Risk Task Group – Meeting Report

November 11, 2017

Present: Francisco Joglar (Chair), Russ Bainbridge, David Charters, Al Condello, Håkan Frantzich, Vladimír Mózer, Todd Ossmann, Rob Plonski, John Ulstrand, and Chris Jelenewicz (Staff).

Apologies: Kevin Frank & Ai Sekizawa

The following was discussed:

1. **Frequency Analysis Chapter**

Action Item: Tim and Francisco will work on updating the existing chapter on Frequency Analysis. Francisco will set up a call with Tim to discuss and draft content before next meeting

2. **Consequence Analysis Chapter**

Action Item: Todd will work on updating existing chapter on Consequence Analysis. Francisco will set up a call with Todd to discuss and draft a section before next meeting

3. **Fire Scenarios Chapter --** Rob, Francisco and Håkan are working on updating Chapter on Fire Scenarios. They previously met via conference call to discuss this section. Francisco presented a new outline for the chapter (see Appendix A). Specifically, the following items were discussed:

    a) Introducing risk triplet concept – fire scenarios, likelihood and consequences
    b) Introduce event tree concept
    c) Structure will not be based on a list of questions as in the current guide. It will provide structured guidance
    d) Some of the current info will go to consequence and frequency sections
    e) Previous content on clusters will be part of the fire scenario chapter.

Action Item: Francisco will update chapter on fire scenarios based on these comments. He will send the revised document to the full task group to review before the next meeting.

4. **Communication, Management & Monitoring –** Vladimir drafted proposed content for the sections related to communication, management and monitoring. See Appendix B.

Action Item: Task Group members were asked to review this content and provide comments for the next Task Group Meeting.

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

End of Report

Appendix A – Draft Fire Scenarios 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.

2 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.

3 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 ??

4 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.,

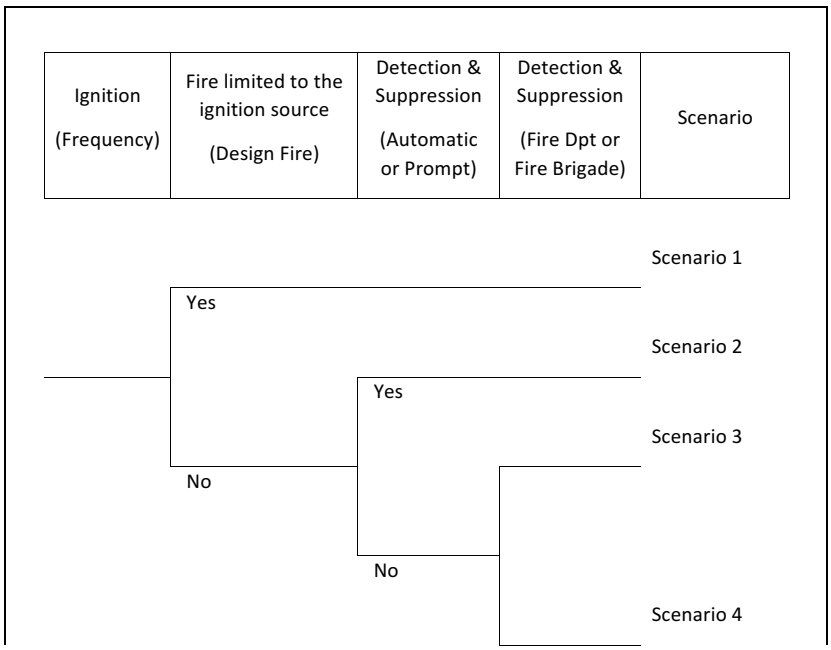
likelihood of occurrence) and consequences. The methodology described in this section specifically addresses the "frequency" element of the triplet.

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.

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

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:



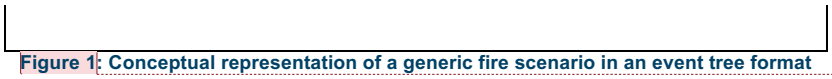


Figure 1: Conceptual representation of a generic fire scenario in an event tree format

Comment [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.

4.1 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?

4.2 Identification of Fire Scenarios Clusters

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.

4.3 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.

Appendix B – Communication, Management and Monitoring

Communication

Scope: The communication section provides guidance on information exchange with external and internal stakeholders during the entire fire risk assessment and management process; this is briefly mentioned in 3.3.3 (original guide). It may be divided into two parts:

1. Communication as part of fire risk assessment at every step of the process. I.e. establishing project scope and objectives, fire protection systems and measures specifications, hazard identification.
   This first item should be included and covered in the individual guidance section, however, a summary should be included in the Communication section as well. The FRA concept report section (15.2 in original guide) also forms part of this item and should be included and updated.
2. Communicating the outcomes and requirements/recommendations of the fire risk assessment to the internal and external stakeholders in extent and format relevant to their objectives.
   This second item will be discussed in detail and provide information on how structure a detailed report documenting the entire FRA / FRM process after an acceptable level of risk has been achieved. Section 15.3 in the original guide is a good base and could be extended with topics on identifying level of criticality of fire protection design components, identification of persons/departments responsible for operations which may have impact on the fire safety strategy and level of risk.

Additionally the section as a whole should guide the user in establishing most important communication links by way of example, e.g. something along the lines of life safety objectives shall should be discussed and approved by the AHJ, property protection objectives with the property owner, user and insurer, etc., but in a greater detail, explaining why it is important and what points should be raised. There may be overlap with other sections, maybe even repetition but information and data are necessary during the FRA/FRM process.

Monitoring and management

Residual risk management is a section that logically connects to the statement that risk cannot be eliminated but can only be reduced to an acceptable / tolerable level. There should be introduction on what are options for residual risk management, relevant to the objectives set out in the initial stages of FRA. This can include topics on:

Role of fire prevention, training, housekeeping etc. – all of these topics are difficult to quantify and include in the FRA, however, they form an integral part of a good fire strategy.

Risk retention vs risk transfer – what are the options, which elements of residual risk can be treated this way.

Management and monitoring is a section

This is briefly introduced in 3.3.1. Also 15.3.8 discussed this issue in relation to FRA documentation. As outlined in the documentation section, this section should provide guidance on how establish how critical are the individual components of the fire safety design (systems, measures, operations) to the level of risk/safety, how outline bounding conditions (what is acceptable and what is a definite no-no)

and how transfer information to the persons responsible for these components in a language natural for them. This includes highlighting relevant procedures in inspection and maintenance procedures, documentation in operations and maintenance manuals, training etc. A very important item in this regard is a section on how to deal with alterations of use, fabric and construction of the building in question and what persons and stakeholders must be consulted. Sections 15.3.3 through 15.3.9 provide some information on this relating to documentation.