

0651 FORBO RESILIENT FINISHES

Branded worksection

This branded worksection has been developed by NATSPEC in conjunction with **FORBO FLOORCOVERINGS**. As with all NATSPEC worksections, it is the responsibility of the user to ensure it is completed appropriately for the project. The user should also check its applicability for local conditions and regulations.

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Worksection application

This worksection is applicable to resilient products supplied by **FORBO FLOORCOVERINGS PTY LTD** as follows:

- Sheet linoleum floor finishes supplied as Marmoleum, Artoleum and Corkment underlay.
- Commercial vinyl sheet and tile floor finishes supplied as Project vinyl in Slip resistant, Wetroom and High performance grades.
- Domestic cushioned vinyl floor finishes.
- Accessories comprising linoleum and vinyl welding cable and pre-formed coved linoleum and vinyl skirtings.
- Static conductive sheet vinyl supplied as ColoRex EC.
- Static dissipative sheet vinyl supplied as ColoRex SD.
- Linoleum supplied as Marmoleum Ohmex.
- Adhesives.
- Guidance text
- All text within these boxes is provided as guidance for developing the specification and should not form part of the final specification. This Guidance text may be hidden or deleted from the document using the NATSPEC Toolbar or the hidden text Hide and Delete functions of your wordprocessing system. For additional instruction visit FAQs at Related material may be found in other worksections. For example: <http://www.natspec.com.au>.

Related material located elsewhere in NATSPEC

Related material may be found in other worksections. For example:

- *Concrete finishes* for substrates.
- *Flooring and decking* for substrates.
- *Access floors*.
- *Seamless floor finishes*.
- *Carpets*.
- *Floor sanding and finishing* for substrates.

Documenting this and related work

You may document this and related work as follows:

- Nominate the locations of finishes and finish abutments, movement joints and note fixed partitions on drawings to your office documentation policy.

Specifying ESD

Refer to NATSPEC TECHreport *Specifying ESD*. The following may be specified here:

- Marmoleum.

1 GENERAL

FORBO FLOORCOVERINGS profile

Forbo, world leading floorcovering manufacturer, offers a complete portfolio of products including linoleum and specialist vinyls suitable for commercial and domestic applications. Forbo's resilient flooring products are highly suited to numerous applications and offer durability, enhanced performance properties and ease of maintenance, combined with unparalleled colour and design flexibility to exercise your creative freedom and meet client needs.

Social and environmental responsibility has been a core value at Forbo for decades. Forbo have an audited ISO 14001 EMS and have made significant achievements minimising the eco-impacts of their products over time. For more information, and for the latest product updates, visit the Forbo web site at www.forbo-flooring.com.au.

1.1 RESPONSIBILITIES

General

General: Provide resilient floor coverings supplied by **FORBO FLOORCOVERINGS PTY LTD** to substrates as follows and to **Selections**:

- To remain secured for the warranty life of the covering.
- To remain consistently smooth for the warranty life of the covering.
- To form the pattern required.

1.2 CROSS REFERENCES

General

Requirement: Conform to the following:

- *General requirements.*

The *General requirements* worksection contains umbrella requirements for all worksections.

- [complete/delete]

List the worksections cross referenced by this worksection. The General requirements worksection references the *Common requirements* worksections. It is not necessary to repeat them here. However, you may also wish to direct the contractor to other worksections where there may be work that is closely associated with this work. See **Related material located elsewhere in NATSPEC** in the introduction *Guidance*.

NATSPEC uses generic worksection titles, whether or not there are branded equivalents. If you use a branded worksection, change the cross reference here.

1.3 INTERPRETATION

Definitions

General: For the purposes of this worksection the definitions given below apply.

- Resilient floor coverings classification: To BS EN 685 as follows:
 - . Domestic Class 23.
 - . Commercial Class 34.
 - . Industrial Class 42.
- Substrate: The building element to which the finish is to be applied. Includes 'subfloor' as defined in AS/NZS 2455.1.
- Underlay: A layer of sheet material or in situ filling on the substrate to provide a suitable surface for the resilient covering.

The Definitions subclause can be edited to suit the project or deleted if not required.

