A DECISION SUPPORT FRAMEWORK FOR ASSESSING THE TECHNICAL ADEQUACY OF PERFORMANCE-BASED DESIGN APPROACHES TO FIRE SAFETY ENGINEERING

by

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Abstract

This research effort addresses key challenges associated with the technical review and acceptance of performance-based design approaches to fire safety engineering through development of a decision support framework and associated tool. Such design approaches seek to confirm that the overall fire safety system, which includes the building and its protective features, meets a set of fire safety objectives established by relevant stakeholders, and this confirmation is achieved through fire safety analysis, or the application of analytical and computational tools and methods. While the current approach to performance-based fire safety analysis relies on guidelines and standards, these rather generic, process-oriented documents do not provide fire protection engineers (FPEs) sufficient guidance to address critical elements of the analysis process in a systematic, consistent and technically adequate manner. Should a fire safety analysis contain technical deficiencies, then it becomes less clear that the design solution being proposed truly achieves the desired fire safety objectives. Moreover, project stakeholders, including the authority having jurisdiction (AHJ), may lack the necessary qualifications, expertise, or design intimacy to, suitably and reliably, identify and challenge deficient analyses. As a result, the current approach to fire safety analysis and its quality assurance has led to large variations in analysis quality and consequently levels of delivered performance. With no existing equivalent, a decision support framework is proposed that will assist the AHJ and FPEs in determining whether a fire safety analysis is of sufficient technical adequacy to support decision-making, regulatory or otherwise. Additionally, a decision support tool is developed to provide measures of confidence regarding an analysis's conclusions and assist in identifying those aspects of the analysis most requiring corrective action. Lastly, while developed to address performance-based design approaches to fire safety engineering, the framework may easily be adapted to similar approaches in other fields of engineering, or more generally, applications that make use of process-oriented, analysis-driven design.

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1. INTRODUCTION

This research seeks to address key challenges associated with the review and acceptance of performance-based design approaches to fire safety engineering and presents a solution to standardize the assessment of their technical quality and adequacy. In short, the aim of this research is to develop and implement into practice a decision support framework that will assist authorities having jurisdiction (AHJs) and fire protection engineering (FPE) practitioners in determining whether a fire safety analysis approach is sufficient to support decision-making, regulatory or otherwise. This framework is implemented through use of a decision support tool that examines the performance-based design approach being applied as well as the conclusions and/or risk insights that the approach can produce. Following this examination, stakeholders are presented with a series of performance indicators that provide a measure of confidence in an analysis's conclusions and/or risk insights and that assist in identifying those aspects of the analysis requiring corrective action.

This research was motivated by my years of performing detailed technical reviews in support of the Nuclear Regulatory Commission (NRC) as nuclear power plants under their regulatory purview moved to implement risk-informed, performance-based fire protection programs. Despite a large industry effort to develop verified and validated methods, testing data and guidance, initial NRC regulatory reviews revealed a number of common analysis deficiencies, some substantial, used to support the licensees' fire protection programs. These deficiencies were identified and characterized through a structured review process supported by decision support tools in the form of standards and analysis guidance. Such tools were used to assess the technical adequacy of the licensees' risk-informed, performance-based analyses and ultimately whether the analyses were sufficient to support regulatory decision-making.

With that said, there is no similar structured review process or analogous set of decision support tools within the built environment. Instead, AHJs and other stakeholders have been accepting performance-based designs of buildings through an ad-hoc review approach that for reasons discussed herein, allows for approval of inconsistent and potentially improper applications of performance-based design. In short, a performance-based fire safety design confirms through fire safety analysis that a fire safety system, which includes building attributes as well as fire protection systems and features, meets fire safety objectives (e.g., life safety, property protection, etc.). Consequently, a degradation in the technical adequacy of the supporting fire safety analysis yields a reduction in the confidence that the chosen fire safety system, if challenged by an actual fire, would be adequate to achieve desired, stakeholder-driven objectives. Thus, the work documented in this dissertation aims to build upon lessons learned from the nuclear industry and to develop a decision support tool to improve the technical adequacy of performance-based designs applied within the built environment. Additionally, it hopes to lay the groundwork for potential applications external to the field of fire safety engineering.

The main themes of this research effort are presented in five primary sections and are supplemented by material contained within eight appendices. Section 2, titled "Technical Adequacy of Performance-Based Designs", defines the research problem in further detail, outlining the approaches to performance-based design and associated challenges, technical or otherwise, that currently result in the unbalanced application of performance-based design. Additionally, a literature review is documented to explore the application of decision support frameworks and tools developed for related applications within fire safety engineering and other fields. Upon formally defining the concept of technical adequacy and its constituent parts (i.e., scope, level of detail, and technical quality), this section concludes with the recommendation and preliminary specification for a decision support framework that will offer a consistent and uniform means by which to (i) assess and compare the technical adequacy of performance-based design approaches to fire safety engineering; (ii) effectively and efficiently determine whether the approach taken is sufficient to justify the specific results and insights that are used to support the regulatory decision under consideration; and (iii) identify those aspects of the approach, if any, requiring further corrective action before its results and insights can be relied upon.

With research objectives defined, Section 3, titled "Decision Support Framework for Assessing Technical Adequacy", describes the three conceptual underpinnings of the proposed decision support framework. The first element represents a set of technical requirements that may be used to assess the scope and level of detail of a given fire safety analysis and assist in the systematic identification of any deficiencies that may impact the analysis's technical quality. The second element represents a network-based analysis that is performed to outline the underlying dependencies between technical requirements and understand, at least qualitatively, how analysis deficiencies related to each requirement may impact the achievement of fire safety objectives. The third and final element represents the quantification of the network-based analysis, which translates qualitative evaluations of technical requirements into a series of quantitative and actionable insights to inform the decisions of stakeholders, including code officials, regarding the acceptance of a fire safety analysis. Note that Appendix A to this report explores this later element in further detail and provides additional justification for selected quantification methods.

With the theory behind each of the three framework elements established, Section 4, titled "Demonstration of Proposed Framework", integrates these elements into a decision support tool that is then used to demonstrate and test the overall functionality, feasibility and utility of the decision support framework. This is done through a case study, which explores the process by which fire safety analysis deficiencies are characterized and evaluates, through the framework's established performance indicators, their impact on not only the technical adequacy of the fire safety analysis and but also fire safety objectives. The results from the case study are analyzed from the perspective of a code official presented with a fire safety analysis and tasked with making the decision of whether to approve a given performance-based design, which the analysis is intended to justify, or take alternative actions (e.g., reject the analysis, request additional information, etc.). Note that Appendices B through H to this report outline the basis and construction of the decision support tool used to implement the case study and documents, in greater detail, the results and analysis thereof.

Drawing upon lessons learned from the case study, Section 5, titled "Implementation of Decision Support Tool for Stakeholders", outlines how the decision support framework and associated tool may be used, in practice, to support relevant stakeholder decisions. In doing so, the specific needs, skills, resources and limitations of different stakeholders associated with the performance-based design process are explored, and use recommendations are made. Additionally, a high-level procedure is provided. This procedure is aimed to assist future users in understanding the steps and inputs required to implement the framework and supporting tool.

Lastly, Section 6, titled "Conclusions and Future Efforts", summarizes the main findings of this research relative to research objectives. Additionally, it suggests future work that while beyond the scope of this effort, is recommended to fully and successfully implement the proposed framework and put the decision support tool into practice.

2. TECHNICAL ADEQUACY OF PERFORMANCE-BASED DESIGNS

2.1. Introduction

This section presents an original research problem, the current approach to the problem, and a hypothetical process for using decision analysis principles and fundamental fire protection engineering knowledge to assist in its solution. It is not intended to specifically identify all of the variables that affect this problem or to solve the problem. Instead, this section will suggest techniques and processes to approach this problem, identify variables of interest, and outline a general decision support solution, which will be further specified in Section 3 of this dissertation.

2.2. Background

As defined by the Society of Fire Protection Engineers Engineering Guide to Performance-Based Fire Protection [1], performance-based design may be defined as:

> "[a]n engineering approach to fire protection design based on: (1) agreed on fire safety goals and objectives; (2) deterministic and/or probabilistic analysis of fire scenarios; and (3) quantitative assessment of design alternatives against fire safety goals and objectives using accepted engineering tools, methodologies, and performance criteria".

Considering this definition, performance-based design approaches are "valuable" in that they incorporate "scientific knowledge" and "engineering rigor" into the design process; avoid arbitrary and often politically motivated "code prescriptions"; and lead to "a comprehensive fire protection strategy in which all systems are integrated, rather than designed in isolation" [2,3]. Nevertheless, as noted by Alvarez, et al. [2], "[i]n a constantly evolving building environment, technical challenges have to be overcome because fire safety engineering still depends greatly on knowledge gained from scientific and engineering research across a broad range of disciplines (e.g., better understanding of the fire phenomena, the behavior and response of the building occupants/contents/structure to the fire, tools for engineering analysis and all the necessary data needed to support tool application)".

Consequently, technical guidance associated with performance-based design should reflect not only the knowledge gained but also the need to accommodate future technological innovations. However, "[e]xisting guidance…has been found to be too generic", i.e., "fire protection engineers [(FPEs)]…are required to significantly expand upon the information provided by this guidance…resulting in wide variation in practice" [4]. Accordingly, regulators and authorities having jurisdiction (AHJs) over the approval of performance-based fire protection designs perceive such inconsistencies [5]. Moreover, the application of performance-based design approaches necessitates stakeholder agreement on fundamental aspects (e.g., definition of the performance criteria and the selection of the fire design scenario) in which "stakeholders have no expertise" [5]. Lastly, the level of guidance available to stakeholders to support their review of performance-based design is severely lacking; current guidance, such as the SFPE's Guidelines for Peer Review in the Fire Protection Design Process [6], is again too generic.

While the above issues are prevalent the application of performance-based design within the general built environment, specialized and high regulated industries, particularly the nuclear industry, have implemented risk-informed, performance-based fire protection programs in a much more standardized and predictable fashion. In preparation for transitioning nuclear power plant fire protection programs from being prescriptive to performance-based, the Nuclear Regulatory Commission (NRC) stewarded a large industry effort to develop detailed guidance, verify and validate fire analysis methods and techniques, and stand up fire testing programs among other actions [e.g., 32-40]. Additionally, under their regulatory purview as the AHJ, the NRC performed detailed technical reviews of each nuclear power plant's licensing submittal that requested implementation of a risk-informed, performance-based fire protection programs under NFPA 805 [7]. These reviews sought to evaluate the technical adequacy of the submittal. Though, despite the NRC's effort to heavily standardize and control the content and implementation of fire safety analyses, initial reviews revealed a number of analysis deficiencies within the licensees' programs. These deficiencies, however, were systematically identified and characterized through a structured review process supported by decision support tools in the form of standards and guidance [e.g., 31-34]. These tools were used by the NRC and industry members to assess the technical adequacy of risk-informed, performance-based analyses and ultimately whether the analyses were sufficient to support regulatory decision-making.

Despite the moderate success of performance-based design with the nuclear industry, there is no such structured review processes or analogous set of decision support tools developed for use in the general built environment. Instead, AHJs and other stakeholders have been accepting performance-based designs of buildings through an ad-hoc approach that for reasons discussed herein, allows for approval of inconsistent and improper applications of performance-based design. In short, for both the FPE and the involved stakeholder (e.g., AHJ), there is a strong need to determine whether the technical adequacy of a performance-based design approach is sufficient to support decision-making, regulatory or otherwise. Additionally, the process by which such adequacy is addressed should be standardized, and the results of this process should be comparable across different performance-based design approaches.

2.3. Performance-Based Design Approaches to Fire Safety Engineering

As Meacham [15] notes, a number of disciplines, including structural, mechanical, and fire protection engineering, make use of performance-based analysis and design approaches, and consequently, performance-based building standards, codes and guidelines have been developed and continue to be enhanced in many countries throughout the world. Since performance-based building regulations were first implemented in the early 1980s, these function- or objective-based building regulations have been developed in more than a dozen countries [15]. As part of this development, Meacham observes that one of the common objectives for many countries, including Australia, Canada, Japan, New Zealand, the USA and the 27 Member States of the European Union, has been to incorporate risk-informed criteria into building regulations and standards as a means to inform "tolerable levels of building performance".

While they vary on a country-by-country basis, specific drivers for implementing performance-based analysis and design approaches include "the desire to reduce regulatory burden, to reduce cost (to government, the market and consumers), to facilitate innovation in building materials and systems, to expand the application of analytical and computational tools and methods (driven in part by leaps in computer technology and computational modelling capability), and ultimately to facilitate better performing buildings – both new and existing" [16]. Furthermore, Meacham [16] points out that performance-based analysis and design approaches have been adapted to address other "pressures and threats", such as changing demographics, climate change impacts and resource depletion, as they emerge. For these reasons, "performance concepts [have] figured prominently in technical and policy aspects of evolving building regulatory systems" [16].

2.3.1. Current Practice of Performance-Based Design Reviews

Summarizing guidance promulgated by the British Standard Institute [17], the International Organization for Standardization [18-21], International Fire Engineering Guidelines [22], and the Society of Fire Protection Engineers [1], Alvarez, et al. [2] divides the current approach to performance-based fire protection design into three major parts:

(1) "Stakeholders establish goals and objectives, which are then translated by FPEs into design objectives and performance criteria. FPEs, working with the client, architect and the design team, develop one or more packages of fire safety measures, often called 'trial designs'. Then, everyone agrees on design fire scenarios upon which trial designs are evaluated. This part of the process is documented in the Fire Engineering Brief (FEB)."

(2) "The FPE evaluates the consequences of the selected design fire scenarios and compares their outcomes with the selected performance criteria. In order to do so, he/she uses appropriate tools to evaluate the development of the fire (fire effects tools), the evacuation of the building occupants and the response of the structure (and the building contents and systems) to the design fire scenarios."

(3) "From the list of trial designs that pass the performance criteria, the stakeholders decide which one to finally retain for the considered project and the FPE writes the related documentation in terms of specification, operation and maintenance of the fire protection measures."

Alvarez, et al. adds that while the current approach to performance-based design relies on guidelines and standards, these "rather generic, process-oriented" documents do not expound on the critical components of the design process (e.g., selection of performance criteria, treatment of fire scenarios, design verification and validation, etc.) but rather leave much for the FPE to resolve in consultation with project stakeholders. Nevertheless, the current approach has led to a large variation of design processes and levels of delivered performance [4].

Despite the lack of detailed guidance and unbalanced application of performance-based design, however, AHJs and other stakeholders have been accepting of such designs [2]. Although literature showcases many performance-based design projects since the inception of performance concepts, Alvarez, et al. [5] observes that the available documentation often does not facilitate a detailed understanding of the resulting designs and approaches used, e.g., due to issues of confidentiality and the lack of transparency in many jurisdictions. For this reason, few comparative assessments of accepted performance-based designs and methodologies have been performed. Research efforts have been undertaken to enhance the application of performance-based design process, particularly risk-informed design [e.g., 4]; however, such attempts have yet to result in any systemic improvements to either the practice or transparency of performance-based design. Moreover, there is no well-defined criteria against which the strengths and weaknesses of a fire analysis may be judged so that decision-makers can determine the degree of reliance that can be placed on the results of interest.

2.3.2. Underlying Challenges Related to the Use of Performance-Based Design Approaches

Mirroring much of the insights of Alvarez, et al. [2] referenced above, Meacham [23] further illuminates upon the current "adolescent" state of fire safety engineering (FSE) and performance-based code frameworks:

> "Although a general framework and vocabulary for FSE exists…, the basic approach is to provide general guidance regarding what should be considered in a FSE analysis, but detailed guidance on how to actually conduct FSE analyses is missing. In addition, guidance regarding how to integrate fire safety performance with all other required and desired performances for a building – in normal and emergency situations – is also missing. Details which are lacking include means to quantify performance expectations and measures, characterize targets and their vulnerabilities, quantify fire threats, and evaluate the building and fire safety systems' ability to deliver desired performance in normal and emergency conditions. In addition, guidance for how to address uncertainty and variability across all aspects of FSE analysis is largely missing. The net result is that fire safety engineers are free to select data, tools and methods of their choice, in consideration of scenarios which they think are important (with varying degrees of stakeholder involvement), evaluated against criteria they select, with the potential for no explicit consideration of uncertainty and variability throughout the life of the building."

Consequently, these and other vulnerabilities in the current performance-based framework contribute to the use of performance-based design approaches that suffer from inconsistencies in or a lack of technical quality and adequacy; regulatory uncertainty or a lack of confidence by regulators; the potential dismissal or omission of key fire performance concerns; and wide variation in building safety performance. More specific technical challenges related to performance-based design approaches are discussed by Alvarez, et al. [5] and include: "the assumption of 'idealized' performance of fire protection measures", the focus on fire protection system performance in isolation of overall building performance, and the lack of sufficient guidance for determining those factors most influential to building performance.

Another challenge to the technical quality and adequacy of performance-based design approaches is identified by Tubbs, et al. [24]. Tubbs, et al. found that limitations in the use of computational tools and data availability continue to be one of the largest barriers to widespread implementation of performance based codes and design. Meacham [23] echoed this sentiment, stating that despite "significant growth in the availability of computational analysis tools", "the availability of data for use in these tools and in engineering analysis in general remains a problem across all FSE areas – from fire properties of materials to human factors". This challenge has often resulted in FPEs making unwarranted use of literature values, or other readily available data. Without appropriately qualified data, however, a performance-based design approach, including its use of computational tools, lacks a proper basis and should therefore not be judged as technically adequate for use in a regulatory decision-making process.

Unsurprisingly, as Tubbs, et al. [24] and Alvarez [4] both explain, performance-based designs face additional barriers regarding the approval process. Due to the number of challenges in applying the current performance-based framework, AHJs are "wary" of approving designs that deviate heavily from code prescriptions [4, 24]. The review and approval process is further impaired by the state of education within fire safety engineering. As Meacham [23] states,

> "We have a lack of adequately qualified fire safety engineers, particularly those with appropriate education, the confidence and wisdom of experience across a diversity of applications, and the ethics and accountability needed to help foster confidence in the profession. At the same time, we have a continued reliance on longstanding prescriptions and rules of thumb to guide decisions, even when the science and data exist to better

> support decisions, and proper application of the science is not mandated. The net result is that critical fire and life safety decisions are sometime being made – and allowed to be made – by people without proper credentials."

Thus, it remains unclear how an AHJ is to make a regulatory decision regarding a performance-based design when that design is based on the results of a performance-based design approach, the details of which are outside of the AHJ's expertise and experience.

The technical challenges associated with performance-based design are also exacerbated by the general lack of detailed documentation and comparative reviews of designs and their base methodologies. Alvarez [23] notes that at least in the United States, there is no centralized mechanism for gathering feedback and lessons learned on the regulatory treatment of performance-based design approaches or even on the approaches themselves. Alvarez supposes that this is, in part, due to the de-centralized, state-managed building regulatory system; the lack of a standardized, compulsory system of design review and acceptance at the state or local level; and the belief by AHJs that each design is unique and not worthy of archival to the extent necessary for comparative analysis. Thus, the current performance-based framework does not effectively allow for the exchange of ideas and techniques for effective use of performance-based design approaches among diverse sets of stakeholders, nor does it provide a means for identifying, over time, areas of consistency or inconsistency in the treatment of issues important to understanding building performance and implementing performance-based design approaches.

Another symptom of the more fundamental challenges related to use of performance-based design approaches is the potential overreliance on engineering tools over good engineering and design. As Meacham [23] states,

> "Application of an engineering tool…is modeling. Engineering is about investigating a problem, properly defining the problem, and developing solutions for the problem using available knowledge and technology, taking appropriate consideration of the uncertainty around the problem and implementation of the solution".

Given the ostensible complexity of some computational tools, they often promote a false sense of technical quality and adequacy, particularly when their limitations are not well understood by the modeler or stakeholders. In truth, technical complexity does not equate to technical quality and adequacy. That is, the right scope and level of detail, occupancy-specificity, and realism necessary to support regulatory decision-making is expected to fall on a continuum; however, the regulatory community, and some fire protection engineering practitioners for that matter, lack the confidence and expertise necessary to strike, what Meacham calls, "a balance between when 'simplified' methods are appropriate and when 'comprehensive' analysis is needed, and what makes for 'good analysis' versus 'good design'."

In brief, the aforementioned challenges necessitate the need for AHJs and fire protection engineering practitioners to have a consistent and uniform means by which (i) to assess and compare the technical quality and adequacy of performance-based design approaches to fire safety engineering and (ii) effectively and efficiently determine whether the design approach taken is sufficient to justify the specific results and insights that are used to support the regulatory decision under consideration.

2.3.3. Deficiencies associated with Performance-Based Design Approaches

A review of guidelines and standards, e.g., the International Fire Engineering Guidelines [22], BSI 7974 [25], the SFPE Engineering Guide to Performance-Based Fire Protection [1], and ISO 13387 [18], reveals that a performance-based fire safety design approach to fire safety engineering consists of three high-level elements: fire safety objectives, fire safety system and fire safety objectives. Fire safety objectives serve to convey the interests of stakeholders with a performance-based design approach. General objectives can include, among others:

(1) "protecting persons in or adjacent to the building";

(2) "protecting the building and adjacent buildings from being affected by a fire";

(3) "maintaining continuity of business operations and financial viability";

(4) "protecting a country's heritage in older or significant building";

(5) "limiting the release of hazardous materials into the environment"; and

(6) "safeguarding community interests and infrastructure" [22].

The fire safety system represents what is being challenged by the fire and includes the building that is being analyzed and all aspects thereof (e.g., construction, use, fire hazards, occupants, building systems, fire protection systems and features, etc.). Lastly, the fire safety analysis provides a qualitative or quantitative assessment of the identified risk in terms of fire scenarios that result in undesired consequences and their frequencies to ensure that the fire safety design, as proposed, is consistent with established fire safety objectives. In short, a performance-based fire safety design confirms through fire safety analysis that a fire safety system meets fire safety objectives.

Should the fire safety analysis have a deficiency, that is, be technical inadequate in some way, then it becomes less clear that the proposed fire safety system being analyzed truly meets fire safety objectives. Both within the nuclear industry as well as in the general built environment, much work has been performed to identify and characterize analysis deficiencies that affect performance-based designs and associated insights. Within the nuclear industry, the NRC performs detailed and systematic technical reviews and audits of every performance-based fire protection program implemented at a nuclear power plant. During this review, the NRC staff, supported by internal and industry guidance as well as decision support tools, evaluates the technical adequacy of the fire safety analysis to assess whether it is of sufficient scope, level of detail and quality to inform decision-making. In this case, the decision is whether the fire safety system (i.e., the as-built, as-operated nuclear power plant) can meet fire safety objectives (e.g., a total core damage frequency of less than 1.0E-04/year). Deficiencies, if identified, are explored further as part of requests for additional information (or RAIs) from the licensees and ultimately addressed to eliminate or minimize their impact on decision-making [e.g., 26-29]. Despite fire protection engineering practitioners' access to detailed industry and regulatory guidance, a number of often significant deficiencies are identified during NRC reviews.

Within the general built environment, the situation is similar, if not more severe, given the challenges associated with implementing performance-based design as discussed in Section 2.3.2. For example, ARUP was commissioned by the New Zealand Fire Service (NZFS) to undertake a technical audit of the NZFS Fire Engineering Unit, which reviews fire engineering design reports and assessments and provides a written memorandum to the Building Consent Authority regarding the fire engineering designs of designated buildings with respect to occupant egress and firefighting needs [30]. The results of this audit identified systematic deficiencies associated with the FEU review process and thereby the reviewed fire safety analyses. For instance,

(1) "Over 80% of the sampled fire engineering reports did not have sufficiently thorough investigation of the fire safety issues".

(2) "In 80% of the sampled reports, the analysis was not sufficiently rigorous".

(3) "There are over 20% of the reports that have used unproven materials or techniques".

(4) "[T]he [FEU review] …failed to check the correctness of input for fire engineering calculations in all cases" [30].

In general, regardless of the industry or application, deficiencies pose a great challenge to AHJs and fire protection engineering practitioners. For one, there are many different flavors of deficiencies, including:

- Unsubstantiated or inappropriately applied data
- Untested or unlisted construction materials and fire protection features (e.g., barriers)
- Insufficient analysis scope
- Inadequate analysis level of detail (e.g., failure to capture all risk-significant fire scenarios)
- Unsupported analysis assumptions
- Lack of uncertainty and sensitivity analyses to assess the impact key sources of modeling uncertainty
- Analysis does not match the as-built, as-occupied building
- Use of fire modeling or analysis methods that have neither been verified nor validated.

Additionally, their individual or collective impact on the decision being supported is often unclear or left unaddressed. Fire protection engineering practitioners or AHJ representatives may lack a systematic process or set of guidelines to properly identify and characterize deficiencies. They may also lack appropriate qualifications. Lastly, there is often a knowledge differential between the fire protection engineering practitioner that performs the analysis and the AHJ representative that reviews it, missing an opportunity for performance of a truly independent review.

2.4. Definition of Technical Adequacy

To decide whether a fire safety analysis is of sufficient technical adequacy to support decision-making, technical adequacy must first be defined. The NRC Regulatory Guide 1.200 [31] describes one acceptable approach for defining the technical adequacy of an acceptable base probabilistic risk assessment (PRA) of a commercial light water reactor nuclear power plant. The use of PRAs within the nuclear industry also applies to assess the impact of fire and ultimately the adequacy of risk-informed, performance-based fire protection programs. The NRC's approach can be adapted here to explain what determines the technical adequacy of a fire safety analysis. In essence, an adequate fire safety analysis has sufficient (i) scope, (ii) level of detail, and (iii) technical quality to support decision-making. Each of these concepts is explored further below.

2.4.1. Scope

The scope of a fire safety analysis is defined by the fire safety objectives addressed by the analysis and the level of analysis performed. Ultimately, the scope is determined by the fire safety analysis's intended use or application as well as characteristics of the fire safety system. For instance, a fire safety analysis developed to assess life safety would have a different scope than one that addresses both life safety and property protection. A similar argument would apply to the modeling of specific fire phenomena; that is, modeling of gas explosions may not be within the scope of the analysis if such ignition sources are not present within the building of interest.

2.4.2. Level of Detail

Like scope, the level of detail is determined by the fire safety analysis's intended use or application. A minimal level of detail is necessary to ensure that the impacts of designed-in dependencies are correctly captured. This minimal level of detail is implicit in the technical elements comprising the analysis and their associated characteristics and attributes. The detail may vary from the degree to which (1) occupancies and safety systems are modeled, (2) specific occupancy experience is incorporated into the model, and (3) realism is incorporated into the analyses that reflect the expected building and occupant response. Essentially, once a characteristic or attribute is designated to be within the scope, it should always be addressed; however, the degree to which it is may vary considerably. For instance, life safety and property protection may both be fire safety objectives associated with a warehouse and a hospital. However, the characteristics of a warehouse and hospital are different such that the fire safety analysis supporting life safety may be performed at a significantly higher level of detail for the hospital than for the warehouse. The opposite may be true for analysis of property protection.

2.4.3. Technical quality

The determination of technical quality is subject to two aspects of the fire safety analysis. The first aspect is the assurance that the fire safety analysis used in the application has been performed in a technically correct manner. That is, the analysis should accurately represent the as-built, as-used facility, including its design, configuration and operation. The analysis must also be able to reliably predict the consequences of fires, and any applicable models are applied within the limitations of the given model. Any analysis that is technically incorrect can lead to incorrect conclusions.

The second aspect is the assurance that the assumptions and approximations used in developing the analysis are appropriate. Different analysts will make different modeling choices and assumptions. The choice of a specific assumption or approximation may, however, influence the results of the analysis. As a result, sources of uncertainty and associated assumptions should be appropriately documented, characterized and justified such that their impact on the analysis is known and can be considered as part of the decision-making.

2.5. Use of Decision Support Frameworks to Assess Technical Adequacy

Decisions about whether fire safety objectives (e.g., life safety, property protection, etc.) are sufficiently addressed by a fire safety system requires a supporting fire safety analysis that is technically adequate. That is, as described above, an analysis that is off sufficient scope, level of detail, and technical quality. However, as it has also been discussed above, decision-making in this regard is not supported by a structured process within the general built environment. If a structured process were to be developed, a decision support framework would prove a viable candidate.

A fundamental principle of decision science is that decision makers do not always have the data needed to decide, nor do they always have the time, resources or expertise to interpret the data. Thus, in the face of incomplete, imperfect, and uncertain information, many disciplines have turned to decision support frameworks and tools, mechanisms by which data important to a decision may be systematically identified and assessed.

Decision support frameworks are derived from the field of decision analysis. As first defined by Howard [41]:

> "Decision analysis is a logical procedure for the balancing of the factors that influence a decision. The procedure incorporates uncertainties, values, and preferences in a basic structure that models the decision…The essence of the procedure is the construction of a structural model of the decision in a form suitable for computation and manipulation…"

According to Edwards [42], the field of decision analysis rests on four "pillars": (i) systems analysis, which grew out of World War II and was concerned with understanding dynamic systems; (ii) decision theory, which is concerned primarily with making decisions in the face of uncertainty and whose roots go back to Bernoulli and Laplace; (iii) epistemic probability, which reflects "a person's knowledge (or equivalently ignorance) about some uncertain distinction"; and (iv) cognitive psychology, which seeks to understand human behavior during the decision-making process.

Overtime, decision support frameworks have been applied to a diverse set of decision problems across a wide range of professional disciplines to help facilitate better decisions under uncertainty. Applications of decision frameworks include arms controls [43], planning and resource allocation [44], fire safety [8-10, 45-51], air traffic control [52], maritime safety [53], nuclear safety [54-55], software quality [56-58], and cancer risk [59], to name a few.

In particular to process quality and adequacy, decision support frameworks have been used in nuclear applications [12, 31 and 60] and environmental assessments [61] among others. For instance, in 1995, the U.S. Nuclear Regulatory Commission (NRC) issued Policy Statement 60 FR 42622 [62] on the use of probabilistic risk analysis (PRA), encouraging its use in all regulatory matters. That policy statement states that "…the use of PRA technology should be increased to the extent supported by the state-of-the-art in PRA methods and data and in a manner that complements the NRC's deterministic approach." Since that time, many uses have been implemented or undertaken, including modification of the NRC's reactor safety inspection program and initiation of work to modify reactor safety regulations. Consequently, confidence in the information derived from a PRA is an important issue, in that the accuracy of the technical content must be sufficient to justify the specific results and insights that are used to support the decision under consideration.

In support of this policy statement, the NRC promulgated Regulatory Guide (RG) 1.200 [31], which describes one acceptable approach for determining whether the technical adequacy of the

PRA is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for light-water reactor plants. The term "PRA" describes a method or approach that (i) provides a quantitative assessment of the identified risk in terms of scenarios that result in undesired consequences (e.g., core damage or a large early release) and their frequencies, and (ii) is comprised of specific technical elements in performing the quantification. The scope of the PRA is determined by its intended use and is defined in terms of (i) the metrics used to characterize risk, (ii) the plant operating states for which the risk is to be evaluated, and (iii) the causes of initiating events (hazard groups) that can potentially challenge and disrupt the normal operation of the plant and, if not prevented or mitigated, would eventually result in core damage and/or a large release. The level of detail of the PRA is also determined by its intended use. Nonetheless, a minimal level of detail is necessary to ensure that the impacts of designed-in dependencies (e.g., support system dependencies, functional dependencies, and dependencies on operator actions) are correctly captured. This minimal level of detail is implicit in the technical elements comprising the PRA and their associated characteristics and attributes.

When used in support of an application, RG 1.200 [31] and referenced standards [e.g., 60] obviates the need for an in-depth review of the base PRA by NRC regulatory reviewers, allowing them to focus their review on key assumptions and areas identified by industry peer reviewers as being of concern and relevant to the application. The technical acceptability and quality of a PRA analysis used to support an application are measured using qualitative, standardized metrics in terms of its appropriateness with respect to scope, level of detail, and realism. Consequently, such a framework provides for a more focused and consistent review process, and as a result, informs the development and characterization of the technical requirements proposed below.

While the NRC tools and methods have also supported fire safety engineering (i.e., through implementation of NFPA 805 [7]), other frameworks exist as well. For instance, decision support frameworks have been used to increase the awareness of fire safety performance during the building design process and ultimately determine whether a building has design features that work against fire safety performance [8-10]. A similar but more generic example is demonstrated by the fire safety concepts tree [11]. This systems-based methodology examines the interrelation of fire safety features and their effect on achieving specific fire safety goals and objectives, assisting fire safety practitioners communicate fire safety and fire protection concepts so they can develop effective strategies and solutions.

As another example of a decision support framework to assess process quality and adequacy, the International Atomic Energy Agency (IAEA) has developed a methodology and tool for self-assessment of regulatory infrastructures for safety, to assist states in undertaking self-assessment of their national safety framework in accordance with the requirements and recommendations of the IAEA safety standards, and to develop an action plan for improvement. IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment, and therefore represent what all regulators should achieve. These standards provide the basics for establishing, maintaining and continuously improving the governmental, legal and regulatory frameworks for safety.

According to IAEA-SVS-27 [12], the IAEA's methodology and tool can be made either through an external review or through internal self-assessment. Self-assessment offers a mechanism by which an organization can assess its performance against established standards and models and thereby identify areas for improvement. The model for IAEA self-assessment of national regulatory infrastructure for safety is based on a three-tier approach with each tier representing progressively more detailed criteria. Additionally, the framework incorporates quantitative performance indicators that objectively measure regulatory infrastructures for safety against established criteria and help in determining priorities, allocating resources and in communicating with various stakeholders. In short, such performance indicators offer one means by which technical quality and adequacy may be more efficiently and objectively accessed and communicated to stakeholders.

In making any important decision, it is prudent to elicit information from others who have expertise in the relevant field or domain of knowledge and it is through the use of decision support frameworks that this human reasoning process can be automated and its relationship with available data modeled. While many methods, e.g., ranking systems, neural networks, Markov models, etc., exist for doing just this, Bayesian belief networks offer a number of advantages that ultimately support their consideration as the quantitative foundation of the proposed decision support framework discussed herein.

Consisting of both qualitative and quantitative aspects, Bayesian belief networks were introduced in the late 1980s as a means to represent and better understand uncertainty [13]. The qualitative component is a directed graph with nodes modeling statistical variables and arcs representing the probabilistic influences between these variables. The probabilities that capture these influences (or dependencies) constitute the quantitative part of the network. The causal relationships in Bayesian belief networks allow the correlation between variables to be modeled and predictions to be made, even when direct evidence or observations are unavailable.

Unlike other methods that only yield point estimates (e.g., analytic hierarchy process), Bayesian belief networks provide probability distributions, which characterize uncertainty and thus lead to more informed decisions for variables that are multidimensional and difficult to measure. In addition, Bayesian belief networks have the ability to quickly perform assessments; following initial development of the model, subsequent implementations offer near-instantaneous results. Lastly, Bayesian belief networks can handle a wide variety of variables (e.g., qualitative, quantitative, discrete, continuous, etc.).

Such characteristics give Bayesian belief networks advantages over other decision analysis and support techniques in the analysis and quantification of performance indicators. In particular, these networks will offer the ability to assess the importance of impediments to technical adequacy via the use of quantitative sensitivity analyses performed on the variables that impact each performance indicator. Such indicators and sensitivities (i) foster understanding between success and failure while trying to achieve stakeholder objectives; (ii) maintain focus on issues significant to design objectives; (iii) assist in measuring the perception of various stakeholders towards the design approach; (iv) allow for early identification of technical deficiencies and relevant corrective actions; (v) help to focus and prioritize AHJ activities, and (vi) ultimately enhance the consistency, acceptability, and efficiency of the performance-based design review process.

2.6. Overall Research Objectives

The objectives set forth by this research effort are to address key challenges associated with the review and acceptance of performance-based design approaches to fire safety engineering through the development and implementation of a decision support framework that will assist AHJs and fire protection engineering practitioners in determining whether a given design approach is sufficient to support regulatory decision-making for a given application. The decision support framework is expected to consist of an evaluation tool that examines the performance-based design approach being applied and the conclusions and/or risk insights that the approach can produce. The result of the proposed decision support framework is a series of performance indicators that provides a measure of confidence in a design approach's ability to support a regulatory decision and identifies those aspects of the approach requiring further corrective action.

The principal objectives of the decision support framework are as follows:

(1) Establish a consistent and uniform method for establishing the technical quality and adequacy of performance-based design approach for a spectrum of potential applications and occupancies;

(2) Enhance confidence needed for stakeholders, including AHJs and fire protection engineering practitioners, to accept integration of performance-based design approaches into the regulatory decision-making process;

(3) Support the structure and development of detailed guidance on not only what should be considered in a performance-based design approach to fire safety engineering analysis but also how such an analysis should be conducted;

(4) Provide a forum and common language for the exchange of ideas and techniques for effective use of performance-based design approaches among stakeholders (e.g., AHJ, FPE engineers);

(5) Offer a means to identify, over time, areas of consistency or inconsistency in the treatment of issues important to understanding building performance and implementing performance-based design approaches;

(6) Aid in defining the state of the art in performance-based design approaches and identifying analytical and experimental research needs; and

(7) Promote the understanding that the level of analysis needed to support regulatory decision-making need not be fixed across all application but rather should be flexible with regard to scope, level of detail, occupancy-specificity, and realism.

While many efforts, including Alvarez [4] and Albrecht [14], have gone to great lengths to propose new paradigms and approaches to advance the state of performance-based design, such efforts have done little to address the challenge presented above. Namely, AHJs and fire protection engineering practitioners must decide whether the performance-based design approach being presented or applied is of sufficient technical quality and adequacy to support decision-making. If a decision-support tool can be developed to address this challenge, regardless of the approach or paradigm being applied, then perhaps the practice of fire safety engineering can be advanced for the better.

2.7. Proposed Decision Support Framework

The proposed framework will be formulated based on the research objectives identified above and seek to address the following:

(1) the spectrum of state-of-the-art, performance-based design approaches (i.e., from deterministic, scenario-driven to fully risk-based);

(2) fire-safety-design-specific attributes and characteristics;

(3) different scopes/applications of performance-based design; and

(4) relevant performance goals/metrics (e.g., life safety, property protection, etc.).

An overview of the proposed decision support framework is provided in Figure 1. In short, this framework evaluates the technical quality and adequacy of a performance-based design approach in three phases. First, a performance-based design approach is assessed against a series of technical requirements that define the scope and level of detail, occupancy-specificity, and realism necessary to support regulatory decision-making. Second, the way these technical requirements, being either met or not met, influences conclusions and/or risk insights with regard to stakeholder-established performance goals is established (i.e., using a Bayesian network approach). Lastly, considering the degree to which technical requirements are met and the relative impact of identified deficiencies, the framework then evaluates, through an assessment of technical quality, a performance-based design approach's ability to produce reliable and consistent conclusions and/or risk insights concerning stakeholder-established performance goals. Ultimately, the technical quality of a performance-based design approach is communicated to stakeholders via a series of quantitative performance indicators.

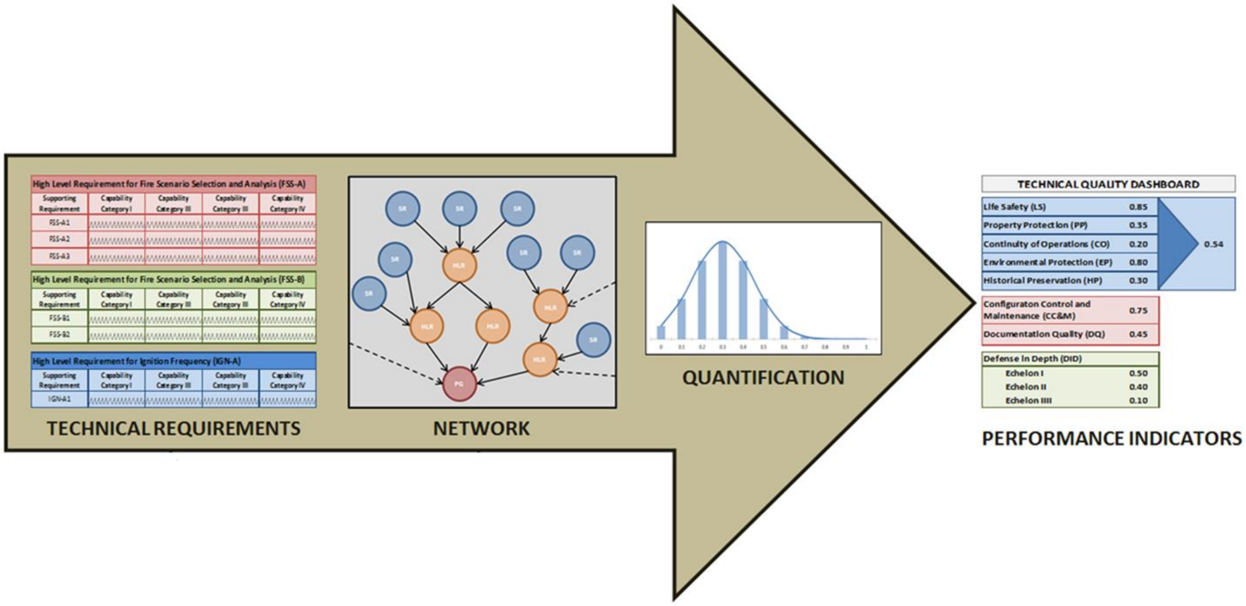

Figure 1: Overview of the Proposed Decision Support Framework

As argued by Alvarez, et al. [5], consideration should also be given to the separation of the technical analysis to be performed by fire protection engineers and the political (or policy) decisions to be made by stakeholders (e.g., the AHJ). Consequently, the decision support framework proposed herein is expected to make this delineation; however, it is important to note that despite this intent, technical adequacy cannot entirely be achieved without proper reflection on the political aspects of the design problem. For instance, stakeholder engagement is needed to aid selection of appropriate fire risk acceptance. To put it more clearly, while the framework questions and measures the ability of the design approach to produce the results upon which decisions are made (a technical matter), the overall acceptability of the end results (a public policy determination) is immaterial to technical quality and adequacy.

Also, note that performance-based design solutions are developed under the context of a regulatory framework. These frameworks can differ greatly in their processes and requirements and therefore have implications on the resulting performance-based design, including:

(1) Specification of fire safety goals and objectives;

(2) Degree to which performance-based design is prescribed;

(3) Selection and acceptability of:

a. analysis approaches (e.g., deterministic versus risk-based);

b. supporting analysis methods, processes and data; and

c. fire safety systems;

(4) Level of regulatory oversight, quality assurance and documentation; and

(5) Sufficiency of results (e.g., risk acceptance, degree of conservatism, etc.).

While the regulatory context is an important factor in performance-based fire safety design acceptance, the primary objective of this research is focused on the establishment of a proposed decision support framework and supporting tool to assess technical adequacy. As a result, the decision support framework will be largely generic and independent of a particular regulatory setting. If adopted within a specific regulatory environment, restrictions can be placed on the framework's use, or its design can be adapted appropriately.

2.8. Conclusion

As more and more countries work to develop new or improve existing performance-based building regulations, there will be greater emphasis placed on establishing a standardized means by which to assess and compare the technical adequacy of performance-based design approaches being applied to demonstrate desired building performance. Consequently, the goal of this research effort is to address those key challenges identified above with regard to the review and acceptability of such approaches to fire safety engineering. To do so, a hypothetical decision support framework is proposed that will assist stakeholders, including AHJs and fire protection engineering practitioners, in determining whether a particular design approach is sufficient to support regulatory decision-making for a given application. Using performance indicators, a measure of confidence in a design approach's ability to support a regulatory decision will be established. The result of this research effort will set out to achieve the principal objectives outlined in Section 2.6.

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3. DECISION SUPPORT FRAMEWORK FOR ASSESSING TECHNICAL ADEQUACY

3.1. Introduction

To address the research objectives outlined in Section 1 and the associated needs of the AHJ and FPE practitioners, a decision support framework that seeks to evaluate the technical adequacy of a performance-based design approach was proposed. This section aims to describe the conceptual underpinnings of this framework for each of its constituent elements. The first element is discussed in Section 3.2 and represents a set of technical requirements that may be used to assess technical adequacy of a fire safety analysis in a systematic manner. The second element is discussed in Section 3.3 and represents a network analysis that is performed to understand the underlying dependencies between technical requirements. The third and final element is reviewed in Section 3.4 and represents the quantification of the network, which leads to an understanding of how failure to meet one or more of the technical requirements impacts the ability of the fire safety analysis to assess desired fire safety objectives. These elements, when integrated, offer a means by which to address the research problem at hand. Integration of the elements is addressed in Section 4.

3.2. Technical Requirements for Fire Safety Analysis

Technical requirements are a set of performance statements that define the scope and level of detail that a fire safety analysis should be expected to achieve. They are meant to address all potentially relevant aspects of the analysis that can influence its technical adequacy and ultimately its sufficiency to support decision-making. Much like the performance-based design process establishes more nuanced functional requirements and performance criteria to evaluate whether a design meets defined objectives, technical requirements are further subdivided. Figure 2 describes the hierarchy of requirements applied to the development of a decision support framework proposed herein. Technical requirements are drafted to address a number of technical elements, each of which is broken up into a series of high-level and supporting requirements. As discussed in Section 3.3.1, technical requirements are best identified through a systemic process.

The concept of a technical requirement and its subsequent division is derived from the standard for probabilistic risk assessments developed by the American Society for Mechanical Engineers (ASME) and the American Nuclear Society (ANS) and used to support nuclear applications, including the assessment of fire risk [1]. Each echelon of the hierarchy shown in Figure 2 will be defined and discussed further in the sections that follow.

Note that at this point, these preliminary considerations are not intended to specifically identify all of the technical requirements that could constitute a technically acceptable design approach. Instead, they simply offer some insights into the higher-level objectives and attributes that will influence the development of the decision support framework for the proposed technical elements. Section 4, as supplemented by Appendices B through H, will demonstrate the identification of technical requirements and their subdivisions for a specific example.

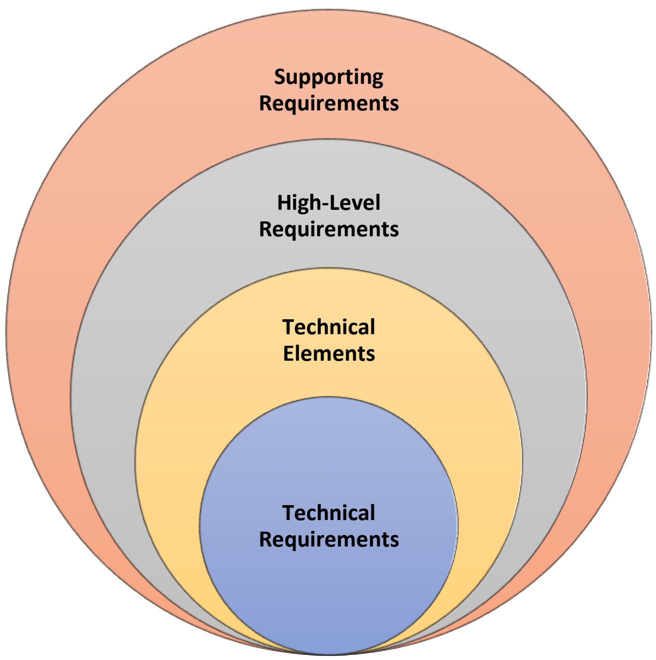

Figure 2: Hierarchy of Technical Requirements

3.2.1. Technical Elements

Technical requirements are expected to be organized into a series of technical elements, which compose the technical scope of a performance-based design approach. Below, Figure 3 provides one proposed set of technical elements to be examined in evaluating a risk-informed, performance-based design approach. For each technical element, it is proposed that a series of high-level requirements be developed that set forth the minimum requirements for a technically acceptable performance-based design approach, independent of a particular application.

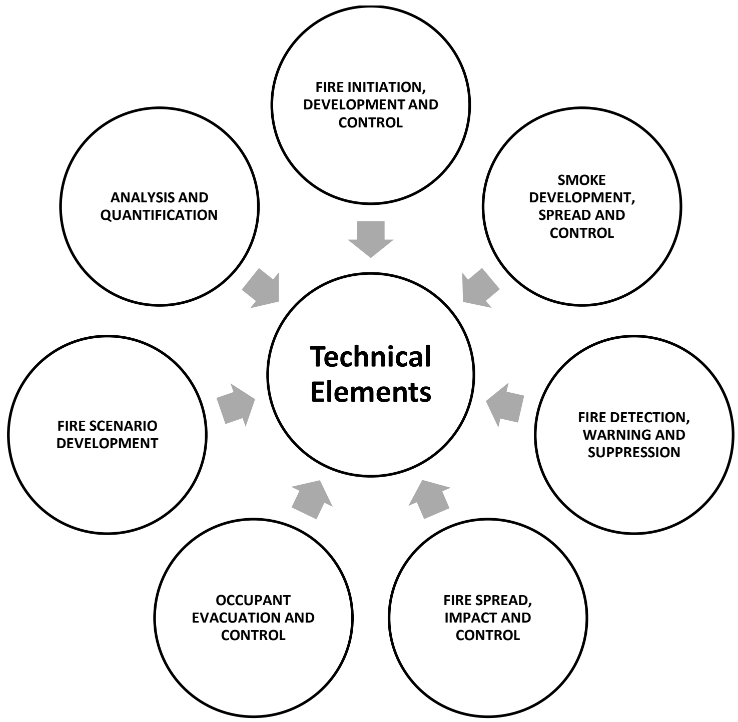

Figure 3: Proposed Technical Elements of a Risk-Informed, Performance-Based Approach

Note that depending on how technical requirements are organized into technical elements, there may be some characteristics of a technically acceptable performance-based design approach that span across multiple technical elements. Consequently, as the decision support framework is developed, consideration should be given as to whether such characteristics are best developed under separate technical elements or incorporated into existing elements as additional technical requirements (i.e., high-level or supporting requirements). Examples include validation and verification of methods, data analysis and characterization, and uncertainty and sensitivity analyses.

3.2.2. High-Level Requirements

For each technical element, it is proposed that a series of high-level requirements be developed that set forth the minimum requirements for a technically acceptable performance-based design approach, independent of a given application. The high-level requirements are to be defined in general terms and present the top-level logic for the derivation of more detailed supporting requirements. Table 1 below provides examples of the high-level requirements that might make up the technical elements of *Fire Initiation, Development and Control* and *Fire Detection, Warning and Suppression* listed in Figure 3.

Table 1: Examples of High-Level Requirements

High Level Requirements for Fire Initiation, Development and Control
Room of Origin Fire Development
Modified Fire Development
Flashover
Beyond Room of Origin Fire Development
High Level Requirements for Fire Detection, Warning and Suppression
Manual Notification System
Automatic Notification System
Manual Suppression and Control
Automatic Suppression and Control
Detection and Activation for Active Fire Barriers
Detection and Activation for Active Smoke Barriers
Detection and Activation for Smoke Control and Management

3.2.3. Supporting Requirements

Because the scope, level of detail and quality of a fire safety analysis is best assessed at a finer level of detail than high-level requirements can allow, each high-level requirement is subsequently divided into a series of support requirements. At the level of supporting requirements, explicit performance requirements upon which fire safety analyses are based can be made. For example, the high-level requirement for *Automatic Suppression and Control* identified in Table 1 can be sub-divided into a series of supporting requirements that address the timing of system actuation, the system's reliability and availability system effectiveness, to name a few.

3.2.4. Capability Categories

As discussed above, the proposed framework is intended to apply to a wide range of applications performance-based design that require a corresponding range of technical capabilities. Applications of the framework may vary with respect to the fire safety objectives employed, the decision criteria used, the reliance on the analysis's conclusions and risk results in supporting a decision, and the degree of analysis required to support the decision. In developing the different portions of the design approach, it is recognized that not every aspect of the approach, for example, the occupant egress model, will be or need be developed to the same degree of detail, occupancy-specificity, or realism.

Although the range of technical capabilities required for each portion of a performance-based design approach is expected to fall on a continuum, discrete capability levels can be defined, so that the supporting requirements that fall under each high-level requirement can be developed, presented, and assessed in a manageable way. These capability categories are expected to be defined considering three basic attributes: scope and level of detail, occupancy-specificity, and realism.

Table 2, below, provides an example of one potential supporting requirement that may fall under a high-level requirement associated with the unavailability of fire protection systems. As the capability category increases, so too does the scope and level of detail, occupancy-specificity, and realism of the modeling. An analogous treatment can be applied to specify other supporting requirements, such as those associated with occupant egress. In this case, the capability categories associated with a parameter such as walking speed may vary depending on the level of analysis performed to address various factors, e.g., walking types (e.g., free or exit movement), walking conditions (e.g., low, optimum, moderate, severe, etc.), occupancy factors (e.g., high-rise apartment, public venue, etc.), occupant type (e.g., adult, child, elderly, etc.), and so forth.

The intent of the delineation of the capability categories within the supporting requirements is generally that the degree of scope and level of detail, the degree of occupancy-specificity, and the degree of realism would increase across the discrete capability levels defined. However, the capability categories are not intended to be based on the level of conservatism associated with a given aspect of the analysis. The level of conservatism (i.e., the tendency to overestimate risk due to simplifications in the design approach) may decrease as the capability category increases and as more detail and realism are introduced into the analysis. However, this is not expected to be true for all supporting requirements and should not be assumed. Specific examples where a lower capability category may be less conservative could include those potential requirements associated with the treatment of fire-induced impacts on building systems. As the capability category increases, the depth of the analysis required may also increase. Hence, for a system that is analyzed with fewer considerations of secondary and tertiary failures, such as would be proposed for a lower capability category, increasing the depth of the analysis, in this case for higher capability categories, would potentially identify additional system failures that could increase risk. Thus, the lower capability category would yield a lower (less conservative) estimated risk. Realism, however, is expected to always increase with increasing capability category.

Table 2: Example of Supporting Requirement Capability Categories

Supporting Requirement	**Capability Category I**	**Capability Category III**	**Capability Category III**	**Capability Category IV**
Unavailability of Suppression Systems	In crediting fire suppression systems, USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards, and (b) the credited system is in a fully operable state.	In crediting fire suppression systems, USE generic estimates of total system unavailability provided that a) the credited system is installed and maintained in accordance with applicable codes and standards b) the credited system is in a fully operable state, and c) the system has not experienced outlier behavior relative to system unavailability.	In crediting fire suppression systems, USE occupancy-specific information, where available, to quantify total unavailability factors.	In crediting fire suppression systems, PERFORM a system-specific reliability assessment, and USE occupancy-specific information, where available, to quantify total unavailability factors.

The boundaries between these capability categories are expected to only be defined in a general sense. When a comparison is made between the capabilities of any given design approach and the supporting requirements of this decision support framework, it is expected that the capabilities assigned to a design approach’s technical elements or portions of the design approach within each of the technical elements will not necessarily all fall within the same capability category, but rather will be distributed among all defined capability categories. For instance, there may be technical elements, or portions of the design approach within the technical elements, that fail to meet the supporting requirements for any of the defined capability categories. While all portions of the design approach need not have the same capability, the design approach should be coherent. The supporting requirements are thus expected to be written so that, within a capability category, the interfaces between portions of the decision support framework are coherent (e.g., requirements for fire scenario event trees are consistent with the definition of proposed fire ignition events).

For each defined capability category, the supporting requirements are expected to define the minimum requirements necessary to meet that capability category. Some supporting requirements may only apply to a single capability category, and some may extend across multiple capability categories. When a supporting requirement spans multiple capability categories, it would apply equally to each capability category. When necessary, the differentiation between capability categories should be made in other associated supporting requirements.

In assessing a performance-based design approach, the determination as to which capability categories should be applied is to be made based on stakeholder input and the performance-based design itself. Considerations given to the performance-based design include the scope of the design, its characteristics, occupancy type, etc. In some cases, supporting requirements may be deemed inapplicable to a particular design. For instance, supporting requirements associated with smoke control systems will not apply if the design does not call for such systems. Stakeholder input requires consideration of performance goals (e.g., life safety, property protection, etc.) and their overall importance to the acceptance of a design. For instance, addressing life safety is deemed to be of higher significance for a hospital than for an unoccupied storage facility. In such a case, supporting requirements that ultimately influence life safety would generally need to be assessed at higher capability categories for a hospital than for a storage facility, which would most likely place a greater emphasis on property protection.

At this time, it is anticipated that a combination of stakeholder input and design characteristics will be used to group occupancies into performance groups, similar to performance-based codes to date. Performance groups, in essence, will require that the performance-based design be assessed against a specific capability category for supporting requirements that influence each relevant performance goal (e.g., life safety, property protection, etc.). The alternative, of course, would be to apply the capability categories as a mere taxonomy to communication to stakeholders the general scope and level of detail of a fire safety analysis that is being used to justify a fire safety system relative to a specific fire safety objective.

Furthermore, it is worth clarifying that the proposed decision support framework is intended to be developed consistent with the philosophy of performance-based design itself. Namely, technical requirements should reflect not only the diversity of methods (or techniques) that have been used to develop existing performance-based designs, but also the need to accommodate future technological innovations. The intent of the decision support framework is not to endorse any particular methods but rather to assess their adequacy relative to the design approach and the results being used to support the regulatory decision-making process. That is, a distinction should be made between methods and the technical requirements that demonstrate quality and adequacy. For example, while the determination of whether a method (e.g., a smoke detector activation model) is technically justified (e.g., used with its verified and validated range of applicability) is relevant to the technical quality and adequacy of a particular design approach, the choice of one method over another is immaterial. Another example in which method selection may influence technical quality and adequacy relates to considerations related to uncertainty, particularly with regard to epistemic uncertainty.

3.2.5. Analysis Spectrum

Up until this point, technical requirements have been discussed independent of the approach or methods of analysis used to support assessment of a fire safety system. As discussed in Section 1.2.9 of International Fire Engineering Guidelines [2], fire safety analyses may comparative or absolute. A comparative approach aims to determine whether the performance-based solution is equivalent to (or better than) a deemed-to-satisfy or prescriptive design. In an absolute approach, the results of the analysis of the fire safety design are matched, using the agreed acceptance criteria, against the objectives or performance requirements without comparison to deemed-to-satisfy or prescriptive design. Additionally, either approach may be quantitative, or in limited cases, qualitative in nature. In any of these cases, the proposed decision support framework would address such considerations with various supporting requirements under the high-level requirement of *Analysis and Quantification*, as posited in Figure 3. However, there is another, more distinguishing factor amongst analysis approaches that requires greater consideration, and that is the choice of the overall performance-based design approach.

Performance-based approaches are best characterized as a spectrum with one end representative of a purely deterministic approach and the other of an entirely risk-based approach. Regarding deterministic methods, the International Fire Engineering Guidelines [2] states that:

> "[They] are based on physical relationships derived from scientific theories and empirical results. Characteristically, for a given set of initial boundary conditions, a deterministic methodology will always produce the same outcome. They do not, however, indicate the probability of that outcome being realized."

In terms of the identification of fire scenarios, only a handful of scenarios are typically analyzed, and they are chosen in consideration of the fire safety system, engineering judgement, fire statistics, literature and the like. Generally, the general types of scenarios to be considered are codified [e.g., 3-6]. Lastly, sensitivity and redundancy studies are often performed to evaluate the importance of or reliance on fire protection features, analysis assumptions, and parameter estimates. Through these studies, changes to the fire safety system may be proposed if upon analysis, the analysis does not yield results with sufficient margin above desired acceptance criteria.

Regarding risk-based methods and their use, the International Fire Engineering Guidelines [2] states that:

> "These methods generally assign reliabilities to the performance of the various fire protection measures and assign frequencies of occurrence of events. They may analyze and combine several different scenarios as part of a complete fire engineering evaluation of a building design. This use of multiple scenarios and their combination through probabilistic techniques is the key feature of some of the methods."

One example of a risk-based approach is the application of methods developed for and applied within the nuclear industry [e.g., 6-15]. In such an approach, the distributions of fire frequencies are developed for each significant ignition source in the plant, and fire modeling tools (e.g., computational fluid dynamics and zone-based modeling) and probabilistic techniques (e.g., event trees and fault trees) are applied to address all significant events (e.g., spread, flashover, suppression, etc.) for modeled fire scenarios, which may number in the 1000s.

In between deterministic and risk-based methods, one finds a broader category of approaches referred to as risk-informed approaches. Typically, such an approach is largely deterministic, but probabilistic methods (e.g., event trees) typical of risk-based approaches are used to weight scenarios by frequency or consequence. This probabilistic weighting assists analysts with identifying and understanding which fire scenarios contribute most to overall risk.

With regard to the proposed decision support framework, capability categories defined to assess supporting requirements could differ quite drastically across the above taxonomy of overall performance-based design approaches. That is, the underlying performance requirements needed to specify a range of scope, level of detail, occupancy-specificity, and realism for a deterministic approach would not be the same as those applied to a risk-based approach. As a result, it is proposed that an alternate set of capability categories be developed for each type of approach: deterministic, risk-informed and risk-based.

3.2.6. Summary of Technical Requirements

In short, technical requirements are defined as a series of hierarchical sub-requirements or categories, including technical elements, high-level requirements and supporting requirements. Then, specific performance statements for each supporting requirement are specified according the overall performance-based analysis approach applied (i.e., deterministic, risk-informed, or risk-based) as well as in consideration of the scope, level of detail, occupancy-specificity, and realism desired. While discrete capability levels better ensure supporting requirements that fall under each high-level requirement are developed, presented, and assessed in a more manageable way, defining discrete capability categories also facilitates the development of consistent and uniform quantitative performance indicators that may then be evaluated for each performance goal based on the degree to which related technical requirements are met and the influence that each requirement has on the results being used to support the regulatory decision-making process.

3.3. Fire Safety Network Analysis

While a set of technical requirements can theoretically be applied and assessed one-by-one, the framework must expand beyond individual technical requirements to address how each requirement, or particularly the extent to which each requirement is met or not met, impacts the overall technical quality of a fire safety analysis as well as decisions regarding performance objectives overall (e.g., life safety). A network-based approach, or more specifically a Bayesian network, is proposed to understand the relationship between technical requirements and performance goals (or fire safety objectives).

3.3.1. Identification of and Dependencies between Technical Requirements

At the highest level, all technical requirements are related by their respective fire safety objectives. More specifically, technical requirements may have phenomenological, analytical or process dependencies. For instance, the heat release rate of a fire impacts the degree of entrainment, which, progressively, affects the smoke layer height, the egress of occupants, and ultimately life safety if tenability criteria are exceeded. However, to ensure completeness, such technical requirements and their interrelationships should be identified through a systematic process.

As referenced earlier, there are several examples in which a systems-based approach has been implemented to understand the interrelation of fire safety features and their effect on achieving specific fire safety goals and objectives. Such efforts have included the use of an analytical hierarchy process [16-19] or a concept tree [20]. Additionally, the International Fire Engineering Guidelines [2] performs a system-based approach to understand the general dependencies between technical elements of a fire safety analysis. In doing so, the fire safety analysis was divided into a series of sub-systems, as indicated in Figure 4. Then, a series of elements (e.g., scope, procedures, phenomena, inputs, outputs, analysis techniques, etc.) were identified and interconnected through a simplified logic diagram, an example of which is provided in Figure 5 for Sub-System A of Figure 4. In this diagram, outputs from one sub-system serves as inputs to others. For instance, Sub-System A outputs related to fire characteristics, such as the fire heat release rate profile, serve as inputs to Sub-System B to support the analysis of smoke development.

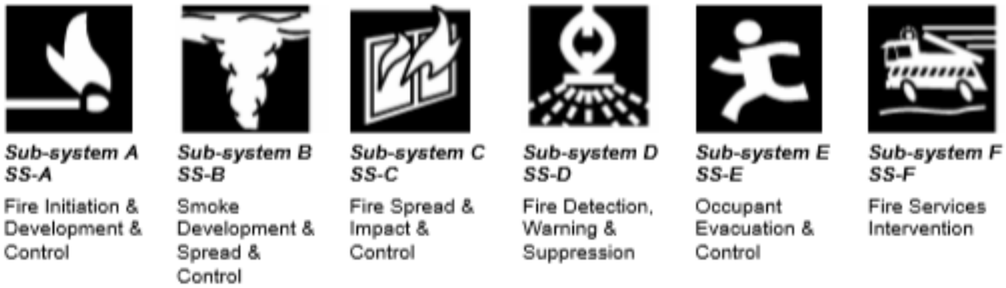

Figure 4: Fire Safety Sub-Systems [2]

In any building, there are many characteristics or features that combine to create an overall fire safety system. To assist in the analysis of a fire safety system, it is convenient to consider it as comprising of sub-systems. Thus, owing to its systematic nature and level of detail, the systems-based approach employed within the International Fire Engineering Guidelines [2] will be employed as a template for the decision support framework proposed herein. Appendix H expands upon this concept further and documents the construction of the fire safety network analysis used to support the case study summarized in Section 4.

