Working Toward an Enhanced and Integrated Performance-Based Regulatory Regime for Fire Safety

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Quality Fire Safety Management

Presented at the 2015 International Symposium on Fire Science & Fire Protection Engineering Technology, October 18-20, 2015, Tianjin, China

Aim of Presentation

- Present current practices for fire safety world wide
- Developments & status of performance-based fire safety design
- Enhancements needed for performance-based fire safety design
- Need for integration of prescriptive fire performance standards with performance-based design
- Ultimate goal is to improve quality & thus fire safety

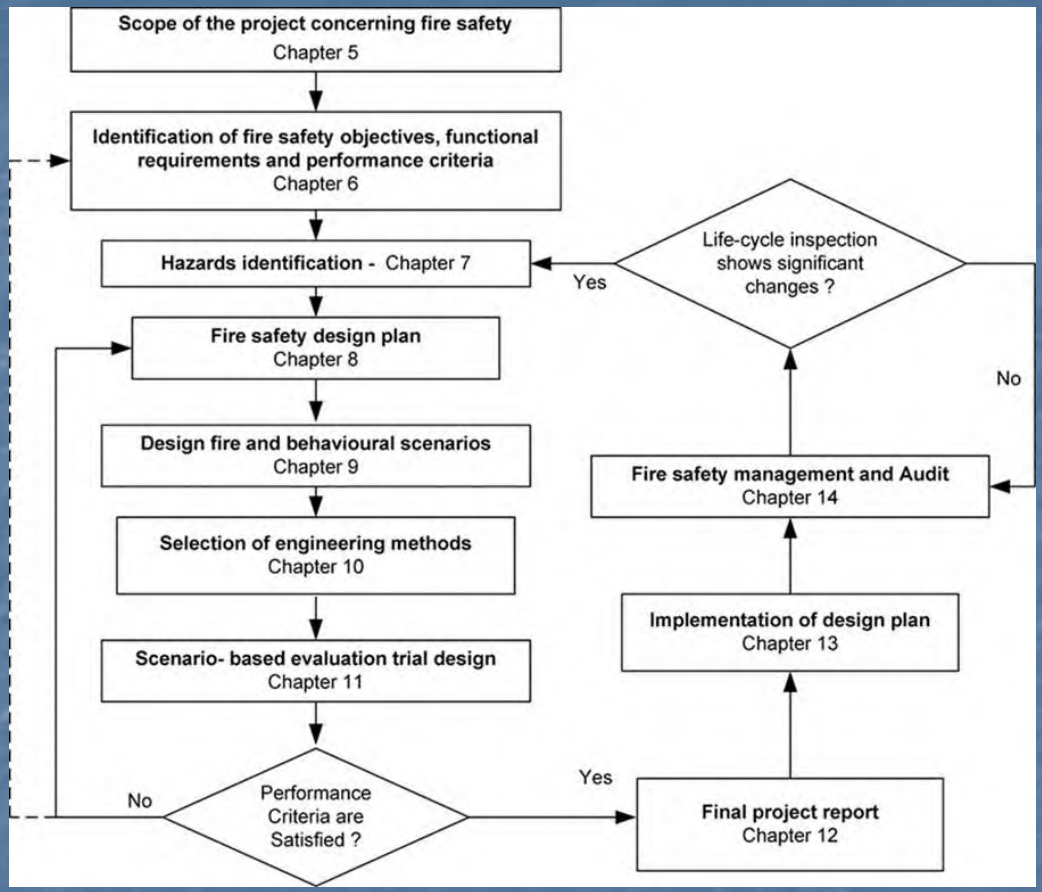
Current Practices of Fire Safety

- Product performance fire standards
  - Combustibility/Flammability
  - Resistance to fire
  - Effects of fire effluents/tenability
- Organizations that publish prescriptive product standards
  - ISO, ASTM, NFPA, etc.

