

# Understanding Fire Safety Strategy



CRISTIAN X. COHEN



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## FOREWORD

Fire protection experts often use the word *strategy* casually in conversations, especially when discussing high-tech fire protection projects like data centers. Someone listening to these conversations and who is just starting a *fire protection engineering* career could feel intimidated for lack of understanding. It could feel rather diminishing for someone looking from the outside.

But believe it or not, many fire professionals have a hard time explaining what a *fire safety strategy* is.

One design book, for example, gives two approaches; meanwhile it never gives a specific definition of what a fire safety strategy is. The same book also mentions that designers have an option through the *Equivalent Alternative*. Another reference book talks about performance-based designs and engineering analyses, both under the heading *Performance-Based Designs*. These examples are confusing.

I, too, went through a period of confusion and want to share what I experienced while presenting my culminating project to complete my Master's degree in fire protection engineering. One of the graduating students thanked me for

clearly explaining the connections between goals, objectives and performance assessments. It was a good feeling to see his eyes open with new understanding.

After that experience, I was moved to write an article. To my surprise the article was published in the 2025 first quarter edition of the SFPE Magazine. I have significantly refined the topic and given multiple presentations about fire safety strategy since that publication.

I feel that it's now time to share the information with even more people. Also, I believe that the material, as presented herein, can serve in more ways than one. I hope you enjoy it.

# LIST OF ACRONYMS

A	Assembly Occupancy
AHJ	Authority Having Jurisdiction
ASET	Available Safe Egress Time
B	Business Occupancy
BTU	British Thermal Unit
CO	Carbon Monoxide
CMDA	Control Mode Design Area
E	Educational Occupancy
ESFR	Early Suppression Fast Response
F	Factory and Industrial Occupancy
FD	Fire Department
FM	Factory Mutual
FPE	Fire Protection Engineer
FACP	Fire Alarm Control Panel
FACU	Fire Alarm Control Unit
FPLS	Fire Protection and Life Safety
GSA	General Services Administration
H	High Hazard Occupancy
HB	Human Behavior
I	Institutional Occupancy
IBC	International Building Code
IDC	Initiating Device Circuit
IFC	International Fire Code
ITM	Inspection, Testing and Maintenance

IEBC	International Existing Building Code
LSC	Life Safety Code
M	Mercantile Occupancy
PBD	Performance-Based Design
PBFP	Performance-Based Fire Protection
NFPA	National Fire Protection Association
R	Residential Occupancy
RSET	Required Safe Egress Time
S	Storage Occupancy
SLC	Signaling Line Circuit
SFPE	Society of Fire Protection Engineers
U	Utility and Miscellaneous Occupancy
US	United States of America

# INTRODUCTION

**S**earch and you'll find no definition of fire safety strategy in either of the two major fire protection engineering handbooks.<sup>[1]</sup> What you will find in one of them is the purpose: A fire safety strategy addresses fire concerns that are specific "to site conditions, operations, and personnel" (Hurley, Ch. 39, p.1289).<sup>[1]</sup> That is all you will get. Nonetheless, the word strategy appears 172 times in one handbook, and 230 times in the other. But, again, no definition!

Similarly, the two primary design books, although not using the word strategy as much, also fail to define what a fire safety strategy is. This implies that everybody knows what it is.

What exactly is a fire safety strategy?

Fire safety strategy is a concept like any other strategy and in this book you will get a thorough understanding of it.

Chapter 1, *Understanding Strategies*, is a deep dive into defining and explaining what a strategy is, including an understanding of the three phases: Analysis, Planning and Implementation. You'll get a crystal-clear explanation of a

strategy in general and what it involves, including starts and ends and everything in between. The material presented is also useful for understanding any kind of strategy.

Chapter 2, *Analysis Phase*, covers phase one of a strategy tailored to fire safety. You will get a thorough understanding of fire safety strategy. You will find total transparency and read about all the terms that comprise the strategy.

Chapter 3, *Planning Phase*, covers phase two of a strategy. The material presented is also useful to understand what fire protection engineering is.

Chapter 4, *Implementation Phase*, covers phase three of a strategy. The material presented highlights how the plan is carried out and when one sees the results.

This book was created for everyone that might cross paths with fire protection engineering: project managers, property managers, maintenance managers, branch chiefs, department heads, undergraduate engineering students, construction managers, engineers practicing in fields that are not fire protection engineering, architects, fire trades and technicians. Even educators might find use for it. Fire protection engineers just beginning practicing can benefit from this book too, especially by offering a framework for what otherwise could be an endless or unlimited topic.

It's time for all to get immersed in fire protection and life safety through total understanding of fire safety strategies.

May this book be for your total benefit and success!



# ONE

## UNDERSTANDING STRATEGIES

**S**trategy, a widely used word, is applicable to the military and business. Certainly, it can be used by individuals for their personal growth and professional development. The word comes from the ancient Greek word *strategos*.<sup>[2]</sup>

Strategos was a word for a leader, general or officer in the Greek army. In the late 1700s, strategos evolved into strategy; however, it kept the association with armies and military.<sup>[3]</sup> Strategy then got adopted to business.

Strategies and plans are not interchangeable words. While plans are always part of a strategy, strategies are much more than plans. “There are three distinct phases for developing a new strategy: analysis, planning and implementation.”<sup>[4]</sup>

At the analysis phase there is research and fact finding. Here one identifies the strengths of the current state, condition or position.

At the planning phase one highlights advantages and sets operational boundaries and realistic budgets. Here providing directions is most important.

The implementation phase is where the plan is carried out and when one sees the results. Here positive thinking and reactions are most important, especially to adapt to changes in circumstances.

A purpose is the reason or the intention for the existence of something. While there is a purpose for having a strategy, a strategy is not to fulfill a reason or an intention. The distinction between purpose and strategy becomes even clearer as you continue reading.

“Strategy is the shortest distance from ends to means, or means to ends,” says Max McKeown author of *How to Think and Act Strategically to Deliver Outstanding Results*.<sup>[5]</sup> There are three important points to highlight from that short definition of strategy.

One. A strategy is the shortest distance. “You want to start here and get somewhere else. And strategy is what allows you to get there in the shortest possible time.”<sup>[5]</sup> The short distance refers to shortest time and not physical length. It is about going from a current state, condition or position to one that is better as quickly and as efficiently as possible.

Some might wonder, is this short distance equivalent to taking shortcuts? Strategy and shortcuts are opposites.

Strategy goes in one direction and shortcuts in the other. They don't coexist. "Shortcuts can appear tempting and actually be the longest route."<sup>[5]</sup>

To illustrate the point, think about assembling furniture or an appliance without first reading the instructions. You open the box and take the parts out, and after a scan of the parts, you go on to work assembling it. Then you discover that you must take down something because you assembled it wrong or on the opposite side or noticed that there are weird spare parts after finishing the job. The sequence and directions to assemble the commodity, however, were clear in the instructions.

By consciously ignoring a necessary step, the "short cut" will result in the completion of the strategy being delayed.

Two. The definition of strategy also includes means. What is this referring to? "Strategy is moving from where you are with what you have to where you want to be," explains Mr. McKeown.<sup>[6]</sup> Means include what you have, what other resources are accessible, how they can be used, and what other options are available. Those are means and the point is to think about how to get to the end.

Three. End appears twice. Why? A strategy is to go from specifying a desired end to attaining the end that is desired. The end needs to be specific. Then the strategy is

complete or over when the end is attained. An end is an outcome or a goal.

A strategy hence is a concept, and it is to guide “the coordinated use of resources through programs, projects, policies, procedures, organizational designs, and performance standards to achieve ... goals and objectives.”<sup>[7]</sup>

The concept can be simplified by WHAT and HOW. WHAT translates to the goal, and HOW translates to programs, projects, policies, procedures, designs, standards and objectives.

