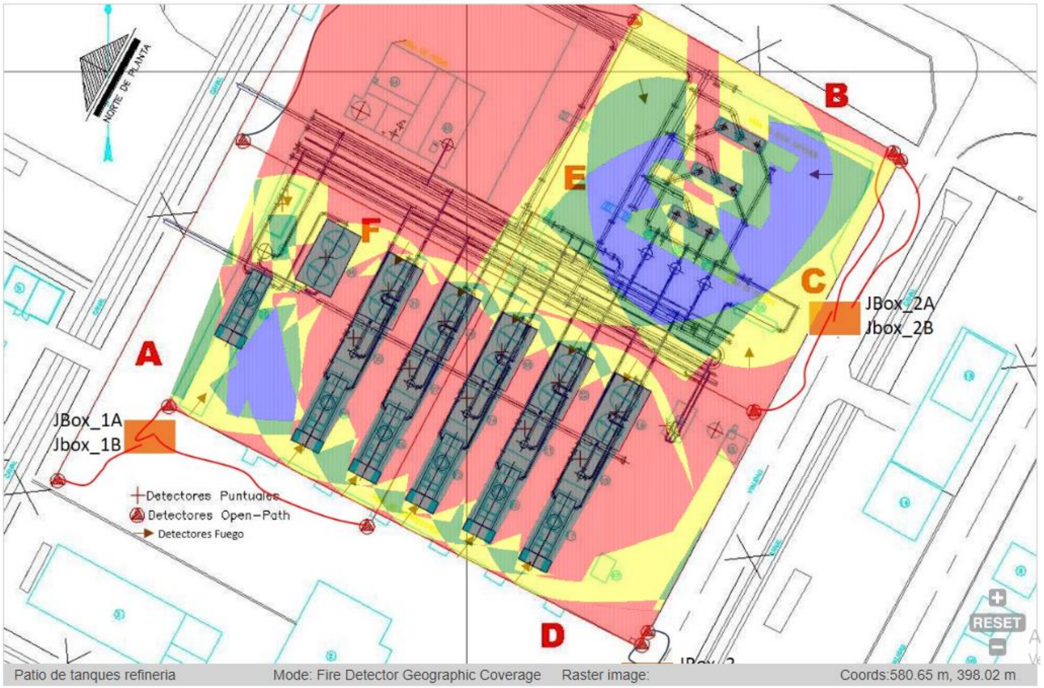
MCL CONTROL



F&G Sensor Mapping and Coverage Study for a Gas Compression Facility

Summary

This application note shows how to approach the optimal design of a Fire and Gas (F&G) detection system for a gas compression facility. The main objective of this study is to provide the maximum coverage of potential Fire and Gas leaks risk scenarios with the minimal number of detectors. This study is based on the guidelines presented in the ISA-TR84.00.07-2018 Technical Report. This study is performed by using a worldwide well known software to evaluate the consequences and some additional tools, developed by MCL Control, to effectively propose an optimal solution for F&G detectors placement from the point of view of risk assessment.

Justification

In recent years, it is well known that all of the new projects related with the manipulation of fuels shall include a Fire & Gas detection system (F&G), as well as a safety instrumented system (SIS), to minimize the risk of such installations. The main objective of the F&G sensor mapping study is to determine the minimum number of sensors, location and detection technology that should be chosen in order to provide the required coverage on the basis of the risk map associated with fire, toxic and combustible gas leak events. In summary the main purposes of these studies are:

- Minimize the number of detectors,
- Maximize the coverage,
- Determine the geographical zones to deploy the F&G detectors on the basis of quantitative risk criteria,
- Define the required minimum coverage,
- Evaluate the sensors voting schemes in order to guaranty the required coverage and at the same time, minimize false trips.

Development

According to the ISA-TR84.00.07-2018, it is necessary to follow the steps depicted in Figure 1.

Therefore, this approach is been used as well as good engineering practices to develop the optimal solution. However, not all the steps proposed in the Guideline are required, it depends on the scope defined with the client. In this application, the list of activities was reduced to steps 1-2-3-4 (area identification, hazard identification, consequences analysis, frequency analysis) and 7-8 (initial design of the FGS and coverage calculation). Although the risk assessment was left to a second stage of the project, the goal coverage was set with the client to detect at least 90% (minimum for the FGS to be considered as an independent protection layer when complying with PFD less than 0.1 according to IEC 61511-3) of the risk events that could lead to life threats as well as physical integrity of the main process equipment.