Current Practices – Cont'd

- Performance-Based(P-B)/Fire safety engineering (FSE):
  - Define, safety objectives, functional requirements, & performance criteria
  - Define fire loads in building/facility
  - Conduct engineering calculations to determine if performance criteria are met
    - Tenability for life safety objectives
    - Heat flux or smoke density for equipment performance

FSE Design Process



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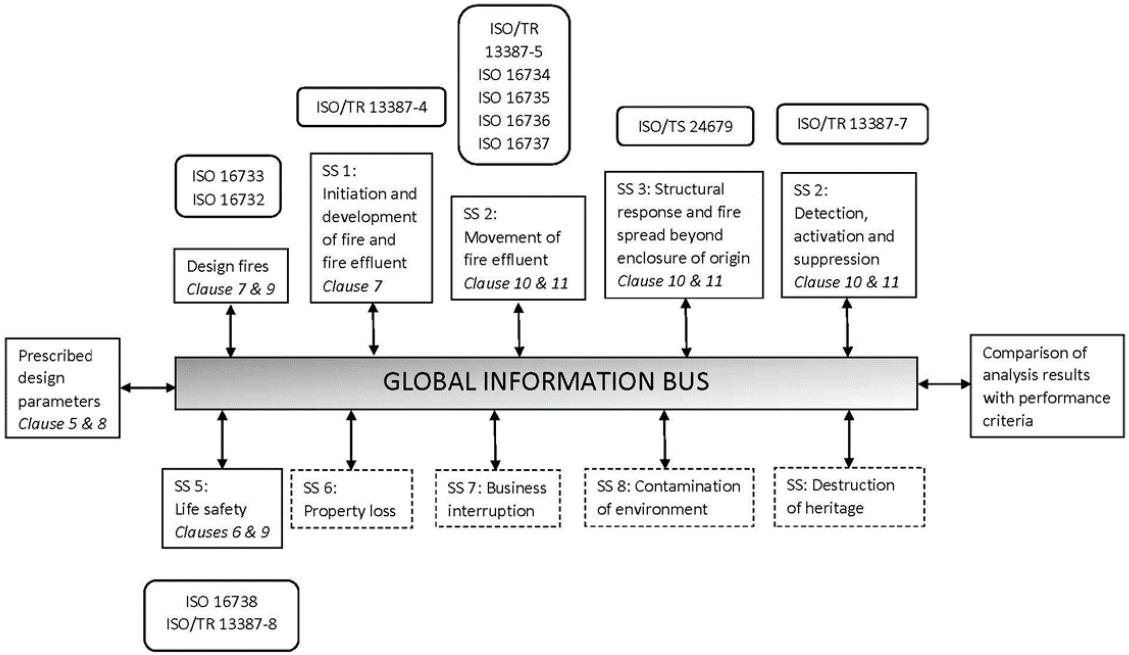
Set of ISO FSE Standards- Global FSE Analysis & Information System

- General procedures & requirements
- Design fire scenarios/design fires and loads
- V&V of engineering calculation methods
- Structural failure calculations
- Fire detection & suppression
- Evacuation modeling

ISO FSE Global Information & Analysis System



Global Fire Safety Engineering Analysis and Information System

Advantages of Global Approach

- Provides awareness of interrelationships between fire evaluations when using ISO or other FSE standards
- Provides logical means to organize analysis & data needed for design
- Computer models cover several subsystems & become a "black box" if awareness of interactions not maintained
- "Quick Calculation Methods" has important role in FSE

ISO Core FSE Standards

Chapter in ISO 23932	List of standards available	Comments
Scope of the project concerning fire safety – Chapter 5	-	Provided by architect to fire safety engineer
Identification of fire safety objectives, functional requirements and performance criteria – Chapter 6	ISO 29761	The standards cover the life safety objective. Other safety objectives have not yet been elaborated.
Hazard Identification - Chapter 7 and Design scenarios – Chapter 9 -	ISO 16733-1, ISO 16732, ISO 29761	ISO 16733-1 covers design scenarios generically, ISO 16732 includes risk methods for scenario selection, and ISO 29761 covers the life safety objective.
Scenario based evaluation of trial design – Chapter 11 -	-	1. Covers fire plumes, smoke layers, ceiling jet flows, and vent flows, respectively.
1. Movement of fire effluents	ISO 16734, ISO 16735, ISO 16736, ISO 16737	
1. Structural response and fire beyond enclosure of origin	ISO/TS 24679	
1. Detection, activation, and suppression	ISO/TR 13387 -	
General to ISO 23932	ISO 16732-1, ISO 16730-1	ISO 16732-1 is used for a fire risk assessment approach. ISO 16730-1 is for verifying & validating methods used for Chapter 11.

