A Guide to
Firefighter Safety
&
Modern Structural Firefighting-

FEMA

www.ModernFirefighting.com

A Guide to Firefighter Safety and Modern Construction to assist fire fighters when fighting fires involving both Modern and Legacy Construction by reminding them of some important features and Hazards associated with Modern Construction Types, Materials and Building Contents.

This Guide has been developed to provide for improved Firefighter Safety when responding to Structural fires. The emphasis is n residential fires because they are the most common scenarios in which firefighters are killed.

It is designed as a reminder to firefighters when fighting a fire that may involve modern construction by reinforcing important features and hazards associated with modern construction materials and building contents.

Frank Brannigan said it best:

"Many investigations into firefighter deaths and injuries suggest that fire departments, incident commanders, incident safety officers and firefighters may not fully consider information related to building occupancy before performing offensive operations or entering structures to initiate interior operations." [1]

"There is no safe time under or on burning trusses. You can have a raging fire over your head or under your feet and not even know it. There is no obligation to kill firefighters to save a disposable building. Paste this on your helmet."

Frank Brannigan

[1] Fighting Fires in Unoccupied Structures, NIOSH

INTRODUCTION

Building construction and furnishings have changed dramatically over the last three decades, but the tactics and equipment used by firefighters has changed very little. These new methods of construction and new materials used in the manufacture of building contents negatively impact firefighter safety. This is not an unknown problem. Many studies point to concern involving modern construction. Changes in fire behavior that require a renewed focus on how to properly handle these incidents is now a reality. While we haven't necessarily changed what the fire service does or how they do it, we can change our behavior by examining the effect new building construction materials and techniques and furnishings have had on the burning characteristics of today's structures. Becoming aware of how those new burning characteristics impact firefighter safety is a critical skill set.

This problem is not just about lightweight construction. Fires create highly toxic environments. We have a greater fuel load, and faster fire propagation.

This guide is designed to provide firefighters with some information about the modern fire environment and act as a reminder of some things to enhance their safety when fighting a fire involving modern construction. This guide can also be used as a reference for

departmental personnel when developing a departmental Incident Action Plan regarding Fire Behavior and Building Construction

A secondary purpose of this document is to provide resources for the development of a local training program to enhance fire fighter safety.

It is imperative that a fire department establish, implement, and update a risk management plan to ensure it recognizes potential risks and hazards. The intent is to make sure that each and every member of the fire department is aware of the potential risks and hazards when responding to an incident.

A *hazard* is defined by the NFPA as a condition, an object, or an activity with the potential of causing personal injury, equipment damage, loss of material, or reduction of the ability to accomplish the mission.

A *risk* is defined by the NFPA as the chance of injury or loss[2].

[2] Understanding and Implementing Standards, NFPA

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Firefighters are at Risk!

Firefighters are at increased risk of death and injury due to trauma while working inside of common residential occupancies. Extreme fire behavior and the failure of the building from collapse is frequently a causal or contributing factor in traumatic fatalities during structural firefighting operations.

Definition of *Residential Building*

A *structure* is a constructed item of which a *building* is one type. The term *residential structure* commonly refers to buildings where people live. To coincide with this concept, the definition of a *residential structure fire* includes only those fires confined to an enclosed building or fixed portable or mobile structure with a residential property use. Such fires are referred to as *residential buildings* to distinguish these buildings from other structures on residential properties that may include fences, sheds, and other uninhabitable structures. *Residential buildings* include, but are not limited to one- or two-family dwellings, multifamily dwellings, manufactured housing, boarding houses or residential hotels, commercial hotels, college dormitories, and sorority/fraternity houses.

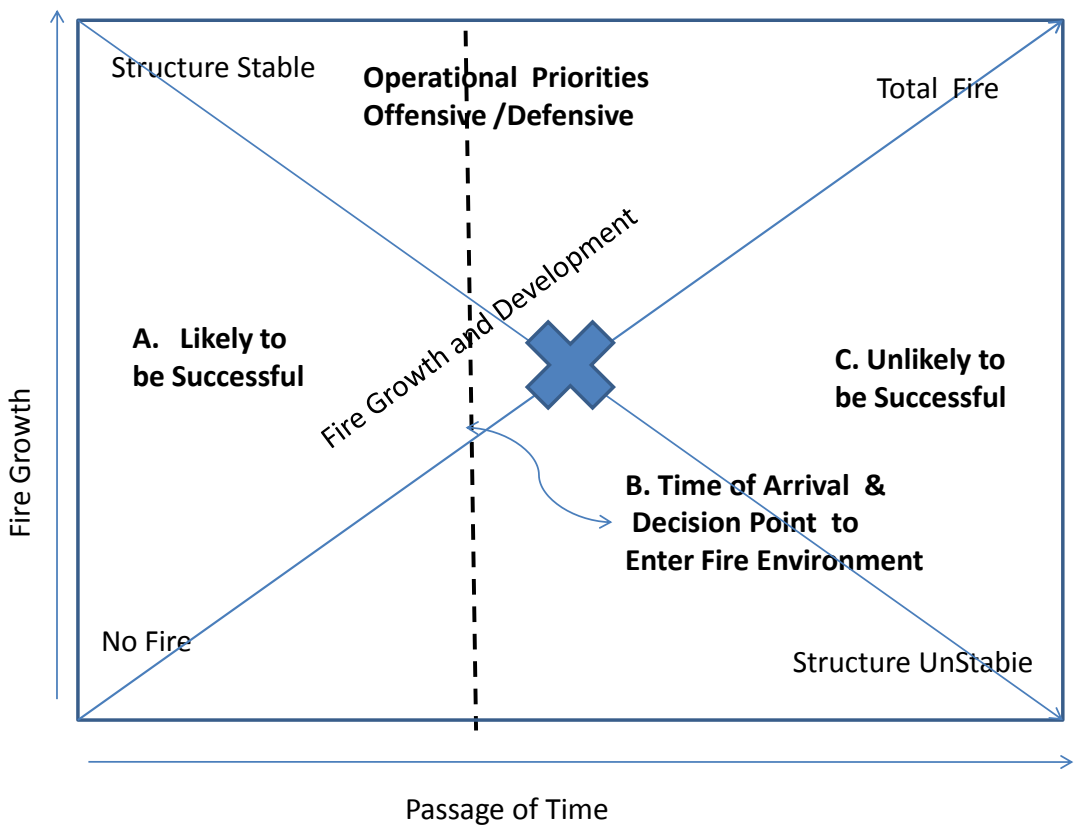
Part of the concern with modern construction stems from the perception that the structural fire resistance of "conventional" wood-frame construction provides a much greater degree of safe working time than for modern construction. As a practical matter, no two fires