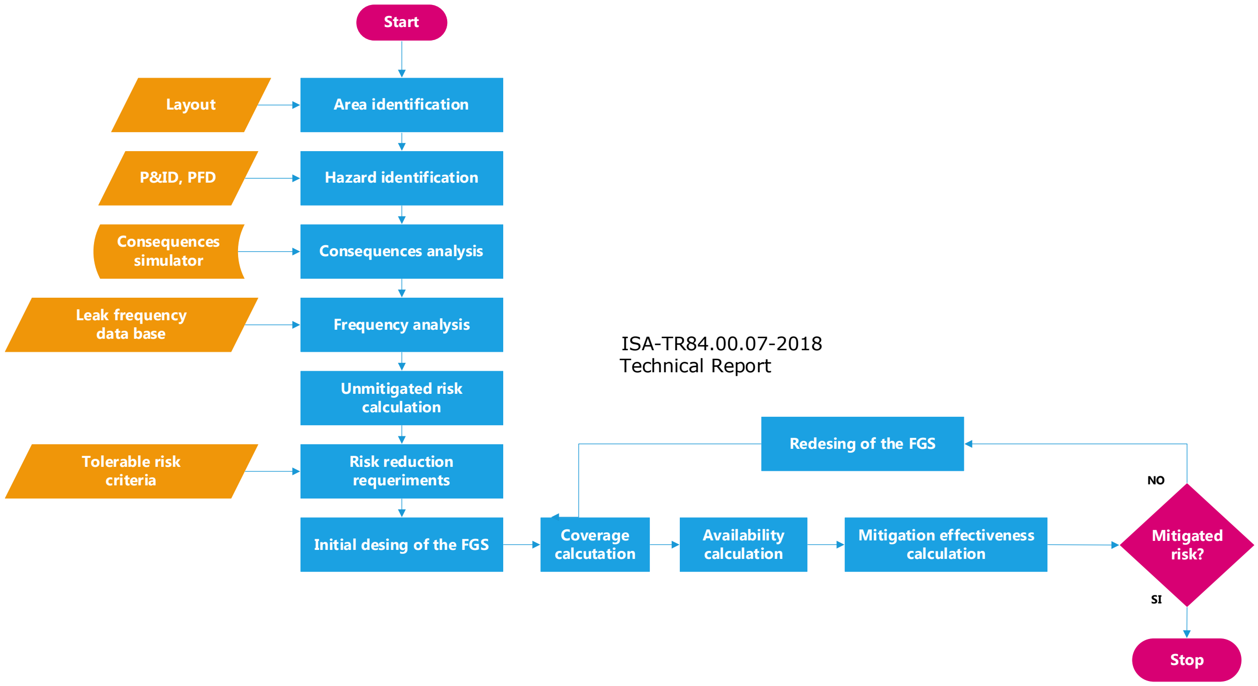


Figure 1. Guidelines to a F&G system design (ISA-TR84.00.07-2018)

Study Case

The study case consists of the determination of the optimal location and quantity of F&G sensors and the type of technology needed to deploy them in gas compression facility. The station has three main areas: Truck loading bays, compressors systems, and tanks. Figure 2 depicts a diagram of the installation covered by the study. It is important to mention that information about the installation as well as meteorological conditions of the site are needed to complete this study.

