Fire Protection Approaches in Site Plan Review

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To my parents (Mohammad and Saeeda) for raising me and teaching me everything I know

To my wife Amber for her love and support

To all plan reviewers and engineers; those who sit behind the desk going unnoticed, spending their lives serving and protecting the people of this world

Contents

Preface

In today's fast-paced transforming industry of uniquely designed buildings with integrated security features, there need to be ground rules for evaluating site plans with regard to fire safety and emergency operations. The concept of square buildings with all-around access and approach has long faded. Zoning requirements, topography challenges, green design, and the need to maximize tenable space per square foot of area have led to complex urbanized layouts. This book provides guidelines for fire site plan review. It provides a technical examination of how to review site plans, taking into consideration an engineering approach to fire emergency service, codes and standards requirements, and best practices. The material mentioned in this text can be amended at the local level so that it benefits the entire organization. The overall objective is to bring uniformity; to develop a procedure so that the men and women responding to the emergency can do their jobs efficiently and safely.

Whether you are just starting to grasp the concepts of site plans or you are an experienced reviewer or an engineer looking for help in getting approval from the authority having jurisdiction (AHJ), this book will provide a fundamental knowledge of fire principles related to site review. It lays out the procedures to consider when examining site plans relating to fire protection features.

Chapter 1 provides an overview of site plans, discussing vital items that should be on a site plan for fire analysis, what kind of information needs to be evaluated, and the items a reviewer should be familiar with as he/she begins to undertake a review.

Chapter 2 establishes the importance of the roads used by fire emergency personnel to get to a site and for a set up, with specific reference to grading. Having an optimal area for a set up will not only provide an accessible route to get to the building, but will also decrease response time.

Chapter 3 dives into the water requirement for a fully engulfed building. It offers techniques to evaluate the quantity of water that is needed to put out fire in a building. The term *fire flow* is introduced.

Chapter 4 discusses the strategic positioning of fire hydrants with reference to the building and to roads. The two different types of fire hydrants, wet and dry, are examined, along with the sizing of adequate feeds to them and the obtainable fire flow.

Chapter 5 examines underground fire service lines that supply water to the active fire protection system of the building (e.g., the sprinkler system). Little attention has been given to the examination of fire lines, and acceptance/inspection is left to field personnel. Fire lines are perhaps the most important single element of the building's automatic fire protection system. Failure of the fire line results in an unprotected building.

Chapter 6 highlights Siamese connections, also known as fire department connections (FDC). For most automatic systems, like the automatic sprinkler system, they are used as a supplementary means to aid the fixed fire protection/suppression system, but for standpipes they are the primary means to supply pressure and flow (e.g., manual standpipes) for internal handheld-hose firefighting. Location and

positioning of FDC, clearance from obstructions, size, and labeling are all looked at in this chapter.

Chapter 7 covers access for emergency vehicles departing from the fire station and en route to the building. The discussion involves having adequate entry points to the site, as well as leaving the site after the incident, with specific attention to dead ends, turnarounds, and street widths.

Chapter 8 proceeds to the analysis of an advanced type of truck, the aerial ladder truck. When are these trucks required, what changes have to be made to the site to support them, and what is the purpose of these units are discussed.

Chapter 9 concludes with the concept of code modifications. These can be thought of as alternatives to the code but are not waivers; rather, their intent is to provide equivalence so that the intent and spirit of the code are met.

The fire protection and life safety issues addressed in this book are discussed on the basis of emergency access to the site and exterior fire protection features. These are the fundamental elements of the fire site plan. While every site should be reviewed for fire protection, this book tends to focus more on urban rather than rural communities. The components of a fire review not only affect internal fire and life safety features, but at times can also prompt a significant change to the architectural design of the building. The codes and standards referenced in this book are the latest available at the time this book was written. These include the International Building Code (IBC), the International Fire Code (IFC), and the National Fire Protection Association (NFPA) standards.

Unit conversion
1 foot (ft) = 0.3048 meters (m)
1 foot = 12 inches
1 inch = 2.54 centimeters (cm) = 25.4 millimeters (mm)
1 gallon = 3.785 liters
1 gallons per minute (gpm) = 3.785 liters per minute (lpm)
$feet^2$ = square feet or sqft representing area

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Author

Mohammad Nabeel Waseem Hasan has an Advanced Diploma from the Seneca College of Applied Arts and Technology in fire protection engineering technology (Ontario, Canada), a Bachelor of Science in fire safety and engineering technology from the University of Cincinnati, and a Master of Engineering in fire protection engineering from the University of Maryland. In addition, he holds a Master of Business Administration (concentration in project management) from Columbia Southern University, where he also served as a part-time adjunct faculty member, teaching various fire science courses. He is a professional member of the Society of Fire Protection Engineers and a certified fire protection specialist. He holds a National Institute for Certification in Engineering Technologies Level III certification in water-based systems, and is a certified fire plans examiner, a fire inspector, and a licensed fire protection engineer in the state of Maryland and the Commonwealth of Virginia. He has over a decade of experience in the fire protection industry, and served as the lead fire protection site reviewer for the Office of the Fire Marshal in Fairfax County, Virginia.

