Safety System Fire Analysis - How can fire challenge the safe operation of a facility? And how can it be established whether a fire can cause a facility/ process to enter an unsafe state?

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The above questions are fundamental in determining whether facilities are capable of operating safely under the adverse conditions encountered during a fire. Not only can a fire prevent the correct operation of safety systems or protection measures (e.g. alarms and automatic shutdown on equipment) installed on a facility, it has the potential to initiate a major incident.

There are additional issues with regards to fire and explosion on facilities such as;

- Are engineers and operators that work on these facilities confident that the safety systems installed, will function correctly in the event of a fire?
- Are safety systems protected from fire?
- Do facilities segregate safety systems to prevent common cause failures throughout to prevent fire undermining safety?
- In the event of a fire would safety system faults/ failures be revealed?
- Could the safety system's response to a fire cause further operational or emergency shutdown issues?

To establish whether a fire could cause a facility/ process to enter an unsafe state, detailed analysis of the facility's fire prevention and mitigation provisions should be completed. This analysis will determine whether the effects of fire could have detrimental effects on the facility's ability to operate safely and establish whether a facility could be shut down in a systematic and controlled manner (including in an emergency), even in the presence of a credible fire.

It is recognised that most hazard studies consider the loss of utilities and control, hence should consider the loss of safety systems but such studies rarely justify the expected outcomes in the event of the fire on a facility. It should be recognised that fire is a cause of common failure of equipment if it is co-located and the questions posed above are not always considered.

On the basis of the safety systems fire analysis, the robustness of the basic process control and safety systems engineering design and their effectiveness can be confirmed, and the requirements for emergency response can be demonstrated.

This paper will provide practical examples of how the effects of fire on safety systems have been analysed, examples of improvements emanating from analysis work and the overall benefit of such an analysis.

Control of Major Accident Hazards (COMAH)

Safety System Fire Analysis is a detailed analysis that can establish whether a fire could cause a facility/ process to enter an unsafe state. Furthermore, the robustness of the basic process control and safety systems engineering design and their effectiveness can be confirmed, and the requirements for emergency response can be demonstrated. The legislative guidance drives the operators of facilities to take all necessary measures to prevent major accidents occurring, and why Safety System Fire Analysis is a critical tool/ process to undertake on such facilities.

All employers have a requirement under the Health and Safety at Work Act (HASAWA) to identify hazards, assess and control risks to a level which is as low as reasonably practicable (ALARP) (HMSO, 1974).

Sites with the potential to cause major accidents have a greater regulatory driver to ensure hazards are systematically identified. For onshore major hazard sites in the chemical and allied industries this is driven by the COMAH Regulations 2015. Furthermore, under COMAH, the Dutyholders are required to identify all foreseeable Major Accident Hazards (MAH) and to demonstrate that they have controlled the associated risk to a level that is ALARP.

"Take all necessary measures to prevent major accidents involving dangerous substances and limit the consequences to people and the environment of any major accidents which do occur." (Health and Safety Executive, 2015).

MAH's are those with the potential to cause multiple fatalities on and off-site and/ or cause a Major Accident To The Environment (MATTE). For top tier COMAH sites (those holding the largest quantities of dangerous substances as defined within the Seveso III Directive and COMAH Regulations 2015), Duty holders are required to provide a safety report.

The Safety Report Assessment Manual (SRAM) is a guidance document associated with the COMAH Regulations 2015, and details how to achieve compliance with the Regulations.

"The safety report should demonstrate that a systematic process has been used to identify all foreseeable major accidents." (Health and Safety Executive 2015).

The Safety Report Assessment Manual (SRAM)

Competent Authority (CA)

The SRAM is the COMAH, CA guidance, on the assessment of COMAH safety reports, which comprises the UK HSE and Office for Nuclear Regulation (ONR) for nuclear establishments, Environment Agency (EA) in England, and National Resource Wales (NRW) in Wales. It applies to all upper-tier COMAH sites.

When operators of upper-tier COMAH establishments submit a safety report, the SRAM details the processes that the CA staff should follow in the assessment of such a report (Health and Safety Executive, 2015). Furthermore, the SRAM is not a guidance document for upper-tier COMAH operators on how to author safety reports; however, it provides vital information on the safety report assessment cycle and details the various types of safety reports.

In conjunction with Safety System Fire Analysis requirements, the SRAM Appendix 10.1 'Predictive Assessment Criteria and Guidance, Criterion 10.3 states that:

"The safety report should contain the results of calculations showing suitable estimates of the severity and extent of the consequences of each major accident."

SRAM and Safety System Fire Analysis

Safety System Fire Analysis can be used (in general terms) as a hazard identification tool, and further guidance within the SRAM, states that:

"*A systematic hazard identification process has been used to identify all major accident scenarios, including worst case and lesser events. A comprehensive process should have considered loss of containment derived from all reasonably foreseeable on-site operations and also external events that may impact upon site operations. The report should outline how major accident hazards are identified and show that a suitable range of events has been identified for further assessment."* (Health and Safety Executive 2015).