Strategies equally apply to the built environment. Specifically, for fire protection and life safety, the concept is known as *fire safety strategy*.

Now you are ready for a thorough explanation of what a fire safety strategy is, what it involves from start to end and everything in between.

# TWO ANALYSIS PHASE

**V**ision: All buildings incorporated with the best prevention and mitigation practices for possible fire emergencies and plausible life safety threats.<sup>[8]</sup>

Fire Protection Engineers (FPEs) exist to ensure that.

How do FPEs get there? Strategy gets them there.

The first step of crafting a strategy is specification of the desired end or outcome—the goal. A fire safety strategy is no different.

In the context of fire protection and life safety, strategic goals are known as *fire goals*.

## Fire Goals

Specifying the fire goal is the first step (Puchovsky & Hofmeister, Ch. 39).<sup>[1]</sup> Strategic goals are normally established by people who have a vested interest in the project, or stakeholders. For a fire safety strategy, stakeholders include owners, investors, project managers,

building managers, authorities having jurisdiction (AHJ), insurance companies, and design professionals (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup>

AHJ is an organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.<sup>[9]</sup>

### **Life Safety**

The first goal is by default always *life safety*. In a typical building that hosts the general public, and assuming that there is no other concern, life safety translates to providing protection for all occupants. Also, life safety means improvement of the survival chances of an occupant close to the ignition source.<sup>[8]</sup>

When referring to life safety in connection with fire safety strategy, it refers to the built environment. This distinction is important because life safety as a goal also applies to medical emergencies, public safety, wildland-urban interphase fires, natural disasters and occupational safety. These are just some examples as there can be other strategies where their goal is also life safety: FPEs collaborate and support most if not all of these strategies.

Life safety however is not the only fire goal.

## **Other Fire Goals**

Stakeholders can select another goal, and it is to be added to the fire safety strategy (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup> Notice: Added. Having another goal does not replace life safety as a goal. Also, these other goals are supported by other professionals, meaning that FPEs will need their input.

A well-known added goal is protection of property, which is mostly underwritten by insurance agencies like Factory Mutual (FM). Another goal is to avoid water runoff contamination. Typically, this goal is associated with an industrial complex. They have environmental departments, and they want to know what happens with the water used to fight fires within their premises.

A fourth goal is structural survivability. The General Services Administration (GSA) in the US applies this goal to their federal buildings, mainly because they are self-insured.

The fifth goal is continuity of operations. This goal is applied to buildings identified as mission critical like data centers. The US federal government also has continuity of operations as a goal in some buildings.

Fire goals are not necessarily limited to these five, however. Stakeholders could come up with another goal.

Once the fire goal is specified, the first step is complete. The second step is selection of the objectives.

## Building Objectives

Stakeholders also select the objectives. Fire safety strategies involve fire goals and include *building objectives* (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup> Building objectives are requirements that need to be met to increase the likelihood of achieving the fire goal (Bukowski & Tubbs, Ch. 56).<sup>[1, 8]</sup>

Code requirements are stated in terms of fixed values, or prescriptive. A prescriptive design is to meet objectives.<sup>[8]</sup> There are objectives to meet for all core areas of fire protection engineering: *Structural Fire Protection, Fire Control and Suppression Systems; Devices, Signals and Appliances; and Means of Egress*. Refer to figure 1 for a visual of the typical building objectives and how they correlate to the core areas.<sup>[10]</sup>

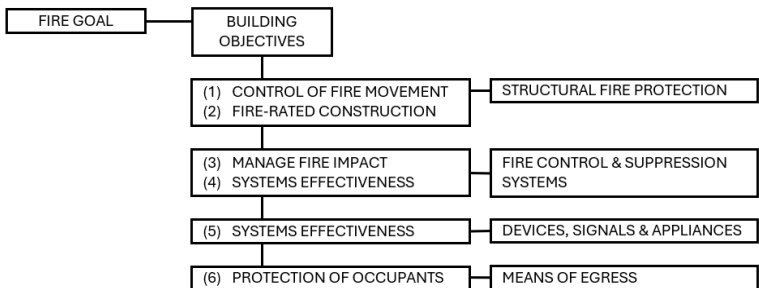


Figure 1: Correlation Between Building Objectives and Core Areas

Two typical objectives to meet for *Structural Fire Protection* are selecting construction materials that have some degree of fire resistance and control of the fire movement. Both objectives will support occupant protection by ensuring that a structure does not collapse in a short time and, at minimum, retarding the movement of the fire and smoke through wall joints and voids.

The objectives for *Fire Control and Suppression Systems* include managing the fire impact by controlling the combustion process and suppression of the fire. The control and suppression systems must be effective for the possible fires in the building.

System effectiveness is also an objective that applies to fire detection devices, signal initiation devices, types of signals and notification appliances. This group, for simplicity throughout the book, is identified as *Devices, Signals and Appliances*.

The objective of the *Means of Egress* is occupant protection. Occupants that are not very close to the ignition source must be protected while they evacuate, escape, exit, relocate, etc. Designers, however, can only promise a reasonable level of life safety for occupants that are near the ignition source.<sup>[8]</sup>

In typical low fire-risk constructions, AHJs will accept prescriptive compliance as reliable to achieve the fire

goal. But when high-consequence and rare fires are predicted for a building, it is important to know in more certain terms if the fire goal would be met. These fires are not covered by prescriptive language. The way to know if the fire goal would be met is through a performance assessment known as performance-based fire protection (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup>

### Performance-Based Fire Protection

Performance-Based Fire Protection (PBFP) assessments offer the opportunity to evaluate the design of the systems and how the same systems will work together to achieve the fire goal. The assessments will reveal or give a better understanding about reliability solely on minimum code requirements (Puchovsky & Hofmeister, Ch. 39).<sup>[1]</sup> PBFP is the best means for determining if a building design is safe. They help to answer the question of whether the minimum requirements are sufficient to attain the fire goal or if there is a need to upgrade.

The FPE will upgrade the design and go through another analysis, or a revision of the assessment, when the stakeholders do not agree with a particular design. The process will be repeated until everyone involved in the decision-making concurs that all systems will lead to

attaining the fire goal upon occurrence of a real fire or life safety event.

The fire goal and building objectives, however, can also be met with the use of alternate systems or design approaches. This is known as the *Equivalent Alternative*.

### Equivalent Alternative

The Equivalent Alternative allows deviation from a prescriptive requirement if the AHJ concurs that the equivalency preserves the intended level of life safety and meets the building objectives and is reliable to attain the fire goal.<sup>[8]</sup>

There are equivalent alternatives already specified or prescribed in the codes, and they are in the form of *exceptions* and *tradeoffs*, which are applicable to new and existing buildings. Examples of tradeoffs are obvious in the IBC, Table 509.1 where the logical expression “or” distinguishes the compliance options. Refer to figure 2 below for a segment reproduced from Table 509.1.<sup>[9]</sup>

For example, observe the first row. A room with equipment having an input of 400,000 BTU per hour can meet the objectives by either having walls that resist fire for one hour or by having fire sprinklers. One or the other. Having both separation and protection will be a design

upgrade. Also notice that not all the rows are tradeoffs, particularly rows 4, 10, 11 and 12.

