IUSS HEALTH FACILITY GUIDES

Internal Floor Finishes in Healthcare Facilities

Gazetted

30 June 2014

Task Team: C:05.1

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INFORMATION	NOTES
Form:	Health facility guides
Status:	*Gazetted, 30 June 2014*
Title:	**Internal Floor Finishes in Healthcare Facilities**
Description:	"Internal Ceiling Finishes in Healthcare Facilities" contains health facility guidance, covering the infrastructure norms and standards for the internal finishes to ceilings in healthcare facilities from primary healthcare, to tertiary healthcare. It is to be read in conjunction with the full norms and standards suite and covers policy and service context (Part A), selection criteria (Part B), technical information (Part C) and performance (Part D).
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Accessing of these guides

This publication is received by the National Department of Health (NDoH), IUSS Steering Committee Chairman, Dr Massoud Shaker and Acting Cluster Manager: Health Facilities and Infrastructure Management, Mr Ndinannyi Mphaphuli. Feedback is welcome.

Application and development process

These IUSS **voluntary standard/ guidance documents** have been prepared as national Guidelines, Norms and Standards by the National Department of Health for the benefit of all South Africans. They are for use by those involved in the procurement, design, management and commissioning of public healthcare infrastructure. It may also be useful information and reference to private sector healthcare providers.

Use of the guidance in this documentation does not dissolve professional responsibilities of the implementing parties, and it remains incumbent on the relevant authorities and professionals to ensure that these are applied with due diligence, and where appropriate, deviations processes are exercised.

The development process adopted by the IUSS team was to consolidate information from a range of sources including local and international literature, expert opinion, practice and expert group workshop/s into a first level **discussion status** document. This was then released for public comment through the project website, as well as national and provincial channels. Feedback and further development was consolidated into a second level **development status** document which again was released for comment and rigorous technical review. Further feedback was incorporated into **proposal status** documents and formally submitted to the National Department of Health. Once signed off, the documents have been **gazetted,** at which stage documents reach **approved status**.

At all development stages documents may go through various drafts and will be assigned a version number and date. The National Department of Health will establish a **Health Infrastructure Norms Advisory Committee,** which will be responsible for the periodic review and formal update of documents and tools. Documents and tools should therefore always be retrieved from the website repository www.iussonline.co.za or Department webportal (forthcoming) to ensure that the latest version is being used.

The guidelines are for public reference information and for application by Provincial Departments of Health in the planning and implementation of public sector health facilities. The approved guidelines will be applicable to the planning, design and implementation of all new public-sector building projects (including additions and alterations to existing facilities). Any deviations from the voluntary standards are to be motivated during the Infrastructure Delivery Management Systems (IDMS) gateway approval process. **The guidelines should not be seen as necessitating the alteration and upgrading of any existing healthcare facilities**.

Acknowledgements

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IUSS Norms and Standards Task Team no. C:05.1: Healthcare Environment/Cross-cutting issues - C:05: (Materials and Finishes):

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Table 1 : IUSS:GNS Reference Documents

CLINICAL SERVICES	Essential	Recommended	SUPPORT SERVICES	Essential	Recommended	HEALTHCARE ENVIRONMENT/ CROSSCUTTING ISSUES	Essential	Recommended	PROCUREMENT& OPERATION	Essential	Recommended
Adult Inpatient Services		x	Administration and Related Services		x	Generic Room Requirements	x		Integrated infrastructure planning		x
Clinical Diagnostic Laboratory Guidelines		x	General Hospital Support Services		x	Hospital Design Principles		x	Briefing Manual	x	
Mental Health		x	Catering Services for Hospitals		x	Building Engineering Services		x	Space Guidelines		x
Adult Critical care		x	Laundry and Linen Department		x	Environment and Sustainability		x	Cost Guidelines		x
Emergency Centres		x	Hospital Mortuary Services		x	Materials and Finishes			Procurement		x
Maternity Care Facilities		x	Nursing Education Institutions		x	Future Healthcare Environments			Commissioning Health Facilities		x
Adult Oncology Facilities		x	Health Facility Residential		x	Healthcare Technology		x	Maintenance		x
Outpatient Facilities		x	Central Sterile Service Department		x	Inclusive Environments		x	Decommissioning		x
Paediatrics and Neonatal Facilities		x	Training and Resource Centre		x	Infection Prevention and Control		x	Capacity Development		
Pharmacy		x	Waste Disposal		x	Information Technology and Infrastructure					
Primary Health Care Facilities		x			x	Regulations		x			
Diagnostic Radiology		x			x						
Adult Physical Rehabilitation		x			x						
Adult Post-acute Services		x			x						
Facilities for Surgical Procedures		x			x						
TB Services		x			x						

Colours Legend

Consultants	
Administrators	
Related documents	

PART A - CONTEXT

1. Overview: Finishes in the healthcare environment

"Flooring occupies every square inch of measured healthcare facility space providing a major life cycle investment opportunity to help realise positive healthcare outcomes." (Centre for Health Design, 2012)

Building finishes account for a large proportion of the overall cost of constructing a healthcare facility. According to Shohet et al. (2002), interior finishing and interior construction accounts for 32% of the initial budget. Maintenance and cleaning of finishes add substantially to the 'whole-life costs' of finishes within a hospital or healthcare facility.

Despite this, finishes are often treated as optional and purely aesthetic components of the building and the spaces within it. When budget constraints are implemented, the finishes are usually the first area to suffer. Institutions will often standardise finishes across a spectrum of rooms/facilities for economy in replacement and/or cleaning regimes.

Interior finishes, however, play a vital role in the healthcare environment, and contribute substantially to the delivery of healthcare service and the protection of staff and patients.

In a study conducted by PricewaterhouseCoopers LLP (PwC) in association with the University of Sheffield and Queen Margaret University College, 2004, the comments from the majority of people who visited hospitals, including staff and patients, included "cold, depressing, dehumanising, Kafkaesque, dirty, smelly, frightening, impersonal, confusing, dull shabby, windowless, grim, stressful…". While it is a fact that most patients interviewed may have been negative as a result of their being ill, it does highlight a problem of the inhumane and threatening appearance of hospital environments (historically) where even more attention should be paid to creating a caring atmosphere.

"UNTIL THE GERM THEORY WAS DEVELOPED, MORE MEN WERE DYING FROM SMALL WOUNDS AND DISEASES THAN FROM MAJOR TRAUMAS ON THE FRONTLINES. BUT AS SOON AS GERM THEORY WAS DEVELOPED A WHOLE NEW PARADIGM, A BETTER WAY OF UNDERSTANDING WHAT WAS HAPPENING MADE DRAMATIC SIGNIFICANT MEDICAL IMPROVEMENT POSSIBLE" (COVEY, 1992)

It is this paradigm shift that is required when considering and selecting finishes. The role of finishes in a healthcare facility has become as important an aspect of design as room sizes and relationships.

FIGURE 1

Building finishes are usually seen as a separate and final application to the building structure (Dean, 1996).

There are however, instances where the finish is integral to the structure. These documents therefore include finishes and materials in such cases.

2. Suite of documents

This document forms part of a series of documents addressing internal materials and finishes in health facilities, which in turn form part of the suite of documents created under the IUSS Project. The aim of the materials and finishes suite of documents is to provide guidance on design and specification for the various building components where current legislation, including the National Building Regulations, does not adequately cover suitability of finishes in the healthcare facility context.

While the guidelines speak mostly to new building work, most of the principles are consistent with refurbishment projects to existing buildings as well.

How to use this document:
Review the selection criteria – Part B
Select a room/department name in Part D, and note the performance category.
Refer to Table 1 for the properties that make up that performance category.
Refer to Part C to assess flooring types that could satisfy those performance requirements.

Other IUSS health facility guides in this series include:

- Internal Ceiling Finishes (draft document rev 4)
- Internal Wall Finishes (draft document rev 4)
- Joinery and Storage Systems (to follow)
- Doors and Ironmongery (to follow)
- Sanitary ware (to follow)
- Signage and Wayfinding (to follow)

These guidelines are updated and revised periodically, and can be accessed at www.iussonline.co.za.

The primary objective of this technical guide is to assist decision-makers with the selection of 'appropriate' floor finishes in the health facility context.

The guide looks at the context (Part A), then examines various selection criteria (Part B) then summarises technical information of various floor finishes (Part C) to assist with assessing the best finish for the facility. Finally, the selection criteria are grouped together to form performance categories (Part D) and a matrix of rooms which indicates the most relevant performance category.

3. Policy context

This document offers guidance on the selection of appropriate floor finishes in health facilities. While the aim is to inform project and design teams about the wide range of considerations to take into account when selecting finishes, it does not diminish the responsibility of the design team to comply with all applicable professional and regulatory obligations and to specify materials and finishes 'fit for purpose'.

Some of the pertinent regulations are the following:

- National Building Regulations and Building Standards ACT, 1977 (Act 103 of 1977) amended 30 May 2008.
- SANS 10400, Code of Practice for the application of the National Building Regulations, first Rev. August 1990.

- R158, Government Notice dated Feb 1980 (updated March 1993) Regulation pertaining to control of Private Hospitals, (revised 05 November 1996, but not gazetted).
- R187, Regulations Governing Private Health Establishments, Western Cape, 22 June 2001.

The design principles on the above documents must be taken into account alongside the recommendations of this document. Furthermore, the South African National Standards (SANS 10400) addresses numerous aspects involving materials and finishes. (Refer specifically to Parts J and T.) Current South African national standards applicable are as follows:

Other provincial policy documents are also applicable:

SANS 204	Energy efficiency in buildings (General)
SANS 281	Hardwood block and strip flooring
SANS 586	Resin modified vinyl floor tiles
SANS 784	Design edition 1 for access and mobility – tactile indicators
SANS 786	Flexible vinyl flooring
SANS 978	Wood mosaic flooring
SANS 1042	Polymer floor dressings
SANS 1375	Woven carpeting
SANS 1415	Textile floor coverings (needle-punch)
SANS 1419	Carpet underlays
SANS 1449	Ceramic wall and floor tiles
SANS 1549 and 52825	Raised access flooring
SANS 2001	EM2 Construction works EM2 – Surface finishes – concrete floors
SANS 2001	EF1 Construction works EF1 – Floor coverings and wall linings
SANS 6160	Electrical resistance of floors
SANS 10043	The installation of wood and laminate flooring
SANS 10070	The installation of resilient thermoplastic/flexible floor covering materials
SANS 10109-1 and 2	Finishes to concrete floors
SANS 10177-4:	Fire-testing of materials Part 4: Surface fire index of floor coverings
SANS 10245	The maintenance of textile floor coverings
SANS 13746	Textile floor coverings – guidelines for installation and use on stairs

- KwaZulu-Natal, Department of Health Policy Document for the Design of Structural Installations, Rev.7, January 2013.
- Eastern Cape Department of Roads and Public Works and Department of Health Hospital Design Guide, Rev. August 2004.

PART B - SELECTION CRITERIA

1. Scope

FIGURE 2

Flooring is probably the most important dimension of a health facility contributing to public and patient perceptions and affecting numerous other aspects, which will be examined under the selection criteria.

Floor finishes cannot be considered independently of their applicable subfloor, installation, adhesives or underlays and the relevant cleaning protocols. These integrated flooring systems need to be evaluated as a whole in terms of the various criteria.

FIGURE 3

In the flooring industry there are four main categories of floor finish:

Hard finishes

This would include rigid finishes such as porcelain or ceramic, marble tiles, or seamless coatings such as cementitious or epoxy coatings.

FIGURE 4

Resilient finishes

This would include flexible and semi-flexible sheeting such as vinyl, linoleum, rubber or cork.

Soft finishes

This would include textiles such as carpets as well as walk-off mats and anti-fatigue mats.

FIGURE 5

Hybrid finishes

This new generation floor finish combines various materials finished with a wear layer. These layers are fused under heat and pressure.

Each floor type has different applications and resultant benefits and disadvantages. The various characteristics would need to be weighed up against the functions of the various rooms within a healthcare facility. Other important aspects to consider in flooring are skirting, transitions or changes in floor finishes, and changes in level including ramps and stairs. These are discussed in more detail under Section C5.

FIGURE 6

The following factors relating to construction and specification will also influence the floor finish:

- Specifications for substrate preparation and installation must be prepared in conjunction with the supplier of the floor finish, before construction commences
- Variance in floor finish thicknesses or falls in floors, e.g. rooms with floor drains may affect floor structure levels. Engineer input may be needed as it could potentially impact cover to reinforcement steel

- Structure and substrates, e.g. concrete floors during construction need to cure and dry adequately before the application of screeds and likewise, the screed, before the application of the final floor finish.
- Involvement of the floor finish supplier from specification, throughout construction and at final completion, i.e. sign-off
-
- Floor finish product guarantees, and prescriptive conditions that could have an impact on construction, such as quality of substrate, installation by approved installers, etc.

2. Environmental aspects in the choice of finishes

A guide of finishes would be incomplete without highlighting the environmental aspects in the choice of finishes.

This is an extremely broad factor covering the following:

- Embodied energy of materials
- Life cycle costing/sustainability
- Toxicity and effects of indoor environment quality

2.1. Embodied energy of materials

The term embodied energy refers to the total energy measure required to manufacture a product. This includes:

- Harvesting/mining of the raw material
- Processing the material
- Manufacturing the product
- Transporting /delivering the product to the manufacturing plant, retail outlets and finally the end user
- Labour or mechanical energy spent on placing the product in its finished position

Buying locally-produced materials is an easy and achievable way to lower embodied energy of a building. The table below gives an indication of the embodied energy of various typical building materials.

Material	Embodied Energy in MJ/kg (million joules per kilogram)
Concrete (in situ)	1.0 – 1.6
Concrete (precast)	2.0
Hardwood timber, kiln dried, rough sawn	2.0
Softwood timber, kiln dried, finished	2.5
Cement	7 – 8
Plywood	10.4
Steel (virgin)	32
Felt underlay to Carpet	18.6
Carpet (polypropylene/needle-punch)	95.4
Ceramic tile	2.5
Rubber (natural latex)	67.5
Rubber (synthetic)	110.0
Vinyl flooring	79.1
Linoleum	116.0

Source: Alcorn and Wood, 1998.

Embodied energy of common flooring materials (finish and substrates)

While health facility design may limit your selection of materials in terms of other performance factors, which are more critical, every opportunity to reduce the embodied energy of materials should be pursued. Manufacturers are increasingly aiming at reducing embodied energy, as well as the carbon footprint in the manufacture of their products. This is driven by the market demand and designers can contribute by choosing materials that support green initiatives in this regard.

2.2. Life cycle costing and sustainability

Life cycle costs are described as the social, economic and environmental costs of a material or product from cradle to grave – that is, from the extraction of the raw ore needed to make it, through the manufacturing, to the end use to disposal or recycling. (Daniel D. Chiras. The New Ecological Home, 2004)

The durability of materials is a key element in the life cycle cost assessment. A product may have a low embodied energy, but require more frequent replacement in the building.

Specifiers should investigate the service life of materials with the respective manufacturers to establish its life span. This element should also be highlighted to funders who often place more emphasis on reducing the capital cost of a facility, without considering the long-term cost.

The graph below indicates how capital outlay costs compare to life span costs – emphasising the importance of life cycle costs.

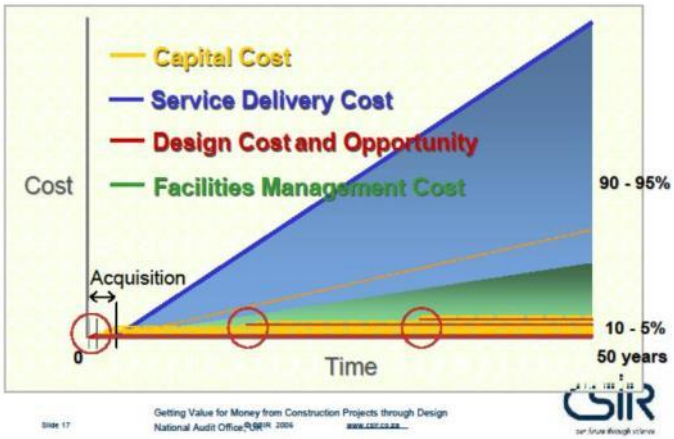

FIGURE 7

Sustainability should be considered in all four stages of product life:

- Manufacture
- Use

The behaviour of various types of floor coverings during normal use as well as the influence of typical contaminations such as oils, coffee, ink & Betadin (iodine) was investigated in a study out in the USA

Life cycle costs (over 15 years):
- costs incl. installation
- replacement
- labour costs for cleaning
- material costs for cleaning

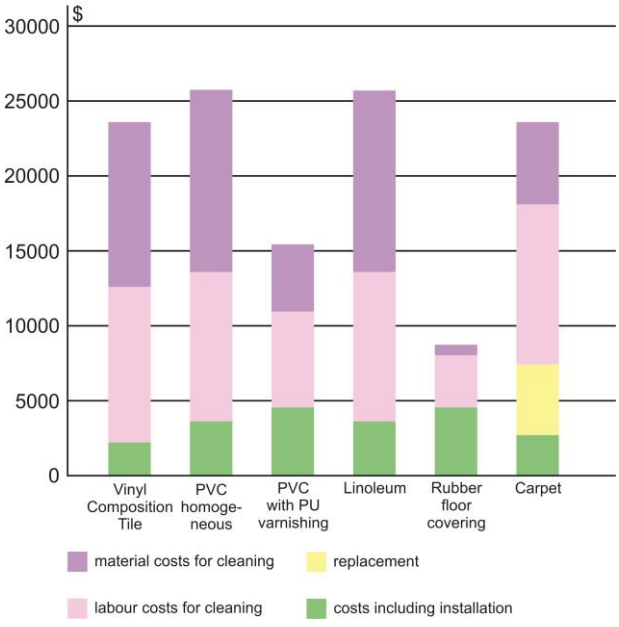

FIGURE 8

- Maintenance
- Disposal

The Green Building Council of South Africa has developed Green Star ™ rating tools which will credit materials with the following:

- Reuse of existing material
- Recycling properties
- Local sourcing

As a practical example, and to indicate the benefit of comparing life cycle costing, the table left shows the comparative life cycle costs of various floor finishes - in this instance demonstrating the low life cycle costs of a rubber product, even though the installation cost for this product was the highest at the outset.

