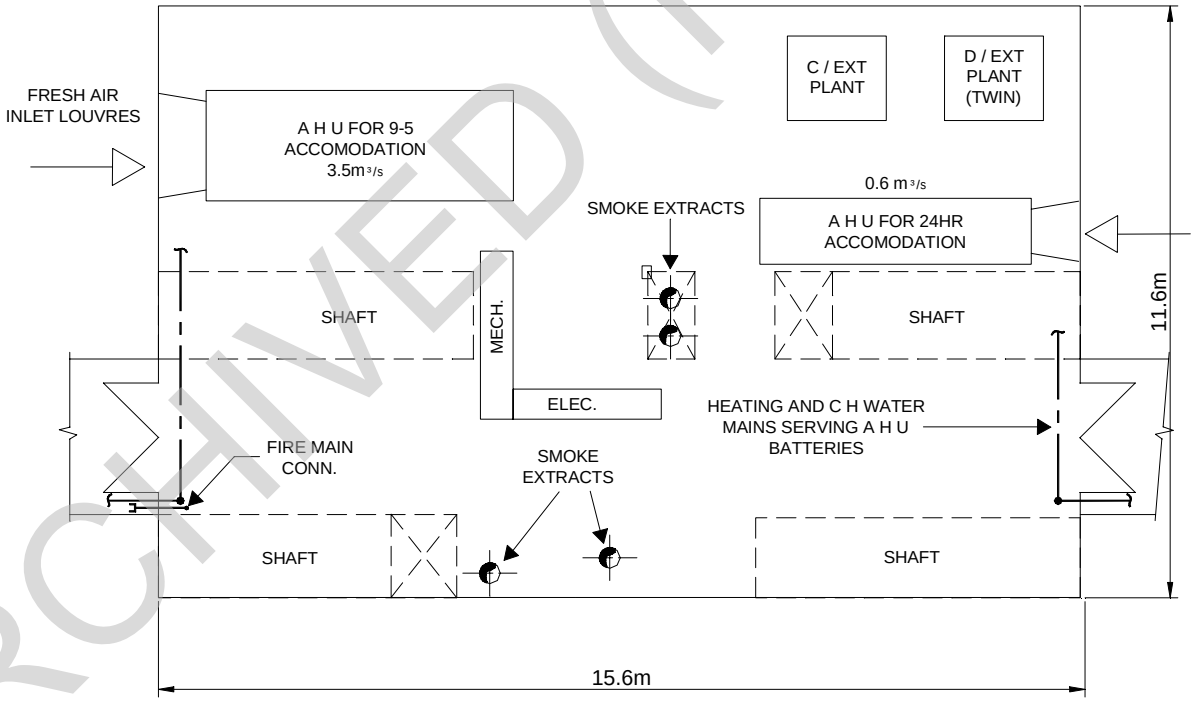


Figure 31: Typical plantroom 4 serving combined 24 hr and 9-5 accommodation

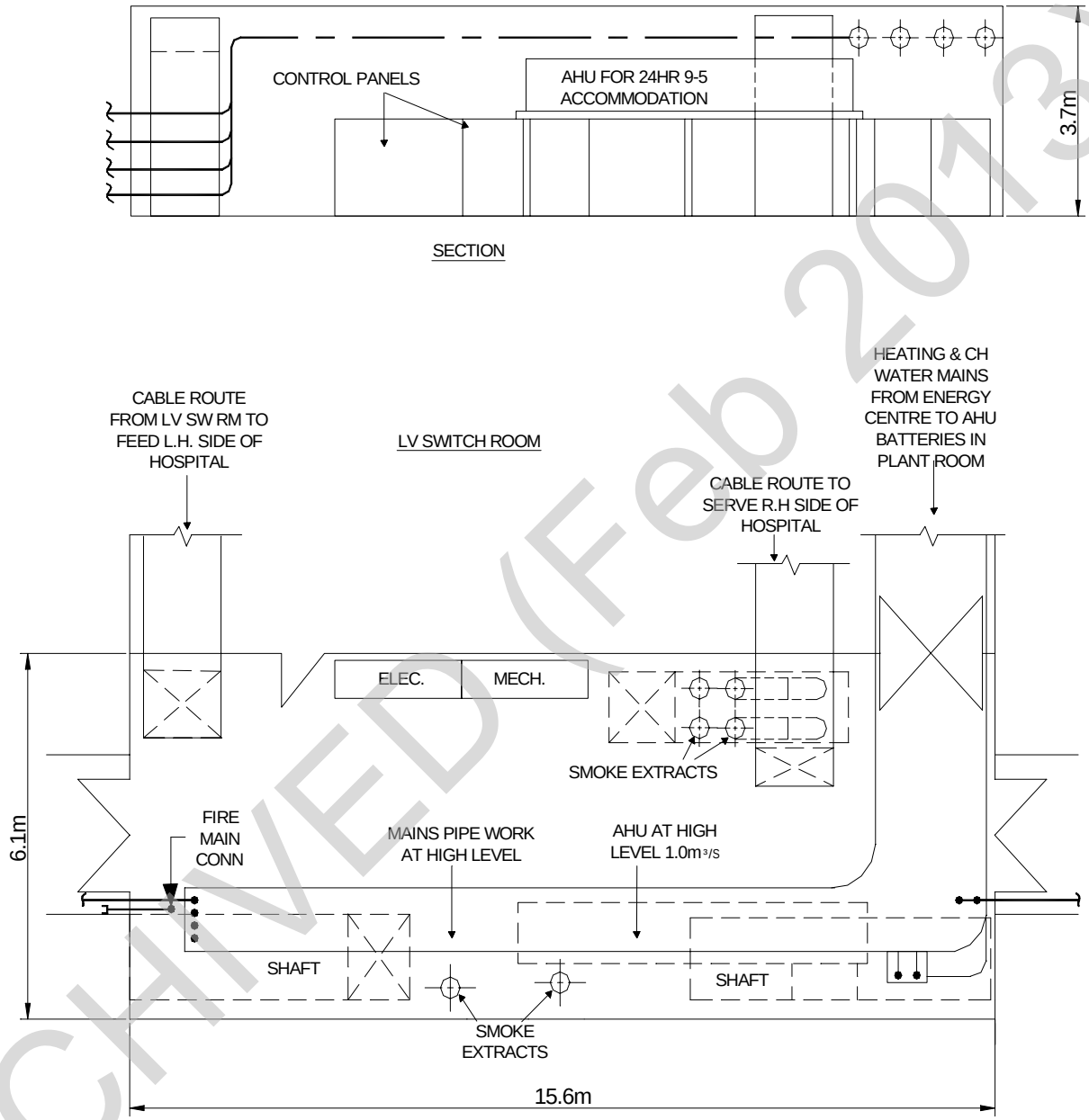
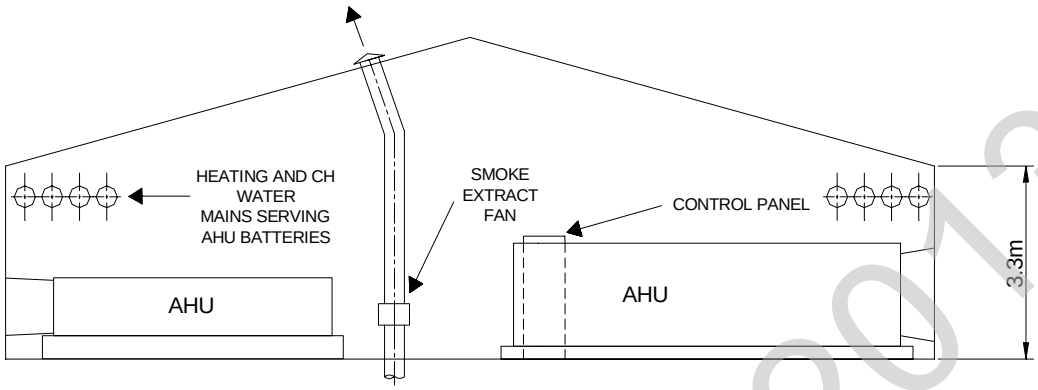


Figure 32: Typical plantroom 5 serving a combination of 24 hr and 9-5 accommodation departments



SECTION

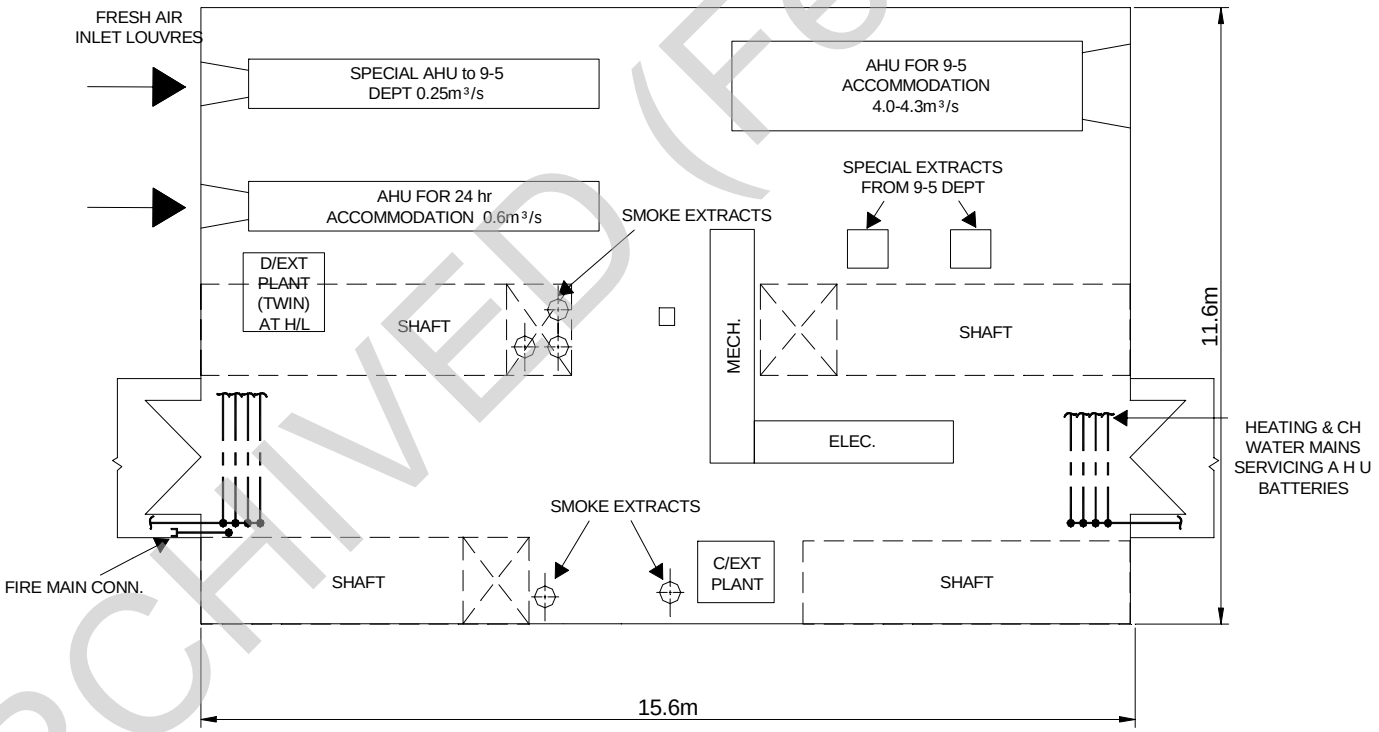


Figure 33: Typical plantroom 6 serving 24 hr accommodation department

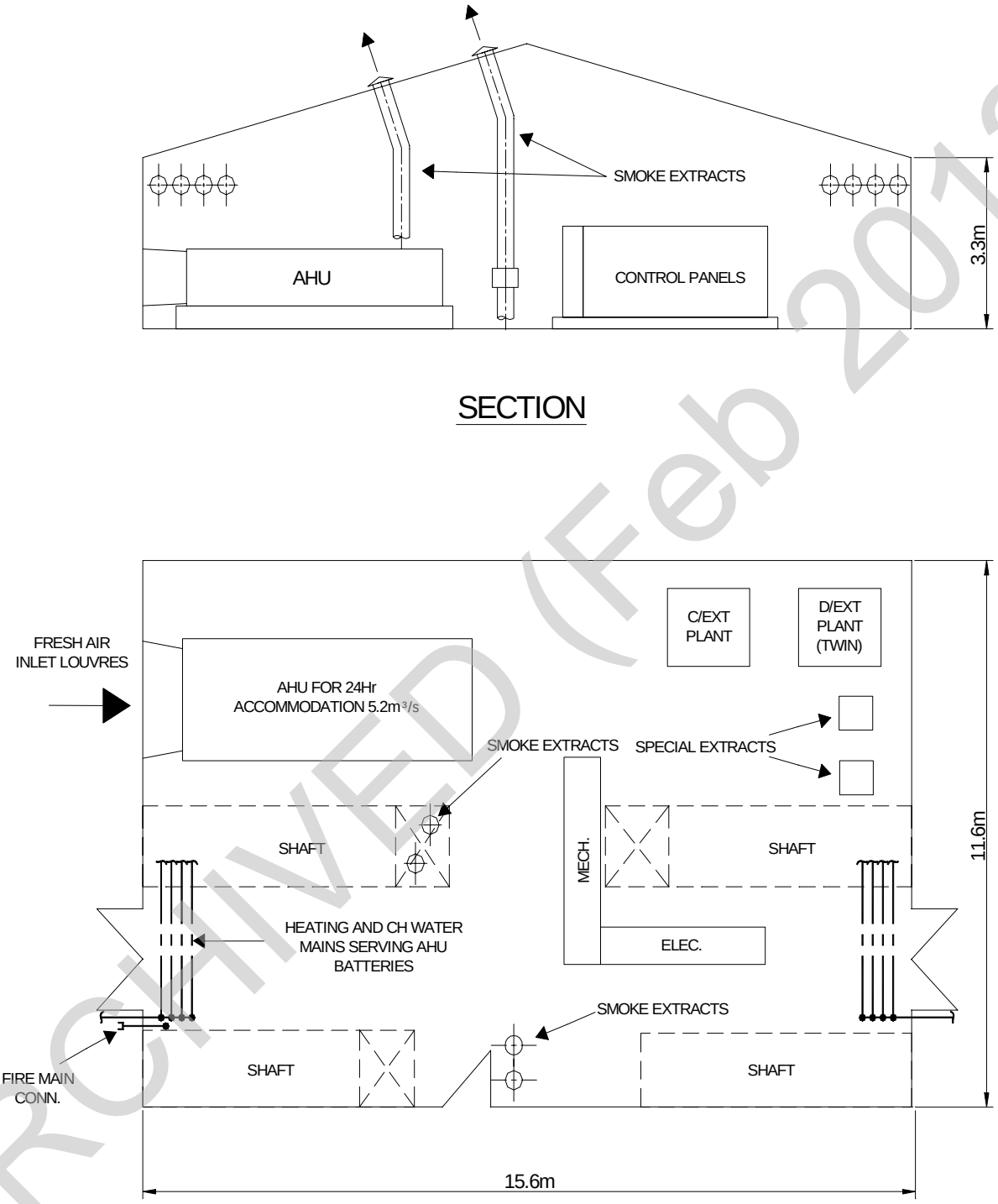


Figure 34: Arrangement 'A' of plantroom 7 serving a combination of 24 hr operating theatres (4) and 9-5 accommodation