are the same and a structure's fire endurance and mode of failure under real fire conditions is unpredictable. Time can quickly be forgotten on the fire-ground and firefighters may not be able to determine if the safe working time has already been exceeded when they arrive.

This necessitates a rethinking of tactical procedures and guidelines for fighting fires in these newer structures or newer contents. Using the same tactical thinking, procedures, and timelines that were commonly used in years past are not the best applicable for modern construction or modern contents. For more specific information please see the UL /NIST videos showing time to flashover in a compartment fire. (http://www.nist.gov/fire/)

> "If you are not acquainted with the structure of the fire building, whatever its age, assume that it contains lightweight materials and construction methods. Today, building officials nationwide are approving remodeling plans for buildings of sawn lumber construction, using wood trusses and I-joists. I have seen these components used in remodels of century-old mill (Type IV) and Ordinary (Type III) buildings as well as Type V wood frame. This is especially true when these old factory and mercantile buildings are turned into apartment buildings and condominiums."
>
> Gregory Havel

Model of Modern Firefighting Strategy and Tactics



Description of Model

This model compares the passage of time with the stability of a structure. On the lower left of this model indicates a building that does not contain a fire and has a high degree of structural stability. The right side of the model discusses what happens if the building is totally involved in fire and the structure is unsafe. To understand this model, you need to follow three factors; what happens to the building when it is on fire and what happens to the stability of that building as the fire progresses. That is reflected by the line that goes from the lower left to upper right. The second thing for consideration is the time of arrival of firefighting personnel. It can either be before the building is badly involved and remains fairly stable or it can occur after the building has been assaulted by fire and is beginning to become unstable. The third factor is the decision point to either engage in offensive tactics or defensive tactics.

The dotted line on the model is a variable. In essence you can arrive at a building on fire very early on or you may arrive late in the fire's development. As a responder, you are unlikely to know how long the fire has been burning until you get a chance to assess fire conditions. The problem occurs when the building has been burning for a considerable period of time and does not show any visible evidence of structural integrity degradation. This would include evidence from both both smoke and heat (flame). This line is also affected by the nature of the contents of the building. Heavy smoke conditions can often

obscure the amount of fire damage that has occurred. Smoke potentially contains large amounts of unburned fuel. Ventilation by the firefighter can accelerate fire growth. Caution should be exercised when ventilating structural fires.

For purposes of establishing a criterion for success, the fire department needs to make decisions about being offensive or defensive before structural conditions become unstable.

Scientific Information

Contemporary literature on modern firefighting emphasizes that the order of execution for tactics and strategy may vary depending upon how much you can control the air and/or the heat. The order of that execution may actually vary from Layman's concept of RECEO. The new sequence of events might well be the following:

- Decision to enter
- Cover and confine
- Ventilation
- Search
- Extinguishment[3]

[3] http://www.fireservicewarrior.com

Before talking about modern tactics, we should review the most fundamental tactics and strategy document created for the fire service. This document is Firefighting Tactics, Lloyd Layman, NFPA.

Basic Divisions of Firefighting Tactics

Size Up or Estimate of the Situation (This now also includes the term "situational awareness")

In the past this was defined as the mental evaluation made by the operational officer in charge of a fire or other emergency. This process enabled the incident commander to determine a course of action and to accomplish the mission. One of the most significant changes in the concept of size-up is the idea that firefighter safety is now the number one priority for the incident commander.[4]

1. **Firefighter Safety** – Includes those decisions which are required to prevent firefighters from being unintentionally exposed to conditions that could result in severe injury or death. It is a determining factor as to whether actions will be offensive or defensive.

2. **Rescue** – Includes those operations which are required to remove human beings from an involved building or other hazardous situation and convey them to a place of safety.

[4] 16 Life Safety Initiative, National Fallen Firefighter Foundation

3. **Exposures –** Includes those operations which are required to prevent a fire from extending to uninvolved buildings or separate units.

4. **Confinement** – Includes those operations which are required to prevent a fire from extending to uninvolved sections of a building.

5. **Extinguishment** – Includes those operations which are required in attacking and extinguishing the main body of fire. Modern building construction and building content must be considered to determine whether the fire is fuel driven or ventilation driven.

6. **Overhaul –** Includes those operations which are required to complete the extinguishment of remaining fire, prevent rekindling and to place the building in a safe condition.