1.4 MANUFACTURER'S DOCUMENTS

Technical manuals

Compliance: Forbo Floorcoverings Installation Guide at

[www.forbo-flooring.com.au/ModuleFiles/mod_document_url/196/Forbo Installation Guide.pdf](http://www.forbo-flooring.com.au/ModuleFiles/mod_document_url/196/Forbo%20Installation%20Guide.pdf)

1.5 INSPECTION

Notice

Inspection: Give notice so that inspection may be made of the following:

- Completion of laying underlay, if any.
- Substrate immediately before fixing resilient finishes.
- Finished surface before applying sealers or polishes (if any).
- Completed installation.

Hold points, if required, should be inserted here.

1.6 SUBMISSIONS

Samples

If the specification does not state selected properties such as colour and texture, the effect of this clause is to require the submission of samples covering the full range of those properties. The specification should define the item with enough

precision, either by description, or by reference to preselected samples, or as a proprietary item, to enable the contractor to identify (and price) it. Where the covering is specified as a proprietary item use this clause as a means of confirmation.

Range: Submit labelled samples of resilient finishes illustrating the range of colour, pattern or texture as seen in the finished work.

Minimum size per sample:

- Sheet: 450 x 450 mm.
- Tiles: A whole tile or 0.09 m², whichever is the greater.
- Linear accessories (coving, skirting, stair nosing, protection strips, and the like): A piece 300 mm long.

Welded joints: Submit a sample joint 300 mm long.

Identification

Labelling: Label each sample, giving product name, and the Forbo code reference.

Sample panels

Location: [complete/delete]

Size (mm): [complete/delete]

Call for sample panels only when large areas are specified. Delete if not required.

Trial set-out: Prepare a trial set-out before fixing.

Subcontractors

General: Submit names and contact details of proposed suppliers and installers taken from the register of suppliers and installers approved by Forbo.

Materials and components

Forbo data: Submit the Forbo Material Safety Data Sheets (MSDS).

2 PRODUCTS

2.1 GENERAL

Critical radiant flux

Standard: to AS ISO 9239.1.

Floor finishes: Conform to the values of critical radiant flux nominated in **Selections**.

Smoke development rate

Standard: To AS ISO 9239.1.

Floor finishes in non-sprinklered buildings: 750 percent-minutes.

Refer to BCA Spec C1.10a.

2.2 MARKING

Identification

General: Deliver materials to the site in the manufacturer's original sealed containers legibly marked to show the following:

- The Forbo identification printed on the tamper-proof tape seal.
- Product brand name.
- Product type.
- Dimensions and quantity.
- Product reference code and batch number.

2.3 UNDERLAYS

A thin cementitious type underlay may be used as an isolating barrier of known resistance beneath antistatic or conductive flooring if required. Other special underlay systems are available for the reduction of impact noise, these may be laid directly on the substrate, or over an isolation pad or board, and an embedded reinforcing mat is usual. Consult manufacturers of both underlay and floor covering for compatibility and installation requirements.

Cementitious

General: Polymer modified cementitious self smoothing and levelling compound.

- Thickness: 3 mm minimum.

Use to correct the substrate. Avoid a feather edge that may curl, by cutting back for a 3 mm minimum thickness. Delete if not appropriate.

Fibre cement underlay

Standard: To AS/NZS 2908.2, Type B, category 2 minimum.

Thickness: 5 mm minimum.

Wet processed fibreboard (hardboard) underlay

Standard: To AS/NZS 1859.4.

Classification: General purpose medium board, manufactured specifically as flooring underlay.

Thickness: 5.5 mm.

Acoustic underlay

Product: Forbo Corkment.

2.4 SHEETS AND TILES

Edges of sheets and tiles

General: Ensure edges are firm, unchipped, machine-cut accurately to size and square to the face, and that tile edges are square to each other.

Linoleum

Standard: To BS EN 548.

Corkment

Standard: To BS EN 688.

Polyvinyl chloride (PVC)

Resilient floor covering polyester felt backing: To BS EN 650.

Resilient floor covering, with foam layer: To BS EN 651.

Proprietary PVC products may be imported and comply with overseas standards. See BEDP EDG PRO 13, PRO 14 and the CSIRO Report 'A discussion of some of the scientific issues concerning the use of PVC' (2001), on the subject of PVC.

Linoleum bench topping

Product: Forbo Desk Top 2 mm gauge sheeting with impregnated paper backing.