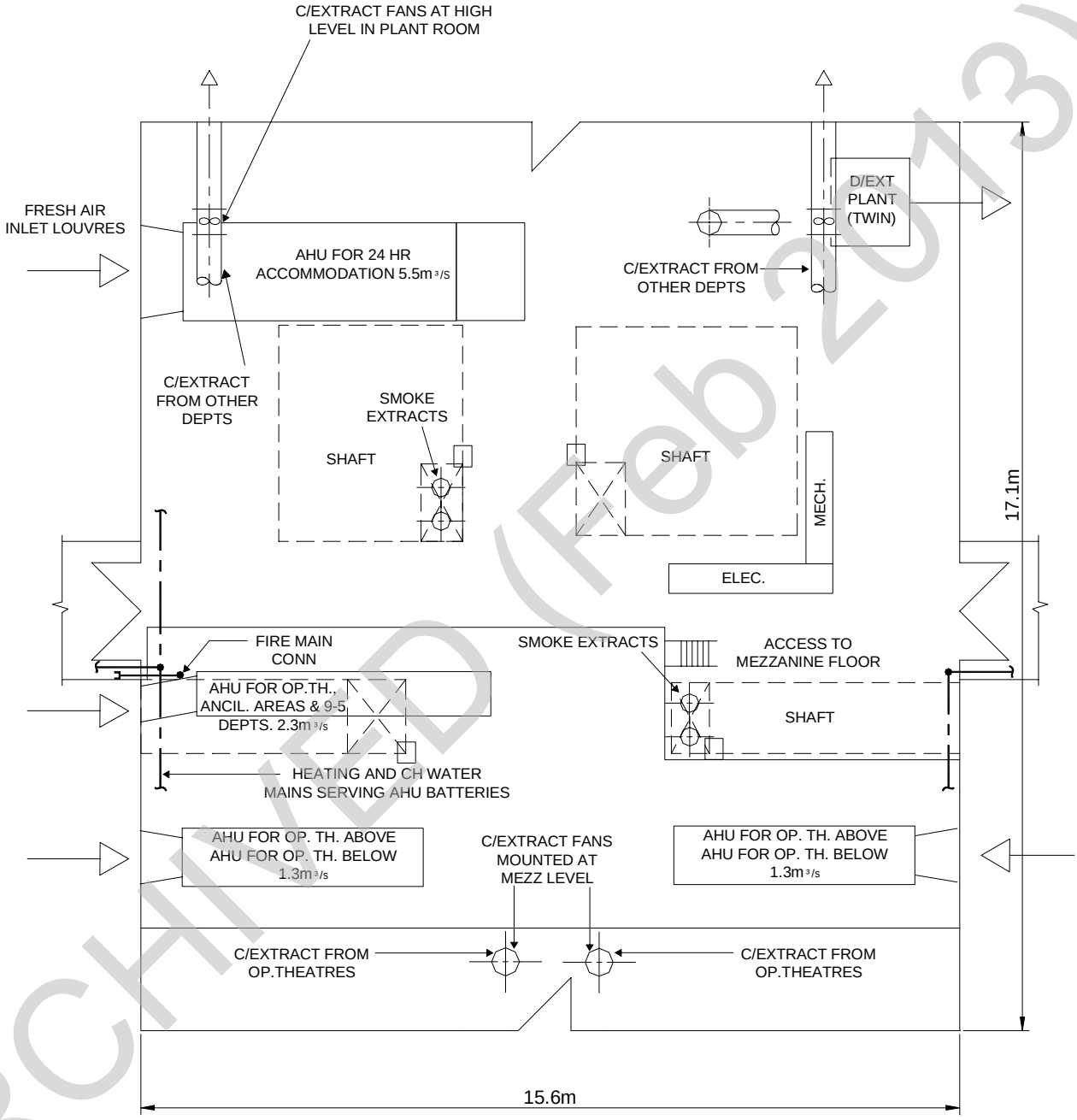


Figure 35: Section through arrangement (plantroom 7)

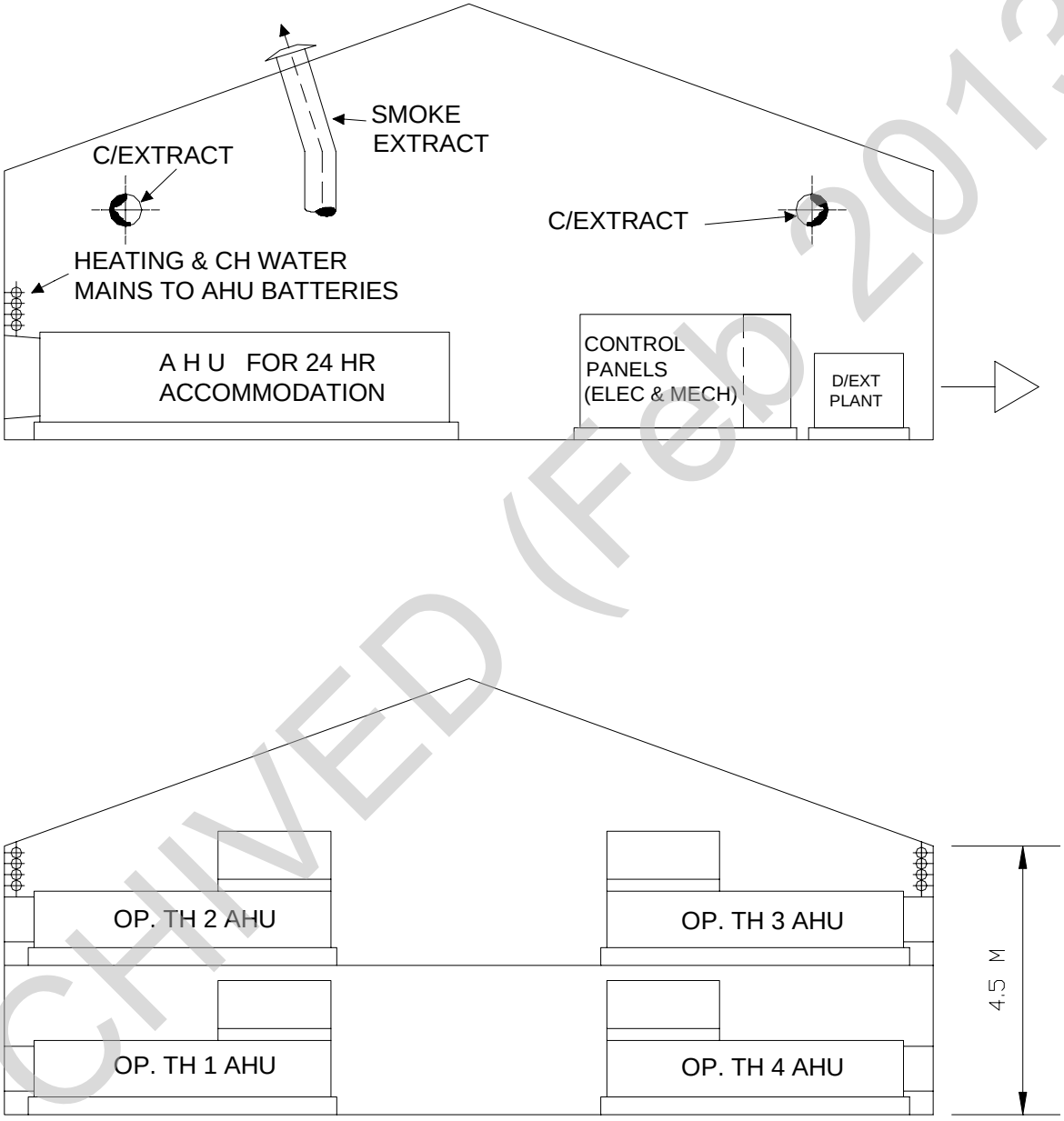


Figure 36: Typical plantroom serving a combination of 24 hr operating theatres (4) and 9-5 accommodation

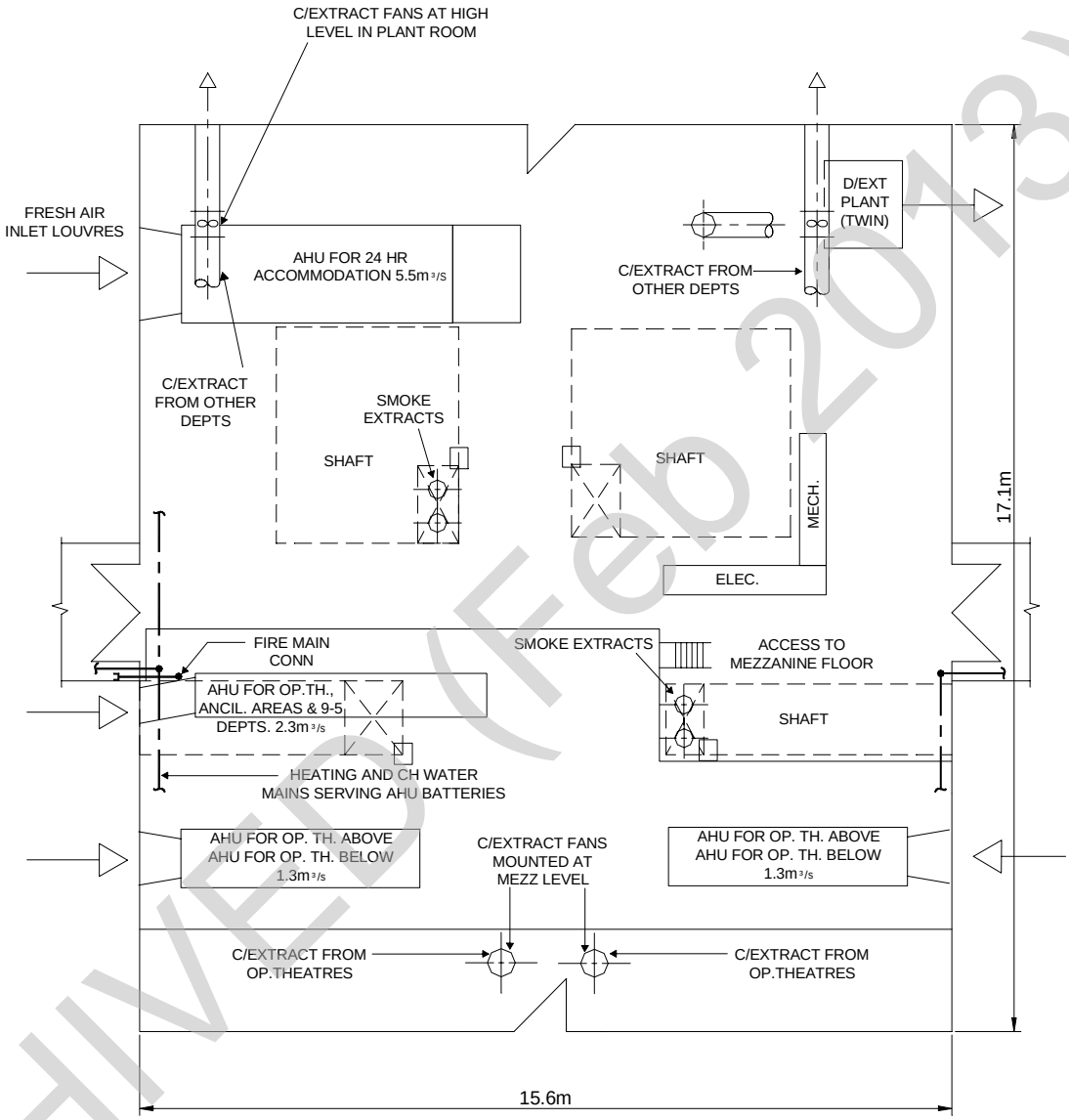


Figure 37: Section through arrangement (plantroom from Figure 36)

