Scottish Health Planning Note 54

Facilities for Cancer Care Centres

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Contents

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About this series

The Scottish Health Planning Note series is intended to give advice on the briefing and design of healthcare premises in Scotland.

These Notes are prepared in consultation with representatives of NHSScotland and appropriate professional bodies. Health Planning Notes are aimed at multidisciplinary NHSScotland teams engaged in:

- designing new buildings;
- adapting or extending existing buildings.

Throughout the series, particular attention is paid to the relationship between the design of a given department and its subsequent management. Since this equation will have important implications for capital and running costs, alternative solutions are sometimes proposed. The intention is to give the reader informed guidance on which to base design decisions.

This guidance is based on core Guidance produced by NHS Estates and adapted for use in Scotland by the Property and Environment Forum Executive on behalf of the NHSScotland Property and Environment Forum.

Aims and objectives

NHSScotland's *'Our National Health: A plan for action, a plan for change'* states that in Scotland the aim is to secure the very best care for everyone, this will require a major service redesign initiative. The Scottish Executive's targets relating to driving down waiting times for screening and treatment and committed investment in new equipment, means that new and upgraded facilities for cancer care will be required. This design and briefing document provides guidance on how the built environment can be designed to support the holistic approach to cancer care.

The ultimate aim is to ensure that the physical facilities in which care is delivered enable the people who provide that care to adopt the latest techniques and best practices thereby promoting efficiency and raising service quality.

The patient's cancer journey has been used as the focus in preparing this guidance. The planning and design of the constituent parts of a cancer care centre, and the way in which those parts relate to each other, have been considered primarily with the patient in mind. In addition, the rapid development in technology – not only in patient diagnosis and treatment but also in many other aspects of care and organisation – is reflected in this document.

Finding solutions that not only advance the modernisation of cancer care but also produce environments that are genuinely sympathetic to the needs of all

users has required an innovative approach. It has been necessary to examine all aspects of cancer care: from social, clinical and scientific considerations to the detailed design and equipping of the buildings. Given such a broad approach, it is hoped that this guidance will be of interest to a wide audience.

Structure

In order to avoid excessive complexity, guidance on cancer facilities will be produced in three publications:

> 'Facilities for cancer care centres' (this document);
>
> 'Facilities for cancer care units and breast care centres' (future publication);
>
> 'Primary care and screening facilities in cancer' (future publication).

All parts will be subject to routine revision as needed. Each part builds from introductory sections describing policy, clinical and scientific background through the patient journey and associated care protocols, and uses these to inform the design process for the built environment. Schedules of accommodation will be published in a separate document covering cancer, cardiac and diagnostic imaging facilities.

Other documents relevant to facilities for cancer care

This work is constructed against a sliding scale of environment specialisation. Those rooms or areas devoted entirely to cancer services are described in detail. However, those rooms used incidentally for such care, together with common areas, are simply listed and the reader is directed to other publications as appropriate. Notable among these are HBN 15 'Accommodation for pathology services'; HBN 40 vol. 2 'Common activity spaces: treatment areas'; SHPN 26 and HBN 26 both titled 'Operating department'; and also SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

Acknowledgements

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Dr H Burns	Director of Public Health, Greater Glasgow Health Board
Dr A Gregor	Consultant Clinical Oncologist, Western General Hospital
Prof. A T Elliott	Chairman, Clinical Services Division, North Glasgow University Hospitals NHS Trust

Endorsement

"I am pleased to endorse this document produced by NHSScotland Property and Environment Forum and acknowledge the extensive work and effort put into compiling the advice herein, recognising also the core work done by our colleagues in NHS Estates, England."

Dr A Gregor, Lead Clinician for Cancer in Scotland

1. Scope of SHPN 54

Introduction

1.1 This guidance summarises the framework for the provision of cancer services and identifies the implications for the built environment in which different elements of services are delivered. It notes that the critical issue for people with cancer is that services themselves should be integrated and seamless – although these may be delivered by different healthcare institutions in various locations. The guidance describes facilities that are unique to cancer services and makes reference to features in facilities that are not used exclusively on people with cancer but have a particular relevance.

1.2 The guidance is based primarily on current government policy but is also influenced by the advice and recommendations of a number of professional and academic bodies. The intention is to present planning teams with a range of options for designing new accommodation or for adapting existing buildings.

1.3 This document is the first of three to be published. This first of the series deals primarily with the facilities and design of cancer care centres. The documents are as listed below:

'Facilities for cancer care centres'

'Facilities for cancer care units and breast care centres'

'Primary care and screening facilities in cancer'.

Intended audience

1.4 This document aims to support the procurement and design of cancer care centres. The multi-disciplinary nature of modern planning teams is acknowledged and in consequence the target audience of this guidance is broader than that of some earlier counterparts.

1.5 Estates professionals will find planning and design advice herein. Background policy and basic clinical information is also given to help planning teams keep pace with rapidly developing techniques in this area.

Policy background and 'Cancer in Scotland: Action for Change'

1.6 Policy on cancer care will be determined by the recommendations of the 'Cancer in Scotland: Action for Change' report, which calls for a new approach to the provision and organisation of cancer services in Scotland.

1.7 The need for a new approach arose partly from concerns about the nature of cancer. First, the incidence and prevalence of cancer for particular age groups

and body sites was, and is rising. Second, cancer places a major economic burden on both the community and the NHSScotland. In addition, it is recognised that cancer deaths could be reduced by early diagnosis through prevention and screening programmes. More recently, a growing emphasis on well-considered treatment policies and protocols has also emerged.

1.8 As well as the nature of cancer, there are also concerns about the way cancer services are being provided:

- treatment outcomes for patients are varied, due partly to variations in the organisation of local cancer services;
- patient access to services was or is unequal due to the disaggregated nature of cancer service provision;
- cancer care expertise is spread too thinly across too many geographical settings;
- the number of new patients being seen generally and in particular locations was and perhaps is too low to facilitate the development of body site specific cancer care expertise;
- co-ordination between primary/community and secondary/tertiary cancer services is inadequate;
- palliative care services for patients in the early as well as terminal stages of care need to be further developed.

Principles of the 'Action for Change' report

1.9 In response to the above challenges future cancer services should be governed by the following principles:

- wherever they may live, all patients should have access to a uniformly high quality of care in the community or hospital to ensure the maximum possible cure rates and best quality of life. Care should be provided as close to the patient's home as is compatible with high quality, safe and effective treatment;
- public and professional education to help early recognition of symptoms of cancer and the availability of national screening programmes are vital parts of any comprehensive programme for cancer care;
- patients, families and carers should be given clear information and assistance, in a form they can understand, about treatment options and outcomes available to them at all stages of treatment from diagnosis onwards;
- the development of cancer care services should be patient-centred and should take account of patients', families' and carers' views and preferences as well as those of professionals involved in cancer care. Individuals' perceptions of their needs may differ from those of the professional. Good communication between professionals and patients is especially important;

- the primary care team is a central and continuing element in cancer care for both the patient and his or her family from primary prevention, pre-symptomatic screening, initial diagnosis, through to care and follow-up or, in some cases, death and bereavement. Effective communication between sectors is imperative in achieving the best possible care;
- in recognition of the impact that screening, diagnosis and treatment of cancer has on patients, families and their carers, psychosocial aspects of cancer care should be considered at all stages;
- cancer registration and careful monitoring of treatment and outcomes are essential.

Implications of the Scottish Executive Health Department's plan for NHSScotland's built environment for cancer services

1.10 The NHS Plan 'Our National Health: A plan for action, a plan for change' was published in 1999 and has subsequently been supplemented by NHS HDL (2001) 54 and 71. Where possible, the implications of the plans have been incorporated in this document, insofar as they have an effect on cancer services. However, some of the developments listed are dependent upon the outcome of further research (called for by Government), and in consequence, the built environment implications cannot be fully assessed at the time of writing.

1.11 Essentially, the new NHSScotland plan of action prioritises cancer care as one of a number of key clinical areas to receive special attention and development. Implicit in this and explained within the Plan are expanded or new areas of expenditure covering the provision of staff, training and the enhancement of cancer care facilities in terms of buildings and the equipment which they contain. The key aim of the Scottish Executive is to improve both standards of cancer prevention and quality of care for cancer patients over a five-to ten-year period.

1.12 In summary, the expansion of cancer diagnosis and treatment facilities is a major feature of the NHSScotland Plan and implies the need for a high quality built environment and better equipment portfolios. Where possible, the drive towards these improvements has been incorporated in this guidance.

2. Cancer care centre organisation and structure

2.1 The multi-tier and multi-disciplinary approach to the care of cancer patients requires the provision of a sophisticated centre with genuinely comprehensive services. This may be devoted to either adults or children with only a few centres providing services to both groups. The cancer care centre is therefore the primary repository of both expertise and specialist facilities needed for care of patients with cancer. The relationship between cancer care facilities and the patient is demonstrated in Figure 1.

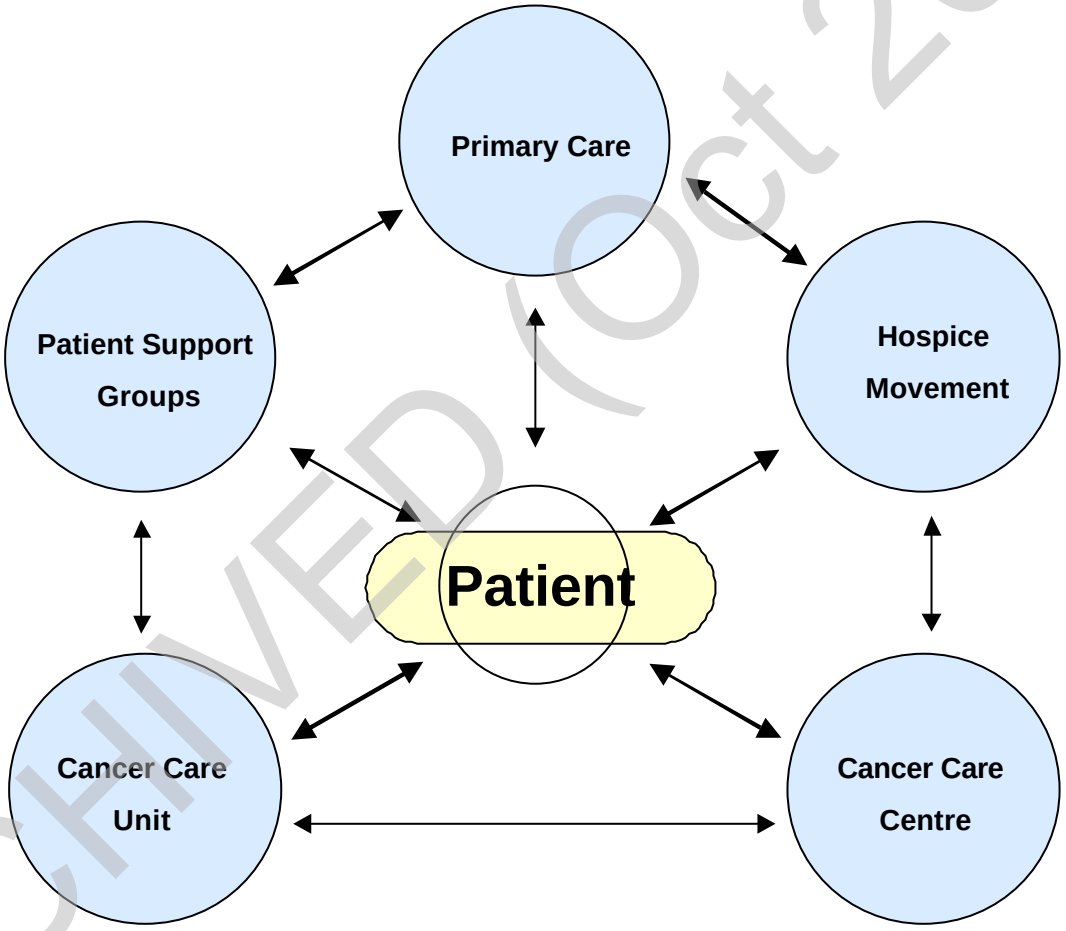


Figure 1: **Relationship between cancer care facilities and patient**

2.2 Cancer care centres operate in support of cancer units: units may refer patients to the cancer care centre for specialist diagnosis and treatment techniques. However, cancer care centres must also function as cancer units for the local catchment population. Cancer patients living locally will attend the cancer care centre rather than the cancer unit simply because it is closer to their home. Cancer care centres must therefore be fully independent offering a comprehensive range of services. A model for cancer referrals is illustrated in Figure 2.

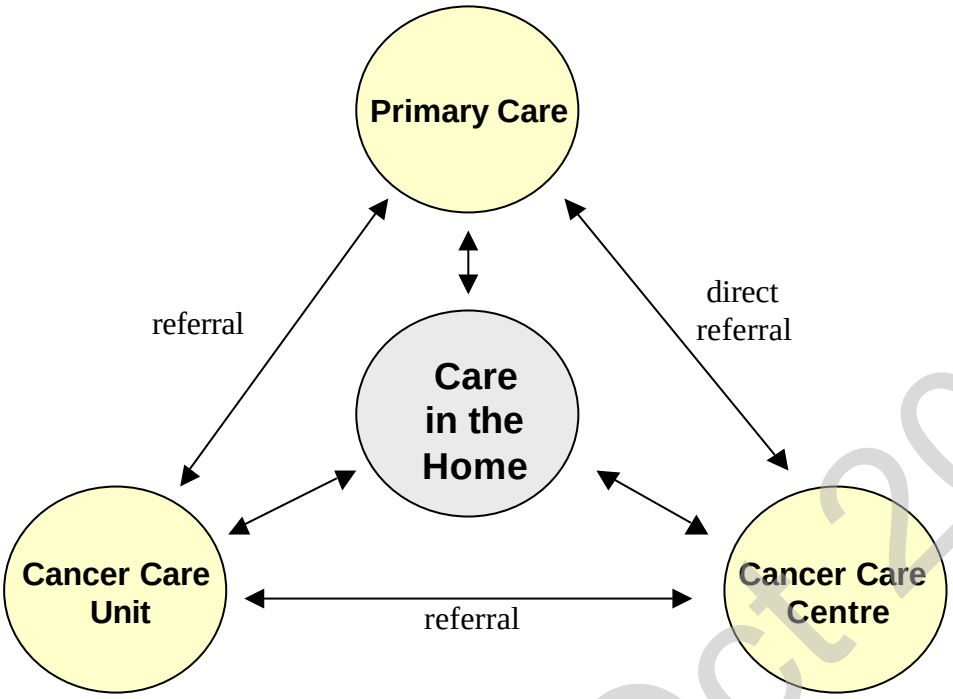


Figure 2: **Relationships between cancer care facilities: referral model**

2.3 It is envisaged that cancer care centres will be sufficiently comprehensive and multi-disciplinary as to be able to provide support to units, not only for the business of dealing with surgery and medicine/therapies concerned directly with tumours, but also in the broader care of patients and any consequential disorders which may flow from their condition. Thus, cancer care centres will support units broadly in the following ways:

- the provision of consultants for clinical sessions in surgery, medical cancer and radiation cancer;
- special pathology services closely related to cancer care such as specialist haematology and histopathology;
- the facility to transfer the patient by referral from the cancer care unit to a centre;
- provision of radiotherapy for patients otherwise cared for in a cancer unit;
- support in the process of chemotherapy regime provision;
- academic, training and research co-operation agreements;
- shared liaison with Social Services;
- development and implementation of appropriate surgical techniques.

2.4 Particular importance is attached to the surgical issues mentioned above. A move is envisaged from the use of general surgery in the treatment of cancer towards a position where cancer surgery is seen either as a speciality in its own right or as an area of trained expertise within a discipline related to particular anatomy. For example, a renal surgeon may have expertise in surgery related to cancer. There has been particular emphasis on moving breast surgery away

from the general surgical domain and into specialist centres with appropriately trained surgical staff.

Research facilities

2.5 Attention is drawn to the essential nature of research and development within the cancer community not only as a means of generating new knowledge but also for the beneficial effects on staff morale and overall service quality. For these reasons designers are asked to consider the provision of suitable and sufficient research accommodation as a basic part of each new or revised development.

2.6 Some major centres will have extensive research portfolios and facilities. These are, for the moment, beyond the scope of this guidance. However, the minimum facilities, described in the paragraphs below, will be essential to support pharmaceutical evaluations or drug trials as well as other key routine research support.

2.7 Drug trials require extensive and detailed record keeping. Accordingly, a clerical office to accommodate two to three staff will be required. This may need access to both local and wide area (LAN/WAN) computer networks. Archive space may also be a requirement, particularly in centres where clinical records are still partly paper based. These areas must be reasonably secure in order to protect the records and confidential information, which research sometimes involves.

2.8 Nurses are a key staff group for research in this area. Many centres will employ small teams of specially trained nurses to undertake or assist with research. Common (often open plan) office accommodation will be a key requirement.

2.9 Patients will often be asked to submit to additional interviews and clinical examinations when they take part in voluntary clinical trials. Many centres prefer dedicated suites to support this activity. These may be located away from other patient care areas. The minimum accommodation will consist of a number of consultation rooms with incorporated or separate examination facilities.

2.10 The majority of small research facilities will require a small laboratory for the receipt and some processing of biological materials. These rooms will be similar to those described in NHSScotland's guidance Scottish Hospital Planning Note 15:'Accommodation for pathology services', however, specifications will need to reflect local requirements and research interests. Local consultation will be essential. There are also likely to be implications for the design of facilities in associated cancer care units to be described in the second document of this guidance, 'Facilities for cancer care units and breast care centres'.

A guide to approximate sizing of cancer care centres

2.11 This is a complex issue owing to the range of diseases covered by the blanket term cancer and the similarly extensive portfolio of diagnostic, surgical and

treatment regimes, which may be applied. Accordingly, careful local evaluation will always be necessary. This will be helpful in assisting with individual evaluations in so far as service patterns and care standards are defined.

2.12 Tables 1– 4 give an outline indication of requirements for cancer care centres against the catchment area population and the numbers of new patients expected for treatment each year. The standing rate of new cancer cases per year is about 3,400 per million of population. Accordingly, simple categories of cancer care centres are derived as follows:

Category	*Catchment populations*	*New patient treatments*	*Special features*
A	450,000 – 550,000	< 1,500	Very small centre
B	550,000 – 750,000	1,500 – 2,500	Minimum full centre
C	750,000 – 1.5m	2,700 – 5,050	Regional centre
D	1.5m – 3m	5,050 – 10,000	Regional centre
E	3m – 5m	10,000 – 15,000	Regional centre

***Table 1:* Catchment populations and new patient treatments**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Linear accelerator (ME)	1	2	2 – 5	5 – 9	9 - 15
Linear accelerator (HE)	1	2	3	3	3 - 5
Simulator/CT simulator	1 – 2	2 – 3	3 – 5	5 – 8	8 - 12
Planning workstations	1 – 2	2	3 – 4	4 – 6	6 -10

***Table 2:* Radiotherapy facilities**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Manual overloading	Optional	1	1	1	1
LDR/MDR	Optional	1	1	2 – 3	3
HDR	-	1	1	1	1
PDR	Optional	Optional	Optional	Optional	Optional

***Table 3:* Brachytherapy facilities**

Facility	*Category A*	*Category B*	*Category C*	*Category D*	*Category E*
Chemotherapy preparation	1	1 – 2	2 – 3	3 – 6	6 – 6
Full chemotherapy pharmacy	Optional	1	1	1	1
Chemotherapy treatment places – couches	12	18	25 – 45	45 – 85	85 - 135
Available operating theatres	1	1 – 2	2 – 3	3 – 6	6 - 9
Specialist operating theatres	Optional	1	1	1	2
Unsealed source treatment	-	1	1	2	2
MRI/CT	1/1 (access)	1/1 (dedicated)	1/2	2/3	3/5

Table 4: **Other major facilities**

Notes to tables 1- 4

ME – medium-energy
HE – high-energy
LDR – low dose rate
MDR – medium dose rate
HDR – high dose rate
CT – computed tomography
MRI – magnetic resonance imaging
PDR – pulsed dose rate

3. Planning considerations

Functional relationships

3.1 The constituent parts of a comprehensive cancer care centre are identified in Figure 3 below. Figure 4 then illustrates how these elements can be grouped into diagnostic, therapeutic, patient support and clinical support areas.

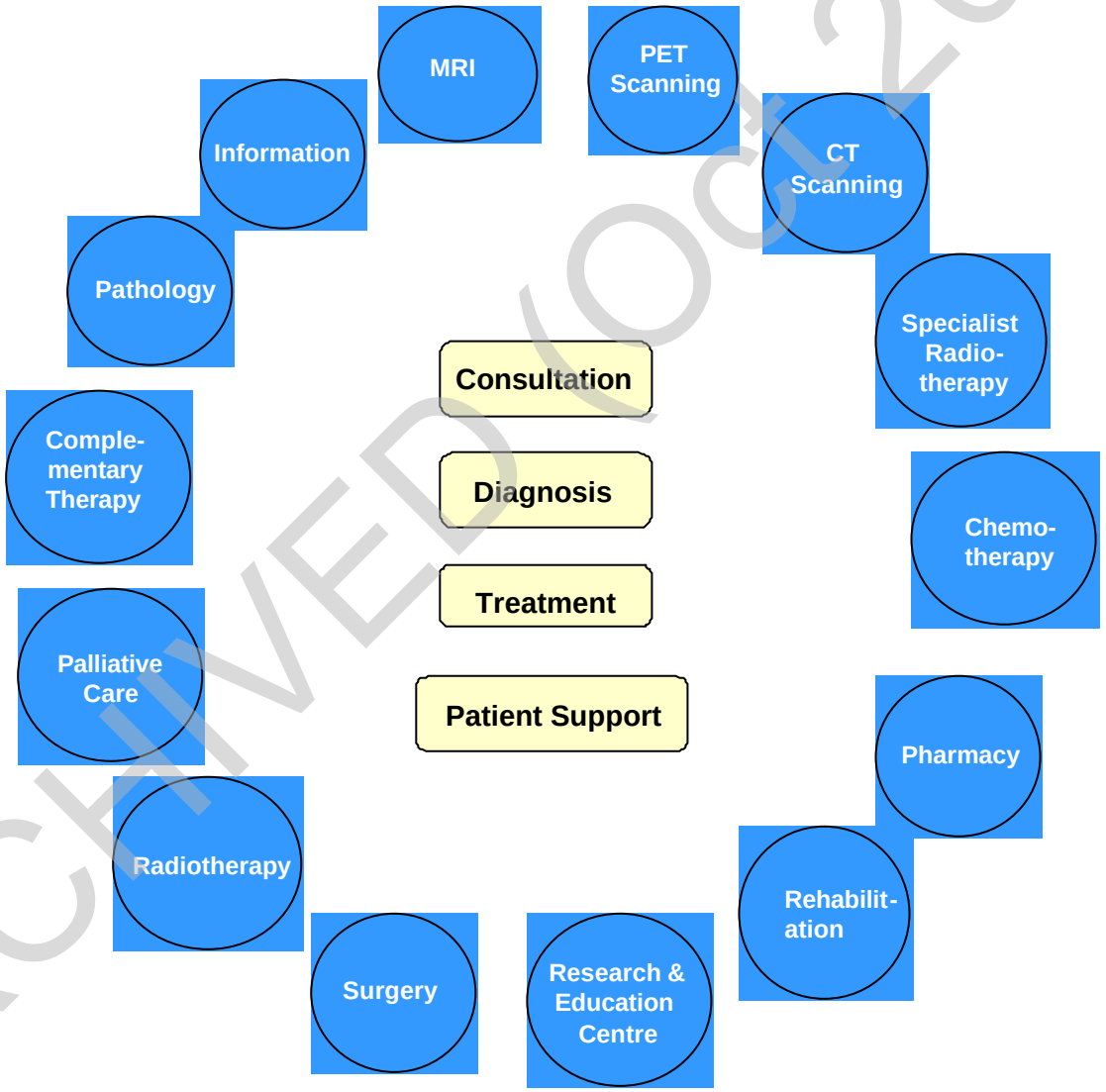


***Figure 3*: Cancer care centre departments**

Note: Specialist radiotherapy includes complex external beam treatments, intra-operative radiotherapy, whole body irradiation and brachytherapy.

Integrated services

3.2 It is recommended that cancer care centres be integrated with more general clinical service providers. Figure 5 illustrates which elements of the service are likely to be dedicated to the cancer care centre and which will be shared with the tertiary hospital.

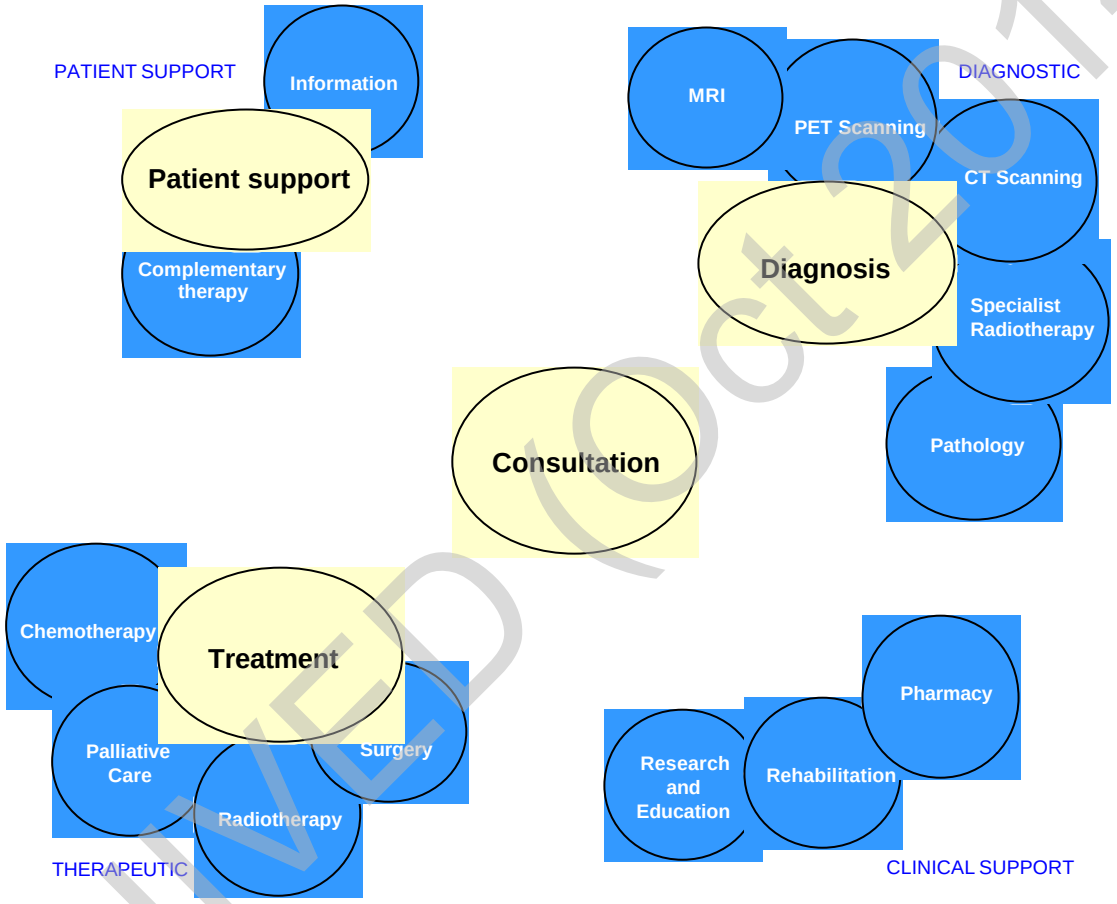


***Figure 4*: Cancer centre departmental relationships**

Siting considerations

3.3 As cancer units and centres are being unified with more general hospital provision, they are sharing services accordingly. Such integration requires a free flow of information and the broad availability of specialist expertise.

The following factors are influential when making siting decisions:

- geographical considerations related to journey times and distances anticipated for patients visiting the facility;
- access by public and private transport (use of public transport should be encouraged for the sake of the environment);

- the substantial nature of the architecture and engineering required by some cancer facilities is such that sites which favour future expansion and flexibility are preferred;
- suitability for receipt, storage, use and disposal of environmentally sensitive materials;
- relationship to academic institutions and research facilities;
- requirement for local access to non-specific but cancer-related services including surgery, pharmacy and pathology;
- the social-medical nature of cancer favours patient care on sites that are suitable for the creation of gardens and water features.

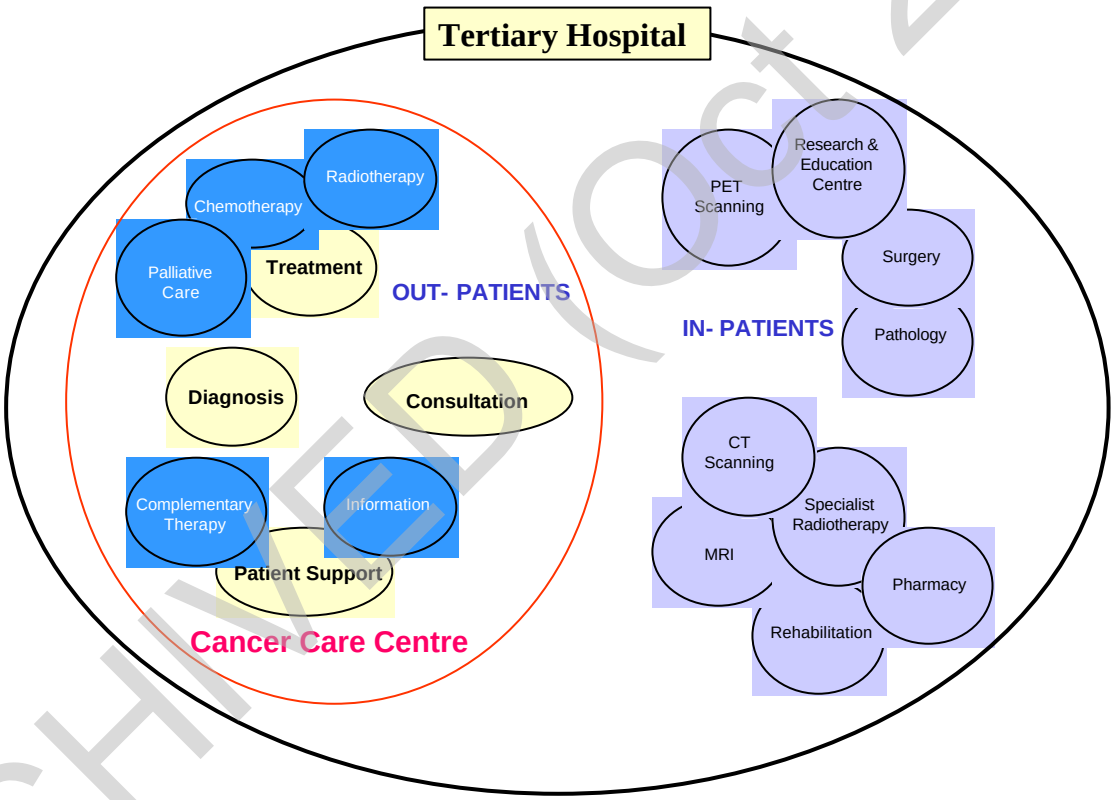


Figure 5: **Integrated general hospital cancer care centre**

4. The patient journey

Outline

4.1 For the majority of patients encountering the possibility of cancer, the initial query or suspicion of a cancer diagnosis will be made at primary care level by a general practitioner (GP). Attendance at Accident and Emergency (A&E) as an initial part of the journey is not commonly observed.

4.2 The patient will pass through the care system generally as illustrated in Figure 6, though significant variations will be observed, an outline description is provided below.

4.3 The feelings of both patients and relatives, particularly following news of a positive diagnosis, must be sensitively handled and this will reflect in the design of the built environment. So far as is possible, the facilities available should combine the need for practical efficiency with an appropriately sensitive and patient-focused quality.

Journey steps

Initial GP consultation

4.4 This may establish the suspicion of cancer or simply generate a referral arising from consideration of the patient's condition, family history and a physical examination. Some limited pathology tests using urine or blood samples may be provided. The GP surgery will typically require a quiet room, away from the remainder of the clinical area, for use in sensitive discussions with the patient and their family in support of ensuring overall as well as strictly medical care of the patient.

Hospital-based investigations

4.5 A proportion of patients will be referred direct to a purpose-built major cancer care centre offering strategic cancer services. Others will encounter a journey that involves passing through other specialist units or a local cancer unit.

Investigations

4.6 Investigations may be conducted at a cancer care unit or centre level, but the centre, with its strategic role, will be able to offer a broader and more sophisticated service.

4.7 On arrival the patient will go to a central reception area where the identity and attendance details are recorded and information on the next part of the patient's

care will be outlined. Some written explanatory information is also likely to be given. Particular care should be taken to ensure that this step is well facilitated for all patient groups including the disabled so that the patient's initial experience of the centre reflects the focus on patient care.

4.8 For the majority of patients the journey will proceed to a central or specific procedure waiting area. In a modern cancer care centre the use of schedule control systems and advanced patient management techniques will be geared to minimising waiting times. This may reflect in a smaller waiting area designed to create a reassuring environment. It is however essential that the waiting area can easily cope with peak times.

Diagnostic consultation

4.9 A meeting with a cancer specialist will outline, for the patient, the steps to be taken in moving towards achieving a reliable diagnosis and from this a plan for treatment. A consulting room will be used for this purpose and a physical examination may also be offered.

4.10 As directed, the patient will proceed to the appropriate specialist diagnostic department and report at the local reception.

4.11 The specialised tests may involve imaging, measurements, and the taking of samples of tissue and/or body fluids and are targeted at benefiting the patient by refining the diagnosis. Although these diagnostic facilities may be dominated, in design terms, by technical considerations, every effort must be made to ensure the environment is not adverse from the patient standpoint. This step may be a part of a series of differing tests involving a number of specialist facilities and journeys between these. Focus on building layout so as to simplify the journey is always necessary for the preservation of acceptable standards of care.

Treatment and diagnostic review

4.12 Where possible the cancer specialist will meet again with the patient to review progress and convey information, as this becomes available. At this point key diagnostic decisions may have been made and these will in turn give rise to discussions on treatment, prognosis or outcome for the individual patient. This news, good or bad, is likely to generate an emotional impact on those involved and this will reflect in the built environment in terms of the need to provide discrete exits and other features. For example it might be preferable for patients not to exit through the waiting areas as they may be extremely upset, and consideration may be given to providing a recovery waiting area.

4.13 The diagnostic cycle described above is likely to be repeated several times for any given patient as the disease and treatments proceed.

4.14 As Figure 6 illustrates, the patient journey now contains a complex series of options, which are dependent in terms of choice upon the patients' wishes and the availability of suitable treatments. For many patients treatment may involve

radical steps including surgery, radiotherapy and chemotherapy, though these techniques are also used in palliative care, which may have no curative intent. Psychological and Social Care may be an essential component of the journey for many patients.