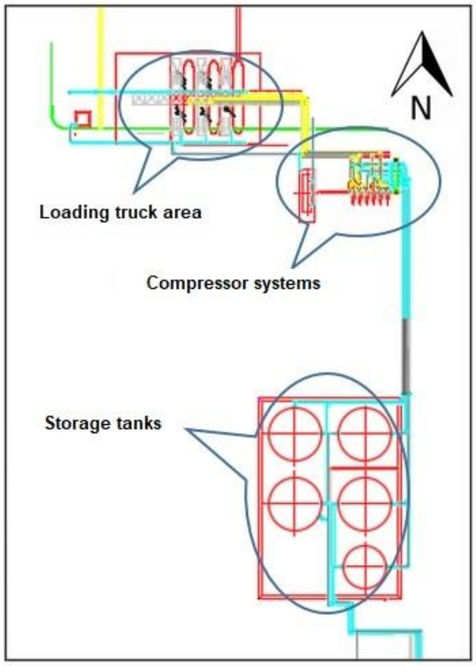


Figure 2.- Plot plan of the installations

Study Results

The results of the study show that it is necessary to divide the installation into three main areas, described in Figure 2 (Step 1). Then three maps were developed to show the dispersion clouds over the scenarios previously identified (Steps 2-3) and considering two gas concentrations (typically 20% LFL (Alarm) and 40% LFL (Shutdown)). An example of such maps is depicted in Figure 3. It is important to mention that these maps are developed by using a world recognized consequence software and a tool, developed by MCL Control, to plot them (Steps 4 and 7 are included in this stage).First of all, a map showing the grading, in terms of risk, related to gas clouds resulting from leaks is developed using the consequence results obtained from the consequence software and the leak frequencies. Once we have got this map, the optimal location of the gas detectors is developed in order to guaranty the coverage goal (Step 8). In this process, the detectors are placed in the areas of higher gas cloud risk ranking and the software tools, developed by MCL Control, can determine if more detectors are needed, keeping in mind the coverage goal. Please note purple areas in Figure 3. These areas denote the higher density of flammable clouds existing in that particular area. The other colors represent lower density of the flammable clouds as a percentage of the total. The process ends when the coverage goal has been achieved while the number of detectors is minimized. Figure 3 also shows the proposed location of the gas detectors after the process has finished.

