Firestopping Performance and Performance of Other Passive Fire Protection Features

What Information Can You Get From Available Fire Statistics?

FCIA

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Using statistics to assess fire safety performance of X

- Can you distinguish fires by X is present vs. X is absent?
- If yes, you can estimate average loss per fire with and without X, and see if those rates are lower when X is present.
- We’ve had that data on fire detectors and automatic extinguishing equipment since 1980.
- We had it for type of construction from 1980 to 1998.
Using statistics to assess fire safety performance of X

- If you can distinguish fires by X is present vs. X is absent, can you distinguish different levels of performance of X? Operated vs. did not operate? Operated effectively vs. ineffectively? Intact or not intact?

- If yes, you can estimate percentage of reported fires with good vs. not so good performance

- We’ve had that data on smoke alarms and sprinklers since 1999
Using statistics to assess fire safety performance of X

- We have never had any of that information on firestopping or any other passive fire protection features
- And you can understand why
Firestopping and many other passive features are located in concealed spaces or other locations (e.g., exterior, attic) that are not where they can be easily seen by firefighters dealing with an ordinary fire inside a building.

That’s one reason they stopped trying to collect data on type of construction. You couldn’t see the construction in most fires, and you would end up estimating based on external conditions that tend to go with a certain type of construction.
Using statistics to assess fire safety performance of X

• Even if you can see them, firestopping and many other passive features are not easily characterized.

• Good vs. bad firestopping – the differences may be subtle. It’s not as simple as saying there are sprinklers or there are no sprinklers – or there are sprinklers but only in certain area.

• So. Hard to see and hard to assess. No wonder they don’t try to collect data routinely. How reliable would it be if they did?
Using statistics to assess fire safety performance of X

- If you can’t provide statistics on the overall performance of X...

- You can still try to collect information when poor performance of X is considered a contributing factor to a bad fire outcome.

- From 1980 to 1983, we got statistics on fires where firestopping and a long list of other factors were cited as factors contributing to flame travel.
Factors contributing to flame travel

- There were nearly a hundred choices of factors contributing to flame travel.

- There was also a separate data element on main avenue of smoke travel. It only had 9 choices but was included from 1980 to 1998.

- What can we learn from the now-old data on factors contributing to flame travel?
Factors contributing to flame travel

- 89% of the fires listed factor contributing to flame travel as unknown or blank
- The data element was supposed to be used to describe a “rapid, unusual, or intense flame spread beyond the room or area of origin”.
- Most reported fires don’t have that kind of flame spread.
- Even if you narrow to fires with flame spread beyond floor of origin, you still have 69% unknown or blank
Factors contributing to flame travel

- Suppose you take out the unknowns and blanks
- Then the “no factor” entries account for nearly half of what’s left (46%), down to 18% if you focus on fires with flame spread beyond floor of origin
- That still leaves us with about 100,000 structure fires per year in 1980-1983 where some factor was identified as contributing to flame travel
Factors contributing to flame travel

• Of that 100,000 or so…

• Largest share of factors was **interior finish (38%)**. Primarily wall and ceiling coverings.

• Next is **structural factors in vertical travel (27%)**. This is led by firestopping.

• Third is **structural factors in horizontal travel (22%)**.

• Finally, contents (8%), unclassified (4%), and physical transfer of ignited material (2%).
Factors contributing to flame travel

- Focusing on what might be called passive fire protection features...
  - Inadequate firestopping (7%)
  - Exterior spread (6%)
  - Vertical travel involving floor/ceiling (6%)
  - Horizontal travel through attic or similar concealed space (5%)
  - Horizontal travel through excessive open area, including corridor (4%)
  - Horizontal travel involving wall (not identified as interior finish) (4%)
  - Unclassified structural factor in vertical spread (3%)
  - Door open in rated assembly (2%)
  - Unclassified structural factor in horizontal spread (2%)
Factors contributing to flame travel

- Focusing on what might be called passive fire protection features (continued)...
  - Unenclosed stairwell or elevator shaft (2%)
  - Horizontal travel via window (2%) [This may be the only statistic we have that seems to relate to the performance or use of fire-rated glazing]
  - Vertical travel involving utility or pipe shaft (2%)
  - Vertical travel involving air handling ducts (2%)
  - Horizontal travel because door burned through rated assembly (1%)
  - Horizontal travel involving air handling ducts (1%)
  - Vertical travel due to failure of a rated assembly (0.2%)
Factors contributing to flame travel

- Notice how many factors have to do with travel into or out of or through spaces that are often unsprinklered even when all the interior spaces are sprinklered.

- It may be that passive fire protection is best assessed not as an alternative to sprinklers but as an essential complement to sprinklers.

- This provides a different framing on the analysis and interpretation of the results.

- A few thoughts on the earlier Exponent talk.
Factors contributing to flame travel

- Now let’s look at specific factors or groups of factors in more detail...

- We now switch to NFPA’s Fire Incident Data Organization (FIDO).

- FIDO is a more detailed database on major fires of technical interest.

