Research Needs for the Fire Safety Engineering Profession SFPE Human Behavior

Threads

Tool, Applications, & Methods

Risk

Innovative

Data	Technology /Materials	Design Tools	/Probabilistic Approaches
		/Materials	/Materials O O O O O O O O O O O O O O O O O O



Research Needs for the Fire Safety Engineering Profession

September 26, 2017

		Tools, Applications, & Methods			
		Data	Innovative Technology/	Design Tools	Risk/Probabilistic
			Materials		Approaches
Threads	Human Behavior	Demographics Vulnerable populations Anthropometry Cultural differences Basis for numbers in codes Response to notification	Smart egress systems Cameras Cell phones Exit usage Other LED strobes Occupant evacuation elevators	Design egress scenarios Behavior based models Cultural Pre-evacuation time Actions other than evacuating Combined fire and evacuation models	 Residential buildings Large populations Community level High challenge environments Quantify level of "life safety" in a building Effects of fire Visibility Gases Impact of public education on fire risk
Ē	Building Fires	Combustibility of external cladding systems Fire loads for structural fire engineering Material testing data (new materials) Effectiveness of existing/new fire safety solutions Quantification of building code performance criteria	Building information modeling Smart buildings Big data Improved test methods	Standardization of design fires and analysis approaches Best practices for retrofitting existing buildings to achieve equivalent level of safety	High-rise building design Risk informed PBD Single family homes Risk assessment/management systems Structural FP performance

Resilience / Sustainability	Environmental impact of fire and fire suppression activities Cost of fire events Cost/benefit of different types and multiple levels of FP measures Environmental impact of fire testing Quantification of structural fire resilience Flame retardant toxicity	Assess fire hazard of new sustainable building materials/practices Identify/quantify sustainability benefits of smoke control systems & natural ventilation Evaluate fire hazards of new sustainable energy technologies Evaluate fire hazards of flammable refrigerants Life expectancy of installed fire protection systems Determine appropriate suppression systems for new technologies	Development of design tools/best practices for fire safety engineering for resilient systems/buildings Analysis of impact of climate change on fire safety Cost effective and resilient FP practices for developing countries Post-fire seismic behavior Identification of critical fire protection aspects for disaster reliability	Development of risk based analysis to compare hazards of fire to long term health impacts of fire mitigation measures Risk and reliability based methods for ITM of fire protection systems Preventative and predictive maintenance Human impact on ITM reliability Reliability of water supplies Reliability of installed equipment
Fire Service	Exposure tracking from incidents Data driven fire inspection scheduling Improved injury, holistic fatality data collection and economic analysis Impact of WUI on fire service Naturally occurring events Rate, severity Fire as a secondary impact	Smart firefighting IoT integration Mechanical augmentation Fire department communication with BIM Firefighter tracking and location Automated, quantifiable exposure monitoring Firefighting PPE and tools Firefighting and fire apparatus cameras for investigation/debrief	Model fire department response leading to better models of Reverse evacuation Egress / ingress Duration of water for FP systems Structural collapse Firefighter response recreation & training aids Compare / contrast tactics internationally to. determine impact of firefighting / construction differences on fire growth / severity	Evolving building technology and fire suppression tactics (i.e. effect of smoke / heat ventilation during firefighting tactics) Fire fighter injuries
Fire Dynamics	 Material properties Fire dynamics of large compartments Test data archiving Model stewardship Toxicity data Sprinkler data 	Standardized / accepted approach for developing material properties Retardant behavior Massively parallel computing Mesoscale Extreme ambient conditions	Practical models for: Pyrolysis of complex materials Extinction & reignition Sprinkler suppression Underventilated combustion Glass breakage Human consequences Deflagrations / detonations Realism in test standards	Ignition frequencies Probabilistic distributions of heat release rate curves Fire spread models Fire frequencies

