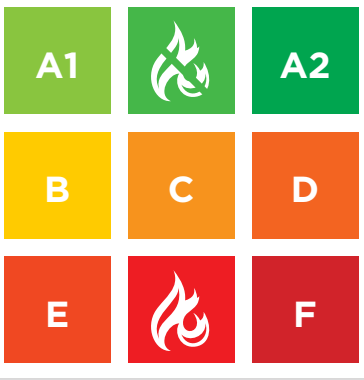
SANS 53501-1

Fire classification of insulation products and building elements Part 1: Classification using data from reaction to fire tests



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TIPSASA 2023 Guide to fire classification of thermal insulation products using data from reaction to fire tests.

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THERMAL INSULATION PRODUCTS & SYSTEMS ASSOCIATION SA

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DISCLAIMER

INTRODUCTION

The revision of SANS 10400-T *Fire Protection* contains changes, effective 31 December 2023, regarding the migration of SANS *428 Fire performance classification of thermal insulated building envelope systems* to SANS 53501-1 *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests.*

SANS 53501-1 is an adoption of EN 13501-1.

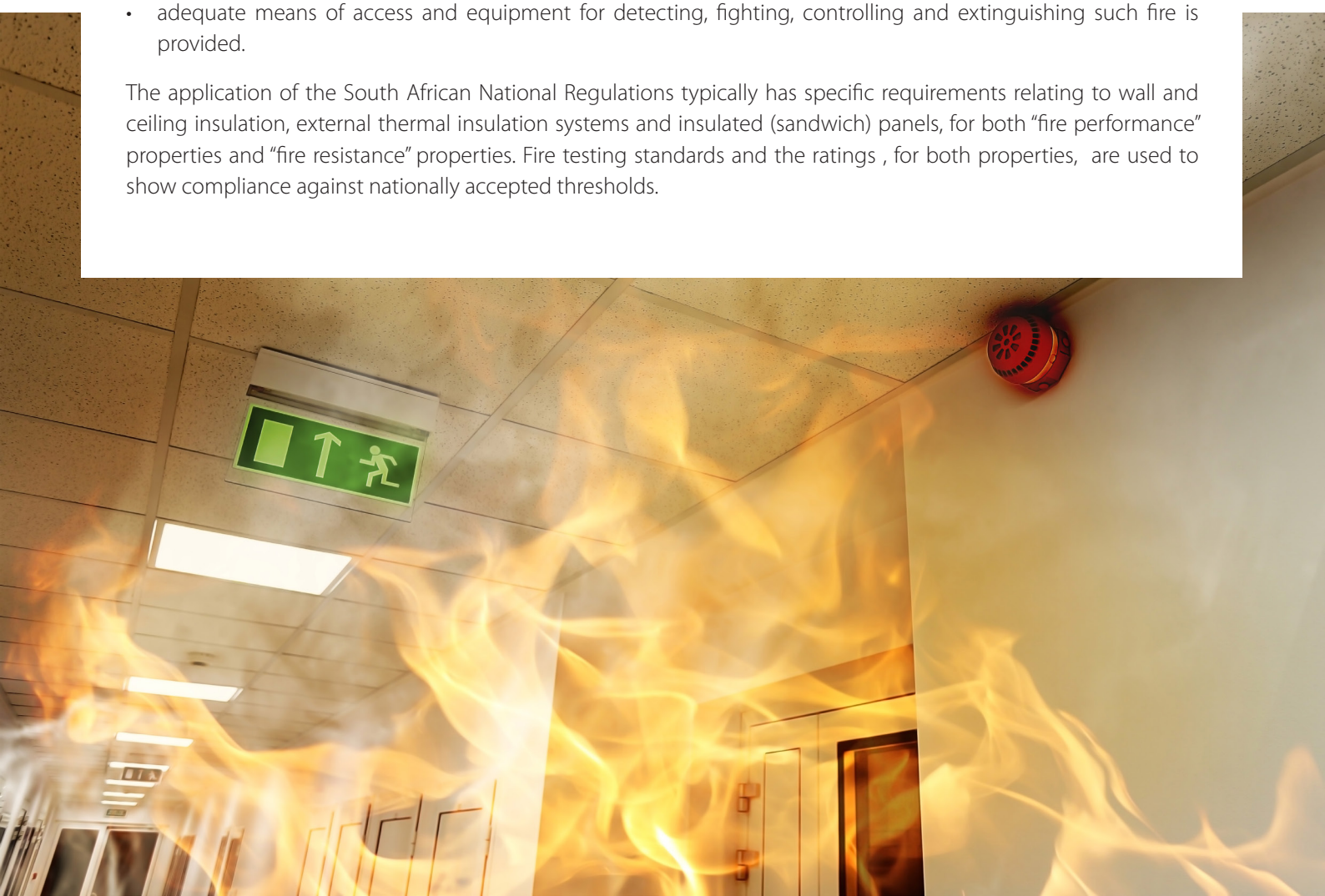
South African Regulatory Requirements

According to the General Requirements of the application of the South African National Building Regulations SANS 10400 Part T: Fire Protection

Any building shall be so designed, constructed and equipped that in case of fire –

- the protection of occupants or users therein is ensured, and that provision is made for the safe evacuation of such occupants or users;
- the spread and intensity of such fire within such building and the spread of fire to any other building will be minimized;
- sufficient stability will be retained to ensure that such building will not endanger any other building: Provided that in the case of any multi-storey building no major failure of the structural system shall occur;
- the generation and spread of smoke will be minimized or controlled to the greatest extent reasonably practicable;
- adequate means of access and equipment for detecting, fighting, controlling and extinguishing such fire is provided.

