Risk Task Group – Meeting Report

January 11, 2018

Present: Francisco Joglar (Chair), Brian Ashe, David Charters, Timothy Hawthorne, Vladimír Mózer, Todd Ossmann, Ai Sekizawa, Armin Wolski, and Chris Jelenewicz (Staff).

The following was discussed:

1. **SharePoint Site –** Task Group members were reminded that a SharePoint site is available to all members that has all relevant Task Group information. The following is the access information for the SharePoint site:

URL -- https://extranet1.jensenhughes.com/sites/SFPEWG

Generic User for Task Group Users

Edit permissions:
UserName: SFPEWG.Write@jensenhughes.com
Password: DayOrder92

Read permissions:
UserName: SFPEWG.Read@jensenhughes.com
Password: FlagRing39

Action Item: Francisco will post the current draft document on the SharePoint site.

2. **Fire Scenario Chapter –** The Chapter on Fire Scenarios was briefly reviewed. It was agreed that each Chapter would have the following format:

   Introduction

   Purpose

   Interfaces

   Guidance

   Examples

   The current draft of the Fire Scenario Chapter that was marked-up during the last two meetings can be found in the Appendix A of this report.

3. **Frequency Chapter –** The Chapter on Frequency was reviewed.

It was agreed that the chapter will start with definition of frequency. All parameters must be clearly defined.

Action Item – Task Group members were asked to review literature related to frequency that is outside the fire literature.

It was agreed that the document must provide clear guidance on what is a frequency and what is a probability. It will also discuss how to combine frequency and conditional probability. Frequency will be discussed from a qualitative and quantitative perspective.

All variables in equations will be labeled.

Action Item – Francisco will set up a smaller conference call to work on frequency chapter.

The current draft of the Frequency Chapter that was marked-up during the meeting can be found in the Appendix B of this report.

4. **Next Meeting –** CJ will scheduled for the next meeting (4 to 5 weeks) via a Doodle Poll. First part of March.

End of Report

Appendix A – Fire Scenario Chapter

1 Fire Scenarios

A fire scenario is a time-sequence-based set of elements characterizing a fire event. The identification and characterization of these key elements differentiate them from other possible fires. Within a fire risk assessment, fire scenarios are the framework for which risk is quantified. Each fire scenario is a risk contributor and therefore, characterized with a likelihood of occurrence and a set of consequences. This is often captured by the concept of the risk "triplet", which is introduced in this chapter and further elaborated in the frequency and consequences chapters later in this document.

Comment [JF1]: Add a discussion that this can be qualitative or quantitative.

Describe this in simple/clear terms…

1.1 Purpose

The purpose of this chapter is twofold:

1. The first objective is to provide guidance on the process of identifying and characterizing fire scenarios to be included in the risk quantification process.
2. The second objective is to introduce the concept of the risk triplet as part of the process of identifying and characterizing fire scenarios.

1.2 Interfaces

The process of defining and characterizing fire scenarios for risk quantification purposes generally requires the following information specific to the facility within the scope of the analysis:

1. Identification of fire hazards, as fire scenarios are developed based on initial hazard identification
2. Description of the facility including layout, type of occupancy, etc.
3. Description of fire detection and suppression capabilities, fire prevention practices, etc.

The Output of chapter generally consists of a table or list of fire scenarios with their corresponding characterization.

Frequency chapter ??

Consequence chapter ??

Risk quantification ??

1.3 Identification & Characterization of Fire Scenarios

The concept of the risk "triplet" captures the essential elements of a risk assessment: scenarios, frequency and consequences. In this application, the fire risk associated with a facility results from a combination of the identified fire scenarios and their corresponding frequencies (i.e., likelihood of occurrence) and consequences. The methodology described in this section specifically addresses the "frequency" element of the triplet.

As mentioned earlier in this chapter, a fire scenario is a fire event characterized as a sequence of events generally including the following elements:

1. Ignition, which refers to the identification and characterization of the first item ignited.
2. Fire Propagation, which refers to the identification and characterization of secondary or intervening combustibles.
3. Fire Detection, which refers to the identification and characterization of fire detection capabilities.
4. Fire Suppression, which refers to the identification and characterization of fire suppression capabilities.
5. Consequences, which refers to the identification and characterization of the damage generated by the fire event.