FEEDBACK

The author welcomes any suggestions to improve the material in this text. Comments and questions can be directed to the author via email at flamenab@hotmail.com with the subject line "Book: Fire Protection Approaches in Site Plan Review."

Introduction

The significance of a site plan may not be easily understood. Information can be contained in a single sheet or can encompass dozens or even hundreds of sheets. Little attention is given to site plans by individuals and agencies, and few people understand their importance in terms of safety.

Let us begin by answering the question: What is a site plan? A site plan is a detailed engineering drawing of proposed improvements to a given lot. It is a written and visual representation of any elements that change the site from its existing condition, including developing a new building or demolishing an old one, building expansions or additions, making changes to grading, landscape, utilities (e.g., water lines, overhead power lines, generators, underground tanks, and storm water), roads, and fire lanes.

When is a site plan required and when does it have to be submitted? Every jurisdiction has its own requirements. Contact the local building department and find out when one is required. Often, changes to a lot are not significant and a minimal submission is needed—a minor site plan. It is good practice to obtain this information well in advance so that you are aware of which agencies are involved and what their requirements are. A site plan can also be requested by other agencies, including state and national organizations. For example, jurisdictions that have adopted the International Building Code (IBC) can request a site plan.

A site plan is not just used for checking soil conditions, setbacks, utilities, roads, storm water, water, landscape, zoning requirements, and parcels. It is crucial for fire safety analysis. As the building is designed and takes shape, site plans must be thoroughly reviewed for code compliance with all regulations. Agencies such as zoning, land development, etc. review specific items against the codes, county policies, standards, and regulations. This book will help you see a site plan through the eyes of a fire protection plan examiner.

When should a site plan be reviewed? Whether you are in a rural area or in an urbanized setting, every development goes through planning. This is to allow for coordination, to achieve a feasible design, and to identify problems so that the project can be cost efficient with the least amount of obstacles. There are many examples where poor design and planning combined with inadequate site plan reviews have led to delays in project completion and increased cost. For example, access is insufficient for emergency responders to get to the building; Siamese connections are not labeled or are on the wrong side of the building; or fire hydrants are randomly placed miles away from a house on fire. Entire buildings have been destroyed with millions of dollars in damages due to these errors.

Consider the following case:

> On the morning of April 1, 2014, in Rockville, Maryland, despite more than 200 firefighters responding to an apartment fire involving 150 brand new units, a loss of US$20 million occurred. The entire building was destroyed as the fire, aided by the wind, spread across 3 acres of the complex. The apartments were nearly complete, with tenants ready to move in. The building had a fully automatic fire suppression system, but

it was not yet operational. Crews had to battle the fire using heavy master streams and aerial ladder trucks to prevent the spread of fire to adjacent occupied buildings, which included the Substance Abuse and Mental Health Services Administration (Figures 0.1 through 0.3). Challenges were encountered in getting access to the hot spots and in attacking the front of the fire, which had rapidly spread to the rear of the building. Fire truck access had not been provided to the rear of the building, so water could not be applied directly. The aerial ladder trucks had to be set up on an interstate highway

FIGURE 0.1 Firefighters use an aerial ladder truck to project a stream of water to control the fire. (Photo by Peter Piringer. 2014. Massive Fire Engulfs, Damages Montgomery County Apartment Building, Retrieved September 13, 2014 from http://wtop.com/news/2014/04/massive-fire-engulfs-damages-montgomery-county-apartment-building-video/slide/2/. With permission.)

FIGURE 0.2 Destroyed apartment complex. (Photo by Dave Thomas. With permission.)

FIGURE 0.3 Roof collapse. (Photo by Dave Thomas. With permission.)

ramp to achieve an appropriate angle of attack. Many of the neighborhood residents were trapped in their community, unable to get out due to hoses blocking the streets. Road closures caused heavy traffic delays and congestion as equipment was moved to battle the blaze. (Bell and Gonzales, 2014)

Whether it is an urban environment or a rural community setting, a detailed analysis of site plan review is needed now more than ever in the twenty-first century and beyond. Fire site plan concepts must be not only in the minds of civil engineers, but also in the mind of the architect as the conceptual design takes place. It is vital for the fire plan review and fire site analysis to occur ahead of time with the planning and zoning commission. This will avoid many problems in design changes further down the path, and help to fit in the fire features from the beginning.

REFERENCE

Bell, B., and Gonzales, J. 2014. Rockville three-alarm fire burns unfinished apartment complex. Allbritton Communications Company (ABC), retrieved September 13, 2014 from http://www.wjla.com/articles/2014/04/rockville-two-alarm-fire-burning-unfinished-apartment-complex-101717.html

Analysis

Issues pertaining to fire protection on a site plan should not be an afterthought or the responsibility of the fire plan reviewers. The concepts discussed in the chapters of this book must be kept in mind by architects/engineers throughout the entire design process. This can reduce, if not eliminate, many issues that will occur during the review process. Overall, it will speed up the approval process and save money by not having expensive changes arise during construction or field inspections, potentially causing delay when the building is about to open. The example mentioned in the Introduction, of the fire that occurred in the United States in 2014 that resulted in the destruction of an entire apartment complex with a US$20 million loss, might not have been prevented, but perhaps with adequate fire truck access to the rear of the building the damage might have been less.