The application of the South African National Regulations typically has specific requirements relating to wall and ceiling insulation, external thermal insulation systems and insulated (sandwich) panels, for both "fire performance" properties and "fire resistance" properties. Fire testing standards and the ratings , for both properties, are used to show compliance against nationally accepted thresholds.



Why the change?

Most locally manufactured products achieve a B/B1/2/H&V fire classification with very little differentiation when classified according to SANS 428.

In 2013 the Thermal Insulation Industry in South Africa voted in favour of adopting European Standards, specifically the construction products classification EN 13501-1 Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests. (SANS 53501-1). The purpose of harmonization with European Standards is to facilitate the free movement of trade in building products by removing trade barriers due to differences in test methods and classification systems.

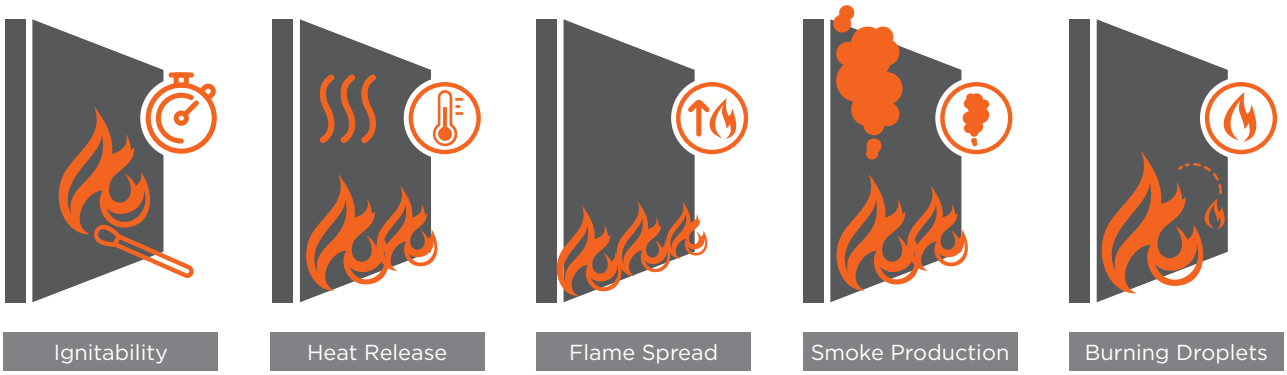
In accordance with the WTO/TBT agreement, the standardising body ensures that standards are not prepared, adopted, or applied with a view to, or with the effect of, creating unnecessary obstacles to international trade. Thermal Insulation material manufactured in South Africa will now be on par with the "Euro-standard", enabling trade across Europe.

Local manufacturers will have to re-test to obtain a classification for their products. Although the classification will be accepted throughout Europe, it does not mean that you will be able to use a product in the same building occupancy as classifications may vary from country to country. It is a harmonized classification system. Each country still has their own building regulations/codes. For example, in France, if you are using your material in a hotel lobby, they may ask for a product which is at least a Euro-class "C", whilst in the UK, you may be asked for a product of at least a Euro-class "B".

What are the test requirements?