Adhesives

Adhesives: As nominated in the Forbo Floorcoverings Installation Guide for the floor material selected.

Linoleum adhesive: LOW-SOLVENT ADHESIVE 414/638.

Vinyl adhesive: SOLVENT-FREE 540.

Special adhesives may be required for anti-static and conductive applications.

Static control flooring

See AS 2834 Appendix D (informative), and NATSPEC TECHnote NTN DES 007 on static control floors.

General: Unbacked flexible PVC or linoleum sheet with carbon particles permanently heat and pressure fused throughout the thickness of the material with electrical resistance within the range of surface resistance specified in AS 2834 clause 2.1.2, when tested to AS 4155.6.

Product: [complete/delete]

Select from the following Forbo products:

- MARMOLEUM OHMEX.
- COLOREX EC/SD.
- SureSTEP PUR.
- Smaragd.
- Effect.

AS 2834 sets out the environmental requirements for computer accommodation and clause 2.1.2 describes floors.

Acoustic sheet vinyl

See NATSPEC TECHnote NTN DES 001 on slip resistance.

Product: [complete/delete]

Select from the following Forbo products:

- SARLON QUARTZ-17dB.
- SARLON TRAFFIC-19dB.
- SARLON TECH-15dB.
- MARMOLEUM with Corkment-14dB.
- MARMOLEUM ACOUSTIC-14dB.
- MARMOLEUM DECIBEL-17dB.

Slip resistant sheet vinyl

Verification: A product type tested to confirm the stated slip resistance classification.

Product: [complete/delete]

Select from the following Forbo products:

- OneSTEP R10
- SureSTEP PUR R10
- SafeSTEP R11
- SafeSTEP R12
- SafeSTEP GRIP R10 (Barefoot / wet area).

Bulletin board

Product: Forbo Bulletin Board fully flexible high cork content linoleum surfacing material with excellent pin hole recovery.

Entrance mat

Product: Forbo Entrance Mat.

Colour: [complete/delete]

Consult Forbo for the colour range.

3 EXECUTION

3.1 PREPARATION

Substrates

General: To AS/NZS 2455.1 Section 2.

Tolerance: Conform to the **Substrate tolerance table**.

Substrate tolerance table

Property	Length of straight edge laid in any direction	Max. deviation under the straight edge
Flatness Class A	3 m	3 mm
Smoothness	150 mm	1 mm
Projections	50 mm	0.5 mm

Flatness tolerance class: Nominate Class A in *Concrete finishes* and *Cementitious toppings* to resilient finishes locations as appropriate for the project.

It is assumed smoothness and projection tolerance corrections form part of substrate preparation.

Cleaning concrete surfaces: Mechanically remove the following surface treatments:

- Sealers and hardeners.
- Curing compounds.

Cleaning timber surfaces: Remove oil, grease and traces of applied finishes.

Concrete substrate correction: Remove projections and fill voids and hollows with a levelling compound compatible with the adhesive.

Consider including the following:

'If raised areas are corrected by grinding test the freshly exposed concrete surface for pH and obtain verification of compatibility with the adhesive'. Freshly exposed concrete has high alkalinity and problems have been encountered overseas.

Timber substrate correction: Remove projections. If conformance to the **Substrate tolerance table** can not be achieved fix an underlay in brick pattern with joints avoiding substrate joints.

Moisture content: Do not commence installation unless:

- Concrete: The moisture content of the concrete has been tested to AS/NZS 2455.1 Appendix B and the values in clause 2.4.2 (c) have been obtained.
- Plywood and timber: the moisture content of battens/joists or plywood background has been tested to AS/NZS 080.1 and values obtained as follows:
 - . Airconditioned buildings: 8 to 10%.
 - . Intermittently heated buildings: 10 to 12.5%.
 - . Unheated buildings: 12 to 15%.

Fixtures: Remove door stops and other fixtures, and refix in position undamaged on completion of the installation.

Refer to NATSPEC TECHnote NTN DES 008.

Working environment

General: Do not start work before the building is enclosed, wet work is complete and dry, and good lighting is available. Protect adjoining surfaces.

