

*SPS.MYP.G6006: Acoustic Multi-Functional Composites for  
Environmental Risks and Health Hazards Reduction*

# Fire resistance testing sound-insulating and sound-absorbing composite materials

Milan Protić, P. Jovanović

University of Niš, Faculty of Occupational Safety

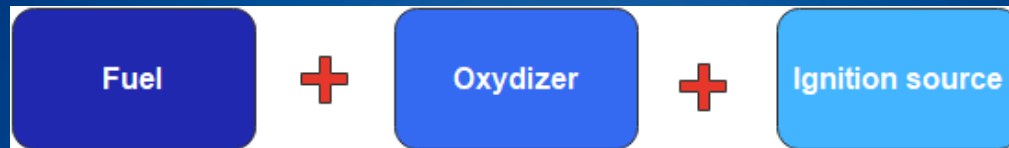


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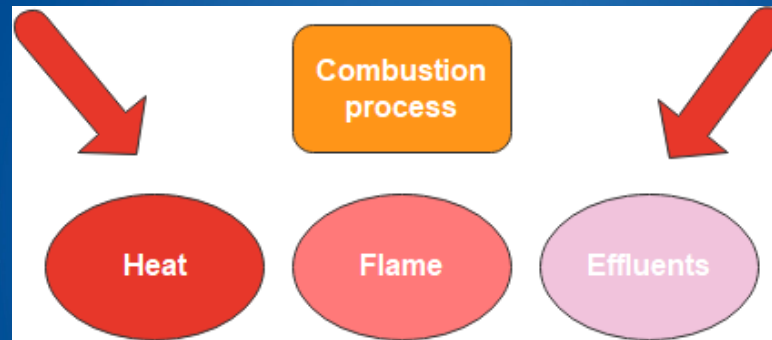
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# Combustion process and fire in brief