2.3. Toxicity and effect on indoor environment

Indoor Environment Quality (IEQ) is one of the nine categories of the Green Building Council of South Africa's Green Star ™ Rating Tools. These rating tools are used to assess environmental performance of a building and/or materials and through improvement in IEQ, the wellbeing of the occupant is protected.

IEQ is measured in terms of the following:

- Internal noise levels (this is discussed in more detail under Selection Criteria: Acoustics)
- Mould prevention (this is discussed in more detail under Selection Criteria: Humidity)
- Volatile organic compounds (VOCs)

Materials such as paints and polyvinyl-chlorides can emit VOCs (gasses) when finishes are new and these reduce over the life span of the product. Sealants and adhesives also give off VOCs, having a negative effect on indoor air quality.

VOCs can cause irritation and odour annoyance and could lead to behavioral, neurotoxic, hemotoxic and genotoxic effects (Meininghaus et al., 2000; Hoskins, 2003; Hodgson et al., 2000)

According to Hoskins (2003), VOCs can be carcinogenic, depending on the compound.

When considering the toxic impact on the environment in which the various floor finishes will be installed, the finish as a whole – complete with sealants, substrate material and adhesives – must be taken into account.

A further important aspect to consider is the use of non-toxic materials in **mental health facilities,** where patients are prone to chew and ingest any materials that can be uplifted off surfaces, from paint to flooring.

Every effort must be made when specifying materials and finishes in these facilities to ensure that materials and their junctions are well secured and cannot be peeled back or picked off by patients. The toxicity of the material content should also be clarified with manufacturers to ensure that these materials are safe and fit for this purpose.

3. Evidence-based design

Determining which criteria to apply when selecting finishes appropriate for health facilities could be very subjective. However, in recent years, there have been substantial advances made by various researchers in providing scientific evidence for the impact of the healthcare environment on healthcare outcomes. Many studies, such as Ulrich et al., (2008) demonstrated connections between the design of facilities and the effect on patients, staff and the public utilising healthcare buildings. This has led to a growing understanding of what are priorities in designing health facilities:

FIGURE 9

Extensive research by The Center for Health Design (CHD) Research Coalition on Evidence-Based Design literature led to the Evidence-based design glossary (Phase 1 Report Healthcare Environmental Terms and Outcome Measures) November 2011.

Various unrelated research papers were gathered with intersting results. These included:

- Environmental factors influencing the contamination of inanimate surfaces (including interior finish materials of flooring and furniture, as well as surface cleaning methods) Anderson, Mackle, Stoler and Mallison 1982, and Lankford, Collins, Youngberg, Rooney, Warren and Noskin 2006).
- Reducing background noise in operating theatres and the impact on surgical errors (Moorthy, Munz, Dosis, Bann and Darzi, 2003).

- Multiple environmental factors affecting patient fall rates (Calkins, Biddle and Biesan, 2011 and Becker et al., 2003).
- Patient satisfaction with quality of care when sound-reflecting ceiling tiles were replaced with sound-absorbing tiles to reduce noise (Hagerman and Colleagues, 2005).
- Positive visual distractions, including windows, nature photographs, etc. and the effect on patients' restless behaviour in waiting rooms (Nanda, 2010, Pati and Nanda, 2011).
- Nurses' exposure to daylight correlating to job satisfaction (Alimoglu and Donmez, 2005).
- Noise as a source of stress and its negative impact on staff (Morrison, Haas, Shaffner, Garett and Fackler, 2003).
- Textile materials containing microbial agents (Takai et al., 2002).
- Aesthetic appeal and its effect on patient and staff satisfaction and patient waiting (Becker and Douglass, 2008).

FIGURE 10

Arising out of an overview of these studies, the following selection criteria have been identified:

- Infection prevention
- Cleaning and maintenance
- Safety
- Indoor air quality – humidity
- Indoor air quality – emissions
- Acoustics
- Aesthetics

Although all these factors are important, the specific functions of each space or room will re-order the priority of fulfilling each aspect.

To assist with establishing these priorities and assessing the effects of each criterion, these are examined in more detail in the next section.

4. Selection criteria

4.1. Infection prevention

The South African Patients' Rights Charter (1997) states: "Everyone has the right to a healthy and safe environment that will ensure their physical and mental health or wellbeing including … protection from all forms of environmental danger, such as pollution, ecological degradation or infection."

According to a survey conducted by Rohde (2002), materials and finishes have in the past been selected according to the following characteristics in declining order of importance: Aesthetics, durability, ease of maintenance, client preference, initial cost, cost of maintenance, infection control, ease of installation and life cycle cost.

"Outbreaks of infection have been related to the design, plan layout, function and/or finish of the built environment."
Cotterill et al. 1996 and Kumari et al. 1998.

Selecting the correct finish is a complex process with many aspects to consider, and the many and varied room types in a health facility extend the options. However, in healthcare facilities, the importance of the effect of a particular finish on the prevention of infection control must be prioritised. While it is understood that not every area of a hospital or health facility will carry infection prevention as the highest priority, this aspect remains the most pressing issue in selection of finishes in health facilities.

The rising incidence of HAIs in hospital and medical facilities supports the view that the selection of materials must first address infection prevention. This impacts the choice of materials in two aspects. The first is whether the surfaces are likely to become reservoirs for infectious agents. This is a function of the surface conditions and structure of the flooring. The second is the ability to clean the finish, and this is discussed further in the next section.

"Ideal features of surfaces that satisfy sustainability, infection prevention and safe patient outcomes include cleanability, resistance to moisture and reducing the risk of fungal

The Center for Disease Control in the United States quoted statistics in 2010 of one out of every 20 hospitalised patients contracting HAIs, particularly in relation to sepsis and pneumonia.

Although there is no known direct evidence linking HAIs in patients to particular floor finishes, there have been numerous studies conducted on microbial counts on floor finishes – particularly in soft textiles such as carpets. Beyer and Belsito (2000) proved that carpets acted as a reservoir for fungi and bacteria.

Anderson, et al., (1982) also carried out microbiological studies comparing patient rooms with and without carpets. The study found higher microbial counts and more E. coli and other organisms on carpet samples than bare floors.

There are two schools of thought in relation to the contentious issue of the use of carpets in healthcare facilities. The one approach builds on the studies listed above and cautions against the use of carpeting where spills would result in damp settings, which are then conducive to growth of bacteria. The role of cleaning in these circumstances would be paramount, but a study by Joseph (2006) found that contamination levels quickly returned to pre-cleaning status and hence were not a reliable means of maintaining a clean surface.

The other approach maintains that carpets neatly trap micro-organisms, which can then be removed by HEPA filter vacuum cleaners. This is compared to hard or resilient surfaces which encourage the redistribution of particles into the air during sweeping or mopping. (Radke, 1997)

Risk categories

Extreme	**High**	**Medium**	**Low**
Operating theatres	General wards	Pathology units	Offices
Intensive care units	Dispensary production areas	Outpatients units	Engineering workshops
Sterile supply units	Treatment rooms	Dispensaries	Medical records
Neonatal	Nurseries	Radiology	Plant rooms
Delivery units		Kitchenettes/ward kitchens	
Burns units		Mortuaries	
Oncology units		Public areas	
Renal units			

The emphasis would then shift to cleaning protocols and management issues. Notwithstanding, it is recommended that carpets be avoided where patients are at greater risk of infection. Above is a table adapted from NSW Health: Infection Control Policy (PD 2007-035), which sets out patient risk categories.

When selecting finishes for a room/area that has an extreme or high infection control risk, special care has to be taken to select an appropriate finish. The available types of skirting to suit the floor finish chosen, must also be considered.

A note about skirtings

FIGURE 11

The specifier must ensure that there is proper detailing to the joint between the wall and floor finish. In high risk functional areas, such as an operating theatres, or where immunocompromised patients are accommodated (such as ICU wards), there should be no joint between the horizontal and vertical surfaces, but rather a rounded integral skirting as a continuation of the floor finish.

Skirting in clinical areas should be a minimum of 150 mm and 100 mm high in non-clinical areas.

Skirtings can be one of the following:

- Integral or coved skirting, which is achieved by installing the floor finish over a 20 to 35 mm radius-coved fillet at the junction of the wall and floor, which supports the continuation of the floor finish up the wall surface for a short distance. This removes the edge of the floor-sheet, and the 'joint' with the wall finish from the corner and makes it more accessible and open for cleaning and maintenance. The top edge of the flooring must be finished with a capping strip, secured and sealed so as to not compromise infection control. This is achievable with sheeting products such as vinyl or linoleum.
- Pre-formed set-in skirtings can also be used, and are applied with adhesives, and seal the joint between floor and walls.
- Sit-on skirtings can vary, from timber to specially formed skirtings, which are not integral. Textile floor finishes are normally applied with a flat, i.e. not coved integral skirting.

Refer to Part D for the individual types of flooring and related skirting, applicable to each floor finish.

Floors that resist the spread of infection will have qualities that can be summarised as follows:

- Smooth
- Impervious
- Joint-less/seamless

On the opposite side of this spectrum, where infection prevention is the lowest priority, flooring will have the following properties:

- Perforated
- Textured
- Jointed

A note about antibacterial treatments and additives to flooring products:

Some manufacturers tout the additional benefit of anti-microbial treatment in paints or grout to combat bacteria. The use of antimicrobial additives in the built environment is growing, for example - the impregnation of wood framing with silver nitrate to prevent microbial and mould growth, and extend the life span of the wood.

The CDC HICPAC guidelines (CDC 2003) indicate that there is no evidence that antimicrobial-impregnated articles will prevent disease. There is a need for further research on products treated with these chemicals in terms of their potential risk and benefit.

- The US Carpet and Rug Institute issued a technical bulletin in 2007 in this regard to curb 'over-zealous marketing claims' regarding these treatments and what they achieve. Since the treatment is applied to the carpet fibres or the backing – or both - no implicit human health claims can be made about the finished product unless that finished product has been tested and registered through an accredited independent testing organisation.
- Synthetic fibres, such as polypropylene textile and vinyl sheeting for example, in themselves do no provide a nutrient source which microbes need to survive, but some finishes can trap soil, dust and moisture which do provide that source.

> "Over the last few years, some carpet manufacturers have treated their products with fungicidal and/or bactericidal chemicals. Although these chemicals may help to reduce the overall numbers of bacteria or fungi present in carpet, their use does not preclude the routine care and maintenance of the carpeting"
> Center for Disease Control –
> Guideline for Environmental Infection Control: 2003

- The American Institute of architects has cautioned against the overzealous adoption of antimicrobial surface finishes without the existence and review of independently validated evidence for dosage, efficacy and efficacy claims.
- The application of antimicrobial surface finishes in is only recommended in South African burns units and where independently validated evidence of efficacy, dosage and safety are available, reviewed and approved.

4.2. Cleaning and maintenance

Cleaning and maintenance of floor finishes is interconnected to infection control, occupational health safety (OHS), slips, trips and falls (STFs) and life cycle costing.

The ability of the floor finish to be cleaned will define the extent to which infectious agents can be removed and prevented from multiplying. For cleaning to be effective, the floor finish must be able to withstand regular and fairly vigorous cleaning.

Sufficient access to all areas of the finish or adversely, the absence of any inaccessible gaps, voids, joints is of critical importance, to prevent breeding areas for bacteria, etc.

A further aspect to consider is the level of disruption required to carry out the cleaning of the floor finish regularly. While textile finishes can reduce cold and institutional environments, they would be totally unsuitable in areas with a high infection control risk and a high incidence of soiling.

FIGURE 12

Damage or shortened life spans of floor finishes are greatly reduced by dirt traps or walk-off carpets at main entrances. Refer to Section C5.

It is also important for the manufacturer of the floor finish to convey the cleaning and maintenance required for product guarantees to remain, to the end-user or institution. An effective cleaning regime is the primary means of defence in terms of controlling infection.

Floors that have a high priority for easy cleaning and low dirt retention can be summarised as follows:

- Low maintenance

- Washable

4.3. Safety

FIGURE 13

Safety as a selection factor for floor finishes can be broadly discussed under the following subheadings:

- Slips, trips and falls (STF)
- Occupational health safety (OHS)
- Slip resistance
- Wheeled equipment use
- Fire performance

Slips, trips and falls (STF)

The following factors impact on the incidence and prevention of STFs:

- Frictional/slip resistance characteristics of the floor finish
- Presence of moisture or fluids, e.g., water, cleaning agents, blood, etc. on the floor
- Cleaning of the floor
- Pedestrian footwear
- Human movement across floor, e.g., walking on crutches, pushing a bed/trolley, carrying objects
- Lighting levels on floor
- Change in level of floor, e.g., ramps, stairs
- Change in floor finish
- Age of pedestrian – the aged and children are most prone to STFs

Occupational health safety (OHS)

For the purpose of this document, OHS is highlighted in terms of the safety of the staff working in the health facility.

Floor finishes can impact on staff as follows:

- Risk of STFs, as dealt with above
- Negative impacts on feet and legs from standing and walking
- Movability of wheeled equipment, such as trolleys and beds
- Risk of injury while cleaning surfaces

Hard surfaces such as porcelain tiles cause more feet and leg fatigue than resilient surfaces, such as vinyl and linoleum. Suitable footwear can also alleviate the fatigue.

Negative OHS impacts on cleaning staff tasked with regular cleaning of rough surfaces and should also be considered, such as possible arm and shoulder injuries.

Slip resistance

Slip resistance of a floor finish is impacted on the following basic factors:

- Surface macro roughness
- Surface micro roughness
- Surface profile
- Properties of the footwear in contact with the floor
- Slope or angle of the floor, e.g., ramps
- Potential for the presence of moisture through regular cleaning or by accidental spills e.g., blood)

The potential risk of reduced slip resistance, caused by cleaning operations, should be considered. Adequate visual notices such as: "Cleaning in progress/Caution wet floors" and the cordoning off of wet areas and allowing sufficient time for drying of the floor, are basic methods of managing the risk. Selecting the appropriate cleaning agent and applying it in correct concentration, also affects the slip resistance of a floor.

FIGURE 14

> Proper moisture control is essential in order to reduce health risks and sick building syndrome in an enclosed space
>
> *Mortenson et al., 2005*

Wheeled equipment use

Wheeled equipment, such as beds, trolleys, wheelchairs, etc. are used frequently in health facilities. The ease with which wheeled equipment can be used on a floor should be considered when selecting a finish. This is of critical importance to rehabilitation and acute departments. The movement of obese patients should also be considered generally.

A general rule is that the larger the wheels' diameter, the more the manoeuvrability of the equipment increases.

The material that the wheels are made of also has an impact. Softer materials, like rubber and inflated wheels, suit hard or resilient finishes. Hard or solid wheel materials, like nylon, suit resilient finishes better. Damage can also be caused by wheeled equipment, particularly if heavy use levels occur or where heavy equipment, e.g. mobile X-Ray machine is used and this should be considered when the floor finish is selected.

FIGURE 15

This factor would be relevant where rooms may have a higher risk due to the above features, and in this instance, flooring with properties that could be beneficial in these circumstances would be indicated thus:

Safety

Note: The requirement for fire safety in respect will not vary much from room to room within a health facility, and is therefore considered a global requirement in the overall building, rather than a 'selection criteria' for an individual space. The specifier would need to consult the fire regulations applicable to the building type.

4.4. Indoor air quality

There are two critical aspects to be considered when selecting floor finishes under the heading of indoor air quality.

- The first is the effect of the functions in that environment on the flooring material - namely water/moisture in wet spaces.
- The second is the effect of the material on the floor material - namely the emission of volatile organic compounds (VOCs).

