

Study on Performance-based Design for Mine Fire Safety Systems

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March 2, 2011

Why Do We Need Fire Safety Design?



Two Fire Safety Design Methods

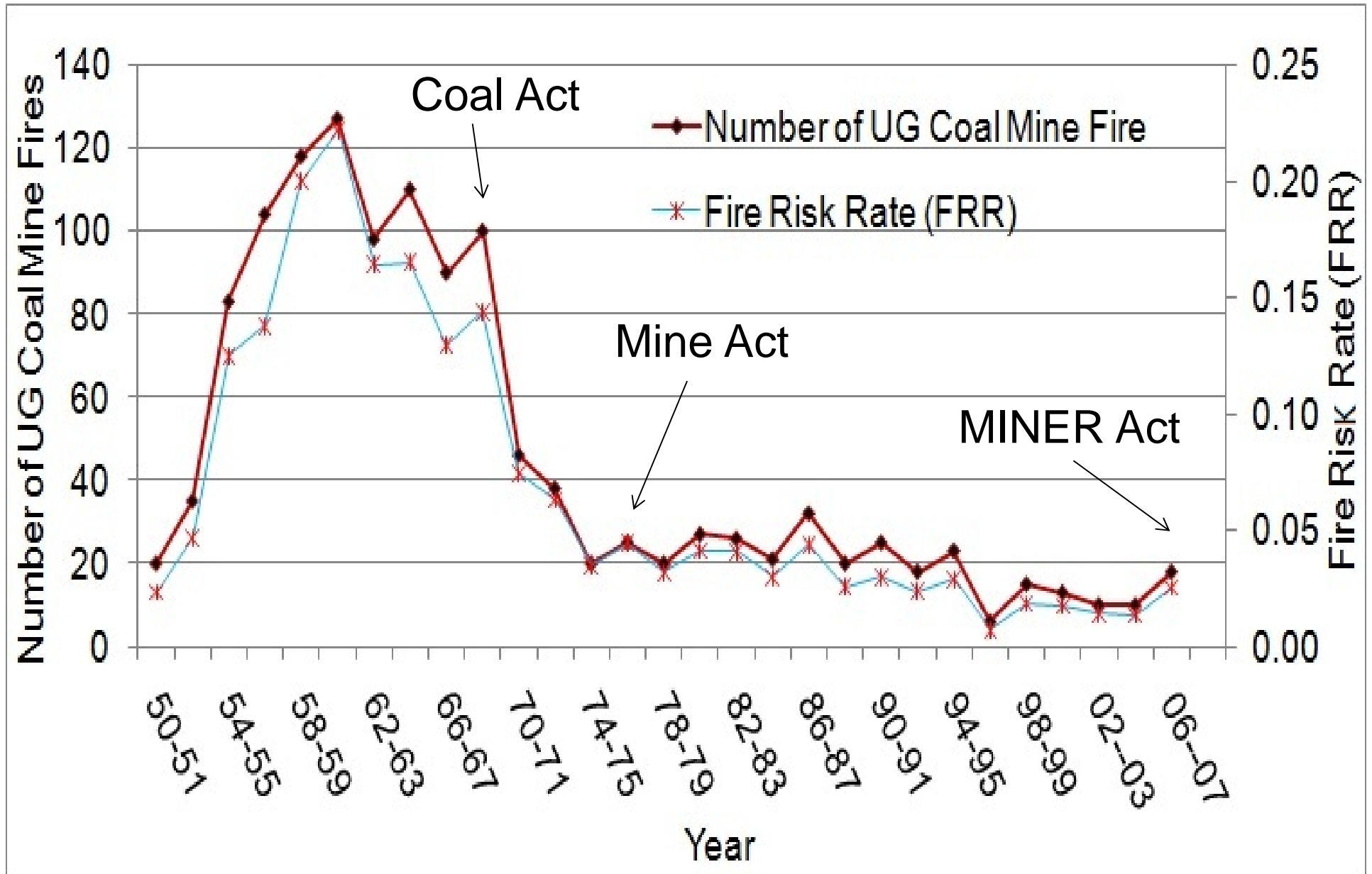
1. Prescriptive-based Design

Based on Regulations, Codes, and Standards

2. Performance-based Design

Based on Engineering Methods

Year	Legislation	Main Items
1891 / 1947	First federal statute/First federal code for mine safety	Established minimum ventilation requirements at underground coal mines; Prohibited operators from employing children under 12 years of age
1952	The Federal Coal Mine Safety Act of 1952	Annual inspections in certain underground coal mines(extended to all underground coal mines in 1966); Civil penalties for refusing inspectors to access to mine property, but no provision was made
1969	The Federal Coal Mine Health and Safety Act of 1969(Coal Act)	Included surface as well as underground coal mines; Two annual inspections of every surface coal mine and four at every underground coal mine; Monetary penalties for all violations/criminal penalties for knowing and willful violations; Included specific procedures for the development of improved mandatory health and safety standards; Provided compensation for miners with "black lung".
1977	Federal Mine Safety and Health Act of 1977 (Mine Act)	Consolidated all coal and non-coal mining industry under a single federal health and safety regulations; The Mine Act strengthened and expanded the rights of miners, and enhanced the protection of miners from retaliation for exercising such rights; Name the new agency the Mine Safety and Health Administration (MSHA); Established the independent Federal Mine Safety and Health Review Commission to provide for independent review of the majority of MSHA's enforcement actions.
2006	Mine Improvement and New Emergency Response Act (MINER Act)	Require mine-specific emergency response plans in underground coal mines; New regulations regarding mine rescue teams and sealing of abandoned areas; Required prompt notification of mine accidents; Enhanced civil penalties.



Definition of Performance-based Design for UG Coal Mine Fire

“Based on the stakeholder’s requirements and the **unique characteristics of each mine**’s layout, ventilation system, combustible materials distribution, and fire-fighting devices condition, to establish the **fire safety goal** by giving consideration to each variable, then to analyze and evaluate the fire/smoke pattern by using **experimental or numerical simulation methods**, to minimize the fire hazard.”

