



Centre for Health Assets Australasia
REPORT ON WALL AND FLOOR FINISHES FOR WET AREAS

PREPARED FOR
NSW HEALTH
ASSET AND CONTRACT SERVICES
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REPORT
ON
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Prepared by CHAA

for

NSW Health
Asset and Contract Services

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1 INTRODUCTION

1.1 Background and Objectives

The selection of floor finishes for healthcare facilities in NSW is currently covered by *TS7 'Floor Coverings in Health Care Buildings'*. First published in 1985 as part of *NSW Health Technical Series publications*, the second 1988 edition is currently under review.

This Document focuses on wet areas in response to the special issues presented by these areas, in particular those found in patient ensuites. Wall finishes are included since these often form part of an integral finishing system. It is intended that this document complement TS7 and be used in conjunction with the *Australasian Health Facility Guidelines (AusHFG)*.

The aims and application of this Document correspond to those stated in *AusHFG Part A* under 'Objectives' and 'Terms of Reference', and in AS 4360: *Risk Management*.

1.2 Scope

The term 'wet area' is used to describe an area provided with running water or where surfaces are in frequent contact with water. This document pays particular attention to areas where the wall or floor surfaces are subject to regular wetting, such as shower areas within ensuites. These areas are of primary concern because of the specific problems associated with safety, durability, waterproofing, maintenance and cost.

Many of the problems associated with wet areas such as leaks and slippery surfaces are widely recognised and well documented, more recent issues have arisen from the introduction of new materials, construction techniques, and to changing user practices and footwear.

Included are other areas where expected contamination, accidental spillages or other risk factors may compromise safety - such as entry points where water may be blown in or transported into the building.

Facility management procedures such as cleaning and risk management are excluded except where these have a direct influence on the design or selection of finishes. Finishes for external and covered areas are outside the scope of this document.

2 GENERAL

2.1 How to use this Document

This Document is directed primarily to:

- Design and construction professionals and those involved in the selection of materials for wet areas.
- Facility managers responsible for the maintenance of materials, for Occupational Health and Safety (OHS), and the interior environment.
- Those involved in the assessment, rectification or replacement of existing finishes.

Material available in published standards, regulations, proprietary specifications and details has in principle not been reproduced. Where this material is included it is to make the text more readily accessible - this information should be checked for currency before use.

In addition to following regulations, guidelines and good practice, it is essential that the designer consults with the client representative and product manufacturer to ensure that the end product is fit for purpose. Informed detailing and specifying is an important element in preventing failures in wet area finishes.

This section addresses finishes in general. Issues relating to specific materials are dealt with in more detail under each material type.

The terms used in this Document in principle are taken from the Australian Standards. Refer to Appendix 1 – Glossary.

2.2 Safety

2.2.1 SLIPS, TRIPS AND FALLS (STFs)

A major part of ensuring floor safety is in reducing the potential for slips, trips and falls (STFs). STFs in turn are directly influenced by the following factors, some of which are difficult to control:

- properties of the floor surface material
- contamination (including water)
- environment
- cleaning regime
- footwear
- human (pedestrian) factors.

The following issues will also compromise safety but are controllable:

- incorrect design
- inappropriate materials
- poor workmanship during installation
- poor maintenance.

2.2.2 PATIENT CARE AREAS

In patient care wet areas particularly ensuites and showers, the principal risk factors are:

- Slip resistance of the floor surface with barefoot and unregulated footwear use.
- The presence of condensation, pooled and running water, oil from products and a build up of soap and body fat.
- Movement for patients and staff within a confined space; and for patients of all age groups, with possible disability, impaired function or distractions.

The presence of running or pooled water requires a well drained floor with adequate falls and drainage. Features that would cause STFs, e.g. smooth floor grates, steps, lips or severe or unidentified changes in slip resistance should be eliminated. Contamination from fats (soaps, body fat), oils (skin products) and mould can be controlled by regular and appropriate cleaning.

The risk of STFs is influenced by users' cognitive senses, motor skills, carrying of objects, unnoticed sources of contamination, unfamiliarity with the environment and distractions.

Age is a factor in STFs, vulnerable groups include the aged, children and the disabled. The elderly are more likely to fall and suffer consequent injury with the risk of further serious complications. Any change in surface should be clearly identified.

2.2.3 RISK MANAGEMENT

The recognition of the obligations for those who specify and manage floor surfaces, together with the implementation of quality assurance procedures from design to maintenance can greatly reduce potential hazards. Consultation between designers, facility and cleaning managers should occur at an early stage in the design process. Duty of care responsibilities are shared between the designer, manufacturer, installer and client (maintenance practices).

Organizational practices including inspections, staff safety training, cleaning practices, reporting and corrective action within a given facility can significantly reduce the risk of injury from falls.

Occupational Health and Safety (OHS) is covered within NSW by legislation and regulation. The legal obligations for employers, building owners (controllers) and employees are defined, including their duties towards 'Third parties'. Floors are required to be designed and constructed to be safe, and maintained to minimise the risk of STFs, with active procedures to identify and rectify hazards.

At present there are no Australian Standards covering safe footwear, the control of the type of footwear worn is uncommon in the Australian healthcare environment, with the exception of food

preparation areas - this should be included in flooring selection criteria.

Safety performance standards that relate to fire resistance, early fire hazard indices and egress are requirements of the BCA where compliance is mandatory.

2.3 Slip resistance of floor surfaces

2.3.1 GENERAL

Slip resistance is a primary consideration in reducing the potential for STFs. Slip resistance is initially provided by the properties of the floor surface material, and is represented by the tested slip resistance of the material. The slip resistant (non-slip) potential of any installed floor surface in use may be considerably less than the tested value of the new material, due to a variety of factors including wear, contamination and inappropriate cleaning.

The slip resistance of a surface is the function of a number of the following factors or properties:

- surface (macro) roughness comprising an aggregate
- surface (micro) roughness relying on irregularities in the surface of the material
- a profiled surface providing volumetric displacement, or structured surface
- the properties of the materials in contact, e.g. attraction/repulsion or visco-elastic.

Each of these factors operate differently. Some products for specific uses will use a combination of these factors, e.g. barefoot wet areas, commercial kitchens, ramps.

Any contamination including water significantly affect the tested rating when dry, Profiled surfaces rely on the interaction of the profile with bare feet or specific footwear, but do not guarantee slip resistance as contamination can build up without an appropriate cleaning regime. Floor components such as gratings or outlets with a smooth surface can provide a slip hazard.

The (micro) roughness rating of a surface when tested dry can be significantly affected by water or the filling of surface pores by contamination, e.g. incorrect cleaning or sealing.

As a small quantity of contaminant will significantly reduce the slip resistance rating, it is important to ensure adequate drainage and regular cleaning. Wet area floor surfaces require enhanced slip resistance - only products with sustainable initial wet slip resistance characteristics that are warranted to be retained at that level for the (warranted) life of the product should be selected.

2.3.2 SPECIFIC APPLICATIONS

In healthcare, aged care and mental health facilities the advice provided by SA HB 197: *An introductory guide to the slip resistance of pedestrian surface materials* should be employed, including the following requirements:

- In areas with constant running water such as showers subject to barefoot and soft soled footwear - a profiled surface with macro-roughness and a dimpled surface to the raised profile should be used.
- In other areas where water could be present on the surface of the flooring during normal operational functions and where standard footwear is being used - a non profiled material with macro-roughness is suitable.
- The slip resistance rating for materials used on slopes and ramps may vary from those used on horizontal surfaces, and should be selected for the degree of incline and specific conditions of use.
- To prevent tripping, any changes in floor surface and slip resistance should be indicated by a visual cue such as a change of colour.

2.3.3 STANDARDS

The following Australian Standards address the slip resistance of floor surfaces.

AS Handbook HB 197: *An introductory guide to the slip resistance of pedestrian surface materials*, provides a general explanation of the subject with flooring selection and classification guides. Written as a 'guide' for information only, it is designed to assist in the use of the principal Standard

AS/NZS 4586.

AS/NZS 4586: *Slip resistance classification of new pedestrian surface materials* provides the various classification groups and recognised test methods.