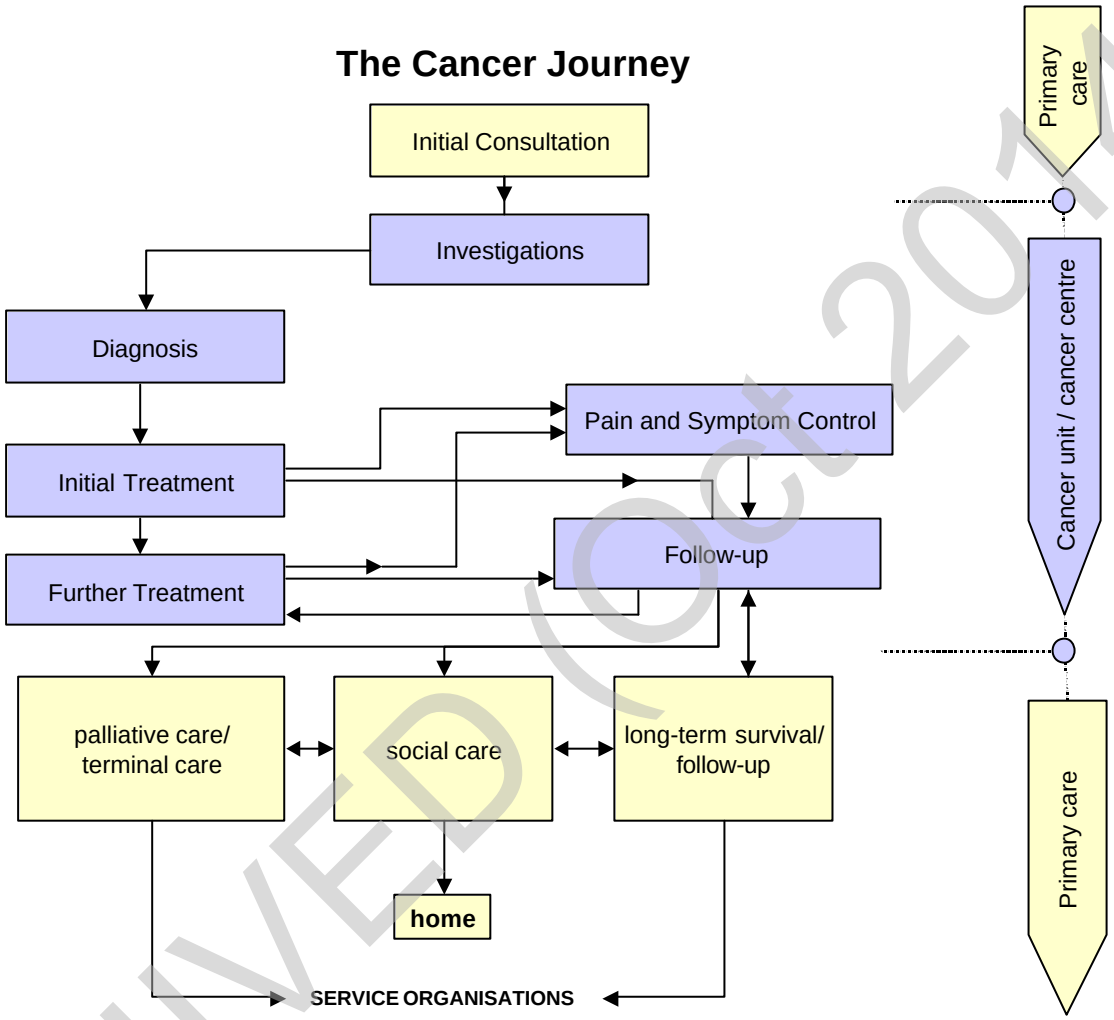


Figure 6: **Cancer care centre patient journey**

Pain and symptom control

4.15 A large proportion of cancer patients will require pain relief. Specific departments will be provided in cancer care centres with many patients making repeated visits. Both consultation and treatment rooms are required. The patient may remain within the department for several hours allowing the supervision and monitoring of treatment. The use of pain relief drugs may be supplemented by other treatments, including palliative radiotherapy.

Follow-up and monitoring

4.16 The patient will make regular visits both to his/her GP and to the cancer care centre to be apprised of progress and advised as to treatment options. These consultations will take place in general consultation rooms but again the need

for careful design to ensure respect for the patient's privacy and sensitivities is needed.

Care in the home

4.17 The cancer care centre may support care for the patient in the home by the provision of information, loan of equipment, etc. Primary care and social services will feature heavily in this part of the overall care package.

Dignity in death

4.18 For some patients the journey will regrettably end in death. In terminal illness some patients may be taken to A&E departments. Increasingly these have facilities for both patient and friends/relatives and are designed to achieve some measure of comfort and dignity in death. If a patient is admitted, a single bedded room should be provided. Others will be allowed to return home to die in the care of their GP team.

Summary of clinical procedures

Initial cancer care centre diagnostic consultation

4.19 As for all clinical episodes, the initial consultation with appropriately qualified specialists is vital. It is at this consultation that the early definitions of diagnosis will be put forward and an initial care plan devised.

Diagnostic work-up

4.20 This is a process by which the initial diagnosis is either confirmed or modified and the identity of the tumour, together with its histology or nature, is fully determined. The process is vital, as the ultimate diagnosis will determine the most appropriate care pathway.

4.21 Modern diagnostics in cancer care are multi-disciplinary and, therefore, contributions from pathology, radiology and general clinical sources need to be incorporated with a very high degree of reliability.

Tumour staging

4.22 The aim of chemotherapy, surgery or radiotherapy is to remove or at least reduce tumours. However, the success of any treatment will depend in large part on how advanced is the cancer. Accurately assessing the spread of the disease in a patient is therefore vital. In the UK there is a rigorous system for assessing the stage that the disease has reached.

Surgical planning and intervention

4.23 Much modern cancer treatment begins with a surgical intervention. The surgery requires extensive imaging before it is carried out. In common with radiotherapy, the surgeon will tend to define a target and will also wish to examine structures that must be avoided in making the surgical approach.

4.24 As an extension of the above, the use of stereotactic localisation to precisely reach tumours in the breast and cranial anatomy is well developed at some cancer care centres.

4.25 The use of image-guided minimal invasive intervention as a form of cancer treatment both in vascular and non-vascular sites is advancing rapidly and requires the provision of specialised facilities. This may replace alternative full-surgical techniques.

Treatment prescription

4.26 Whether the treatment is to be chemotherapy and/or radiotherapy, a strict prescription system is in use throughout the UK in all sectors of healthcare. For chemotherapy, the prescription will consist of a dose of selected drugs administered in a defined pattern over an agreed period of time. With unsealed radionuclide source therapy there will be a prescription, as for chemotherapy, which will specify the amount of activity to be administered rather than a patient radiation dose.

4.27 In radiotherapy, the prescription will consist of an agreed dose, to be delivered over a number of fractions or episodes of treatment, typically between 4 and 30.

Definition of treatment volume

4.28 The treatment volumes, that is the size, shape and site of the disease, will normally be defined either by the use of radiographs or by cross-sectional imaging involving CT or MRI.

4.29 Film-based imaging is increasingly being replaced by new digital techniques. The role of telemedicine in cancer care is discussed below.

Radiotherapy support scanning by CT and MRI

4.30 In addition to the routine diagnostic use of cross-sectional imaging, some additional imaging, directly related to the business of planning treatments rather than diagnosis will also be required. Much of this will be by CT, though some use of MRI may also be appropriate.

4.31 The data generated by these scans is transferred to a specialised computer or workstation that is devoted to radiotherapy treatment planning (RTP). All of this data is then used in the construction of a radiotherapy treatment plan, the

purpose of which is to generate treatment parameters for use on a linear accelerator, brachytherapy or Cobalt 60 treatment machine, etc.

4.32 This package of data is checked by a clinical oncologist and then logged for use by the department in the treatment of the individual patient.

4.33 In recent times, European legislation and Codes of Practice in the UK have required that for each patient two treatment plans be created, each by a different method. In practical terms this requires two technologists using at least two standalone or networked workstations.

Radiotherapy treatment simulation

4.34 This process is conducted in the simulator room and involves the use of an X-ray machine that emulates the geometry of radiation beams to be used for the patient on the linear accelerator.

4.35 The majority of radiotherapy patients receive simulation unless their treatment regime is very simple. Some patients may occasionally be simulated more than once.

4.36 Modern practice and design of simulators incorporates the use of image intensifiers similar to those used in diagnostic imaging departments to acquire the relevant images and in some cases reconstruct the data from different views to form low-resolution CT cross-sectional images. This latter feature usually requires additional equipment.

4.37 Alternatively, for film-based solutions, either the data acquired using the image intensifier is sent directly to a laser imager located within the department, or images are collected directly onto film using cassette holders integrated within the simulator's configuration.

4.38 A typical room layout incorporating facilities for digital imaging and treatment planning 'Simulator with treatment planning and conference suite' is shown in Appendix 2: Room layouts.

Image-based treatment validation and portal imaging

4.39 Portal imaging systems permit linear accelerator systems themselves to create images of the patient's anatomy. This gives a final check that the correct volume is being irradiated.

4.40 If hard copy film-based portal images are acquired then a separate unit, a digitiser, may be required. The digitiser will convert the images into a digital data format in order that they can be compared with simulation and planning images.

4.41 In the future, as treatment technologies become more sophisticated, image based validation to check that treatments are being delivered correctly will be an important element.

Treatment verification records and management (VRM)

4.42 The overall approach to radiotherapy treatment management should involve the use of a VRM or similar computer to bring together many of the data treatment elements referred to elsewhere in this section. In essence, the verification, record and management computer is responsible for maintenance of all the data concerned with treating the patient. Alternatively some cancer care centres may continue with paper-based records, which will require physical storage.

4.43 While the VRM concept is described here in the context of radiotherapy, verification and management elements can also be applied to a similar process in chemotherapy and indeed other forms of cancer treatment.

Review process

4.44 For some patients the cancer or tumour will regress under treatment and this regression is fairly constant and readily understood so that the treatment regimes need not be varied sharply. However, for others, initial treatments may not be successful or complications may develop. In these latter cases, which are not uncommon, patients should be reviewed regularly so that their condition can be assessed and alterations made to their treatment as necessary.

Palliative care measures

4.45 The purpose of palliative care is to control symptoms and alleviate suffering in patients who cannot be cured of their disease. It is important to understand that while palliative treatment regimes may be somewhat simpler than their radical alternatives, this does not imply any reduction in the quality of the care delivered.

4.46 Over and above the physically defined parameters, the palliative patient, sometimes in common with radically treated persons, may require periods of care in a hospice or psychological care/counselling. The quality of this treatment is just as important as that used to regress tumours or control pain.

Hospice services

4.47 The last 15 years have seen a marked rise in the provision of hospice services, mainly through the NHS and the charitable sector. The aim of hospice services is to provide a supportive and caring environment away from the hospital setting often, though not always, in pursuit of palliative care.

4.48 The hospice movement supports respite care services. These are often helpful to people caring for friends or relatives at home. For example, a cancer patient may attend a hospice on either a day or residential basis, thus relieving the carers at home, or the carers themselves may attend support sessions at the hospice, leaving others at home to care for the patient.

4.49 A trained specialist in palliative care will lead the palliative care team. The team may be based in a hospice unit, in a hospital support team or as a home support team within a community primary care trust. Palliative care units and teams may be funded by the NHS or in the charitable sector. In recent times, joint health authority and charity funding has emerged. Many specialist posts and initiatives in palliative care are pump-primed by the Cancer Relief Macmillan Fund.

4.50 The detailed information on operational requirements and facility design will be available in the third document of this set of guidance.

Brachytherapy

4.51 This is a special form of radiotherapy. A patient will initially undergo surgery involving the insertion or implantation of applicators for use with radioactive materials. This may be carried out in operating theatres, or, in some cases, in the simulator room.

4.52 Radioactive sources may then be inserted by mechanical means through the applicators under computer control with all persons, other than the patient, excluded from the treatment suite. Some manual insertion is still used but this is a declining practice largely because of safety difficulties.

Scheduling requirements

4.53 Recent reports from the Royal College of Radiologists and other learned bodies have stressed the importance of accurate scheduling in the entire process of patient care in cancer care services. This implies a built environment and equipment portfolio designed to encourage reliability and prevent delays.

5. Special considerations in paediatric care

Basic specialisations and working definitions

5.1 Cancer in children and young persons occurs at a low rate compared to that in the general adult population. The nature and characteristics of disease in these groups differs in many cases from that observed in adult cancer care centres and may include disorders which are diagnosed at or even before birth.

5.2 Children are for this purpose defined as being from birth to 14 years of age while the paediatric group also includes young persons aged from 15 to 21 years.

5.3 Paediatric care may be given in dedicated cancer care centres or in specialist departments within a more general facility. At present in Scotland, all paediatric radiation oncology is provided within adult centres and current workload may not justify special paediatric centres. Special facilities are needed for only a limited range of clinical services but the long-term nature of much of the care, including prolonged in-patient stays, requires the provision of family and schooling accommodation. Delicate social factors are also influential on design and department character.

The paediatric patient journey

5.4 The paediatric patient's journey will be determined by the child's age and disease. The rapid onset of many childhood cancers is also a significant factor in the care approach and in the speed and intensity of treatment applied.

5.5 The journey will begin with a paediatric assessment requested either by a family GP or directly from neonatal care. This process may be urgent and will be backed by pathology and imaging tests as needed; an in-patient stay may commence at once.

5.6 For many children the prolonged nature of the treatments may mean that the cancer journey must also incorporate other aspects of normal life and personal development for the child, family and others. This includes the need to provide facilities that will support a hospital-based community within which the child or young adult lives.

5.7 Further special journey elements will occur in the case of certain patients, including those with the blood disorder leukaemia which will potentially require treatment by total body irradiation. The effects of treatment include a great reduction in the body's immune response and protection against infection is accordingly required. The patient journey will therefore involve remaining in an aseptic environment for long periods of time.

5.8 Although the child will spend much time within the confines of the paediatric cancer facility, economic and practical considerations mean that the journey will often embrace visits to adult facilities, particularly for some diagnostic procedures and radiotherapy.

5.9 Although used only when essential, the administration of anaesthesia and/or sedation is common for children and accordingly modifies the journey when compared to an adult journey. The giving of anaesthetics may occur locally to the treatment facility or in procedure rooms on the ward.

5.10 The nature of paediatric cancer and its sensitive treatment is such as to require high levels of mutual commitment and continuity, possibly extending over many years. The patient journey reflects this and may include continued visits to the same care provider even if the family moves elsewhere. Such visits may be for additional treatment but social needs and counselling are equally important.

Clinical background

5.11 Diagnostic procedures for paediatric cancer differ little from their adult counterparts but the need for anaesthetics will, in many cases, extend the time taken to investigate, and will also influence facility design.

5.12 Discrete children-only facilities are not generally justified on clinical grounds but workload may mean that dedicated CT scanning and ultrasound rooms are appropriate. Access to positron emission tomography (PET) scanning is of particular importance. This may involve increased provision or efficient transport and communication with established service providers.

5.13 Treatment involving chemotherapy and/or radiotherapy is commonly applied. Paediatric cancer surgery is a highly developed speciality. Generally adult facilities can be effectively shared however, the provision of dedicated chemotherapy is relatively easy to achieve and generates significant benefit in terms of patient care standards and social sensitivity.

5.14 Both unsealed or liquid radioactive source treatments as well as sealed/solid source brachytherapy can be useful though the frequency of use is low.

5.15 Cancer treatments are often quite harsh and may themselves cause a controlled level of damage or injury. Accordingly, long-term follow-up of these patients is especially important and may result in visits by patients from children who have moved into an older age group.

5.16 Much of the above may be used in connection with ‘play therapy’, which has been found to usefully reduce the extent to which sedation, particularly for immobilisation, is needed. Play therapy would typically involve toys and games that, safely and in a friendly fashion, reflect the treatments which the child may later encounter.

5.17 In the modern era much is done to maximise the extent to which the child may be cared for in his or her own home. The use of outreach nursing, which must be facilitated by the cancer care centre, is particularly helpful.

Special accommodation requirements

5.18 Some of the accommodation does not differ in character or design from that used for adults and may indeed be shared facilities. However, a number of special issues do arise and some of these are observed as key to successful patient care.

5.19 In radiotherapy the linear accelerator bunkers will require special design elements to give the long source-to-target distances required for total or whole body irradiation. Special facilities to soften the environment in a child-friendly way should also be considered.

5.20 As treatment interruptions in some radiotherapy regimes may be especially harmful to children, the need to provide sufficient facility as to give effective back up or redundancy is particularly important.

5.21 Linear accelerator and other teletherapy rooms for paediatric use will always require anaesthetic and monitoring facilities. Consideration should be given to the use of permanently installed monitoring. Closed-circuit TV (CCTV) observation is always essential. Colour equipment must be used. Voice communication with the patient, accessible to the parents/nurses etc., is a very useful enhancement in reducing fear and gaining patient co-operation.

5.22 The provision of brachytherapy rooms for low or medium dose rate sealed source treatments is a difficult issue. Paediatric patients may be expected to benefit from these rooms being specially adapted and adjacent to other children's facilities. However, the frequency of use may be low so that for smaller centres a compromise with adult facilities may be essential for cost reasons. No special challenge arises for high dose rate facilities and the adult facility will always be used.

5.23 Unsealed source treatments present a particular challenge, given the need for a child-friendly yet specialised side ward environment which cannot be used for other purposes for much of the time due to radioactive contamination. The use of adult facilities is feasible but difficult in both nursing and social terms. The giving of such treatments on the open ward is unlikely to be lawful under the Ionising Radiations Regulations 1999. See Appendix 2: Room layouts for an illustration of a modern treatment room, 'Iodine treatment room with en-suite shower/wc'.

5.24 Ward accommodation must necessarily feature a high density of single bedrooms. Accommodation for parents local to or within side rooms is needed. The designs must be such as to allow for personalisation of the rooms by children who may remain for long periods of time. In view of practical considerations of travel times, etc., full family units will be required. These

should have adequate accommodation even for an extended family on a stay of considerable duration. The use of anaesthetics will increase the number of treatment rooms needed on each ward or unit.

5.25 Well developed procedure rooms or a minor procedures theatre will be needed in or adjacent to wards. This will be used for bone marrow transplant (BMT) and a range of other procedures including lumbar puncture. This shall incorporate filtered air ventilation and anaesthetic facilities with scavenging. A recovery room will be needed.

5.26 Special isolation facilities for those with compromised immunological status or infection vulnerability will be essential. These are of specialised design and will also have pressure control filtered ventilation systems.

5.27 As might be expected, family members may themselves require social and psychological care. This will typically be facilitated within the paediatric cancer facility. Meeting rooms and accommodation for family support groups will be needed.

5.28 Long in-patient stays necessitate on-site education facilities. This must include school rooms and facilities for the accommodation of teachers and the preparation of education materials.

5.29 Teenage patients will require an informal room with entertainment facilities. Care must be taken in siting this to avoid noise nuisance and to ensure security.

5.30 Paediatric rehabilitation will be essential as a dedicated facility and should include a modest gymnasium.

5.31 Dedicated information and help centres will be needed for paediatric facilities. The material stocked should differ noticeably from that available in adult facilities.

6. Diagnostic services including pathology and specialist radiology

Facilities for diagnostic techniques

Introduction

6.1 Diagnostic medicine is a key, intrinsic feature of high-quality patient care in the whole range of cancer diseases. Much of the science is highly developed and recent years have seen a high pace of advance.

6.2 The role of the diagnostic services extends to a number of features which are aimed at enhancing patient survival rates and minimising pain and discomfort or any feelings of defeat. The essential elements include primary or preliminary diagnosis, differential diagnosis, which specifically refines the picture, and tumour staging coupled with treatment monitoring.

6.3 Fundamentally the services required divide into three categories with variable levels of specialisation to cancer. The non-specific techniques are mentioned but not described here. The categories are: pathology services; imaging including cross-sectional work; patient and physiological assessment. The latter is general and not detailed here.

Pathology services

6.4 Pathology services will be provided by the parent institution related to the cancer care centre with the possible exception of specialised histopathology and cytology which are related to the examination of cell types sampled from the patient, in some cases by biopsy. These services may be specifically developed for cancer care centre use or be part of that centre. Other services such as clinical chemistry, biochemistry, haematology and microbiology are all important to cancer. However, other than refinements to the range of tests offered and a possible need for an increase in service capacity, the descriptions given in NHSScotland's guidance Scottish Hospital Planning Note 15 ‘Accommodation for pathology services’ apply without change where a cancer care centre is present.

Imaging services

6.5 The importance of these has risen sharply in recent years and given rise to a national modernisation programme which has increased the quality and capacity of the service offered to patients. This work has focused particularly on CT and MRI though almost all modern imaging techniques are used in connection with cancer. Again the parent institution will provide the majority of the service and an influence on capacity requirements in general X-ray,

vascular imaging services and ultrasound will be found. The role of image-assisted minimal invasive therapies is also developing rapidly and again has capacity implications in fluoroscopy, ultrasound and cross-sectional imaging (CT and MRI).

6.6 Minimal invasive therapy has a marked influence on the design of the rooms used, particularly in fluoroscopy and angiography. This is described in detail in Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

6.7 Specifically within cancer care centres the intensive use of CT, and increasingly MRI, means that dedicated units will be required as an essential feature. These are described in further detail below as well as in NHSScotland's guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

General pathology

6.8 The reader is referred to NHSScotland's guidance Scottish Hospital Planning Note 15 'Accommodation for pathology services'.

Histopathology

6.9 These laboratories, which may be part of the general histopathology laboratory complex, are used as part of the national cervical screening programme. Although cervical disease can be treated by the Manchester brachytherapy system and also by medical oncological or chemotherapy means, early diagnosis is known to have a significant effect upon prognosis.

6.10 Cervical screening involves the taking of a cell scrape from the cervix in a room that ensures effective clinical work under discreet conditions. The so-called 'cervical smear' is transferred to a laboratory for preparation and microscopic examination by histopathologists and specially trained screening staff.

6.11 The Medical Devices Agency (MDA) document 97/31/S has generated advice and standards in this area. In addition, NHS Estates' guidance HTM 67 'Laboratory fitting out systems' and Scottish Hospital Planning Note 15 'Accommodation for pathology services' also provides advice in this respect. The histopathology laboratories used for these purposes differ little from those generally described by NHSScotland for this area of pathology. However, recent work has drawn attention to a number of key items:

- the standards of concentration and care required to achieve reliable diagnosis in this area are particularly high. Accordingly, the environment must be quiet and the number of persons accommodated for the size of laboratory will be relatively low. The use of carpets in these laboratories is increasingly widespread because of the added comfort and noise suppression which this form of floor surface can provide;

- long periods of work in which the operator focuses carefully through a binocular microscope to examine specimen slides can lead to eye fatigue. Accordingly, windows permitting the operator to view a distant horizon and relax the eyes by focusing on infinity are needed;
- seated ergonomics have been demonstrated by independent study to be important in this area. Variable height seating using stools or chairs equipped with backrests, coupled with a similar ability to vary the height of the working surfaces which support microscopes and other equipment has been held to be necessary. Care is needed over lighting levels and variable control. Light diffusion within the room is also a key factor.

General radiology

6.12 The reader is referred to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

X-ray mammography

6.13 This modality has two related basic methods by which diagnosis can be achieved. The first of these is high-resolution X-ray imaging while the second uses a special form of such imaging to guide a breast biopsy. The material removed at biopsy is then sent for laboratory characterisation in histology in order to detect the presence or absence of cancer cells.

6.14 The service is often intimately associated with a breast care unit, which is a key feature of most adult cancer care centres. The imaging technique will be used early in the cancer journey for those with suspected or confirmed breast disease.

6.15 A technology change is in progress at the time of writing and as a result some units may continue to be provided with film-based imaging whilst others are moving to filmless techniques involving digital radiography (DR). The former requires very high quality film processing in a small but specially equipped darkroom. Daylight film processing is available for mammography but is less useful in the low throughput cancer care centre environment than is the case for high-volume scanning conducted elsewhere. Digital imaging removes the need for a darkroom but creates a necessity to house imaging viewing and processing computers, and requires a local area network (LAN).

6.16 During imaging examinations, mammography X-ray suites will be required to accommodate only the specially trained radiographer and the patient within the X-ray or examination room itself. However, when the facility is used for needle aspiration or biopsy employing stereotactic methods and equipment, occupancy pressures could be three or four persons. These will include a radiologist in addition to the patient and radiographer. Preferably a nurse will also be accommodated, though this is dependent on local practice.

6.17 The mammography room itself will be accompanied by modest waiting facilities, typically large enough to accommodate six people. In view of the potentially stressful nature of the examination, the waiting area should be of a quiet and relaxing character and positioned away from busy circulation space, etc.

6.18 The radiation quality or beam harness used in mammography is very low and soft. Accordingly, while the X-rays are classified as penetrating, they are much more heavily attenuated by ordinary building materials, including dense studded partitions, than is the case in broader general X-ray. This being the case, levels of shielding in terms of lead equivalence are substantially lower than encountered elsewhere. Typically, equivalence of less than 0.5 mm of lead will be needed to generate levels of attenuation which will protect persons in accordance with the requirements of the Ionising Radiation Regulations 2000.

7. Specialist cross-sectional imaging and positron emission tomography

Introduction

7.1 There is a debate over the location of imaging provision. The overwhelming view of diagnostic radiologists is that this should be integrated with the tertiary hospital's department to provide the most efficient and cost-effective service overall.

Computed tomography (CT) suite

7.2 CT scanning is an X-ray diagnostic technique. The basic principle involves an X-ray source or tube which rotates quickly about the patient. The X-ray beam is attenuated by the dense structures, such as bone, within the patient's head or body and the resulting changed beam is intercepted by an imaging detector mounted in a gantry opposite the X-ray tube. The image is then produced by the use of a powerful computer and displayed on a monitor or printed to laser film. Essentially, the product images are slices through the anatomy at selected points.

7.3 The image is captured in digital format for transmission over computer networks both for diagnostic viewing and also for special use in radiotherapy treatment planning (RTP), for which CT is increasingly essential. This latter function requires the provision of one or more CT scanners within a cancer care centre and good standards of access in cancer care units.

7.4 Recent developments in CT have led to 'spiral CT' techniques for faster image production and shorter scanning times giving increased capacity. Furthermore, 'multi-beam' CT is now being commonly installed with still further benefits for throughput. These new machines often enable minimal invasive procedures such as tumour biopsy.

7.5 Technological developments in the acquisition and processing of CT images are enabling cancer care centres to use CT simulation instead of traditional simulation for many, but not all, simulated treatments in radiotherapy. This development is expected to lead to a reduction in the number of simulators employed but an increased need for CT, with larger centres requiring two machines.

7.6 The machine consists of three major modules. These are the scanning gantry and patient support, a control console and a number of electronics or computing racks. A dedicated control room will house the console and provide a direct view of the scanning room through an X-ray protected window. The electronics racks will be placed in a dedicated 'machine room'.

7.7 As the scanning process involves the use of X-rays there is a need to construct the walls, doors and possibly windows of the scanning room from high-density X-ray attenuating materials. The shielding specifications must meet the requirements of the Ionising Radiation Regulations 2000 and the advice of the local Radiation Protection Advisor (RPA) must be sought by statutory obligation.

7.8 Visual and audio contact with the patient during the CT scan is maintained through a protective glass screen supplemented by CCTV and intercom. Patient access on foot, in wheelchair, bed or trolley is obligatory.

7.9 The reader is referred to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology' for further details.

7.10 **Components of a CT suite**

- Scanning room;
- Scanning control room;
- Data/image review room;
- Patient preparation room;
- Clean utility, where applicable.

Magnetic resonance imaging (MRI) suite

7.11 MRI is a diagnostic facility utilising magnetic resonance signals to generate detailed cross-sectional images at selected blocks or slices across the length of the patient's head and/or body. The technique is powerful in the ability to image both normal and tumour tissues at high resolution and often with good sensitivity to the presence and nature of disease. Use of MRI in the support of treatment through both minimal invasive therapy and radiotherapy is also established.

7.12 In outline technical terms, MRI combines a powerful magnet, smaller time-varying magnetic fields, radio signals and a sophisticated computer to produce high-quality images that display the soft tissues of the body. The digital information generated can be used to form cross-sectional, three-dimensional or moving images which may be stored and distributed in a variety of ways. This can be a complex process but in essence the images generated may be viewed on a television monitor or produced as laser hard copy, similar to X-ray film.

7.13 The scanning process takes place in a room which is constructed from normal building materials but which is surrounded internally by a Radiofrequency (Rf) cage. The cage is essentially a bonded wire or sheet screen used to protect both the MRI and adjacent equipment from unwanted Rf signals or radiation. The strong magnetic field generated by the MRI unit may also give rise to a design challenge; part of the field described as 'the stray magnetic field' will be present in the surrounding environment. In the past this frequently gave rise to the need for magnetic shielding in the form of ferrous sheets or plates fitted to

the room walls outside the Rf shield. Current units, often including the increasingly common 1.5 Tesla (T) type, have very effective 'self shielding', reducing or removing the external shielding requirement. Protection against the magnetic stray field down to 0.05mT or less is needed in order to protect persons, particularly those fitted with cardiac pacemakers, and also to ensure normal operation of electronic equipment in surrounding rooms.

7.14 It should be noted that modern high-gradient MR systems generate a great deal of noise.

7.15 The machine consists of three major units. Largest and weighing two to five metric tonnes is the gantry unit which consists of the imaging magnet and patient support system. A control console will be required and is housed in its own room, adjacent to the scanning room, and with a sight provision generated by a special window which is itself part of the Rf shield, as is the special scanning room door. Lastly a number of electronics racks must be accommodated in a separate but adjacent machine room.

7.16 Visual and audio contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

7.17 Cryogenic gases will ordinarily cool the strong magnet though resistive electromagnets and permanent magnet types are also used in smaller, less capable machines. Where cryogenic gases, such as liquid helium, are used, an emergency external 'quench' pipe will be essential and the need to bring cryogenic materials to the suite must also be considered.

7.18 Much of the suite design is orientated toward producing a patient-friendly environment but the existence of hazards and the need for control of access also has a strong influence.

7.19 The reader should consult MDA safety publications and NHSScotland guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

7.20 **Components of an MRI suite**

- MRI scanning room;
- Scanning control room;
- Patient waiting and changing area;
- Machine and computer room;
- Outer controlled area;
- Data/image review room.

Positron emission tomography (PET) suite

7.21 This relatively new technique has gained considerable importance in the United States and some other overseas areas but is in the relatively early stages of development within the UK. The principle cancer application is in the detection and evaluation of possible secondary cancer growths or metastases. PET also has a number of important non-cancer applications in the neurosciences and elsewhere so that shared facilities may be a relevant consideration.

7.22 The technique uses very small amounts of glucose sugar in a modified form (DG), to which trace quantities of the positron-emitting radioactive material Fluorine-18 are attached by chemical bonding to produce FDG. Positrons are novel anti-matter particles which annihilate matter to generate two gamma rays, which travel in opposite directions to each other. This special property allows a positron camera to detect, and by tomography locate, the position of the radioactive material within the patient's anatomy. This in turn highlights the presence of secondary tumour growth.

7.23 In clinical terms, although as yet unproven, the technique may help doctors to determine which patients would benefit from radical (curative) treatment and which should proceed to palliative care and a pain control programme. The progress of treatments may also be monitored by this modality or approach.

Practicalities and the built environment

7.24 Producing FDG is very difficult, it can only be produced by a cyclotron; it must be an infection-free material; and Fluorine-18 has a short half-life, only a few hours. Accordingly, specialist and quite major facilities are necessary. These may occasionally be on-site with a large cancer care centre but, more commonly, will be located in regional centres or produced commercially. The production centre will need to be within three to four hours transport time of the cancer centre if the material is to be usable.

7.25 The patient journey requires attendance at a PET scanning centre, which will not necessarily itself be located close to the cancer care centre, though some logistical advantages may be observed in easy patient flow and care. It is important that the patient is very calm before the scan can successfully be undertaken and accordingly the reception and waiting areas should be particularly restful in character. A similar argument applies to the transfer of non-ambulatory patients. The giving of muscle relaxant drugs within a calm individual waiting or preparation room is often regarded as standard practice.

7.26 The patient must change into an examination gown and all metallic objects, etc, placed safely in a locker or similar repository.

7.27 The FDG is given as an intravenous injection and after a waiting period, again in a very calm environment, the patient will be taken for scanning. This work uses a positron camera or in some cases a modified nuclear medicine gamma camera to generate the tomographic scan described above. This scanning

process takes about 45 minutes and again the scanning room must be calming, and reduced but safe lighting levels are often used.

7.28 It is important that WC facilities for the exclusive use of the patients are provided. These must be close to the waiting and clinical areas of the PET diagnostic suite. There must not be steps, floor slopes, etc., in the linking space as these may increase the patient's exertion and compromise the quality of rest required.

7.29 After scanning, the recovery time is short and the majority of patients may leave for home. However, as the patient is slightly but not insignificantly radioactive, special transport arrangements or a delayed departure may be necessary. These transport requirements may involve the use of patients', relatives' or friends' vehicles and thus special thought must be given to convenient vehicle access and parking.

Safety and special design considerations

7.30 The radioactive material used, and medical constraints present, have important considerations for building design. F-18 has higher radiation energy when compared with most, if not all, nuclear medicine radioactive materials. This and a number of similar factors gives rise to an increased need for heavier radiation shielding and protection by the use of distance and other controls.

7.31 In suite design, the use of shielding local to the radioactive materials as well as within the building structure should be considered in consultation with the local RPA. The shielding will consist of lead protective containers and enclosures combined with dense block wall construction. The rooms used to store and separately administer the FDG should be separated by at least a few metres from the scanning room in order to avoid unwanted detection of stored materials by the camera during scanning. The scanning room will require an adjacent control room with shielded viewing window and CCTV.

7.32 Protection against radioactive contamination is important and the essential measures differ only in detail from those used in nuclear medicine. However, the standards which must be achieved are higher and place a premium on detailed design and the selection of impermeable materials.

7.33 The need to constrain both the radiation and radioactive contamination will also affect the care of inpatients and the environment in which they are nursed. The spacing of beds in wards may require review and the presence of low-level radioactivity in the patient's body fluids gives rise to the need for monitoring in respect of contamination and the provision of modest containment facilities (see Section 16). The bedding and other materials brought into contact with the patient may need to be stored separately as part of this containment. Equally the provision and storage of a 'spill kit' is essential in order to deal safely with the results of minor incidents or incontinence.

7.34 There are requirements under the Radioactive Substances Act that relate to storage, use and disposal of radioactive materials. These generate many

implications particularly in terms of security against source theft and the possibility of fire. Disposal by radioactive decay in short-term stores specially constructed and shielded for the purpose will be needed.

7.35 The reader is referred to NHSScotland's guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

7.36 **Components of a PET diagnostic suite**

- Patient scanning room;
- Scanning control room;
- Patient preparation and pharmaceutical administration area;
- Pharmaceutical preparation laboratory;
- Waste disposal facilities;
- Patient rest area.

7.37 An example layout for a PET diagnostic suite is given in Appendix 2: Room layouts.

8. Therapeutic services including radiotherapy and chemotherapy

Radiotherapy

Introduction

8.1 The provision of radiotherapy is a key feature of all cancer care centres.

8.2 There are three forms of radiotherapy treatment using sealed and unsealed sources of radiation: **teletherapy** in which an external beam is generated by a machine source of radiation, **brachytherapy** in which a tumour is treated by placing a radioactive source inside the body. The source of radiation is normally placed into a tube or applicator device that has been implanted or inserted at surgery. This approach of placing the radioactive source after surgery is known as 'afterloading'. The insertion of the radioactive source can be manual, or more commonly, conducted by a remote afterloading machine. Among many advantages, afterloading protects the staff against the problems and doses associated with handling radioactive materials in the operating theatre.

8.3 Another way of treating disease from within is by using unsealed radioactive sources. These are usually administered to the patient in the form of a liquid, taken as a drink, a capsule or by intravenous injection. Guidance on the use of unsealed radioactive sources is contained in Chapter 10.

8.4 All three forms of radiotherapy outlined above require dedicated facilities which must be carefully designed to match ergonomic, patient care and safety requirements. Safety will include protection against fire, electrical hazards and radiation and radioactive material.

Radiotherapy equipment and outline treatment room requirements – teletherapy

Linear accelerator

8.5 This is a powerful electrical device which, as the name suggests, accelerates electrons to very high energies by using radio frequency waves, generated by a magnetron or klystron within a high-vacuum waveguide. The electrons are then either emitted into the air as a beam directed towards the patient or used to produce X-rays by being guided into a transmission target. The beam is then shaped to match the treatment requirements using an electron applicator or X-ray collimating jaws as appropriate.

8.6 This specialist equipment requires installation in a purpose-designed linear accelerator bunker with very heavy protective shielding built into the construction. Traditionally reinforced concrete and steel have been used but

new materials, for example, 'Ledite', (see Appendix 2: Room layouts) are now providing alternative approaches, which may have advantages in terms of reusability and reduced footprint. The bunker entrance will normally be protected against the escape of X-rays into the adjacent environment by a concrete maze; however, some recent designs have seen the reintroduction of heavy protective doors without the provision of a maze. In the past, Barytes bricks have also been used for protection and they may still have a use in refurbishment works.

8.7 Linear accelerators may be categorised as single mode or multi-mode. The former are used for X-ray treatments only, while the latter can produce external electrons in addition to X-ray beams. Multi-mode linear accelerators may have special built environment requirements over and above an X-ray protective bunker, particularly if used to generate X-rays above a defined energy threshold. These relate to the need to protect persons against unwanted neutrons produced by interactions involving the high-energy X-rays. Neutron attenuation and absorption favours the use of light materials such as wax and plastics.

