

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

Dr. Monideep Dey



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

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

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.

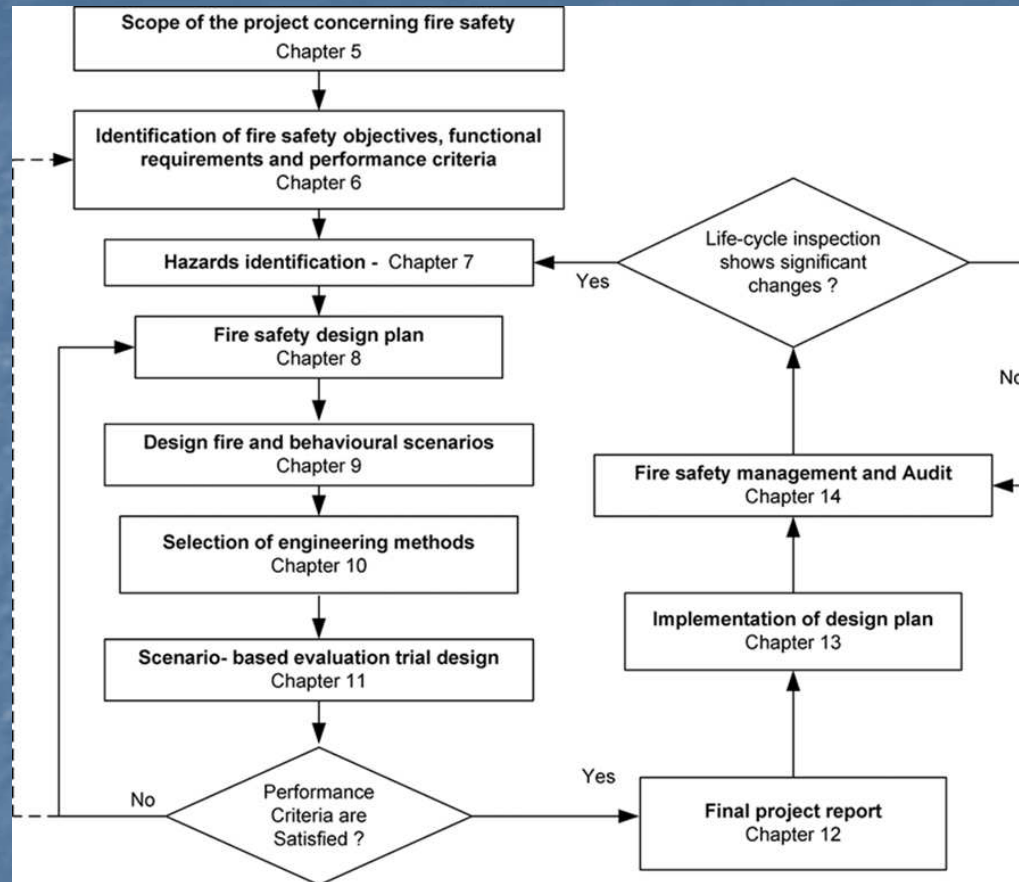
Presented at the 2015 International
Symposium on Fire Science & Fire Protection
Engineering Technology, October 18-20, 2015,
Tianjin, China