A. **Ventilation** – Includes those operations which are required to displace a heated and confined atmosphere within an involved building with normal air from the outside atmosphere. In modern construction, this also involves consideration of the actions taken by firefighters that can have an effect upon the actual flow path of a fire. It is now recognized that actions taken by firefighters can have an adverse impact upon fire spread.

B. **Salvage** – Includes those operations which are required to protect buildings and contents from preventable damage due to water or other elements. Modern building construction and content now recognizes

that once a fire is extinguished that an atmosphere that is immediately dangerous to life and health (IDLH) can exist in the salvage phase and that self-contained breathing apparatus should be utilized unless conditions have been measured and found safe.

In summary, Layman laid out the operational considerations that would have to be addressed but did not go much further into the "how to do these things". The word safety was not included anywhere in the narrative of the text. Layman's use of the concept of size up seemed to be focused more on the incident commander rather than the firefighter. This makes it easy to feel that Layman's construct may not be up to speed with contemporary decision making factors.

Contemporary Texts

Safe and effective fire-ground operations require knowledge of fire dynamics and building construction. The creation of the concept of situational awareness by Richard Gassaway, and others provides a transition between Layman and all other future considerations. This next section addresses how contemporary recommendations have expanded upon Layman's framework.[5] [6]

Fire Behavior (important because of changing contents)

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[5] Gassaway, Richard, Situational Awareness

[6] Ten Rules for Survival

This requires a solid understanding of the key fire behaviors and the relationship between these behaviors and the actions being taken by the fire fighters themselves. Tactics used by the firefighters can influence the fire's development and direction of travel. .

- Fuel Driven Fires – this requires a basic understanding of fire behavior.
    - Time Elements of Fire Behavior
    - Products of Combustion of Modern Fuels
    - Stages of Fire Development
- Ventilation Driven Fires – this requires an understanding of flow path.
    - Flow Path – "every new ventilation opening provides a flow path to the fire and vice versa. This could create a very dangerous condition when there is a ventilation limited fire."[7] This requires that firefighters be aware of flow path and air track. *Flow path* is the course of movement that hot gases follow between the fire area and exhaust openings. It affects the movement of air into the fire. Air track is considered closely related. *Air track* is the observation of the movement of both air and smoke as observed from the perspective of inside

[7] Kerber, Steve, Underwriters Laboratory

or outside of the structure. Air track terminology describes a group of fire behavior indicators. These indicators include direction and intensity of smoke, velocity and turbulence and movement between the upper and lower boundaries of thermal balance.[8]

- Contaminated Atmosphere – the products of combustion of modern fires have clearly been a source of injury and fatality of firefighters. The term used to describe this contamination is called *Immediately Dangerous to Life and Health*, (IDLH). For specific information on how to protect yourself from IDLH, review websites listed in the website contacts at the end of this document.

Building Construction (Important because of components)

- Fire Resistance Issues
- Legacy vs Contemporary Lumber

Structural Collapse (Fire and life safety issue)

- Load Path
- Fighting Fire in Structures

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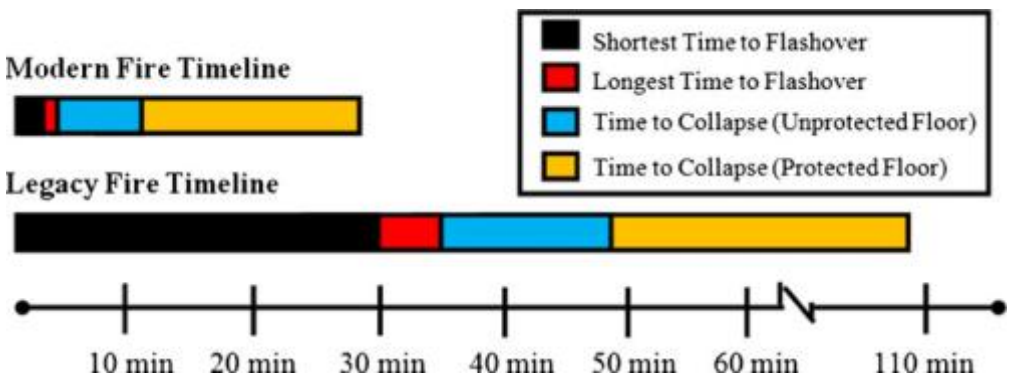
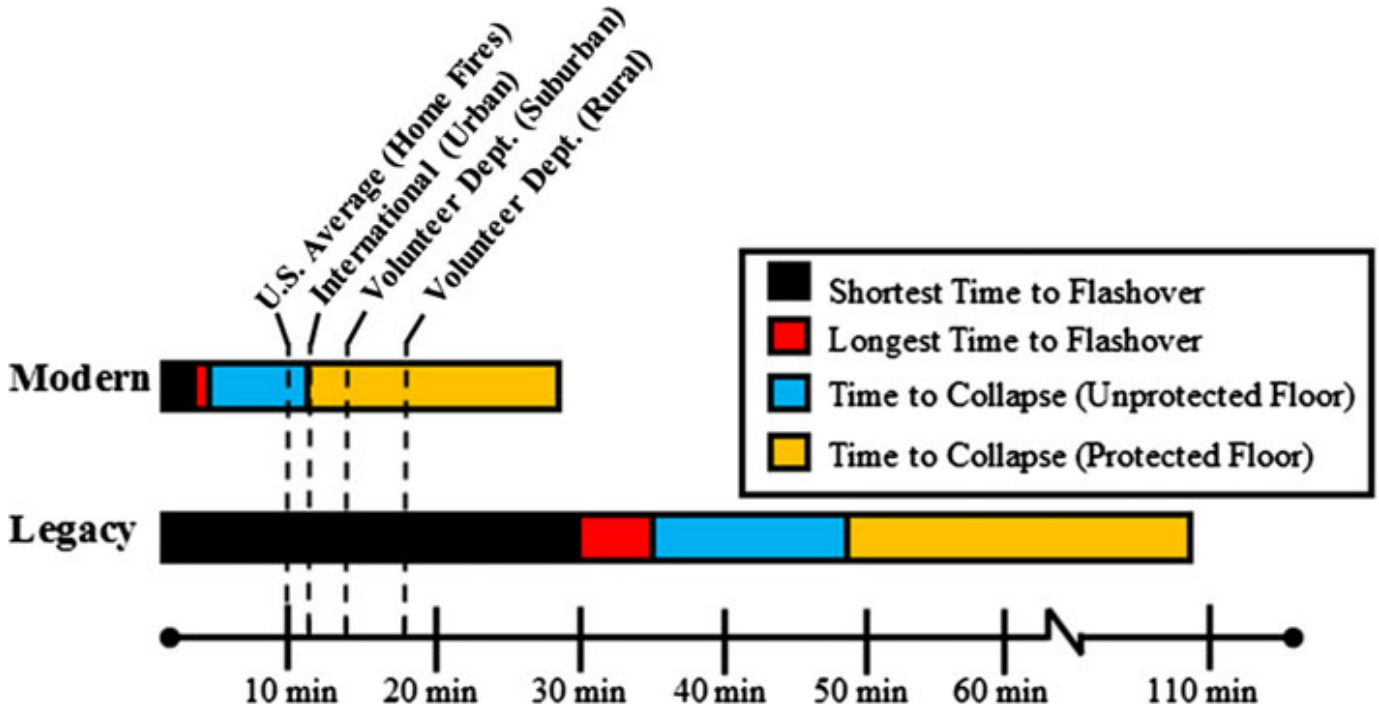
8 http://cfbt-us.com/wordpress/?tag=situational-awareness