Fires (other than MAHs), on upper-tier COMAH establishments are considered to be external events, and Safety System Fire Analysis can establish whether a fire can cause a facility/ process to enter an unsafe state. Furthermore, the SRAM Appendix 12C 'Process Safety Assessment Criteria and Guidance, Criterion 12.2.1.1 (Schedule 3 para 5 (d)) states that:

*"The safety report should describe how the establishment and installations have been designed to an appropriate standard." (*Health and Safety Executive 2015).

The associated guidance for this criterion within the SRAM continues to state:

"Show that the principles of redundancy, diversity, separation and segregation have been applied to reduce the risk of common mode or common cause failure and to ensure the availability of back-up systems if required. It should also identify how the behaviour of equipment on failure has been addressed, including events which may cause a fault and disable protective systems. Show that the performance standards (reliability, availability, accuracy, speed of response etc.) are adequate."

Safety System Fire Analysis, enables upper-tier COMAH establishments to further understand their facilities and determine whether fire could have a detrimental effect on its safe operation and controlled shutdown (including emergency). In addition, the various methods of analysis (detailed in the following sections), can highlight where there is potential for common mode or common cause failure due to fire and thus highlighting the effectiveness of the safety systems if a credible fire did occur, permitting the site operators to meet the defined requirements and acceptable targets for worker and public risk.

In addition to the SRAM, the Control, Electrical and Instrumentation (CE&I) Delivery Guide (Health and Safety Executive), outlines three priority topics: functional safety, explosive atmospheres and electrical power systems. Functional Safety is concerned with the management, design, installation, operation and maintenance of instrumented process safety systems that reduce the risk of a major accident, including process control systems, safety instrumented systems and alarm systems; therefore the lifecycle of an Functional Safety requirement should have been assessed with regards to impact of fire on its design function. Equipment used in potentially explosive atmospheres all have the common theme of reducing the likelihood of ignition; therefore has sufficient analysis been conducted to ensure the results of a fire have been considered. In the context of major accident hazards, electrical power systems are concerned with:

- the initiation of major accidents by electrical equipment through fire and explosion;
- the management, design, installation, operation and maintenance of electrical power systems so that they provide the necessary reliability and availability to prevent or mitigate major accidents and so that they prevent danger to personnel.

Therefore can operators of upper-tier COMAH establishments be sure that safety analysis has considered fire to the depth required to determine whether it would lead to a major accident hazard or that faults would be revealed.

Fire and Safety System Fire Analysis

Fire is typically regarded as having a disaster potential less than that of an explosion or toxic release, however, fires in the process industries cause more serious accidents than explosions and toxic releases (Lee. F.P. 1996). With this in mind, there is an obvious driver to minimise the initiation of fire and also to control the potential for fire spread should it occur.

Fires can spread by various mechanisms: due to either direct flame impingement or by the transfer of heat to other combustible materials (by way of conduction, convection and radiation), causing secondary ignition. Furthermore, there are various types of fires, some of which are not large events which are easily revealed. It's these fires that could potentially cause common cause failure of safety systems.

Electrical (Solid) Fires

Electrical fires can be initiated by various means (e.g. arcing, short circuits and overcurrent), and on plant, they can occur in places such as terminal blocks or junction boxes. Arcing, is an example of an electrically initiated cable fire, which involves a high power discharge of electricity between two or more conductors, and this discharge translates into heat which in turn can break down a wires insulation, causing an electrical fire. Figure 1 below details an example of where an electrical fire affected one side of a junction box (potential arcing due to cable damage).

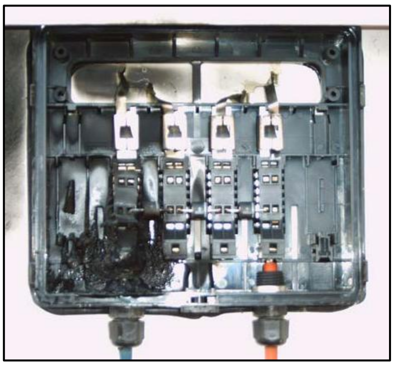
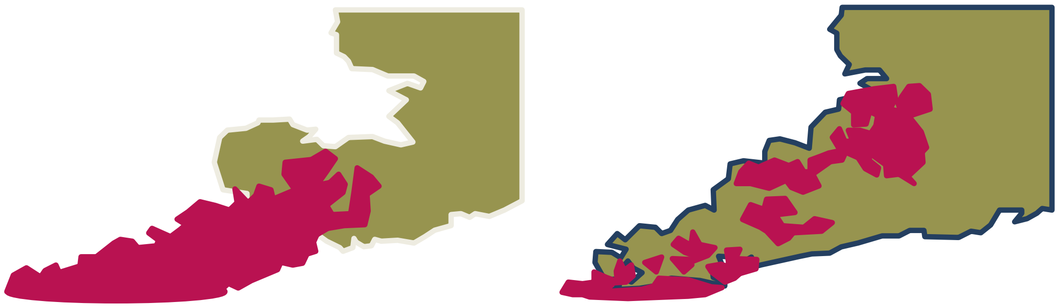


Figure 1 – Electrical Fire in a Junction Box

Hydrocarbon fires

Hydrocarbon fires can be more significant than those detailed above, and are likely to be revealed (e.g. by the fire detection and alarm system or operators in the area), and due to their nature they are more likely to cause a MAH. Hydrocarbon fires fall into three main categories, as described below. Each type having potentially differing consequences.