ROW	ROOM OR AREA	SEPARATION AND/OR PROTECTION
1	Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour <b>OR</b> provide automatic sprinkler system
2	Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour <b>OR</b> provide automatic sprinkler system
3	Refrigerant machinery room	1 hour <b>OR</b> provide automatic sprinkler system
4	Hydrogen fuel gas rooms, not classified as Group H	1 hour in Group B, F, M, S and U occupancies; 2 hours in Group A, E, I and R occupancies.
5	Incinerator rooms	2 hours and provide automatic sprinkler system
6	Paint shops, not classified as Group H, located in occupancies other than Group F	2 hour; <b>OR</b> 1 hour and provide automatic sprinkler system
7	In Group E occupancies, laboratories and vocational shops not classified as Group H	1 hour or provide automatic sprinkler system
8	In Group I-2 occupancies, laboratories not classified as Group H	1 hour <b>OR</b> provide automatic sprinkler system
9	In ambulatory care facilities, laboratories not classified as Group H	1 hour <b>OR</b> provide automatic sprinkler system
10	In Group I-2, laundry rooms over 100 square feet	1 hour
11	In Group I-3 cells and Group I-2 patient rooms equipped with padded surfaces	1 hour
12	In Group I-2, physical plant maintenance shops	1 hour

Credit: IBC

Figure 2: Examples of Tradeoffs from IBC Table 509.1

This completes the Analysis Phase of the strategy. The strategic analysis is displayed in figure 3 below. Notice that it is not a process flow and it is not a hierarchy.

The analysis does not change. Rather it needs to be adjusted from project to project, mainly when there is a need to add another box to the left of the fire goal to include other

goals when there is another goal besides life safety. Another major adjustment is when a project does not include a performance assessment.

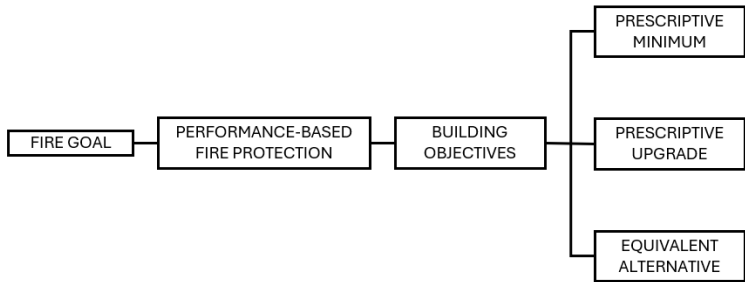


Figure 3: Analysis

Remember the analysis by WHAT and HOW. They are the strategic analysis in brief.

A fire safety strategy has a goal, WHAT. It also has three possible ways to meet the objectives, HOW. And the means to test the fire goal at design is through Performance-Based Fire Protection assessments.

Seniors and experts in the field of fire protection and life safety (FPLS) use the word *strategy* often to describe either design, approach or methods for a particular project. This indicates that the fire safety strategy is different from building to building.

Yes, every building is different, and the design of the FPLS systems is tailored for each building. But all fire safety strategies are to attain goals and to meet building objectives; all objectives are met in one or more ways: by prescriptive minimum, by upgrading over the prescriptive requirements or by the application of the Equivalent Alternative; and the best way to know if the goal will be met is through performance assessments. *This will never change unless there is a fundamental change in fire protection engineering.*

Furthermore, someone could say that implementation of the strategy varies from building to building. You will read in chapter 4 that this too is incorrect. Implementation of the strategy will only need adjustments, but what entails implementation applies to all buildings as much as analysis does.

Again, what is different from building to building or for each project is the plan.

This leads us to phase two: *Planning*. (Continued on page 22).

# Take The Lead

*An analogy between baseball and safe building designs.*

**T**ake me out to the ball game!!! Major League Baseball—America’s pastime. What does baseball have to do with safe building designs, you might be wondering. You’ll be surprised. Keep reading.

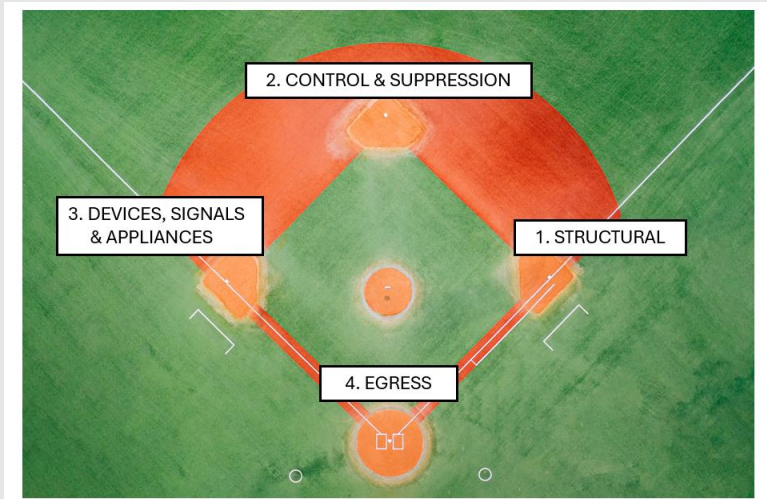
The process to design a fire-safe building can be explained using baseball concepts. The ballpark, for example, is equivalent to the built environment. Another example is that in baseball there is a defensive side and an offensive side. Such sides exist also in the built environment.

A project that involves fire protection and life safety is equal to a team going on the offensive.

As we will see, baseball analogies get deeper and more interesting. Design of fire-safe buildings follows a four-step logical sequence.

In baseball, there are four bases, and scoring requires progressive advancement until the runner makes it to the plate. The offensive, in other words, starts with getting on

base, more specifically, first base. Refer to figure 4 for the correlation between the four bases and the core areas of fire protection engineering.



\*Credit: Microsoft Office\Stock Images\Baseball

Figure 4: Correlation Between Baseball Bases and Core Areas

## Structural

Protecting the structure is the start, the first step where all projects must start.

Every movement towards completing a safe design requires reaching first base—*Structural Fire Protection*. The effectiveness of all other systems for protection and life safety depends on a protected structure. Underestimating the importance of Structural Fire Protection is equivalent to a slugger that is overcome with emotions, after hitting a homerun, and forgets to touch first when running the bases. He is then embarrassed by being called out and the run annulled.

Reaching first base safely, however, does not ensure scoring a run. The offensive effort must continue: a runner must then advance from first to second base.

## Control and Suppression

The first thing to occur in a fire is ignition. What is desired, at minimum, is that the fire be controlled within the area of origin. Even more desired is a rapid suppression.

The logical order of a fire emergency, therefore, is control and suppression of the fire. Together, control and suppression are second base. Thus, the offensive continues by advancing towards second base—*Fire Control and Suppression Systems*. All buildings are equipped with systems designed to control or suppress a fire in some form

or manner. The systems will limit the size and reduce the release of heat from a fire until its complete extinction.

The safe building design is halfway home when completing Fire Control and Suppression Systems. Likewise, it is in baseball: when a base runner makes it safe to second base a team is halfway to scoring a run. For a runner, the next step is to make it to third base.

### Devices, Signals and Appliances

Control and suppression systems, for the most part, are capable of automatic fire detection and are interconnected to an alarm system. Alarm signals will then actuate notification to occupants. Moreover, manual methods to initiate an alarm must be provided for when an occupant detects the fire and there are no automatic means available.

Fire detection devices, signal initiation devices, types of fire signals, and notification appliances, all of them together, are equivalent to third base—*Devices, Signals and Appliances*. They deal with sending automatic or manual signals, monitoring water flow and tampering and notification to occupants.

Devices, Signals and Appliances are an inflection point: the design shifts to focus more on life safety. A runner reaching third base is an inflection point in baseball as well:

all efforts narrow to getting the runner to the last base, Home Plate.

## Egress

Occupants need ready access and reliable means to get out of buildings and safely make it to a public space. Reliable exits, access to exits and discharge from exits—together known as *Means of Egress*—represent a design where occupants can safely make it out of a building. It also includes exits signs and other components.

Means of Egress facilitate movement from within a building to a safe environment. It is a path of travel from anywhere within a building to a public space.

A design where occupants can safely get to a safe public space represents Home Plate in baseball. The offensive side nevertheless must outperform the defensive side.

An offensive effort needs a batting order that maximizes each batters' strengths against the opposing pitcher and the defensive lineup. It is the way to ensure that a team has the best chances to get on base, score runs and *take the lead*. Batting orders are a key element of baseball's offensive strategy.