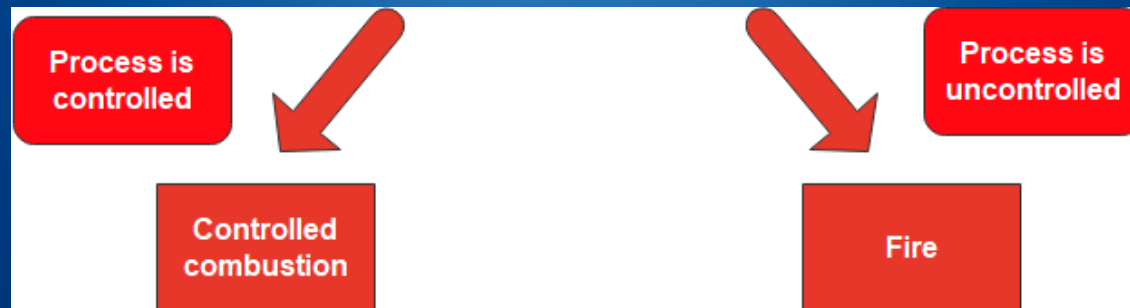
Preconditions



Process



Types

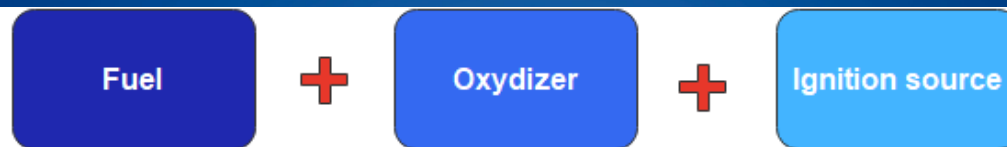


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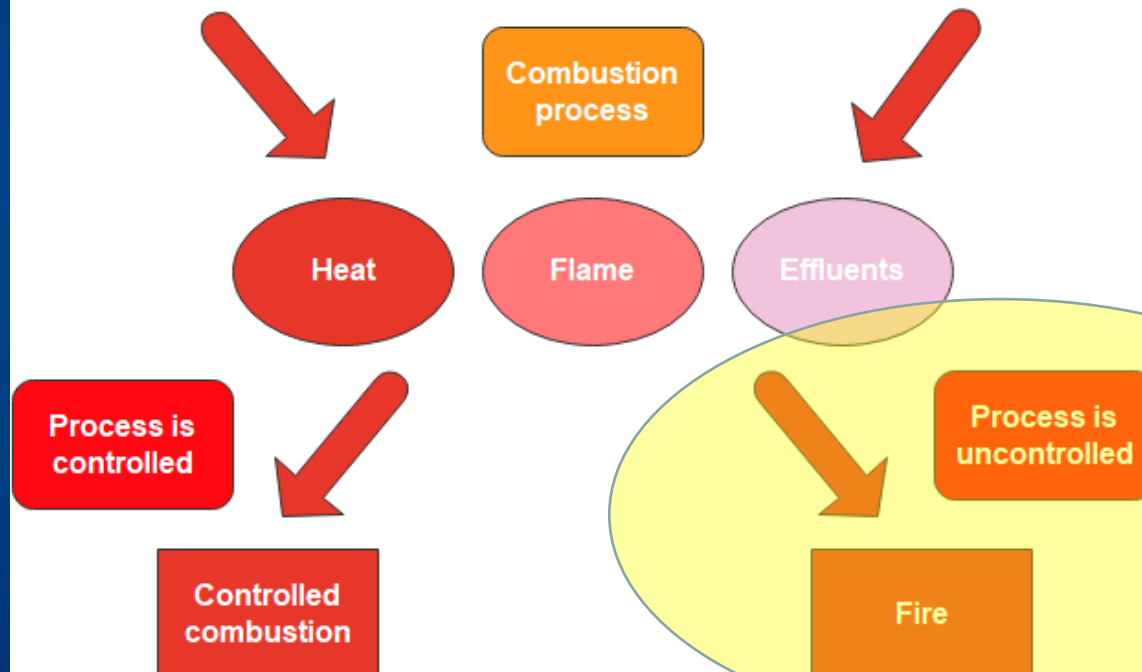
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# Combustion process and fire in brief

