Tips on Fire Scene Documentation for Fire Modeling

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During the investigation the investigator may have only one opportunity to document a fire scene. This article is intended to provide methods and procedures that will assist the on-scene investigator to efficiently obtain the information necessary to do computer modeling for the scene at a later date.

Personnel at MDE have been modeling fire for many years and have been involved with the development of the modeling software leading to the current version of Fire Dynamic Simulations (FDS). With the introduction of (FDS) there has been an increased utilization of fire models in the process of fire investigation and subsequent litigation. The current version of FDS provided by NIST is well documented in providing data on a timeline to reach tenability limits or when an environment becomes un-survivable to an occupant. These models may be used in the verification of an investigators' hypothesis or theory of a fire progression. In the event that there has been a fatality or severe injury, it is almost essential to take these measurements.

In any given fire scene it may not be clear if modeling will be necessary during the first aspects of fire investigation. It is prudent to obtain the basic information first and if time and resources allow, collect more detailed information. Note that some structures have "as built" drawings; if available, the investigator should take time to verify that the prints are representative of the structure.

Basic Scene Information

Basic information necessary for an accurate model to be developed includes room geometry, ventilation, initial fuel and ignition source. The geometry or shape of the structure is some of the primary information required to perform modeling or even to describe the structure. The units used to measure a scene are not important as it is a simple process to convert units to the metric system used in FDS modeling.

In many instances a witness can recall the approximate locations of various objects in relation to other objects in the structure. They may know the status of doors or windows as being open or closed. However, few witnesses will remember the exact dimensions of a structure. This is where the fire scene diagram to document physical attributes is applied.

The geometry and materials closest to the area of fire origin are the most influential. Farther away from the origin the type of material is less critical but the flow of gases may be important. The geometry and openings of the structure remote from the fire may have a significant effect on the fire by influencing the flow of fresh air and hot gases.

The diagrams that are normally obtained during fire scene documentation may be sufficient if they contain the following:

- Dimensions of each room in length, width and height, i.e. 7'6" in height, 10' in width and 12' in length.
- Dimensions of objects in the room of origin, in detail, and material type, if known.
- Any beams in the ceiling that would affect the flow of gasses should be located and dimensioned.
- Less detailed measurements on rooms farther away from the area of origin.
- Doorways or openings to the adjacent rooms such as hallways, closets, bathroom and the exterior, including the door width and height, the soffit height and any gaps at the bottom or top of the door.
- Windows and other wall openings must be described so that they can be positioned on a wall. A window requires the number of panes, single or double glazed, the height and width of

each pane, the sill and soffit positions as well as the distance to the wall or next room object. The window framing materials may also be documented.

- Surface lining material of the ceiling, walls and floor that represent more that 10% of the area. Include thickness, density and other material characteristics, take samples if possible.

- Locate smoke detectors; include height on wall and type.

Ventilation

A timeline of events that influenced the ventilation of the fire is a critical factor. If a window broke, when did that occur? Can the time be approximated? If a door was opened or closed, when did that event occur in the timeline of the fire?

One example is that a door, originally closed, was opened by an escaping occupant, and then remained open until fire extinguishing crews entered. Another example is a window that breaks due to heat and pressure that ventilates the fire, but the exact timeframe the window broke is not known. Window breakage time estimates can be approximated during the modeling process and an opening in the fire model representing the window opening can be inputted to occur at a predetermined time based on temperature near the window.

Heating, ventilation and air conditioning (HVAC) move air through a structure. Include data on air flows from HVAC systems. Identify the positions of supply, return, and exhaust vents in the room being documented. Collecting information from the HVAC units will help in determining air flow rates into and out of the various rooms of your model. Even an estimate, if noted as such, is helpful. Also sizes and types of ducts and diffusers should be documented. This type of information is used to transport the hot gases and smoke from a fire to other areas of the structure. Incoming air may serve as a source of oxygen in an otherwise closed room. Documenting the smoke stains inside the ducts may prove that the system was operating or not.

The tightness of walls, windows, doors and other features can be classified as tight, average, or loose. If the fit is very loose, try to get the size, number and location of cracks, gaps, holes and other openings. Tight construction is represented by well caulked, new construction. Loose is non-insulated, non-caulked with visible gaps in the frame around the window. Average is somewhere between tight and a loose configuration.

Initial Fuel and Ignition

Initial fuel items and possible sources of ignition should be described. For example a full-sized recliner chair with synthetic cloth fabric, and polyurethane foam cushion, and polyester batting, wood sub-frame should be described in such detail. Second fuel was drapery, cotton described as medium to heavy.