This has resulted in a new "Time Frame for decision making. The following is a modern versus legacy timelines.[9]



This research examines a consistent change in the residential fire environment. Firefighters must change their approach to these fires or suffer the consequences. For further information see the footnoted reference.

[9] Kerber, Steve, Analysis of Changing Residential Fire Dynamics and its Implications on Firefighter Operational Timelines, UL



Fire Service arrival times versus Fire development

This chart clearly illustrates the shortening of the time frames for safe operations by the fire service and should be considered in all tactical decision making. Do you have the time to do what you want to do to control the situation?

The following chart gives you some estimate of the times that have been derived from tests conducted under scientific control.

Unprotected Structural Element Testing

ASTM E119 Assembly Tests at Full Design Load					
Test	Structural Member	Spacing (inches o.c)	Structural Failure (min:sec)	Average Deflection at Floor (inches)	Loading (psf) – Percent Design Stress
FM FC 209	2 x 10	24	**13:34**	2.83	62.1 – 100%
FM FC 212	2 x 10	24	**12:06**	3.58	62.4 – 100%
NBS 421346 (2)	2 x 10	16	**11:38**	2.70	63.7 – 100%
NBS 421346 (4)	2 x 10	16	**11:38**	3.30	63.7 – 100%
FPL	2 x 10	16	**6:30**	4.00	79.2 – 100%
FM FC	12” Truss	24	**10:12**	11:50	60.0 – 100%
FM FC 208	7 ¼” Steel C-joist	24	**7:30**	7.00	69.8 – 100%

Importance of Pre-Fire Planning

Pre-fire planning is defined as the study of buildings to prepare for an eventual fire. The changes in modern building construction and the content have significantly increased the importance of pre-fire planning. Those departments that do not engage in pre-fire planning are gambling on the safety of their personnel. For local application, see NFPA Standard on Pre-Fire Planning.[10]

Go into the field and inventory buildings in your area that might create hazards when the buildings involved in fire.

Fire Resistance Issues

- ✓ All buildings are built with some consideration of fire resistance. That is the nature of such things as fire walls and area limitation. However, once a fire occurs in a building the manner in which it progresses may or may not be in accordance with the original code provisions. There is no such thing as a fire proof building. Even buildings constructed entirely with non-combustible material can suffer major damage due to a fire contained to the contents of that building. Fire resistance performance should include all of the following:

[10] NFPA Standard 1620- Pre-Incident Planning, Current Edition, Quincy MASS

- Structural components, exterior and interior finish components, building contents, detection and alarm systems, exit design, built-in fire protection systems, property setbacks from adjacent buildings or exposure to other fire hazards, ease of access for firefighters and the availability for firefighting services.

Structural Collapse (Fire and Life Safety Issue)

The combination of all hazards associated with buildings can create an environment in which firefighters lives can be lost. The issue of an unlikely and unpredictable collapse should be of prime importance to the incident commander. Firefighters should use extreme caution when operating on or under either an attic or basement fire. In multi-story buildings, operating above any fire is dangerous. The department should have written SOPs for emergency warning to order an evacuation. The SOPs should include but not be limited to instant accountability for crews on the scene.

STRUCTURAL COLLAPSE?