Pool fires are typically observed in lower volatility flammable materials, which are in the liquid phase at ambient temperature and pressure. A typical example is a crude oil fire or kerosene fire. Once ignited, the fire will generally increase in size until the entire surface of the flammable material is on fire, unless suitable fire-fighting activities are initiated.



(a) (b)

Figure 2 – Flames and Smoke in large pool fires (a) LNG (b) LPG Fire (Lee. F.P. 1996)

Jet fires are the combustion of a pressurised system of combustible gas or atomised liquid. If the release is ignited soon after the release occurs, the result is an intense jet flame. A release results in an elongated flame directing outwards from the release point (which experiences 'lift off' due to pressurised release, i.e. the section of the jet nearest to the release point is considered to be unignited gas). A jet fire is usually very localised, however, can be very destructive to anything in proximity to it. Due to the high velocity of the material being released, there is a large entrainment of air into the flame, causing very efficient combustion, therefore intensifying the flame.

As the presence of a jet fire indicates a flammable substance under pressure, the extinguishing of a jet fire flame may cause the release of unburned flammable material, which in turn may lead to the development of an explosion on re-ignition.

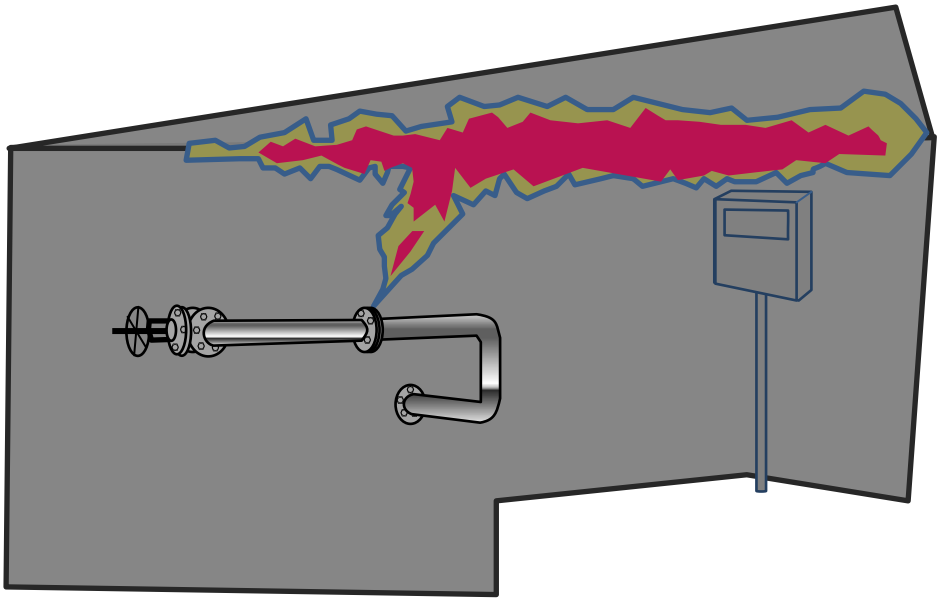


Figure 3 - Jet Fire Adjacent to Facility/ Process Safety Equipment

If the released combustible material is not ignited immediately, a vapour cloud will form. This will be dispersed by natural ventilation and ambient conditions. If it is ignited at this point, but does not explode, this will produce a flash fire. This causes the vapour cloud to burn rapidly. If the release has not been stopped, it will result in a jet fire.

A flash fire is represented by its flammable envelope, since no damage is caused beyond it, and the extent is usually taken to be the Lower Explosive Limit (LEL) of the vapour cloud.