AS/NZS 4663: *Slip resistance measurement of existing pedestrian surfaces* is concerned with methods of testing, and is commonly used in auditing existing surfaces.

These Standards are subject to regular review and should be checked for currency before use.

For more information on classifications and test methods - Refer: APPENDIX 4. Slip Resistance – Test methods.

Additionally the BCA (by referencing AS 1428.1) requires slip resistance in relation to continuous paths of travel, including ramps and stair treads.

2.4 Selection of Finishes and the Project Program

As an element of risk management and cost control, decisions involving built elements such as floor set-downs, falls, and solid or stud partitions, are often directly linked to the selection of finishing materials, requiring resolution early in the Project. The selection of finishes in these early stages should be sufficiently comprehensive so as to be adequately covered in the Cost Plan.

The decision to use ceramic tiling flooring to falls will require designed slab set downs for screeds, material thickness and bedding, whereas other finishing materials may require only a surface profile in the concrete slab. Conversely a structural system such as prestressed floor units may influence the floor finish in wet areas by restricting topping thicknesses and set downs for falls.

Most of the sheet and tile products reviewed in this Document are now manufactured overseas. The period of time from selection, to final delivery will include shipping and often manufacture and should be planned for. Many products ordered from overseas can only be selected from samples and manufacturer's data sheets - if the landed product fails to meet the required standard and is rejected, this will impact the construction program. The use of effective specifying, quality compliance and monitoring methods are essential.

2.5 Materials

The following materials are those in general use for wet areas:

- sheet vinyl
- ceramic tiling
- seamless systems.

Other floor finishes suitable for general areas outside the 'wet area' definition such as linoleum, rubber and terrazzo are covered in TS7.

2.6 Selection Criteria

The selection of suitable materials for wet areas presents a particular set of issues for designers and facility staff. Finishes for these areas should be selected primarily on a 'fit for purpose' basis (matching use to performance), for each specific application and user category; selections should be made on the basis of evidence based data.

The experience of the facility staff with existing products should be sought, but as this information can express personal preferences it should carefully evaluated before use.

Where ambulance trolleys (small wheels) access the building, loose or uneven surfaces, ridges (entry mats) or studded flooring should be avoided, since these cause difficulties and risk in moving patients.

In the case of safety flooring, the slip resistance requirements must be ensured, despite any real or perceived reduction to the ease of cleaning. Recent developments in coating technology have reduced the gap between slip resistance and ease of cleaning.

In acute mental health facilities and high security areas, damage, removal and misuse of finishes by patients constitutes a known risk.

Selection can be further affected by factors such as existing building substrates, and the lack of

availability of particular materials or trades in remote locations - for the life of the installation.

2.7 Acts, Regulations and Guidelines

2.7.1 AUSTRALASIAN HEALTH FACILITY GUIDELINES (AusHFG)

The following sections of the AusHFG cover various aspects of finishes and should be consulted:

- *Standard components – Room data sheets (RDS).*
- *Standard Facility Cost Planning Guidelines.*
- *Part A – Introduction and Instructions for Use.*
- *Part B – Health Facility Briefing and Planning.*
- *Part C – Design for Access, Mobility, OHS and Security.*
- *Part D – Infection Prevention and Control.*

2.7.2 BUILDING REGULATIONS

The *Building Code of Australia* (BCA) is mandated in NSW with state variations. The provisions affecting finishes can be found under the general provisions, health and amenity, and fire resistance. The BCA provides performance requirements or 'deemed to satisfy' provisions, Australian Standards referenced by the BCA provide the basis for minimum performance.

The design and selection of materials should comply with the BCA, relevant NSW Health policy directives and other applicable legislation or regulation.

Refer to AusHFG *Part A. section 40 'Administration'*.

Refer to APPENDIX 3 – References.

2.7.3 OCCUPATIONAL HEALTH AND SAFETY (OHS)

The focus of Occupational Health and Safety (OHS) legislation is employee safety in the workplace. Various parts of OHS legislation apply to building processes and to certain aspects of the design and use of Health Facilities.

In the selection of a finishing system, care should be taken to ensure that installation methods and materials comply with OHS requirements. Although OHS provisions covering building processes have traditionally been outside the designers' province, the selection of a particular finishing system may now breach these provisions at any stage in the life cycle of the system from installation, to eventual removal and disposal. Care should be taken that any material substitution during the construction process does not reduce the performance of the system, or breach OHS requirements.

Refer to *Australasian HFG Part C* for further information on OHS.

In selecting finishes any relevant non-statutory guidelines or policies should be observed, including those issued by area health authorities or individual healthcare facility management.

Where installation work occurs within or adjacent to an occupied area then additional environmental safeguards may be required to protect occupants. Risks that may adversely affect the safety and comfort of occupants should be identified. These may include indoor air quality, noise, vibration, loss of existing amenities and privacy.

The subject of slip resistance as a risk management solution has been discussed previously and is dealt with further under each material category.

2.7.4 PRODUCT SPECIFICATION

To ensure the quality and performance of finishes, both selection and specification need to be based on conformance to standards. Standards generally provide minimum performance levels, this should be borne in mind where a generic (non proprietary) specification is called for. NSW Government policy for the procurement and specification of proprietary products should be followed.

This Document assumes that selection and specification will be achieved through appropriate professional or industry based expertise, and no attempt is made here to provide this level of detailed

technical description.

2.7.5 STANDARDS

Most finishes materials will be a manufactured product conforming to Australian or overseas standards. These standards cover properties, installation methods, testing and special conditions relating to use.

Many floor and wall finish products are manufactured outside Australia and New Zealand and carry test certificates, standard compliances and labelling conforming to either European or US norms. These qualifications may not be accepted in Australia, and certification in the form of NATA testing, CSIRO appraisals or testing by a similar recognised body may be required.

Fortunately Standards are now becoming more global with the increasing adoption of ISO, BS and EN standards by Australia, and by the acceptance of external accredited testing between Standards Organizations.

2.8 Ecologically Sustainable Development (ESD)

2.8.1 GENERAL

ESD involves the complete life cycle of the products or processes. This includes extraction, manufacture, installation, use, eventual removal and disposal of the product.

The environmental performance of a material or system may be required to satisfy relevant Commonwealth, State, or local regulations and policy. Information should be sought from NSW Government and Health policy directives, and from material manufacturers.

One objective in the NSW Health '*Process of Facility Planning*' (POFP) document is the efficient use of resources. The selection of finishes should be included in the Environment Performance Report (EPR) system. This system applies to all new NSW government buildings with a construction value of greater than \$5M.

The selection process for all building materials should be as detailed in the NSW Government Procurement Document – 1999 *Mainstreaming Ecological Sustainable Development in Procurement* which states: "Products should be assessed equally and impartially on their demonstrated comparative merits in terms of performance, cost and environmental impact, where available expert scientific opinion should form the basis of such comparisons".

2.8.2 ESD REPORTING AND STANDARDS

The Environment Performance Report (EPR) system is used for the performance reporting of new NSW government buildings. The process is managed by the Government Asset Management Committee (GAMC). It asks questions regarding building data and performance in a number of environmental performance areas such as energy, water, materials, indoor environment, biodiversity and transport. Materials are assessed within the terms of Life Cycle Analysis (LCA) and whole of life costing.

Product information is generally provided by the manufacturer's data sheets, the information will usually cite ISO standards or local/regional industry reporting standards. Labelling, symbols and marking will generally conform to ISO standards.

In some overseas jurisdictions manufacturers of materials and the construction industry are addressing sustainable development projects and improved *Environmental Systems Accreditation*. For building material manufacturers this process consists of a system of continuous improvement and performance measured by external auditors. This and the European *EMAS Regulation (761/2001)* are drafted to prevent or minimise environmental impact.

In Australia there are as yet no legislated Australian or International Environmental Standards. Some countries have individual Indoor Air Quality Standards. The AgBB/DIBT Committee for Health-related Evaluation of Building Products Standard is legislated in Germany and internal building fit out materials are tested to this system. The protocol of this system is being considered for the basis of a new European Standard.