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ISO Global FSE System

- ISO 23932:2009, Fire Safety Engineering – General principles.
- ISO 16733-1:2015, Fire safety engineering -- Selection of design fire scenarios and design fires — Part 1: Selection of design fire scenarios.
- ISO 16732-1:2012, Fire safety engineering -- Fire risk assessment -- Part 1: General.
- ISO 16734:2006, Fire safety engineering -- Requirements governing algebraic equations -- Fire plumes.
- ISO 16735:2006, Fire safety engineering -- Requirements governing algebraic equations -- Smoke layers.
- ISO 16736:2006, Fire safety engineering -- Requirements governing algebraic equations -- Ceiling jet flows.
- ISO 16737:2012, Fire safety engineering -- Requirements governing algebraic equations -- Vent flows.
- ISO/TS 24679:2011, Fire safety engineering -- Performance of structures in fire.
- ISO 16730-1:2015, Fire safety engineering — Procedures and requirements for verification and validation of calculation methods – Part I: General
- ISO 29761:2015, Fire Safety Engineering -- Selection of design occupant behavioural scenarios and design behaviours

Other International FSE Standards

- Society of Fire Protection Engineering (SFPE)
  - Performance-based guidelines
- American Society of Testing & Materials (ASTM)
  - National adoption of ISO FSE standards
- British Standards Institute
- Standards Australia

Experience & Evolution of Fire Safety Engineering

- New Zealand, C/VM2, Verification Method: Framework for Fire Safety Design
- Nordic Countries, prINSTA TS 950, Fire Safety Engineering — Verification of fire safety design in buildings
- Australian verification method
- CEN initiatives

Why ISO Fire Standards

- ISO fire safety standards will become dominant in future
- ISO standards developed by member national standards bodies, not individuals
- ISO & UN promoting use of ISO standards around the globe, specifically in developing countries
- *"Using and referencing ISO and IEC standards to support public policy and regulation"*, Conference and Training, November 2015, Geneva, Switzerland

General Issues for Fire Standards

- Generally, performance-based approaches used when prescriptive requirements cannot be met
- Authorities question when P-B design is used to justify design when design does not meet requirements
- Currently, FSE standards are not connected & integrated with prescriptive product fire performance standards
- Need to integrate performance-based with prescriptive standards

Pros & Cons of Standard Fire Tests

- Standardized fire test methods give information on performance of a material or assembly *'in the test'*
- May not be related to the most likely real fire scenarios
- Valuable for ranking materials or assemblies under standard fire exposure
- Play important role in prescriptive regulations
- Good for ranking but not reflect performance in real world or suitable for supporting performance-based design

Pros and Cons of Performance-Based Design

- Requirements not easily understood
- Standards for performance-based design to allow uniform conformity assessment not available
- Lack of uniformity of application across the industry
- Allows fire safety designs to be based on real fire scenarios & effects
- Establishment & monitoring of fire loads biggest advantage

Improvements Needed for FSE Standards

- Must be practical & easily understood by practicing engineers as a cohesive set of standards
- Can be adopted by national authorities & form basis of conformity assessment with minimal judgments
- Decrease present uncertainty in use of FSE & variability in results for fire safety systems design
- Improve quality of implementation of FSE

Specific Improvements Needed for FSE

- Quantifiable performance measures of safety objectives
- Specific design scenarios and design fires
- Specific input data and assumptions that cover a broad range of fire scenarios
- Requirements to address uncertainty and safety factors as part of quality assurance for performance-based design
- Development of application guides

Activities at ISO TC 92 SC 4

- Strategic plan developed
- Standards should be simple, usable & practical for use world wide
- Link ISO standards as a package
  - Global FSE Analysis & Information System
- Publication of ISO 16730-1, V&V standard
- Quick calculation methods
- Input data for FSE

Need for Application Guidelines

- ISO standards apply generally to all industrial sectors, very difficult to make specific to application
- Need to develop application guidelines for specific "applications" and country
- Tall buildings
- Tunnels
- Warehouses
- Industrial facilities & nuclear power plants

Application Guidelines – Cont'd

- Guidelines will make standards more practical and helpful for engineers, but still have the "ISO" quality brand name
- Will be specific to each sector
- Will provide uniformity of application across China
- Increase fire safety across China