Conditioning

General: Stabilise the room temperature for seven days prior to, and two days after, installation of resilient finishes, as follows:

- Areas with airconditioning installed: Run airconditioning at operational temperature.
- Airconditioned areas not operational: Maintain a room temperature range of < 27° > 18°C.
- Underfloor heating: Turn off heating 48 hours prior to laying.
- Un-airconditioned areas: Install at < 27° > 18°C.

Change of finish

General: Maintain finished floor level across changes of floor finish including carpet.

3.2 SHEET INSTALLATION

Sheet set out

General: Set out sheets to give the minimum number of joints. Run sheet joints parallel with the long sides of floor areas, vertically on walls.

Non welded joints

Linoleum: Butt edges together to form neat open joints the thickness of a credit card.

Delete if joints are welded.

Welded joints

Heat welding: After fixing, groove the seams using a grooving tool and weld the joints with matching filler cable and using a hot air welding gun. Ensure the welding cable type, gun heat and operating speed are appropriate for the flooring material. When the weld rod has cooled, trim off flush.

Perimeter sealing

Wet areas and areas of wet maintenance: Seal the perimeter of the flooring behind skirtings with wet area silicone sealant.

Delete sealing if welded coved skirtings are installed.

Static dissipative or Static conductive vinyl and linoleum sheeting

Installation: As nominated in the Forbo Floorcoverings Installation Guide.

Provide an earthing system if electrical resistance to earth or a conductive floor is required. The earthing grid will consist of metallic strips laid directly under the flooring material, connection to building is made by a qualified electrician – a back up connection is recommended. Metal fixtures and fittings should be isolated from the flooring. Additional requirements e.g. earthing rails, placement of switches and outlets outside the area, atmosphere ionisation and humidity controls may be required – include these under the relevant worksection.

3.3 TILE INSTALLATION

Tile set out

General: Set out tiles from the centre of the area. Wherever possible cut tiles at margins only, to give a cut dimension of at least 100 mm x full tile width. Match edges and align patterns. Arrange the material so that variation in appearance is minimised.

Junctions

General: Scribe neatly up to returns, edges, fixtures and fittings. Finish flush with adjoining surfaces.

Rolling

General: Where rolling is required, roll the finish in 2 directions before the adhesive sets, using a 68 kg multi-wheeled roller.

Cleaning

General: Keep the surface clean as the work proceeds.

3.4 STAIRS

Vinyl and linoleum finish

Scribed and adhered: Install to the following sequence:

- Risers.
- Proprietary stair nosing.
- Treads.

3.5 JOINTS AND ACCESSORIES

At areas of heavy use, particularly with wheeled traffic, consider specifying a prototype test for the joint product installation using the anticipated wheeled equipment.

Accessories

General: Provide purpose-made matching moulded accessories for nosings, coves, skirtings, edge cover strips and finishes at junctions, margins, and angles, if available. Otherwise form accessories from the sheet material. Provide solid backing for radiused coves and nosings.

Junctions

General: Finish junctions tapered to with adjoining surfaces. Where changes of floor finish occur at doorways locate the joint on the centreline of the closed door leaf.

If the floor finish is to be divided into bays, specify here the bay size, dividing strip or joint filler. Delete if not required. be subject to heavy use.

Edge strips

Locations: Provide edge cover strips at junctions with different floor finishes and to exposed edges.

Metal cover strip: Extruded tapered strip 25 mm wide, of the same thickness as the sheet or tile. Fix with matching screws to timber bases or to masonry anchors in concrete bases, at 200 mm maximum centres.

- Material: [complete/delete]

e.g. 'Brass', 'Stainless steel' or 'Aluminium'.

UPVC cover strip: Feather-edge strip matching the floor finish, fixed with contact adhesive.

- Width (mm): [complete/delete]

e.g. '25 mm', '50 mm'.

- Colour: [complete/delete]

Movement joints

Location: Provide movement joints as follows:

- Over structural (isolation, contraction, expansion) joints.
- At junctions between different substrates.

Depth of joint: Right through to the substrate.

Sealant width: 6 – 25 mm.

Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Movement joint materials – sheet flooring

Proprietary slide plate divider strip: An arrangement of interlocking metal plates grouted into pockets formed in the concrete joint edges to finish flush with the flooring surface.

Movement joints schedule – Proprietary slide plate

Location			
Product			
Material			
Insert colour			

Location: State here or refer to a Finishes schedule.

