The Future of Fire Protection

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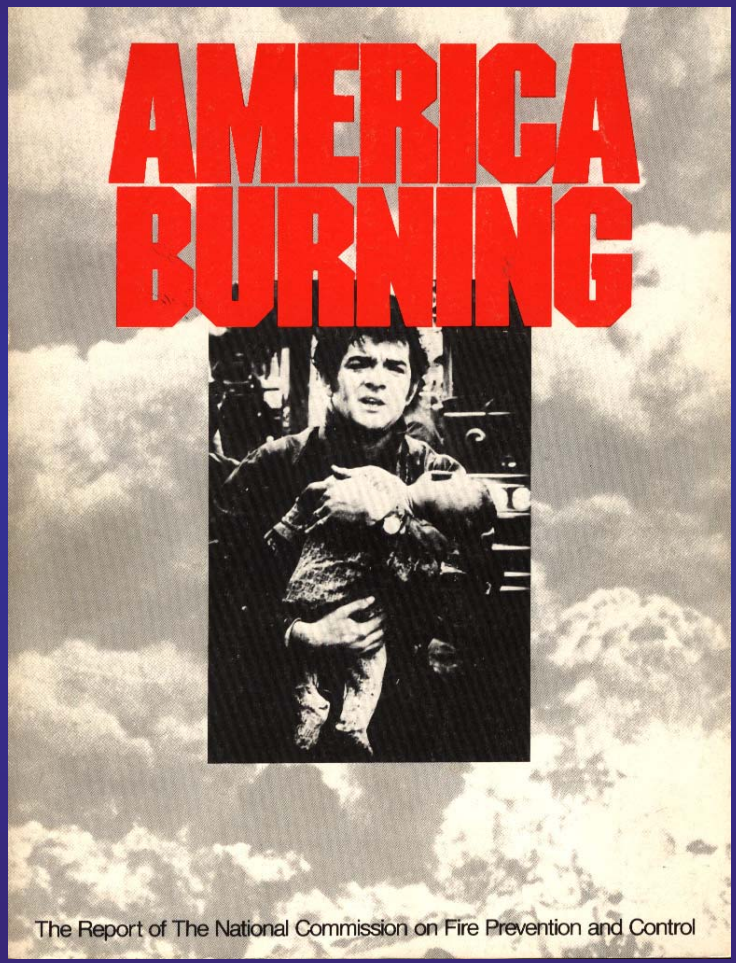
Forecasting the Future

- The future isn't like it used to be
- Those who ignore history are destined to repeat it
- The past is prologue
- He who does not remember the past is condemned to forget where he parked
- Predicting the future is easy…being right is the hard part

Changes over the Past 38 Years



"Appallingly, the richest and most technologically advanced nation in the world leads all the major industrialized countries in per capita deaths and property loss from fire."
1973

Changes over the Past 38 Years

- National Commission on Fire Prevention and Control
- 90 Recommendations
- America Burning recommends $113 million increase in fire research funding (today's dollars).
- United States Fire Administration created by Congress; funded, unfunded, funded
- Center for Fire Research created at NIST

Changes over the Past 38 Years

- Performance-based codes
- Performance-based design
- Model building code orgs merged
- NFPA does health, sanitation, earthquakes

Changes over the Past 38 Years

- Hydraulically calculated sprinkler systems
- Retrofit of high rise buildings
- Sprinkler retrofit of nursing homes
- Smoke detectors in over 80% of American homes
- American fire death rate down over 50%
- Halon banned
- Residential sprinklers arrive

Changes over the Past 38 Years

- Computer fire models
- A few textbooks hit the market.
- IIT and Edinburgh shut down
- Other schools start up FPE degree programs
- Distance learning
- University fire research grants shrink 85%
- Production of young scholars declines (Emmons produced 51 PhD's)

Changes over the Past 38 Years

- Fire services shifted from fire to EMS
- FPE Professional Engineer examination
- SFPE Handbook
- SFPE Performance-based Design Guide
- SFPE Peer Review Guide
- QUITE AMAZING!

What about the Future?

- What will today's engineering graduate see over the next 38 years?
- Could the changes possibly be as dramatic?
- What's next?
- Another 50% drop in fire deaths??
- What are some of the issues to be resolved?