The Green Building Council of Australia (gbcaus) publishes *Green Star – Health as built*, a tool for analysis and rating healthcare facilities. Rating is achieved through 'credit points' based on carbon

credits. Categories include: 'MAT (Materials) - walls and floors. - Indoor Air Pollutants Criteria and Compliance Document – VOCs (volatile organic compounds), mould prevention and internal noise levels. Materials and IEQ (indoor environment quality) account for approximately 40% of the available credits. This rating tool if not endorsed in NSW can still provide a useful reference for comparing finishes.

2.9 Whole of Life Costs

Whole of Life costs include materials and installation, level of usage, cleaning and maintenance, disposal and replacement. Accurate Whole of Life cost comparisons between finishes and finishing systems should be sought at the time of selection. In refurbishment the removal of the original wall finish and rectification of the substrate to the required standard should be included in the cost analysis.

Indirect costs should be considered as these can include compensation, the result of civil actions, and costs associated with organizational disruption due to the replacement, repair or treatment to a faulty finish.

2.10 Construction

2.10.1 PARTITIONS

Internal drywall partitioning is now generally used in preference to solid partitions. Compressed Fibre Cement (CFC) or 'High Density' sheet should be used for 'wet area' drywall lining in preference to the Standard grade or other materials, especially in high use patient care areas. Generally a 9 mm thick sheet will withstand impact and provide protection against flexure and cracking. CFC sheet provides a strong and durable platform for the high number of penetrations and fixings required in these areas. CFC will withstand prolonged exposure to water penetration, and the removal of waterproofing or adhesives by chemical or mechanical means.

Adequate in-wall support for fittings and attachments in the form of noggings or fixing plates should be provided; particular attention should be given to basins, grab rails, hooks and door stops, or any other item subject to repeated use and liable to loosening.

Water resistant plasterboard has been available for a considerable period of time and is widely used in the residential market. However it does not match the performance of CFC nor meet the more stringent demands of the institutional environment outlined above, and for these reasons should not be used.

2.10.2 FLOORS

An acceptable moisture content is required for concrete floor slabs (substrates), before application of preparation materials, waterproofing, adhesive or floor covering. These levels and the test methods to be used before installation of ceramic tiling and resilient finishes are provided in the respective Australian standards and manufacturers' data sheets.

The application of a vapour or moisture barrier can reduce the waiting time before application of the flooring material. Problems found in refurbishment may stem from water leaks, capillary action or faulty moisture barriers to slabs on ground; any pre-existing problems must be rectified.

2.10.3 FLOOR GRADIENTS

In shower areas a gradient (fall) of 1:60 to 1:80 will shed water, in other wet areas 1:80 to 1:100 (AS 3958.1, AS 3740). In an average sized ensuite the required set-down (minimum screed and finish thickness) for these falls will not usually affect floor slab reinforcement. For larger rooms multiple floor wastes can be used to avoid increasing set-downs depths.

For patient showers a floor waste to fit a nominal 100 mm diameter outlet (pipe) with a 150 mm (approx) diameter grate is recommended, this size remains functional with a patient standing on the grate. In special conditions a back up floor waste can be provided where accidental obstruction is expected e.g. a dropped towel. This can be positioned at the basin where a smaller diameter outlet is adequate.

2.10.4 WATERPROOFING

The decision to waterproof wet areas will usually result from the selection of the finishes system.

Waterproofing is recommended for ceramic tiling. For welded sheet materials and seamless applied materials the decision to omit a separate waterproofing membrane should be based on the assurance that the finish joints and penetrations will be impervious for the life of the material.

If wall and floor waterproofing is proposed, the requirements for walls are less demanding than for floors. However, the systems used for each should be compatible with each other and with the trades that follow.

AS 3740: *Waterproofing of wet areas within residential buildings* is referenced by the BCA (F1.7) and applies to Class 9a healthcare facilities, a number of other requirements are also listed.

Waterproofing systems include applied liquid membranes (including fibreglass), sheet materials and preformed bases. AS 3740 Appendix B (informative) covers design considerations including movement, Appendix C covers falls in floor finishes.

The failure of a waterproof membrane in shower areas is an expensive and disruptive event, any product or system selected should be based on proven performance backed up by test certificates and warranties. The failure of many liquid applied 'acrylic' membranes to shower bases from exposure to household chemicals and prolonged wet or moist conditions, has led to their gradual replacement by more durable products such as polyurethanes.

Note: If the wall finish is removed for any reason this will usually damage the waterproof membrane, requiring time for repair and setting/curing. For renovation work the removal of existing waterproofing and allied work should be included in the program.

2.10.5 MOVEMENT

Differential movement generally occurs from contraction, expansion or settlement. Movement can occur in the structure - covered by design rules and regulation, or in non structural elements such as stud partitions reliant on the manufacturer's testing and design guides. The principle method of controlling movement is by adequate fastening and the use of construction and movement joints.

2.10.6 CAUSES OF FAILURE

A principle cause of failure apart from incorrect material selection for the intended use, relates to on-site workmanship with failure most often occurring in joints, adhesion and waterproofing.

Contributory factors include:

- Inadequate allowance of time for the structure to dry out before installation of the finish.
- Inadequate quality control during installation.
- Failure of the finishing material or substrate.
- Completion of a specialist task by an allied trade e.g. waterproofing installed by a screeding subcontractor.
- Damage caused to the finish.

2.10.7 FITTINGS

Leaks occurring at fixtures such as grab rails and hydraulic fittings can only be prevented through adequate fitting, fixing and sealing. Unfortunately as there are a sequence of trades involved e.g. for the installation of a hydraulic tap, the final result is directly proportional to on-site quality control.

The support and fixings for grab rails should meet the requirements of the BCA for applied loadings. It is recommended that this apply to any item which may be used as a de-facto grab rail - including vertical rails for sliding shower heads.

2.11 Cleaning

The cleaning of wall and floor surfaces in healthcare facilities is accompanied by the added requirement for infection control. This has resulted in cleaning materials which contain disinfectant ingredients. The effect of disinfectants and the type of cleaning equipment used should be considered in selection of surface materials.

As previously stated a common misconception includes the assumption that ease of cleaning is inversely proportional to surface roughness. It is possible to select a floor finish which is both

cleanable (microbial and soiling) while providing the required slip resistance rating, without compromising either - Refer: CIRIA: C652 - 2006.

2.12 Warranty and Certification

When using proprietary systems for partitions, linings and finishing systems, the manufacturer's written instructions should be strictly followed to fulfil the conditions of warranty. Any provision requiring the use of approved applicators should be confirmed.

The subject of warranties, contractual obligations and the responsibilities of the various parties involved in the construction process is outside the scope of this Document.

As previously stated a designer now has responsibilities under OHS preventative legislation that vary on a State by State basis. The designers' obligations extend to the design decision making process; a risk assessment methodology is recommended using AS 4360: *Risk management* as an appropriate tool.

3 VINYL SHEET

3.1 General

3.1.1 PROPERTIES

Classed as a 'Resilient Finish', vinyl sheet is a flexible waterproof material supplied in roll form; joints may be formed by heat welding, chemical adhesive or simply sealed using a sealant. In theory the finish should act as the waterproof barrier without the need to provide a separate waterproof membrane.

The flexibility of the vinyl sheet used with correct detailing should accommodate differential movement in the substrate (within prescribed limits) without fracture.

3.1.2 ADVANTAGES

The advantages generally given for using vinyl sheet for wet area applications such as showers and ensuites are:

- assists infection control
- ease of cleaning and maintenance
- good floor safety properties
- elimination of back up waterproofing (conditional)
- good durability and Whole of Life cost efficiency.

These factors are influenced by a number of variables and need to be confirmed on a project by project basis.

3.1.3 DISADVANTAGES

In the past client and designer concern with appearance and image often influenced the choice in favour of ceramic tiling - especially in the private sector. Recent aesthetic improvements and expansion in the wall and floor vinyl ranges have improved acceptance. The patching of damaged areas is visually not as successful in comparison to replacement of a tile; and tiling will generally provide better resistance to stains, with easier removal.