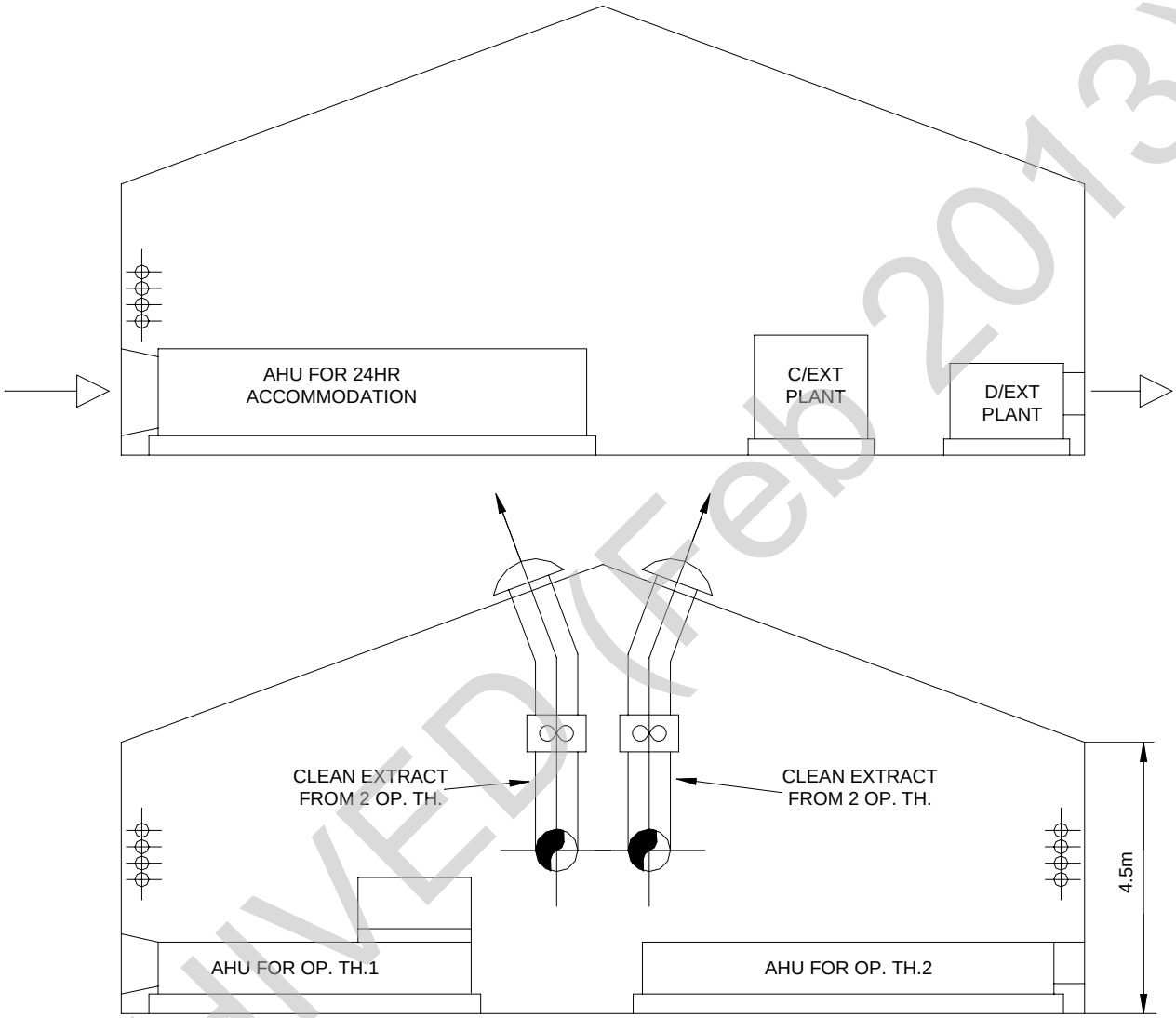


Figure 38: Typical plantroom serving a combination of 24 hr operating theatres (2) and 9-5 accommodation. End location.

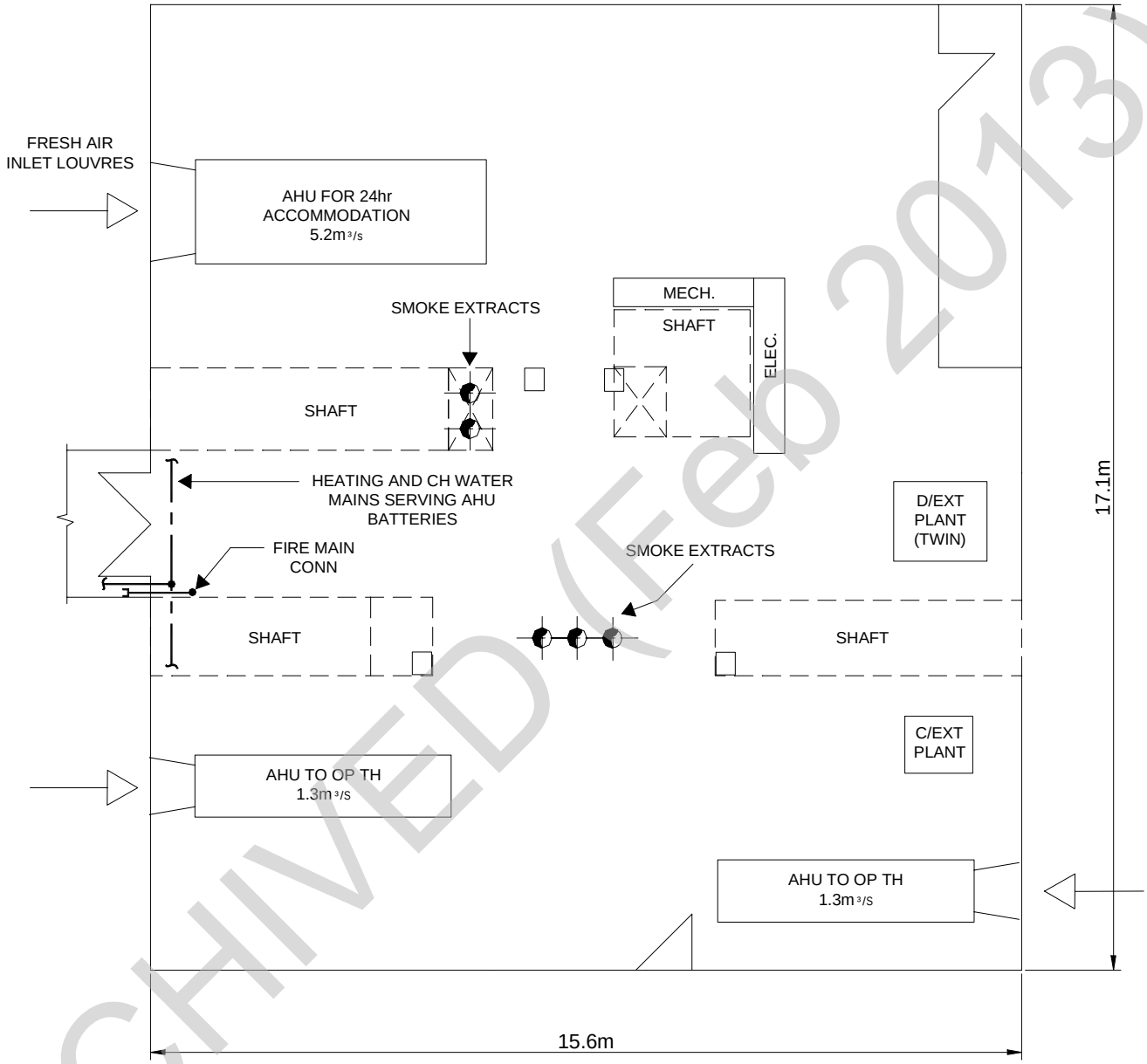


Figure 39: Section through plantroom from Figure 38

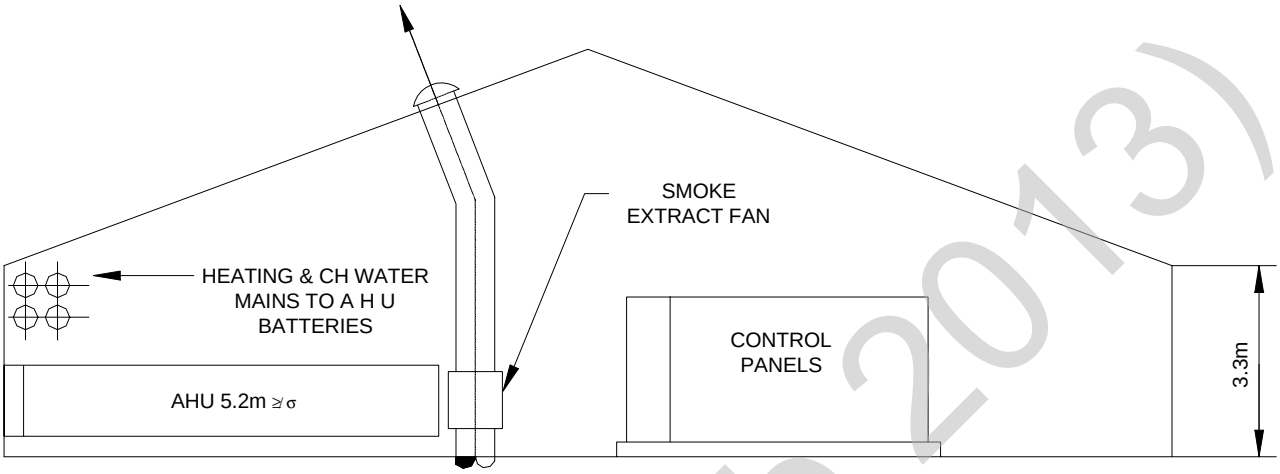


Figure 40: Typical plantroom. End location

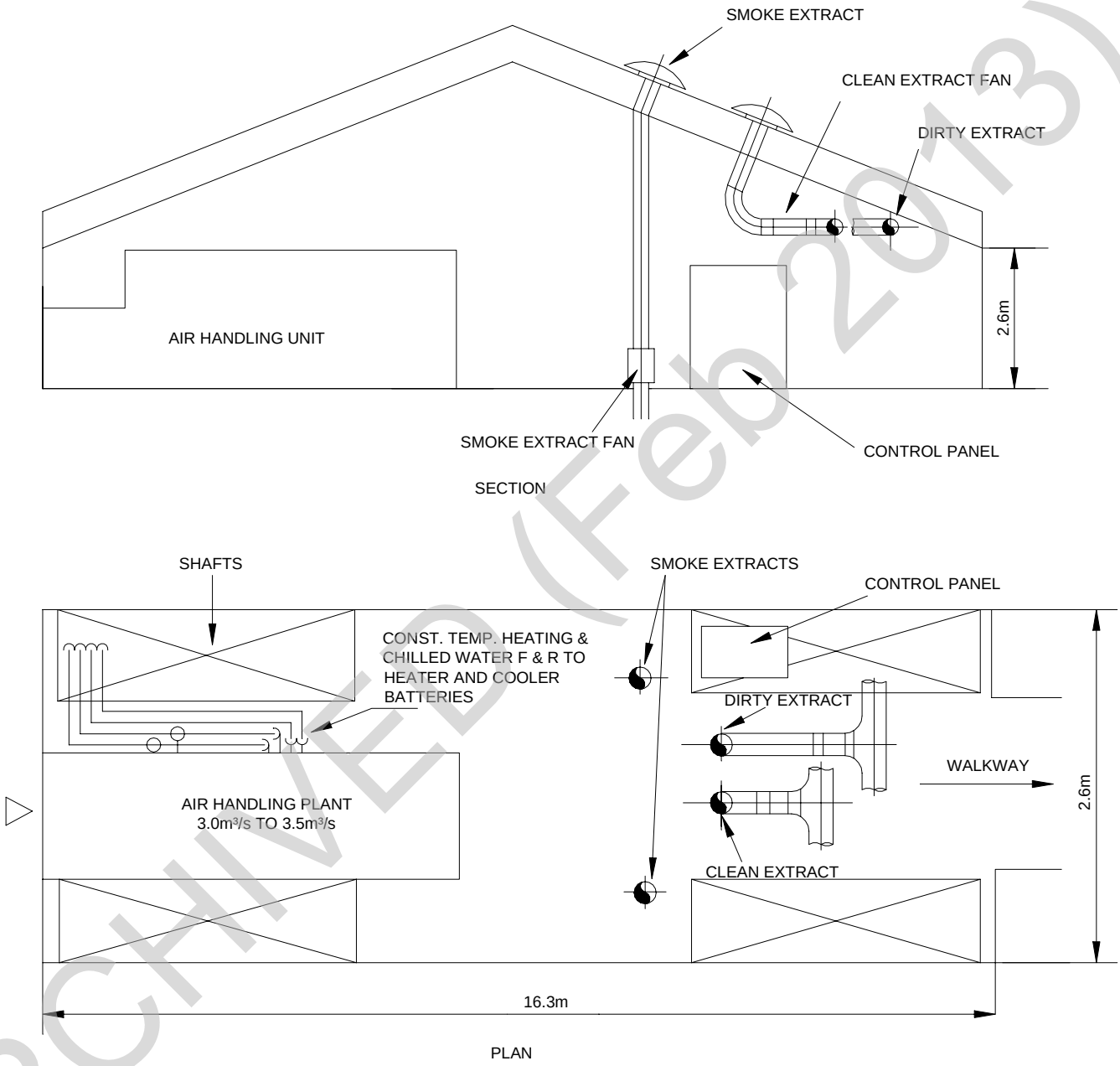


Figure 41: Typical plantroom serving a combination of 24 hr and 9-5 accommodation