Humidity

Certain rooms and areas of health facilities are by nature of the function they house, wet spaces. These are spaces specifically used for the purpose of cleaning, washing, bathing or food preparation. These rooms will generate more moisture than others, and as a result will require moisture resistant finishes. If the floor finishes are hygroscopic, these finishes can be prone to mildew and mould growth. Surfaces must remain dry and clean in order to prevent the growth of fungus. (Hodgson et al., 2000)

Non-porous materials that do not absorb water are essential in these areas. These materials should also withstand regular cleaning, and should be able to withstand regular exposure to the moisture. Indoor air quality (IAQ) may be compromised by microbial contaminants such as mould, bacteria, allergens, chemicals, etc. in the air, which can affect the health of people. Where this is a requirement in a floor finish, this property will be listed as:

- High humidity

Emissions from materials

As discussed under environmental aspects, the kind of flooring installed can affect the environmental quality of the interior if VOCs are given off (commonly referred to as off-gassing) by one of the following:

- The product itself
- The adhesives used to fix the product
- The sealants used to finish
- The cleaning solutions required for regular maintenance

The smell of the interior of a new car – enjoyed by many – is an example of plasticisers that have evaporated – emissions that affect the indoor air quality. Various methods for measuring VOCs have been developed in recent years since the increase in awareness that these emissions exist and can have an influence on the indoor air quality.

FIGURE 16

The Green Building Council of South Africa (GBCSA) awards points in the IEQ13 Category where interior finishes minimise the contribution and levels of VOCs in buildings – with reference to paints, adhesives/sealants and carpets/flooring, where these products meet the IEQ levels outlines. IEQ14 section measured the formaldehyde minimisation, which is common with composite wood products. In addition, MAT-7 section recognises the reduction of PVC-products in the building materials used. It should be noted that primary VOCs decline quickly in the short-term (<1 year), while secondary emissions can continue for the life span of the product, and should also be borne in mind when assessing this aspect of materials. Timing of the testing will yield very diverse results.

> "Unnecessary noise is the most cruel abuse of care which can be inflicted on either the sick or the well"
> Florence Nightingale (1859)

Occupants with respiratory weaknesses such as asthma are most likely to be affected by VOC-emissions, and high-risk patients would benefit from materials that do not contribute to their condition. The ultimate goal of reducing emissions in the manufacture of building products should be to create a better and healthier environment for the patients and users of the facility.

However, the 'order of magnitude' should also be applied when using 'low VOC emissions' as a criterion to select finishes. The use of vinyl sheeting, for example, may result in higher VOC emissions than say, ceramic tiles, but the infection control benefits of the seamless finish of the vinyl will outweigh the risks from VOC emissions. (More fatalities in patients have been linked to infection control issues than to VOC emissions issues.) 1999)

> To achieve 'low VOC emissions' should be a global criterion for a healthcare building rather than for one or more specific rooms, and hence a separate criterion has not been listed for this item. More detail on the VOC-emissions of the individual flooring types is discussed under the Technical Section C.

4.5. Acoustics

Noise in health facilities is mainly generated by the following:

- Impact sounds, e.g., pedestrian and wheeled equipment, bedrails moved up and down, doors closing and opening, footfalls, etc.
- Airborne sounds, e.g., speech, medical equipment bleeps and alarms, nurse calls, PA system, etc.

Acoustical engineers at John Hopkins University found that average (continuous level equivalent, LA_{eq}) daytime hospital noise levels have risen from 57 dBA in 1960, to 72 dBA in 2006, with night-time sounds increasing from 42 dBA to 60 dBA over the same period. (Sound Practices: Noise Control in the Healthcare Environment – Research Summary, 2006, Herman Miller Healthcare). An average motorcycle noise level measures 85 dB. The World Health Organization recommended LA_{eq} value for ward areas is 30 dBA.

Studies have shown that high levels of noise have negative physical and psychological effects on patients, disrupting sleep, increasing stress and raising blood pressure levels (Cmiel et al., 2004). The University of Michigan released a news brief in November 2005, showing that chronic noise increased the risk of heart-attack in patients by 50% for men and 75% for women. The negative effect of chronic noise extends to staff as well. While the presence of electronic devices and healthcare apparatus, designed to give audible signals and alarms to the nursing staff of the patient's vital signs, architects and health facility planners need to make an effort to minimise this effect of noise and alarm fatigue.

Long straight passages are perfect echo corridors, often amplifying noises. Disturbances in the sound path help limit the sound transmission, for example by creating steps in the ceiling level or changes of direction in the passageways.

Nurses' stations during shift change are areas where noise levels can reach those similar to jack-hammer levels, according to Cmiel, et al. (2004). Consideration should be given to applying acoustic materials to these areas to maximise sound absorption where possible.

People who work in noisy environments for long shifts day in and day out, also have similar stress-induced experiences. They report everything from exhaustion to burnout, depression and irritability"

Recesses to accommodate noisy equipment can also be treated acoustically to reduce reverberation. Distance is also a good strategy where feasible as sound intensity decreases with distance, provided that the room dimensions and surfaces are such that there is very little reverberation.

Flooring that absorbs sound, or at least does not contribute to noise levels, used in conjunction with sound absorbent ceiling finishes should be used in key areas such as nurses' rest rooms or waiting areas where infection control requirements would not be as critical. In areas where sound reduction rates highly as a requirement (e.g. ICU and general wards), then this factor would be listed as:

FIGURE 17

- High acoustic

4.6. Aesthetics

Research results from CABE (2004 and 2005), King's Fund (2004) and Leather, Beale and Lee (2000) all highlight the need for an integrated, holistic and sympathetic hospital aesthetic.

Key results show that the architectural setting, including finishes, has an effect on the patient's experience as well as the recruitment and retention of staff – happy staff are more motivated to care for patients, who in turn recover more quickly.

Paediatric wards particularly give an opportunity to set a playful scene and help little patients feel at ease. In public areas, more emphasis may also be required for an attractive and welcoming interior.

Colour and pattern can be used in floor finishes in health facilities for practical and aesthetical purposes:

- to improve the 'institutional/cold' interior look of the facility, room or area;
- for way-finding, e.g., colour-coding per department; or
- to create 'spaces' by giving individuality, e.g., to a specific area within a large open area.

However, the following is to be considered:

- Excessive combination of colours and patterns are inappropriate in certain areas/rooms, such as operating theatres.
- Some patterns and colours could impact negatively on certain patient groups, e.g., the aged or mentally ill.

Where aesthetics is a primary requirement, this factor will be listed as:

- High aesthetics

FIGURE 20

PART C - TECHNICAL INFORMATION – FLOORING TYPES

1. Hard finishes

Hard finishes are generally durable and easy to keep clean. As with any floor finish, a poor substrate will result in poor performance by the finish on the floor. The following factors should be considered in installation of any hard finish:

- The concrete floor slab should be sufficiently cured and have achieved the required moisture content before the screed is applied. These tests can be performed by hydro, Romus or Tramex meters.
- The screed specification to be adapted to suit the requirements of the manufacturer. Consider thickness, strength, levelness, panels etc. SANS 50197-1: 2000 and SANS 1083 refers.
- The specifier should consult with the manufacturer and obtain detailed installation methods and procedures confirming joint widths, joint material, adhesive, primers, recommended panel sizes, movement joints at wall perimeters, on panels and expansion joint sealers.
- It is useful to specify and include floor-traps in tiled floors for easy draining when cleaning, but ensure then that the screed is laid to fall to the floor drain.

1.1. Porcelain and ceramic tiles

General description and properties

Porcelain and ceramic tiles generally provide a durable, aesthetically acceptable floor finish that is moisture-resistant. A wide spectrum of tiles is available, with varying sizes, material composition, quality and cost, resulting in varying performance. Porcelain and/or ceramic tiles are most commonly used in health facilities in wet areas, such as bathrooms, kitchens, utility and cleaning areas due to the impervious quality and performance under wet conditions. The use of unglazed tiles not recommended in health facilities as these absorb moisture and other fluids which may be present in kitchens, mortuaries, etc.

FIGURE 21

The specifier should research the actual tile carefully, ascertain if the product is imported, what long-term stocks would be available, and ensure the tiles have been sufficiently cured. Where possible, the specifier should use full-bodied porcelain tiles rather than glazed porcelain or glazed ceramic tiles. This is evident in the comparison of the general properties of the two tile types as follows:

- Full-bodied porcelain tile:
- 'Colour' is throughout, as the term 'full-bodied' implies.
- 'Squareness' of tiles consistent with minor deviations.
- Tile sizes are consistent with minor deviations.
- Smaller joints can be used, due to tile size consistency.
- 'Flatness' of tile face consistent.

Glazed ceramic tile:

- 'Colour' is a glaze on top of tile that can wear or chip off.
- Tile sizes can vary.
- 'Squareness' of tiles can vary.

- Wider joints required, due to size and squareness inconsistencies.
- Tiles often not 'flat' and edge surfaces tend to dip resulting in uneven floors.
- Porcelain tiles carry a PEI-rating which will indicate the anticipated wear rating of that tile and what applications will be suitable. The ratings range from Class 0 (wall tile only – should not be used on floors) to Class 5, which is suited to heavy commercial and institutional floors subjected to heavy traffic. This Class 5 would be the required rating for hospitals or healthcare facilities.

The more highly polished the tile, the less slip resistance, so porcelain tiles should be used with careful consideration in health facilities. They could be used in a mortuary, hospital kitchen and laundry where non-slip tiles would be necessary and in non-circulation route public spaces, such as cafeterias.

Infection prevention

Although an individual tile unit complies with selection criteria such as being impervious, and easy to clean, a finished tiled floor - including grout and movement joints - provides a less favourable result in terms of:

- Grout in the joints is porous and can retain moisture which encourages the growth of mould.
- Grout joints pose a potential infection control risk in small cracks and openings that form between the tile edge and the body of the grout.
- Expansion joint material (polysulfide, etc.) is susceptible to damage, due to wear and mechanical cleaning.
- Tiles may crack and chip when items are dropped on them – creating small cracks where moisture can be retained and microbes can grow.
- Replacement of these damaged tiles, or re-grouting is disruptive to the daily operations of the facility.
- Antifungal grout will contribute to the control of mildew, but cannot replace good maintenance regimes.

Cleaning and maintenance

Porcelain tiled floors generally require to be cleaned with water and cleaning agent, using a map or similar. For specific spills in specialised areas, such as hospital kitchens and mortuaries, appropriate cleaning will be required. The ease of cleaning, as well as the durability of the tiles under rigorous cleaning regimes, makes a tiled floor suitable in areas where spills are common – such as kitchens and bathrooms.

FIGURE 22

Safety

Highly polished (especially porcelain-tiled) surfaces can be a slip hazard, particularly where frail or weak patients will navigate the area. This is amplified during cleaning procedures. High reflection and glare can also lead to disorientation. (Wilmott and Colleagues, 1986)

- Tiles with non-slip surfaces can be used where risks are higher, and the likelihood of water on the floor is more prevalent, but note that increasing the texture of the tile for slip resistance will also create a 'cleanability' issue.
- The potential for injury is also increased where slips or trips lead to falls on the unforgiving, hard surface.
- Tiled surfaces also contribute to staff fatigue more than softer finishes.

Indoor air quality: Humidity

The polished or glazed surfaces of the tiles make them highly suitable and unaffected by high humidity in the room. However, as mentioned above, the joints are susceptible to moisture retention and encourage mould and microbe growth in the minute cracks and gaps. Proper scrubbing and regular maintenance will inhibit fungal contamination.

Indoor air quality: Emissions

Porcelain tiles and cementitious grout (**not recommended in health facilities**) do not generate VOC emissions, but some adhesives, other grouts, sealants and cleaning agents do generate VOCs affecting the indoor air quality. The production of tiles has a high energy input, with high sustainability production 'costs' and production emissions.

Acoustics

Tiles contribute substantially to noise in the healthcare setting. This is due to the hard, reflective surfaces, as well as the small dips at the joints, which cause the clattering of trolley wheels common in these facilities. The specifier should consider the kind of traffic that will be using the space and the resultant acoustic effect.

Aesthetics

Tiles are available in a wide selection of colours, shapes and sizes. This allows for visually appealing non-institutional aesthetics in health facilities. Patterns can be used for wayfinding or demarcation of public and off-limit areas, as well as branding in foyers and front of house areas. Since the surfaces do not scratch or scuff easily, the aesthetic appeal is durable.

FIGURE 23

Skirtings

Skirting on tiles floors can be formed by simply cutting floor tiles or using preformed ceramic or porcelain skirting tiles. Wall tiles are common in wet areas, running from ceiling to floor, and no separate skirting is needed. The joints between the wall and floor are however an infection control risk area, as these areas are not easy to clean or dry, and moisture retention leads to bacterial contamination.

FIGURE 24

Typical specifications for tiling – e.g., full-bodied porcelain

SPEC FOR FULL-BODIED PORCELAIN TILES

Allow all new concrete work and screeds to cure for at least 28 days before proceeding. All new concrete work and screeds must have a moisture content of 5% or less before tiling can be commenced. When tiling directly onto concrete, ensure that the surfaces are clean and free of all traces of shutter release and curing agents, laitance and any other surface contaminants, preferably by scarifying or sandblasting.

Full-bodied porcelain floor tiles PEI-rating Class 5, size 400 x 400 x 8 mm *(confirm size)* affixed to wood floated 1:4 cement and sand screed with manufacturer-approved rapid setting tile adhesive using a notched floor trowel with 3 mm joints continuous in both directions, grouted with fine epoxy grout as approved by the manufacturer. Allow a minimum 5 mm expansion joints at perimeter, and maximum 5 m centres internally in both directions and allow all structural expansion and construction joints to be carried through. *(Confirm colour and code.)*

1.2. Terrazzo, cementitious and seamless coatings

General description and properties

Terrazzo is a composite material, consisting of marble, quartz, granite, onyx and glass chips in a cement or resinous matrix, poured in situ. After curing, it is ground and polished to a smooth finish. Application requires skill and experience. The use of terrazzo in health facilities should be restricted to high volume 'front of house' areas, with careful consideration to slip resistance.

FIGURE 25

Cementitious and granolithic toppings generally provide a hard, durable and cost-effective finish. Grano requires a good specification, attention to aggregate selection and experience in application. These finishes are suited to use in plant rooms and external passages and provide a fairly slip-resistant finish.

Epoxy/polyurethane/resin coatings – This term encompasses a wide range of liquid or trowel applied products such as epoxy, polyurethane resins. Thicknesses of coatings vary. This provides a more impervious surface than cementitious coatings.

Infection prevention

Although these finishes produce continuous, seamless coatings, the product should be laid in panels according to the manufacturer's instruction, and underslab joints must be carried through the finish. These finishes are commonly used in food process and pharmaceutical prep areas due to the high chemical resistance, abrasion and impact resistance.

Both cementitious and granolithic toppings are prone to fine, barely noticeable cracks and together with the 'panel joints' present weaknesses in terms of infection control as these areas can store moisture and encourage microbial growth.

Cleaning and maintenance

The impervious surface lends itself to easy cleaning and maintenance and the surface resists most chemicals and does not stain easily. The finish is able to withstand rigorous cleaning regimes and mild alkaline detergent

used with a single- or double-head rotary scrubber is recommended for regular cleaning. With good maintenance, a life expectancy of 10 years is common.

Safety

Epoxy finishes present an increased risk of slips, trips and falls due to the smoothness of the surface, and this is amplified during cleaning. Nonslip finishes are available, but decrease 'cleanability' of the surface.

The hard surface increases the risk of injury when falls do happen, and staff fatigue is also increased due to the hardness underfoot. The installation process presents OHS risks during construction, e.g.: grinding of terrazzo, scarifying substrate to prepare for cementitious topping application, etc.

Indoor air quality: Humidity

These surfacbodes are durable in areas of high moisture/humidity and are easily dried with the appropriate mops, making them suitable for service areas. The fine cracks which can result will retain moisture, however, making them unsuitable for use where infection control is a high priority.

Indoor air quality: Emissions

Body The high synthetic content of epoxy and polyurethane coatings affect the indoor environment through VOC-emissions. These are most notable directly after installation, but these continue, albeit reduced, for the life span of the product. This does vary from one manufacturer to another, and most will claim low VOC emissions, and some even claim VOC--free products.

Acoustics

The hard reflective surface of this finish will contribute significantly to a noisy environment as very little sound absorption will take place. This finish is not suitable for use in sound-sensitive environments.

FIGURE 26

Aesthetics

Terrazzo coatings are available in vivid colours, and stone chip textures give a lively appearance below the glossy smooth surface. Vibrant patterns can be created for an impressive foyer for example. Most other epoxy and cementitious coatings are monochromatic, flat colours that appear quite utilitarian. They are most commonly used in plant rooms.

Skirtings

Integral skirting can be formed in one with the floor covering for a clean and tidy junction. Skill and experience is needed for a neat, durable result. The same tendency to crazing and cracks over long lengths will increase the infection control risk.

Typical specifications for terrazzo

Allow all new concrete work and screeds to cure for at least 28 days before proceeding, and ensure a minimum strength of 25 mPa is achieved. The surface is to be free from laitance, dust and any other contamination, and must not exceed relative humidity of 75%. The installation is to be carried out by a subcontractor approved by the product manufacturer only. Apply primer at 0.25 kg/m^2 followed by 8 mm epoxy terrazzo topping including granite chips at a rate of 16.8 kg/m^2, and an average density of 2.1 kg/litre (*confirm colour.)* The topping to be ground down to 6 mm, all joints grouted with manufacturer approved coloured grout, and the surface to be sealed in accordance with manufacturer's instructions.