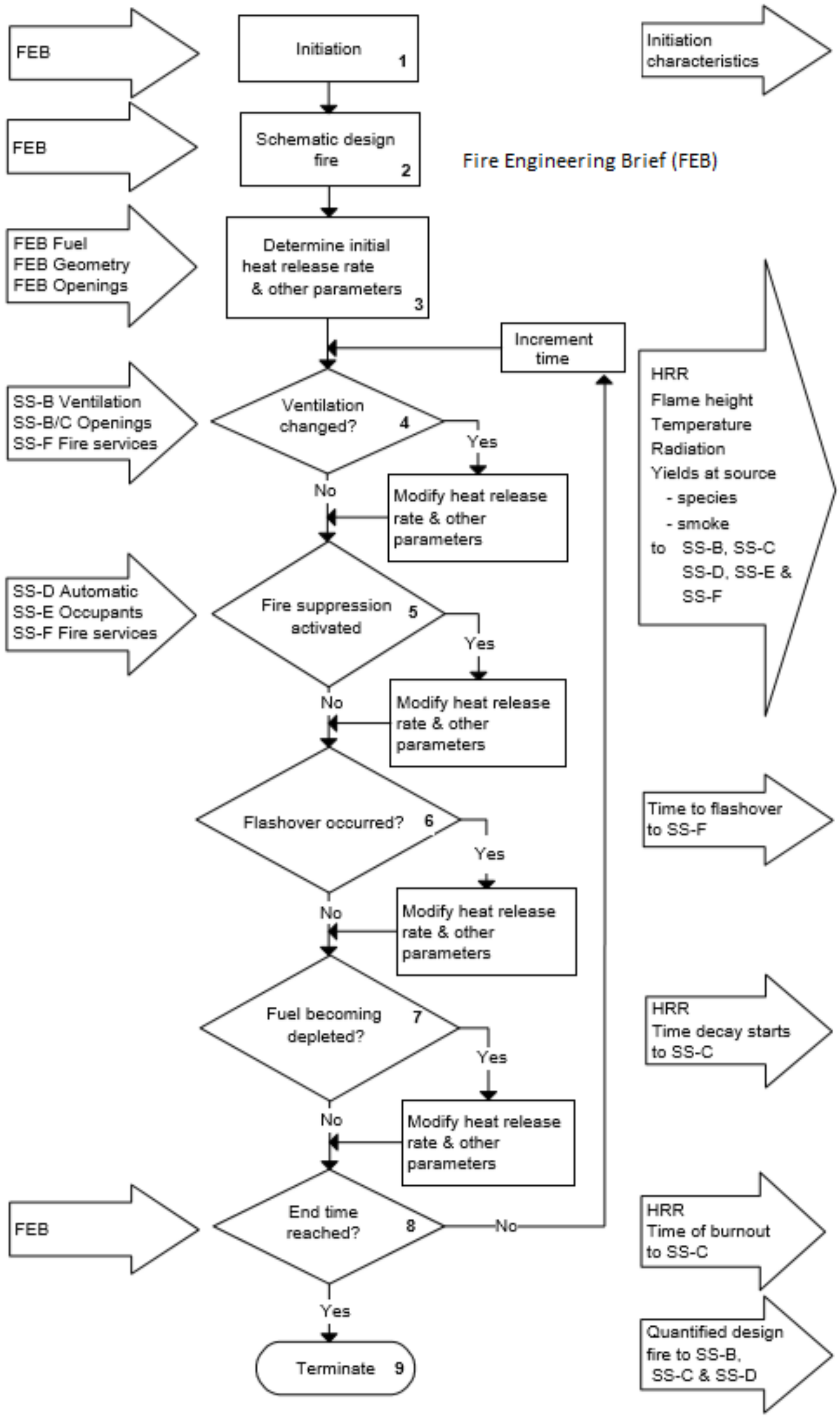

Figure 5: Fire Safety Sub-System Logic Diagram [2]

3.3.2. Implementation of the Fire Safety Network

Based on a systems-based approach, technical requirements for each aspect of the fire safety analysis can be related. This relationship, though, is made at the supporting requirement level. For instance, if one were to posit a high-level requirement associated with fire development within the room of origin, then there would naturally be a supporting requirement associated with the fire's size or heat release rate (HRR). If the impact of fire development within the room of origin on the timing of automatic detection needed to be understood, then additional supporting requirements would be needed. Based on a systems-based approach, the fire size influences the smoke yield (i.e., concentration) and smoke production (i.e., entrainment) within the room of origin. The smoke production, in turn, influences the smoke layer height. A combination of the smoke layer height and concentration affects the optical density within the room of origin, and this ultimately influences the time to automatic fire detection for an ionization-type detector.

As a result, from this simplified scenario, the following high-level and supporting requirements (HLRs and SRs) can be identified:

- HLR: Room of Origin Fire Development
    - SR: Fire Size/HRR
    - SR: Smoke Yield (Concentration)
- HLR: Room of Origin Smoke Development
    - SR: Smoke Production (Entrainment)
    - SR: Optical Density
- HLR: Automatic Suppression and Control
    - SR: Timing of Automatic Detection

In this example, the interrelationships are clear. In terms of network development, the supporting requirements represent the nodes within the network, and dependencies between the supporting requirements represent the connections (or edges) between the nodes. This example could even be expanded further. For instance, the time of fire detection triggers both potential fire suppression systems (if present) and the initiation of occupant egress. Smoke and fire conditions, modified by fire safety and protection features or not, will then dictate, relative to egress timing, whether untenable conditions are attained.

Moving beyond this simple example, the number of supporting requirements needed to explain a performance goal, such as life safety, and the connections between them can be quite large. Additionally, it should be noted that there are other factors that are needed to explain the extent to which a supporting requirement is met. Returning to the above example, fire size within the room of origin is dependent upon on a number of other factors, including ignition characteristics, building characteristics, fuel and loading characteristics, ventilation conditions, and fire growth and flame spread. In the proposed decision support framework, these additional factors are called influencing factors. Note that in some cases, the influencing factors may be not simple factors but other supporting requirements, which are explained by their own set of influencing factors. Figure 6 below summarizes the dependencies between the different node types within the proposed network.

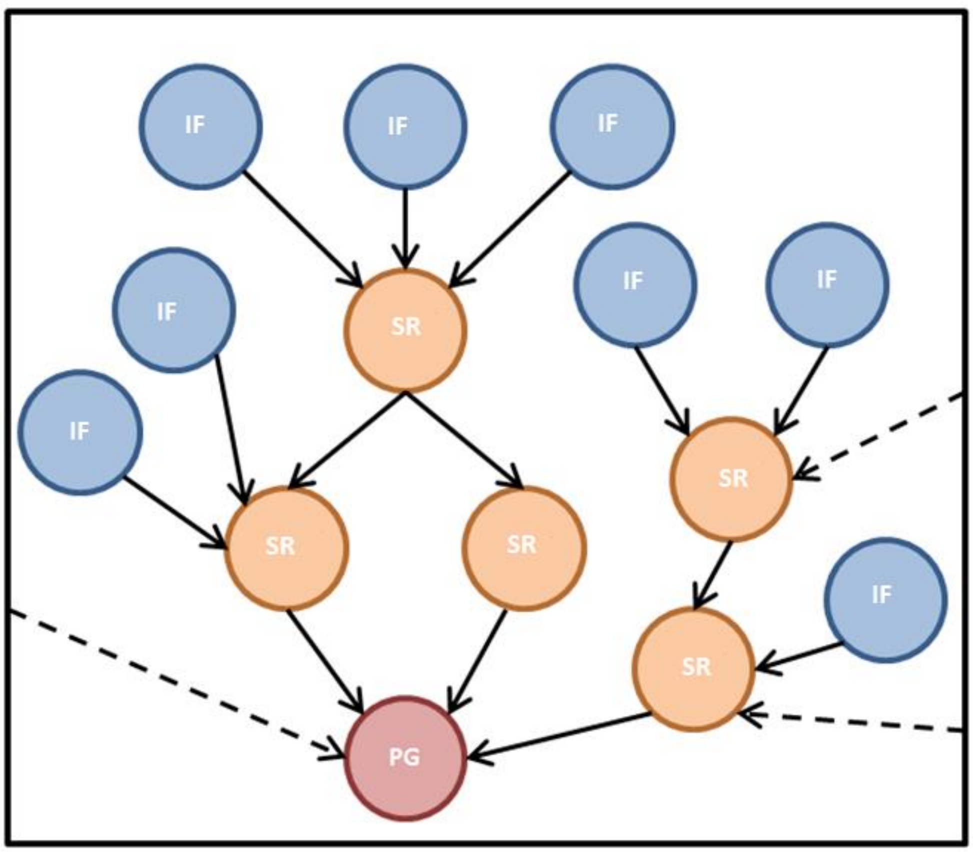

Figure 6: Dependencies between Influencing Factors (IF), Supporting Requirements (SR) and Performance Goals (PG)

Given that the goal is to evaluate the quality of the fire safety analysis, influencing factors need not be physical (e.g., building characteristics, occupant characteristics) or phenomenological (e.g., ignition characteristics). Rather, they may also be analytical (i.e., related to the fire safety analysis itself). For instance, they may represent the degree to which uncertainty in parameter or method selection is addressed or the extent to which models used to predict phenomena have been verified and validated.

Note that the resulting performance indicator for the fire safety network is based upon the fire safety objective of interest. For instance, if the fire safety objective is related to life safety, then the performance indicator that all supporting requirements and influencing factors would inform would be a measure of confidence in a fire safety analysis's ability to support a decision, regulatory or otherwise, related to life safety. Should additional indicators be considered (e.g., property protection), additional networks would need to be developed, but it is noted that much of the underlying structure, particularly regarding fire development, would be consistent.

3.3.3. Summary of the Fire Safety Network

The systems-based approach provides a systematic means by which to identify and characterize technical requirements. Once developed, the network can be applied to understand, at least qualitatively, how the quality of one aspect of the analysis impacts that of another. Additionally, if a technical requirement is not met or is deficient, it can be understood how this deficiency could potentially propagate through the network and influence performance objectives. Though, to fully make use of the network, additional work is required to develop a process of characterizing nodes individually and in a standardized manner (i.e., quantitatively using a scale that represents technical quality). Also, a method is needed to reliably and efficiently determine how each technical requirement, or more specifically a deficiency therein, impacts performance. This work is further discussed below in Section 3.4.

3.4. Quantitative Assessment of Technical Quality

As described above, the nodes within the proposed fire safety network are representative of supporting requirements and their associated influencing factors. When a supporting requirement is not met for a given capability category, it is the result of a deficiency within the fire safety analysis. Such deficiencies manifest amongst the influencing factors associated with the affected supporting requirement. That is, the technical quality of a supporting requirement is dictated by the quality of its influencing factors. For instance, deficiencies associated with the fire size or heat release rate in the room of origin is a function of its influencing factors, e.g., fuel and fuel loading characteristics, ventilation conditions, etc., and if a deficiency exists, it would be associated with and assessed against one or more of these underlying influencing factors. The goal of any quantitative method for assessing technical quality of a fire safety analysis would, therefore, include:

(1) Translating qualitative evaluations of technical requirements, or more precisely network nodes, into an assessment of technical quality on a common quantitative scale;
(2) Reflecting the relationships between nodes and assessing their degree of influence on each other; and
(3) Propagating the assessments of individual nodes to address the overall impact on defined performance goals.

3.4.1. Assessment Approaches and Tools

As described in Section 2.5, there are a number of potentially viable network analysis techniques; however, Bayesian belief networks offer advantages over other decision analysis and support techniques in their ability to (i) define the explicit relationships between nodes; (ii) efficiently assess the degree of influence between nodes; and (iii) analyze and quantify performance indicators. The following sections describe the theoretical basis and implementation issues associated with Bayesian networks.

3.4.1.1. Bayesian Networks

A Bayesian network is a probabilistic graphical model that represents a set of random variables as nodes and the causal or influential relationships between variables via directed arcs or edges [20]. Additionally, as explained by Fenton, et al. [21],

> "The conditional independence assertions about the variables, represented by the lack of arcs, reduce significantly the complexity of inference and allow the underlying joint probability distribution to be decomposed as a product of local conditional probability distributions (CPDs) associated with each node and its respective parents. If the variables are discrete, the CPDs can be represented as Node Probability Tables (NPTs), which list

the probability that the child node takes on each of its different values for each combination of values of its parents. Since a BN encodes all relevant qualitative and quantitative information contained in a full probability model, it is an excellent tool for many types of probabilistic inference where [one] need[s] to compute the posterior probability distribution of some variables of interest (unknown parameters and unobserved data) conditioned on some other variables that have been observed."

In the case of the proposed decision support framework, the observed variables are the various influencing factors associated with each supporting requirement. In each case, value judgements regarding the level of technical quality at which each influencing factor has been addressed are made, and the network is solved to arrive at an estimate of the technical quality associated with overall performance goals, e.g., life safety. While constructing a network of interrelated nodes is straightforward, informing the local condition probability distributions, or node probability tables in the case of discrete variables, for all combinations of nodes is time-consuming, potentially prone to error, and based on the objectives of this research, not practical. To address this challenge, additional techniques, as discussed in Section 3.4.1.2, must be applied.

3.4.1.2. Ranked Nodes and Weighting Functions

To overcome the implementation issues associated with informing conditional probabilities associated with a Bayesian network, a combination of ranked nodes and weighting functions can be employed. Ranked nodes, as described by Fenton, et al. [21-25], can be defined on an underlying unit interval scale (from 0 to 1). Along this scale, divisions are made to form a set of discrete and equal intervals to which qualitative assessments (e.g., low, medium, and high) can be attributed. Thus, using ranked nodes, quality states associated with network influencing factors may be assessed both qualitatively, i.e., at a given interval, and quantitatively, using a doubly truncated Normal distribution along a unit interval scale.

In lieu of eliciting stakeholders to assess a series of conditional probabilities, the proposed approach makes use of weighting functions, which only require elicitation of the relative weight that each parent node has on a child node. Depending on the application, various forms of these weighting functions may be used to propagate evidence through the network. Appendix A explores the overall approach in more detail as well as its general equivalency to more standard techniques for informing the quantitative aspects of a Bayesian network, i.e., direct elicitation of node probability tables. Section 3.4.2.2 clarifies that the type of weighting function applied to the proposed framework.

3.4.2. Assessment of Technical Quality

As described in 2.4.3, technical quality consists of providing the following two assurances:

- the fire safety analysis has been performed in a technically correct manner, and
- the assumptions and approximations used in developing the fire safety analysis are appropriate.

With these considerations in mind, a process by which to assess technical quality at the nodal level and propagate such beliefs through the fire safety network must be defined, and such is discussed in the sections that follow.

3.4.2.1. Nodal Analysis of Technical Quality

As clarified in 3.4.1.2 and Appendix A, ranked nodes provide an adequate characterization scheme for assessing the degree of technical quality achieved for influencing factor relevant to the fire safety analysis. In general, technical quality will be assessed along a five-point scale, and as a result, each node that represents a specific influencing factor can take one of five states. These states as well as their numerical equivalent along the underlying unit interval scale are shown in Table 3.

Table 3: Quality States

Quality Ratings	Numerical Equivalent
Low	0.0 (0%)
Low-Medium	0.25 (25%)
Medium	0.5 (50%)
Medium-High	0.75 (75%)
High	1.0 (100%)

However, guidance must be provided to AHJ representatives and fire protection engineering practitioners on what constitutes a low level of quality versus, say, a higher one. To do so, it is proposed that performance statements are provided to guide the user of the decision support framework regarding what constitutes low, medium and high degrees of quality for each influencing factor. Given that influencing factors represent such a broad set of analysis characteristics, including fire phenomena, uncertainty modeling, model verification and validation, a single definition of what constitutes a particular level of quality is not satisfactory. As a result, a set of quality definitions is proposed for each type of influencing factor. The types of influencing factors proposed will include, at a minimum:

- Fire characteristics
- Smoke characteristics
- Building characteristics
- Fire protection system characteristics
- Occupant characteristics
- Method verification and validation
- Modeling uncertainty
- Parametric uncertainty

Other scales may be defined as needed by the scope of the proposed decision support framework. Two examples of such scales are provided in Table 4. Note that "Low-Medium" and "Medium-High" states are chosen if the quality were to fall between the defined categories.

Table 4: Examples of Quality Scales

Fire Characteristics		
LOW	**MEDIUM**	**HIGH**
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.

Method Verification and Validation		
LOW	**MEDIUM**	**HIGH**
Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.

In addition to eliciting a measure of technical quality from the user, a degree of belief is also obtained. The uncertainty associated with a value judgement is not only a function of the assessor's state of knowledge but also is highly influenced with the level of documentation associated with the fire safety system and analysis. Based on the selection of a doubly truncated Normal distribution, as detailed in Appendix A, the parameter of interest regarding uncertainty is the variance, or σ^2.

Table 5 shows the ratings developed for the proposed framework and provides their qualitative and quantitative interpretations. As the variance increases, the distribution associated with the associated node becomes wider and flatter. Figure 7 demonstrates this concept for a generic node with an observed value of *Medium* (i.e., a mean of 0.5 on the unit interval scale).

Table 5: Uncertainty Ratings

Uncertainty Ratings	σ^2	Description
None	0.00	The quality at which the influencing factor is addressed can be completely substantiated by a well-documented basis for the parameters or methods of interest. No engineering judgement is needed.
Low	0.04	↕
Low-Medium	0.09	
Medium	0.16	The quality at which the influencing factor is addressed is equally supported a documented basis and engineering judgement.
Medium-High	0.27	↕
High	0.45	
Complete	8.0	The quality at which the influencing factor is addressed cannot be determined by engineering judgement, and there is no documented basis for the parameters or methods of interest.

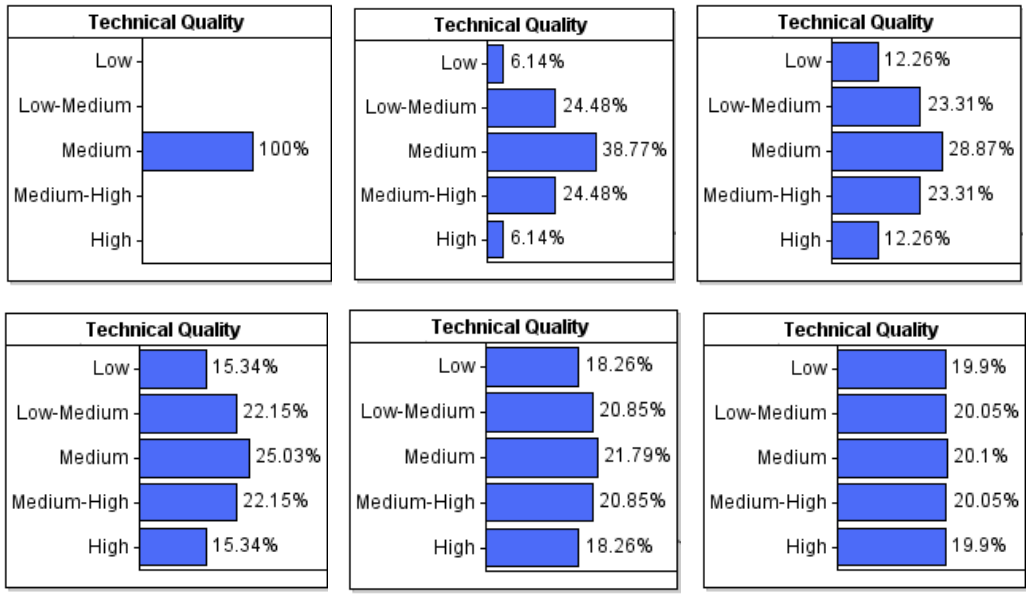

Figure 7: Characterization of Nodal Uncertainty

Note that the similar quality scales can be developed for each performance indicator (e.g., life safety); however, because this final child node is informed by its parents and not by the user, then a generic five-point scale serves as sufficient insight for the user. Uncertainty ratings for parent nodes would equally apply to the performance indicator.

3.4.2.2. Nodal Influence and Weighting

With nodes characterized, their degree of influence on each other must be systematically characterized. As highlighted in Section 3.4.1.2 and further explained in Appendix A, this can be done through use of a weighting function. The function applied for assessing technical quality of child nodes within the proposed framework is the weighted minimum function, which is mathematically represented as follows:

$$WMIN = \min_{i=1..n}\left[\frac{w_i X_i + \sum_{i \neq j}^{n} X_j}{w_i + (n-1)}\right]$$

Where w_i represents the influence weight of a parent node, X_i is the state value of the parent node, and n is the number of parent nodes [21].

The WMIN function can be viewed as a generalized version of a normal minimum function, MIN. If all of the weights are large, then WMIN is close to MIN. At the other extreme, if all the weights are equal to 1, then WMIN is simply the average of the parent nodal variables, AVERAGE. Mixing the magnitude of the nodal influence weights gives a result between a MIN and an AVERAGE. Note that for these reasons, there are additional considerations beyond the degree of influence. The base influence weights for the proposed decision support framework are defined in Table 6.

Table 6: Influence Weights for Influencing Factors

Degree of Influence	Weight
N/A	0
Low	1
Low-Medium	3
Medium	5
Medium-High	7
High	10

Fenton, et al. [21, 26] explored the WMIN function as well as several other types of weighting functions that could be used to model qualitative value judgments in Bayesian networks. The examination established general rules of practice for applying such functions, referencing studies in which they were applied. A review of these general rules and referenced studies [22-24, 27-28] informed the selection of the WMIN function as being the most applicable to the current application. In evaluation of technical quality, the result is most often reflective of the parent with the lowest quality. For instance, a fire model can incorporate the best quality and most applicable data available; however, if the method applied has not been verified and validated for the intended use, the factors predicted by the fire model would be of low quality. On the other hand, the use of a method that has been fully verified and validated may somewhat compensate for the use of lower quality data. In such a case, verification and validation of the method would be said to have a slightly greater influence on the quality (or weight) than the inputs to the model. This generic example is exemplified in Table 7, where different assumptions regarding the states of the parent nodes are evaluated to show their impact on the child. It is important to note from this example that use of a weighting function that represents an average parent node states cannot achieve such results and can arbitrarily distort the child nodal quality should there be more higher quality influencing factors defined than lower quality ones. Similar applications of the WMIN function can be found in assessing quality of software and associated testing [21-22].

Table 7: Demonstration of WMIN Function

IF…	Assumption 1	Assumption 2	Assumption 3	Assumption 4
Parent Node 1 (Lower Weight)	High	Low	Low	High
Parent Node 2 (Higher Weight)	High	Low	High	Low
THEN… Child Node	Heavily skews High	Heavily skews Low	Centered toward Low-Medium	Centered toward Low

Lastly, influence weights, unlike nodal quality and uncertainty assessments, are not to be entered by the user. Instead, they are to be pre-defined considering a number of analytical, phenomenological, and occupancy-specific factors, including those shown in Table 8. That is, the user would only be expected to identify broad characteristics associated with the building of interest and the appropriate weights would be defaulted into the decision support framework. Thus, the overall concept established by this decision support framework allows for weights to be preselected based on a limited subset of fixed characteristics that are outside of the user's subjective judgement. As a result, insights provided by the model will be more consistent across users and reflective of inherent risk factors associated with the occupancy being assessed.

For instance, the quality at which egress timing (i.e., the child node) is addressed within a given fire safety analysis is a function of how each different phase of egress (i.e., the parent nodes) is addressed (i.e., detection, cue recognition, the initiation of movement, and the completion of movement). However, at a very general level, only limited information about the type of occupancy (e.g., office building or hospital) and building characteristics (e.g., size, number of floors, etc.) is needed to inform the relative influence of child nodes on the parent. Such an approach has been proposed in similar efforts to gage the relative importance of fire safety attributes [16-18].

To conclude, network weights should be informed by stakeholders and domain experts for individual occupancies and risk factors. Then, the defined weights should be benchmarked across a suite of different occupancies and adjusted accordingly to ensure that the weights assigned to the different occupancies and risk factors are consistent relative to each other.

Table 8: Influence Weight Factors

Factor	Example Characteristics
Fire Dynamics and Characteristics	Ignition characteristics, fire load and density, fire growth rate, etc.
Analysis Characteristics	Deterministic, risk-informed or risk-based Availability of Data
Occupancy Characteristics	Use, functions, contents, lighting, environment, etc.
Methods and Models	Availability of verified and validated methods
Building Characteristics	Room geometry, number of exits, square footage, number of floors, compartmentation, etc.
Credited Fire Safety System	Manual/automatic detection and suppression systems, smoke control and management systems, active/passive barriers for fire and smoke, etc.
Occupant Characteristics	Age, mobility, cognition, ability, walking speed, etc.

3.4.3. Importance Metric

A natural result of the proposed decision support framework is one or more performance indicators that provide a measure of confidence in a fire safety analysis's ability to support decisions and identify those aspects of the approach requiring further corrective action. However, one additional benefit of the proposed framework is its capability to assess the importance of identified deficiencies that underlie any reduced quality ratings. That is, once all nodes within the fire safety network are characterized, the network can be re-quantified in an iterative fashion, hypothetically resolving each deficiency independently. A measure of the importance for a given deficiency would then be the relative or absolute difference between the baseline performance indicator result and the one with the deficiency resolved. An alternative importance metric would involve quantifying the network with only a single deficiency present at a time. The cross-comparison amongst the resulting performance indicators would allow a ranking of deficiencies to occur. Lastly, deficiencies can also be analyzed as a group (e.g., all those related to building characteristics) to provide additional insights.

3.5. Conclusion

To address the research objectives outlined in Section 2.6 and the associated needs of the AHJ and fire protection engineering practitioners, a decision support framework that seeks to evaluate the technical adequacy of a performance-based design approach was proposed. The concept of technical requirements was explored as a means to assess the scope and level of detailed associated with a fire safety analysis in a systematic manner. Then, a network analysis approach was outlined in which the extent to which technical requirements are met can be quantified as one indication of technical quality using defined influencing factors. Additionally, methods were explored that propagated the findings on individual technical requirements to inform an assessment as to the overall quality of the fire safety analysis relative to high-level performance indicators (e.g., life safety). This overall approach is tested as part of a case study referenced in Section 4.

3.6. References

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4. DEMONSTRATION OF PROPOSED FRAMEWORK

The decision support framework proposed in Section 2 and formally specified in Section 3 is a worthwhile thought exercise; however, in its conceptual form, the framework offers no tangible benefit to stakeholders. To be of value to stakeholders and meet the objectives set forth by this research effort, the framework must be exercised and demonstrated through a tool that not only accounts for the needs, qualifications, expertise, and/or design intimacy of stakeholders but also provides actionable information regarding the acceptance of fire safety analyses in a straightforward manner. Such a tool has been specified and developed as part of this research effort. The following sections summarize the development and use of this tool by examining its construction and its application. The tool's application is shown through a case study, which this section also seeks to summarize through the study's key findings and those results most relevant to stakeholders, particularly code officials. Through use of this supporting tool, the decision support framework is exercised by a series of three examples, namely, Case Study Examples A, B and C, each of which is explained in the discussion that follows. Note that the complete specification and full results of the case study are detailed in Appendices B through H.

4.1. Case Study Development

To support its development and specification, the case study was adapted from one developed for the Society of Fire Protection Engineers (SFPE) Tenth International Conference on Performance-Based Codes and Fire Safety Design Methods held in Gold Coast, Queensland, Australia on November 10-12, 2014 [1]. The SFPE case study involves the development of a performance-based fire safety design and supporting project report by international chapters and participating countries for a challenging (or even controversial) application of performance-based design approaches to fire safety engineering. Apart from a limited but standardized set of specifications, including fire and life safety objectives, a basic building description, drawings, and minimum requirements for the project, practitioners for each represented country are free to develop a design solution consistent with their respective codes and standards; regulatory structure; and system and analysis preferences. The resulting variation between documented fire safety designs provides a backdrop that is well suited for exercising the proposed decision support framework and supporting tool.

4.1.1. Scope of the Case Study

The building addressed by the SFPE case study is shown in Figure 1 and is a mixed-use occupancy. However, for the purposes of the case study explored herein, consideration is limited to the office portion of the building. The overall interconnectivity of the office levels is regarded as the key issue for the SFPE case study as smoke from a fire may readily spread through the various level interconnections. In addition to the level interconnectivity, there are also other issues associated with the office space that would generally challenge the application of prescriptive codes, including (i) the number and construction of exits; (ii) common path, travel distance, and exit remoteness; and (iii) egress capacity.

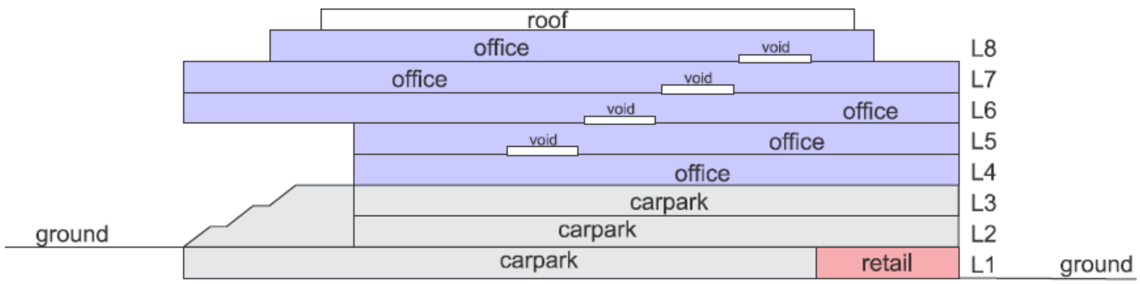


Figure 8: Cross-Section of Case Study Building

While the SFPE case study evaluates multiple objectives, including property protection and environmental impact, the decision support tool proposed for this case study will only seek to assess whether a performance-based fire safety analysis developed to justify a proposed fire safety design is of sufficient technical adequacy to support resulting conclusions made with respect to the safety of building occupants within the office space. Lastly, other assumptions were made in support of the case study. To the extent practical, such assumptions were based on the criteria and constraints of the SFPE case study, but in other cases, simplifications were made to reduce the overall complexity of this demonstrative decision support tool. Appendix B to this report provides further details on all assumptions made regarding the scope of the case study.

4.1.2. Construction of a Decision Support Tool

The decision support tool used to demonstrate the proposed framework was constructed through integration of the three framework elements reviewed in Section 3, namely:

- ***Technical Requirements*** that set forth the minimum requirements for a technically acceptable performance-based design approach, independent of a particular application;
- ***Fire Safety Network Analysis*** that addresses the underlying dependencies between defined technical requirements and fire safety objectives; and
- ***Quantitative Assessment of Technical Quality*** that evaluates, through use of performance indicators, the individual and collective impact of unsatisfied technical requirements (i.e., analysis deficiencies) on technical adequacy.

Based on the scope established for the case study and theory outlined in Section 3, a series of technical requirements were developed and specified down to the supporting requirement level. For each support requirement, capability categories were established for each of the three types of performance-based design approaches specified in Section 3.2.5, namely deterministic, risk-informed and risk-based performance-based design. The resulting supporting requirements and capability categories are summarized in Appendix C to this report. Additionally, influencing factors were defined for each supporting requirement. All specified supporting requirements, capability categories and influencing factors were organized into an Excel spreadsheet whose interface is shown in Appendix F.

The decision support tool interface presented in Appendix F also provides a means by which a user may specify quality and uncertainty ratings for each influencing factor associated with a given supporting requirement. As detailed in Appendix B, quality ratings for influencing factors are assigned through use of qualitative scales specific to the type of influencing factor being addressed; these scales are summarized in Appendix E. Uncertainty ratings are assigned using a single scale, which is discussed in Section 3.4.2.

With technical requirements defined, a network was constructed to assess the interrelations that exist between technical requirements at the supporting requirement and influencing factor level. Appendix H explores the development of this network in detail. The resulting logic of the fire safety network is embedded within the spreadsheet environment of the decision support tool interface. Nodal weights applied by the network are summarized in Appendix G and based on a standardized scale presented in Section 3.4.2.

Because the Bayesian network approach applied by the tool is inherently probabilistic and quality assessments of each influencing factor (or node) with the fire safety network are represented by distributions, the Palisade @Risk tool, which is an add-on to Microsoft Excel, was used to quantify the life safety performance indicator of the case study via Monte Carlo simulation. By default, all quality and uncertainty ratings are assigned as *High* and *None*, respectively, and if quantified, the life safety performance indicator would be 100%, or of *High* quality, and its uncertainty would be 0.00, or *None*. As deficiencies are identified and characterized within the tool below, the network may be re-quantified to determine the change's impact on the life safety performance indicator.

4.1.3. Comparison of Designs and Design Approaches

All SFPE case study practitioners performed assessments of the building's fire hazards to ensure that their respective fire safety designs were consistent with the established fire safety objectives; however, while similarities exist between their overall approaches to fire safety analysis (i.e., all approaches are largely deterministic in nature), no two assessments are the same. Each SFPE case study practitioner implemented a unique set of processes, methods and data (e.g., for selecting, characterizing and modeling fire scenarios); made use of different tools (e.g., modeling occupant egress using SimTread, Pathfinder, FDS+Evac, or hand calculations); formulated differing assumptions, either simplifying the analysis (e.g., application of a single, bounding time to smoke detector and sprinkler activation to all scenarios) or addressing uncertainties (e.g., those associated with the post-sprinkler-activation heat release rate); and evaluated the sensitivity of analysis conclusions to different factors (e.g., reliability of active systems). In fact, this variation amongst practitioners, in part, demonstrates the need for the proposed framework.

Additionally, owing to differences in their respective codes and standards, regulatory structure, and fire safety analysis preferences, the SFPE case study practitioners did not all arrive at the same definition of the resulting fire safety system, which represents the collective preventative and mitigate safety features proposed by fire safety engineering practitioners to meet fire safety objectives and be consistent with building and occupant characteristics. In some cases, practitioners relied largely on automatic fire sprinklers, and in others, additional measures were taken (e.g., mechanical smoke control systems, smoke curtains, etc.). For the purposes of the case study performed herein, the decision support tool was developed, acknowledging and accounting for these differences in fire safety system design strategies. To do so, the case study was developed to explore three fire safety systems based on the SFPE case study. Each fire safety system consists of fire alarm, detection and communication systems; fire hydrants, hose reels and portable extinguishers; and exit signs and emergency lighting. In addition, the following features are addressed for each of the summary design:

- Fire Safety System 1
    - Automatic Fire Sprinklers
- Fire Safety System 2
    - Automatic, Mechanical Smoke Ventilation System
- Fire Safety System 3
    - Automatic Fire Sprinklers
    - Automatic Smoke Curtains and passive smoke barriers
    - Automatic, Natural Smoke Ventilation System

In short, to appropriately evaluate the different design strategies and fire safety systems, the decision support tool and its constituent parts, e.g., technical requirements, must be developed consistent with the technical breadth of the fire safety analyses to be evaluated. That is, the decision support tool must be able to evaluate the necessary fire phenomena analyzed by each analysis as well as all credited fire safety systems. Appendix B explores this issue in further detail, but suffice it to say that the case study tool was developed to an extent that is sufficient to perform the case study.

4.1.4. Identification and Characterization of Design Deficiencies

The first step in evaluating the technical adequacy of a performance-based fire safety analysis is to determine the capability category at which the fire safety analysis should be assessed. In essence, there are two ways of making this determination. The first is to assess the scope and level of detail of the analysis against the supporting requirements to define the capability category that the fire safety meets (or most represents). The second is to have stakeholders agree on which capability category (or categories) an acceptable analysis should be required to meet. Based on assumptions of this case study outlined in Appendix B, the desired capability category was assumed to CC-II for each overall performance approach. As discussed in Section 3.2.4, the chosen capability category stipulates the required scope and level of detail that an analysis must encompass to be acceptable for the application at hand. For instance, if life safety is the primary objective of concern, then related supporting requirements should be evaluated at a sufficiently high capability category for the analysis to be adequate; the capability categories assigned to other supporting requirements, such as those related solely to property protection, may be given lower priority and thus be held to a lower capability category.

With the desired capability category known, the fire safety analysis is then reviewed against the performance statements documented by each supporting requirement to determine whether the analysis was performed consistent with the technical requirements and in consideration of the identified influencing factors. As reviewed in Appendix B, if one or more of the influencing factors of interest are inadequate, then the technical quality associated with the supporting requirement will be diminished. In such a case, a deficiency is identified against the inadequate influencing factor, and its impact on technical quality is assessed. As shown in Appendix F, such deficiencies may be documented within the decision support tool under the column titled, "Findings & Observations (F&Os)".

For the purposes of the case study, F&Os are written against theoretical fire safety analyses that are based on the SFPE case study; that evaluate the life safety of the building described above; and that reflect the considerations documented in this section and Appendix B (e.g., credited fire protection features). Because the fire safety analyses are somewhat hypothetical, general deficiencies are defined and then further specified, as needed, for each of the overall performance-based approaches (i.e., deterministic, risk-informed, and risk-informed). Table 9 provides the characterization of the deficiencies proposed for not only Case Study Example A but also Case Study Examples B and C. The affected supporting requirements and influencing factors are identified in both Table 9 and Appendix F.

Based on the description of each hypothetical deficiency, a quality rating was assigned to the affected influencing factor(s). For example, F&O 1 from Table 9 indicates that the fire safety analysis does not appropriately justify the severity and growth rate of fire(s) within the room of origin. By underestimating the fuel loading within the office occupancy, the fires analyzed by the fire safety analysis are not as severe as those that would typically occur in an office environment.

Additionally, once present, a fire is assumed to grow at a slower rate than is warranted by existing data. Lastly, spread to secondary combustibles is not fully considered. As a whole, this overall deficiency of the analysis in addressing fire growth and development decreases confidence in the risk insights that are provided by the fire safety analysis for informing the likelihood of successful egress of building occupants. A similar thought process can be followed for each of the deficiencies proposed in Table 9. However, the more severe the deficiency is, the lower the quality that would be assigned.

Note that guidance on assigning quality ratings is provided for each influencing factor that affects a given supporting requirement, as indicated in Appendix F. The quality ratings assigned below are representative of the deficiency's severity relative to the context defined by the case study. The relative importance of a deficiency to overall performance indicators for life safety is dictated by assigned network weights, which the user of the decision support tool is not expected to assign. Rather, such weights are pre-determined based on factors related to the occupancy, as discussed in Section 3.4.

Table 9: Characterization of Hypothetical Deficiencies

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
1	A B C	The fire safety analysis does not appropriately justify, for the occupancy of interest, the severity and growth rate of fire(s) within the room of origin.	FIDC-A1 - Fuel and Loading Characteristics (ROO)	The fire safety analysis does not substantiate, via applicable data or testing, the heat releases (HRR) applied to fire scenarios within the room of origin, and considering the fuel characteristics typical of this occupancy, the HRRs applied within the analysis substantially underpredicts the effects of fire.	Low
			FIDC-A2 - Temporal Profile (ROO)	Based on the types of fuel packages for this occupancy, the overall growth rate is expected to be medium; though, the analysis applies a slower rate, which may or may not have a substantial impact on the results of the analysis.	Low-Medium
			FIDC-A2 - Fuel Characteristics (ROO)	Spread to secondary combustibles is not considered by the applied HRRs. This is expected to have more than a minimal impact.	Low
2	A B C	The fire safety analysis does not use soot yield data that are appropriate for the fire scenario(s) being modeled in the room of origin.	FIDC-A4: Smoke Yield (ROO)	The burning material assumed by the fire reaction is not characteristic of the materials most typical of the occupancy. Though not representative, the soot yield applied is expected to have a minimal impact.	Medium
			FIDC-B4 - Smoke Yield Data (MOD)		Medium
3	A B C	The fire safety analysis does not appropriately estimate smoke production within the room of origin.	SDSC-A1 - Method Verification and Validation (ROO)	The method applied to calculate the air entrainment rate into the fire plume has not been fully validated for the application at hand. No documentation of such validation is provided, and available references indicate that the method has been applied outside of its range of applicability. The impact is expected to be substantial.	Low
			SDSC-B1 - Method Verification and Validation (MOD)		Low

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
4	A B C	The fire safety analysis does not adequately justify the time to sprinkler actuation. Additionally, the availability of the sprinkler system was not appropriately estimated.	FDWS-D3: Timing of Automatic Detection (AS&C)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-D5 - System Design and Maintenance (AS&C)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium
5	A B C	The fire safety analysis does not appropriately estimate egress timing.	OEC-B3 - Occupant Characteristics (RSET)	The speed of travel on in stairwells assumed for occupants during egress is much faster than that which would typical and the same as the speed of travel assumed for flat surfaces. The impact may be more than minor.	Low-Medium
6	C	The fire safety analysis does not appropriately justify the time to actuation of active smoke barriers or consider the availability of associated detection.	FDWS-F3 - Detector Characteristics (DA-ASB)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-F4 - System Design and Maintenance (DA-ASB)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
7	C	The fire safety analysis does not appropriately justify the time to actuation of the smoke management and control system or consider the availability of associated detection.	FDWS-G3 - Detector Characteristics (DA-SC&M)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-G4 - System Design and Maintenance (DA-SC&M)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium

4.2. Case Study Results

As discussed throughout this report, code officials looking to approve a performance-based fire design supported by an analysis with deficiencies should have concern; however, without further analysis, it is not clear to what extent these deficiencies impact the evaluation of life safety or other performance metrics being considered. Additionally, with limited resources and design intimacy, code officials would benefit from knowing which deficiencies should be prioritized for corrective action and which would not impact analysis conclusions to such an extent that an alternate decision would be made by the code official. As a result, the decision support tool was developed to provide several outputs that can be used to inform the decisions of not only code officials but also analysis, or even design, choices made by FPE practitioners. These outputs are summarized in Figure 11, and their implications on decision-making are reviewed in sections below. Note that detailed quantitative results are analyzed further in Appendix B.

4.2.1. Case Study Example A

As reviewed above and detailed in Appendix B, the purpose of this case study example is to explore the process of characterizing fire safety analysis deficiencies to evaluate, through framework performance indicators, their impact on fire safety objectives and ultimately the technical adequacy of a fire safety analysis. For this case study example, Fire Safety System 1 provides the basis for the fire safety analysis. Thus, weights within the associated fire safety network are assigned accordingly and are documented in Appendix G. The sections below summarize the results obtained from this case study example and review the implications that such results have on stakeholder decision-making.

4.2.1.1. Results

Quantitative results aside, a crucial insight of value to stakeholders is a clear understanding of the areas in which the fire safety analysis is deficient. The hierarchical structure and organization of the technical requirements established by the framework serve to facilitate not only the review of the fire safety analysis but also the communication of its results. Deficiencies, or F&Os, for Case Study Example A are documented in Table 11; however, the technical requirements impacted by these F&Os are also shown. The impacted requirements provide an initial roadmap of areas of the fire safety analysis that should be addressed as part of the performance-based design review process. Lastly, it should also be noted that those requirements and capability categories that are deemed to be met, without deficiency, by the fire safety analysis also provide a certain level of understanding about the technical adequacy of the fire safety analysis.

With F&Os as well as associated quality and uncertainty ratings for affected supporting requirements annotated through use of the decision support tool (as shown in Appendix F), quantification of the Bayesian network embedded within the tool's interface can be performed to inform stakeholders regarding not only the overall technical quality of the fire safety analysis but also about those aspects of the analysis in most need of corrective action (i.e., identified F&Os). As an overall indicator of technical quality, performance indicators within the fire safety network provide stakeholders a measure of confidence as to whether a fire safety analysis is of sufficient technical quality to support decision-making relative to the indicator. For Case Study Example A, this indicator is one associated with life safety.

As shown in Figure 9, the overall technical quality of the fire safety analysis, given deficiencies identified in Table 11, is most predominantly "Low-Medium". Additionally, the results suggest that the low levels of uncertainty associated with quality ratings, as documented in Table 11, are not large factor influencing the overall technical quality. For code officials, the simple qualitative indicators of "Low-Medium" and "Low" for technical quality and uncertainty, respectively, are believed to be generally sufficient as they provide a simple and straightforward interpretation of a complex analysis. Quantitatively speaking, the life safety performance indicator, as a result of all F&Os, has a mean (μ) of 39.2% and an effective variance (σ^2) of 0.018, which is a "low" level of uncertainty. This more informed level of detail may be most beneficial for FPE practitioners as they use the decision support tool to inform the design and analysis process before code official review

It should be noted that the performance indicators developed in support of the proposed decision support framework, while absolute in nature, are best used as a relative indicator of technical quality. That is, additional testing, as proposed in Section 6, would be required to determine, based on stakeholder input, what levels or values of technical quality are acceptable for a given application. Such testing could include implementation of the framework under a varied set of circumstances, e.g., different occupancies and performance-based designs, and real-world scenarios to better gage and define what is adequate with regard to technical quality.

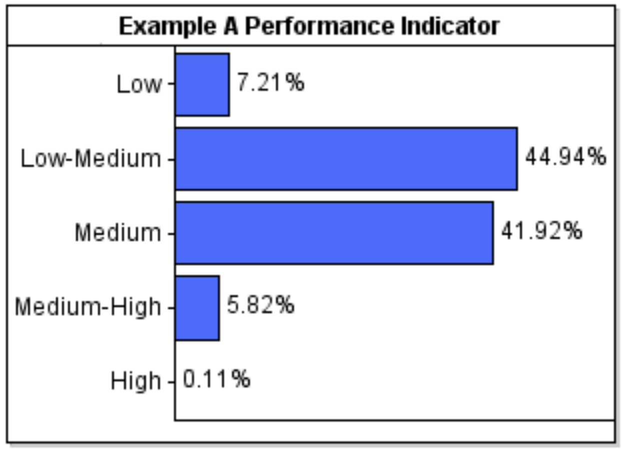


Figure 9: Distribution of Performance Indicator for Case Study Example A

In addition to evaluating the overall technical quality in the context of identified deficiencies, the change in quality associated with the resolution of individual F&Os can also be assessed to inform the importance of each such deficiency. Ultimately, the importance of individual deficiencies can then be used to inform which deficiencies are of the utmost importance to address and which need not be addressed further. Table 10 defines an importance rating based on the importance indicator defined in Section 3.4.3. In these cases, the degree to which the overall life safety performance indicator changes as a result of a deficiency being resolved is measured.

Table 10 provides the results of the importance analysis and indicates that F&O 3 is the deficiency that is most impacting technical quality. These results, thus, reveal that while the analysis supporting fire development and sprinkler availability is largely deficient, the impact of improper modeling approaches associated with smoke production on technical quality is greater. Based on a more detailed review of results generated from the decision support tool, the basis for this conclusion is centered on the fact that for this occupancy, deficiencies associated with smoke production greatly impact both sprinkler activation as well as the estimation of untenable conditions for determining the available safe egress time.

For stakeholders, all identified F&Os may be ranked by their importance rating to provide a priority list of those deficiencies to address. As each deficiency is addressed, the life safety performance indicator and importance analysis may be recalculated. This iterative process would then continue until either all deficiencies are fully resolved, or the life safety performance indicator becomes acceptable. Remaining deficiencies, if any, should then be of low importance. As the decision support framework and tool are implemented in practice, screening levels could be established to define, a priori, those F&Os that should be addressed as part of a code official review to achieve a more consistent level of performance across performance-based design reviews. Based on Case Study Example A, this screening level could be set at an importance indicator of 20 or below. This would suggest that F&O 5 would not necessarily need to be addressed should all of the other important F&Os are addressed.

Table 10: Importance Ratings

Importance Indicator	**Importance Rating**
$0 \leq II \leq 10$	Low
$10 < II \leq 20$	Low-Medium
$20 < II \leq 30$	Medium
$30 < II \leq 40$	Medium-High
$40 < II$	High

In addition to overall performance indicators and the results of the importance analysis, stakeholders can also be informed by other results associated with the fire safety network quantification, namely the quality values at individual nodes within the network. Given that nodes represent technical requirements or derivatives thereof, the quality scoring at each node can provide further insight regarding those areas of the fire safety analysis requiring additional clarification or revision. Based again on Case Study Example A, the fire safety network was quantified with deficiencies identified in Table 11 included. Then, the quality metric or scoring associated with each supporting requirement was determined. Table 12 through Table 18 provide the results of this analysis.

From these tables and considering the definition of associated technical requirements, stakeholders can easily see where the trouble spots of the fire safety analysis are based on the F&Os present. More importantly, stakeholders can begin to understand how the negative impact of F&Os on a limited set of technical requirements propagate through the network to influence the quality of other technical requirements for which no deficiencies were identified. Given that the network is based, at least in part, on phenomenological conditions (see Appendix H), such propagation of influence is consistent with fire engineering principles.

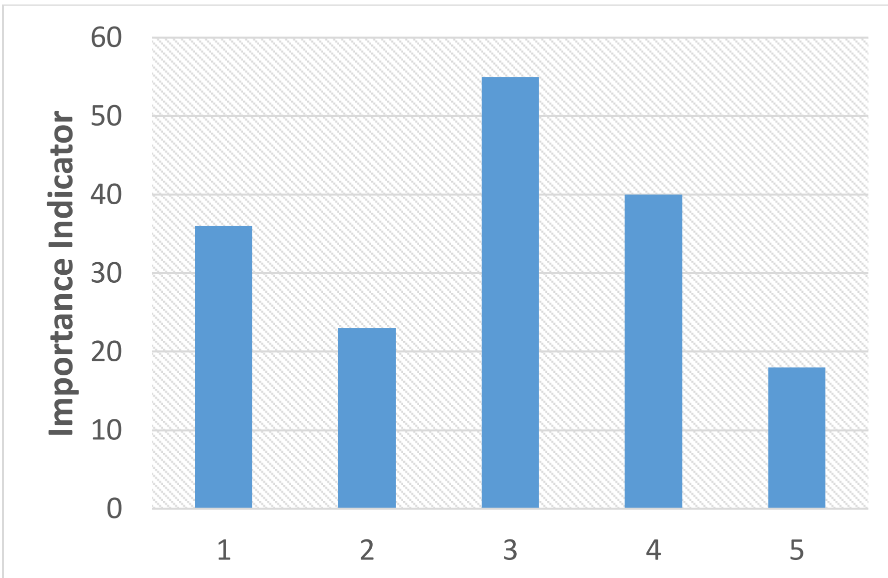


Figure 10: F&O Importance Ranking for Case Study Example A

Note that the complete results for Case Study Example A are provided and analyzed further in Appendix B.

Table 11: F&O Importance Analysis for Case Study Example A

F&O ID	General Deficiency	Technical Requirements Impacted	F&O Description	Assessment		Importance Rating
				Quality	Uncertainty	
1	The fire safety analysis does not appropriately justify, for the occupancy of interest, the severity and growth rate of fire(s) within the room of origin.	Fire Initiation, Development and Control → Room of Origin Fire Development → Fire Size/Heat Release Rate → Fuel and Loading Characteristics	The fire safety analysis does not substantiate, via applicable data or testing, the heat releases (HRR) applied to fire scenarios within the room of origin, and considering the fuel characteristics typical of this occupancy, the HRRs applied within the analysis substantially underpredicts the effects of fire.	Low	Low	Medium-High
		Fire Initiation, Development and Control → Room of Origin Fire Development → Fire Growth and Flame Spread → Temporal Profile	Based on the types of fuel packages for this occupancy, the overall growth rate is expected to be medium; though, the analysis applies a slower rate, which may or may not have a substantial impact on the results of the analysis.	Low-Medium	Low	
		Fire Initiation, Development and Control → Room of Origin Fire Development → Fire Growth and Flame Spread → Fuel Characteristics	Spread to secondary combustibles is not considered by the applied HRRs. This is expected to have more than a minimal impact.	Low	Low	
2	The fire safety analysis does not use soot yield data that are appropriate for the fire scenario(s) being modeled in the room of origin.	Fire Initiation, Development and Control → Room of Origin Fire Development → Smoke Yield → Smoke Yield Data	The burning material assumed by the fire reaction is not characteristic of the materials most typical of the occupancy. Though not representative, the soot yield applied is expected to have a minimal impact.	Medium	Low	Medium
		Fire Initiation, Development and Control → Modified Fire Development → Smoke Yield → Smoke Yield Data		Medium	Low	

3	The fire safety analysis does not appropriately estimate smoke production within the room of origin.	Smoke Development, Spread and Control → Room of Origin Smoke Development → Smoke Production → Method Verification and Validation	The method applied to calculate the air entrainment rate into the fire plume has not been fully validated for the application at hand. No documentation of such validation is provided, and available references indicate that the method has been applied outside of its range of applicability. The impact is expected to be substantial.	Low	Low	High
		Smoke Development, Spread and Control → Modified Smoke Development → Smoke Production → Method Verification and Validation		Low	Low	
4	The fire safety analysis does not adequately justify the time to sprinkler actuation. Additionally, the availability of the sprinkler system was not appropriately estimated.	Fire Detection, Warning and Suppression → Automatic Suppression and Control → Timing of Automatic Detection → Detector Characteristics	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low	Low	Medium-High
		Fire Detection, Warning and Suppression → Automatic Suppression and Control → System Reliability and Availability → System Design and Maintenance	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium	Low	
5	The fire safety analysis does not appropriately estimate egress timing.	Occupant Evacuation and Control → Required Safe Egress Time → Completion of Movement → Occupant Characteristics	The speed of travel on in stairwells assumed for occupants during egress is much faster than that which would typical and the same as the speed of travel assumed for flat surfaces. The impact may be more than minor.	Low-Medium	Low	Low-Medium

Table 12: Analysis Results for Fire Initiation, Development and Control

HLR-FIDC-A: Room of Origin Fire Development		
FIDC-A1	Fire Size/Heat Release Rate	23%
FIDC-A2	Fire Growth and Flame Spread	15%
FIDC-A3	Toxic Species Yield	36%
FIDC-A4	Smoke Yield	33%
FIDC-A5	Flame Height, Temperature and Radiation	36%
FIDC-A6	Ventilation Conditions	100%
FIDC-A7	Modeling Uncertainty	100%
FIDC-A8	Parametric Uncertainty	100%

HLR-FIDC-B: Modified Fire Development		
FIDC-B1	Fire Size/Heat Release Rate	37%
FIDC-B2	Fire Growth and Flame Spread	100%
FIDC-B3	Toxic Species Yield	48%
FIDC-B4	Smoke Yield	45%
FIDC-B5	Flame Height, Temperature and Radiation	43%
FIDC-B6	Ventilation Conditions	78%
FIDC-B7	Modeling Uncertainty	100%
FIDC-B8	Parametric Uncertainty	100%

HLR-FIDC-C: Flashover		
FIDC-C1	Fire Size/Heat Release Rate	44%
FIDC-C2	Fire Growth and Flame Spread	100%
FIDC-C3	Toxic Species Yield	53%
FIDC-C4	Smoke Yield	53%
FIDC-C5	Flame Height, Temperature and Radiation	49%
FIDC-C6	Ventilation Conditions	100%
FIDC-C7	Modeling Uncertainty	100%
FIDC-C8	Parametric Uncertainty	100%

HLR-FIDC-D: Beyond Room of Origin Fire Development		
FIDC-D1	Fire Size/Heat Release Rate	91%
FIDC-D2	Fire Growth and Flame Spread	88%
FIDC-D3	Toxic Species Yield	92%
FIDC-D4	Smoke Yield	92%
FIDC-D5	Flame Height, Temperature and Radiation	92%
FIDC-D6	Ventilation Conditions	91%
FIDC-D7	Modeling Uncertainty	100%
FIDC-D8	Parametric Uncertainty	100%

Table 13: Analysis Results for Smoke Development, Spread and Control

HLR-SDSC-A: Room of Origin Fire Development		
SDSC-A1	Smoke Production	8%
SDSC-A2	Smoke Layer Interface Height	13%
SDSC-A3	Smoke Temperature	19%
SDSC-A4	Smoke Optical Density	20%
SDSC-A5	Smoke Concentration	20%
SDSC-A6	Radiation from Smoke Layer	19%
SDSC-A7	Modeling Uncertainty	100%
SDSC-A8	Parametric Uncertainty	100%

HLR-SDSC-B: Modified Fire Development		
SDSC-B1	Smoke Production	8%
SDSC-B2	Smoke Layer Interface Height	15%
SDSC-B3	Smoke Temperature	21%
SDSC-B4	Smoke Optical Density	22%
SDSC-B5	Smoke Concentration	22%
SDSC-B6	Radiation from Smoke Layer	21%
SDSC-B7	Modeling Uncertainty	100%
SDSC-B8	Parametric Uncertainty	100%

HLR-SDSC-C: Flashover		
SDSC-C1	Smoke Production	47%
SDSC-C2	Smoke Layer Interface Height	51%
SDSC-C3	Smoke Temperature	53%
SDSC-C4	Smoke Optical Density	54%
SDSC-C5	Smoke Concentration	54%
SDSC-C6	Radiation from Smoke Layer	54%
SDSC-C7	Modeling Uncertainty	100%
SDSC-C8	Parametric Uncertainty	100%

HLR-SDSC-D: Beyond Room of Origin Fire Development		
SDSC-D1	Smoke Production	33%
SDSC-D2	Smoke Spread	24%
SDSC-D3	Smoke Layer Interface Height	39%
SDSC-D4	Smoke Temperature	43%
SDSC-D5	Smoke Optical Density	45%
SDSC-D6	Smoke Concentration	45%
SDSC-D7	Radiation from Smoke Layer	42%
SDSC-D8	Modeling Uncertainty	100%
SDSC-D9	Parametric Uncertainty	100%

HLR-SDSC-E: Smoke Control and Management		
SDSC-E1	System Effectiveness	N/A
SDSC-E2	Parametric Uncertainty	N/A
SDSC-E3	Modeling Uncertainty	N/A

HLR-SDSC-F: Smoke Barrier Failure		
SDSC-F1	Active Smoke Barrier Effectiveness	N/A
SDSC-F2	Passive Smoke Barrier Effectiveness	N/A
SDSC-F3	Parametric Uncertainty	N/A
SDSC-F4	Modeling Uncertainty	N/A

Table 14: Analysis Results for Fire Detection, Warning and Suppression

HLR-FDWS-A: Manual Notification System		
FDWS-A1	Timing of Manual Detection	100%
FDWS-A2	Reliability and Availability of Manual Detection	100%
FDWS-A3	Timing of Automatic Detection	100%
FDWS-A4	Reliability and Availability of Automatic Detection	100%
FDWS-A5	Reliability and Availability	100%
FDWS-A6	Effectiveness	100%
FDWS-A7	Modeling Uncertainty	100%
FDWS-A8	Parametric Uncertainty	100%

HLR-FDWS-B: Automatic Notification System		
FDWS-B1	Timing of Manual Detection	100%
FDWS-B2	Reliability and Availability of Manual Detection	100%
FDWS-B3	Timing of Automatic Detection	100%
FDWS-B4	Reliability and Availability of Automatic Detection	100%
FDWS-B5	Reliability and Availability	100%
FDWS-B6	Effectiveness	100%
FDWS-B7	Modeling Uncertainty	100%
FDWS-B8	Parametric Uncertainty	100%

HLR-FDWS-C: Manual Suppression and Control		
FDWS-C1	Timing of Manual Detection	45%
FDWS-C2	Reliability and Availability of Manual Detection	100%
FDWS-C3	Timing of Automatic Detection	50%
FDWS-C4	Reliability and Availability of Automatic Detection	100%
FDWS-C5	Reliability and Availability	48%
FDWS-C6	Effectiveness	41%
FDWS-C7	Modeling Uncertainty	100%
FDWS-C8	Parametric Uncertainty	100%

HLR-FDWS-D: Automatic Suppression and Control		
FDWS-D1	Timing of Manual Detection	24%
FDWS-D2	Reliability and Availability of Manual Detection	100%
FDWS-D3	Timing of Automatic Detection	20%
FDWS-D4	Reliability and Availability of Automatic Detection	100%
FDWS-D5	Reliability and Availability	30%
FDWS-D6	Effectiveness	30%
FDWS-D7	Modeling Uncertainty	100%
FDWS-D8	Parametric Uncertainty	100%

HLR-FDWS-E: Detection and Activation for Active Fire Barriers
N/A

HLR-FDWS-F: Detection and Activation for Active Smoke Barriers
N/A

HLR-FDWS-E: Detection and Activation for Smoke Control and Management
N/A

Table 15: Analysis Results for Fire Spread, Impact and Control

HLR-FSIC-A: Internal Fire Spread through Openings		
FSIC-A1	Internal Fire Spread through Openings	39%
FSIC-A2	Modeling Uncertainty	100%
FSIC-A3	Parametric Uncertainty	100%

HLR-FSIC-B: Fire Barrier Failure		
FSIC-B1	Active Fire Barrier Effectiveness	N/A
FSIC-B2	Passive Fire Barrier Effectiveness	N/A
FSIC-B3	Modeling Uncertainty	N/A
FSIC-B4	Parametric Uncertainty	N/A

Table 16: Analysis Results for Occupant Evacuation and Control

HLR-OEC-A: Available Safe Egress Time		
OEC-A1	Establishment and Integration of ASET Criteria	24%
OEC-A2	Modeling Uncertainty	100%
OEC-A3	Parametric Uncertainty	100%

HLR-OEC-B: Required Safe Egress Time		
OEC-B1	Detection Phase Timing: Occurrence of Cues	100%
OEC-B2	Pre-Movement Phase Timing: Recognition of Cues	100%
OEC-B3	Pre-Movement Phase Timing: Initiation of Movement	100%
OEC-B4	Movement Timing: Completion of Movement	30%
OEC-B5	Integration of RSET Criteria	100%
OEC-B6	Modeling Uncertainty	100%
OEC-B7	Parametric Uncertainty	100%

HLR-OEC-C: Integration of ASET/RSET Criteria		
OEC-C1	Integration of ASET/RSET Criteria	30%
OEC-C2	Modeling Uncertainty	100%
OEC-C3	Parametric Uncertainty	100%

Table 17: Analysis Results for Fire Scenario Development

HLR-FSD-A: Fire Hazards		
FSD-A1	Fire Hazard Analysis	100%

HLR-FSD-B: Potential Fire Scenarios		
FSD-B1	Potential Fire Scenarios	100%

HLR-FSD-C: Design Fire Scenarios for Analysis		
FSD-C1	Design Fire Scenarios for Analysis	100%

Table 18: Analysis Results for Analysis and Quantification

HLR-AQ-A: Quantification Methodology		
AQ-A1	Quantification	100%

HLR-AQ-B: Modeling Uncertainty		
AQ-B1	Modeling Uncertainty	100%

HLR-AQ-C: Parametric Uncertainty		
AQ-C1	Parametric Uncertainty	100%

HLR-AQ-D: Completeness Uncertainty		
AQ-D1	Completeness Uncertainty	100%

4.2.1.2. Recommended Actions

Based on the high-level results, i.e., an overall technical quality of "Low-Medium", stakeholders would be correct in arriving at the determination that additional analytical work is needed to improve the fire safety analysis before accepting a performance-based design that this analysis is attempting to substantiate. For this reason, an evaluation of each deficiency's relative importance would be needed to prioritize corrective actions, and from this evaluation, resolution of F&Os 3, 4, 1 and then 2 would, at a minimum, be recommended. As each deficiency is resolved, the resulting quality rating for the life safety performance indicator will increase. With the resolution of F&Os 3, 4, 1 and 2, the overall technical quality would be "Medium-High".

As an alternative to resolving multiple F&Os, the fire safety system could be altered to provide additional assurances that the resultant design is sufficiently justified by the fire safety analysis, be it a partially deficient one. As shown by Case Study Example C, the addition of redundant systems generally improves the overall technical quality of a fire safety analysis. By not simply relying on one primary means of fire protection (i.e., automatic sprinklers in Case Study Example A), the relative importance of F&Os generally decreases; however, as demonstrated Case Study Example C, such a decrease may be limited should the redundant systems made dependent by a common deficiency.

4.2.2. Case Study Example B

The purpose of this case study example is to explore how the uncertainties associated with nodal quality assessments are characterized using the decision support framework and propagated to assess framework performance indicators. In Case Study Example A, quality ratings were assigned based on Table 9; however, the uncertainty associated with these ratings was assumed to be *Low*. That is, the confidence in assessments made for supporting requirements affected by noted deficiencies was assumed to be high. For Example B, the level of uncertainty regarding the user's understanding of relevant fire phenomena and design, at least based on their expertise, experience, and currently available information (e.g., the fire safety analysis), is limited to such an extent that the user cannot assign a given quality rating with complete confidence. To better evaluate the impact of this source of uncertainty on stakeholder decision-making, multiple uncertainty ratings, as defined in Section 3.4, were explored. To do so, Case Study Example A inputs were altered accordingly.

4.2.2.1. Results

The uncertainty assessments for all F&Os addressed by Case Study Example A were changed from *Low* to *Medium* and then to *High*, and the network model was re-quantified. As the level of uncertainty increased at the F&O level, the uncertainty at the life safety performance indicator level also increased. Quantitatively speaking, the range of possible values for the life safety performance indicator grew, and as a result, decision-makers become less certain about the true quality of the fire safety analysis. The full results for Case Study Example B are provided and analyzed further in Appendix B. In this appendix, additional sensitivity cases are performed; however, the conclusions yield similar insights.

In addition to studying variations of the overall life safety performance indicator, Case Study Example B also proposed a measure of importance associated with uncertainty ratings associated with supporting requirements. As the results in Appendix B show, the uncertainty associated with F&O 4 has the largest impact on the life safety performance indicator; however, this result is despite the fact that uncertainty aside, F&O 4 has less of an impact on the life safety performance indicator than, say, F&O 3. Based on the building being analyzed, uncertainty associated with the quality of methods to evaluate sprinkler actuation, in fact, drives the overall technical quality more than deficiencies related to smoke production alone. As a result, the lack of knowledge associated with aspects of the fire safety analysis can be a determining factor in a stakeholder's acceptance of a performance-based design.

4.2.2.2. Recommended Actions

As stakeholders, including code officials, evaluate a fire safety analysis, care should be taken when aspects of the analysis are not clear, unsubstantiated or poorly documented. Additionally, code officials may not have sufficient expertise, experience or design intimacy to adequately judge the degree to which an FPE practitioner has addressed the intent of a given technical requirement. Under these circumstances, the decision support tool gives code officials, or their surrogates, the ability to mark affected technical requirements with a level of uncertainty. When the quantification of decision support performance indicators is performed, the uncertainties are propagated and thus explicitly considered as part of the proposed decision support metrics.

An additional level of analysis may also be performed to evaluate the overall importance of assessment uncertainties. In doing so, code officials would not only evaluate importance indicators associated with overall technical quality but also review the ranking of F&Os according to their impact on the spread of the life safety performance indicator. This is achieved by considering the impact of F&O uncertainties on the variance of the life safety performance indicators by "removing" associated uncertainties individually. As noted above, variances, or more specifically differences therein, can be presented either qualitatively (e.g., "Medium") or quantitatively. In short, the decision support tool would not only provide code officials recommendations regarding corrections needed in the fire safety analysis but also inform those aspects of the analysis, such as analytical approaches or modeling assumptions, requiring a more definitive and well-documented basis.

4.2.3. Case Study Example C

As reviewed above and further detailed in Appendix B, the purpose of this case study example is to explore and demonstrate the influence of candidate fire safety systems on framework performance indicators and ultimately the technical adequacy of a fire safety analysis. Note that equivalent overall technical quality is theoretically achievable for any effective fire safety system; however, the way deficiencies are manifested within the fire safety network is largely influenced by nodal influences and associated weighting, which are themselves influenced by the fire safety system design. For this case study example, the three fire safety system designs reviewed earlier are considered. To do so, Case Study Example A is applied; however, inputs to the decision support tool (e.g., quality ratings associated with affected supporting requirements, network weights, etc.) are manipulated to be consistent the three proposed fire safety systems reviewed in Section 4.1.3.

Additionally, as indicated in Table 9, F&Os 4, 6 and 7 represent deficiencies associated with fire safety systems. F&O 4 is applicable to Fire Safety System 1, which includes an automatic sprinkler system. F&O 7 is applicable to Fire Safety System 2, which includes an automatic, mechanical smoke ventilation system. F&Os 4, 6 and 7 are applicable to Fire Safety System 3, which includes: an automatic sprinkler system; an automatic, natural smoke ventilation system;

and automatic smoke curtains and passive smoke barriers. To support the comparison of life safety performance indicator results, deficiencies and associated quality ratings were made consistent across the different fire safety systems

The sections below summarize the results obtained from this case study example and review the implications that such results have on stakeholder decision-making.