Preconditions



Process



Types



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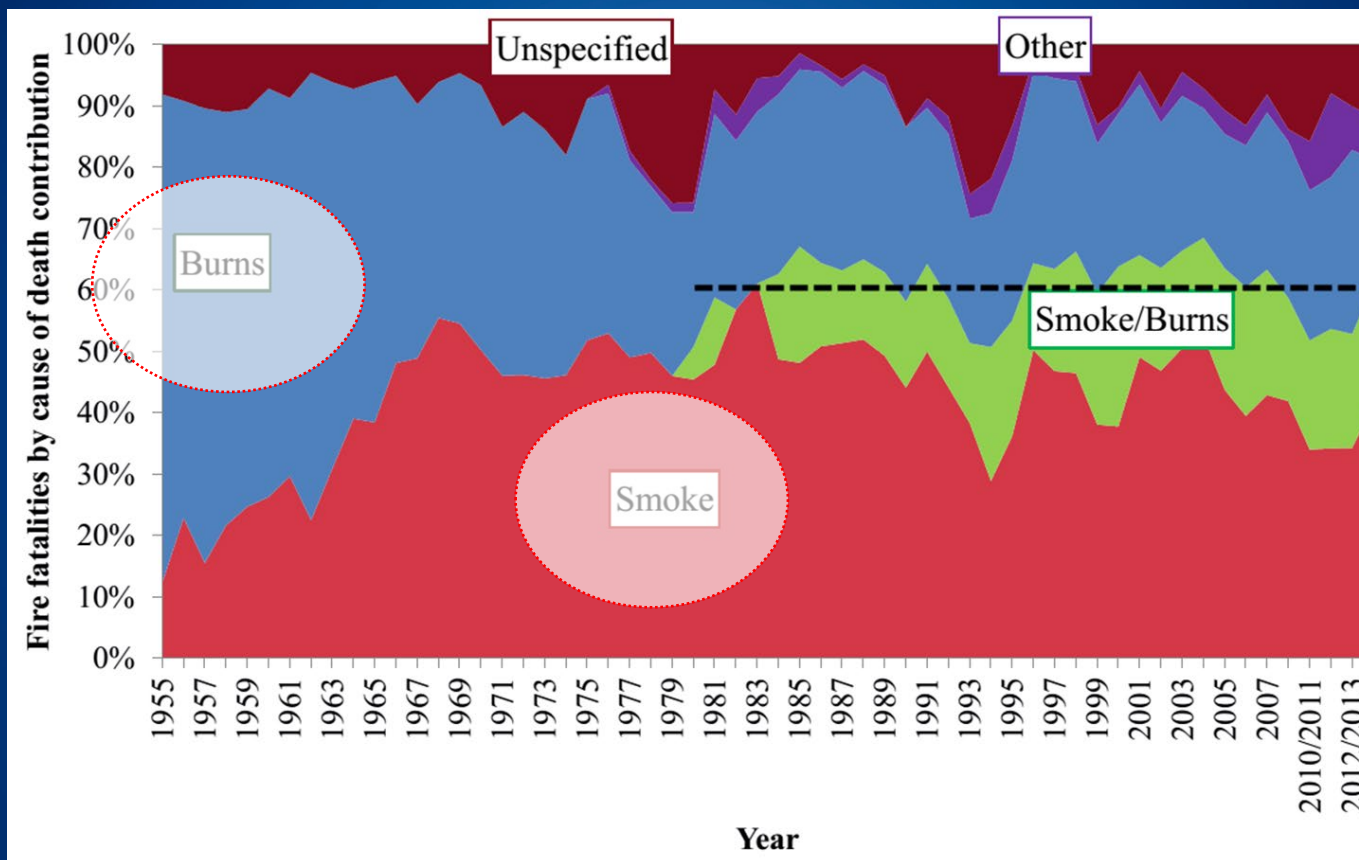
# Devastating effects of a compartment fire



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# The main causes of fatalities in fires – **Heat** and Fire effluents (Smoke)



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Data for  
UK

# Fire tests

- Fire tests have been developed to address nearly every aspect of fire behavior
- Tests are developed by leading global standardizing bodies:
  - Society of Fire Protection Engineers (SFPE)
  - National Fire Protection Association (NFPA)
  - ASTM International (formerly the American Society for Testing and Materials)
  - International Organization for Standardization (ISO)
  - European Norms (EN)
  - Underwriters Laboratories (UL)



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# Two key categories for fire testing

- **Fire resistance testing**

- Fire resistance tests are designed to check whether building construction assemblies prevent fires from spreading from the point of origin through the assembly and into adjacent compartments. These kind of tests are usually performed on building structural elements and fire-resistant barriers (walls, floors, columns, doors, and windows).

- **Reaction to fire tests**

- Reaction to fire tests evaluate how materials behave when exposed to a fire source, focusing on their immediate response. Unlike fire resistance tests, they do not measure the duration a material can endure fire exposure.



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# Fire resistance testing

- **Fire resistance test** standards ensure that structures meet the fire protection and separation standards outlined in building codes.
- In these tests, the „**fire resistance rating**„ indicates the duration the assembly can withstand standard exposure before reaching a „critical endpoint“
- The construction element undergoes exposure to a progressively intense fire, following a **standard time-temperature curve**.