Typical specification for grano

Float up to 5 mm of finished surface with layers of concrete (grano) approximately 10 mm thick, composed 1 part cement, 2.5 parts concrete sand and 3.5 parts granite or other approved hard stone chippings. Form finished surface with 1 part cement and 1 part fine granite chippings or other approved hard stone (graded up to particles which will pass a 6 mm mesh) brought to a smooth surface with a steel trowel. Grano finish: 30 mpa (25 mm thick). The floating and finishing coats are to be performed in one operation. The grano-lithic work is to be carried out by experienced workmen and is to be laid in panels v-jointed and not exceeding 6 m^2 in area unless otherwise specified. Thin strips of wood or other suitable materials are to be laid between panels to break contact. All granolithic floors are to be covered up and protected from damage and discoloration during the progress of the work. Allow for cleaning down and for one coat of architect approved wax polish, well rubbed into floor at completion. No dry cement powder or grout to be applied to surface preparation of surface beds.

Typical specification for epoxy paint (to be applied to grano)

Ensure grano substrate has a maximum moisture content of 4%. The surface is to be free from laitance, dust and any other contamination. The installation is to be carried out by a subcontractor approved by the product manufacturer only. Prime surface with manufacturer recommended clear primer (spread rate – 6 m^2/litre). Apply three coats semi-gloss water-based epoxy coating *(confirm colour) wi*th a minimum dry film thickness of 60 microns thick per coat with a maximum over-coating time of 12 hours. Applied in accordance with approved manufacturer specifications.

2. Resilient finishes

Resilient finishes are generally flexible floor coverings that provide a continuous impervious finish well suited to the healthcare environment's needs. The sheeting is seldom more than 5 mm thick and is therefore very dependent on the quality of the sub-base onto which it is laid.

Due to the comparatively thin, smooth, polished aesthetics of resilient flooring, it is critically important that the sub-base is of adequate strength, perfectly level and has controlled moisture content, as any failure in the substrate will affect the performance of the floor finish. Any imperfections will be emphasised, creating scuffing and uneven wear. Minor movements in substrate however can be tolerated in the flexibility of the sheeting.

In recent years, self-levelling screeds/compounds have been introduced prior to the installation of sheeting. A variety of products are available of varying strength, thicknesses, cost and drying periods. Generally, self-levelling screeds are fast-setting, allowing foot traffic within hours and sheeting application within short periods, from 24 hours to longer. Installers can lay around 200 m^2/hour. Sheeting is applied with adhesives to the substrate as per the manufacturer's specifications. Joints in resilient sheeting are formed by using welding rods and these are heat welded for a seamless finish.

Building expansion joints needs to be taken through the self-levelling and sheeting to allow movement and special cover-strips are used in these instances.

Typical screed specification

Screeds are a critical part of ensuring a successful floor covering, and where thin sheeting such as vinyl, etc. is to be applied to the surface, the specification of the screed must meet certain criteria. The four important aspects are:

- Strength – is it strong enough for its purpose?
- Levelness – is it level enough for its purpose?
- Moisture content – is there moisture present?
- Adhesion to the concrete slab – is it sticking to the slab?

FIGURE 19

FIGURE 18

To conduct the necessary tests takes time and costs money, but unless these tests are specified and priced as part of the tender documentation, the quality of the floor finish is left up to the installer, with no control measures for the specifier to check the quality, so it is essential that these specifications be included.

SPEC FOR SCREED STRENGTH

The screed mix must consist of 1 part cement to 3 parts sand. Both sand and stone must comply with SABS 1083. Cement must comply with SANS 50197-1:2000, and achieve strength of 25 mPa. No dry mix permitted. The screed must be laid to a minimum of 25 mm thick (preferably 40 mm thick) with a wood-trowelled finish where self-levelling compound is to be laid. Cube samples of the screed mix must comply when tested in accordance with SANS 5861-3:1994. The dry, cured (minimum of 14 days) screed must also be tested using a BRE screed tester, with one test per 20 to 25 m^2, and 3 to 5 m intervals on corridors.

These tests must meet the requirements as follows: *(specify which is relevant)*
Strength Category A – maximum of 3 mm indentation – for hospital operating suites and related corridors or rooms requiring microbe or dust-free environments.
Strength Category B – maximum of 4 mm indentation – for public areas such as lobbies, passages, wards
Strength Category C – maximum of 5 mm indentation – for offices, consulting rooms and domestic premises

Since most projects will carry a single specification for screed to cover all areas of the project, the best category applicable should be used – which is Category A.

SPEC FOR LEVELNESS – IN HEALTH FACILITIES

The screed must meet Class 1 standard for levelness (which means that there is a maximum difference of 3 mm, from the highest to the lowest point, over a 3 m straight line joining two points on the surface.) This test can be conducted with an aluminium straight edge, and should be checked in various directions on the screed.

SPEC FOR MOISTURE CONTENT

The screed should be completely dry (cured for a minimum of four weeks - as a rule of thumb, concrete or cement will cure at a rate of 25 mm/month.) Moisture content should be checked at regular intervals - every 30 m2 (approximately), or at least in every area where external conditions might differ – (e.g. – ground level may be raised around a portion of the building). Moisture readers, such as the "Tramex"-meter, will only give superficial readings (within 5 mm of the surface). For true readings of the moisture content of a sub-base, the probes/readers must be able to read 40 to50 mm deep. Readers such as "protimeters" or "Wagner"- moisture readers use two probes approximately 100 mm apart to give relative humidity readings. Readings should not exceed 75% RH (max.) If the moisture does exceed 75%, and is not more than 90%, painted on moisture barrier coatings can be used to good effect.

Phenolphthalein solution can be used as a liquid moisture test as this chemical compound will show if moisture/damp is present. This liquid will remain clear in dry conditions, change to pink where moisture is detected, or turn purple where the surface is wet. Again, it is only an indication of the surface moisture, not what the conditions are below the surface.

SPEC FOR ADEHESION TO THE SUB-BASE CONCRETE

Pull-off tests are also recommended – and should be conducted every 30 m^2 (or each room if smaller) by a recognised laboratory to establish the adhesion of the screed to the sub-base and the results supplied for approval.

Typical self-levelling/Smoothing compound specification

Self-levelling compounds will improve the smoothness, and levelness of screeds, and these compounds are a pre-requisite by most manufacturers for the installation of resilient sheeting.

Cement and calcium-sulphate screeds must be abraded and vacuumed prior to laying the self-levelling compound. In addition, the screed must be sound, dry, free from cracks, clean and free from any materials that could impair adhesion. Apply two coats of primer, with the second coat applied in cross-direction to the first coat, in accordance with manufacturer's instructions. Once dry, the self-levelling compound is to be applied using the pumped method *(refer to manufacturer's spec)* to a 5 mm thickness *(confirm thickness).* The compound is to be spread using a notched floor rake to ensure the correct thickness is achieved, and rolled with a spiked roller to ensure all air bubbles are removed. The finished surface is to be lightly abraded with 30 to 60 grit paper (*usually with a floor sander*) prior to laying the resilient sheeting. The self-levelling compound is to be installed by a manufacturer-approved contractor.

FIGURE 20

2.1. Vinyl sheeting

General description and properties

Vinyl sheeting is manufactured from a combination of vinyl resin and various additives such as the following:

- Plasticisers – used to make the sheet more flexible,
- Stabilisers – to minimise degradation and discoloration
- Pigments – for colours and patterns
- Fillers – such as lime, or other locally available material

Vinyl sheeting is generally 2 to 2.5 mm thick and depending on the manufacturer, is supplied in 1.2 m or 2 m wide rolls. It is commonly used as a floor finish in health facilities, because it provides a durable, resilient and impervious finish.

Vinyl is available in a range of types:

- **Homogeneous**: Sheet consists of a single layer of consistent materials, with the wear layer being the full sheet. It is uncoated and requires stripping and sealing unless it is supplied with a specialised surface treatment such as polyurethane reinforcement (PuR).
- **Heterogeneous**: Sheet consists of three to four different layers including the carrier, PVC-layers, printed film and a clear PVC-wear layer. Good durability will be achieved with a 0.7 mm wear layer.

FIGURE 21

- **Directional or non-directional patterns**: This relates to the visual pattern which may mean laying all sheets in the same direction. Non-directional sheeting is less limiting in terms of the pattern, but the manufacturer's instructions must still be adhered to when laying sheets.
- **With or without PuR finish**: Polyurethane reinforcement (PuR) is introduced in the manufacturing process and provides a 'ready polished' product. When sheeting has a PU-coating, stripping and sealing directly after installation is not essential. However, water-based dressings and appropriate cleaning is still needed to maintain the product. The PU-coating also improves resistance to staining and cleaning chemicals and supports indentation recovery. It is also important to establish whether high-speed buffing machines are required for cleaning of the product, and whether the institution has this equipment available.

FIGURE 22

Infection prevention

Vinyl sheeting as a material has been found to inhibit the growth of bacteria, and particularly MRSAs. The welded joints prevent dust or dirt congregating in areas that are difficult to clean, and the integral skirting supports this seamless appeal. This has made vinyl sheeting very suitable for use in healthcare facilities. Some heterogeneous products also have silver-ions in the finishing layer to create an antibacterial surface.

Cleaning and maintenance

The sheeting is easily washed, which contributes to its performance as a hygienic flooring finish. Vinyl sheeting is not easily damaged, and when treated with a polymer dressing/surface treatment, is low maintenance. When maintained properly, the sheets have a long life span, and therefore fairly cost-effective by comparison to other floor finishes.

Products with PuR require only spray and dry buffing for general cleaning although water-based dressings are beneficial. Special cleaning solutions are used for heavy staining, but abrasive cleaning methods should not be used. No abrasive black or brown cleaning pads should be used on PU-coated floors as these will damage the surface and destroy the sheen. Only buffing and shampoo pads should be used.

Cleaning should always be carried out as per the manufacturer's specifications, to comply with material warranties, and the specifier should ensure that these instructions are included in handover packs issued to the building owner/user when occupation takes place.

An effective entrance barrier/dirt trap mat can reduce cleaning by 65%. The highly-abrasive African soil conditions create an extremely aggressive environment that can shorten the life span of the floor-sheeting, and without removing the bulk of this dirt and grit at the entrance of the health facility, the vinyl floor will suffer.

Strip and seal procedures should not be done more than once or twice a year, even in high traffic areas. Discoloration is often a result of poor daily maintenance, leaving a dirty residue which binds to the finish. Dry buffing brings out the natural colours, and a sealant will give the high shine finish.

FIGURE 23

Safety

In terms of slips, trips and falls care must be taken where highly polished floors are used in wet areas. Attention also needs to be given to thresholds where floor finishes of differing thicknesses meet, as these can present a hazard if not detailed as a smooth transition.

In terms of use by staff, the sheeting is softer underfoot than hard finishes, reducing leg fatigue. The smooth finish is easy to use with wheeled equipment, which creates a safe and workable environment for staff in health facilities.

Vinyl sheeting is generally slip-resistant, and most manufacturers will indicate results from the wet pendulum test or the dry floor friction test. Specialised sheeting with surface textures and/or quartz additives helps improve traction and reduce slipperiness. Antistatic sheeting is also available when required.

In terms of SANS 10400, operating theatres, ICU, high-care or critical care units are required to have a floor finish with 120 minutes' fire resistance. Compliance with this should be checked with the manufacturer.

Indoor air quality: Humidity

Vinyl sheeting is well suited to areas of high humidity, and wet areas such as sluice rooms. Spills should be wiped as quickly as possible though as condensation blooming can take place in the clear wear layer.

Indoor air quality: Emissions

Some manufacturers have addressed VOC emissions in their products and indicate a pass in VOC emissions tests as well as BRE A+ ratings. Materials are 100% recyclable and also contain a percentage of recycled

materials. Each supplier will differ, and specifiers should check these aspects when considering a product. VOC emissions of adhesives and sealants, where applicable, are also to be considered.

Aesthetics

The wide variety of colourways available in vinyl sheeting allows for creative patterns to enhance the healing environment. Patterns can be used for wayfinding, signage (e.g., ward numbers), definition of public and staff only areas, or distinction between different departments.

In addition, creative floor patterns can present branding identity, and enhance the environment to set patients at ease. Complex patterns should be aquajet cut, and the related budget allowances made at design stage. Skilled installers are also able to create many designs by hand.

Acoustics

Vinyl sheeting is relatively soft underfoot, and has better sound absorption qualities than hard finishes. Specialised vinyl sheeting products created for acoustic control are thicker at around 3.7 mm, but the extra foam backing on these types of sheeting can hamper the use of wheeled equipment in these areas.

FIGURE 24

Skirtings

Vinyl sheeting can be laid with a variety of skirting solutions. The use of the flooring material as an integrally welded skirting, forming a coved joint between the wall and the floor is the best solution in terms of infection control as the joints are welded and the 'corner' is smooth, rounded and easy to clean. The cove former which supports the turn-up of the sheeting can be sealed off at each end (supplied in approx. 25 m rolled lengths) to ensure there is no access into this gap.

Extruded PVC-skirting is also readily available, and these can either be set in to abut the floor-sheet, or simply glued on top of the sheet, with a small 'foot' taking the curve into the wall. The specifier must ensure that the thickness of the set in skirting matches the floor thickness. The set in skirting is welded against the floor-sheet.

Capping strips can be used with all these types to create a neat line on the top edge.

Typical specifications

Since there is a range of vinyl products available, the specifier will need to determine whether homogenous or heterogeneous vinyl sheeting is preferred, and whether a PuR-layer is required or not before making the selection. A typical specification for homogenous type sheeting with PuR treatment is supplied as an example,

SPECIFY STRIP AND SEAL WHERE SHEETING IS SUPPLIED WITHOUT PUR
Allow to strip with manufacturer approved stripper and seal with two coats of polyurethane sealant in accordance with SABS 825 and 1042, and manufacturer's instructions – within 72 hours of installation.

but the specifier should always liaise with the manufacturer for project specification.

HOMOGENOUS VINYL SHEETING WITH PUR TREATMENT

Supply and fix *2/2.5* mm thick – *(confirm thickness)* x 2 m wide fully-flexible, *nondirectional* or *marbleised pattern/directional - (select type)* vinyl floor-sheeting with polyurethane reinforcement and surface treatment - abrasion group *T/P (select group)*, and manufactured to EN 649.

Sheeting is to be laid in *pressure-sensitive or acrylic* adhesive *(select type as approved by flooring manufacturer)*, with a notched trowel at the rate of 5.5 to 6.5 m^2/litre on a previously prepared Class 1 sub-base elsewhere described and measured. The sheet is to be rolled in both directions with a 68 kg three-sectional metal floor roller, during the course of the installation, immediately after the sheeting is laid in the adhesive. *Factory edges of vinyl sheeting are to be removed before laying (10 to 20 mm) – recommended by some manufacturers (select if applicable)*. Installation in accordance with SABS 786:2007. Specify colour: *(confirm code).* Joints are to be butted, grooved to about half the depth of the sheet, (about 1 mm) and heat welded, with a welding rod. The finished width of the weld should be a width of 3 mm, and ensure a minimum 70% bond with the sheeting – all in accordance with the manufacturer's spec. No concave or convex joints allowed – the joints must finish flush with the sheeting. All welds to be glazed and checked prior to polishing. No cross-joins allowed. On completion, PuR treated sheeting is to be washed down, and two coats of matt sealant is to be applied. This will prolong the life of the floor.

(Note: No stripping to PuR finished floors as this will damage the sheeting.)

SPECIFICATIONS FOR VINYL SKIRTINGS – *Select one option:*

Coved floor-sheet skirting: Matching floor vinyl sheeting coved 150 mm high against walls to form coved skirting, and welded to floor-sheet. Coved skirting to be laid over preformed 20 x 20 mm cove former – with ends sealed with glue. Allow for butterfly corner method at all corners including at thresh-holds, all in accordance with manufacturer's specifications. Skirting to be finished with extruded capping strip (*or clip-on capping strip with backing)* to be supplied and fixed with manufacturer approved contact adhesive spread evenly and quickly onto both material and wall surface. Ensure that no gaps remain between the wall, the skirting and the floor.

Set-in: Extruded cove skirting to be supplied to abut flooring, and welded against the floor finish. The skirting is to be fixed with manufacturer approved contact adhesive spread evenly and quickly onto both material and wall surface. Once touch dry (approximately 15 minutes) cove skirting to be applied firmly working gradually along the length from one end to the other. Extruded capping strip (*or clip-on capping strip with backing)* to be supplied and fixed with manufacturer approved contact adhesive spread evenly and quickly onto both material and wall surface. Ensure that no gaps remain between the wall, the skirting and the floor.

Sit-on: Extruded cove skirting to be glued on top of floor-sheeting, and against wall. The skirting is to be fixed with manufacturer approved contact adhesive spread evenly and quickly onto both material and wall surface. Once touch dry (approximately 15 minutes) cove skirting to be applied firmly working gradually along the length from one end to the other. Extruded capping strip (*or clip-on capping strip with backing*) to be supplied and fixed with manufacturer approved contact adhesive spread evenly and quickly onto both material and wall surface. Ensure that no gaps remain between the wall, the skirting and the floor.