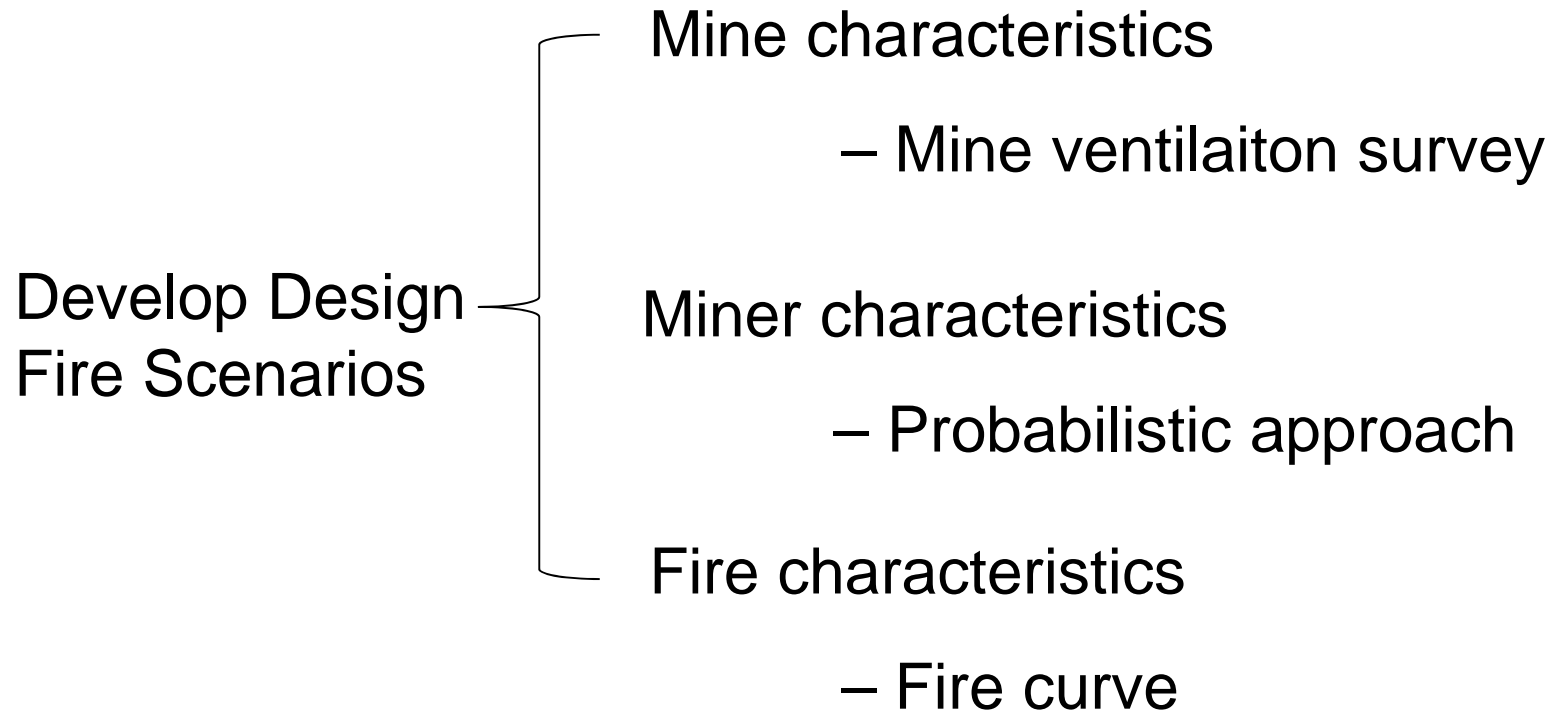
Performance-based Design Process

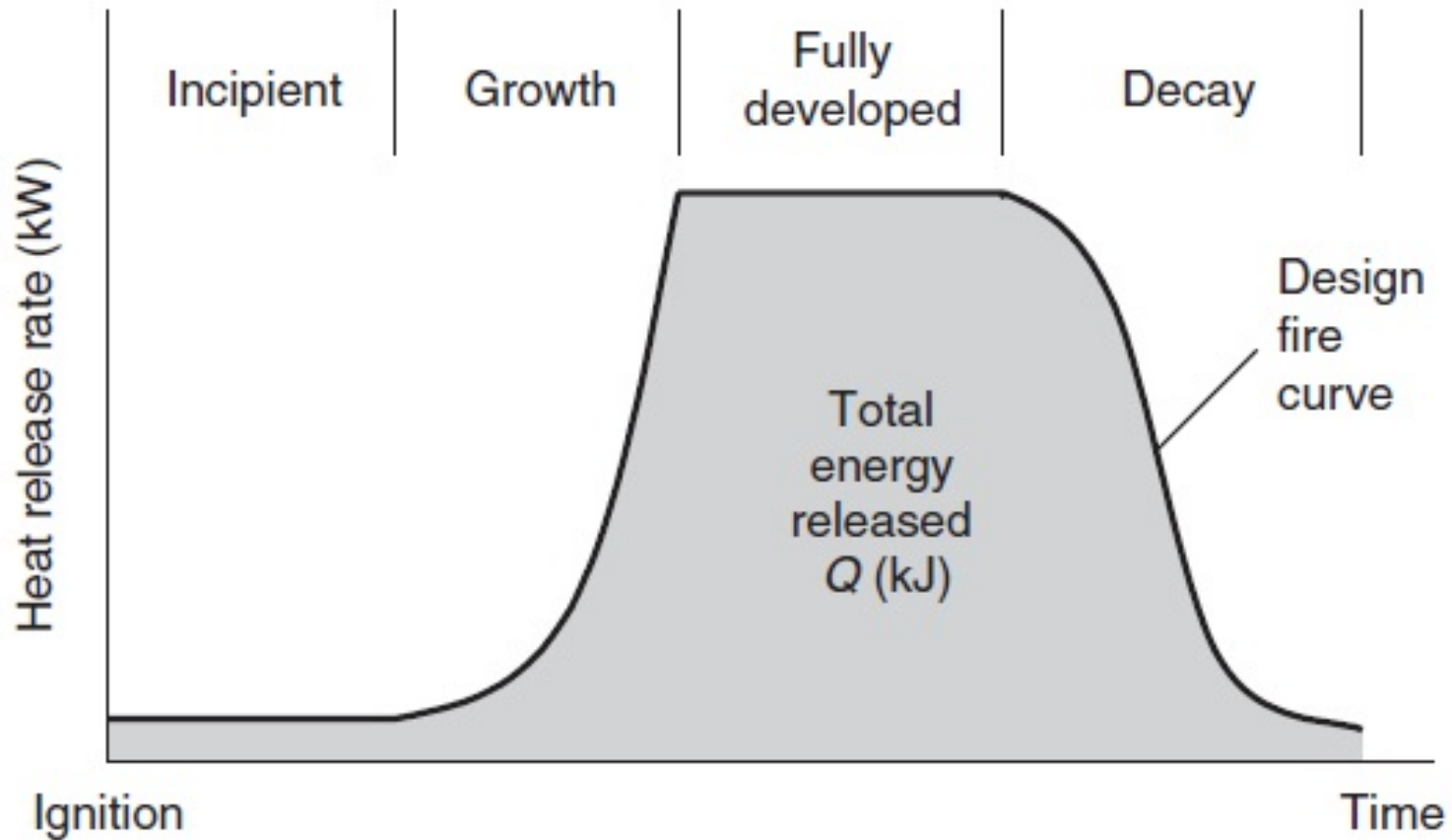
1. Defining Goals and Objectives

Steps	Example
1. Scope of project	To evaluate an existing detection system in an existing mine
2. Fire Protection goals	To provide continuity of operations and business
3. Stakeholder's objectives	To prevent any interruption to operation in excess of 24h
4. Design objectives	To control the toxic gases within a certain level
5. Performance criteria	To limit the concentration of CO to exceed 300 ppm.

Performance-based Design Process

2. System Design and Evaluation





Stages of Design Fire Curves
(Fire Protection Handbook[®], 20th Edition)