A similar situation occurs for the built environment. A fire safety strategy is not complete without assessing the interaction of the systems against possible fires and how smoke can spread.

The strength of each system against fire and smoke must be understood to the best of engineering foresight. This is done through a performance assessment.

### Performance Assessments

Performance assessments give a better understanding about a design being robust enough—if the synergy of the four areas of Structural Fire Protection, Fire Control and Suppression Systems; Devices, Signals and Appliances; and Means of Egress—will successfully enable occupants to make it to a safe public space.

Stakeholders accepting the results of a performance assessment is equivalent to scoring a run in baseball. A team scoring at the top of the inning takes the lead. Taking the lead in the built environment is equivalent to a safe building design.

The authority having jurisdiction thereafter issues the Certificate of Occupancy, which is a permit that allows the building to be occupied and for its purpose to be carried

out. The Certificate of Occupancy is equivalent to the end of the top of the inning in baseball.

At this point, the offence switches to defense, a change in the game. This change occurs also in the built environment. The safe building design switches to the defensive side.

It's time now to protect the lead with Gold Glove defense! <sup>i</sup> Protect the building from day-to-day fire risks by ensuring quality in the implementation of the strategy. (Implementation is thoroughly covered in chapter 4.)

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<sup>i</sup> Baseball players are recognized with the Gold Glove award for outstanding defensive abilities and exceptional fielding skills.

# THREE PLANNING PHASE

**S**pecial knowledge is required to design fire-safe buildings. But that does not mean that you cannot understand how to complete a building design that is considered safe from fire threats. Moreover, what I surely would love is that this book sparks your curiosity and interest beyond just having understanding.

The prescriptive language of the codes is the starting point to meet the objectives.<sup>[8]</sup> Meeting the objectives however is just the minimum to complete a safe building design.

The International Building Code (IBC) is the primary reference book for fire protection engineering in the US. The IBC is used for new buildings and, usually, is modified in some form or manner when adopted by local jurisdictions. Existing buildings are commonly evaluated against the International Existing Building Code (IEBC). There are other codes within the US and around the world for both new

and existing buildings, and the one which applies will depend on the local jurisdiction.

A safe building design will include all four core areas of fire protection engineering. Full technical coverage of the core areas is impossible in this volume. What follows is a synopsis—key concepts and main points—that will help you navigate the highly technical and detailed areas more easily. These areas are Structural Fire Protection, Fire Control and Suppression Systems; Devices, Signals and Appliances; and Means of Egress.

## Structural Fire Protection

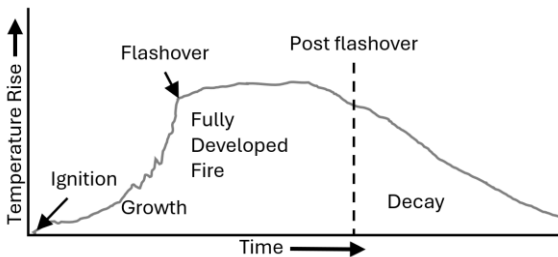
*Structural Fire Protection* is a passive system. Passive refers to fires being controlled “by systems that are built into the structure or fabric of the building, not requiring operation by people or automatic controls” (Buchanan & Abu, Ch. 2, p.12).<sup>[11]</sup>

Fires are described in five stages. Refer to figure 5 below for an idealized representation of the fire stages.

The first stage is ignition, followed by growth. Then is flashover, which is a “transition from a growing fire to a fully developed fire” (Walton et. al., Ch. 30, p. 997).<sup>[1]</sup> The

flashover stage might be easier to understand as the transition from a fire in a room to a room on fire.<sup>ii</sup>

Fourth is the fully developed stage, and lastly is the decay stage.



\*Credit: SFPE Handbook

Figure 5: Fire Stages

Protection of the structure must be provided for both pre-flashover and post-flashover. “For pre-flashover fires, passive control includes selection of suitable materials for building construction and interior linings that do not support rapid flame spread or smoke production in the fire growth period. In post-flashover fires, passive control is provided by structures and assemblies which have sufficient fire

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<sup>ii</sup> As expressed by Dr. Frederick Mowrer, California Polytechnics Institute.

resistance to prevent both spread of fire and structural collapse” (Buchanan & Abu, Ch.2, p.12).<sup>[11]</sup>

The effectiveness of all other fire protection and life safety systems depends on sound structural fire protection practices. “Occupant escape and firefighter access is only possible if buildings and parts of buildings will not collapse in a fire or allow the fire to spread.”<sup>[11]</sup>

History shows that overlooking the importance of structural fire protection will have catastrophic consequences. For example, *The Grenfell Tower Fire* in London, UK. A common fridge-freezer fire within a dwelling unit got out of control. Firefighters had extinguished the fire within the unit, but the exterior wall insulation and cladding materials were highly combustible. The appliance was close to the exterior wall, and the fire reached a concealed space that extended vertically within the wall all the way to the crown of the tower. By contribution of the combustibility of the materials and the vertical opening, the fire spread rapidly to the other units above and blocked the means of egress for all the stories above.<sup>[12]</sup>

### Fire Control and Suppression Systems

Sprinkler systems are the most popular *Fire Control and Suppression System*. A sprinkler system designed for fire

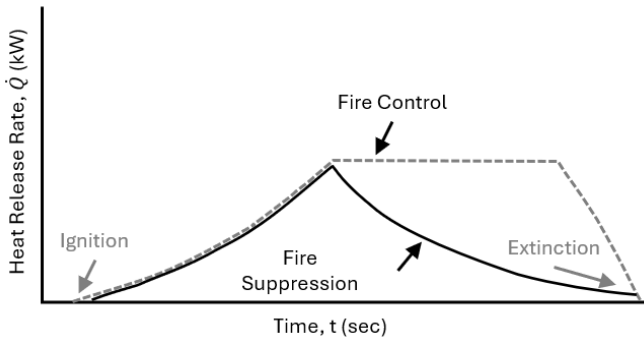
control, however, is not equivalent to one designed for fire suppression.

Standard sprinklers, including Quick-Response, are designed for *fire control* and are associated with the control mode design area (CMDA) method. The CMDA method utilizes the area with the highest water demand. For the calculation, it is necessary to classify the fire hazard for the area, what are the minimum pressure requirements for the area, and what is the minimum area size that is required. The calculation results are water pressure and flow demand that are specific for each sprinkler system.<sup>[13]</sup>

Early-Suppression Fast-Response (ESFR) sprinklers are specifically designed for *fire suppression*. The calculations for ESFR are based on a fixed area of 1,200 square feet, on 12 sprinkler heads open at the same time spraying water, on the size of the sprinkler head, and on a much higher water pressure. The calculation results are water pressure and flow demand that are also specific for each sprinkler system. The water and pressure demand by using the ESFR method are much higher than if the CMDA method were to be used instead.<sup>[13]</sup>

Refer to figure 6 below for a quick reference of the differences between systems designed for CMDA and ESFR. The figure shows a simplified curve of the heat that is released from a package that is burning and how the heat

output would be affected by a sprinkler system that is designed for fire control versus one that is designed for fire suppression. The package can refer to a product, equipment, or any item that can burn and where water can be used as the fire extinguishing agent.



\*Credit: NFPA 13

Figure 6: Fire Control vs. Fire Suppression

Many sprinkler-supporting components and subsystems, like underground and aboveground piping and fire pumps, are also part of this core area. Fire sprinklers, however, are not the only control and suppression systems available. Under this core area we also have portable fire extinguishers, commercial kitchen fire suppression systems and any other system that uses or does not use water as an agent to extinguish fires.

Nevertheless, all control and suppression systems must be effective for the expected fires in the building regardless of the function, kind and type.

### Devices, Signals and Appliances

System effectiveness also applies to fire detection devices, signal initiation devices, types of fire signals and notification appliances.