8.8 Radiotherapy treatments must be precise and accurate in terms of aiming the beam at the intended target. This requirement means that almost all linear accelerators use a base frame set into the floor which links the accelerator gantry to the patient support device or couch.

8.9 The recent introduction of two new technologies has had a small but important influence on treatment room design. The first of these is the multi-leaf collimator, a device that accurately shapes the beam to the tumour and has reduced the need for special low-melting point (LMP) lead blocks which were previously used for this function and required local storage. Secondly, imaging is now possible before or during treatment by digital means, using electronic portal imaging.

Cobalt 60 machines

8.10 This technology is based upon the production of a gamma ray beam from a very large cobalt radioactive source contained inside a protective housing equipped with mechanical shutter and basic beam-shaping collimators. The relative simplicity of such machines is an advantage but a lack of flexibility and the environmental challenge of radioactive waste disposal mean that only small numbers of machines remain in use today. The possibility of new installations or upgrades cannot however be excluded.

8.11 The treatment rooms or bunkers used are similar in concept to those described for linear accelerators, but the special high-energy considerations are not relevant.

Superficial X-ray treatment machines

8.12 These devices use conventional, though powerful, X-ray tube technology to produce lower-energy treatment beams. The emergence of linear accelerator electron treatments has reduced demand for superficial X-ray treatments but some disease conditions remain more effectively treated with this older technology.

8.13 The X-ray tube is mounted on a simple but robust and accurate floor or ceiling suspension and is powered by a conventional X-ray generator system. The treatment couch will be mobile and is not mechanically linked to the X-ray tube mounting.

8.14 Treatment rooms are similar to those used in diagnostic X-ray and may incorporate thin lead shielding or be constructed from conventional dense building materials. Protective doors and viewing windows will also be used. A maze is not needed in protection against these low-energy radiations.

Orthovoltage X-ray treatment machines

8.15 In common with superficial X-ray treatment machines, these X-ray systems use a conventional tube and generator though they are considerably more powerful than their superficial counterparts. The need for these machines is in marked decline and it is likely that few will be installed in future unless new clinical applications develop.

8.16 The treatment rooms are more heavily shielded than those used for superficial treatment and a small maze is a viable alternative to heavy door construction.

Radiotherapy equipment and outline treatment room requirements - brachytherapy

Manual afterloading

8.17 This technique is declining in use but may be offered for Iridium 192 wire treatment of tongue or breast as well as a number of other applications. The approach involves the patient in a visit to the operating theatre for the insertion or implantation of applicator tubes under general anaesthetic. This is followed by the insertion of the pre-prepared encapsulated wires in a suitably shielded single patient side ward.

8.18 The shielding is intended to protect clinical and nursing staff as well as visitors and the public. As a result of these requirements 'shadow shields' are more likely to be employed. These consist of very heavy lead castings or plates supported on mobile frames and strategically positioned to shadow key areas around the patient's bed. In modern installations structural wall shielding is also likely to be employed but local RPAs must be consulted on this issue.

8.19 The wires are prepared for use in a shielded workstation within a medical physics sealed source laboratory. Such facilities contain the shielded

workstation together with a storage safe for the sealed sources. The preparation varies with the treatment requirement but will always include assay of the radioactivity present and may involve source sterilization.

Machine afterloading

8.20 In order to reduce operator dose and afford greater treatment flexibility, the widespread introduction of machine-based afterloading has occurred. In this group of techniques, the source is contained within a shielded store built into the afterloading machine. Using sophisticated computer-based control, the machine achieves mechanical or pneumatic transfer of the source(s) from the store into the applicators which have been previously implanted or inserted in the ward or operating theatre environment.

8.21 The sources may be automatically withdrawn to the storage safe when nurses, visitors etc enter the room. Safety interlocks are always applied. With the sources withdrawn, nursing may be conducted in an unhurried and normal way. Compliance with IRR requirements is also aided substantially.

8.22 The treatment room will always be wall rather than shadow shielded, though the level of shielding required will be greatly influenced by the dose regimes as outlined below. If afterloading systems are being used in a multi-storey building, then the shielding will be required to the floor and ceiling. All control functions and some routine monitoring of the patient will be conducted from a shielded area outside the treatment room. The use of CCTV observation is helpful in removing the need to interrupt treatments by the withdrawal of sources on an excessive number of occasions. Intercom communication with the patient is an essential requirement. A typical machine afterloading system is shown in Figure 7.

Figure 7: Machine afterloading system

Low dose rate (LDR) machine afterloading

8.23 In LDR brachytherapy the treatments will last from 18 to 48 hours in terms of source exposure time. Only a single treatment fraction is used. The patient will remain in bed within the shielded room for a total of about two days after which the applicator tube will be disconnected from the machine. Following this, the patient will undergo applicator removal surgery on the side ward or in the operating theatre.

8.24 In common with medium dose rate (MDR) treatments, the tumour volume is continuously irradiated throughout the source exposure time. The treatment machines are also of similar design to those used in MDR, that is to say self-contained units of 150 to 250 kilogrammes weight and being less than two metres tall. Some machines require a separate compressor mounted or housed so as to control noise. In the UK the majority of systems employed use multiple Caesium 137 or Iridium 192 radioactive sources. A minority of currently installed units may still support the use of radium and gold sources in some LDR applications.

8.25 In the modern era, treatment flexibility requirements will give rise to the need for multi-use brachytherapy facilities. It is envisaged that a single shielded side room with shielded en-suite shower room and toilet will be provided. With care in design this may be used for manual afterloading, LDR and MDR treatments as required. The room may also be used for routine nursing but not with unsealed source treatments.

8.26 The control panel will be mounted in a secure location outside the treatment room and is duplicated on the machine itself. TV monitors must also be located so as to preserve privacy while permitting observation by nurses. The use of independent radiation monitors is advised.

8.27 The provision of external windows is desirable and may be achieved at ground level by the use of shielding walls outside, acting as shadow shields to the external environment. The area between the window and shielding wall will require rigorous access control.

Medium dose rate (MDR) brachytherapy

8.28 MDR treatments typically take around two to four hours source exposure time, depending on the type of treatment undertaken. Unlike pulsed dose rate (PDR) brachytherapy, the tumour is continuously irradiated. The treatment prescribed may include the use of multiple or single radioactive seeds. These machines tend to be larger and carry more sources than a high dose rate unit, described below. The majority of sources utilised in the units are either Caesium 137 or Iridium 192. In common with LDR, some manufacturers build machines that incorporate the option to treat two patients simultaneously. This will require two adjacent shielded treatment rooms.

8.29 Where suites are required to facilitate MDR, the design will be broadly as for that described above. However MDR brings with it additional shielding requirements and these may have greater structural implications.

Pulsed dose rate (PDR) brachytherapy

8.30 In this instance, a single radioactive Iridium source is used. This has a level of radioactivity of about three times that used, per source, in MDR treatments. Treatment times last up to 48 hours.

8.31 In this treatment method, the single source is moved into an applicator within the treatment site for up to 10 minutes per hour and is then retracted by the brachytherapy treatment unit and placed into the next tube or applicator location. The principal benefit of this treatment is to obtain the same radio-biological properties as LDR brachytherapy treatments and yet allow the use of a single source and greater flexibility in nursing time.

8.32 Suite design is as described for LDR but with reconsideration of the shielding requirements. High instantaneous dose rates make the use of external windows more difficult and the advice of local RPAs must be sought.

High dose rate (HDR) brachytherapy

8.33 This modern patient treatment approach differs in many respects from those discussed for LDR/MDR and PDR above. The dose rates used and levels of radioactivity are much higher, giving rise to greatly reduced treatment times and the need for fractionation in many cases. The patient will undergo applicator removal surgery on the side ward or in the operating theatre. As the source exposure time will normally be of the order of 10 to 25 minutes, the nature of the care process and the required built environment, are unique to this form of therapy.

8.34 A single highly radioactive sealed source of Iridium 192 or Cobalt 60 is used. This is moved within the applicator to generate the required dose distribution within the tumour. In common with the other machine-based afterloading techniques, the source may be withdrawn under remote control to a safe within the machine.

8.35 The patient journey, like the care process, has important differences to the techniques described earlier. The patient will generally be taken to an operating theatre where the applicator will be inserted, implanted or placed under radiological control using a mobile or permanently installed image intensifier. Here the journey has two mutually exclusive options, the choice being dependent on the built environment design selected by the care team.

8.36 In the first option, the intermediate standard operating theatre is built with heavily shielded walls and have the facility to monitor the patient from an adjacent shielded area. The HDR machine is housed in the theatre and following the placement of the applicator within the patient the HDR machine is coupled and treatment may commence. This option works particularly well

where the applicator is, or may be, readily inserted and removed. The patient will return on subsequent days for the administration of further dose fractions as necessary. During treatment, all persons other than the patient must leave the treatment room which is then an exclusion area.

8.37 The second option is more conventional and involves the patient being taken from the operating theatre where the applicator(s) have been inserted to a separate treatment room. This may involve moving an anaesthetised patient, with the safety problems that are attendant to this action. Accordingly, it may be greatly desirable to position the facilities so as to ease and/or shorten this transfer. In some centres a Cobalt or linear accelerator treatment room may be used; others have constructed purpose-designed shielded rooms. The former choice reduces building and maintenance costs but interrupts the use of the teletherapy treatment equipment. The specially constructed room is free of these objections but may not offer great advantages in terms of cost and flexibility compared to the shielded intermediate operating theatre.

8.38 Regardless of the option selected above, the room in which the applicator is inserted must be large enough to support a surgical team in aseptic conditions and to allow the use of an image intensifier. Full anaesthetics and patient monitoring facilities will be required. Colour CCTV is needed to monitor anaesthetised patients during treatment.

8.39 The relevant regulations and codes of practice require that HDR treatment procedures are undertaken in relatively high radiation shielded areas incorporating the use of a small maze entrance.

Brachytherapy treatment planning

8.40 The majority of brachytherapy treatments will require careful planning in terms of treatment choice, dose used and dose distribution obtained from a given applicator position. This may entail an X-ray or other examination to show the location of the applicator in-situ.

8.41 A dedicated treatment planning system, connected to a network, will be needed in some instances while other technical choices will permit this function to be performed by a planning computer also used for teletherapy.

8.42 **Components of a radiotherapy suite**

- Treatment room and maze for use with linear accelerator;
- Linear accelerator control areas;
- Physics equipment store and laboratories;
- Pre-treatment interview room (radiotherapy);
- Information area and library;
- Brachytherapy source storage and preparation;
- Plant room for each linear accelerator.

8.43 See Appendix 2: Room layouts, for example layouts.

Chemotherapy

Chemotherapy treatment techniques and facilities

8.44 Chemotherapy involves the use of cytotoxic drugs either individually or in combinations to treat cancers. The drugs are usually given by the intravenous route, either as a bolus over minutes or an infusion over hours but may in some cases be taken orally as a tablet or capsule. In principle the drugs are toxic to both cancer cells and normal cells of the body. The treatment intent is to effectively poison the tumour cells whilst giving a dose to normal tissues that is low enough to assure the patient's survival.

8.45 Chemotherapy can be used to treat metastatic (secondary) and primary disease simultaneously and often is the treatment of choice in diffuse, non-focal disease.

8.46 In recent times, new drugs and methods have improved this treatment in terms of reduced patient suffering and morbidity. Selective administration of the drugs, using lines or catheters placed into the tumour or adjacent vascularity, can be helpful and is increasingly practised. The use of chemotherapy as part of the overall treatment strategy, which also involves hormone therapy, tumour suppressive drugs and radiotherapy, is a common and necessary practice.

8.47 Patient-specific fractionation treatment protocols will be adapted from standardised procedures to suit the type of tumour, proliferation rate stage, etc. One fraction may consist of a combination of drugs given over a period of one or two weeks, or two or more cytotoxic drugs administered over a period of one day. In essence, a cycle of chemotherapy drug administration is configured and prescribed before the course of chemotherapy treatment is commenced and then repeated until the entire prescription is completed or a cure is established. In some instances, where there is little or no response from the tumour, then the regime may be changed during or at the end of the initial treatment. The patient will be subject to regular imaging investigations and pathology tests to validate or otherwise the success of the treatment.

8.48 Treatment can take from two months to two years depending on the type of cancer.

8.49 The patients must have a blood test prior to treatment to determine the final composition of drugs and other clinical factors. This may take place at a GP surgery or local hospital up to 24 hours before treatment. When testing is conducted immediately prior to treatment there will be a waiting period of 30 minutes between taking the blood sample and the delivery of drugs, patients may wait in a waiting area or treatment area depending on throughput and care strategy.

8.50 The patient journey involves chemotherapy and associated care being given on a day-case basis or as an outpatient in the majority of cases. However, as chemotherapy may be used with those whose disease is at an advanced and debilitating stage, in-patient care may be needed. In the majority of cases patients will be mobile, although attached to a drip during the administration of the cytotoxic drugs.

8.51 For those patients receiving lines, e.g. Hickman system or drug administration catheters, the journey will involve a visit to a purpose-designed interventional radiology facility or standard operating theatre. The procedures are relatively minor and will have only a short recovery time though general anaesthetic is sometimes used. There is no express need for these facilities to be within the cancer care centre but such incorporation is often helpful in avoiding treatment delays and ensuring continuity of care.

8.52 Long term or 'stochastic' reactions can include stunted growth and development in older paediatric patients as the cytotoxic drugs inhibit thyroid function. The tight integration of other acute medical services is therefore vital to the overall care of the patient. In addition, it is known that certain cytotoxic drugs can have an effect on cardiac function and this needs to be monitored in at-risk patients during and after treatment. Baseline measurements of cardiac function are also required and for several drugs, measurements of renal functions are advised.

8.53 Hair loss as a result of the toxic effects of these drugs is a declining but still prevalent patient care issue. The use of 'cold caps' as a means of reducing hair loss is increasingly common though not always successful. The use of these caps requires the provision of storage facilities and a domestic refrigerator/freezer. For some patients the fitting of wigs will be necessary, though only a minority of facilities incorporate this service within the chemotherapy facilities.

8.54 Books, televisions, etc and other patient entertainment facilities should be a feature of chemotherapy day-care units and wards. Essentially, the patient remains on a treatment chair or couch for periods of 30 minutes to several hours. It is often beneficial if relatives, friends or hospital staff can remain with the patient and some units will give social care as an integral part of the treatment process. Commonly, day-care treatment rooms will accommodate six to 12 patients in an open area with good nursing observation. Typically such units will also incorporate side rooms or separated areas for those requiring treatment in more private circumstances.

8.55 The cytotoxic drugs will have a harmful effect on the patient's immune system. Greater emphasis must be placed on design to enable staff to keep the treatment unit, or ward, clean and as free from infection as is reasonably possible, while still providing a comfortable environment. Immediate reactions to the drugs may include nausea and vomiting, though this is less common with modern techniques. However, the room design should be such as to facilitate easy cleaning and decontamination.

8.56 Further to the above, patients occasionally have a more severe adverse reaction to the treatment. Nursing facilities must include oxygen and suction outlet in a group room plus an emergency box with full resuscitation facilities near at hand.

8.57 Chemotherapy facilities should include at least one area where a tuberculosis (TB) patient can be cared for as tumours may develop as a consequence or complication of this disease. Similar considerations may also need to be applied to the care of patients with HIV or AIDS without discriminating against them.

8.58 Access for people with disabilities to chemotherapy facilities should be regarded as essential.

8.59 Special equipment requirements within chemotherapy areas will be variable and should be subject to local consultation. However, the cytotoxic drugs are hazardous and regulatory requirements extend to secure storage in locked and alarmed facilities which will include the need for refrigeration in most instances. Facilities for manual or computerised record keeping are essential. Records must permit ready audit of cytotoxic drug use and administration to individual patients. In addition, patient-monitoring equipment must be available though occasional rather than routine use is expected.

Cytotoxic drug preparation, storage, transport and disposal

8.60 Pharmacy facilities, purpose-built or adapted, are required by regulation. Cytotoxic drugs for use in chemotherapy must be prepared in an aseptic pharmacy preparation room, this may be located in a main hospital or as a pharmacy outpost in the cancer care centre.

8.61 The nature of the facilities depends on the classification of the work done under the pharmaceutical regulations. This is concerned with the extent to which drugs are being manufactured or, more simply, prepared. In all cases, operator protection against toxic aerosols and surface contamination is an essential feature and implies the use of a controlled environment, housing containment and safety cabinets. Ease of decontamination is an essential feature and dictates the use of impermeable and smooth floors, walls and bench surfaces.

8.62 The discharge of cytotoxic materials into the environment is also regulated. Accordingly, specific routes for disposal must be agreed and described in local rules and protocols.

8.63 The suite will be designed to facilitate controlled access for those with appropriate authorisation only. The use of protective clothing is necessary and requires the provision of storage and modest changing facilities.

8.64 Cytotoxic drugs may be delivered by hand or by pneumatic tube, however the means of delivery must be secure and traceable.

8.65 **Components of a chemotherapy suite**

- Chemotherapy treatment room;
- Inpatient chemotherapy ward;
- Chemotherapy storage, use and disposal facilities;
- Chemotherapy pharmaceutical preparation laboratories.

8.66 See Appendix 2: Room layouts for example layouts.

9. Medical physics services

The role of medical physics

9.1 The provision of medical physics services or clinical science support is undoubtedly essential to the provision of a range of modern cancer care services, particularly in the area of radiotherapy. The following list illustrates the range of contributions which clinical scientists and medical physics technicians may be expected to provide:

- radiation protection advice and scientific support of safe ty provision;
- calibration and output monitoring facilities for devices which generate radiation beams, including linear accelerators, etc., used in teletherapy and also radioactive sources applied in brachytherapy;
- the provision of quality assurance services in both therapeutic and diagnostic facilities applied to cancer care;
- first line and, in some cases, more comprehensive services for the maintenance of cancer care equipment, particularly linear accelerators and radiotherapy simulators;
- the design and construction of accessory devices used in routine teletherapy such as shielding blocks and other modifying items;
- the provision of patient dosimetric services to include patient surface dose measurement by thermo luminescent dosimetry (TLD) and the use of radiation-sensitive diode arrays;
- clinical scientist and medical physics technicians have a learned role in terms of maintaining the scientific and technical standards of understanding within a department and also supporting the research endeavours of other professional groups;
- a role in the maintenance of good standards in respect of imaging, including the use of image computing and the development of such facilities;
- provision of scientific and technical support to the radiotherapy treatment planning process for both teletherapy and brachytherapy;
- a ‘troubleshooting’ role related to the correction of deficiencies in operational protocols and the routine functioning of radiotherapy departments and, in some instances, medical cancer facilities;
- installation and commissioning of major equipment.

Facilities required

9.2 The following rooms or facilities are needed to accommodate the long list of functions for medical physics above:

- the provision of offices suitable to accommodate administrative and academic functions and also for treatment planning;
- laboratory space with suitable benching and under-bench storage to permit the conduct of physical science experiments over a very broad range of objectives but to include instrument calibration and the development of bespoke devices;
- storage facilities for an extensive range of equipment including delicate instrumentation, dosimetry equipment, quality assurance devices and sundry materials used in mould rooms and engineering workshops;
- metal fabrication and general engineering workshops. The scale of these workshops will be dependent upon the technological choices made for the delivery of teletherapy services in particular, though the majority of departments also support a broader role.

9.3 Detailed guidance on these facilities is given in Chapter 16.

10. Facilities for the use of unsealed radioactive sources

Unsealed source therapy

10.1 Unsealed radioactive sources are simply radioactive materials present in a non-encapsulated form, normally implying a liquid solution, though gases, droplet suspensions and powders are also occasionally used. Rigorous care and attention to safety matters is always an important component in unsealed source use, storage and disposal. This care requirement and the use of strict protocols significantly influences cancer care centre design.

10.2 In clinical terms these materials may be used for both diagnostic and therapeutic applications. In both cases the underlying principle employs biochemical and physiological mechanisms of substance uptake. For example, the sugar glucose is taken up from blood and metabolised by the brain. If this sugar is 'labelled' by the attachment of a radioactive substance to form an injectable unsealed source then the brain may be imaged using the very low level radiation produced.

10.3 In therapeutic terms, the objective is clearly not to image but is instead to deliver a large radiation dose selectively to a tumour or cancerous tissue. The most commonly used example employs unsealed Iodine 131 to treat cancer of the thyroid gland by taking advantage of the natural uptake of iodine by that organ.

10.4 The availability of both diagnostic and therapeutic unsealed source related services are intrinsic to the care of cancer patients in a cancer care centre.

10.5 Cleanliness, and often sterility, are important in the medical use of unsealed sources. For substances given to the patient orally, for example the iodine drink or capsules referred to above, high standards of cleanliness are essential. For injectable (IV) materials, full pharmaceutical standards must be met such that aseptic and sterile considerations are to be respected.

10.6 Unsealed sources clearly emit ionising radiations and thus all the issues surrounding the shielding of the sources and environment apply equally here. However, for unsealed materials, an additional challenge is generated by the need to avoid spillage and to control the spread of radioactive contamination from such sources. These two requirements influence design significantly, both in terms of structure used and surface finishes applied. There are also important implications for material choice due to chemical considerations, for example the often irremovable nature of iodine contamination of stainless steel. The detailed advice of the local Radiation Protection Adviser (RPA) should be sought at an early stage.

10.7 The use of some, though not all, radioactive unsealed sources has a significant environmental influence.

10.8 A full background description and design advice on the diagnostic uses of unsealed radioactive sources is provided in NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

The patient journey

10.9 The patient journey for those cancer patients receiving unsealed source therapy differs greatly from the general case. An outline description with notes on the built environment implications is given below:

- referral for unsealed source therapy will follow from diagnostic procedures and a meeting with the patient's responsible consultant, who may be from one of a number of disciplines;
- the patient will be admitted as an in-patient for the majority of treatments, most particularly for iodine treatment of the thyroid. This is necessary both for clinical safety reasons and owing to the need to control the potentially hazardous materials and radiation used;
- a side room with special facilities is needed to accommodate the patient during treatment. Key features include protection against both radiation and radioactive contamination;
- in the majority of instances, the unsealed source drink or capsule will be given to the patient in the side room to the treatment suite. This minimises the risk of contamination spread in the hospital and promotes patient-centered care;
- the administration of the substance will be given by a clinician often accompanied by a clinical scientist and nurse. Monitoring of the radiation level will be conducted for both safety and treatment control purposes with the patient in bed;
- the patient will remain confined to the treatment room until the radiation level drops below a defined threshold, after which transfer to the general ward or discharge will be considered. In older designs of treatment room the use of shadow-type protective shields alone implied that the patient must remain largely in the bed. However, modern designs give greater freedom and have en-suite facilities for the patient's use. This latter feature has the major advantage that radioactive urine and faeces are discharged by the soil drainage system, of special design, within the treatment room. Equally a washing machine, washing-up sink and washhand basin for use by staff play a useful role in preventing the spread of contamination;
- during the long period of confinement within the treatment room, good design and the use of shadow shields will permit the patient to have visitors on a limited basis, and afford the possibility of less minimal nursing. Some advanced designs also incorporate a window and use external shielding as a garden feature. Patient groups indicate that such features are helpful in

relieving the effect of treatment room stays of typically two to five days. Such solutions may require controls on outside access.

10.10 **Components of unsealed source rooms – therapy suite**

- iodine treatment room, en-suite facilities;
- storage facilities for unsealed radioactive materials;
- delivery facilities for unsealed radioactive materials;
- unsealed source preparation laboratory (materials are generally sourced from Radiopharmacies;
- contaminated items store; decay store;
- monitoring instruments store;
- storage facilities for spill kit;
- personnel decontamination facilities.

Care of the disabled

10.11 Generally within cancer care centres there is little or no reason why design elements should not be incorporated to permit access for the full range of disabled persons to all facilities, without compromise to general or specialist safety requirements. However, for wheelchair users a special problem is thought to exist so far as access and egress is concerned and in controlling contamination from iodine and similar treatments. This arises from the use of water bars at strategic points on the floor within the treatment room. These are required to contain any spills or other 'accidents' containing radioactivity. To date no fully effective solution to this challenge has been identified.

10.12 During the process of showering, washing or other body functions, excreted body fluids containing radioactivity pose a particular problem. Designs to restrict the spread of contamination at the entrance to the sanitary accommodation, and if possible at the entrance to the treatment room, are strongly recommended.

11. Cancer surgery requirements

Characteristics and applications of cancer surgery

11.1 Although radiotherapy, chemotherapy and hormonal work have all gained substantial ground in recent years, the majority of clinical referrals continue to be directed to cancer surgeons. This reflects the very high value of cancer surgery both in palliative work and radical curative applications. Although greatly variable across the UK, the majority of surgery will form part of an integrated treatment programme by making use of many parts of the portfolio described in this document.

11.2 The profile of cancer surgery continues to change markedly and is the subject of constant learned and advanced technological development. This is reflected in the increasing range of surgical techniques and broadening envelope of use as well as improved outcomes. The boundaries of surgical activity are less distinct than hitherto owing to the rise of minimal invasive therapies which may supplement or replace conventional surgical techniques.

11.3 As might be expected for surgery as a whole, the level of invasion and severity of procedures is broad. The following list, although not fully comprehensive, is representative of commonly applied techniques which must be supported by cancer care centres:

- laser ablation for the treatment of cervical pre-cancer and a range of other relatively accessible lesions;
- the removal of surface or skin lesions by conventional or cryosurgical means;
- cancer-related uses of endoscopy;
- the insertion of lines and catheters, including Hickman-type, by surgical or minimal invasive means, often under X-ray control;
- the insertion or implantation of brachytherapy applicators or tubes for machine controlled afterloading radiotherapy. Occasionally pre-loading of sealed radioactive sources in the operating theatre may still be required;
- breast surgery as a part of a comprehensive breast care service. This will range from relatively modest lumpectomy procedures to radical mastectomy, including the removal of lymph nodes. For the purposes of this guidance, the commonly applied technique of mammography guided needle biopsy is considered to be non-surgical;
- some centres will be offering surgery to the prostate, including robotic procedures, though not all such work is cancer-related;

- a broad category of investigative surgery continues in use. This area is in modest decline owing to the increasing contribution of cross-sectional imaging by CT and MRI;
- de-bulking of benign, and some forms of malignant, tumours. Such surgery can be radical in nature and is frequently a precursor to other forms of treatment;
- surgery with direct curative intent on largely nonmetastatic low-invasion tumours;
- *surgical biopsy*. This range of techniques continues to be very important as it permits the sampling of suspected cancer tissues for histological examinations which may confirm or deny the presence of malignancy. This area is developing quickly in technological terms owing to the increasingly common introduction of both stereotactic and navigational techniques. These technologies, which have their origins in neurosurgery, are now more broadly applied. Images from CT and MRI are used to enable this type of surgery;
- *reconstructive surgery*. There is a greatly increasing demand to reconstruct parts of the body that have been damaged by cancer or the processes of surgery. These procedures are particularly common in the breast and are increasingly seen as indicators of high-quality care;
- *intra-operative radiotherapy.* This is a technique which has begun to be used in the United States and could be expected to spread. A small source of ionising radiation is used in the operating theatre to treat an exposed tumour with associated radiation hazards. This will require at least some structural radiation shielding to be incorporated into the walls of the operating theatre, together with shadow-shielding. It may have implications also for the electrical supplies required to that theatre.

11.4 The above clearly represents an extensive portfolio of techniques which places a range of demands on operating theatre design and availability. In considering programmes to modernise cancer care centre provision, project teams should evaluate, at local level, the number of operating theatres and associated facilities required. The nature of such facilities is dealt with later in this guidance.

Outline classification of requirements

11.5 The range of surgical facilities needed to accommodate the above techniques is wide and variable in nature. In order to simplify planning and design challenges, this document uses a simple but arbitrary classification scheme. This scheme grades operating theatres from Levels 1 to 4 according to the protective requirements in terms of possible infection. In addition, three categories are used to indicate the extent to which the theatres concerned are standard, modified to suit cancer treatment or largely devoted to such treatment. These groups represent categories 1, 2 and 3 respectively, see Table 5.

11.6 The Chief Medical Officer advises continued and increased vigilance concerning the quality of the built environment used for the decontamination, sterilization and storage of surgical instruments. Mention of these facilities is made below, however, attention is drawn to the Property and Environment Forum's compendium of documents and advice published on CD-ROM.

Built environment requirements

11.7 The following provides an outline description of the requirements for cancer surgery using the categorisation described above. For general advice the reader is referred to NHS Estates guidance HBN 26 'Operating department' together with Scottish Hospital Planning Note 26 'Operating department.'

Facilities for relatively minor procedures

11.8 This environment is perceived as being appropriate for procedures where the risk of infection is relatively low and the period of immediate recovery short. As may be seen from Table 5, most of the surgery is to the skin or body orifices, though some simple biopsy work will be included. General advice on the largely similar 'treatment area' concept is given in NHS Estates guidance HBN 40 Volume 2 – 'Common activity spaces: treatment areas'.

11.9 The rooms broadly have the characteristics required for general minor procedures. Particular attention is drawn to the need for easy-to-clean surfaces, devoid of dust traps. The drive toward reduced infection rates puts particular emphasis on good quality clinical hand washing facilities. Some local teams may also require scrub-up facilities which may be located adjacent to, or in a corner of, the procedures room. A simple support suite for reception of patients, who will mostly be ambulatory, should be provided together with facilities to receive patients in wheelchairs or on trolleys.

11.10 Within the procedures room, basic medical gas supplies including air, oxygen and vacuum/suction will be needed, though general anaesthesia is not envisaged at this level. A low-power, ceiling-mounted operating light will be needed together with a single surgical pendant. The introduction of the pendant is now seen as an essential requirement in the interests of improved patient service arising from the greater dependence on technology use in these rooms. The need to eliminate or reduce hazards to staff from trailing cables has also been considered. Mechanical ventilation, using a coarse filtered air supply, will be required but the business of micropore filtration and accurate airflow control is not seen as a key requirement. The room shall incorporate facilities for cryosurgery where local demand can be demonstrated.

11.11 The suite should include a recovery room sufficient for two patients, storage facilities for lay-up of small surgical trolleys, drugs, etc., and a separate dirty storage room for the short-term accommodation of contaminated surgical equipment. The local decontamination and recycling of surgical equipment is not recommended.

11.12 Three options for the location of the cancer minor procedures facility should be considered:

Option one

Close to the outpatients department or facilities used for general cancer patient care.

Option two

As part of a theatre complex but located towards the periphery of the theatre grouping in a relatively patient-accessible location. This should be such as to ensure the absence of need for the patient to enter the clean theatre corridor other than under the full control of staff.

Option three

Adjacent to in-patient wards and other treatment areas.

Surgical technique	*Theatre level*	*Room category*
Laser ablation	2	2
Surface cryosurgery	1	2
Cancer endoscopy	1	2
Insertion of lines and catheters	2	2
Brachytherapy implants	2/3	1 (HDR 3)
Breast surgery	2/3	1
Prostate procedures	2/3	2
Investigative surgery	2/3	1
Tumour de-bulking	2/3	1
Curative surgery	3	1
	3/4	3
Reconstructive	4	1 (3)

Table 5: **Operating theatre facilities required for cancer surgery**

Facilities for intermediate level procedures

11.13 These may be characterised as operating theatres for full, but not especially prolonged, anaesthesia and incorporating a full operating table, surgery lamp(s), monitoring facilities and be of sufficient size to allow for a full operating team of six persons. Full scrub-up facilities adjacent to the operating room must be provided. The theatre shall be equipped with a full filtered air system with pressure and flow regulation but ultra clean facilities are not envisaged at this level.

11.14 The theatre suite shall incorporate a recovery room with full observation facilities, trolley lay-up or preparation room (clean supply), separate used trolley storage or, if local conditions allow, trolley breakdown room with adjacent decontamination facilities.

11.15 In order to promote efficient and safe operating theatre use, there is a clear requirement for a separate but adjacent anaesthetic and patient preparation room, equipped with full medical gases as for the theatre itself.

11.16 Some specific cancer specialisations present themselves in relation to facilities of this type. Where local treatment approach so requires, the insertion of brachytherapy applicators will be supplemented by facilities to permit high dose rate machine afterloading treatment. Such facilities are an observably effective option to the provision of treatment rooms specialised for HDR only. Where incorporated into operating facilities, HDR will require room shielding-based radiation protection and remote protected observation/control. Colour closed circuit TV (CCTV) will be needed for patient observation. The design of the facility should be such as to afford the anaesthetist an acceptable level of confidence while HDR procedures take place as the patient remains under anaesthetic.

11.17 Theatre type standard finishes and general facilities as described in NHS Estates guidance HBN 26 'Operating department' and Scottish Hospital Planning Note 26 'Operating department', are fully applicable but particular attention should be paid to the need for mobile C-arm or image intensifier access and use. Special storage facilities for Hickman lines, catheters, guide wires, etc., will be needed. These should be within or immediately adjacent to the operating room.

11.18 Where cervical and other Class 3 laser treatment procedures are to be offered, the special considerations, set out by the Medical Devices Agency guidance, must be followed. This will include special power supplies for laser equipment, reduced or non use of polished surfaces and the provision of window blinds, laser safety signs, etc. The laser radiation protection advisor (LRPA) must be consulted on theatre design, the declaration of a laser controlled area and the provision of warning lights, etc.

11.19 Options are readily identified in terms of the provision of this facility:

Option one

A location adjacent to other cancer inpatient facilities as a satellite of the main hospital operating theatres.

Option two

This option entails that the theatre simply be a part of the hospital's main theatre unit. This may pose a special challenge if HDR facilities are incorporated and the theatres are above the ground floor. This difficulty arises from the need for heavy radiation protection shielding and its consequent structural loading.

Locations adjacent to radiotherapy facilities are seen as undesirable owing to the need for full theatre conditions and possible out of hours use.

11.20 Although this group of facilities may be reasonably seen as little more than a limited modification of general operating theatre design concepts, a thorough consultation with the broad cancer care team is recommended at an early stage in design. Particular care should be paid to engineering requirements and energy use in these theatres. Further advice is provided in Appendix 1: 'Specialist engineering requirements'.

Facilities for high level procedures

11.21 A proportion of cancer surgery requires a longer period of anaesthesia and particular care over protection against infection. This being the case, access to a large area, high category operating facility will be necessary for the majority of cancer care centre teams. The provision of dedicated facilities will be needed only where local treatment programmes and specialisations are required. Thorough consultation with cancer surgeons and their support teams is essential.

11.22 The procedures conducted at this high level are of increased complexity and make use of additional technologies and may require further members of staff when compared to the less elaborate procedures accommodated by the facilities described above.

11.23 Complex organ surgery, which may encompass vascular aspects, and relatively new techniques that use stereotactic or navigational technologies are included within this area of activity. Some will be based on and applied in neurosurgery. Of these, the image-based navigation approach is developing quickly and requires that image data derived from pre-operative imaging, or alternatively imaging during procedures, be utilised. In the first instance, the images are transferred by disk or network to a navigation computer which must be accommodated within the operating room. These machines are relatively bulky and are associated with special cameras that also have to be accommodated, which track the position of surgical instruments within the patient's anatomy. Such surgery was originally confined to brain and spine but is now finding increasing applications over a broader range of anatomy.

11.24 Reconstructive surgery provides further examples of surgical tasks that are subject to the need for particular care in order to avoid patient infection. This gives rise to careful detailed design to reduce dirt and dust traps. Further, the standard filtered mechanical ventilation system, typical of the operating theatres described under intermediate level procedures, will require a higher standard. Attention to the use of micropore filtration to further reduce particles and quantity is appropriate. Systems are further augmented by the use of precision theatre room atmosphere pressure control and ventilation portals. These will require detailed engineering consultation. Further information is provided under 'ultra-clean ventilation' in NHS Estates guidance HBN 26 'Operating department' together with SHPN 26 'Operating Department'.

11.25 The use of overhead service pendants is required and care should be taken both in the numbers selected and their position relative to the operating table, surgical lamps and any plenum canopy used with the ultra-clean air system.