3.1.4 FAILURE

With the exception of accidental damage the failure of the finished installation is dependant on the adequacy of the risk management and quality control systems employed in selection, installation and maintenance.

Risk can be defined as a failure of the material or system to meet set performance standards. Wet areas provide a particular set of problems which are commonly not adequately met. These may be either construction failures or performance failures e.g. floor safety.

The vinyl sheet material product will seldom provide the source of failure if manufactured under the ISO 9000 series quality control protocols.

A major cause of failure is due to the presence of moisture causing de-lamination from the substrate, this can result from any of the following factors:

- inappropriate selection of the sheet material, jointing or system
- inadequate or incorrect construction documentation and detailing
- unacceptable moisture content in the substrate during installation
- poor workmanship including inadequate fastening or sealing of fixtures and penetrations
- mechanical damage to the sheet during installation or use, including incorrect cleaning
- damage or wear initiated by protrusions in the substrate or unglued sections.

A back-up waterproofing membrane in theory should not be required for a welded vinyl sheet shower installation. Collaboration between the designer and the resilient flooring manufacturer's Technical Support Services prior to documentation is an important part of any risk management strategy.

3.1.5 SUSTAINABILITY

The use of PVC (Polyvinyl chloride) in respect to sustainable practice has been the subject of considerable debate over the last decade. The main issues cited are:

- by-products of the manufacturing process
- toxicity of the PVC component - off-gassing (VOCs), final disposal and the resulting by-products.

Contract documentation should ensure that PVC based resilient floor coverings are ISO 14001 Environmental Systems Accreditation compliant, and have independent international third party assessments and auditing of both the environmental profile and indoor air quality impacts.

Despite requiring compliance with overseas standards, ultimately the selection of the complete finishing system must satisfy the minimum environmental requirements and controls prescribed by Commonwealth and state legislation, regulation and NSW Health policy current at the time of tendering.

The following information is provided by vinyl material manufacturers in support of the use of vinyl construction products in general:

- Test certification is available which shows that PVC based flooring materials when tested to the AgBB/DIBT protocol fall comfortably below this Green Star requirement.
- CSIRO reviews of the environmental impact of PVC building materials in 1996, 1998 and 2001 concluded "the balance of available evidence indicates that PVC in its building and construction applications has no more effect on the environment than its alternatives".
- PVC based products are approved for the 2008 Olympic venue overturning the previous bans imposed on the 2000 and 2004 games venues, adding that this reversal is due in part to an evidence based approach to the available information.

3.2 Materials and Components

3.2.1 FLOOR SHEET

An enhanced slip resistance flooring surface is recommended for use in wet areas. This is produced as a sheet with a raised pattern of studs, a non-slip surface of embedded mineral particles or a combination of both. These products are usually homogeneous with products specifically designed for wet area and other uses.

Sheet material is usually produced in approximately 1800 - 2000mm wide rolls and in thicknesses from 2.0mm upwards.

3.2.2 SKIRTING

For areas where water remains on the floor due to operational functions, it is recommended the sheet vinyl flooring is coved integrally to form a skirting. This provides a more acceptable profile for the

cleaning and infection control processes necessary for these areas. It also significantly reduces the potential risk of material damage resulting from building movement at the junction of the floor and wall.

3.2.3 WALL SHEET

The use of sheet vinyl specifically produced for wall application is recommended. This is produced in thicknesses of 0.9mm upwards and in widths of approximately 1800 - 2000mm, either heterogeneous or homogeneous depending on the product. If horizontal laying is selected then this will reduce the number of joints. It is recommended that an installation contractor recommended by the resilient flooring manufacturer is used for these specialist areas.

3.2.4 JOINTS

Joints in vinyl sheet are formed by:

- hot welding – using a vinyl welding rod
- sealant
- adhesive fixed – with an unsealed tight butt joint
- chemical welding.

For joints in the floor sheet, hot welding is recommended as this provides a durable and waterproof joint.

For joints in the wall sheet, the product will dictate the method of jointing. The gauge and composition of wall sheet may exclude welding, and require sealant. Guidance should be sought from the resilient flooring manufacturer for a satisfactory detail to ensure a waterproof joint between the vinyl wall and floor sheet which are often of different gauges.

With partial height wall cladding the free edges or strips are usually glued, if not completely secured will be vulnerable in a wet or damp environment. Full height wall sheets in shower areas are therefore recommended.

The combination of a vinyl floor finish and ceramic wall tiling is more common than the reverse. A number of available solutions exist for joints between these different finishes. These solutions may rely on sealants, use a preformed (metal or plastic) strip to provide a 'flashing' over the floor material, or simply overlap the coved flooring with the wall tiling. These may be adequate for residential use, but are inadequate for institutional use and the risks associated with leaks in healthcare and multi storey construction.

Any such solutions are a potential weakness in a complete system and pose a problem with warranties; the ultimate responsibility often resides with the designer or project manager.

If the combination of sheet vinyl and ceramic tiles is to be used, then a trial installation should be tested or similar existing installations reviewed. Often the manufacturer's published construction details do not adequately cover actual site conditions, e.g. failure of metal/plastic profiles to fit closely over set joint contours, or eventual loosening of mechanical fixings from long term impact. To ensure warranty compliance written approval from each manufacturer for the proposed combined installation should be obtained before proceeding.

3.2.5 COMBINED WALL AND FLOOR VINYL SHEET INSTALLATIONS

In many cases the initial decision to use vinyl safety flooring will influence the choice of wall finish. The selection of both wall and floor finish from the same manufacturer - including recommended trim, adhesives, waterproofing and sealants, reduces risk and simplifies the warranty of the complete system. Any aesthetic advantage in selecting from a coordinated range from the same manufacturer is an individual design choice.

3.2.6 WATERPROOFING AND ACCESSORIES

In theory a complete vinyl installation with hot welded joints should provide a reliable waterproof barrier and require no separate waterproofing. Failures in waterproofing can occur as previously discussed, and some designers and clients may insist on a backup waterproofing system.

If backup waterproofing is proposed then a proprietary system approved by the vinyl sheet

manufacturer is recommended; this should be compatible with the adhesives, hot welding, or sealant jointing and substrate. If liquid waterproofing is applied it should not form any unevenness on the surfaces which would produce raised areas in the vinyl wall finish.

Accessories include items such as solid cove formers of different radii, welding rods etc, and should be provided or approved by the sheet finish manufacturer.

3.2.7 FLOOR WASTES

The floor waste selected should have a clamping grate, providing a waterproof joint between floor finish and drain; the fitting should be approved by the hydraulic consultant and vinyl flooring manufacturer.

3.2.8 INTEGRAL SYSTEMS

In wet area applications and in shower areas specifically, it is recommended that a “wet area integral system” is specified which can be supplied by the manufacturer. This will include floor preparation materials, adhesive system, accessories and vinyl sheeting from the one manufacturer. For warranty purposes these will be from the manufacturers’ approved range for the intended use and site conditions. Compliance with OHS and environmental legislation is essential.

3.3 Design and selection

3.3.1 SAFETY

As stated previously the materials and methods used in the installation of vinyl sheet should comply with all OHS requirements.

Patient profile will further influence the selection, as raised profiles or excessive slip resistance may contribute to falls for elderly patients.

Refer to ‘Ceramic Tiles - selection’ for comment on comparisons between vinyl and ceramic tile flooring, in relation to the risk of injury from falls in patient areas.

3.3.2 INFECTION CONTROL

Sheet vinyl with welded joints forms a flexible impervious material. In shower areas sheet vinyl is generally preferred to tiling, where the high ratio of joints to tiles provides an increased potential for cracking and harbouring sources of infection. Specialist tiling systems for procedure and process areas can be used, and this is common practice in countries where high quality tiles are produced or provide an economic alternative.

If products containing a ‘bacteriostat’ are required then it is recommended that the material has test certification confirming that the material inhibits the growth of specific organism(s) e.g. MRSA obtained by independent assessment.