Proprietary slide plate:

- Nominate the product type suitable for the anticipated movement.
- Material: e.g. stainless steel.
- Insert colour: Nominate colour or omit if no insert.

Coiled vinyl skirting

Select from the following.-

Feather edge: Forbo moulded PVC skirting section.

Intended for use with PVC or similar flat surface floor finishes, feather edge provides coverage of floor termination at the vertical surface. Occasionally used where partitions are retro fixed over carpet.

Fixing: Scribe as necessary. Mitre corners. Fix to walls with contact adhesive.

Minimum height: 100 mm.

Preformed vinyl covered skirtings

Provide where a continuous surface is required e.g. Wet areas, wet mopping, hygiene and clean rooms. A sealant or cover mould may be necessary at the joint with the wall finish, the door jamb profile and width may require special consideration to ensure a sealed overlap where the coving terminates at the door jamb.

Product: Forbo Preformed Vinyl Coving.

Installation: Carry the flooring material to the profiled coving section as appropriate for 'sit-on' or 'set-in' products to form a skirting.

Preformed linoleum covered skirtings

Product: Forbo Pre-formed Linoleum Coving (set-in) with resin and glass fibre backing support.

Thickness: 2.5 mm.

3.6 COMPLETION**Protection of sheet materials**

General: Keep traffic off floors until bonding has set or for 24 hours after laying, whichever period is the longer. Do not allow water in contact with the finish for 7 days.

Reinstatement: Repair or replace faulty or damaged work. If the work cannot be repaired satisfactorily, replace the whole area affected.

Warranties

- Form: Manufacturer warranties are available from the Forbo customer services department: Provide the following:
- For each type of resilient finish specified, submit the installer's warranty of the workmanship and application.
- For each type of resilient finish specified, submit the Forbo product warranty.

Minimum period: [complete/delete]

Certificate of compliance

General: Provide a Certificate of compliance for antistatic and conductive floor installations.

Maintenance manual

General: Submit Forbo published use, care and maintenance requirements for each type of finish.

The following publications are available:

Cleaning and Maintenance – Slip resistant, Linoleum, Project Vinyl

<http://www.forbo-flooring.com.au/default.aspx?menuid=658>

Spare materials

General: Supply spare matching covering materials and accessories of each type for future replacement purposes. Store the spare materials on site where directed.

Quantity: At least 1% of the quantity installed.

Spare material schedule

Material	Quantity	Storage location

Cleaning

Consult the Forbo Floor Care system brochure. For installations in existing buildings, consult the building user as to current maintenance procedures, type of polish used, etc., and make the new installations compatible as far as possible.

General: Mop and leave the finished surface clean and undamaged on completion.

Cleaning antistatic and conductive flooring

Sealers and polishes affect or destroy the antistatic properties.

General: Do not use sealers, wax or floor polish. Clean using a mild neutral detergent and lukewarm water. A clean floor may be dry buffed using a normal scrubbing machine and a white nylon pad.

4 SELECTIONS

These schedules refer to the selections of the product/material by its properties, but does not locate it within the project. For this you should prepare a separate document e.g. a Finishes schedule to locate the various finishes by reference to a designation code or abbreviation of the finish.

4.1 SCHEDULES

Sheet and tile schedule

Property	Code		
	RF1	RF2	RF3
Forbo products			
Colour			
Tile laying pattern			
Underlay			
Impact sound insulation laboratory value: -Weighted normalised impact sound pressure level (and spectrum adaption term if applicable) $L_{n,w} + (CI)$			
Impact insulation field test: -Weighted standardised impact sound pressure level (and spectrum adaption term if applicable) $L_{nT,w} + (CI)$			
Slip resistance grade: -Dry floor friction -Wet pendulum -Oil wet ramp			
Tactile indicators – directional: -Product -Colour			

Property	Code		
	RF1	RF2	RF3
Tactile indicators – warning: -Product -Colour			
Critical radiant flux and smoke development rate			
Skirting type			
Stairs: -Finish -Nosing			
Cover strips			

Use RF1, RF2 etc. as the finish type designation for a Finishes Schedule to your office documentation policy.

Forbo product selection: Utilise the link to the Forbo web site for the selection of the floor finish and the product characteristics.

Tile laying pattern: e.g. 'Checkerboard' or 'Stretcher bond'.