- ✓ **Incident Command – duration of burn**
- ✓ **Size-up – interior/exterior conditions and signs**
- ✓ **Lightweight Construction – truss/masonry veneer walls/chimneys**
- ✓ **Sound out floor/surfaces upon entry**
- ✓ **Be aware of area weight capacity – standing water & personnel**

- ✓ **Heavy suspended mechanical equipment**
- ✓ **Collapse zone – 1.75 X.**

Load Path

Strengthening the structural frame of a building involves the idea of creating a "continuous load path" within your structure. So what is a continuous load path? It's a method of construction that uses a system of wood, metal connectors, fasteners (like nails and screws) and shear-walls to connect the structural frame of the house together from top to bottom. Maintaining a continuous load path is important to preventing the building from having a structural collapse. This is not unlike the idea that a chain is not any stronger than its weakest link. A Load Path ties the house together from the roof to the foundation. When any component is damaged by fire it can fail, thereby compromising the rest of the structure.

The direction that loads are transferred through any specific structure is important and must be identified as quickly as possible when the building is on fire.

- the footings support the flooring structure which consist of bearers, joists and flooring
- the stud walls and bracing transfer their load to the flooring
- the roof trusses support the battens which support the roof cladding and this load is transferred to the walls.

Although modern building codes require homes to be built with a continuous load path, older buildings may not be built to that standard. In addition not all parts of the country follow national building standards. The age of a building can also help determine whether it has a continuous load path or not. Older homes, built before 1985, typically do not have a continuous load path. Homes built after that may have a load patch, but the components may not be of the same design as the older buildings. Modern construction techniques may consist of lighter weight structural components. To help you learn more about the structural integrity of buildings and how to fight fires within them, you should be knowledgeable on structural safety.

Recommended guidelines for fighting fires in residential structures

Before you enter a building that is on fire you should consider the following:

- ✓ *Do you know how to determine the occupant Survival Profile?* If the answer is no - then go to the IAFC website at http://www.iafc.org/Operations/LegacyArticleDetail.cfm?ItemNumber=4486 and review the proposed process there.

- ✓ *Can you determine the possibility or probability that the occupants have still survived?*

- ✓ *The company officer and firefighter have to be able to consider fire conditions in relation to possible occupant survival if a successful rescue event is going to be part of their initial and ongoing individual risk assessment and action-plan development.*
- ✓ The fire service has a long history of aggressive search and rescue operations as an initial priority of first arriving fire companies. History (and firefighter fatalities) also reflects that firefighters are exposed to the greatest risk of injury and death during primary search and rescue operations. *Search efforts must be based on the potential to save lives.*
- ✓ A safe and appropriate action plan can't be accurately developed until we first *determine if any occupants are trapped and can survive the fire conditions during the entire rescue event (find and then remove them).*
- ✓ If survival isn't possible for the entire extraction period, a more cautious approach to fire operations must be taken. Fire control should be obtained before proceeding with the primary and secondary search efforts.

RULES OF ENGAGEMENT FOR FIREFIGHTER SURVIVAL

- Recognize that maintaining your safety is a shared responsibility. Comply with all departmental SOP's and safety rules.

- Size-Up Your Tactical Area of Operations - Be constantly aware of your surroundings
- Report any unusual conditions encountered to your officer, incident commander or incident safety officer.
- Determine the Occupant Survival Profile.
- **DO NOT** Risk Your Life for Lives or Property That Can Not Be Saved
- Extend ***LIMITED*** Risk to Protect **SAVABLE** Property
- Extend **Vigilant** and **Measured** Risk to Protect and Rescue **SAVABLE** Lives.
- Go in together, *Stay together*, and Come Out Together
- Maintain Continuous Awareness of Your Air Supply, Situation, Location and Fire Conditions.
- Constantly Monitor Fire-ground Communications for Critical Radio Reports.
- You Are Required to Report Unsafe Practices or Conditions That Can Harm You.
- Stop, Evaluate and Decide.
- You are required to abandon your position and retreat before deteriorating conditions can harm you.
- Declare a **May Day** As Soon As You **THINK** You Are in Danger.

Read, and adopt the IAFC Rules of Engagement

10 Rules of Engagement for Structural Fire Fighting

Acceptability of Risk

1. No building or property is worth the life of a firefighter.
2. All interior fire fighting involves an inherent risk.
3. Some risk is acceptable, in a measured and controlled manner.
4. No level of risk is acceptable where there is no potential to save lives or savable property.
5. Fire fighters shall not be committed to interior offensive fire fighting operations in abandoned or derelict buildings

Risk Assessment

1. All feasible measures shall be taken to limit or avoid risks through risk assessment by a qualified officer.
2. It is the responsibility of the incident commander to evaluate the level of risk in every situation.
3. Risk assessment is a continuous process for the entire duration of each incident.
4. If conditions change, and risk increases, change strategy and tactics.
5. No building or property is worth the life of a fire fighter.

http://www.iafcsafety.org/downloads/Rules_of_Engagement.pdf

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Risk Assessment/Rules of Engagement			
Fire Fighter Injury/ Life Safety Risk	**High Probability of Success**	**Marginal Probability of Success**	**Low Probability of Success**
Low Risk	**Initiate offensive operations. Continue to monitor risk factors.**	**Initiate offensive operations. Continue to monitor risk factors.**	**Initiate offensive operations. Continue to monitor risk factors.**
Medium Risk	**Initiate offensive operations. Continue to monitor risk factors. Employ all available risk control options.**	**Initiate offensive operations. Continue to monitor risk factors. Be prepared to go defensive if risk increases.**	**Do not initiate offensive operations. Reduce risk to fire fighters and actively pursue risk control options.**
High Risk	**Initiate offensive operations only with confirmation of realistic potential to save endangered lives.**	**Do not initiate offensive operations that will put fire fighters at risk for injury or fatality.**	**Initiate defensive operations only.**

Firefighters must understand the dangers of any structural component exposed to direct fire, regardless of the component material, especially when there are large amounts of stored items

[11] Permission Required from IAFC

such as furniture or other items within the area. It is important to consider that all building components must be designed, installed and maintained properly in order to perform properly. In many cases, homeowners are asking for much larger spans without intermediary support of the structural components.

