System design

During the design of a flame detection system the end-user will be asked to estimate the required fire size to be detected and its relation to the ignition probability and the consequential losses. The end-user has the best expertise to make an estimate of what the consequences are of a fire and how quick his organization is able to respond with follow up actions such as extinguishing and shut downs.

Flame detection system fires with Heptane as a reference fuel:

33 x 33 cm (10 kW) for "very high risk", approx. 650 ml Heptane

A. 50 x 50 cm (25 kW) for "high risk", 1500 ml Heptane
B. 100 x 100 cm (100 kW) for "moderate risk", 6000 ml Heptane

An estimate of the risk can be made with help of the zone classification of the ATEX 137 standard, the ignition probability and the expected consequential loss. The default response time is; a positive detection within 30 seconds. In an ATEX 137 zone 0 there is almost always an explosive (gas)mixture in the area and therefore always the design fire A (33 x 33 cm) will be applied. Below a table is shown which enables getting an indicative image of the performance fire size:

ATEX 137	Ignition probability	Consequential damage	Performance Fire
0	-	-	A
1	very high	very high	A
1	very high	high	A
1	high	very high	A
1	high	moderate	B
1	moderate	high	B
1	moderate	moderate	B
2	very high	very high	B
2	very high	high	B
2	high	very high	B
2	high	high	B
2	moderate	high	C
2	moderate	moderate	C

For industrial safe areas (areas where no explosion hazardous gases and vapor will occur) with flammable solids one may take the ATEX 137 zone "2".

When determining the ignition probability one should for example take the risk into consideration that a vehicle might collide with the object or that several hot machines or electrical equipment are in the vicinity. Also phenomena such as lightning or the fire risk in adjacent buildings should be taken into account.

Consequential losses are for example production losses, damage on production facilities, unscheduled shut downs, environmental damages etc.

Caution: The table shown and the descriptions are purely indicative with the purpose to enable the end-user to determine the size of a performance fire.

Example:
For a for gasoline and diesel loading area the performance fire size may be estimated as follows:
- Jetty:
The location of the interface between the vessel (ship) and the equipment on the dock is often ATEX zone 2, the ignition probability is high and the consequential losses are very high: design fire B. The rest of the Jetty and the

Vessel itself: design fire C.
- Interconnecting piping between Jetty and Storage Tanks:
The pipe-racks have a moderate risk and high consequential losses: performance fire C.
- Loading location:
The location were the fuels are pumped into the tank of the truck has a very high ignition probability because of a hot exhaust or hot brakes of the truck and also because of the occurrence of much electrical (measuring)equipment and the consequential losses are high: performance fire A.

Detection distance:
The system design distance of a flame detector relative to the object to be protected in a system design lies on 70% of the maximum distance as a safety factor to compensate for spurious factors:

Indoor application:
- The height of the room, due to the accumulation of smoke under the ceiling.
- The ventilation grade.
- The lighting.
- The ambient temperature.
- The relative humidity.
- The reflection-properties of the obstacles, walls, floor and ceiling of the room.
- The height above sea level.

Outdoor application:
- The wind velocity and direction.
- The outdoor temperature.
- The relative humidity.
- The reflection properties of obstacles and objects.
- The occurrence of sunlight.
- The position of the sun.
- The height above sea level.

Factory setting:
The manufacturer supplies the flame detectors with a standard setting which is typically 50% to 75% of the maximum sensitivity. The reason is normally the suppression of the probability of false alarms but under special conditions it is possible, after consulting the manufacturer, to deviate form the standard settings. You can also agree with the end-user that the standard settings are compensated in the design of the flame alarm system. It is also possible to agree that for example at the take over point the flame detectors are tested at the highest sensitivity and after the test are put back into the default factory settings.

Contamination: Often the decay of the sensitivity due to contamination on the flame detector window is neglected. Because of contamination regular maintenance is obligatory. Flame detectors with a Built in Test automatically check the window of the flame detector. A negative test means that the detector has only 50% of the original sensitivity of the detector but a blob in the middle of the window might not be detected while the flame detector is completely blind. Compensation is necessary for critical applications.

Cone of Vision limitation:
The sensitivity of flame detectors on the edge of the cone of vision is often not as high as the sensitivity in the optical axis of the flame detector. Often the minimum sensitivity is 70% at a total cone of vision of 90 degrees.

Example:
The end-user has determined that for an outdoor application a target fire of 33 x 33 cm Heptane must be detected and there must be a spacial coverage. The pollution is limited and therefore no compensation in the design is necessary for the pollution.

One applies a flame detector at a maximum detection distance of 60 meters for a 33 x 33 cm Heptane fire if the highest sensitivity settings are set. The factory setting is 75% of the maximum sensitivity and these settings will be applied in the project. The sensitivity on the edges of the field if view of the flame detector is 100% on 45 degrees off the optical axis.
Maximum distance from to the object on the optical axis of the flame detector :
60 meters x 0,7 (spurious influences compensation) x 0,75 (factory setting) = 31,5 meters.