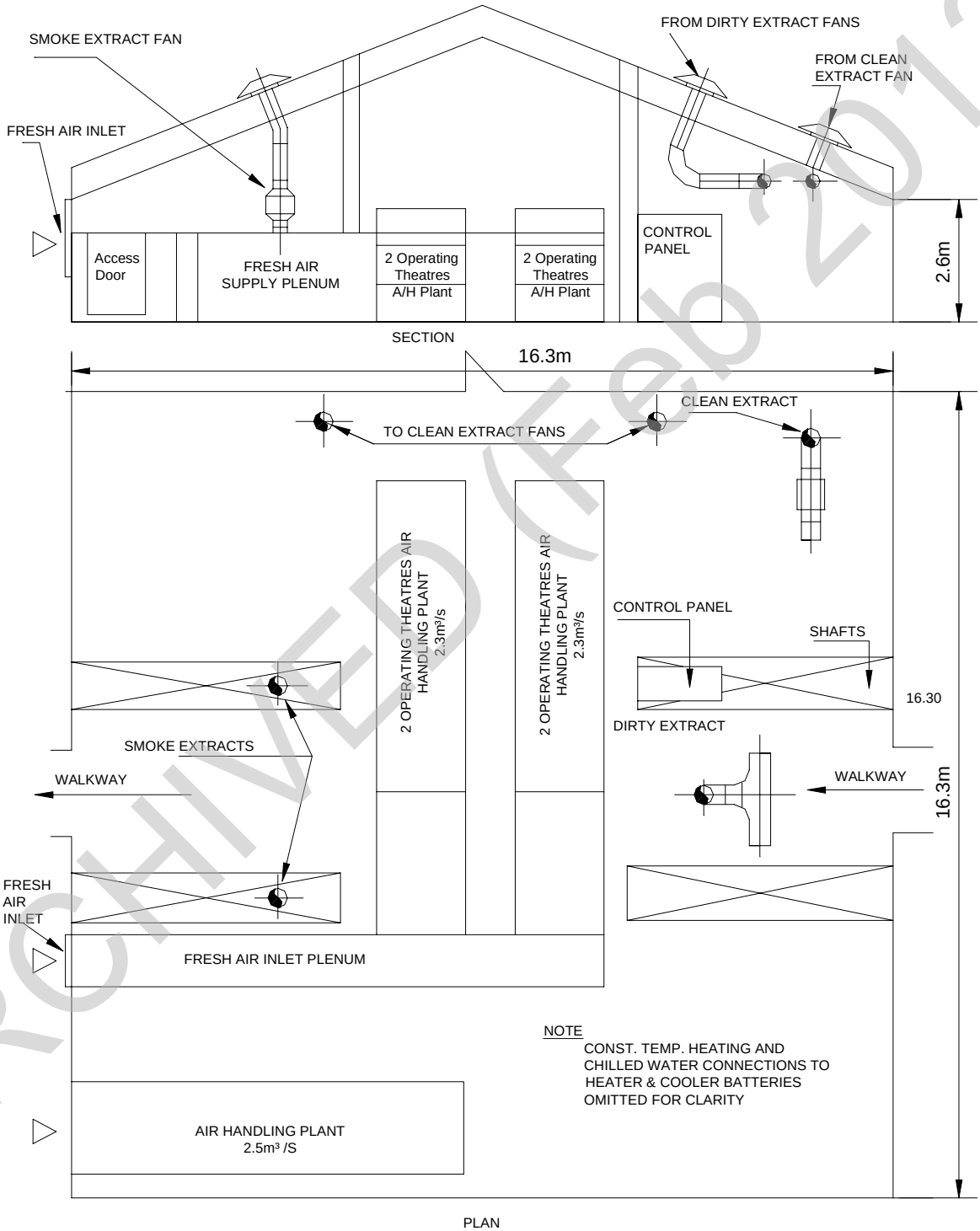


Figure 42: Typical plantroom including hot water boilers and HWS calorifiers

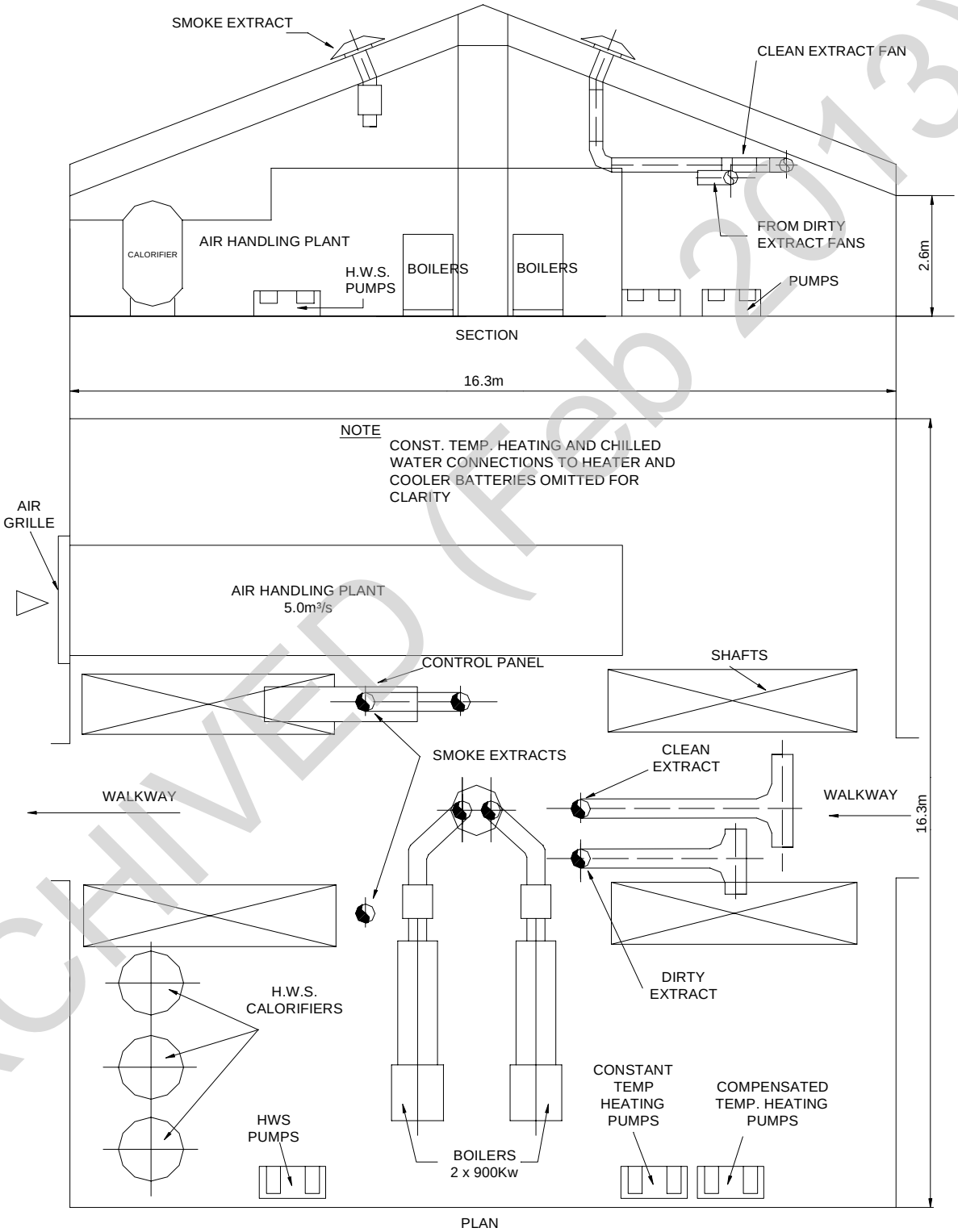


Figure 43: Typical segregated routes for services *not to scale*

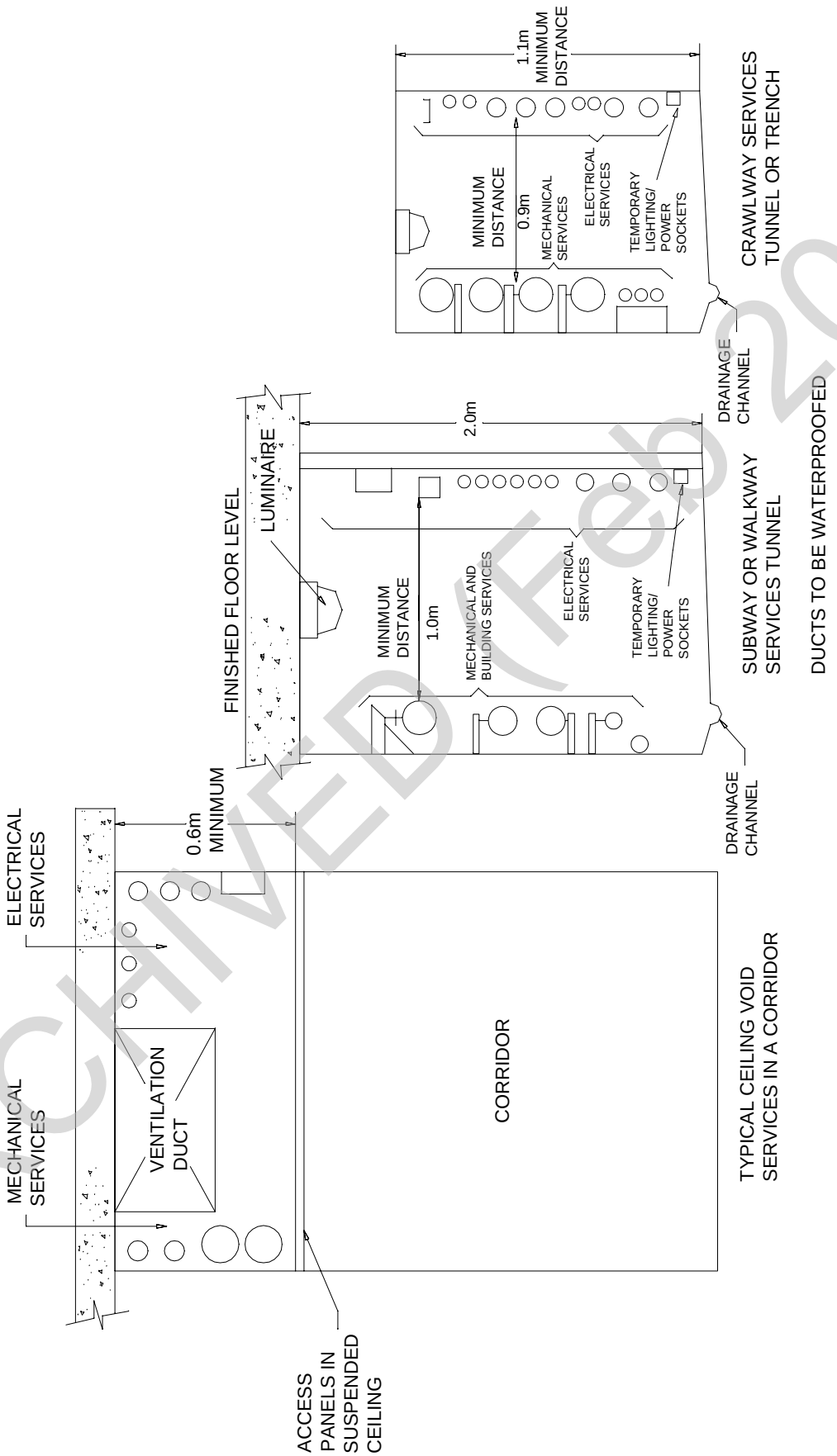


Figure 44: Sub-station with HV ring main switchboard, two transformers and low voltage switchboard cubicle type

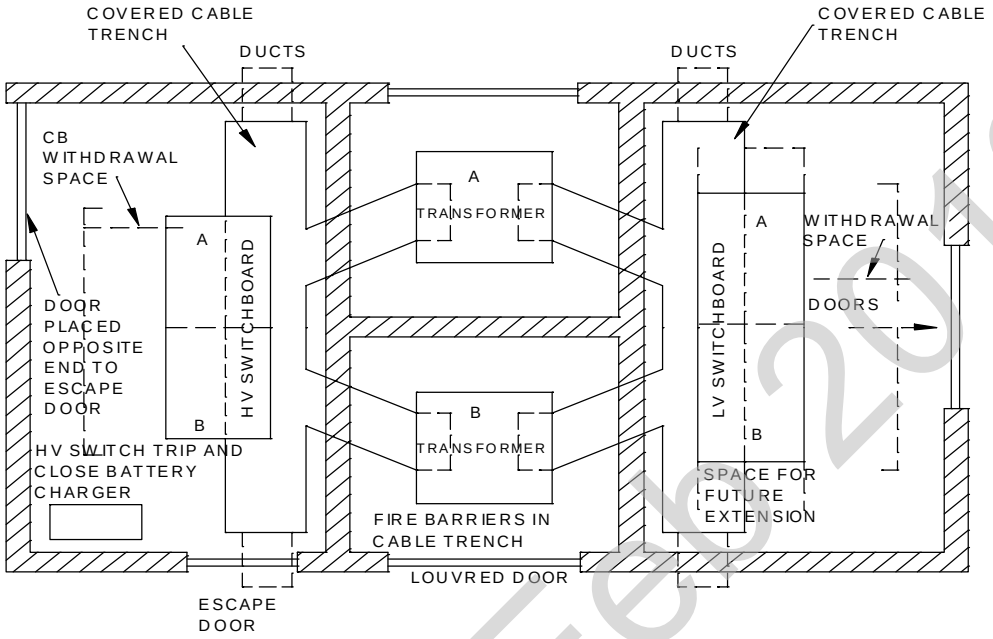


Figure 45: Sub-station with single HV switch, dry transformer and low voltage switchboard

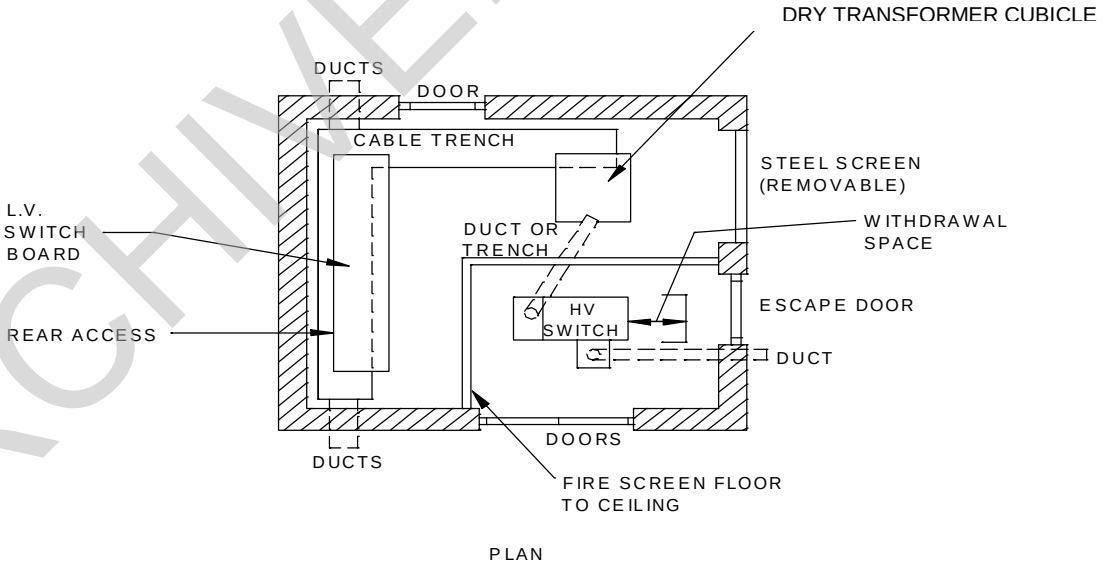


Figure 46: Typical diesel generator installation (100kW)