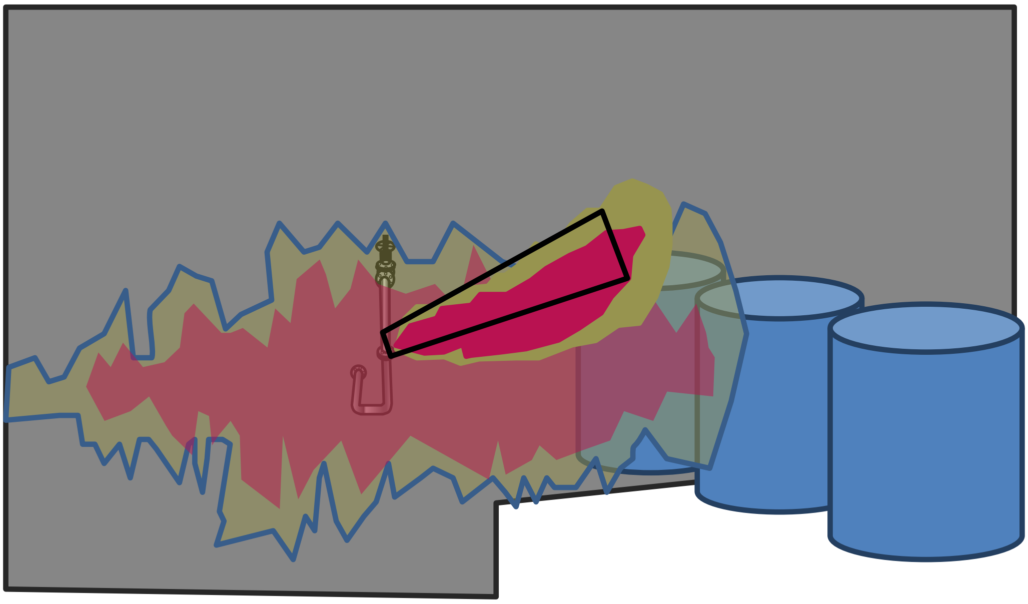


Figure 4 - Flash Fire Adjacent to Facility/ Process

Safety System Fire Analysis is a foundation system tool for identifying whether a fire can cause a facility/ process to enter an unsafe state, and utilising a systematic approach to determine whether the effects of fire could have a fatal effect on the safe operation of a facility/ process. The analysis can be utilised at any stage of a project, and depending on the type of plant/ process specific analysis techniques can be used.

A Safety System Fire Analysis process flowchart is summarised below for an existing facility in Figure 5:

Figure 5 - Safety System Fire Analysis Process Flowchart

Safety System Fire Analysis can be used on sites with varying hazards, such as upper-tier COMAH sites and nuclear licenced sites. The completion of Safety System Fire Analysis can result in the identification of a credible fire that could challenge the safe operation of a facility; the following sections will detail how this analysis process is undertaken to ensure that all credible fires are suitably assessed and steps taken to reduce the fire risk where required.

Each of the headings from Figure 5 are discussed in more depth below. This is based on existing facilities, but the approach could be tailored for new build facilities/ processes.

Review of the facility

Depending on specific information made available (the plant/ process could be at the design stage), a facility review will take place, where all engineering and safety documentation will be reviewed, prior to any meetings or walkdowns of the plant taking place.

The purpose of this process is to establish and confirm the design basis for those items important to safety and to ensure that the overall design is capable of meeting prescribed requirements and acceptable targets and limits for fire. The review stage will examine (but is not limited to) the following:

- All planned normal operational modes of the plant;
- Plant performance in anticipated operational occurrences;
- Design basis accidents;

- Fault sequences that may lead to a severe accident.

On the basis of this initial review, the robustness of the engineering design in withstanding postulated initiating events and design basis accidents can be established, the effectiveness of the safety systems and safety related items can be demonstrated, and the requirements for emergency response can be established.

Multidiscipline Safety System Fire Analysis Meeting

The purpose of the Multidiscipline Safety System Analysis Meeting is to review the process, equipment, safety systems and procedures to identify potential vulnerability to fire and explosion. The meeting is typically carried out in two parts, with the first being a review of the current plant fault sequences identified in the engineering and safety documentation for any vulnerability to fire and the second being consideration of whether fire could cause any design based accidents that were not considered in the existing plant Safety Report.

The meeting is facilitated by a Fire Engineer who is considered to be a Suitably Qualified and Experienced Person (SQEP), and a technical scribe records all relevant discussions/ information. These minutes are displayed onto a screen for the duration of the meeting, for all participants to see, and to add/ change anything they think is required.

The participants of the meeting receive prompts/ guidewords to assist in discussions during the meeting. Some examples of the guidewords and the typical engineering disciplines required to attend the Multidiscipline Safety System Fire Analysis Meetings are detailed in Table 1 below:

Table 1 - Guidewords and Participants required for a Multidiscipline Safety System Fire Analysis Meeting

<table>
<tr><th colspan="3">Examples of Prompt/ Guidewords</th></tr>
<tr><td>Direct Radiant Heat</td><td>Convected Heat</td><td>Indirect Radiant Heat</td></tr>
<tr><td>Direct Flame Impingement</td><td>Sparks</td><td>Explosion as Initiating Event</td></tr>
<tr><td>Secondary Explosion due to Fire</td><td>Hot Gases/ Smoke</td><td>Secondary Effects</td></tr>
<tr><td>Operator Action</td><td>Conducted Heat</td><td>Overheating</td></tr>
<tr><th colspan="3">Participants Typically Required</th></tr>
<tr><th>Discipline</th><th colspan="2">Related Input</th></tr>
<tr><td>Civil, Structural and Architectural (CS&A)</td><td colspan="2">Materials of construction, barriers, main building structure</td></tr>
<tr><td>CE&I</td><td colspan="2">Cable routing, cable selection, control system dependency, hot shorts</td></tr>
<tr><td>Ventilation</td><td colspan="2">Fire damper operation, fire rated ducting, preventing spread of fire and combustion products</td></tr>
<tr><td>Operations</td><td colspan="2">Physical locations, issues on plant, operation/ maintenance regimes</td></tr>
<tr><td>Mechanical</td><td colspan="2">Dropped load protection, lubricating or hydraulic fluids, impact of heat generation/ friction</td></tr>
<tr><td>Process</td><td colspan="2">Impact a fire/ explosion may have on a process</td></tr>
<tr><td>Safety</td><td colspan="2">Consideration of fire as an Initiator/ threat, and provide information on other measures in place</td></tr>
</table>

