# ISC Safety Lore

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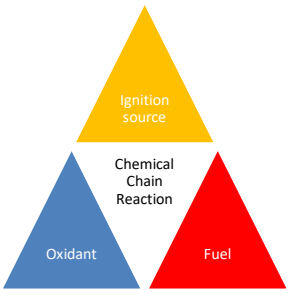
## Key lessons from incidents related to flammable atmospheres

### Introduction

Flammable atmospheres can be present across a range of different industries. The key concern related to flammable atmospheres is the risk of explosion and/or fire. There are four key elements required for a fire to form in a flammable atmosphere. This is called the fire tetrahedron. These elements are fuel, oxidant, ignition source and chemical chain reaction. A fire cannot occur or be sustained if any one of these elements is removed.




### Case 1 – Chemical manufacturing company

On 9 November 2010 a contract welder and foreman were repairing the agitator support on the top of an atmospheric storage tank (tank 1). The tank service was a flammable substance, called vinyl fluoride. While the welding was being performed, flammable vapours inside the tank ignited, causing an explosion. The welder was killed in the initial blast and the foreman suffered burns and minor injuries. The initial work was done while the slurry tanks were isolated and out of service. The work was delayed because of material availability. When the work recommenced tank 1 remained out of service, but the isolations were removed. There was also a vent line that connected the vapour space of Tanks 1, 2 and 3, that was never isolated. When tanks 2 and 3 were returned to service, vapour migrated to the tank 1 vapour space. This connection provided the pathway for flammable vapour to be present in the tank being worked on.

### Key findings

The work on these tanks had commenced when all the tanks were out of service, but due to delays and scope change, tanks 2 and 3 had been returned to service, meaning their isolations had been removed. The presence of a common vent line meant that vapours could travel between tanks. Tank 1 was not adequately isolated or vapour free when the welding took place. The late change of scope meant that the work was not planned as part of the initial shutdown activities. The permit to work form was not completed thoroughly, skipping the section on potential flammable atmospheres.

### Case 2 – Winery

On 17 January 2008 a contract welder was working on a tank (tank 104) at a winery. He was working alongside the chief winemaker and the assistant winemaker. The welder had visited the winery a few days prior to the incident to scope the work to install an upgraded cooling system. This work involved welding on a stainless-steel tank. When the welding was being undertaken there was no indication the tank was in service or contained ethanol. The welding ignited the flammable atmosphere, resulting in an explosion which killed the welder and chief winemaker. The assistant winemaker suffered serious burns.

### Key findings

Around a week before welding had been performed on tank 106, so when a delivery of ethanol arrived, it was pumped into tank 104 instead. When welding was arranged for tank 104, the contents of the tank were not checked and there was no effective safe work system to identify hazards and document controls to be implemented as part of the hot work. No atmospheric testing was conducted prior to the welding, nor was the tank positively isolated.


The ISC believes that leadership across six key functional elements is vital to achieve good process safety outcomes. These elements are:

- systems & procedures
- engineering & design
- assurance
- knowledge & competence
- human factors
- culture

In the *What can I do* section below you can see how each of these elements plays a part.

**Figure 1**: The ISC Framework

| What can I do? | |
|---|---|
| **Management** | |
| | • Ensure that safe work systems, such as permit to work, lock out tag out and atmospheric monitoring systems are in place and followed. |
| | • Make sure that the risks of hot work in flammable atmospheres are understood. |
| | • Ensure that there are written procedures for the operation of tanks, including labelling. |
| | • Ensure that the firefighting resources are available in the event of a fire when undertaking hot work. |
| | • Ensure that changes to scope are adequately assessed and approved prior to any work taking place. |
| | • Ensure all required personnel are adequately trained and competent in the permit to work systems, and that they know how to use the atmospheric monitoring devices. |
| | • Ensure there is a maintenance management system that defines how work is identified and scoped, and people are trained and competent in its use. |
| **Process Engineer/Supervisor** | |
| | • Make sure to follow company rules and operating procedures to protect workers. |
| | • Perform regular checks of the worksite to ensure controls are in place and working. |
| | • Ensure atmospheric monitoring is being performed where there is hot work in potentially flammable atmospheres. |
| | • Ensure that all scope changes are adequately risk assessed and documented. Any changes must be reviewed to ensure the conditions are suitable for the work to be performed. |
| | • Ensure all aspects of the safe work systems are in place and working appropriately. |
| | • When issuing a permit to work, ensure all hazards specific to the task are identified and that controls are implemented to manage these hazards. Ensure all those involved in the task are familiar with the hazards and controls. |
| | • Ensure all isolations are fully documented and perform a line walk to verify all isolations are correct. |
| **Operator** | |
| | • Ensure all plant is safely isolated as required by permit to work systems. |
| | • Ensure all atmospheric monitoring is completed as required by permit to work systems. |
| | • Perform regular plant checks on all work to ensure it is being performed as required and following the permit to work controls. |
| | • Report any deviation from the permit to work system. |
| | • Ensure plant is safely returned to work following the job. |