4.2.3.1. Results

Detailed quantitative results for Case Study Example C are provided and analyzed in Appendix B and will not be repeated here; however, a few high-level of conclusions can be drawn from the results. First, fire safety systems providing an equivalent level of protection, in terms of life safety, were demonstrated to yield similar values for their respective life safety performance indicators using the decision support tool and accounting for postulated deficiencies. As noted earlier, the fire safety systems addressed by Case Study Example C were chosen based on the fire safety solutions developed by FPE practitioners in the SFPE case study [1]. A review of the life safety analyses (i.e., RSET/ASET calculations) performed for Fire Safety Systems 1 and 2 and documented as part of the SFPE case study revealed that these safety systems are roughly equivalent in their level of protection.

On the other hand, Fire Safety 3, which has an added level of redundancy due to credit for automatic smoke curtains and passive smoke barriers, offers a greater safety margin in the SFPE case study, and consequently, associated life safety performance indicators resulting from the decision support tool are predictably higher than those for Fire Safety Systems 1 and 2 given the presence of equivalent deficiencies. As additional layers of redundancy, or “defense in depth”, are added to a fire safety design, the relative impact of related deficiencies is reduced, and thus, the concomitant technical quality metrics are increased. Similarly, as these additional layers of protection become subject to their own independent deficiencies, the subject fire safety analysis’s technical quality begins to approach that of an analysis whose level of protection is comparably less.

Lastly, it is important to note that a fire safety system’s “worth” relative to the performance indicators associated with the decision support framework is largely function of the deficiencies that are present. That is, the degree of influence of credited fire safety systems on the life safety performance indicator is a function of the extent to which deficiencies indirectly influence the technical quality of the credited fire safety systems. For instance, F&O 5, which is related to occupant speed of travel during egress, is entirely independent of the modeling or treatment of fire safety systems within the fire safety analysis. Therefore, there is no means by which the technical quality of the credited fire safety systems can be influenced, and the largest benefit, relative to the life safety performance indicator, is achievable. On the other hand, F&O 3, which is related to smoke production within the room of origin, is a casual precursor to all postulated fire safety systems within the fire safety network because actuation of such systems is dependent upon smoke production and smoke-related parameters (e.g., optical density). For this reason, F&O 3, which has the largest impact on overall technical quality, results in the smallest benefit for credited fire safety systems, and removal of fire safety systems, under such circumstances, move yield the smallest change in the life safety performance indicator.

4.2.3.2. Recommended Actions

Stakeholders should remain aware that the impact of deficiencies on the technical quality associated with a fire safety analysis is highly dependent upon the characteristics of the fire safety systems (for instance, the means by which fire safety systems are actuated), and in turn, the benefit of such systems may, under some circumstances, be greatly limited unless the deficiencies are fully resolved. Though, in some cases, full resolution of deficiencies may not be feasible; however, the decision support tool and its results can be used by stakeholders, particularly code officials, to suggest alternatives.

For instance, code officials may suggest the addition of safety factors to the analysis to compensate for deficiencies and unknowns; importance analyses and quality assessments associated with individual supporting requirements can be used to determine where such factors may be best implemented. Additionally, code officials may suggest the addition of fire protection systems and features that are not affected by the present deficiencies. The decision support tool could then be re-quantified using such a modified fire safety system to achieve a higher life safety performance metric. A similar result could also be achieved by adding redundancies to already credited fire protection systems and features. In all such cases, insights obtained from the decision support tool can be used to inform a feasible path forward.

4.3. Lessons Learned

In this section, a limited-scope case study was performed to demonstrate the overall functionality, feasibility and utility of the framework. To do so, three case study examples were formulated to characterize the technical adequacy of a hypothetical fire safety analysis, understand the impact of uncertainties associated with user judgements, and evaluate the influence of different fire safety systems. The results of the effort were analyzed, and the insights gained demonstrated that the proposed decision support framework can be a useful tool for stakeholders, including code officials, to improve the technical adequacy and consistency of fire safety analyses associated with performance-based design approaches to fire safety engineering. Employing the various metrics, importance factors, and detailed results that the decision support tool can produce, stakeholders can easily see, judge and improve outcomes. Lastly, stakeholders can better assess the implications of decisions they make regarding relevant performance indicators, such as life safety and property protection.

4.4. References

[1] Society of Fire Protection Engineers, Fire Engineering Design Case Study, Tenth International Conference on Performance-Based Codes and Fire Safety Design Methods, Gold Coast, Queensland, Australia, November 10-12, 2014.

5. IMPLEMENTATION OF DECISION SUPPORT TOOL FOR STAKEHOLDERS

As summarized in Section 2.6, the aim of this research is to develop and implement into practice a decision support framework that will assist stakeholders, including AHJs and fire protection engineering practitioners, in the design and review of performance-based options to fire safety engineering. Such assistance includes not only determining whether a fire safety analysis approach is sufficient to support decision-making, regulatory or otherwise, but also facilitating the integration of performance-based design approaches into the regulatory decision-making process. In Section 4, the decision support framework was demonstrated, and through use of an associated decision support tool, results were generated and analyzed. However, to best support stakeholders and ultimately meet research objectives, the results that the decision support framework yields, whether qualitative or quantitative, must be tailored to the specific needs, skills, resources and limitations of stakeholders. The sections that follow outline relevant stakeholders and explain how the framework can be used by them to inform their decisions.

5.1. Process Stakeholders

Within the performance-based design process, stakeholders serve a key role, not least of which is establishing goals and objectives, which are then translated by FPEs into design objectives and performance criteria. Within the context of fire safety analysis, as defined in Section 2, stakeholders may be divided into two broad categories: the first are those who are involved in the development and substantiation of the analysis and the second are those who are charged with either the implicit or explicit approval of said analysis. The incarnation of the former is the FPE(s) tasked with performing the fire safety analysis, whereas the latter may be most aptly represented by the AHJ, or code official.

With regard to the FPE, the fire safety analysis offers a means by which a desired fire safety system can be justified relative to established but often competing objectives, e.g., life safety, cost, property protection, etc. However, the FPE must develop, perform and document this analysis in such a way that it provides confidence to other stakeholders, namely the AHJ, that the respective fire safety system is appropriate for the application at hand. Though, as discussed in Section 2.3.2, there are several underlying challenges associated with the use of performance-based approaches, one of the most significant of which is often the knowledge or experience gap between stakeholders, including between the AHJ and FPEs.

Most often, the AHJ is not as familiar with the fire safety analysis or design as the FPEs who were responsible for its development. Additionally, with an expertise largely premised on prescriptive fire protection, the AHJ may not have the experience or education to fully understand or question the validity of the fire safety analysis or design performed under a performance-based context. Lastly, the AHJ may not have the resources needed to perform a detailed technical review of the FPE's analysis, particularly to the level of detail needed to identify key deficiencies. Thus, to be useful, the decision support tool (and the process used to implement it) must address these two different categories of stakeholders, namely the FPE and the AHJ.

5.2. Condition of Tool Use

The decision support tool developed in support of the Section 4 case study and presented in Appendix F serves as one example of what stakeholders could use to implement the associated framework. For FPEs, the tool may be implemented during the design process, that is, before the fire safety analysis is finalized, to ensure that the analysis being developed remains technically adequate and would yield justifiable insights. Alternatively, the tool could be applied as part of a quality assurance process, serving as an independent review of the fire safety analysis. For the AHJ, the tool could be applied as part of the performance-based design review and acceptance process, either directly or through an independent contractor.

Regardless of the conditions under which the tool is used, training of the user on the tool's use and the underlying framework is needed to ensure that tool use is appropriate. The decision support framework was designed to ensure consistency across applications thorough its systematic structure, user-independent network weights and other features; though, it is assumed that the user has a basic understanding of performance-based design and safety analysis. Additionally, while the user is not expected to be expert in fire protection engineering, some qualifications are necessary to ensure that terms and concepts employed by the framework are adequately understood and implemented.

5.3. Tool Implementation

The implementation of the tool may be summarized using the high-level procedure documented in Figure 11. The following subsections review each step of this procedure, including all necessary inputs.

5.3.1. Establishment of the Required Scope and Level of Detail (Step 1)

After a fire safety analysis has been completed, a determination about whether the analysis sufficiently justifies the associated fire safety system must be made, e.g., by a code official. To assess the technical adequacy of the analysis, the user of the decision support tool must first assign the scope and level of detail against which the fire safety analysis should be assessed. Such a determination is based on the application at hand as well as stakeholder objectives, including regulatory requirements.

First, as discussed in Section 3, the type of performance-based approach, i.e., deterministic, risk-informed, or risk-based, is determined. Once the approach is defined, the scope and level of detail is further established by the performance indicators (e.g., life safety) and technical requirements (e.g., technical elements, high-level requirements, and supporting requirements) that are applicable to the analysis or required by relevant stakeholders (e.g., code officials). Similarly, the most appropriate capability category, as discussed in Section 3.2.4, must also be set. It is envisaged that initially, stakeholders would define the most appropriate scope and level of detail on an application-specific basis, but that with repeated application of the decision support framework and tool, consistent levels could be defined based on stakeholder risk tolerances and under defined sets of conditions (e.g., occupancy type, applicable performance indicator, construction, fire safety systems credited, etc.).

Inputs to this step include information derived from the fire safety system and analysis, which are being reviewed, as well as fire safety objectives, which ultimately should inform chosen performance indicators and the selection of applicable technical requirements.

5.3.2. Evaluation of the Fire Safety Analysis (Step 2)

With the scope and level of detail fully specified, the fire safety analysis is then reviewed against the technical requirements set forth by the framework. Considering the applicable analysis method and capability category, a determination is made as to whether the fire safety analysis meets performance statements associated with each supporting requirement, as illustrated in Appendix F. If the fire safety analysis is not consistent with the scope and level of detail articulated by a given supporting requirement at the designated capability category, the fire safety analysis is said to not meet the requirement, and a deficiency should be noted. The responsible party for such a review may be the FPE practitioner that developed the fire safety analysis, the code official, or a assigned third-party that could, for instance, provide an independent technical review using the decision support tool.

In all cases, influencing factors documented for each supporting requirement should be reviewed in the context of how well the fire safety analysis addresses each factor. Quality scales, as documented in Appendices E and F, are provided for each factor to assist in assigning quality ratings (i.e., from low to high). Once a quality rating (i.e., from low to high) is determined, the user should evaluate the overall confidence of their conclusion based on available documentation (e.g., fire engineering brief) and discussions, if applicable, with the responsible FPEs. Where deficiencies exist, each should be identified as a finding and observation (F&O) within the decision support tool, as shown in Appendix F for Case Study Example A. As discussed below, the fire safety network, once quantified, can then assist stakeholders in determining which deficiencies (or F&Os) are of most relevance or importance to decision-making.

Inputs to this step include information derived from the fire safety system and analysis. Each is reviewed to determine the most appropriate quality and uncertainty ratings for each applicable supporting requirement.

5.3.3. Assessment of Technical Adequacy (Step 3)

For the case study discussed in Section 4, network weights, as listed in Appendix G, were defined consistent with the case study's scope and level of detail because these aspects of the analysis ultimately influence the weights that must be specified for the network model. For instance, the presence of a smoke removal system would necessitate inclusion and characterization of certain technical requirements that would otherwise not need to be addressed within the decision support tool. Thus, implementing the approach for other applications, beyond the documented case study, may require that additional and/or different weights be defined for other conditions, as clarified in Section 3.4.2.2.

However, from the user's perspective, the intended application of the framework would, in theory, be similar to that of the case study in that the network weights would be applied consistent with the application at hand and not subject to user input. Section 6 explains that additional research efforts are needed to arrive at a consistent weighting across applications. Nodal weights applied within the case study are subjective and based on the engineering judgement of the researcher for a single application. In practice, a scheme would need to be developed that arrives at weights in a systematic fashion for a broad range of applications, addressing different occupancies and risk factors.

With the scope and level of detail specified in Step 1, quality and uncertainty assessments entered in Step 2, and network weights incorporated into Step 3, the underlying network model may be quantified to yield the insights listed in Figure 11 and exemplified in Section 4.

5.3.4. Review of Analysis Insights (Step 4)

With quantitative results and qualitative measures in hand, stakeholders would then use these outputs from the decision support tool to either propose improvements to the fire safety analysis or even reject it. Section 4 summarizes several recommended actions that stakeholders may take based on the insights obtained from the decision support tool. However, should corrective actions be adopted, revisions to the fire safety analysis may be captured within the decision support tool, and revised outputs from the tool can be obtained. An iterative approach could thus be followed until the outputs offered by the tool are consistent with the stakeholders' expectations regarding technical adequacy.

Step 1: Establishment of the Required Scope and Level of Detail
Assign the scope and level of detail against which the fire safety analysis is to be assessed.

Technical Requirements

Determine which supporting requirements are relevant to the fire safety analysis.

Performance-Based Design Approach

Assess which design approach is being applied (i.e., deterministic, risk-informed or risk-based).

Capability Categories

Select the capability category that the fire safety analysis is expected to meet for relevant supporting requirements.

Performance Indicators

Select the pertinent indicators based on fire safety objectives (e.g., life safety).

Input

Fire Safety System
Fire Safety Analysis
Fire Safety Objectives

Step 2: Evaluation of the Fire Safety Analysis
Evaluate the fire safety analysis using the decision support tool.

For each relevant supporting requirement

Performance Assessment

Assess the fire safety analysis against the performance statement(s) given for the selected performance-based design approach and capability category.

For each influencing factor

Quality Rating

Assess how well the fire safety analysis addresses each influencing factor by choosing the most appropriate quality rating within the decision support tool.

Uncertainty Rating

Evaluate the overall degree of confidence in each quality rating assigned by choosing the most appropriate uncertainty rating within the decision support tool.

Findings and Observations

Document all identified deficiencies within the decision support tool under the most relevant influencing factor(s).

Input

Fire Safety System
Fire Safety Analysis

Figure 11: Procedure for Assessing the Technical Adequacy of a Performance-Based Design

Step 3: Assessment of Technical Adequacy
Assess the overall technical adequacy of the fire safety analysis.

Quantification

Quantify the fire safety network using the decision support tool to yield:

Primary Outputs

Performance Indicators

Importance Indicators for Identified Deficiencies

Additional Insights

Quality Ratings for Supporting Requirements

Importance Indicators for Supporting Requirements

Importance Indicators for Uncertainty Ratings

Input

Network Weights

Step 4: Review of Analysis Insights
Take steps to improve the fire safety analysis, or reject it.

Corrective Actions
Prioritize corrective actions to be taken regarding the fire safety analysis based on performance and importance indicators.

Revisions to the Fire Safety Analysis
Propose any necessary revisions to be made to the fire safety analysis, and return to Step 2, stopping when the analysis and associated decision support tool insights becomes acceptable.

Figure 10 (Cont.)

6. CONCLUSIONS AND FUTURE EFFORTS

This research effort sought to address key challenges associated with the review and acceptance of performance-based design approaches to fire safety engineering through the development and implementation of a decision support framework that will assist AHJ representatives and fire protection engineering practitioners in determining whether a given design approach is sufficient to support decision-making, regulatory or otherwise, for a given application. In this vain, a decision support framework and supporting tool was developed, demonstrated, and found to effectively and feasibly evaluate the technical adequacy of such performance-based analysis approaches. As documented herein, the decision support framework met intended research objectives, including:

(1) Establishing a consistent and uniform method, using a defined set of technical requirements, for establishing the technical quality and adequacy of performance-based design approach for a spectrum of potential performance-based design applications;

(2) Providing a measure of confidence to stakeholders, through a series of performance indicators, regarding a design approach's ability to support a decision and identifies those aspects of the approach requiring further corrective action;

(3) Supporting the structure and development of future, more detailed guidance on not only what should be considered in a performance-based design approach to fire safety engineering analysis but also how such an analysis should be conducted;

(4) Providing a forum and common language for the exchange of ideas and techniques for effective use of performance-based design approaches among;

(5) Offering a means to identify, over time, areas of consistency or inconsistency in the treatment of issues important to understanding building performance and implementing performance-based design approaches;

(6) Aiding in defining the state of the art in performance-based design approaches and identifying analytical and experimental research needs; and

(7) Promoting the understanding that the level of analysis needed to support regulatory decision-making need not be fixed across all application but rather should be flexible with regard to scope, level of detail, occupancy-specificity, and realism.

Additionally, it should be noted that while the focus of the above objectives was on fire safety engineering applications, the framework may easily be adapted to similar approaches in other fields of engineering, or more generally, applications that make use of process-oriented, analysis-driven design. Given this flexibility in application, the feasibility and efficacy of the framework is compelling. However, to fully implement the decision support framework and tool in practice, additional efforts are needed. These efforts are described below.

6.1. Implementation

The decision support framework and tool may be implemented as fire safety solutions are being designed to address fire safety objectives or after the fire safety design is complete to evaluate its overall technical adequacy. In either case, the fire safety analysis, albeit in different stages of development, would be reviewed by relevant stakeholders against the technical requirements outlined within the decision support tool, and as described throughout this dissertation, concerns (or deficiencies) would be characterized to understand their impact and importance relative to the given fire safety objectives. In the end, a series of performance indicators and other insights would be provided by the tool to inform stakeholders of whether the fire safety analysis is of sufficient technical quality to support decision-making regarding the acceptability of a fire safety solution. While the theory of this approach has been outlined and demonstrated on a small scale through the case study documented in Section 4, the approach needs to be broadened to address a wider range of applications, but before doing so, there are issues affecting the possible implementation of this approach that should be researched further.

6.1.1. Scalability

With further effort, the decision support framework and tool can, in theory, be adapted and scaled to address any performance-based application for which some sort of fire safety analysis is performed. The modular nature of the technical requirements and fire safety network approach means that scaling the framework requires only developing the necessary technical requirements and subsequently defining the associated nodes and connections within the fire safety network.

For instance, addressing other types of occupancies and buildings than the one addressed by the case study would require evaluating those aspects of the fire safety analysis not already addressed by the framework and expanding it accordingly. This task would also necessitate gaining an understanding of the relevant risk factors for each occupancy and building to ensure that technical requirements are of sufficient scope and level of detail. The same treatment would apply to the addition of fire safety objectives beyond life safety (e.g., property protection), different types of fire safety systems, and unanalyzed technical elements (e.g., structural collapse, fire service suppression and rescue activities, etc.).

In short, the limiting factor in scaling the framework to address other applications is not its inherent structure or underlying methodologies. Rather, it is the effort needed to research the technical issues addressed by the framework to the extent necessary to adequately define the technical requirements and the structure of the network. Also, testing and validation of the network is required to ensure that the weights assigned within the network yield expected results as well as consistency across different applications. These and other implementation issues are further explored in the next section.

6.1.2. Implementation Issues

This research effort underscored the necessity for a more systematic and consistent approach to evaluating the technical adequacy of performance-based analysis approaches; however, there are a number of areas that must be addressed before the framework can be fully implemented as intended:

- The formal development of technical requirements (including technical elements, high-level requirements, and supporting requirements) would best be served by a standards development process through which key stakeholders can be involved. This would also apply to the development of capability categories as well as rules for determining those categories against which a given application should be assessed. Doing so would also enforce consistency across applications.
- Subject-matter experts in relevant domains are needed to ensure that all requirements and influencing factors are appropriately identified and characterized such that they are technically correct and of sufficient scope and level of detail. This would also apply to

the descriptions of influencing factors provided within the decision support tool as a guide to users.

- Nodal weights applied within the case study are subjective and based on the engineering judgement of the research for a single application. In practice, a scheme would need to be developed that arrives at weights in a systematic fashion for a broad range of applications, addressing different occupancies and risk factors.
- Validation and testing efforts would be needed to ensure nodal weights and tool outputs, including performance indicators, are appropriate and consistent across occupancies and risk factors. Additionally, benchmarking efforts should be employed to qualify acceptable levels of quality for given applications.
- The tool as developed is meant to be applied at the scenario, compartment or building level such that insights provided by the tool are effectively averaged across the fire safety analysis. However, there is theoretically a point at which relevant characteristics within the scope of the fire safety analysis could diverge to such an extent that this averaging begins to distort framework insights (e.g., multi-occupancy buildings). In such cases, additional research is needed to fully understand the implications and suggest proper action; though, an immediate solution would be to segment the analysis into more manageable and homogeneous divisions (e.g., individual compartments, types of occupancies, etc.).
- To implement the decision support tool in practice, users, i.e., AHJ representatives and fire protection engineering practitioners, would require training on the use of the tool as well as a limited understanding of the framework's overall approach. The degree of training is a function of the guidance provided by the tool itself. That is, the level of detail and prescriptiveness to which technical requirements, quality ranking scales, and influencing factor descriptions are drafted would be most indicative of the training and fire protection expertise needed to effectively and responsibly use the tool.

6.2. Future Research Efforts

In conclusion, the decision support framework and associated tool proposed directly addresses some of the underlying challenges related to the use of performance-based design approaches to fire safety engineering, and thus, the approach, if implemented, would improve upon current practice. Though, as identified above, additional research is still needed to put the approach into practice and to address a broader range of applications. Most importantly, the involvement of relevant stakeholders, including AHJ representatives, engineering practitioners, industry boards, codes and standards committees, and subject-matter experts, is needed to ensure that the decision support tool achieves its stated objectives and retains currency.

APPENDIX A

Exploration and Validation of Bayesian Network Analysis
using Ranked Nodes

A.1. INTRODUCTION

As described in Section 3.4.1.1 of the main report, a Bayesian network is a probabilistic graphical model that offers a structure process for documenting and analyzing the interrelationships amongst a set of variables. With regard to the proposed decision support framework, these variables represent technical requirements that define the scope and level of detail necessary for a technically adequate fire safety analysis. When a deficiency is present within a fire safety analysis, technical quality is challenged, but the degree to which this is so is unclear, particularly when many such deficiencies exist concurrently.

To better inform stakeholders on matters of technical quality, the proposed framework applies Bayesian network analysis to assess the degree of influence that deficiencies have on the technical quality of the fire safety analysis. Overall technical quality is measured at assigned performance indicator node(s) within the network. To quantify the network at these indicator nodes, the network must be informed; that is, local conditional probability distributions (CPDs) associated with each node and its respective parents must be defined. However, while the methods for quantifying Bayesian networks and associated distributions are well established [1-6] and straightforward, the manner in which they are informed can be time intensive, and even for seemingly simple problems, entirely unfeasible.

Luckily, a well-documented and tested method exists for informing Bayesian networks, making the process for elicitation of network inputs not only efficient but also highly intuitive [7-11]. This method involves the use of ranked network nodes and weighting functions to overcome many of the challenges involved with classical methods for informing Bayesian networks. In the sections that follow, this appendix will briefly review a classical method for informing Bayesian networks and compare it with the method to be employed for the proposed decision support framework. Ultimately, it will be shown that use of weighting functions, in combination with ranked nodes, is not only equivalent to more classical methods but also much more tractable for constructing an efficacious and efficient decision support tool.

A.2. BAYESIAN NETWORK APPROACH

For demonstration purposes, a simplified Bayesian network is defined and shown in Figure A.1. In this example, the network indicates that the adequacy of an analysis, say a fire safety analysis, is dependent upon two elements: the methods used in the analysis and the inputs applied. Each node may be in one of five quality states: low, low-medium, medium, medium-high, and high. For example, if one were to observe that the adequacy of inputs and methods is low, then the adequacy of the analysis would, more than likely, be low as well. Likewise, if one were to observe that the adequacy of inputs and methods is high, then the adequacy of the analysis would, more than likely, be high as well. However, without making further assumptions, the degree of analysis adequacy for other combinations of nodal input quality states is not yet known. Moreover, there are 25 such combinations (or relationships) that must be defined.

With that said, the purpose of the Bayesian network analysis is to directly encode these combinations such that the adequacy of the analysis may be informed to whatever degree to which the two parent nodes are known. Classically, this is done by informing a Node Probability Table (NPT), which lists the probability that the child node takes on each of its different values for each combination of values of its parents. Such combinations are displayed in Table A.2.

While the number of combination for this simple example is limited, the complexity and number of these combinations increases greatly as additional nodes are added to the network. Moreover, to inform network performance indicators, conditional probabilities for each combination would need to be elicited and input into the network model. For a network as large as the one proposed for the decision support framework, the sheer number of such combinations makes such a process indefensible. As noted by Fenton [7], elicitation at such a scale is fraught with challenges, including a lack of self-consistency that undoubtedly will arise when elicitation of values is too refined.

Often, elicitations are most accurate and beneficial when they kept simple and intuitive. However, deriving quantitative values from highly qualitative insights is a challenging endeavor even if the number of nodes or combinations remains small. With regard to the simplified example in Figure A.1, qualitative insights, such as those in Figure A.1, could feasibility be obtained from relevant stakeholders. Table A.2 attempts to replicate an NPT consistent with these qualitative assumptions. Yet, if such an exercise were to be repeated by different practitioners, alternate values could be interpreted. Ultimately, this creates a challenge for implementation of the proposed decisions support framework that proposes dozens of individual nodes.

Table A.1: Qualitative Assumptions on Nodal Weights

IF…	Assumption 1	Assumption 2	Assumption 3	Assumption 4
Parent Node 1 (Lower Weight)	High	Low	Low	High
Parent Node 2 (Higher Weight)	High	Low	High	Low
THEN… Child Node	Heavily skews High	Heavily skews Low	Centered toward Low-Medium	Centered toward Low

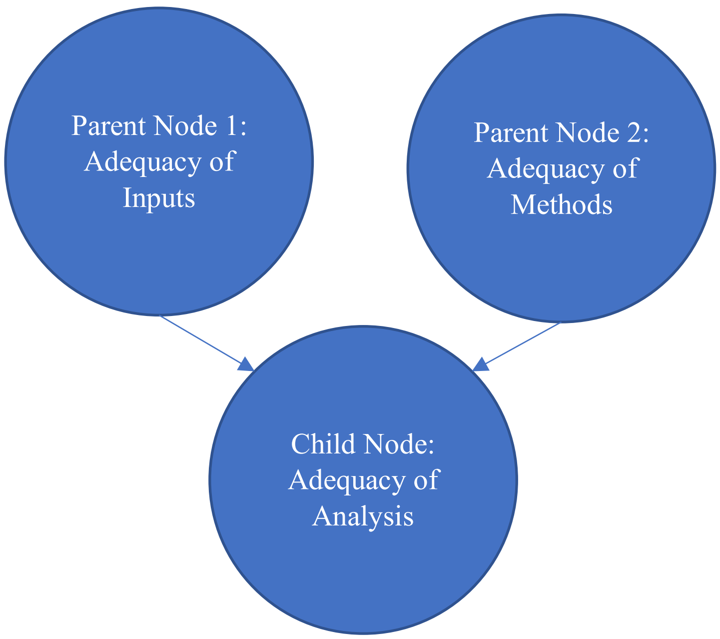


Figure A.1: Simplified Fire Safety Network

A.3. RANKED NODE APPROACH WITH WEIGHTING FUNCTIONS

Ranked nodes, as described by Fenton, et al. [7], represent "discrete variables whose states are expressed on an ordinal scale that can be mapped onto a bounded numerical scale that is continuous and monotonically ordered". For instance, ranked nodes can be defined on an underlying unit interval scale (from 0 to 1). This scale can then be discretized for a given number of intervals defined. For example, using a 5-point scale (e.g., very low, low, average, high, very high), the interval widths for each state would be 0.2. Thus, the first state is associated with the interval from 0 to 0.2, the second from 0.2 to 0.4, and so forth.

Additionally, as explained by Fenton, et al. [7], mathematical convenience is best attained by characterizing network nodes with a doubly truncated Normal distribution. Beyond the computational simplifications, the use of this distribution also preserves the intuitive properties between parent and child nodes that the inference network should satisfy. The doubly truncated Normal distribution is denoted by TNormal(μ, σ^2, 0, 1), where μ is the mean, σ^2 is the variance, and its finite range is from 0 to 1.

For the proposed framework, ranked nodes may be applied to represent indicators of quality associated with supporting requirements and influencing factors. Provided that a meaningful quality scale can be defined, the use of ranked nodes would serve an efficient and relatively straightforward means by which to elicit and characterize the value judgments of AHJ representatives and fire protection engineering practitioners regarding supporting requirements and influencing factors. Additionally, the use of doubly truncated Normal distribution provides a means by which the degree of certainty associated with each value judgement can be considered (i.e., through the variance). The development of a quality scale and uncertainty judgements is explored further in Section 3.4.2.1 of the main report.

With individual nodes characterized using discrete intervals, the degree of their influence on each other needs to be predictably understood. To overcome the challenges associated with informing the various NPTs associated with a particular Bayesian network, weighting functions, as raised in Section 3.4.1.2 of the main report and discussed by Fenton, et al. [7], can be employed. Instead of eliciting probability values individually for the various combinations needed to construct an NPT, a weighting function and associated weights are applied consistent with general qualitative insights. For the example presented in Figure A.1 above, only two weights would need to be elicited (i.e., instead of the 25 probabilities needed to fully inform the NPT). These weights are relative to the degree of influence that each parent node is believed to have on its child.

To illustrate this in more detail, assume that as outlined in Figure A.2, Node 4 is a consequence of the three cause nodes, i.e., Nodes 1, 2 and 3, representing variables X, Y and Z, respectively. With Nodes 1, 2 and 3 being ranked nodes, each of their respective variables can theoretically be in any one of a set of discrete states (e.g., low, medium and high). Without making individual determinations of Node 4 outcomes for each combination of variable values for Nodes 1, 2 and 3, the overall influence of a set of parent nodes (i.e., Nodes 1, 2 and 3) on a child node (i.e., Node 4) can be determined by a set of nodal weights, which represents the relative degree of influence that a parent node has on its child, and a weighting function. As shown in Figure A.2, the expected value of variable A for the child Node 4 can then be determined using a weighting function, which itself is a function of the parent nodal weights and variable values. The weighting function can be arithmetic (e.g., using addition), probabilistic (e.g., using probability distribution), or mixed (e.g., convolving multiple distributions).

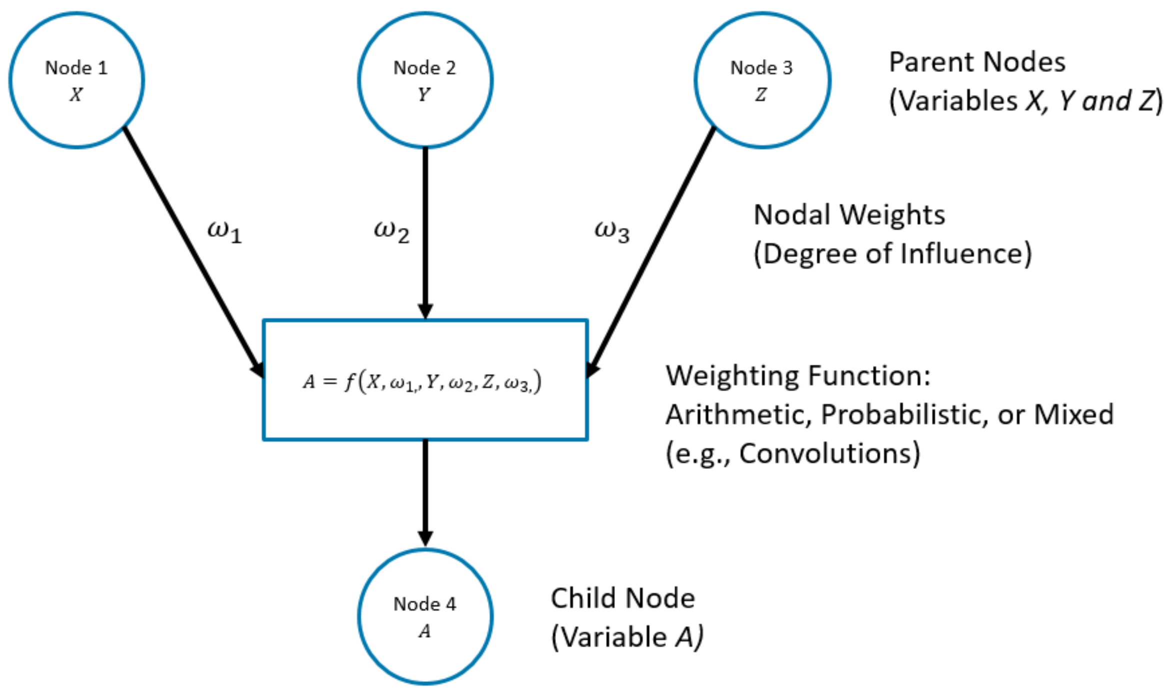


Figure A.2: Implementation of Weighting Functions

Fenton, et al. [7], through extensive experience constructing large NPTs for ranked nodes in the real-world cases [7-11], has proposed a scheme of weighting functions that sufficiently generates almost all the ranked node NPTs elicited in practice. In general, this scheme can be summarized as consisting of four functions:

- A simple weighted sum function;
- A weighted minimum function;
- A weighted maximum function; and

- A mixed minimum and maximum function.

In each of these cases, nodes are assigned relative weights based on their degree of influence. The identification of an applicable weighting function for the proposed decision support framework is explored further in Section 3.4.2.2 of the main report.

A.4. COMPARISON

To compare the above two methods of informing Bayesian networks, the simplified example reviewed above in Section A.2 is used. As discussed in Section A.2, a NPT was completed by the author based on the classical method; that is, Table A.2 was constructed manually based on qualitative assumptions documented in Table A.1. To implement the method involving a weighting function, weights were assigned to each of the parent nodes shown in Figure A.1, consistent with the qualitative insights documented in Table A.1. Note that there are several weighting functions that may be chosen, and for every child node, a function must be selected. Choice of the most appropriate weighting function is based on the characteristics of the relationship between parent and child nodes. In the case of this simplified example, a WMIN function, as defined by [7] and further substantiated in Section 3.4.2.2 of the main report, was applied in order to yield results consistent with the qualitative insights documented in Table A.1.

With weighting function selected, the weighting values were slightly adjusted until the results obtained through use of weighting functions were closely aligned with those from use of classical methods. In the end, the "Adequacy of Methods" node was assigned a weight that was four times that of the "Adequacy of Inputs" node. Results for the two approaches are presented in Tables A.2 through A.4 as well as Figures A.2 and A.3. Note, again, that the purpose of this exercise is to demonstrate equivalency of numerical results and not to compare the elicitation procedures, practices and/or outcomes associated with each method. A number of elicitation methods exist and may be used with either of the two network quantification methods.

A.5. CONCLUSION

As discussed above, an NPT was manually constructed based on the classical methods approach. While an NPT is not a direct result of the approach that makes use of weighting functions, one can be created by performing a Monte Carlo analysis of the child node and binning the results for various combinations of the parent nodes. Table A.3 presents the results of an associated Monte Carlo simulation, and Table A.4 compares these results to those in Table A.2. Based on this comparison, it is clear that the two methods can feasibly yield similar, and given proper specification, theoretically equivalent NPT results. A similar comparison of the results of the child node was also made for select combinations of the parent nodes. As shown in Figures A.2 and A.3, the results for the child node for each method are largely equivalent.

In conclusion, the selection between a classical method for informing a Bayesian network and one in which weighting functions are applied is largely a decision based on problem complexity, resource constraints, and the degree to which elicitation can be reliably performed. As the results above demonstrate, quantitative results will remain equivalent between the two methods provided the same assumptions are made. For the purpose of the proposed decision support tool, use of weighting functions allows for a more intuitive, efficient and informed weighting scheme than would otherwise be achievable had each NPT within the network needed to be explicitly informed, combination by combination.

Table A.2: Elicitation by Node Probability Table

	Adequacy of Methods	Low					Low-Medium					Medium					Medium-High					High				
	Adequacy of Inputs	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High
Adequacy of Analysis	Low	83.0%	73.0%	68.0%	63.0%	57.0%	60.0%	25.0%	16.0%	13.0%	10.0%	38.0%	7.0%	1.0%	0.0%	0.0%	19.0%	2.0%	0.0%	0.0%	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%
	Low-Medium	16.0%	26.0%	31.0%	35.0%	40.0%	38.0%	61.0%	59.0%	57.0%	55.0%	55.0%	55.0%	25.0%	16.0%	13.0%	62.0%	37.0%	7.0%	1.0%	0.0%	55.0%	19.0%	2.0%	0.0%	0.0%
	Medium	1.0%	1.0%	1.0%	2.0%	3.0%	2.0%	14.0%	24.0%	29.0%	34.0%	7.0%	37.0%	61.0%	59.0%	57.0%	19.0%	54.0%	54.0%	25.0%	16.0%	37.0%	62.0%	37.0%	7.0%	1.0%
	Medium-High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	2.0%	0.0%	2.0%	14.0%	24.0%	29.0%	0.0%	7.0%	37.0%	61.0%	59.0%	2.0%	19.0%	55.0%	55.0%	27.0%
	High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	0.0%	0.0%	2.0%	14.0%	24.0%	0.0%	0.0%	7.0%	38.0%	72.0%

Table A.3: Elicitation by WMIN Weighting Function

	Adequacy of Methods	Low					Low-Medium					Medium					Medium-High					High				
	Adequacy of Inputs	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High
Adequacy of Analysis	Low	83.0%	73.0%	68.0%	63.0%	57.0%	60.0%	25.0%	16.0%	13.0%	10.0%	38.0%	7.0%	1.0%	0.0%	0.0%	19.0%	2.0%	0.0%	0.0%	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%
	Low-Medium	16.0%	26.0%	31.0%	35.0%	40.0%	38.0%	61.0%	59.0%	57.0%	55.0%	55.0%	55.0%	25.0%	16.0%	13.0%	62.0%	37.0%	7.0%	1.0%	0.0%	55.0%	19.0%	2.0%	0.0%	0.0%
	Medium	1.0%	1.0%	1.0%	2.0%	3.0%	2.0%	14.0%	24.0%	29.0%	34.0%	7.0%	37.0%	61.0%	59.0%	57.0%	19.0%	54.0%	54.0%	25.0%	16.0%	37.0%	62.0%	37.0%	7.0%	1.0%
	Medium-High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	2.0%	0.0%	2.0%	14.0%	24.0%	29.0%	0.0%	7.0%	37.0%	61.0%	59.0%	2.0%	19.0%	55.0%	55.0%	27.0%
	High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	0.0%	0.0%	2.0%	14.0%	24.0%	0.0%	0.0%	7.0%	38.0%	72.0%

Table A.4: Difference between Elicitation Methods

	Adequacy of Methods	Low					Low-Medium					Medium					Medium-High					High				
	Adequacy of Inputs	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High	Low	Low-Medium	Medium	Medium-High	High
Adequacy of Analysis	Low	-0.2%	0.2%	0.1%	0.3%	-0.2%	0.3%	0.2%	-0.1%	0.3%	0.2%	0.4%	0.0%	0.4%	-0.3%	-0.2%	0.3%	0.1%	-0.1%	0.0%	0.0%	0.0%	-0.4%	0.0%	0.0%	0.0%
	Low-Medium	-0.5%	-0.4%	0.2%	-0.4%	0.0%	-0.3%	-0.1%	0.0%	-0.4%	0.2%	-0.3%	0.5%	0.5%	0.0%	0.4%	-0.4%	0.4%	0.0%	0.4%	-0.3%	0.5%	0.5%	0.1%	-0.1%	0.0%
	Medium	0.7%	0.2%	-0.3%	0.1%	0.2%	0.0%	0.1%	-0.1%	0.3%	0.5%	0.0%	0.4%	0.3%	0.2%	-0.2%	0.4%	-0.5%	-0.5%	0.5%	0.0%	0.4%	-0.2%	0.4%	0.0%	0.3%
	Medium-High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.2%	-0.2%	0.1%	-0.1%	0.1%	0.1%	-0.1%	0.3%	-0.4%	0.0%	0.4%	0.1%	-0.2%	0.1%	0.5%	0.5%	-0.3%	0.2%
	High	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.2%	-0.2%	0.0%	-0.1%	0.1%	0.1%	-0.5%	0.0%	-0.4%	0.0%	0.4%	-0.5%

Figure A.2: Elicitation by Node Probability Table

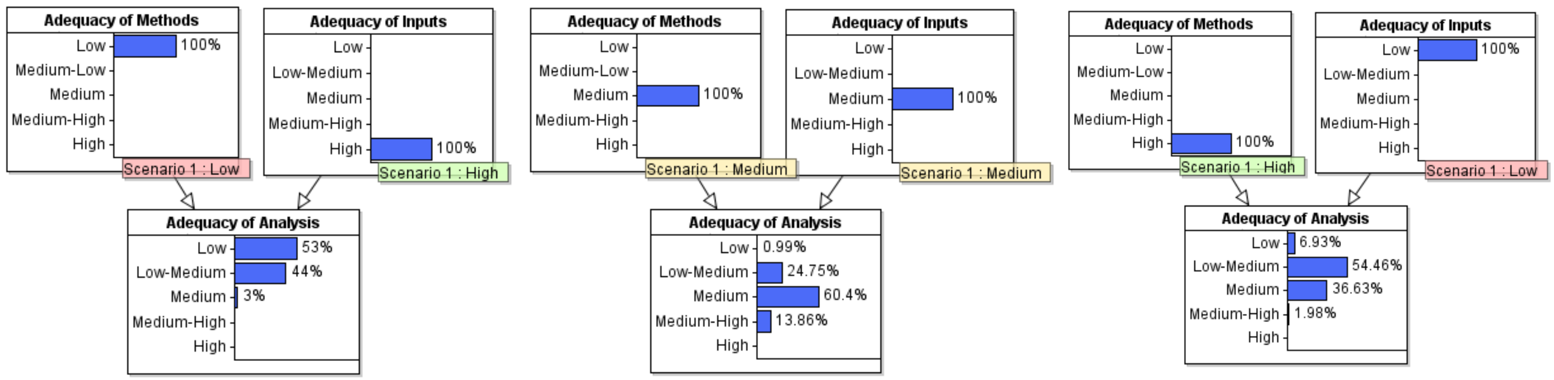
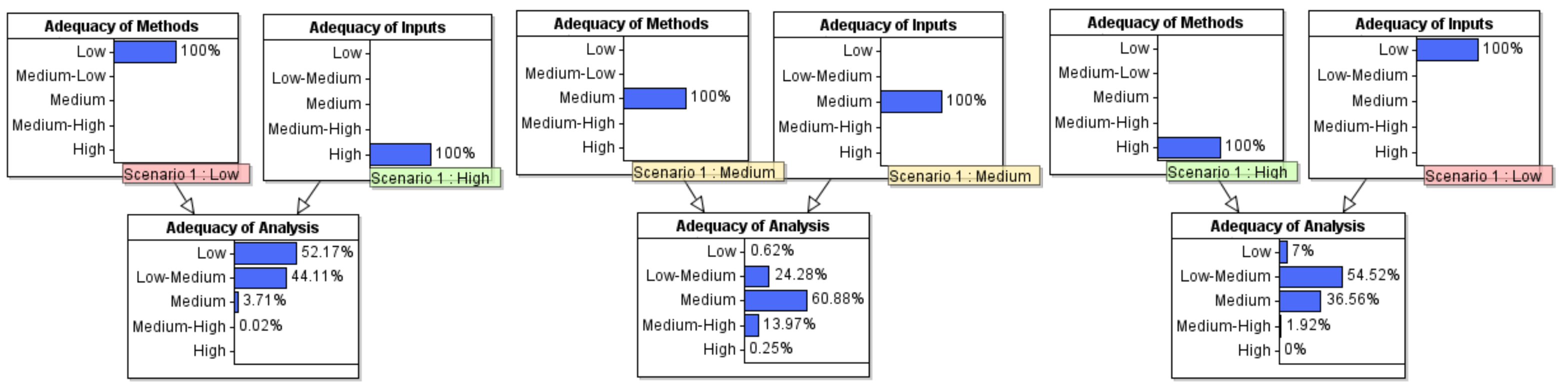


Figure A.3: Elicitation by WMIN Weighting Function



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APPENDIX B

Detailed Case Study Analysis

B.1. DEMONSTRATION OF PROPOSED FRAMEWORK

B.1.1. Introduction

The primary objective of this research effort is to address key challenges associated with the review and acceptance of performance-based design approaches to fire safety engineering through the development and implementation of a decision support framework that will assist AHJ representatives and FPE practitioners in determining whether a particular fire safety analysis is of sufficient technical adequacy to support regulatory decision-making for a given application. As defined by the framework, technical adequacy is evaluated along three measures: scope, level of detail and technical quality. To support implementation of the framework and thus the assessment of performance-based design approaches against these measures, a decision support tool is proposed and specified to yield a series of performance indicators that provide a measure of confidence in a design approach's ability to support a regulatory decision and that identify those aspects of the approach requiring further corrective action.

While the proposed framework and supporting tool is theoretically adaptable to the full range and variability of state-of-the-art performance-based design applications, a limited-scope case study is proposed herein to demonstrate the overall functionality, utility and scalability of the framework in a feasible and time-effective manner. To demonstrate functionality and utility, a series of case study examples are formulated. These examples:

- Explore the process of characterizing fire safety analysis deficiencies as a means to evaluate, through framework performance indicators, their impact on fire safety objectives and ultimately technical adequacy;
- Explain the aggregate impact of uncertainty associated with user-defined quality assessments on framework performance indicators; and
- Demonstrate the influence of candidate fire safety systems on framework performance indicators.

To demonstrate scalability, the constraints and limitations defined to shape the case study's scope will be, in a sense, relaxed, and their implications on the development and implementation of a broader scope framework and supporting tool will be assessed. This assessment will seek to explore and draw conclusions on the framework's general applicability to performance-based design applications. In short, by establishing the framework's functionality, utility and scalability, the proposed case study will serve to certify that overall research objectives are met.

B.1.2. SFPE Fire Engineering Design Case Study

To support its specification and implementation, the case study is adapted from one developed for the Society of Fire Protection Engineers (SFPE) Tenth International Conference on Performance-Based Codes and Fire Safety Design Methods held in Gold Coast, Queensland, Australia on November 10-12, 2014 [1]. The SFPE case study involves the development of a performance-based fire safety design and supporting project report by international chapters and participating countries for a challenging (or even controversial) application of performance-based design approaches to fire safety engineering. Apart from a limited but standardized set of specifications, including fire and life safety objectives, a basic building description, drawings, and minimum requirements for the project, practitioners for each represented country are free to develop a design solution consistent with their respective codes and standards; regulatory structure; and system and analysis preferences. The resulting variation between documented fire safety designs provides a backdrop that is well suited for exercising the proposed decision support framework and supporting tool.

Note, however, that owing to the scope and hypothetical nature of the SFPE case studies, the level of analysis and documentation performed by SFPE case study practitioners is not necessarily intended to reflect what would be seen in actual applications of performance-based design approaches. This is due, at least in part, to the limited specifications given to SFPE case study practitioners, who are consequently required to make a number of simplifying assumptions to facilitate performance-based design. For such reasons, the fire safety designs developed for the SFPE case study will be not individually assessed by the proposed decision support framework and supporting tool for technical adequacy. Instead, the SPFE case study, as a whole, will provide the context needed to inform and evaluate a set of hypothetical examples that form the case study proposed herein.

B.1.2.1. Building Description

The building addressed by the SFPE case study is shown in Figure 1 and is a mixed-use occupancy. Levels 1 through 3 contain carparks and leasable retail space, whereas Levels 4 through

8 are primarily office space. Level 9, the roof level, serves as a mechanical penthouse. As shown in Figure B.1 and Figure B.2, the building incorporates five office levels interconnected by floor voids that step diagonally up the office levels. Additionally, as shown on Figure B.2, each office level is connected by open stairways. The overall interconnectivity of the office levels is regarded as the key issue for the SFPE case study as smoke from a fire may readily spread through the various level interconnections. In addition to the level interconnectivity, there are also other issues associated with the office space that would generally challenge the application of prescriptive codes, including (i) the number and construction of exits; (ii) common path, travel distance, and exit remoteness; and (iii) egress capacity.

For simplicity, the case study proposed herein will only consider the office space on Levels 4 through 8 in demonstrating the decision support framework and supporting tool. Additional building and occupant characteristics for these levels may be found in each of the SFPE case study design reports.

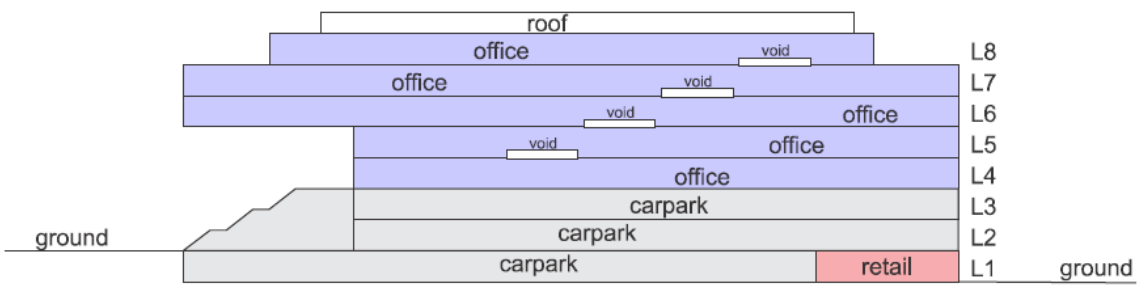

Figure B.1: Cross-Section of Case Study Building

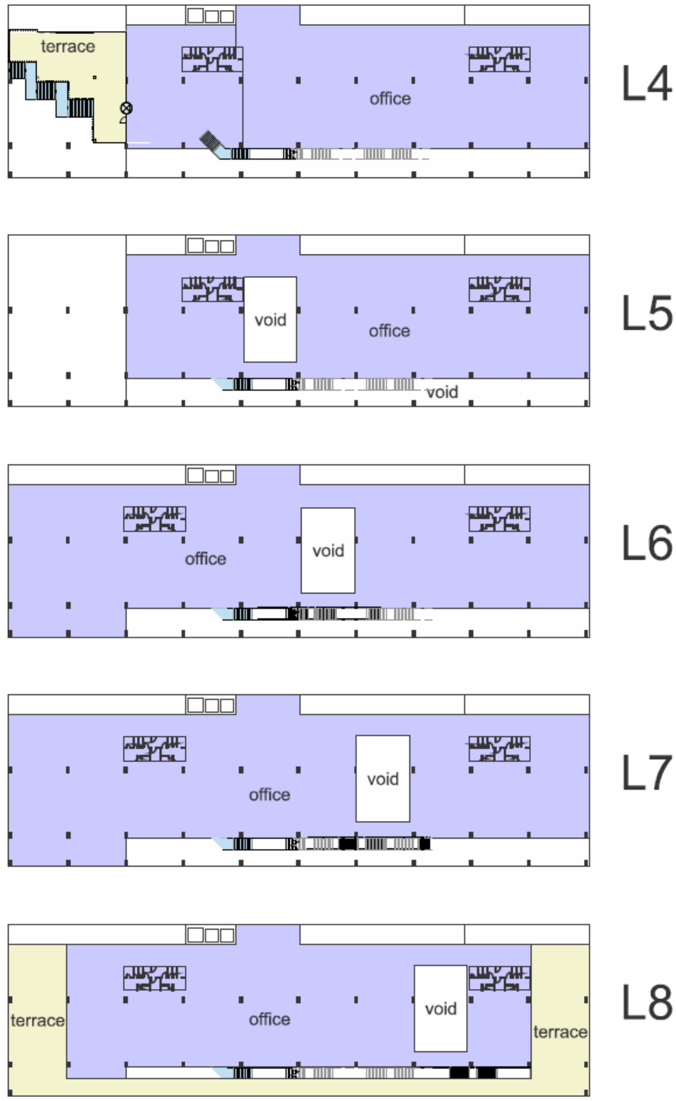

Figure B.2: Office Space Layout of Case Study Building

B.1.2.2. Regulatory Environment

For the specific SFPE case study referenced above, nine countries participated. The SFPE case study practitioners from each represented country that developed performance-based design solutions did so under the context of their country's respective regulatory frameworks. These frameworks can differ greatly in their processes and requirements and therefore have implications on the resulting performance-based design, including:

- specification of fire safety goals and objectives;
- degree to which performance-based design is prescribed;

- selection and acceptability of:
- analysis approaches (e.g., deterministic versus risk-based);
- supporting analysis methods, processes and data; and
- fire safety systems;
- level of regulatory oversight, quality assurance and documentation; and
- sufficiency of results (e.g., risk acceptance, degree of conservatism, etc.).

While the regulatory context is an important factor in performance-based fire safety design acceptance, the primary objective of the ongoing research is focused on the establishment of a proposed decision support framework and supporting tool to assess technical adequacy. As a result, the decision support framework will be largely generic and independent of a particular regulatory setting. If adopted within a specific regulatory environment, restrictions can be placed on the framework's use, or its design can be adapted appropriately.

B.1.2.3. Overview of Performance-Based Design Elements

As defined by the proposed decision support framework, performance-based fire safety designs confirm through fire safety analysis (i) that a fire safety system (ii) meets a defined set of fire safety objectives (iii). The SFPE case study practitioners address each of these three elements of fire safety design in various, albeit very similar ways. A brief overview of how each element was addressed by SFPE case study practitioners is provided below along with any implications on the scope of the case study proposed herein.

B.1.2.3.1. Fire Safety Objectives

Although the regulatory context may influence their makeup and assessment, the fire safety objectives of the SFPE case study can generally be summed up as the following:

- Safeguard occupants from injury due to fire until they reach a safe place;
- Safeguard fire fighters while performing rescue operations or attacking the fire;
- Design to avoid structural failure in the event of fire; and
- Design to avoid building-to-building fire spread.

These and other objectives (e.g., property protection) can be assessed by the decision support framework; however, the focus, at least for the purpose of the case study proposed herein, will be on life safety. In short, the framework, once implemented for the case study, will assess whether a performance-based fire safety analysis developed to justify a proposed fire safety design is of sufficient technical adequacy to support resulting conclusions made with respect to the safety of building occupants.

B.1.2.3.2. Fire Safety Analysis

All SFPE case study practitioners performed assessments of the building's fire hazards to ensure that their respective fire safety designs were consistent with the established fire safety objectives; however, while similarities exist between their overall approaches to fire safety analysis (i.e., all approaches are largely deterministic in nature), no two assessments are the same. Each SFPE case study practitioner implemented a unique set of processes, methods and data (e.g., for selecting, characterizing and modeling fire scenarios); made use of different tools (e.g., modeling occupant egress using SimTread, Pathfinder, FDS+Evac, or hand calculations); formulated differing assumptions, either simplifying the analysis (e.g., application of a single, bounding time to smoke detector and sprinkler activation to all scenarios) or addressing uncertainties (e.g., those associated with the post-sprinkler-activation heat release rate); and evaluated the sensitivity of analysis conclusions to different factors (e.g., reliability of active systems). In fact, this variation amongst practitioners, in part, demonstrates the need for the proposed framework.

To be consistent with research objectives, the proposed decision support framework should represent a consistent and uniform process for evaluating the technical adequacy of performance-based design approach for the full spectrum of fire safety analysis approaches. To do so, the proposed framework discretizes this spectrum into three high-level analysis approaches: deterministic, risk-informed, and risk-based. For each of the three analysis approaches, the framework proposes a series of technical requirements against which the technical adequacy of a particular fire safety analysis, including its supporting processes, methods and data, is assessed. In short, the decision support framework and its supporting tool, once implemented for the case study proposed herein, will be structured to address each of the three analysis approaches to performance-based design discussed above. In doing so, the proposed case study will not only encompass the SFPE case study but also serve to demonstrate the framework's general applicability to the full spectrum of fire safety analysis approaches.

Note that while the determination of whether supporting processes, methods or data are technically justifiable is relevant to the technical adequacy of a particular fire safety analysis, the selection of one process, method or data set over another is immaterial if either can satisfy the relevant technical requirements.

B.1.2.3.3. Fire Safety System

The fire safety system represents the collective preventative and mitigate safety features proposed by fire safety engineering practitioners to meet fire safety objectives and consistent with building and occupant characteristics. Owing to differences in their respective codes and standards, regulatory structure, and fire safety analysis preferences, the SFPE case study practitioners did not all arrive at the same definition of the resulting fire safety system. In some cases, practitioners relied largely on automatic fire sprinklers, and in others, additional measures were taken (e.g., mechanical smoke control systems, smoke curtains, etc.). For the purposes of the case study proposed herein, the decision support framework and supporting tool will be developed to acknowledge and account for differences in fire safety system design strategies. To do so, the proposed case study will, based on the SFPE case study, be developed to explore three fire safety systems. Each fire safety system consists of fire alarm, detection and communication systems; fire hydrants, hose reels and portable extinguishers; and exit signs and emergency lighting. In addition, the following features are addressed for each design:

- Fire Safety System 1
    - Automatic Fire Sprinklers
- Fire Safety System 2
    - Automatic, Mechanical Smoke Ventilation System
- Fire Safety System 3
    - Automatic Fire Sprinklers
    - Automatic Smoke Curtains and passive smoke barriers
    - Automatic, Natural Smoke Ventilation System

B.1.3. General Considerations for Development of Framework Elements

As clarified in the main report, the proposed decision support framework consists of three primary elements:

- ***Technical Requirements*** that set forth the minimum requirements for a technically acceptable performance-based design approach, independent of a particular application;
- ***Fire Safety Network Analysis*** that addresses the underlying dependencies between defined technical requirements and fire safety objectives; and
- ***Quantitative Assessment of Technical Quality*** that evaluates, through use of performance indicators, the individual and collective impact of unsatisfied technical requirements (i.e., analysis deficiencies) on technical adequacy.

As previously noted, the scope of the case study proposed herein to demonstrate the utility, functionality and scalability of the framework will be informed by the SFPE fire engineering case study. For this and other reasons, a number of assumptions that simplified the development of the framework were outlined above. In this section, the implications of these assumptions on each of the three primary elements of the framework will be reviewed.

B.1.3.1. Technical Requirements

For the purposes of the case study, the technical requirements of the decision support framework will be tailored to the scope limitations discussed above. These scope limitations limit the number of technical requirements that need to be developed to effectively demonstrate the proposed decision support framework. The following considerations apply:

- The framework will address the spectrum of potential fire safety analysis approaches by discretizing it into three high-level approaches: deterministic, risk-informed, and risk-based. Technical requirements will be developed for each of these approaches.
- Consistent with the focus on life safety, technical requirements will only seek to address this fire safety objective, more specifically, egress of building occupants and evaluation of tenability criteria.

- Additional scope limitations will also be applied to the framework for simplicity, and for this reason, technical requirements will give no consideration to the following aspects of the fire safety analysis:
    - Structural collapse
    - Shelter-in-place strategies
    - Fire service suppression and rescue activities
    - External fire spread
    - External fire scenarios
- Technical requirements will be developed to the extent needed to address the three fire safety designs proposed above.

Lastly, while the analysis approaches used by practitioners in SFPE case study were largely deterministic, the case study examples and posited analysis deficiencies, as discussed later, will also explore hypothetical applications of the framework that seek to meet the technical requirements established for the other two high-level analysis approaches (i.e., risk-informed and risk-based). It is also worth noting that to further characterize the scope and level of detail associated with each of the three high-level analysis approaches, the framework sub-divides each technical requirement into one of three capability categories. While the full set of technical requirements (apart from scope limitations) will be developed for demonstration purposes, the case study examples will center on the assumption that the middle or second capability category for each high-level analysis approach is the one deemed acceptable by the fictitious case study stakeholders. As such, the level of effort associated with the development of technical requirements for the case study will be scaled accordingly and as needed.

B.1.3.2. Fire Safety Network Analysis

Given that the fire safety network addresses the underlying dependencies between defined technical requirements and fire safety objectives, the scope limitations posed above for technical requirements will similarly apply to the fire safety network analysis developed for the case study. Limitations placed upon the scope of the framework are manifested by a reduction in either the number of nodes contained within the network or the connections between them. To facilitate demonstration of the framework, these reductions are both practical and acceptable.

B.1.3.3. Quantitative Assessment of Technical Quality

The fire safety network is analyzed as a Bayesian network and quantified to arrive at performance indicators related to the fire safety objective(s) being addressed. As expected, the scope limitations reviewed above for technical requirements and the fire safety network filter through to the quantification of the network itself. Requirements for quantification include assignment of weights to assess nodal influence as well as nodal quality assessments and associated uncertainty estimates.

Nodal influence may be dictated by factors associated with either the fire safety design or building/occupant characteristics. Given that all case study examples evaluate the same building, these latter factors will be assessed using information derived from the SFPE case study project reports and used to assign weights to all case study examples described herein. For the other factors, they will be assessed for each of three proposed fire safety designs and used to assign weights to the case study examples based on the design each employs.

Nodal quality assessments are based on the degree to which relevant technical requirements are met and the characterization of any associated analysis deficiencies. As described in the case study examples below, hypothetical analysis deficiencies will be introduced and characterized to demonstrate how such quality assessments are made. A similar process will be followed to address uncertainty.

B.1.4. Case Study Examples

The decision support framework can be demonstrated through use of its supporting tool, which will be exercised by a series of three examples. The tool consists of an interactive spreadsheet that contains all technical requirements and allows for the structured documentation of technical adequacy assessments. Relevant inputs from the spreadsheet are then used to structure the fire safety network analysis and quantify the performance indicators, including associated importance factors. Below, the purpose of each case study example below is discussed. Any additional conditions and limitations on the framework or tool are also reviewed.

B.1.4.1. Case Study Example A

The purpose of this case study example is to explore the process of characterizing fire safety analysis deficiencies as a means to evaluate, through framework performance indicators, their impact on fire safety objectives and ultimately the technical adequacy of a fire safety analysis. As indicated previously, this case study example will explore implementation of the decision support framework and its supporting tool for each of the three high-level analysis approaches (i.e., deterministic, risk-informed and risk-based). The general process for this example is described as follows:

- Develop and specify the decision support framework and supporting tool to be consistent with the general considerations and assumptions discussed above.
- Assign weights to assess nodal influences based on the fire safety design as well as building/occupant characteristics. For this case study example, Fire Safety System 1 will provide the basis for weights where relevant.
- Assume that the expectations of the case study's fictitious stakeholders are to demonstrate fire safety objectives using a fire safety analysis that meets requirements associated with the second or middle capability category for each of the three fire safety analysis approaches. The selection of which technical requirements to apply is based on a number of factors that are particular to the application (e.g., occupancy type, building and occupant characteristics, stakeholder expectations, the fire safety system design, risk tolerance, etc.).
- Propose and develop a series of general fire safety analysis deficiencies, i.e., with regard to scope, level of detail and technical quality, that are informed by both the SFPE case study and real-world practice. Each general deficiency defined will be common across all three of the high-level analysis approaches (i.e., deterministic, risk-informed and risk-based), but each will then be further specified to reflect the expectations of each approach's respective technical requirements as well as the processes, methods and data typical of that approach.
- Use the decision support tool to assess the technical requirements and assign nodal quality assessments in the context of the posited deficiencies. For simplicity, technical requirements not impacted by posited deficiencies will be assumed to meet the intent

of those requirements without impact to technical quality. In addition, uncertainties associated with nodal quality assessments will all be uniformly characterized (i.e., low); the issue of uncertainty will be further explored by Case Study Example B.

- Assess the collective impact of posited deficiencies on performance indicators. An importance analysis will also be performed to assess the relative importance of individual deficiencies.

B.1.4.1.1. Simplified Network Analysis

As conceptualized in the main report, a systems-based approach, as proposed by the International Fire Guidelines [2] and informed by the Fire Safety Concept Tree [3] and Park, et al. [4-6], was employed to develop a simplified network that is consistent with the general case study considerations and assumptions in Section B.1.3. The resulting network is presented in Figure B.3. The sub-systems considered by the network are described in Table B.1. Considering the primary fire safety objective of the case study, the performance indicator for the network is life safety.

This preliminary network was developed to facilitate initial identification of technical requirements and to understand their relationship to each other and the life safety performance indicator. In many ways, the network intuitively mirrors the natural development and progression of a fire scenarios. Starting with fire development in the room of origin, the network then queries how such influences smoke development and actuation of fire safety systems, the effect of which alters (or modifies) fire and smoke development within the room of origin. Additionally, the potential for flashover must be considered. With different states of fire and smoke development within the room of origin characterized, the collective influence of these states on fire and smoke spread external to the room of origin is then addressed. The goal is to understand the influence the two primary components of egress, namely the available and required safe egress times (i.e., ASET and RSET, respectively). In the end, the life safety performance indicator for technical quality is then a function of three components: the manner in which fire scenarios were (1) identified, (2) characterized (i.e., considering safe egress), and (3) analyzed.

In Section B.1.4.1.2, the process of identifying and defining technical requirements, particularly supporting requirements and influencing factors, will greatly increase the network's level of complexity (i.e., the number of nodes and edges). Figure B.3 will continue to serve as a general roadmap of the final case study network; however, additional logic was needed to address identified supporting requirements and their influencing factors, consistent with the main report. Appendix H provides a summary of how the complete fire safety network supporting was developed for this this case study.