ADDITIONAL SPECIFICATIONS TO CONSIDER FOR VINYL SHEETING

Note -1: It is highly recommended to the specifier to include in the project costing, an item for the preparation of a mock-up area of a minimum of 10 m^2 of flooring installation – complete with sub-base and skirting, to be inspected and approved prior to the main installation.

Note 2 – If patterns are anticipated, these must be designed or at least described in the specification, so that it can be measured or budgeted for at documentation stage.

2.2. Linoleum sheeting

General description and properties

Linoleum has been used as flooring for over 100 years. It is manufactured from 97% natural, raw materials that are renewable and undergo an eco-friendly manufacturing process which does not produce environmental contaminants. Linoleum is made from linseed oil, rosin (from pine trees), wood and cork flour, limestone, organic pigments (for colour) and jute, which forms the backing.

Linoleum is less flexible and more porous than vinyl. It is available in a thickness of 2.5 mm, generally in rolls of 2 m width.

FIGURE 26

Infection prevention

Bactericidal properties of linoleum prevent micro-organisms from multiplying. This includes MRSAs and this has been tested and proven by TNO (Netherlands Organization for Applied Scientific Research) and NAMSA (US Scientific Institute) in 1998.

Joints can be welded giving a seamless and hygienic finish. Coved and welded integral skirting can be achieved, with skill and experience.

Cleaning and maintenance

New generation linoleum products come with a factory-applied surface finish or shield, which includes a primer and tough top layer which enhance low maintenance properties, and are restorable. This floor finish requires no stripping upon installation and to do so will damage the sheeting. This linoleum should simply be cleaned after installation in accordance with manufacturer's instructions.

FIGURE 25

Linoleum that is supplied without the surface shield will however still require stripping and sealing on installation where the sealant acts as a sacrificial coat. Ensure that the correct products and procedure – as approved by the manufacturer – are applied, as sealers for vinyl will stain linoleum sheeting. Compliance with cleaning and maintenance, as laid down by the manufacturer, is required, to avoid invalidating the product guarantees. No alkaline products should be used as these will damage the linoleum.

Linoleum is resistant to staining by blood or urine, but will discolour with iodine.

Bleach will cause deterioration and loss of gloss. It has a good resistance to chemicals, diluted acids, oils and fats, and is extremely wear-resistant. Dirt-trap matting is recommended at entrances to the facility, to reduce the effect of the aggressive African soil conditions.

FIGURE 27

Safety

Linoleum has slip-resistant properties, although with any smooth surface, care must be taken when cleaning. Attention must be given to thresholds where differing floor thicknesses meet, and a smooth transition should be formed.

Linoleum is soft underfoot, resulting in reduced staff leg fatigue when compared with hard finishes. The smooth finish, however, is easy to use with wheeled equipment, creating a safe and workable environment for the health facility.

According to EN 13501-1, linoleum is suitable for exit routes in terms of fire safety, and is classified CFL/S1.

Indoor air quality: Humidity

Although the floor installation is welded, the use of linoleum in wet areas is not recommended due to the jute/hessian backing.

Indoor air quality: Emissions

Linoleum is a nontoxic natural product that does not emit VOCs, and makes for a better indoor air quality than rooms finished with petroleum-based/synthetic materials such as vinyl sheeting – which do emit VOCs. The linoleum is fully recyclable, and will earn credits for green-rated projects. A 30 to40 -year life span is not uncommon where floors are properly maintained, making for a low life cycle cost.

According to C. Maloney (LEED Green Associate at Cornell University), linoleum is preferable to vinyl as a flooring product, because it is better for the environment, and also for the wellbeing of the occupants.

Acoustics

LINOLEUM SHEETING WITH PROTECTIVE TOP LAYER

Supply and fix 2.5 mm thick x 2 m wide linoleum sheeting manufactured to specification EN 548 (with double protective top layer), laid in manufacturer-approved acrylic adhesive, spread with a notched trowel having 2.1 mm in height x 2.7 mm in width at 2.3 mm centres at a rate of 3 m² per litre on a previously prepared Class 1 subfloor by builder, as described above and elsewhere measured, including all cutting and waste. All joints to be butted or grooved and heat-welded with approved welding rods, ensuring that the welding rod bonds to more than 70% of the sheet thickness. It is essential that during the course of installation the material be rolled in both directions with an articulated 68 kg three-sectional metal floor roller.

Regular linoleum has excellent sound absorption properties and produces results of around 5 dB when tested for acoustical impact noise reduction under EN ISO 7127-2. Specialised acoustic linoleum is even more effective in creating a calm, quiet environment. Cushion-backed flooring helps to dampen reverberation sounds, and patients respond well to the calming effect of the muffled sounds in usually noisy hospital environments.

Aesthetics

Linoleum is available in a wide range of colours and designs help create healing environments. Patterns include wood-grains, marble and other interesting designs. Patterns are easy to achieve. Budget provision must be made for aquajet cutting where more intricate patterns are desired.

Skirtings

Due to its reduced flexibility, integral skirting using the floor-sheet requires special skill to form. The cove must be supported, properly fixed and capped. Preformed skirting can be fitted where budgets allow.

Typical specification for linoleum flooring

2.3. Rubber flooring

FIGURE 28

General description and properties

Rubber flooring is formed by vulcanising and compressing natural rubber, which is extracted from the sap of the tropical rubber plant. It is a simple process. There is no PVC-content, and it is available in tile and sheeting approximately 3 to 3.5 mm thick. The product is not manufactured locally in South Africa, but is available imported through local suppliers.

European norms (ENs) that set the industry standard for rubber flooring include:

- EN 1817 – Homogenous and heterogeneous rubber flooring
- EN 1816 – as above, with foam backing

Rubber is an extremely dense, hard-wearing product which will handle forklift traffic and has an extended life cycle of 30 to40 years. The most common surface finish is the classic round raised pastille.

Some rubber is made from a combination of natural and synthetic rubber, and there are numerous interlocking tile products available that look similar to rubber, but are made of PVC.

Infection prevention

Rubber flooring is bacteriostatic and will prevent the growth of mould and fungus. This makes is suitable for use in healthcare environments. The joints between the tiles, however, do present a risk, and sheeting is preferable in this regard, as all seams can be welded. The 'wall-floor' joint can also be an area of risk as integral skirting is difficult since the material is very dense and has reduced flexibility (although not impossible with skill). This can be an area that forms a reservoir to moisture and growth spot for microbes, and hence its

SKIRTING - SELECT ONE

Coved floor-sheet skirting: Matching floor linoleum sheeting coved 150 mm high against walls to form coved skirting, and welded to floor-sheet. Coved skirting to be laid over pre-formed 20 x20 mm cove former – with ends sealed with glue. Allow for butterfly corner method at all corners including at thresholds, all in accordance with manufacturer's specifications. Skirting to be finished with extruded capping strip (*or clip-on capping strip with backing)* to be supplied and fixed with manufacturer-approved contact adhesive spread evenly and quickly onto both material and wall surface. Ensure that no gaps remain between the wall, the skirting and the floor.
Sit on extruded coved PVC--skirting, followed by capping strip (*confirm size of skirting, capping strip and colour),* using manufacturer-approved contact adhesive, spread evenly and quickly with a brush onto both material and working surface. Allow both surfaces to become touch dry – approximately 15 minutes. Place material carefully into position at one end, and then work gradually along its length. When completely positioned, apply firm pressure along whole length to ensure perfect contact between the two adhesive surfaces. Ensure that no gaps remain between the wall, the skirting and the floor.
Clip-on capping strips with backing can also be specified – refer to manufacturers.

reduced application in health facilities.

Cleaning and maintenance

Rubber is extremely hard-wearing and durable and required uncomplicated maintenance with neutral detergents, rinsing and dry sweeping/vacuuming. As with any product, maintenance will prolong the life and enhance the appearance of the product.

Safety

The circular pastille pattern of tiles and the textured surface of the sheeting provide a slip-resistant surface which is suitable even in wet conditions. Good walking comfort is achieved with less leg fatigue than hard surfaces. The raised pattern will produce slightly more drag than a perfectly smooth surface when it comes to wheeled equipment being pushed across it.

FIGURE 29

Rubber is a Class BF1/S1 fire-retardant material in terms of the EN 13501-1 test method.

Indoor air quality: Humidity

Rubber is well suited for use in high-humidity/wet spill areas, as it is not adversely affected by moisture, and the slip-resistant surface makes it safe to use in these areas.

Indoor air quality: Emissions

Rubber is a natural product that does not emit toxic VOCs. No formaldehyde materials are used in the manufacture of rubber flooring, and in terms of EN 14041:2004, an E1 classification is achieved, which means emissions fall into the 'less than 0.7 ppm (parts per million)' category. Rubber does have a distinctive odour.

Acoustics

Rubber is an excellent absorber of sound, with a sound absorption value of between 6 to10 dB. Rougher textured tiles will absorb even more, and specialised acoustic products up to 20 dB. The muffling of impact sounds in a healthcare environment will clam patients and contribute to a quiet, peaceful space.

Aesthetics

Rubber is available in a limited range of monochromatic colours. Simple patterns can be achieved, but the single colour flooring can appear somewhat utilitarian – which may be suitable for specific areas. The durability of the flooring means that it maintains its appearance well, still visually appealing after many years of use.

Skirtings

Coving of the wall/floor joint is possible with rubber sheeting, but its reduced flexibility and thickness require expertise and special skills to achieve. Preformed skirting is more readily available. Rubber tiles are more commonly used in South Africa, and skirting then cannot be coved or welded to the flooring.

Typical specification for rubber sheeting

SPECIFICATION FOR RUBBER FLOOR-SHEETING:
Supply and fix 2.0 mm thick x 1.22 mm wide rubber floor-sheeting with a changing base colour, consisting of three harmoniously matched colour components and characteristic granule inclusions, laid into manufacturer approved contact adhesive spread according to manufacturer's recommendations on a previously prepared Class 1 sub-floor by a builder, (specified above and elsewhere measured) , including all cutting and waste. Join sealing required, according to the manufacturer's recommendations.

SKIRTING: SELECT ONE

Coved floor-sheet skirting: Matching floor-sheeting coved 150 to 200 mm *(select)* high against walls to form coved skirting, and welded to floor-sheet. Coved skirting to be laid over preformed 20 x 20 mm cove former – with ends sealed with glue. Skirting to be finished with extruded capping strip (*or clip-on capping strip with backing)* to be supplied and fixed with manufacturer-approved contact adhesive spread evenly and quickly onto both material and wall surface. Ensure that no gaps remain between the wall, the skirting and the floor.
(*Confirm skirting **set-in** or **sit-on**)* Supply and fix extruded coved fillet and capping strip *(confirm skirting type, radius and size, colour, capping strip size and colour),* using manufacturer-approved contact adhesive, spread evenly and quickly with a brush onto both material and working surface. Allow both surfaces to become touch dry – approximately 15 minutes. Place material carefully into position at one end, and then work gradually along its length. When completely positioned, apply firm pressure along whole length to ensure perfect contact between the two adhesive surfaces.

2.4. Cork flooring

General description and properties

Cork flooring is made from the bark of the cork oak tree, which is an evergreen tree common in Southern Europe and North Africa. The bark is ground and processed into sheets before being kiln-baked. The hand harvesting is strictly controlled, and since the bark grows back, this is a highly sustainable product.

FIGURE 30

The main constituent of cork is a waxy, rubbery substance called suberin. This hydrophobic substance gives cork flooring its elastic and impermeable quality.

The cork sheeting is most commonly formed into tiles or planks of between 4 to6 mm thick and varying sizes. The tiles are most commonly glued to the floor surface which must be free of imperfections, level dry and smooth. The tiles or planks are generally butt-jointed. Floating cork floors can be achieved by laying cork planks over timber floors. Interlocking, glue-less installation is also available. Cork is also formed into rolls for use as an underlay below other flooring materials to improve acoustic performance and prevent moisture ingress. It is recommended that cork suitable for commercial use (Class EN31-35) is used in healthcare facilities.

Cork and rubber have also been combined with polymers such as neoprene and nitrite to create tough, durable floor-sheeting. Cork has also been combined with linoleum to form flooring products that are imported. These imported products cater for residential, commercial and industrial grade applications. Although cork has predominantly been used in the residential sector in South Africa, it is beginning to find a place in the commercial, and particularly the healthcare sectors, where budgets allow.

Infection prevention

Cork is bacteriostatic and antifungal. Dirt and grime may collect, but not be trapped by the floor, and provided the floor is regularly swept or vacuumed, microbes will not be able to colonise, and the floor will prevent the spread of infection. Some manufacturers treat the cork with an additional antimicrobial sealant to prolong the durability of the product. Joints cannot be welded, and tiles are laid with butt joints. These joints can gather dust and moisture over time, and sealing the finished floor with a sealant is recommended.

Cleaning and maintenance

This is a low maintenance product, with simple cleaning procedures such as regular mopping and sweeping – no sophisticated equipment is needed. No harsh cleaning agents or polishing is required. Tiles usually come pre-sealed; however, application of an additional polyurethane sealant to cover the joints on the finished floor is recommended. Unless the floor is properly sealed, it can stain, and the sealant will need re-application periodically. The resilient nature of cork means it has excellent impact resistance. The 40 million microscopic air-pockets per cm^3 allow cork to return easily to its original shape, even after pressure from furniture or heavy foot traffic.

Safety

Cork consists of 50% air, which is contained in the microscopic honeycomb compartments that make up the material. This makes cork a great shock-absorber, reducing leg fatigue as well as injuries where patients may fall (particularly the elderly). The cellular structure also makes it slip-resistant. Nanobead technology surface finishes are available which provide excellent traction to prevent slipping.

Indoor air quality: Humidity

Suberin is a natural waxy substance found in cork, and is responsible for the moisture repellent/resistant properties of cork. Cork is commonly used as an underlay to prevent the transfer of moisture to the floor finish. It is however not recommended to glue cork to consistently damp or wet areas as adhesive to the substrate may fail, and the moisture will divert to other finishes.

Indoor air quality: Emissions and insulation

Cork, and the process of producing cork flooring contains no formaldehyde or other toxic substances, and cork does not emit VOCs. However, adhesives, finishing/protection coats and sealants used with these flooring products may contain solvents and emit VOCs. Cork is also very lightweight due to the high air content and this reduces the transport costs and in turn the carbon cost of the product. Solvent- and formaldehyde-free polyurethane surface finishes are also available for commercial use (Class EN 32). The insulation properties of cork will produce good energy savings where heat load is a factor on the floor.

FIGURE 31

Acoustics

Impact sound reduction tests (in accordance with ISO140-8) show that cork can absorb and reduce sound by up to 16 dB. The air-filled compartments are excellent sound absorbers and will contribute to a calm, quiet environment. Sealants will reduce this capacity, but slightly increasing the reflectivity. ISO 10140-1:2010 indicated a 53% reduction in footfall sound.

Aesthetics

Cork, like timber, is a naturally-grown product and much of its aesthetic appeal comes from the uniqueness of each batch of cork. Colour variations add to the appeal, and are to be expected from different trees and harvests. The colours range from yellows to dark browns, although off-whites are also being achieved through

treatment. Exposure to light will over time lead to some degree of fading. Engineered multilayered cork products will be more consistent in pattern and colour. These hybrid products are examined more under Section C4.

Skirtings

Cork cannot be coved or welded. Any suitable coved set-in skirting can be used, with the flooring abutting this skirting. The thickness of the cork tiles should be borne in mind when abutting a coved skirting, however, as the cork is thicker than most pre-moulded coved skirting on the market.

Typical specification for cork tiles

3. Soft finishes

3.1. Carpet textiles

General description and properties

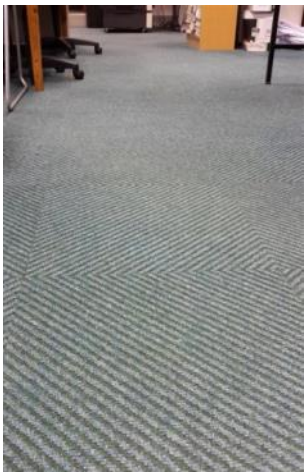

FIGURE 32

Carpets are manufactured from fibres attached to a backing. The fibres range from natural wool to synthetically manufactured nylon or polypropylene fibres. Carpets can be made up of cut pile – individual strands, or tufted pile – which are closed loops. These are needle-punched into the backing. The heights of the tufts can be varied to create the striations and patterns commonly found in needle-punch carpets. The synthetic fibres are often treated to prevent the growth of mould and microbes, and make the carpet resistant to staining.

Traditional carpets had jute backings, but this organic material - which had limitations such as rotting when exposed to moisture, or encouraging microbe infestation, has largely been replaced by synthetic fibre or resin-based backings which are more durable, non-allergenic and can resist moisture.