3.3.3 CLEANING AND MAINTENANCE

Washing with water or dilute soap/detergent and a soft cloth is usual for general cleaning. Sterilisation solutions and pressure cleaning with hot water equipment can be used but not abrasive cleaning methods. Special cleaning solutions are used for heavy staining. All cleaning methods and cleaning supplies should be approved by the vinyl manufacturer.

For floors a deck scrubber or scrubbing machine can be used, with special cleaning agents available for grease or hard lime deposits. The cleaning regime and subsequent maintenance protocols should be selected to safeguard the performance of the finish.

In the case for enhanced slip resistance vinyl flooring, historically the level of cleaning required was directly proportionate to the level of slip resistance required. Recent technological advances in soil releasing polymer treatments significantly improve the ease of cleaning.

3.3.4 SURFACE PREPARATION

Both the substrate and any applied finish e.g. waterproofing should be inspected for uneven surfaces, and any defects rectified before laying the finish. Unevenness will affect the surface of the sheet vinyl, and in floor finishes may present a safety hazard, accelerate wear and affect cleaning.

The maximum moisture content of concrete floor slabs (sub floors) should comply with AS 1884 and the resilient flooring manufacturer's recommendations. Commencement of the installation process is deemed as acceptance that the sub floor substitute is acceptable to receive resilient floor finishes.

Note: Before preparation materials, waterproofing, an adhesive or floor covering can be applied to a floor slab, a maximum RH (relative humidity) reading of 70% when tested by the Hygrometer system, or a maximum of 5.5% when tested by the electrical Protimeter system is recommended.

4 CERAMIC TILES

4.1 General

4.1.1 BACKGROUND

Until the introduction of vinyl sheet in Australia, ceramic tiling provided the principal method for finishing wet areas, food preparation areas and areas requiring infection control. Despite a decline in tiling for these areas in Australia, tiling is still preferred as a wet area finish in the residential sector. Tiling for healthcare use is more common in countries that manufacture or have ready access to good quality ceramic tiles. Australia now relies exclusively on overseas manufacturers for the supply of ceramic tiles suitable for interior use in healthcare facilities.

4.1.2 STANDARDS

In Australia ceramic tiles are covered by AS 4662: *Ceramic tiles - Definitions, classification, characteristics and marking*, which reproduces the international standard ISO 13006. Other standards cover the selection and installation of tiling systems, adhesives, grouts, waterproofing and testing. Many of the standards have been revised to reflect changes in products, practice and terminology. It is essential to refer to the latest standards when selecting a product or system.

Additional testing is recommended for products claiming compliance with a standard organization other than ISO, SAA, BS, CEN or ASTM.

AS 3740: *Waterproofing of wet areas within residential buildings* referenced by the BCA is applicable to class 9a buildings.

Refer also to AS 3958.1: *Ceramic Tiles - Guide to the Installation of Ceramic Tiles*, and AS 3958.2: *Guide to the selection of a ceramic tiling system*.

4.1.3 PROPERTIES

AS 4662 divides tiles into groups according to their method of manufacture (shaping), and their water absorption. A basic familiarity with this standard and the terms covered is a requirement for selection.

Refer: Appendix 6: Ceramic Tile Classification.

4.1.4 SELECTION

Despite the depth of information covered in the standards; the selection of tiling for a wet area can be simplified by initially addressing the performance requirements - including appearance.

The selection parameters for materials for remote areas should include the availability of trades – not only to install but to provide ongoing maintenance and repair for the life of the installation. Tiling is a traditional trade found in most locations whereas wet area vinyl requires more specialist skills. This factor alone may favour the use of tiling in some locations.

In TS7 *Floor Coverings in Health Care Buildings* ceramic tiling was not recommended as a floor finish in patient occupied areas because of its "hard and non-resilient nature", however the context of that statement applied to a wide range of room types and floor finishes. While this Document does not exclude ceramic tiling for wet area application it is recommended that a thorough evidence based risk assessment analysis be conducted for this issue, and those issues covered in Section 2 GENERAL, including safety, life cycle costs and maintenance.

The published data for carpeted and uncarpeted wood, and concrete floors indicates a relationship between injury reduction and impact absorption. However falls in bathrooms and toilets are atypical,

and influenced by either the presence of staff or the crowded environment e.g. rails, basins and walls contributing to breaking of falls. Refer: *Age and Aging* Vol 33 No 3 – British Geriatrics Society 2004.

The choice between ceramic tile and safety vinyl should be based on empirical evidence linking injury from falls to impact absorption for these materials; not on studies using other materials with different characteristics or on anecdotal evidence.

4.1.5 ADVANTAGES

In wet areas for patient use, appearance is usually cited by user groups as a primary reason for preferring ceramic tile to sheet vinyl. However experience with tiling in the domestic environment can be misleading when applied to the requirements for tiling in a healthcare setting.

Besides appearance the other properties of tiling cited as an advantage include:

- impermeable surface
- hardness
- durability - resistance to scratching and staining
- ease of cleaning
- stability.

For cost comparisons, the whole of life costs need to be established for each project.

4.1.6 DISADVANTAGES

Although tiles are tested as individual units, the finished tiling system includes joints, grouting, bedding and waterproofing. This combination of tiles with other less durable products combined with the multiplicity of elements, and trade actions can lead to poor overall end quality and performance, despite the best efforts of the manufacturer and designer.

Some of the listed attributes such as hardness may contribute to acoustic issues in patient care areas. Hardness (rigidity) will also less easily accommodate impact or flexure from loading resulting in tile fracture or damage to the tile surface.

In tile systems, joints are a major factor in reducing overall performance despite the quality of the tile selected. Joints can provide a point of entry for moisture; standard grout is porous and may deteriorate and require re-pointing, it is less resistant to mechanical cleaning than a tile, and can provide an infection source. Joints are designed to ensure cracking occurs at the joint and not through the tile unit, this factor and the multiplicity of joints can contribute to some of the issues listed below.

The following disadvantages are cited for tiling in comparison to resilient sheet materials:

- increased cleaning and maintenance (joints and cracked tiles)
- reduced infection control (joints)
- waterproofing membrane required, (may also apply for sheet vinyl)
- increased overall installation cost (labour intensive).

Movement caused by tile growth generally only applies to large areas such as commercial kitchens. In these cases specialist advice from the tile manufacturer, and design to the appropriate standard are recommended; e.g. BS 5385 *Wall and Floor Tiling*. Movement is increased by shrinkage of the background material (concrete, calcium silicate etc.).

4.1.7 FAILURE

The use of tiling may be ruled out where significant differential movement in the substrate, impact and applied loadings including earthquake shock are expected.

The effect of differential movement is usually eliminated by movement joints and the selection of an appropriate system, whereas dynamic loads and impact may exceed the capabilities of the tile and tiling system.

Flexible movement joints using sealant become the least durable part of the system, and the expected service life can be reduced by exposure to chemicals, cleaning products, cleaning methods and

mechanical damage. The use of sealant joints for some areas may be excluded by the patient profile, e.g. acute mental care.

4.1.8 SUSTAINABILITY

ESD ratings and labelling are not dealt with under AS 4662 or in the other Australian tiling standards.

While neither ceramic tile nor cementitious grout generate VOC emissions, tile production has traditionally had a high embodied energy component. Energy efficiency is now a priority within the Tile Industry in an effort to reduce production costs and emissions.

Since adhesives, sealants, waterproofing and special grouts can generate VOCs - either in the long or short term, any products selected should satisfy OHS requirements during and after installation.

4.2 Materials and Components

Tiling is a specialized trade extensively covered by standards and technical literature. Tiling terminology varies with the country of origin and source of the information. The terms used in this document are taken from Australian Standards to avoid confusion. The following information is provided as an overview to assist the selection process.

4.2.1 TILE INSTALLATIONS

AS 3958.1 *Guide to the installation of ceramic tiles* covers the subject of bond breakers, adhesives and bedding, underlays, screeds, reinforcement, waterproof membranes and other general system requirements. Any installation should, at minimum, comply with the relevant parts of this standard.

TILE SELECTION

Interior tiles selected for use in wet areas will generally be dry pressed with a low to medium water absorption rating, with any other special properties required for specific purposes such as slip resistance.