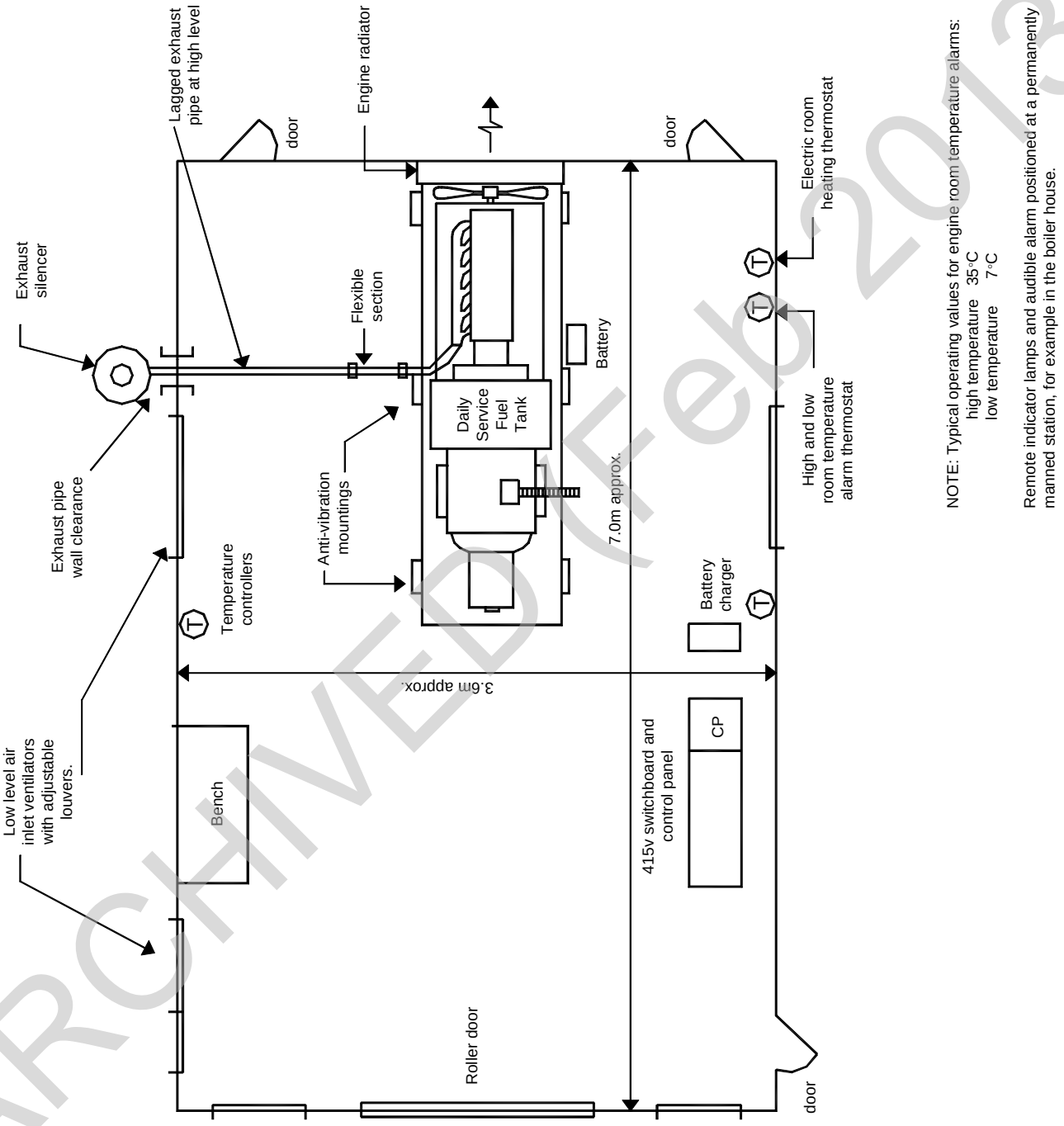
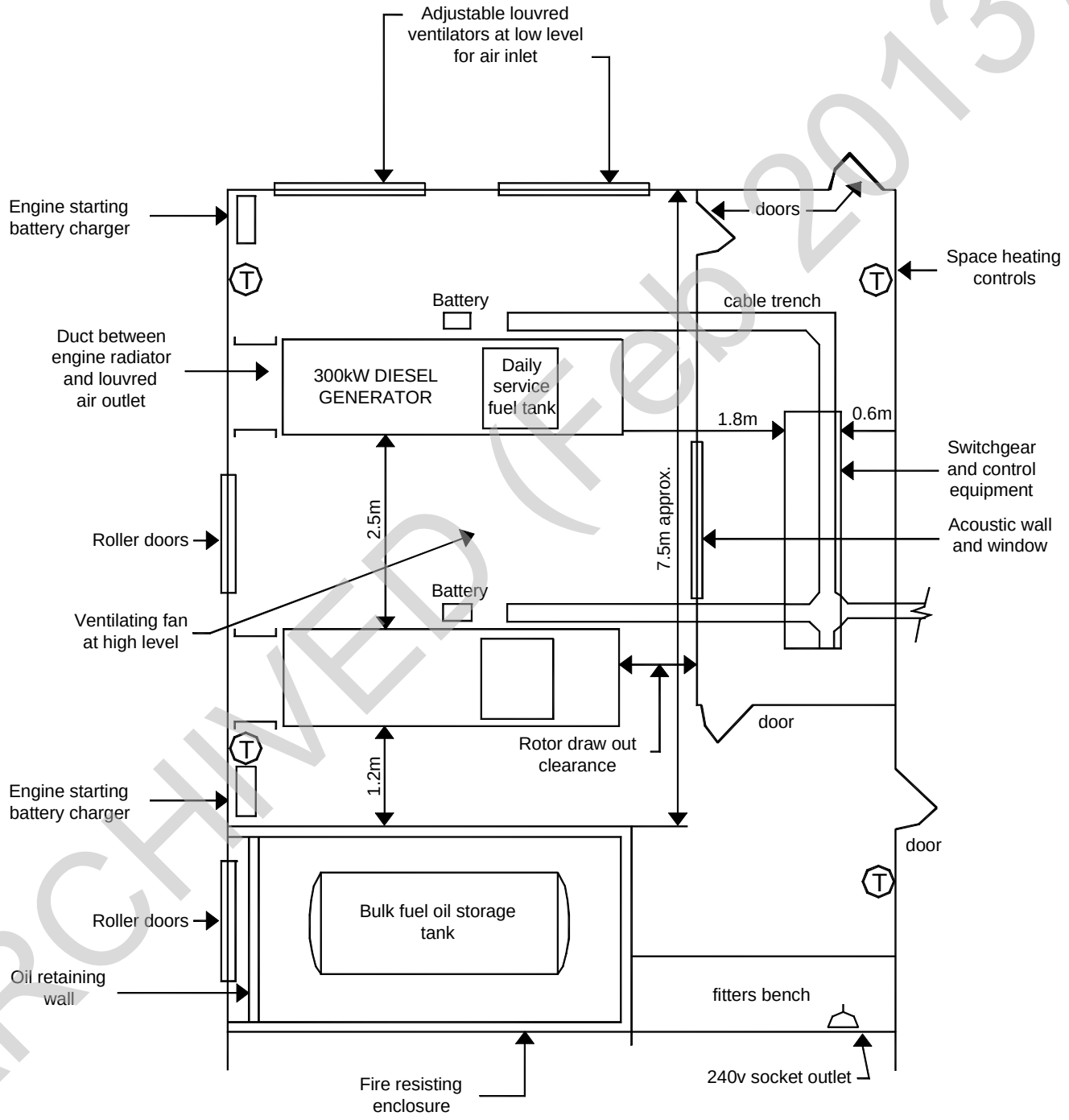


Figure 47: Typical layout for two 300 kW diesel generator sets



Note: Layout not to scale.

Figure 48: Plantroom areas for HWS storage calorifiers

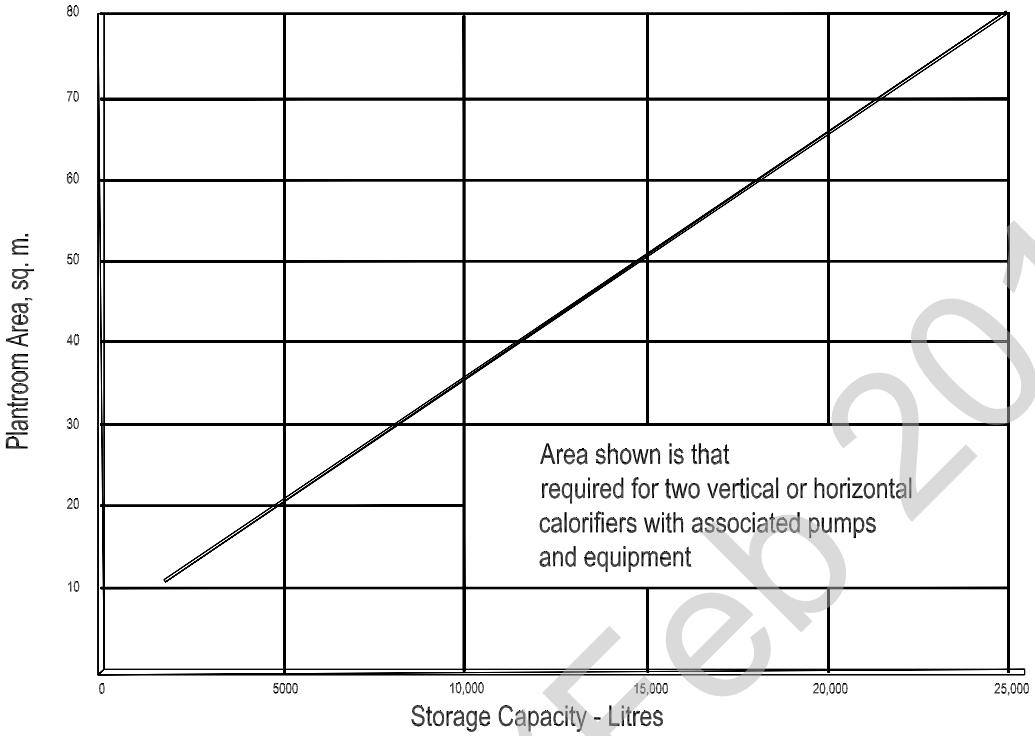


Figure 49: Plantroom areas for heating calorifiers

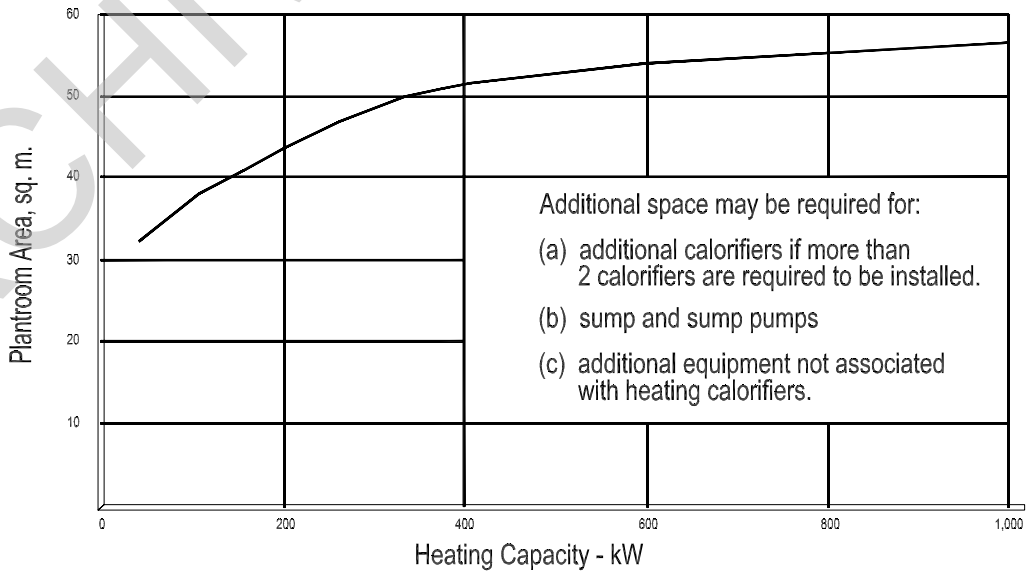
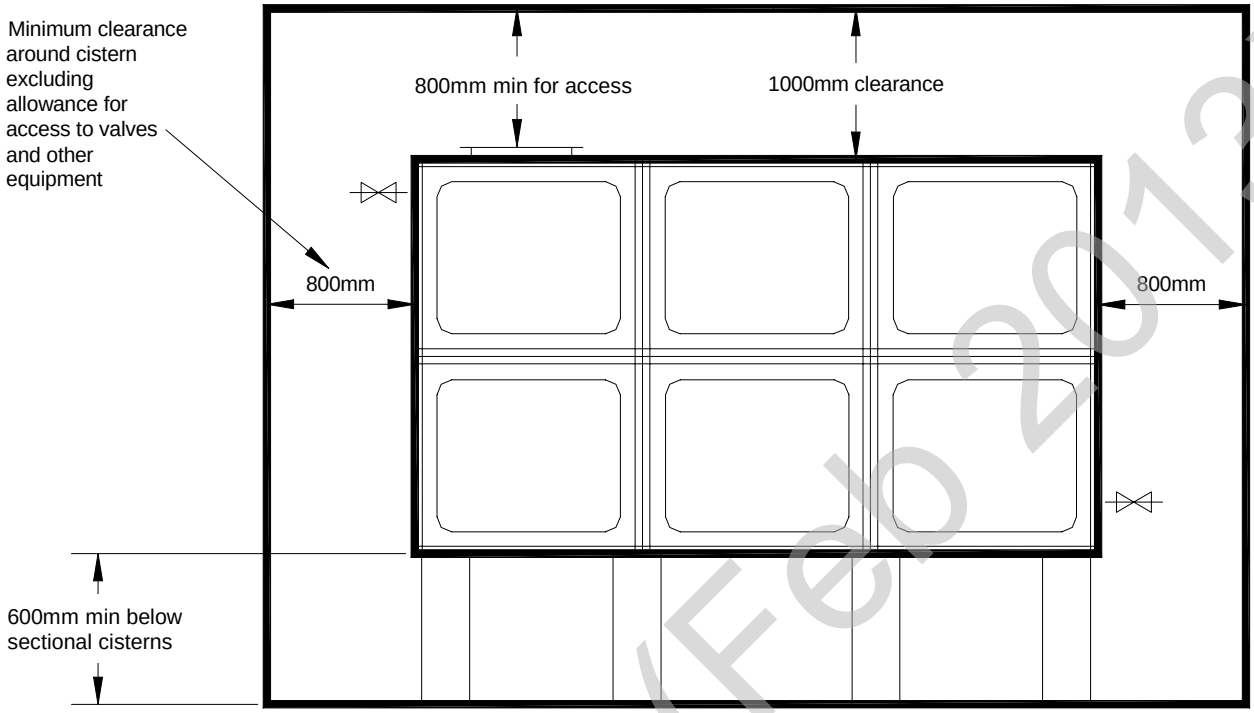


Figure 50: Sectional elevation on cistern



NOTE: Clearance below sectional cisterns to be in accordance with manufacturers' requirements which may be greater than 600 mm.