The use of navigational computers and some other surgical aids will require that power and other services be provided to computer/instruments systems. This is frequently best achieved by the use of a pendant partly or wholly devoted to this purpose. While all operating system power supplies will be connected to hospital back-up or generator systems, the use of an uninterruptible power supply (UPS) will frequently be necessary in order to safeguard proper operation of some of these computerised instruments.

11.26 Operating microscopes are worthy of particular attention in terms of the power supply considerations mentioned above, and also because of the exceptional bulk of some examples. These instruments, particularly in robotic form, are especially space consuming, being approximately two metres deep and requiring a lateral movement of one and a half metres. This space must be free of obstruction. Similar considerations may be expected to apply in future to other forms of robotic surgery and telesurgical technologies. Extending these considerations, the optical devices mentioned have a particular sensitivity to mechanical vibration which may influence decisions in terms of theatre siting and some elements of construction.

11.27 Storage facilities associated with operating theatres used for the specialised applications mentioned above will need to be larger than is otherwise contemporary and subject to special considerations on positioning so as to ease the movement of equipment. As this equipment will require frequent maintenance, the storage facilities or alternative areas should be sized so as to permit access by one or two service engineers. The provision of task lighting arrangement and power supplies to support this activity should also be considered.

11.28 The need for specialist decontamination of electronic surgical instruments should be evaluated. Many of these are unsuitable for conventional steam load porous sterilization.

11.29 The use of imaging technology and the specialist nature of some of the cancer-related surgery will place additional requirements on design in terms of data communication and teaching facilities. Theatres at this level must be equipped with a wide-bandwidth optical LAN to support image and general data communication to reduce the risk of interference from Rf-generating surgical instruments such as bi-polar forceps. Observation of procedures by staff and students in training is likely to be a frequent requirement. Consideration should be given to the possibility of elevated viewing windows or the lower cost alternative of CCTV systems.

11.30 The long periods of time spent by surgical teams, particularly the leading surgeon and their assisting nurse, give rise to a need for careful consideration of ergonomics, some aspects of lighting and the possibility of eyestrain. At the current state of understanding NHSScotland is not able to prescribe design solutions, but asks design teams to discuss these issues at local level with the staff concerned.

11.31 The siting of this category of operating room is essentially restricted to the principal theatre complex of the host hospital. It is important that the theatre has full local access to auxiliary accommodation and postoperative patient care facilities.

12. Offices and support facilities

Introduction

12.1 In general terms the office and general accommodation of a cancer care centre does not differ greatly from that of other hospital-based facilities of comparable size. However, a number of points requiring special care do arise.

Offices

12.2 Consultation rooms used for sensitive discussions with seriously ill patients and their relatives require careful siting. There is a need for discretion in terms of sound control, use of induction loop hearing aids, and of access and departure arrangements.

12.3 As part of the business of advancing cancer services, the great majority of centres are engaged in a range of clinical trials. These have special office needs to accommodate staff with roles such as record keeping and data analysis.

12.4 The National Cancer Registry is an intrinsic part of the drive towards better cancer outcomes and, as with clinical trials, there may be a need for temporary or permanent accommodation for a high-level clerical team.

12.5 The introduction of new technologies which better combine and handle patient treatment data, particularly in radiotherapy, has given rise to the need for data entry and review facilities for use by radiographers and other key treatment delivery staff. These can be accommodated in an open plan office suite adjacent to the radiotherapy facilities.

12.6 Office accommodation for those responsible for psychological and social care of patients and their families will be required, and open access rooms for patient information services are necessary.

Educational facilities

12.7 The widespread increase in the sophistication of approach to cancer care and the near-ubiquitous need for continuous professional development (CPD) has placed an increasing emphasis on education facilities. Key points in relation to cancer care centres include:

- the clear need for a seminar or lecture room with modern audio-visual facilities and good computer systems access, this is now well established. In order to promote effective use this should be located close to patient care areas. In the future, the seminar room will probably be the location of the

main telemedicine 'node' within the cancer care centre, therefore space and service provision should be made for this equipment;

- library facilities and Internet access points, these are key to modern cancer care services. It is essential to consider providing private study space. Remotely located facilities have been shown to exhibit poor level of uptake and use. Convenient staff access is accordingly an important parameter;
- specialist staff training facilities for the basic and postgraduate education of staff members such as radiographers, physiotherapists, etc. Design details are not within the scope of this guidance.

13. Information system requirements – image, pathology and radiotherapy data; computerised management of cancer care processes

13.1 The range of data types that must be used in cancer care is very large. It is recommended to bring together multi-disciplinary teams, and use a broad range of equipment, to optimise the treatment of patients and also to ensure that the treatment deals with the whole patient and not merely some aspect of their disease. Intrinsically, this requires that disparate data be brought together in a coherent way to generate clear clinical information.

13.2 In some traditional radiotherapy and cancer care centres within the NHS, the whole information process can be dealt with on film and paper since methodologies exist and very large spaces are available for storage.

13.3 In new and reconfigured cancer care centres, the feasibility of maintaining complex records on hard copy file materials is thought to be dubious. A move away from paper and hard copy materials is likely to be appropriate in some established centres from an economic and operational viewpoint. However, there is a substantial impact on building design when paper storage spaces are replaced by IT facilities.

13.4 In light of the above, the use of comprehensive computerisation at new centres is one preferred option and is in keeping with a trend in that direction by other major NHS centres. Consequently, distributive robust networks of multiple computer workstation servers is needed and this should be reflected in the building design. Suitable rooms should be allocated in which these servers and the associated network hub units can be placed. Network structures should be incorporated into service ducts, etc. Data entry and review rooms are also needed.

13.5 The multi-disciplinary nature of the work in cancer care requires that most , if not all, the services presently offered by the hospital remain but that they become intimately associated, where necessary, with new services provided. This being the case, any network used must have close ties to any network within the host hospital itself. Furthermore, if the hospital network is of relatively modest bandwidth, some upgrades within the hospital will undoubtedly be necessary.

13.6 The Royal College of Radiologists and a number of other learned bodies have drawn to the attention of the medical community the critical nature of delays, interruptions and errors in chemotherapy and radiotherapy treatments. This being the case, it is important that data is secured, not only against intrusion, but also against loss. Interruptions in or the inability to transmit data from places of storage to places of use may also be detrimental to patient service quality. Accordingly, if a digital option is to be pursued, a backbone network with

extensive route duplication and dual connection of servers and other critical devices appears to be necessary.

13.7 If the option above is to be pursued, the operational and design consequences should be carefully considered when developing or adapting a cancer care centre.

13.8 Changes in the way information is handled will have a great effect on the patient's cancer journey, and treatment schedule, when compared to traditional film and paper methodologies. In particular, reduced waiting times and more rapid throughput have been observed in radiotherapy departments modernised in this way.

13.9 The computer-based option may also free up some space used previously by large storage and film libraries. However, some of this space may be taken up by servers and other computer equipment as mentioned above. There may also be a need to store some data media in more than one building in order to protect against loss in the event of fire.

13.10 The computerised option will allow centres to communicate with cancer care units and primary care practices using telemedical means. This will almost certainly have an effect on patient journeys throughout cancer treatment by easily allowing some routine monitoring and follow-up to be carried out at local cancer care units and at primary care level.

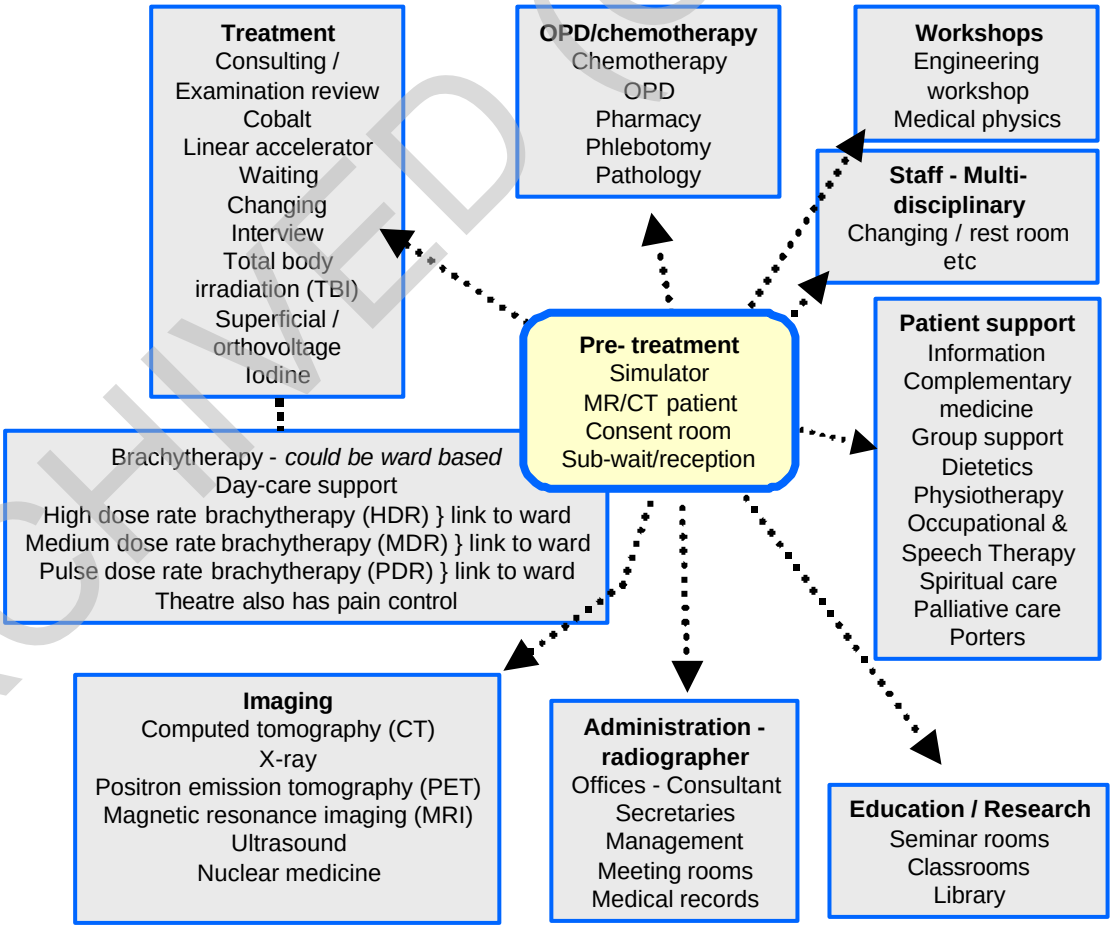
14. Description of accommodation

Introduction

14.1 This Chapter gives detailed guidance on the planning and design of accommodation in a cancer care centre and it:

- outlines the planning process;
- gives a detailed description of room requirements in diagnostic, treatment and support areas;
- highlights general design considerations.

14.2 Details of activities, equipment, environmental conditions and finishes are given in NHS Estates Activity DataBase. Detailed schedules of accommodation will be published in a separate document that will include cardiac and diagnostic imaging data.



Relationship between clinical functions and rooms or facilities used.

The planning process

14.3 Throughout this guidance, detailed attention is paid to safety, risk control and the implications for building design. The requirement to give such attention to building projects is embraced in SI 1994 No 3140 The Construction (Design and Management) Regulations. These are broad-based but ascribe particular and specific duties to both designers and others who contribute to the shaping of design solutions. The regulations were subject to technical amendment in 2000 with a clarification on the statutory definition of a designer.

14.4 The primary duty is for due regard to health and safety in design work. This includes a requirement to conduct risk assessments both in respect of the building and the process of its construction. In addition to an overall consideration of broad risk categories, the regulations also instruct on the need for safety and risk analysis at the detailed design level. There is a requirement to evaluate design options in terms of risk reduction and the cost of such, though a balanced approach with due consideration of many other factors is described as appropriate.

14.5 A large part of the design process must always consist of close collaboration and consultation with end users of the new development and those responsible for existing buildings within the same or closely related institutions. The regulations may be interpreted as requiring broad care in respect of overall design and facilities management as well as technical alignment. There is a particular need to avoid solutions that may be technically acceptable but not compatible with organisational and operational requirements.

14.6 In all instances there are duties for the designer and planning supervisor but those of the client or end user must also be respected. This will often require close co-operation and collaboration between employers including all participant parties in private finance initiative (PFI) and public private partnership (PPP) agreements.

Description of accommodation

14.7 These descriptions below cover the full range of built environments that may be used by cancer care centre patients, related healthcare professionals, support group members and relatives.

14.8 Some aspects of the accommodation described will be largely or wholly devoted to the care of cancer patients while other spaces will be of only limited relevance. This guidance covers the dedicated accommodation in detail but also describes any cancer-related specialisation or adaptation to more general rooms.

14.9 The full design details for the standard rooms are given in other NHSScotland and NHS Estates publications.

Common spaces

Main entrance

14.10 Ambulances and taxis may deliver and/or collect patients. The entrance canopy should be large enough to afford adequate weather protection for patients alighting from and entering vehicles, and high enough to clear lights and aerials on ambulances. The space should be well lit and suitable for use by those with disabilities.

14.11 Access to and from the main entrance should be through a draught lobby with automatic doors. The lobby should be large enough to allow people to stand aside to permit the passage of a patient accompanied by an escort and also to allow pushchairs and wheelchairs to pass. Consideration should be given to providing a smoking facility in order to avoid people congregating outside the main entrance.

14.12 For further information refer to:

NHS Estates guidance 'The design of hospital main entrances (Design Guide)' which can be used with general caution in Scotland.

NHSScotland and NHS Estates guidance SHPN/HBN 40 – 'Common activity spaces' Vols 1 to 5.

14.13 Attention is drawn to the need for the installation of induction loops for those with hearing difficulties.

14.14 The main entrance will be the principal route in and out of the centre for the majority of visitors and staff.

Reception and waiting areas

14.15 The reception and waiting areas will be the first point of contact for patients and carers when they visit the facility. It is important not to miss the opportunity to provide a reception that warmly greets all those who enter with a feeling of support and reassurance balanced with a sense of efficiency. A well considered reception with friendly staff and well managed appointments will help to reduce stress to both patients and staff. The benefits available from good interior and environmental design have been well researched and documented.

The influence of information technology

14.16 Conventionally equipped and managed treatment facilities and appointment systems generate waiting areas well represented in the NHSScotland and NHS Estates guidance referred to above. However, centres with fully integrated, computer-managed equipment and appointment systems and a well designed patient flow pattern with sub-waiting areas, are likely to result in smaller waiting areas whose character is calmer, less stressful and more humane. Reduced waiting times benefit the patient and promote a more efficient and relaxing

environment. Good examples of this arrangement are at Derriford Hospital near Plymouth and at the Karolinska Institute in Stockholm, Sweden.

Lounge/reception area at the Linda Jackson Macmillan Centre

Reception for chemotherapy waiting area. Note low desk section for talking to those in wheelchairs

Diagnostic facilities

14.17 The diagnosis processes will involve the use of one or more of the following departments. Depending on the circumstances of the cancer care centre these may be located in an adjacent building if the unit is part of a hospital, or the patient may have to visit a remote facility.

Radiology

14.18 In the cancer care environment, the purpose of a radiology department is to provide a range of facilities for the investigation of patients by means of radiological and complementary techniques. Investigations and procedures are selected by an oncologist supervising the patient's care in consultation with a radiologist. Radiology departments carry out investigations and report on the results as quickly as is reasonably practicable.

14.19 For further information refer to NHSScotland guidance SHPN 06 'Facilities for diagnostic imaging and interventional radiology'.

Haematology

14.20 Haematology is the study of blood, its function and disorders. Refer to NHSScotland guidance Scottish Hospital Planning Note 15 – 'Accommodation for pathology services'.

Consulting rooms

14.21 These will be used for consultation, examination, taking and recording of blood pressure, and for minor diagnostic and treatment procedures. Space is needed for a desk and chairs, and an examination couch, screened by curtains. There should be sufficient space within the curtained area for a patient to undress/dress in privacy, with assistance when required. The examination couch should be accessible from both sides. Space is needed for storing small items of equipment and small quantities of supplies and for a mobile adjustable examination lamp. Clinical hand wash facilities are required.

14.22 Consulting rooms should be large enough to accommodate a multi-disciplinary medical team as well as the patient, who may be in a wheelchair, and an escort. This will allow an integrated and balanced consultation to be delivered when appropriate.

14.23 The layout of the room should allow patient and consultant to be seated facing each other in an informal arrangement without any intervening barrier such as a desk, and should ensure maximum privacy, especially when the door is opened. Communicating doors between adjacent consulting rooms may facilitate the movement of staff, but they are not recommended as their use intrudes upon both the patient's privacy and the consultation.

Computed tomography (CT) suites

14.24 The scanning process involves the use of equipment that generates X-rays and therefore takes place in a room that is constructed from radiation shielding materials placed between adjacent rooms including the control room associated with the CT scanner.

14.25 Audio-visual contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

Magnetic resonance imaging (MRI) facilities: whole and part-body

14.26 The scanning process takes place in a room that is constructed from normal building materials but which is surrounded by a bonded wire screen to protect adjacent equipment from the strong magnetic field that is generated by the MRI unit.

14.27 Audio-visual contact with the patient during the scan is maintained through a protective glass screen supplemented by CCTV and intercom.

14.28 For further information see NHSScotland guidance Scottish Health Guidance Note 'Magnetic resonance imaging'.

Cytology laboratories and cervical screening

14.29 Cytology screening, particularly in respect of cervical cancer, constitutes a major established programme within the overall strategy for cancer care across the UK. The practice is to utilise microscope-based observations of cells or tissue samples obtained by the use of a speculum to scrape material directly from the cervical anatomy. There is no suggestion that these laboratories should only be in cancer care centres.

14.30 The process is vulnerable to error and in consequence, subject to very rigorous quality control. Audit measures are applied at every stage.

Accommodation and design

14.31 The cytology screening room is a dedicated cancer facility. The room will differ fundamentally in character from general pathology laboratories because of its special role and the very great need for care in ergonomic design. The walls should be finished in anti-glare neutral colours much as for the benches. The floors will be carpeted in heavy-duty material again with similar attention to the colour, carpet is used in order to suppress sound and also to soften the general characteristics of the room. Ceiling design should incorporate sealed light fittings and be constructed to minimise dust traps. The infection control team should always be consulted on finishes in clinical areas.

14.32 Some temporary storage of microscope slides, as well as auxiliary equipment, will be needed within the room.

14.33 It will be necessary to accommodate PC or similar computer equipment for access to pathology record systems and, in some instances, dedicated cytology screening records.

14.34 Windows should be largely restricted to those required to permit relaxation of the eyes by focusing on the outside horizon. Overhead natural daylight is unhelpful.

14.35 There are no special privacy considerations but full laboratory security measures are necessary. Access to the room will be restricted to professionals and auxiliary staff only. No patient access or access for relatives is required.

14.36 Professionals carrying out cytology screening may be disabled, and access and accommodation for the disabled, including wheelchair users, is an appropriate consideration.

14.37 The use of pendant-type service installations above some benches should be considered. This feature is particularly helpful over the height-adjustable island benches used for teaching, training and review as described earlier.

Information requirements

14.38 The keeping of records, both on paper and computer, is an important function.

14.39 For information on pathology facilities, many of which may be used as a part of the cancer care process, the reader should refer to NHSScotland's guidance Scottish Hospital Planning Note 15 'Accommodation for pathology services'. Information on the fitting out of laboratories is given in NHS Estates guidance HTM 67 'Laboratory fitting out systems'.

Therapeutic facilities

Nurse practitioner accommodation

14.40 A room of broadly clinical character and surfaces should be selected to promote easy decontamination and to reduce the risk of cross-infection.

14.41 Good standards of lighting with variable light level and a modest examination lamp, which may be either floor standing or ceiling suspended by an articulated arm, is suitable to permit the examination of surface anatomy or natural body orifices.

14.42 The room will contain an examination couch in an area that may be curtained off or otherwise separated from the remainder of the accommodation. Within the couch area, basic monitoring facilities to include those necessary for blood pressure measurement shall be included. Facilities for phlebotomy and the collection of readily accessible tissue samples are also required.

14.43 The examination or couch part of the accommodation must be large enough to accommodate the nurse practitioner and at least two other healthcare professionals as well as the patient.

14.44 In view of the potential for unpleasant odours arising from the procedures undertaken, the use of simple mechanical ventilation is required, 20–30 air changes per hour to allow for heated make-up fresh air. More complete mechanical air handling may be considered desirable where this is compatible with overall building design.

14.45 A consulting area in which the nurse practitioner may sit comfortably with the patient and up to two relatives should be provided. This should be of a relatively domestic character and the provision of coffee table and soft furnishings should be considered. The intention is to generate an environment where difficult issues can be discussed without undue formality. The nurse practitioner will require the use of a standard desk to be equipped with a personal computer suitably interfaced both to a LAN and through that to a WAN as required for communication with other medical sources including a local cancer care unit. The location of the desk and space afforded around it should be such as to permit small conferences with up to two other healthcare professionals in a relatively formal setting.

14.46 The nurse practitioner accommodation shall take the form of a fully enclosed room and access for patients by a light control or an enunciator system will be needed. It is also important that personal safety and security considerations in respect of the healthcare professionals utilising the room are considered. The fitting of an alarm button and use of CCTV are appropriate.

14.47 Nurse practitioner accommodation shall be positioned so as to permit easy access from the patient waiting area(s) and to other clinical consultation rooms used by GPs, etc.

14.48 A small refrigerator will be needed for the storage of body fluids, etc. A small lockable cupboard complying with the appropriate regulations for the storage of prescription drugs will be needed.

14.49 Filing cabinets and other means for the storage of paper records will be needed, though the requirements in this area are likely to decline as progress with the electronic patient record (EPR) advances at primary care level.

Minor procedures room

14.50 A room of clinical character and surfaces selected to promote easy decontamination and to reduce the risk of cross-infection is required.

14.51 Patients may be brought to the room on a bed or a trolley, in a wheelchair or on foot: members of staff and an escort will possibly accompany them. The door should be wide enough to permit easy access. Door swings should not impede movement or activities within the room.

14.52 Procedures may be carried out by doctors, nurses and appropriate other staff, with the patient lying on a bed, a trolley or an examination couch; sitting in a wheelchair or a chair; or standing. Access is required to all sides of a patient.

The examination couch should be mobile so that it can be moved easily to allow access to patients who need to be treated on a bed or a trolley.

14.53 The treatment room should be equipped with outlets for oxygen, vacuum, an X-ray viewing facility and a mobile examination lamp.

14.54 A preparation area is required where sterile packs, lotions and drugs for immediate use are stored and prepared for use, and where trolleys can be prepared for use and/or held. The preparation area should be separated from the procedures room by means of a partition wall, with the preparation area interfacing the standard treatment room and circulation space from which entry is made. Emergency call points, and clinical hand wash facilities are also required.

14.55 Clinical-quality colour-rendering light sources should be provided and walls, ceilings and floors should be of suitable colour and reflectance. The room should be sound attenuated. Natural light is preferred but not essential. Mechanical ventilation should be provided.

Endoscopy unit

14.56 Endoscopy is a general term relating to examination of a body passage or organ by means of an endoscope for purposes of diagnosis or treatment. Sophisticated diagnostic imaging may be employed where appropriate.

14.57 Further information and guidance including unit schedules of accommodation and room relationships are contained in NHSScotland guidance Scottish Health Planning Note 52 'Accommodation for day care – Part 2: Endoscopy unit'.

Nuclear medicine

14.58 The broad range of facilities including storage of radioactive waste is addressed in NHSScotland guidance Scottish Health Planning Note 06 'Facilities for diagnostic imaging and interventional radiology'.

Chemotherapy treatment rooms

14.59 A preparation area is required where sterile packs, lotions and drugs for immediate use are stored and prepared for use, and where trolleys can be prepared for use and/or held. The preparation area should be separated from the standard treatment room by means of a partition wall, with the preparation area interfacing the standard treatment room and circulation space from which entry is made.

14.60 The standard treatment room should have easy access from the consulting room(s) and bedrooms and be positioned between the clean and dirty utility rooms, with direct access for staff to each from the preparation area. A fridge should be available for scalp coolers.

Facilities for cancer surgery (special aspects of operating theatre suites)

14.61 The volume of cancer-related surgery cases generated will not normally justify a dedicated theatre suite, however good links with a general operating facility are essential. The theatre facilities do not generally differ in character from other theatre facilities, for example, laser equipment will be needed in some cases, techniques that are commonly found in gynaecological surgery.

14.62 Consultation with the laser protection advisor (LPA) at an early stage of the design process will identify operational, safety, engineering and built environment issues.

In-patient wards and related accommodation

14.63 Refer to NHSScotland guidance Scottish Health Planning Note 04 'In-patient accommodation: options for choice'. The general character will not differ from that of normal ward accommodation. However, a number of areas are different and will significantly affect the design. So far as is reasonably practicable, in accordance with the Scottish Executive's publication 'Our National Health – A plan for action, a plan for change', consideration should be given to the provision of patient *bedside* television/telephone/radio facilities; for further advice contact the NHSScotland Property and Environment Forum Executive.

14.64 Consultation early in the design process that relates to these areas is recommended in order to understand fully the implications for engineering services and the built environment.

14.65 Special side wards will be needed for those receiving treatment with sealed radioactive sources. These consist of en-suite single bed accommodation. The enclosing structure is shielded to prevent radiation passing from the room into the surrounding areas and typically consists of concrete in the order of 500mm thick with shielding doors and sophisticated electronic patient monitoring (see Appendix 2: Room layouts). For treatment with unsealed radioactive sources, the shielding does not require to be so thick. The concrete only requires to be between 100mm and 200mm thick (see Figure 2 and Appendix 2: Room layouts).

The RPA should always be consulted early in the design stage when those areas are being considered.

Radiotherapy reception

14.66 A well-considered reception with friendly staff and well-managed appointments will help to reduce stress to both patients and staff. The benefits available from good interior and environmental design have been well researched and are documented. For further information refer to NHS Estates guidance Design Guide 'The design of hospital main entrances', and Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces', Vols 1 to 5.

General design considerations

14.67 Reception desk design should balance the need to provide adequate data protection of appointment workstations and low sections of counter for exchange with patients in wheelchairs.

14.68 Reception counters will need to accommodate a number of workstations that will vary from facility to facility, the number depends on areas served, network point/s and printer. They should also afford adequate clerical desktop workspace and cupboard space for stationery, etc.

14.69 The waiting area, entrances and exit points should be visible from the reception desk.

14.70 Good wayfinding is essential to help reduce stress to both patients and staff and contribute to a calm well-organised atmosphere. For further information refer to NHSScotland Property and Environment Forums guidance 'Wayfinding'.

14.71 Sub-reception points should be near to entrance routes and near to treatment rooms. One sub-reception point is required per two linear accelerator treatment rooms or simulators.

Radiation therapy facilities (radiotherapy)

Patient changing facilities

14.72 Wherever possible, changing facilities should be adjacent to the treatment/planning facility and positioned so that patients cannot be seen by others once they have changed.

14.73 To assist with effective throughput, a minimum of two changing rooms per facility are required. One should be of sufficient size to permit changing for the disabled. Ideally, there should be a two-door arrangement where the patient enters the changing room from the waiting area, changes then exits into the treatment room/maze.

Treatment room

14.74 The dominating nature of a linear accelerator and the mass of high-tech equipment are likely to present a daunting experience for patients, which may be further exacerbated by equipment haphazardly placed around the room, often due to the lack of adequate storage space. Therefore every opportunity should be taken with the interior design to minimise these effects. The aim should be to create comfortable and cheerful surroundings with a sense of order and reassurance.

14.75 Lighting will play an important role. It will need to vary from subtle, for patient relaxation; low level when using laser alignment light; to normal levels for routine access and duties and high levels for maintenance tasks. The room should also have a 2-way sound system to lessen the patient's feeling of isolation during treatment.

Maze

14.76 The maze, the entrance and entry into the treatment room, must allow access for the treatment machine and subsequent replacement equipment. It should be wide enough to admit a hospital bed with additional equipment, trolleys, wheelchairs and large heavy components for linear accelerators. Corner/wall protection against damage by equipment wheelchairs, stretchers, beds, etc, should be provided. In certain circumstances the equipment may be delivered through 'access' openings which are then completed and filled in as necessary.

14.77 If there is a particularly long maze, consideration should be given to having a fold-down seat for more infirm patients.

14.78 Access control gates and/or infra red beams must be provided.

14.79 Lighting should be subtle and not glaring.

Engineering services

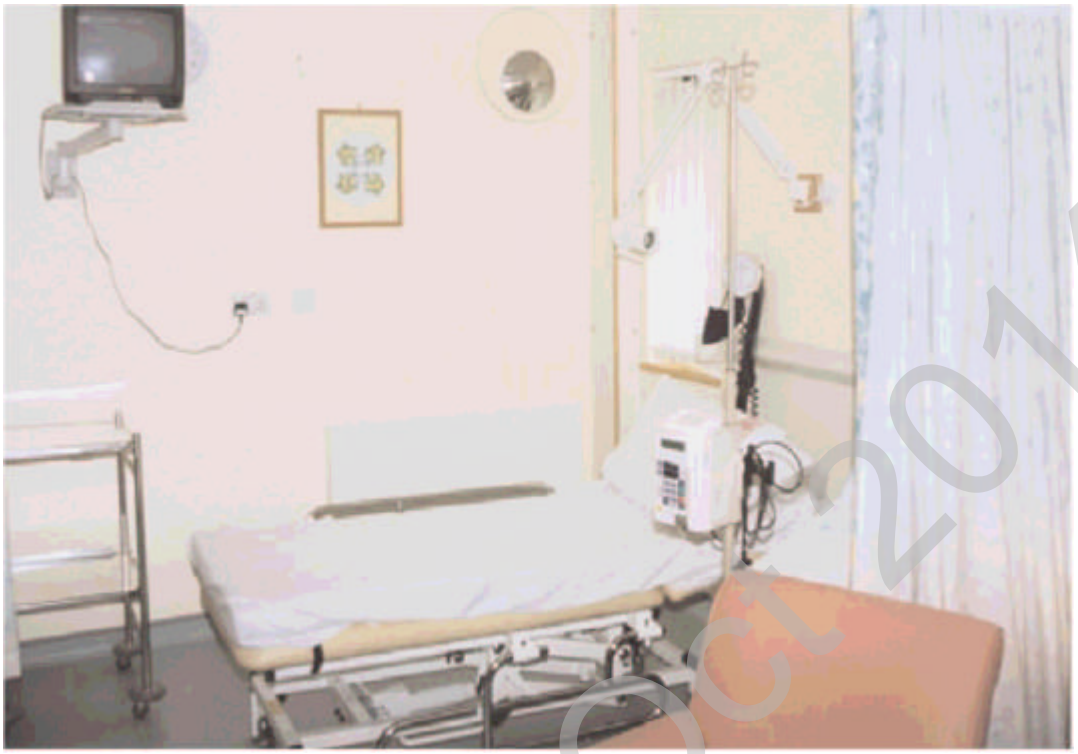
14.80 The usual way for environmental services to gain access to the shielded treatment area is by way of the ceiling void of the maze. The effectiveness of the shielding in the maze is often increased by concrete downstand baffles. These overlap to stop the direct path of radiation but are offset from each other and positioned in such a way as to allow services to weave through the chicane of concrete baffles.

Linear accelerator treatment room (general purpose)

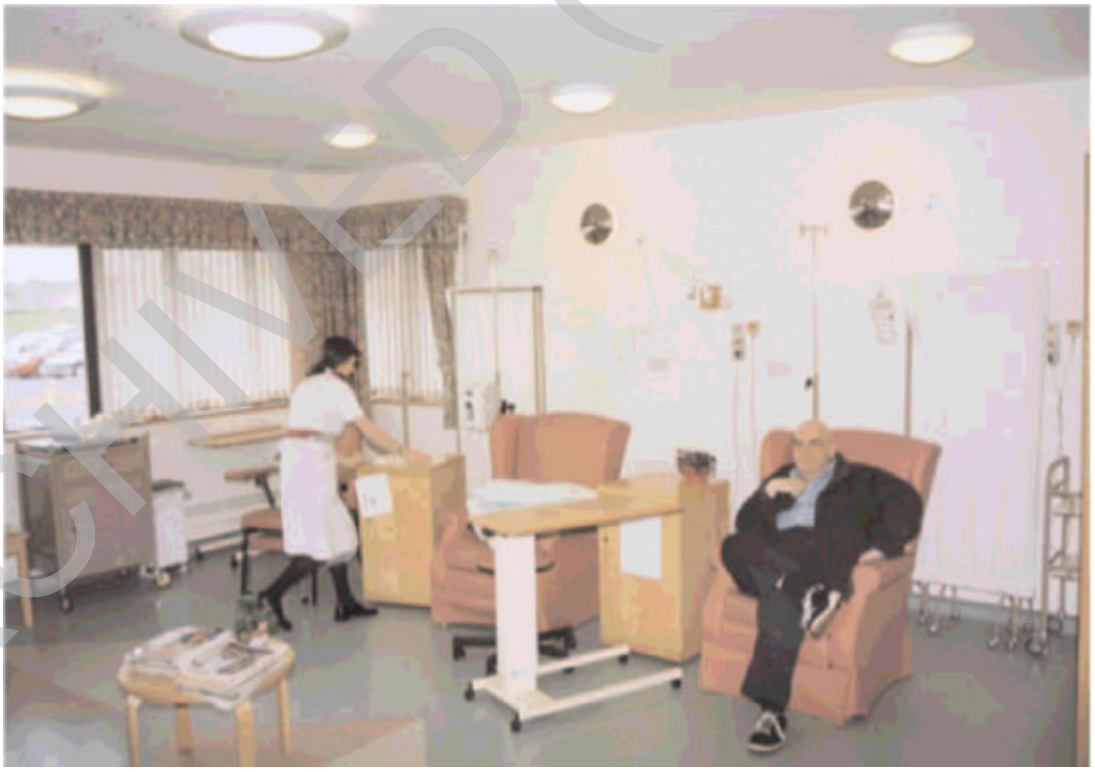
14.81 This room must be easily accessible from changing cubicles and sub-waiting areas.

14.82 The size of this room is critical, there must be enough room for storage of equipment and easy access, enough space for easy movement around the room and space for patients on beds, trolleys and wheelchairs. The open shelving seen in this photograph may not be suitable everywhere on hygiene grounds.

14.83 For total body irradiation treatment, consideration must be given to the positioning of the treatment unit within the room to ensure the adequate distance is achieved between the treatment unit and the patient couch. The couch is usually placed against the wall, i.e. the treatment unit is often found off-centre in the room to achieve this relationship.



Single patient treatment couch in a chemotherapy department used where patient privacy is needed



Chemotherapy treatment area

Linear accelerator treatment room showing customised storage facility

14.84 The trenches and floor chases required for hidden cables and support frames will be extensive and will vary from one manufacturer to another. It may be possible to establish through consultation with manufacturers and specialist agencies the extent and critical dimensions of these features. It is essential that this information is available to the design team at an early enough point in the design programme to allow these features to be incorporated into the drawings used for the construction of the concrete shielding structure or treatment room.

14.85 A floor trench between the wall of the treatment room and control area is needed to gather all services passing between control area and treatment machine.

14.86 A duct passes between the floor trench and a similar trench in the control area. The trench and ducts must not compromise the radiation shielding offered by the shielding walls or floor in the case of a treatment room with radiation sensitive areas beneath. A separate duct is required for dosimetry cables to allow the cables to take the shortest route from machine to control desk.

14.87 Recess is needed for the base frame and table floor, this will allow service connection back to treatment machine base and floor trench.