The outcomes of such an analysis are to determine where no further action is required, and where further investigation is needed. Additionally, it can identify potential shortfalls, and provides an indication of the specific areas that need to be examined during the walkdown of the facility.

Fire Walkdown

The SRAM Appendix 12C 'Process Safety Assessment Criteria and Guidance, Criterion 12.2.1.10 (Schedule 3 para 5 (d)) states that:

"*The safety report should describe how adequate safeguards have been provided to protect the plant against excursions beyond design conditions".*

In addition, the associated guidance continues to state:

"*To meet this criterion the Safety Report should describe: The emergency prevention and protection measures and show that these are fit for purpose. These measures include:*

- *Active and passive fire protection"*

During the fire walkdown, the features that are analysed are dependent on the stage of the project, and there are typically three stages, detailed in Table 2 below:

Table 2 - Project Stages and the Fire Walkdown

Stage of the Project	Analysis during the Fire Walkdown
Design/ Installation/ Construction	Confirm that safety/ protection systems and safety features forming the safeguards are being installed in accordance with the design specification. Installation of fire protection measures are confirmed by inspection. Investigate potential issues raised during the Multidiscipline Safety System Fire Analysis Meeting.
Commissioning	Final confirmation that the measures developed for the fire protection of the safety/ protection systems have been implemented. Confirmation that the basis for the fire protection measures remain valid by reference to the location of plant items, routing of services, combustible and flammable inventories and predicted fire development. Investigate potential issues raised during the Multidiscipline Safety System Fire Analysis Meeting.
Operational	Checks made to ensure that nuclear fire protection measures are being maintained and managed correctly. Checking understanding of plant operators on nuclear fire safety related required operating instruction and operating assumptions. Investigate potential issues raised during the Multidiscipline Safety System Fire Analysis Meeting.

In general, the fire walkdown will ensure that fire safety features on plant are correctly implemented (e.g. unsealed penetrations in walls, i.e. passive fire protection systems), and that these are adequately maintained and in satisfactory working order. Another purpose of the walkdown is to investigate issues that may have arisen during the Multidiscipline Safety System Fire Analysis Meeting, and to identify areas where fire could be a significant contributor to the failure of, or malfunction of the safety systems.

Figure 6 below details an example of where a fire walkdown of a plant can highlight an unsealed penetration in a fire compartment. The Fire Engineer conducting the walkdown can determine whether it's a fire compartment, utilising fire layout drawings of the plant, or identifying that the pipework has been painted with ablative coating.

Figure 6 – Unsealed Penetration in a Fire Compartment

During the walkdown, not all issues are easily identifiable, such as; junction panels containing A/ B supplies (co-location of cabling), and duty and standby fans located adjacent to each other.

Figure 7 below details some of the issues that can be identified, not only on the walkdown, but on drawings and safety report documentation.