Figure 51: Typical arrangement of combined manifold and gas cylinder storage rooms

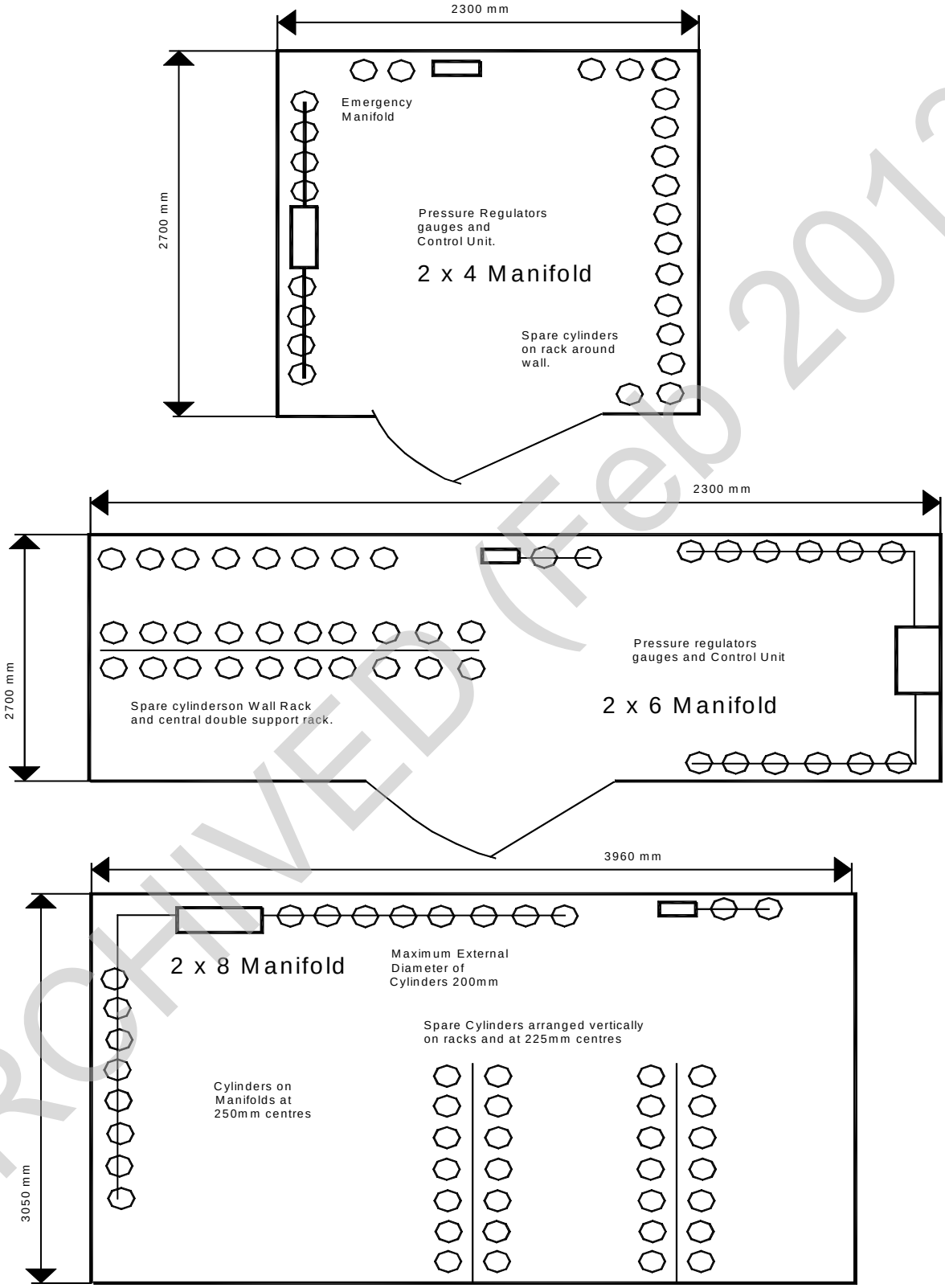


Figure 52: Typical plan of medical air compressor plantroom

F.A.D. 7.2 bar (litres)	Length 'A' minimum (mm)	Length 'B' minimum (mm)	Roof Height minimum (mm)
180	3800	3700	2400
1400	4700	4900	3200
3800	5700	5900	3800

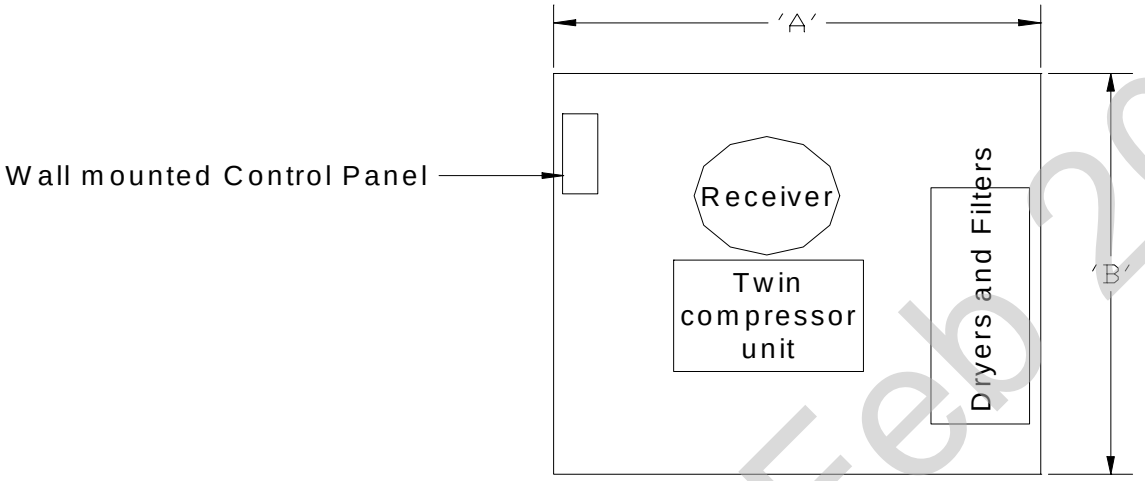


Figure 53: Typical plan of medical vacuum plantroom.

Capacity at minus 500 Hg (Litres/min)	Length 'A' minimum (mm)	Length 'B' minimum (mm)	Roof Height minimum (mm)
180	4200	3900	2600
1400	4300	4100	2600
3800	5800	4700	2600
5000	6100	7900	2600

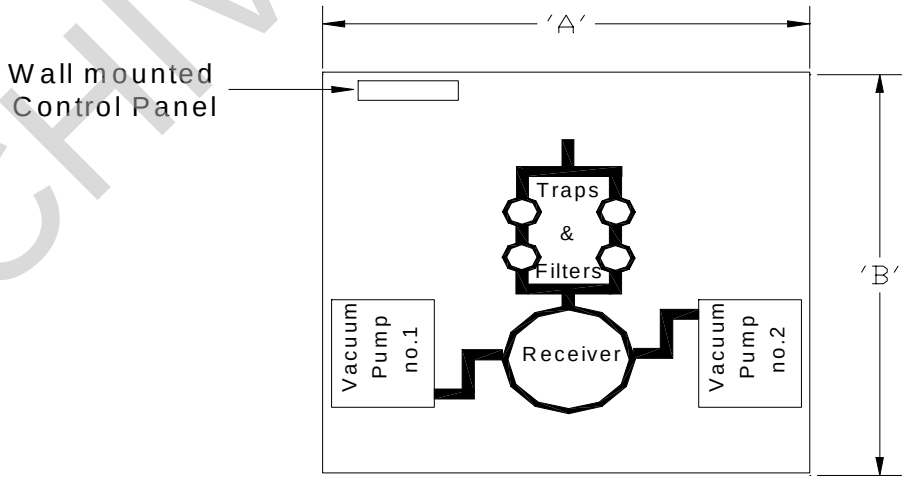


Figure 54: Safety distances: distances between oxygen storage and typical exposure for storage tanks up to 20 tonnes net liquid capacity (in metres)

SAFETY DISTANCES FOR LIQUID OXYGEN STORAGE UP TO 20 TONNES NET LIQUID CAPACITY (DISTANCES IN METRES)

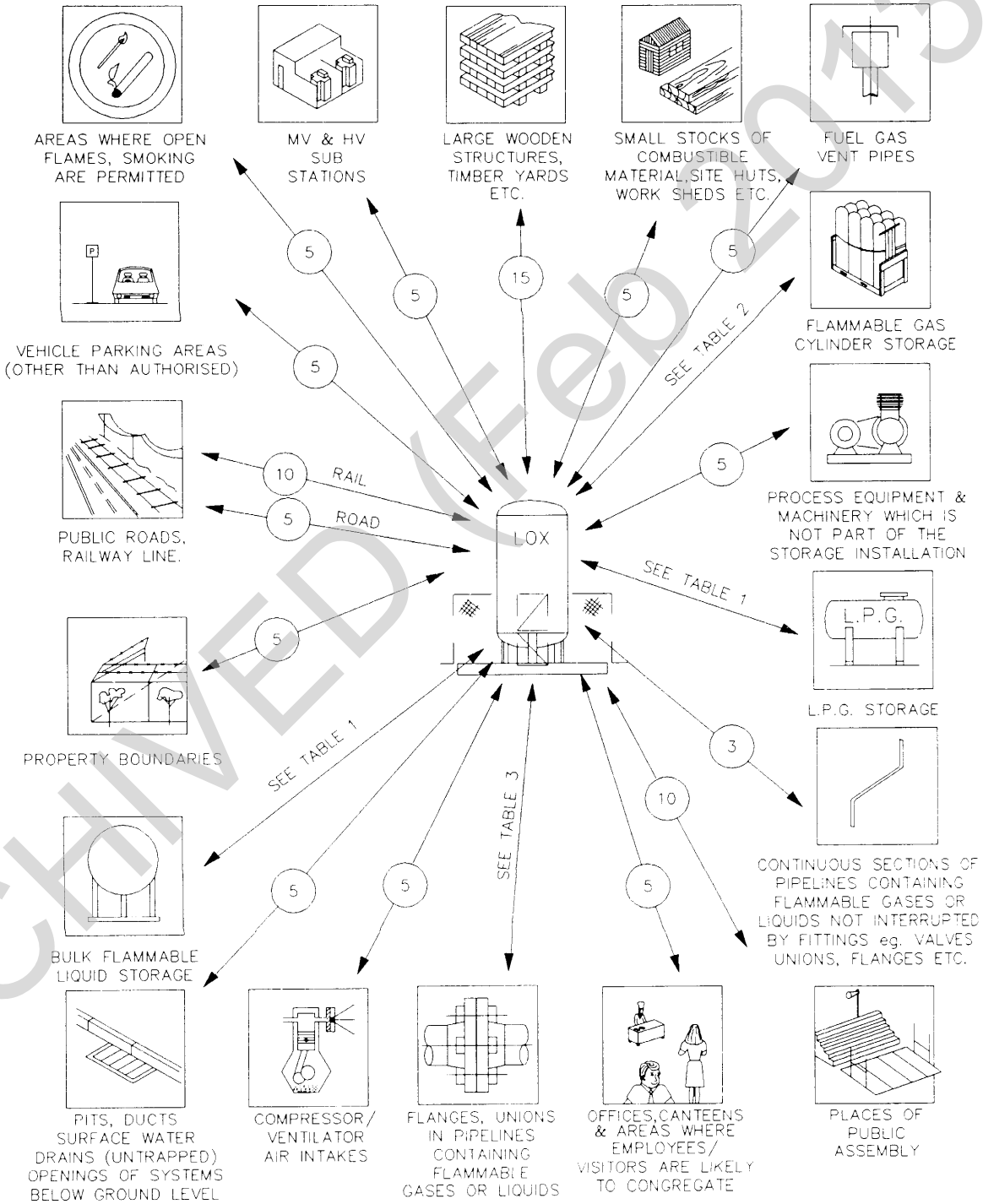
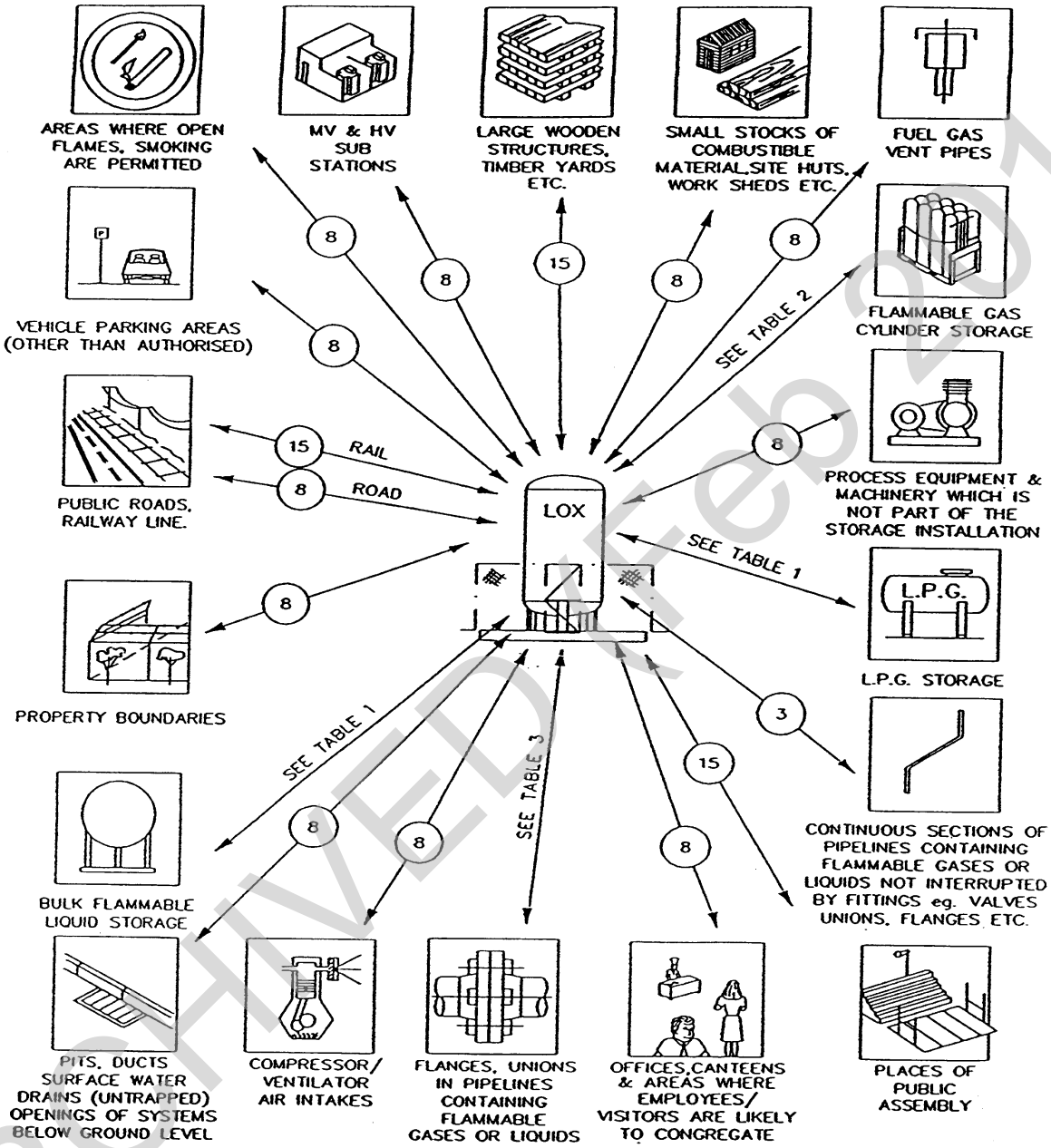