Broadloom carpet widths are most commonly 3,66 m wide, but some manufacturers supply 4 m widths or narrower 1.8 m widths as well. Carpet tiles are generally 500 to600 mm square, but larger sizes and rectangular tiles are also available to order. A wide range of thicknesses are available – from 3 to 12 mm depending on the backing. Carpets are graded for various applications and traffic weights - from residential to heavy commercial. The colouring process ranges from pre-dyeing/injecting colour into the yarn, to continuous

Subfloors must be level, permanently dry, solid and free from cracks, dirt and adhesion inhibiting substances and not exceed a maximum humidity of 75% RH. Ensure that the subfloor is well absorbent. If the subfloor shows low absorbency or no absorbency, apply a high quality cement based levelling compound in a minimum thickness of 2 to 3 mm (measured elsewhere). Note that latex or acrylic levelling compounds will detrimentally affect the adhesion of the adhesives. Apply 600 x 300 x 3.2 mm thick cork panels consisting of 0.25 mm vinyl backing layer, 1.65 mm cork agglomerated core, 0.8 mm genuine cork veneer and 0.5 mm hard wearing surface, and prefinished with specialised surface treatment suitable for Class EN 33 Use (or equivalent). Panels are to be glued to the substrate (350 to400 g/m^2 spread rate) with a notched trowel using adhesive as per the cork panel manufacturer's recommendation. Ensure the adhesive ridges are compressed completely to an even adhesive film. Roll with a 50 kg multipart roller after a short period and repeat rolling after approx. one hour. If necessary, weigh down edges. The edges of flooring area are to be caulked before fitting the skirting. A 15-year warranty is to be provided on the flooring product.

dyeing – where dyes are rolled or sprayed onto the carpet or by boiling in vats of dye after the manufacturing process is complete.

The fibre weight varies from 400 gsm to 1 100 gsm, although this should be seen in relation to the overall weight of the carpet including the backing. The suitability of the carpet however, is reliant on its fitness for purpose, such as using the correct location grade, and the guarantees and warranties provided by the manufacturer.

Infection prevention

Although there is no direct evidence linking any flooring type directly to HAIs, the study by Sehulster and Chinn for Center for Disease Control (2003), recommended that carpets not be used in areas where spills are likely to occur, such as laboratories or cleaners rooms, nor where patients are at greater risk from infection from airborne pathogens, such as in burns units, ICUs and operating rooms. While fibres can trap pathogens (and thereby prevent them from circulating in the air), the proper cleaning of carpets and effective removal of these pathogens is difficult to check on a daily basis. In addition, the carpet is porous and permeable, (although some may have an impermeable backing) which is in conflict with the National Health requirements for these high-risk areas. Carpets in offices or waiting areas do provide a welcome relief from the noisy ward areas where harder surfaces are present.

Some manufacturers indicate the additional benefit of antimicrobial treatment using phosphate amines such as silver, zinc or copper to combat bacteria. The US Carpet and Rug Institute issued a technical bulletin in regard to these treatments and what they achieve. Since the treatment is applied to the carpet fibres or the backing – or both, no implicit human health claims can be made about the finished product unless that finished product has been tested and registered by accredited independent testing organizations. Synthetic fibres in themselves do no provide a nutrient source which microbes need to survive, but textiles can trap soil, dust and moisture, which do provide that source.

Cleaning and maintenance

The first means of protecting and extending the life of carpets is the use of dirt-trapping mats at all entrances to the facility. This will remove a substantial amount of soil and dirt carried in on shoes/feet from the exterior. Fine soil crystals damage the fibres as they are ground into the carpet pile, and this can be avoided with regular vacuuming. The build-up of soil over time will also dull the appearance of the carpet.

FIGURE 33

It is recommended that heavy traffic areas are vacuumed daily, while for other areas, once a week will suffice – depending on what function the room accommodates. Carpets should be professionally cleaned at least once a year – with products recommended by the manufacturer, as any sticky residue left behind after cleaning will only attract soil build-up. Facility managers must also ensure that vacuum cleaner filters are regularly cleaned and replaced when necessary, as this will also affect the efficacy of vacuuming. If vacuum cleaners are not well maintained, they may also aerosolise pathogens during vacuuming. Carpet protectors should also be used where chairs with castors are present – where recommended by the manufacturer.

Safety

Since slips usually occur when there is too little friction between feet and the walking surface, the rough texture of carpets results in a highly slip-resistant surface. The cushioned effect of some backing types also reduces leg fatigue. Too much cushioning can reduce roller mobility though, making carpets with plush fibre or thick cushioning unsuitable where trolleys or wheelchairs for example, need to traverse the floor.

Healthcare facilities are occupied by patients that are frail and sometimes non-ambulatory. With this in mind, the fire regulations for this occupancy code are more stringent in the National Building Regulations, and the specifier must ensure that the fire ratings of carpeting types comply with the relevant occupancy.

Indoor air quality: Humidity and insulation

Carpets are not suitable for use in high humidity areas for reasons discussed under infection control above. Carpeting is an effective insulation material, particularly when laid with an underlay.

Indoor air quality: Emissions

Studies conducted by the US Carpet and Rug Institute show that - despite the 'new carpet smell' - carpet is one of the lowest emitters of VOCs indoors, less than paints for example, and these odours dissipate within days. Most local manufacturers indicate that the VOC emissions meet the GBCSA Green Star Rating – check product specific literature for the carpet under consideration.

Since carpets are often glued-down installations, the adhesives are often the culprit with VOC emissions on these floors. The specifier should check with the manufacturers about the levels of emission on the recommended adhesives.

Aesthetics

Carpets are being manufactured in a diverse range of colours, patterns and textures. The variety allows for creative, non-institutional application. Tiles are usually laid tessellated, which also adds to the interesting texture of the floor. Patterns and borders are achievable with tiles and most broadloom carpet, and can contribute to a professional atmosphere in the administrative sections of the healthcare facility.

An interesting study by Harris (2011) recorded at the Centre for Disease Control demonstrated that the amount of time visitors spent in rooms with carpets was higher than they did in rooms with vinyl floor finishes – this is perhaps an indication of how an environmental aspect can influence behaviour, and could be linked to aesthetics, temperature comfort and sound attenuation.

Acoustics

According to the Center for Health Design, carpets have the highest noise reduction co-efficient (NRC) for impact noise of all flooring types. Note that this is in relation to impact noise only – sounds such as footfalls, and dropping of objects onto the floor. The ability of carpet to absorb airborne sound is however mediocre, and according to the technical brief: 'Acoustic Environments' by Green Guide for Healthcare (2007), the acoustical benefit of carpet is to reduce impact rather than airborne noise. The noise attenuation properties of flooring, is often a trade-off with infection control. According to a study by Sehulster and Chinn for CDC in 2003, carpet should be avoided in areas housing immuno-compromised patients.

Skirtings

Traditionally timber skirting has been most commonly installed with carpeted floors, but there are very few limitations on the size and type of skirting that can be fitted.

Typical specification for carpet (broadloom)

SPEC FOR CARPET BROADLOOM WITH UNDER-CUSHION
Fit heavy commercial (SABS location grade: 5) textile carpet sheeting, with solution dyed nylon fibres, plain cut pile/level cut loop/tufted cut pile (select) OR polypropylene structured needle-punch fibre and woven polypropylene backing - SABS Class 2 fire rating. Carpet thickness 7 mm to 10 mm (confirm) Carpet fibres are to be pretreated against stains, and guarantee and warranty supplied. Broadloom carpet sheeting to be laid in accordance with the manufacturer's specification by an approved installer in accordance with SANS 10186:2010. Carpets are to be installed over commercial grade, non-allergic, latex foam under-cushion. (Optional) (Confirm colour and weight/m2 of carpet)

Typical specification for carpet tiles

SPEC FOR PLAIN-BACKED CARPET TILES FOR MEDIUM COMMERCIAL:
Plain backed carpet tiles, medium commercial (SABS use class U4), with needle-punched fibres, size 500 x 500 x 5 mm thick (confirm size and thickness) with SABS Class 2 fire rating, fibre weight of 700 g/m² and total weight of 940 g/m², (confirm weight). Carpet tiles manufactured in accordance with SANS 1415:2000, installed by an approved installer in accordance with SANS 10186:2010. Carpet fibres are to be pre-treated against stains, and guarantee and warranty supplied. Confirm colour and relevant code).

3.2. Flocked flooring

General description and properties

Flocked flooring falls under textiles in terms of definition, but also has characteristics of resilient flooring. It combines the acoustic properties and warm feel of textiles with the waterproof, durable and washable properties of resilient flooring.

FIGURE 34

Flocked flooring is manufactured by applying millions of short, cylindrical polyamide (nylon) fibres to an adhesive coated surface through an electrostatic process. The first electrostatically flocked flooring was made in 1960, so the technology is not new. The flooring consists of various layers including:

- Densely flocked polyamide fibres
- Waterproof PVC-adhesive
- Stable glass-fibre mesh interlays for strength and durability
- Cushioned waterproof, rot-resistant PVC--backing

The sheeting is available in 2 m wide lengths, and 4.3 mm total thickness. Tiles are 500 x 500 mm, and 5.3 mm thick. The tiles and sheet are suitable for heavy commercial grade application.

Infection prevention

Flocked flooring responds in a similar way to resilient flooring in terms of infection control. The flooring is fully waterproof and washable, being easily cleaned when wet spillages occur. This impermeable quality aids in infection control. The upright nylon fibres are very short when compared to other carpet fibres, and these more easily give up dirt that has fallen among the fibres, preventing microbes from settling in to grow. Like polypropylene fibres, the nylon fibres do not provide a source of nutrient for microbes, and the flooring is the only textile with the UK Allergy Approval certificate. The finished installation is not jointless however, as the joints are not welded, and the skirting is independent of the floor. These are areas that could be an infection risk.

Antibacterial treatment is also integrated into the manufacturing process. As discussed under Carpets, these may contribute to the reduction of fungus or bacterial growth, but cannot substitute for routine and regular cleaning and maintenance.

Cleaning and maintenance

As mentioned above, the finish is easily vacuumed, and wet spills are easy to clean up as the finish is waterproof. As with any floor, regular cleaning will extend the life and appearance of the product as the build-up of soil over time will dull the appearance. The use of dirt-trapping mats at all entrances to the facility will remove a substantial amount of soil and dirt carried in from the exterior. Because the product is easily vacuumed, it is less likely to trap soil or dirt long enough to encourage microbial growth on the particles of soil and moisture – both of which would need to be present since the nylon fibres themselves provide no nutrient value. Periodic professional cleaning will restore the appearance and this product has a far longer life span than regular carpet textiles.

Safety

Since flocked flooring provides very high slip-resistance, even where spills occur, this product is very safe for use in health facilities, and for many years has been used in the marine industry to finish decks on boats. The cushioned effect also reduces leg fatigue without reducing roller mobility as a result of the short straight fibres of nylon.

Healthcare facilities are occupied by patients that are frail and sometimes non-ambulatory. With this in mind, the fire regulations for this occupancy code are more stringent in the National Building Regulations, and the specifier must ensure that the fire ratings of carpeting types comply with the relevant occupancy. Flocked sheeting is Class BF1/S1 fire-retardant material in terms of the EN 13501-1 test method.

Indoor air quality: Humidity

Due to the waterproof characteristics of the flooring, flocked flooring is not adversely affected by wet areas and can tolerate humid conditions. However, special attention needs to be paid to sealing of joints and edges where moisture could get under the tiles or sheeting if the adhesive is not thoroughly applied.

Indoor air quality: Emissions

The manufacturers of flocked flooring indicate that VOC emissions are very low, and that certain ranges conform to all standards including the new VOC emissions classes in Europe. The specifics would be dependent on the product specified. Low-emission adhesives are also available. Responsible initiatives on the part of manufacturers include using recycled content in backing, and also supporting PVC-recycling projects.

Aesthetics

A wide selection of patterns and colourways are available, from natural tones to bright colours, monochrome to multiple colours, standard or purpose-designed - there is ample opportunity for creativity. Tiles can be laid checkerboard or broadloom style. Cutting designs into the sheeting can also be achieved for branding or more

intricate patterns. Conventional rotary screen-printing builds colours up in successive layers before heat fixing the print permanently onto the fibres. Digital printing can also be achieved where budgets allow.

Acoustics

With around 70 million fibres/m^2, the flooring is extremely dense, and it is this property that can substantially reduce impact sound. The flocked flooring has been tested under BS EN ISO 10140-2010 and proven to absorb 20 dB on the sheeting, and 17 dB on the tiles. The soft floor was also shown to absorb ambient noise. This finish would be appropriate in waiting areas or counselling rooms.

Skirting

Coved and welded skirting cannot be achieved with flocked flooring. Traditional timber skirting is suitable but as for carpeted floors, but there are very few limitations on the size and type of skirting that can be fitted.

Typical specification for flocked flooring (broadloom)

SPEC FOR FLOCKED FLOORING
Supply and fix 4.3 mm thick x 2 m wide electrostatically flocked textile floor-sheet covering, manufactured to specification EN 1307. Spread manufacturer approved acrylic adhesive on the exposed substrate with a trowel having triangular notches 1.78 x 1.78 x 1.6 mm at 3.0 mm centres at the rate of between 5.5 m² and 6.5 m² per litre depending on sub-floor porosity, on a previously prepared sub-floor by the builder, (as described) and elsewhere measured. Factory edges to be butted for seaming. It is essential that during the course of installation the product be rolled in both directions with an articulated 68 kg three-sectional metal floor roller immediately after it has been laid into the adhesive.

4. Hybrid floor finishes

Traditionally flooring types were limited to hard, resilient or soft finishes, but with new technology and manufacturing processes, a new class of flooring is beginning to surface – namely: hybrid floor finishes. The term refers to floors that are engineered from various layers, or combinations of various products. This could include hard, soft and resilient finishes. To some extent, flocked flooring could fall under this category as it crosses the boundary between resilient and soft finishes, but it has been classified as a textile at present. Laminated flooring is another such product. Laminated flooring consists of various layers which are compressed. There are two main types, namely those with a fibreboard substrate (like medium density fibreboard) and others with a vinyl substrate.

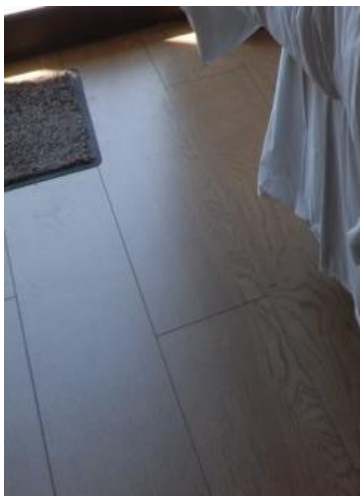

FIGURE 35

4.1. Laminated timber flooring: Fibreboard substrate

General description and properties

Laminated timber flooring has largely replaced traditional timber flooring and parquet products due to the reduced cost, ease of installation, wider range of wood grain aesthetics available, as well as the reduced impact on the use timber resources. Laminated timber flooring consists of four layers:

- A top layer/film of transparent aluminium oxide and melamine (the wear layer which makes the surface scratch- and scuff-resistant)
- The highly realistic photographic paper image of the wood
- the core layer of medium or high density fibreboard treated for water resistance
- A base layer of waterproof film for stability

These layers are fused under heat and high-pressure. The density of the fibreboard can vary substantially, and overall thicknesses range from 6 mm to 12 mm, but the industry recommendation is the 8 to9 mm plank for most applications. Plank sizes also vary in size, but generally are 200 mm x 1 300 mm. The interlocking system of the planks means that the floor finish can be installed without adhesives. The surface of the junction between planks can be a smooth butt-joint, a pronounced v-joint or fitted with a flush rubber strip for an anti-slip finish suited to wet areas. Expansion joints against walls are important, as is the laying of moisture barrier sheeting under the flooring. Sound-dampening underlays of 2 to 3 mm are also recommended.

The majority of laminated timber flooring is suited to residential applications, but commercial grades are also available. Flooring is graded for levels of use according to EN 685. Health facilities would require a minimum EN 31 Class: Commercial Moderate (for public and commercial use which is low or intermittent), but medium, heavy and intense traffic may be more suited to specific areas of the facility. (En Class 32, 33 and 34 respectively.) Abrasion Class 5 (AC5 EN 33) can be used in public and commercial areas with heavy traffic.

Abrasion Classes 1 to2 are for light domestic use only.

Infection prevention

Laminated floor planks can present an infection control risk in the small grooves of the interlocking joints which can trap small particles of dust and moisture, and are difficult to clean thoroughly. Open V-joints are easier to clean, but provide deeper 'reservoirs' for dust, and will need thorough and regular vacuuming or broom cleaning to remove dirt. While this flooring may not be suited to areas where infection control is a priority, it can be used in other areas of health facilities, such as offices or public recreational access areas such as coffee shops.

Cleaning and maintenance

Laminated timber floors should be dry-brushed and vacuumed regularly to remove dirt and grit which can lead to scratches. Spills should be wiped up immediately, and cleaning should never be done with large amounts of water. Slightly damp, well-squeezed dry laminate mops or cloths should be used with manufacturer approved cleaning agent. No abrasive cleaners should be used, and no stripping, sanding, waxing, polishing or varnishing is required.

Dirt trapping mats are the best investment in maintaining these floors. Felt pads are recommended under the feet of furniture and soft tread castors should be used on chairs.