Looking Back 125 Years

- Later part of 19th Century
- Very few rules (codes)
- Cities burning to the ground

Great Chicago Fire of 1871

- Destroyed world market center for grain, livestock, lumber
- 90,000 homeless
- 17,000 buildings destroyed

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Rules Proliferate

- Building Codes
- Fire Prevention Codes
- Electrical Codes
- New institutions (NFPA, FM, UL, NBFU)
- Municipal Grading Schedule
- Technical standards (e.g. sprinklers)
- Conflagrations subside; fire deaths decline

Regulatory Reforms of Today
Out with the Rules!

- Performance-based codes, practices
- Few rules
- No longer just “meet the code”
- Now calculate building performance
- Use any materials and systems which meet the goal

Regulatory Reform – Australia, 1997

- Microeconomic reform
- One nation/one market
- Privatization
- Innovations in construction
- National standardization
- International competitiveness
- Performance code

Regulatory Reform – United Kingdom, 1992

- Building code reduced from 307 pages to 19 pages.
- *"The building shall be designed so that there are means of escape…to a place of safety outside the building…"*

Regulatory Reform – USA, 2001

- International Building Code 675 pages
  (20 pages for performance-based track)
- NFPA 5000 375 pages
  (6 pages for performance track)
- *"Buildings shall be designed and constructed to reasonably prevent structural failure…"*

How Can so Few Rules Work?

- We now have science to rely on

Works Well in Other Disciplines

- Structural engineers have been doing performance-based design for decades
- Known as "Limit State Design"
- Well established and accepted by practitioners and regulatory authorities

  "Building shall safely sustain imposed loads…"

Limit State Design

- Building strength must exceed load
- Agreement on loads (gravity, wind, snow, earthquake)
- Agreement on procedure; widely published and taught
- Agreement on published safety factors (Overestimate loads)
- Agreement on published reliability factors (Underestimate strength)
- Agreement on performance goals

Limit State Equation

Building Strength > Dead Load + Live Load + Snow Load + Wind Load + Earthquake Load

Safety & Reliability Factors

$$\left[0.9\right]\left[\begin{array}{l}\text{Building}\\ \text{Strength}\end{array}\right] > \left(\begin{array}{l}\text{1.2 Dead Load}\\ +\ \text{1.6 Live Load}\\ +\ \text{1.6 Snow Load}\\ +\ \text{1.3 Wind Load}\\ +\ \text{1.4 Earthquake Load}\end{array}\right)$$

Importance Factors

Occupancy		EQ	Snow	Wind
I	"Normal" Buildings	1.00	1.00	1.00
II	Assembly, Heath Care without Surgery	1.25	1.10	1.15
III	Hospitals with Surgery, Police, Fire, Aviation, Power	1.50	1.20	1.15
IV	Agriculture, Small Warehouse, Temporary Buildings	1.00	0.80	0.87

Limit State Equation in Fire

- Strength must exceed sum of loads, with acceptable safety and reliability factors

“Load”

- Smoke
- Heat
- Toxic Species

"Strength"

- Sprinkler systems
- Detection and alarm systems
- Fire resistance of frame and barriers
- Smoke control
- Exit systems

Fire Safety Limit State Equation

- Units can't be added together. Very difficult to quantitatively add loads and add "strengths".

Sprinklers		Smoke
+	>	+
Exits		Heat ?

Gaps and Limitations

- No widely accepted protocol (like Limit State Design)
- Little agreement on measurable performance goals
- Lack of Data
- Limited agreement on fire load and design fires

Safety Factors – What should be overestimated?

- Travel time?
- HRR curve?
- Detection time?
- Sprinkler density?
- Toxic gas concentrations?
- Smoke layer height?

Reliability Factors – What should be underestimated?

- Sprinkler reliability?
- Water supplies?
- Power supplies?
- Fire door & damper performance?
- Alarm notification?
- Occupant response?

Challenge for Decades Ahead

While FPE may never develop a “limit state equation” like the structural engineers, the same principles of analytical discipline must be accounted for.

Fire protection engineers and AHJ’s must reach clear agreement and have access to credible published resources.

Vital Imperatives

- Vastly strengthen science to support performance-based practice
- Produce more tried, tested and validated engineering methods
- Restore production of advanced degree scholars to work as the researchers of the future.
- Restore 85% drop in university fire research funding