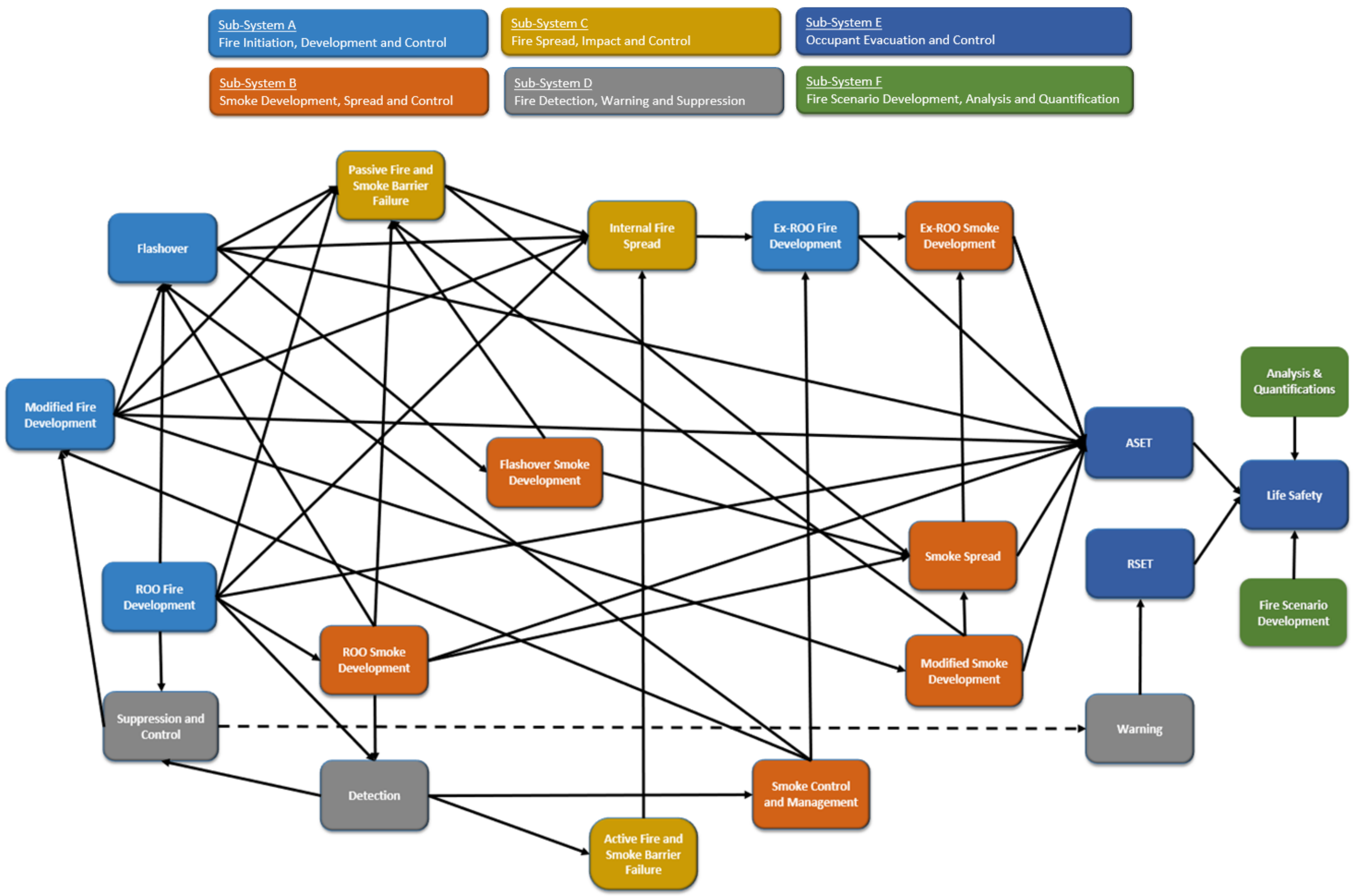

Figure B.3: Simplified Fire Safety Network

B.1.4.1.2. Technical Requirements

As conceptualized in the main report, a series of technical requirements were formulated for this case study example. Such requirements include technical elements, high-level requirements and requirements. Each level of technical requirement is discussed below.

<u>Technical Elements</u>

The technical elements for this case study example were derived from the sub-systems identified in Section B.1.4.1.1. Table B.1 below describes each proposed technical element.

Table B.1: Case Study Technical Elements

Sub-System	Technical Element	Description
A	Fire Initiation, Development and Control (FIDC)	This element relates to design fires in the enclosure of fire origin as well as enclosures to which the fire has subsequently spreads and how fire initiation and development might be controlled.
B	Smoke Development, Spread and Control (SDSC)	This element analyzes the development of smoke, its spread within the building, the properties of the smoke at locations of interest and how the development and spread might be controlled.
C	Fire Spread, Impact and Control (FSIC)	This element analyzes the spread of fire beyond an enclosure, the impact a fire might have on the structure and how the spread and impact might be controlled.
D	Fire Detection, Warning and Suppression (FDWS)	This element analyzes detection, warning and suppression for fires. This process enables estimates to be made of the actuation, availability and effectiveness of fire safety systems, including suppression.
E	Occupant Evacuation and Control (OEC)	This element analyzes the evacuation of the occupants of a building. This process enables estimates to be made of the times required for occupants to reach a place of safety.
F	Fire Scenario Development (FSD)	This element analyzes the identification, selection and characterization of fire scenarios to be assessed.

Sub-System	Technical Element	Description
F	Analysis and Quantification (AQ)	This element addresses the analysis and quantification techniques of assessed fire scenarios. This process includes characterization of parametric and epistemic uncertainties.

High Level Requirements

Each of the technical elements defined in Table B.1 is further subdivided into a series of high-level requirements. As defined in the main report, high-level requirements, through their supporting requirements, set forth the minimum requirements for a technically acceptable fire safety analysis. High-level requirements developed for this case study example are provided and described in Table B.2.

Table B.2: Case Study High-Level Requirements

Technical Element (TE)	High-Level Requirements (HLRs)		Description
	ID	Title	
Fire Initiation, Development and Control (FIDC)	HLR-FIDC-A	Room of Origin Fire Development (ROO)	These HLRs address each of the proposed stages of fire development.
	HLR-FIDC-B	Modified Fire Development (MOD)	
	HLR-FIDC-C	Flashover (FO)	
	HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)	
Smoke Development, Spread and Control (SDSC)	HLR-SDSC-A	Room of Origin Smoke Development (ROO)	These HLRs address each of the proposed stages of smoke development as well as efforts to control and management smoke spread, either by ventilation systems or barriers.
	HLR-SDSC-B	Modified Smoke Development (MOD)	
	HLR-SDSC-C	Flashover Smoke Development (FO)	
	HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)	
	HLR-SDSC-E	Smoke Control and Management (SC&M)	
	HLR-SDSC-F	Smoke Barrier Failure (SBF)	

Technical Element (TE)	High-Level Requirements (HLRs)		Description
	ID	Title	
Fire Spread, Impact and Control (FSIC)	HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)	These HLRs address the spread of fire from the room of origin through openings or as a result of barrier failures.
	HLR-FSIC-B	Fire Barrier Failure (FBF)	
Fire Detection, Warning and Suppression (FDWS)	HLR-FDWS-A	Manual Notification System (MNS)	These HLRs address the actuation, availability and effectiveness of fire protection systems that notify building occupants of fire; control and suppress the fire; or control and manage fire and smoke spread.
	HLR-FDWS-B	Automatic Notification System (ANS)	
	HLR-FDWS-C	Manual Suppression and Control (MS&C)	
	HLR-FDWS-D	Automatic Suppression and Control (AS&C)	
	HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)	
	HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)	
	HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)	
Occupant Evacuation and Control (OEC)	HLR-OEC-A	Available Safe Egress Time (ASET)	These HLRs address the egress of building occupants, through the calculation and comparison of ASET and RSET.
	HLR-OEC-B	Required Safe Egress Time (RSET)	
	HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)	
Fire Scenario Development (FSD)	HLR-FSD-A	Fire Hazards (FH)	These HLRs address the identification and characterization of fire hazards and scenarios within the building or compartment of interest.
	HLR-FSD-B	Potential Fire Scenarios (PFS)	
	HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)	
Analysis and Quantification (AQ)	HLR-AQ-A	Quantification Methodology (Q)	These HLRs address quantification of fire scenarios identified for analysis. This includes the treatment of parametric and epistemic uncertainties, as defined by NUREG-1855 [17].
	HLR-AQ-B	Modeling Uncertainty (MU)	
	HLR-AQ-C	Parametric Uncertainty (MU)	
	HLR-AQ-D	Completeness Uncertainty (CU)	

Supporting Requirements

As defined in the main report, supporting requirements represent the most refined level of technical requirement, at which explicit performance requirements define the scope and level of detail of the fire safety analysis. The process of identifying a set of supporting requirements for each high-level requirement was informed by the systems-based approaches applied by the International Fire Guidelines [2], the Fire Safety Concept Tree [3] and Park, et al. [4-6] as well as other performance-based fire protection engineering references, including SFPE guidance [7], National Fire Protection Association codes [e.g., 8-9], and nuclear industry guidance [10-16].

Because the performance indicator of interest for the case study example is life safety, the supporting requirements for HLRs FIDC and SDSC were developed to inform the phenomenological conditions for each fire state (i.e., room of origin, modified, flashover and external to the room of origin) that limit tenability: smoke layer height, smoke obscuration, smoke toxicity and thermal effects, including radiation from fire and smoke layer. For HLR FDWS, the supporting requirements reflected general consideration of fire protection system actuation, availability and effectiveness. HLR OEC focused primarily on the integration of tenability concerns associated with fire and smoke phenomena and the general occupant egress timing considerations. The HLR FSD mirrored a generic fire scenario development process, which consists of identifying potential scenarios based on fire hazards present and then limiting those scenarios to those that are formally analyzed. Lastly, the HLR AQ simply considered fire safety analysis quantification and the treatment of associated parametric and epistemic uncertainties.

The full set of supporting requirements developed for the case study example are detailed in Appendix C and are organized by technical element and high-level requirement.

B.1.4.1.3. Capability Categories

Consistent with approach outlined in the main report and informed by the ASME/ANS standard for probabilistic risk assessments [16], capability categories were defined for each of the three overall fire analysis approaches addressed by the framework, i.e., deterministic, risk-informed, and risk-based. For the case study example, each supporting requirement, in theory, could have up to nine capability categories, or three for each approach. However, in many cases, only one or two performance statements, or technical capabilities, were defined for each approach; that is, for some supporting requirements, capability categories were merged. Each capability category should generally reflect a consistent scope, level of detail, occupancy-specificity, analysis approach and realism across all supporting requirements. Appendix C provides the capability categories and associated performance statements for each supporting requirement defined for the case study example.

B.1.4.1.4. Influencing Factors

While the supporting requirements and their capability categories control the fire safety analysis scope and level of detail, the technical quality of the fire safety analysis, as discussed in the main report, is dictated by the degree to which the fire safety analysis considers a series of influencing factors defined for each supporting requirement. For instance, according to the supporting requirement that addresses fire size for the room of origin (i.e., SR FIDC-A1), fire scenarios must develop and justify one or a set of heat release rates to be applied prior to flashover or actuation of fire protection features. However, to do so properly, the analyst must address characteristics associated with the ignition source (e.g., energy), the fuel (e.g., loading, density, heat of combustion, etc.) and the building. In addition, ventilation conditions and the manner in which the fire will grow and spread within the room of origin must also be considered. Lastly, the analysis of the fire size must be performed using acceptable models and methods.

If one or more of the aforementioned factors are inadequate, then the technical quality associated with analyzing the fire size in the room of origin will be diminished. Note that in some cases and as dictated the fire safety network analysis, the influencing factor under one supporting requirement may be a causal link to another supporting requirement. For instance, the fire size or heat release rate in the room of origin, which is addressed by one supporting requirement (i.e., SR FIDC-A1), would influence smoke production within the room of origin, which is itself another supporting requirement (i.e., SR SDSC-A1).

Appendix D documents all influencing factors that were identified for each supporting requirement considered by the case study example. A description of each influencing factor is also provided. While these high-level descriptions are more or less generic, they can be further specified for different occupancies (e.g., hospital), building configurations (e.g., atrium), use (e.g., gathering place), etc. to ensure the end user of the decision support tool interprets each influencing factor correctly.

As explained in Section B.1.4.1.1, these factors and their interrelationships with the supporting requirements add complexity to the simplified fire safety network defined earlier in

Figure B.3. In some cases, to facilitate nodal characterization and weighting, additional logic (or intermediary nodes) were created to combine supporting requirements in a more intuitive fashion. This logic is, in part, summarized in Appendix B. In Appendix D, influencing factors that are greyed out under the supporting requirements identify those factors that represent causal connections to other supporting requirements or intermediary nodes.

B.1.4.1.5. Nodal Analysis of Technical Quality

Nodes refer to individual influencing factors and were quantitatively characterized consistent with the main report and Appendix A. That is, each node is represented as a doubly truncated Normal distribution with a mean value indicative of that node's assigned technical quality and a variance representative of the user's state of knowledge regarding the nodes true value. Node quality and variance are mapped onto a five-point ranked scale (i.e., low, low-medium, medium, medium-high, and high) to facilitate their characterization and communication.

Consistent with the approach specified, nodal quality scales were developed for each influencing factor as a means of providing guidance to the user regarding the selection of quality states. For each influencing factor, an explanation of what constitutes low-, medium- and high-quality values is provided, and intermediate values can be selected as needed. Factors of a similar type (e.g., building characteristics) make use of a common quality scale. Appendix E provides the quality scales for all influencing factors considered by the decision support tool.

Note that after the quality of all influencing factors associated with a given supporting requirement is assessed, the quality of that supporting requirement is then determined using quantification techniques discussed within the main report and Appendix A. If the supporting requirement serves as an influencing factor under another supporting requirement, the resulting quality is carried forward and would influence the quality of the other supporting requirement. The same process is applied for assessing the quality of intermediary nodes discussed in Section B.1.4.1.4. In effect, users are only expected to assess the quality of true influencing factors and not referenced supporting requirements or intermediary nodes. As a result, such objects in the Appendix F decision support tool lack quality scales as well as user-defined quality and uncertainty inputs.

For the purposes of this case study example, the technical quality of all influencing factors is assumed to be *High* unless a deficiency, such as those discussed in Section B.1.4.1.7, is identified. Similarly, all uncertainty ratings were defaulted to *None,* but if assigned to an influencing factor with a deficiency, they were changed to *Low*. However, Case Study Example B, as detailed in Section B.1.4.2, will explore the impact of alternate uncertainty assessments.

B.1.4.1.6. Nodal Influence and Weighting

As discussed in the main report and Appendix A, network weights are based on several factors. While it is expected that future iterations of the decision support tool would generate network weights based on a limited set of inputs, e.g., the occupancy of interest and a defined set of risk factors (e.g., building height, fuel loading and characteristics, etc.), a systematic effort to develop such a scheme and benchmark it to ensure proper relativity between applications is beyond the scope of this research effort. However, for the purposes of this case study, use of engineering judgement of the researcher will suffice as a means to demonstrate the value and effectiveness of the decision support tool. When assigning the relative weights, care must be taken to account for the characteristics of the WMIN weighting function being applied. Under some circumstances (e.g., when all weights are high), WMIN approaches a normal MIN function, and under others (e.g., when all weights are low), it represents the AVERAGE function.

Appendix G documents the weights, including those assigned to intermediary nodes, applied in this case study example. Note that as described in Section B.1.4.1, the weights associated with Fire Safety System 1 are assigned to Case Study Example A.

B.1.4.1.7. Proposed Deficiencies

In general, the purpose of the proposed decision support tool is to assist the user, either an AHJ representative or a fire protection engineering practitioner, in evaluating the technical adequacy of a performance-based fire safety analysis being used to justify a fire safety system relative to some fire safety objective (e.g., life safety). The first step in doing so is to determine the capability category at which the fire safety analysis should be assessed. In essence, there are two ways of making this determination. The first is to assess the scope and level of detail of the analysis against the supporting requirements to define the capability category that the fire safety meets (or most represents). The second is to have stakeholders agree on which capability category (or categories) an acceptable analysis should be required to meet. Based on assumptions of this case study outlined in Section B.1.4.1, the desired capability category is assumed to CC-II for each overall performance approach.

Note that the capability category chosen does not inherently impact the quality of the fire safety analysis. That is, a high-level, conservative analysis can be just as appropriate with respect to justifying a performance-based design as a detailed, realistic one; though, in some cases (e.g., where risk is high with regard to a particular fire safety objective), the analytical results of the former may, independent of its quality, be unable to meet established performance-based acceptance criteria.

With the desired capability category known, the fire safety analysis is then reviewed against the associated performance statements to determine whether the analysis was performed consistent with the technical requirements and in consideration of the identified influencing factors. As reviewed in Section B.1.4.1.4, if one or more of the influencing factors of interest are inadequate, then the technical quality associated with the supporting requirement will be diminished. In such a case, a deficiency is identified against the inadequate influencing factor, and its impact on technical quality is assessed. As shown in Appendix F, such deficiencies may be documented under the column titled, "Findings & Observations (F&Os)".

For the purposes of the case study, F&Os are written against a theoretical fire safety analysis that evaluates the life safety of the building described in Section B.1.2 and that reflects the considerations documented in Section B.1.3 and this section (e.g., credited fire protection features). Because the fire safety analysis is hypothetical, general deficiencies will be defined and then further specified, as needed, for each of the overall performance-based approaches (i.e., deterministic, risk-informed, and risk-informed). Table B.3 provides the characterization of the deficiencies proposed for not only Case Study Example A but also Case Study Examples B and C, which will be explored in Sections B.1.4.2 and B.1.4.3, respectively. The affected supporting requirements and influencing factors are identified in both Table B.3 and Appendix F.

Based on the description of each hypothetical deficiency, a quality rating was assigned to the affected influencing factor(s). Note that the same quality ratings were applied to deficiencies associated with credited fire safety systems (i.e., F&Os 4, 6 and 7). This was done to more precisely assess, under Case Study Example C, the relative impact of the different safety systems on quality, or more specifically the life safety performance indicator.

Table B.3: Characterization of Hypothetical Deficiencies

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
1	A B C	The fire safety analysis does not appropriately justify, for the occupancy of interest, the severity and growth rate of fire(s) within the room of origin.	FIDC-A1 - Fuel and Loading Characteristics (ROO)	The fire safety analysis does not substantiate, via applicable data or testing, the heat releases (HRR) applied to fire scenarios within the room of origin, and considering the fuel characteristics typical of this occupancy, the HRRs applied within the analysis substantially underpredicts the effects of fire.	Low
			FIDC-A2 - Temporal Profile (ROO)	Based on the types of fuel packages for this occupancy, the overall growth rate is expected to be medium; though, the analysis applies a slower rate, which may or may not have a substantial impact on the results of the analysis.	Low-Medium
			FIDC-A2 - Fuel Characteristics (ROO)	Spread to secondary combustibles is not considered by the applied HRRs. This is expected to have more than a minimal impact.	Low
2	A B C	The fire safety analysis does not use soot yield data that are appropriate for the fire scenario(s) being modeled in the room of origin.	FIDC-A4: Smoke Yield (ROO)	The burning material assumed by the fire reaction is not characteristic of the materials most typical of the occupancy. Though not representative, the soot yield applied is expected to have a minimal impact.	Medium
			FIDC-B4 - Smoke Yield Data (MOD)		Medium
3	A B C	The fire safety analysis does not appropriately estimate smoke production within the room of origin.	SDSC-A1 - Method Verification and Validation (ROO)	The method applied to calculate the air entrainment rate into the fire plume has not been fully validated for the application at hand. No documentation of such validation is provided, and available references indicate that the method has been applied outside of its range of applicability. The impact is expected to be substantial.	Low
			SDSC-B1 - Method Verification and Validation (MOD)		Low

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
4	A B C	The fire safety analysis does not adequately justify the time to sprinkler actuation. Additionally, the availability of the sprinkler system was not appropriately estimated.	FDWS-D3: Timing of Automatic Detection (AS&C)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-D5 - System Design and Maintenance (AS&C)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium
5	A B C	The fire safety analysis does not appropriately estimate egress timing.	OEC-B3 - Occupant Characteristics (RSET)	The speed of travel on in stairwells assumed for occupants during egress is much faster than that which would typical and the same as the speed of travel assumed for flat surfaces. The impact may be more than minor.	Low-Medium
6	C	The fire safety analysis does not appropriately justify the time to actuation of active smoke barriers or consider the availability of associated detection.	FDWS-F3 - Detector Characteristics (DA-ASB)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-F4 - System Design and Maintenance (DA-ASB)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium

F&O ID	Applicable Case Study Examples	General Deficiency	Affected SRs and Influencing Factors	Hypothetical F&Os	Quality Rating
7	C	The fire safety analysis does not appropriately justify the time to actuation of the smoke management and control system or consider the availability of associated detection.	FDWS-G3 - Detector Characteristics (DA-SC&M)	The optical density required for activation is not characteristic of the detector employed by the fire safety system. The threshold values assumed will result in much earlier detection and subsequent system actuation than would otherwise be expected.	Low
			FDWS-G4 - System Design and Maintenance (DA-SC&M)	The system design as to be installed is not consistent with applicable codes and standards. Such deviations are expected to diminish the overall availability of the system. For risk-informed and -based approaches, such outlier behavior would make generic estimates of system availability inappropriate. This may have a more than minor impact on the results of the analysis.	Low-Medium

B.1.4.1.8. Review of Quantification Methods and Results

The decision support tool for this case study was developed in Microsoft Excel. Appendix F is a snapshot of this tool. The logic and nodal weights of the fire safety network, which was preliminarily outlined in Figure B.3 and further detailed in B.1.4.1.2, are embedded within the spreadsheet environment. With quality and uncertainty assessments assigned for all relevant influencing factors, the underlying fire safety network can be quantified.

Because the Bayesian network approach applied by the tool is inherently probabilistic and quality assessments of each influencing factor (or node) with the fire safety network are represented by distributions, the Palisade @Risk tool, which is an add-on to Microsoft Excel, was used to quantify the life safety performance indicator via Monte Carlo simulation. By default, all quality and uncertainty ratings are assigned as *High* and *None*, respectively, and if quantified, the life safety performance indicator would be 100%, or of *High* quality, and its uncertainty would be 0.00, or *None*. As deficiencies are identified and characterized within the tool, the network can be re-quantified to understand their impact on the life safety performance indicator.

To evaluate the impact of deficiencies identified for Case Study Example A in Table B.3, the quality ratings documented for each F&O in this table were assigned to the relevant influencing factor within the tool. The network was then quantified using Palisade @Risk. The life safety performance indicator, as a result of all F&Os, has a mean (μ) of 39.2% (*Low-Medium)* and an effective variance (σ^2) of 0.018 (*Low).* The distribution of the life safety performance indicator is presented in Figure B.4. Based on this visualization of the indicator, the fire safety analysis can be said to be of *Low-Medium* or *Medium* quality.

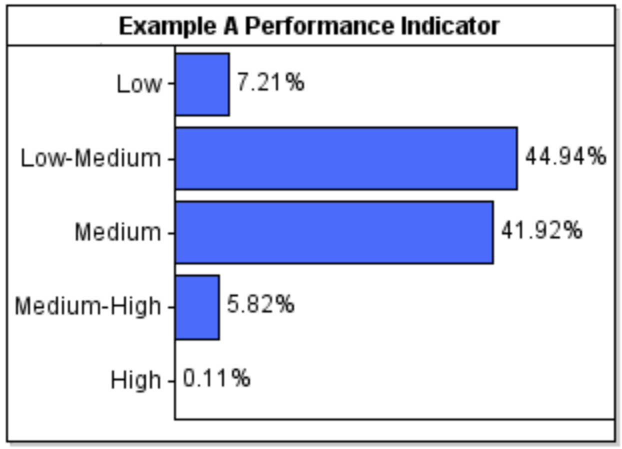

Figure B.4: Distribution of Performance Indicator for Case Study Example A

Based on this quality rating, it is questionable that the safety analysis would be of sufficient technical quality to support decision-making regarding life safety. That is, the fire safety system may theoretically be effective and limit risk to life safety from fire to an acceptable level, but the fire safety analysis, with the identified deficiencies left unaddressed, should not be relied upon to conclude so. As discussed in Section 6 of the main report, further benchmarking of the tool would be needed before interpreting the quantified results as an absolute measure of technical quality.

To provide additional insights, the life safety performance indicator is quantified for the different combinations of the F&O identified in Table B.4; that is, the F&Os not identified were effectively resolved by reassigning the quality of affected influencing factors as *High*. Note that the resulting uncertainty of each performance indicator is *Low*. Results are documented in Table B.4.

With regard to those F&Os associated with fire development in the room of origin (i.e., F&Os 1 and 2), F&O 1, regarding fire heat release and growth rates, dominates. With these two deficiencies, the overall quality is reduced to 64.1%; however, should the automatic suppression system credited by the fire safety system be deficient in analysis space (i.e., F&O 4), the quality is reduced further to 53.9%. This demonstrates that despite having deficiencies associated with fire development, the automatic suppression system, barring quality concerns of its own, would provide additional assurance and reduce the importance of the fire development deficiencies. However, the same cannot be said for F&O 3, which has the largest impact on quality is F&O 3.

If the fire safety analysis has deficiencies associated with smoke development (i.e., F&O 3) as well, then the quality is even further reduced to 42.8%. Yet, the lack or presence of deficiencies associated with the automatic suppression system effectively does not change the overall quality assigned to the fire safety analysis. In this circumstance, the automatic suppression system credited by the fire safety system should provide no additional assurance regarding life safety considerations. In other words, the quality of F&Os 1, 2 & 3 suggests that the fire safety analysis would underestimate challenges to life safety to such an extent that the mere presence of an automatic suppression system should not be relied upon by stakeholders to justify the fire safety system being proposed. In comparing the quality result for F&O 5 (83.3%) against that for F&Os 4 & 5 (66.4%), the opposite conclusion can be drawn; namely, the inclusion of the automatic suppression system in the fire safety analysis without deficiencies may obviate the resolution of F&O 5.

Table B.4: Summary of Performance Indicators (PIs) for Case Study Example A

F&O ID	**PI**		**F&O ID**	**PI**	
	μ	**σ^2**		**μ**	**σ^2**
All	39.2%	0.018	1 & 2	64.1%	0.013
1	64.1%	0.014	1 & 4	53.9%	0.016
2	76.4%	0.005	2 & 4	59.5%	0.016
3	45.3%	0.017	1, 2 & 4	53.9%	0.017
4	60.5%	0.017	1, 2 & 3	42.8%	0.018
5	83.3%	0.010	1, 2, 3 & 4	42.1%	0.017
			4 & 5	58.2%	0.021

B.1.4.1.9. Importance Analyses

As discussed in the main report, a metric can be defined to assess the relative importance of F&Os. Doing so can prioritize the resolution of deficiencies. For the purposes of this case study, the importance metric was defined as the difference between perfect quality (i.e., 100%) and the actual quality rating quantified by the tool for the deficiency of interest. Figure B.5 displays the resulting importance indicators for each F&O considered for Case Study Example A. As discussed in the preceding section, F&O 3 has the highest importance to the overall quality of the fire safety analysis and should have the highest priority for resolution.

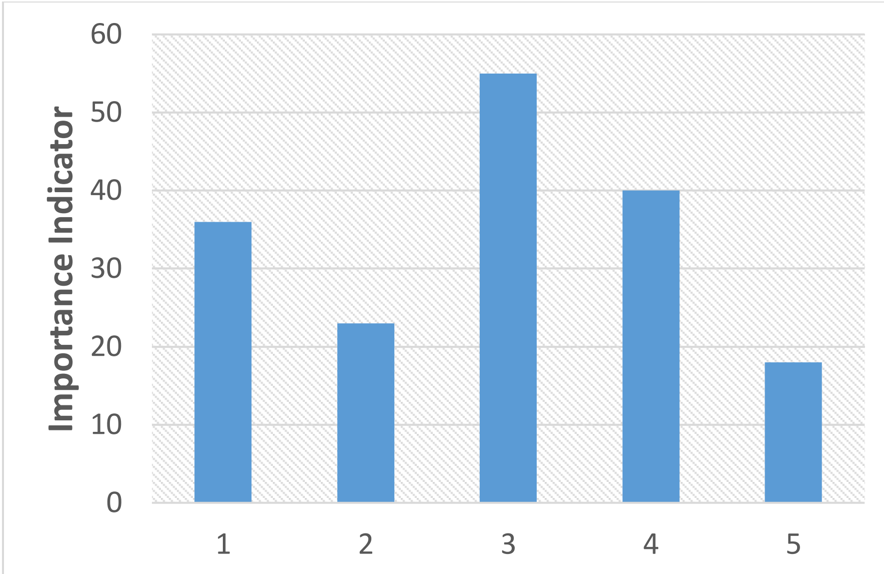

Figure B.5: F&O Importance Ranking for Case Study Example A

B.1.4.2. Case Study Example B

The purpose of this case study example is to explore how the uncertainties associated with nodal quality assessments are characterized using the decision support framework and propagated to assess framework performance indicators. The general process for this example is described as follows:

- Apply Case Study Example A, and expand it to address uncertainty associated with nodal quality assessments.
- Re-characterize deficiencies defined and specified for Example A to include hypothetical uncertainties associated with relevant analysis methods, processes and data.
- Assess the collective impact of posited deficiencies and uncertainties on performance indicators.
- Analyze the results, summarizing insights gained.

B.1.4.2.1. Revisions to Case Study Example A

The inputs to Case Study Example B (e.g., network weights, quality ratings associated with deficiencies) remained the same as those to Case Study Example A with the exception of the uncertainty values, which were adjusted as indicated in the next section.

B.1.4.2.2. Review of Quantification Results

The uncertainty assessments for all F&Os addressed by Case Study Example A were changed from *Low* to *Medium* and then to *High*, and the network model was re-quantified. Figure B.6 demonstrates the impact of uncertainty on the overall life safety performance indicator. As the uncertainty of deficient nodes within the network increases, the distribution of the performance indicator spreads out and becomes flatter. Additionally, the mean values of the indicator change as well. With *Low* uncertainty, the mean is 39.2%; with *Medium*, 44.5%; and with *High*, 49.4%. Similarly, the uncertainty rating of the life safety performance indicator also increases, i.e., from 0.018 (*Low)* to 0.094 (*Medium)*; though, this increase is not as drastic as it is for the deficient nodes because the other nodes in the network, as discussed earlier, are assumed to have an uncertainty rating of *None*.

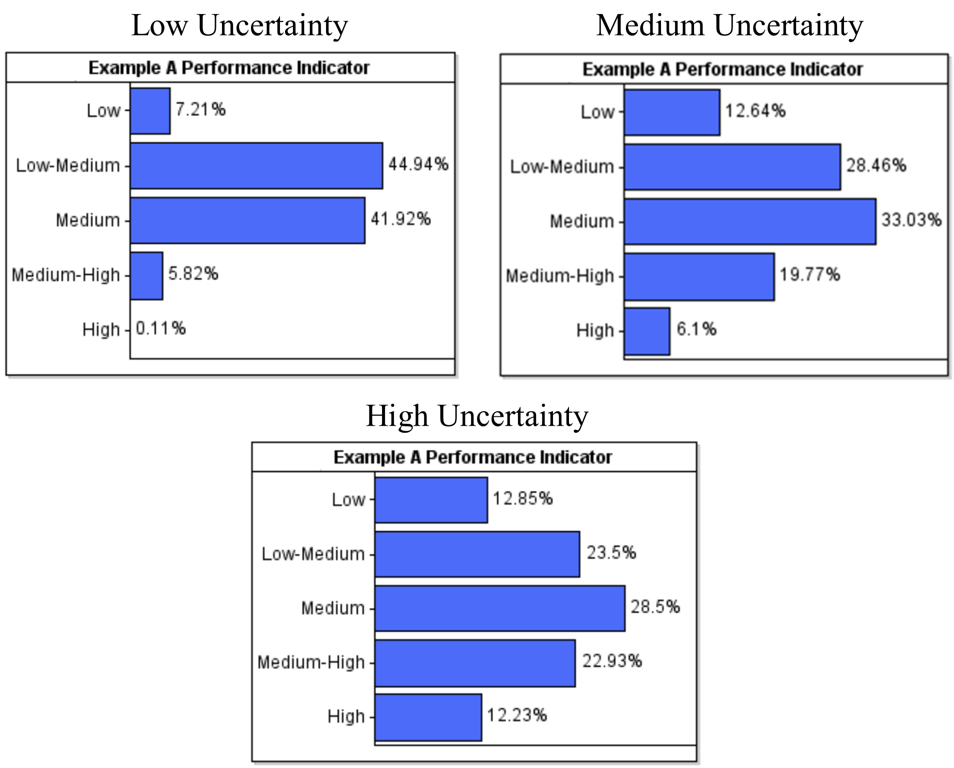

Figure B.6: Variation of Variance for Case Study Example A

In this next example, the uncertainty assessments were only changed for F&Os 1, 2 and 4 from *Low* to *Medium* and then to *High*. The other F&Os addressed by Case Study Example A were turned off, and the network model was re-quantified. Figure B.7 demonstrates the impact of these changes. As the uncertainty assessments for affected nodes increase, the distribution associated with the life safety performance indicator spreads out and flattens. The mean value of the distribution also increases slightly from 53.9% to a high of 59.2%. This example and the previous one predictably indicates that as the beliefs of the user becomes less certain, the technical quality also becomes less clear.

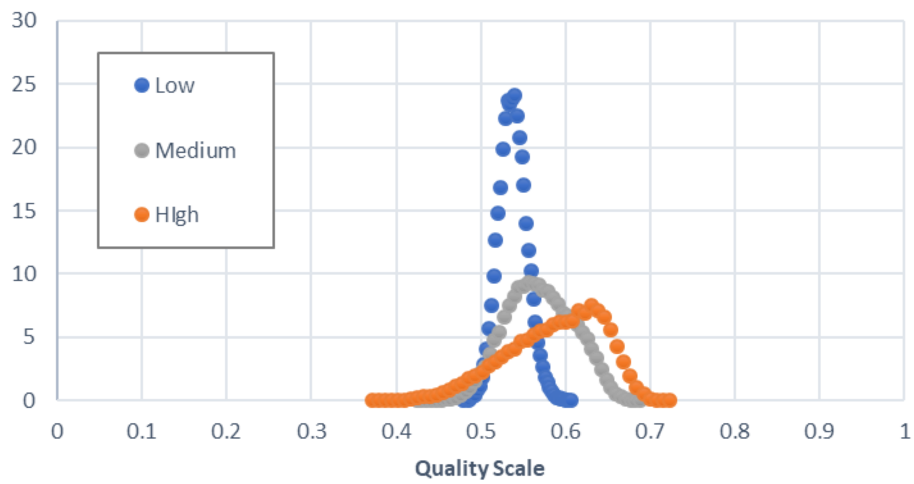

Figure B.7: Variation of Variance (F&Os 1, 2 & 4)

B.1.4.2.3. Importance Analyses

The importance analysis performed in Section B.1.4.1.9 was repeated for the cases in which the quality ratings associated with F&Os were marked with *High* uncertainty. Table B.5 compares the results of this analysis against those previously obtained with *Low* uncertainty ratings applied. As expected, the differences between the importance ratings for the *High* uncertainty case become less distinguishable. Note also that the general order, with the minor exception of F&Os 1 and 4, remains the same.

A comparison of the variance in the life safety performance indicator across F&Os reveals that independent of other F&Os, the uncertainty associated with F&O 4 has the largest impact on the life safety performance indicator with a variance of 0.120. This result is despite the fact that uncertainty aside, F&O 4 has less of an impact on life safety performance indicator than, say, F&O 3. As such, an importance analysis on variance (in addition to quality) can be used to inform the user about those aspects of the fire safety analysis that should be further investigated or better known to reduce the uncertainty associated with the user's beliefs.

Table B.5: Performance (PI) and Importance (II) Indicators with Low and High Nodal Uncertainties

F&O ID	Low Uncertainty			High Uncertainty		
	PI		II	PI		II
	μ	σ^2		μ	σ^2	
1	64.1%	0.014	36	60.6%	0.103	39
2	76.4%	0.005	24	69.3%	0.074	31
3	45.3%	0.017	55	57.1%	0.117	43
4	60.5%	0.017	40	61.9%	0.120	38
5	83.3%	0.010	17	71.6%	0.089	28

B.1.4.3. Case Study Example C

The purpose of this case study example is to explore and demonstrate the influence of candidate fire safety systems on framework performance indicators and ultimately the technical adequacy of a fire safety analysis. Note that equivalent overall technical quality is theoretically achievable for any theoretically effective fire safety system; however, the manner in which deficiencies are manifested within the fire safety network is largely influenced by nodal influences and associated weighting, which are themselves influenced by the fire safety system design. For this case study examples, the three fire safety system designs reviewed earlier are considered. The general process for this example is described as follows:

- Apply Case Study Example A, and expand it to also consider Fire Safety Systems 2 and 3, albeit independently.
- Assign weights to assess nodal influences according to each of the three fire safety systems.
- Assess the collective impact of posited deficiencies on performance indicators. An importance analysis will also be performed to assess the relative importance of individual deficiencies.
- Analyze the results, summarizing insights gained. The focus will be on how the same deficiencies influence the performance indicators differently based on the fire safety system design applied.

B.1.4.3.1. Revisions to Case Study Example A

The impact of different fire safety systems on the technical quality of a fire safety analysis will be explored. The three fire safety system configurations that are considered are discussed in Section B.1.2.3.3. In general, the inputs to Case Study Example C (e.g., uncertainty assessments) remained the same as those to Case Study Example A with the exception of the network weights and those deficiencies related to the fire safety systems. The influence of the three fire safety systems on network weights was considered, and the weights were adjusted accordingly. The network weights for all three safety systems are presented in Appendix G.

Additionally, as indicated in Table B.3, F&Os 4, 6 and 7 represent deficiencies associated with fire safety systems. F&O 4 is applicable to Fire Safety System 1, which includes an automatic sprinkler system. F&O 7 is applicable to Fire Safety System 2, which includes an automatic, mechanical smoke ventilation system. F&Os 4, 6 and 7 are applicable to Fire Safety System 3, which includes: an automatic sprinkler system; an automatic, natural smoke ventilation system; and automatic smoke curtains and passive smoke barriers.

Note that as indicated in Section B.1.4.1.7, deficiencies and associated quality ratings were made consistent across fire safety systems (e.g., automatic sprinklers, smoke management and control and active barriers) to support the comparison of life safety performance indicator results.

B.1.4.3.2. Review of Quantification Results

To evaluate the different fire safety system configurations, the fire safety network was re-quantified separately for each configuration and associated F&Os. As a means to provide additional insights, the life safety performance indicator was also quantified for different combinations of F&Os identified in Table B.6; that is, the F&Os not identified were effectively resolved by reassigning the quality of affected influencing factors as *High*. Again, note that the resulting uncertainty of each performance indicator is *Low*.

Table B.6: Performance Indicators (PIs) for Case Study C

Case	F&O ID	PI (μ) System 1*	PI (μ) System 2*	PI (μ) System 3*
A	1	64%	66%	73%
B	2	76%	76%	78%
C	1 & 2	64%	66%	72%
D	1, 2 & 4	54%	N/A	62%
E	1, 2 & 7	N/A	57%	64%
F	1, 2, 4 & 7	N/A	N/A	61%
G	1, 2, 4, 6 & 7	N/A	N/A	59%
H	1, 2 & 3	43%	44%	51%
I	1, 2, 3 & 4	42%	N/A	49%
J	1, 2, 3 & 7	N/A	43%	50%
K	1, 2, 3, 4 & 7	N/A	N/A	48%
L	1, 2, 3, 4, 6 & 7	N/A	N/A	46%
M	5	83%	83%	83%
N	4 & 5	58%	N/A	62%
O	5 & 7	N/A	59%	63%
P	4, 5, 6 & 7	N/A	N/A	60%
N	All	39%	40%	45%

* Note that N/A appears when one or more F&Os do not apply to the given fire safety system.

The results for Fire Safety System 2 in Table B.6 are consistent with those obtained previously for Fire Safety System 1 under Case Study Example A. For all cases, the quality results for the life safety performance indicator between the two systems are largely equivalent; however, in several cases, Fire Safety System 2 provides more assurance than Fire Safety System 1 in reducing the importance of deficiencies. The difference between the two systems can be up to 3 percentage points (e.g., Case D versus Case E), and this appears to be consistent with the fire safety analyses documented in the SFPE case study [1], which shows credit for an automatic, mechanical smoke control and management system offers a slightly higher margin of safety than credit for an automatic sprinkler system.

A review of the results for Fire Safety System 3 reveals a similar trend. However, for this system, the quality results for the life safety performance indicator can be up to 9 percentage points higher than Fire Safety System 1 and up to 7 percentage points for Fire Safety System 2. This is consistent with the fact that the ratings for Fire Safety System 3 should be as high, if not higher, than Fire Safety System 1 because Fire Safety System 3 credits automatic smoke curtains and passive smoke barriers in addition to an automatic sprinkler system. As expected, the quality for Fire Safety System 3, owing to its additional safety features, should not be as sensitive to present deficiencies. As these additional features are affected by deficiencies, the quality of Fire Safety System 3 begins to approach that of the other two systems. However, note that Fire Safety System 3 credits passive smoke barriers, which are not subject to any identified deficiencies in Table B.3. In comparing the cases containing F&Os 4, 6 and 7 for Safety System 3 with those containing F&Os 4 and 7 for Fire Safety Systems 1 and 2, respectively, one will see that the presence of passive smoke barriers results in up to a 5 percentage points higher quality rating.

Another general trend to note is that the benefit, in terms of overall technical quality, of credited fire safety systems is affected greatly by the types of deficiencies present within the fire safety analysis. To examine this, take the difference between cases in which fire safety systems are deficient and ones in which they are not. For instance, for Fire Safety System 1, this would be the difference between Cases C and D (64% - 54% = 10%), H and I (43% - 42% = 1 %), and M and N (83% - 58% = 25%). Equivalent calculations can be performed for the other systems.

In the end, one reveals that fire safety systems are "worth" between 9 and 13 percentage points for F&Os 1 and 2; between 1 and 5 percentage points for F&Os 1, 2 and 3; and between 23 and 25 percentage points for F&O 5. This demonstrates that the fire safety systems have, at times, less influence on the life safety performance indicator. The degree of influence of credited fire safety systems on the life safety performance indicator is a function of the extent to which these other deficiencies indirectly influence the technical quality of the credited fire safety systems. For instance, F&O 5, which is related to occupant speed of travel during egress, is entirely independent of the modeling or treatment of fire safety systems within the fire safety analysis. Therefore, there is no means by which the technical quality of the credited fire safety systems can be influenced, and the largest benefit is achievable. On the other hand, F&O 3, which is related to smoke production within the room of origin, is a casual precursor to fire safety systems within the fire safety network because actuation of such systems is dependent on smoke parameters (e.g., optical density) dependent upon smoke production. For this reason, F&O 3, which has the largest impact on overall technical quality, results in the smallest benefit for credited fire safety systems.

In conclusion, while the degree of absolute difference between the quality results for the different cases can be debated, the consistent, relative trends that can be derived from analysis of different fire safety systems are convincing. By its very nature, a performance-based approach allows for different fire safety solutions to be applied and tested against performance criteria, and ultimately, several solutions may be acceptable. This decision support tool fully embraces this feature of performance-based design and provides meaningful insights regarding the influence that different solutions may have on the overall technical quality of a supporting fire safety analysis.

B.1.4.3.3. Importance Analyses

Like Section B.1.4.1.9, an importance analysis was performed to assess the relative importance of F&Os, but in this case, the analysis was expanded to address each of the three fire safety systems. Table B.7 provides the results of the analysis, while Figure B.8 provides a visual comparison of importance indicators for each F&O.

Table B.7: Performance (PI) and Importance (II) Indicators for Case Study C

F&O ID	**System 1**		**System 2**		**System 3**	
	PI (μ)	**II**	**PI (μ)**	**II**	**PI (μ)**	**II**
1	64%	36	66%	34	73%	27
2	76%	24	76%	24	78%	22
3	45%	55	43%	57	58%	42
4	60%	40	N/A	N/A	65%	35
5	83%	17	83%	17	83%	17
6	N/A	N/A	N/A	N/A	95%	5
7	N/A	N/A	60%	40	66%	34

* Note that N/A appears when one or more F&Os do not apply to the given fire safety system.

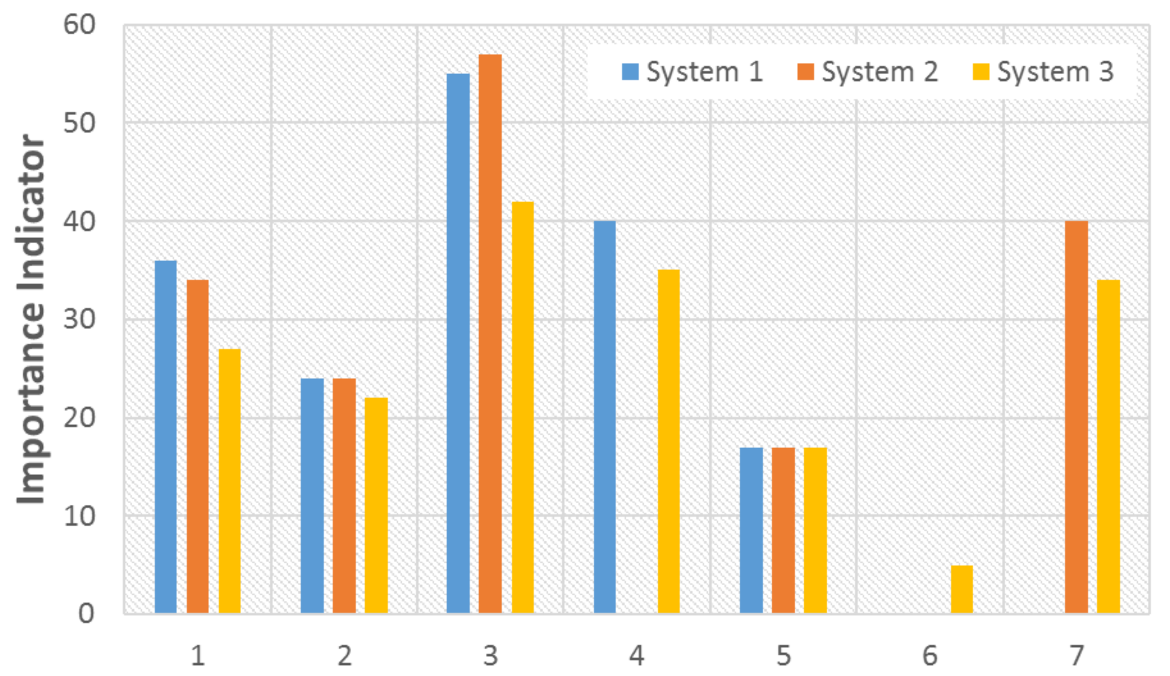

Figure B.8: F&O Importance Ranking for Case Study Example C

Considering the analysis of results documented in the previous section, the relative difference in importance rankings between systems for a given F&O is dependent on the degree to which that F&O influences the quality of the fire safety system of interest (as determined by the causal links within the fire safety network). This influence is ultimately based on the characteristic of the system itself (e.g., how it is actuated). The difference in importance ratings for F&Os 3 ad 5 is one example.

Additionally, the relative difference in importance rankings between systems for a given F&O is also dependent on the number of fire safety systems credited in the analysis and their degree of redundancy. For instance, Fire Safety System 3 not only credits an automatic sprinkler system but also an automatic, natural smoke control system as well as active and passive smoke barriers. As a result, the importance ranking of each F&O for this system is generally lower than for the other systems.

B.1.5. Conclusion

In this appendix, a limited-scope case study was performed to demonstrate the overall functionality, feasibility and utility of the framework. To do so, three case study examples were formulated to characterize the technical adequacy of a hypothetical fire safety analysis, understand the impact of uncertainties associated with user judgements, and evaluate the influence of different fire safety systems. The results of the effort were analyzed, and the insights gained demonstrated that the proposed decision support framework can be a useful tool to improve the technical adequacy and consistency of fire safety analyses associated with performance-based design approaches to fire safety engineering. The tool can also help users, including AHJ representatives and fire protection engineering practitioners, prioritize the performance, review and approval of fire safety analysis by identifying those issues most important to improving technical adequacy.

While the proposed framework and supporting tool is theoretically adaptable to the full range and variability of state-of-the-art performance-based design applications, the case study only explored one possible application. The scalability of this framework and tool is further explored in Section 6 of the main report. Additionally, issues associated with the framework's implementation that were identified during the case study will explored in Section 5 of the main report.

B.1.6. References

[1] Society of Fire Protection Engineers, Fire Engineering Design Case Study, Tenth International Conference on Performance-Based Codes and Fire Safety Design Methods, Gold Coast, Queensland, Australia, November 10-12, 2014.

[2] IFEG (2005) International Fire Engineering Guidelines, Australian Building Codes Board, Department of Building and Housing (New Zealand), International Code Council (USA), and National Research Council (Canada).

[3] National Fire Protection Association (2012), "Guide to the Fire Safety Concepts Tree"

[4] Park, H. (2014), "Development of A Holistic Approach to Integrate Fire Safety Performance with Building Design," Dissertation Submitted to the Faculty of the Worcester Polytechnic Institute.

[5] Park, H. and Goulthorpe, M. (2013), "Conceptual Model Development for Holistic Building Fire Safety Performance Analysis," Fire Technology, Vol. 51, pp. 173–193.

[6] Park, H., Meacham, B. J., Dembsey, N. A., & Goulthorpe, M. (2014). Integration of fire safety and building design. Building Research & Information, 42(6), 696-709. doi: 10.1080/09613218.2014.913452.

[7] Society of Fire Protection Engineers (2007), SFPE Engineering Guide to Performance-Based Fire Protection.

[8] National Fire Protection Association (2009), NFPA 101 Life Safety Code® Handbook, eleventh edition.

[9] National Fire Protection Association (2009), NFPA 101 Life Safety Code®.

[10] RG 1.200 (2009), An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, Revision 2.

[11] RG 1.205 (2009), Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants, Revision 1.

[12] NUREG/CR-6850 (2005), EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 1: Summary & Overview.

[13] NUREG/CR-6850 (2005), EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology.

[14] NUREG-1824 (2007), Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications.

[15] NUREG-1921 (2012), EPRI/NRC-RES Fire Human Reliability Analysis Guidelines.

[16] ASME/ANS RA-Sa-2009, Addenda to ASME/ANS RA-S–2008 Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications.

[17] NUREG-1855 (2017), Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking.

APPENDIX C

Case Study Supporting Requirements
and associated Capability Categories

Fire Initiation, Development and Control (FIDC)

FIRE INITIATION, DEVELOPMENT AND CONTROL (FIDC)

High Level Requirements for Fire Initiation, Development and Control (FIDC)	
Designator	**Requirement**
HLR-FIDC-A	Room of Origin Fire Development (ROO)
HLR-FIDC-B	Modified Fire Development (MOD)
HLR-FIDC-C	Flashover (FO)
HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)

Supporting Requirements for HLR-FIDC-A: Room of Origin Fire Development (ROO)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FIDC-A1: Fire Size/HRR (ROO)	For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of two heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a distribution of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-A2: Fire Growth and Flame Spread (ROO)	For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-A3: Toxic Species Yield (ROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-A4: Smoke Yield (ROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-A5: Flame Height, Temperature and Radiation (ROO)	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-A6: Ventilation Conditions (ROO)	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-A6: Modeling Uncertainty (ROO)	DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-A7: Parametric Uncertainty (ROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FIDC-B: Modified Fire Development (MOD)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FIDC-B1: Fire Size/HRR (MOD)	For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B2: Fire Growth and Flame Spread (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B3: Toxic Species Yield (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B4: Smoke Yield (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B5: Flame Height, Temperature and Radiation (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B6: Ventilation Conditions (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B7: Modeling Uncertainty (MOD)	DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-B8: Parametric Uncertainty (MOD)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FIDC-C: Flashover (FO)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FIDC-C1: Fire Size/HRR (FO)	For each selected scenario, DETERMINE whether the conditions are approrpiate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, DETERMINE whether the conditions are approrpiate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, DETERMINE whether the conditions are approrpiate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C2: Fire Growth and Flame Spread (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C3: Toxic Species Yield (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C4: Smoke Yield (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C5: Flame Height, Temperature and Radiation (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C6: Ventilation Conditions (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C7: Modeling Uncertainty (FO)	DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-C8: Parametric Uncertainty (FO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FIDC-D: Beyond Room of Origin Fire Development (EXROO)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FIDC-D1: Fire Size/HRR (EXROO)	For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is most representative, considering both likelihood and consequence CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies external to the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of two heat release rates that applies external to the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a distribution of heat release rates that applies external to the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-D2: Fire Growth and Flane Spread (EXROO)	For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-D3: Toxic Species Yield (EXROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-D4: Smoke Yield (EXROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.
FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-D6: Ventilation Conditions (EXROO)	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	
FIDC-D7: Modeling Uncertainty (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		
FIDC-D8: Parametric Uncertainty (EXROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.

Smoke Development, Spread and Control (SDSC)

SMOKE DEVELOPMENT, SPREAD AND CONTROL (SDSC)

High Level Requirements for Smoke Development, Spread and Control (SDSC)	
Designator	**Requirement**
HLR-SDSC-A	Room of Origin Smoke Development (ROO)
HLR-SDSC-B	Modified Smoke Development (MOD)
HLR-SDSC-C	Flashover Smoke Development (FO)
HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)
HLR-SDSC-E	Smoke Control and Management (SC&M)
HLR-SDSC-F	Smoke Barrier Failure (SBF)

Supporting Requirements for HLR-SDSC-A: Room of Origin Smoke Development (ROO)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
SDSC-A1: Smoke Production (ROO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A2: Smoke Layer Interface Height (ROO)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A3: Smoke Temperature (ROO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A4: Smoke Optical Density (ROO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A5: Smoke Concentration (ROO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A6: Radiation from Smoke Layer (ROO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A7: Modeling Uncertainty (ROO)	DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-A8: Parametric Uncertainty (ROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-SDSC-B: Modified Smoke Development (MOD)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
SDSC-B1: Smoke Production (MOD)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B2: Smoke Layer Interface Height (MOD)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B3: Smoke Temperature (MOD)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B4: Smoke Optical Density (MOD)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B5: Smoke Concentration (MOD)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B6: Radiation from Smoke Layer (MOD)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B7: Modeling Uncertainty (MOD)	DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-B8: Parametric Uncertainty (MOD)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-SDSC-C: Flashover Smoke Development (FO)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
SDSC-C1: Smoke Production (FO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C2: Smoke Layer Interface Height (FO)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C3: Smoke Temperature (FO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C4: Smoke Optical Density (FO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C5: Smoke Concentration (FO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C6: Radiation from Smoke Layer (FO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C7: Modeling Uncertainty (FO)	DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-C8: Parametric Uncertainty (FO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-SDSC-D: Beyond Room of Origin Smoke Development (EXROO)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
SDSC-D1: Smoke Production (EXROO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D2: Smoke Spread (EXROO)	For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D3: Smoke Layer Interface Height (EXROO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D4: Smoke Temperature (EXROO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D5: Smoke Optical Density (EXROO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D6: Smoke Concentration (EXROO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D7: Radiation from Smoke Layer (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D8: Modeling Uncertainty (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-D9: Parametric Uncertainty (EXROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-SDSC-E: Smoke Control and Management (SC&M)

Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
SDSC-E1: System Effectiveness (SC&M)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-E2: Modeling Uncertainty (SC&M)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-E3: Parametric Uncertainty (SC&M)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-SDSC-F: Smoke Barrier Failure (SBF)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
SDSC-F1: Active Smoke Barrier Effectiveness (SBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-F3: Modeling Uncertainty (SBF)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		
SDSC-F4: Parametric Uncertainty (SBF)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.

Fire Spread, Impact and Control (FSIC)

FIRE DETECTION, WARNING AND SUPPRESSION (FDWS)

High Level Requirements for Fire Detection, Warning and Suppression (FDWS)	
Designator	**Requirement**
HLR-FDWS-A	Manual Notification System (MNS)
HLR-FDWS-B	Automatic Notification System (ANS)
HLR-FDWS-C	Manual Suppression and Control (MS&C)
HLR-FDWS-D	Automatic Suppression and Control (AS&C)
HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)
HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)
HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)

Supporting Requirements for HLR-FDWS-A: Manual Notification System (MNS)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FDWS-A1: Timing of Manual Detection (MNS)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-A2: Reliability and Availability of Manual Detection (MNS)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-A3: Timing of Automatic Detection (MNS)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-A4: Reliability and Availability of Automatic Detection (MNS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-A5: Reliability and Availability (MNS)	QUALIFY total system unavailability, and CONFIRM that the credited system is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-A6: Effectiveness (MNS)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-A7: Modeling Uncertainty (MNS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-A8: Parametric Uncertainty (MNS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-B: Automatic Notification System (ANS)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FDWS-B1: Timing of Manual Detection (ANS)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-B2: Reliability and Availability of Manual Detection (ANS)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-B3: Timing of Automatic Detection (ANS)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-B4: Reliability and Availability of Automatic Detection (ANS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-B5: Reliability and Availability (ANS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-B6: Effectiveness (ANS)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-B7: Modeling Uncertainty (ANS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-B8: Parametric Uncertainty (ANS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-C: Manual Suppression and Control (MS&C)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FDWS-C1: Timing of Manual Detection (MS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-C2: Reliability and Availability of Manual Detection (MS&C)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-C3: Timing of Automatic Detection (MS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-C5: Reliability and Availability (MS&C)	QUALIFY total unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-C6: Effectiveness (MS&C)	JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-C7: Modeling Uncertainty (MS&C)	DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-C8: Parametric Uncertainty (MS&C)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-D: Automatic Suppression and Control (AS&C)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FDWS-D1: Timing of Manual Detection (AS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-D2: Reliability and Availability of Manual Detection (AS&C)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-D3: Timing of Automatic Detection (AS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-D5: System Reliability and Availability (AS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-D6: System Effectiveness (AS&C)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-D7: Modeling Uncertainty (AS&C)	DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-D8: Parametric Uncertainty (AS&C)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-E: Detection and Activation for Active Fire Barriers (DA-AFB)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FDWS-E1: Timing of Manual Detection (DA-AFB)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-E3: Timing of Automatic Detection (DA-AFB)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-E5: System Reliability and Availability (DA-AFB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-E6: Modeling Uncertainty (DA-AFB)	DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-E7: Parametric Uncertainty (DA-AFB)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-F: Detection and Activation for Active Smoke Barriers (DA-ASB)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FDWS-F1: Timing of Manual Detection (DA-ASB)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-F3: Timing of Automatic Detection (DA-ASB)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-F5: System Reliability and Availability (DA-ASB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-F6: Modeling Uncertainty (DA-ASB)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-F7: Parametric Uncertainty (DA-ASB)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FDWS-G: Detection and Activation for Smoke Control and Management (DA-SC&M)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FDWS-G1: Timing of Manual Detection (DA-SC&M)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.			If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	
FDWS-G3: Timing of Automatic Detection (DA-SC&M)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-G5: System Reliability and Availability (DA-SC&M)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.
FDWS-G6: Modeling Uncertainty (DA-SC&M)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.		
FDWS-G7: Parametric Uncertainty (DA-SC&M)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.

Fire Detection, Warning and Suppression (FDWS)

FIRE SPREAD, IMPACT AND CONTROL (FSIC)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)
HLR-FSIC-B	Fire Barrier Failure (FBF)

Supporting Requirements for HLR-FSIC-A: Internal Fire Spread through Openings (IFSTO)

Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FSIC-A1: Internal Fire Spread through Openings (IFS)	EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.			EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.			EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.		
FSIC-A2: Modeling Uncertainty (IFS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.		
FSIC-A3: Parametric Uncertainty (IFS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-FSIC-B: Fire Barrier Failure (FBF)

Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
FSIC-B1: Active Fire Barrier Effectiveness (FBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FSIC-B2: Passive Fire Barrier Effectiveness (FBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		
FSIC-B3: Modeling Uncertainty (FBF)	DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		
FSIC-B4: Parametric Uncertainty (FBF)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.

Occupant Evacuation and Control (OEC)

OCCUPANT EVACUATION AND CONTROL (OEC)

High Level Requirements for Occupant Evacuation and Control (OEC)	
Designator	**Requirement**
HLR-OEC-A	Available Safe Egress Time (ASET)
HLR-OEC-B	Required Safe Egress Time (RSET)
HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)

Supporting Requirements for HLR-OEC-A: Available Safe Egress Time (ASET)

Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
OEC-A1: Establishment and Integration of ASET Criteria (ASET)	For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.		
OEC-A2: Modeling Uncertainty (ASET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.		
OEC-A3: Parametric Uncertainty (ASET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-OEC-B: Required Safe Egress Time (RSET)

Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	
OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY a distribution of times to the RSET analysis,evaluating the uncertainty interval of the parameter.. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY a distribution of times to the RSET analysis,evaluating the uncertainty interval of the parameter.. CONSIDER each of the below influencing factors and/or referenced SRs.
OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.
OEC-B4: Movement Timing - Completion of Movement (RSET)	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.
OEC-B5: Integration of RSET Criteria (RSET)	SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).		SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).	Probabiliistically SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific, distribution of estimates of the Required Safe Evacuation Time (RSET).	SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).	Probabiliistically SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific, distribution of estimates of the Required Safe Evacuation Time (RSET).
OEC-B6: Modeling Uncertainty (RSET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.		
OEC-B7: Parametric Uncertainty (RSET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.

Supporting Requirements for HLR-OEC-C: Integration of ASET/RSET Criteria (ASET/RSET)									
Index No.	Deterministic			Risk-Informed			Risk-Based		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III
OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)	EVALUATE the difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.			EVALUATE the difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.			EVALUATE the probabilistic difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.		
OEC-C2: Modeling Uncertainty (ASET/RSET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.		
OEC-C3: Parametric Uncertainty (ASET/RSET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.

Fire Scenario Development (FSD)

FIRE SCENARIO DEVELOPMENT (FSD)

High Level Requirements for Fire Scenario Development (FSD)	
Designator	**Requirement**
HLR-FSD-A	Fire Hazards (FH)
HLR-FSD-B	Potential Fire Scenarios (PFS)
HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)

Supporting Requirements for HLR-FSD-A: Fire Hazards (FH)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FSD-A1: Fire Hazard Analysis (FH)	PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		

Supporting Requirements for HLR-FSD-B: Potential Fire Scenarios (PFS)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FSD-B1: Potential Fire Scenarios (PFS)	DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		

Supporting Requirements for HLR-FSD-C: Design Fire Scenarios for Analysis (DFSA)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
FSD-C1: Design Fire Scenarios for Analysis (DFSA)	SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		

Analysis and Quantification (AQ)

ANALYSIS AND QUANTIFICATION (AQ)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-AQ-A	Quantification Methodology (Q)
HLR-AQ-B	Modeling Uncertainty (MU)
HLR-AQ-C	Parametric Uncertainty (MU)
HLR-AQ-D	Completeness Uncertainty (CU)

Supporting Requirements for HLR-AQ-A: Quantification Methodology (Q)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
AQ-A1: Quantification (Q)	For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. If scenarios result in the RSET exceeding the ASET, DEVELOP criteria based on the conditional probability or likelihood of each sceanrio to determine the acceptability of this exceedance CONSIDER each of the below influencing factors and/or referenced SRs.			For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. If scenarios result in the RSET exceeding the ASET, DEVELOP criteria based on the conditional probability or likelihood of each sceanrio to determine the acceptability of this exceedance. CONSIDER each of the below influencing factors and/or referenced SRs.		

Supporting Requirements for HLR-AQ-B: Modeling Uncertainty (MU)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
AQ-B1: Modeling Uncertainty (MU)	DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.		

Supporting Requirements for HLR-AQ-C: Parametric Uncertainty (MU)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
AQ-C1: Parametric Uncertainty (PU)	CONFIRM that bounding treatments applied to varaibles throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each varaible applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.		CONFIRM that bounding treatments applied to varaibles throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each varaible applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.		CONFIRM that bounding treatments applied to varaibles throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each varaible applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	

Supporting Requirements for HLR-AQ-D: Completeness Uncertainty (CU)									
Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**		
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**
AQ-D1: Completeness Uncertainty (CU)	PERFORM sensitivity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.			PERFORM sensitvity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.			PERFORM sensitvity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.		