Performance-based Design Process

Develop&Evaluate
Trial Designs

Fire Initiation and Development

Smoke Spread and Control

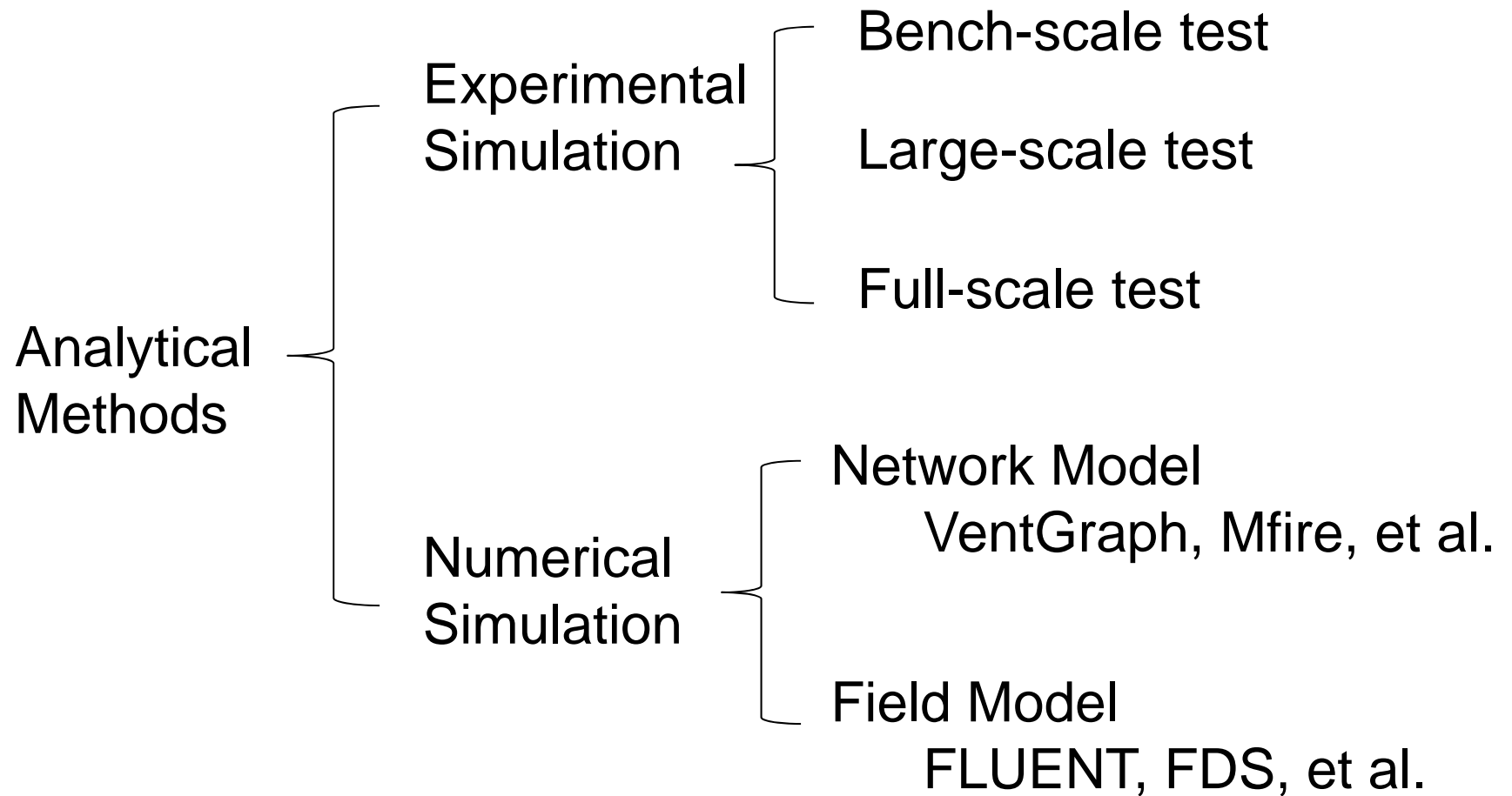
Fire Detection and Notification

Fire Suppression

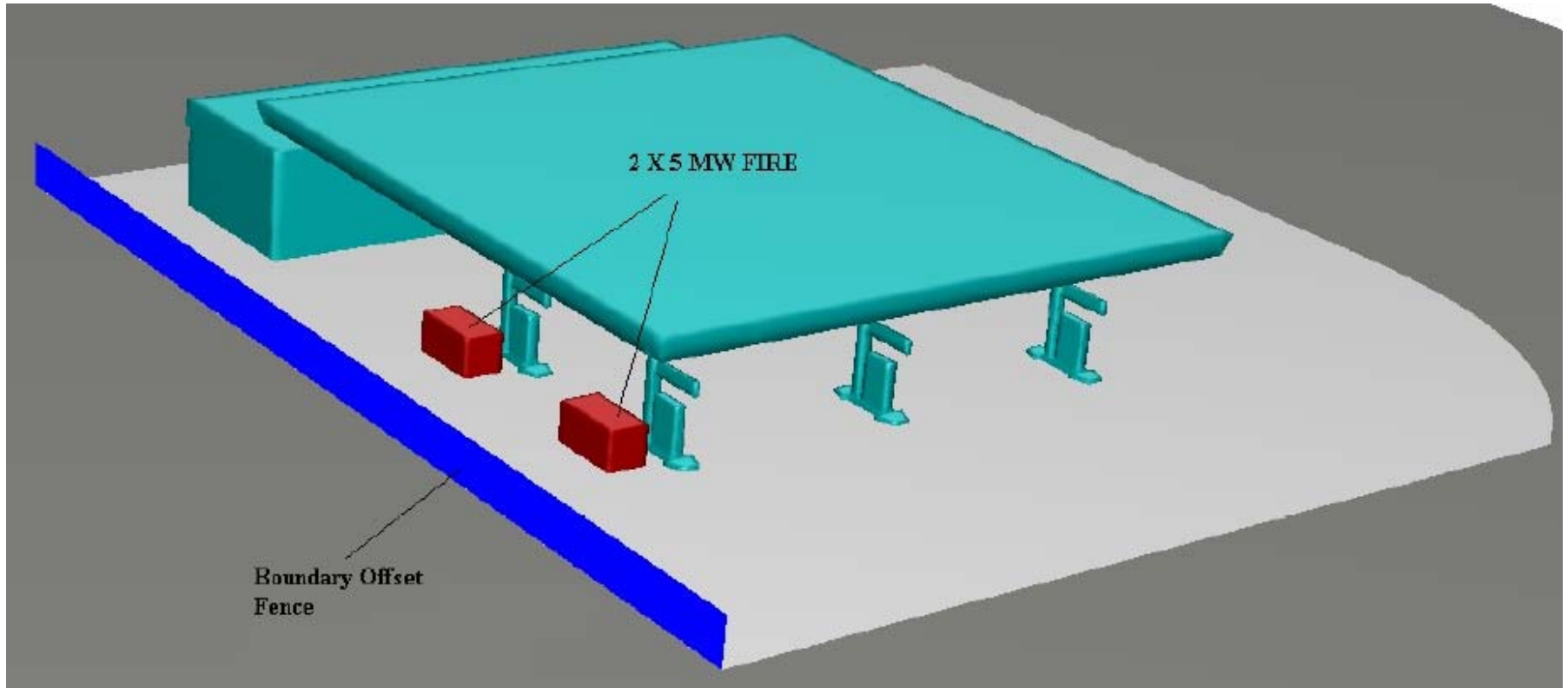
Occupant Behavior and Egress

Passive Fire Protection

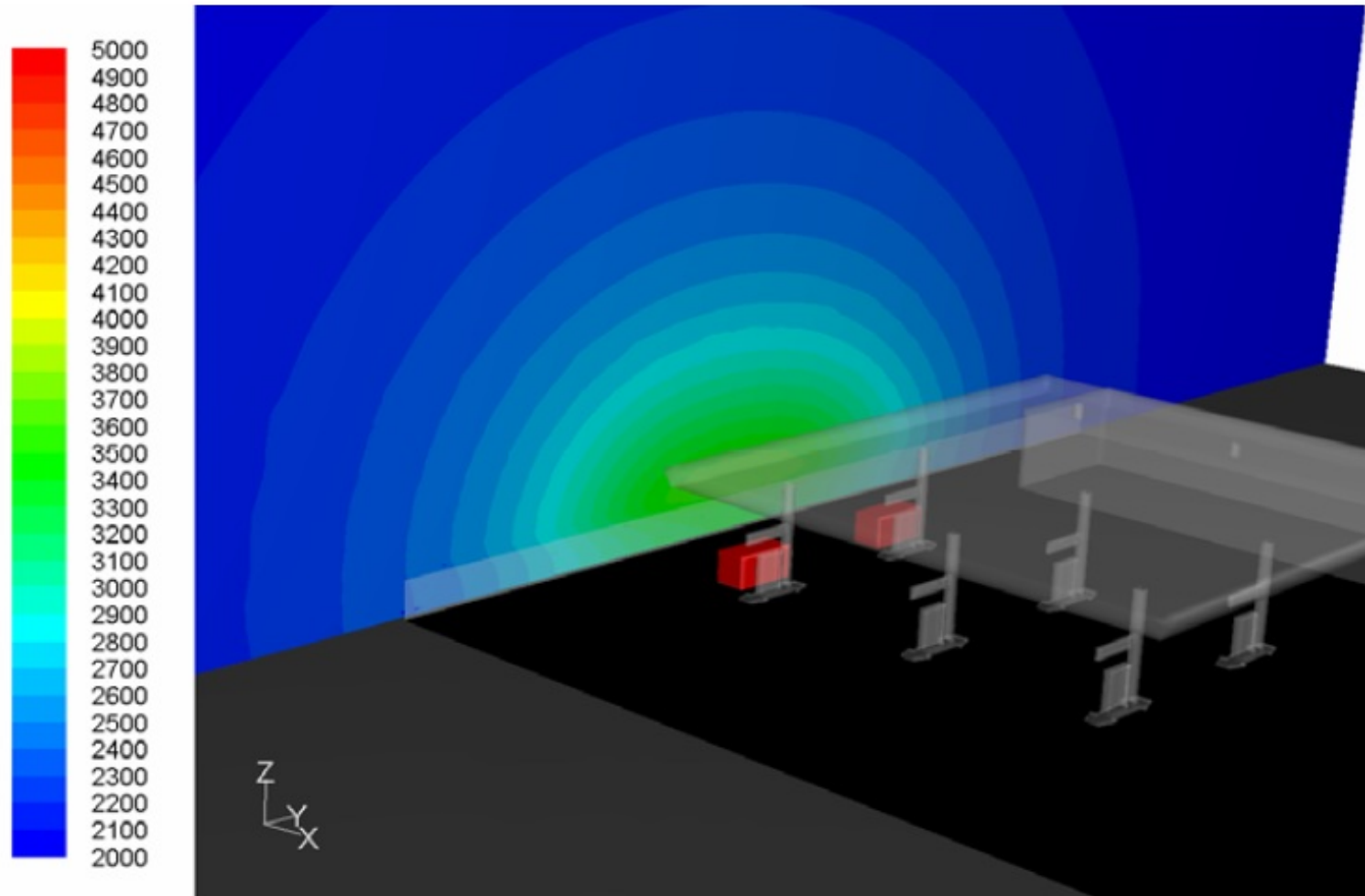
Performance-based Design Process



Example of Performance-based Design Method (Dayanandan S. and Chong D., 2008)



An offset distance from the boundary fence to the nearest petrol dispenser, **6m** is considered in the model, and the prescribed minimum of **15m** is required by regulation.



The radiation flux reaches a maximum of about **3.6** kW/m², which is below **20** kW/m² required to cause ignition.

Summaries

1. Analyze the drawbacks and limitations of the prescriptive-based design method.
2. Give out the definition of the performance-based design for underground coal mine fire.
3. Outline the fire safety design process by using performance-based design method for underground coal mine.

Thanks!

Questions?