There is a total of four new **Reaction to Fire test** standards and one Classification standard for wall, ceiling and roof insulation:

1. EN ISO 1182 (SANS 11820 or SANS 10177-5) – non combustibility test
2. EN ISO 1716 (SANS 1743) – bomb calorimeter test (provides a calorific value)
3. EN 13823 (SBI) (SANS 53823) – heat release and smoke production test
4. EN ISO 11925-2 (SANS 11925-2) – ignitability test



The classification is in accordance with:

EN 13501-1 (SANS 53501-1) – classification standard (tells you how to use the four test standards in order to obtain a classification)

Class & Criteria

A combination of the tests are used to obtain a classification from "A1" (best) down to "F" (worst).

In order to obtain an "**A1**" classification, SANS 10177-5 (SANS 11820) and SANS 1743 must be performed and the criteria in SANS 53501-1 must be met.

In order to obtain an "**A2**" classification, SANS 53823 (SBI) must be performed, together with a test to SANS 10177-5 or SANS 1743. These results must meet the criteria in SANS 53501-1. In order to obtain a "**B**", "**C**" or "**D**" classification, SANS 11925-2 **and** SANS 53823 (SBI) must be performed. The results obtained will designate the classification, depending on the criteria specified in SANS 53501-1.

In order to obtain an "**E**" classification, SANS 11925-2 must be performed and the criteria in SANS 53501-1 must be met. In addition, an "**E**" classification must also test to SANS 10177-11.

"**F**" is designated for a product that has no performance determined. A product is assigned an F if it fails to meet the minimum criteria for an E classification. An F classification would under no circumstances be allowed in an interior building application.

All the materials classified A2, B, C, D and E obtain an additional classification regarding the emission of smoke and the production of flaming droplets and/or particles.

"s" - Smoke emission level: values range from 1 (absent/weak) to 3 (high)
"d" - Droplets: flaming and/or particles - values range from 0 (absent) to 2 (high)

Classes of reaction to fire performance for thermal insulation products

CLASS	TEST METHODS	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
A1	SANS 11820 [a] and	$\Delta T \leq 30°$ C; and $\Delta m \leq 50\%$; and $t_f = 0$ (i.e. no sustained flaming, tr ≤ 5 s)	-
	SANS 1743	PCS ≤ 2.0 MJ/kg [a] and PCS ≤ 2.0 MJ/kg [b c] and PCS ≤ 1.4 MJ/m^2 [d] and PCS ≤ 2.0 MJ/kg [e]	-
A2	SANS 11820 [a] or	$\Delta T \leq 50°C$; and $\Delta m \leq 50\%$; and $t_r \leq 20$ s	-
	SANS 1743 and	PCS ≤ 3.0 MJ/kg [a] and PCS ≤ 4.0 MJ/m^2 [b] and PCS ≤ 4.0 MJ/m^2 [d] and PCS ≤ 3.0 MJ/kg [e]	-
	SANS 53823	FIGRA ≤ 120 W/s; and LFS < edge of specimen; and THR $_{600s}$ ≤ 7.5 MJ	Smoke production [f] and Flaming droplets/particles [g]
CLASS	**TEST METHODS**	**CLASSIFICATION CRITERIA**	**ADDITIONAL CLASSIFICATION**
B	SANS 53823 and	FIGRA ≤ 120 W/s; and LFS < edge of specimen; and THR $_{600s}$ ≤ 7.5 MJ	Smoke production [f] and Flaming droplets/particles [g]
	SANS 11925-2 [l] Exposure = 30 s	Fs ≤ 150mm within 60s	
C	SANS 53823 and	FIGRA ≤ 250 W/s; and LFS < edge of specimen; and THR $_{600s}$ ≤ 15 MJ	Smoke production [f] and Flaming droplets/particles [g]
	SANS 11925-2 [l] Exposure = 30 s	Fs ≤ 150mm within 60 s	
D	SANS 53823 and	FIGRA ≤ 750 W/s	Smoke production [f] and Flaming droplets/particles [g]
	SANS 11925-2 [l] Exposure = 30 s	Fs ≤ 150mm within 60 s	
E	SANS 11925-2 [l] Exposure = 15 s	Fs ≤ 150mm within 20 s	Flaming droplets/particles [f]
F	No performance determined		