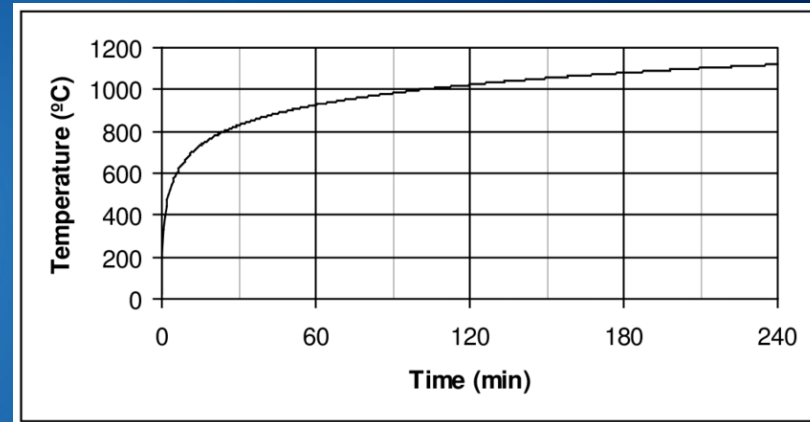
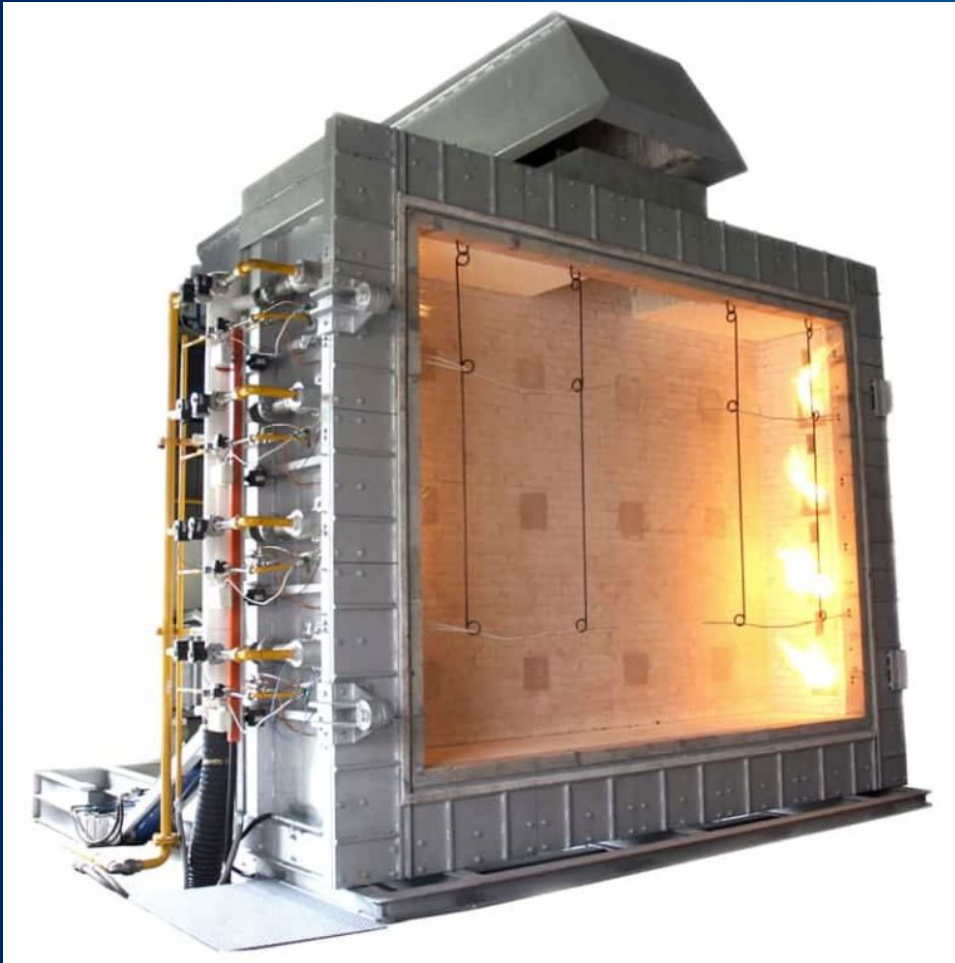


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# Large Scale Hydraulic Tilting Fire Resistance Test Furnace for Vertical & Horizontal Test Specimens



Standard time-temperature curve for an ASTM E119 fire exposure



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# Reaction to fire tests

- Most of the ongoing fire testing primarily focuses on examining reaction-to-fire characteristics
- These tests typically evaluate properties such as:
  - Ignitibility
  - Ease of extinction
  - Flame propagation
  - Smoke and release of toxic gases and
  - Heat release rate