14.88 A lifting beam will be located over the centre of the treatment machine. Services must not cross under the beam.

14.89 Supports are required for heavy ceiling-mounted equipment such as the frames of data monitors.

14.90 Rigid support is needed for wall-mounted alignment lasers.

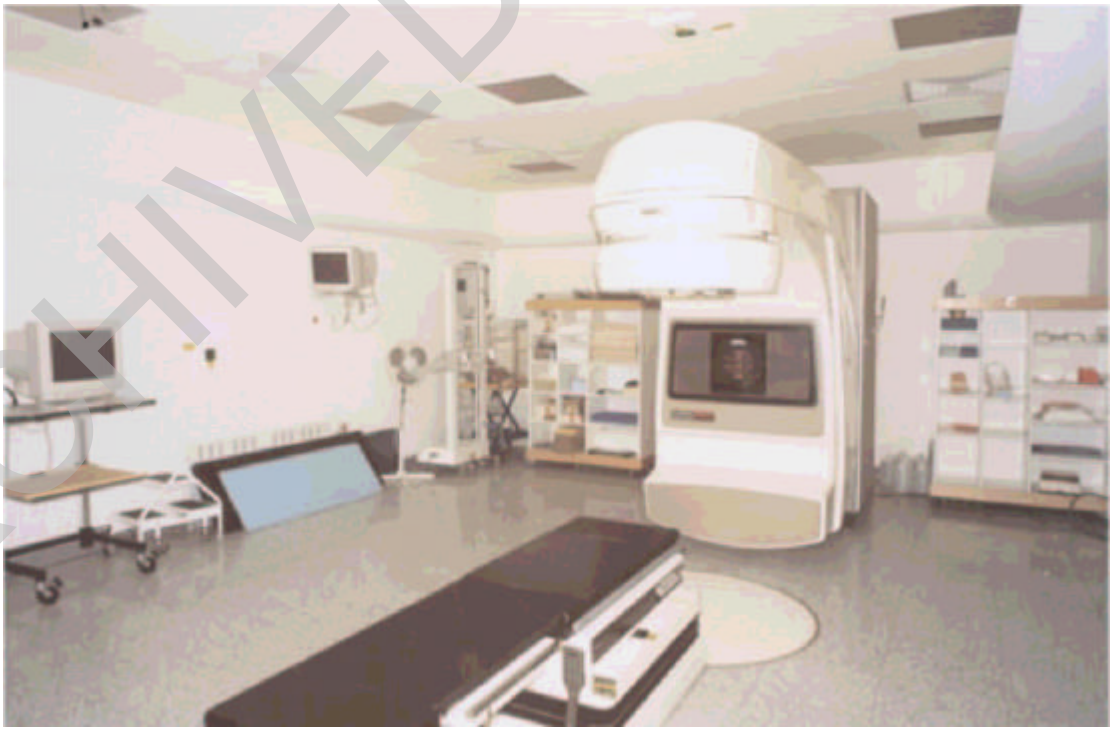
14.91 Consultation with the local radiation protection advisor (RPA) at all stages is essential.

Storage

14.92 The range of medical equipment, immobilisation devices applicators, etc., used on a regular basis in these rooms can result in a very untidy situation arising with even the most diligent staff. The consequent environment encountered by patients can prove alarming and not conducive to reducing fear and stress. Bespoke designed storage facilities, repeated in similar treatment facilities or technically matched treatment machines, will allow staff to move between these areas and work more efficiently as they will be more familiar with the arrangement from room to room.

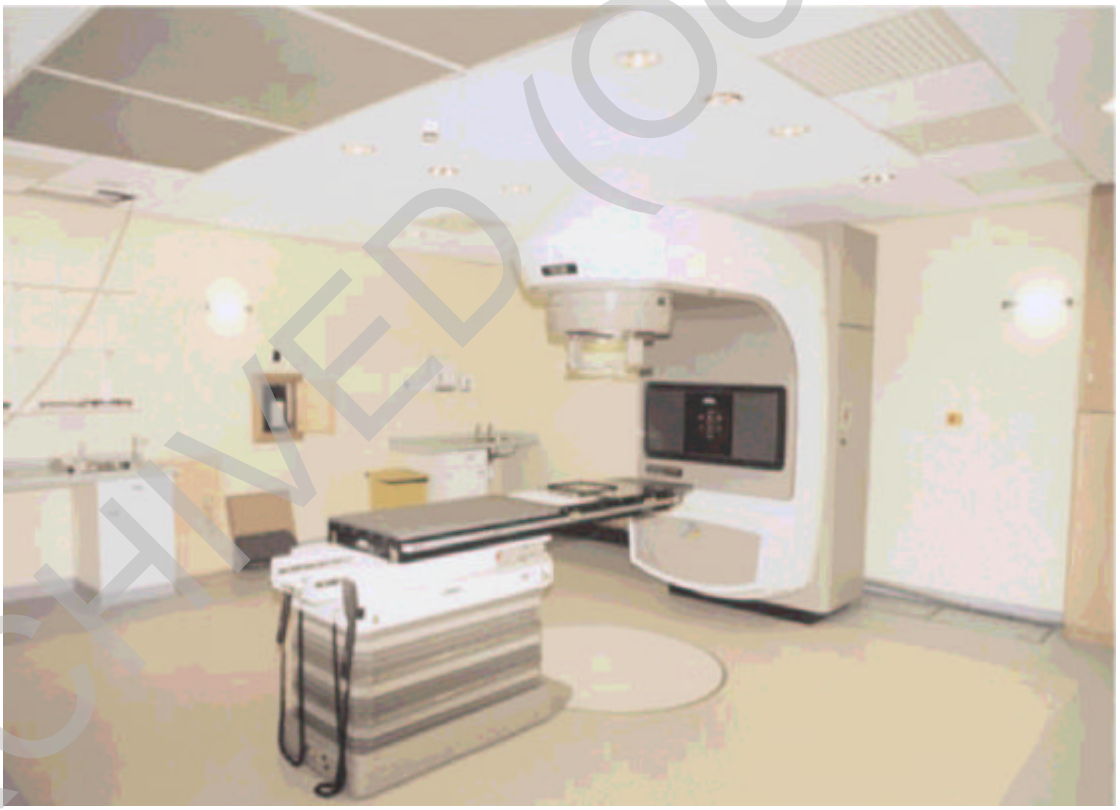
14.93 Shelving and cupboards must be adequate for all storage requirements and designed individually for each department. It is essential to liaise with users and machine specialists.

14.94 Specialised storage is needed for immobilisation devices; special lead blocks if no MLC; vacubags and body casts, etc. It should be noted that future stereotatic techniques will require a greater use of vacubags. The resulting storage requirements will grow accordingly, probably demanding separate storage and logistics arrangements.

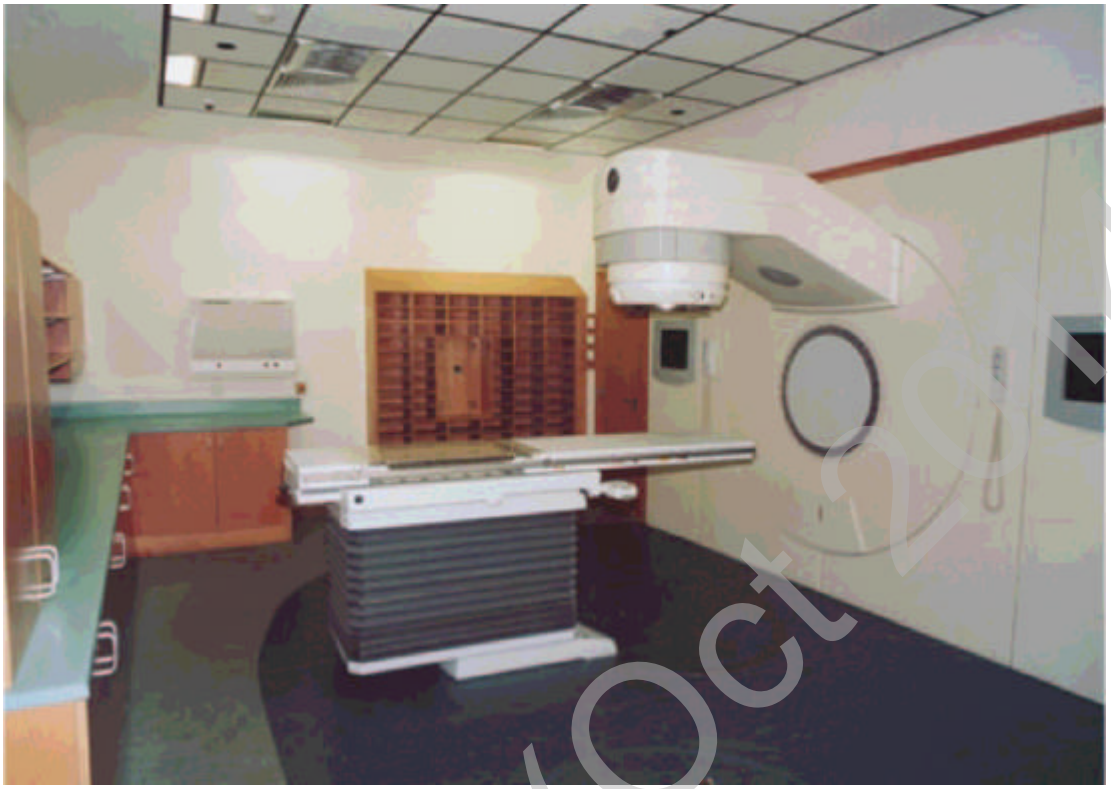


Linear accelerator treatment room showing treatment gantry with enclosed machine cabinet

Control area for recently constructed linear accelerator treatment rooms



Linear accelerator treatment room with example of linac employing an independent machine gantry



Linear accelerator treatment room where linac fascia panel is used to create a machine room

14.95 It is essential that accessory equipment e.g. breast boards, etc. should have dedicated storage, either in cupboards, on shelves or hanging.

14.96 Where necessary adequate storage must be provided for total body irradiation equipment.

Other design features

14.97 The design features which will be required will vary from project to project. The following is an indication, but is not an exhaustive list:

- drinking water;
- dispensers;
- wall-mounted dispensers for paper towels, paper cups, soap, paper sheets, etc;
- alignment lasers firmly bolted to structure, linked to laser generator using fibre-optic cable;
- last-man-out button located near entrance to maze;
- independent radiation monitor, wall-mounted;
- music for patient relaxation;
- nurse call system;

- CCTV cameras mounted at high level to monitor patient during unaccompanied periods;
- X-ray viewers, wall mounted;
- miscellaneous medical stands and trolleys.

Environmental considerations

14.98 Ventilation and the number of air changes must be adequate. In most situations air conditioning will be required complete with fail safe arrangements to prevent humidity control malfunction. Guarantees for expensive equipment may be made void if water is allowed to cause damage.

14.99 In rooms where anaesthetics are administered, there must be adequate scavenging for gas/air extraction.

14.100 Local variable temperature control is required.

14.101 It is essential to be able to dim the lighting for setting up the patient. A spotlight is required at the foot of the bed.

14.102 Music facility for the patient's own tapes/CDs, etc., should be considered.

14.103 CCTVs are required, the number is optional, depending on department practice. CCTV must have pan and zoom facility and secrecy switches. It should not be interlocked to the entry system to the maze because there are occasions when it is necessary to see what is happening in the room between times.

14.104 X-ray viewing boxes are optional, depending on department practice.

14.105 Two-way intercom to control area/room – optional.

Finishes and artwork

14.106 Murals and paintings on walls, ceilings with decorative or entertaining features, etc., are all considered to be of value in occupying the patient's mind and offering some measure of distraction.

14.107 The artwork and forms of patient distraction should be considered at an early point in the design process to allow adequate and timely consultation with the user to allow debate on the suitability of the proposals.

14.108 As there are MRSA cross-infection issues, the use of carpet is not considered appropriate. Linacs usually require anti-static finishes and have a critical level tolerance around the area of the patient bed.

Linear accelerator control areas

Note: The notes on the control areas, treatment preparation area and check-room need to be read in conjunction with this section.

14.109 The processes carried out in each area will be dependent on local work practices but space will be needed for the activity to be performed in either one of the areas.

14.110 The number of computers, keyboards, workstations, etc., will be dependent on local practice.

14.111 Early consultation is recommended to establish the full complement of equipment to be accommodated in the control area and its position relative to the maze entrance and patient areas to achieve efficiency of patient observation; ease of staff movement; data protection. When planning it should be remembered that as well as the operational staff there will often be other members of staff present who are undergoing training.

14.112 Control areas must afford space for the movement of all staff and easy access to the treatment room maze. Consideration must be given to the ability of the staff to see patients approaching the maze entrance, whilst shielding from view the monitors displaying patient information. It is essential for blind entrances to have a gate and CCTV monitoring the entrance to the maze.

14.113 The minimum depth of worktops must be 1000mm to accommodate large computer monitors. A minimum of 9 metres length will be required for each linear accelerator. There must be sufficient space between the control desk and the wall to allow radiographers to move behind each other.

14.114 Worktop height will need to be determined locally but must address health and safety issues, such as VDU use. Keyboards may be on the worktop, on pull-out shelves underneath, or a combination of the two.

14.115 Consideration must be given to issues of ventilation, dust protection, noise, heat and cabling.

14.116 The requirement for X-ray viewing boxes will be determined locally.

14.117 Daylight in the control area is highly desirable but monitors must not be subject to glare from direct sunlight.

14.118 There will be a need for a large number of sockets and computer network points in the control areas. Trunking systems that offer flexibility and change may be considered appropriate.

14.119 Easy access to a direct connection between the control area and the treatment room for QA monitoring cables is required. This penetration of the shielding wall must be aligned so that the radiation shielding is not compromised. Pre-planned underfloor ducts may be useful where distance is critical.

14.120 Consultation with the radiation protection advisor (RPA) at all stages is essential.

High-energy treatment room

14.121 To the patient, the appearance of a high-energy treatment room will be similar to that of a low/medium energy treatment room. The maze will probably be longer and the linear accelerator bigger and some differences will occur with other equipment. Apart from this little else will change visually.

Artwork

14.122 The comments made previously about the need to enhance the environment apply with equal measure in this treatment room. However, certain types of paint media are affected by the high-energy radiation beams. Care must therefore be taken when positioning artwork to avoid sites within the primary beam zone. Advice should be obtained from the radiation protection advisor (RPA) about the likely effect on any artwork proposed for use within high-energy installations

Construction issues

14.123 Despite similarities with low medium energy treatment rooms, differences will be apparent when the construction of the structural enclosure is examined. These will arise from the need to protect against increased levels of radiation energy. The concrete shielding enclosure, including the primary beam collar, will be thicker. The geometry of the shielding will be different, altering the shape of the room as well as the length and layout of the maze.

14.124 When the treatment prescribed requires these machines to be operated at high energies, a further hazard is produced in the form of free neutrons. Neutrons behave in a different way to radiation beams; as a result other measures are added to deal with the hazard that they present.

14.125 A full-height vertical recess is formed in the structural wall of the maze in the vicinity of the treatment area. The geometry of the slot or trap, as it is referred to, and the proprietary wax-like material placed in it, help to attenuate the energy of neutrons entering the maze. This wax is supported in place by a framework of hardwood studs held together with brass screws. Further attenuation takes place by positioning similar material above the suspended ceiling over the linear accelerator as well as using boron coated paper to line the walls and ceiling of the maze. For a fuller description of the protection requirements refer to the section on environmental considerations in this document.

Pre-treatment interview room (radiotherapy)

14.126 The ideal is to have one pre-treatment interview room per treatment room but this will depend on space and local practice. Room specification is similar to any other interview room. The pre-treatment interview room should be near to the

entrance/exit of treatment rooms; a minimum of one per two linear accelerators or simulators is required.

Information area and library

14.127 The information area and library will be sited locally within the radiotherapy department in close proximity to the treatment areas.

14.128 Natural light is preferable. Facility for the display of leaflets and support group booklets is required, that is, a small library with information readily available for radiographers to give to patients. Appropriate seating which is comfortable with a mixture of chair heights. Other requirements include: tables; IT points for Internet access, etc; lockable cupboards; telephone; TV/video facilities; facilities for making beverages.

Superficial and orthovoltage treatment

Treatment room

14.129 The treatment room must be of sufficient size that all areas of the body can be treated with the patients lying/sitting in a stable position.

14.130 Typically the room will need to contain: specialist shelving to house the beam defining applicators, in the case of orthovoltage these could be heavy and need to be stored at a height to meet the requirements of current health and safety legislation; a shielded window or CCTV to view the patient during the treatment exposure; a treatment couch; a bed with movements similar to a dentist chair is recommended; washhand basin; sink; lockable drugs cupboard; spotlight; interlocked door between treatment and control room.

14.131 Interior design and the provision of piped music should be considered to improve the atmosphere for the patient.

14.132 The floor must be washable.

Control area

14.133 The control area should be adjacent to the door of the treatment room. There should be sufficient workspace to contain all the equipment associated with the machine. There should be data points to support any networking requirements. There should be sufficient sockets and telephone points to meet local need.

14.134 In some cases, particularly where a high workload is undertaken, a dedicated clinic room adjacent to the treatment room may be an advantage.

14.135 Sufficient space is needed to accommodate staff being trained as well as those providing treatment.

Generator room

14.136 Provision for a sound-proofed area or room for the treatment machine generator is recommended.

Pre-treatment area

14.137 This should take the form of a completely integrated suite, encompassing interview rooms, simulators, mould room, treatment planning, dedicated CT or equivalent. Darkroom and film storage will depend on local practice.

Simulator room

14.138 The simulator room must be large enough to accommodate full rotation of the couch without collision hazards.

14.139 The orientation of the simulator, diagonal or straight, within the room will depend on space and local decision, but easy access to the couch by stretchers, beds and wheelchairs is required.

14.140 If the simulator and couch are not offset for viewing the patient, consider windows being offset to give the best possible view of the patient during simulation procedures as well as the equipment as it moves by remote control.

14.141 CT attachment is essential, particularly where access to diagnostic scanners for treatment planning is minimal.

Control area

14.142 This is usually a very busy area with radiographers, planning staff, doctors, students, etc., all needing access from time to time during the simulation procedures. The control area therefore needs to be appropriate for the working practices of the department.

14.143 Ideally there should be a separate room adjacent to the control area where conferences between different staff groups can be carried out pertaining to the patient/s of the day. Teleconferencing facilities may be helpful in the future for split-site cancer care centres. If lack of space precludes a separate discussion room, the control area should be large and remote enough for patients not to hear inappropriate conversation. If no doors separate the simulator room from the control room, a separate area needs to be allocated for general discussions.

14.144 Viewing boxes will be required even if department is digital, they will be used for films from external sources.

14.145 Other requirements include a workbench with network points, depending on equipment purchased, for doing calculations, etc., cupboards/drawers for storage (medical notes, treatment sheets, etc.), spotlight, telephone, lockable drug cupboard, shelving; general cupboards and workbench, sink, mirror, drinking water, etc.

14.146 A simulator ante-room for preparation of patients requiring barium, catheterisation, etc, is required.

14.147 Changing cubicles – see paragraph 14.72.

Treatment planning

14.148 A minimum of one workstation per two linear accelerators is needed to cope with increasingly complex techniques. This will depend on local practice and on treatment planning systems used; some systems are slow even for production of breast plans. It will also depend on the use of conformal treatment planning.

14.149 There should also be a special workstation for brachytherapy and stereotactic work because of the time taken to plan.

14.150 Planning systems are required to 'network' with different elements when planning treatments. These elements will not necessarily be within the cancer care centre or even on the same site. They include simulator, CT, MRI, these are essential, as well as links to linear accelerator and patient information systems.

14.151 Modem links are required to the supplier of the treatment planning system for 'remote diagnostics testing' as part of service agreements.

14.152 Radiotherapy target definition and associated image process and display suites are required.

14.153 Accommodation for paper and/or computer based record keeping and treatment management is required.

14.154 Film processing and laser imager rooms are required.

Mould rooms and patient immobilisation facilities

14.155 During the delivery of the treatment, it will frequently be necessary to immobilise the patient to ensure the safe, accurate delivery of the radiotherapy treatment. To achieve this, a mask is made from thin plastic sheet, individually produced to match the patient's features, so that it can be fitted on to the patient and secured to the treatment couch, thus restricting movement during treatment.

14.156 To align the part of the body to receive radiation treatment, it may often be necessary to prop or support a particular part or limb of the body. This is achieved with air-filled sacks or foam blocks that may be readily available as standard items or may have to be specially produced to accommodate a particular situation. These items are custom-made in the mould room suite.

Patient fitting room

14.157 This is the room in which the patients will be fitted with immobilising shells or supporting devices. The process may be lengthy and unpleasant, and may involve the taking of impressions using plaster of Paris. To ease the process for

the patient, the room should offer a light, airy environment and be as comfortable as possible.

14.158 The technicians will need to view imaging data and carry out clerical work and reporting. A workstation should be provided with a computer network point, sockets, telephone, filing cabinet, etc.

14.159 The patient will usually need to remove clothing, therefore changing facilities with a curtained area will be needed.

14.160 The dignity of the patient should be considered when locating the couch in relation to doors.

14.161 Ceilings may be designed with some point of interest to relieve patients' boredom.

14.162 Background music with facilities for patient choice may be considered.

14.163 A shower and changing area with mirror, shelf, seat, , curtain or door and coat hooks will be required.

14.164 Seating should be provided for relatives or carers accompanying patients. Mobiles, stencils, toys, etc., for children are useful for relieving boredom.

14.165 Wheelchair/bed access is essential.

14.166 Locally adjustable heating and ventilation to give patient and staff relief from local heat gain and smells is essential.

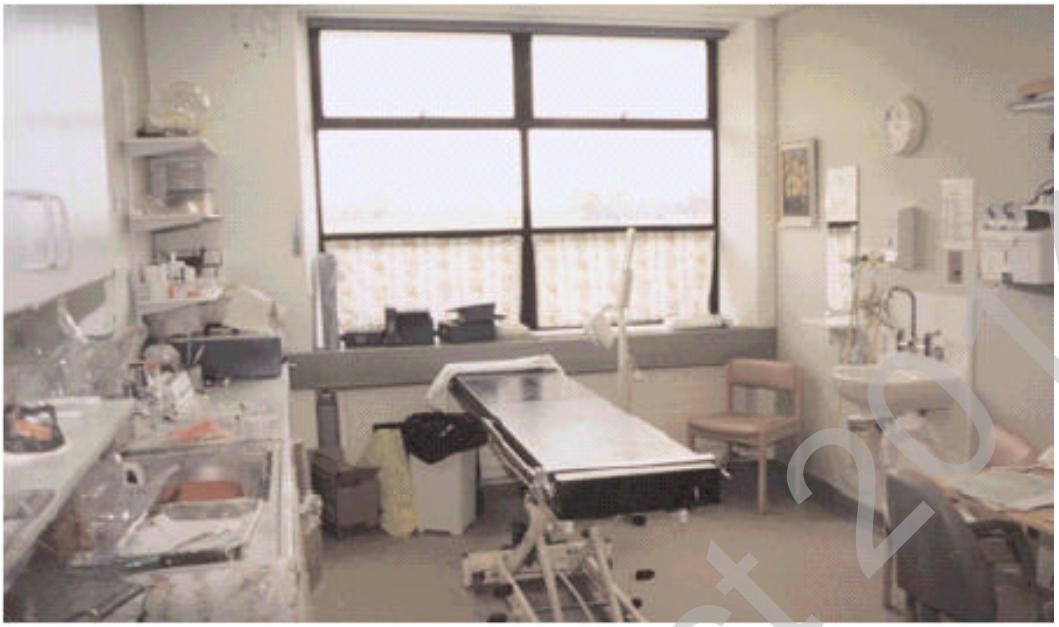
14.167 The floor covering should be linoleum or vinyl with coved skirting for ease of cleaning.

14.168 The plaster trap sink will require a tiled or other form of splash-back. The trap must be easily accessible as it requires regular, and easy, cleaning.

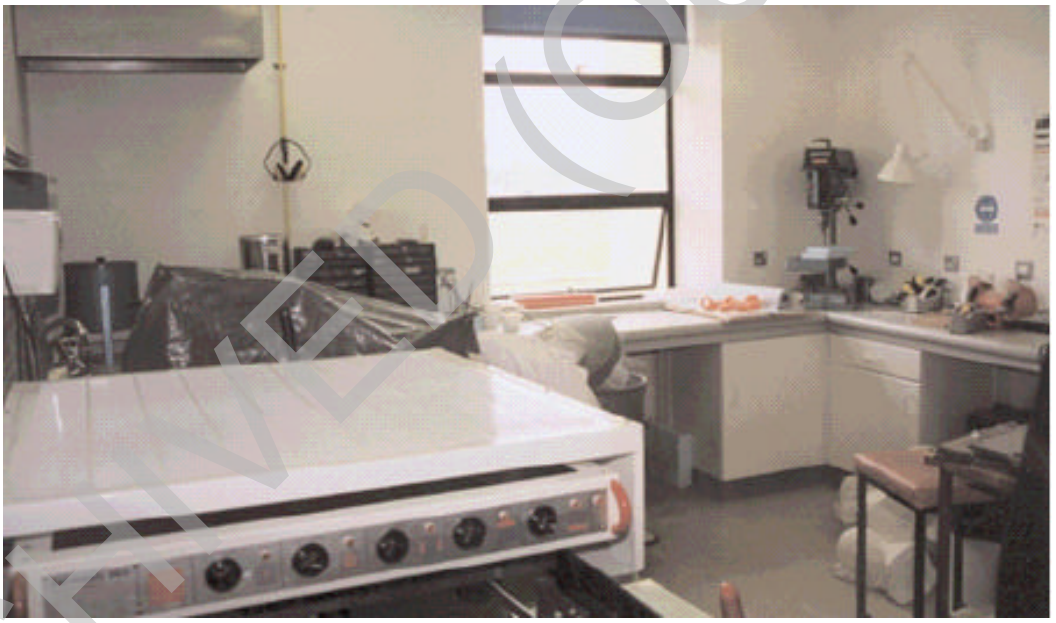
14.169 A hot water bath will be required if using thermoplastics for immobilisation.

14.170 Alignment lasers and variable height treatment to mimic the treatment area are needed.

14.171 A height-adjustable couch will be required.



Mould room workshop showing typical patient preparation area.



Mould room workshop showing profile machine, low temperature alloy smelting area with extract hood.

14.172 A dentist chair, relocatable frames, etc., will be required for departments intending to use stereotactic techniques instead of shells.

Machine room and workshop

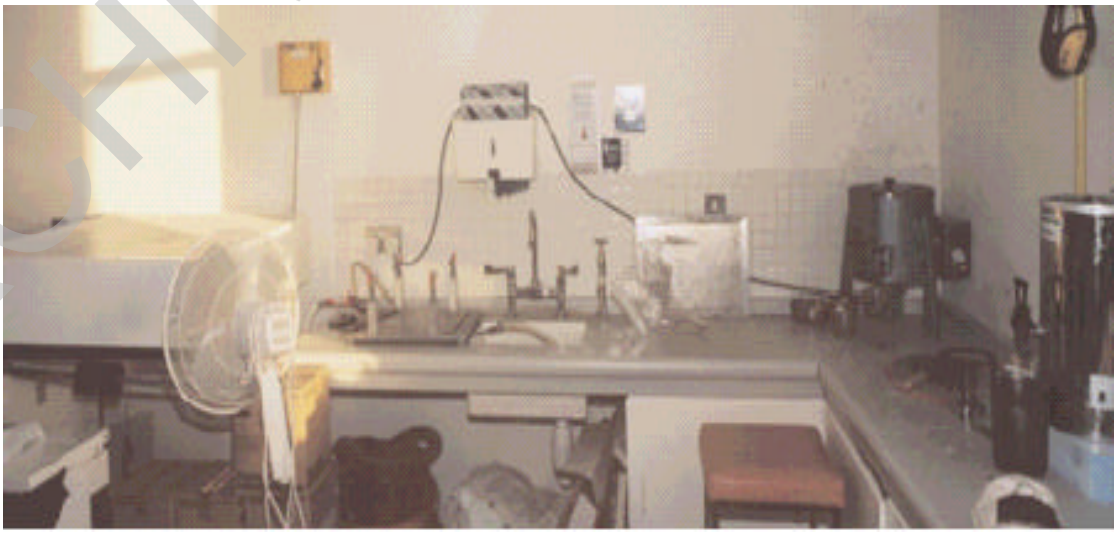
14.173 The immobilising shells and supporting devices are fabricated here. The processes include:

- vacuum forming techniques;
- injection moulding;
- cold setting resin formulations;
- epoxy/polyester techniques.

These processes are essentially light engineering in character. Workshop conditions are required with appropriate floor and wall surfaces. A good general level of lighting is needed with task lighting at workstations.

14.174 Ideally the machine room should be separate from the workshop assembly area, as assembly and adjustment require concentration and cleaner conditions.

14.175 Good ventilation is essential and cooling will have to be considered due to equipment heat output. Local extraction will be required over processes generating dust and fumes. Consideration needs to be given to the provision of three-phase electrical supply and a floor drain. Equipment will depend on project requirements but is likely to include: LMP cutter/compensator maker and melting pot in laminar flow cupboard or equivalent; vacuum forming machine with compressor; contouring device, this will depend on local practice; electric furnace; electric oven; saws; bandsaw; bench drill; bench grinder; bench sander and polisher; hot wire cutter; wax bath; various hand-held tools and workbench, this could be mobile, on a trolley; bunsen burner; work benches; storage cupboards; compressed air outlet; wall-mounted viewing boxes; telephone and network point to planning and HIS; plaster trap sink.



Mould room workshop area

14.176 Staff should be able to leave the machine room and workshop without having to pass through the patient fitting room.

Storage

14.177 Adequate and appropriate storage is essential in all areas of this key supporting facility. The activities carried out are diverse in nature, requiring access to a wide range of materials and tools including plaster models, bandages, Uvex sheets, etc., size will depend on local activity and practice. To carry out this work effectively, work areas and conditions generally need to be well organised.

Stereotactic radiotherapy facilities

14.178 The design of the treatment couch is such that it will accept interchangeable body shells, uniquely moulded to fit each patient's body shape. The body shell will need to be kept for as long as the patient is receiving treatment and may, during this period, need replacing to allow for changes in the patient's body.

14.179 This technique will generate a considerable demand for storage of body shells. They will also require labelling and cataloguing. Early consultation with the project team will be essential to assess the extent of storage if stereotactic radiotherapy is proposed.

Paediatric facilities

Procedures room

14.180 A procedures room used to carry out minor treatments and procedures such as dressing changes will be necessary close to bedroom accommodation. Ideally there should be two procedure rooms for every 15 beds and they should be located away from the bedroom areas so that those remaining in their rooms are not disturbed by noise from the procedure room. The rooms should take the form of a treatment room as described in NHS Estates guidance HBN 23 'Hospital accommodation for children and young people', may be used with general caution by NHSScotland.

Recovery area

14.181 This provides for the recovery of the patient after a procedure often involving anaesthesia. The recovery can be supervised without preventing the use of the procedures room for further patients. As this area may have high voltage electrical equipment, water and other fluid services should be avoided above this room.

Offices

14.182 Outreach nurses play an important role. Many patients will spend time at home between periods in hospital and the outreach nurse will give support during this period. Close liaison between the staff involved with a patient in hospital and the development of a relationship with the patient in hospital is very important. The

office accommodation should be integrated with, or be as close as possible to, the children's accommodation.

14.183 Offices for social workers will be required. There will be a greater number of social workers and other supporting staff associated with a children's cancer facility than other childrens' illness or other departments of a hospital, as a result of the traumatic effect that this illness can have, not only on the patient but their whole family.

Other accommodation

14.184 Other accommodation is required as follows:

- play therapy room;
- school room;
- rehabilitation room;
- office for anaesthetist;
- single bedrooms with parent accommodation;
- single bedrooms for barrier nursing with air-conditioning or special ventilation arrangements;
- iodine treatment room, en-suite, with radiation barrier, to allow visitors into room;
- brachytherapy room;
- recreation room with access restricted to 'young people' only;
- parent accommodation suite for longer stay, separate but nearby;
- interview rooms/multi-disciplinary rooms/seminar staff training rooms.

Clinical support spaces

Medical physics and bioengineering accommodation

14.185 The medical physics department will serve the needs of many departments in the hospital. However, certain facilities within medical physics are essential to the routine operation of cancer care facilities.

Mechanical workshop

14.186 In PFI schemes it is common for the responsibility for maintaining linear accelerators and other equipment to be transferred to a third party, usually the equipment manufacturer or its agent. However, workshops will be needed where equipment maintenance remains largely in-house or where prototyping work or bespoke engineering devices are required in support of research purposes.

14.187 The workshop character is generally one of a well-equipped engineering workshop with a selection of lathes, drills, grinders, saws, etc. A three-phase electrical supply will almost certainly be required in this room.

14.188 The construction and layout of equipment must meet the requirements of current health and safety regulations. Storage will be needed for tools. Facilities for lifting heavy objects will be required eg overhead rail and hoist.

14.189 Robust wall finishes and slip and oil resistant flooring will be essential. Good natural and artificial lighting is essential. Solar control and mechanical ventilation will be needed. Air extract systems will be required to remove fumes caused by welding, etc.

14.190 Storage of a full range of materials should be located conveniently for retrieval and use. Access for deliveries by lorry to the store should be considered. Working facilities for equipment should be provided. As fluids are sometimes stored here, a floor gulley may be required in order to help with the cleaning up of any spills. Contamination from the liquids concerned may need special arrangements in the drainage design, appropriate consultation should be undertaken with the RPA and local authority.

Electronics workshop and development facilities

14.191 An electronics workshop will be needed so that the task of maintaining the integrity and safety of the wide array of electronic equipment that will be found in a radiotherapy facility can be performed.

14.192 The standard of work carried out is demanding, requiring considerable expertise therefore the conditions for performing this work are important. A clean, dust-free environment is important, as is good quality general lighting with task lighting at the workbench positions. Natural lighting and ventilation is required but solar control and mechanical ventilation may be needed to maintain suitable temperatures for working.

14.193 Other requirements include: generous benching with cupboards and drawer under; bench-mounted trunking to allow power outlets as required; space to perform record keeping and logs; shelving for manuals; bookcases; and a computer workstation. Anti-static arrangements will need to be made.

Quality assurance and dosimetric laboratory

14.194 Quality control and calibration of machinery is an essential and regularly performed task. Much of the work will be performed on machines and equipment located in their respective room or area which will, more often than not, be located some way from the medical physics department. For this reason it is seen as important to provide a suitable room, near to the cancer care facility to act as a local base for this function to be carried out.

14.195 Considerations for inclusion within this area include: secure room; storage of manuals and records; storage of measuring equipment; worktop for bench-

mounted equipment including bunsen burner; worktop for routine tasks; computer workstation; telephone.

Secure room

14.196 Functions and requirements include storage of manuals and records; storage of measuring equipment; worktop for bench-mounted equipment including bunsen burner; worktop for routine tasks; computer workstation; telephone.

Sealed source store brachytherapy

14.197 The function of this room is to provide a suitable environment for the receipt, storage and handling of solid or sealed radioactive materials which are used to administer radiation treatment by either local application or interstitial insertion.

14.198 The design must comply with the Code of Practice for Ionising Radiation.

14.199 An area will be needed for recording radioactive materials in stock and in transient use. Storage will be required for shielded containers used for transporting radioactive materials and for applicators and accessories in regular use.

14.200 A shielded workbench, normally constructed using lead, is required to allow staff to handle and prepare radioactive sources for clinical use. Due to the weight of lead shielding needed, localised floor loading will be abnormal and will need to be taken into account, either by design of the structure or siting.

Medical physics support accommodation

14.201 A number of offices are needed, these will vary depending on the project size:

- senior physicist's offices;
- secretaries' offices;
- physicists' offices;
- laboratory/physicists' offices.

Record keeping facilities

14.202 Cancer registration, ie the careful keeping of records of treatments and outcomes is essential to the successful development of cancer care. The dissemination of information to the cancer registries allows comprehensive data to be compiled allowing trends related to epidemiology of the disease, treatment and survival rates to be carried out. Office facilities will be necessary, as will storage for paper records being processed.

Phlebotomy – venepuncture rooms

14.203 Facilities will be required for taking and testing blood specimens.

14.204 A venepuncture room may need to accommodate more than one patient at the same time. In order to preserve patient privacy and dignity in such cases the venepuncture room should include individual cubicles.

14.205 Each venepuncture area will require a venepuncture chair, storage facilities for a working stock of sterile and other supplies, and clinical hand wash facilities. Normally, only the phlebotomist will attend the patient.

Bereavement facilities

14.206 Refer to NHSScotland guidance Scottish Health Planning Note 20 'Facilities for mortuaries and post-mortem room services'. It will be necessary to provide facilities where relatives and those close to someone deceased can come and spend some time with the body.

14.207 The aim of the interior designer should be to create a serene and reassuring surroundings using colour, texture, lighting and environmental control to best effect.