Many developers, owners, and contractors think that their building will never catch fire or burn because their building has an automatic sprinkler system. The apartment building above was fully sprinklered, but during construction the system was not yet operational; nor was it required to be until construction was complete.

It can be argued that if the fire suppression sprinkler system had been active, the fire would not have spread. Sprinklers provide interior protection, and it is true that a "sprinkler system is considered reliable and effective when properly designed, installed and maintained" (Long et al., 2010). The NFPA states "that a properly installed and maintained automatic sprinkler system will reduce the average property loss from fire by one-half to two-thirds. According to the U.S. Fire Administration (USFA), property losses are 85 percent less in buildings that are protected with fire sprinklers compared to those without sprinklers" (International Fire Service Training Association, 2010, p. 16). No one better than the fire plan reviewer and firefighter understands the importance of sprinklers and how they are one of the greatest inventions. An automatic sprinkler system is invaluable; however, it does not replace firefighters. One key thing to realize is that typical fire sprinklers for office, commercial, mercantile, and school buildings are designed to control the fire, not suppress it. The activated sprinkler heads work by cooling the gas jet layer and preventing fire by preventing flashover conditions. The design is to limit the fire from spreading so that once firefighters respond, they can extinguish it. For certain occupancies, such as warehouses, the design could include the use of early suppression fast response (ESFR) sprinklers, which have the ability to achieve complete suppression. ESFR is not the solution for every occupancy. With them there are additional design factors and increased costs, and the system still does not provide a 100% guarantee. Additionally, sprinklers do little good in an exterior fire aided by strong winds.

At this point it is worth looking at some statistics regarding sprinkler systems and past fires. According to the NFPA Fire Analysis and Research, the report "U.S. Experience with Sprinklers," for fires between 2007 and 2011, indicates the following:

> When sprinklers were present in the fire area of a fire large enough to activate them, in a building not under construction, they operated 91% of the time. When they operated,

> they were effective 96% of the time, resulting in a combined performance of operating effectively in 87% of reported fires … (Hall, 2013).

On this basis, there is a 13% chance that sprinkler heads will not be sufficient to control the fire. This may be seen as a low probability, but at what risk? Every effort must be made to ensure life safety and property protection. The counteractive measure against the failure rate comes in the form of manual fire protection, which relies on a fire site plan review to ensure that fire trucks have adequate access, the required fire flow is present, the fire hydrants are correctly located and at the right distance so that water is available, and much more.

Perhaps the article titled "Lessons Learned from Unsatisfactory Sprinkler Performance: An Update on Trends and a Root Cause Discussion from the Investigating Engineer's Perspective" puts it in the best terms: "Oftentimes, performance is affected by factors not linked to the initial design or installation" (Long et al., 2010).

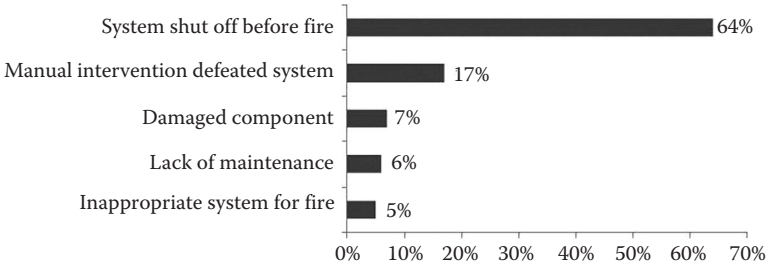

FIGURE 0.4 Reasons sprinklers fail to operate, 2007–2011. (Reprinted from Hall, J.R. 2013. U.S. Experience with Sprinklers, 6/13. National Fire Protection Association. With permission.)

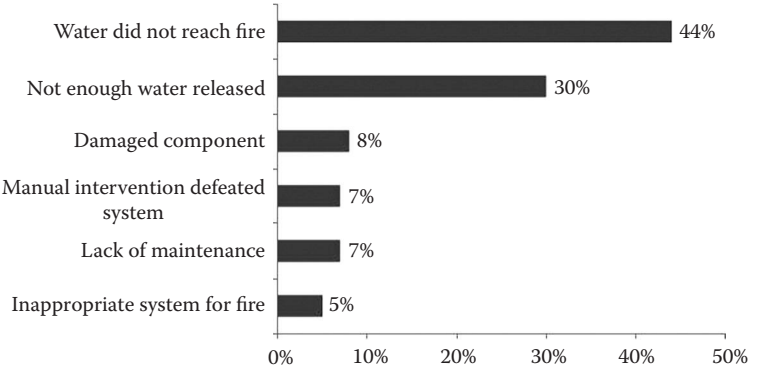

FIGURE 0.5 Reasons sprinklers are ineffective, 2007–2011. (Reprinted from Hall, J.R. 2013. U.S. Experience with Sprinklers, 6/13. National Fire Protection Association. With permission.)