The performance requirements for floor and wall tiles differ, consequently the tiling system (including waterproofing) for each should be selected accordingly. If floor tiles are used on walls then the problems and costs associated with hardness (drilling) should be considered in view of the number of attached fittings required in healthcare facilities.

Glass mosaic and ceramic tiles (below 50 mm sq) are generally not recommended for healthcare use as these generally have reduced performance and higher life cycle costs.

4.2.2 GROUT AND SEALANTS

AS 4992.3: *Ceramic tiles: Products for installation - Grouts: Definitions and specifications* classifies grouts into 2 types, cementitious grout (CG) (including liquid admix or latex additive), and reaction resin grout (RG). These are further divided into classes such as normal, improved and fast setting, each having a list of minimum performance requirements. Application methods are also covered. Grout types will vary for location, e.g. wall, floor and for general or specialist applications such as showers, hygiene, food preparation and harsh environments. It is sufficient to specify the grout type and compliance with the standard. Sealants should be selected on a performance basis for the intended use, if necessary endorsed by the tile manufacturer.

4.2.3 BEDDING – ADHESIVE

AS 4992.1(Int): *Ceramic tiles - Products for installation. Adhesives - Definitions and specifications* lists adhesives under 'thin bed methods' as cementitious adhesive (C), dispersion adhesive (D) and reaction resin adhesives (R). For each of these types it is possible to have different classes. It is usual to specify only that an adhesive conform to the Standard, however a specialist product would be required for applications such as food preparation areas.

4.2.4 UNDERLAYS AND REINFORCEMENT

Slip sheets or separation membranes are used to isolate the tiled surface from structural movement, or to reduce the transmission of impact generated sound. Although seldom used in the majority of small wet area applications, slip sheets may be required for large areas and areas for food preparation using epoxy grouts. Where movement in the substrate is expected, it is usual to provide

reinforcement in a mortar bed - over the slip sheet.

4.3 Hydrotherapy Pools

An appendix to AS 3958.1 deals with continually immersed tiling including pools. This is titled 'informative' but can be used as a guide in performance specifying.

Hydrotherapy and other pool tiling and systems should be selected from a specialist pool tiling range which will include special purpose tiles, profiles and accessories. Performance will depend on the complete installation including pool construction, waterproofing, method of fixing and sealing. The subject is adequately covered by standards, and in literature from tile organizations and manufacturers. Since this is a specialised and infrequent application, further description is outside the scope of the present Document.

5 APPLIED SEAMLESS COATINGS

5.1 General

These products comprise a variety of liquid or trowel applied synthetic resin products that set or 'cure' to provide a floor or wall finish. Products are usually epoxy, polyurethane or acrylic based.

Epoxy resin systems are the most common type used for general flooring and are generally self levelling, with a finished thickness from 150 microns to 6 mm - the thinner coating requiring more frequent re-application. Self levelling screeds are also common, are cement based and can provide an integral surface finish.

With the exception of some formulations VOC emissions are generally high. Product data sheets should be checked to ensure compliance with the relevant regulations and Health Authority requirements.

The technical specifications for this group of products are usually based on American or European standards; and often include requirements for the substrate, environmental and test data.

These finishes are generally not used in patient wet areas such as ensuites, but used typically for other areas where running water, or contamination is usual:

- Food preparation and wet processes
- Hygiene and store areas
- Laboratories and cleanrooms
- Workshop and loading docks
- Chemical storage areas.

A further range of coatings and sealing agents are available for more specific applications such as:

- Car parking or vehicle areas
- Services plant rooms
- Surfaces subject to severe chemical or marine environments.

6 OTHER FINISHES

There are a number of other floor finishes that are suitable for general use areas where accidental spillages or contamination occur. However these are generally not suitable for 'wet areas' within the definition of this document - a full description can be found in *TS7 'Floor Coverings in Health Care Buildings'*. Finishes include:

- rubber and polymetric sheet and tile
- linoleum
- vinyl tile and resilient backed vinyl sheet

- terrazzo - cement based
- screeds – cement based or synthetic anhydrite
- textile finishes: Carpet and Carpet tiles.

7 SUMMARY

7.1 General

As stated in the introduction a primary focus in this Document is on wet areas such as showers and ensuite, where a high proportion of problems related to installation, durability, OHS and patient safety issues occur.

Additionally there are a wide variety of areas such as pools, commercial food preparation, sports and exercise areas, laboratories, stairs, ramps, service ladders and walkways that exceed fall outside the scope of this document, and require varying degrees of specialist knowledge and advice.

7.1.1 WET AREAS

The choice of finishes for patient wet areas such as showers and ensuite, remains primarily between sheet vinyl and ceramic tile, or a combination of the two.

Ceramic tile is included for use in these areas with the recommendation that the issues previously covered are thoroughly addressed. In particular - OHS, patient safety and whole of life costs.

7.1.2 CONCLUSION

The selection of wall and floor finishes for wet areas in healthcare facilities is a complex subject covering a wide range of issues. In addition the range of products, standards, regulations and responsibilities are subject to continual change and expansion. A basic understanding of the technical issues involved in selection is a minimum requirement.

From the perspective of risk management, selection should be made or assisted by design or construction professionals, senior product support staff or facility managers, preferably with prior knowledge of the subject. This document has been prepared on this basis and with the aim to assist the selection process, and reduce the impact on the environment.

7.2 TABLE A - Recommended finishes.

Table A lists finishes suitable for 'wet areas' as defined, it may not cover the requirements of some specialized areas.

The slip resistance of floor materials should follow the recommendations of SAA HB 197, and comply with AS 4586 for new materials, and AS/NZS 4663 for existing surfaces.

The slip resistance of Safety flooring is initially provided by the Slip resistance value of the surface, complimented by the micro-surface roughness. In resilient sheet materials this is provided initially by the addition of an abrasive aggregate either in the surface layer or body of the material. Surface profiling and the use of increased aggregate density or size provide additional slip resistance for specific uses. The following general rules apply:

For areas subject to occasional wetting for barefoot or soft soled footwear use non-profiled 'safety' grade flooring, e.g. aggregate composition or unglazed tile.

For areas with running water or constantly wet for barefoot or soft soled footwear use an enhanced 'safety' flooring with a profiled surface.

For areas with wet/slippy commercial or industrial processes use an industrial grade safety flooring with or without a heavily profiled surface. The type and grade should be selected to suit the specific use and conditions.

Paint and applied seamless finishes for walls/floors should be selected for use to APAS and product manufacturers recommendations, and comply with the relevant Australian Standard.

TABLE A 1 Material codes

Floors

VS-S	Vinyl sheet safety.	SC-S	Seamless coating safety.
VS-ES	Vinyl sheet safety enhanced.	ISC	In-situ concrete.
VS-HD S	Vinyl sheet Heavy duty safety.	GT	Granolithic topping.
CT-S	Ceramic tile safety: (unglazed).	RS-S	Rubber sheet safety.
CT-SP	Ceramic tile safety profiled: (unglazed).	RS-RP	Synthetic resilient sheet product for pool surrounds.

All sheet vinyl with welded joints unless noted.

Walls

CT-W	Ceramic tile wall grade (glazed).
WSV	Wall vinyl sheet (welded joints).
P-W	Paint interior washable - Provide splashbacks at basins, sinks etc.
P-IC	Paint industrial coating - System to suit function and special conditions.
S/B	Splashback coating - Smooth/impervious, resilient/rigid sheet or tile, or applied coating.