Scenarios are typically represented in the form of an event tree, which is a logic model capturing the chronology of an event. In this type of model, the sequence of event is identified at the top and each event within the tree is characterized by its possible outcomes. Consider as an example event tree depicted in Figure 1 capturing the general elements of a fire scenario:

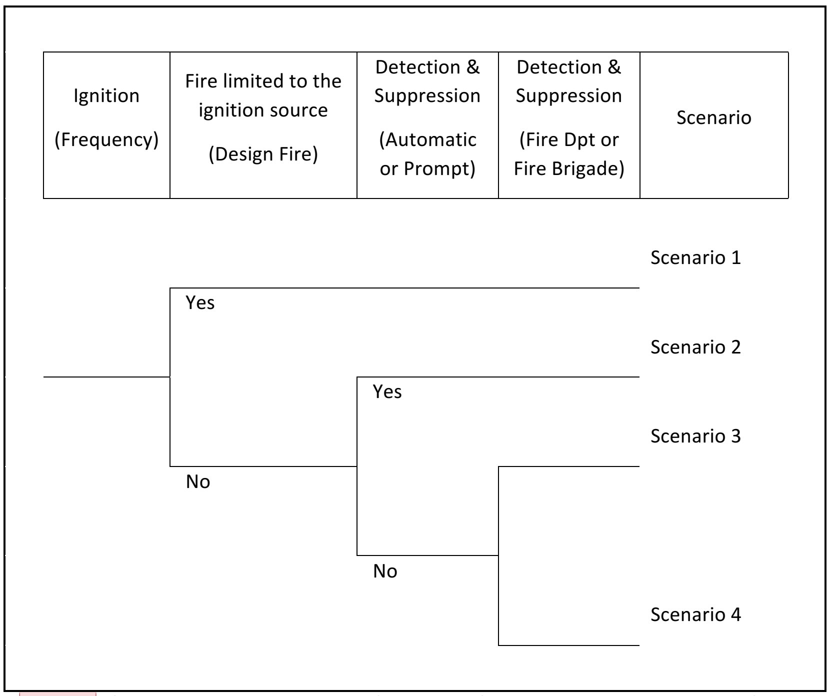

Figure 1: Conceptual representation of a generic fire scenario in an event tree format

Comment [JF2]: Include the term design fire in the description of the elements of a fire scenario.

Comment [JF3]: Consider how to make this figure more comprehensive to indicate that this is the framework for only one of the fire progressions in an analysis. The figure should suggest that there are more fires that need to be considered.

Event is generic. Specific scenarios/application may need to have a different structure. Also, indicate that this is a function of time….

The event tree depicted above includes the sequence of event at the top of the tree. This sequence consists of ignition, fire propagation, two detection and suppression attempts and the consequences of each resulting path. In practice, each branch in an event tree is defined so that the top branch is a "positive" outcome of that event and the lower branch is "negative" outcome of the event. For example, the first set of consequences result from a fire limited to the ignition source with no propagation. In contrast, consequence number four consists of a fire that propagates outside of the ignition source (i.e., answer to the first event is "No") and detection and suppression attempts fail twice. Notice that in this formulation, the event tree captures most of the elements characterizing the fire scenario. The ignition event is often characterized with a likelihood of occurrence. Detection and suppression features are characterized with failure probabilities. Finally, consequences are also represented in qualitative of quantitative terms.

1.3.1 Identification of Fire Scenarios

Since fire scenarios for the basis for risk quantification, there are two key questions that need to be addressed during the process of identifying fire scenarios. It is noted that there is no pre-dispositioned answered to these questions as they are often answered during the process of developing the risk assessment. These two questions are:

1. How many fire scenarios should be included?
2. Which fire scenarios should be included?

Fundamentally, fire scenarios are selected and incorporated in a risk assessment so that the fire risk is appropriately characterized to meet the objectives of the study. The following guidance may assist in the process of appropriately identifying fire scenarios:

1. Used the identified hazards as the starting point for the fire scenario identification process.
    a. Identify the initial heat source, initial fuel source, and point of fire origin. This should include initial heat sources continuously present in the facility or those that may be brought in on a temporary basis.
    b. Identify potential secondary fuel packages?
    c. Include in the evaluation process the impact of any fire prevention program in place
2. Identify the available fire detection and suppression features
    a. Include prompt, automatic and delayed fire detection capabilities.
    b. Include prompt, automatic and delayed fire suppression capabilities
    c. Include passive fire protection features
3. Identify the potential consequences of the identified fire events
    a. Is there a smoldering phase? The duration of this phase, and of each successive phase should be considered.

b. Is there a small open flaming phase, in which the first fuel source is the only object burning?

c. Does the fire spread to secondary objects or, where applicable, is there considerable flame spread over the surface (e.g., along a wall or over the top of a couch)?

d. Does the fire reach flashover and/or full involvement of the first compartment or enclosed space (e.g., passenger cabin of an airplane)?

e. Does the fire spread to a second room, compartment or space (e.g., concealed space, exterior)?

f. Does the fire spread to a second floor or level (e.g., upper deck of a bus)?

g. Does the fire spread beyond the building, structure, vehicle or other object of origin?