APPENDIX D

Case Study Supporting Requirements
and associated Influencing Factors

Fire Initiation, Development and Control (FIDC)

FIRE INITIATION, DEVELOPMENT AND CONTROL (FIDC)

High Level Requirements for Fire Initiation, Development and Control (FIDC)	
Designator	**Requirement**
HLR-FIDC-A	Room of Origin Fire Development (ROO)
HLR-FIDC-B	Modified Fire Development (MOD)
HLR-FIDC-C	Flashover (FO)
HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)

Supporting Requirements for HLR-FIDC-A: Room of Origin Fire Development (ROO)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FIDC-A1: Fire Size/HRR (ROO)	**FIDC-A1 - Ignition Characteristics (ROO)**	Ignition may be piloted, non-polited or self-induced. The influence of the size, energetics and type of ignition source on fire development should be considered.	
	FIDC-A1 - Fuel and Loading Characteristics (ROO)	The fire load within a compartment and its associated properties will influence the duration and severity of a fire. Fire loading characteristics include both those associated with the physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	
	FIDC-A6: Ventilation Conditions (ROO)		
	FIDC-A1 - Building Characteristics (ROO)	Fire development within the room of origin should consider influential building characteristics. Examples include thermal properties of internal linings and the building envelope.	
	FIDC-A1 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
	FIDC-A2: Fire Growth and Flame Spread (ROO)		
FIDC-A2: Fire Growth and Flame Spread (ROO)	**FIDC-A2 - Temporal Profile (ROO)**	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	
	FIDC-A2 - Fuel Characteristics (ROO)	The characteristics of secondary combustibles will influence the duration and severity of a fire over time. Characteristics include both those associated with physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	
	FIDC-A2 - Building Characteristics (ROO)	Building characteristics that influence the growth and spread of the fire within the room of origin. Examples include room geometry.	
	FIDC-A2 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FIDC-A3: Toxic Species Yield (ROO)	**FIDC-A3 - Toxic Species Data (ROO)**	The princpal toxic species should be identified and their yield quantified.
	FIDC-A3 - Combustion Characteristics (ROO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.
	FIDC-A3 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-A1: Fire Size/HRR (ROO)	
FIDC-A4: Smoke Yield (ROO)	**FIDC-A4 - Smoke Yield Data (ROO)**	The princpal species should be identified and their yield quantified.
	FIDC-A4 - Combustion Characteristics (ROO)	The nature of combustibles invovled and their influence on smoke yield should be considered.
	FIDC-A4 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-A1: Fire Size/HRR (ROO)	
FIDC-A5: Flame Height, Temperature and Radiation (ROO)	**FIDC-A5 - Building Characteristics (ROO)**	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.
	FIDC-A5 - Fuel and Loading Characteristics (ROO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.
	FIDC-A5 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-A1: Fire Size/HRR (ROO)	

FIDC-A6: Ventilation Conditions (ROO)	**FIDC-A6 - Building Characteristics (ROO)**	Building characteristics that influence ventilation conditions within the room of origin should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iV) leakage rates through doors and barriers.
	FIDC-A6 - Occupant Characteristics (ROO)	The influence of occupants on ventilation conditions should be addressed. Examples include occupants opening or closing doors.
	FIDC-A6 - Environmental Conditions (ROO)	Environmental conditions (e.g., temperature, natural ventilation, etc.) within or external to the room of origin should be addressed if they can influence fire development.
	FIDC-A6 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FIDC-A6: Modeling Uncertainty (ROO)	**FIDC-A6 - Modeling Uncertainty (ROO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FIDC-A7: Parametric Uncertainty (ROO)	**FIDC-A7 - Parametric Uncertainty (ROO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-FIDC-B: Modified Fire Development (MOD)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FIDC-B1: Fire Size/HRR (MOD)	**FIDC-B6: Ventilation Conditions (MOD)**		
	FIDC-B1 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
	HLR-FDWS-C: Manual Suppression and Control (MS&C)		
	HLR-FDWS-D: Automatic Suppression and Control (AS&C)		
	FIDC-B2: Fire Growth and Flame Spread (MOD)		
FIDC-B2: Fire Growth and Flame Spread (MOD)	**FIDC-B2 - Temporal Profile (MOD)**	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	
	FIDC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FIDC-B3: Toxic Species Yield (MOD)	**FIDC-B3 - Toxic Species Data (MOD)**	The princpal toxic species should be identified and their yield quantified.	
	FIDC-B3 - Combustion Characteristics (MOD)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.	
	FIDC-B3 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
	FIDC-B1: Fire Size/HRR (MOD)		

FIDC-B4: Smoke Yield (MOD)	**FIDC-B4 - Smoke Yield Data (MOD)**	The princpal species should be identified and their yield quantified.
	FIDC-B4 - Combustion Characteristics (MOD)	The nature of combustibles invovled and their influence on smoke yield should be considered.
	FIDC-B4 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-B1: Fire Size/HRR (MOD)	
FIDC-B5: Flame Height, Temperature and Radiation (MOD)	**FIDC-B5 - Building Characteristics (MOD)**	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.
	FIDC-B5 - Fuel and Loading Characteristics (MOD)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.
	FIDC-B5 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-B1: Fire Size/HRR (MOD)	
FIDC-B6: Ventilation Conditions (MOD)	**HLR-SDSC-E: Smoke Control and Management (SC&M)**	
	FIDC-B6 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FIDC-B7: Modeling Uncertainty (MOD)	**FIDC-B7 - Modeling Uncertainty (MOD)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FIDC-B8: Parametric Uncertainty (MOD)	**FIDC-B8 - Parametric Uncertainty (MOD)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-FIDC-C: Flashover (FO)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FIDC-C1: Fire Size/HRR (FO)	**FIDC-C1 - Flashover Criteria (FO)**	The time of flashover should be specified by defined criteria. These may be taken to be the time at which the hot layer temperature in the enclosure reaches a certain temperature or when the rate of heat released from the fire is equal to that required to cause flashover. Another criterion often used is the time at which the radiation at the floor from the hot layer reaches a certain point.	
	Impact of ROO Fire and Smoke Development on FO Scenarios		
	Impact of MOD Fire and Smoke Development on FO Scenarios		
	FIDC-C6: Ventilation Conditions (FO)		
	FIDC-C2: Fire Growth and Flame Spread (FO)		
	FIDC-C1 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FIDC-C2: Fire Growth and Flame Spread (FO)	**FIDC-B2 - Temporal Profile (MOD)**	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	
	FIDC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FIDC-C3: Toxic Species Yield (FO)	**FIDC-C3 - Toxic Species Data (FO)**	The princpal toxic species should be identified and their yield quantified.	
	FIDC-C3 - Combustion Characteristics (FO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.	
	FIDC-C3 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
	FIDC-C1: Fire Size/HRR (FO)		

FIDC-C4: Smoke Yield (FO)	**FIDC-C4 - Smoke Yield Data (FO)**	The princpal species should be identified and their yield quantified.
	FIDC-C4 - Combustion Characteristics (FO)	The nature of combustibles invovled and their influence on smoke yield should be considered.
	FIDC-C4 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-C1: Fire Size/HRR (FO)	
FIDC-C5: Flame Height, Temperature and Radiation (FO)	**FIDC-C5 - Building Characteristics (FO)**	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.
	FIDC-C5 - Fuel and Loading Characteristics (FO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.
	FIDC-C5 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-C1: Fire Size/HRR (FO)	
FIDC-C6: Ventilation Conditions (FO)	**FIDC-C6 - Building Characteristics (FO)**	Building characteristics that influence ventilation conditions within the room of origin and as a result of flashover should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iv) leakage rates through doors and barriers.
	FIDC-C6 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FIDC-C7: Modeling Uncertainty (FO)	**FIDC-C7 - Modeling Uncertainty (FO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FIDC-C8: Parametric Uncertainty (FO)	**FIDC-C8 - Parametric Uncertainty (FO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on FO Scenarios

FIDC-A1: Fire Size/HRR (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on FO Scenarios

FIDC-B1: Fire Size/HRR (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Supporting Requirements for HLR-FIDC-D: Beyond Room of Origin Fire Development (EXROO)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FIDC-D1: Fire Size/HRR (EXROO)	**FIDC-D1 - Ignition Characteristics (EXROO)**	Ignition may be piloted, non-polited or self-induced. The influence of the size, energetics and type of ignition source on fire development should be considered.	
	FIDC-D1 - Fuel and Loading Characteristics (EXROO)	The fire load within a compartment and its associated properties will influence the duration and severity of a fire. Fire loading characteristics include both those associated with the physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	
	FIDC-D6: Ventilation Conditions (EXROO)		
	FIDC-D1 - Building Characteristics (EXROO)	Fire development within the room of origin should consider influential building characteristics. Examples include thermal properties of internal linings and the building envelope.	
	FIDC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
	FIDC-D2: Fire Growth and Flane Spread (EXROO)		
FIDC-D2: Fire Growth and Flane Spread (EXROO)	**FIDC-D2 - Temporal Profile (EXROO)**	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	
	FIDC-D2 - Fuel Characteristics (EXROO)	The characteristics of secondary combustibles will influence the duration and severity of a fire over time. Characteristics include both those associated with physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	
	FIDC-D2 - Building Characteristics (EXROO)	Building characteristics that influence the growth and spread of the fire external to the room of origin. Examples include combustibility of compartment contents and internal linings.	
	FSIC - Fire Spread		
	FIDC-D2 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FIDC-D3: Toxic Species Yield (EXROO)	**FIDC-D3 - Toxic Species Data (EXROO)**	The princpal toxic species should be identified and their yield quantified.
	FIDC-D3 - Combustion Characteristics (EXROO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.
	FIDC-D3 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-D1: Fire Size/HRR (EXROO)	
FIDC-D4: Smoke Yield (EXROO)	**FIDC-D4 - Smoke Yield Data (EXROO)**	The princpal species should be identified and their yield quantified.
	FIDC-D4 - Combustion Characteristics (EXROO)	The nature of combustibles invovled and their influence on smoke yield should be considered.
	FIDC-D4 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-D1: Fire Size/HRR (EXROO)	
FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	**FIDC-D5 - Building Characteristics (EXROO)**	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.
	FIDC-D5 - Fuel and Loading Characteristics (EXROO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.
	FIDC-D5 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	FIDC-D1: Fire Size/HRR (EXROO)	

FIDC-D6: Ventilation Conditions (EXROO)	**FIDC-D6 - Building Characteristics (EXROO)**	Building characteristics that influence ventilation conditions within the room of origin should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iV) leakage rates through doors and barriers.
	FIDC-D6 - Occupant Characteristics (EXROO)	The influence of occupants on ventilation conditions should be addressed. Examples include occupants opening or closing doors.
	HLR-SDSC-E: Smoke Control and Management (SC&M)	
	FIDC-D6 - Environmental Conditions (EXROO)	Environmental conditions (e.g., temperature, natural ventilation, etc.) external to the room of origin should be addressed if they can influence fire development.
	FIDC-D6 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FIDC-D7: Modeling Uncertainty (EXROO)	**FIDC-D7 - Modeling Uncertainty (EXROO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FIDC-D8: Parametric Uncertainty (EXROO)	**FIDC-D8 - Parametric Uncertainty (EXROO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

FIDC: Modeling Uncertanty (MU)

FIDC-A6: Modeling Uncertainty (ROO)

FIDC-B7: Modeling Uncertainty (MOD)

FIDC-C7: Modeling Uncertainty (FO)

FIDC-D7: Modeling Uncertainty (EXROO)

FIDC: Parametric Uncertanty (PU)

FIDC-A7: Parametric Uncertainty (ROO)

FIDC-B8: Parametric Uncertainty (MOD)

FIDC-C8: Parametric Uncertainty (FO)

FIDC-D8: Parametric Uncertainty (EXROO)

Smoke Development, Spread and Control (SDSC)

SMOKE DEVELOPMENT, SPREAD AND CONTROL (SDSC)

High Level Requirements for Smoke Development, Spread and Control (SDSC)	
Designator	**Requirement**
HLR-SDSC-A	Room of Origin Smoke Development (ROO)
HLR-SDSC-B	Modified Smoke Development (MOD)
HLR-SDSC-C	Flashover Smoke Development (FO)
HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)
HLR-SDSC-E	Smoke Control and Management (SC&M)
HLR-SDSC-F	Smoke Barrier Failure (SBF)

Supporting Requirements for HLR-SDSC-A: Room of Origin Smoke Development (ROO)		
SDSC-A1: Smoke Production (ROO)	**FIDC-A1: Fire Size/HRR (ROO)**	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A1 - Building Characteristics (ROO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-A1 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-A2: Smoke Layer Interface Height (ROO)	**SDSC-A1: Smoke Production (ROO)**	
	SDSC-A2 - Building Characteristics (ROO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-A2 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-A3: Smoke Temperature (ROO)	**SDSC-A1 - Building Characteristics (ROO)**	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.
	FIDC-A4: Smoke Yield (ROO)	
	SDSC-A3 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	SDSC-A1: Smoke Production (ROO)	
SDSC-A4: Smoke Optical Density (ROO)	**FIDC-A4: Smoke Yield (ROO)**	
	SDSC-A2: Smoke Layer Interface Height (ROO)	
	SDSC-A4 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-A5: Smoke Concentration (ROO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	
	FIDC-A3: Toxic Species Yield (ROO)	
	SDSC-A2: Smoke Layer Interface Height (ROO)	
	SDSC-A5 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-A6: Radiation from Smoke Layer (ROO)	**SDSC-A3: Smoke Temperature (ROO)**	
	SDSC-A2: Smoke Layer Interface Height (ROO)	
	SDSC-A6 - Building Characteristics (ROO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.
	SDSC-A6 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-A7: Modeling Uncertainty (ROO)	**SDSC-A7 - Modeling Uncertainty (ROO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
SDSC-A8: Parametric Uncertainty (ROO)	**SDSC-A8 - Parametric Uncertainty (ROO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-SDSC-B: Modified Smoke Development (MOD)		
SDSC-B1: Smoke Production (MOD)	**FIDC-B1: Fire Size/HRR (MOD)**	
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	
	SDSC-B1 - Building Characteristics (MOD)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-B1 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-B2: Smoke Layer Interface Height (MOD)	**SDSC-B1: Smoke Production (MOD)**	
	HLR-SDSC-E: Smoke Control and Management (SC&M)	
	SDSC-B2 - Building Characteristics (MOD)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-B3: Smoke Temperature (MOD)	**SDSC-B1 - Building Characteristics (MOD)**	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.
	FIDC-B4: Smoke Yield (MOD)	
	SDSC-B3 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	SDSC-B1: Smoke Production (MOD)	
SDSC-B4: Smoke Optical Density (MOD)	**FIDC-B4: Smoke Yield (MOD)**	
	SDSC-B2: Smoke Layer Interface Height (MOD)	
	SDSC-B4 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-B5: Smoke Concentration (MOD)	**FIDC-B3: Toxic Species Yield (MOD)**	
	SDSC-B2: Smoke Layer Interface Height (MOD)	
	SDSC-B5 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-B6: Radiation from Smoke Layer (MOD)	**SDSC-B3: Smoke Temperature (MOD)**	
	SDSC-B2: Smoke Layer Interface Height (MOD)	
	SDSC-B6 - Building Characteristics (MOD)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.
	SDSC-B6 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-B7: Modeling Uncertainty (MOD)	**SDSC-B7 - Modeling Uncertainty (MOD)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.

SDSC-B8: Parametric Uncertainty (MOD)	**SDSC-B8 - Parametric Uncertainty (MOD)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-SDSC-C: Flashover Smoke Development (FO)		
SDSC-C1: Smoke Production (FO)	**FIDC-C1: Fire Size/HRR (FO)**	
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	
	SDSC-C1 - Building Characteristics (FO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-C1 - Method Verification and Validation (FO)	Enter description here.
SDSC-C2: Smoke Layer Interface Height (FO)	**SDSC-C1: Smoke Production (FO)**	
	HLR-SDSC-E: Smoke Control and Management (SC&M)	
	SDSC-C2 - Building Characteristics (FO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-C2 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-C3: Smoke Temperature (FO)	**SDSC-C1 - Building Characteristics (FO)**	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.
	FIDC-C4: Smoke Yield (FO)	
	SDSC-C3 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	SDSC-C1: Smoke Production (FO)	

SDSC-C4: Smoke Optical Density (FO)	**FIDC-C4: Smoke Yield (FO)**	
	SDSC-C2: Smoke Layer Interface Height (FO)	
	SDSC-C4 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-C5: Smoke Concentration (FO)	**FIDC-C3: Toxic Species Yield (FO)**	
	SDSC-C2: Smoke Layer Interface Height (FO)	
	SDSC-C5 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-C6: Radiation from Smoke Layer (FO)	**SDSC-C3: Smoke Temperature (FO)**	
	SDSC-C2: Smoke Layer Interface Height (FO)	
	SDSC-C6 - Building Characteristics (FO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.
	SDSC-C6 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-C7: Modeling Uncertainty (FO)	**SDSC-C7 - Modeling Uncertainty (FO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
SDSC-C8: Parametric Uncertainty (FO)	**SDSC-C8 - Parametric Uncertainty (FO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-SDSC-D: Beyond Room of Origin Smoke Development (EXROO)		
SDSC-D1: Smoke Production (EXROO)	**FIDC-D1: Fire Size/HRR (EXROO)**	
	FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	
	SDSC-D2: Smoke Spread (EXROO)	
	SDSC-D1 - Building Characteristics (EXROO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-D2: Smoke Spread (EXROO)	**Impact of ROO Fire and Smoke Development on Smoke Spread through Openings**	
	Impact of MOD Fire and Smoke Development on Smoke Spread through Openings	
	Impact of FO Fire and Smoke Development on Smoke Spread through Openings	
	SDSC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-D3: Smoke Layer Interface Height (EXROO)	**SDSC-D1: Smoke Production (EXROO)**	
	HLR-SDSC-E: Smoke Control and Management (SC&M)	
	SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	
	SDSC-G - Active Smoke Barriers	
	SDSC-D2 - Building Characteristics (EXROO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.
	SDSC-D2 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-D4: Smoke Temperature (EXROO)	**SDSC-D1 - Building Characteristics (EXROO)**	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.
	FIDC-D4: Smoke Yield (EXROO)	
	SDSC-D3 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
	SDSC-D1: Smoke Production (EXROO)	
SDSC-D5: Smoke Optical Density (EXROO)	**FIDC-D4: Smoke Yield (EXROO)**	
	SDSC-D3: Smoke Layer Interface Height (EXROO)	
	SDSC-D4 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-D6: Smoke Concentration (EXROO)	**FIDC-D3: Toxic Species Yield (EXROO)**	
	SDSC-D3: Smoke Layer Interface Height (EXROO)	
	SDSC-D5 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-D7: Radiation from Smoke Layer (EXROO)	**SDSC-D4: Smoke Temperature (EXROO)**	
	SDSC-D3: Smoke Layer Interface Height (EXROO)	
	SDSC-D6 - Building Characteristics (EXROO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.
	SDSC-D6 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-D8: Modeling Uncertainty (EXROO)	**SDSC-D8 - Modeling Uncertainty (EXROO)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
SDSC-D9: Parametric Uncertainty (EXROO)	**SDSC-D9 - Parametric Uncertainty (EXROO)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-SDSC-E: Smoke Control and Management (SC&M)		
SDSC-E1: System Effectiveness (SC&M)	**SDSC-A2: Smoke Layer Interface Height (ROO)**	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-E1 - Building Characteristics (SC&M)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	SDSC-E1 - System Design and Characteristics (SC&M)	The system design and those characteristics that influence system effectiveness should be addressed. Examples include system flow rates, the size of openings, etc.
	SDSC-E1 - Method Verification and Validation (SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-E2: Modeling Uncertainty (SC&M)	**SDSC-E2 - Modeling Uncertainty (SC&M)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
SDSC-E3: Parametric Uncertainty (SC&M)	**SDSC-E3 - Parametric Uncertainty (SC&M)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

HLR-SDSC-E: Smoke Control and Management (SC&M)

FDWS-G - Detection

FDWS-G5: System Reliability and Availability (DA-SC&M)

SDSC-E1: System Effectiveness (SC&M)

Supporting Requirements for HLR-SDSC-F: Smoke Barrier Failure (SBF)		
SDSC-F1: Active Smoke Barrier Effectiveness (SBF)	**Impact of ROO Fire and Smoke Development on Smoke Barriers**	
	Impact of MOD Fire and Smoke Development on Smoke Barriers	
	Impact of FO Fire and Smoke Development on Smoke Barriers	
	SDSC-B1 - Barrier Characteristics (SBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.
	SDSC-B1 - Building Characteristics (SBF)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pathway diversion effects that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	SDSC-B1 - Method Verification and Validation (SBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	**Impact of ROO Fire and Smoke Development on Smoke Barriers**	
	Impact of MOD Fire and Smoke Development on Smoke Barriers	
	Impact of FO Fire and Smoke Development on Smoke Barriers	
	SDSC-B2 - Barrier Characteristics (SBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.
	SDSC-B2 - Building Characteristics (SBF)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pathway diversion effects that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	SDSC-B2 - Method Verification and Validation (SBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
SDSC-F3: Modeling Uncertainty (SBF)	**SDSC-F3 - Modeling Uncertainty (SBF)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
SDSC-F4: Parametric Uncertainty (SBF)	**SDSC-F4 - Parametric Uncertainty (SBF)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Smoke Barriers

- **FIDC-A5: Flame Height, Temperature and Radiation (ROO)**
- **SDSC-A3: Smoke Temperature (ROO)**
- **SDSC-A6: Radiation from Smoke Layer (ROO)**

Impact of MOD Fire and Smoke Development on Smoke Barriers

- **FIDC-B5: Flame Height, Temperature and Radiation (MOD)**
- **SDSC-B3: Smoke Temperature (MOD)**
- **SDSC-B6: Radiation from Smoke Layer (MOD)**

Impact of FO Fire and Smoke Development on Smoke Barriers

- **FIDC-C5: Flame Height, Temperature and Radiation (FO)**
- **SDSC-C3: Smoke Temperature (FO)**
- **SDSC-C6: Radiation from Smoke Layer (FO)**

Impact of ROO Fire and Smoke Development on Smoke Spread through Openings

- **SDSC-A2: Smoke Layer Interface Height (ROO)**
- **SDSC-A3: Smoke Temperature (ROO)**
- **SDSC-A6: Radiation from Smoke Layer (ROO)**

Impact of MOD Fire and Smoke Development on Smoke Spread through Openings

- **SDSC-B2: Smoke Layer Interface Height (MOD)**
- **SDSC-B3: Smoke Temperature (MOD)**
- **SDSC-B6: Radiation from Smoke Layer (MOD)**

Impact of FO Fire and Smoke Development on Smoke Spread through Openings

- **SDSC-C2: Smoke Layer Interface Height (FO)**
- **SDSC-C3: Smoke Temperature (FO)**
- **SDSC-C6: Radiation from Smoke Layer (FO)**

SDSC-G - Active Smoke Barriers

- **FDWS-F - Detection**
- **FDWS-F5: System Reliability and Availability (DA-ASB)**
- **SDSC-F1: Active Smoke Barrier Effectiveness (SBF)**

ADDITIONAL LOGIC AND OUTPUTS

SDSC: Modeling Uncertanty (MU)

SDSC-A7: Modeling Uncertainty (ROO)

SDSC-B7: Modeling Uncertainty (MOD)

SDSC-C7: Modeling Uncertainty (FO)

SDSC-D8: Modeling Uncertainty (EXROO)

SDSC-E2: Modeling Uncertainty (SC&M)

SDSC-F3: Modeling Uncertainty (SBF)

SDSC: Parametric Uncertanty (PU)

SDSC-A8: Parametric Uncertainty (ROO)

SDSC-B8: Parametric Uncertainty (MOD)

SDSC-C8: Parametric Uncertainty (FO)

SDSC-D9: Parametric Uncertainty (EXROO)

SDSC-E3: Parametric Uncertainty (SC&M)

SDSC-F4: Parametric Uncertainty (SBF)

Fire Detection, Warning and Suppression (FDWS)

FIRE DETECTION, WARNING AND SUPPRESSION (FDWS)

High Level Requirements for Fire Detection, Warning and Suppression (FDWS)	
Designator	**Requirement**
HLR-FDWS-A	Manual Notification System (MNS)
HLR-FDWS-B	Automatic Notification System (ANS)
HLR-FDWS-C	Manual Suppression and Control (MS&C)
HLR-FDWS-D	Automatic Suppression and Control (AS&C)
HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)
HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)
HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)

Supporting Requirements for HLR-FDWS-A: Manual Notification System (MNS)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FDWS-A1: Timing of Manual Detection (MNS)	**FDWS-A1 - Building Characteristics (MNS)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-A1 - Occupant Characteristics (MNS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-A1 - Ventilation Conditions (MNS)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FDWS-A1 - Fire Characteristics (MNS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.	
	FDWS-A1 - Smoke Characteristics (MNS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	
	FDWS-A1 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-A2: Reliability and Availability of Manual Detection (MNS)	**FDWS-A2 - Building Characteristics (MNS)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-A2 - Occupant Characteristics (MNS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-A2 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-A3: Timing of Automatic Detection (MNS)	**FDWS-A3 - Building Characteristics (MNS)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-A3 - Detector Characteristics (MNS)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-A3 - Ventilation Conditions (MNS)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FDWS-A3 - Fire Characteristics (MNS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.
	FDWS-A3 - Smoke Characteristics (MNS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.
	FDWS-A3 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-A4: Reliability and Availability of Automatic Detection (MNS)	**FDWS-A4 - Building Characteristics (MNS)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-A4 - System Design and Maintenance (MNS)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-A4 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-A5: Reliability and Availability (MNS)	**FDWS-A5 - Building Characteristics (MNS)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., lighting, power, etc.).
	FDWS-A5 - System Design and Maintenance (MNS)	System characteristics that influence reliability and availability should be addressed. Examples include the development of and training on procedures..
	FDWS-A5 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

FDWS-A6: Effectiveness (MNS)	**FDWS-A6 - Building Characteristics (MNS)**	Building characteristics that influence system effectiveness should be addressed. Examples include dependencies on building systems (e.g., speaker systems, building arrangement, etc.).
	FDWS-A6 - Occupant Characteristics (MNS)	Occupant characteristics that influence system effectiveness should be addressed. Examples include occupant ability or desire to follow instructions.
	FDWS-A6 - System Characteristics (MNS)	System characteristics that influence its effectiveness should be addressed. Examples include the quality of procedures.
	FDWS-A6 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-A7: Modeling Uncertainty (MNS)	**FDWS-A7 - Modeling Uncertainty (MNS)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-A8: Parametric Uncertainty (MNS)	**FDWS-A8 - Parametric Uncertainty (MNS)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

FDWS-A - Manual Detection (MNS)

FDWS-A1: Timing of Manual Detection (MNS)

FDWS-A2: Reliability and Availability of Manual Detection (MNS)

FDWS-A - Automatic Detection (MNS)

FDWS-A3: Timing of Automatic Detection (MNS)

FDWS-A4: Reliability and Availability of Automatic Detection (MNS)

FDWS-A - Detection (MNS)

Manual Detection

Automatic Detection

Supporting Requirements for HLR-FDWS-B: Automatic Notification System (ANS)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FDWS-B1: Timing of Manual Detection (ANS)	**FDWS-B1 - Building Characteristics (ANS)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-B1 - Occupant Characteristics (ANS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-B1 - Ventilation Conditions (ANS)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FDWS-B1 - Fire Characteristics (ANS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.	
	FDWS-B1 - Smoke Characteristics (ANS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	
	FDWS-B1 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-B2: Reliability and Availability of Manual Detection (ANS)	**FDWS-B2 - Building Characteristics (ANS)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-B2 - Occupant Characteristics (ANS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-B2 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-B3: Timing of Automatic Detection (ANS)	**FDWS-B3 - Building Characteristics (ANS)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-B3 - Detector Characteristics (ANS)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-B3 - Ventilation Conditions (ANS)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FDWS-B3 - Fire Characteristics (ANS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.
	FDWS-B3 - Smoke Characteristics (ANS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.
	FDWS-B3 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-B4: Reliability and Availability of Automatic Detection (ANS)	**FDWS-B4 - Building Characteristics (ANS)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-B4 - System Design and Maintenance (ANS)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-B4 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-B5: Reliability and Availability (ANS)	**FDWS-B5 - Building Characteristics (ANS)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-B5 - System Design and Maintenance (ANS)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.
	FDWS-B5 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

FDWS-B6: Effectiveness (ANS)	**FDWS-B6 - Building Characteristics (ANS)**	Enter description here.
	FDWS-B6 - Occupant Characteristics (ANS)	Enter description here.
	FDWS-B6 - System Characteristics (ANS)	Enter description here.
	FDWS-B6 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-B7: Modeling Uncertainty (ANS)	**FDWS-B7 - Modeling Uncertainty (ANS)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-B8: Parametric Uncertainty (ANS)	**FDWS-B8 - Parametric Uncertainty (ANS)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

FDWS-B - Manual Detection (ANS)

- **FDWS-B1: Timing of Manual Detection (ANS)**
- **FDWS-B2: Reliability and Availability of Manual Detection (ANS)**

FDWS-B - Automatic Detection (ANS)

- **FDWS-B3: Timing of Automatic Detection (ANS)**
- **FDWS-B4: Reliability and Availability of Automatic Detection (ANS)**

FDWS-B - Detection (ANS)

- **FDWS-B - Manual Detection (ANS)**
- **FDWS-B - Automatic Detection (ANS)**

Supporting Requirements for HLR-FDWS-C: Manual Suppression and Control (MS&C)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FDWS-C1: Timing of Manual Detection (MS&C)	**FDWS-C1 - Building Characteristics (MS&C)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-C1 - Occupant Characteristics (MS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-C1 - Ventilation Conditions (MS&C)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)		
	SDSC-A2: Smoke Layer Interface Height (ROO)		
	SDSC-A4: Smoke Optical Density (ROO)		
	SDSC-A6: Radiation from Smoke Layer (ROO)		
	FDWS-C1 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-C2: Reliability and Availability of Manual Detection (MS&C)	**FDWS-C2 - Building Characteristics (MS&C)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-C2 - Occupant Characteristics (MS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-C2 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-C3: Timing of Automatic Detection (MS&C)	**FDWS-C3 - Building Characteristics (MS&C)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-C3 - Detector Characteristics (MS&C)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-C3 - Ventilation Conditions (MS&C)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	FDWS-C3 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)	**FDWS-C4 - Building Characteristics (MS&C)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-C4 - System Design and Maintenance (MS&C)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-C4 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

FDWS-C5: Reliability and Availability (MS&C)	**FDWS-C5 - Building Characteristics (MS&C)**	Building characteristics that influence reliability and availability should be addressed. Examples include building complexity.
	FDWS-C5 - Occupant Characteristics (MS&C)	Occupant characteristics that influence reliability and availability should be addressed. Examples include the likelihood that an occupant will make use of manual suppressants.
	FDWS-C5 - Equipment Design and Maintenance (MS&C)	Equipment characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of equipment.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A2: Smoke Layer Interface Height (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	SDSC-A6: Radiation from Smoke Layer (ROO)	
	SDSC-A5: Smoke Concentration (ROO)	
	FDWS-C5 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-C6: Effectiveness (MS&C)	**FDWS-C6 - Building Characteristics (MS&C)**	Building characteristics that influence effectiveness should be addressed. Examples include building geometry.
	FDWS-C6 - Equipment Characteristics (MS&C)	Occupant characteristics that influence effectiveness should be addressed. Examples include occupant training.
	FIDC-A1: Fire Size/HRR (ROO)	
	FDWS-C6 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-C7: Modeling Uncertainty (MS&C)	**FDWS-C7 - Modeling Uncertainty (MS&C)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-C8: Parametric Uncertainty (MS&C)	**FDWS-C8 - Parametric Uncertainty (MS&C)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS
FDWS-C - Manual Detection
FDWS-C1: Timing of Manual Detection (MS&C)
FDWS-C2: Reliability and Availability of Manual Detection (MS&C)
FDWS-C - Automatic Detection
FDWS-C3: Timing of Automatic Detection (MS&C)
FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)
FDWS-C - Detection
FDWS-C - Manual Detection
FDWS-C - Automatic Detection
HLR-FDWS-C: Manual Suppression and Control (MS&C)
FDWS-C - Detection
FDWS-C5: Reliability and Availability (MS&C)
FDWS-C6: Effectiveness (MS&C)

Supporting Requirements for HLR-FDWS-D: Automatic Suppression and Control (AS&C)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FDWS-D1: Timing of Manual Detection (AS&C)	**FDWS-D1 - Building Characteristics (AS&C)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-D1 - Occupant Characteristics (AS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-D1 - Ventilation Conditions (AS&C)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)		
	SDSC-A2: Smoke Layer Interface Height (ROO)		
	SDSC-A4: Smoke Optical Density (ROO)		
	SDSC-A6: Radiation from Smoke Layer (ROO)		
	FDWS-D1 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-D2: Reliability and Availability of Manual Detection (AS&C)	**FDWS-D2 - Building Characteristics (AS&C)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).
	FDWS-D2 - Occupant Characteristics (AS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.
	FDWS-D2 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-D3: Timing of Automatic Detection (AS&C)	**FDWS-D3 - Building Characteristics (AS&C)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-D3 - Detector Characteristics (AS&C)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-D3 - Ventilation Conditions (AS&C)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	FDWS-D3 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)	**FDWS-D4 - Building Characteristics (AS&C)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-D4 - System Design and Maintenance (AS&C)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-D4 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.

FDWS-D5: System Reliability and Availability (AS&C)	**FDWS-D5 - Building Characteristics (AS&C)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-D5 - System Design and Maintenance (AS&C)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.
	FDWS-D5 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-D6: System Effectiveness (AS&C)	**FDWS-D6 - Building Characteristics (AS&C)**	Building characteristics that influence system reliability and availability should be addressed. Examples include obstructions.
	FDWS-D6 - System Characteristics (AS&C)	System characteristics that influence reliability and availability should be addressed. Examples include the design and the type of fire involved.
	FIDC-A1: Fire Size/HRR (ROO)	
	FDWS-D6 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-D7: Modeling Uncertainty (AS&C)	**FDWS-D7 - Modeling Uncertainty (AS&C)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-D8: Parametric Uncertainty (AS&C)	**FDWS-D8 - Parametric Uncertainty (AS&C)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

FDWS-D - Manual Detection

- **FDWS-D1: Timing of Manual Detection (AS&C)**
- **FDWS-D2: Reliability and Availability of Manual Detection (AS&C)**

FDWS-D - Automatic Detection

- **FDWS-D3: Timing of Automatic Detection (AS&C)**
- **FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)**

FDWS-D - Detection

- **FDWS-D - Manual Detection**
- **FDWS-D - Automatic Detection**

HLR-FDWS-D: Automatic Suppression and Control (AS&C)

- **FDWS-D - Detection**
- **FDWS-D5: System Reliability and Availability (AS&C)**
- **FDWS-D6: System Effectiveness (AS&C)**

Supporting Requirements for HLR-FDWS-E: Detection and Activation for Active Fire Barriers (DA-AFB)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FDWS-E1: Timing of Manual Detection (DA-AFB)	**FDWS-E1 - Building Characteristics (DA-AFB)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-E1 - Occupant Characteristics (DA-AFB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-E1 - Ventilation Conditions (DA-AFB)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)		
	SDSC-A2: Smoke Layer Interface Height (ROO)		
	SDSC-A4: Smoke Optical Density (ROO)		
	SDSC-A6: Radiation from Smoke Layer (ROO)		
	FDWS-E1 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)	**FDWS-E2 - Building Characteristics (DA-AFB)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-E2 - Occupant Characteristics (DA-AFB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-E2 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-E3: Timing of Automatic Detection (DA-AFB)	**FDWS-E3 - Building Characteristics (DA-AFB)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-E3 - Detector Characteristics (DA-AFB)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-E3 - Ventilation Conditions (DA-AFB)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	FDWS-E3 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)	**FDWS-E4 - Building Characteristics (DA-AFB)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-E4 - System Design and Maintenance (DA-AFB)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-E4 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-E5: System Reliability and Availability (DA-AFB)	**FDWS-E5 - Building Characteristics (DA-AFB)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-E5 - System Design and Maintenance (DA-AFB)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.
	FDWS-E5 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-E6: Modeling Uncertainty (DA-AFB)	**FDWS-E6 - Modeling Uncertainty (DA-AFB)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-E7: Parametric Uncertainty (DA-AFB)	**FDWS-E7 - Parametric Uncertainty (DA-AFB)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS	
FDWS-E - Manual Detection	
	FDWS-E1: Timing of Manual Detection (DA-AFB)
	FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)
FDWS-E - Automatic Detection	
	FDWS-E3: Timing of Automatic Detection (DA-AFB)
	FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)
FDWS-E - Detection	
	FDWS-E - Manual Detection
	FDWS-E - Automatic Detection
FDWS-E5: System Reliability and Availability (DA-AFB)	

Supporting Requirements for HLR-FDWS-F: Detection and Activation for Active Smoke Barriers (DA-ASB)

Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FDWS-F1: Timing of Manual Detection (DA-ASB)	**FDWS-F1 - Building Characteristics (DA-ASB)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-F1 - Occupant Characteristics (DA-ASB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-F1 - Ventilation Conditions (DA-ASB)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)		
	SDSC-A2: Smoke Layer Interface Height (ROO)		
	SDSC-A4: Smoke Optical Density (ROO)		
	SDSC-A6: Radiation from Smoke Layer (ROO)		
	FDWS-F1 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)	**FDWS-F2 - Building Characteristics (DA-ASB)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-F2 - Occupant Characteristics (DA-ASB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-F2 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-F3: Timing of Automatic Detection (DA-ASB)	**FDWS-F3 - Building Characteristics (DA-ASB)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-F3 - Detector Characteristics (DA-ASB)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-F3 - Ventilation Conditions (DA-ASB)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	FDWS-F3 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)	**FDWS-F4 - Building Characteristics (DA-ASB)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-F4 - System Design and Maintenance (DA-ASB)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-F4 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-F5: System Reliability and Availability (DA-ASB)	**FDWS-F5 - Building Characteristics (DA-ASB)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-F5 - System Design and Maintenance (DA-ASB)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.
	FDWS-F5 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-F6: Modeling Uncertainty (DA-ASB)	**FDWS-F6 - Modeling Uncertainty (DA-ASB)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-F7: Parametric Uncertainty (DA-ASB)	**FDWS-F7 - Parametric Uncertainty (DA-ASB)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS	
FDWS-F - Manual Detection	
	FDWS-F1: Timing of Manual Detection (DA-ASB)
	FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)
FDWS-F - Automatic Detection	
	FDWS-F3: Timing of Automatic Detection (DA-ASB)
	FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)
FDWS-F - Detection	
	FDWS-F - Manual Detection
	FDWS-F - Automatic Detection
FDWS-F5: System Reliability and Availability (DA-ASB)	

Supporting Requirements for HLR-FDWS-G: Detection and Activation for Smoke Control and Management (DA-SC&M)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FDWS-G1: Timing of Manual Detection (DA-SC&M)	**FDWS-G1 - Building Characteristics (DA-SC&M)**	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	
	FDWS-G1 - Occupant Characteristics (DA-SC&M)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	
	FDWS-G1 - Ventilation Conditions (DA-SC&M)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)		
	SDSC-A2: Smoke Layer Interface Height (ROO)		
	SDSC-A4: Smoke Optical Density (ROO)		
	SDSC-A6: Radiation from Smoke Layer (ROO)		
	FDWS-G1 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)	**FDWS-G2 - Building Characteristics (DA-SC&M)**	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	
	FDWS-G2 - Occupant Characteristics (DA-SC&M)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	
	FDWS-G2 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FDWS-G3: Timing of Automatic Detection (DA-SC&M)	**FDWS-G3 - Building Characteristics (DA-SC&M)**	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.
	FDWS-G3 - Detector Characteristics (DA-SC&M)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.
	FDWS-G3 - Ventilation Conditions (DA-SC&M)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	
	SDSC-A3: Smoke Temperature (ROO)	
	SDSC-A4: Smoke Optical Density (ROO)	
	FDWS-G3 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)	**FDWS-G4 - Building Characteristics (DA-SC&M)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-G4 - System Design and Maintenance (DA-SC&M)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.
	FDWS-G4 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-G5: System Reliability and Availability (DA-SC&M)	**FDWS-G5 - Building Characteristics (DA-SC&M)**	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).
	FDWS-G5 - System Design and Maintenance (DA-SC&M)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.
	FDWS-G5 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
FDWS-G6: Modeling Uncertainty (DA-SC&M)	**FDWS-G6 - Modeling Uncertainty (DA-SC&M)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FDWS-G7: Parametric Uncertainty (DA-SC&M)	**FDWS-G7 - Parametric Uncertainty (DA-SC&M)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

FDWS-G - Manual Detection

- **FDWS-G1: Timing of Manual Detection (DA-SC&M)**
- **FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)**

FDWS-G - Automatic Detection

- **FDWS-G3: Timing of Automatic Detection (DA-SC&M)**
- **FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)**

FDWS-G - Detection

- **FDWS-G - Manual Detection**
- **FDWS-G - Automatic Detection**

FDWS-G5: System Reliability and Availability (DA-SC&M)

ADDITIONAL LOGIC AND OUTPUTS

FDWS: Modeling Uncertanty (MU)

- **FDWS-A7: Modeling Uncertainty (MNS)**
- **FDWS-B7: Modeling Uncertainty (ANS)**
- **FDWS-C7: Modeling Uncertainty (MS&C)**
- **FDWS-D7: Modeling Uncertainty (AS&C)**
- **FDWS-E6: Modeling Uncertainty (DA-AFB)**
- **FDWS-F6: Modeling Uncertainty (DA-ASB)**
- **FDWS-G6: Modeling Uncertainty (DA-SC&M)**

FDWS: Parametric Uncertanty (PU)

- **FDWS-A8: Parametric Uncertainty (MNS)**
- **FDWS-B8: Parametric Uncertainty (ANS)**
- **FDWS-C8: Parametric Uncertainty (MS&C)**
- **FDWS-D8: Parametric Uncertainty (AS&C)**
- **FDWS-E7: Parametric Uncertainty (DA-AFB)**
- **FDWS-F7: Parametric Uncertainty (DA-ASB)**
- **FDWS-G7: Parametric Uncertainty (DA-SC&M)**

Fire Spread, Impact and Control (FSIC)

FIRE SPREAD, IMPACT AND CONTROL (FSIC)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)
HLR-FSIC-B	Fire Barrier Failure (FBF)

Supporting Requirements for HLR-FSIC-A: Internal Fire Spread through Openings (IFSTO)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FSIC-A1: Internal Fire Spread through Openings (IFS)	**Impact of ROO Fire and Smoke Development on Fire Spread through Openings**		
	Impact of MOD Fire and Smoke Development on Fire Spread through Openings		
	Impact of FO Fire and Smoke Development on Fire Spread through Openings		
	FSIC-A1 - Building Characteristics (IFS)	Building characteristics that influence internal spread should be addressed. Examples include room geometry, size and arrangement of openings, etc.	
	FSIC-A1 - Method Verification and Validation (IFS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FSIC-A2: Modeling Uncertainty (IFS)	**FSIC-A2 - Modeling Uncertainty (IFS)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	
FSIC-A3: Parametric Uncertainty (IFS)	**FSIC-A3 - Parametric Uncertainty (IFS)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	

Supporting Requirements for HLR-FSIC-B: Fire Barrier Failure (FBF)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FSIC-B1: Active Fire Barrier Effectiveness (FBF)	**Impact of ROO Fire and Smoke Development on Fire Barriers**		
	Impact of MOD Fire and Smoke Development on Fire Barriers		
	Impact of FO Fire and Smoke Development on Fire Barriers		
	FSIC-B1 - Building Characteristics (FBF)	Building characteristics that influence barrier effectiveness should be addressed. Examples include fire resistivity of surrounding construction, arrangement of contents, etc.	
	FSIC-B1 - Barrier Characteristics (FBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	
	FSIC-B1 - Method Verification and Validation (FBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
FSIC-B2: Passive Fire Barrier Effectiveness (FBF)	**Impact of ROO Fire and Smoke Development on Fire Barriers**		
	Impact of MOD Fire and Smoke Development on Fire Barriers		
	Impact of FO Fire and Smoke Development on Fire Barriers		
	FSIC-B2 - Building Characteristics (FBF)	Building characteristics that influence barrier effectiveness should be addressed. Examples include fire resistivity of surrounding construction, arrangement of contents, etc.	
	FSIC-B2 - Barrier Characteristics (FBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	
	FSIC-B2 - Method Verification and Validation (FBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

FSIC-B3: Modeling Uncertainty (FBF)	**FSIC-B3 - Modeling Uncertainty (FBF)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
FSIC-B4: Parametric Uncertainty (FBF)	**FSIC-B4 - Parametric Uncertainty (FBF)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Fire Barriers

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Fire Barriers

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Fire Barriers

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-C3: Smoke Temperature (FO)

SDSC-C6: Radiation from Smoke Layer (FO)

Impact of ROO Fire and Smoke Development on Fire Spread through Openings

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Fire Spread through Openings

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Fire Spread through Openings

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-C3: Smoke Temperature (FO)

SDSC-C6: Radiation from Smoke Layer (FO)

FSIC-B - Active Fire Barriers

FDWS-E - Detection

FDWS-E5: System Reliability and Availability (DA-AFB)

FSIC-B1: Active Fire Barrier Effectiveness (FBF)

FSIC - Fire Spread

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FSIC-A1: Internal Fire Spread through Openings (IFS)

FSIC-B - Active Fire Barriers

FSIC-B2: Passive Fire Barrier Effectiveness (FBF)

ADDITIONAL LOGIC AND OUTPUTS

FSIC: Modeling Uncertanty (MU)

FSIC-A2: Modeling Uncertainty (IFS)

FSIC-B3: Modeling Uncertainty (FBF)

FSIC: Parametric Uncertanty (PU)

FSIC-A3: Parametric Uncertainty (IFS)

FSIC-B4: Parametric Uncertainty (FBF)

Occupant Evacuation and Control (OEC)

OCCUPANT EVACUATION AND CONTROL (OEC)

High Level Requirements for Occupant Evacuation and Control (OEC)	
Designator	**Requirement**
HLR-OEC-A	Available Safe Egress Time (ASET)
HLR-OEC-B	Required Safe Egress Time (RSET)
HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)

Supporting Requirements for HLR-OEC-A: Available Safe Egress Time (ASET)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
OEC-A1: Establishment and Integration of ASET Criteria (ASET)	**OEC-A1 - Smoke Layer Interface Height (ASET)**		
	OEC-A1 - Smoke Obscuration (ASET)		
	OEC-A1 - Toxicity (ASET)		
	OEC-A1 - Thermal Effects (ASET)		
	OEC-A1 - Tenability Criteria Selection (ASET)	The conditions under which an enclosure or building become untenable should be defined to address each type of fire exposure.	
	OEC-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
OEC-A2: Modeling Uncertainty (ASET)	**OEC-A2 - Modeling Uncertainty (OEC)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	
OEC-A3: Parametric Uncertainty (ASET)	**OEC-A3 - Parametric Uncertainty (OEC)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	

ADDITIONAL LOGIC AND OUTPUTS

OEC-A1 - Smoke Layer Interface Height (ASET)

- **SDSC-A2: Smoke Layer Interface Height (ROO)**
- **SDSC-B2: Smoke Layer Interface Height (MOD)**
- **SDSC-C2: Smoke Layer Interface Height (FO)**
- **SDSC-D3: Smoke Layer Interface Height (EXROO)**

OEC-A1 - Smoke Obscuration (ASET)

- **SDSC-A4: Smoke Optical Density (ROO)**
- **SDSC-B4: Smoke Optical Density (MOD)**
- **SDSC-C4: Smoke Optical Density (FO)**
- **SDSC-D5: Smoke Optical Density (EXROO)**

OEC-A1 - Toxicity (ASET)

- **SDSC-A5: Smoke Concentration (ROO)**
- **SDSC-B5: Smoke Concentration (MOD)**
- **SDSC-C5: Smoke Concentration (FO)**
- **SDSC-D6: Smoke Concentration (EXROO)**

OEC-A1 - Thermal Effects (ASET)

- **SDSC-A6: Radiation from Smoke Layer (ROO)**
- **FIDC-A5: Flame Height, Temperature and Radiation (ROO)**
- **SDSC-B6: Radiation from Smoke Layer (MOD)**
- **FIDC-B5: Flame Height, Temperature and Radiation (MOD)**
- **SDSC-C6: Radiation from Smoke Layer (FO)**
- **FIDC-C5: Flame Height, Temperature and Radiation (FO)**
- **SDSC-D7: Radiation from Smoke Layer (EXROO)**
- **FIDC-D5: Flame Height, Temperature and Radiation (EXROO)**

Supporting Requirements for HLR-OEC-B: Required Safe Egress Time (RSET)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)	**FDWS-A - Detection (MNS)**		
	FDWS-A5: Reliability and Availability (MNS)		
	FDWS-B - Detection (ANS)		
	FDWS-B5: Reliability and Availability (ANS)		
	OEC-B1 - Integration of Cues (RSET)	All possible fire detection cues should be considered. These include those visual as well as automatic cues.	
	OEC-B1 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	**FDWS-B6: Effectiveness (ANS)**		
	FDWS-A6: Effectiveness (MNS)		
	OEC-B2 - Building Characteristics (RSET)	Building characteristics that influence the recognition of cues should be addressed. Examples include visual obstructions or competing activities (e.g., loud noises).	
	OEC-B2 - Occupant Characteristics (RSET)	Occupant characteristics that influence the recognition of cues should be addressed. Examples include occupant sensitivity to cues.	
	OEC-B2 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	**OEC-B3 - Building Characteristics (RSET)**	Building characteristics that influence the initiation of movement should be addressed. Examples include occupancy type and related activities.
	OEC-B3 - Occupant Characteristics (RSET)	Occupant characteristics that influence the initiation of movement should be addressed. Examples include occupant relationships.
	OEC-B3 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
OEC-B4: Movement Timing - Completion of Movement (RSET)	**OEC-B3 - Building Characteristics (RSET)**	Building characteristics that influence movement timing should be addressed. Examples include building geometry, number of exits, complexity, etc.
	OEC-B3 - Occupant Characteristics (RSET)	Occupant characteristics that influence movement timing should be addressed. Examples include occupant capacity, speed, etc.
	OEC-B3 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
OEC-B5: Integration of RSET Criteria (RSET)	**OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)**	
	OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	
	OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	
	OEC-B4: Movement Timing - Completion of Movement (RSET)	
	OEC-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.
OEC-B6: Modeling Uncertainty (RSET)	**OEC-B6 - Modeling Uncertainty (OEC)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.
OEC-B7: Parametric Uncertainty (RSET)	**OEC-B7 - Parametric Uncertainty (OEC)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).

Supporting Requirements for HLR-OEC-C: Integration of ASET/RSET Criteria (ASET/RSET)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)	**OEC-A1: Establishment and Integration of ASET Criteria (ASET)**		
	OEC-B5: Integration of RSET Criteria (RSET)		
	OEC-C1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	
OEC-C2: Modeling Uncertainty (ASET/RSET)	**OEC-C2 - Modeling Uncertainty (OEC)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	
OEC-C3: Parametric Uncertainty (ASET/RSET)	**OEC-C3 - Parametric Uncertainty (OEC)**	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	

ADDITIONAL LOGIC AND OUTPUTS

OEC: Modeling Uncertanty (MU)

OEC-A2: Modeling Uncertainty (ASET)

OEC-B6: Modeling Uncertainty (RSET)

OEC-C2: Modeling Uncertainty (ASET/RSET)

OEC: Parametric Uncertanty (PU)

OEC-A3: Parametric Uncertainty (ASET)

OEC-B7: Parametric Uncertainty (RSET)

OEC-C3: Parametric Uncertainty (ASET/RSET)

Fire Scenario Development (FSD)

FIRE SCENARIO DEVELOPMENT (FSD)

High Level Requirements for Fire Scenario Development (FSD)	
Designator	**Requirement**
HLR-FSD-A	Fire Hazards (FH)
HLR-FSD-B	Potential Fire Scenarios (PFS)
HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)

Supporting Requirements for HLR-FSD-A: Fire Hazards (FH)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
FSD-A1: Fire Hazard Analysis (FH)	**FSD-A1 - General Layout (FH)**	Considerations include dead end corridors, unusual egress provisions, location of hazardous materials and processes, and exposures to external radiant sources.	
	FSD-A1 - Activities (FH)	Considerations include repair and maintenance, process and construction, and disregarding safety procedures	
	FSD-A1 - Ignition Sources (FH)	Considerations include smoking materials, electrical equipment, heating appliances, and unusual ignition sources.	
	FSD-A1 - Fuel Sources (FH)	Considerations include amount of combustible materials, location of combustible materials, fire behaviour properties, and dangerous goods and explosives.	
	FSD-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

Supporting Requirements for HLR-FSD-B: Potential Fire Scenarios (PFS)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FSD-B1: Potential Fire Scenarios (PFS)	**FSD-B1 - Combustibles (PFS)**	Considerations include the nature, quantity, arrangement and burning behaviour of combustibles in each enclosure.	
	FSD-B1 - Enclosures (PFS)	Considerations include their geometry, number and relationship.	
	FSD-B1 - Fire Proection Measures (PFS)	Considerations include the fire protection measures in the building and their effect on the fire.	
	FSD-B1 - Ventilation Changes (PFS)	Considerations include occupant activities, window glazing breaking, the operation of air handling or smoke management equipment, doors or other partitions burning through, and openings created by fire services intervention.	
	FSD-B1 - Method Verification and Validation (PFS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

Supporting Requirements for HLR-FSD-C: Design Fire Scenarios for Analysis (DFSA)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FSD-C1: Design Fire Scenarios for Analysis (DFSA)	**FSD-C1 - Frequency (DFSA)**	This factor addresses the frequency of ignition for fire sceanrios.	
	FSD-C1 - Consequence (DFSA)	This factor addresses the overall potential severity of fire sceanrios.	
	FSD-C1 - Screening (DFSA)	This factor evaluates whether there are some fire sceanrios that can be excluded from being considered by the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.	
	FSD-C1 - Method Verification and Validation (DFSA)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

ADDITIONAL LOGIC AND OUTPUTS

FSD - Fire Scenario Development

FSD-A1: Fire Hazard Analysis (FH)

FSD-B1: Potential Fire Scenarios (PFS)

FSD-C1: Design Fire Scenarios for Analysis (DFSA)

ADDITIONAL LOGIC AND OUTPUTS			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
FSD-D1: Modeling Uncertainty (MU)	**FSD-D1 - Modeling Uncertainty (MU)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	

Analysis and Quantification (AQ)

ANALYSIS AND QUANTIFICATION (AQ)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-AQ-A	Quantification Methodology (Q)
HLR-AQ-B	Modeling Uncertainty (MU)
HLR-AQ-C	Parametric Uncertainty (MU)
HLR-AQ-D	Completeness Uncertainty (CU)

Supporting Requirements for HLR-AQ-A: Quantification Methodology (Q)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
AQ-A1: Quantification (Q)	**AQ-A1 - Comparative Approach (Q)**	A comparative approach aims to determine whether the alternative solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design.	
	AQ-A1 - Absolute Approach (Q)	When an evaluation is carried out on an absolute basis, the results of the analysis of the trial design are matched, using the agreed acceptance criteria, against the objectives or performance requirements without comparison to deemed-tosatisfy or prescriptive or "benchmark" designs.	
	AQ-A1 - Qualitative Assessments (Q)	Qualitative analysis may be sufficient for the consideration of limited non-compliance issues, to demonstate equivalency or to evaluate general adequency. The quantitative methods will often be supported by additional qualitative arguments.	
	AQ-A1 - Screening (Q)	This factor evaluates whether there are some fire sceanrios that can be removed from the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.	
	AQ-A1 - Method Verification and Validation (Q)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

Supporting Requirements for HLR-AQ-B: Modeling Uncertainty (MU)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
AQ-B1: Modeling Uncertainty (MU)	FIDC: Modeling Uncertanty (MU)		
	SDSC: Modeling Uncertanty (MU)		
	FDWS: Modeling Uncertanty (MU)		
	FSIC: Modeling Uncertanty (MU)		
	OEC: Modeling Uncertanty (MU)		
	FSD-D1: Modeling Uncertainty (MU)		
	AQ-A2 - Identification of Key Sources of Uncertainty (MU)	This factor addresses the identification of those sources of modeling uncertainty that if addressed by alternate analysis assumptions, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	
	AQ-A2 - Impact of Key Sources on Life Safety (MU)	This factor addresses the characterization of those sources of modeling uncertainty that if addressed by alternate analysis assumptions, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	

Supporting Requirements for HLR-AQ-C: Parametric Uncertainty (MU)			
Index No.	Deterministic		
	Capability Category I	Capability Category II	Capability Category III
AQ-C1: Parametric Uncertainty (PU)	FIDC: Modeling Uncertanty (MU)		
	SDSC: Modeling Uncertanty (MU)		
	FDWS: Modeling Uncertanty (MU)		
	FSIC: Modeling Uncertanty (MU)		
	OEC: Modeling Uncertanty (MU)		
	AQ-A2 - Identification of Key Uncertainties (PU)	This factor addresses the identification of those sources of parametric uncertainty whose associated variables, if altered within their interval of uncertainty, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	
	AQ-A2 - Impact of Key Uncertainties on Life Safety (PU)	This factor addresses the characterization of those sources of parametric uncertainty whose associated variables, if altered within their interval of uncertainty, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	

Supporting Requirements for HLR-AQ-D: Completeness Uncertainty (CU)			
Index No.	**Deterministic**		
	Capability Category I	**Capability Category II**	**Capability Category III**
AQ-D1: Completeness Uncertainty (CU)	**AQ-D1 - Defense in Depth (CU)**	This factor explores the concept of defense in depth. This concept attempts to evaluate the balance between three echelons of fire protection: prevention of ignition, reduction in fire severity, and limiting exposure (e.g., to occupants). Fire protection designs should be proposed that address each of these three echelons equally such that there is not overreliance on one echelon. Such a concept is a means to address completeness uncertainty.	
	AQ-D1 - Safety Margin (CU)	This factor explores the concept of safety margin. This concept attempts to ensure a sufficient level of conservatism in the analysis such that uncertainties associated with completeness (e.g., unknowns) . Such a concept may be implemented through the use of safety factors.	
	AQ-D1 - Method Verification and Validation (CU)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	

Life Safety

Supporting Requirements for Baseline Life Safety Metric:	
Index No.	**Assessment**
Life Safety Metric	**OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)**
	FSD - Fire Scenario Development
	AQ-A1: Quantification (Q)
	AQ-B1: Modeling Uncertainty (MU)
	AQ-C1: Parametric Uncertainty (PU)
	AQ-D1: Completeness Uncertainty (CU)

APPENDIX E

Case Study Quality Scales

To implement the decision support tool effectively for the proposed case study, guidance must be developed to determine what constitutes a low level of quality versus, say, a higher one when characterizing the degree of technical quality achieved for those influencing factors relevant to the fire safety analysis. As explained in Section 3.4.2.1 of the main report, performance statements may be used to guide the user of the decision support tool for addressing a broad set of analysis characteristics, including fire phenomena, uncertainty modeling, model verification and validation, etc. As a result, a set of quality definitions were outlined for each type of influencing factor relevant to the case study. The tables below provide such definitions.

Table E.1: Fire Characteristics

LOW	**MEDIUM**	**HIGH**
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.

Table E.2: Smoke Characteristics

LOW	**MEDIUM**	**HIGH**
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.

Table E.3: Building Characteristics

LOW	MEDIUM	HIGH
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.

Table E.4: Fire Protection System Characteristics

LOW	MEDIUM	HIGH
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.

Table E.5: Occupant Characteristics

LOW	MEDIUM	HIGH
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.

Table E.6: Method Verification and Validation

LOW	MEDIUM	HIGH
Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.

Table E.7: Modeling Uncertainty

LOW	MEDIUM	HIGH
Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	All assumptions and sources of uncertainty are systematically and fully identified.

Table E.8: Parameter Uncertainty

LOW	MEDIUM	HIGH
Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.