Detection and initiation devices are often addressed together. However, there are key distinctions between them. The distinctions are highlighted below.

Detection devices automatically respond when there is a change in ambient conditions related to fire protection and life safety.<sup>[14]</sup> Some detection devices are heat, smoke, flame and carbon monoxide (CO) detectors.

Not all fire detectors are alarm initiation devices. For example, the fusible links and glass bulbs in fire sprinkler heads are heat detectors, but they do not send an automatic signal. The waterflow switches that are attached to sprinkler pipes are the ones that send the fire alarm signal when detecting that water is flowing.

Signal initiation devices can be manual or automatic, but not all signal initiation devices are for fire alarm. Fire

alarm is just one type of signal. The different types of signals are covered below.

Fire alarm boxes are manual methods for occupants to initiate an alarm.

The operation of all automatic and manual fire alarm initiation devices is linked to fire detection.

### **Circuit Connections**

There are two types of device circuit connections: Initiating and Signaling. *Initiating* connections can be identified by zones within buildings but cannot be identified individually. Initiating connections are known as Initiating Device Circuits (IDC). Whereas *signaling* connections can be identified individually and indicate the exact location of the problem. Signaling connections are known as Signaling Line Circuits (SLC).

The detectors and initiation devices that send signals do it regardless of whether their circuit connection is IDC or SLC.

Signals deal with things like types of signals and zones, control functions, infrastructure and power. The types of signals are mainly for fire alarm, supervisory and trouble.

## Signal Types

A fire alarm signal is a specific term that results from the manual or automatic detection of a fire condition. Fire alarm conditions are very specific and are different from those of a supervisory or trouble condition.<sup>[14]</sup>

Upon receiving a fire alarm signal, the control system must start all occupant notification appliances.<sup>[9]</sup> Audible notification appliances alert by the sense of hearing. Visual notification appliances alert by the sense of sight.<sup>[14]</sup>

Supervisory condition means there is an issue with a system, process, or equipment that is monitored by the fire alarm control unit. One example is tampering switches that monitor open and close valve positions. When a sprinkler system valve is closed, this must “show up as a supervisory signal on the control unit” (Mahoney, March 2021).<sup>[15]</sup>

“A trouble condition means there is an issue or fault with the fire alarm system.”<sup>[15]</sup> Examples include off-normal outputs from integrity monitoring circuits, the light and sound from activated trouble notification appliances, trouble data transmission to a supervising station.<sup>[14]</sup> “This would show up as a trouble signal on the control unit.”<sup>[15]</sup>

Fire alarm control units (FACU) cannot identify the fire point beyond a zone and are known as *conventional*. These are not adequate for signaling devices. Fire alarm control panels (FACP) support both initiating and signaling

connections and are known as *addressable*. Conventional initiation devices are modified or adapted to SLC connections so that their exact location may also be identified at an addressable panel.

### Means of Egress

The objective of the *Means of Egress* is occupant protection. Means of Egress facilitate the movement of occupants inside a building from one area of a fire or life safety emergency into a safe space or environment. This action may include selective, partial or complete evacuation of the building or relocation within the building.<sup>[14]</sup>

*Means of Egress* includes exits, access to exits and discharge from exits. It also includes egress components like exit signs and markings, exit doors and hardware, exit stairs and ramps, and exit passageways.

Exits can be a stair enclosure, an exterior exit door or a passage that leads to an area of refuge. Discharge from exits leads to a public way but can also be discharged to a dispersal area that is designed to be safe.<sup>[9]</sup>

Building structures therefore must last, at least, from the time of ignition to full evacuation of occupants and even for some time over an established tenability limit.<sup>[8]</sup> Some examples of tenable conditions within a room or space are

smoke layers above six feet from the floor, 16 percent or more of oxygen content in the air, and 30,000 ppm/min or less of exposure to carbon monoxide.<sup>[8]</sup>

The oxygen percentage is the minimum required in air to sustain human life. Parts per million per minute (ppm/min) is the unit used to express the concentration of a substance. Products of combustion, like carbon monoxide is one example. Carbon monoxide is a dangerous gas, and when present in high concentrations in the air, does not allow proper oxygenation of the blood and can lead to death.

Meeting the prescriptive language of the codes, however, only represents the minimum requirements to complete a safe building design.<sup>[8]</sup> The best engineering foresight for a *safe building design* is through a performance-based fire protection (PBF) assessment (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup>

Design and engineering are the two components of the assessments.<sup>[8]</sup> The assessment consists of a Performance-Based Design (PBD) and an Engineering Analysis (Puchovsky & Hofmeister, Ch. 39).<sup>[1]</sup> Refer to figure 7 below for complete details about the components of the PBF assessment. The figure also shows the connection between fire goals, building objectives and performance assessments.

## Performance-Based Design

Performance-Based Design (PBD) is an “identification of the types of fires, occupant characteristics, and building characteristics for which the systems are intended to provide protection” (Hurley & Rosenbaum, Ch. 37, p.1233).<sup>[1]</sup> PBD builds first upon fire sciences that include, among other things, risk assessments, fire signatures and fire scenarios.

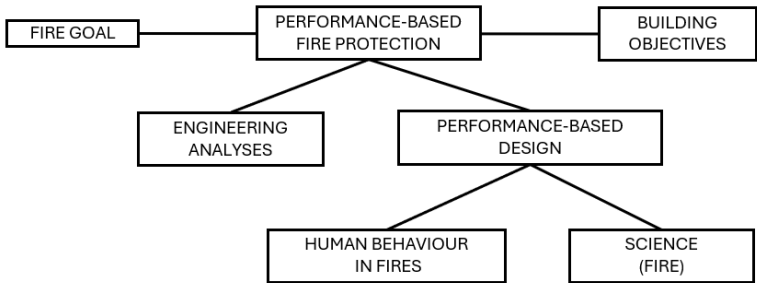


Figure 7: Performance-Based Fire Protection Components

Fire signatures refer to the atmospheric changes that fires produce. These changes can be measured and are the basis for the operation of fire detection devices.<sup>[14]</sup>

Second, PBD involves human characteristics as well as cues, decisions, and actions. Human behavior (HB) in fire would be impacted by occupant characteristics. “Not all

characteristics are essential factors, but those critical and expected to influence the reaction and behavior of a group or groups should be noted” (SFPE HB in Fires, Ch. 3, p. 15).<sup>[16]</sup> However, “it may be possible to rely on a single defined occupant group that is recognized as the most critical and is conservatively characterized.”

At Performance-Based Design (PBD), engineers gather all the information about the problem of interest that “should be clearly defined” (Hurley & Rosenbaum, Ch. 37, p. 1250).<sup>[1]</sup> Remember that PBD is just one component of the assessment.

Research data is “quantified in some manner and translated into performance” (Puchovsky & Hofmeister, Ch. 39, p. 1295).<sup>[1]</sup> The data will serve as inputs for fire models aimed at testing the performance of the fire protection and life safety systems as designed.<sup>[8]</sup>

Modeling is a transition to the second component of the Performance-Based Fire Protection (PBFPP) assessment. Modeling and the analysis of the outputs is known as an *Engineering Analysis*.

## Engineering Analysis

Fire models “are used to simulate fire phenomena” and could be either manual calculations or simulation software or a

combination of both. There are three types of fire models: algebraic models, zone models and computational fluid dynamics models (Hurley & Rosenbaum, Ch. 37, p. 1249).<sup>[1]</sup> The simplest, Algebraic models, are mathematical equations. Zone models are more complex than algebraic but simplify fire behavior. Computational fluid dynamics models use differential equations or advanced math and are the most complex.

### **Available Safe Egress Time**

The hazard calculations from the models “estimate the development and growth of a fire and the spread of resulting combustion products” (SFPE HB in Fires, Ch. 6, p.51).<sup>[16]</sup> These calculations are associated with the “time before untenable conditions exist in occupied spaces”. The time before untenable conditions is known as *Available Safe Egress Time* (ASET).