While the 2012 Edition of the International Residential Code now requires protection on the basement ceiling side of a structure, most residential buildings built before this code will not have this protection. Over the years, there have been collapses involving basement fires that have led to firefighter entrapment. They have involved many different types of construction. On all incidents it is necessary to examine the conditions present and determine if the risk of attempting to save lives outweighs the danger of putting out the fire with an interior attack. It is recommended that tools such as a thermal imaging camera be used to examine for hidden fires or those affecting a focused area of the structural components. NIST has conducted research on these devices. This research clearly describes the limitations of the thermal imaging camera. <u>They should not be used as the only tool during initial size up or ongoing situational awareness</u>. It is necessary for all firefighters to review buildings during construction and become familiar with the different products installed in buildings today.

THE INCIDENT COMMANDERS RULES OF ENGAGEMENT FOR FIREFIGHTER SAFETY

- ✓ Rapidly Conduct, or Obtain, a 360 Degree Size-Up of the Incident
- ✓ Determine the Occupant Survival Profile.
- ✓ Conduct an Initial Risk Assessment and Implement a **SAFE ACTION PLAN.**
- ✓ If You Do Not Have The Resources to Safely Support and Protect Firefighters – Seriously Consider a Defensive Strategy.
- ✓ **DO NOT** Risk Firefighter Lives for Lives or Property That Can Not Be Saved – Seriously Consider a Defensive Strategy.
- ✓ Extend ***LIMITED*** Risk to Protect **SAVABLE** Property.
- ✓ Extend **Vigilant** and **Measured** Risk to Protect and Rescue **SAVABLE** Lives.
- ✓ Act Upon Reported Unsafe Practices and Conditions That Can Harm Firefighters.
- ✓ Stop, Evaluate, Decide
- ✓ Maintain Frequent Two-Way communications and Keep Interior Crews Informed of Changing Conditions.

- ✓ Obtain Frequent Progress Reports and Revise the Action Plan.
- ✓ Insure Accurate Accountability of All Firefighters Location and Status.
- ✓ If, After Completing the Primary Search, Little or No Progress Towards Fire Control Has Been Achieved – Seriously Consider a Defensive Strategy.
- ✓ Always Have a Rapid Intervention Team in Place at All Working Fires.
- ✓ Always Have Firefighter Rehab Services in Place at All Working Fires.

DEPARTMENTAL PLANNING

- Develop and enforce risk management plans.
- Make sure all personnel are trained on the risk management plan.
- Inspect and preplan buildings within the jurisdiction.
- Enter preplan information in the communications center or dispatch center to be readily available to the entire response force.

WATCH OUT SITUATIONS

- IF A SIZE-UP HAS NOT BEEN DONE ON THE FIRE – ***WATCH OUT!***
- IF YOU ARE SEEING IRRATIC FIRE BEHAVIOR – ***WATCH OUT!***
- IF YOU DO NOT HAVE COMMUNICATIONS WITH OTHER CREW MEMBERS AND THE INCIDENT COMMANDER – ***WATCH OUT!***
- IF YOUR INSTRUCTIONS OR ASSIGNMENT ARE NOT CLEAR – ***WATCH OUT!***
- IF YOU DON'T KNOW WHAT THE STRATEGY, TACTICS OR HAZARDS ARE – ***WATCH OUT!***
- IF YOU HAVE FIRE BURNING ABOVE OR BELOW YOU – ***WATCH OUT!***
- IF THE STRUCTURE HAS WOOD TRUSSES – ***WATCH OUT!***
- IF YOU DON'T HAVE ANY IDEA HOW LONG THE FIRE HAS BEEN BURNING – ***WATCH OUT!***

- IF YOU FIND YOURSELF ALONE IN THE INVOLVED STRUCTURE – ***WATCH OUT!***

- IF YOU HEAR CRACKING OR CREAKING – ***WATCH OUT!***

- IF YOU HAVE NOT HAD A RECENT CLASS OR RECENTLY REVIEWED INFORMATION ON FIREFIGHTER SAFETY AND STRUCTURAL COLLAPSE – ***WATCH OUT!***

- IF YOU BEGIN AN INTERIOR ATTACH OF A STRUCTURE FIRE BEFORE THERE ARE AT LEAST 4 FIRE FIGHTERS ON SCENE (2 IN AND 2 OUT) – ***WATCH OUT!***

- IF YOU ARE ON A FIRE OF A BUILDING HAVING PARAPET WALLS AND A COLLAPSE ZONE HAS NOT BEEN ESTABLISHED AROUND THE BUILDING – ***WATCH OUT!***