- The fires in FIDO are not representative and tend to skew toward deadlier or costlier fires. Keep that in mind. This is exploratory data mining only.
Inadequate firestopping

- FIDO has records on 1,777 fires (1972-2011) with inadequate firestopping reported by property use:
  - One- or two-family dwellings (571 fires)
  - Apartments (362)
  - Eating or drinking places (98)
  - Building under construction (64)
  - Hotels and motels (55)
  - Churches and other religious properties (49)
  - Schools, grades K to 12 (44)
  - Offices (39)

- Any fire problem is usually most common in home fires

- Remember FIDO may not be representative
Inadequate firestopping

- FIDO also has statistics by “cause of flame/fire spread”
  - Design deficiency (32%)
  - Unknown or blank (29%)
  - Construction deficiency (23%)
  - Deliberate act (5%)
  - Installation deficiency (3%)

- The 1980-1998 NFIRS shows opening in construction ranking first when there is an avenue of smoke travel cited (35% of such fires)
Interior spread

- FIDO has records on 265 fires (1972-2011) with vertical fire spread involving exterior spread
  - Apartments (78 fires)
  - One- or two-family dwellings (57)
  - Hotels and motels (16)
  - Wood or paper product manufacturing or storage properties (16)

- Remember FIDO may not be representative
Exterior spread

- Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (38%)
  - Deliberate act (17%)
  - Design deficiency (7%)
  - Failure to isolate fire (7%)
Exterior spread

- NFPA is working on a new analysis report focusing on exterior fires – building fires that start outside or on the exterior surfaces of a building.

- One of the topics it may examine is the importance of intentional fires in starting such fires.

- With the growth in frequency of history-size wildland/urban interface fires in recent decades, there has been increased interest in understanding more about fires entering buildings from the outside.
Exterior spread

- NFPA has begun tracking large loss apartment building fires where an NFPA 13R system is installed, which allows the attic to remain unsprinklered. We are documenting fires that begin on the balcony, spread up the exterior walls, enter the building in the attic, and grow large in the undivided, unsprinklered attic.

- Here is a very specific scenario where passive fire protection could complement sprinklers and save a lot of property but often are not present to do so.
Attic or related concealed space

- FIDO has records on 2,167 fires (1972-2011) with horizontal fire spread involving the attic or related concealed space
  - One- or two-family dwellings (292 fires)
  - Apartments (261)
  - Eating or drinking places (206)
  - Wood or paper product manufacturing or storage properties (111)
  - Schools, grades K to 12 (107)
  - Offices (88)
  - Hotels or motels (83)

- Remember FIDO may not be representative
Attic or related concealed space

- Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (49%)
  - Design deficiency (19%)
  - Construction deficiency (11%)
  - Deliberate act (5%)
Door open or burned through or failure of rated assembly

- FIDO has records on 359 fires (1972-2011) with horizontal fire spread because a door was open (330) or burned through (19) in a rated assembly or with vertical fire spread because of failure of a rated assembly (10)
  - One- or two-family dwellings (93 fires)
  - Apartments (90)
  - Hotels or motels (24)
  - Offices (15)

- Remember FIDO may not be representative
Door open or burned through or failure of rated assembly

• Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (36%)
  - Failure to isolate fire (27%)
  - Deliberate act (6%)
  - Materials improperly handled or stored (5%)
Failure or burn-through of a rated assembly is probably quite rare … but that does not necessarily mean that they are acting effectively to contain fire.

What data we have suggest that blocking doors open is quite common.

It’s like the one-fifth to one-third share of home smoke alarms that aren’t working … only worse.
Door open or burned through or failure of rated assembly

- When it comes to rolling or sliding doors, we find a similar problem in a different form.
- A special FIDO study at NFPA on these doors found some of them blocked open.
- But when they weren’t defeated, they were rendered irrelevant.
- The fire simply found another path out of the space on one side of the door and into the spaces on the other side.
FIDO has records on 2,259 fires (1972-2011) with vertical spread due to unenclosed stairways or elevator shafts

- One- or two-family dwellings (920 fires)
- Apartments (526)
- Hotels or motels (98)
- Vacant buildings (80)
- Rooming or boarding homes (69)

Remember FIDO may not be representative
Unenclosed stairway or elevator shaft

- Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (45%)
  - Design deficiency (27%)
  - Deliberate act (11%)
  - Construction deficiency (4%)

- The 1980-1998 NFIRS shows stairwell or elevator 
  shaft accounting for 12% of fires when there is an 
  avenue of smoke travel cited. Stairwell cases 
  outnumber elevator shaft cases by about 30 to 1.
A study I did of 1970s hotel fires with 10+ deaths, investigated by NFPA, showed lack of sprinklers and unenclosed stairways as the dominant contributing factors.

It appears that unenclosed stairways are now much less common, but there is no way to confirm that impression with currently available data.