APPENDIX F

Case Study Decision Support Tool

Fire Initiation, Development and Control (FIDC)

FIRE INITIATION, DEVELOPMENT AND CONTROL (FIDC)

High Level Requirements for Fire Initiation, Development and Control (FIDC)	
Designator	**Requirement**
HLR-FIDC-A	Room of Origin Fire Development (ROO)
HLR-FIDC-B	Modified Fire Development (MOD)
HLR-FIDC-C	Flashover (FO)
HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)

Supporting Requirements for HLR-FIDC-A: Room of Origin Fire Development (ROO)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment				
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III					
FIDC-A1: Fire Size/HRR (ROO)	For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a discrete set of two heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, DEVELOP and JUSTIFY a distribution of heat release rates that applies prior to flashover or activation of fire protection features (e.g., sprinkler system) in the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-A1 - Ignition Characteristics (ROO)	Ignition may be piloted, non-piloted or self-induced. The influence of the size, energetics and type of ignition source on fire development should be considered.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A1 - Fuel and Loading Characteristics (ROO)	The fire load within a compartment and its associated properties will influence the duration and severity of a fire. Fire loading characteristics include both those associated with the physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		F&O 1	**Quality Rating:**	Low	**Uncertainty:**	Low
	FIDC-A6: Ventilation Conditions (ROO)													
	FIDC-A1 - Building Characteristics (ROO)	Fire development within the room of origin should consider influential building characteristics. Examples include thermal properties of internal linings and the building envelope.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A1 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A2: Fire Growth and Flame Spread (ROO)													

Index No.	Deterministic CC I	Deterministic CC II	Deterministic CC III	Risk-Informed CC I	Risk-Informed CC II	Risk-Informed CC III	Risk-Based CC I	Risk-Based CC II	Risk-Based CC III	Assessment				
FIDC-A2: Fire Growth and Flame Spread (ROO)	For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-A2 - Temporal Profile (ROO)	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		F&O 1	**Quality Rating:**	Low-Medium	**Uncertainty:**	Low
	FIDC-A2 - Fuel Characteristics (ROO)	The characteristics of secondary combustibles will influence the duration and severity of a fire over time. Characteristics include both those associated with physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		F&O 1	**Quality Rating:**	Low	**Uncertainty:**	Low
	FIDC-A2 - Building Characteristics (ROO)	Building characteristics that influence the growth and spread of the fire within the room of origin. Examples include room geometry.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A2 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None

Index No.	Deterministic CC I	Deterministic CC II	Deterministic CC III	Risk-Informed CC I	Risk-Informed CC II	Risk-Informed CC III	Risk-Based CC I	Risk-Based CC II	Risk-Based CC III	Assessment		
FIDC-A3: Toxic Species Yield (ROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specific data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specific data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specific data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FIDC-A3 - Toxic Species Data (ROO)	The princpal toxic species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A3 - Combustion Characteristics (ROO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A3 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A1: Fire Size/HRR (ROO)							

FIDC-A4: Smoke Yield (ROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A4 - Smoke Yield Data (ROO)	The princpal species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.	F&O 2	**Quality Rating:** Medium	**Uncertainty:** Low
	FIDC-A4 - Combustion Characteristics (ROO)	The nature of combustibles invovled and their influence on smoke yield should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A4 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A1: Fire Size/HRR (ROO)							

FIDC-A5: Flame Height, Temperature and Radiation (ROO)	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A5 - Building Characteristics (ROO)	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A5 - Fuel and Loading Characteristics (ROO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A5 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A1: Fire Size/HRR (ROO)							

FIDC-A6: Ventilation Conditions (ROO)	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, EVALUATE the compartment ventilation conditions in the room of origin prior to flashover or activation of fire protection features (e.g., smoke control and management systems), and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A6 - Building Characteristics (ROO)	Building characteristics that influence ventilation conditions within the room of origin should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iV) leakage rates through doors and barriers.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A6 - Occupant Characteristics (ROO)	The influence of occupants on ventilation conditions should be addressed. Examples include occupants opening or closing doors.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
	FIDC-A6 - Environmental Conditions (ROO)	Environmental conditions (e.g., temperature, natural ventilation, etc.) within or external to the room of origin should be addressed if they can influence fire development.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FIDC-A6 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FIDC-A6: Modeling Uncertainty (ROO)	DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A6 - Modeling Uncertainty (ROO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:** High	**Uncertainty:** None

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FIDC-A7: Parametric Uncertainty (ROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A7 - Parametric Uncertainty (ROO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-FIDC-B: Modified Fire Development (MOD)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FIDC-B1: Fire Size/HRR (MOD)	For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY how the heat release rate assessed under FIDC-A1 is modified following activation of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-B6: Ventilation Conditions (MOD)											
	FIDC-B1 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None
	HLR-FDWS-C: Manual Suppression and Control (MS&C)											
	HLR-FDWS-D: Automatic Suppression and Control (AS&C)											
	FIDC-B2: Fire Growth and Flame Spread (MOD)											

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FIDC-B2: Fire Growth and Flame Spread (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on fire growth and flame spread assumed under FIDC-A2. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-B2 - Temporal Profile (MOD)	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FIDC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FIDC-B3: Toxic Species Yield (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A3. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-B3 - Toxic Species Data (MOD)	The princpal toxic species should be identified and their yield quantified.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FIDC-B3 - Combustion Characteristics (MOD)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None

	FIDC-B3 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B1: Fire Size/HRR (MOD)									

FIDC-B4: Smoke Yield (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on toxic species yield assumed under FIDC-A4. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-B4 - Smoke Yield Data (MOD)	The princpal species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.	F&O 2	**Quality Rating:**	Medium	**Uncertainty:**	None
	FIDC-B4 - Combustion Characteristics (MOD)	The nature of combustibles invovled and their influence on smoke yield should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B4 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B1: Fire Size/HRR (MOD)									

FIDC-B5: Flame Height, Temperature and Radiation (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on flame properties assumed under FIDC-A5. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-B5 - Building Characteristics (MOD)	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B5 - Fuel and Loading Characteristics (MOD)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B5 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-B1: Fire Size/HRR (MOD)									

FIDC-B6: Ventilation Conditions (MOD)	For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of fire protection features (e.g., sprinkler system, smoke control and management system, etc.) in the room of origin on ventilation conditions under FIDC-A6. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	HLR-SDSC-E: Smoke Control and Management (SC&M)									
	FIDC-B6 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FIDC-B7: Modeling Uncertainty (MOD)	DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with the modified room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-B7 - Modeling Uncertainty (MOD)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	None

FIDC-B8: Parametric Uncertainty (MOD)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**		
	FIDC-B8 - Parametric Uncertainty (MOD)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	High	**Uncertainty:**	None	

Index No.	Deterministic		Risk-Informed		Risk-Based	Assessment		
	Capability Category I	Capability Category II / Capability Category III	Capability Category I / Capability Category II / Capability Category III		Capability Category I / Capability Category II / Capability Category III			
FIDC-C1: Fire Size/HRR (FO)	For each selected scenario, DETERMINE whether the conditions are appropriate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, DETERMINE whether the conditions are appropriate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, DETERMINE whether the conditions are appropriate for flashover to occur, and JUSTIFY how the heat release rates assessed under FIDC-A1 and FIDC-B1 are altered in the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-C1 - Flashover Criteria (FO)	The time of flashover should be specified by defined criteria. These may be taken to be the time at which the hot layer temperature in the enclosure reaches a certain temperature or when the rate of heat released from the fire is equal to that required to cause flashover. Another criterion often used is the time at which the radiation at the floor from the hot layer reaches a certain point.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	Impact of ROO Fire and Smoke Development on FO Scenarios							
	Impact of MOD Fire and Smoke Development on FO Scenarios							
	FIDC-C6: Ventilation Conditions (FO)							
	FIDC-C2: Fire Growth and Flame Spread (FO)							
	FIDC-C1 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
FIDC-C2: Fire Growth and Flame Spread (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on fire growth and flame spread assumed under FIDC-A2 and FIDC-B2. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-B2 - Temporal Profile (MOD)	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
FIDC-C3: Toxic Species Yield (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A3 and FIDC-B3. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-C3 - Toxic Species Data (FO)	The princpal toxic species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C3 - Combustion Characteristics (FO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C3 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C1: Fire Size/HRR (FO)							
FIDC-C4: Smoke Yield (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on toxic species yield assumed under FIDC-A4 and FIDC-B4. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-C4 - Smoke Yield Data (FO)	The princpal species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C4 - Combustion Characteristics (FO)	The nature of combustibles invovled and their influence on smoke yield should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C4 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-C1: Fire Size/HRR (FO)							

FIDC-C5: Flame Height, Temperature and Radiation (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on flame properties assumed under FIDC-A5 and FIDC-B5. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-C5 - Building Characteristics (FO)	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-C5 - Fuel and Loading Characteristics (FO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-C5 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-C1: Fire Size/HRR (FO)									

FIDC-C6: Ventilation Conditions (FO)	For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the impact of flashover in the room of origin on ventilation conditions assumed under FIDC-A6 and FIDC-B6. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-C6 - Building Characteristics (FO)	Building characteristics that influence ventilation conditions within the room of origin and as a result of flashover should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iv) leakage rates through doors and barriers.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-C6 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FIDC-C7: Modeling Uncertainty (FO)	DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with flashover in the room-of-origin fire development. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-C7 - Modeling Uncertainty (FO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	None

FIDC-C8: Parametric Uncertainty (FO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified flashover scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-C8 - Parametric Uncertainty (FO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.				**Quality Rating:**	High	**Uncertainty:**	None

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on FO Scenarios

FIDC-A1: Fire Size/HRR (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on FO Scenarios

FIDC-B1: Fire Size/HRR (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Supporting Requirements for HLR-FIDC-D: Beyond Room of Origin Fire Development (EXROO)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	

FIDC-D1: Fire Size/HRR (EXROO)	For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is most representative, considering both likelihood and consequence CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, DEVELOP and JUSTIFY a discrete set of heat release rates that applies external to the room of origin and that encompass risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, JUSTIFY that the heat release rate applied external to the room of origin is bounding. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, DEVELOP and JUSTIFY a discrete set of two heat release rates that applies external to the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, DEVELOP and JUSTIFY a distribution of heat release rates that applies external to the room of origin and that encompasses risk contributing fire events. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FIDC-D1 - Ignition Characteristics (EXROO)	Ignition may be piloted, non-polited or self-induced. The influence of the size, energetics and type of ignition source on fire development should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D1 - Fuel and Loading Characteristics (EXROO)	The fire load within a compartment and its associated properties will influence the duration and severity of a fire. Fire loading characteristics include both those associated with the physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D6: Ventilation Conditions (EXROO)									
	FIDC-D1 - Building Characteristics (EXROO)	Fire development within the room of origin should consider influential building characteristics. Examples include thermal properties of internal linings and the building envelope.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D2: Fire Growth and Flane Spread (EXROO)									

FIDC-D2: Fire Growth and Flane Spread (EXROO)	For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ASSUME that the fire grows at a bounding rate or is initiated at full peak intensity. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, JUSTIFY the heat release profile stages (e.g., fire growth, steady-state, or decay stages) included in the analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FIDC-D2 - Temporal Profile (EXROO)	The growth and spread of the fire should be represented as a function of time. Various stages of the fire may be explicitly captured or bounded.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D2 - Fuel Characteristics (EXROO)	The characteristics of secondary combustibles will influence the duration and severity of a fire over time. Characteristics include both those associated with physical configuration (e.g., density, arrangement, etc.) as well as more intrinsic properties (e.g., heat of combustion).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D2 - Building Characteristics (EXROO)	Building characteristics that influence the growth and spread of the fire external to the room of origin. Examples include combustibility of compartment contents and internal linings.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FSIC - Fire Spread									
	FIDC-D2 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FIDC-D3: Toxic Species Yield (EXROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with toxic species yield. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE generic data or estimates associated with toxic species yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with toxic species yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FIDC-D3 - Toxic Species Data (EXROO)	The princpal toxic species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-D3 - Combustion Characteristics (EXROO)	The nature of combustibles invovled and their influence on the yield of toxic species should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**

	FIDC-D3 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D1: Fire Size/HRR (EXROO)									

FIDC-D4: Smoke Yield (EXROO)	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE expert expert judgement, and DOCUMENT the rationale behind the choice of parameter values associated with smoke yield. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, USE generic data or estimates associated with smoke yield for the most similar situation, adjusting if necessary to account for differences. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, USE scenario-specifc data or estimates associated with smoke yield based on testing or similar documentation. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-D4 - Smoke Yield Data (EXROO)	The princpal species should be identified and their yield quantified.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D4 - Combustion Characteristics (EXROO)	The nature of combustibles invovled and their influence on smoke yield should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D4 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D1: Fire Size/HRR (EXROO)									

FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE bounding flame properties. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE time-dependent flame properties.CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-D5 - Building Characteristics (EXROO)	Building characteristics that influence the height, temperature and radiation of the fire flame should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D5 - Fuel and Loading Characteristics (EXROO)	The nature of combustibles invovled and their influence on the the height, temperature and radiation of the fire flame should be considered.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D5 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D1: Fire Size/HRR (EXROO)									

FIDC-D6: Ventilation Conditions (EXROO)	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs. For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ASSUME steady-state conditions that are bounding in terms of fire and smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EVALUATE the compartment ventilation conditions external to the room of origin, and ESTIMATE time-dependent conditions. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-D6 - Building Characteristics (EXROO)	Building characteristics that influence ventilation conditions within the room of origin should be considered and include: (i) the location, status (open or closed) and nature (fire rated or not), and size of openings such as doors, windows and roof vents; (ii) changes in ventilation condition (e.g. due to windows breaking or smoke dampers closing); (iii) the status of mechanical systems (e.g., HVAC); and (iV) leakage rates through doors and barriers.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D6 - Occupant Characteristics (EXROO)	The influence of occupants on ventilation conditions should be addressed. Examples include occupants opening or closing doors.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	HLR-SDSC-E: Smoke Control and Management (SC&M)									
	FIDC-D6 - Environmental Conditions (EXROO)	Environmental conditions (e.g., temperature, natural ventilation, etc.) external to the room of origin should be addressed if they can influence fire development.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None

	FIDC-D6 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	**High**	**Uncertainty:** None

FIDC-D7: Modeling Uncertainty (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with fire development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	FIDC-D7 - Modeling Uncertainty (EXROO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	**High**	**Uncertainty:** None

FIDC-D8: Parametric Uncertainty (EXROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling the fire scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	FIDC-D8 - Parametric Uncertainty (EXROO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	**High**	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

FIDC: Modeling Uncertanty (MU)

- **FIDC-A6: Modeling Uncertainty (ROO)**
- **FIDC-B7: Modeling Uncertainty (MOD)**
- **FIDC-C7: Modeling Uncertainty (FO)**
- **FIDC-D7: Modeling Uncertainty (EXROO)**

FIDC: Parametric Uncertanty (PU)

- **FIDC-A7: Parametric Uncertainty (ROO)**
- **FIDC-B8: Parametric Uncertainty (MOD)**
- **FIDC-C8: Parametric Uncertainty (FO)**
- **FIDC-D8: Parametric Uncertainty (EXROO)**

Smoke Development, Spread and Control (SDSC)

SMOKE DEVELOPMENT, SPREAD AND CONTROL (SDSC)

High Level Requirements for Smoke Development, Spread and Control (SDSC)	
Designator	**Requirement**
HLR-SDSC-A	Room of Origin Smoke Development (ROO)
HLR-SDSC-B	Modified Smoke Development (MOD)
HLR-SDSC-C	Flashover Smoke Development (FO)
HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)
HLR-SDSC-E	Smoke Control and Management (SC&M)
HLR-SDSC-F	Smoke Barrier Failure (SBF)

Supporting Requirements for HLR-SDSC-A: Room of Origin Smoke Development (ROO)

Index No.	Deterministic (Capability Category I / II / III)		Risk-Informed (Capability Category I / II / III)		Risk-Based (Capability Category I / II / III)	Assessment		
SDSC-A1: Smoke Production (ROO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-A1: Fire Size/HRR (ROO)							
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)							
	SDSC-A1 - Building Characteristics (ROO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	SDSC-A1 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.	F&O 3	**Quality Rating:** Low	**Uncertainty:** Low

Index No.	Deterministic		Risk-Informed		Risk-Based	Assessment		
SDSC-A2: Smoke Layer Interface Height (ROO)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-A1: Smoke Production (ROO)							
	SDSC-A2 - Building Characteristics (ROO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	SDSC-A2 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

Index No.	Deterministic	Risk-Informed	Risk-Based	Assessment		
SDSC-A3: Smoke Temperature (ROO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	SDSC-A1 - Building Characteristics (ROO)	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FIDC-A4: Smoke Yield (ROO)									
	SDSC-A3 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None
	SDSC-A1: Smoke Production (ROO)									

SDSC-A4: Smoke Optical Density (ROO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-A4: Smoke Yield (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A4 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of	**LOW** Methods and models applied have not been fully verified or validated.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and	**HIGH** All methods and models applied have been fully verified, and to the extent		Quality Rating:	High	Uncertainty:	None

SDSC-A5: Smoke Concentration (ROO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-A3: Toxic Species Yield (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A5 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

SDSC-A6: Radiation from Smoke Layer (ROO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-A. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-A3: Smoke Temperature (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A6 - Building Characteristics (ROO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	SDSC-A6 - Method Verification and Validation (ROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

SDSC-A7: Modeling Uncertainty (ROO)	DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with room-of-origin smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-A7 - Modeling Uncertainty (ROO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:**	High	**Uncertainty:**	None

SDSC-A8: Parametric Uncertainty (ROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-A8 - Parametric Uncertainty (ROO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	High	**Uncertainty:**	None

Supporting Requirements for HLR-SDSC-B: Modified Smoke Development (MOD)

Index No.	**Deterministic**			**Risk-Informed**			**Risk-Based**			**Assessment**				
	Capability Category I	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**	**Capability Category I**	**Capability Category II**	**Capability Category III**					
SDSC-B1: Smoke Production (MOD)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-B1: Fire Size/HRR (MOD)													
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)													
	SDSC-B1 - Building Characteristics (MOD)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-B1 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		F&O 3	**Quality Rating:**	Low	**Uncertainty:**	Low

SDSC-B2: Smoke Layer Interface Height (MOD)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-B1: Smoke Production (MOD)													
	HLR-SDSC-E: Smoke Control and Management (SC&M)													
	SDSC-B2 - Building Characteristics (MOD)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-B2 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None

SDSC-B3: Smoke Temperature (MOD)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	SDSC-B1 - Building Characteristics (MOD)	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High		**Uncertainty:** None
	FIDC-B4: Smoke Yield (MOD)								
	SDSC-B3 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High		**Uncertainty:** None
	SDSC-B1: Smoke Production (MOD)								

SDSC-B4: Smoke Optical Density (MOD)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	FIDC-B4: Smoke Yield (MOD)								
	SDSC-B2: Smoke Layer Interface Height (MOD)								
	SDSC-B4 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High		**Uncertainty:** None

SDSC-B5: Smoke Concentration (MOD)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	FIDC-B3: Toxic Species Yield (MOD)								
	SDSC-B2: Smoke Layer Interface Height (MOD)								
	SDSC-B5 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High		**Uncertainty:** None

SDSC-B6: Radiation from Smoke Layer (MOD)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-B. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**
	SDSC-B3: Smoke Temperature (MOD)								
	SDSC-B2: Smoke Layer Interface Height (MOD)								
	SDSC-B6 - Building Characteristics (MOD)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High		**Uncertainty:** None

Index No.	Supporting Requirement	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
	SDSC-B6 - Method Verification and Validation (MOD)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating: High	Uncertainty: None

Index No.	Deterministic	Risk-Informed	Risk-Based	Findings & Observations	Quality Assessment	Uncertainty Assessment
SDSC-B7: Modeling Uncertainty (MOD)	DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT the assumptions and sources of uncertainty associated with modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment

Supporting Requirement	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
SDSC-B7 - Modeling Uncertainty (MOD)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		Quality Rating: High	Uncertainty: None

Index No.	Deterministic – Capability Category I	Deterministic – Capability Category II	Deterministic – Capability Category III	Risk-Informed – Capability Category I	Risk-Informed – Capability Category II	Risk-Informed – Capability Category III	Risk-Based – Capability Category I	Risk-Based – Capability Category II	Risk-Based – Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
SDSC-B8: Parametric Uncertainty (MOD)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling modified smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment

Supporting Requirement	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
SDSC-B8 - Parametric Uncertainty (MOD)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.		Quality Rating: High	Uncertainty: None

Supporting Requirements for HLR-SDSC-C: Flashover Smoke Development (FO)

Index No.	Deterministic	Risk-Informed	Risk-Based	Findings & Observations	Quality Assessment	Uncertainty Assessment
	Capability Category I / Capability Category II / Capability Category III	Capability Category I / Capability Category II / Capability Category III	Capability Category I / Capability Category II / Capability Category III	Assessment		
SDSC-C1: Smoke Production (FO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment
	FIDC-C1: Fire Size/HRR (FO)					
	FIDC-C5: Flame Height, Temperature and Radiation (FO)					

Supporting Requirement	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
SDSC-C1 - Building Characteristics (FO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
SDSC-C1 - Method Verification and Validation (FO)	Enter description here.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating: High	Uncertainty: None

Index No.	Deterministic	Risk-Informed	Risk-Based	Findings & Observations	Quality Assessment	Uncertainty Assessment
SDSC-C2: Smoke Layer Interface Height (FO)	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the height of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment
	SDSC-C1: Smoke Production (FO)					
	HLR-SDSC-E: Smoke Control and Management (SC&M)					

	SDSC-C2 - Building Characteristics (FO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** **High**	**Uncertainty:** **None**
	SDSC-C2 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** **High**	**Uncertainty:** **None**

SDSC-C3: Smoke Temperature (FO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the temperature of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-C1 - Building Characteristics (FO)	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** **High**	**Uncertainty:** **None**
	FIDC-C4: Smoke Yield (FO)							
	SDSC-C3 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** **High**	**Uncertainty:** **None**
	SDSC-C1: Smoke Production (FO)							

SDSC-C4: Smoke Optical Density (FO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-C4: Smoke Yield (FO)							
	SDSC-C2: Smoke Layer Interface Height (FO)							
	SDSC-C4 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** **High**	**Uncertainty:** **None**

SDSC-C5: Smoke Concentration (FO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC-C3: Toxic Species Yield (FO)							
	SDSC-C2: Smoke Layer Interface Height (FO)							
	SDSC-C5 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** **High**	**Uncertainty:** **None**

SDSC-C6: Radiation from Smoke Layer (FO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer in the room of origin in a manner consistent with fire development assessed by HLR-FIDC-C. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

Index No.	Deterministic Capability Category I	Deterministic Capability Category II	Deterministic Capability Category III	Risk-Informed Capability Category I	Risk-Informed Capability Category II	Risk-Informed Capability Category III	Risk-Based Capability Category I	Risk-Based Capability Category II	Risk-Based Capability Category III	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	SDSC-C3: Smoke Temperature (FO)													
	SDSC-C2: Smoke Layer Interface Height (FO)													
	SDSC-C6 - Building Characteristics (FO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-C6 - Method Verification and Validation (FO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None
SDSC-C7: Modeling Uncertainty (FO)	DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-C7 - Modeling Uncertainty (FO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:**	High	**Uncertainty:**	None
SDSC-C8: Parametric Uncertainty (FO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling flashover smoke development. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-C8 - Parametric Uncertainty (FO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	High	**Uncertainty:**	None

Supporting Requirements for HLR-SDSC-D: Beyond Room of Origin Smoke Development (EXROO)

Index No.	Deterministic Capability Category I	Deterministic Capability Category II	Deterministic Capability Category III	Risk-Informed Capability Category I	Risk-Informed Capability Category II	Risk-Informed Capability Category III	Risk-Based Capability Category I	Risk-Based Capability Category II	Risk-Based Capability Category III	Assessment				
SDSC-D1: Smoke Production (EXROO)	For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected fire scenario, ESTIMATE how much smoke (including entrained air) is expected to be generated in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FIDC-D1: Fire Size/HRR (EXROO)													
	FIDC-D5: Flame Height, Temperature and Radiation (EXROO)													
	SDSC-D2: Smoke Spread (EXROO)													
	SDSC-D1 - Building Characteristics (EXROO)	Building characteristics that influence smoke production should be addressed. Examples include ceiling height and other aspects of room geometry.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None

Requirement	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
SDSC-D2: Smoke Spread (EXROO)	For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the height of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	Impact of ROO Fire and Smoke Development on Smoke Spread through Openings									
	Impact of MOD Fire and Smoke Development on Smoke Spread through Openings									
	Impact of FO Fire and Smoke Development on Smoke Spread through Openings									
	SDSC-D1 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

Requirement	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
SDSC-D3: Smoke Layer Interface Height (EXROO)	For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the temperature of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-D1: Smoke Production (EXROO)									
	HLR-SDSC-E: Smoke Control and Management (SC&M)									
	SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)									
	SDSC-G - Active Smoke Barriers									
	SDSC-D2 - Building Characteristics (EXROO)	Building characteristics that influence the smoke layer height should be addressed. Examples include ceiling height and other aspects of room geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-D2 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

Requirement	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
SDSC-D4: Smoke Temperature (EXROO)	For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the optical density of the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	SDSC-D1 - Building Characteristics (EXROO)	Building characteristics that influence smoke temperature should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-D4: Smoke Yield (EXROO)									
	SDSC-D3 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-D1: Smoke Production (EXROO)									

SDSC-D5: Smoke Optical Density (EXROO)	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the concentration of toxins in the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FIDC-D4: Smoke Yield (EXROO)									
	SDSC-D3: Smoke Layer Interface Height (EXROO)									
	SDSC-D4 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SDSC-D6: Smoke Concentration (EXROO)	For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected fire scenario, ESTIMATE the radiation from the smoke layer external to the room of origin in a manner consistent with fire development assessed by HLR-FIDC-D. CONSIDER each of the below influencing factors and/or referenced SRs.		Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FIDC-D3: Toxic Species Yield (EXROO)									
	SDSC-D3: Smoke Layer Interface Height (EXROO)									
	SDSC-D5 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SDSC-D7: Radiation from Smoke Layer (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		Findings & Observations	Quality Assessment		Uncertainty Assessment	
	SDSC-D4: Smoke Temperature (EXROO)									
	SDSC-D3: Smoke Layer Interface Height (EXROO)									
	SDSC-D6 - Building Characteristics (EXROO)	Building characteristics that influence radiation from the smoke layer should be addressed. Examples include thermal properties of the enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-D6 - Method Verification and Validation (EXROO)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SDSC-D8: Modeling Uncertainty (EXROO)	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT the assumptions and sources of uncertainty associated with smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.		Findings & Observations	Quality Assessment		Uncertainty Assessment	
	SDSC-D8 - Modeling Uncertainty (EXROO)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	None

SDSC-D9: Parametric Uncertainty (EXROO)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke development external to the room of origin. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-D9 - Parametric Uncertainty (EXROO)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-SDSC-E: Smoke Control and Management (SC&M)

Index No.	Deterministic: Capability Category I	Deterministic: Capability Category II	Deterministic: Capability Category III	Risk-Informed: Capability Category I	Risk-Informed: Capability Category II	Risk-Informed: Capability Category III	Risk-Based: Capability Category I	Risk-Based: Capability Category II	Risk-Based: Capability Category III	Assessment		
SDSC-E1: System Effectiveness (SC&M)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-A2: Smoke Layer Interface Height (ROO)											
	SDSC-A3: Smoke Temperature (ROO)											
	SDSC-E1 - Building Characteristics (SC&M)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	SDSC-E1 - System Design and Characteristics (SC&M)	The system design and those characteristics that influence system effectiveness should be addressed. Examples include system flow rates, the size of openings, etc.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	SDSC-E1 - Method Verification and Validation (SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None

SDSC-E2: Modeling Uncertainty (SC&M)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-E2 - Modeling Uncertainty (SC&M)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:** High	**Uncertainty:** None

SDSC-E3: Parametric Uncertainty (SC&M)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-E3 - Parametric Uncertainty (SC&M)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

HLR-SDSC-E: Smoke Control and Management (SC&M)

FDWS-G - Detection

FDWS-G5: System Reliability and Availability (DA-SC&M)

SDSC-E1: System Effectiveness (SC&M)

Supporting Requirements for HLR-SDSC-F: Smoke Barrier Failure (SBF)

Index No.	Deterministic (Capability Category I / II / III)	Risk-Informed (Capability Category I / II / III)	Risk-Based (Capability Category I / II / III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
SDSC-F1: Active Smoke Barrier Effectiveness (SBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment

Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
Impact of ROO Fire and Smoke Development on Smoke Barriers							
Impact of MOD Fire and Smoke Development on Smoke Barriers							
Impact of FO Fire and Smoke Development on Smoke Barriers							
SDSC-B1 - Barrier Characteristics (SBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
SDSC-B1 - Building Characteristics (SBF)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pathway diversion effects that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
SDSC-B1 - Method Verification and Validation (SBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating: High	Uncertainty: None

Index No.	Deterministic (Capability Category I / II / III)	Risk-Informed (Capability Category I / II / III)	Risk-Based (Capability Category I / II / III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment	Uncertainty Assessment

Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
Impact of ROO Fire and Smoke Development on Smoke Barriers							
Impact of MOD Fire and Smoke Development on Smoke Barriers							
Impact of FO Fire and Smoke Development on Smoke Barriers							
SDSC-B2 - Barrier Characteristics (SBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None

	SDSC-B2 - Building Characteristics (SBF)	Building characteristics that influence system effectiveness should be addressed. Examples include room geometry (e.g., pathway diversion effects that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	SDSC-B2 - Method Verification and Validation (SBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SDSC-F3: Modeling Uncertainty (SBF)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-F3 - Modeling Uncertainty (SBF)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:** High	**Uncertainty:** None

SDSC-F4: Parametric Uncertainty (SBF)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	SDSC-F4 - Parametric Uncertainty (SBF)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Smoke Barriers

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Smoke Barriers

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Smoke Barriers

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-C3: Smoke Temperature (FO)

SDSC-C6: Radiation from Smoke Layer (FO)

Impact of ROO Fire and Smoke Development on Smoke Spread through Openings

SDSC-A2: Smoke Layer Interface Height (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Smoke Spread through Openings

- SDSC-B2: Smoke Layer Interface Height (MOD)
- SDSC-B3: Smoke Temperature (MOD)
- SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Smoke Spread through Openings

- SDSC-C2: Smoke Layer Interface Height (FO)
- SDSC-C3: Smoke Temperature (FO)
- SDSC-C6: Radiation from Smoke Layer (FO)

SDSC-G - Active Smoke Barriers

- FDWS-F - Detection
- FDWS-F5: System Reliability and Availability (DA-ASB)
- SDSC-F1: Active Smoke Barrier Effectiveness (SBF)

ADDITIONAL LOGIC AND OUTPUTS

SDSC: Modeling Uncertanty (MU)

- SDSC-A7: Modeling Uncertainty (ROO)
- SDSC-B7: Modeling Uncertainty (MOD)
- SDSC-C7: Modeling Uncertainty (FO)
- SDSC-D8: Modeling Uncertainty (EXROO)
- SDSC-E2: Modeling Uncertainty (SC&M)
- SDSC-F3: Modeling Uncertainty (SBF)

SDSC: Parametric Uncertanty (PU)

- SDSC-A8: Parametric Uncertainty (ROO)
- SDSC-B8: Parametric Uncertainty (MOD)
- SDSC-C8: Parametric Uncertainty (FO)
- SDSC-D9: Parametric Uncertainty (EXROO)
- SDSC-E3: Parametric Uncertainty (SC&M)
- SDSC-F4: Parametric Uncertainty (SBF)

Fire Detection, Warning and Suppression (FDWS)

FIRE DETECTION, WARNING AND SUPPRESSION (FDWS)

High Level Requirements for Fire Detection, Warning and Suppression (FDWS)	
Designator	**Requirement**
HLR-FDWS-A	Manual Notification System (MNS)
HLR-FDWS-B	Automatic Notification System (ANS)
HLR-FDWS-C	Manual Suppression and Control (MS&C)
HLR-FDWS-D	Automatic Suppression and Control (AS&C)
HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)
HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)
HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)

Supporting Requirements for HLR-FDWS-A: Manual Notification System (MNS)

Index No.	Deterministic (Capability Category I / Capability Category II / Capability Category III)	Risk-Informed (Capability Category I / Capability Category II / Capability Category III)	Risk-Based (Capability Category I / Capability Category II / Capability Category III)	Assessment: Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-A1: Timing of Manual Detection (MNS)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

Influencing Factor	Deterministic	LOW	MEDIUM	HIGH	Findings & Observations	Quality Rating	Uncertainty
FDWS-A1 - Building Characteristics (MNS)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
FDWS-A1 - Occupant Characteristics (MNS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
FDWS-A1 - Ventilation Conditions (MNS)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
FDWS-A1 - Fire Characteristics (MNS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
FDWS-A1 - Smoke Characteristics (MNS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
FDWS-A1 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

Index No.	Deterministic	Risk-Informed (Capability Category I)	Risk-Informed (Capability Categories II / III)	Risk-Based (Capability Category I)	Risk-Based (Capability Categories II / III)	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-A2: Reliability and Availability of Manual Detection (MNS)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FDWS-A2 - Building Characteristics (MNS)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A2 - Occupant Characteristics (MNS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A2 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-A3: Timing of Automatic Detection (MNS)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-A3 - Building Characteristics (MNS)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A3 - Detector Characteristics (MNS)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A3 - Ventilation Conditions (MNS)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A3 - Fire Characteristics (MNS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A3 - Smoke Characteristics (MNS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-A3 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-A4: Reliability and Availability of Automatic Detection (MNS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-A4 - Building Characteristics (MNS)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None

	FDWS-A4 - System Design and Maintenance (MNS)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A4 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-A5: Reliability and Availability (MNS)	QUALIFY total system unavailability, and CONFIRM that the credited system is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE generic estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that the credit is implemented and trained upon in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-A5 - Building Characteristics (MNS)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., lighting, power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A5 - System Design and Maintenance (MNS)	System characteristics that influence reliability and availability should be addressed. Examples include the development of and training on procedures..	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A5 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-A6: Effectiveness (MNS)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-A6 - Building Characteristics (MNS)	Building characteristics that influence system effectiveness should be addressed. Examples include dependencies on building systems (e.g., speaker systems, building arrangement, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A6 - Occupant Characteristics (MNS)	Occupant characteristics that influence system effectiveness should be addressed. Examples include occupant ability or desire to follow instructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A6 - System Characteristics (MNS)	System characteristics that influence its effectiveness should be addressed. Examples include the quality of procedures.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-A6 - Method Verification and Validation (MNS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-A7: Modeling Uncertainty (MNS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
	FDWS-A7 - Modeling Uncertainty (MNS)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:** High	**Uncertainty:** None

Index No.	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-A8: Parametric Uncertainty (MNS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-A8 - Parametric Uncertainty (MNS)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-A - Manual Detection (MNS)

FDWS-A1: Timing of Manual Detection (MNS)

FDWS-A2: Reliability and Availability of Manual Detection (MNS)

FDWS-A - Automatic Detection (MNS)

FDWS-A3: Timing of Automatic Detection (MNS)

FDWS-A4: Reliability and Availability of Automatic Detection (MNS)

FDWS-A - Detection (MNS)

Manual Detection

Automatic Detection

Supporting Requirements for HLR-FDWS-B: Automatic Notification System (ANS)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FDWS-B1: Timing of Manual Detection (ANS)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-B1 - Building Characteristics (ANS)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FDWS-B1 - Occupant Characteristics (ANS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FDWS-B1 - Ventilation Conditions (ANS)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FDWS-B1 - Fire Characteristics (ANS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None

	FDWS-B1 - Smoke Characteristics (ANS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B1 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-B2: Reliability and Availability of Manual Detection (ANS)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-B2 - Building Characteristics (ANS)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B2 - Occupant Characteristics (ANS)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B2 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-B3: Timing of Automatic Detection (ANS)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-B3 - Building Characteristics (ANS)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B3 - Detector Characteristics (ANS)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B3 - Ventilation Conditions (ANS)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B3 - Fire Characteristics (ANS)	Fire characteristics that influence the timing of manual detection should be addressed. Examples include fire size and the time to a flaming fire.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-B3 - Smoke Characteristics (ANS)	Smoke characteristics that influence the timing of manual detection should be addressed. Examples include smoke concentration.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The collective impact associated with omissions of relevant phenomena and the use of unjustified data is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena are systematically identified and considered, and any applied data is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None

	FDWS-B3 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-B4: Reliability and Availability of Automatic Detection (ANS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-B4 - Building Characteristics (ANS)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-B4 - System Design and Maintenance (ANS)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-B4 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-B5: Reliability and Availability (ANS)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-B5 - Building Characteristics (ANS)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-B5 - System Design and Maintenance (ANS)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-B5 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-B6: Effectiveness (ANS)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-B6 - Building Characteristics (ANS)	Enter description here.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None

	FDWS-B6 - Occupant Characteristics (ANS)	Enter description here.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-B6 - System Characteristics (ANS)	Enter description here.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-B6 - Method Verification and Validation (ANS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-B7: Modeling Uncertainty (ANS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-B7 - Modeling Uncertainty (ANS)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-B8: Parametric Uncertainty (ANS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic notification systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FDWS-B8 - Parametric Uncertainty (ANS)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.		**Quality Rating:**	High	**Uncertainty:**	**None**

ADDITIONAL LOGIC AND OUTPUTS

FDWS-B - Manual Detection (ANS)

FDWS-B1: Timing of Manual Detection (ANS)

FDWS-B2: Reliability and Availability of Manual Detection (ANS)

FDWS-B - Automatic Detection (ANS)

FDWS-B3: Timing of Automatic Detection (ANS)

FDWS-B4: Reliability and Availability of Automatic Detection (ANS)

FDWS-B - Detection (ANS)

FDWS-B - Manual Detection (ANS)

FDWS-B - Automatic Detection (ANS)

Supporting Requirements for HLR-FDWS-C: Manual Suppression and Control (MS&C)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FDWS-C1: Timing of Manual Detection (MS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FDWS-C1 - Building Characteristics (MS&C)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-C1 - Occupant Characteristics (MS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-C1 - Ventilation Conditions (MS&C)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	SDSC-A6: Radiation from Smoke Layer (ROO)									
	FDWS-C1 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-C2: Reliability and Availability of Manual Detection (MS&C)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-C2 - Building Characteristics (MS&C)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-C2 - Occupant Characteristics (MS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-C2 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-C3: Timing of Automatic Detection (MS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-C3 - Building Characteristics (MS&C)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**

	FDWS-C3 - Detector Characteristics (MS&C)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FDWS-C3 - Ventilation Conditions (MS&C)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A3: Smoke Temperature (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	FDWS-C3 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-C4 - Building Characteristics (MS&C)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FDWS-C4 - System Design and Maintenance (MS&C)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FDWS-C4 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

FDWS-C5: Reliability and Availability (MS&C)	QUALIFY total unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of unavailability, and CONFIRM that credited actions can be implemented in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-C5 - Building Characteristics (MS&C)	Building characteristics that influence reliability and availability should be addressed. Examples include building complexity.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FDWS-C5 - Occupant Characteristics (MS&C)	Occupant characteristics that influence reliability and availability should be addressed. Examples include the likelihood that an occupant will make use of manual suppressants.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None

	FDWS-C5 - Equipment Design and Maintenance (MS&C)	Equipment characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of equipment.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	SDSC-A6: Radiation from Smoke Layer (ROO)									
	SDSC-A5: Smoke Concentration (ROO)									
	FDWS-C5 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

FDWS-C6: Effectiveness (MS&C)	JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the manual suppression equipment is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the available equipment given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-C6 - Building Characteristics (MS&C)	Building characteristics that influence effectiveness should be addressed. Examples include building geometry.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FDWS-C6 - Equipment Characteristics (MS&C)	Occupant characteristics that influence effectiveness should be addressed. Examples include occupant training.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating:	High	Uncertainty:	None
	FIDC-A1: Fire Size/HRR (ROO)									
	FDWS-C6 - Method Verification and Validation (MS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating:	High	Uncertainty:	None

FDWS-C7: Modeling Uncertainty (MS&C)	DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-C7 - Modeling Uncertainty (MS&C)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		Quality Rating:	High	Uncertainty:	None

FDWS-C8: Parametric Uncertainty (MS&C)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling manual suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-C8 - Parametric Uncertainty (MS&C)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			Quality Rating:	High	Uncertainty:	None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-C - Manual Detection

- **FDWS-C1: Timing of Manual Detection (MS&C)**
- **FDWS-C2: Reliability and Availability of Manual Detection (MS&C)**

FDWS-C - Automatic Detection

- **FDWS-C3: Timing of Automatic Detection (MS&C)**
- **FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)**

FDWS-C - Detection

- **FDWS-C - Manual Detection**
- **FDWS-C - Automatic Detection**

HLR-FDWS-C: Manual Suppression and Control (MS&C)

- **FDWS-C - Detection**
- **FDWS-C5: Reliability and Availability (MS&C)**
- **FDWS-C6: Effectiveness (MS&C)**

Supporting Requirements for HLR-FDWS-D: Automatic Suppression and Control (AS&C)

Index No.	Deterministic: Capability Category I	Deterministic: Capability Category II / Capability Category III	Risk-Informed: Capability Category I / Capability Category II / Capability Category III		Risk-Based: Capability Category I / Capability Category II / Capability Category III	Assessment: Findings & Observations	Assessment: Quality Assessment		Assessment: Uncertainty Assessment	
FDWS-D1: Timing of Manual Detection (AS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-D1 - Building Characteristics (AS&C)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-D1 - Occupant Characteristics (AS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-D1 - Ventilation Conditions (AS&C)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A2: Smoke Layer Interface Height (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	SDSC-A6: Radiation from Smoke Layer (ROO)									
	FDWS-D1 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

						Findings & Observations	Quality Assessment		Uncertainty Assessment	
FDWS-D2: Reliability and Availability of Manual Detection (AS&C)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.					
	FDWS-D2 - Building Characteristics (AS&C)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-D2 - Occupant Characteristics (AS&C)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-D2 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

						Findings & Observations	Quality Assessment		Uncertainty Assessment	
FDWS-D3: Timing of Automatic Detection (AS&C)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.					
	FDWS-D3 - Building Characteristics (AS&C)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-D3 - Detector Characteristics (AS&C)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 4	**Quality Rating:**	Low	**Uncertainty:**	Low
	FDWS-D3 - Ventilation Conditions (AS&C)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A3: Smoke Temperature (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	FDWS-D3 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

								Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.			

Element	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-D4 - Building Characteristics (AS&C)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
	FDWS-D4 - System Design and Maintenance (AS&C)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
	FDWS-D4 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
FDWS-D5: System Reliability and Availability (AS&C)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-D5 - Building Characteristics (AS&C)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
	FDWS-D5 - System Design and Maintenance (AS&C)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 4	**Quality Rating:**	**Low-Medium**	**Uncertainty:**	**Low**
	FDWS-D5 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
FDWS-D6: System Effectiveness (AS&C)	JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the system design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of the installed system given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-D6 - Building Characteristics (AS&C)	Building characteristics that influence system reliability and availability should be addressed. Examples include obstructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
	FDWS-D6 - System Characteristics (AS&C)	System characteristics that influence reliability and availability should be addressed. Examples include the design and the type of fire involved.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
	FIDC-A1: Fire Size/HRR (ROO)									
	FDWS-D6 - Method Verification and Validation (AS&C)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
FDWS-D7: Modeling Uncertainty	DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling automatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	

Index No.	Supporting Requirement	Description	Low	Medium	High	Findings & Observations	Quality Rating	Uncertainty
(AS&C)	**FDWS-D7 - Modeling Uncertainty (AS&C)**	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		High	None

Index No.	Deterministic Capability Category I	Deterministic Capability Category II	Deterministic Capability Category III	Risk-Informed Capability Category I	Risk-Informed Capability Category II	Risk-Informed Capability Category III	Risk-Based Capability Category I	Risk-Based Capability Category II	Risk-Based Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-D8: Parametric Uncertainty (AS&C)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling auotmatic suppression. CONSIDER each of the below influencing factors and/or referenced SRs.			

Influencing Factor	Description	Low	Medium	High	Findings & Observations	Quality Rating	Uncertainty
FDWS-D8 - Parametric Uncertainty (AS&C)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.		High	None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-D - Manual Detection

- **FDWS-D1: Timing of Manual Detection (AS&C)**
- **FDWS-D2: Reliability and Availability of Manual Detection (AS&C)**

FDWS-D - Automatic Detection

- **FDWS-D3: Timing of Automatic Detection (AS&C)**
- **FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)**

FDWS-D - Detection

- **FDWS-D - Manual Detection**
- **FDWS-D - Automatic Detection**

HLR-FDWS-D: Automatic Suppression and Control (AS&C)

- **FDWS-D - Detection**
- **FDWS-D5: System Reliability and Availability (AS&C)**
- **FDWS-D6: System Effectiveness (AS&C)**

Supporting Requirements for HLR-FDWS-E: Detection and Activation for Active Fire Barriers (DA-AFB)

Index No.	Deterministic Capability Category I	Deterministic Capability Category II	Deterministic Capability Category III	Risk-Informed Capability Category I	Risk-Informed Capability Category II	Risk-Informed Capability Category III	Risk-Based Capability Category I	Risk-Based Capability Category II	Risk-Based Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-E1: Timing of Manual Detection (DA-AFB)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.					

Influencing Factor	Description	Low	Medium	High	Findings & Observations	Quality Rating	Uncertainty
FDWS-E1 - Building Characteristics (DA-AFB)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		High	None
FDWS-E1 - Occupant Characteristics (DA-AFB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		High	None

	FDWS-E1 - Ventilation Conditions (DA-AFB)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)							
	SDSC-A2: Smoke Layer Interface Height (ROO)							
	SDSC-A4: Smoke Optical Density (ROO)							
	SDSC-A6: Radiation from Smoke Layer (ROO)							
	FDWS-E1 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-E2 - Building Characteristics (DA-AFB)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-E2 - Occupant Characteristics (DA-AFB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-E2 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-E3: Timing of Automatic Detection (DA-AFB)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-E3 - Building Characteristics (DA-AFB)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-E3 - Detector Characteristics (DA-AFB)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-E3 - Ventilation Conditions (DA-AFB)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)							
	SDSC-A3: Smoke Temperature (ROO)							

	SDSC-A4: Smoke Optical Density (ROO)									
	FDWS-E3 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-E4 - Building Characteristics (DA-AFB)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-E4 - System Design and Maintenance (DA-AFB)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-E4 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-E5: System Reliability and Availability (DA-AFB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-E5 - Building Characteristics (DA-AFB)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-E5 - System Design and Maintenance (DA-AFB)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	**None**
	FDWS-E5 - Method Verification and Validation (DA-AFB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	**None**

FDWS-E6: Modeling Uncertainty (DA-AFB)	DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling active fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-E6 - Modeling Uncertainty (DA-AFB)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	**None**

Index No.	Deterministic: Capability Category I	Deterministic: Capability Category II	Deterministic: Capability Category III	Risk-Informed: Capability Category I	Risk-Informed: Capability Category II	Risk-Informed: Capability Category III	Risk-Based: Capability Category I	Risk-Based: Capability Category II	Risk-Based: Capability Category III	Findings & Observations	Quality Assessment		Uncertainty Assessment	
FDWS-E7: Parametric Uncertainty (DA-AFB)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.					
	FDWS-E7 - Parametric Uncertainty (DA-AFB)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	High	**Uncertainty:**	None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-E - Manual Detection

FDWS-E1: Timing of Manual Detection (DA-AFB)

FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)

FDWS-E - Automatic Detection

FDWS-E3: Timing of Automatic Detection (DA-AFB)

FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)

FDWS-E - Detection

FDWS-E - Manual Detection

FDWS-E - Automatic Detection

FDWS-E5: System Reliability and Availability (DA-AFB)

Supporting Requirements for HLR-FDWS-F: Detection and Activation for Active Smoke Barriers (DA-ASB)

Index No.	Deterministic: Capability Category I	Deterministic: Capability Category II	Deterministic: Capability Category III	Risk-Informed: Capability Category I	Risk-Informed: Capability Category II	Risk-Informed: Capability Category III	Risk-Based: Capability Category I	Risk-Based: Capability Category II	Risk-Based: Capability Category III	Assessment: Findings & Observations	Assessment: Quality Assessment		Assessment: Uncertainty Assessment	
FDWS-F1: Timing of Manual Detection (DA-ASB)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			Findings & Observations	Quality Assessment		Uncertainty Assessment	
	FDWS-F1 - Building Characteristics (DA-ASB)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-F1 - Occupant Characteristics (DA-ASB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-F1 - Ventilation Conditions (DA-ASB)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)													
	SDSC-A2: Smoke Layer Interface Height (ROO)													
	SDSC-A4: Smoke Optical Density (ROO)													

	SDSC-A6: Radiation from Smoke Layer (ROO)									
	FDWS-F1 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-F2 - Building Characteristics (DA-ASB)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-F2 - Occupant Characteristics (DA-ASB)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-F2 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-F3: Timing of Automatic Detection (DA-ASB)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-F3 - Building Characteristics (DA-ASB)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-F3 - Detector Characteristics (DA-ASB)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 6	**Quality Rating:**	Low	**Uncertainty:**	Low
	FDWS-F3 - Ventilation Conditions (DA-ASB)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A3: Smoke Temperature (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	FDWS-F3 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-F4 - Building Characteristics (DA-ASB)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-F4 - System Design and Maintenance (DA-ASB)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 6	**Quality Rating:** Low-Medium	**Uncertainty:** Low
	FDWS-F4 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-F5: System Reliability and Availability (DA-ASB)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-F5 - Building Characteristics (DA-ASB)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-F5 - System Design and Maintenance (DA-ASB)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FDWS-F5 - Method Verification and Validation (DA-ASB)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

FDWS-F6: Modeling Uncertainty (DA-ASB)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-F6 - Modeling Uncertainty (DA-ASB)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:** High	**Uncertainty:** None

FDWS-F7: Parametric Uncertainty (DA-ASB)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling automatic smoke barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FDWS-F7 - Parametric Uncertainty (DA-ASB)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	LOW Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	MEDIUM Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	HIGH This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.		Quality Rating: High	Uncertainty: None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-F - Manual Detection

FDWS-F1: Timing of Manual Detection (DA-ASB)

FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)

FDWS-F - Automatic Detection

FDWS-F3: Timing of Automatic Detection (DA-ASB)

FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)

FDWS-F - Detection

FDWS-F - Manual Detection

FDWS-F - Automatic Detection

FDWS-F5: System Reliability and Availability (DA-ASB)

Supporting Requirements for HLR-FDWS-G: Detection and Activation for Smoke Control and Management (DA-SC&M)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-G1: Timing of Manual Detection (DA-SC&M)	For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.					
	FDWS-G1 - Building Characteristics (DA-SC&M)	Building characteristics that influence the timing of manual detection should be addressed. Examples include visual obstructions.		LOW Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		MEDIUM Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		HIGH This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			Quality Rating: High	Uncertainty: None
	FDWS-G1 - Occupant Characteristics (DA-SC&M)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant sensitivity to fire and smoke characteristics.		LOW Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		MEDIUM Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		HIGH This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			Quality Rating: High	Uncertainty: None
	FDWS-G1 - Ventilation Conditions (DA-SC&M)	Ventilation characteristics that influence the timing of manual detection should be addressed. Examples include mechanical or natural ventilation.		LOW Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		MEDIUM Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		HIGH This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			Quality Rating: High	Uncertainty: None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)											
	SDSC-A2: Smoke Layer Interface Height (ROO)											
	SDSC-A4: Smoke Optical Density (ROO)											
	SDSC-A6: Radiation from Smoke Layer (ROO)											
	FDWS-G1 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		LOW Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		MEDIUM Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		HIGH All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			Quality Rating: High	Uncertainty: None

SR	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)	If credited, QUALIFY general unavailability of manual detection, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.		If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	If credited, USE generic estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs. If credited, USE occupancy-specifc estimates of manual detection unavailability, and CONFIRM that the credit is consistent with current fire protection engineering practice. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-G2 - Building Characteristics (DA-SC&M)	Building characteristics that influence the reliability or availability of manual detection should be addressed. Examples include occupancy uses that could obscure fire conditions (e.g., cooking).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-G2 - Occupant Characteristics (DA-SC&M)	Occupant characteristics that influence the timing of manual detection should be addressed. Examples include occupant ability to distinguish between smoke from fire and other sources, likelihood of reporting, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-G2 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SR	Influencing Factor	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment		Uncertainty Assessment	
FDWS-G3: Timing of Automatic Detection (DA-SC&M)	For each selected scenario, EXPLAIN and JUSTIFY the time of automatic detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, EXPLAIN and JUSTIFY the time of manual detection, if credited, and CONFIRM that it is consistent with fire and smoke development assessed under HLRs FIDC and SDSC, respectively. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-G3 - Building Characteristics (DA-SC&M)	Building characteristics that influence system timing should be addressed. Examples include room geometry (e.g., pocketing effects or blockages that might impact plume behaviors), natural or mechanical ventilation effects, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FDWS-G3 - Detector Characteristics (DA-SC&M)	Detector characteristics that influence timing of detection should be addressed. Examples include the design or type of detector.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 7	**Quality Rating:**	Low	**Uncertainty:**	Low
	FDWS-G3 - Ventilation Conditions (DA-SC&M)	Ventilation characteristics that influence the timing of automatic detection should be addressed. Examples include mechanical or natural ventilation.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)									
	SDSC-A3: Smoke Temperature (ROO)									
	SDSC-A4: Smoke Optical Density (ROO)									
	FDWS-G3 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

SR	Requirement		Capability Category I	Capability Category II	Capability Category III	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

Element	Sub-element	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment	Uncertainty Assessment
	FDWS-G4 - Building Characteristics (DA-SC&M)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
	FDWS-G4 - System Design and Maintenance (DA-SC&M)	System characteristics that influence system reliability and availability should be addressed. Examples include the design of the system as well as its frequency and degree of maintenance.	LOW Si+A426:G429gnificant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
	FDWS-G4 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating: High	Uncertainty: None

Element	Sub-element	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-G5: System Reliability and Availability (DA-SC&M)	QUALIFY total system unavailability, and CONFIRM that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.		USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs.	USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs. USE generic estimates of total system unavailability provided that the credited system is installed and maintained in accordance with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.	USE generic estimates of total system unavailability provided that (a) the credited system is installed and maintained in accordance with applicable codes and standards and (b) the system has not experienced outlier behavior relative to system unavailability. CONSIDER each of the below influencing factors and/or referenced SRs. USE system-specific information, where available, to quantify total unavailability factors. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-G5 - Building Characteristics (DA-SC&M)	Building characteristics that influence system reliability and availability should be addressed. Examples include dependencies on building systems (e.g., power, etc.).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		Quality Rating: High	Uncertainty: None
	FDWS-G5 - System Design and Maintenance (DA-SC&M)	System characteristics that influence reliability and availability should be addressed. Examples include the design and maintenance of the system.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.	F&O 7	Quality Rating: Low-Medium	Uncertainty: Low
	FDWS-G5 - Method Verification and Validation (DA-SC&M)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		Quality Rating: High	Uncertainty: None

Element	Sub-element	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-G6: Modeling Uncertainty (DA-SC&M)	DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling smoke control and management systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-G6 - Modeling Uncertainty (DA-SC&M)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		Quality Rating: High	Uncertainty: None

Element	Sub-element	Description	LOW	MEDIUM	HIGH	Findings & Observations	Quality Assessment	Uncertainty Assessment
FDWS-G7: Parametric Uncertainty (DA-SC&M)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs. PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling smoke management and control systems. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FDWS-G7 - Parametric Uncertainty (DA-SC&M)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.	**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.		Quality Rating: High	Uncertainty: None

ADDITIONAL LOGIC AND OUTPUTS

FDWS-G - Manual Detection

- FDWS-G1: Timing of Manual Detection (DA-SC&M)
- FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)

FDWS-G - Automatic Detection

- FDWS-G3: Timing of Automatic Detection (DA-SC&M)
- FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)

FDWS-G - Detection

- FDWS-G - Manual Detection
- FDWS-G - Automatic Detection

FDWS-G5: System Reliability and Availability (DA-SC&M)

ADDITIONAL LOGIC AND OUTPUTS

FDWS: Modeling Uncertanty (MU)

- FDWS-A7: Modeling Uncertainty (MNS)
- FDWS-B7: Modeling Uncertainty (ANS)
- FDWS-C7: Modeling Uncertainty (MS&C)
- FDWS-D7: Modeling Uncertainty (AS&C)
- FDWS-E6: Modeling Uncertainty (DA-AFB)
- FDWS-F6: Modeling Uncertainty (DA-ASB)
- FDWS-G6: Modeling Uncertainty (DA-SC&M)

FDWS: Parametric Uncertanty (PU)

- FDWS-A8: Parametric Uncertainty (MNS)
- FDWS-B8: Parametric Uncertainty (ANS)
- FDWS-C8: Parametric Uncertainty (MS&C)
- FDWS-D8: Parametric Uncertainty (AS&C)
- FDWS-E7: Parametric Uncertainty (DA-AFB)
- FDWS-F7: Parametric Uncertainty (DA-ASB)
- FDWS-G7: Parametric Uncertainty (DA-SC&M)

Fire Spread, Impact and Control (FSIC)

FIRE SPREAD, IMPACT AND CONTROL (FSIC)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)
HLR-FSIC-B	Fire Barrier Failure (FBF)

Supporting Requirements for HLR-FSIC-A: Internal Fire Spread through Openings (IFSTO)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FSIC-A1: Internal Fire Spread through Openings (IFS)	EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.			EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.			EVALUATE the potential, timing and effect of fire spread through openings (e.g., doors, wall openings) via all mechanisms (e.g., immersion of secondary combustibles within smoke layer, radiation from flames, etc.) from the room of origin consistent with fire and smoke development assessed under HLRs FIDC and SDSC.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	Impact of ROO Fire and Smoke Development on Fire Spread through Openings											
	Impact of MOD Fire and Smoke Development on Fire Spread through Openings											
	Impact of FO Fire and Smoke Development on Fire Spread through Openings											
	FSIC-A1 - Building Characteristics (IFS)	Building characteristics that influence internal spread should be addressed. Examples include room geometry, size and arrangement of openings, etc.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	FSIC-A1 - Method Verification and Validation (IFS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None
FSIC-A2: Modeling Uncertainty (IFS)	DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FSIC-A2 - Modeling Uncertainty (IFS)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:** High	**Uncertainty:** None
FSIC-A3: Parametric Uncertainty (IFS)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire spread through openings. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FSIC-A3 - Parametric Uncertainty (IFS)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-FSIC-B: Fire Barrier Failure (FBF)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FSIC-B1: Active Fire Barrier Effectiveness (FBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	Impact of ROO Fire and Smoke Development on Fire Barriers									
	Impact of MOD Fire and Smoke Development on Fire Barriers									
	Impact of FO Fire and Smoke Development on Fire Barriers									
	FSIC-B1 - Building Characteristics (FBF)	Building characteristics that influence barrier effectiveness should be addressed. Examples include fire resistivity of surrounding construction, arrangement of contents, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FSIC-B1 - Barrier Characteristics (FBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FSIC-B1 - Method Verification and Validation (FBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FSIC-B2: Passive Fire Barrier Effectiveness (FBF)	JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.		JUSTIFY that the barrier design is in compliance with applicable codes and standards as well as current fire protection engineering practice. CONFIRM the suitability of installed barriers given the nature of the fire source being analyzed and building charateristics. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	Impact of ROO Fire and Smoke Development on Fire Barriers									
	Impact of MOD Fire and Smoke Development on Fire Barriers									
	Impact of FO Fire and Smoke Development on Fire Barriers									
	FSIC-B2 - Building Characteristics (FBF)	Building characteristics that influence barrier effectiveness should be addressed. Examples include fire resistivity of surrounding construction, arrangement of contents, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FSIC-B2 - Barrier Characteristics (FBF)	The barrier design and related characteristics that influence its effectiveness should be addressed. Examples include its fire resistivity, size, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:**	High	**Uncertainty:**	None
	FSIC-B2 - Method Verification and Validation (FBF)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

FSIC-B3: Modeling Uncertainty (FBF)	DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FSIC-B3 - Modeling Uncertainty (FBF)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	None

FSIC-B4: Parametric Uncertainty (FBF)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for modeling fire barriers. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FSIC-B4 - Parametric Uncertainty (FBF)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	**High**	**Uncertainty:**	**None**

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Fire Barriers

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Fire Barriers

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Fire Barriers

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-C3: Smoke Temperature (FO)

SDSC-C6: Radiation from Smoke Layer (FO)

Impact of ROO Fire and Smoke Development on Fire Spread through Openings

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-A3: Smoke Temperature (ROO)

SDSC-A6: Radiation from Smoke Layer (ROO)

Impact of MOD Fire and Smoke Development on Fire Spread through Openings

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-B3: Smoke Temperature (MOD)

SDSC-B6: Radiation from Smoke Layer (MOD)

Impact of FO Fire and Smoke Development on Fire Spread through Openings

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-C3: Smoke Temperature (FO)

SDSC-C6: Radiation from Smoke Layer (FO)

FSIC-B - Active Fire Barriers

FDWS-E - Detection

FDWS-E5: System Reliability and Availability (DA-AFB)

FSIC-B1: Active Fire Barrier Effectiveness (FBF)

FSIC - Fire Spread

FSIC-A1: Internal Fire Spread through Openings (IFS)

FSIC-B - Active Fire Barriers

FSIC-B2: Passive Fire Barrier Effectiveness (FBF)

ADDITIONAL LOGIC AND OUTPUTS

FSIC: Modeling Uncertanty (MU)

FSIC-A2: Modeling Uncertainty (IFS)

FSIC-B3: Modeling Uncertainty (FBF)

FSIC: Parametric Uncertanty (PU)

FSIC-A3: Parametric Uncertainty (IFS)

FSIC-B4: Parametric Uncertainty (FBF)

Occupant Evacuation and Control (OEC)

OCCUPANT EVACUATION AND CONTROL (OEC)

High Level Requirements for Occupant Evacuation and Control (OEC)	
Designator	**Requirement**
HLR-OEC-A	Available Safe Egress Time (ASET)
HLR-OEC-B	Required Safe Egress Time (RSET)
HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)

Supporting Requirements for HLR-OEC-A: Available Safe Egress Time (ASET)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
OEC-A1: Establishment and Integration of ASET Criteria (ASET)	For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.			For each selected scenario, JUSTIFY the selection of tenability criteria, and EVALUATE the time at which identified tenability criteria are exceeded. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	OEC-A1 - Smoke Layer Interface Height (ASET)											
	OEC-A1 - Smoke Obscuration (ASET)											
	OEC-A1 - Toxicity (ASET)											
	OEC-A1 - Thermal Effects (ASET)											
	OEC-A1 - Tenability Criteria Selection (ASET)	The conditions under which an enclosure or building become untenable should be defined to address each type of fire exposure.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. That is, significant phenomena that can affect occupants are not identified or considered. Omissions assocaited with criteria have a substantial impact on the final results.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. That is, significant phenomena that can affect occupants are identified and considered. Selected criteria are appropriate and justified. Any omissions have minimal impact on the final results.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant phenomena that can affect occupants are systematically identified and considered. Selected criteria are appropriate and fully justified.			**Quality Rating:** High	**Uncertainty:** None
	OEC-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:** High	**Uncertainty:** None
OEC-A2: Modeling Uncertainty (ASET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	OEC-A2 - Modeling Uncertainty (OEC)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:** High	**Uncertainty:** None
OEC-A3: Parametric Uncertainty (ASET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of ASET. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	OEC-A3 - Parametric Uncertainty (OEC)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:** High	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

OEC-A1 - Smoke Layer Interface Height (ASET)

SDSC-A2: Smoke Layer Interface Height (ROO)

SDSC-B2: Smoke Layer Interface Height (MOD)

SDSC-C2: Smoke Layer Interface Height (FO)

SDSC-D3: Smoke Layer Interface Height (EXROO)

OEC-A1 - Smoke Obscuration (ASET)

SDSC-A4: Smoke Optical Density (ROO)

SDSC-B4: Smoke Optical Density (MOD)

SDSC-C4: Smoke Optical Density (FO)

SDSC-D5: Smoke Optical Density (EXROO)

OEC-A1 - Toxicity (ASET)

SDSC-A5: Smoke Concentration (ROO)

SDSC-B5: Smoke Concentration (MOD)

SDSC-C5: Smoke Concentration (FO)

SDSC-D6: Smoke Concentration (EXROO)

OEC-A1 - Thermal Effects (ASET)

SDSC-A6: Radiation from Smoke Layer (ROO)

FIDC-A5: Flame Height, Temperature and Radiation (ROO)

SDSC-B6: Radiation from Smoke Layer (MOD)

FIDC-B5: Flame Height, Temperature and Radiation (MOD)

SDSC-C6: Radiation from Smoke Layer (FO)

FIDC-C5: Flame Height, Temperature and Radiation (FO)

SDSC-D7: Radiation from Smoke Layer (EXROO)

FIDC-D5: Flame Height, Temperature and Radiation (EXROO)

Supporting Requirements for HLR-OEC-B: Required Safe Egress Time (RSET)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the period of time from fire initiation to the occurrence of a selected cue consistent with HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.		Findings & Observations	Quality Assessment	Uncertainty Assessment
	FDWS-A - Detection (MNS)											
	FDWS-A5: Reliability and Availability (MNS)											
	FDWS-B - Detection (ANS)											
	FDWS-B5: Reliability and Availability (ANS)											
	OEC-B1 - Integration of Cues (RSET)	All possible fire detection cues should be considered. These include those visual as well as automatic cues.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. That is, the cues that are most significant with regard to egress are not considered. The selected cues are not appropriate or justified. Any omitted cues have substantial impact.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. That is, the cues that are most significant with regard to egress are considered. The selected cues are appropriate and justified. Any omitted cues have minimal impact.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant cues are systematically considered. The selected cues are appropriate and fully justified.			Quality Rating: High	Uncertainty: None
	OEC-B1 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			Quality Rating: High	Uncertainty: None

OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY a distribution of times to the RSET analysis,evaluating the uncertainty interval of the parameter.. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. SELECT a bounding time to apply to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY scenario-specific times to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	DEVELOP a set of criteria by which the analysis will determine whether the occupants recognize the various cues. For each selected scenario, ESTIMATE this response period consistent with the cues assessed under HLR FDWS. APPLY a distribution of times to the RSET analysis,evaluating the uncertainty interval of the parameter.. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	FDWS-B6: Effectiveness (ANS)												
	FDWS-A6: Effectiveness (MNS)												
	OEC-B2 - Building Characteristics (RSET)	Building characteristics that influence the recognition of cues should be addressed. Examples include visual obstructions or competing activities (e.g., loud noises).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	OEC-B2 - Occupant Characteristics (RSET)	Occupant characteristics that influence the recognition of cues should be addressed. Examples include occupant sensitivity to cues.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	OEC-B2 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None

OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the recognition of cues and the initiation of the movement towards safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-B3 - Building Characteristics (RSET)	Building characteristics that influence the initiation of movement should be addressed. Examples include occupancy type and related activities.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	OEC-B3 - Occupant Characteristics (RSET)	Occupant characteristics that influence the initiation of movement should be addressed. Examples include occupant relationships.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None
	OEC-B3 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	High	**Uncertainty:**	None

OEC-B4: Movement Timing - Completion of Movement (RSET)	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a bounding delay period to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY scenario-specific delay periods to the RSET analysis. CONSIDER each of the below influencing factors and/or referenced SRs.	For each selected scenario, ESTIMATE the time span between the initiation and completion of the movement to a place of safety. APPLY a distribution of delay periods to the RSET analysis, evaluating the uncertainty interval of the parameter. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-B3 - Building Characteristics (RSET)	Building characteristics that influence movement timing should be addressed. Examples include building geometry, number of exits, complexity, etc.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential building characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant building characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.			**Quality Rating:**	High	**Uncertainty:**	None

Index No.	Deterministic – Capability Category I	Deterministic – Capability Category II	Deterministic – Capability Category III	Risk-Informed – Capability Category I	Risk-Informed – Capability Category II	Risk-Informed – Capability Category III	Risk-Based – Capability Category I	Risk-Based – Capability Category II	Risk-Based – Capability Category III	Findings & Observations	Quality Assessment		Uncertainty Assessment	
	OEC-B3 - Occupant Characteristics (RSET)	Occupant characteristics that influence movement timing should be addressed. Examples include occupant capacity, speed, etc.		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.		**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		F&O 5	**Quality Rating:**	**Low-Medium**	**Uncertainty:**	**Low**
	OEC-B3 - Method Verification and Validation (RSET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	**High**	**Uncertainty:**	**None**
OEC-B5: Integration of RSET Criteria (RSET)	SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).		SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).	Probabiliistically SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific, distribution of estimates of the Required Safe Evacuation Time (RSET).	SUM the bounding estimates of the cue period, response period, delay period and movement period to arrive at a bounding estimate of the Required Safe Evacuation Time (RSET).	SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific estimates of the Required Safe Evacuation Time (RSET).	Probabiliistically SUM scenario-specific estimates of the cue period, response period, delay period and movement period to arrive at scenario-specific, distribution of estimates of the Required Safe Evacuation Time (RSET).	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)													
	OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)													
	OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)													
	OEC-B4: Movement Timing - Completion of Movement (RSET)													
	OEC-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.		**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.		**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.		**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.			**Quality Rating:**	**High**	**Uncertainty:**	**None**
OEC-B6: Modeling Uncertainty (RSET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-B6 - Modeling Uncertainty (OEC)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.		**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.		**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.			**Quality Rating:**	**High**	**Uncertainty:**	**None**
OEC-B7: Parametric Uncertainty (RSET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-B7 - Parametric Uncertainty (OEC)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	**High**	**Uncertainty:**	**None**

Supporting Requirements for HLR-OEC-C: Integration of ASET/RSET Criteria (ASET/RSET)

Index No.	Deterministic – Capability Category I	Deterministic – Capability Category II	Deterministic – Capability Category III	Risk-Informed – Capability Category I	Risk-Informed – Capability Category II	Risk-Informed – Capability Category III	Risk-Based – Capability Category I	Risk-Based – Capability Category II	Risk-Based – Capability Category III	Assessment		
OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)	EVALUATE the difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.			EVALUATE the difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.			EVALUATE the probabilistic difference between ASET and RSET for all scenarios. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	OEC-A1: Establishment and Integration of ASET Criteria (ASET)											
	OEC-B5: Integration of RSET Criteria (RSET)											

	OEC-C1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	High	**Uncertainty:**	None

OEC-C2: Modeling Uncertainty (ASET/RSET)	DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.		DOCUMENT the assumptions and sources of uncertainty associated with evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-C2 - Modeling Uncertainty (OEC)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	High	**Uncertainty:**	None

OEC-C3: Parametric Uncertainty (ASET/RSET)	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a characterization (e.g., qualitative discussion) of the uncertainty intervals for the paramters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a representative value and characterization of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	PROVIDE a mean value and statistical representation of the uncertainty intervals for the parameters used for evaluation of integration of ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**		**Uncertainty Assessment**	
	OEC-C3 - Parametric Uncertainty (OEC)	Parameter uncertainty relates to the uncertainty in the computation of input parameter values used by the fire safety analysis (e.g., within models).		**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be substantial.		**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. All significant sources of parametric uncertainty are identified and characterized. The collective impact of omissions is expected to be minimal.		**HIGH** This influencing factor is wholly addressed and consistent with the intended capability category. All relevant sources of parametric uncertainty are systematically identified and fully characterized.			**Quality Rating:**	High	**Uncertainty:**	None

ADDITIONAL LOGIC AND OUTPUTS

OEC: Modeling Uncertanty (MU)

- **OEC-A2: Modeling Uncertainty (ASET)**
- **OEC-B6: Modeling Uncertainty (RSET)**
- **OEC-C2: Modeling Uncertainty (ASET/RSET)**

OEC: Parametric Uncertanty (PU)

- **OEC-A3: Parametric Uncertainty (ASET)**
- **OEC-B7: Parametric Uncertainty (RSET)**
- **OEC-C3: Parametric Uncertainty (ASET/RSET)**

Fire Scenario Development (FSD)

FIRE SCENARIO DEVELOPMENT (FSD)

High Level Requirements for Fire Scenario Development (FSD)	
Designator	**Requirement**
HLR-FSD-A	Fire Hazards (FH)
HLR-FSD-B	Potential Fire Scenarios (PFS)
HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)

Supporting Requirements for HLR-FSD-A: Fire Hazards (FH)

Index No.	Deterministic (Capability Category I / II / III)		Risk-Informed (Capability Category I / II / III)		Risk-Based (Capability Category I / II / III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
FSD-A1: Fire Hazard Analysis (FH)	PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			
	FSD-A1 - General Layout (FH)	Considerations include dead end corridors, unusual egress provisions, location of hazardous materials and processes, and exposures to external radiant sources.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The most influential characteristics on establishing potential fire hazards are not identified or considered. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-A1 - Activities (FH)	Considerations include repair and maintenance, process and construction, and disregarding safety procedures	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The most influential characteristics on establishing potential fire hazards are not identified or considered. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-A1 - Ignition Sources (FH)	Considerations include smoking materials, electrical equipment, heating appliances, and unusual ignition sources.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The most influential characteristics on establishing potential fire hazards are not identified or considered. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-A1 - Fuel Sources (FH)	Considerations include amount of combustible materials, location of combustible materials, fire behaviour properties, and dangerous goods and explosives.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The most influential characteristics on establishing potential fire hazards are not identified or considered. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) on establishing potential fire hazards is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-A1 - Method Verification and Validation (ASET)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-FSD-B: Potential Fire Scenarios (PFS)

Index No.	Deterministic (Capability Category I / II / III)		Risk-Informed (Capability Category I / II / III)		Risk-Based (Capability Category I / II / III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
FSD-B1: Potential Fire Scenarios (PFS)	DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.		DETERMINE, through a systematic process, potential sceanrios based on the hazard analysis assessed in SR FSD-A1, data in published literature, review of fire statistics, and expert judgment. PERFORM a systematic review of the occupancy to establish potential fire hazards, both ordinary and special. CONSIDER each of the below influencing factors and/or referenced SRs.			
	FSD-B1 - Combustibles (PFS)	Considerations include the nature, quantity, arrangement and burning behaviour of combustibles in each enclosure.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-B1 - Enclosures (PFS)	Considerations include their geometry, number and relationship.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None

	FSD-B1 - Fire Proection Measures (PFS)	Considerations include the fire protection measures in the building and their effect on the fire.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-B1 - Ventilation Changes (PFS)	Considerations include occupant activities, window glazing breaking, the operation of air handling or smoke management equipment, doors or other partitions burning through, and openings created by fire services intervention.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The most influential characteristics are identified, and their influence (or lack thereof) is appropriate and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. All relevant characteristics are systematically identified, and their influence (or lack thereof) is appropriate and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-B1 - Method Verification and Validation (PFS)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-FSD-C: Design Fire Scenarios for Analysis (DFSA)