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# Ignitibility

- Ignitability refers to a material's tendency to ignite and sustain combustion
- Key properties
  - Minimum ignition temperature
  - Critical/minimal heat flux required to initiate the ignition
  - Time to ignition under the specified incident heat flux
- While ignition temperature is crucial, only a few standards specifically address the procedures for determining it



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# Ignitibility

- The minimum ignition temperature is measured as an additional parameter during heat and smoke release tests
- Most commonly used standard for determining heat and smoke release is **ISO 5660** Reaction-to-fire tests — Heat release, smoke production and mass loss rate
- Number of flammability parameters are determined on device called Cone calorimeter



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# Ignitability

- Cone calorimeter



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# Ease of extinction

- Ease of extinction is measured indirectly via determining the combustion behavior of plastics by measuring the oxygen index at ambient temperature
- The oxygen index indicates the lowest concentration of oxygen in an oxygen-nitrogen mixture that supports material combustion
- ASTM D2863 Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)



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# Ease of extinction – ASTM D2863 instrument

- Oxygen Index



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# Flame spread

- Understanding flame spread is crucial for predicting fire growth and flashover
- Flame spread tests are widely used to gauge material performance in fire situations
- Standards
  - ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
  - ASTM E1321 Standard Test Method for Determining Material Ignition and Flame Spread Properties
  - ISO 5658 Reaction to fire tests Spread of flame Part 2: Lateral spread on building and transport products in vertical configuration



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# Flame spread - ISO 5658 Reaction to fire tests Spread of flame Part 2: Lateral spread on building and transport products in vertical configuration

- LIFT, IMO Spread of Flame Apparatus



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# Smoke and toxic gas release

- Smoke from fires poses several significant problems
- Two are the most important: reduced visibility and toxicity.
- Smoke clouds can severely limit visibility, making it difficult to escape a burning building.
- Standards
  - ASTM E662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
  - ISO 5659 Plastics - Smoke generation Part 2: Determination of optical density by a single-chamber test
  - ISO 19702, ISO/TS 21397, ISO 13344 and ISO 19703



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# Heat release rate

- Heat release rate (HRR) stands out as the most crucial parameter in assessing the size of a fire and its associated hazard
- It is significantly more important in assessing fire hazard than factors such as ignitability, fire spread, and toxic effluent emissions
- Can be determined on various scales



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# Heat release rate - bench scale

- Cone calorimeter



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# Heat release rate - bench scale

- Fire Propagation Apparatus



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# Heat release rate - medium scale

- Single Burning Item



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# Heat release rate - Full scale test

