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The Nexus Between Flashover and Response Time

Almost every time somebody starts discussing fire in a building, the subject of the flashover curve comes up. We have all seen it. It consists of the nexus between two things: time and temperature. Many individuals have discussed this chart in public settings without really clearly understanding that the flashover chart is not everything that it seems to be. As a result, there are people that are pushing back on the idea that the flashover chart means anything.

Let me be more specific. The flashover chart is almost always illustrated in documents as being a curve that shows that within a certain number of minutes, fires go to flashover in occupancies and that this is supposedly the basis for the amount of travel time that fire departments take to get to the scene. Well, that's partially right, but it's also partially wrong. Let me be real blunt – not all fires go to flashover. Some fires are never going to go to flashover. Some fires achieve flashover long before that time interval because they have been accelerated by artificial means.

So is there truly a nexus between the flashover curve and response time. The answer is yes. However, one cannot take the flashover curve and use it as the only justification for a response time developed by a department. The basis for the flashover curve is from the American Standard Time Temperature Curve. This is a chart that has been published in fire protection publication for as long as I can recall in my career. I actually believe that the seminal work on flashover determination was probably done clear back in the 1920s or 1930s. Unfortunately, there have been individuals who have failed to study all of the other components of fire behavior and therefore overly simplify this process.

Let me be more specific. Fire must go through several stages of development before it reaches the flashover stage. The degree to which a fire is detected and warning been sent to the fire department, means that a fire department can literally arrive at the scene of a fire when it still remains in almost the incipient smoldering stage. I authored an article once entitle "Era Analysis" or the systems approach to staffing and manning. Apparently not many people read that article because they still continue to make the same mistake. They tend to say that all fires are a potential for flashover when in fact only a limited number of them are. But it's that limited number that really makes a difference.

This was also complicated by a research project that was done in the City of Santa Ana. I was State Fire Marshal at the time that document was produced and have a reasonably knowledgeable basis for questioning the authenticity of using that to justify everybody else's attitude about the flashover curve. The subject of that research project was not flashover. The subject was overcrowding and extremely high fuel loads. And, it is true that fuel arrangement and compartment size have a tremendous effect on whether or not a fire goes to flashover or not.



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That's the truth. All fires that reach a state of open flame production must be able to sustain that combustion to the point where certain conditions exist or flashover will not occur.

Let me give you an example. If you create a small fire in a closet with the door closed with a lot of clothes hanging right about it, i.e., the typical scenario of a young child playing with candles in a closet, the potential of that fire going to a high challenge stage in a matter of a very few moments is quite high. If you take that same amount of fuel and set it out in the middle of a gymnasium floor in a room where the ceilings are 50 feet high, you could theoretically consume all of the fuel without ever even activating a sprinkler head. That's because the reality is that fire behaves according to multiple variables and that the line on the flashover chart is just one of those variables. It is not, in fact, the determining factor.

What this really points to is the fact that fire departments that base their entire response to threats to life and property on the response of a fire truck, are liable to end up at the scene of a lot of fires with nothing to do but collect fire report information and to identify the bodies. For example, here is a press release that was taken right off the Internet recently. The name of the department has been excluded for purposes of anonymity. But, read the headlines. This building was within a hundred yards of a firehouse and people died in it. Was response time responsible for their deaths? I don't think so.

Therefore, where do we take this argument in terms of overall response time? First thing we need to recognize is that what is threatening to life and property is an open flame fire that is within a compartment that contains a sufficient amount of fuel to endanger lives and property in a very short timeframe. I have personally burnt over 500 single-family dwellings in my career. Ray Russell, from State Fire Training in California, and I once joked about the fact that we have burnt down enough buildings to make a small town if they had all been on in one place. What I have been able to determine is that flashover is easy to achieve in a single-family dwelling within five to seven minutes of "open flame production."

That is an absolutely significant statement that cannot be ignored. A wastebasket that smolders for three days is just as lethal. This is the basis for many of the arguments about the effectiveness of smoke detectors. If a smoke detector cannot identify the fact that smoldering conditions exist and that products of combustion are being discharged into the atmosphere, then lives will be lost while fire trucks are still setting in the fire stations.

But, if open flame production does occur and if those open flames reach a height of 18 to 24 inches off the floor and have the ability to produce radiant heat flux and/or convected heat to reach another fuel that's within those 18 to 24 inch range, then the clock is ticking quite rapidly. In fact, the time temperature curve on the left-hand side of the flashover curve is not minute zero. It is minute plus open flame production.



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If you follow through the line of logic that smoke detectors are designed to prevent people from dying in their beds from smoldering fires – and if you agree with the assumption that residential sprinklers are designed to try to confine a fire in the first seven to ten minutes – then you must also recognize that when there are no residential sprinklers, that fire truck had better be out of that station and on the road and arrive at the scene of that building sometime within five to seven minutes or they stand absolutely no chance of preventing flashover from occurring.

Moreover, when they get to the scene of that fire, if they do not have the ability to gain entry, perform ventilation, and conduct the other types of activities within a reasonable timeframe before water is put on the open flame, then firefighters lives themselves are in danger.

The nexus between the time temperature curve and response time is really fairly simple. The reason why travel time has been established as the benchmark of fire department intervention is the fact that *if* the fire is in the open challenge mode when the fire department is notified, they have a minimum window of opportunity to mitigate that fire before it becomes a severe threat to life and property. That's it! It is true that we cannot state to the public that every fire is going to go to flashover. It is also true that we could state that any fire that goes to open flame has the possibility of going to flashover. We can also state that unless the fire department arrives in a timely fashion once a fire has gone to open flame that the threat to the life of firefighters increases expeditiously.