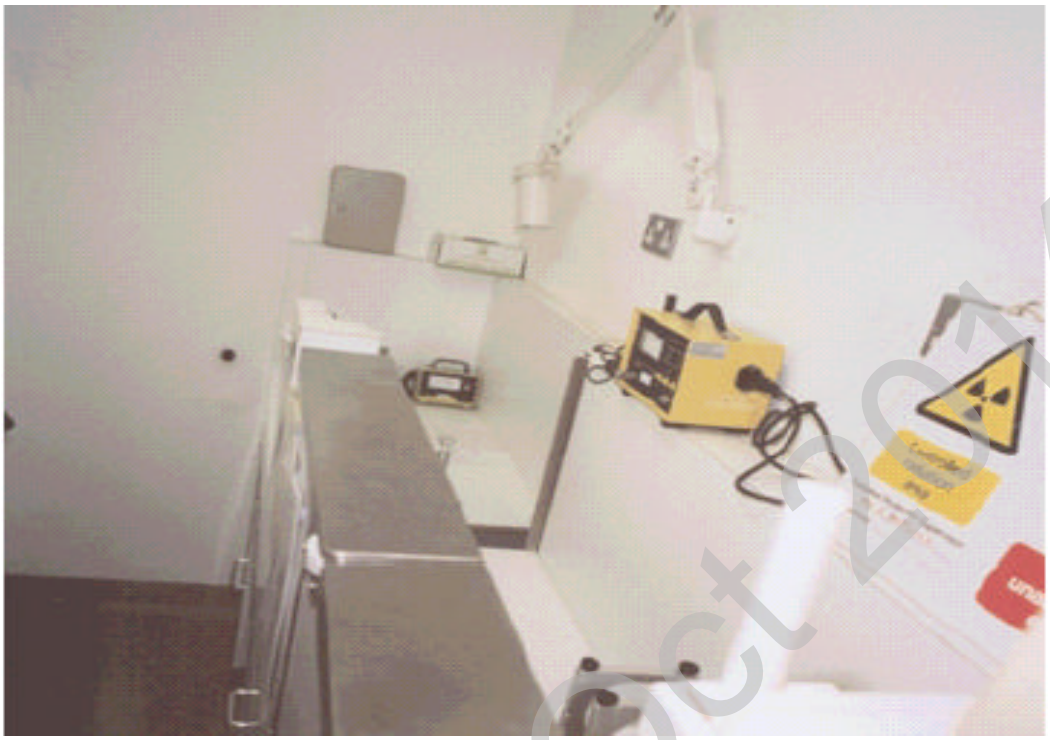
14.208 It is important to remember that the area should be able to accommodate those religions and cultures that are likely to use the facilities.

Mortuary accommodation

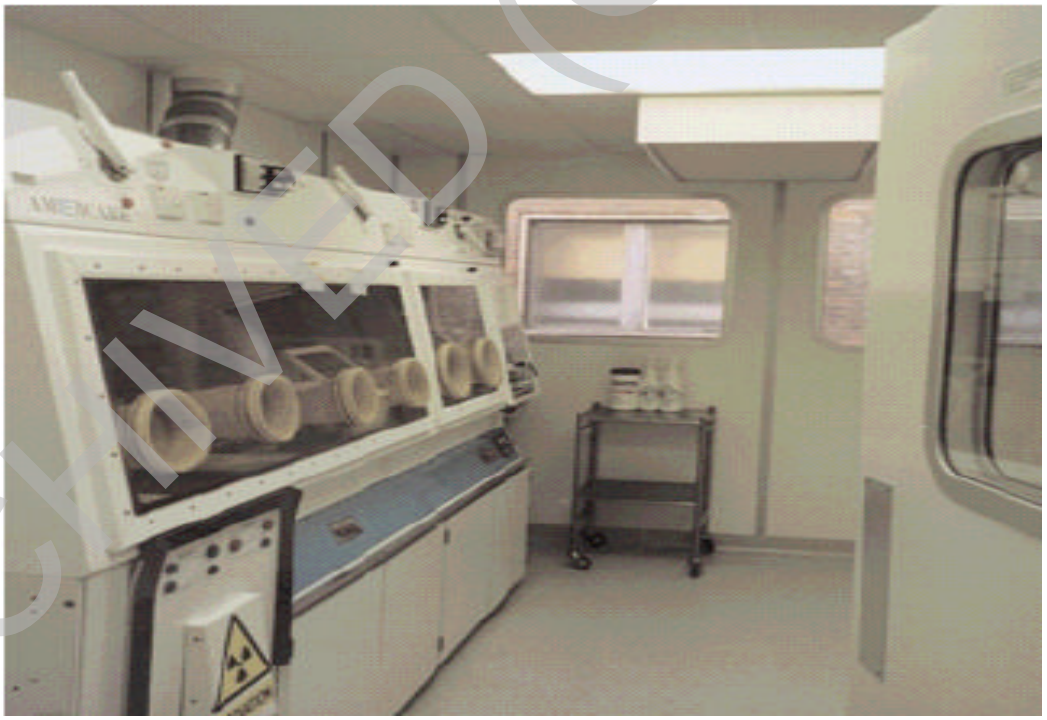
14.209 Refer to NHSScotland guidance Scottish Health Planning Note 20 'Facilities for mortuaries and post-mortem room services'.

Contaminated articles store

14.210 Articles, materials or equipment that are contaminated with radiation will need to be stored in a safe place until the radiation has fallen to a safe level. This is commonly dealt with by collecting the articles in a shielded container and taking them to the contaminated articles store for storage until safe. The contaminated store is described elsewhere in this document.



Sealed source store showing shielded workstation



Microbiological safety cabinet used in radio -pharmacy preparation area

Patient support spaces

Complementary medicine facilities

14.211 Complementary therapy requires a relatively relaxed environment of a domestic character, with use of diffused low light levels, although the ability to increase the light level during therapies may be necessary on occasion.

14.212 A relatively small room is preferred and this should be capable of comfortably accommodating the patient and up to two professionals, together with possible attendance by a relative or friend.

14.213 The patient will ordinarily be supported using a clinical couch with a low permeability soft finish capable of easy cleaning, particularly in respect of oily substances. The couch must feature a tilting or backrest facility which may be used to ease access to the patient's back during aromatherapy. While in reflexology, the patient would normally be in the supine position.

14.214 It is important that the sound levels in the room, especially arising from extraneous sources, should be well controlled. Accordingly, consideration should be given to the use of sound insulating materials in walls, doors, etc. It may also be important to locate the room in a part of the building where the other surrounding activities are themselves quiet and where the traffic of persons is light. The floors should be finished in readily cleaned materials such as welded vinyl or linoleum, though rugs may be utilised in order to soften the appearance and give a more domestic quality. Walls require non-glossy finishes in colours chosen to generate a relatively subdued and relaxed character.

14.215 For aromatherapy it may be necessary to change from one oil to another with widely differing aromatic qualities. Accordingly, there is a need to remove the scent of the preceding treatment. In light of this, some degree of mechanical ventilation to the room allowing for occasional rapid air changes, at least 20–30 air changes per hour will be needed. This need not imply a fully integrated mechanical system where this is not generally provided within the remainder of the building.

Reasonable standards of temperature control are required in order to promote effective use of the aromatherapy and reflexology technique.

14.216 The use of potted plants as a feature within these rooms is common. Use carefully designed wall-wash lighting or uplighters. Similarly, waiting rooms that are partly or wholly devoted to serving suites used for alternative therapy should be relatively relaxed and subdued with soft furnishings and plants. In some applications, devices to generate pleasant aromas within waiting areas have been used successfully.

Support group rooms

14.217 See also NHS Estates guidance Health Building Note 36 'Local healthcare facilities', Vol.1, 4.91, which may be used with general caution by NHSScotland.

14.218 As part of the patient support movement that underpins both therapeutic and palliative treatment of cancer, patient collaborative or support groups play an invaluable part in improving the quality of life for patients and their carers.

14.219 Cancer care centres should include a multi-purpose room that will accommodate between 10 and 15 people. This may be sufficient to meet the needs of cancer patients as well other patients. Local needs and resources should be reviewed.

14.220 Consideration should also be given to the provision of the following:

- patient information facilities;
- telemedical facilities.

Psychological and psychiatric accommodation

14.221 Accommodation will be required for patient counselling or used for giving psychiatric help. Small rooms, capable of accommodating up to four people in an informal setting are required for this purpose.

Patient retreat facilities

14.222 It is considered to be very important that patients can retire at times to an area that is dedicated to their use and free from all clinical staff. The nature and position will vary but should be informal in nature. The area or room should allow individuals or small groups to use the facility.

General design considerations

Internal routes of access and departure

14.223 Patient and staff flow patterns normally used for day-to-day use will have been established. These will involve the use of identified entrances and exits from the building. However, advice has been received from numerous sources, not least a report for NHS Estates by Cancerlink, highlighting the need for a discrete exit from the building for those who have just received bad news. The support for this facility makes an overwhelming case for inclusion in any new facility. It should also be considered as an improvement to any existing building where appropriate.

Building access considerations

14.224 Access to the building and its facilities for both patients and staff is a fundamental consideration. Guidance dealing with basic design considerations and building management to ensure the continuance of access and means of escape is available in existing publications and regulations. These cover access from the perimeter of the site, approaches to the building and use within the building. References include:

- NHS Estates guidance Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces';
- The Scottish Building Regulations;
- NHSScotland guidance Scottish Hospital Planning Note 45 'External works for health buildings'.

Equipment access

14.225 Equipment access to treatment rooms will require very careful consideration, both for initial delivery and future replacements. Some equipment may be able to be delivered through the maze but some larger or heavier equipment may require special consideration. Where equipment is delivered early, and further building work is required to complete the closure, the question of protection and responsibility of the valuable equipment are important contract issues.

Waste disposal

14.226 The workshop will generate waste which is normally disposed of in waste skips. The location of the skip should be considered. Imaging machine waste disposal is best outwith the building, and relies on gravity feed to containers which require special disposal. This may involve external pits due to the normal requirement for Linac Rooms on ground floor, as well as vehicular access to the pits.

The Disability Discrimination Act (DDA)

14.227 DDA 1995 introduces new laws and measures aimed at ending the discrimination that many disabled people face. Over time, the act gives disabled people new rights and places new duties on, among others, employers and service providers. References include:

- Scottish Health Facilties Note 14 'Disability access';
- Access Audit Checklist: 'Access for disabled people in healthcare premises';
- Good Practice Guide: 'Equality for disabled people in the NHS in Scotland', issued by SEHD.

It is recommended that readers consult bodies such as:

- local disabled user group organisations;
- the Centre for Accessible Environments.

Access audits should be carried out at design and completion stages as the DDA will be fully implemented from October 2004.

Special facilities for individual or small group catering

14.228 Patients suffering from disease or from the effects of their treatment often do not wish to eat at prescribed times. They may have very specific dietary requirements or other difficulties with eating that require special measures. For these reasons, consideration should be given to providing catering facilities for in-patient accommodation that will meet these special situations. This may not easily fit in with current local arrangements.

14.229 In some cases, where particular difficulties are experienced when eating, staff advice and patient practice may be needed. This should take place in a room away from the main accommodation areas where patient dignity can be maintained.

Special construction features

14.230 Special care is required when constructing the treatment room's primary shielding, particularly where joints are required. Day joints in concrete structures require special consideration to avoid radiation paths through them.

15. Radiation protection in cancer services

Use of radiation in cancer services

15.1 Radiation that may be detrimental to a whole healthy living organism can conversely be helpful where the damaging effects of the ionising radiation are concentrated on a tumour or other form of cancer. It is this basic phenomenon which is responsible for the treatment uses of radiations in cancer care services. There are also a range of diagnostic uses where the aim is essentially to minimise the amounts or dose of radiation involved, while maximising the information yield from the test concerned.

15.2 When planning and designing for radiation uses in cancer care services, early consultation with the local radiation protection advisor (RPA), ordinarily employed by or contracted to a Trust, is advised and may be required by statute. Each existing centre, department, etc., will also have appointed a Radiation Protection Supervisor (RPS) who is necessarily a member of staff. This RPS will be a good source of information on local practices and safety rules.

15.3 Therapeutic uses of ionising radiation in cancer care services divide into two categories, previously described in detail. These are:

- teletherapy, in which X-ray or gamma beams are generated by a machine and used to treat a tumour with the X-ray source being outside the patient's body;
- brachytherapy and unsealed source treatments. These are basically the same except that they will use chemical or nuclear sources of radiation and these will be within the patient's body, either as a solid material, for brachytherapy, or as a solution in unsealed source treatments. Unsealed source therapies would include treatment for thyroid cancer using radioactive Iodine 131.

Containment of radioactive materials and prevention of contamination

15.4 The use of radiations of nuclear origin as unsealed radioactive sources, essentially liquid solutions, has been mentioned above and is dealt with in detail elsewhere in this document. As these radioactive materials are liquid solutions, there is clearly a possibility that they will escape from the containers or containment within which it is intended that they will remain. This is particularly true when the radioactive material is given to the patient as a drink or introduced into the body by an intravenous injection. In the former instance, the radioactive solution itself may be subject to leakage from its container or to accidental spillage. In the second instance, the patient's urine, sweat and other

body fluids may become radioactive due to the presence of the radioactive material in solution.

15.5 Coming into contact with these unconstrained radioactive solutions is known as radioactive contamination. Simply, the contaminated surface or person has the liquid radioactive solution present and this in turn may give rise to the possibility of ingestion. Clearly, as in these circumstances, there is no separation between the radioactive source and the person concerned, so the probability that high radiation doses will be delivered may be expected to be increased.

15.6 Much design work in regard of the facilities within which these unsealed sources are used is aimed at minimising the risk of radioactive contamination and being able to deal with it quickly and easily should it occur. This implies the use of impermeable and easily cleaned smooth surfaces and careful attention to jointing. Sinks will be such as to resist permanent contamination, particularly if used for waste disposal. Washhand basins are an essential provision and these shall be of ceramic construction with foot or elbow operated taps.

Internal view of linear accelerator bunker under construction using blocks of alternative shielding materials. Joints are formed using specialised proprietary mortar. Shows services entering from maze corridor and steel joists supporting roof structure.

Constraint of radiation dose and the use of shielding

15.7 The reasoning behind the need to restrict or minimise radiation dose has been established. There are three essential mechanisms by which dose can be reduced. These are:

- minimising the time or period of exposure to the radiation;
- maximising the distance between the radioactive source and any persons who may be present;
- the introduction of a barrier or shield between the source of radiation and the people to be protected.

15.8 The amount of shielding that will need to be used in any given circumstance depends essentially on the quantity of radiation being produced; the distance from the point of production to the area needing to be protected; and thirdly, the type of radiation involved. It will be readily appreciated, therefore, that shielding types and magnitudes vary markedly. Detailed accounts are given at appropriate points within this document but the following summarises the common shielding strategies:

- teletherapy involving the treatment of patients with X-ray beams derived from linear accelerators or gamma ray beams from Cobalt 60 machines. Here, the effectiveness of the shield is controlled in part by the sheer mass of material present. This being the case, the use of dense materials, most commonly concrete and steel, is favoured. The masses involved will be such as to have major design and structural implications for the building used. In very recent times, alternative materials such as 'Ledite' have become available and these will in some instances offer special advantages in terms of reducing the volume or space occupied by the shield. To some degree the effectiveness of all shields is influenced by their shape and geometry but in the case of linear accelerator bunkers and their shielding walls, this is particularly important;
- neutron protection. This is an exception to the high energy radiation beam shielding methodologies briefly mentioned above. Neutrons are only produced by a very small minority of linear accelerators, specifically those operating at above 8.5MV, with the problem or challenge being especially notable above 12MV. The neutrons penetrate heavy and dense materials relatively easily, unlike X-rays or gamma rays, but are stopped by hydrogenous materials which are very light and preferably should be Boron-loaded hydrogenous materials. Accordingly for the special high energy linear accelerators where neutrons are produced as an unwanted by-product, the use of very low density shielding materials in addition to the concrete and steel will be necessary. The design of these neutron shields is a highly specialised process requiring detailed advice from a qualified source;
- sealed and unsealed radioactive sources. Again, the radiations produced by these sources will lead to detriment if adequate shielding of the sources is not used. However, in the majority of cases, it is more practical to surround the source with the shielding material, often lead, rather than to surround the room within which they are contained. In some instances, however, both strategies will be needed in order to meet practicalities and provide an adequate level of shielding to ensure reasonable safety;
- lower energy X-ray beam shielding. For the more modest energy teletherapy treatments, such as superficial and orthovoltage as well as all

diagnostic X-ray uses, room shielding will be more modest but nevertheless essential. Here, doors, window frames, etc., will often be shielded by modest thicknesses of lead, say, 1–3 mm. High-density building block options are also frequently employed. A relatively modest glass containing lead salts or equivalent plastic base materials can be used for windows with high standards of visibility into the area where the radiation source, normally an X-ray tube, is present.

UK Legislation

15.9 There are three major items of UK legislation that affect the design and operation of cancer care facilities with particular emphasis on some diagnostic and all radiotherapy departments. These are as follows:

- The 1999 Ionising Radiations Regulations and HSC approved Code of Practice;
- The Ionising Radiation (Medical Exposure) Regulations 2000;
- The 1993 Radioactive Substances Act.

16. Basis of environmental protection

Introduction

16.1 The potentially toxic materials used in the clinical aspects of cancer care services require careful handling and use, and particular concern surrounds disposal of these materials. Equally, cancer services buildings can be of particularly heavy construction, for example in radiotherapy departments, so the environmental impact of demolition may be significant.

Concept of radioactive discharge

16.2 In essence, just as there is background radiation so there is also background radioactive material present in the normal environment. Principally, this will consist of long-lived derivatives of natural uranium which ultimately gives rise to so called 'soil gas' or, more correctly, radon. This gas makes a marked contribution to natural irradiation of the population. Given that this is the case, it is clearly important that we restrict the degree to which we add to the level of radioactivity present in the environment. Broadly, the use of relatively short half-life radioactive materials in medicine counters this challenge effectively but some longer half-life material is also used.

16.3 Wherever reasonably practical and permitted by law, radioactive materials will be dealt with by the simple expedient of leaving them to decay until they reach an essentially safe or non-radioactive state. This will involve the construction of suitable storage facilities known as ‘decay stores’. However, for longer-lived materials, some discharge to the drainage system of the hospital, or into the air as a result of disposal by burning in approved incinerators, will be necessary. Discharge to drains or into the air may also occur routinely in the use of radioactive materials or as a result of accident.

16.4 It is important that the design of the building within which these radioactive materials are used constrains their release into the general outside environment to be at, or below, levels that have been pre-determined and agreed with the Scottish Environmental Protection Agency (SEPA). This agency has the responsibility to licence such disposals under the Radioactive Substances Act.

Minimisation of discharge and environmental impact

16.5 In principle, the discharge minimisation springs from concepts devised by the International Commission for Radiation Protection (ICRP) which states that radioactive materials should only be used where there is no viable alternative. However, where their use cannot be avoided, we are required to model and assess the levels of radioactive contamination that may be expected in the environment, particularly in respect of watercourses into which radioactive fluids

may be discharged. Dilution factors are critically important here; if a discharge can be rapidly diluted by enabling a drain to join with others of larger flow and capacity at an earlier stage, so the dilution will minimise radioactive concentrations and the hazards associated with that, though the overall discharge is unaffected. This is important to the water system engineering of many cancer care services buildings.

16.6 The administrative structure for the control of radioactive discharge and environmental protection will be common with that used for radiation protection in the great majority of healthcare institutions. Accordingly, the radiation protection advisor (RPA) will also render advice on the environmental impact and will be responsible for the generation of environmental impact models as needed.

16.7 When undertaking building design, the estimation of the environmental impact of radioactive discharges should be considered at an early stage. The presence or absence of such discharges, as well as the levels that may be expected, will be critically dependent upon the clinical tasks undertaken. In particular, nuclear medicine and the treatment of patients by the use of radioactive iodine will influence the level of discharge significantly. It is important to note that patients who have received radioiodine or other unsealed materials will discharge these in the form of body fluids, most obviously urine. For some of these treatments a great majority of the radioactive material administered will appear in urine and will accordingly be discharged over a short period of time, a few hours, into the drainage system of the hospital or other healthcare environments. This element of radioactive discharge is, in practical terms, unavoidable.

Population radiation dose and effective control

16.8 Clearly the discharge of radioactive materials from sites or institutions that make use of such contributes to population dose. However, the contribution from medical discharge is small and although this will be taken into account in modelling conducted by the radiation protection advisor (RPA), it is unlikely that this will result in constraint on medical activities on a given site. However, local limits for discharge exist and these should be carefully observed at an early stage in the planning process.

Decommissioning of facilities

16.9 Essentially, wherever radioactive materials are used, be they sealed or unsealed, the possibility of the long-term build-up of radioactive contamination may exist. However, in the modern era, the controls exerted on sealed sources should, particularly in healthcare institutions, be such as to mean that their chronic loss will not be tolerated or encountered. Accordingly, the need to examine the built environment for such sources is no longer prevalent, though incidents may occasionally occur and rooms where such sources are handled should be designed with this in mind. Specifically, it is helpful if gaps and surface discontinuity are avoided.

Single bed LDR/MDR treatment room showing window in external shielding wall. Shielding continuity is maintained by use of a free-standing concrete shielding wall enclosing a controlled area that can be landscaped for the benefit of the patient.

16.10 More commonly, unsealed radioactive sources present as liquid solutions may give rise to chronic contamination of the rooms in which they are used and most especially the drainage system from that room if discharge to drains is permitted. In this case, the RPA should be consulted and records examined to determine the nature of the radioactive materials present and, in particular, their effective half-life in that environment. If the half-life is short, it may be wise to delay dismantling the pipework, etc., for an appropriate period of time so that radioactive decay can effectively remove the hazard. Where the half-life is long or such delay cannot be accommodated, special precautions will be necessary and the pipework itself may constitute solid radioactive waste. Should this be the case, the RPA will write a decommissioning scheme of work and will also undertake to work with SEPA to ensure appropriate ultimate disposal of the materials.

16.11 In respect of the above decommissioning of unsealed radioactive source sinks, drains, etc., there is a particular need for care if chemical agents are being used to reduce the radioactive burden. In particular, care must be taken when decommissioning teams use chemicals, including bleach, since these may oxidise some radioactive materials in solution, rendering them insoluble. Such process may then result in radioactive gases being released into the immediate environment, giving rise to an increased hazard to workers. Detailed professional advice must always be obtained for each specific situation and the use of general rules is unwise.

16.12 Generating radioactive materials within the structure of machines or in the built environment that contains them is often poorly understood as a part of a decommissioning process. In the great majority of cases, the X-ray or gamma

ray beams employed by X-ray machines and linear accelerators do not generate radioactive induction in the built environment or structures around them. Accordingly, for the huge majority of such installations, there are no special decommissioning criteria and no special precautions need be taken in respect of radioactivity.

16.13 Linear accelerators operating at above 8.5MV are capable of inducing radioactive activation in their own structures, most notably the collimators or jaws as well as parts of the couch. In very unusual instances, this activation may extend to the built environment of the bunker shielding that surrounds the machine. However, good design can virtually eliminate this as a consideration while in older, poorly designed units, the extent of activation and the half-life of the radioactive materials present is such that special precautions are not likely to be needed. However, when high-energy linear accelerator bunkers are being decommissioned, a radioactivity site survey should be conducted and the RPA consulted as to whether or not special precautions are needed in the specific instance. It is unlikely that the move toward new materials such as 'Ledite' will materially affect radioactive activation, though the potential re-use of 'Ledite' is a factor.

Economic considerations

16.14 The decontamination and radiation control issues mentioned above are not likely to add severely to decommissioning costs in radiotherapy and nuclear medicine facilities. However, the business of using possibly very large amounts of shielding does have a potential impact and the problems associated with the disposal of that shielding at the end of the useful life of the facility should be considered. Bunkers should therefore be constructed to take in the future, high energy and larger machines wherever possible, to enable flexibility in future use.

16.15 Reinforced concrete structures are amenable to removal only by on-site breakage and demolition. The waste materials are then conventionally removed from site using heavy vehicles and are disposed of by landfill or, in some instances, a recycling process, which involves crushing the material. By contrast some of the new shielding materials, 'Ledite' being the best known example, are amenable to re-use and can simply be dismantled and either returned to the supplier or redeployed in new buildings. In considering the overall costs within a business plan, particularly for a radiotherapy development, an assessment of environmental protection and impact in respect of demolition or reuse of materials is a relevant consideration.

HDR control area showing the afterloading machine control and monitors.

17. Control of infection in cancer patients

Introduction

17.1 Infectious diseases and healthcare associated infection represent an increasing problem for hospitalised patients and a major cause of morbidity and mortality in patients with compromised immune systems. Readers are referred to the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment - design and planning'.

17.2 All patients, staff and visitors to healthcare institutions are subject to a measure of exposure to possible cross-infection due to the obvious concentration of disease within such buildings. There is accordingly a clear duty of care, frequently reinforced by government measures, to minimise such risk at every reasonable opportunity. Control is dependent upon the generation of suitable policies and protocols at local level, but also necessarily involves attention to detail in building design.

17.3 Readers are referred to NHSScotland guidance, Scottish Health Technical Memorandum 2040 – 'The control of legionellae in healthcare premises – a code of practice'. Further detailed advice on the prevention of infection spread through pharmaceuticals is contained within Health Building Note 29 'Accommodation for pharmaceutical services'. Much of the latter advice will apply to radiopharmaceuticals.

Vulnerability of cancer patients – general and specific

17.4 The group of patients discussed in this document may have a broad variation in immunological function and for this reason and because individual immunological functions will vary according to the stage of treatment, it is difficult to be prescriptive.

17.5 The risk of infection for cancer patients as a group has not been shown to differ substantially from others suffering acute illness. However, an exception exists for those who are immuno-compromised as part of treatment for a range of diseases, most commonly leukaemia. Such treatment may involve total body irradiation followed by a bone marrow transplant and a long period of infection-protective nursing. This is a particular consideration in paediatric services.

17.6 Cancer patients may have complications in terms of other diseases that potentially give rise to enhanced vulnerability. The skew inpatient–age distribution towards older age groups should also be noted.

Sources of risk

17.7 A number of diseases pose quantifiable levels of risk for infection in healthcare premises, particularly hospitals. Prominent among these is methicillin resistant staphylococcus aureus (MRSA) but the range of hospital-acquired infections (HAI) is wide and the prevalence amongst patients is as high as 10-12%. This can give rise to a significant additional hurdle that must be overcome in the provision of satisfactory care for cancer patients. A summary is provided in The Socioeconomic Burden of Hospital-acquired Infection, available from Public Health Laboratory Service or the Department of Health Web site (http://www.doh.gov.uk/haicosts.htm).

17.8 Infection may spread by a variety of routes including patient-to-patient, patient-via-staff and contact with building fittings or furniture previously contaminated by the infectious agent.

17.9 Transmission of infection within a hospital requires three elements to be considered:

- sources of potentially pathogenic organisms;
- susceptible hosts;
- means of transmission.

Sources of potentially pathogenic organisms

The environment

17.10 The environment has been increasingly implicated as a source of infection in the hospital setting and bacteria such as MRSA have been shown to survive in dust and on equipment for long periods.

Hands

17.11 Hand-washing is without doubt the most important intervention in the control of cross-infection and it is important that hospital accommodation is designed to encourage hand washing, see 'Clinical sinks – design for clean hands' in the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment: design and planning'.

Patients' own endogenous flora

17.12 This is a difficult area to control and may be addressed by pharmaceutical means. Intravenous administrations can also be implicated in cross infection.

Other human sources of infection

17.13 Occasionally staff, patients and visitors may be a source of infection as they also may be incubating a disease or be colonised with bacteria.

17.14 Inclusion of single bedrooms or small two-bed bays into the design of new build healthcare facilities can help to overcome some of these problems.

Susceptible hosts

17.15 Factors such as age, immune status, underlying disease, certain treatments and breaks in the first line of defence are all possible problems that may render this group of patients more susceptible to infection.

Means of transmission

17.16 Transmission of potentially pathogenic organism occurs by:

- contact, usually staff to patient, either direct or indirect which involves contact of a susceptible host with a contaminated object or the environment;
- airborne transmission – coughing, sneezing, talking or during certain procedures such as bronchoscopy. Droplets containing micro-organisms that remain suspended in the air for long periods of time or dust particles containing infectious agents. Infection spread in this way can be dispensed widely and may be inhaled by susceptible hosts either within the immediate environment or over longer distances. Special air handling or ventilation is required to prevent airborne transmission;
- isolation precautions are designed to prevent transmission of infection in hospital and especially for this patient group during periods of susceptibility; temporary periods of neutropenia.

17.17 During periods when they are not undergoing treatment some patients may have other underlying risk factors such as a break in skin integrity through a Hickman line/CVP, or problems with other metabolic factors such as malnutrition, etc. In these circumstances basic infection control procedures apply in the same way as to any other hospitalised patient.

Preventative measures

Built environment and facilities management

17.18 Exposure to exogenous pathogens should be reduced. This can be assisted by attention to the built environment by providing the following:

- single rooms/small two-bed/four-bed bays with doors;
- space around the beds;
- hand wash facilities;
- staff change areas;
- decontamination facilities;
- design for a clean environment;

- appropriate ventilation;
- suitable furnishing/fixtures, fittings and flooring;
- portable water;
- catering facilities;
- hand wash facilities for patients and visitors;
- reverse isolation/barrier nursing;
- an environment that is easily cleaned and then actually kept clean;
- a high standard of decontamination of equipment/instruments and medical devices, etc.

Specific infection control issues during renovation/refurbishment or construction

17.19 It is important that the infection control team is consulted early in the planning stage of either refurbishment or renovation of existing buildings or in any new schemes for healthcare buildings. For timing of inclusion and areas of consultation see the NHSScotland guidance Scottish Health Facilities Note 30 'Infection control in the built environment: design and planning' .

17.20 It is also important that the infection control team carry out risk assessments for any building work that will take place in patient areas, especially in areas where immuno-compromised patients are looked after, and produce a policy for contractors. Continued monitoring is then necessary and can be achieved by carrying out environmental rounds once the building work is under way.

17.21 General care in design should extend to the avoidance of design elements that promote the accumulation of dirt or microbial growth. Particular attention should be paid to wall, floor and bench surface finishes where care to ensure the absence of discontinuity and promote ease of cleaning is required. This will apply particularly in chemotherapy treatment rooms and minor procedures facilities. Extensive additional information is available in NHS Estates guidance Health Building Note/Scottish Hospital Planning Note 40 'Common activity spaces'.

17.22 Debris arising from building operations or from the breakdown of building materials, including some ceiling tiles, is known to promote infection by some species including fungi such as Aspergillus spp.

17.23 Infection control issues during refurbishment and new build include:

- timely notification and involvement of the infection control team;
- design to support infection control practice, i.e., ventilation, single rooms, hand hand basins, fixtures/fittings/furnishings;
- utility rooms, storage and space;
- dust and debris control, the problems of Aspergillus spp;

- prevention of contamination of patient rooms, ward areas and supplies/equipment;
- impact of work being carried out around at-risk patients;
- interruption of services; ventilation, water;
- water contamination;
- flooring, ie, carpets versus hard floor.

17.24 The spread of infection from hand-to-hand contact is a particular challenge that should be countered by the provision of washhand basins in sufficient numbers, and located so as to promote their frequent use, particularly by staff on wards and in treatment areas. This challenge must not be neglected in specialist areas such as radiotherapy treatment facilities.

17.25 Restriction on the spread of infection should be a design priority in the provision of natural or mechanical ventilation. The reader is referred to the NHSScotland guidance Scottish Health Technical Memorandum 2025 'Ventilation in healthcare premises' .

17.26 The operating theatre is an area of particular concern. Some elements of advice are contained within this document in respect of common cancer-related procedures. Readers are referred to NHS Estates guidance Health Building Note 26 'Operating department together with NHSScotland Scottish Hospital Planning Note 26 'Operating department' for general advice.

Facilities for immuno-compromised patients

17.27 The use of total body irradiation as part of leukaemia therapy and other treatments, with the subsequent need for infection-protective nursing and high levels of precaution against infection with such patients, will be a special concern for some cancer care centres. Patients will be accommodated in individual rooms, often grouped around a common nursing and access area. High levels of nursing supervision and access control are necessary. Facilities must satisfy the requirements of the Level 4 care standard defined by the Clinical Haematology Task Force of the British Society of Haematology.

17.28 The design team must include the control of infection team, specialists in theatre level ventilation systems and a clinical consultant with special interest in this specific patient group.

17.29 The patients' rooms will be subject to special consideration on surface finishes, with very high standards of surface continuity being considered essential. The choice of materials will also reflect the need for frequent disinfection and rigorous chemical cleaning. The selection of furnishing must also be cautious in terms of cleanability, the avoidance of loose fibres and the near total exclusion of environments in which bacteria or fungi may be able to grow.

17.30 Mechanical ventilation, with a micropore filtration system, is necessary and will itself preclude the non-controlled use of natural ventilation. The use of over-

pressure to ensure a constant outflow of air, such as to exclude uncontrolled air leakage into the room will be essential.

17.31 The use of local article sterilisation facilities should be considered.

17.32 Staff will require local dedicated changing facilities to permit the use of theatre standard clothing and very high standards of personal hygiene. Some staff will require scrub facilities.

18. Appendices

Appendix 1:

Specific engineering requirements

Introduction

1. This Appendix describes specific engineering services requirements for Cancer Care Centres. It complements the general engineering services guidance given in Scottish Health Planning Note 03 'General design guidance'. The combined guidance should not inhibit the design solution, but will acquaint the engineering members of the multi-disciplinary design team with the design criteria and material specification needed to meet the functional requirements. Specific requirements should be formulated in discussion with both end-users and manufacturers of specialist equipment. Some issues particularly those related to radiation safety will require specific and detailed discussion with other professional consultants including the local RPA.

Maximum demands

2. Details of power consumption and load patterns of significant individual items of equipment must be sought from manufacturers and/or suppliers. Most commonly this information will be received as part of the equipment tendering process.

3. Estimated engineering loadings etc for one high-energy linear accelerator suite are given below, as a guide and for preliminary planning purposes only.

Earthing for linear accelerators

Recommended – 0.1 Ohms but must not exceed 0.2 Ohms when measured between any point in the system and the main earth reference terminal.

Example: Siemens, Mevatron Linear Accelerator

Mass of machine

- weight of accelerator when installed; 7030 kg;
- heaviest component when being transferred to bunker; 4082 kg.

Power requirements

- typically 480V or 380V preferred to 240V source when available;
- three-phase delta to star at 50/60Hz with +/- 1Hz frequency variation permitted;

- power use or requirements; 30kVA;
- typical system input voltage; 240V line to line, 120V line to neutral;
- line voltage variation, +/- 10% maximum;
- phase balance, 2% between 2 phases;
- line impedance <= 0.050 Ohms maximum line to neutral at secondary of transformer;
- surges and sags 10% above and below line voltage, 20msec maximum duration;
- high frequency noise, no single event greater than 10V in the range 10kHz and 2MHz;
- spikes, no single event greater than 100% of the nominal line to line voltage expressed as peak voltage; 240 peak for 240V input;
- typical circuit protection, 80Amps.

Heat dissipation into air

- 13,989 BTU/hour when operated or 14kW/hour approximate;
- 6,824 BTU/hour when in standby or 6.9kW/hour;

Noise at 1m distance

- 75dB(A); maximum value;

Room temperature requirements

- no condensation;
- room temperature not to exceed 26°C and 65% relative humidity;
- atmospheric pressure, treatment room must not differ by more than +/- 250mbar when compared to control area.

Air filtering

- class EU 4 (B2) and observe German standard DIN 1946.

Room air changes

- the air-conditioning should be capable of at least seven air changes per hour to allow for a maximum duty cycle of 15 minutes per hour and an ozone concentration of less 0.05ppm.

Accelerator water supply

- closed-loop chiller water system;

- water temperature, 10°C minimum, 25°C maximum;
- flow rate, 30l/minute at 25°C;
- dissolved solids in facility water cooling system must not exceed 0.01%;
- heat dissipation to water, typical consumption, inlet temp of 14°C and patient load of six per hour would use between 2 and 4 litres/minute;
- direct mains water for cooling must not be used, cooling water should be recirculated.

Physical distance between cables

Standard cabling length from control console/accelerator interface is 24m and allowance must be made 3m from conduit exit point to the interface on the linear accelerator or control console. Maximum conduit length is 18m.