Fire Safety	Impact of ITM requirements on	Integrated FP systems and	Corrosion protection design best	Adequacy of passive fire resistive
Systems	system reliability FP systems performance data Evaluation of new and existing active FP systems efficacy Suppression of unique and emerging hazards System design criteria Smoke control system Evaluation of passive FP systems efficacy Evaluation of durability of FP systems Gaseous fire suppression systems applied to high air flow environments	building connectivity Efficacy of detection, alarm, communication systems Protection of storage Automated High challenge Reliability of detection/alarm/communication False positives Failure on demand Failure modes due to extreme environments	practices Guidelines on suppression effectiveness at various heights FP System design Atrium protection and modeling Smoke control systems Passive FP system design and test methods	construction Evaluation of Smoke control systems impact on reduction of risk of losses Adequacy of passive fire resistive construction Effectiveness of fire stop installation by multiple trades versus certified technicians Life quality indices to assess FP performance Reliability of Water supplies Suppression systems failure modes, aging and complex systems
Forensics/ Investigations	Persistence of burn patterns under different compartment fire conditions Building material properties as inputs for fire models Fire effects on building electrical systems/components Evaluation of incident heat flux profiles from non-standard fuels Damage resulting from heat radiation and blast waves on buildings, industrial assets, etc. Digital recordings of distributed control systems and programmable logic controllers Digital data collection (black boxes) Status and data related to availability of FP measures during event	Improved tools for obtaining building dimensions and fire sizes from photographs and video Use of cloud based home/consumer devices to pinpoint fire origin Linking of 3D scanning technology with computer fire models Overview of large scenes from drones Data mining to identify chemical process deviations Methods to preserve evidence Tools to extract data from digital sources	Improved software to create multiple-source dynamic event timelines Tools to evaluate impact of ventilation on compartment fires Simulation tools to recreate process conditions in chemical plants Advanced calculation methods to evaluate hypothesis Tools to estimate damage effects Virtual reality / augmented reality to describe and test scenarios	quantifying measurement and calculation uncertainty Repeatability of fire test measurements Root cause analysis methods and tools Causes and causal mechanism analysis

Wildland/ WUI Fires	Impact of firebrands Fire hazard identification and quantification Ignition of WUI materials Fire behavior and fire spread Emissions and health effects Fire ecology and long-term effect Data to support WUI codes and standards	Building fire protection in WUI Wildland/WUI fire damage mitigation Warning and notification Remote sensing and communications	Design against exterior building fires Wildland/WUI fire modeling Firebrand ignition prevention Fire behavior prediction tools Resilience design tools Landscape planning tools	Risk assessment of WUI structures Risk of combustible fuels in WUI/wildland Assessment of risk, effectiveness, and economics
Non-Building Fires	Data for hazard identification/reliability /severity/frequency (industrial) Alternative energy generation PV installation fire spread Petrochemical fire incident frequency Causes of vehicle fires	Energy Storage Containment for new products/damaged products Higher reliability manufacturing/more resilient product design Safer energy storage chemistries New inspection techniques Self-monitoring of equipment Safe transportation Improvements to petrochemical equipment safety Tunnel fire suppression	Product safety standards Installation Standards SES SIGNO Oil/gas drilling CFD fire models (tunnels/underground, tank fires Design considering first responders (ESS, vehicles, tunnels) Heat transfer models for energy storage cell design Tunnel evacuation/fire models Models for use in siting and design of tank farms Tunnel design fires	Improved identification of high risk industrial facilities Improvement of risk management practices at chemical facilities

Note: Items highlighted in RED are identified as the highest priority for each thread. Items highlighted in BOLD are identified as the highest priority for each cell.

List of Acronyms

BIM - Building Information Modeling

CFD – Computational Fluid Dynamics

ESS – Emergency Storage System

FP – Fire Protection

IoT – Internet of Things

ITM – Inspection, Testing and Maintenance

LED – Light Emitting Diode

PBD – Performance-Based Design

PPE – Personal Protective Equipment

PV -- Photovoltaic

WUI – Wildland Urban Interface