Figure 55: Distance between oxygen storage and typical exposure for storage tanks of 20 tonnes to 200 tonnes net liquid capacity (in metres)

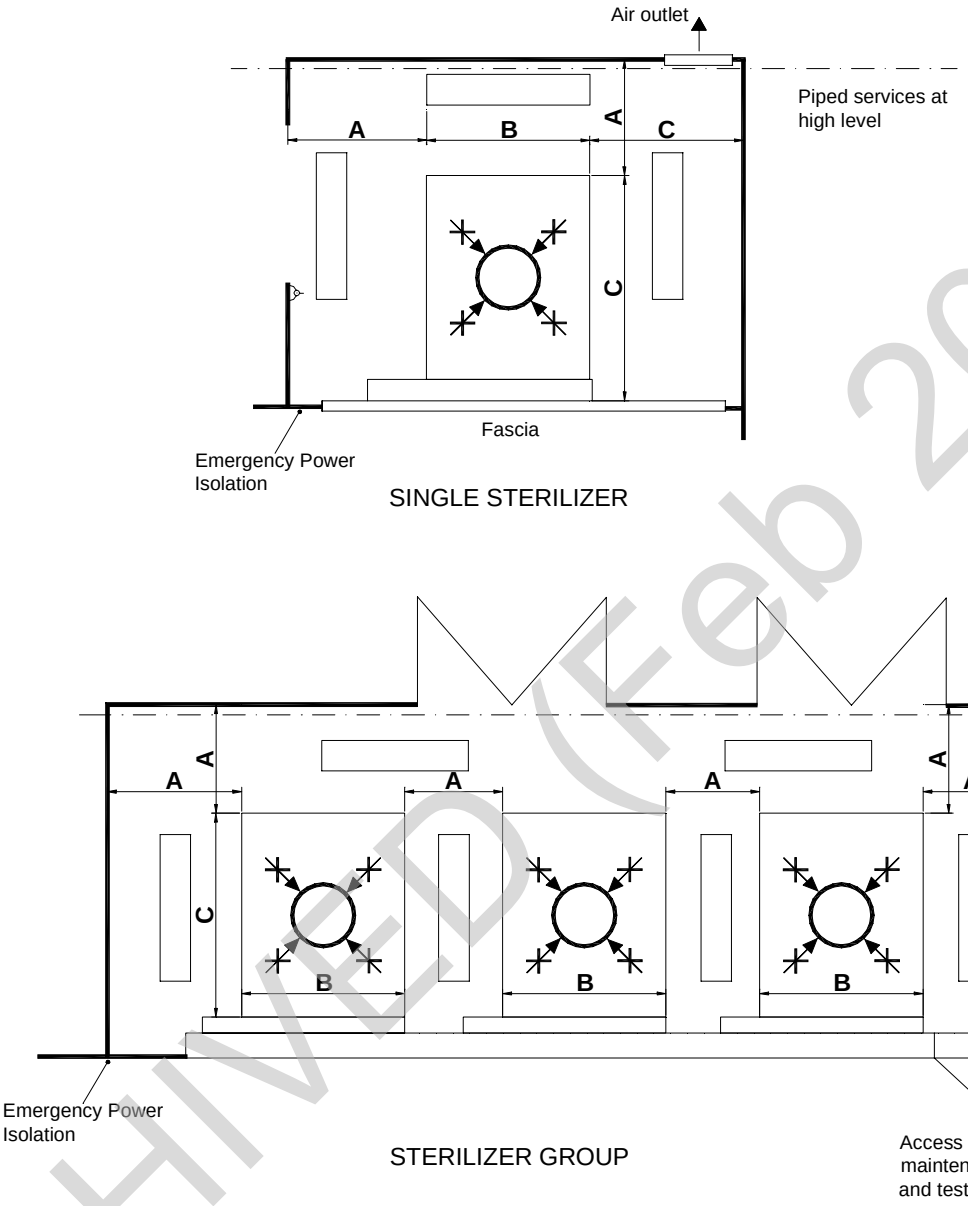


NOTE: (1) The safety distances are measured from the exposure to:-
a) any point on the storage system where in normal operation oxygen leakage or spillage can occur, or
b) the tank outer jacket, or
c) the vessel nozzles, whichever gives the greater safety distance to the LOX storage tank.

NOTE: (2) Assumed maximum liquid phase pipework diameter 50mm (2") nominal bore, for the liquid oxygen piping.

NOTE: (3) For buildings, the distances are measured to the nearest opening in the building, eg doors, windows, ventilation openings. Ventilator air intakes should be at least 1.0 metre above ground level, if within 10 metres of the installation.

Figure 56: Typical layouts *not to scale*



1.Sliding doors are illustrated.
2.Lighting fittings should be installed between and not over sterilizers.
3.Refer to Table 8.5 for dimensions.
4.For temperature sensor access a 50mm aperture with a swing single fixing cover should be fitted on the fascia at a low level and between each sterilizer.
5.An electrical isolator for each sterilizer should be located in the plantroom.
6.In the working area the distance between the fascia and the opposite wall should be 3m or twice the length of the loading carriage.
7.Ventilation air to the plant room may be taken in at a low level from the working area or from an independent source.

Figure 57: Standard arrangement – engineering shafts level plan

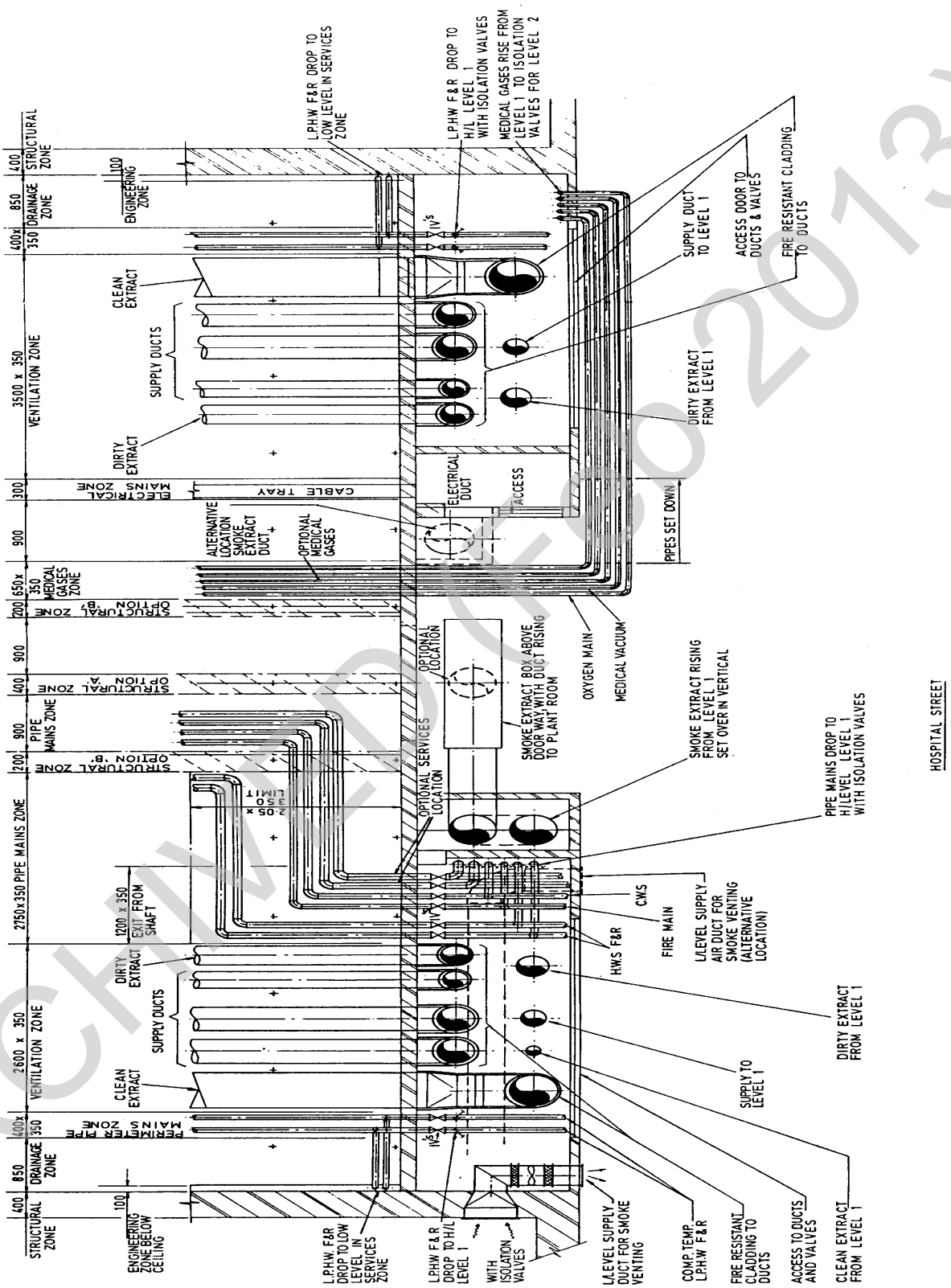


Figure 58: Standard arrangement – engineering shafts section at street interface

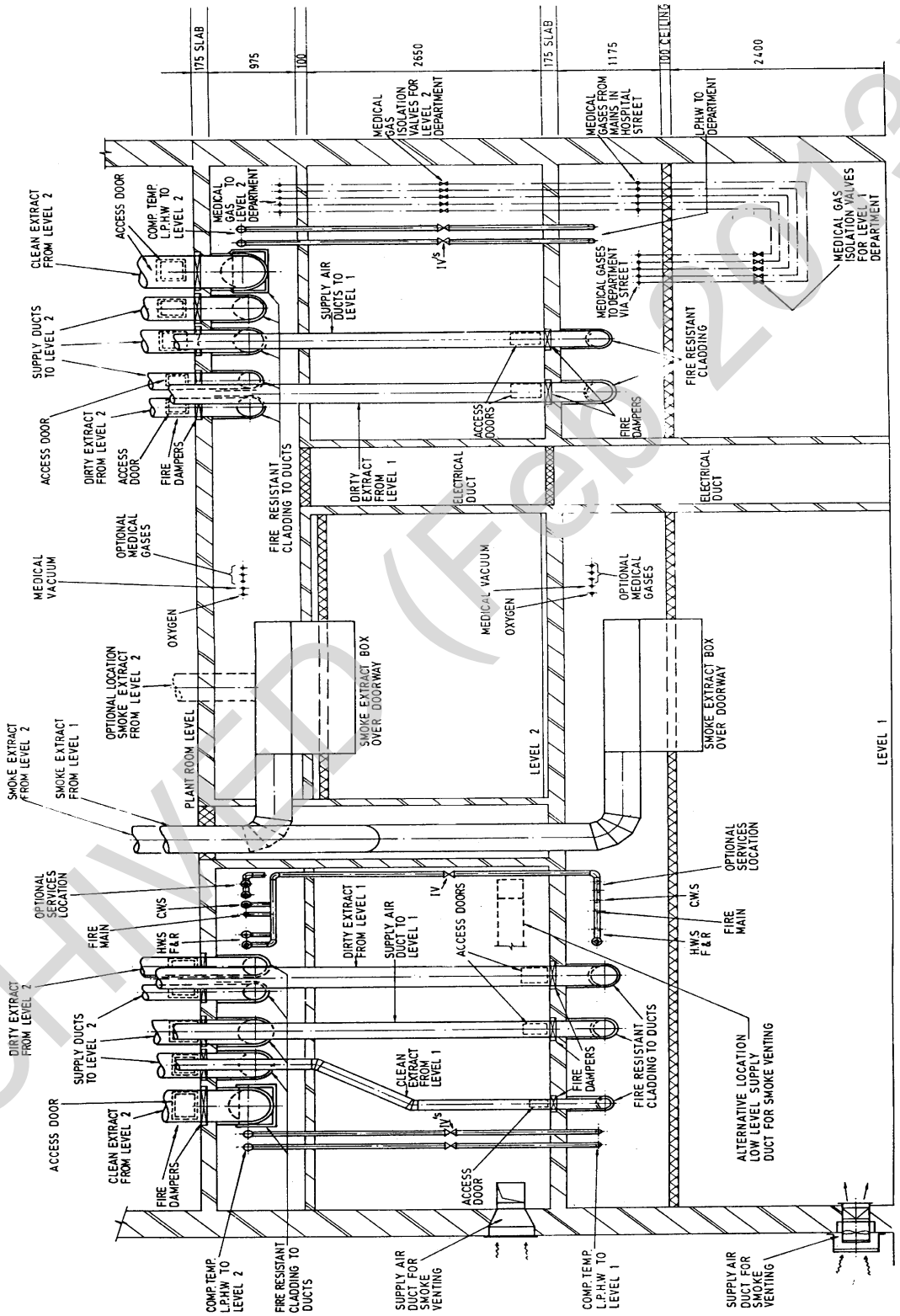


Figure 59: Typical sectional elevation through a multi-storey department showing suggested minimum service zones