I have often drawn a comparison between these two charts by putting one of the charts a top the other and indicating that a three-minute response time to a fire that's already at the fully involved state is somewhat irrelevant. I truly believe that. In my career, I can't tell you the number of times that I pulled out of a firehouse and realized that we could walk to the scene just as about as fast because we were not going to make that much difference on the interior of that building.

However, maybe we should steal a line from TV commercials, "Wait – there's more!" And that more has to do with exposure protection. There's a tendency sometimes for people to think that all initial attack is about is going inside a burning building and saving people. It's more than that. Initial attack is also designed to assure that a fire that has got out of control has a reasonably good chance of be retained on the property. Lloyd Lamond taught us this lesson many years ago when he placed exposure protection as one of the highest factors to be considered.

Recently I read an article about a fire department that had a fire with relatively small parameters on a kitchen stove and the firefighters refused to enter the building until two additional firefighters showed up. We all know where that comes from – it's the "two in, two out rule." However, I don't believe that that was the intent of creating that high level of prohibition. I find it hard to believe that an IDLH existed in a building that had basically a very small fire burning on a kitchen stove – but according to the



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information that I was given, the individuals were prohibited by policy from entering the building. That sort of prohibition is based upon the strictest of interpretation of what your law intends to do.

But, how does the two in and two out rule apply to a building that's fully involved on arrival? The answer is, it doesn't. You're not going to go in anyway. What you have to be prepared to do is to generate sufficient amount of fire flow to keep that building from taking the one next to it. In my personal opinion, it often takes more staffing to fight exposure fires than it does to fight interior ones. You try generating 500 GPMs on two sides of a burning building with a three-person engine company.

Research over the last couple of years has really placed an emphasis on time elements that the fire service has been accustomed to ignoring. Until the Accreditation Commission started talking about alarm processing and turnout time, that was taken as a given by many fire departments. Without analysis of that component, little did they realize that in some cases they were losing precious minutes that were going to cost them on the other end. Even so, while this approach is gaining widespread recognition in the fire service today, there are many fire departments that still don't have a clue of what's going on between the time of ignition and the time of the fire department being notified and respond. Those departments that are focusing little or no attention on that component could put fire trucks one minute apart and still going to suffer major losses.

Moreover, the current attention to deployment analysis is starting to look very carefully at such things as the road traffic network, including roadbed realities that affect the response times, as well as, the variables that have to do with how fast the vehicle can transient from the fire station to the scene of an emergency. The fire service is finding out an awful lot about things that has been taken for granted for years.

The fire reporting systems are beginning to realize that time stamping is not just an extraordinary thing for a communications or dispatch officer to do whenever they get around to it. It is essential for analysis. The continued attention of the fire department on response time requires that we collect more and more accurate information on what it actually means with respect to performance.

Which brings us back then to this discussion of what is the nexus between the time temperature curve and response time. You cannot guarantee to anybody that if you place fire stations on the basis of response time that you're not going to have major losses of life and property. What you are doing is establishing a response **GOAL**. The response goal is to arrive at the scene of 90% of your fire calls by the time before the structure has achieved a fire environment conducive to flashover. That's it. You're not saying that you're going to stop all flashovers. You're not saying that all fires will have gone to flashover before you get there. What you're doing is establishing a goal that if it is successfully accomplished in most communities, will result in a fairly minimal loss of life and property.



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One could not complete this article without stating that it is also true that fire behavior is not the only thing that drives response times these days. Getting to the scene of an emergency medical services call is just as important. However, we have a different model that we must look to there. In the Commission on Fire Accreditation's research, we discovered the Utstein criteria. This particular chart clearly illustrates that a cascade of time events does have a lot to do with the potential survivability of cardiac care patients. Please note that we talk about cardiac care patients. This does not mean that an Utstein criterion applies to every medical aid that comes down the pike. There are many injuries that a person could sustain in life that they can survive for any number of hours without medical treatment.

But, the reason that paramedic systems have been brought into effect in many communities is to prolong the life of those individuals who receive major trauma or immediate threat of loss of breathing or circulation. That's why there is a parallel between the flashover curve and the Utstein criteria. Both of them state that if a given set of circumstances occurs, you've got a limited amount of time to intervene successfully.

To coin a term from another conversation, this is a twofer. You're getting two potential response goals to be achieved within the same timeframe. Frankly, those fire departments that are not in the EMS business don't have the opportunity to accomplish that. Those emergency medical services departments that are not responsible for responding to fires can't take credit for the flashover phenomena either. It is one of the reasons why fire agencies are now being looked upon as multi-tasked organizations. They do provide a strategically positioned, readily available response force to deal with two problems that society has in context – structural fires and emergency medical aids.

What remains to be done, however, is to convince policy makers that this is not an arbitrary and capricious relationship. Those individuals who display the flashover curve and follow it up with a dire prediction are making a mistake. Those organizations that are ignoring the existence of fire behavior phenomena and stating that they can afford to gamble and not deal with response time are making a bigger mistake. This is a relationship between Mother Nature and mankind. Response time is related to damage, damage is related to response time.

It is noteworthy to be reminded of the fact that a study was done in Sweden back in the 1970s that clearly indicated that there was no direct nexus between response time and property loss. In fact, that study, which will be cited at the end of this article, indicated that what was more important was the warning system and the mitigation measures that were taken prior to the initiation of event. Maybe that's a lesson we in the American fire service need to continue to learn.