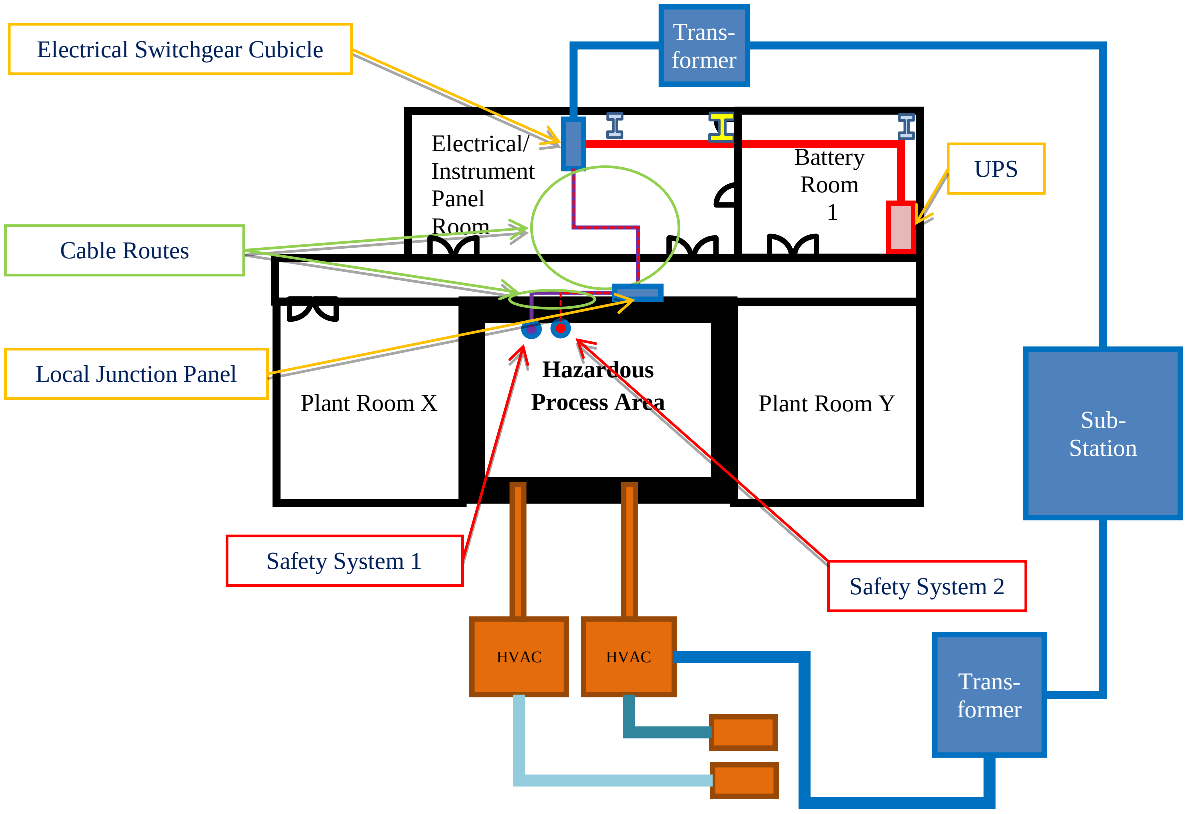


Figure 7 – Examples of the potential issues identified on plants

As Figure 7 details, there are various challenges to safety systems that can be identified during a fire walkdown, and potentially leave safety systems (i.e. Safety Systems 1 & 2) vulnerable to a common cause failure due to fire.

One issue that can be identified during analysis is common cable routes in a cable route/ tray, which a credible fire could develop along and have detrimental effects on common safety systems on the facility/ process. Furthermore, as cable trays can contain varying amounts of cabling, there could be a high fire load present. This type of fire could potentially affect the adjacent steelwork in the room/ area, in which case Safety System Fire Analysis (fire modelling) could determine whether structural failure could occur if a cable tray fire was to affect the steelwork.

Other issues that are encountered during analysis are; junction panels containing A/ B supplies, single sub stations providing power to multiple sources and electrical switchgear cubicles. More importantly, these fires could potentially go unnoticed, as a fire inside an electrical panel that is accessed/ opened infrequently, could be small, and produce very little smoke.

Specific Fire Modelling

The specific fire modelling that needs to be completed is typically identified during the; review of the plant, Multidiscipline Safety System Fire Analysis Meeting and the fire walkdown.

All buildings should have suitable fire compartmentation in order to allow occupants to evacuate safely; this is achieved through compliance with the Building Regulations 2010 (Building Regulations, 2010). However, there is an additional consideration for plants or processes that contain various items of equipment that are essential for the maintenance of plant safety. In such facilities, a strategy is often used to segregate items important to plant safety from high fire loads or areas of special fire hazard and to segregate safety systems which have been designed with redundancy or diversity from each other. This is referred to as fire containment.

In order to achieve fire containment, the fire resistance rating of any fire compartment boundary should be sufficiently high that total combustion of the fire load in the compartment can occur (i.e. 'total burnout') without breaching the fire barriers. All components of the fire compartment boundary (e.g. doors, services penetrations, etc.) should have a fire resistance at least equal to the fire resistance necessary for the fire barrier itself.

To determine the total combustion of the fire load within a compartment, a fire loading study is completed. A fire loading study estimates the potential size and severity of a fire and thus the endurance required of walls, columns, doors, floor-ceiling assemblies and other parts of an enclosing fire compartment. Furthermore, the term "fire load" is defined as the total heat output upon complete combustion of all the combustible material contained inside a building or fire compartment. The heat content per unit area is called the fire load density; the higher its value, the greater the potential fire severity and damage as the duration of the burning period of the fire is considered proportional to the fire load.

Each combustible item and material identified within the room will be been taken into account and recorded within a validated fire loading tool. The output from the tool forms part of the Safety System Fire Analysis, and the values will be utilised in further fire modelling.

To ascertain potential hot gas layer threats when all the combustibles in a specific room or area within the plant are consumed in a fire, the most the most appropriate method of modelling would be fire containment. For this method, the Consolidated Fire and Smoke Transport (CFAST) modelling tool is used.