The most typical untenable condition is based on an average person measuring six feet high. Therefore, the untenable time is when smoke descends to a level of six feet above the floor within a room or space.<sup>[1]</sup> Remember that smoke rises and, in typical scenarios, accumulates at ceiling level. Then smoke descends and could completely fill the room.

Regardless of the model selected, designers are always advised to verify and validate them so that there is no use “beyond the scope of its capability” (Hurley & Rosenbaum, Ch. 37, p.1250).<sup>[1]</sup>

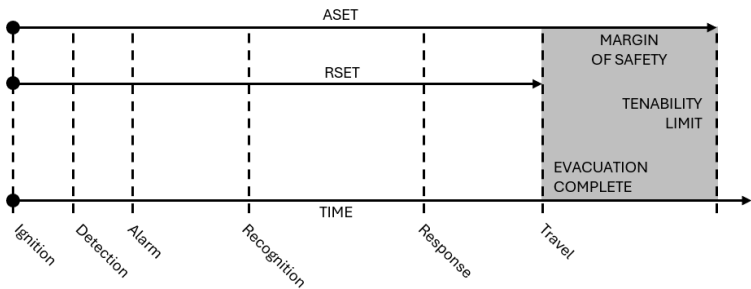
### **Required Safe Egress Time**

Some models, although employed for fire applications, are tailored for egress.<sup>[16]</sup> Egress models can also be known as movement calculations or evacuation models. The output of an egress model is the “time necessary between ignition of a fire and the time at which all occupants can reach an area of safety” (Gwynne & Boyce, Ch. 64, p.2435).<sup>[1]</sup> The time to reach safety is known as the *Required Safe Egress Time* (RSET). Refer to figure 8 below which highlights RSET against ASET. Other terms that can be appreciated from figure 8 are detection time, warning time, recognition time, response time, and travel time.

*Detection* time is the “interval between fire ignition and the first detection of the fire by a device or an individual. *Warning* time is the “interval between detection ... and the time at which an alarm signal is activated or notification of occupants” (Gwynne & Boyce, Ch.64, pp. 2434-2435).<sup>[1]</sup>

*Recognition* time is the “interval between the time at which the alarm signal is perceived and the time at which the occupant interprets this signal as indicating a fire/emergency

event.” *Response* time is the “interval between recognition time and the time at which the first move is made to evacuate the building.” *Travel* time is the “time needed, once movement toward an exit has begun, for all occupants to reach a place of safety.”



Credit: SFPE Handbook

Figure 8: Representation of the Engineering Timeline

Escaping the harmful effects of fire or mitigating them is, effectively, a race against time.<sup>[8]</sup> “The [simplest] model for the evaluation of an engineered design compares” ASET with RSET (SFPE HB in Fires, Ch. 6, p.51).<sup>[16]</sup>

“When ASET is greater than RSET, with some not-yet-defined safety factors and a safety margin applied, the engineered design is considered ‘safe’” by the authority. A safety factor of 50 percent is commonly used. Authority

approval completes *Performance-Based Fire Protection* (PBFPP).<sup>[8]</sup>

## Professional Collaborations

Safe building designs must be standalone. In other words, the design of the systems—Structural Fire Protection, Fire Control and Suppression Systems; Devices, Signals and Appliances; and Means of Egress—must be enough to achieve the fire goal without reliance on the Fire Department (FD).

Fire protection and life safety (FPLS) reports, nonetheless, also include specifications for FD services: fire apparatus roads, hydrants, standpipes, hose connections, elevator two-way communication systems, among others. It is important to highlight that FD response to a fire emergency is redundant to the safe building design.<sup>[12]</sup> Also remember that FD responds to life safety emergencies beyond fire emergencies.

Fire protection engineers (FPEs) do not just serve and collaborate with fire departments. Service and collaboration of FPEs with other professionals is much broader.

The interaction of FPEs with other professionals is extensive: Electrical Engineers, Mechanical Engineers,

Structural Engineers, Controls Designers, Architects, Acousticians, Security Designer, IT and Communications, Plumbing Engineers, AHJ, and Commissioning and Integrated Testing Agents (Jacoby et. al., Ch. 49).<sup>[1]</sup> When FPEs interact with so many other professionals, communication is even more important. Word selection is very important for written communication, not just verbal. And, of course, the scope and size of the project will determine how many other professionals will also be involved.

FPEs interact with these many professionals at the different planning steps of a construction project. Do not confuse the *Planning Phase* of the fire safety strategy with the planning steps of a construction project. They are two different subjects yet overlapping at this point.

### **Construction Project Planning Steps**

The three planning steps of a construction project are schematic design, design development and construction documents. At schematic design there are a lot of visuals and schematic site plans. It is mostly about crucial building sections, elevations and a description of the building.<sup>[17]</sup>

It is at the schematic design step where FPEs produce full narratives about FPLS, or what is required to meet the

objectives. The narrative is like narrowing down the code to just what is pertinent for a specific project.

The project then moves to design development. Professionals produce dimension-rich floor plans and comprehensive building sections at design development.

Safe building designs now include a lot more details beyond the building code; they now incorporate many system-specific standards like NFPA 13, for the design of sprinkler systems, and NFPA 72 for the design of detection devices systems, initiation devices systems, fire signals systems, and notification appliances systems.

All code specifications for the building are verified at design development, including those for FPLS. The plans for the safe building design at this step also include any product data and samples. Other plans related to the safe building design include fire drills, inspection, testing and maintenance.

Building officials, at the end of the design development step, have completely approved the safe building design.

The last step of construction planning is construction documents. Floor plans must be finished by this point. No alteration to the design is allowed. The drawings must be accurate and descriptive, and they will be used as references by contractors for construction and installations.

## Equivalent Alternative Process

The *Equivalent Alternative* is favorable for architectural innovation and interior design challenges that cannot be anticipated by codes.<sup>[8, 9]</sup> Equivalency allows for deviation from a prescriptive requirement if, the AHJ concurs that the equivalency preserves the intended level of life safety and meets the building objectives and is reliable to attain the fire goal.

Designers must first reach a mutually agreeable solution with the AHJ about providing the same or better level of safety when compared to the prescriptive requirement.<sup>[8]</sup> This agreement is done at a meeting known as the *design brief*, which must occur early during schematic design. Reaching an agreement is the *first step* towards employing equivalency. Otherwise, it would result in time-wasting efforts (Hurley & Rosenbaum, Ch. 37).<sup>[1]</sup> Also, the level of complexity of the proposed equivalency would determine if there would be a need for a performance assessment (PBFP) so that the alternative may be approved.

The second step for designers is to demonstrate to the AHJ that the equivalent solution meets the objective and that the alternative is reliable to attain the fire goal. Justifications for equivalent alternatives are also submitted for official

evaluation during schematic design, and the evaluations can extend to design development.

## **Independent Reviewers**

Some equivalent alternative proposals can be so complicated that building officials need to ask for an independent reviewer, often referred to as third-party plan reviewers. Typically, these are qualified individuals with thorough knowledge and understanding of the principles of physics and chemistry governing fire growth, spread, and extinction.<sup>[8]</sup>

Independent reviewers typically deal with equivalencies involving PBFPA assessments. For these reviewers, the job is not just to look at visuals, charts, tables and conclusions from performance-based designs (PBDs) and engineering analyses. Their job starts with evaluating the inputs for the simulations. They must examine the inputs for human physiology and psychology, as well as the fire science inputs. They must also examine the software so that there is no use “beyond the scope of its capability” (Hurley & Rosenbaum, Ch. 37, p.1250).<sup>[1]</sup>

In summary, independent reviewers must examine the inputs, calculation steps, the results, and everything about RSET and ASET. The reviewers will finally determine whether the design would meet the fire goal or not. The

## PLANNING PHASE

feedback will go to building officials, specifically to the AHJ.