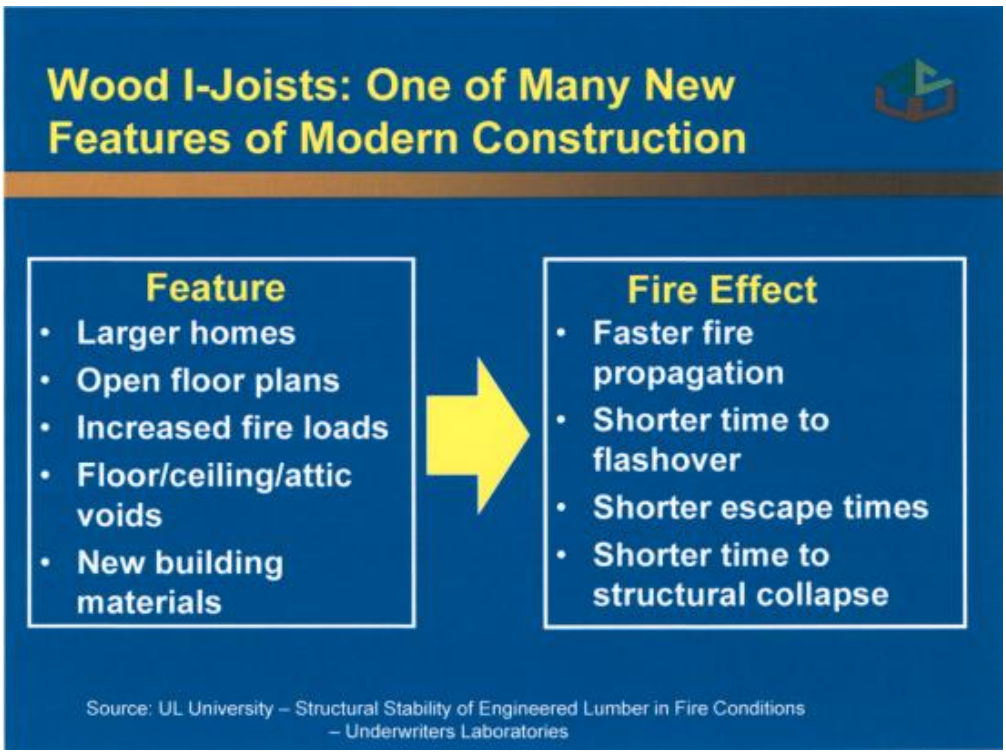
The 13 Fire-ground Indiscretions
By BC Mark Emery

Without further introduction, here are the *13 Fireground Indiscretions*:

1. Lack of pre-incident knowledge and information
2. Most Significant problem not identified
3. Inappropriate operational mode
4. No plan formulated and communicated
5. Insufficient personnel
6. Absence of **tactical** accountability
7. Span of control out of control
8. Nobody watching the clock
9. Poor fire grown management
10. Insufficient gpm for Btu
11. Fire officers operating at task-level
12. Random undisciplined communication
13. No regular, periodic situation reassessment

WOOD I-JOISTS

Shaped like the letter “I,” I-Joists are composed of two horizontal components called flanges and a vertical component called a web. I-Joists are used as a framing material primarily in floors, but may also be used as roof rafters where long length and high load capacity are required

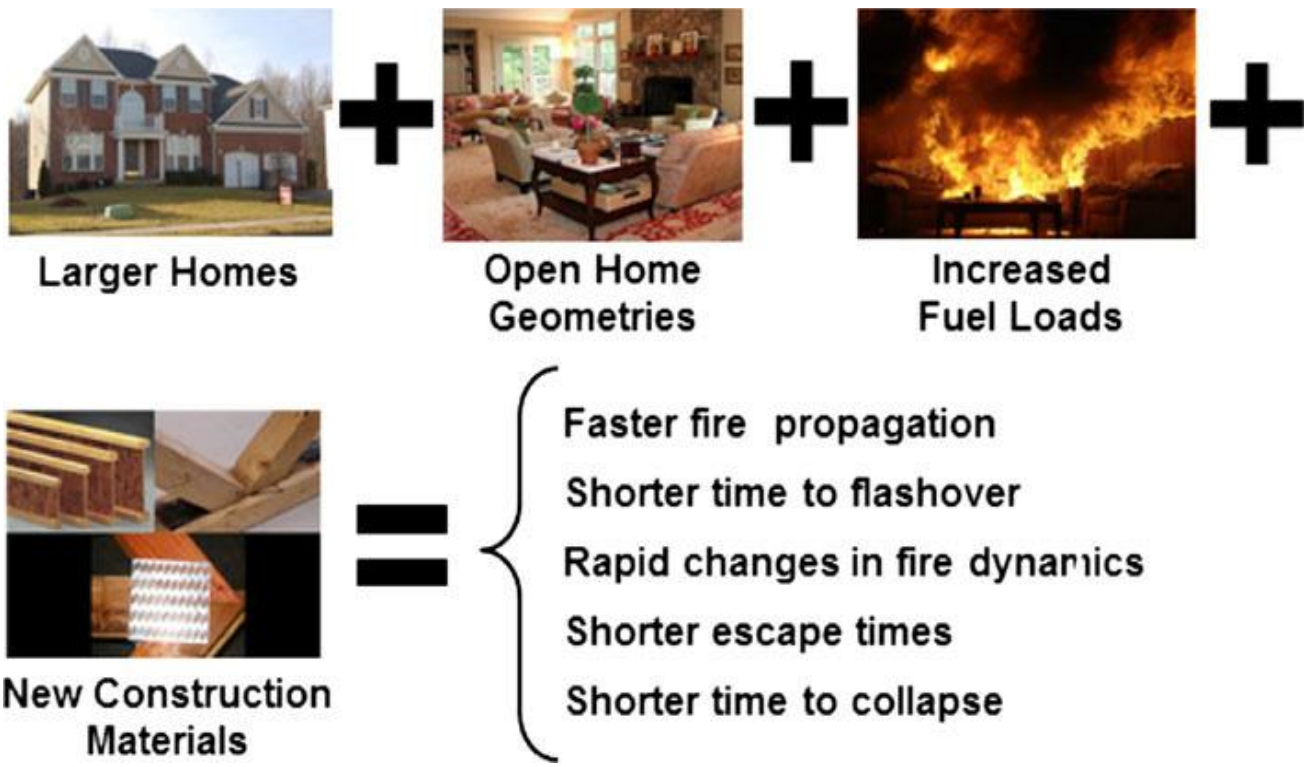
2. 