CFAST is a two-zone fire model that predicts the thermal environment caused by a fire within a compartmented structure. Each compartment is divided into an upper and lower gas layer. The fire drives combustion products from the lower to the upper layer via the plume. The temperature within each layer is uniform, and its evolution in time is described by a set of ordinary differential equations derived from the fundamental laws of mass and energy conservation (National Institute of Standards and Technology, 2015). The output from CFAST forms part of the Safety System Fire Analysis, and is detailed via graphs, tables and various figures.

Figure 8 below details the output from an example fire within a plant. Furthermore, Figure 8 also displays where the seat of the fire is located (in the room with the highest temperature), and the temperatures in the surrounding rooms. Where ventilation ducts/ penetrations are passing through specific rooms, CFAST will determine the temperature through such areas.

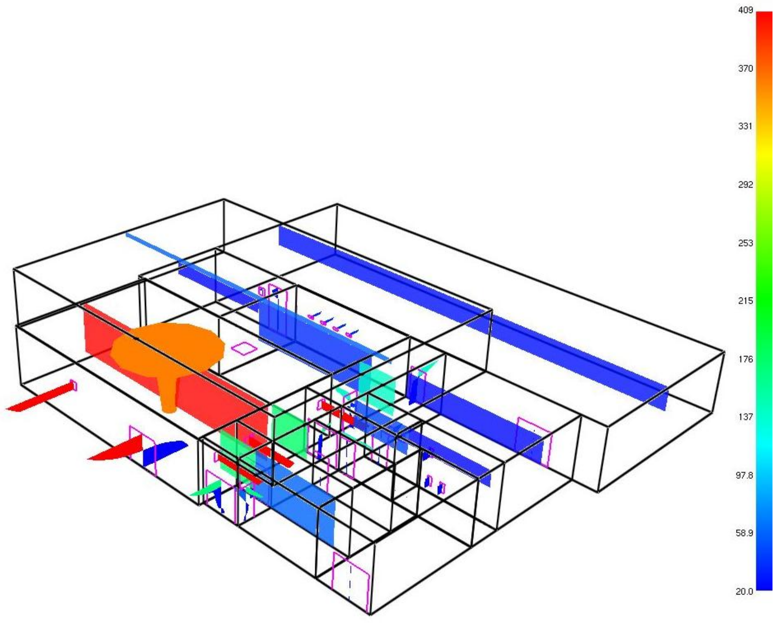


Figure 8 - Fire in a Room/ Area on Plant (Doors Open)

The graphs in CFAST indicate the fire growth rate and average peak temperature achieved when all combustibles are consumed in a fire. The models can be run with the doors assumed to be closed, and open to allow for sufficient ventilation to ensure a fuel controlled fire in the area (plant specific). Figure 9 and Figure 10 detail the gas layer temperature and smoke layer height in the room of which the fire originates.

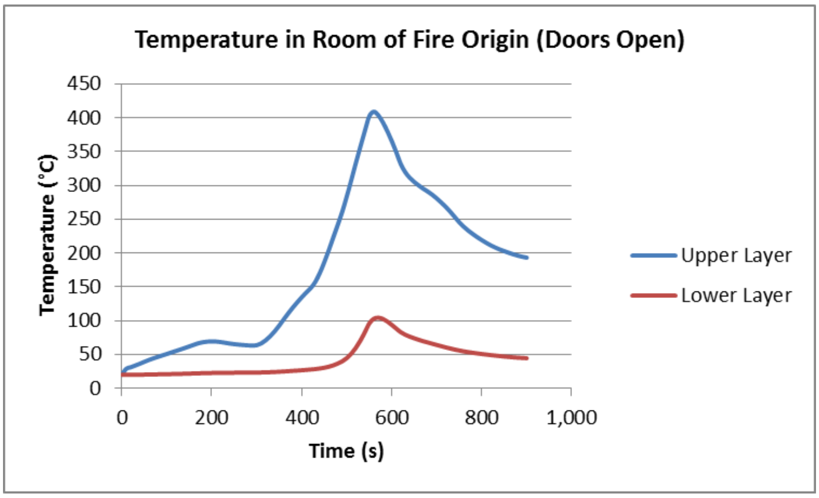


Figure 9 - Graph Showing Gas Layer Temperatures (Doors Open)

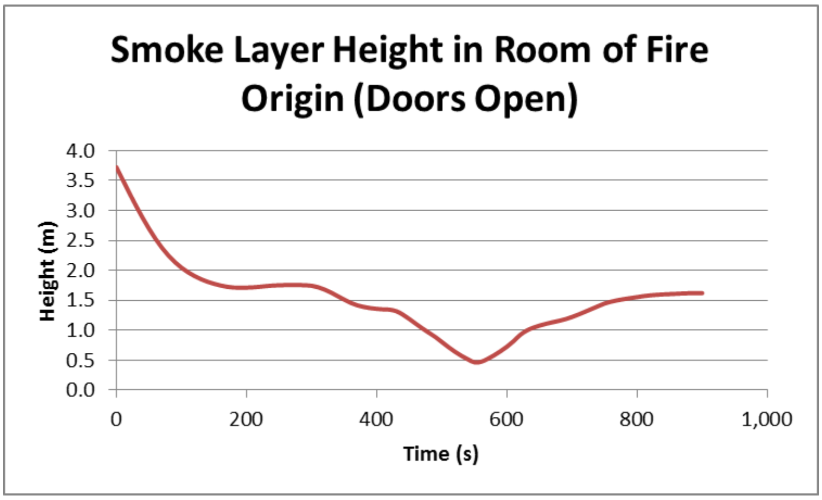


Figure 10 - Graph Showing Smoke Layer Height (Doors Open)