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FSD-C1: Design Fire Scenarios for Analysis (DFSA)	SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			SELECT, through a systematic process, the number and nature of fire scenarios evaluated by the fire safety analysis. CONFIRM that this process is consistent with applicable codes and standards. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FSD-C1 - Frequency (DFSA)	This factor addresses the frequency of ignition for fire sceanrios.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The ignition frequency of significant fire scenarios is not characterized or justified. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The ignition frequency of each significant fire scenario is characterized and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The ignition frequency of each potential fire scenario is systematically characterized and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-C1 - Consequence (DFSA)	This factor addresses the overall potential severity of fire sceanrios.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The consequence of significant fire scenarios is not characterized or justified. The collective impact of any omissions is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The consequence of each significant fire scenario is characterized and fully justified. The collective impact of omissions is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The consequence of each potential fire scenario is systematically characterized and fully justified.		**Quality Rating:** High	**Uncertainty:** None
	FSD-C1 - Screening (DFSA)	This factor evaluates whether there are some fire sceanrios that can be excluded from being considered by the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The screening of potential fire scenarios is not appropriate. Screened scenarios have a significant impact on the fire safety analysis.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The screening of potential fire scenarios is mostly appropriate. Any screened scenarios have a minimal impact on the fire safety analysis.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The screening of potential fire scenarios is systematic and fully justified. Screened scenarios have an insignifcant impact on the fire safety analysis.		**Quality Rating:** High	**Uncertainty:** None
	FSD-C1 - Method Verification and Validation (DFSA)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

ADDITIONAL LOGIC AND OUTPUTS

FSD - Fire Scenario Development

FSD-A1: Fire Hazard Analysis (FH)

FSD-B1: Potential Fire Scenarios (PFS)

FSD-C1: Design Fire Scenarios for Analysis (DFSA)

ADDITIONAL LOGIC AND OUTPUTS

Index No.	Deterministic			Risk-Informed			Risk-Based			Assessment		
	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III	Capability Category I	Capability Category II	Capability Category III			
FSD-D1: Modeling Uncertainty (MU)	DOCUMENT the assumptions and sources of uncertainty associated with fire scenario development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with fire scenario development. CONSIDER each of the below influencing factors and/or referenced SRs.			DOCUMENT the assumptions and sources of uncertainty associated with fire scenario development. CONSIDER each of the below influencing factors and/or referenced SRs.			**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

	FSD-D1 - Modeling Uncertainty (MU)	Model uncertainty arises because different approaches may exist to represent certain aspects of the fire safety analysis and none is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions.	**LOW** Significant assumptions and sources of uncertainty are not identified. The collective impact of omissions is expected to be substantial.	**MEDIUM** Significant assumptions and sources of uncertainty are identified. The collective impact of omissions is expected to be minimal.	**HIGH** All assumptions and sources of uncertainty are systematically and fully identified.		**Quality Rating:**	**High**	**Uncertainty:**	**None**

Analysis and Quantification (AQ)

ANALYSIS AND QUANTIFICATION (AQ)

High Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-AQ-A	Quantification Methodology (Q)
HLR-AQ-B	Modeling Uncertainty (MU)
HLR-AQ-C	Parametric Uncertainty (MU)
HLR-AQ-D	Completeness Uncertainty (CU)

Supporting Requirements for HLR-AQ-A: Quantification Methodology (Q)

Index No.	Deterministic (Capability Category I / Capability Category II / Capability Category III)		Risk-Informed (Capability Category I / Capability Category II / Capability Category III)		Risk-Based (Capability Category I / Capability Category II / Capability Category III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
AQ-A1: Quantification (Q)	For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. CONSIDER each of the below influencing factors and/or referenced SRs.		For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. If scenarios result in the RSET exceeding the ASET, DEVELOP criteria based on the conditional probability or likelihood of each scenario to determine the acceptability of this exceedance CONSIDER each of the below influencing factors and/or referenced SRs.		For each scenario, QUANTIFY the safety margin (if any) that exists between ASET and RSET. If scenarios result in the RSET exceeding the ASET, DEVELOP criteria based on the conditional probability or likelihood of each scenario to determine the acceptability of this exceedance. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	AQ-A1 - Comparative Approach (Q)	A comparative approach aims to determine whether the alternative solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The comparative analysis involves the differing assumptions, models, calculations and input data for the proposed trial design and the deemed-tosatisfy or prescriptive design.The collective impact of differences is significant.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The comparative analysis involves the similar assumptions, models, calculations and input data for the proposed trial design and the deemed-tosatisfy or prescriptive design.The collective impact of differences is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The comparative analysis involves the same assumptions, models, calculations and input data for the proposed trial design and the deemed-tosatisfy or prescriptive design.		**Quality Rating:** High	**Uncertainty:** None
	AQ-A1 - Absolute Approach (Q)	When an evaluation is carried out on an absolute basis, the results of the analysis of the trial design are matched, using the agreed acceptance criteria, against the objectives or performance requirements without comparison to deemed-tosatisfy or prescriptive or "benchmark" designs.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The absolute analysis does not measures the collective impact of significant scenarios, using the agreed acceptance criteria, against well-defined objectives or performance requirements.Omissions have a substantial impact.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The absolute analysis measures the collective impact of all significant scenarios, using the agreed acceptance criteria, against well-defined objectives or performance requirements. Omissions have a minimal impact.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The absolute analysis measures the collective impact of all scenarios, using the agreed acceptance criteria, against well-defined objectives or performance requirements.		**Quality Rating:** High	**Uncertainty:** None
	AQ-A1 - Qualitative Assessments (Q)	Qualitative analysis may be sufficient for the consideration of limited non-compliance issues, to demonstate equivalency or to evaluate general adequency. The quantitative methods will often be supported by additional qualitative arguments.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The use of qualitative assessments is not minimal. Also, the basis (logic) for doing so is not well documented or supported by formal process. The omission is shown to have a substantial impact.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category.The use of qualitative assessments is minimal. Also, the basis (logic) for doing so may not be well documented or supported by formal process; however, the omission is shown to have a minimal impact.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The use of qualitative assessments is minimal. Also, the basis (logic) for doing so is well documented with appropriate references or supported by a formally defined and well documented process.		**Quality Rating:** High	**Uncertainty:** None
	AQ-A1 - Screening (Q)	This factor evaluates whether there are some fire sceanrios that can be removed from the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The screening of additional fire scenarios is not appropriate. Screened scenarios have a significant impact on the fire safety analysis.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The screening of any additional fire scenarios is mostly appropriate. Any screened scenarios have a minimal impact on the fire safety analysis.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. Any additional screening of fire scenarios is systematic and fully justified. Screened scenarios have an insignifcant impact on the fire safety analysis.		**Quality Rating:** High	**Uncertainty:** None
	AQ-A1 - Method Verification and Validation (Q)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:** High	**Uncertainty:** None

Supporting Requirements for HLR-AQ-B: Modeling Uncertainty (MU)

Index No.	Deterministic (Capability Category I / Capability Category II / Capability Category III)	Risk-Informed (Capability Category I / Capability Category II / Capability Category III)	Risk-Based (Capability Category I / Capability Category II / Capability Category III)	Assessment: Findings & Observations	Assessment: Quality Assessment	Assessment: Uncertainty Assessment
AQ-B1: Modeling Uncertainty (MU)	DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	DOCUMENT key sources of modeling uncertainty for each TE, and EVALUATE the impact of these uncertainties on the safety margin. APPLY safety factors as needed. Should selection of alternative methods result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**
	FIDC: Modeling Uncertanty (MU)					
	SDSC: Modeling Uncertanty (MU)					
	FDWS: Modeling Uncertanty (MU)					

FSIC: Modeling Uncertainty (MU)									
OEC: Modeling Uncertainty (MU)									
FSD-D1: Modeling Uncertainty (MU)									
AQ-A2 - Identification of Key Sources of Uncertainty (MU)	This factor addresses the identification of those sources of modeling uncertainty that if addressed by alternate analysis assumptions, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. Key sources of modeling uncertainty are not systematically identified or characterized. Omissions have a substantial impact.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. Key sources of modeling uncertainty are systematically identified using a set of well-defined criteria and well-documented process that characterizes significant assumptions and potential sources. Omissions are of minimal impact.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. Key sources of modeling uncertainty are systematically identified using a set of well-defined criteria and well-documented process that characterizes all identified assumptions and potential sources.		**Quality Rating:**	High	**Uncertainty:**	**None**
AQ-A2 - Impact of Key Sources on Life Safety (MU)	This factor addresses the characterization of those sources of modeling uncertainty that if addressed by alternate analysis assumptions, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The individual and/or collective impact of key sources of modeling uncertainty on the fire safety analysis are not evaluated. The impact of omitted sources on the analysis is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The individual impact of key sources of modeling uncertainty on the fire safety analysis is evaluated. Their collective impact of key sources with significant correlation is explored. The impact of omitted sources on the analysis is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The individual and collective impact of key sources of modeling uncertainty on the fire safety analysis is evaluated.		**Quality Rating:**	High	**Uncertainty:**	**None**

Supporting Requirements for HLR-AQ-C: Parametric Uncertainty (MU)

Index No.	Deterministic: Capability Category I	Deterministic: Capability Category II / III	Risk-Informed: Capability Category I	Risk-Informed: Capability Category II / III	Risk-Based: Capability Category I	Risk-Based: Capability Category II / III	Assessment		
AQ-C1: Parametric Uncertainty (PU)	CONFIRM that bounding treatments applied to variables throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each variable applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	CONFIRM that bounding treatments applied to variables throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each variable applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	CONFIRM that bounding treatments applied to variables throughout the analysis result in a conservative estimate of the safety margin. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	Perform sensivity studies to evaluate the impact of uncertainty intervals on the safety margin. IDENTIFY those variables determined to be key sources of uncertainty, and JUSTIFY the estimates for each variable applied in the analysis. APPLY safety factors as needed. Should selection of alternative estimates result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

FIDC: Modeling Uncertainty (MU)									
SDSC: Modeling Uncertainty (MU)									
FDWS: Modeling Uncertainty (MU)									
FSIC: Modeling Uncertainty (MU)									
OEC: Modeling Uncertainty (MU)									
AQ-A2 - Identification of Key Uncertainties (PU)	This factor addresses the identification of those sources of parametric uncertainty whose associated variables, if altered within their interval of uncertainty, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. Key sources of parametric uncertainty are not systematically identified or characterized. Omissions have a substantial impact.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. Key sources of parametric uncertainty are systematically identified using a set of well-defined criteria and well-documented process that characterizes significant assumptions and potential sources. Omissions are of minimal impact.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. Key sources of parametric uncertainty are systematically identified using a set of well-defined criteria and well-documented process that characterizes all identified assumptions and potential sources.		**Quality Rating:**	High	**Uncertainty:**	**None**
AQ-A2 - Impact of Key Uncertainties on Life Safety (PU)	This factor addresses the characterization of those sources of parametric uncertainty whose associated variables, if altered within their interval of uncertainty, would result in significant changes, by some defined criteria, to the final metric of concern (e.g., the difference between RSET and ASET).	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The individual and/or collective impact of key sources of parametric uncertainty on the fire safety analysis are not evaluated. The impact of omitted sources on the analysis is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The individual impact of key sources of parametric uncertainty on the fire safety analysis is evaluated. The collective impact of key sources with significant correlation is explored. The impact of omitted sources on the analysis is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The individual and collective impact of key sources of parametric uncertainty on the fire safety analysis is evaluated.		**Quality Rating:**	High	**Uncertainty:**	**None**

Supporting Requirements for HLR-AQ-D: Completeness Uncertainty (CU)

Index No.	Deterministic (Capability Category I / II / III)	Risk-Informed (Capability Category I / II / III)	Risk-Based (Capability Category I / II / III)	Assessment		
AQ-D1: Completeness Uncertainty (CU)	PERFORM sensitivity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	PERFORM sensitivity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	PERFORM sensitivity studies to evaluate the extent of redundancy or defense-in-depth available in the fire safety design. This would involve the removal of one or more fire safety and design features to assess their impact on safety margin. ESTABLISH criteria to judge the adequacy of remaining safety margin. Should selection of alternative fire safety configurations result in safety margin being inadequate under some circumstances, PROVIDE justification. CONSIDER each of the below influencing factors and/or referenced SRs.	**Findings & Observations**	**Quality Assessment**	**Uncertainty Assessment**

AQ-D1 - Defense in Depth (CU)	This factor explores the concept of defense in depth. This concept attempts to evaluate the balance between three echelons of fire protection: prevention of ignition, reduction in fire severity, and limiting exposure (e.g., to occupants). Fire protection designs should be proposed that address each of these three echelons equally such that there is not overreliance on one echelon. Such a concept is a means to address completeness uncertainty.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. The individual and collective impact of the most significant fire protection features on the fire safety analysis is not explored. The impact of disregarded features on defense in depth is substantial.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. The individual impact of the most significant fire protection features on the fire safety analysis is explored. Their collective impact is also explored where correlations may exist. The impact of disregarded features on defense in depth is minimal.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. The individual and collective impact of all fire protection features on the fire safety analysis is explored.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
AQ-D1 - Safety Margin (CU)	This factor explores the concept of safety margin. This concept attempts to ensure a sufficient level of conservatism in the analysis such that uncertainties associated with completeness (e.g., unknowns) . Such a concept may be implemented through the use of safety factors.	**LOW** Significant (or dominant) aspects of this influencing factor are neither addressed by the fire safety analysis nor consistent with the intended capability category. Factors of safety are not applied at the end of a calculation sequence and result in overly conservative and/or distorted outcomes. No or a limited basis for factors is provided.	**MEDIUM** Significant (or dominant) aspects of this influencing factor are largely addressed by the fire safety analysis and consistent with the intended capability category. Factors of safety are mostly applied at the end of a calculation sequence and may result in overly conservative outcomes. However, it is demonstrated that the overall results are not distorted.	**HIGH** This influencing factor is wholly addressed by the fire safety analysis and consistent with the intended capability category. Factors of safety are applied at the end of a calculation sequence, do not result in overly conservative outcomes, and are consistent with fire protection engineering practice.		**Quality Rating:**	**High**	**Uncertainty:**	**None**
AQ-D1 - Method Verification and Validation (CU)	Methods and predicitve models applied should be verified and validated to demonstrate that they have sufficient capability to model the conditions of interest and only within known limits of applicability.	**LOW** Methods and models applied have not been fully verified or validated. Consensus methods and models may have been applied; though, their applicability or consistency with fire engineering practice is not clear. Engineering judgement is used but limited to no justification is provided. The collective impact of any omissions is substantial.	**MEDIUM** Methods and models applied have been fully verified, but not all methods and models have been formally validated. Engineering judgement is used; though, consensus methods and models are applied if applicable and consistent with fire engineering practice. The collective impact of any omissions is minimal.	**HIGH** All methods and models applied have been fully verified, and to the extent practical, validated. Where no validated methods or models exist, data from the literature, field studies or real-world simulations may be used if justified. Consensus methods and models may also be applied if applicable and consistent with fire engineering practice.		**Quality Rating:**	**High**	**Uncertainty:**	**None**

Life Safety

Baseline Life Safety Metric	
μ	σ^2
66%	0.02

Supporting Requirements for Baseline Life Safety Metric:	
Index No.	**Assessment**
Life Safety Metric	Node Descriptions
	OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)
	FSD - Fire Scenario Development
	AQ-A1: Quantification (Q)
	AQ-B1: Modeling Uncertainty (MU)
	AQ-C1: Parametric Uncertainty (PU)
	AQ-D1: Completeness Uncertainty (CU)

APPENDIX G

Case Study Influencing Weights

Fire Initiation, Development and Control (FIDC)

FIRE INITIATION, DEVELOPMENT AND CONTROL (FIDC)

High-Level Requirements for Fire Initiation, Development and Control (FIDC)	
Designator	**Requirement**
HLR-FIDC-A	Room of Origin Fire Development (ROO)
HLR-FIDC-B	Modified Fire Development (MOD)
HLR-FIDC-C	Flashover (FO)
HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)

Supporting Requirements for HLR-FIDC-A: Room of Origin Fire Development (ROO)

		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
FIDC-A1: Fire Size/HRR (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A1 - Ignition Characteristics (ROO)	Low	Low	Low
	FIDC-A1 - Fuel and Loading Characteristics (ROO)	Medium	Medium	Low-Medium
	FIDC-A6: Ventilation Conditions (ROO)	Low-Medium	Low-Medium	Low-Medium
	FIDC-A1 - Building Characteristics (ROO)	Low	Low	Low
	FIDC-A1 - Method Verification and Validation (ROO)	High	High	High
	FIDC-A2: Fire Growth and Flame Spread (ROO)	Medium	Medium	Medium

FIDC-A2: Fire Growth and Flame Spread (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A2 - Temporal Profile (ROO)	Medium	Medium	Low-Medium
	FIDC-A2 - Fuel Characteristics (ROO)	Medium	Medium	Low-Medium
	FIDC-A2 - Building Characteristics (ROO)	Low	Low	Low
	FIDC-A2 - Method Verification and Validation (ROO)	High	High	High

FIDC-A3: Toxic Species Yield (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A3 - Toxic Species Data (ROO)	Medium	Medium	Medium
	FIDC-A3 - Combustion Characteristics (ROO)	Low	Low	Low
	FIDC-A3 - Method Verification and Validation (ROO)	Medium	Medium	Medium
	FIDC-A1: Fire Size/HRR (ROO)	Medium	Medium	Medium

FIDC-A4: Smoke Yield (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A4 - Smoke Yield Data (ROO)	Medium	Medium	Medium
	FIDC-A4 - Combustion Characteristics (ROO)	Low	Low	Low
	FIDC-A4 - Method Verification and Validation (ROO)	Medium	Medium	Medium
	FIDC-A1: Fire Size/HRR (ROO)	Medium	Medium	Medium

FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A5 - Building Characteristics (ROO)	Low	Low	Low
	FIDC-A5 - Fuel and Loading Characteristics (ROO)	Low-Medium	Low-Medium	Low-Medium
	FIDC-A5 - Method Verification and Validation (ROO)	Medium	Medium	Medium
	FIDC-A1: Fire Size/HRR (ROO)	Medium	Medium	Medium

FIDC-A6: Ventilation Conditions (ROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A6 - Building Characteristics (ROO)	High	High	High
	FIDC-A6 - Occupant Characteristics (ROO)	Low	Low	Low
	FIDC-A6 - Environmental Conditions (ROO)	Medium-High	Medium-High	Medium-High
	FIDC-A6 - Method Verification and Validation (ROO)	High	High	High

Supporting Requirements for HLR-FIDC-B: Modified Fire Development (MOD)

FIDC-B1: Fire Size/HRR (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B6: Ventilation Conditions (MOD)	Low	High	Low
	FIDC-B1 - Method Verification and Validation (MOD)	High	High	High
	HLR-FDWS-C: Manual Suppression and Control (MS&C)	Low	Low	Low
	HLR-FDWS-D: Automatic Suppression and Control (AS&C)	High	N/A	High
	FIDC-B2: Fire Growth and Flame Spread (MOD)	Low	Medium	Low

FIDC-B2: Fire Growth and Flame Spread (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B2 - Temporal Profile (MOD)	Low	Medium	Low
	FIDC-B2 - Method Verification and Validation (MOD)	High	High	High

FIDC-B3: Toxic Species Yield (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B3 - Toxic Species Data (MOD)	Medium	Medium	Medium
	FIDC-B3 - Combustion Characteristics (MOD)	Low	Low	Low
	FIDC-B3 - Method Verification and Validation (MOD)	Medium	Medium	Medium
	FIDC-B1: Fire Size/HRR (MOD)	Medium	Medium	Medium

FIDC-B4: Smoke Yield (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B4 - Smoke Yield Data (MOD)	Medium	Medium	Medium
	FIDC-B4 - Combustion Characteristics (MOD)	Low	Low	Low
	FIDC-B4 - Method Verification and Validation (MOD)	Medium	Medium	Medium
	FIDC-B1: Fire Size/HRR (MOD)	Medium	Medium	Medium

FIDC-B5: Flame Height, Temperature and Radiation (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B5 - Building Characteristics (MOD)	Low	Low	Low
	FIDC-B5 - Fuel and Loading Characteristics (MOD)	Low-Medium	Low-Medium	Low-Medium
	FIDC-B5 - Method Verification and Validation (MOD)	High	High	High
	FIDC-B1: Fire Size/HRR (MOD)	High	High	High

FIDC-B6: Ventilation Conditions (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	HLR-SDSC-E: Smoke Control and Management (SC&M)	N/A	Low	N/A
	FIDC-B6 - Method Verification and Validation (MOD)	Low	Low	Low

Supporting Requirements for HLR-FIDC-C: Flashover (FO)

FIDC-C1: Fire Size/HRR (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C1 - Flashover Criteria (FO)	High	High	High
	Impact of ROO Fire and Smoke Development on FO Scenarios	Low-Medium	Low-Medium	Low-Medium
	Impact of MOD Fire and Smoke Development on FO Scenarios	Low	Low-Medium	Low
	FIDC-C6: Ventilation Conditions (FO)	Low	Low	Low
	FIDC-C2: Fire Growth and Flame Spread (FO)	Medium	Medium	Medium
	FIDC-C1 - Method Verification and Validation (FO)	High	High	High

FIDC-C2: Fire Growth and Flame Spread (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B2 - Temporal Profile (FO)	Low	Low	Low
	FIDC-B2 - Method Verification and Validation (MOD)	Medium	Medium	Medium

FIDC-C3: Toxic Species Yield (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C3 - Toxic Species Data (FO)	Medium	Medium	Medium
	FIDC-C3 - Combustion Characteristics (FO)	Low	Low	Low
	FIDC-C3 - Method Verification and Validation (FO)	Medium	Medium	Medium
	FIDC-C1: Fire Size/HRR (FO)	Medium	Medium	Medium

FIDC-C4: Smoke Yield (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C4 - Smoke Yield Data (FO)	Medium	Medium	Medium
	FIDC-C4 - Combustion Characteristics (FO)	Low	Low	Low
	FIDC-C4 - Method Verification and Validation (FO)	Medium	Medium	Medium
	FIDC-C1: Fire Size/HRR (FO)	Medium	Medium	Medium

FIDC-C5: Flame Height,	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

Temperature and Radiation (FO)	FIDC-C5 - Building Characteristics (FO)	Low	Low	Low
	FIDC-C5 - Fuel and Loading Characteristics (FO)	Low-Medium	Low-Medium	Low-Medium
	FIDC-C5 - Method Verification and Validation (FO)	High	High	High
	FIDC-C1: Fire Size/HRR (FO)	High	High	High

FIDC-C6: Ventilation Conditions (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C6 - Building Characteristics (FO)	Low	Low	Low
	FIDC-C6 - Method Verification and Validation (FO)	Low	Low	Low

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on FO Scenarios	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A1: Fire Size/HRR (ROO)	Low	Low	Low
	SDSC-A3: Smoke Temperature (ROO)	Low	Low	Low
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low

Impact of MOD Fire and Smoke Development on FO Scenarios	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B1: Fire Size/HRR (MOD)	Low	Low	Low
	SDSC-B3: Smoke Temperature (MOD)	Low	Low	Low
	SDSC-B6: Radiation from Smoke Layer (MOD)	Low	Low	Low

Supporting Requirements for HLR-FIDC-D: Beyond Room of Origin Fire Development (EXROO)

FIDC-D1: Fire Size/HRR (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D1 - Ignition Characteristics (EXROO)	Low	Low	Low
	FIDC-D1 - Fuel and Loading Characteristics (EXROO)	Medium	Medium	Medium
	FIDC-D6: Ventilation Conditions (EXROO)	Low-Medium	Low-Medium	Low-Medium
	FIDC-D1 - Building Characteristics (EXROO)	Medium	Medium	Medium
	FIDC-D1 - Method Verification and Validation (EXROO)	High	High	High
	FIDC-D2: Fire Growth and Flane Spread (EXROO)	Medium	Medium	Medium

FIDC-D2: Fire Growth and Flane Spread (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D2 - Temporal Profile (EXROO)	Medium	Medium	Medium
	FIDC-D2 - Fuel Characteristics (EXROO)	Medium	Medium	Medium
	FIDC-D2 - Building Characteristics (EXROO)	Low	Low	Low
	FSIC - Fire Spread	Low	Low	Low
	FIDC-D2 - Method Verification and Validation (EXROO)	High	High	High

FIDC-D3: Toxic Species Yield (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D3 - Toxic Species Data (EXROO)	Low	Low	Low
	FIDC-D3 - Combustion Characteristics (EXROO)	Low	Low	Low
	FIDC-D3 - Method Verification and Validation (EXROO)	Medium	Medium	Medium
	FIDC-D1: Fire Size/HRR (EXROO)	Medium	Medium	Medium

FIDC-D4: Smoke Yield (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D4 - Smoke Yield Data (EXROO)	Low	Low	Low
	FIDC-D4 - Combustion Characteristics (EXROO)	Low	Low	Low
	FIDC-D4 - Method Verification and Validation (EXROO)	Medium	Medium	Medium
	FIDC-D1: Fire Size/HRR (EXROO)	Medium	Medium	Medium

FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D5 - Building Characteristics (EXROO)	Low	Low	Low
	FIDC-D5 - Fuel and Loading Characteristics (EXROO)	Low-Medium	Low-Medium	Low-Medium
	FIDC-D5 - Method Verification and Validation (EXROO)	High	High	High
	FIDC-D1: Fire Size/HRR (EXROO)	High	High	High

FIDC-D6: Ventilation Conditions (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D6 - Building Characteristics (EXROO)	High	High	High
	FIDC-D6 - Occupant Characteristics (EXROO)	Low	Low	Low
	HLR-SDSC-E: Smoke Control and Management (SC&M)	N/A	High	N/A
	FIDC-D6 - Environmental Conditions (EXROO)	Medium-High	Medium-High	Medium-High
	FIDC-D6 - Method Verification and Validation (EXROO)	High	High	High

ADDITIONAL LOGIC AND OUTPUTS

FIDC: Modeling Uncertainty (MU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A6: Modeling Uncertainty (ROO)	High	High	High
	FIDC-B7: Modeling Uncertainty (MOD)	Low-Medium	High	Low-Medium
	FIDC-C7: Modeling Uncertainty (FO)	Low	Low-Medium	Low
	FIDC-D7: Modeling Uncertainty (EXROO)	Low	Low	Low

FIDC: Parametric Uncertainty (PU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A7: Parametric Uncertainty (ROO)	High	High	High
	FIDC-B8: Parametric Uncertainty (MOD)	Low-Medium	High	Low-Medium
	FIDC-C8: Parametric Uncertainty (FO)	Low	Low-Medium	Low

	FIDC-D8: Parametric Uncertainty (EXROO)	**Low**	**Low**	**Low**

Smoke Development, Spread and Control (SDSC)

SMOKE DEVELOPMENT, SPREAD AND CONTROL (SDSC)

High-Level Requirements for Fire Initiation, Development and Control (SDSC)	
Designator	**Requirement**
HLR-SDSC-A	Room of Origin Smoke Development (ROO)
HLR-SDSC-B	Modified Smoke Development (MOD)
HLR-SDSC-C	Flashover Smoke Development (FO)
HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)
HLR-SDSC-E	Smoke Control and Management (SC&M)
HLR-SDSC-F	Smoke Barrier Failure (SBF)

Supporting Requirements for HLR-SDSC-A: Room of Origin Smoke Development (ROO)

		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
SDSC-A1: Smoke Production (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A1: Fire Size/HRR (ROO)	High	High	Low-Medium
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Medium	Medium	Low-Medium
	SDSC-A1 - Building Characteristics (ROO)	Low	Low	Low
	SDSC-A1 - Method Verification and Validation (ROO)	High	High	Low-Medium

SDSC-A2: Smoke Layer Interface Height (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	SDSC-A1: Smoke Production (ROO)	High	High	High
	SDSC-A2 - Building Characteristics (ROO)	Low	Low	Low
	SDSC-A2 - Method Verification and Validation (ROO)	High	High	High

SDSC-A3: Smoke Temperature (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	SDSC-A1 - Building Characteristics (ROO)	Low	Low	Low
	FIDC-A4: Smoke Yield (ROO)	Medium	Medium	Medium
	SDSC-A3 - Method Verification and Validation (ROO)	Medium	Medium	Medium
	SDSC-A1: Smoke Production (ROO)	Medium	Medium	Medium

SDSC-A4: Smoke Optical Density (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A4: Smoke Yield (ROO)	Medium	Medium	Medium
	SDSC-A2: Smoke Layer Interface Height (ROO)	Medium	Medium	Medium
	SDSC-A4 - Method Verification and Validation (ROO)	Medium	Medium	Medium

SDSC-A5: Smoke Concentration (ROO)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC-A3: Toxic Species Yield (ROO)	Medium	Medium	Medium
	SDSC-A2: Smoke Layer Interface Height (ROO)	Medium	Medium	Medium
	SDSC-A5 - Method Verification and Validation (ROO)	Medium	Medium	Medium

SDSC-A6: Radiation from Smoke Layer (ROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A3: Smoke Temperature (ROO)	High	High	High
	SDSC-A2: Smoke Layer Interface Height (ROO)	High	High	High
	SDSC-A6 - Building Characteristics (ROO)	Low	Low	Low
	SDSC-A6 - Method Verification and Validation (ROO)	High	High	High

Supporting Requirements for HLR-SDSC-B: Modified Smoke Development (MOD)

SDSC-B1: Smoke Production (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B1: Fire Size/HRR (MOD)	High	High	Low-Medium
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	Medium	Medium	Low-Medium
	SDSC-B1 - Building Characteristics (MOD)	Low	Low	Low
	SDSC-B1 - Method Verification and Validation (MOD)	High	High	Low-Medium

SDSC-B2: Smoke Layer Interface Height (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-B1: Smoke Production (MOD)	High	High	High
	HLR-SDSC-E: Smoke Control and Management (SC&M)	N/A	High	Medium
	SDSC-B2 - Building Characteristics (MOD)	Low	Low	Low
	SDSC-B2 - Method Verification and Validation (MOD)	High	High	High

SDSC-B3: Smoke Temperature (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-B1 - Building Characteristics (MOD)	Low	Low	Low
	FIDC-B4: Smoke Yield (MOD)	Medium	Medium	Medium
	SDSC-B3 - Method Verification and Validation (MOD)	Medium	Medium	Medium
	SDSC-B1: Smoke Production (MOD)	Medium	Medium	Medium

SDSC-B4: Smoke Optical Density (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B4: Smoke Yield (MOD)	Medium	Medium	Medium
	SDSC-B2: Smoke Layer Interface Height (MOD)	Medium	Medium	Medium
	SDSC-B4 - Method Verification and Validation (MOD)	Medium	Medium	Medium

SDSC-B5: Smoke Concentration (MOD)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B3: Toxic Species Yield (MOD)	Medium	Medium	Medium
	SDSC-B2: Smoke Layer Interface Height (MOD)	Medium	Medium	Medium
	SDSC-B5 - Method Verification and Validation (MOD)	Medium	Medium	Medium

SDSC-B6: Radiation from Smoke Layer	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

(MOD)	SDSC-B3: Smoke Temperature (MOD)	High	High	High
	SDSC-B2: Smoke Layer Interface Height (MOD)	High	High	High
	SDSC-B6 - Building Characteristics (MOD)	Low	Low	Low
	SDSC-B6 - Method Verification and Validation (MOD)	High	High	High

Supporting Requirements for HLR-SDSC-C: Flashover Smoke Development (FO)

SDSC-C1: Smoke Production (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C1: Fire Size/HRR (FO)	High	High	Low-Medium
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	Medium	Medium	Low-Medium
	SDSC-C1 - Building Characteristics (FO)	Low	Low	Low
	SDSC-C1 - Method Verification and Validation (FO)	High	High	Low-Medium

SDSC-C2: Smoke Layer Interface Height (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-C1: Smoke Production (FO)	High	High	High
	HLR-SDSC-E: Smoke Control and Management (SC&M)	N/A	High	Medium
	SDSC-C2 - Building Characteristics (FO)	Low	Low	Low
	SDSC-C2 - Method Verification and Validation (FO)	High	High	High

SDSC-C3: Smoke Temperature (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-C1 - Building Characteristics (FO)	Low	Low	Low
	FIDC-C4: Smoke Yield (FO)	Medium	Medium	Medium
	SDSC-C3 - Method Verification and Validation (FO)	Medium	Medium	Medium
	SDSC-C1: Smoke Production (FO)	Medium	Medium	Medium

SDSC-C4: Smoke Optical Density (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C4: Smoke Yield (FO)	Medium	Medium	Medium
	SDSC-C2: Smoke Layer Interface Height (FO)	Medium	Medium	Medium
	SDSC-C4 - Method Verification and Validation (FO)	Medium	Medium	Medium

SDSC-C5: Smoke Concentration (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C3: Toxic Species Yield (FO)	Medium	Medium	Medium
	SDSC-C2: Smoke Layer Interface Height (FO)	Medium	Medium	Medium
	SDSC-C5 - Method Verification and Validation (FO)	Medium	Medium	Medium

SDSC-C6: Radiation from Smoke Layer (FO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-C3: Smoke Temperature (FO)	High	High	High
	SDSC-C2: Smoke Layer Interface Height (FO)	High	High	High

	SDSC-C6 - Building Characteristics (FO)	Low	Low	Low
	SDSC-C6 - Method Verification and Validation (FO)	High	High	High

Supporting Requirements for HLR-SDSC-D: Beyond Room of Origin Smoke Development (EXROO)

SDSC-D1: Smoke Production (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D1: Fire Size/HRR (EXROO)	Low	Low	Low
	FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	Medium	Medium	Medium
	SDSC-D2: Smoke Spread (EXROO)	High	High	Medium
	SDSC-D1 - Building Characteristics (EXROO)	Low	Low	Low
	SDSC-D1 - Method Verification and Validation (EXROO)	High	High	High

SDSC-D2: Smoke Spread (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Smoke Spread through Openings	Low-Medium	Medium-High	Low-Medium
	Impact of MOD Fire and Smoke Development on Smoke Spread through Openings	Low	Medium-High	Low
	Impact of FO Fire and Smoke Development on Smoke Spread through Openings	Low	Low	Low
	SDSC-D1 - Method Verification and Validation (EXROO)	High	Medium-High	High

SDSC-D3: Smoke Layer Interface Height (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-D1: Smoke Production (EXROO)	High	High	Low-Medium
	HLR-SDSC-E: Smoke Control and Management (SC&M)	N/A	High	Low-Medium
	SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	N/A	N/A	High
	SDSC-G - Active Smoke Barriers	N/A	N/A	High
	SDSC-D2 - Building Characteristics (EXROO)	Low	Low	Low
	SDSC-D2 - Method Verification and Validation (EXROO)	High	High	High

SDSC-D4: Smoke Temperature (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-D1 - Building Characteristics (EXROO)	Low	Low	Low
	FIDC-D4: Smoke Yield (EXROO)	Medium	Medium	Medium
	SDSC-D3 - Method Verification and Validation (EXROO)	Medium	Medium	Medium
	SDSC-D1: Smoke Production (EXROO)	Medium	Medium	Medium

SDSC-D5: Smoke Optical Density (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-D4: Smoke Yield (EXROO)	Medium	Medium	Medium
	SDSC-D3: Smoke Layer Interface Height (EXROO)	Medium	Medium	Medium
	SDSC-D4 - Method Verification and Validation (EXROO)	Medium	Medium	Medium

SDSC-D6: Smoke Concentration	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

(EXROO)	FIDC-D3: Toxic Species Yield (EXROO)	Medium	Medium	Medium
	SDSC-D3: Smoke Layer Interface Height (EXROO)	Medium	Medium	Medium
	SDSC-D5 - Method Verification and Validation (EXROO)	Medium	Medium	Medium

SDSC-D7: Radiation from Smoke Layer (EXROO)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-D4: Smoke Temperature (EXROO)	High	High	High
	SDSC-D3: Smoke Layer Interface Height (EXROO)	High	High	High
	SDSC-D6 - Building Characteristics (EXROO)	Low	Low	Low
	SDSC-D6 - Method Verification and Validation (EXROO)	High	High	High

Supporting Requirements for HLR-SDSC-E: Smoke Control and Management (SC&M)

SDSC-E1: System Effectiveness (SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A2: Smoke Layer Interface Height (ROO)	N/A	Low	Low
	SDSC-A3: Smoke Temperature (ROO)	N/A	Low	Low
	SDSC-E1 - Building Characteristics (SC&M)	N/A	Medium	Medium
	SDSC-E1 - System Design and Characteristics (SC&M)	N/A	Medium-High	Medium-High
	SDSC-E1 - Method Verification and Validation (SC&M)	N/A	Medium-High	Medium-High

ADDITIONAL LOGIC AND OUTPUTS

HLR-SDSC-E: Smoke Control and Management (SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G - Detection	N/A	Low	Low
	FDWS-G5: System Reliability and Availability (DA-SC&M)	N/A	Medium	Medium
	SDSC-E1: System Effectiveness (SC&M)	N/A	Medium	Medium

Supporting Requirements for HLR-SDSC-F: Smoke Barrier Failure (SBF)

SDSC-F1: Active Smoke Barrier Effectiveness (SBF)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low
	Impact of MOD Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low
	Impact of FO Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low
	SDSC-B1 - Barrier Characteristics (SBF)	N/A	N/A	Medium
	SDSC-B1 - Building Characteristics (SBF)	N/A	N/A	Low
	SDSC-B1 - Method Verification and Validation (SBF)	N/A	N/A	Medium

SDSC-F2: Passive Smoke Barrier Effectiveness (SBF)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low
	Impact of MOD Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low
	Impact of FO Fire and Smoke Development on Smoke Barriers	N/A	N/A	Low

	SDSC-B2 - Barrier Characteristics (SBF)	N/A	N/A	Medium
	SDSC-B2 - Building Characteristics (SBF)	N/A	N/A	Low
	SDSC-B2 - Method Verification and Validation (SBF)	N/A	N/A	Medium

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Smoke Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	Low
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	Low
	SDSC-A6: Radiation from Smoke Layer (ROO)	N/A	N/A	Low

Impact of MOD Fire and Smoke Development on Smoke Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	N/A	N/A	Low
	SDSC-B3: Smoke Temperature (MOD)	N/A	N/A	Low
	SDSC-B6: Radiation from Smoke Layer (MOD)	N/A	N/A	Low

Impact of FO Fire and Smoke Development on Smoke Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	N/A	N/A	Low
	SDSC-C3: Smoke Temperature (FO)	N/A	N/A	Low
	SDSC-C6: Radiation from Smoke Layer (FO)	N/A	N/A	Low

Impact of ROO Fire and Smoke Development on Smoke Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A2: Smoke Layer Interface Height (ROO)	High	High	High
	SDSC-A3: Smoke Temperature (ROO)	Medium	Medium	Medium
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low

Impact of MOD Fire and Smoke Development on Smoke Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-B2: Smoke Layer Interface Height (MOD)	High	High	High
	SDSC-B3: Smoke Temperature (MOD)	Medium	Medium	Medium
	SDSC-B6: Radiation from Smoke Layer (MOD)	Low	Low	Low

Impact of FO Fire and Smoke Development on Smoke Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-C2: Smoke Layer Interface Height (FO)	High	High	High
	SDSC-C3: Smoke Temperature (FO)	Medium	Medium	Medium
	SDSC-C6: Radiation from Smoke Layer (FO)	Low	Low	Low

SDSC-G - Active Smoke Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F - Detection	N/A	N/A	Low

	FDWS-F5: System Reliability and Availability (DA-ASB)	N/A	N/A	Medium
	SDSC-F1: Active Smoke Barrier Effectiveness (SBF)	N/A	N/A	Low

ADDITIONAL LOGIC AND OUTPUTS				
SDSC: Modeling Uncertanty (MU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A7: Modeling Uncertainty (ROO)	High	Medium-High	High
	SDSC-B7: Modeling Uncertainty (MOD)	Low-Medium	Medium	Low-Medium
	SDSC-C7: Modeling Uncertainty (FO)	Low	Low	Low
	SDSC-D8: Modeling Uncertainty (EXROO)	Medium-High	Medium-High	Medium-High
	SDSC-E2: Modeling Uncertainty (SC&M)	N/A	Medium-High	Medium-High
	SDSC-F3: Modeling Uncertainty (SBF)	N/A	N/A	Medium-High

SDSC: Parametric Uncertanty (PU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A8: Parametric Uncertainty (ROO)	High	Medium-High	High
	SDSC-B8: Parametric Uncertainty (MOD)	Low-Medium	Medium	Low-Medium
	SDSC-C8: Parametric Uncertainty (FO)	Low	Low	Low
	SDSC-D9: Parametric Uncertainty (EXROO)	Medium-High	Medium-High	Medium-High
	SDSC-E3: Parametric Uncertainty (SC&M)	N/A	Medium-High	Medium-High
	SDSC-F4: Parametric Uncertainty (SBF)	N/A	N/A	Medium-High

Fire Detection, Warning and Suppression (FDWS)

FIRE DETECTION, WARNING AND SUPPRESSION (FDWS)

High-Level Requirements for Fire Detection, Warning and Suppression (FDWS)	
Designator	**Requirement**
HLR-FDWS-A	Manual Notification System (MNS)
HLR-FDWS-B	Automatic Notification System (ANS)
HLR-FDWS-C	Manual Suppression and Control (MS&C)
HLR-FDWS-D	Automatic Suppression and Control (AS&C)
HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)
HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)
HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)

Supporting Requirements for HLR-FDWS-A: Manual Notification System (MNS)		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
FDWS-A1: Timing of Manual Detection (MNS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FDWS-A1 - Building Characteristics (MNS)	Medium	Medium	Medium
	FDWS-A1 - Occupant Characteristics (MNS)	High	High	High
	FDWS-A1 - Ventilation Conditions (MNS)	Medium	Medium	Medium
	FDWS-A1 - Fire Characteristics (MNS)	Low	Low	Low
	FDWS-A1 - Smoke Characteristics (MNS)	High	High	High
	FDWS-A1 - Method Verification and Validation (MNS)	High	High	High

FDWS-A2: Reliability and Availability of Manual Detection (MNS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FDWS-A2 - Building Characteristics (MNS)	Low	Low	Low
	FDWS-A2 - Occupant Characteristics (MNS)	High	High	High
	FDWS-A2 - Method Verification and Validation (MNS)	High	High	High

FDWS-A3: Timing of Automatic Detection (MNS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FDWS-A3 - Building Characteristics (MNS)	Low	Low	Low
	FDWS-A3 - Detector Characteristics (MNS)	Medium	Medium	Medium
	FDWS-A3 - Ventilation Conditions (MNS)	Low	Low	Low
	FDWS-A3 - Fire Characteristics (MNS)	N/A	N/A	N/A
	FDWS-A3 - Smoke Characteristics (MNS)	Medium	Medium	Medium
	FDWS-A3 - Method Verification and Validation (MNS)	Medium	Medium	Medium

FDWS-A4: Reliability and Availability of Automatic Detection (MNS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FDWS-A4 - Building Characteristics (MNS)	Low	Low	Low
	FDWS-A4 - System Design and Maintenance (MNS)	High	High	High
	FDWS-A4 - Method Verification and Validation (MNS)	High	High	High

FDWS-A5: Reliability and Availability (MNS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FDWS-A5 - Building Characteristics (MNS)	Low	Low	Low

	FDWS-A5 - System Design and Maintenance (MNS)	High	High	High
	FDWS-A5 - Method Verification and Validation (MNS)	High	High	High

FDWS-A6: Effectiveness (MNS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A6 - Building Characteristics (MNS)	Low	Low	Low
	FDWS-A6 - Occupant Characteristics (MNS)	Medium	Medium	Medium
	FDWS-A6 - System Characteristics (MNS)	Low-Medium	Low-Medium	Low-Medium
	FDWS-A6 - Method Verification and Validation (MNS)	Medium	Medium	Medium

ADDITIONAL LOGIC AND OUTPUTS

FDWS-A - Manual Detection (MNS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A1: Timing of Manual Detection (MNS)	Low	Low	Low
	FDWS-A2: Reliability and Availability of Manual Detection (MNS)	Low	Low	Low

FDWS-A - Automatic Detection (MNS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A3: Timing of Automatic Detection (MNS)	Low	Low	Low
	FDWS-A4: Reliability and Availability of Automatic Detection (MNS)	Low	Low	Low

FDWS-A - Detection (MNS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Manual Detection	Low	Low	Low
	Automatic Detection	High	High	High

Supporting Requirements for HLR-FDWS-B: Automatic Notification System (ANS)

FDWS-B1: Timing of Manual Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B1 - Building Characteristics (ANS)	Medium	Medium	Medium
	FDWS-B1 - Occupant Characteristics (ANS)	High	High	High
	FDWS-B1 - Ventilation Conditions (ANS)	Medium	Medium	Medium
	FDWS-B1 - Fire Characteristics (ANS)	Low	Low	Low
	FDWS-B1 - Smoke Characteristics (ANS)	High	High	High
	FDWS-B1 - Method Verification and Validation (ANS)	High	High	High

FDWS-B2: Reliability and Availability of Manual Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B2 - Building Characteristics (ANS)	Low	Low	Low
	FDWS-B2 - Occupant Characteristics (ANS)	High	High	High
	FDWS-B2 - Method Verification and Validation (ANS)	High	High	High

FDWS-B3: Timing of Automatic Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B3 - Building Characteristics (ANS)	Low	Low	Low
	FDWS-B3 - Detector Characteristics (ANS)	Medium	Medium	Medium
	FDWS-B3 - Ventilation Conditions (ANS)	Low	Low	Low
	FDWS-B3 - Fire Characteristics (ANS)	N/A	N/A	N/A
	FDWS-B3 - Smoke Characteristics (ANS)	Medium	Medium	Medium

	FDWS-B3 - Method Verification and Validation (ANS)	Medium	Medium	Medium

FDWS-B4: Reliability and Availability of Automatic Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B4 - Building Characteristics (ANS)	Low	Low	Low
	FDWS-B4 - System Design and Maintenance (ANS)	High	High	High
	FDWS-B4 - Method Verification and Validation (ANS)	High	High	High

FDWS-B5: Reliability and Availability (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B5 - Building Characteristics (ANS)	Low	Low	Low
	FDWS-B5 - System Design and Maintenance (ANS)	High	High	High
	FDWS-B5 - Method Verification and Validation (ANS)	High	High	High

FDWS-B6: Effectiveness (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B6 - Building Characteristics (ANS)	Low	Low	Low
	FDWS-B6 - Occupant Characteristics (ANS)	Medium	Medium	Medium
	FDWS-B6 - System Characteristics (ANS)	Low	Low	Low
	FDWS-B6 - Method Verification and Validation (ANS)	Medium	Medium	Medium

ADDITIONAL LOGIC AND OUTPUTS

FDWS-B - Manual Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B1: Timing of Manual Detection (ANS)	Low	Low	Low
	FDWS-B2: Reliability and Availability of Manual Detection (ANS)	Low	Low	Low

FDWS-B - Automatic Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B3: Timing of Automatic Detection (ANS)	Low	Low	Low
	FDWS-B4: Reliability and Availability of Automatic Detection (ANS)	Low	Low	Low

FDWS-B - Detection (ANS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B - Manual Detection (ANS)	Low	Low	Low
	FDWS-B - Automatic Detection (ANS)	High	High	High

Supporting Requirements for HLR-FDWS-C: Manual Suppression and Control (MS&C)

FDWS-C1: Timing of Manual Detection (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C1 - Building Characteristics (MS&C)	Medium	Medium	Medium
	FDWS-C1 - Occupant Characteristics (MS&C)	High	High	High
	FDWS-C1 - Ventilation Conditions (MS&C)	Medium	Medium	Medium
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Low	Low	Low
	SDSC-A2: Smoke Layer Interface Height (ROO)	Medium	Medium	Medium
	SDSC-A4: Smoke Optical Density (ROO)	Medium	Medium	Medium
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low
	FDWS-C1 - Method Verification and Validation (MS&C)	High	High	High

FDWS-C2: Reliability and Availability of Manual Detection (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C2 - Building Characteristics (MS&C)	Low	Low	Low
	FDWS-C2 - Occupant Characteristics (MS&C)	High	High	High
	FDWS-C2 - Method Verification and Validation (MS&C)	High	High	High

FDWS-C3: Timing of Automatic Detection (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C3 - Building Characteristics (MS&C)	Low	Low	Low
	FDWS-C3 - Detector Characteristics (MS&C)	Medium	Medium	Medium
	FDWS-C3 - Ventilation Conditions (MS&C)	Low	Low	Low
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	Medium	Medium	Medium
	FDWS-C3 - Method Verification and Validation (MS&C)	Medium	Medium	Medium

FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C4 - Building Characteristics (MS&C)	Low	Low	Low
	FDWS-C4 - System Design and Maintenance (MS&C)	High	High	High
	FDWS-C4 - Method Verification and Validation (MS&C)	High	High	High

FDWS-C5: Reliability and Availability (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C5 - Building Characteristics (MS&C)	Low	Low	Low
	FDWS-C5 - Occupant Characteristics (MS&C)	High	High	High
	FDWS-C5 - Equipment Design and Maintenance (MS&C)	High	High	High
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Medium-High	Medium-High	Medium-High
	SDSC-A2: Smoke Layer Interface Height (ROO)	Low	Low	Low
	SDSC-A4: Smoke Optical Density (ROO)	Low	Low	Low
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low
	SDSC-A5: Smoke Concentration (ROO)	Low	Low	Low
	FDWS-C5 - Method Verification and Validation (MS&C)	High	High	High

FDWS-C6: Effectiveness (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C6 - Building Characteristics (MS&C)	Low	Low	Low
	FDWS-C6 - Equipment Characteristics (MS&C)	High	High	High
	FIDC-A1: Fire Size/HRR (ROO)	High	High	High
	FDWS-C6 - Method Verification and Validation (MS&C)	High	High	High

ADDITIONAL LOGIC AND OUTPUTS

FDWS-C - Manual Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C1: Timing of Manual Detection (MS&C)	Low	Low	Low
	FDWS-C2: Reliability and Availability of Manual Detection (MS&C)	Low	Low	Low

FDWS-C - Automatic Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C3: Timing of Automatic Detection (MS&C)	Low	Low	Low
	FDWS-C4: Reliability and Availability of Automatic Detection (MS&C)	Low	Low	Low

FDWS-C - Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C - Manual Detection	Low	Low	Low
	FDWS-C - Automatic Detection	High	High	High

HLR-FDWS-C: Manual Suppression and Control (MS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-C - Detection	Medium	Medium	Medium
	FDWS-C5: Reliability and Availability (MS&C)	Low	Low	Low
	FDWS-C6: Effectiveness (MS&C)	Medium	Medium	Medium

Supporting Requirements for HLR-FDWS-D: Automatic Suppression and Control (AS&C)

FDWS-D1: Timing of Manual Detection (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D1 - Building Characteristics (AS&C)	Medium	N/A	Medium
	FDWS-D1 - Occupant Characteristics (AS&C)	High	N/A	High
	FDWS-D1 - Ventilation Conditions (AS&C)	Medium	N/A	Medium
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Low	N/A	Low
	SDSC-A2: Smoke Layer Interface Height (ROO)	High	N/A	High
	SDSC-A4: Smoke Optical Density (ROO)	High	N/A	High
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	N/A	Low
	FDWS-D1 - Method Verification and Validation (AS&C)	High	N/A	High

FDWS-D2: Reliability and Availability of Manual Detection (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D2 - Building Characteristics (AS&C)	Low	N/A	Low
	FDWS-D2 - Occupant Characteristics (AS&C)	High	N/A	High
	FDWS-D2 - Method Verification and Validation (AS&C)	High	N/A	High

FDWS-D3: Timing of Automatic Detection (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D3 - Building Characteristics (AS&C)	Low	N/A	Low
	FDWS-D3 - Detector Characteristics (AS&C)	Medium	N/A	Medium
	FDWS-D3 - Ventilation Conditions (AS&C)	Low	N/A	Low
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	Medium	N/A	Medium
	FDWS-D3 - Method Verification and Validation (AS&C)	Medium	N/A	Medium

FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D4 - Building Characteristics (AS&C)	Low	N/A	Low
	FDWS-D4 - System Design and Maintenance (AS&C)	High	N/A	High
	FDWS-D4 - Method Verification and Validation (AS&C)	High	N/A	High

FDWS-D5: System Reliability and Availability (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D5 - Building Characteristics (AS&C)	Low	N/A	Low
	FDWS-D5 - System Design and Maintenance (AS&C)	High	N/A	High
	FDWS-D5 - Method Verification and Validation (AS&C)	High	N/A	High

FDWS-D6: System Effectiveness (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D6 - Building Characteristics (AS&C)	Low	N/A	Low
	FDWS-D6 - System Characteristics (AS&C)	High	N/A	High
	FIDC-A1: Fire Size/HRR (ROO)	High	N/A	High
	FDWS-D6 - Method Verification and Validation (AS&C)	High	N/A	High

ADDITIONAL LOGIC AND OUTPUTS

FDWS-D - Manual Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D1: Timing of Manual Detection (AS&C)	Low	N/A	Low
	FDWS-D2: Reliability and Availability of Manual Detection (AS&C)	Low	N/A	Low

FDWS-D - Automatic Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D3: Timing of Automatic Detection (AS&C)	Low	N/A	Low
	FDWS-D4: Reliability and Availability of Automatic Detection (AS&C)	Low	N/A	Low

FDWS-D - Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D - Manual Detection	Low	N/A	Low
	FDWS-D - Automatic Detection	High	N/A	High

HLR-FDWS-D: Automatic Suppression and Control (AS&C)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-D - Detection	Low	N/A	Low
	FDWS-D5: System Reliability and Availability (AS&C)	Medium	N/A	Medium
	FDWS-D6: System Effectiveness (AS&C)	Medium	N/A	Medium

Supporting Requirements for HLR-FDWS-E: Detection and Activation for Active Fire Barriers (DA-AFB)

FDWS-E1: Timing of Manual Detection (DA-AFB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E1 - Building Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E1 - Occupant Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E1 - Ventilation Conditions (DA-AFB)	N/A	N/A	N/A
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A2: Smoke Layer Interface Height (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	N/A	N/A	N/A
	SDSC-A6: Radiation from Smoke Layer (ROO)	N/A	N/A	N/A
	FDWS-E1 - Method Verification and Validation (DA-AFB)	N/A	N/A	N/A

FDWS-E2: Reliability and	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

Availability of Manual Detection (DA-AFB)				
	FDWS-E2 - Building Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E2 - Occupant Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E2 - Method Verification and Validation (DA-AFB)	N/A	N/A	N/A

FDWS-E3: Timing of Automatic Detection (DA-AFB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E3 - Building Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E3 - Detector Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E3 - Ventilation Conditions (DA-AFB)	N/A	N/A	N/A
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	N/A	N/A	N/A
	FDWS-E3 - Method Verification and Validation (DA-AFB)	N/A	N/A	N/A

FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E4 - Building Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E4 - System Design and Maintenance (DA-AFB)	N/A	N/A	N/A
	FDWS-E4 - Method Verification and Validation (DA-AFB)	N/A	N/A	N/A

FDWS-E5: System Reliability and Availability (DA-AFB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E5 - Building Characteristics (DA-AFB)	N/A	N/A	N/A
	FDWS-E5 - System Design and Maintenance (DA-AFB)	N/A	N/A	N/A
	FDWS-E5 - Method Verification and Validation (DA-AFB)	N/A	N/A	N/A

ADDITIONAL LOGIC AND OUTPUTS

FDWS-E - Manual Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E1: Timing of Manual Detection (DA-AFB)	N/A	N/A	N/A
	FDWS-E2: Reliability and Availability of Manual Detection (DA-AFB)	N/A	N/A	N/A

FDWS-E - Automatic Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E3: Timing of Automatic Detection (DA-AFB)	N/A	N/A	N/A
	FDWS-E4: Reliability and Availability of Automatic Detection (DA-AFB)	N/A	N/A	N/A

FDWS-E - Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E - Manual Detection	N/A	N/A	N/A
	FDWS-E - Automatic Detection	N/A	N/A	N/A

Supporting Requirements for HLR-FDWS-F: Detection and Activation for Active Smoke Barriers (DA-ASB)

FDWS-F1: Timing of Manual Detection (DA-ASB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F1 - Building Characteristics (DA-ASB)	N/A	N/A	Medium
	FDWS-F1 - Occupant Characteristics (DA-ASB)	N/A	N/A	High
	FDWS-F1 - Ventilation Conditions (DA-ASB)	N/A	N/A	Medium

	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	Low
	SDSC-A2: Smoke Layer Interface Height (ROO)	N/A	N/A	High
	SDSC-A4: Smoke Optical Density (ROO)	N/A	N/A	High
	SDSC-A6: Radiation from Smoke Layer (ROO)	N/A	N/A	Low
	FDWS-F1 - Method Verification and Validation (DA-ASB)	N/A	N/A	High

FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F2 - Building Characteristics (DA-ASB)	N/A	N/A	Low
	FDWS-F2 - Occupant Characteristics (DA-ASB)	N/A	N/A	High
	FDWS-F2 - Method Verification and Validation (DA-ASB)	N/A	N/A	High

FDWS-F3: Timing of Automatic Detection (DA-ASB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F3 - Building Characteristics (DA-ASB)	N/A	N/A	Low
	FDWS-F3 - Detector Characteristics (DA-ASB)	N/A	N/A	Medium
	FDWS-F3 - Ventilation Conditions (DA-ASB)	N/A	N/A	Low
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	N/A	N/A	Medium
	FDWS-F3 - Method Verification and Validation (DA-ASB)	N/A	N/A	Medium

FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F4 - Building Characteristics (DA-ASB)	N/A	N/A	Low
	FDWS-F4 - System Design and Maintenance (DA-ASB)	N/A	N/A	High
	FDWS-F4 - Method Verification and Validation (DA-ASB)	N/A	N/A	High

FDWS-F5: System Reliability and Availability (DA-ASB)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F5 - Building Characteristics (DA-ASB)	N/A	N/A	Low
	FDWS-F5 - System Design and Maintenance (DA-ASB)	N/A	N/A	High
	FDWS-F5 - Method Verification and Validation (DA-ASB)	N/A	N/A	High

ADDITIONAL LOGIC AND OUTPUTS

FDWS-F - Manual Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F1: Timing of Manual Detection (DA-ASB)	N/A	N/A	Low
	FDWS-F2: Reliability and Availability of Manual Detection (DA-ASB)	N/A	N/A	Low

FDWS-F - Automatic Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F3: Timing of Automatic Detection (DA-ASB)	N/A	N/A	Low
	FDWS-F4: Reliability and Availability of Automatic Detection (DA-ASB)	N/A	N/A	Low

FDWS-F - Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-F - Manual Detection	N/A	N/A	Low
	FDWS-F - Automatic Detection	N/A	N/A	High

Supporting Requirements for HLR-FDWS-G: Detection and Activation for Smoke Control and Management (DA-SC&M)				
FDWS-G1: Timing of Manual Detection (DA-SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G1 - Building Characteristics (DA-SC&M)	N/A	Medium	Medium
	FDWS-G1 - Occupant Characteristics (DA-SC&M)	N/A	High	High
	FDWS-G1 - Ventilation Conditions (DA-SC&M)	N/A	Medium	Medium
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	Low	Low
	SDSC-A2: Smoke Layer Interface Height (ROO)	N/A	High	High
	SDSC-A4: Smoke Optical Density (ROO)	N/A	High	High
	SDSC-A6: Radiation from Smoke Layer (ROO)	N/A	Low	Low
	FDWS-G1 - Method Verification and Validation (DA-SC&M)	N/A	High	High

FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G2 - Building Characteristics (DA-SC&M)	N/A	Low	Low
	FDWS-G2 - Occupant Characteristics (DA-SC&M)	N/A	High	High
	FDWS-G2 - Method Verification and Validation (DA-SC&M)	N/A	High	High

FDWS-G3: Timing of Automatic Detection (DA-SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G3 - Building Characteristics (DA-SC&M)	N/A	Low	Low
	FDWS-G3 - Detector Characteristics (DA-SC&M)	N/A	Medium	Medium
	FDWS-G3 - Ventilation Conditions (DA-SC&M)	N/A	Low	Low
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	N/A	N/A	N/A
	SDSC-A3: Smoke Temperature (ROO)	N/A	N/A	N/A
	SDSC-A4: Smoke Optical Density (ROO)	N/A	Medium	Medium
	FDWS-G3 - Method Verification and Validation (DA-SC&M)	N/A	Medium	Medium

FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G4 - Building Characteristics (DA-SC&M)	N/A	Low	Low
	FDWS-G4 - System Design and Maintenance (DA-SC&M)	N/A	High	High
	FDWS-G4 - Method Verification and Validation (DA-SC&M)	N/A	High	High

FDWS-G5: System Reliability and Availability (DA-SC&M)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G5 - Building Characteristics (DA-SC&M)	N/A	Low	Low
	FDWS-G5 - System Design and Maintenance (DA-SC&M)	N/A	High	High
	FDWS-G5 - Method Verification and Validation (DA-SC&M)	N/A	High	High

ADDITIONAL LOGIC AND OUTPUTS				
FDWS-G - Manual Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G1: Timing of Manual Detection (DA-SC&M)	N/A	Low	Low
	FDWS-G2: Reliability and Availability of Manual Detection (DA-SC&M)	N/A	Low	Low

FDWS-G - Automatic Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight

	FDWS-G3: Timing of Automatic Detection (DA-SC&M)	N/A	Low	Low
	FDWS-G4: Reliability and Availability of Automatic Detection (DA-SC&M)	N/A	Low	Low

FDWS-G - Detection	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-G - Manual Detection	N/A	Low	Low
	FDWS-G - Automatic Detection	N/A	High	High

ADDITIONAL LOGIC AND OUTPUTS

FDWS: Modeling Uncertanty (MU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A7: Modeling Uncertainty (MNS)	Low	Low	Low
	FDWS-B7: Modeling Uncertainty (ANS)	High	High	High
	FDWS-C7: Modeling Uncertainty (MS&C)	Low	Low	Low
	FDWS-D7: Modeling Uncertainty (AS&C)	High	N/A	High
	FDWS-E6: Modeling Uncertainty (DA-AFB)	N/A	N/A	N/A
	FDWS-F6: Modeling Uncertainty (DA-ASB)	N/A	N/A	High
	FDWS-G6: Modeling Uncertainty (DA-SC&M)	N/A	High	High

FDWS: Parametric Uncertanty (PU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A8: Parametric Uncertainty (MNS)	Low	Low	Low
	FDWS-B8: Parametric Uncertainty (ANS)	High	High	High
	FDWS-C8: Parametric Uncertainty (MS&C)	Low	Low	Low
	FDWS-D8: Parametric Uncertainty (AS&C)	High	N/A	High
	FDWS-E7: Parametric Uncertainty (DA-AFB)	N/A	N/A	N/A
	FDWS-F7: Parametric Uncertainty (DA-ASB)	N/A	N/A	High
	FDWS-G7: Parametric Uncertainty (DA-SC&M)	N/A	High	High

Fire Spread, Impact and Control (FSIC)

FIRE SPREAD, IMPACT AND CONTROL (FSIC)

High-Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)
HLR-FSIC-B	Fire Barrier Failure (FBF)

Supporting Requirements for HLR-FSIC-A: Internal Fire Spread through Openings (IFSTO)		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
FSIC-A1: Internal Fire Spread through Openings (IFS)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Fire Spread through Openings	Low-Medium	Low-Medium	Low-Medium
	Impact of MOD Fire and Smoke Development on Fire Spread through Openings	Low	Low-Medium	Low
	Impact of FO Fire and Smoke Development on Fire Spread through Openings	Low	Low	Low
	FSIC-A1 - Building Characteristics (IFS)	High	High	High
	FSIC-A1 - Method Verification and Validation (IFS)	High	High	High

Supporting Requirements for HLR-FSIC-B: Fire Barrier Failure (FBF)				
FSIC-B1: Active Fire Barrier Effectiveness (FBF)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Fire Barriers	N/A	N/A	N/A
	Impact of MOD Fire and Smoke Development on Fire Barriers	N/A	N/A	N/A
	Impact of FO Fire and Smoke Development on Fire Barriers	N/A	N/A	N/A
	FSIC-B1 - Barrier Characteristics (FBF)	N/A	N/A	N/A
	FSIC-B1 - Building Characteristics (FBF)	N/A	N/A	N/A
	FSIC-B1 - Method Verification and Validation (FBF)	N/A	N/A	N/A

FSIC-B2: Passive Fire Barrier Effectiveness (FBF)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	Impact of ROO Fire and Smoke Development on Fire Barriers	Low-Medium	Low-Medium	Low-Medium
	Impact of MOD Fire and Smoke Development on Fire Barriers	Low	Low-Medium	Low
	Impact of FO Fire and Smoke Development on Fire Barriers	Low	Low	Low
	FSIC-B2 - Barrier Characteristics (FBF)	Low	Low	Low
	FSIC-B2 - Building Characteristics (FBF)	Low	Low	Low
	FSIC-B2 - Method Verification and Validation (FBF)	High	High	High

ADDITIONAL LOGIC AND OUTPUTS

Impact of ROO Fire and Smoke Development on Fire Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Medium-High	Medium-High	Medium-High
	SDSC-A3: Smoke Temperature (ROO)	Low	Low	Low
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low

Impact of MOD Fire and Smoke Development on Fire Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	Low	Medium-High	Low
	SDSC-B3: Smoke Temperature (MOD)	Low	Low	Low
	SDSC-B6: Radiation from Smoke Layer (MOD)	Low	Low	Low

Impact of FO Fire and Smoke Development on Fire Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	Low-Medium	Low-Medium	Low-Medium
	SDSC-C3: Smoke Temperature (FO)	Low	Low	Low
	SDSC-C6: Radiation from Smoke Layer (FO)	Low	Low	Low

Impact of ROO Fire and Smoke Development on Fire Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Medium-High	Medium-High	Medium-High
	SDSC-A3: Smoke Temperature (ROO)	Low	Low	Low
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low	Low

Impact of MOD Fire and Smoke Development on Fire Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	Low	Medium-High	Low
	SDSC-B3: Smoke Temperature (MOD)	Low	Low	Low
	SDSC-B6: Radiation from Smoke Layer (MOD)	Low	Low	Low

Impact of FO Fire and Smoke Development on Fire Spread through Openings	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	Low-Medium	Low-Medium	Low-Medium
	SDSC-C3: Smoke Temperature (FO)	Low	Low	Low
	SDSC-C6: Radiation from Smoke Layer (FO)	Low	Low	Low

FSIC-B - Active Fire Barriers	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-E - Detection	N/A	N/A	N/A
	FDWS-E5: System Reliability and Availability (DA-AFB)	N/A	N/A	N/A
	FSIC-B1: Active Fire Barrier Effectiveness (FBF)	N/A	N/A	N/A

FSIC - Fire Spread	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FSIC-A1: Internal Fire Spread through Openings (IFS)	Low	Low	Low
	FSIC-B - Active Fire Barriers	N/A	N/A	N/A
	FSIC-B2: Passive Fire Barrier Effectiveness (FBF)	Low	Low	Low