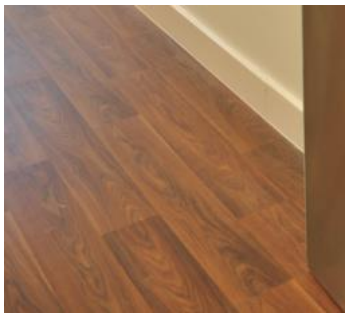

FIGURE 36

Safety

Laminated flooring provides a smooth, sheer finish, which can present a slip hazard, particularly if spills occur. Floors with rubber inserts in the V-joints provide a slip-resistant surface. This hard floor finish can be fitted with underlays to reduce leg fatigue. Fire ratings vary substantially, depending on the product, and these should be checked with the manufacturer to ensure suitability for use in the health facility.

Indoor air quality: Humidity

Laminated timber floors are not suited to commercial areas where wet processes will take place. The junctions between planks are not sealed, and will allow moisture access. This will adversely affect the products – some of which have a fibreboard core.

Indoor air quality: Emissions

Medium-density fibreboard contains a higher resin to wood ratio than any other urea-formaldehyde pressed wood product, and is recognised as being the highest formaldehyde-emitting pressed wood product. (Source: US Environmental Protection Agency). These VOCs are fairly quickly dissipated though, and the glue-free

installation of the interlocking planks means lower emissions when compared to a glued-down system using high-VOC adhesives.

Aesthetics

The popularity of laminated timber flooring has widened the range of 'wood-look' finishes available. The diversity of the timber grains and hues provides creative opportunities that echo a natural environment –albeit in appearance only. The move in healthcare to provide a more 'homely' residential appeal has also seen these timber laminates being used more in certain areas of health facilities.

Acoustics

Laminated flooring tends to amplify the sound of footfalls, but sound-deadening acoustic underlays should be used where possible. These loose-laid or glued-down sub-layers can improve the sound of impact by 20 dB, when used with the laminated flooring.

Skirtings

Matching moulded skirting is usually available in matching grains and colours to suit the floor panels. This independent skirting is not recommended in high infection control risk areas as the small crevices are difficult to clean, and will gather dust and moisture. Varnished timber skirting is also commonly used with the laminated flooring.

Typical specification for laminated timber flooring

4.2. Laminated flooring – PVC planks

General description and properties

Interlocking laminated floor planks are also manufactured from PVC-layers, which are more durable than the fibreboard core planks. In addition, the formaldehydes associated with MDF and HDF are avoided, and the performance under wet conditions is superior. This product is more suitable in heavy commercial applications than laminated timber planks, and in some ranges even suitable for light industrial applications. These 'planks' are actually small rigid vinyl sheets which are formed with an interlocking joint detail. These products are thinner than MDF laminates at 2.5 to 5 mm thick, but are available in similar sizes as the laminated timber planks (around 150 to 230 mm wide x 1 200 mm long). Some ranges are available in 600 x 600 tiles. The basic layers of the product include:

FIGURE 37

- A polyurethane reinforced surface treatment
- The embossed high-density wear layer of 0.4 to0.7 mm pure PVC (this makes the surface scratch- and scuff-resistant)
- The decorative layer with the highly realistic photographic paper image of the wood , stone or other graphic design
- The stabilising glass fibre fleece core layer (around 1 mm) for dimensional stability
- A PVC-composite load-bearing base layer

These layers are fused under heat and high-pressure. The interlocking system of the planks means that the floor finish can be installed without adhesives – as a floating floor. This has advantages in terms of the VOCs

given off where solvent adhesives are used. The surface of the junction between planks can be a smooth butt-joint, or a pronounced bevel/V-joint.

Glued-down planks/tiles are however also available (in 2.5 to3 mm thickness with 0.55 and 07 mm PU--wear layers respectively). Both are suitable for heavy commercial and the latter for light industrial use. The glued-down planks have a deep embossed finish giving a realistic appearance to the wood-grain, and improving slip-resistance.

Flooring is graded for levels of use according to EN 685. Health facilities would require a minimum EN 31 Class: Commercial Moderate (for public and commercial use which is low or intermittent), but medium, heavy and intense traffic may be more relevant to specific areas of the facility. (En Class 32, 33 and 34 respectively.) Abrasion Class 5 (AC5 EN 33) can be used in public and commercial areas with heavy traffic. Abrasion resistance should meet Group T.

Infection prevention

Although the laminated vinyl floor planks do not provide a nutrient source for bacteria, this flooring can present an infection control risk in the small grooves of the interlocking joints which could trap small particles of dust and moisture, and are difficult to clean thoroughly. Open V-joints are easier to clean, but provide deeper 'reservoirs' for dust, and will need thorough and regular vacuuming or broom cleaning to remove dirt. A well-maintained floor will however present an easy to clean, hygienic floor finish suited to the healthcare environment.

Cleaning and maintenance

The vinyl planks with PU-reinforcement make for a simple maintenance regime. The floor should be swept and vacuumed regularly, and washed periodically with water and manufacturer-approved cleaning agent. No abrasive cleaning agents or tools should be used, and no stripping, sanding, waxing, polishing or varnishing is required. Dirt trapping mats are the best investment in maintaining these floors.

The glued-down tiles/planks should not be washed for a few days after installation – in accordance with the manufacturer's recommendations -to allow the planks to settle in the adhesive. Moisture exposure during this stage may also affect the adhesive bond.

Safety

Laminated vinyl planks are deeply embossed to enhance the realistic wood grain. This ridged surface provides good slip-resistance. The floating floor installation can be laid with sound-absorbing underlays, which also reduce leg-fatigue. Fire ratings vary substantially, depending on the product, and these should be checked with the manufacturer to ensure suitability for use in the health facility. The laminated vinyl plank is a Class BF1/S1 fire-retardant material in terms of the EN 13501-1 test method.

Indoor air quality: Humidity

Laminated vinyl planks can be used in areas where occasional spills occur, although spills should be wiped up immediately.

Indoor air quality: Emissions

The floating – interlocking planks will not require adhesives to fix the floor in place, and this will reduce the VOC emissions when compared to glued-down systems. Certain vinyl planks have been certified with a Gold Indoor Air Comfort-rating which is awarded to products of very low VOC emissions where these are below any globally determined imit.

Aesthetics

The popularity of laminated flooring has widened the range of 'wood-look' finishes available. The diversity of the timber grains and hues provides creative opportunities that echo a natural environment –albeit in

appearance only. The move in healthcare to provide a more 'homely' residential appeal has also seen these vinyl planks being used more in certain areas of health facilities. The grain should always be laid parallel to the direction of the natural light falling into the room.

Acoustics

Floating laminated flooring tends to amplify the sound of footfalls, but sound-deadening acoustic underlays should be used where possible. These loose-laid or glued-down sublayers can improve the sound of impact by 20 dB, when used with the laminated flooring. Glued-down systems have less echo effect for the sound of footfalls and impact.

Skirtings

The PVC-planks cannot be coved - more as a result of the directional pattern, but also the rigidity. Using a complementary colour vinyl skirting could still be used. This allows for a seamless skirting and hygienic finish. Matching moulded skirting can also be used in matching grains and colours to suit the floor panels. This independent skirting is not recommended in high infection control risk areas as the small crevices are difficult to clean, and will gather dust and moisture. Varnished timber skirting is also commonly used with the laminated flooring.

Typical specification for laminated vinyl planks

5. Flooring accessories

AC5 - EN 33 Class interlocking *(or glued-down – specify)* vinyl PVC--layered flooring plank 1 219 x228 x 5 mm thick *(confirm size and thickness)* in four-sided V-groove, bevel-edge joint (*select edge detail*), fixed floating (*or laid in manufacturer approved adhesive).* Expansion gaps between walls and floor to be provided in accordance with the manufacturer's recommendations. Installation only by manufacturer- approved installer. Supplier to provide 10-year commercial warranty. *(Confirm colour, texture, code.)*

5.1. Walk-off dirt trapping mats

FIGURE 38

An effective entrance barrier or dirt trapping mat can reduce cleaning by up to 65%. The highly abrasive African soil conditions create an extremely aggressive environment that can shorten the life span of the floor-sheeting. Without removing the bulk of this dirt and grit at the entrance, the floor finish - whether hard, soft, resilient or hybrid - can be badly damaged by the dirt and grit that is carried in on visitors' shoes.

Walk-off mats should be placed strategically at all entrances, allowing a minimum of four to five paces, (around 3 m) across which people will walk. This will remove the majority of loose particles, and prolong the life of the floor finish.

Various types of entrance barrier matting are available including:

- Coarse carpet with ridged surface
- Coir bristle brush
- PVC-brush
- Aluminium structure with inserts of rubber

- Aluminium structure with inserts of carpet

A recess in the screed should be specified and/or detailed to the exact depth of the mat. This will ensure a flush finish at floor level, and prevent the mat from becoming a tripping hazard. If the mats are not recessed, they will need to be firmly anchored, and have bevelled edges on all sides.

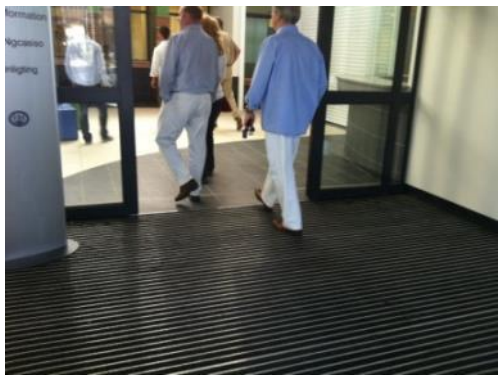

FIGURE 39

5.2. Expansion joints

Expansion joints must be carried through the floor finish and screed from the slab below to prevent cracks in the finish. This applies to hard and resilient flooring. Soft finishes such as carpet, can be laid over the screed joint. These joints should be finished with purpose-designed expansion joint covers which will vary according to the type of finish laid, and include:

- Extruded PVC-covers that are glued to the floor either side of the joint
- Metal joint covers made of aluminium, stainless steel or brass with rubber inserts or metal clip-on covers

Where PVC joint covers are used with resilient sheeting, the joint must be filled to support the expandable section of the joint cover.

Preventing uneven surfaces is a priority, and every effort must be made to ensure a smooth transition over expansion joints to minimise tripping hazards.

Consult flooring manufacturers for appropriate treatment of expansion joint covers and ensure that these are specified at documentation stage.

FIGURE 40

5.3. Transition strips, stairs and ramps

Transitions:

The UK National Health Service identified uneven surfaces and changes in level as one of four main causes of "'slip and trip' accidents in healthcare facilities. (Healey, 2007)

Changes in floor finish often mean a difference in levels of friction or surface resistance, which can lead to falls. It can also result in a slight change in floor level, if the floor finish thickness varies – as is often the case when sheeting meets a tiles floor for example. It is recommended that these transitions do not exceed 5 mm vertically, but a bevelled transition of 5 mm over 100 mm length (minimum) is less likely to cause tripping. Planning and detail design will reduce the risks.

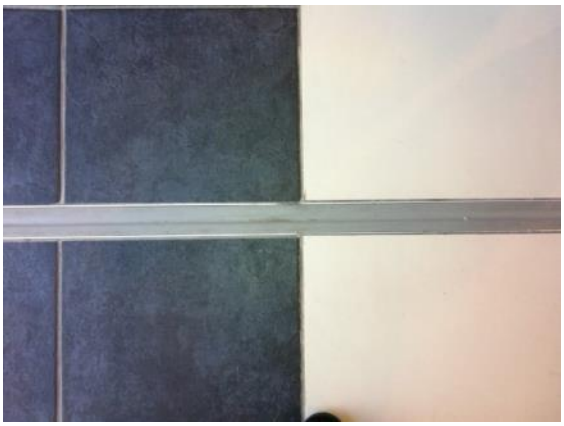

FIGURE 41

By positioning the transition at a threshold also minimises risk as it is more expected here. Purpose-made cover strips are manufactured to link different types of floor finish and thickness and these should be selected, described at specification stage. These are available in metals, such as aluminium, brass, and stainless steel and these strips are also manufactured from extruded PVC.

In areas where highly sensitive patients (such as spinal surgery patients) are wheeled to theatre, transition strips, or any bumps or ridges, must be avoided as any unnecessary vibration can adversely affect the patient.

Stairs:

Stairways are also an area where trips and falls are more common, and need careful planning in terms of finish. Specifying stair nosing will:

- Provide good slip resistance to the leading edge of the step
- Visually define the step end
- Protect the exposed edge of the finish – irrespective of whether its tile, vinyl or carpet

Stair nosing is available in extruded and ridged PVC-strips, aluminium strips with rubber or carborundum inserts, or purpose-made step tiles with bull-nosed edges and non-slip grooves. Ensure that the treatment of the stair edge does not become a tripping hazard in itself. The stair nosing must finish as near to flush as possible to the finish on the tread itself.

Ramps:

The National Building Regulations give clear parameters for universal/wheelchair access. In addition, the use of wheeled equipment in hospital and healthcare facilities from beds to food trolleys to drip stands, means high-volume use of ramps. The potential for slipping increases due to the gradient. Finishes that provide reasonable slip-resistance are appropriate in this application.

5.4. C5.4 External finishes at entrances

Special attention should be paid to the external areas leading up to all entrances to health facilities bearing in mind that infirm patients will be using this access. At casualty/emergency units, patient drop-off zones, and ambulance bays, there is the additional need for stretchers, wheelchairs and emergency trolleys to be quickly and smoothly wheeled through these entrances. Bevel-edged pavers will add to the effort required to push a trolley over a pavement.

FIGURE 42

FIGURE 43

Stormwater grids and manhole covers should ideally not be located on these routes, and non-mountable kerbing or rainwater channels should also be avoided. Ramps and slopes should be suitably treated to avoid slipping in wet weather.

Areas set aside for helicopter landings, and the route from there to the casualty/emergency entrance should also be viewed with these comments in mind.

FIGURE 44

PART D - PERFORMANCE

1. Performance categories

The properties described in the selection criteria in Section C above have been listed in Table 2 below, and then grouped into five performance categories that would satisfy the requirements in various areas within a healthcare facility

TABLE 2

FLOOR PROPERTIES	PERFORMANCE CATEGORY			
	1	2	3	4
Smooth	✓	✓	O	O
Impervious	✓	✓	O	O
Jointless/seamless	✓	O	O	O
Textured	O	×	O	O
Perforated	O	×	O	O
Jointed	O	O	O	O
Low maintenance	✓	✓	✓	✓
Washable/easily cleaned	✓	✓	✓	O
Suited to high humidity areas	O	✓ O	× ✓	×
Acoustic priority	O	×	✓	×
Aesthetic priority	O	×	✓	×

Legend/Key:

✓ indicates this property is required for the class

× indicates this property is not required for the class

O indicates this property is an optional requirement for the class

Examples of flooring materials or finishes for Class 1 (typical area – operating theatre or ward):

- Vinyl sheeting, linoleum sheeting, etc.

Examples of flooring materials or finishes for Class 2 (typical room – passage):

- Vinyl sheeting, linoleum sheeting, rubber sheeting, etc.

Examples of flooring materials or finishes for Class 3 (typical area – dirty utility):

- Vinyl sheeting or tiles, linoleum sheeting or tiles, rubber sheeting or tiles, ceramic tiles, porcelain tiles, etc.

Examples of flooring materials or finishes for Class 4 (typical area – office or waiting room):

- Vinyl Sheeting or tiles, linoleum sheeting or tiles, rubber sheeting or tiles, cork tiles, ceramic tiles, porcelain tiles, laminated flooring, carpets, etc.

Examples of flooring materials or finishes for Class 5(typical area – plant room):

- Epoxy paints, rubber sheeting or tiles, etc.

Refer to Table *3 Matrix of recommended floor performance categories* to establish what performance category the floor of the room in question will require.