Need to Integrate Performance & Prescriptive Requirements

- Set of design fire scenarios provides possible means to integrate performance-based with prescriptive requirements
- Need to identify when prescriptive requirements necessary
- New Zealand approach in verification method (C/VM2)
- 10 design fire scenarios used to encompass most fire safety requirements

Design Fire Scenarios – Example from New Zealand Building Code

- Fire blocks exit
- Fire in normally unoccupied room threatens occupants in other rooms
  - ASET/RSET analysis or provide separation
- Fires in concealed spaces
  - Provide separation

Design Fire Scenarios – Example from New Zealand Building Code

- Smoldering fire
  - Provide automatic detection & alarm
- Fire spread in internal linings
  - Use suitable materials proven by tests
- Challenging fire for evacuation & life safety
  - ASET/RSET analysis

Design Fire Scenarios – Example from New Zealand Building Code

- Robustness check
  - ASET/RSET analysis assuming fire safety system unavailable
- Horizontal fire spread to other buildings
  - Radiation calculation
- External vertical fire spread
  - Use suitable materials proven by tests

Need to Develop a Fire Standards Infrastructure

- *Framework of Standards for Fire Safety (FSFS)* - ISO TC92/TG244 N10 – June 2004
- Document provides interesting approach to integration of prescriptive & performance standards, but was never implemented
- Initiative taken at ICO TC 92 to update document & start implementation
- Will require national standards bodies to be involved

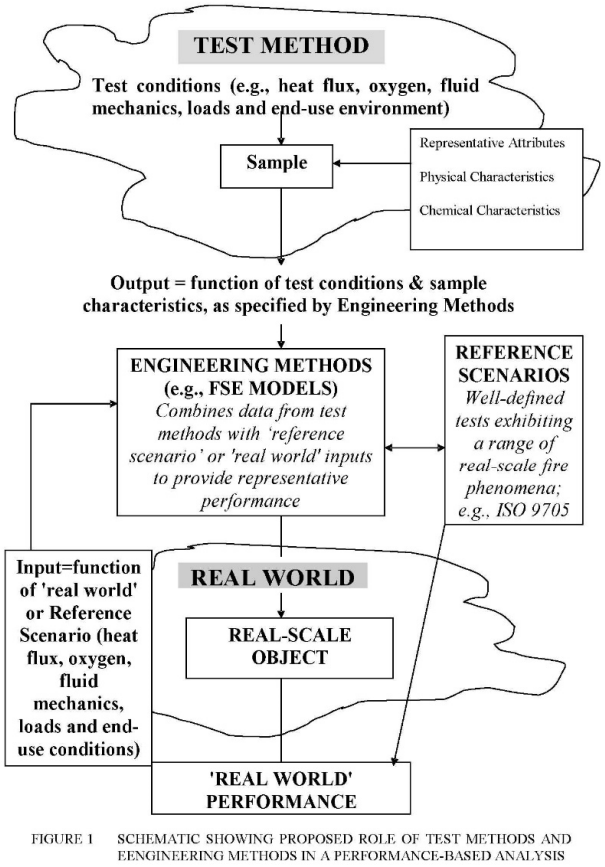

FIGURE 1 SCHEMATIC SHOWING PROPOSED ROLE OF TEST METHODS AND EENGINEERING METHODS IN A PERFORMANCE-BASED ANALYSIS

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Areas Needing Standardization

- Relationship between fire safety design & construction process
- Fire safety management
- Fire safety training/education
- Fire safety regulation (ISO initiatives in use of ISO standards for public policy and regulation, Geneva Conf.)

Conclusions & Recommendations

- Fire safety can be increased through use of fire safety engineering
- Major benefit of FSE is the determination of fire hazards
- Fire protection is based on hazard & fire loads
- Safety management is important part of FSE to monitor changes in hazards & protection in building/facility

Recommendations – Cont'd

- Necessary to improve technology, standards, & regulation to implement FSE successfully
- Need to develop application guidelines for specific applications in different sectors
- Necessary to integrate prescriptive & FSE standards
- Follow ISO initiatives for standards implementation through regulation & conformity assessment

Questions

- Comments and discussion
- Thank you

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