Example: Varian Oncology Systems, Dual Energy Clinac

Mass of machine

- 17,508 kg when installed;
- largest component; 4,240kg when moved onto bunker.

Power requirements

- Dual Energy Clinac – 45kVA;
- typical international requirements, 360 to 440VAC 50/60Hz line to line, three-phase supply four wire plus ground star configuration, line voltage regulation +/- 5.

Heat load

- 12kW per hour.

Note: These examples are typical at the time of writing but due to the rapid rate of change in technological requirements care is advised. Several additional suppliers also provide linear accelerators to the NHS.

Activity data

4. Environmental and engineering technical data and equipment details are described in the relevant Activity Database, available from NHS Estates as a subscription service. This should be referred to for space, temperatures, lighting levels, outlets for power, telephones, equipment details, etc. Significant gains in both management and patient service areas may be expected from the provision of a wide-bandwidth LAN and associated computing equipment. This is especially true in the areas of radiotherapy and some parts of diagnosis and

treatment planning. Also refer to NHSScotland guidance Scottish Health Planning Note 03 'General design guidance'.

Safety

5. The Ionising Radiation (Medical Exposure) Regulations 2000 and the associated Codes of Practice place onerous requirements upon engineering aspects of design and operational practices in cancer care centres and units. Over and above this, there are additional requirements in the 1993 Radioactive Substances Act with respect to storage, use and disposal of radioactive materials. The local radiation protection adviser (RPA) and custodian of radioactive substances must be consulted.

Environmental requirements

6. Detailed environmental requirements for specialist equipment relating to this accommodation should be obtained from manufacturers. The comfort of patients and staff should be considered in respect of temperature stability and the effects of waste heat derived from high-powered diagnostic or treatment systems. Humidity control is often a key feature of successful design.

Space for plant and services

7. It should be noted that machine plant rooms are required for each accelerator. These should be structured such that plant for one accelerator can be isolated without affecting operations of any other. Similarly, it should be possible for engineering staff to work, under an approved 'Permit to work' system, without any hazard to themselves by the operation of other accelerators.

8. All mechanical and electrical services entering rooms potentially containing radiation must be routed through specially designed access ports so that shielding is not compromised. It may also be necessary to design-in changes in direction of ductwork, and cable containment systems to provide protection against radiation breakout, services into linear accelerators will all pass through the maze, with possibly an additional chicane for high-energy linear accelerators.

9. In other situations, existing installations for example, services may pass into the room at low level and rise into their final position. The precise arrangements will be project specific and should be determined with the installation specialist.

10. In a diagnostic or treatment simulation area the access arrangements must not compromise the radiological protection provided for these rooms. Consideration should be given to the comfort as well as safety of patients and others. It may be appropriate to use a 'double knock' system whereby attempted unauthorised access first initiates an audible warning and only when the access attempt is continued is radiation-emitting equipment switched off. However, the hazard

levels present with therapy equipment require a more stringent approach in which any intrusion will trigger beam shutdown.

Engineering commissioning

11. The services for linear accelerators may require to be commissioned early in the engineering contract programme. This is to ensure that the linear accelerators commissioning is completed prior to the first patient arriving. Parts of this commissioning are concerned with radiation safety and the approval of the local RPA must be obtained for the processes and schedules used.

Mechanical services

Heating

12. Special care is needed when radiators are installed in rooms where unsealed or liquid radioactive sources are used. Protection of such fittings against radioactive contamination will be essential.

13. In calculating heating requirements care must be taken to include heat yield from high-powered equipment used in cancer care centres.

Ventilation

14. The majority of the areas within the facility will require mechanical ventilation, due to equipment heat gains, patient/staff numbers and clinical/radiology reasons.

15. The supply plant for ancillary accommodation should be separate from plant serving the cancer care facility.

16. Fume cupboards and microbiology cabinets will be required and their exhaust locations will need careful consideration. These items are used for a range of specific containment tasks such as dealing with cytotoxic drugs or radioactive materials. Equipment types and installation requirements will vary significantly with the application and hazards involved. Detailed local advice must be sought from the appropriate scientists and pharmacists.

17. Consideration should be given, in discussion with the user, regarding the possible use of aromatherapy via the centre ventilation system. This may be effective as an environmental enhancement and there is some limited evidence of particular benefit to this patient group. The smell-masking produced may also be of value.

Ventilation of therapy rooms and bunkers

18. Due to the excessive heat emission from some equipment such as linear accelerators, etc., and the special and often prolonged nature of the

procedures, mechanical ventilation will be a requirement to achieve the required air changes. It is possible that they may also require that the air supply to these rooms be mechanically cooled. Discussions should take place between the users, manufacturers and engineers to ensure an appropriate temperature is achieved. Where deep planning of other continuously occupied spaces, for example offices, is unavoidable, there will also be occasions when acceptable levels of comfort can only be maintained by air-cooling.

Ventilation of pharmaceutical services rooms

19. Details of specialist ventilation of pharmaceutical departments are included in NHS Estates guidance Health Building Note 29 'Accommodation for pharmaceutical services', which can be used with general caution in Scotland. However, the use of cytotoxic drugs in chemotherapy generates an additional series of considerations. These include the need to effectively control toxic fumes and the prevention of environmental contamination. Specially adapted microbiological safety cabinets and other containment devices will be needed. Discharge filtration will be applicable in the majority of instances.

Ventilation controls

20. Supply and extract ventilation systems should include local controls and indicator lamps to confirm the operational status of each system. Where the system is used in a regular daily pattern, timeswitch control with manual override for a limited period should be considered, staff-controlled boost ventilation for a linear accelerator after some patient treatments where the control of odours may be important. The indicators for a system serving a particular space should be in or immediately adjacent to that space. It may be appropriate to locate all indicators at the staff base. Where manual controls are available for staff use, they should be provided with labels that clearly define their function. Such manual controls are more likely to be needed in cancer care because of the need to clear odours generated by some types of tumour. Local consultation with healthcare professionals is advised.

Ventilation filtration

21. Ventilation supply plant should include air filters having a minimum arrestance of 85% when tested in accordance with BS EN 779. In urban or other areas of high atmospheric pollution, a higher standard of filtration may be economically justified to reduce the level of staining to internal finishes. Filters must be readily accessible for replacement and should be provided with a pressure-differential indicator.

Ventilation of isolation rooms

22. The facility may require isolation rooms to protect patients and/or staff. Guidance should be sought from the project team or end user.

23. The mechanical ventilation system for isolation rooms should be designed to provide either a 'source' or 'protective' isolation non-changeover system that provides balanced supply and extract ventilation to each room and a gowning lobby is recommended. A 'constant mode' system has a number of advantages and avoids the complications and reliability problems associated with changeover systems.

24. The gowning lobby, which functions as an airlock, will require a relatively high and balanced supply and extract air change rate to be effective against airborne organisms moving between circulation areas and the rooms. For this reason, the gowning lobby should be relatively small.

25. Staff entering the gowning lobby from the corridor will go through a clinical hand-washing procedure and during this period, the ventilation system will dilute the air entrained from the corridor. Further entrainment and dilution occurs as staff move from the gowning lobby to the room. The amount of air and number of organisms transferred from the corridor to the room through this process should be exceptionally low and will be inversely proportional to the time spent gowning up. The reverse will also apply as staff leave the single bedroom.

26. The mechanical ventilation system should also include mechanical cooling and provide for a range of temperatures which can be adjusted by staff. The humidity within the single room should also be controlled.

Piped medical gases and vacuum

27. Guidance on piped medical gas systems, anaesthetic gas scavenging and gas storage is contained in NHSScotland guidance Scottish Health Technical Memorandum 2022 'Medical gas pipeline systems'. There is a high likelihood that such services will be needed in selected treatment rooms. Local consultation is essential.

27 Special non-ferrous fittings will be needed if equipment may also be used in MRI scanning rooms.

Bedhead services

28. Depending on the type of care being provided, it may be desirable to provide a more domestic environment. To achieve this, bedhead services can be concealed within a cupboard or behind some other movable feature. However to enclose such services requires care to ensure that there is adequate ventilation in the event of gas leakage. Sufficient space must be provided. Current clinical practice is to leave devices permanently inserted into medical gas outlets and plugged into electric sockets.

Lighting

29. Emergency lighting of control rooms should also be arranged in accordance with the requirements of users and NHSScotland guidance Scottish Health Technical Memorandum 2011 'Emergency electricity services'.

Electrical interference

30. Care should be taken to avoid mains borne interference, electrical radio frequency and telephone interference affecting physiological monitoring equipment, computers or other electronic equipment used in this accommodation. Special care requires to be taken with dosimetry, IT and CCTV cables, which should be accommodated individually to prevent any problems.

Lighting treatment rooms

31. An examination luminaire should be provided over the treatment chair/table. It should be adjustable in pitch and rotation to allow the beam to be directed locally. Reasonably shadow-free illumination, with negligible heat development, should be provided to avoid injury to patient and staff. The examination luminaires should be manufactured and tested in accordance with the requirements specified in the relevant sections of BS 4533.

32. For linear accelerators and some other treatment machines, automatic switching to low-level room lighting will be needed to facilitate the use of field marker lights and low-power alignment lasers. Conversely, high levels of lighting are needed for equipment maintenance.

Illuminated signs

33. At each entrance to a radiodiagnostic or radiation treatment room, a safety sign and a warning lamp must be provided in order to comply with the statutory requirements for radiological protection. The warning lamp must give a clear indication in red when it is energised and may incorporate the legend "do not enter", visible only when illuminated. All warning lamps should have incandescent filaments energised from a suitable power source within the room and switched via appropriate devices interlocked with the operation of the diagnostic or therapeutic equipment.

34. Other illuminated signs may also be required within the facility. All such signs should be connected to essential supplies where necessary. For therapy equipment, where exclusion of persons other than the patient is essential, the warning systems must work with interlocks and be specifically approved by the local RPA.

Socket outlets and power connections

35. Socket outlets in areas for consultation, examination or treatment and wherever X-ray films are processed, reported on or stored, should be connected such that within each area a supply is available from at least two separately fused circuits of the same phase.

Electrical supplies to diagnostic and therapy equipment

36. Advice on the power supply and requirements for fixed and mobile radiodiagnostic equipment is contained in NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services: supply and distribution'. Individual project requirements should be discussed at an early stage with manufacturers and suppliers of equipment.

37. The earth connection at the power termination should be suitable for the functional earth requirements specified by the radiology equipment manufacturer, and be arranged to receive a direct connection from the earth reference terminal which should be provided or designated in every radiodiagnostic room. Further guidance on the purpose, characteristics and performance criteria of an earth reference terminal are given in NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services: supply and distribution'.

Staff location system

38. The hospital staff location system should be extended to include this facility. Further guidance is contained in NHSScotland Scottish Health Planning Note 03 ‘General design guidance’. There are particular advantages to the use of such systems in cancer care. Patients’ groups have emphasised the value in continuity of contact with a familiar care team and individual members of staff.

Patient/staff and staff/staff call systems

39. Particular care will be required in choosing and siting call units for use whilst a patient is undergoing treatment, for example, within a linear accelerator.

Telephones

40. At least one ex-directory line should connect directly with the local ambulance services control centre, depending on local policy. It should have a distinctive bell or buzzer.

Intercom systems

41. The character of the diagnostic techniques used within cancer services may make it appropriate to provide intercom stations in addition to the telephone and call systems. These permit ‘hands-free’ speech contact, staff/staff, patient/staff

or staff/patient. Consideration should be given to the local circumstances and treatment methods.

CCTV

42. CCTV should be provided, where required, to monitor patients undergoing treatment in restricted areas. The interference to which such equipment may be subject should be taken into account when it is specified to ensure acceptable electromagnetic compatibility. Care should be taken in the positioning of monitors in order to preserve patient privacy.

Music and television

43. Conduits for television/video and background music system outlets should be provided to public areas, bedheads and treatment rooms.

44. The provision of an independent or independently controlled music distribution system from the rest of the hospital should be considered in light of local patient needs.

Chemical and radioactive contaminated effluent

45. Providing that there is adequate dilution and the silver content has been effectively recovered, effluent can be discharged into the internal drainage system. Project teams are advised to establish the acceptable levels for silver and other processing chemicals at the planning stage of a scheme, as these are subject to change.

46. The drain from the toilet and shower associated with the diagnostic room where nuclear medicine imaging is undertaken will carry slightly radioactive effluent. It must be sealed throughout its run to the main sewer and its route chosen with regard to the areas likely to be affected if leaks develop. It is recommended that drainage for this purpose should not be into a pumped system.

47. At an appropriate early stage in the design process the project proposals for the collection and discharge of chemical and radioactive contaminated effluent should be discussed and verified with the local authority. Some local authorities may impose restrictions on the quantity and rate of discharge of such effluent into public sewers. Refer to the section within this guidance on environmental protection.

Appendix 2:

Room layouts

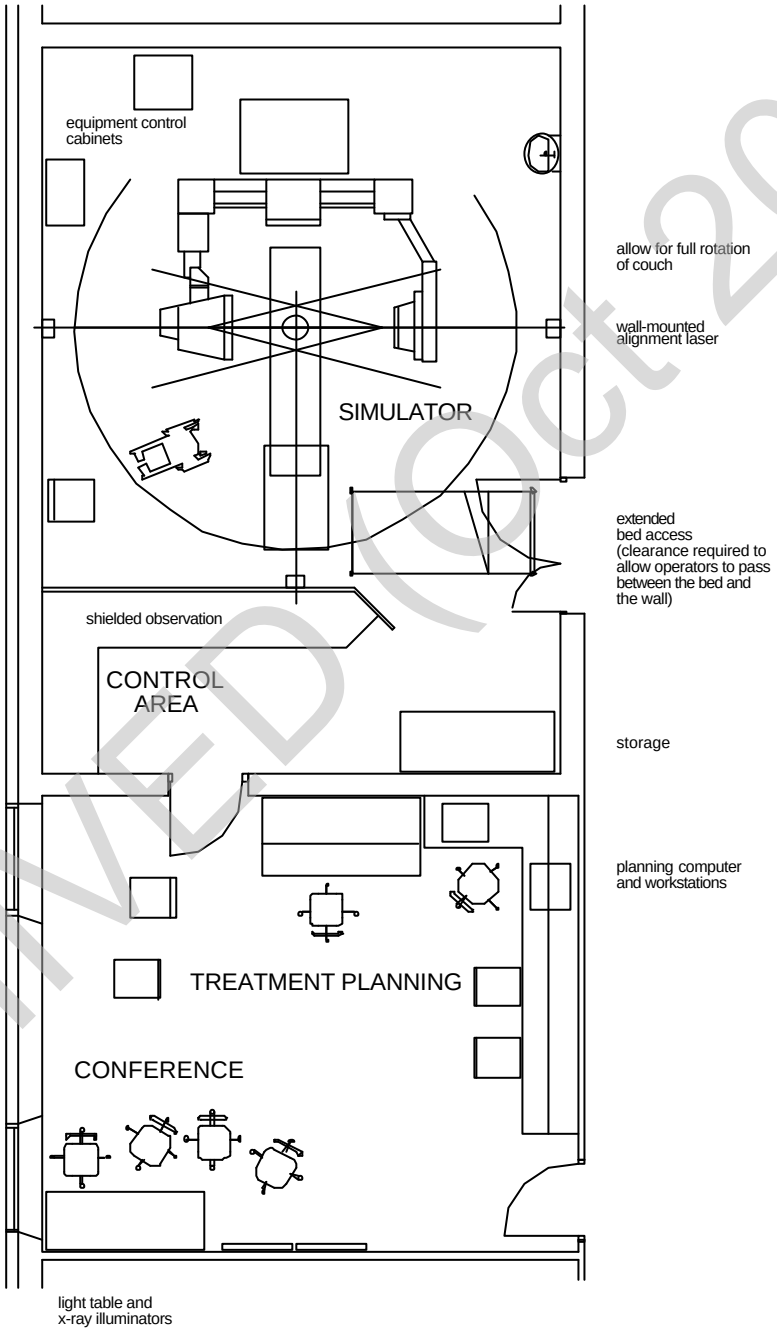


Figure 1: **Simulator with treatment planning and conference suite**

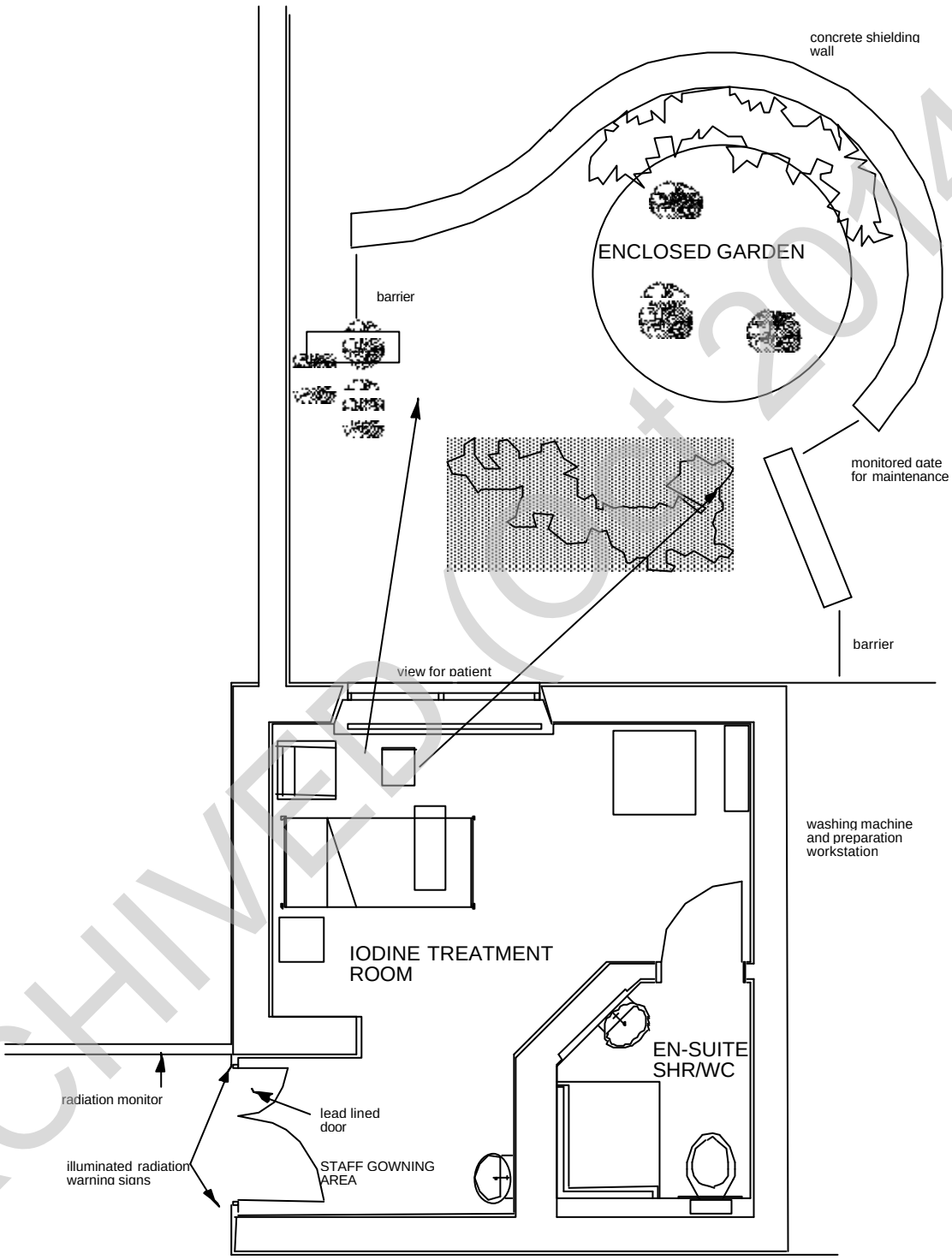


Figure 2 : **Iodine treatment room with ensuite shower/WC**

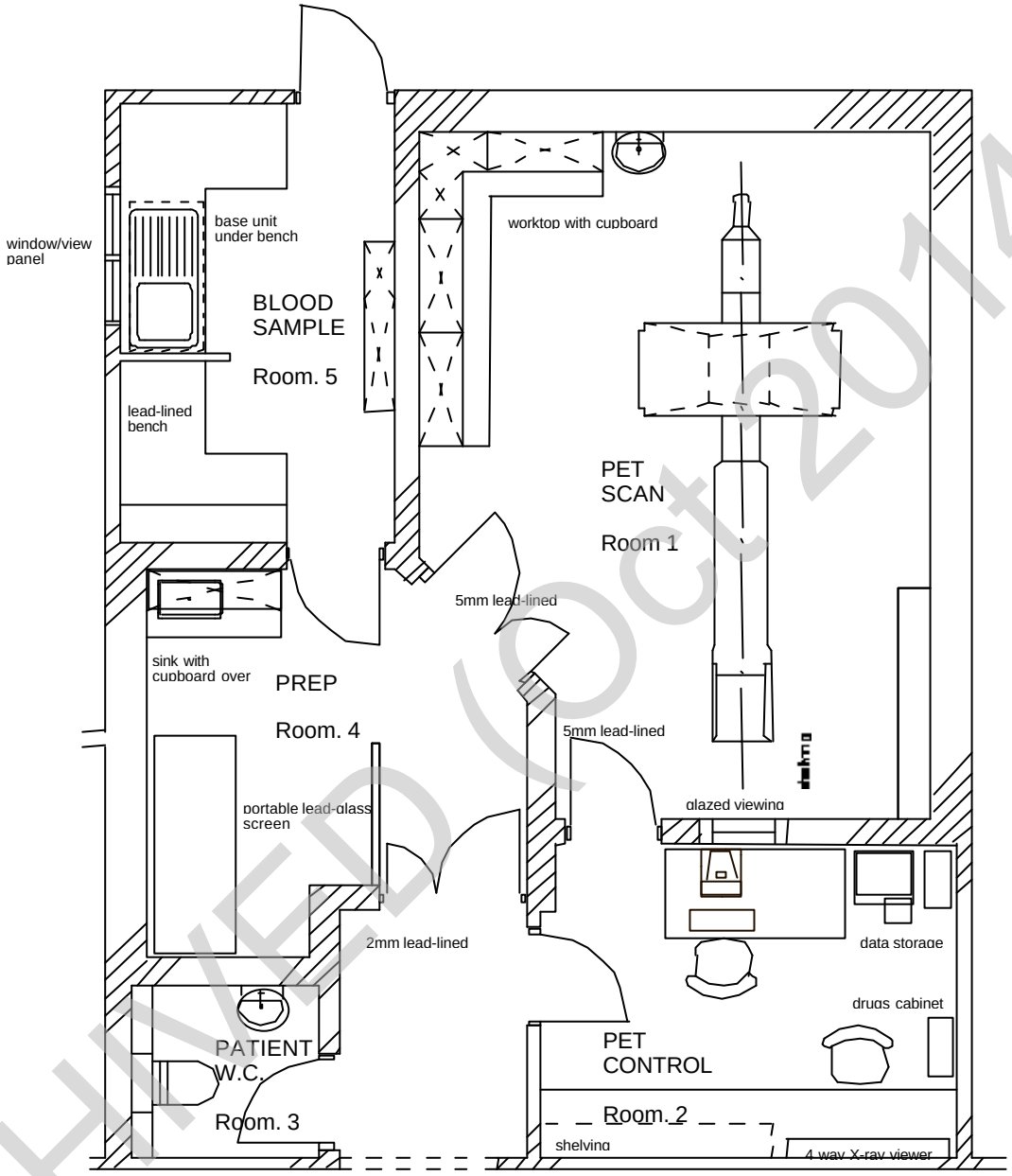


Figure 3: **A typical PET suite**

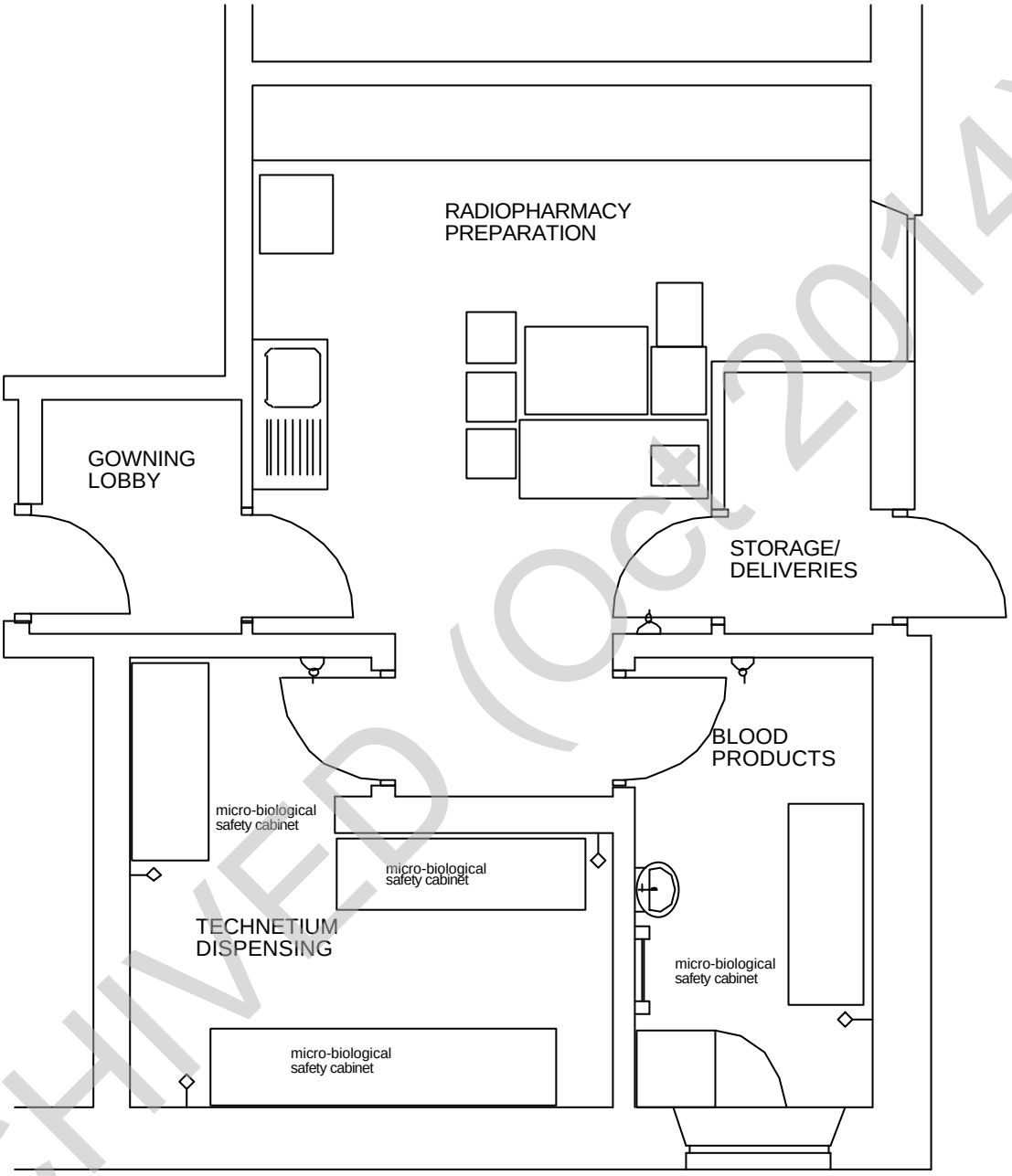


***Figure 4*: Example layout radiopharmacy suite.**

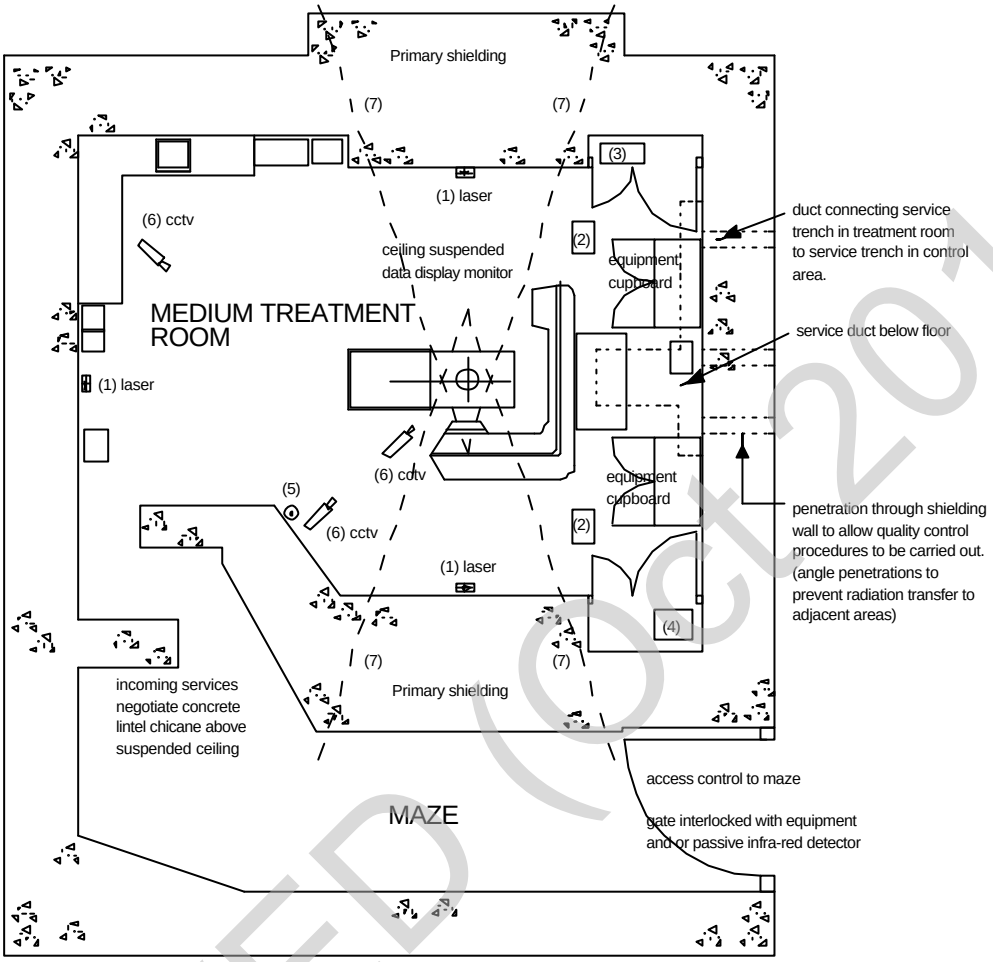


Figure 5: **Example layout of medium-energy accelerator treatment room**

1) Laser alignment light rigidly mounted to structure and connected to laser generator using fibre optic cables.
2) Data monitor.
3) Laser generator.
4) Stabiliser.
5) Last person out button.
6) CCTV patient monitoring cameras, fixed focus and/or patient zoom.
7) Primary beam and intermediate scatter cone.