[a] For homogenous products and substantial components of non-homogenous products.
[b] For any external non-substantial components of non-homogenous products.
[c] Alternatively, any external non-substantial component having a PCS ≤ 2.0 MJ/m^2, provided that the product satisfies the following criteria of SANS 53823: FIGRA ≤ 20W/s, and LFS < edge of specimen and THR $_{600s}$ ≤ 4.0 MJ and s1, and d0.
[d] For any internal non-substantial component of non-homogenous products.
[e] For the product as a whole.
[f] In the last phase of the development of the test procedure, modifications of the smoke measurement system have been introduced, the effect of which needs further investigation. This may result in a modification of the limit values and/or parameters for the evaluation of the smoke production.
s1 = SMOGRA ≤ 30m^2/s^2 and TSP $_{600S}$ ≤ 50m^2;
s2 =SMOGRA ≤ 180m^2/s^2 and TSP$_{600S}$ ≤ 200m^2;
s3 = not s1 or s2.
[g] d0 = No flaming droplets/particles in SANS 53823 within 600 s;
d1 = No flaming droplets/particles persisting longer than 10 s in SANS 53823 within 600 s;
d2 = not d0 or d1.
Ignition of paper in SANS 11925-2 results in a d2 classification
[h] Pass = no ignition of paper (no classification; Fail = ignition of the paper (d2 classification)
l Under condition of surface flame attack and, if appropriate to the end-use of the product, edge flame attack.

EXPLANATORY TERMS					
ΔT	Temperature rise (k)	LFS	Lateral flame spread (m)	THR	Total heat release (MJ)
Δm	Mass loss (%)	tr	Duration sustained flaming (s)	PCS	Gross calorific potential (MJ/kg or MJ/m^2)
FIGRA	Fire growth rate	SMOGRA	Smoke growth rate	PCI	Net calorific potential (MJ/kg or MJ/m^2)
F_s	Flame spread (mm)	TSP	Total smoke production	For more info purchase SANS 53501-1 from SABS.	

SANS 10177-5 / SANS 11820

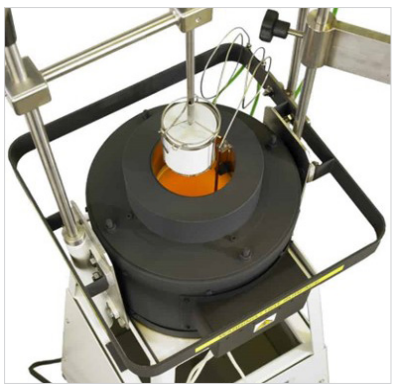
Reaction to fire tests for building products – Non-combustibility test

This single zone furnace has a maximum operating temperature of 750°C. During a test, the `temperature of the furnace, specimen surface and specimen centre thermocouples are recorded at a rate of 30 seconds per reading and the temperatures displayed on a graph in real time. Also, the initial, maximum and final temperatures recorded by the two thermocouples are displayed during the test run.

The test report shows the material information, the initial, maximum, and final temperatures, the required temperature rises, the total flaming time, the mass loss (actual and as a percentage of the initial mass) and a graph of the recorded temperatures against time. The test report also includes a reference to the pass-fail criteria given in the appropriate standards and states whether the specimen meets these criteria.


Photo: Courtesy of Ignis Testing

Major changes in the determination of non-combustibility



YEAR	2012 - 2022	2023/2024	2023/2024
Classes	A	A1	A2
Temperature furnace	750°C	750°C	750°C
Temperature increase	ΔT ≤ 50°C	ΔT ≤ 30°C	ΔT ≤ 50°C
Mass loss	-	Δm ≤ 50%	Δm ≤ 50%
Sustained flaming	tf 10s	tf 5s	tf 20s
Test duration	30 min	30 min	30 min


Photo: Courtesy of Ignis Testing

SANS 1743
Reaction to fire tests for building products – Determination of the heat of combustion

The Bomb Calorimeter is an affordable high resolution temperature regulated oxygen bomb calorimeter with embedded control computer.

The bomb calorimeter is the most common device for measuring the heat of combustion or calorific value of a material. With this apparatus a test specimen of specified mass is burned under standardised conditions. The heat of combustion determined under these conditions is calculated on the basis of the observed temperature rise while taking account of heat loss. The combustion process is initiated inside an atmosphere of oxygen in a constant volume container, the bomb, which is a vessel built to withstand high pressures.