TABLE A 2 Functional Space requirements**Wet areas** – Slip resistance of floor surfaces to SA HB 197 recommendations

Generic areas	Floor finish	Wall finish	Comment
Ensuite, Assisted and ADL bathrooms	VS-S or CT-S	WSV or CT-W	Integral covered skirting –vinyl
At shower locations	VS-ES or CT-SP	WSV or CT-W	Ditto
Hydrotherapy pools	RS-RP, VS-ES or CT-SP	CT-W or P-IC	
Trolley wash	VS-HDS	P-IC, WSV or CT-W	Integral covered skirting -vinyl Wall protection
Central laundry Mortuary CSSD clean up	VS-S, CT-S	P-IC, WSV or CT-W	Integral covered skirting – vinyl
Central Food preparation, cooking, washup	CT-S, SC-S	CT-W, P-IC	Safety flooring, Details to comply with regulations

Utility and General Areas subject to spills or contamination

Slip resistance of floor surfaces to SA HB 197 recommendations

Back of house circulation, 'clean' and 'dirty' areas Loading dock	VS-S, RS-S, or SC-S ISC or GT [sealed]	P-W or P-IC or No finish or sealed	Comply with regulations. Check fork lift use and spillage types e.g. oil, chemical
Dirty Utility Domestic laundry Basin locations	VS-S	P-W and S/B	Integral covered skirting - vinyl
Toilet	VS-S or CT-S	P-W and S/B	Integral covered skirting – vinyl
Beverage bays ADL kitchen Cleaners room	VS-S	P-W and S/B	Integral covered skirting – vinyl
Pantry	VS-S	P-W or P-IC and S/B	Integral covered skirting - vinyl Splashback at sink and basin
Food consumption	VS-S	P-W	Safety flooring at servery area Integral covered skirting - vinyl Comply with regulations
Main entry Retail, vending	VS-S, Terrazzo or CT-S	P-W	Safety flooring or treatment as required
Stairs and ramps	VS-S	P-W	Safety flooring up to or strip at tread edge.

Services plant
rooms

VS-S, RS-S, or
SC-S

P-W or P-IC,
or

Comply with regulations.
Finish to suit equipment
type, spillage type and
use.

ISC or GT
[sealed]

No finish or
sealed

Refer to Australasian HFG Parts B, C and D including Room Data Sheets (RDS) for additional requirements and specific recommendations.

8 APPENDICES

8.1 APPENDIX 1 – Glossary

Abrasion resistance	Classified by P.E.I rating from 0 to 5.
Accessible	Facilities that are designed for use by people with a disability.
Area	Used generically to denote any room, part of a room, or open space.
Building Code of Australia	The regulation controlling construction of all buildings in Australia and any subsequent amendments or updates.
Contamination	Any substance on a walking surface (wet or dry) that may reduce slip resistance.
Differential movement	Uneven movement of different parts.
Durability	Ability to maintain performance over time (CPD 89/106/EEC).
Hardness	Classified by Moh's scale from 1 to 10, based on minerals.
Heterogeneous	Separate wear layer bonded to a base material (vinyl sheet).
Homogeneous	Uniform composition throughout material (vinyl sheet).
Informative	For information and guidance only (Australian Standards).
Macro-rough	Surfaces with embedded but protruding aggregate or similar material.
Micro-rough (rough)	Irregularities in a surface measured in microns. Refer to rough.
Non-slip flooring	or 'Safety flooring', possessing slip resistant properties.
Normative	Refers to the part integral to the application of an Australian Standard.
Patient Care Area	Part of a healthcare building normally used for the treatment, care, accommodation, recreation, dining and holding of patients including a ward and treatment area (BCA).
Pendulum test value (PTV)	Used in BS 7976 Pendulum testers. Refer to slip resistance value.
Plastic	Synthetic or semisynthetic polymerization product.
Profiled surface	A surface with a designed geometric vertical profile.
Rough (micro-rough)	Surfaces with a roughness (Rz) measured by a roughness meter.
Roughness (Rz)	The measurement of average peak to trough height as measured by a micro-roughness meter.
Safety flooring	Refer to non-slip flooring.
Slip resistance	Coefficient of friction of floor surface under varying condition and use, determined by an approved test method.
Slip resistance value (SRV)	PTV achieved using a Four-S rubber slider.
Substrate	Surface or building element receiving the applied finish.
Sustainable	General non-technical term referring to ESD principles.
'Vinyl'	PVC (polyvinylchloride). Refer Plastic.
Wet Area	Area with running water or surfaces in frequent contact with water.

8.2 APPENDIX 2 – Abbreviations

ANSI	American Standards Institute
APAS	Australian Paint Approval Scheme
ASTM	American Society for Testing and Materials Standards
BRE	Building Research Establishment (UK)
CEN	Comité Européen de Normalisation
CIRIA	The Construction Industry Research and Information Association (UK)
COF	Coefficient of Friction
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ESD	Ecologically sustainable development, includes sustainable design, energy efficiency and similar issues. This term is used in legislation.
HSE	Health and Safety Executive: UK
HSL	Health and Safety Laboratory: UK
ISO	International Standards Organization
MRSA	Methicillin Resistant Staphylococcus Aureus
NATA	National Association of Testing Authorities
NFSI	National Floor Safety Institute. US
OHS	Occupational Health and Safety
PEI	Porcelain Enamel Institute (USA)
PSAE	Pseudomonas Aeruginosa
STF	Slips, trips and falls
VRE	Vancomycin-Resistant Enterococcus

8.3 APPENDIX 3 – References

8.3.1 ACTS and REGULATIONS

Commonwealth Government.

Building Code of Australia 2007 edition (as amended)

Disability Discrimination Act 1992, Commonwealth Consolidated Act, Act No. 135 (1992).

New South Wales Government.

Occupational Health and Safety (OH&S) Act 2000,

Private Hospitals and Day Procedure Centres Act, 1988. No 123.

Private Hospitals Regulation, 1996.

Day Procedures Centres Regulation, 1996.

International.

EMAS Regulation (EC) No 761/2001 - Environmental Management and Auditing Systems.

<http://ec.europa.eu/environment/emas/about/summary_en.htm>.

8.3.2 STANDARDS

Australian Standards

AS 1428 Design for access and mobility

AS 1428.1–2001: General requirements for access–New building work

AS 1428.2–1992: Enhanced and additional requirements–Buildings and facilities

AS 1428.3–1992: Requirements for children and adolescents with physical disabilities

AS/NZS 1428.4–2002: Tactile indicators

AS 1884–1985: Floor coverings–Resilient sheet and tiles–Laying and maintenance practices

AS 2358–1990: Amdt 1–1994 Adhesives - For fixing ceramic tiles

AS 2818–1993: Guide to swimming pool safety

AS 2865–1995: Safe working in a confined space

AS/NZS 2982.1–1997: Laboratory design and construction - General requirements

AS 3588–1996: Shower bases and shower modules

AS/NZS 3661: Slip resistance of pedestrian surfaces

AS/NZS 3661.2–1994: Guide to the reduction of slip hazards

AS 3740–2004: Waterproofing of wet areas within residential buildings

AS 3958 Ceramic tiles

AS 3958.1–2007: Ceramic Tiles - Guide to the Installation of Ceramic Tiles

AS 3958.2–1992: Guide to the selection of a ceramic tiling system

AS/NZS 4360-2004: Risk management

AS 4459 series Parts 1 - 16: Methods of sampling and testing ceramic tiles

AS/NZS 4586–2004: Slip resistance classification of new pedestrian surface materials

AS 4662–2003: Ceramic tiles - Definitions, classification, characteristics and marking

AS/NZS 4663–2004: Slip resistance measurement of existing pedestrian surfaces

AS 4674–2004: Construction and fit out of food premises

AS/NZS 4801–2001: Occupational health and safety management systems–Specification with guidance for use

AS/NZS 4804–2001: Occupational health and safety management systems–General guidelines on principles, systems and supporting techniques

AS/NZS 4858–2004: Wet area membranes

AS 4992 Ceramic tiles - Products for installation

AS 4992.1(Int)–2003: -Adhesives - Definitions and specifications

AS 4992.2(Int)–2003: Adhesives - Test methods

AS 4992.3–2004: Definitions and specifications

AS/NZS ISO 9000–2006: Quality management systems - Fundamentals and vocabulary

AS/NZS ISO 14000 Set–2005: Environmental Management Standards Set

Australian Standards - Handbooks

HB 52–2000: The Bathroom Book

HB 139–2003: Guidance on Integrating the Requirements of Quality, Environment, and Health and Safety Management System Standards

HB 197–1999 An introductory guide to the slip resistance of pedestrian surface materials

HB 260–2003: Hospital acquired infections - Engineering down the risk

HB 436–2004: Risk management guidelines – Companion to.