NFPA 921 Annex A Compartment Modeling Form Figure A 15.3.2(i) contains a segment to describe the suspected ignitor. It is not recommended to present a suspected ignitor in the field notes. Field notes are fact based and a "suspected ignitor" is conjecture, an opinion that could change with new evidence or information.

The location of the lowest burn pattern or the deepest char is fact-based information that should be included in field notes.

Data Collection Techniques

Grid paper is useful to reference the scale of the scene. It also assists in drawing a straight line by hand. A scale of ¼" equals one foot permits a 31' by 37' scale diagram on a letter sized page. A scale of 1/8" equals one foot permits a 62' by 74' scale diagram to be drawn on the same size paper. Using multiple pages allows greater scale in the areas of interest on one page and the larger outline of the building at a smaller scale on another page. Mosaic very large structures on multiple pages using the same scale.

When documenting a fire scene use a stiff tape measure and three measurements to any given point helps locate an item. Some of the non-contact measuring devices use an ultrasonic mechanism and LASER pointer; care must be used when using non-contact devices as the measurement beam is not as narrow as the LASER pointer and may be taking a reading from a post in the middle of the room instead of the far wall for which the measurement in intended. The ultra sonic device is great for flat areas that you cannot easily reach such as a tall ceiling or the far wall of a debris filled room. A room description of 10' x 12' and having a height of 7'6" describes all three boundary dimensions of a simple cubical space.

When referring to a window or doorway it is beneficial to denote the dimensions of the window, the height above the floor or distance down from the ceiling and the distance from a room corner. Thereby, it is a simple process to position the window or door in the wall within a room. For example, an aluminum casement window 2'0"W x 4'0"H with a sill height of 3'0" and located with the nearest edge 5 feet 0 inches west from the NE corner

of room A (see Figure 1) would be a suitable description.

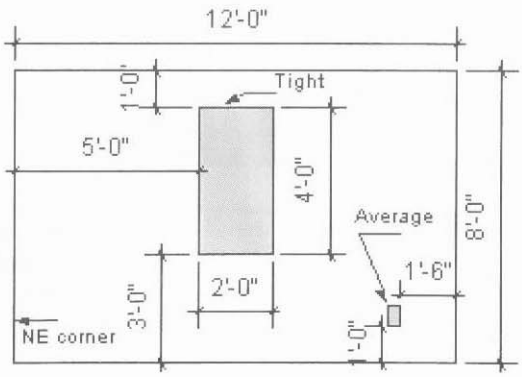

Figure 1: Diagram with a description of wall and openings

When referring to an object within the room a good description is valuable. For example, a coffee table 24" wide and 36" long with the 36" side parallel to the couch and 18" from the front of the couch with the back of the couch adjacent to the west wall. The coffee table is a solid hardwood material with no lower shelf and is approximately 2.5" thick on the top and legs and has a char pattern that is documented.

Materials

The physical characteristics of material used in a model can have a direct bearing on the results. There are a limited number of materials that currently exist within the FDS model library as it comes from NIST. As an on scene investigator you may be able only to take photographs. If permitted, small samples can be collected and used to identify materials. A description of the material can be extremely helpful and might include thickness and density. If an example of the material can be found, it is possible to develop the physical characteristics to input into the FDS fire model. If a material is unusual, collect samples of adequate size to prepare cone calorimeter or intermediate calorimeter (ICAL) testing to determine the physical properties.

Conclusion

Documentation of a fire scene is one of the most important tasks of a fire scene investigation. Photography and video records contain a great deal of information, but they do not replace a good sketch with dimensions and notes. A sketch, even roughly drawn, but containing the necessary information, is adequate. The fire scene diagram may be one of the most important demonstrative exhibits at trial. Time spent at the scene taking measurements will benefit later when communicating the fire scene to other investigators, attorneys, jurors and fire modelers.

The mechanics and outcomes of what can be accomplished with fire modeling is a more complex subject that is covered in other books and articles. Some examples are to determine the operation times of detectors, escape paths, carbon monoxide concentrations, temperature, heat flux levels, and visibility levels diminished by smoke. As the technology improves and the usage becomes accepted by a broader base, the applications for fire modeling will increase.

References

NFPA 921 2004 Figure A 15.3.2 is a two page sample form titled: Compartment Fire Modeling Fire. It is located in Annex A along with other forms useful to the investigator.

NFPA 921 2001 also contains essentially the same form located in Annex A

Forensic Fire Scene Reconstruction, by David Icove and John DeHaan.