2. Performance categories recommended per room

TABLE 3 MATRIX OF RECOMMENDED FLOOR PERFORMANCE CATEGORIES

Department	Room Name	Floor Performance				
		1	2	3	4	5
Acute In-Patient Wards (Adults)	Circulation Space		●			
	Cleaners Room			●		
	Consulting Room		●			
	Day Lounge (patients)		●			
	Dirty Utility Room (Sluice)			●		
	Duty Room				●	
	Equipment Store			●		
	General Ward (single or multi-bed)		●			
	Isolation Ward	●				
	Kit Room			●		
	Linen Room			●		
	Office				●	
	Patient ablutions			●		
	Patient Assisted Ablution			●		
	Staff Ablutions			●		
	Staff Change Room			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Treatment Room		●			
	Waiting area (public)				●	
	Ward Kitchen			●		
	Ward Nurse Station		●			
Administration Department	Circulation		●			
	Cleaners Room			●		
	Offices/ interview rooms				●	
	Reception				●	
	Boardroom				●	
	Stores				●	
	Kitchenette			●		
	Records Room				●	
	Print room				●	
	Staff WC's			●		
	Waiting area (public)				●	
Casualty & Trauma	**Circulation**		●			
	Cleaners Room			●		
	Consulting Room		●			
	Dirty Utility Room (Sluice)			●		
	Duty Room				●	
	Equipment Store			●		
	Hazmat Shower					●
	Minor Theatre / Suture Room	●				
	Observation Area	●				
	Office				●	
	Patient ablutions			●		

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Patient Assisted Ablution			●		
	POPS Suite		●			
	Public WC's			●		
	Reception/ Nurse Station		●			
	Rehydration Area	●				
	Resuscitation Area	●				
	Scrub area	●				
	Staff Ablutions & Ablutions			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Waiting area (public)				●	
Central Sterilising & Supply Department (CSSD)	Dirty Utility		●			
	Chemical Store					●
	Circulation		●			
	Cleaner's Room		●			
	Dirty Linen		●			
	Office		●			
	Packing	●				
	Plant Room					●
	Staff Change Room		●			
	Staff Rest Room				●	
	Staff WC's			●		
	Sterile Storage	●				
	Sterilization (Autoclaves)	●				
	Trolley Wash				●	
	Washing & Disinfecting Area	●				
Community Health Centre	Circulation			●		
	Cleaners Room			●		
	Consulting Room		●			
	Delivery Room	●				
	Dental Surgery	●				
	Dirty Utility Room (Sluice)			●		
	Dispensary		●			
	Duty Room				●	
	Equipment Store			●		
	Guard House or Security Kiosk			●		
	Isolation/ Separate Nursing Ward	●				
	Linen Store		●			
	Observation Area	●				
	Office			●		
	Off-Loading or Holding area for Pharmacy					●
	PABX / Server Rooms			●		
	Patient ablutions			●		
	Patient Assisted Ablution			●		
	Pharmacy		●			
	Plant Room					●
	POPS Suite	●				
	Public WC's & change rooms			●		
	Reception/ Nurse Station			●		
	Records Room				●	
	Recovery Area	●				
	Rehydration Area	●				

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Resuscitation Area	●				
	Staff Ablutions			●		
	Staff Change Room			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Treatment Room	●				
	Trolley Bay (entrances)			●		
	Ultrasound Room				●	
	Ward	●				
	Waiting area (public)				●	
	X-Ray Room		●			
Day Clinic (Department)	Circulation Space		●			
	Cleaners Room			●		
	Consulting Room		●			
	Dirty Utility Room (Sluice)			●		
	Duty Room				●	
	Equipment Store			●		
	General Ward (single or multi-bed)		●			
	Kit Room				●	
	Linen Room			●		
	Office				●	
	Operating Theatre	●				
	Patient ablutions			●		
	Patient Waiting				●	
	Recovery Area	●				
	Scrub Area	●				
	Setting Area	●				
	Staff Ablutions & Change Room			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Treatment Room	●				
	Waiting area (public)				●	
	Ward Kitchen			●		
	Ward Nurse Station		●			
Dental Unit (Dept)	Circulation Space		●			
	Cleaners Room			●		
	Consulting Room		●			
	Dental Surgery	●				
	Dirty Utility Room (Sluice)			●		
	Equipment Store		●			
	Panoral Room		●			
	Patient ablutions			●		
	Reception / Office				●	
	Records Room				●	
	Staff Ablutions			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Waiting Area (Public)				●	
High Care or Cardiac Care Unit (HC / CCU)	Circulation	●				
	Cleaners Room		●			
	Dirty Utility		●			
	Duty Room		●			

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Equipment Store		●			
	Isolation Ward	●				
	Linen Room		●			
	Nurse Station	●				
	Open Ward Area	●				
	Patient Ablutions		●			
	Staff Change Room		●			
	Staff Rest Room			●		
	Staff WC's		●			
	Surgical Sundries Store		●			
	Ward Kitchen		●			
Intensive Care Unit (ICU)	Circulation	●				
	Cleaners Room		●			
	Dirty Utility		●			
	Duty Room		●			
	Equipment Store		●			
	Isolation Ward	●				
	Linen Room		●			
	Nurse Station	●				
	Open Ward Area	●				
	Patient Ablutions		●			
	Staff Change Room		●			
	Staff Rest Room			●		
	Staff WC's		●			
	Surgical Sundries Store		●			
	Ward Kitchen		●			
Kitchen – (Main Hospital)	Bulk Dry Goods Store			●		
	Chemical Store					●
	Cleaner's Room			●		
	Cold Room/Freezer			●		
	Cooking Area			●		
	Cutlery/Crockery Store			●		
	Dishwashing & Potwashing Area			●		
	Food Preparation Area			●		
	Office				●	
	Plating /Serving Area			●		
	Receiving Area					●
	Staff Ablutions			●		
	Staff Rest Room				●	
	Trolley wash area			●		
Laboratory (Pathology/Cytology/Haematology/ Chemistry) (Biosafety Level 2)	Blood and blood products store	●				
	Cell and Tissue Laboratory	●				
	Cytopathology Sample storage	●				
	Clinical material store	●				
	Disposal area (dangerous materials)					●
	Drug & Vaccines Store	●				
	Flammable goods store (external)					●
	Gas Cylinder & Pressure Vessel store					●
	Hazardous substances store	●				
	Histopathology Laboratory	●				
	Microbiology Laboratory	●				

Department	Room Name	Floor Performance				
		1	2	3	4	5
Laboratory (Pathology/Cytology/Haematology/ Chemistry) (Biosafety Level 2)	Offices			●		
	POCT consulting room		●			
	Reagents / Chemical Stores					●
	Records Rooms			●		
	Sample Collection laboratory	●				
	Specimen Reception & Sorting rooms	●				
	Stores (protective clothing/equipment)		●			
	Staff Ablutions			●		
	Staff Change Room incl. lockers			●		
	Staff Rest Room				●	
Laundry – (Main Hospital)	Assembly, packing and dispatch			●		
	Chemical Store					●
	Circulation			●		
	Cleaners Room			●		
	Office				●	
	Pressing			●		
	Sorting			●		
	Staff Ablutions			●		
	Staff Rest Room				●	
	Stores				●	
	Washing Room			●		
Maternity / Delivery Department	Baby bathing area			●		
	Circulation	●				
	Delivery Suite	●				
	Dirty Utility Room			●		
	Duty Room		●			
	Equipment Store		●			
	First Stage Room	●				
	Kit Room			●		
	Linen Store		●			
	Milk Kitchen	●				
	Nurse Station		●			
	Nursery	●				
	Patient Ablutions			●		
	Staff Change room			●		
	Staff Rest Room				●	
	Staff WC's			●		
	Surgical Sundries Store		●			
	Viewing Area				●	
	Waiting Area				●	
	Ward Kitchen			●		
	Wards		●			
Mental Health Facility	Body Room	●				
	Children's Play Area				●	
	Clean Utility			●		
	Cleaner's Room/ Station			●		
	Consulting Room	●				
	Counselling Room				●	
	Dirty Linen			●		
	Dirty Utility (Sluice)			●		

Department	Room Name	Floor Performance				
		1	2	3	4	5
	ECT procedure room	●				
	En Suite bath/shower room					●
	Equipment Store			●		
	Group Therapy Room				●	
	Gymnasium (OT & Physio)	●				
	IT Room			●		
	Kit Room			●		
	Linen Store			●		
	Medicine Store	●				
	Multi-Purpose Hall		●			
	Nurse Station		●			
	Office				●	
	Patient Assisted Bathroom/Shower				●	
	Patient Dining room			●		
	Patient Laundry			●		
	Patient Lounge			●		
	Pharmacy	●				
	Quiet Room				●	
	Records Room				●	
	Seclusion Room					●
	Security Control Room					●
	Security Search Room					●
	Staff Change Room & WC's			●		
	Surgical Sundries Store			●		
	Treatment Room	●				
	Wards	●				
	Ward Kitchen			●		
	Waste Disposal Room					●
Mortuary	Blue Room		●			
	Circulation space		●			
	Cleaner's Room			●		
	Dirty Utility			●		
	Instruments Room		●			
	Linen Room			●		
	Medical Observation room		●			
	Office				●	
	Pathologist Change Room			●		
	Post-Mortem Room	●				
	Staff Change Room			●		
	Staff WC's			●		
	Viewing Room				●	
	Visitor's Waiting Room				●	
Neo-Natal Intensive Care Unit (NNICU)	Circulation		●			
	Cleaners Room			●		
	Dirty Utility			●		
	Duty Room			●		
	Equipment Store		●			
	Incubator Ward Area	●				
	Isolation Ward	●				
	Linen Room		●			
	Milk Kitchen	●				
	Mother's Rest Area				●	
	Nurse Station			●		

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Staff Change Room			●		
	Staff Rest Room				●	
	Staff WC's			●		
	Surgical Sundries Store		●			
Operating Theatre (Dept.)	Circulation	●				
	Cleaners Room		●			
	Dirty Utility		●			
	Duty Room		●			
	Equipment Store		●			
	Nurse Station	●				
	Operating Theatre	●				
	Post-Operative Recovery Area	●				
	Pre-Operative Holding Area	●				
	Scrub-up Area/Room	●				
	Setting Room	●				
	Staff Change Room		●			
	Staff Rest Room				●	
	Staff WC's			●		
	Surgical Sundries Store		●			
Outpatients Department	Reception / Nurse Station			●		
	Admissions Room		●			
	Baby Changing area		●			
	Children's Play / waiting				●	
	Circulation		●			
	Consulting Room		●			
	Dirty Utility Room			●		
	Duty Room		●			
	Equipment Store			●		
	Kitchenette			●		
	Linen Store			●		
	Offices				●	
	POPS Room		●			
	Public Ablutions			●		
	Records Room				●	
	Staff Ablutions			●		
	Staff Change room			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Treatment Room	●				
	Waiting Areas (public)				●	
	Wheelchair Storage area			●		
Paediatric Ward	Child Assist Ablution			●		
	Circulation Space	●				
	Cleaners Room		●			
	Consulting Room		●			
	Dirty Utility - Isolation	●				
	Dirty Utility Room (Sluice)			●		
	Duty Room				●	
	Equipment Store			●		
	General Ward (single or multi-bed)	●				
	Isolation Ward	●				
	Kit Room			●		

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Linen Room			●		
	Milk / Ward Kitchen			●		
	Nurse Station		●			
	Office				●	
	Parent Ablutions			●		
	Play Area (patients)				●	
	Staff Change Room			●		
	Staff Rest Room				●	
	Staff WC's			●		
	Surgical Sundries Store		●			
	Treatment Room	●				
Pharmacy/ Dispensary	Cleaner's Room			●		
	Bulk Stores					●
	Circulation space			●		
	Counselling Cubicle				●	
	Dispensary		●			
	Liquid filling Room			●		
	Office			●		
	Off-Loading Bay					●
	Patient Waiting Room				●	
	Schedule Drugs Strong Room	●				
	Staff Change Room			●		
	Staff WC's			●		
	Tablet Packing Room		●			
	Vacolitre Stores			●		
Physiotherapy Department	Audiology Testing				●	
	Circulation		●			
	Consulting Room			●		
	Equipment Store			●		
	Gymnasium		●			
	Kitchenette			●		
	Occupational Therapy room		●			
	Patient Ablutions			●		
	Reception				●	
	Speech Therapy			●		
	Staff Rest Room				●	
	Staff WC's			●		
	Treatment room		●			
	Waiting Area				●	
Primary Health Clinic	Circulation	●				
	Cleaners Room			●		
	Consulting Room			●		
	Delivery Room	●				
	Dirty Utility Room (Sluice)			●		
	Dispensary & Pharmacy		●			
	Duty Room				●	
	Equipment Store			●		
	Guard House or Security Kiosk			●		
	Linen Store			●		
	Observation / Rehydration Area	●				
	Office			●		
	Public ablutions			●		

Department	Room Name	Floor Performance				
		1	2	3	4	5
	Plant Room					●
	POPS Suite	●				
	Reception/ Nurse Station				●	
	Records Room			●		
	Staff Ablutions & Change Room			●		
	Staff Rest Room				●	
	Surgical Sundries Store		●			
	Treatment Room	●				
	Trolley Bay (entrances)			●		
	Waiting area (public)				●	
Radiology (Diagnostic)	Bucky Room (general x-ray rm)	●				
	Change cubicles		●			
	Circulation	●				
	Cleaners Room			●		
	CT / MRI Scan Room	●				
	Dirty Utility / Sluice			●		
	Fluoroscopy Room		●			
	Fluoroscopy Control Room		●			
	In-patient waiting		●			
	Kitchenette			●		
	Linen Room		●			
	Mammogram Room				●	
	Office			●		
	Patient ablutions			●		
	Public waiting Area				●	
	Porters & wheelchair/trolley parking				●	
	Reception				●	
	Records room				●	
	Server Room				●	
	Staff Rest Room				●	
	Staff WC's			●		
	Stores (Equipment/ General)			●		
	Ultrasound Room				●	
	Telemedicine Room				●	
	Viewing Room/ CR Room/ Reporting area		●			
Nurses Residence	Ablutions			●		
	Bedrooms				●	
	Circulation			●		
	Kitchenette			●		
	Lounge				●	
	Offices				●	
	Public Ablutions			●		
	Reception				●	
	Stores					●
	Waiting Areas (public)				●	

DEFINITIONS

1. Terminology

Aggregation	Collected together from different sources and considered a whole.
Ambulant/Ambulatory	(of a patient) Being able to walk or move around; not being confined to a bed.
Bacteriostatic	A word used to describe the property of a material which claims to inhibit the multiplication of bacteria.
Bariatric	Describing the condition of obesity.
Bonded	Chemically attached or fused in layers.
Guarantee	A document setting out a promise of quality made by a manufacturer or the provider of a service, a formal promise that a product will be repaired free of charge if it breaks or fails within a particular period or that substandard work will be redone.
Heterogeneous	Consisting of various layers or types throughout.
Homogenous	Consisting of things of similar type throughout.
Hydrophobic	Water-repellent.
Hygroscopic	Readily absorbing moisture from the atmosphere.
Impervious	Not allowing passage through (usually of water/moisture).
Interstices	Small holes or perforations.
Jointed	Junctions which may be open or covered, but not completely sealed and smooth.
Jointless	Without joints or having joints which are sealed by materials and methods which make the whole surface imperious and prevent the collection of dirt and bacteria in the joint.
Olfactory	Relating to the smell or the sense of smell.
Perfusion	Inject liquid into tissue or organ by circulating through blood vessels in the body.
Polyamide	A synthetic polymer made by the linkage of an amino group of one molecule and a carboxylic acid group of another, including many synthetic fibres such as nylon.
Resilient finish	The quality of a material to spring back quickly into shape after being bent, stretched, or squashed. Resilient flooring refers to flooring materials which have a relatively firm surface, yet characteristically have 'give' and 'bounce back' to their original surface profile from the weight of objects that compress its surface.
Seamless	A surface without open joints or junctions, or where such joints are completely sealed and smooth to create a continuous and whole membrane.
Slip-resistant	A quality of a finish to prevent wet or dry slipping. This relates to the friction of the material in relation to the pedestrian traffic across it, and also the type of footwear users have when walking across this finish. Wet pendulum and dry floor friction tests indicate comparative results. Refer to section B4.3.3 for more detail.
Smooth surface	A flat surface without projections, indentations or perforations such as a brush-painted plastered surface.
Textured	A surface finish which is not smooth, but has a fissured/embossed or ridged finish.

Tufted	A group of threads drawn through a fabric and tied securely beneath the surface.
Vitrified	To change a material into glass, under high heat and other conditions.
Warranty	A written promise to repair or replace a product that has a manufacturing fault. This commonly comes with conditions and is limited to a timeframe given at the time of purchase.
Washable	A term implying that a finish can be repeatedly and regularly cleaned using water and water-diluted cleaners without detrimental effect to the finish.

2. Abbreviations

CCU	Cardiac Care Unit
CHD	Center for Health Design
CSSD	Central Sterilising and Supply Department
EN	European norms
ENT	Ear, nose and throat
HAI	Healthcare-associated infections
HC	High care
HDF	High-density fibreboard
IAQ	Indoor air quality
ICU	Intensive Care Unit
IEQ	Indoor environmental quality
IUSS	Infrastructure Unit Systems Support
MDF	Medium-density fibreboard
MRSA	Methicillin-resistant staphylococcus aureus, (a common skin bacterium that is resistant to a range of antibiotics), otherwise referred to as multi-drug resistant bacteria
NDoH	National Department of Health
NICU	Neonatal Intensive Care Unit
NRC	Noise reduction coefficient
OHS	Occupational health and safety
OoM	Order of magnitude
PMIS	Project Management Information System
PMSU	Project Management Support Unit
PuR	Polyurethane-resistant
PVC	Polyvinylchloride
RC	Recommendation Committee
STF	Slips, trips and falls
TNO	Netherlands Organization for Applied Scientific Research
VOC	Volatile organic compound

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Fig.10	R. van Rensburg
Fig.11 to13	M. Swinney
Fig.14	R. van Rensburg
Fig.15	R. van Rensburg
Fig.16	M. Swinney
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Fig.41	R. Cubbin
Fig.42	R. van Rensburg
Fig.43	M. Swinney
Fig. 44	R. Cubbin
Fig.45	R. van Rensburg
Fig.46	M. Swinney
Fig.47	R. van Rensburg