The process of identifying fire scenarios is likely to generate an unmanageably large number of potentially relevant fire scenarios. Therefore, it may be necessary to create a representative set of all of these relevant scenarios. This representative set of relevant scenarios is referred as scenario clusters, which collectively include all relevant scenarios. Each scenario cluster group a similar fire scenarios identified in the facility and is expected not to overlap.

In general, scenarios can be grouped together to form a cluster if consequences are similar. That is, the consequences are a common factor in the analysis that allows for the combination of individual scenarios and their corresponding frequencies. Building on the concept of the risk triplet, the frequency of a scenario cluster should include the contribution of all the scenarios included in the cluster. At the same time, the number of scenarios will be reduced by the creation of the clusters.

Scenario clusters often provide a crude (i.e., bounding or conservative) assessment of risk associated with the conditions captured in the cluster. This will later allow an effective quantification process as groups of scenarios can be evaluated together and screening decisions can be made. Specifically:

1. A scenario cluster may be found to be a low risk contributor and no further analysis or design changes are necessary for that group of scenarios.
2. In contrast, a scenario cluster may be found to be a high-risk contributor requiring detailed evaluation of the scenarios within the cluster in order to identify key risk insights associated with improving fire safety.

1.3.2 Characterization of Fire Scenarios

- How to characterize Frequencies (fire scenario frequencies)
    - Frequency characterization will be treated in the frequency chapter. In this chapter, we will only qualitatively describe some of the factors affecting the frequency as a manner of introduction, as for example:
        - Detection and suppression
            - Include prompt, automatic, or “delayed” response (fire brigade or fire department)
        - Fire prevention program
        - Passive fire protection

        - Likelihood of ignition and propagation
- How to characterize Consequences. This chapters will only qualitatively describe factors affecting consequences. Details will be presented in the consequence chapter.
        - Detection and suppression (if it works or fails)
        - Fire prevention program (if it works or fails)
        - Passive fire protection (if it works or fails)
- How to integrate the characterization process- We have a chapter for quantification.

1.4 Example Applications

NOTE: This would be an example limited to the material in this chapter… we will may need to add an appendix to the guide with a comprehensive example that covers the full process.

Comment [JF4]: Close each chapter as appropriate with examples

Appendix B – Frequency Chapter

2 Fire frequency analysis

Each fire scenario is characterized by a frequency. Recall that the frequency is one the elements of the Risk Triplet introduced earlier in this guide. Frequency refers to the number of time san event occurs within a specified time interval. Consequently, it characterizes the likelihood of occurrence of a fire scenario. Frequencies are often further characterized by conditional probabilities that are used to incorporate scenario specific characteristics into the risk equation such as fire protection features.

$$R = \sum_i \lambda_i \cdot P_i \cdot C_i$$

Comment [JF5]: These parameters of this equation, even if the equation not explicitly shown in the chapter should be clearly described in the introduction.

1.Review literature on risk assessment outside fire protection to ensure the use of conditional probabilities is appropriate and not a new concept we are introducing

2. Review existing literature and methods on fire risk assessment to ensure consistency with current approaches

2.1 Purpose

The purpose of this chapter is twofold:

1. Describe the use of frequencies and conditional probabilities in the process of characterizing a fire scenario.
2. Provide guidance on the process of assessing fire ignition frequencies for fire scenarios
3. Provide guidance on the process of assessing conditional probabilities for characterizing fire scenarios.

2.2 Interfaces

The process characterizing frequencies and conditional probabilities for risk quantification purposes generally requires the following information specific to the facility within the scope of the analysis:

1. Historical information or fire events records associated
2. Fire protection features included in the risk assessment as part of the fire scenarios

The Output of this chapter generally consists of a table or list of fire scenarios with their corresponding frequencies and conditional probabilities to be used in the risk quantification process. This guide recommends that frequencies and probabilities be based, to the maximum extent possible, on sound, relevant data. However, this does not mean that frequencies and probabilities should be exclusively or primarily based on relevant loss history. Empirically, historically based frequencies may not provide reliable estimates of probabilities under current conditions, let alone probabilities resulting from a set of design, operating, and other decisions.

2.3 Characterization of Fire Ignition Frequencies

Describe from a qualitative perspective

Describe from a quantitative perspective

2.4 Characterization of Conditional Probabilities

Describe from a qualitative perspective

Describe from a quantitative perspective

2.5 Example Applications

TBD