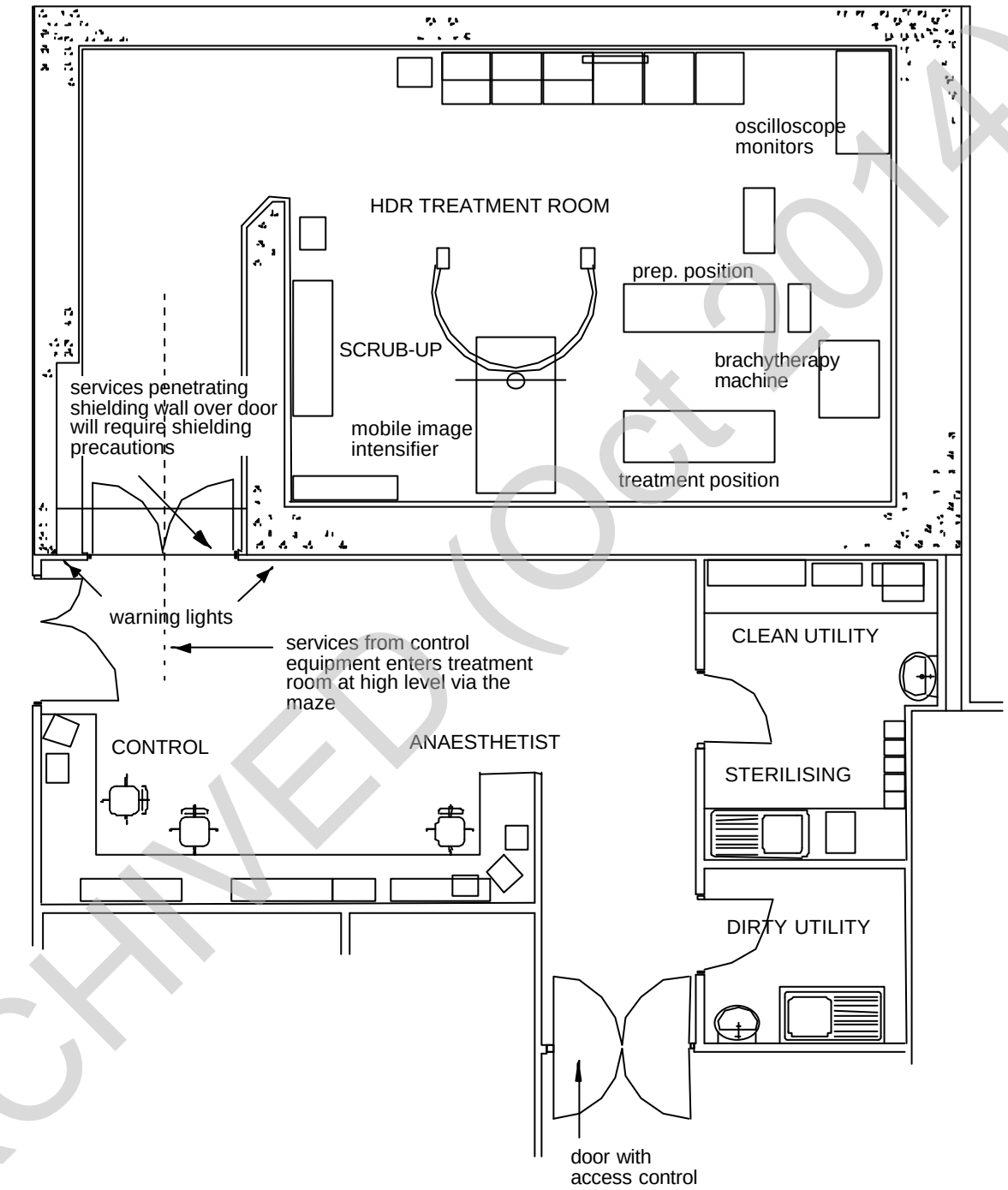


***Figure 6*: Example layout of high-dose radiotherapy suite**

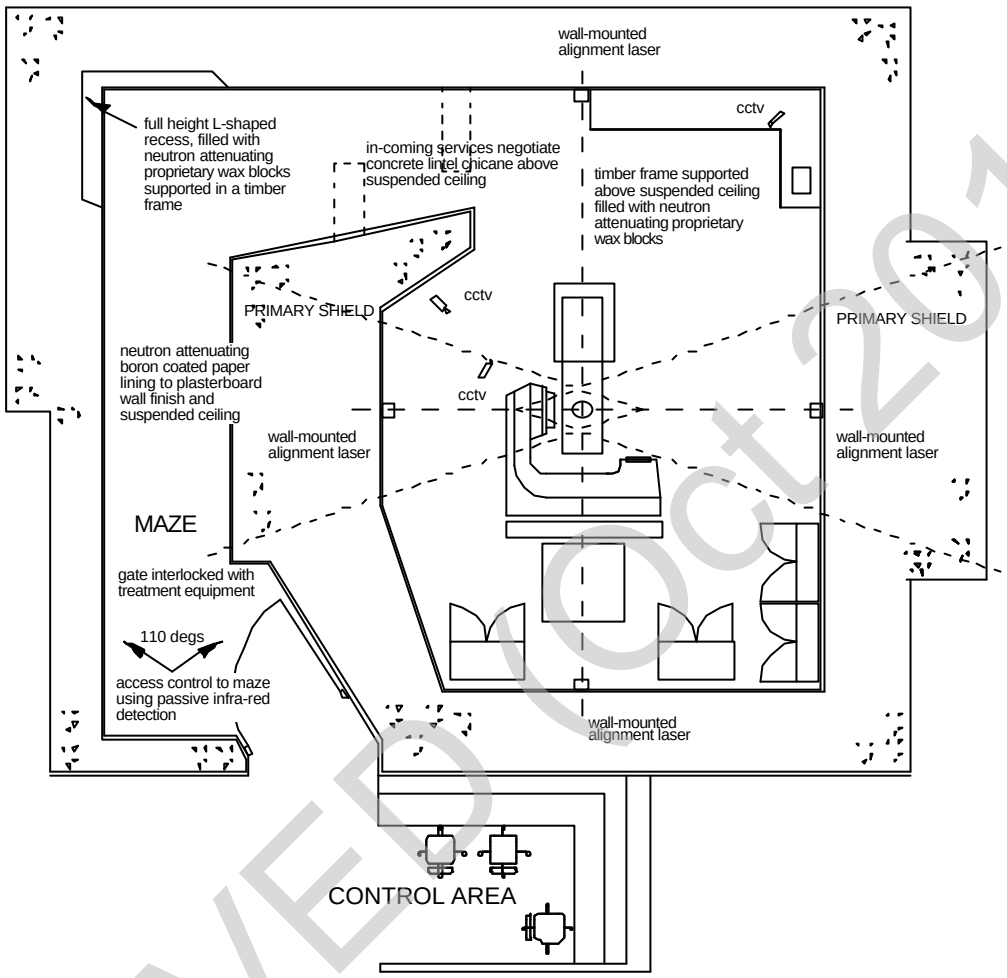


Figure 7: **Example layout of high-energy linear accelerator treatment room**

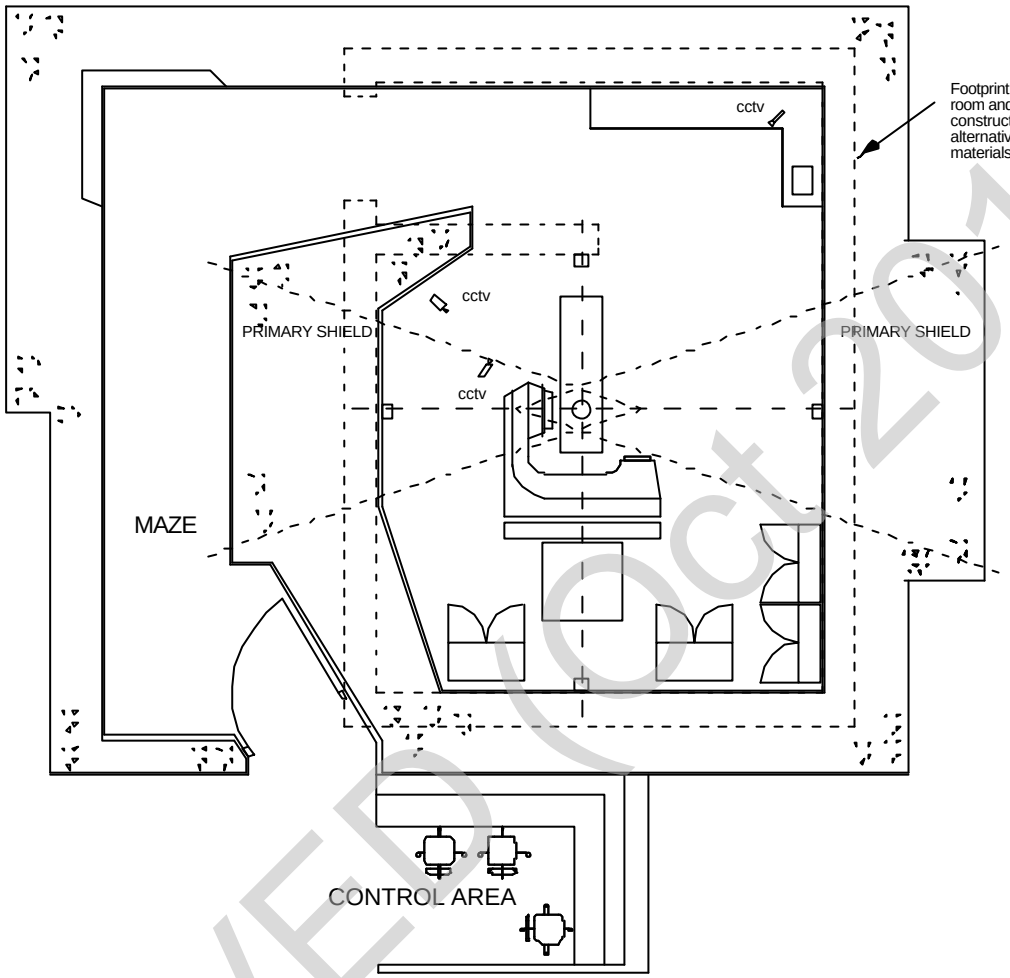


Figure 8: **Example layout showing comparison between footprints of high-energy linear accelerator rooms constructed using concrete shielding walls and alternative proprietary shielding material**

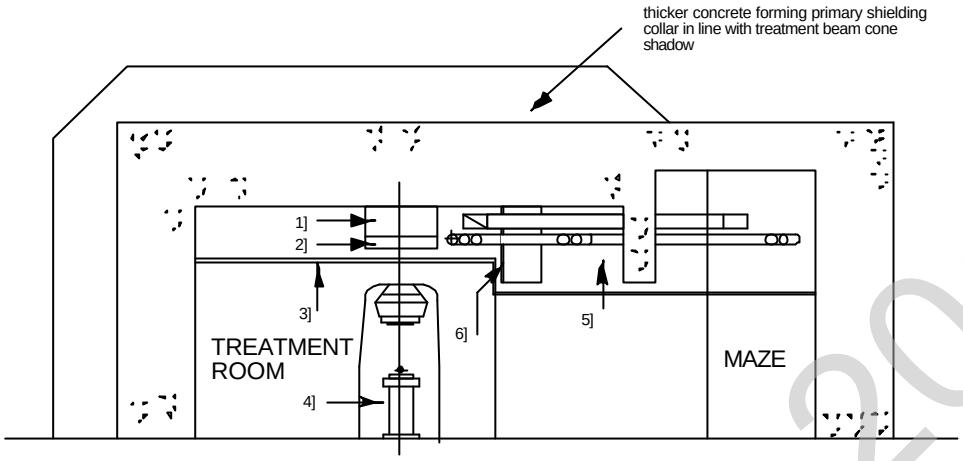


Figure 9: **Cross-section through treatment room and maze showing shielding chicane and entry for services**

1) Lifting beam over treatment machine.
2) Wax block neutron attenuation supported in timber cradle.
3) Suspended ceiling. **N.B** access required to lifting beam during equipment installation and maintenance, lifting eyes required attached to concrete soffite behind line of machine gantry.
4) Treatment machine and patient couch.
5) Services negotiate concrete downstand 'chicane' as they enter treatment room.
6) Downstand faced with wax neutron attenuation.

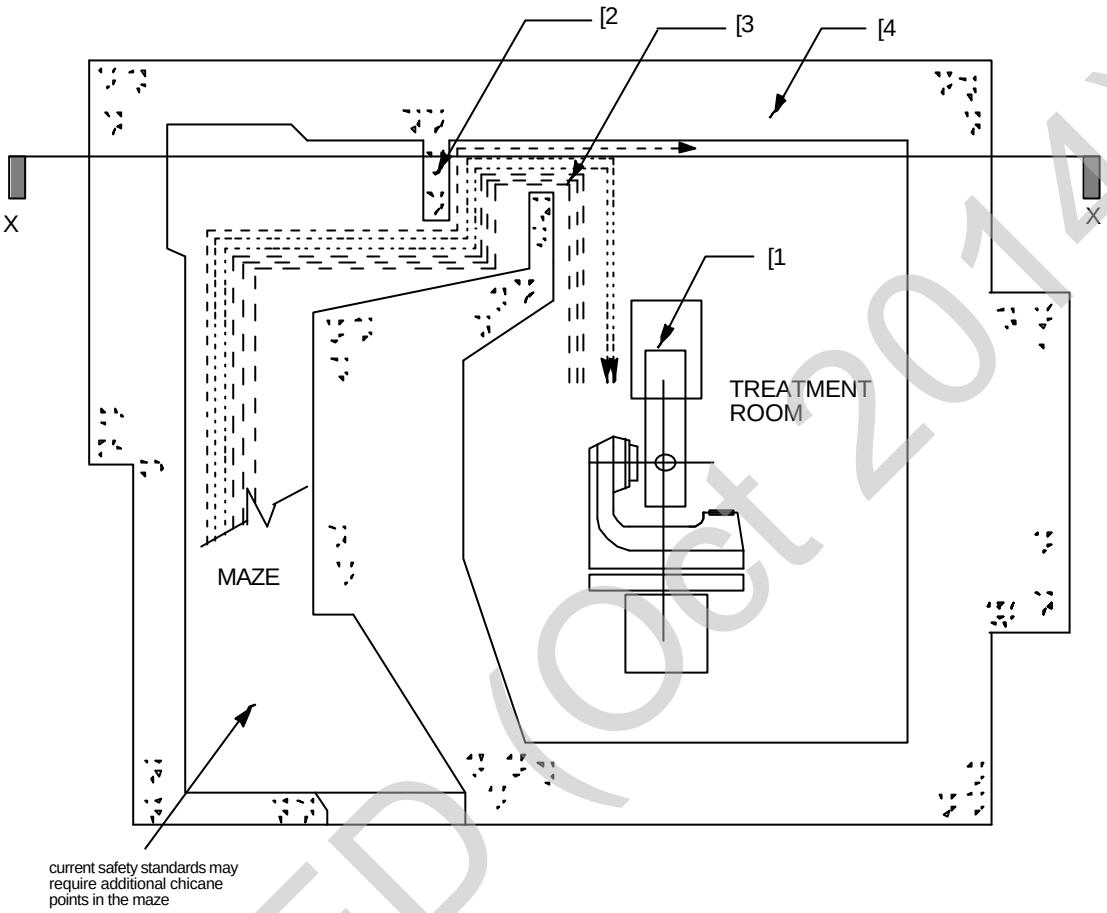


Figure 10: **Plan of treatment room and maze at ceiling void level. Showing diagrammatic service route along maze passing through shielding chicane and into treatment room**

1) Wax block neutron attenuation supported timber cradle.
2) Concrete downstands (faced with wax block neutron attenuation).
3) Services negotiate downstand 'chicane' as they pass into treatment room.
4) Concrete shielding walls.

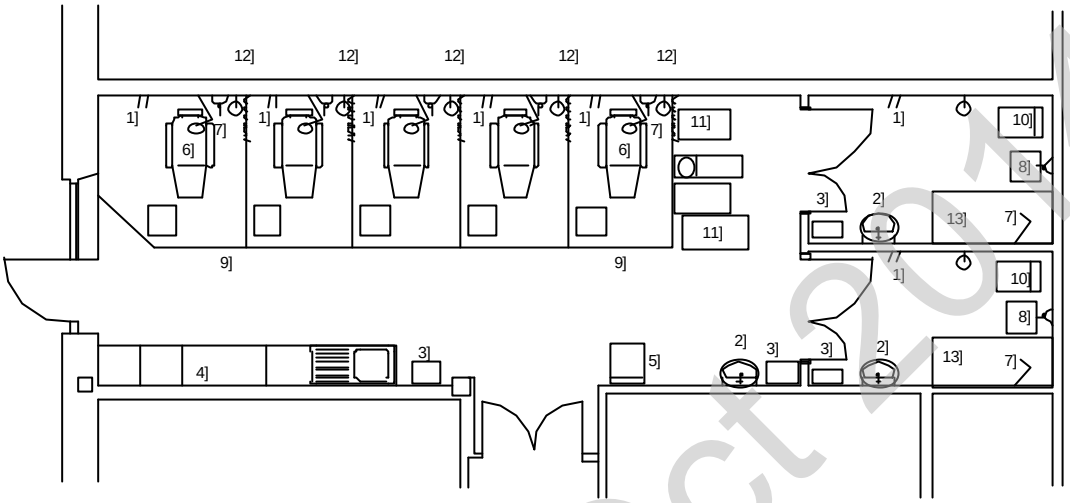


Figure 11: **Example layout of chemotherapy treatment day space showing combined shared space and single patient rooms**

1) Coat hooks
2) Clinical hand wash basin
3) Sack holder
4) Worktop
5) Easy chair
6) Reclining chair
7) Examination light and services
8) Bedside locker
9) Cubicle curtain track
10) Easy chair
11) Trolley
12) Curtains
13) Bed

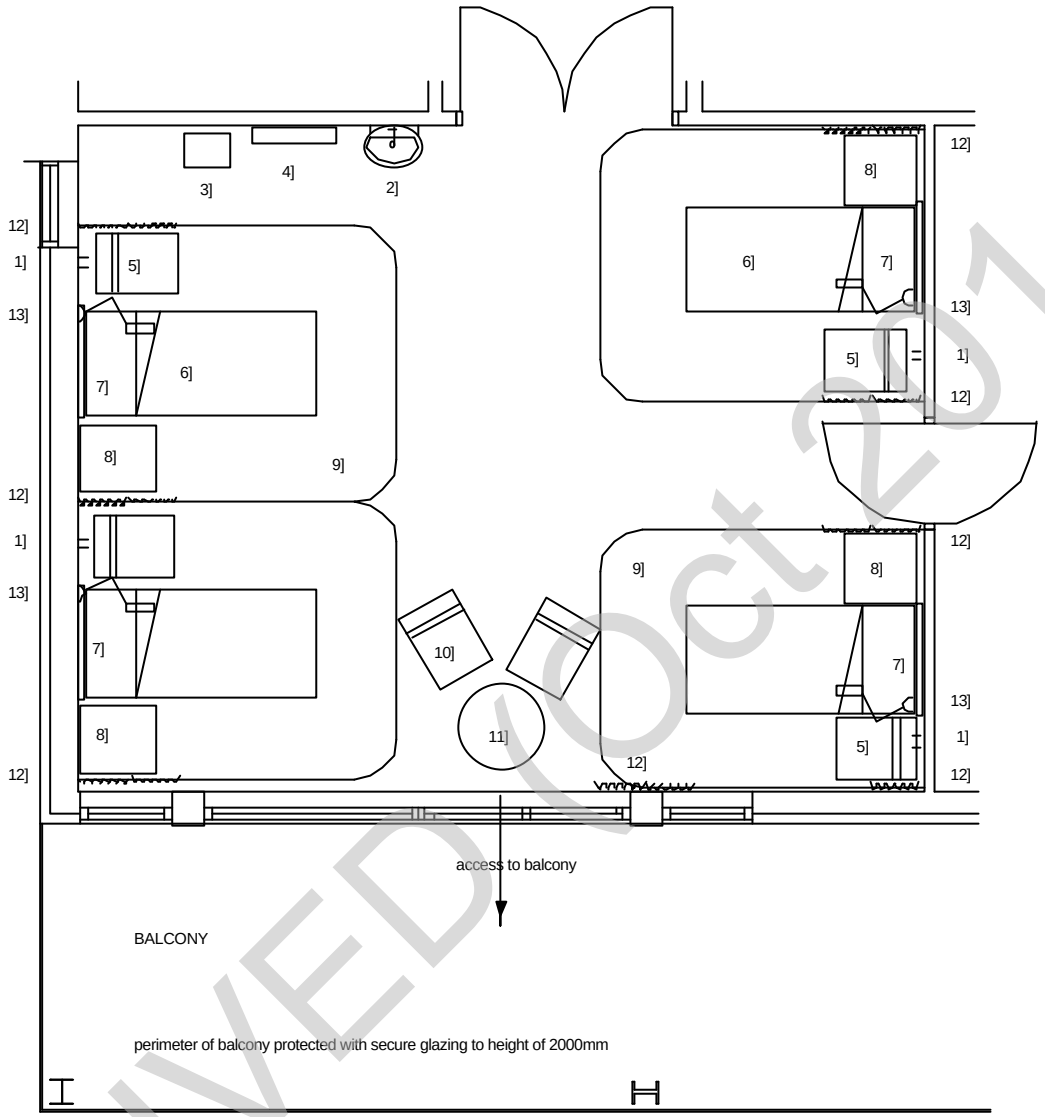


Figure 12: **Example layout of chemotherapy treatment space for four patients using beds**

1) Coat hooks
2) Clinical hand wash basin
3) Sack holder
4) X-ray viewer
5) Easy chair
6) Bed
7) Chinagraph board
8) Bedside locker
9) Cubicle curtain track
10) Easy chair
11) Coffee table
12) Curtains
13) Television

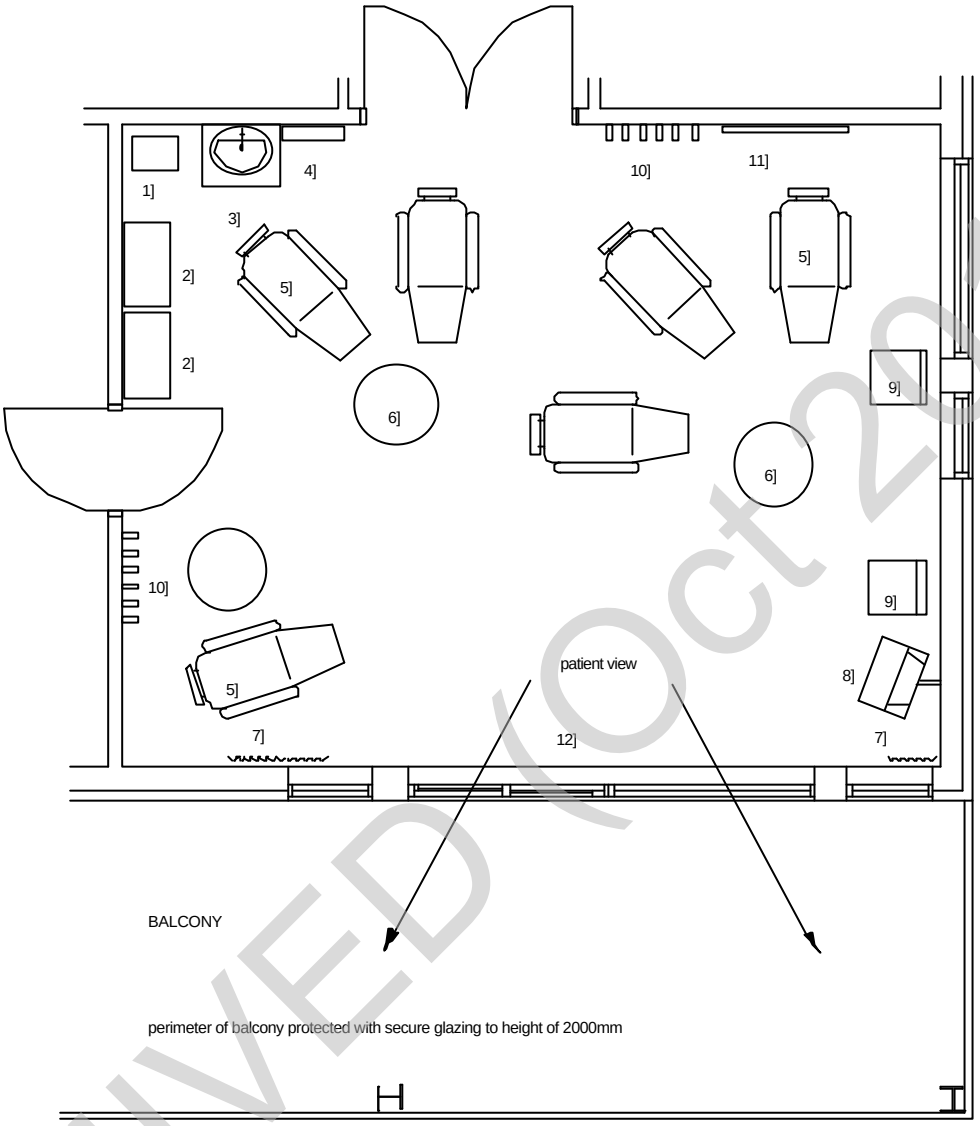


Figure 13: **Example layout of chemotherapy treatment day space for six patients using reclining chairs**

1) Sack holder
2) Dressings trolley
3) Vanity Unit
4) Wall shelf
5) Reclining chair
6) Circular table
7) Curtains
8) Wall mounted television
9) Chair
10) Coat hooks
11) Notice board
12) Sliding doors with access to balcony

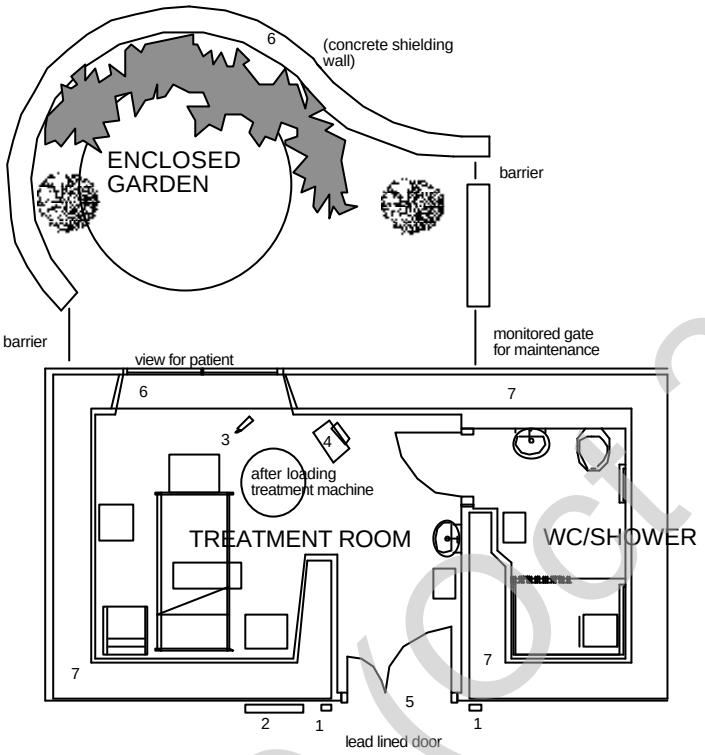


Figure 14: **Brachytherapy treatment suite with en-suite shower/wc**

1) Radiation monitor at entrance.
2) Control panel for after-loading treatment machine.
3) CCTV patient monitor.
4) Ceiling mounted TV.
5) Lead lined doors with access control.
6) Windows can be included if alternative radiation protection is provided. In this arrangement, an external garden area was created with concrete shielding walls.
7) Enclosing structure constructed from concrete 450mm thick. Job specific advice should be obtained from the Radiation Protection Agency.

Note: After-loading equipment uses compressed air during the treatment process. Suitable accommodation will be required to afford sound attentuation and access for routing maintenance.

Appendix 3:

Fire safety in radiotherapy treatment rooms

Background

1. For the majority of rooms within a cancer care centre the fire risks and precautions will not differ from other similar rooms within a hospital. However a special case is identified for radiotherapy treatment rooms.

2. Linear accelerator bunkers may potentially be a seat of fire. Clearly the linear accelerator itself employs high-tension electricity so that the potential for electrical fire exists. The figures on the extent of risk are significantly variable from country to country and it is difficult to give a clear quantitative view at this time.

3. The design of the engineering services should comply with the recommendations of NHSScotland guidance 'Firecode', which includes Scottish Health Technical Memoranda 81, 82 and 83. Design guidance for fire precautions in new hospitals is contained in Scottish Health Technical Memorandum 81 ‘Fire precautions in new hospitals’. Technical information concerning the design and specification of fire alarm and detection systems is contained in Scottish Health Technical Memorandum 82 ‘Alarm and detection systems’. This Scottish Health Technical Memorandum replaces or modified certain clauses of BS 5839 Part 1 to meet the needs of healthcare buildings. More general advice on fire safety in healthcare premises is contained in Scottish Health Technical Memorandum 83 ‘Fire safety in healthcare premises’.

Fire compartments

4. Despite some concerns over operational efficiency, NHSScotland recommends the use of 30-minute fire resisting doors to FD30 standard at the entrance to linear accelerator bunker maze structures. The intention is to restrict the spread of both fire and smoke. However, a special problem arises since the Codes of Practice constructed under Ionising Radiations Regulations require that some form of access control or warning device be used at the entrance to linear accelerator bunkers. Commonly, in order to avoid delays in terms of radiographers moving in and out of these specialist rooms, the Code of Practice requirements are met by the use of a light or infrared beam connected to both a warning system and linear accelerator beam control. Clearly such an arrangement will be more difficult, though not impossible, if fire protective doors are employed. This requirement should be discussed with the local RPA.

5. The use of smoke or fire detector-actuated fire door self-closing devices are considered helpful. Fire dampers should also be incorporated into the service duct or other penetrations which enter the treatment room.

Means of escape

6. With a single entrance, dead-end conditions apply in all linear accelerator bunkers. This has important safety implications and places a premium on fire prevention, detection and control. In certain cases the maximum single direction travel distance permitted by the Scottish Building Regulations will be exceeded. In these cases a Relaxation application will be required. The following specific precautions should be incorporated:

- the fire loading within the bunkers is to be kept to a minimum (see 'fire loading');
- automatic fire detection should be provided (see 'fire alarm system');
- the walls and doors separating the bunker from the adjacent accommodation must meet the half-hour fire-resisting standard and should be to FD30S standard and fitted with effective self-closing devices;
- in order to assist in the rescue of patients in the event of a fire occurring, it is recommended that a smoke reservoir be created in the ceiling void above the bunker where feasible. This has significant design implications where radiation baffles are used but the determined false ceiling height will be 3.1m with a door height of 2.1m. The space created may be usefully adapted. The elevated internal ceiling height forming a reservoir, that is to the concrete or Ledite shield above, is likely to be an advantage in terms of radiation protection and the reduction of radiation dose rates in the accompanying maze. However this should be referred to the local RPA;
- the circulation space outside the bunkers must be maintained free of combustible materials.

7. The construction of linear accelerator bunkers in reinforced concrete using supplementary steel shielding, where necessary, is a common and accepted practice. However, there is now a movement toward the use of new materials including Ledite. Some of these alternative materials lend themselves to design changes, which include the provision of heavy shielding doors as a partial but not complete replacement for the provision of a maze. Where this is the case, clearly the fire protective nature of these doors will require evaluation. These heavy doors are generally power operated therefore consideration must be given to their 'fail safe' arrangement in the event of power failure and/or fire. This will require to be considered in conjunction with radiation protection.

Fire loading

8. Consideration should be given to the minimisation of fire loading or available fuel in these environments. Attention is drawn to the following points:

- wax or plastic blocks are used in some locations, not necessarily corners, to absorb particular radiations, specifically neutrons. Such radiation protection measures are only necessary in linear accelerator installations where X-rays are produced at energies of roughly 10MV and above. Accordingly, the use of these materials will not be encountered in the majority of linear accelerator installations. Consideration should be given to encasing these materials within removable plasterboard or other fire-resistant cladding. The performance of individual cladding solutions has not been evaluated at the time of writing;
- the equipment will frequently use oil insulators and may be heavily greased;
- benches are frequently constructed in wood and may support linen, plastic and polycarbonate shells and other combustible materials. The use of enclosed cupboards is most helpful in this and other regards.

Fire alarm system

9. A fire alarm system conforming to BS 5839: Part 1: 1988 and the NHSScotland guidance Scottish Health Technical Memorandum 82 'Alarm and detection systems', must be installed throughout the linear accelerator suite.

10. Each manual call point must be boldly indicated by a notice to clearly identify the fire alarm operating point and conform to the Health and Safety (Safety Signs and Signals) Regulations 1996.

11. An analogue addressable, automatic fire detection system comprising smoke and heat detectors as appropriate should be installed throughout the proposed suite. Positions for the detectors will be dependent on the ceiling layout and compliance with the British Standard.

12. The alarm and detection system should also include the ceiling voids and should be integrated with the existing hospital alarm system in accordance with the NHSScotland guidance SHTM 82 'Alarm and detection systems' and local hospital policy.

13. In respect of degradation of components within fire and smoke detectors, these units will have a shorter life within the linear accelerator bunkers than may be the case in other environments. The effect is at its most significant if the detectors are placed within the belt of heavy radiation protection shielding that encircles the linear accelerator in such a way as to capture the primary or direct beam. The life of these units or components will be very much better if fire and smoke detectors are positioned outside the area irradiated by the primary beam. Further, a few instances of false alarms have been recorded due to the irradiation of smoke detectors by the primary beam of linear accelerators.

Emergency lighting

14. In addition to the normal lighting, an electrical emergency lighting system must be installed, capable of illuminating all exit signs, doors, the maze and treatment room interior. In addition this must cover corridors and all such routes of egress including the external routes to safety. The installation should comply with the NHSScotland guidance Scottish Health Technical Memorandum 2007 'Electrical services supply and distribution' and the British Standard Code of Practice 5266: Part 1:1988.

Indication of fire exits

15. All exits providing access to means of escape must be clearly indicated, as appropriate, by suitable signs that should be positioned where they can be seen clearly.

16. The signs should take the form of a pictogram with the words "fire exit" and where appropriate incorporate a directional arrow. Fire safety signs must comply with the relevant requirements of the Health and Safety (Safety Signs and Signals) Regulations 1996.

Fire fighting equipment

17. The use of fire blankets within the linear accelerator bunker is seen as particularly valuable since these are especially direct in terms of their action.

18. The installation of carbon dioxide fire extinguishers is required for linear accelerator bunkers. However, where these are used, they should be installed outside the area irradiated by the primary beam of the linear accelerator, particularly if this is of the high-energy type operating above the 10-12MV thresholds mentioned earlier. Extinguishers should be mounted on brackets, fixed securely to the walls or other upright structures, so that the top of each one is approximately one metre above floor level.

19. Inert gas fire suppression will be used within the equipment housing or an equipment room. In the former case this would require that the machine have a seal with controlled leakage in order to achieve 10 to 20% gas concentration.

20. The use of multi-criteria interlocked inert/fire suppressive gas extinguishant system in the treatment room and supporting 'machine/modulator' rooms should be evaluated. Such systems may use Argonite or FM 200. In the selection of extinguishing agent care must be taken to avoid corrosive gas options in view of the high value of the treatment equipment. This measure gives an equipment protection option but is not specifically thought to benefit patient or staff fire protection and thus is not adequate used alone.

21. Some new systems use directional inert/fire suppressive gas techniques. Although automatically activated they may be evaluated for use in linear accelerator rooms without interlocks.

22. Where separate 'machine/modulator' rooms are used, 60 minutes fire compartment arrangements are appropriate. Fire suppression gas systems are particularly suitable for rooms of this type in protecting equipment and giving early suppression of fire.

Fire notices

23. Printed instructions as to the action to be taken in the event of a fire should be displayed adjacent to each fire alarm call point.

24. Fire safety signs must comply with the relevant requirements of the Health and Safety (Safety Signs and Signals) Regulations 1996.

Operational implications

25. An emphasis on safety in connection with high-tension electricity is clearly appropriate. Fire teams should be made aware that linear accelerators contain high-storage value electrical capacitors, which take some considerable time to discharge following the isolation of the linear accelerator from its power supply.

26. In operational terms and when considering fire emergency/contingency plans, it is important that there be careful liaison with those responsible for radiation protection. Clearly any precaution that is taken to protect against radiation should also be appropriate in the fire context and vice versa. In addition to the local RPA already mentioned, consultation with the radiation protection supervisor who will be a senior professional member of the radiotherapy or oncology staff is also of value. The fire rules should be appended to or contained within the radiation protection local rules for the reasons already mentioned.

Glossary of terms and abbreviations

A&E	Accident and emergency
BMT	Bone marrow transplant
CCTV	Closed circuit television
CT	Computed tomography
DDA	Disability Discrimination Act
DR	Digital radiography
EPR	Electronic patient record
F-18	Radioactive substance – Fluorine-18
FD30	30 minutes fire resisting door
FDG	2 - (Fluorine-18) Fluoro-2 - Deoxy-0-Glucose
GP	General practitioner
HBN	NHS Estates, England Health Building Note
HDR	High Dose rate brachytherapy
HIS	Hospital information system
HSC	Health & Safety Commission
HTM	NHS Estates, England Health Technical Memorandum
ICRP	International Commission for Radiation Protection
IRR	Ionising Radiations Regulations
IT	Information technology
LAN	Local area network (computer communications)
LA	Linear accelerator treatment machine
LDR	Low dose rate brachytherapy
Linac	Linear accelerator

LMP	Low melting point
LPA	Laser radiation protection advisor (MDA guidance)
MDA	Medical Devices Agency
MDR	Medium dose rate brachytherapy
MLC	Multi-leaf collimator for LA
MRI	Magnetic resonance imaging
NICE	National Institute for Clinical Excellence
NOF	New Opportunities Fund
NSCLC	Example of modern chemotherapy techniques
PDR	Pulse dose rate brachytherapy
PET	Positron emission tomography
PFI	Private Finance Initiative
QA	Quality assurance
Rf	Radio-frequency radiation or transmissions
RPA	Radiation protection advisor (1999 IRR)
RPS	Radiation protection supervisor (1999 IRR)
RTP	Radiotherapy treatment planning
SHPN	Scottish Health Planning Note
SHTM	Scottish Health Technical Memoranda
Shr/WC	Shower/toilet
T	Tesla magnetic field strength
TBI	Total body irradiation usually by LA
TLD	Thermo luminescent dosimetry
UVEX	Polycarbonate material used in immobilisation of patients
VRM	Verification record and management of treatment data
WAN	Wide area network

NHSScotland guidance

Listed below is NHSScotland guidance some of which relates to this SHPN. The guidance produced by the Property and Environment Forum Executive is correct at the time of publication of this SHPN. Refer to the Forum website, www.show.scot.nhs/pef for the full current list of guidance.

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45 **External works for health buildings**, TSO 1994

47 **Health records department**, TSO 1995

51 **Accommodation at the main entrance of a District General Hospital**, TSO 1992

51 **Accommodation at the main entrance of a District General Hospital Supplement A – Activity space data sheets**, TSO 1993

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Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification
Part 4	Operational management

SHTM 2007 Electrical services supply and distribution

Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification

Part 4 Operational management

SHTM 2009 Pneumatic air tube transport systems

Part 1 Overview and management responsibilities

Part 2 Design considerations and Good Practice guide

SHTM 2010 Sterilization

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification

Part 4 Operational management

Part 5 Good practice guide

Part 6 Testing and validation protocols

SHTM 2011 Emergency electrical services

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification

Part 4 Operational management

SHTM 2015 Bedhead services

Part 1 Overview and management responsibilities

Part 2 Design considerations

Part 3 Validation and verification/Operational management

SHTM 2020 Electrical safety code for low voltage systems (Escode – LV)

Volume 1 Operational management

SHTM 2021 Electrical safety code for high voltage systems (Escode – HV)

Part 1 Overview and management responsibilities

Part 2 Operational management

SHTM 2022 Medical gas pipeline systems

Part 1 Design, installation, validation and verification

Part 2 Operational management

Supplement 1 Dental compressed air and vacuum systems

Supplement 2 Piped medical gases in ambulance services

SHTM 2023 Access and accommodation for engineering services

Part 1 Overview and management responsibilities

Part 2 Good practice guide

SHTM 2024 Lifts

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification
Part 4 Operational management

SHTM 2025 Ventilation in healthcare premises

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification
Part 4 Operational management

SHTM 2027 Hot and cold water supply, storage and mains services

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Operational management
Part 4 Validation and verification

SHTM 2030 Washer-disinfectors

Part 1 Design considerations
Part 2 Operational management
Part 3 Validation and verification

SHTM 2031 Clean steam for sterilization

SHTM 2035 Mains signalling

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Validation and verification/Operational management

SHTM 2040 The control of legionellae in healthcare premises – a code of practice

Part 1 Overview and management responsibilities
Part 2 Design considerations
Part 3 Operational management
Part 4 Validation and verification
Part 5 Good practice guide

Part 6	Supplementary guidance applicable to intermittently used healthcare premises

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Part 1	Overview and management responsibilities
Part 2	Design considerations
Part 3	Validation and verification/Operational management
Part 4	Audiology

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SHGN	**'Safe' hot water and surface temperatures**
SHGN	**Static discharges**
SHTN 2	**Domestic hot and cold water systems for Scottish Healthcare Premises**
SHTN 3	**Management and disposal of clinical waste**
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