REMEMBER:

- "We will risk our lives a lot, in a calculated manner to save savable lives.
- We will risk out lives a little in a calculated manner to save savable property.
- We WILL NOT risk our lives at all for a building or lives that are already lost.[12]"

[12] Chief Alan Brunacini (1985, 2002)

FIRE PROPAGATION



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[13] Kerber, Steve, Analysis of Changing Residential Fire Dynamics and its Implications on Firefighter Operational Timelines, UL

Study Links to Further Information Regarding Fighting Fires in Modern Building Construction

It is strongly recommended that you visit these websites and obtain your own library of information. This information can be used to enhance your decision making abilities on the fire ground.

Modernfirefighting.org
American Wood Council - http://www.awc.org/
American Iron & Steel Institute - http://www.steel.org/
Buildings on Fire - http://buildingsonfire.com/
CFBT http://cfbt-us.com
Fire Chief Magazine – firechief.com
Fire Rescue Magazine – http://www.fire-rescue.com/
Fire Engineering Magazine - http://www.fireengineering.com/
International Association of Fire Chiefs - http://www.iafc.org/
http://commandsafety.com
Structural Building Components Association
http://www.sbcindustry.com/firepro.php
Woodaware.org
United States Fire Administration – http://www.usfa.fema.gov/

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NIOSH Alert Document - Preventing Deaths and Injuries due truss system failures.

UL Document - Analysis of Changing Residential Fire Dynamics, and its implications on firefighter operational time frames.

Dunn, Vincent, Collapse of Burning Buildings, A Guide to Fireground Safety, Fire Engineering. Tulsa, Oklahoma, 2010

www.idbdtraining.com

Additional information on these topics can be found at Modernfirefighting.com

Glossary

Construction:

Traditional Construction: of or pertaining to a characteristic of "older" styles of a particular product or process. It is recognized that many of the changes in construction started about 1970. Generally involves dimensional lumber

Modern Construction - of, relating to, or characteristic of the present or the immediate; of, relating to, or characteristic of a period extending from a relevant recent past to the present time. In this case it means buildings built after 1970 and includes those built yesterday.

Legacy Construction - of or relating to, or characteristic of the past practices of the construction industry. This could involve buildings that are over 100 years old.

Engineered Construction -Engineered wood products can be defined as products consisting of a combination

of smaller components to make a structural product, designed using engineering methods. They are an alternative to traditional sawn lumber

Fire Resistance - A fire-resistance rating typically means the duration for which a passive fire protection system can withstand a standard fire resistance test. This can be quantified simply as a measure of time, or it may entail a host of other criteria, involving other evidence of functionality or fitness for purpose.

Fire Stopping - (Fire Blocking) Building materials or approved materials installed to resist the free passage of flame to other areas of the building through concealed spaces.

Flame Spread is a **rating** is a ranking derived by laboratory standard test methodology of a material's propensity to burn rapidly and spread flames. There are several standardized methods of determining flame spread,

Flow Path is the course of movement that hot gases follow between the fire area and exhaust openings. It affects the movement of air into the fire. Air track is considered closely

related. *Air track* is the observation of the movement of both air and smoke as observed from the perspective of inside or outside of the structure. Air track terminology describes a group of fire behavior indicators.

I-Joists - Wood I-joists are composed of two horizontal components called flanges and a vertical component called a web. Wood I-joists are used as a framing material primarily in floors, but may also be used as roof rafters where long length and high load capacity are required.

IDLH - IDLH atmospheres are capable of causing death, irreversible adverse health effects, or the impairment of an individual's ability to escape from a dangerous atmosphere. SEE WEBSITE http://www.cdc.gov/niosh/idlh/idlhintr.html

Lightweight Construction - Lightweight construction is a method of construction using lightweight materials such as plaster, wood, glass, aluminum, steel or similar materials and in this way is different from conventional construction that uses concrete and masonry. This is a type of construction where vertical and horizontal structural elements are primarily formed by a system of

repetitive wood or cold formed steel framing remembers. Engineered wood products can be defined as products consisting of a combination of smaller components to make a structural product, designed using engineering methods. They are an alternative to traditional sawn lumber.

Load Path - Strengthening the structural frame of a building involves the idea of creating a "continuous load path" within a structure. A load path is a method of construction that uses a system of wood, metal connectors, fasteners (like nails and screws) and shear-walls to connect the structural frame of the house together from top to bottom. Maintaining a continuous load path is important to preventing the building from having a structural collapse. This not unlike the idea that a chain is not any stronger than its weakest link. A Load Path ties the house together from the roof to the foundation. When any component is damaged by fire it can fail, thereby compromising the rest of the structure.

Occupant Survival ability Profile - determining if any occupants are trapped and if they can survive the current and projected fire conditions.

Situational Awareness - The perception of environmental elements with respect to time and/or space, the comprehension of their meaning, and the projection of their status after some variable has changed, such as time, or some other variable, such as a predetermined event. In the case of the fire service Situation Awareness is related to Building Construction, Command Risk Management and Firefighter Safety is another mission critical element.

Toxicity is the degree to which a substance can damage a firefighter when exposed to IDLH.

NOTES

This document was compiled as part of a Federal Grant. It was assembled by Ronny J Coleman and Hugh Council. Comments and suggestion can be submitted for future editions by sending an email to Ron@Fireforceone.com. The subject line should read Guide Input.