International Standards

BS 6431: Ceramic floor and wall tiles

NF EN ISO 22870–May 2006: Point-of-care testing (POCT) - Requirements for quality and competence

AgBB – Health related Evaluation Procedure for Volatile Organic Compound Emmissions (VOC and SVOC) from Building Products. 2005. Committee for Health-related Evaluation of Building Products (AgBB). <www.umweltbundesamt.de/building-products/agbb>

8.3.3 GUIDELINES AND DIRECTIVES

Australasian HFG (Health Facility Guidelines). <www.healthfacilityguidelines.com.au>

Part A- Introduction and Instructions for Use.

Part B- Health Facility Briefing and Planning.

Part C- Design for Access, Mobility, OHS and Security.

Part D- Infection Prevention and Control.

Part F- Project Implementation.

Standard Facility Cost Planning Guidelines.

Standard Components Room Data Sheets (RDS's)

NSW Health Department Publications <www.health.nsw.gov.au>

Policy Directive, PD2007_036, Infection Control Policy, NSW Health.

Policy Directive, PD2005_306, High Environmental Performance for Buildings, NSW Health.

Circular 2004/87, Workplace Health and Safety: Policy and Better Practice Guide, NSW Health.

Australian Council on Healthcare Standards. <www.achs.org.au>

14–2001, Fundamentals for Infection Control. ACHS.

720–1999, Fundamentals for Operating Suites. ACHS.

Workplace Health and Safety Queensland, 2007, *Guide to the workplace health and safety obligations of designers of structures.*

8.3.4 TECHNICAL PUBLICATIONS AND FURTHER READING

Alan Bullement, 2000. *BK019: Selecting Flooring*. BRANZ. NZ.

BDP (Building Design Professionals) *Environment Design Guide*. Royal Australian Institute of Architects. <www.architecture.com.au>.

Bowman, R. (2003). *Designing for slip resistance*. Melbourne: CSIRO.

BRANZ 1998. *Bulletin 370: Slip Resistant Floors* BRANZ.

Building Research Establishment UK, *BRE Environmental profiles of construction materials*, website for the Centre for Sustainable Construction - <www.bre.co.uk>

Carpenter J, Lazarus D, Perkins C. (2006), *C652 Safer surfaces to walk on – Reducing the risk of slipping*, CIRIA, London.

Ecospecifier, <www.ecospecifier.org>.

The Green Building Council of Australia, *Green Star – Health as built*, <www.gbca.org.au>.

NATSPEC Specifications - Construction Information Systems Ltd. <www.natspec.com.au>.

Davis Langdon (2005). *Safe Design Info Data series* <www.davislangdon.com>.

Tile Association. (2004). *Slip resistance of hard floors*, The Tile Association, London.

8.3.5 ORGANIZATIONS and TRADE ASSOCIATIONS

Australian Tile Council: <www.australiantilecouncil.com.au>

Australian Paint Approval Scheme (APAS): <www.apas.gov.au>

BRANZ (Building Research Assoc of NZ): <www.branz.org.nz>

Building Research Establishment UK (BRE): <www.bre.co.uk>

Centre for Health Assets Australasia <www.chaa.net.au>

CIRIA: <www.ciria.org>

HSE (Health and Safety Executive): <www.hse.gov.uk>

Infotile: <www.infotile.com.au>

The Resilient Floor Covering Institute (RFCI): <www.rfci.com>

The Vinyl Council of Australia (VCA): <www.vinyl.org>

8.4 APPENDIX 4: Slip Resistance – Test methods

The test methods currently employed in the Australia Standards with the various classifications relating to each method are summarised below, and address new surfaces in Wet areas in particular.

1 – Wet Pendulum Test.

Classifications indicate the contribution of the floor to the risk of slipping when wet.

V - Very low (risk)

W - Low

X - Moderate

Y - High

Z - Very high

The descriptions of the classifications are from HB 197 Table 2. Table 1 adds to the interpretation of these definitions. The wet pendulum test method is based on a risk management approach.

The test methods can use 'Four S rubber' or 'TRL rubber' sliders, the method used to obtain the mean value must be stated. Refer AS/NZS 4586 (Draft DR07066CP) Table 2 for value ranges.

May not be applicable to heavily profiled surface with a high slip resistance.

2 - Dry Floor Friction Test.

F – Floor friction tester value COF (Coefficient of friction) ≥ 0.40

G – Floor friction tester value COF < 0.40

May not be applicable to heavily profiled surface with a high slip resistance.

3 - Wet Barefoot Ramp Test:

The classification indicates the range of the ramp inclination (in degrees) allowing a safe limit in walking:

A - $\geq 12^\circ < 18^\circ$

B - $\geq 18^\circ < 24^\circ$

C - $\geq 24^\circ$

4 - Oil-Wet Ramp Test.

Similar to the wet ramp but uses special footwear and engine oil of specified viscosity.

R9 - $\geq 3^\circ < 10^\circ$

R10 - $\geq 10^\circ < 19^\circ$

R11 - $\geq 19^\circ < 27^\circ$

R12 - $\geq 27^\circ < 35^\circ$

R13 - $\geq 35^\circ$

Displacement Volume Test.

This measures the size of the displacement space of severely profiled/structured surfaces.

Values given as 'Surface related minimum volume of Displacement space'.

V4 – $4 \text{ cm}^3/\text{dm}^2$

V6 - 6 cm³/dm²

V8 - 8 cm³/dm²

V10 - 10 cm³/dm²

Applicable to floors in industrial work areas subject to contamination. Used in conjunction with oil-wet ramp test values for specific commercial and industrial areas. Refer HB 197 Table 5.

Additional proposals for AS/NZS 4586 (Refer AS Draft DR07066CP).

Appendix F: Surface roughness method of measurement.

The peak to trough roughness R_z is measured with an approved testing device, provides a quick and convenient method of testing existing surfaces to provide a Surface roughness value SRV. Unsuitable for very rough or profiled surfaces.

Appendix G: Slope design value (SDV) and slope correction value (SCV) determination.

Tables provided to for the calculation of SDV and SCVs.

Appendix H: Pedestrian selection flooring guide for normal conditions.

Revises and expands existing HB 197 Table 3 for minimum pendulum and ramp test recommendations.

8.5 APPENDIX 5: Slip resistance – General

AS/NZS 4586 (Draft revision DR07066) proposes that internal pedestrian surfaces subject to a reasonably foreseeable risk of contamination (water or other) be classified by at least one of methods 1, 2 or 3 listed above. Additional requirements and qualifications apply.

The recommendations in HB 197 should be read in conjunction with AS/NZS 4586. Appendix H: Pedestrian selection flooring guide for normal conditions, revises and expands Table 3 in HB 197 for minimum pendulum and ramp test recommendations.

Heavily profiled surfaces and junctions should be considered with reference to trip hazards as described in AS 1428 parts 1 and 2 under walkways and ramps.

8.6 APPENDIX 6: Ceramic Tile Classification

AS 4662: *Ceramic tiles - Definitions, classification, characteristics and marking* divides tiles into groups according to their method of manufacture (shaping), and their water absorption.

Manufacturing 'method A' covers extruded tiles, 'method B' covers dry pressed tiles suitable for interior wet areas. Water absorption *E* is classified into the following groups 1 (low), 2 (medium), and 3 (high), these are further divided into sub groups.

The properties within each tile group are then defined under the headings:

- dimensions and surface quality;
- physical properties;
- chemical properties.

Each of these headings contain a range of characteristics such as:

- surface flatness;
- water absorption;
- breaking strength;
- abrasion resistance;
- coefficient of linear thermal;
- expansion (including crazing resistance);
- coefficient of friction;
- impact resistance;
- resistance to staining;
- resistance to chemicals.

Annex N provides a classification of glazed tiles for floors according to their abrasion resistance (PEI); this ranges from Class 0 – glazed tiles not recommended for use on floors, to Class 5 - glazed tiles suitable for severe pedestrian traffic over sustained periods.

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