Underlay: e.g. 'Trowelled', 'Hardboard', 'Fibre cement sheet'. Consult manufacturers of resilient flooring for recommended underlay for particular applications. State thickness.

Slip resistance grade: Nominate the grade. Ensure the product selected carries the slip resistance grade for the location/application. Visit the Forbo website for the product specification.

Tactile indicators: See AS/NZS 1428.4.

- Tactile indicator colour: A colour contrast is required, in both wet and dry conditions, between the tactile indicators and the adjacent surface and that the colour provides a luminance contrast to the surrounding surface of not less than 0.3 (30%).

Critical radiant flux and smoke development rate: Refer to BCA Spec. C1.10a. Delete smoke development rate for sprinklered areas.

Skirting type: e.g. Coiled vinyl, preformed covered vinyl or preformed covered linoleum.

Cover strips: e.g. nosings, wedge fillets, tile edge trim, wall and capping trim and state whether they are to be a proprietary item, purpose-made or formed (see Junctions). For floor wastes to wet areas consult with manufacturer for special requirements e.g. flanged fittings to clamp over finish, and coordinate with the **Sanitary drainage** clause in the Wastewater worksection.

Synthetic sporting surfaces schedule

Property	Code		
	SS1	SS2	SS3
Type			
Sport/activity			
Underlay			
Surface product			
Skirting			
Critical radiant flux			
-Spread of flame			
-Heat evolved			
-Smoke developed			
Surface marking method			

Type: 'Indoor' or 'Outdoor'.

Sport / activity: See AS 3541.1 Table 1 'Guide to surfacing materials'.

Underlay: Consult the manufacturer of the proprietary surface for recommendations as to the need for, and type of, underlay.

Critical radiant flux: Refer to BCA Spec. C1.10a.

Surface marking method: See AS 3541.1 clause 12 for guidance.

REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

AS/NZS 1080 Timber - Methods of test

AS./NZS 1080.1 1997 Moisture content

AS/NZS 1859 Reconstituted wood based panels

AS/NZS 1859.4 2004 Wet-processed fibreboard

AS/NZS 2455 Textile floor coverings - Installation practice

AS/NZS 2455.1 2007 General

AS/NZS 2455.2 2007 Textile floor coverings - Installation practice - Carpet tiles

AS 2834 1995 Computer accommodation

AS/NZS 2908 Cellulose-cement products

AS/NZS 2908.2 2000 Flat sheets

AS 4155 Test methods for general access floors

AS 4155.6 1993 Test methods for general access floors - Test for floor resistance for electrostatic control

AS ISO 9239 Reaction to fire tests for floor coverings

AS ISO 9239.1 2003 Determination of the burning behaviour using a radiant heat source

BS EN 548 2004 Resilient floor coverings – Specification for plain and decorative linoleum

BS EN 650 1997 Resilient floor coverings. Polyvinyl chloride floor coverings on jute backing or on polyester felt backing or on polyester felt with polyvinyl chloride backing. Specification

BS EN 651 1997 Resilient floor coverings - Polyvinyl chloride floor coverings with foam layer. Specification

BS EN 685 2007 Resilient textile and laminate floor coverings. Classification

BS EN 688 1997 Resilient floor coverings – Specification for corklinoleum

The following documents are mentioned only in the guidance text:

AS/NZS 1428 various Design for access and mobility

AS/NZS 1428.4 2002 Tactile indicators

AS 3541 Synthetic sporting surfaces

AS 3541.1 1988 General principles

BCA Spec C1.10a Fire resistance - Fire hazard properties - Floors, walls and ceilings

BEDP EDG PRO 13 2003 Polyvinyl chloride - Manufacture

BEDP EDG PRO 14 2002 Polyvinyl chloride - Products, use and disposal

NTN DES 001 2005 Slip resistance

NTN DES 007 2006 Static control floors

NTN DES 008 2006 Preparation of concrete substrates

NATSPEC TECHreport Specifying ESD

ISO 14001 2004 Environmental management systems - Requirements with guidance for use

BCA citations of the above referenced standards include:

AS/NZS 2908.2 A1.1 General provisions - Interpretation - Definitions - Fire-protective covering

AS ISO 9239.1 A1.1 General provisions – Interpretation – Definitions – Critical radiant flux and smoke development rate