Photo: Courtesy of Ignis Testing

SANS 53823
Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item

The Single Burning Item (SBI) is a method of test for determining the reaction to fire behaviour of building products (excluding floorings) when exposed to the thermal attack by a single burning item (a sand-box burner supplied with propane).

The basis of the research for the SBI test was the correlation between the performance of the SBI and the time to reach flashover in the room corner test (ISO 9705).

The specimen is mounted on a trolley that is positioned in a frame beneath an exhaust system. The reaction of the specimen to the burner is monitored instrumentally and visually. Heat and smoke release rates are measured instrumentally, and physical characteristics are assessed by observation.


Photo: Courtesy of Ignis Testing

SANS 11925-2
Reaction to fire tests for building products – Ignitability of building products subjected to direct impingement of flame – Part 2 Single flame source test

The Single Flame Source Test is built in accordance with "SANS 11925-2: Reaction to fire tests for building products - Part 2: Ignitability when subjected to direct impingement of flame".

The apparatus is based on the German Kleinbrenner method for determining ignitability of building products in the vertical orientation by direct small flame impingement under zero impressed irradiance.

Fire classification of thermal insulation products per building occupancy classes

CLASS OF BUILDING OCCUPANCY		FIRE CLASS SANS 428 OR BETTER	REACTION TO FIRE CLASSIFICATION SANS 53501-1 THE CLASSIFICATION INDICATED OR BETTER		
			SINGLE STOREY	DOUBLE STOREY	3 STOREYS OR MORE
A1	Entertainment & public assembly	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
A2	Theatrical and indoor sport	B/B1/2	D-s3,d2	C-s3,d2	A2-s1,d0
A3	Places of instruction	B/B1/2	D-s3,d2	C-s3,d2	B-s3,d2
A4	Worship	B/B1/2	D-s3,d2	C-s3,d2	A2-s1,d0
A5	Outdoor sport	B/B4/B	E-s3,d2	D-s3,d2	A2-s1,d0
B1	High risk commercial service	B/B1/2	A2-s1,d0	A2-s1,d0	A2-s1,d0
B2	Moderate risk commercial service	B/B1/2	D-s3,d2	C-s3,d2	A2-s1,d0
B3	Low risk commercial service	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
C1	Exhibition hall	B/B1/2	D-s3,d2	C-s3,d2	A2-s1,d0
C2	Museum	B/B1/2	D-s3,d2	C-s3,d2	A2-s1,d0
D1	High -risk industrial	B/B1/2	A2-s1,d0	A2-s1,d0	A2-s1,d0
D2	Moderate-risk industrial	B/B1/2	D-s3,d2	C-s3,d1	A2-s1,d0
D3	Low-risk industrial	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
D4	Plant room	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
E1	Place of detention	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
E2	Hospital	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
E3	Other institutional (residential)	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
E4	Health care	B/B1/2	A2-s1,d0	A2-s1,d0	A2-s1,d0
F1	Large shop	B/B3/3	D-s3,d2	C-s3,d1	A2-s1,d0
F2	Small shop	B/B3/3	D-s3,d2	C-s3,d2	A2-s1,d0
F3	Wholesalers' store	B/B3/3	D-s3,d2	C-s3,d2	A2-s1,d0
G1	Offices	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
H1	Hotel	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
H2	Dormitory	A/A1/1	A2-s1,d0	A2-s1,d0	A2-s1,d0
H3	Domestic residence	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
H4	Dwelling House	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
H5	Hospitality	B/B3/3	D-s3,d2	C-s3,d2	A2-s1,d0
J1	High-risk storage	B/B1/2	A2-s1,d0	A2-s1,d0	A2-s1,d0
J2	Moderate-risk storage	B/B1/2	C- s3,d2	B-s3,d2	A2-s1,d0
J3	Low-risk storage	B/B3/3	E-s3,d2	D-s3,d2	A2-s1,d0
J4	Parking garage	B/B4/4	D-s3,d2	C-s3,d2	A2-s1,d0

Example of fire classes & criteria – in addition: smoke and droplets

The main part of the classification is its letter – A1, A2, B, C, D, E and F.

A1 is the highest level of performance, with F the lowest performance level

A2 – s1, d0

There is a smoke classification of S1 (absent/ weak), S2 or 3 (high)

There is a classification of flaming droplets of d0, d1 or d2. d0 is the best level of performance (absent) and d2 is the worst performance level (high).