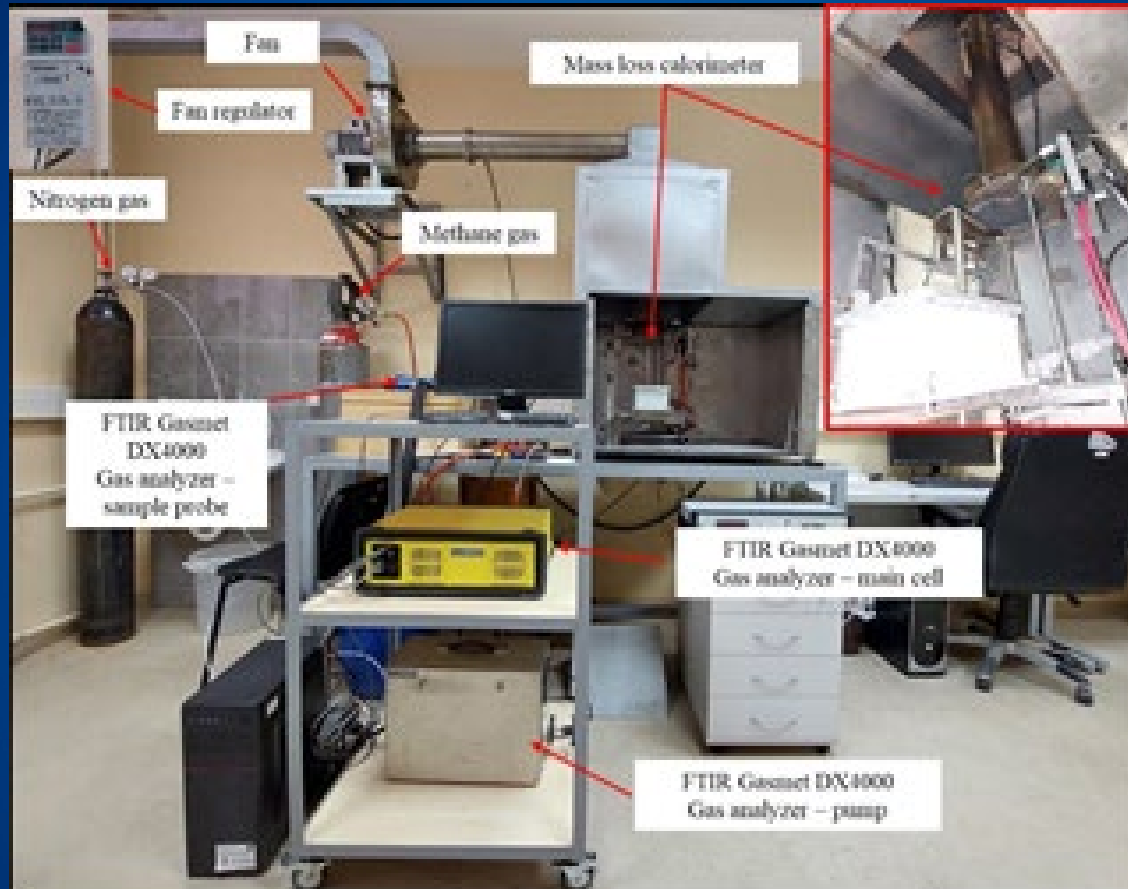
- Room Corner Test



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# FOS custom-made installation for evaluation of flammability parameters



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# Fire testing of acoustic materials - Rarity and necessity of fire testing for acoustic materials

- Fire testing for acoustic materials is often overlooked due to cost and complexity, but it is essential for ensuring comprehensive building safety
- As building designs become more complex, the integration of fire-tested acoustic materials is crucial to meet evolving safety requirements.
- Conducting regular fire tests on acoustic materials is a proactive approach to risk management, anticipating potential fire hazards before they become critical.



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# Fire testing of acoustic materials - Importance of Fire Testing for Acoustic Materials

- **Ensures Safety Compliance** - Fire testing verifies that acoustic materials meet safety standards and regulations, reducing the risk of fire hazards in buildings and public spaces.
- **Prevents Catastrophic Failures** - Acoustic materials, often made from synthetic fibers and foams, can be highly flammable.
- **Enhances Building Safety** - Fire-resistant acoustic materials help contain fires, providing more time for evacuation and reducing potential damage
- **Assures Product Reliability** - Regular fire testing confirms the performance of acoustic materials under fire conditions, ensuring they perform as intended without compromising safety
- **Improves Market Trust** - Manufacturers who conduct regular fire testing can assure customers and regulatory bodies of the safety and reliability of their products
- **Mitigates Legal and Financial Risks** - Compliance with fire safety standards through testing reduces the likelihood of legal repercussions and financial losses from fire-related incidents



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# Fire testing of acoustic materials - Recommendations

- **Regular Testing Protocols** - Establish regular fire testing schedules for all acoustic materials used in construction and manufacturing
- **Comprehensive Testing Standards** - Adhere to national and international fire safety standards to ensure thorough testing and compliance
- **Research and Development** - Invest in R&D to develop fire-resistant acoustic materials and improve existing products
- **Training and Awareness** - Educate industry professionals about the importance of fire testing for acoustic materials and the benefits it provides



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