Unenclosed stairways and unenclosed elevator shafts pose different problems and have different solutions. The coded data don’t show that detail.
Air handling ducts

- FIDO has records on 506 fires (1972-2011) with either vertical or horizontal fire spread through air handling ducts
  - Wood or paper product manufacturing or storage facilities (78 fires)
  - Metal or metal product manufacturing or storage facilities (64)
  - Textile or textile product manufacturing or storage facilities (59)
  - Eating or drinking places (59)
  - One- or two family dwellings (37)
  - Apartments (23)

- Remember FIDO may not be representative
Air handling ducts

- Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (38%)
  - Design deficiency (9%)
  - Lack of maintenance or worn out (9%)
  - Unclassified act responsible (6%)
  - Failure to isolate fire (5%)
  - Materials improperly handled or stored (5%)

- The 1980-1998 NFIRS shows air handling duct accounting for 4% of fires when there is an avenue of smoke travel cited.
Air handling ducts

• This is the only feature analyzed here where FIDO cases are not predominantly located in homes – and the only feature where industrial settings show up in large numbers

• These may be the fires to examine if you want to examine the need for, use of and performance of fire and smoke dampers
Utility or pipe shaft

- FIDO has records on 161 fires (1972-2011) with vertical spread through utility or pipe shafts
  - Apartments (67 fires)
  - One- or two-family dwellings (12)
  - Hotels or motels (11)
  - Offices (9)

- Remember FIDO may not be representative
Utility or pipe shaft

- Looking at statistics by “cause of flame/fire spread”
  - Unknown or blank (44%)
  - Construction deficiency (22%)
  - Design deficiency (12%)

- The 1980-1998 NFIRS shows utility opening in wall (4%) or in floor (2%) accounting for 7% of fires when there is an avenue of smoke travel cited.
Is there a way to drill deeper into any of this data?

- FIDO has more detail, including more coded detail than NFIRS, the national fire incident data base, but not that much more detail.

- You can select a group of FIDO incidents for more data mining of the narratives.

- Or you can select FIDO fires that were investigated by NFPA, assuring very detailed analyses of any feature cited.

- It’s still anecdotal, not representative, and it won’t provide stats on overall performance, but it gives you much more to work with.
Investigations where “penetration” was mentioned

- A quick check of the NFPA Fire Investigations database under the term “penetration” identified:
  - 1987 Dupont Plaza Hotel fire with 97 deaths
  - 1989 fire in elderly housing with 16 deaths
  - 1986 Canadian fire in high-rise office building with $80 million loss
  - 1984 hotel fire success story with no deaths, in part because protection prevented penetration into guest rooms
  - 1984 hotel fire with 1 death, victim in enclosed stairway that smoke entered via multiple penetrations and open door in the basement
  - 1984 fire in a dwelling that was also an historic building; estimated $10 million loss due in part to multiple penetrations during renovations
  - and others
Investigations where “penetration” was mentioned

- This illustrates the many points that can be illuminated by a FIDO-based narrative analysis

  - The **importance of a feature** is illustrated by its role in some fires with very large loss of life and property, including some fires of historic size that will already be well known to target audiences

  - The **value of a feature** may be illustrated by some near-miss **success stories** with no deaths and few losses, attributed in part to the good performance of the feature
Investigations where “penetration” was mentioned

- This illustrates the many points that can be illuminated by a FIDO-based narrative analysis
  - The importance of reliability and the ease with which some features can be defeated by predictable actions may be illustrated by fires in places where the feature has no obvious or critical deficiencies.
  - The role of unusual circumstances may be illustrated by fires occurring during construction or renovation or with other special conditions that are not as unlikely as many may assume.
  - Each of these types of examples can be helpful in emphasizing good practice and a starting point in identifying aspects of features that could use still more improvement.
Final thoughts

• National fire incident data has never recorded the use of – let alone the type of or the performance of – any passive fire protection features.

• Because such features are often concealed from view and difficult to describe in simple categories, this lack of routine access to usage data is unlikely to change.

• You can’t say how well they work, but you may be able to say how much they are needed.
Final thoughts

- There is older data with some details on factors in fire spread and avenues of smoke spread.
- You can use this data to set some priorities on which features are more vs. less often cited as problems.
- If you solve problems or improve the situation, you won’t be getting new data to show that. The latest data on factors in flame spread is from 1983!!!
Final thoughts

• You can treat large fires as a database and ask how often various features are cited as problems. This will get you more current data.

• Fires investigated by NFPA have the most extensive detail and the most reliable descriptions. They even have some documented success stories. But NFPA now performs less than one investigation per year.

• You won’t have a lot of data to work with. You will mostly be looking for large shares and trying to infer lessons from those patterns alone.
Final thoughts

With all these limitations, available data can be analyzed and used to craft:

- **Advocacy statements** on the need for various features
- **Explanatory statements** on the ways that passive and active fire protection can complement each other
- **Research strategy ideas** on which performance issues might most usefully be tackled first – to provide better products where the improvements might produce the greatest impact on losses
- **Support for training messages** on the importance of good practices in design, construction, installation, maintenance and operation.
Final thoughts

- Not a bad pay-off for data with such extensive limitations

- At the end of the day, we are all trying to help people make better fire safety decisions – decisions that will suit their needs and risks best.

- That’s why my group analyzes fire data. Even on challenging topics like yours, we can do our job better by using available data.

- Contact me if you want to discuss this further.