Fire Resistance vs Fire Retardant abilities

Fire Resistance is often confused with Fire Retardant abilities. The main function of thermal insulation material is to reduce heat transmission through the building envelope (roof, walls and floors) and provide an acceptable finish to the inside of the building. Insulation is not intended as fire barriers, unless designed and tested in accordance with SANS 10177-2 Fire resistance test for building elements – the shortest period for which a building insulation element or component will comply with the requirements for stability, and integrity. Thermal insulation used in buildings must not contribute to the spread of a fire, hence the inclusion of fire retardants. The incorporation of a fire retardant does not make a product "safe" or non-combustible, it may make it more difficult to ignite and retard the rate of combustion or ease of ignition, to enable sufficient time for evacuation.

SANS 10177-2 Photo courtesy of Firelab

Fire Resistance Testing

SANS 10177-2 Fire resistance test for building elements – the shortest period for which a building insulation element or component will comply with the requirements for stability, and integrity.

The construction detail of the assembly should be clearly described in the test report, complete with fasteners, structure, sealants and size.

Pending on the type of occupancy class, requirements will clearly indicate, 30min, 60min or 120min.

External Thermal Insulation Cladding Systems (ETICS)

ETICS is the abbreviation for External Thermal Insulation Composite System. ETICS can be used to improve the energy efficiency of both new and existing buildings. Insulating the exterior of a building's structure provides an optimal thermal envelope and reduces thermal bridging.

ETICS consist of various types of insulating cores, like glass fibre or polystyrene etc. and the necessary components for fixing to the outside wall with adhesive, anchors or mechanically with rails. After that they are coated with plaster that has been reinforced with woven glass fibre mesh. The final layer consists of the finishing plaster or the desired surface material. ETICS can be used for a great variety of buildings.

The core materials of ETICS are classified in accordance with SANS 53501-1 however the complete system must be tested in accordance with SANS 8414.

The fire safety of an external insulating cladding system, which is either fitted to the structural external wall or frame, must comply with the requirements for temperature, flame spread, mechanical failure such as flaming debris and debris falling down during the evaluation of the system when tested in accordance with SANS 8414-1 Fire performance of external cladding systems - Test method for non-loadbearing external cladding systems applied to the masonry face of a building and/or SANS 8414-2 Fire performance of external cladding systems - Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame.

SANS 8414 Test - Photos courtesy of Firelab & Technopol SA

5 Golden Fire Safety Design Rules

1. Safe escape & evacuation.
2. Limit fire to origin, no spread.
3. Retain structural stability, no endangerment to any other building.
4. Limit spread of fire & smoke.
5. Stable infrastructure for safe evacuation & fire fighting.

Principle of Assessment

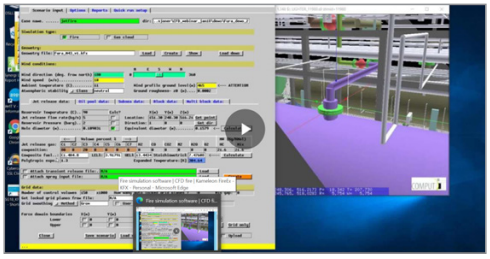
Assessment should determine the following possible fire hazards:

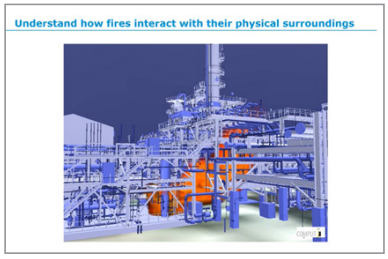
- the contribution of the system to fire development up to flashover;
- the potential for transmitting an interior fire to outside spaces or other compartments or adjacent buildings;
- the possibility of structural collapse;
- the development of smoke and fire gases inside the test room.

Fire Simulation

Fire simulation software now allows you to test your designs with ease.

- The classification data from reaction to fire tests can be used to do fire modelling.
- Fire modelling is a tool used by engineers during their research, fire investigators and teaching institutions to study the behaviour of fire outbreaks and to make assumptions on the performance in a fire at design stage.





TIPSASA
Ground Floor, West Wing
AAAMSA House
2 Superior Road, Halfway House
Midrand, 1685

Tel: 0861 000 334
Cell: 082 305 8559
E-mail: info@tipsasa.co.za

www.tipsasa.co.za

TIPSASA
THERMAL INSULATION PRODUCTS & SYSTEMS ASSOCIATION SA