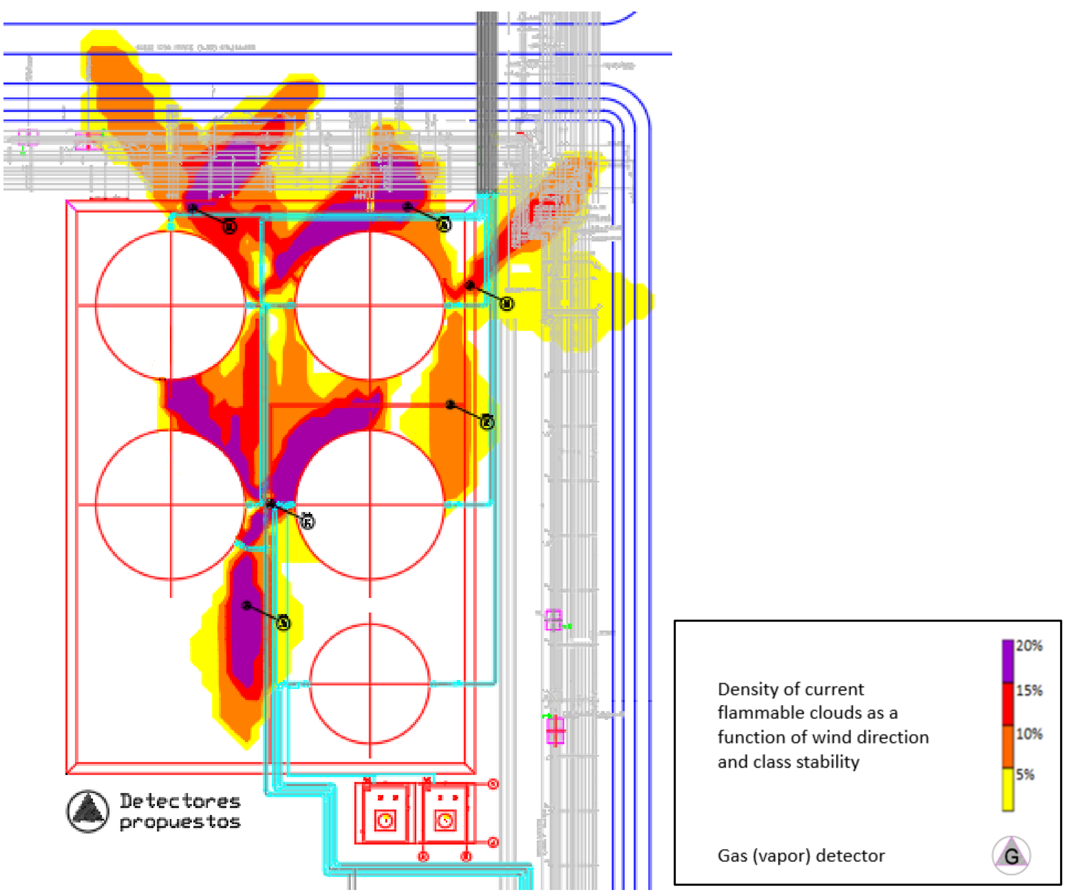


Figure 3. Cloud density in the truck loading area at 40 %LFL

For the fire detectors mapping, the methodology is quite different. First, the location and direction of the jet fires and the position of the pool fires are plotted in order to proceed with the initial location of the fire detectors. Then, it is necessary to determine if the potential jet and pool fires (Figure 4) are within the field of vision of the proposed fire detector. For this, a projection of the cone of vision of each fire detector is developed, taking into account the information provided by the detector manufacturer, and the obstacles that may hinder the vision of each detector (shadow areas). Figure 5 show the vision cones of the proposed fire detectors matching the location of the jet fires in the zone. The stripped area of the vision cones correspond to the shadow areas, while the remaining of the cones correspond to the detection area.

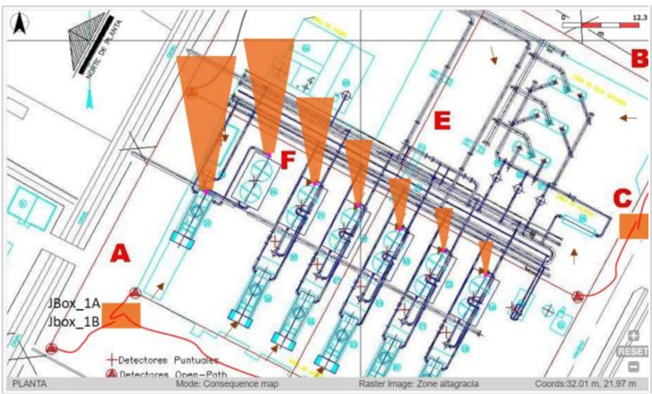


Figure 4. Potential Jet Fires plotted on the plot plan

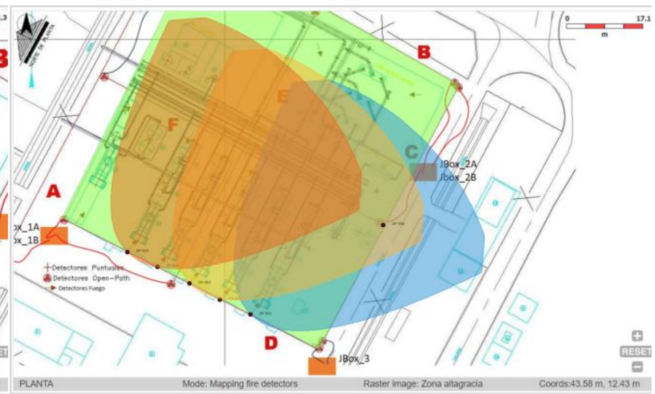


Figure 5. Projection of the field of view of fire detectors

In figure 6 it is possible to observe the initial geographic coverage of the area taking into account all the fire detectors and the obstacles present in the field of vision. Figure 7 shows the geographical coverage of the area adjusting the location, tilt and orientation, maintaining the same number of detectors. Red areas have no coverage, yellow areas have coverage of one detector, green areas have coverage of two detectors, and blue areas have coverage of 3 or more detectors.

The coverage is then calculated by dividing the fraction of detected fires (within the cone of vision) by the total frequency (risk based) of fires. At the end of the study it is possible to determine the coverage, in terms of risk, and propose an optimal location to achieve the coverage goal.

Figure 6. Initial fire detectors coverage

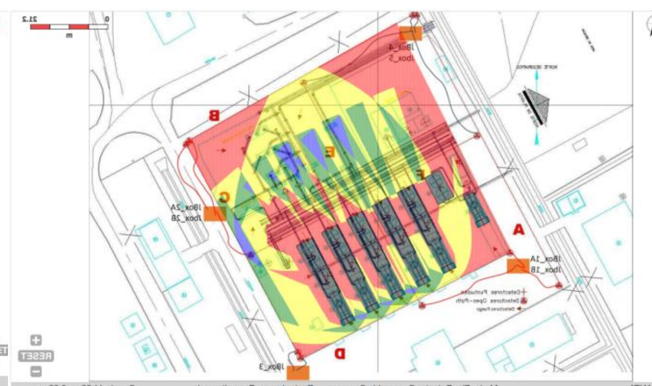


Figure 7. Actual fire detectors coverage (enhanced)

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