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

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

FSE Design Process



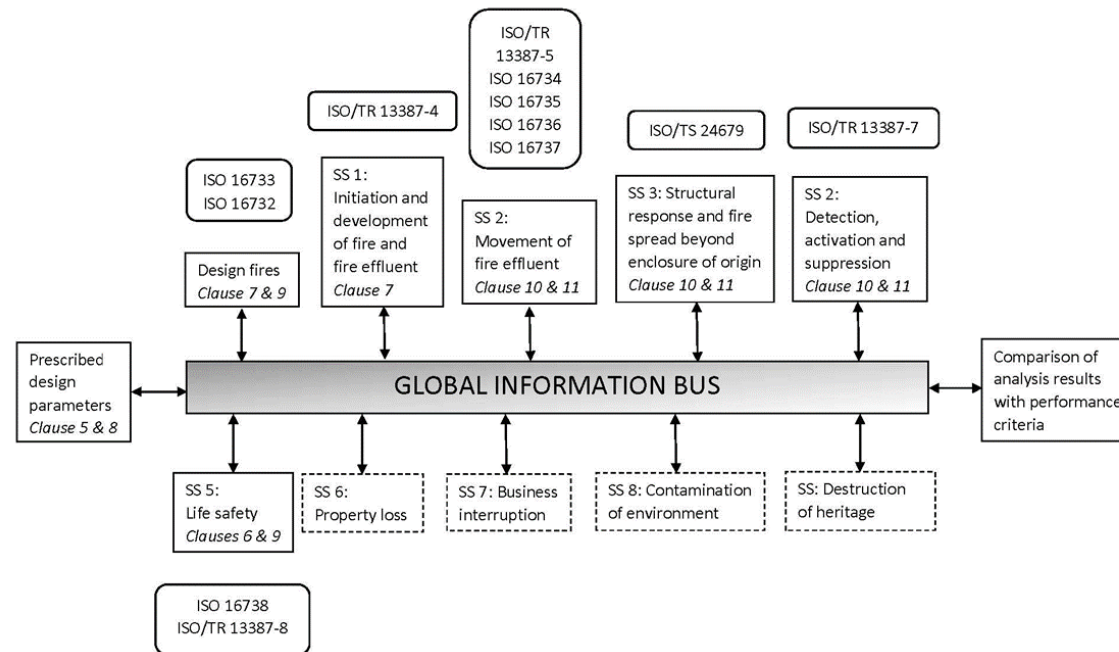
Presented at the 2015 International
Symposium on Fire Science & Fire Protection
Engineering Technology, October 18-20, 2015,
Tianjin, China

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

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

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

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

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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

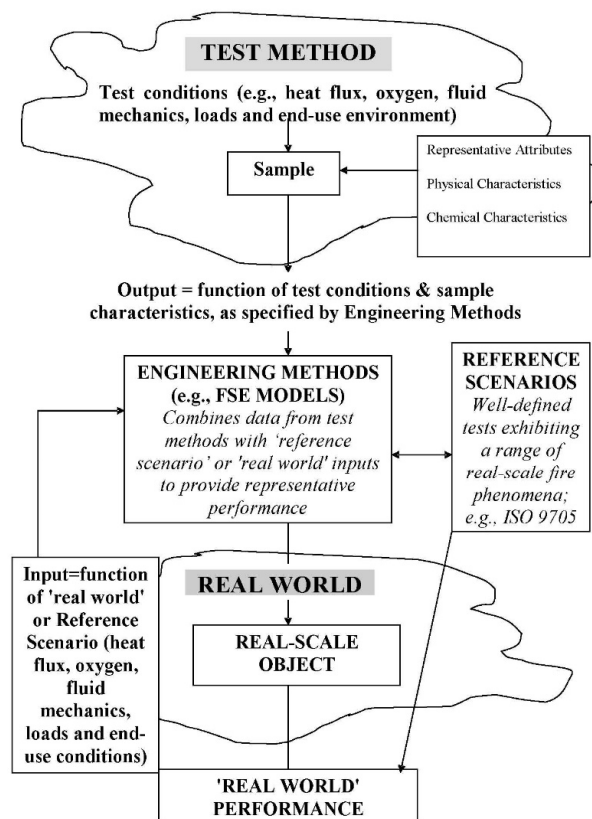


FIGURE 1 SCHEMATIC SHOWING PROPOSED ROLE OF TEST METHODS AND ENGINEERING METHODS IN A PERFORMANCE-BASED ANALYSIS

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

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.)

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

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

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

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

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

Questions

- Comments and discussion
- Thank you

- Contact Information:
- deytec@frontiernet.net
- www.deytecinc.com or www.linkedin.com/pub/dr-monideep-dey/1b/94/a13

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