This completes the Planning Phase. Next is phase three: *Implementation*. (Continued on page 48.)

# Not Alike

*MUST is an accurate word, while SHALL is not.  
Use of the right word will have positive impact on your  
project.*

**A**re MUST and SHALL alike? Use MUST for project specifications. “The word ‘must’ is the clearest way to” make the point.<sup>[18]</sup> It “is grammatically correct and universally understood ... and accurate word usage.”

SHALL has different meanings and applications. “‘Shall’ is imprecise. It can indicate either an obligation or a prediction.”<sup>[19]</sup>

The wrong use of SHALL in project specifications causes communication issues. “Architects and engineers complain that contractors don’t read the specifications. Why would they .... Nobody wants to read paragraph after paragraph of Contractor shall’s to get to the meat of the requirements.”<sup>[20]</sup>

“Writing that is clear and to the point helps improve all communication as it takes less time to read and comprehend.”<sup>[18]</sup> Contractors need clear communication

when something is necessary. “Clear writing tells the reader exactly what the reader needs to know.”

Engineers at all levels casually use SHALL and some even justify it because codes define it as mandatory. In other words, putting the blame on contractors for their ambiguous instructions.

True, codes define SHALL as a mandatory requirement and is to convey a duty or an obligation to designers.<sup>[8, 21]</sup> But code authors are not authority over any project.<sup>[8]</sup> For designers, code authors’ message is this: *if you want to comply with this code, then you are mandated to use this code for your design specifications; otherwise, you are not following this code, and your design will not be considered according to this code.*

The designer’s duty and mandate are to use the language of the code and not language from another source. Also, it is the duty of the designer to convey in the clearest way to contractors that they must do something: Contractors do not have the duty of going to the code.<sup>[21]</sup> Refer to figure 9 below, which highlights the best uses for MUST and SHALL.

A safe building design, for example, is sealed by a Fire Protection Engineer (FPE). Therefore, the authority over all fire protection and life safety systems is that FPE that sealed the plans that include the specifications for

design. The specifications must use **MUST** to convey the requirements for the implementation of the safe building design. If the FPE uses **SHALL** in specifications and the contractor fails to comply with something, the contractor will not be held accountable for breaching contract if sued.<sup>[21]</sup>

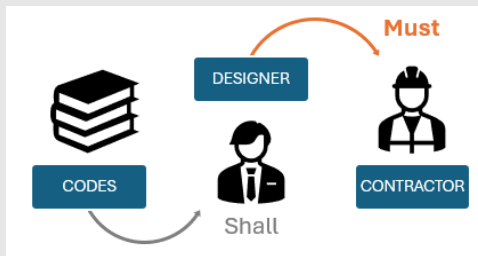


Figure 9: Representation of the Best Practices for Using Must and Shall

Ambiguous instructions, however, are not the only negative effect for loosely using **SHALL** in FPE specifications. When not used appropriately, **SHALL** is received as the FPE bossing over and undermining the contractor’s authority over subcontractors. Tread carefully: Remember that architects and engineers, in this context, are authority over systems and processes but not over contractors. “Leave it up to him to decide who he wants to actually perform the work; that’s his job.”<sup>[20]</sup>

MUST and SHALL are almost, *almost* the same ... but not quite alike.<sup>[22]</sup> They might have similar definitions, but their meanings and applications are different.<sup>[23]</sup>

In plain language, MUST “avoids creating barriers that set us apart from ... whom we are communicating.”<sup>[18]</sup> Beyond correct and accurately understood, MUST “also improves reader response to messages.”

Put projects in better paths of progress by using MUST.

# FOUR

## IMPLEMENTATION

### PHASE

**I**mplementation and execution are not interchangeable words. Their definitions might be related but their applications and meanings are different. The differences between both words are clear in this chapter.

The *Implementation Phase* has three parts: construction and installation, readiness, and execution.

#### Construction and Installation

The first part, construction and installation of the fire protection and life safety (FPLS) systems, starts once the plans are fully approved. This part includes awards for work contracts, procurement and delivery of materials, parts and systems. The shift is towards physical work or work at the job site and less knowledge work. Fire technicians and professional trades are involved in the project now.

Inspections, while the systems are under construction and installation are important. For example, piping, valves,

hydrants, gaskets and fittings must be inspected for damage, and to ensure they match the specifications when received and after installations.<sup>[13]</sup> Fire alarm cables also must be inspected at delivery and installation for the same reasons.

The quality of the installations and the functionality of the systems is assessed through commissioning. Commissioning is a one-time field test to confirm all systems' performance according to all design requirements. The authority having jurisdiction (AHJ) thereafter issues the Certificate of Occupancy.

The *Certificate of Occupancy* is a permit that allows the building to be occupied and for its purpose to be carried out. It represents the belief that the fire goal will be met if a fire or life safety emergency occurs in the building.

Granting the permit ends the first part of the implementation phase.

The systems, however, must remain ready for the lifetime of the building. That's why robust inspection, testing and maintenance (ITM) programs are very important. This is readiness, the second part of implementation.

### Readiness

The best engineered systems require ITM. "An inspection, testing, and maintenance regimen employed at regular

intervals is essential for ensuring ... reliable performance ... Because at some point in its lifetime any system will suffer a failure, a schedule of inspection, testing, and maintenance must be developed based on the size and complexity of the system. The four main system elements—design, equipment, installation, and maintenance—are critical to the reliability of the system and should be the focus of the regimen” (Cholin, Ch. 5).<sup>[24]</sup>

Critical to the reliability of a system, for example, is identification and correction for obstructions to sprinkler efficiency. An inefficient fire sprinkler system can be overwhelmed by any of the possible fires for the building.

Engineers share tailored ITM plans with owners as part of the safe building design package. The ITM plan must address the unique features of the building, especially when including complex equivalencies.

The fire safety strategy in the two existing building examples that follow, use a combination of prescriptive and creative equivalent alternatives. Surveyors, inspectors and testing and maintenance technicians should be aware of the particularities of these buildings when evaluating life safety and producing their reports.

*Airport Tunnel.*<sup>iii</sup> At an undisclosed airport and location, there was a need for a new tunnel to move luggage from one side of the airport to the other. Problem: The tunnel would run under an active tarmac. The tunnel was so long that it exceeded the prescriptive travel distance to an exit. The code asked for an exit stair that would have occupants discharging to the level above. That would involve major changes to the airport's tarmac that was directly above, make the project excessively costly, and have a significant impact on the airport's operation. Unreasonable.

The designer in this case proved that the tenability limit for occupants in the tunnel, an ASET that is greater than RSET, far exceeded the time required to exit. The equivalency was between *smoke management and travel distance*. By using the equivalent alternative, the designers managed to meet code requirements.

*Stratosphere Tower.*<sup>[8]</sup> Another example of the use of an equivalent alternative is the Stratosphere Tower in Las Vegas, NV. The total occupant load for the tower prescribed a total of three exits. Problem: The width of the supporting

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<sup>iii</sup> Keynote Presentation by Senior FPE, M.F at the California Polytechnic State University's 12<sup>th</sup> Annual FPE Student Symposium on Thursday, June 13, 2024, at the Advance Technology Labs in San Luis Obispo, California.

structure did not allow for the three exit stairways to be remote enough from each other as the building code required. Designers proved that *adding areas of refuge under the occupied levels* would also comply with the intended level of safety for all occupants.

The Equivalent Alternative, in these two examples, entailed creative thinking.