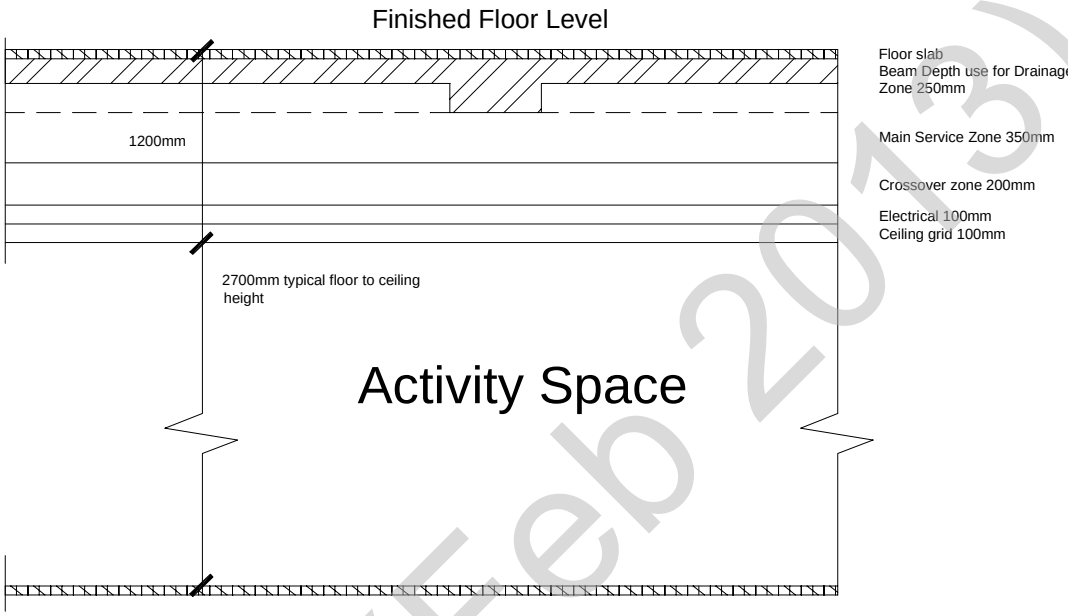
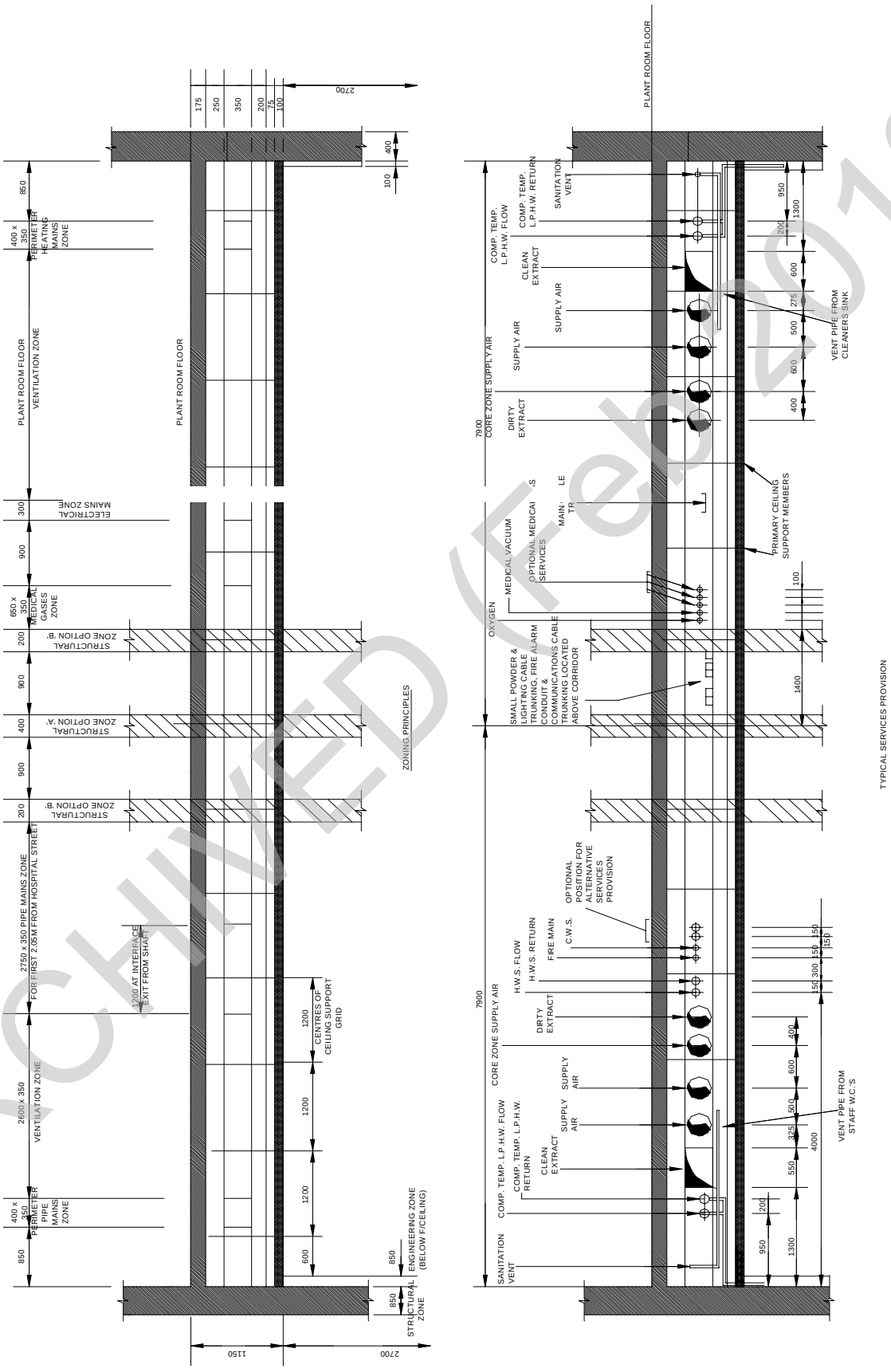


Figure 60: Standard arrangement – flat slab section at department interface



References

NOTE:
Where there is a requirement to address a listed reference, care should be taken to ensure that all amendments following the date of issue are included.

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
Acts and Regulations				
	The Building (Scotland) Act	HMSO	1959	
	Clean Air Act	HMSO	1993	
	Electricity Act	HMSO	1989	
	Health and Safety at Work etc Act	HMSO	1974	
	Registered Establishments (Scotland) Act	HMSO	1998	
	The Water (Scotland) Act	HMSO	1980	
SI 2179 & 187	The Building Standards (Scotland) Regulations (as amended)	HMSO	1990	
	The Building Standards (Scotland) Regulations: Technical Standards Guidance	HMSO	1998	
SI 1460	Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP2)	HMSO	1997	
SI 3140	Construction (Design and Management) Regulations	HMSO	1994	
SI 437	Control of Substances Hazardous to Health Regulations (COSHH)	HMSO	1999	
SI 635	Electricity at Work Regulations	HMSO	1989	
SI 1057	Electricity Supply Regulations (as amended)	HMSO	1988 (amd 1994)	
SI 2372	Electromagnetic Compatibility Regulations (as amended)	HMSO	1992	
SI 2451	Gas Safety (Installation and Use) Regulations	HMSO	1998	
SI 917	Health & Safety (First Aid) Regulations	HMSO	1981	
SI 682	Health & Safety (Information for Employees) Regulations	HMSO	1989	
SI 2115	Control of Asbestos at Work Regulations (as amended)	HMSO	1987	
SI 1713	Confined Space Regulations	HMSO	1997	

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
SI 2792	Health and Safety (Display Screen Equipment) Regulations	HMSO	1992	
SI 341	Health and Safety (Safety Signs and Signals) Regulations	HMSO	1996	
SI 1380	Health and Safety (Training for Employment) Regulations	HMSO	1990	
	Highly Flammable Liquids and Liquefied Petroleum Gases Regulations	HMSO	1972	
SI 2307	Lifting Operations and Lifting Equipment Regulations (LOLER)	HMSO	1998	
SI 3242	Management of Health and Safety at Work Regulations	HMSO	1999	
SI 2793	Manual Handling Operations Regulations	HMSO	1992	
SI 1790	Noise at Work Regulations	HMSO	1989	
SI 3139	Personal Protective Equipment (EC Directive) Regulations (as amended)	HMSO	1992	
SI 2966	Personal Protective Equipment at Work (PPE) Regulations	HMSO	1992	
SI 2306	Provision and Use of Work Equipment Regulations (PUWER)	HMSO	1998	
SI 3163	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)	HMSO	1995	
SI 3004	Workplace (Health, Safety and Welfare) Regulations	HMSO	1992	
British Standards				
BS 349	**Specification for identification of the contents of industrial gas containers** (AMD 6132, 5189)	BSI Standards	1973	
BS 1319	**Specification for medical gas cylinders, valves and yoke connections** (AMD 3029, 6179, 4603, 6184)	BSI Standards	1976	
BS 5378	**Safety signs and colours**	BSI Standards		
BS 5499	**Fire safety signs and graphic symbols**	BSI Standards		
BS 5266	**Code of practice for emergency lightning**	BSI Standards	1988	
BS 8313	**Code of practice for accommodations of building services in duct**	BSI Standards	1997	

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
Scottish Health Technical Guidance				
SHTM 2007	Electrical services supply and distribution	P&EFEx	2001	CD-ROM
SHTM 2010	Sterilization	P&EFEx	2001	CD-ROM
SHTM 2011	Emergency electrical services	P&EFEx	2001	CD-ROM
SHTM 2014	Abatement of electrical interference	P&EFEx	2001	CD-ROM
SHTM 2020	Electrical safety code for low voltage systems (Escode – LV)	P&EFEx	2001	CD-ROM
SHTM 2021	Electrical safety code for high voltage systems (Escode – HV)	P&EFEx	2001	CD-ROM
SHTM 2022	Medical gas pipeline systems	P&EFEx	2001	CD-ROM
SHTM 2024	Lifts	P&EFEx	2001	CD-ROM
SHTM 2025	Ventilation in healthcare premises	P&EFEx	2001	CD-ROM
SHTM 2027	Hot and cold water supply, storage and main services	P&EFEx	2001	CD-ROM
SHTM 2045	Acoustics	P&EFEx	2001	CD-ROM
SHPN 1	Health service building in Scotland	HMSO	1991	
SHPN 2	Hospital briefing and operational policy	HMSO	1993	
SHTN 1	Post commissioning documentation for health buildings in Scotland	HMSO	1993	
SHTN 4	General Purposes Estates and Functions Model Safety Permit-to-Work Systems	EEF	1997	
	NHS in Scotland – PROCODE	P&EFEx	2001	Version 1.1
NHS in Scotland Firecode				
SHTM 81	Fire precautions in new hospitals	P&EFEx	1999	CD-ROM
SHTM 82	Alarm and detection systems	P&EFEx	1999	CD-ROM
SHTM 83	Fire safety in healthcare premises: general fire precautions	P&EFEx	1999	CD-ROM
SHTM 84	Fire safety in NHS residential care properties	P&EFEx	1999	CD-ROM
SHTM 85	Fire precautions in existing hospitals	P&EFEx	1999	CD-ROM
SHTM 86	Fire risk assessment in hospitals	P&EFEx	1999	CD-ROM
SHTM 87	Textiles and furniture	P&EFEx	1999	CD-ROM
SFPN 3	Escape bed lifts	P&EFEx	1999	CD-ROM
SFPN 4	Hospital main kitchens	P&EFEx	1999	CD-ROM

Publication ID	*Title*	*Publisher*	*Date*	*Notes*
SFPN 5	Commercial enterprises on hospital premises	P&EFEx	1999	CD-ROM
SFPN 6	Arson prevention and control in NHS healthcare premises	P&EFEx	1999	CD-ROM
SFPN 7	Fire precautions in patient hotels	P&EFEx	1999	CD-ROM
SFPN 10	Laboratories on hospital premises	P&EFEx	1999	CD-ROM
UK Health Technical Guidance				
EH 40	HSE Occupational Exposure limits	HSE	Annual	
MES	Model Engineering Specifications	NHS Estates	1997	As required
Approved code of practice	The Control of Asbestos at Work Regulations	HMSO	1987	
Approved code of practice	Work with Asbestos Insulation, Asbestos Coating and Asbestos Insulating Board	HMSO	1988	
HSE Publications				
CS 4	Keeping of LPG in cylinders and similar containers	HMSO	1986	
CS 5	Part 1: Entry into confined spaces Part 2: Cleaning and gas freeing of tanks containing flammable residues	HMSO	1977	
Miscellaneous References				
	Space allowances for building services distribution systems: detail design stage (TN 10/92)	Building Services Research and Information Association (BSRIA)	1992	
	The safe storage of gaseous hydrogen in seamless cylinders and similar containers (CP 8)	British Compressed Gases Association	1986	