CFAST modelling is an important aspect of Safety System Fire Analysis, due to it providing valuable information (gas later temperature and smoke layer height) to establish whether a fire in a plant could cause that plant (or a process within the plant) to enter an unsafe state.

As well as the fire containment approach, an alternative approach is that of fire influence. Where there is a requirement to protect specific equipment or material from a fire load within a fire compartment, the 'fire influence approach' must be adopted. This requires that fire protection measures are used that prevent a fire in the same compartment from impacting detrimentally on adjacent systems, structures and components (SSCs).

The SRAM Appendix 12C 'Process Safety Assessment Criteria and Guidance, Criterion 12.2.1.3 (Schedule 3 paras 3(d) and 4(a)) state that:

"*Layout of the plant should limit the risk during operations, inspection, testing, maintenance, modification, repair and replacement".*

In addition, the associated guidance continues to state:

"*To meet this criterion the Safety Report should show that: Separation between hazardous plant(s) and storage areas to limit the spread of fire and other domino effects".*

Where the 'fire influence approach' is adopted, and it's not considered appropriate to use the CFAST modelling tool, hand calculations will be used to determine the effects of fire. In some instances the validated Fire Dynamics Tools spreadsheets provided by the US Nuclear Regulatory Commission will be used to complete these calculations (NUREG, 2004). Formulas for the calculations have been taken from the SFPE Handbook for Fire Protection Engineering (SFPE, 2015).

The hand calculations that are completed can determine the following (but not limited to):

- Heat release rate
- Radiated heat flux (varying distances from the fire if required)
- Flame height
- Burning duration
- Rise in steel temperature (varying distances from the fire if required)
- Critical temperature of steelwork (various sizes if required)

Fire Hazard Analysis

The Fire Hazard Analysis (FHA) is the stage of the analysis when the information from the initial review, meetings, and the fire walkdown are collated into one document. Furthermore, the FHA will ensure that everything has been captured throughout the process, and the following will be included:

- Analysis of the potential for fire ignition and growth and the possible consequence on safety systems and other SSCs important to plant/ process safety.
- Determine the need for segregation of plant and the location and required fire resistance of boundaries to limit the spread of fire.
- Determine the capacity and capability of the detection and fire fighting systems to be provided.

For example when completing the specific fire modelling stage of the Safety System Fire Analysis, the modelling document highlights the shortfalls and potential threats from fire, however, these are not analysed further. This further analysis is brought forward into the FHA for inclusion with all the other assessment information.

The FHA will ultimately either discount the effects of fire, or identify shortfalls and suggest improvements to the fire protection arrangements. The final stage of the analysis is to provide reasonable and achievable recommendations, and where necessary include acceptable justifications.

Justifications and Recommendations

In this stage of the analysis justification and recommendations will be made if necessary, these will typically be incorporated into the FHA document.

Recommendations of improvements will be made where the impacts of fire can be prevented or is above tolerable criteria, and additional mitigation is required. An example of a recommendation made during a Safety System Fire Analysis would be; C*onsider the installation of Visual Alarm Devices (VADS) in Plant Room X that are linked to the facilities fire alarm system, to allow effective warning of fire.*

Justifications will be incorporated where the impact of fire on the safety system is tolerable. An example of a justification made during a Safety System Fire Analysis would be; '*Ensure that a high level of fire safety management within the building is maintained to prevent the build-up of combustibles close to structural steel elements within the Electrical/ Instrument Panel Room'.*

Vison for the Future

RPS Risk Management have conducted a vast amount of Safety System Fire Analysis on a variety of facilities in the nuclear sector, and also at upper-tier COMAH establishments; therefore we have developed a robust methodology alongside the Office of Nuclear Regulation (ONR), and operators to ensure the analysis is fit for purpose

However, we don't want to rest on our laurels and we feel that we can continue to develop our approach to undertaking Safety System Fire Analysis, by working alongside upper-tier COMAH sites operators and the offshore industry. Both of which have complex, and high hazard environments which rely heavily on safety systems.

Our experience tells us that there needs to be a positive engagement with all stakeholders during the analysis process, as it ensures the outcome of the analysis is taken beyond our involvement by operator personnel.

As a final point for consideration; inherently safer designs should be something that all operators on upper-tier COMAH sites should be striving towards. Implementation of Safety System Fire Analysis on site should ensure that designated safety systems are designed with fire in mind, thus reducing costly design changes in the future.

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