ADDITIONAL LOGIC AND OUTPUTS

FSIC: Modeling Uncertanty (MU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FSIC-A2: Modeling Uncertainty (IFS)	Low	Low	Low
	FSIC-B3: Modeling Uncertainty (FBF)	Low	Low	Low

FSIC: Parametric Uncertanty (PU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FSIC-A3: Parametric Uncertainty (IFS)	Low	Low	Low
	FSIC-B4: Parametric Uncertainty (FBF)	Low	Low	Low

Occupant Evacuation and Control (OEC)

OCCUPANT EVACUATION AND CONTROL (OEC)

High-Level Requirements for Occupant Evacuation and Control (OEC)	
Designator	**Requirement**
HLR-OEC-A	Available Safe Egress Time (ASET)
HLR-OEC-B	Required Safe Egress Time (RSET)
HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)

Supporting Requirements for HLR-OEC-A: Available Safe Egress Time (ASET)		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
OEC-A1: Establishment and Integration of ASET Criteria (ASET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-A1 - Smoke Layer Interface Height (ASET)	Medium-High	Medium-High	Medium
	OEC-A1 - Smoke Obscuration (ASET)	Medium-High	Medium-High	Medium
	OEC-A1 - Toxicity (ASET)	Medium-High	Medium-High	Medium
	OEC-A1 - Thermal Effects (ASET)	Low	Low	Low
	OEC-A1 - Tenability Criteria Selection (ASET)	Low-Medium	Low-Medium	Low-Medium
	OEC-A1 - Method Verification and Validation (ASET)	Low-Medium	Low-Medium	Low-Medium

ADDITIONAL LOGIC AND OUTPUTS				
OEC-A1 - Smoke Layer Interface Height (ASET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A2: Smoke Layer Interface Height (ROO)	Low	Low	Low
	SDSC-B2: Smoke Layer Interface Height (MOD)	High	High	High
	SDSC-C2: Smoke Layer Interface Height (FO)	Low	Low	Low
	SDSC-D3: Smoke Layer Interface Height (EXROO)	Low	Medium-High	Low

OEC-A1 - Smoke Obscuration (ASET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A4: Smoke Optical Density (ROO)	Low	Low	Low
	SDSC-B4: Smoke Optical Density (MOD)	High	High	High
	SDSC-C4: Smoke Optical Density (FO)	Low	Low	Low
	SDSC-D5: Smoke Optical Density (EXROO)	Low	Medium-High	Low

OEC-A1 - Toxicity (ASET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A5: Smoke Concentration (ROO)	Low	Low	Low
	SDSC-B5: Smoke Concentration (MOD)	High	High	High
	SDSC-C5: Smoke Concentration (FO)	Low	Low	Low
	SDSC-D5: Smoke Optical Density (EXROO)	Low	Medium-High	Low

OEC-A1 - Thermal Effects (ASET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	SDSC-A6: Radiation from Smoke Layer (ROO)	Low	Low-Medium	Low
	FIDC-A5: Flame Height, Temperature and Radiation (ROO)	Low	High	Low
	SDSC-B6: Radiation from Smoke Layer (MOD)	High	High	High
	FIDC-B5: Flame Height, Temperature and Radiation (MOD)	Low	Medium-High	Low
	SDSC-C6: Radiation from Smoke Layer (FO)	Low	Low-Medium	Low
	FIDC-C5: Flame Height, Temperature and Radiation (FO)	Low	Low	Low
	SDSC-D7: Radiation from Smoke Layer (EXROO)	Medium	High	Low-Medium
	FIDC-D5: Flame Height, Temperature and Radiation (EXROO)	Medium	Medium-High	Low-Medium

Supporting Requirements for HLR-OEC-B: Required Safe Egress Time (RSET)

OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-A - Detection (MNS)	Low	Low	Low
	FDWS-A5: Reliability and Availability (MNS)	Low	Low	Low
	FDWS-B - Detection (ANS)	High	High	High
	FDWS-B5: Reliability and Availability (ANS)	High	High	High
	OEC-B1 - Integration of Cues (RSET)	High	High	High
	OEC-B1 - Method Verification and Validation (RSET)	High	High	High

OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	FDWS-B6: Effectiveness (ANS)	Low	Low	Low
	FDWS-A6: Effectiveness (MNS)	High	High	High
	OEC-B2 - Building Characteristics (RSET)	Low	Low	Low
	OEC-B2 - Occupant Characteristics (RSET)	Medium	Medium	Medium
	OEC-B2 - Method Verification and Validation (RSET)	High	High	High

OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-B3 - Building Characteristics (RSET)	Low	Low	Low
	OEC-B3 - Occupant Characteristics (RSET)	High	High	High
	OEC-B3 - Method Verification and Validation (RSET)	High	High	High

OEC-B4: Movement Timing - Completion of Movement (RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-B3 - Building Characteristics (RSET)	Medium	Medium	Medium
	OEC-B3 - Occupant Characteristics (RSET)	High	High	High

	OEC-B3 - Method Verification and Validation (RSET)	Medium	Medium	Medium

OEC-B5: Integration of ASET Criteria (RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-B1: Detection Phase Timing - Occurrence of Cues (RSET)	Medium	Medium	Medium
	OEC-B2: Pre-Movement Phase Timing - Recognition of Cues (RSET)	Low	Low	Low
	OEC-B3: Pre-Movement Phase Timing - Initiation of Movement (RSET)	Low	Low	Low
	OEC-B4: Movement Timing - Completion of Movement (RSET)	Medium	Medium	Medium
	OEC-A1 - Method Verification and Validation (ASET)	Medium	Medium	Medium

Supporting Requirements for HLR-OEC-C: Integration of ASET/RSET Criteria (ASET/RSET)

OEC-C1: Integration of ASET/RSET Criteria (ASET/RSET)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-A1: Establishment and Integration of ASET Criteria (ASET)	Medium	Medium	Medium
	OEC-B5: Integration of ASET Criteria (RSET)	Low	Low	Low
	OEC-C1 - Method Verification and Validation (ASET)	Medium	Medium	Medium

ADDITIONAL LOGIC AND OUTPUTS

OEC: Modeling Uncertanty (MU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-A2: Modeling Uncertainty (ASET)	Low	Low	Low
	OEC-B6: Modeling Uncertainty (RSET)	Low	Low	Low
	OEC-C2: Modeling Uncertainty (ASET/RSET)	Low	Low	Low

OEC: Parametric Uncertanty (PU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	OEC-A3: Parametric Uncertainty (ASET)	Low	Low	Low
	OEC-B7: Parametric Uncertainty (RSET)	Low	Low	Low
	OEC-C3: Parametric Uncertainty (ASET/RSET)	Low	Low	Low

Fire Scenario Development (FSD)

FIRE SCENARIO DEVELOPMENT (FSD)

High-Level Requirements for Fire Scenario Development (FSD)	
Designator	**Requirement**
HLR-FSD-A	Fire Hazards (FH)
HLR-FSD-B	Potential Fire Scenarios (PFS)
HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)

Supporting Requirements for HLR-FSD-A: Fire Hazards (FH)		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
FSD-A1: Fire Hazard Analysis (FH)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FSD-A1 - General Layout (FH)	Low	Low	Low
	FSD-A1 - Activities (FH)	Low	Low	Low
	FSD-A1 - Ignition Sources (FH)	Low	Low	Low
	FSD-A1 - Fuel Sources (FH)	Low	Low	Low
	FSD-A1 - Method Verification and Validation (ASET)	Medium	Medium	Medium

Supporting Requirements for HLR-FSD-B: Potential Fire Scenarios (PFS)				
FSD-B1: Potential Fire Scenarios (PFS)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FSD-B1 - Combustibles (PFS)	Low	Low	Low
	FSD-B1 - Enclosures (PFS)	Low	Low	Low
	FSD-B1 - Fire Proection Measures (PFS)	Low	Low	Low
	FSD-B1 - Ventilation Changes (PFS)	Low	Low	Low
	FSD-B1 - Method Verification and Validation (PFS)	Medium	Medium	Medium

Supporting Requirements for HLR-FSD-C: Design Fire Scenarios for Analysis (DFSA)				
FSD-C1: Design Fire Scenarios for Analysis (DFSA)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FSD-C1 - Frequency (DFSA)	Low	Low	Low
	FSD-C1 - Consequence (DFSA)	Low	Low	Low
	FSD-C1 - Screening (DFSA)	Low	Low	Low
	FSD-C1 - Method Verification and Validation (DFSA)	Medium	Medium	Medium

ADDITIONAL LOGIC AND OUTPUTS				
FSD - Fire Scenario Development	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**

	FSD-A1: Fire Hazard Analysis (FH)	**Low**	**Low**	**Low**
	FSD-B1: Potential Fire Scenarios (PFS)	**Low**	**Low**	**Low**
	FSD-C1: Design Fire Scenarios for Analysis (DFSA)	**Low**	**Low**	**Low**

Analysis and Quantification (AQ)

ANALYSIS AND QUANTIFICATION (AQ)

High-Level Requirements for Fire Spread, Impact and Control (FSIC)	
Designator	**Requirement**
HLR-AQ-A	Quantification Methodology (Q)
HLR-AQ-B	Modeling Uncertainty (MU)
HLR-AQ-C	Parametric Uncertainty (MU)
HLR-AQ-D	Completeness Uncertainty (CU)

		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
Supporting Requirements for HLR-AQ-A: Quantification Methodology (Q)				
AQ-A1: Quantification (Q)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	AQ-A1 - Comparative Approach (Q)	High	High	High
	AQ-A1 - Absolute Approach (Q)	Low	Low	Low
	AQ-A1 - Qualitative Assessments (Q)	Low	Low	Low
	AQ-A1 - Screening (Q)	Low	Low	Low
	AQ-A1 - Method Verification and Validation (Q)	High	High	High

Supporting Requirements for HLR-AQ-B: Modeling Uncertainty (MU)				
AQ-B1: Modeling Uncertainty (MU)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC: Modeling Uncertanty (MU)	Low	Low	Low
	SDSC: Modeling Uncertanty (MU)	Low	Low	Low
	FDWS: Modeling Uncertanty (MU)	Low	Low	Low
	FSIC: Modeling Uncertanty (MU)	Low	Low	Low
	OEC: Modeling Uncertanty (MU)	Low	Low	Low
	FSD-D1: Modeling Uncertainty (MU)	Low	Low	Low
	AQ-A2 - Identification of Key Sources of Uncertainty (MU)	Medium	Medium	Medium
	AQ-A2 - Impact of Key Sources on Life Safety (MU)	Medium	Medium	Medium

Supporting Requirements for HLR-AQ-C: Parametric Uncertainty (MU)				
AQ-C1: Parametric Uncertainty (PU)	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	FIDC: Modeling Uncertanty (MU)	Low	Low	Low
	SDSC: Modeling Uncertanty (MU)	Low	Low	Low
	FDWS: Modeling Uncertanty (MU)	Low	Low	Low
	FSIC: Modeling Uncertanty (MU)	Low	Low	Low
	OEC: Modeling Uncertanty (MU)	Low	Low	Low
	AQ-A2 - Identification of Key Uncertainties (PU)	Medium	Medium	Medium

	AQ-A2 - Impact of Key Uncertainties on Life Safety (PU)	Medium	Medium	Medium

Supporting Requirements for HLR-AQ-D: Completeness Uncertainty (CU)				
AQ-D1: Completeness Uncertainty (CU)	Node Description	Nodal Weight	Nodal Weight	Nodal Weight
	AQ-D1 - Defense in Depth (CU)	Low	Low	Low
	AQ-D1 - Safety Margin (CU)	Low	Low	Low
	AQ-D1 - Method Verification and Validation (CU)	Medium	Medium	Medium

Life Safety

		Fire Safety System 1	Fire Safety System 2	Fire Safety System 3
Supporting Requirements for Baseline Life Safety Metric:				
Life Safety Metric	**Node Description**	**Nodal Weight**	**Nodal Weight**	**Nodal Weight**
	OEC-C1: Integration of ASET/RSET Criteria	**High**	**High**	**High**
	FSD - Fire Scenario Development	**Low**	**Low**	**Low**
	AQ-A1: Quantification (Q)	**Low**	**Low**	**Low**
	AQ-B1: Modeling Uncertainty (MU)	**Low**	**Low**	**Low**
	AQ-C1: Parametric Uncertainty (PU)	**Low**	**Low**	**Low**
	AQ-D1: Completeness Uncertainty (CU)	**Low**	**Low**	**Low**

APPENDIX H

Case Study Fire Safety Network Analysis

H.1. INTRODUCTION

This appendix documents the development of the fire safety network analysis used to demonstrate the proposed decision support framework as part of the case study outlined in Appendix B. The fire safety network and its structure are based upon the design and analysis principals set forth by the International Fire Engineering Guidelines (IFEG) [1]. As defined by the IFEG, a fire safety system represents one or any combination of the methods used in a building to:

- warn people of an emergency;
- provide for safe evacuation;
- restrict the spread of fire; and/or
- control or extinguish a fire.

To assist in the general design and evaluation of a fire safety system, the IFEG consider such a system as being comprised of six possible sub-systems. These sub-systems are summarized below in Figure H.1 and detailed further in Table H.1.

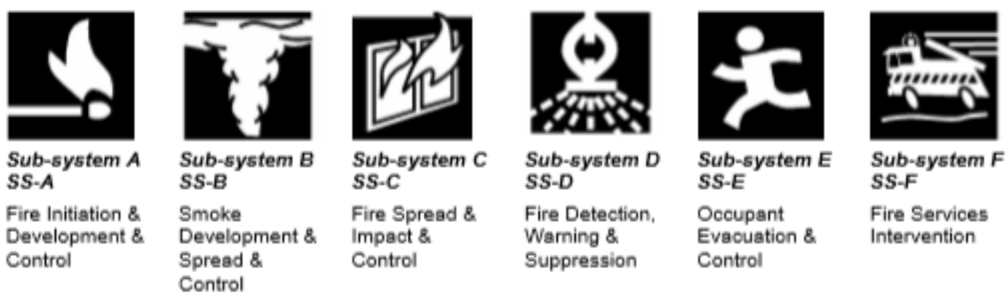


Figure H.1: IFEG Fire Safety Sub-Systems [1]

Within the IFEG, interactions between sub-systems are reflected by the inputs and outputs from one sub-system to another and are demonstrated through a series of flowcharts, repeated, in part, as Figures 3 through 7 below. Not only does this systems-based approach provide a structured fire safety design and analysis process, but it also comprehensively outlines, from ignition to suppression, the physical and analytical relationships between fire phenomena and the characteristics and response of the building systems and occupants. For this reason, the IFEG provide an exceptional foundation upon which to base the fire safety network analysis and subsequently demonstrate the proposed decision support tool.

Table H.1: IFEG Fire Safety Sub-Systems [1]

Sub-System (SS)		Description
A	Fire Initiation, Development and Control	This sub-system relates to design fires in the enclosure of fire origin as well as enclosures to which the fire may subsequently spread and how fire initiation and development might be controlled.
B	Smoke Development, Spread and Control	This sub-system analyzes the development of smoke, its spread within the building, the properties of the smoke at locations of interest and how the development and spread might be controlled.
C	Fire Spread, Impact and Control	This sub-system analyzes the spread of fire beyond an enclosure, the impact a fire might have on the structure and how the spread and impact might be controlled.
D	Fire Detection, Warning and Suppression	This sub-system analyzes detection, warning and suppression for fires. This process enables estimates to be made of the actuation, availability and effectiveness of fire safety systems, including suppression.
E	Occupant Evacuation and Control	This sub-system analyzes the evacuation of the occupants of a building. This process enables estimates to be made of the times required for occupants to reach a place of safety.
F	Fire Services Intervention	This sub-system analyzes the effects of the intervention activities of fire services on a fire including the effectiveness of suppression activities.

Moreover, the IFEG are a product of an international, collaborative effort involving the following organizations:

- National Research Council of Canada;
- International Code Council, United States of America;
- Department of Building and Housing, New Zealand; and
- Australian Building Codes Board.

Other organizations within New Zealand and Australia have endorsed or indicated formal support for the aims of the IFEG as describing an appropriate process for design and approval of fire safety in buildings by competent practitioners. With that said, it should be noted that paradigms other than the IFEG (e.g., [2-6]) do exist and may, if preferred, be used in a similar manner to support the objectives of the proposed decision support tool.

H.2. FIRE SAFETY NETWORK DEVELOPMENT

As described in Section 3.3 of the main report, the fire safety network is formed by the interrelationships between supporting requirements and their associated influencing factors, and it is these interrelationships that seek to inform fire safety design performance goals, such as life safety. To construct the fire safety network based upon the IFEG, the logic associated with each of the sub-systems proposed by the IFEG, namely, the decision gates, inputs and outputs of the IFEG flowcharts shown in Figures 3 through 7 below, must be adapted to the network-based structure illustrated in Figure 6 of the main report.

To do so, the decision gates and associated logic of the IFEG flowcharts were first reformatted into the simplified network shown in Figure H.2. Each IFEG sub-system and associated flowchart was reviewed to identify a corresponding high-level set of technical topics consistent with the case study scope outlined in Section 4.3 of the main report. The logical links between each technical topic were then developed to be consistent with those proposed by the IFEG. With the goal of the case study being the evaluation of the life safety performance goal, the Available Safe Evacuation Time (ASET) and Required Safe Evacuation Time (RSET) end-states of the IFEG flowcharts were applied. As highlighted in Figure H.2, the scope and definition of the IFEG sub-systems were maintained for Sub-Systems A through E. Given that Sub-System F, as defined by the IFEG, was not within the case study scope, this sub-system was, as discussed in Section H.2.6, re-purposed to more explicitly address fire scenario development, analysis and quantification, which are reviewed by the IFEG external to the sub-system flowcharts.

With Figure H.2 serving as a roadmap, the IFEG flowcharts were then examined further to identify, for each sub-system, relevant supporting requirements and influencing factors as well as logical links between them. The process and results for each sub-system are reviewed in the sections that follow. After its construction, the case study fire safety network was lastly compared once more with guidance in the IFEG and its supporting flowcharts to ensure that the developed network was consistent with intent, structure, and physics embedded within the IFEG.

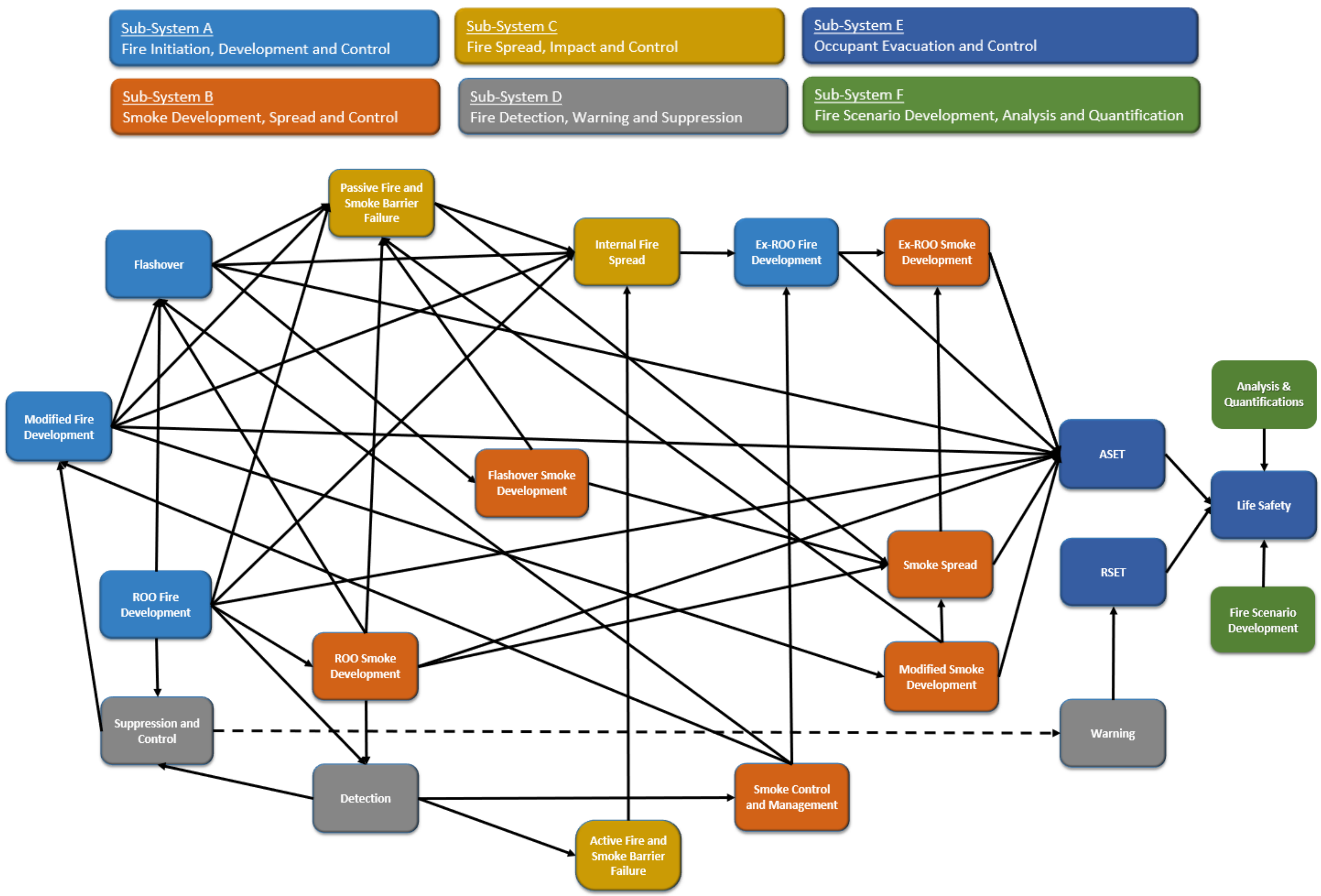


Figure H.2: Simplified Fire Safety Network

H.2.1 Sub-System A: Fire Initiation, Development and Control (FIDC)

According to the IFEG, Sub-System A relates to the analysis of fires within the enclosure of fire origin as well as those enclosures to which the fire may subsequently spread. Additionally, this sub-system addresses how fire initiation and development might be controlled, for example, by activation of fire suppression systems. As shown in Figure H.3, the IFEG flowchart for Sub-System A follows a design fire through multiple stages of its development, addressing its initial growth as well as the consequences of ventilation changes, fire suppression and control, flashover and fuel depletion.

To address each of these stages, the following high-level topics were proposed for the simplified fire safety network shown in Figure H.2: room-of-origin (ROO) fire development, modified fire development, flashover and ex-ROO fire development. In this case, modified fire development addresses the influence of suppression and control as well as ventilation changes occurring as a result of activated smoke control and management systems; ventilation conditions within the room of origin prior to flashover or activation of fire protection features are addressed as part of the ROO fire development. For Sub-System A, the four technical topics, as indicated in Table H.2, represent the high-level requirements that are applied within the proposed decision support tool.

Table H.2: High-Level Requirements for Sub-System A

HLR-FIDC-A	Room of Origin Fire Development (ROO)
HLR-FIDC-B	Modified Fire Development (MOD)
HLR-FIDC-C	Flashover (FO)
HLR-FIDC-D	Beyond Room of Origin Fire Development (EXROO)

The outputs documented for IFEG flowchart for Sub-System A in Figure H.3 serve as inputs to other sub-systems (e.g., Sub-System C, Fire Spread, Impact and Control). For the purpose of developing the fire safety network analysis, these outputs inform the supporting requirements necessary to specify each high-level requirement identified above. A summary of these outputs is provided in Table H.3 below. Within both the fire safety network and IFEG flowcharts, these outputs, through logical links, inform the following:

- smoke development;
- the performance of smoke and fire barriers;
- internal fire spread;
- the time to detection or activation of fire protection features (e.g., suppression and control, smoke control and management, etc.); and
- ASET.

For instance, characteristics of the design fire, including its heat release rate (HRR) and smoke yield, directly influence smoke production and are thus linked accordingly within the IFEG flowcharts and the fire safety network.

Table H.3: Summary of Supporting Requirements for Sub-System A

Fire Size/HRR	Flame Height, Temperature and Radiation
Fire Growth and Flame Spread	Ventilation Conditions
Toxic Species Yield	Smoke Yield
Modeling Uncertainty*	Parametric Uncertainty*

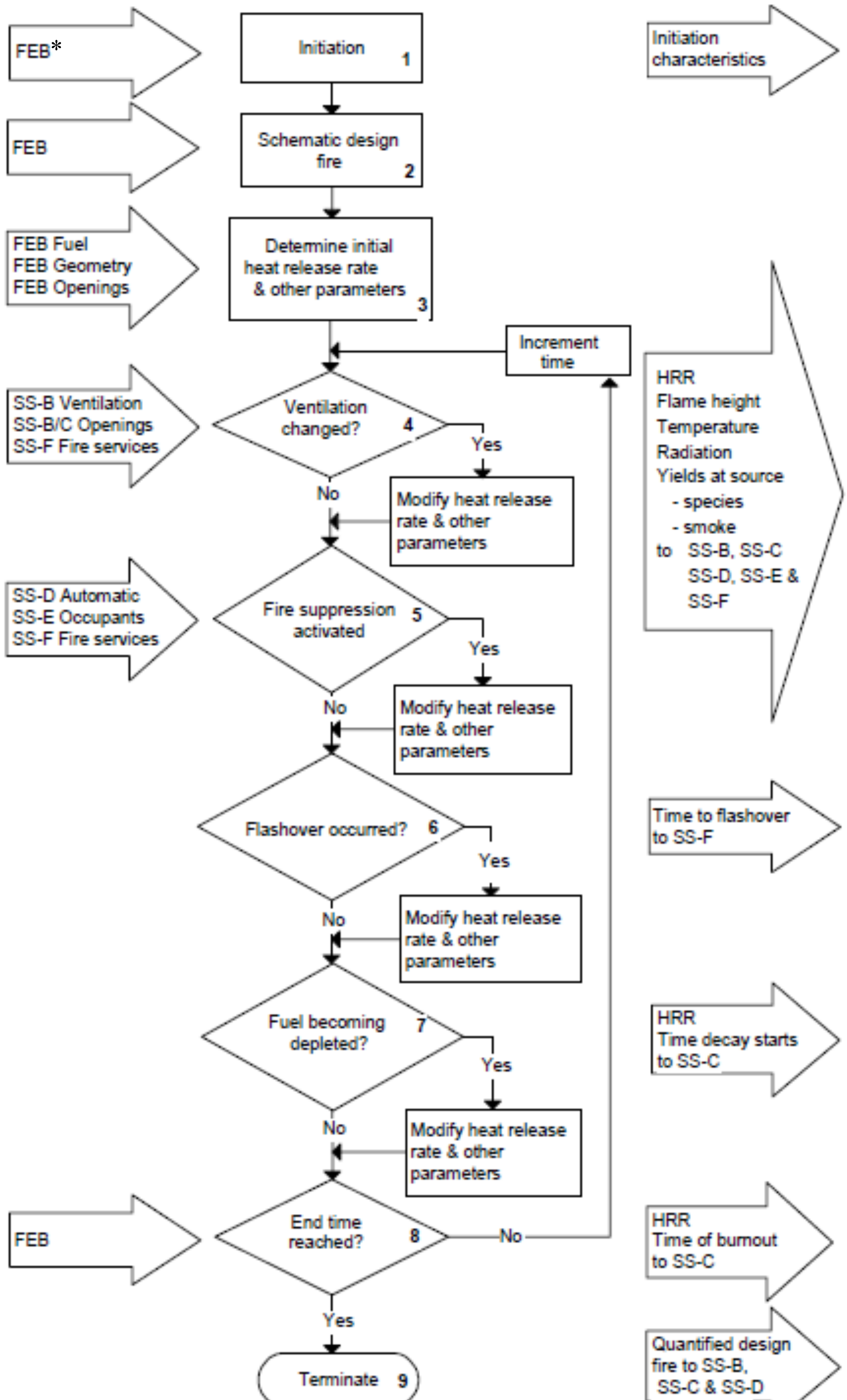
* Modeling and parametric uncertainty are addressed in Section H.2.6.

As shown in Figure H.3, the decision gates documented for IFEG flowchart for Sub-System A are informed by a series of inputs, which may either be outputs from other sub-systems (e.g., Sub-System D, Fire Detection, Warning and Suppression) or data characterizing the building (e.g., fuel and loading characteristics) and/or its occupants. These inputs are represented within the fire safety network as influencing factors to those supporting requirements identified in Table H.3. For instance, the activation, availability and effectiveness of suppression and control, either manual or automatic, associated with Sub-System D (Fire Detection, Warning and Suppression) directly influences whether and to what degree ROO fire development (e.g., Fire Size/HRR) is modified; thus, logical links are established accordingly within the IFEG flowcharts and the fire safety network.

Additionally, in limited cases, outputs from some Sub-System A supporting requirements may serve as inputs to other supporting requirements within Sub-System A. For instance, the "Fire Growth and Flame Spread" supporting requirement is logically linked to the "Fire Size/HRR" supporting requirement. Doing so acknowledges that as the fire grows and spreads, so too does its HRR.

Lastly, note that in some cases, additional logic and outputs beyond identified supporting requirements and their associated influencing factors were required by the fire safety network to better reflect fire development or more accurately model the logic within the IFEG Sub-System A flowchart. For example, in the case of flashover, additional logic and outputs were developed to address the fact that fire conditions within the room of origin (e.g., fire HRR, smoke layer temperature and radiation, etc.) influence the development of flashover conditions, and the supporting requirements representing these conditions were grouped together into single node and logically linked to the relevant flashover supporting requirements.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.



* Fire Engineering Brief (FEB)

Figure H.3: IFEG Flowchart for Sub-System A [1]

H.2.2 Sub-System B: Smoke Development, Spread and Control (SDSC)

According to the IFEG, Sub-System B relates to the analysis of the development and spread of smoke within the building as well as its properties at locations of interest. Additionally, this sub-system addresses how the development and spread might be controlled, for example, by activation of smoke control and management systems. As shown in Figure H.4, the IFEG flowchart for Sub-System B follows the development of smoke and its spread external to the enclosure of fire origin, addressing its production as well as the consequences of ventilation changes, activation of smoke control and management features, and fire conditions.

To address the above, the following high-level topics were proposed for the simplified fire safety network shown in Figure H.2: ROO smoke development, modified smoke development, flashover smoke development, ex-ROO smoke development, smoke spread, and smoke control and management. The four topics (or stages) associated with smoke development are analogous to their fire development counterparts addressed under Sub-System A. For Sub-System B, the six technical topics were adapted into the high-level requirements that are shown in Table H.4. Note that the technical topic of smoke spread was encompassed under ex-ROO smoke development, particularly as a source of smoke external to the ROO alongside that associated with any fire spread external to the ROO. An additional high-level requirement was also added to address smoke barrier failure as a means of smoke spread.

Table H.4: High-Level Requirements for Sub-System B

HLR-SDSC-A	Room of Origin Smoke Development (ROO)
HLR-SDSC-B	Modified Smoke Development (MOD)
HLR-SDSC-C	Flashover Smoke Development (FO)
HLR-SDSC-D	Beyond Room of Origin Smoke Development (EXROO)
HLR-SDSC-E	Smoke Control and Management (SC&M)
HLR-SDSC-F	Smoke Barrier Failure (SBF)

The outputs documented for IFEG flowchart for Sub-System B in Figure H.4 serve as inputs to other sub-systems (e.g., Sub-System E, Occupant Evacuation and Control). For the purpose of developing the fire safety network analysis, these outputs inform the supporting requirements necessary to specify each high-level requirement identified above. A summary of smoke-development-related outputs is provided in Table H.5 below. Other outputs, and therefore supporting requirements, are those related to smoke spread and the effectiveness of active and passive smoke barriers. Within both the fire safety network and IFEG flowcharts, these outputs, through logical links, inform the following:

- flashover;
- the performance of smoke and fire barriers;
- internal fire spread;
- the time to detection or activation of fire protection features (e.g., suppression and control, smoke control and management, etc.); and
- ASET.

For instance, smoke characteristics, including temperature and optical density, directly influence the egress of occupants and are thus linked accordingly within the IFEG flowcharts and the fire safety network. Similarly, the influence of smoke characteristics (e.g., temperature) on the performance of smoke barriers must also be addressed.

Table H.5: Sampling of Supporting Requirements for Sub-System B

Smoke Production	Smoke Layer Interface Height
Smoke Temperature	Smoke Concentration
Radiation from Smoke Layer	Smoke Optical Density
Modeling Uncertainty*	Parametric Uncertainty*

* Modeling and parametric uncertainty are addressed in Section H.2.6.

As shown in Figure H.4, the decision gates documented for IFEG flowchart for Sub-System B are informed by a series of inputs, which may either be outputs from other sub-systems (e.g., Sub-System D, Fire Detection, Warning and Suppression) or data characterizing the building (e.g., room geometry and openings) and/or its occupants. These inputs are represented within the fire safety network as influencing factors to those supporting requirements discussed above. For instance, the activation, availability and effectiveness of smoke barriers, either passive or automatic, may directly influence whether and to what degree smoke spreads external to the ROO;

thus, logical links are established accordingly within the IFEG flowcharts and the fire safety network.

Lastly, note that in some cases, additional logic and outputs beyond identified supporting requirements and their associated influencing factors were required by the fire safety network to better reflect smoke development or more accurately model the logic within the IFEG Sub-System B flowchart. For example, in the case of smoke spread, additional logic and outputs were developed to address the fact that smoke characteristics within the room of origin (e.g., smoke layer temperature and interface height) influence the degree of smoke spread through openings (e.g., doors and balconies), and the supporting requirements representing these characteristics were grouped and logically link to the relevant smoke-spread-related supporting requirements.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.

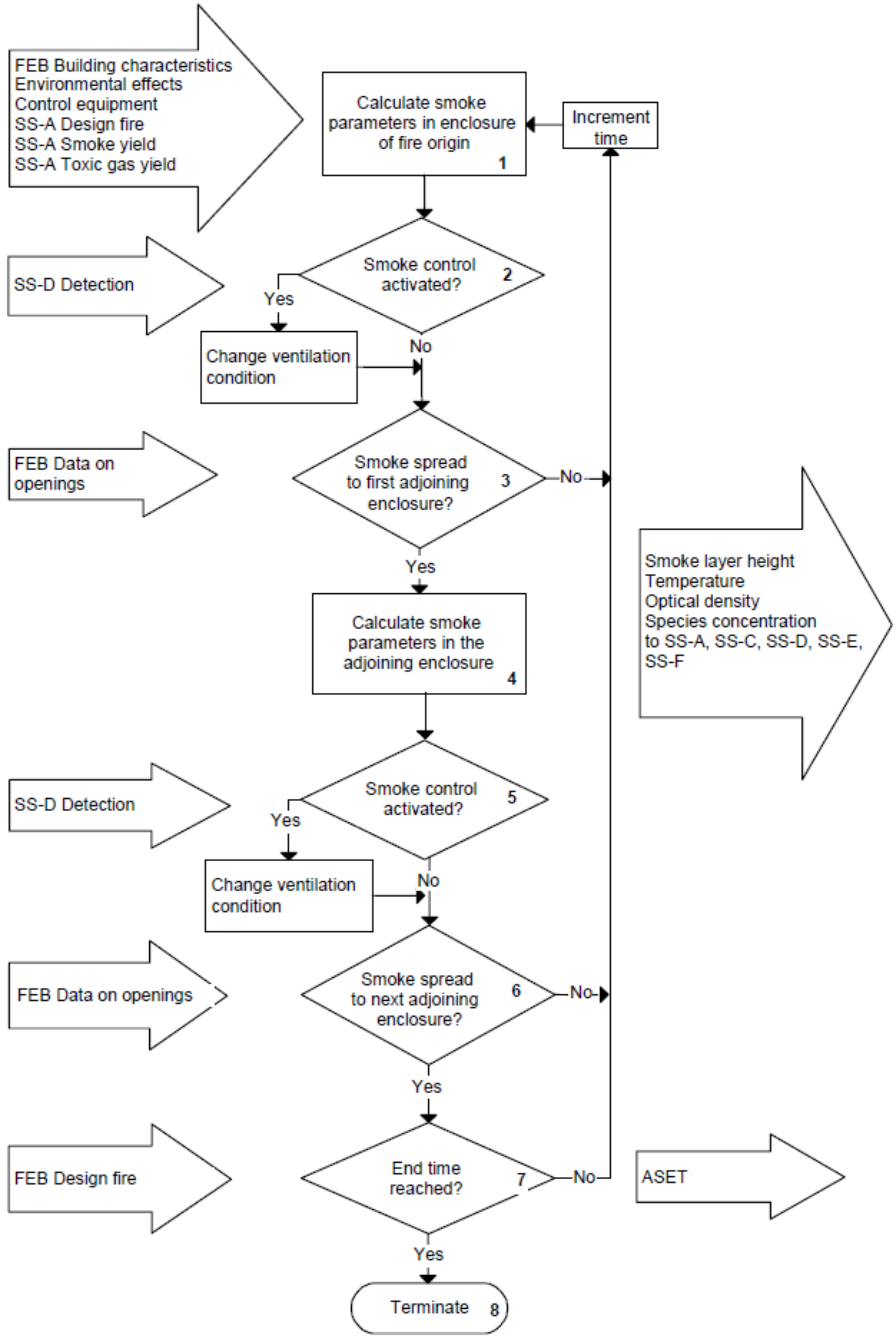


Figure H.4: Flowchart for Sub-System B [1]

H.2.3 Sub-System C: Fire Spread, Impact and Control (FSIC)

According to the IFEG, Sub-System C relates to the analysis of fire spread beyond the room of origin. Additionally, this sub-system addresses how the spread and impact might be controlled, for instance, through the use of active and passive fire barriers. As shown in Figure H.5, the IFEG flowchart for Sub-System C follows the spread of fire external to the enclosure of fire origin through openings, barriers and structural elements, the latter of which, at least from a structural stability standpoint, is not fully within the scope of the proposed decision support tool.

To address the above, in-scope aspects of fire spread, the following high-level topics were proposed for the simplified fire safety network shown in Figure H.2: passive fire and smoke barrier failure, active fire and smoke barrier failure, and fire spread. For Sub-System C, these three technical topics were adapted into the two high-level requirements that are shown in Table H.6. Note that those aspects of technical topics related to smoke barriers are addressed by the analysis of Sub-System H.

Table H.6: High-Level Requirements for Sub-System C

HLR-FSIC-A	Internal Fire Spread through Openings (IFSTO)
HLR-FSIC-B	Fire Barrier Failure (FBF)

The outputs documented for IFEG flowchart for Sub-System C in Figure H.5 serve as inputs to other sub-systems (e.g., Sub-System A, Fire Initiation, Development and Control). For the purpose of developing the fire safety network analysis, these outputs inform the supporting requirements necessary to specify each high-level requirement identified above. These outputs are provided in Table H.7 below. Within both the fire safety network and IFEG flowcharts, these outputs, through logical links, inform fire development, in particular the degree to which it may spread. That is, the presence of openings and the failure of fire barriers directly influences Ex-ROO fire development as they provide by which fire may spread external to the ROO. As a result, these features, i.e., internal fire spread through openings and barrier effectiveness, are linked accordingly within the IFEG flowcharts and the fire safety network.

Table H.7: Supporting Requirements for Sub-System C

Internal Fire Spread through Openings	Active Fire Barrier Effectiveness
Parametric Uncertainty*	Passive Fire Barrier Effectiveness
Modeling Uncertainty*	

* Modeling and parametric uncertainty are addressed in Section H.2.6.

As shown in Figure H.5, the decision gates documented for IFEG flowchart for Sub-System C are informed by a series of inputs, which may either be outputs from other sub-systems (e.g., Sub-System B, Smoke Development, Spread and Control) or data characterizing the building (e.g., barrier characteristics) and/or its occupants. These inputs are represented within the fire safety network as influencing factors to those supporting requirements discussed above. For instance, fire and smoke conditions (e.g., HRR, flame temperature, smoke layer temperature and height, etc.) directly influences the degree to which either fire spreads through openings or fire barriers remain effective; thus, logical links are established accordingly within the IFEG flowcharts and the fire safety network.

Lastly, note that in some cases, additional logic and outputs beyond identified supporting requirements and their associated influencing factors were required by the fire safety network to better reflect fire spread or more accurately model the logic within the IFEG Sub-System C flowchart. For example, additional logic and outputs were developed to address the activation, availability and effectiveness of active fire barriers by linking these to supporting requirements associated with Sub-Systems D, Fire Detection, Warning and Suppression. That is, active fire barriers are dependent upon smoke or fire detection systems to actuate.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.

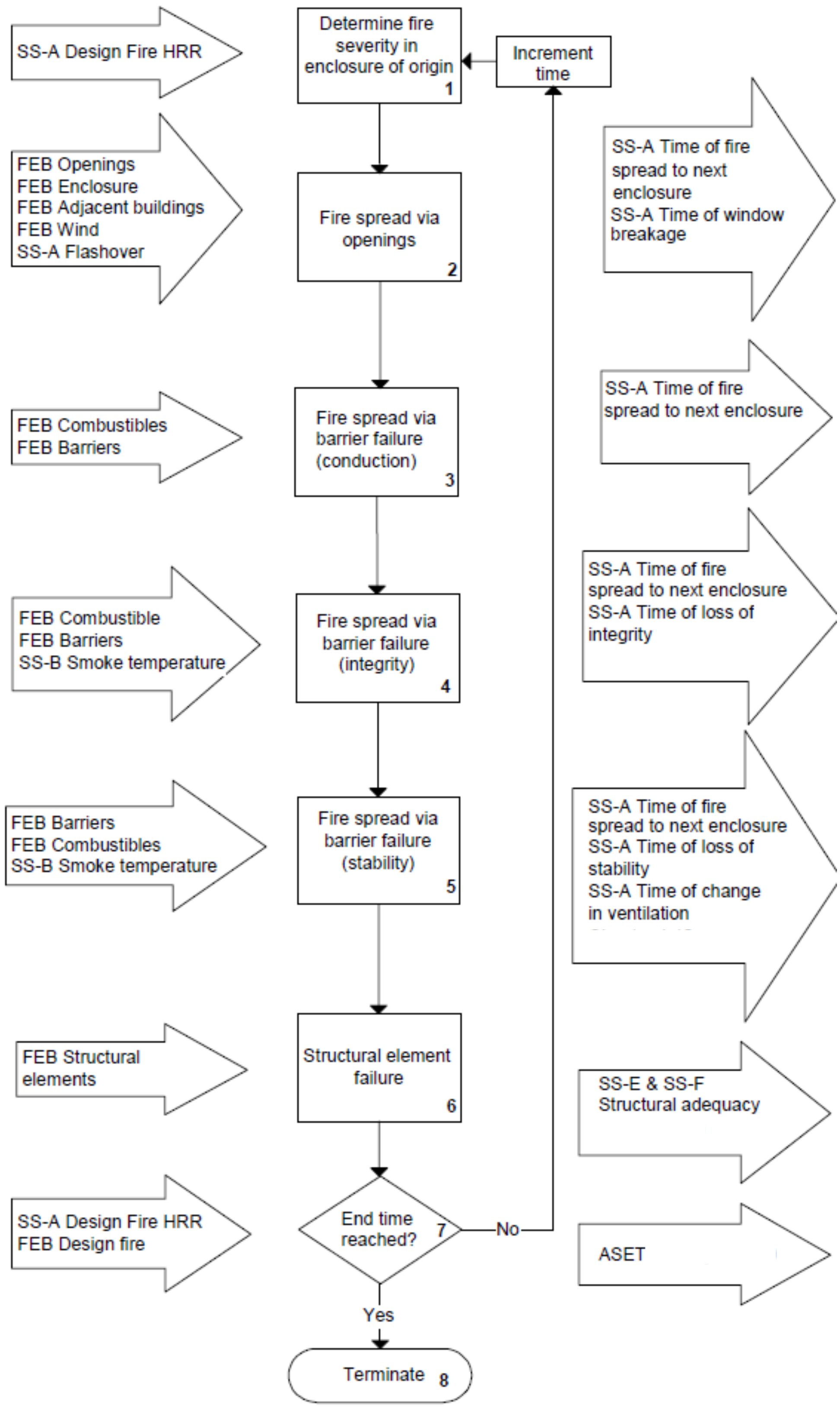


Figure H.5: Flowchart for Sub-System C [1]

H.2.4 Sub-System D: Fire Detection, Warning and Suppression (FDWS)

According to the IFEG, Sub-System D relates to the analysis of installed detection, warning and suppression systems. In particular, this sub-system addresses the actuation, availability and effectiveness of such fire safety systems. As shown in Figure H.6, the IFEG flowchart for Sub-System D evaluates whether local conditions permit both actuation of and an effective response from relevant fire safety features, be they fire suppression/control, smoke control/management or alarm/notification systems.

To address the above, the following high-level topics were, respectively, proposed for the simplified fire safety network shown in Figure H.2: detection, suppression and control, and warning. For Sub-System D, the three technical topics were adapted into the seven high-level requirements that are shown in Table H.8 and reflect the case study's proposed scope.

Table H.8: High-Level Requirements for Sub-System D

HLR-FDWS-A	Manual Notification System (MNS)
HLR-FDWS-B	Automatic Notification System (ANS)
HLR-FDWS-C	Manual Suppression and Control (MS&C)
HLR-FDWS-D	Automatic Suppression and Control (AS&C)
HLR-FDWS-E	Detection and Activation for Active Fire Barriers (DA-AFB)
HLR-FDWS-F	Detection and Activation for Active Smoke Barriers (DA-ASB)
HLR-FDWS-G	Detection and Activation for Smoke Control and Management (DA-SC&M)

The outputs documented for IFEG flowchart for Sub-System D in Figure H.6 serve as inputs to other sub-systems (e.g., Sub-System E, Occupant Evacuation and Control). For the purpose of developing the fire safety network analysis, these outputs inform the supporting requirements necessary to specify each high-level requirement identified above. These outputs are summarized in Table H.9 below. Within both the fire safety network and IFEG flowcharts, these outputs, through logical links, inform the following:

- fire development;

- the time to detection or activation of fire protection features (e.g., suppression and control, smoke control and management, etc.); and
- RSET.

For instance, the time to fire detection and subsequent actuation of alarm and occupant notification systems directly influence the timing of the detection and movement phases associated with occupant egress and are thus linked accordingly within the IFEG flowcharts and the fire safety network.

Table H.9: Supporting Requirements for Sub-System D

Timing of Manual Detection	Reliability and Availability of Manual Detection
Timing of Automatic Detection	Reliability and Availability of Automatic Detection
Reliability and Availability of the Fire Protection Feature	Effectiveness of the Fire Protection Feature
Modeling Uncertainty*	Parametric Uncertainty*

* Modeling and parametric uncertainty are addressed in Section H.2.6.

As shown in Figure H.6, the decision gates documented for IFEG flowchart for Sub-System D are informed by a series of inputs, which may either be outputs from other sub-systems (e.g., Sub-System B, Smoke Development, Spread and Control) or data characterizing the building (e.g., room geometry and openings, detector characteristics, etc.) and/or its occupants. These inputs are represented within the fire safety network as influencing factors to those supporting requirements discussed above. For instance, depending on the means of detection, flame and/or smoke characteristics directly influence whether and how quickly fire protection features are engaged; thus, logical links are established accordingly within the IFEG flowcharts and the fire safety network.

Lastly, note that in some cases, additional logic and outputs beyond identified supporting requirements and their associated influencing factors were required by the fire safety network to better reflect fire protection features or more accurately model the logic within the IFEG Sub-System D flowchart. For example, in the case of automatic suppression and control, additional nodes were added to and linked within the fire safety network to more efficiently integrate the supporting requirements associated with the timing and availability of detection, either manual or automatic, with those representing the automatic suppression and control system's availability and effectiveness. As a result, a single node representing automatic suppression and control was developed, and thus, this node could more easily be mapped as an input to other supporting requirements.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.

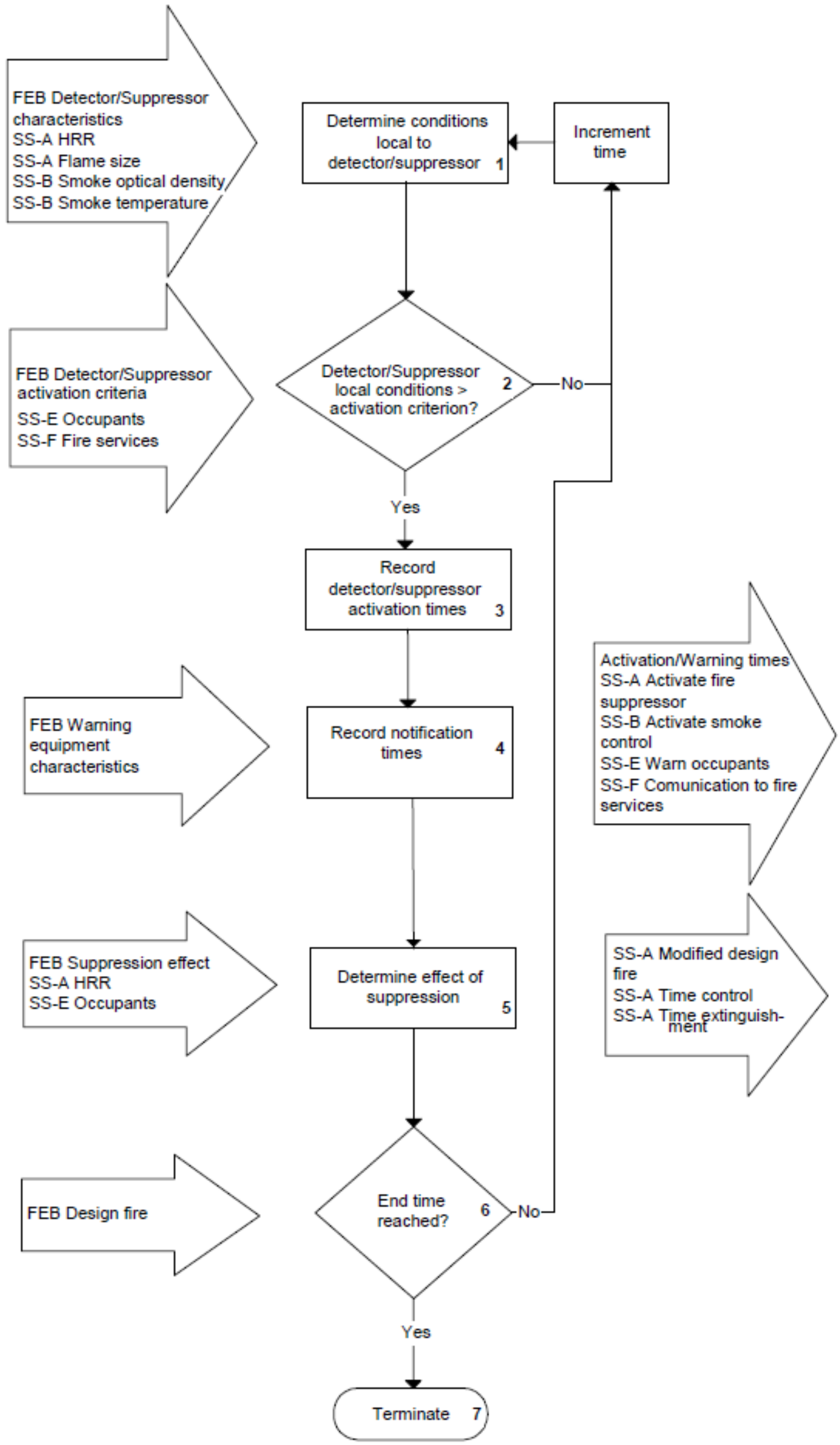


Figure H.6: Flowchart for Sub-System D [1]

H.2.5 Sub-System E: Occupant Evacuation and Control (OEC)

According to the IFEG, Sub-System E relates to the analysis of occupant egress from the building during a fire. As shown in Figure H.6, the IFEG flowchart for Sub-System D not only evaluates the occurrence and recognition of cues but also the initiation and completion of movement.

To address the above, the following high-level topics were proposed for the simplified fire safety network shown in Figure H.2: ASET, RSET, and life safety. For Sub-System E, these three technical topics were adapted into the three high-level requirements that are shown in Table H.10 as well as the life safety performance metric, against which fire safety analyses are to be assessed using the proposed decision support tool.

Table H.10: High-Level Requirements for Sub-System D

HLR-OEC-A	Available Safe Egress Time (ASET)
HLR-OEC-B	Required Safe Egress Time (RSET)
HLR-OEC-C	Integration of ASET/RSET Criteria (ASET/RSET)

The outputs documented for IFEG flowchart for Sub-System E in Figure H.7 serve as input to the final analysis upon which conclusions regarding life safety, among other factors, are drawn. For the purpose of developing the fire safety network analysis, these outputs inform the supporting requirements necessary to specify each high-level requirement identified above. These outputs are summarized in Table H.11 below. For the ASET criteria, the influences of the smoke layer height, smoke obscuration, smoke toxicity, and thermal effects (e.g., flame radiation) are integrated, whereas for the RSET criteria, the influences of the different timing phases of egress are. Once established, ASET and RSET criteria are then linked logically to ultimately inform the network's life safety performance metric.

Table H.11: Supporting Requirements for Sub-System E

Establishment and Integration of ASET Criteria	Detection Phase Timing - Occurrence of Cues (RSET)
Pre-Movement Phase Timing - Recognition of Cues (RSET)	Pre-Movement Phase Timing - Initiation of Movement (RSET)
Movement Timing - Completion of Movement (RSET)	Integration of RSET Criteria (RSET)
Integration of ASET/RSET Criteria	Parametric Uncertainty*
Modeling Uncertainty*	

* Modeling and parametric uncertainty are addressed in Section H.2.6.

As shown in Figure H.7, the decision gates documented for IFEG flowchart for Sub-System E are informed by a series of inputs, which may either be outputs from other sub-systems (e.g., Sub-System B, Smoke Development, Spread and Control) or data characterizing the building (e.g., building geometry, number of exits, etc.) and/or its occupants (e.g., physical capacity, awareness, speed, etc.). These inputs are represented within the fire safety network as influencing factors to those supporting requirements discussed above. For instance, the establishment of ASET criteria is dependent upon the integration and influence of the smoke layer height, smoke obscuration, smoke toxicity, and thermal effects (e.g., flame radiation).

Lastly, note that in some cases, additional logic and outputs beyond identified supporting requirements and their associated influencing factors were required by the fire safety network to better reflect ASET/RSET criteria or more accurately model the logic within the IFEG Sub-System E flowchart. For example, fire and smoke phenomena (e.g., smoke layer height, smoke toxicity, etc.) associated with each stage of fire development (i.e., ROO, modified, flashover and Ex-ROO) were integrated, through logical links, to capture their collective influence on ASET criteria.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.

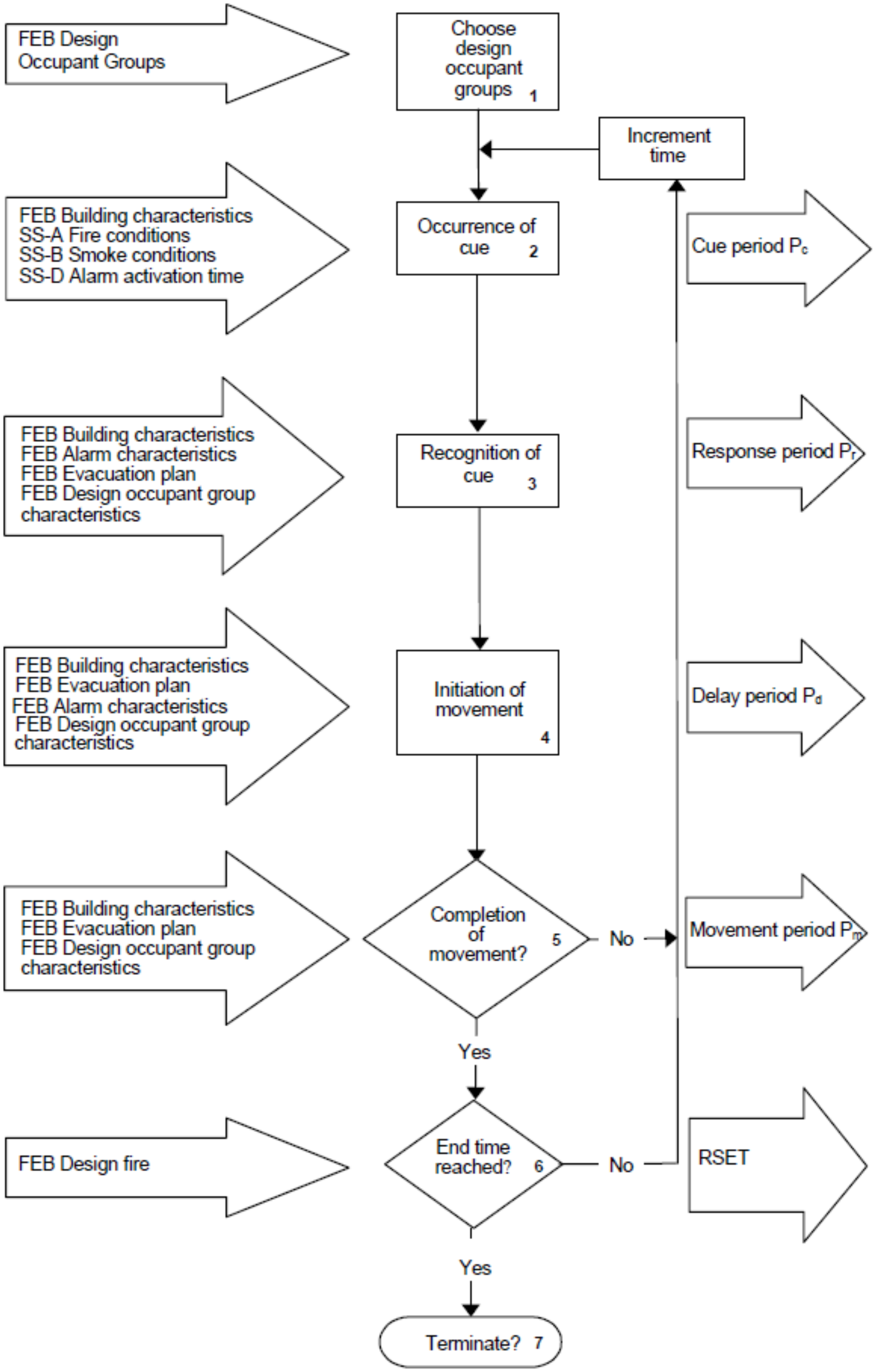


Figure H.7: Flowchart for Sub-System E [1]

H.2.6 Sub-System F: Fire Scenario Development, Analysis and Quantification (FSD)

The IFEG, by establishing a formal process, provide guidance on the scope of work needed for a technically acceptable fire safety analysis. As part of this scope and thus any performance-based design, fire scenarios must be appropriately identified, characterized, and in all but the most exceptional cases, quantified. While the procedures for such are not outlined through process flowcharts like those for fire sub-systems above, they are elaborated in detail in Section 1.2 of the IFEG. Such procedures, however, can equally be adapted into logically linked technical requirements that provide the basis for the fire safety network approach and thus the proposed decision support tool.

The discussion that follows reviews the structure, content and basis of Sub-System F, which serves to address the influence of fire scenario development, analysis and quantification on the fire safety analysis performance goal of life safety. For the purpose of developing the fire safety network analysis, two high-level requirements are derived from the IFEG: Fire Scenario Development as well as Fire Scenario Analysis and Quantification. Because of the importance and nature of fire scenarios within the performance-based design context, these requirements, as shown in Figure H.2, are directly linked to the life safety metric within the fire safety network. Ultimately, regardless of whether fire scenarios are being addressed in a technically adequate manner, the overall technical quality may still be degraded for the scenarios themselves may not be adequate for the conditions at hand (e.g., building and occupant characteristics).

With regard to fire scenario development, three supporting requirements, as outlined in Table H.12, were applied to achieve consistency with guidance in the IFEG. First, to properly identify fire scenarios, a systematic review is needed to establish potential fire hazards, both normal and special, within the occupancy. Additionally, based on the results of this review, potential fire scenarios are to be identified and characterized, yielding a smaller number of design fire scenarios for analysis. Tables H.13, H.14 and H.15 provide the considerations that are to be reflected in a technically acceptable fire safety analysis, and it is these considerations that serve as the influencing factors within the fire safety network.

Table H.12: Supporting Requirements for Fire Scenario Development

HLR-FSD-A	Fire Hazards (FH)
HLR-FSD-B	Potential Fire Scenarios (PFS)
HLR-FSD-C	Design Fire Scenarios for Analysis (DFSA)

Table H.13: Hazard Analysis Considerations

General Layout	Considerations include dead end corridors, unusual egress provisions, location of hazardous materials and processes, and exposures to external radiant sources.
Activities	Considerations include occupant activities characteristic of the occupancy, repair and maintenance, process and construction, and the potential disregard for any safety procedures.
Ignition Sources	Considerations include smoking materials, electrical equipment, heating appliances, and unusual ignition sources.
Fuel Sources	Considerations include the amount of combustible material, location of combustible materials, fire behavior properties, and dangerous goods and explosives.

Table H.14: Considerations for Potential Fire Scenarios

Combustibles	Considerations include the nature, quantity, arrangement and burning behavior of combustibles in each enclosure.
Enclosures	Considerations include their geometry, number and relationship.
Fire Protection Measures	Considerations include the fire protection measures in the building and their effect on the fire.
Ventilation Changes	Considerations include occupant activities, glazing failure, the operation of air handling or smoke management equipment, doors or other partitions burning through, and openings created by fire service intervention.

Table H.15: Considerations for Design Fire Scenarios

Frequency	Considerations include the frequency of ignition for fire scenarios.
Consequence	Considerations include the overall potential severity of fire scenarios.
Screening	Considerations include whether there are some fire scenarios that can be excluded from being considered by the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.

With regard to fire scenario analysis and quantification, four supporting requirements, as outlined in Table H.16, were applied to achieve consistency with guidance in the IFEG. As outlined in Section 1.2.9 of the IFEG, there are alternate methods of scenario quantification that may be used to determine whether a fire safety design meets the acceptance criteria, e.g., with regard to life safety. Such considerations are outlined in Table H.17 and reflect fire safety network influencing factors.

Table H.16: Supporting Requirements for Analysis and Quantification

HLR-AQ-A	Quantification Methodology (Q)
HLR-AQ-B	Modeling Uncertainty (MU)
HLR-AQ-C	Parametric Uncertainty (MU)
HLR-AQ-D	Completeness Uncertainty (CU)

Table H.17: Considerations for Quantification of Fire Scenarios

Comparative Approach	A comparative approach aims to determine whether the alternative solution is equivalent to (or better than) a deemed-to-satisfy or prescriptive design solution.
Absolute Approach	When an evaluation is carried out on an absolute basis, the results of the analysis of the trial design are matched, using the agreed acceptance criteria, against the objectives or performance requirements without comparison to deemed-to-satisfy, prescriptive, or "benchmark" design solutions.
Qualitative Assessments	Qualitative analysis may be sufficient for the consideration of limited non-compliance issues to demonstrate equivalency or to evaluate general adequacy. The quantitative methods will often be supported by additional qualitative arguments.
Screening	This factor evaluates whether there are some fire scenarios, or portions thereof, that can be removed from the fire safety analysis (e.g., to reduce the analysis burden) without altering the overall conclusion that would be achieved had they been included.

In addition to simply quantifying fire scenarios, fire safety analyses, as discussed in Section 1.2.9.5 of the IFEG, require critical assessment of inputs, processes and outputs in order to achieve a high level of confidence in the evaluation outcomes. To provide such confidence, the IFEG recommends that uncertainty studies be incorporated into the process of quantitative evaluation. NUREG-1855 [7] provides a useful nomenclature for discussing and assessing outcomes under three types of uncertainty: parameter, modeling and completeness.

Parameter uncertainty relates to the uncertainty in the computation of the input parameter values used to quantify analysis results, e.g., ASET and RSET values. Modeling uncertainty, on the other hand, arises because different approaches may exist to represent certain aspects of the fire safety analysis, and no one approach is clearly more correct than another. The uncertainty associated with the model and its constituent parts is typically dealt with by making assumptions. In general, parameter and modeling uncertainties are addressed by determining the sensitivity of the analysis results to different input parameter values and model assumptions, respectively. Within the fire safety network, the treatment of parameter and modeling uncertainty is assessed as separate supporting requirements under all relevant high-level requirements. The collective influence of these individual assessments is then logically linked to the life safety metric.

Completeness uncertainty relates to fire phenomena or other factors that are not addressed by the fire safety analysis. These types of uncertainties may either be known but not included or be unknown and therefore unanalyzed. In some cases, there may be no agreement on how a fire safety analysis should address certain effects, and in other cases, the analysis may have just simply omitted phenomena, failure mechanisms, or other factors. The fire safety network addresses completeness uncertainty consistent with the IFEG but does so using concepts taken from NUREG-1855, namely that of defense in depth and safety margin. The concept of defense in depth attempts to evaluate the balance between three echelons of fire protection: prevention of ignition, reduction in fire severity, and limiting exposure (e.g., to occupants). Fire protection designs should be proposed that address each of these three echelons equally such that there is not an overreliance on one echelon and its associated uncertainties. The concept of safety margin attempts to ensure a sufficient level of conservatism in the analysis such that uncertainties associated with completeness will be bounded by the adjusted analysis results. Such concepts may be implemented by enhancing redundancy or using safety factors as discussed in Sections 1.2.9.5 and 1.2.10.2 of the IFEG, respectively.

Appendix D provides full list of supporting requirements and their associated influencing factors as well as any additional logic and outputs needed to translate the IFEG into the network construct.

Conclusion

The development of the fire safety network analysis, which is used to demonstrate the proposed decision support framework as part of the case study outlined in Section 4 of the main report, applies the guidance of the IFEG to support the determination of what constitutes a technically adequate fire safety analysis. This guidance is captured within the fire safety network by the logical links (or edges) established between its various nodes. Above all, the fire safety network is based on key mathematical and engineering principles that preserve the physical and analytical relationships between fire phenomena and the characteristics and response of the building systems and occupants. Note that the structure and logic of the fire safety network was built within a spreadsheet-based environment that is discussed in Section 4.4.1.8 of the main report and was quantified using mathematical relationships that are outlined in Sections 4.4.1.6 and 3.4.2.2 and further explored in Appendix A.

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