Great opportunities are coming for supporters of performance-based fire protection engineering. There is interest in bringing traditional and classical architecture back to federal buildings in America.<sup>[25]</sup>

The revival of traditional and classical architecture is an opportunity on the horizon for creativity, novelty and innovation in fire protection. The buildings are likely to incorporate designs that codes cannot anticipate in their prescriptive language. Performance-based fire protection engineering is the solution. Safe building designs would be possible through the Equivalent Alternative. Fire protection professionals will use performance-based designs and engineering analyses to demonstrate the equivalencies.

Developments in America could totally shift towards being driven by equivalent alternatives and performance-based rather than just staying with the traditional prescriptive approach. It's important to recognize however that a safe

building design will never get completely away from prescriptive guidelines.<sup>[8]</sup>

Readiness to meet the goal also includes fire drills. Full and periodic fire drills are as critical for the success of the fire safety strategy as is a robust ITM program. Drills are great opportunities for instructing and practicing occupant movement. Refer to figure 10 for a visual of the different ways to keep a building ready for possible fire emergencies and plausible life safety threats. The figure also includes the other two parts of Implementation.

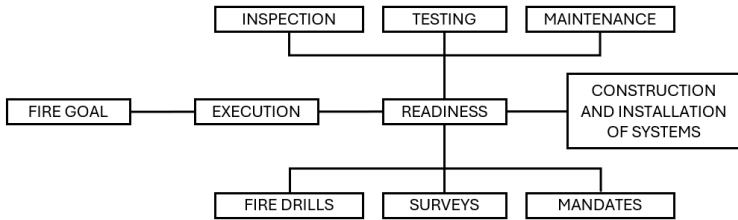


Figure 10: Implementation

Building surveys are another means to assess readiness. *Surveys* will reflect the conditions of FPLS systems and the capabilities to meet modern fire threats.

Typically, building codes are revised at three-year cycles. Evaluation of the building against the new edition of

the code could be interpreted as renewing the strategy. In some cases, jurisdictions issue *mandates* to upgrade the systems. Other jurisdictions would allow owners to prove through existing building codes that the design is still reasonably safe for the most recent fire threat trends.

The last part of the implementation phase is execution.

## Execution

Activation in any way of fire protection and life safety systems will be equivalent to executing the strategy. Execution occurs during a fire emergency. So, if there is never a fire in a building, we might never know if the fire goal is attained. But since we don't want fires in buildings, everyone will call that victory. This is in contrast with business strategies, where executives need to know when goals are attained. In this, fire safety strategies are unique.

Implementation, as you are now aware, consists of three parts: construction and installation, readiness and execution. The way the strategy is executed is the same for all buildings. The other two parts will only need adjustments based on the building design, which vary from building to building. Only the safe building designs are different. But the plans must incorporate all core areas of fire protection

## IMPLEMENTATION PHASE

and life safety in all buildings. Therefore, a fire safety strategy is always the same, consisting of three phases: *Analysis, Planning and Implementation.*

You are now crystal clear about what a fire safety strategy is.

# Turn Over Every Stone

*Learn about an overlooked risk that will cause fire sprinkler inefficiency.*

**W**hen search and rescue operations use the *Area Search Tactic* to find a missing subject, their advances are controlled and methodical so that areas are thoroughly covered. “In this mode, the searchers ... strive to investigate every bush, rock formation, downed tree, etc.”<sup>[26]</sup> In lay terms, searchers *turn over every stone*.

Successful execution of fire safety strategies also depends on inspectors, surveyors, technicians and maintenance staff applying the turn-over-every-stone tactic. Fire sprinklers are one of the important systems to care for. All risks to the performance of water-based fire protection systems must be identified, and immediate and appropriate actions must be taken.<sup>[27]</sup>

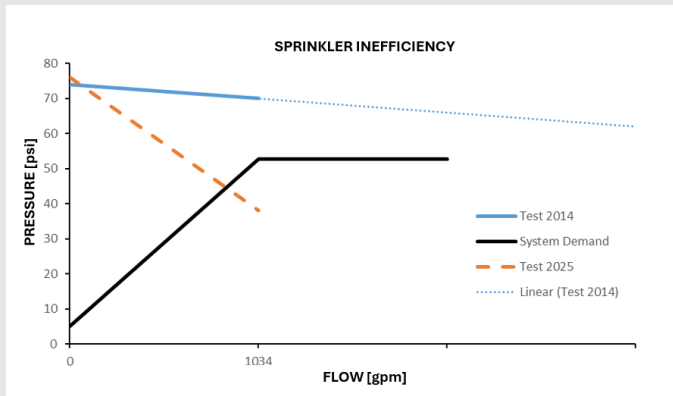
Flushing of underground piping after completing whole installations is an excellent example of thorough search for sources that impact the efficiency of fire protection systems.

Unthinkable debris have been expelled after flushing piping: rocks, construction gloves, screwdrivers, wood, rugs, cans and other foreign materials. Such materials can be carried into fire protection system piping and cause obstructions and system failure during a fire.<sup>[13]</sup>

A good practice to prevent rocks and other foreign materials from entering piping during installation is to plug and cover the open ends of piping, valves, hydrants, and fittings when work is stopped.

But are there any gray areas in the implementation of fire safety strategies where inspectors, surveyors, technicians or maintenance staff are not turning over every stone? Read this: A flow test for a 51,000 square feet (ft<sup>2</sup>) warehouse in a major city in the US revealed unexpected results. Refer to figure 11 below for a visual of the flow test results against the sprinkler system demand.

The test, done in late 2025, revealed a public waterworks system supplying 23 percent less flow and 45 percent less pressure when compared to a test done back in 2014 for the construction of the same warehouse. Additionally, the supply was below the flow and pressure demand by 28 percent when comparing the recent test with the warehouse's fire sprinkler system demand.



Existing sprinkler system inefficiency due to low water supply. Inefficient system: where *Test 2025* intercepts *System Demand*

Figure 11: Flow Tests and Sprinkler System Demand

Upon a real fire, a flow and pressure reduction of 28 percent would have resulted in an inefficient sprinkler system to protect the warehouse. This is a *red flag*. A greater red flag, however, is for the other bigger warehouses in the area that have greater water demands for their sprinkler systems, translating into greater inefficiency.

Inefficient sprinkler systems will impact significantly the chances of success of a fire safety strategy, if not making it fail altogether.

Examination of the results triggered an internal investigation, resulting in the discovery of two municipal valves that were closed. Why? We may never know. No one is aware that the jurisdiction has been under a water reduction program for over ten years.<sup>[13]</sup>

Engineers already use safety factors in designs, including the risk of water supply reductions for seasonal water shortages. But a reliable water supply source that is no longer reliable is a problem that will defeat even the most robust fire safety strategy.

Closed municipal valves are stones that were left unturned. Is this happening elsewhere?

## AFTERWORD

A fire safety strategy aims to fulfill the vision of having all buildings with the best prevention and mitigation practices for possible fire emergencies and plausible life safety threats. All fire goals are aligned with that vision.

The strategy guides the use of resources to ensure that buildings are safe from fire threats. The resources are coordinated through organizational designs, procedures, projects, policies, performance standards and programs to meet the building objectives and achieve the fire goals.

The quality of implementation is as important as the quality of analysis and planning. All three phases—Analysis, Planning and Implementation—are equally important.

The word strategy must never be used interchangeably with plans, designs, approaches, assessments, means or methods.

There are boards that regulate the practice of engineering, and national institutes and associations that certify technicians, especially in the US. A great responsibility is placed on designers, surveyors, inspectors

and technicians to ensure public safety for both new and existing buildings.

Human character might not be improved by sharing understanding about what a fire safety strategy is. But, at minimum, understanding fire safety strategy will promote greater appreciation for things done right.

You are now crystal clear—you are now an expert in fire safety strategy, regardless of your background, whether you are a project manager, property manager, maintenance manager, branch chief, department head, undergraduate engineering student, construction manager, junior FPE, engineer in other fields, architect, technician, or educator.

Share this information and help others to understand it too.



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