MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE
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FLASH ARIA
February 2021

BARPI
DGPR SRT

Recurring events: Fire/explosion of tanks equipped with heating devices

Consultation of the ARIA database reveals that many events recur in similar contexts and with similar causes. These causes may be generic, such as equipment malfunctions or the mixing of incompatible products, or more specific to sectors of activity: silo fires, warehouse fires, or specific to the use of certain products: ammonia, hydrogen, etc.

This is illustrated by events on tanks equipped with heating systems. The events observed involve installations having highly similar operating principles and have been identified in various sectors of activity with varying frequency over the last twenty years:

- Surface treatment workshops (no less than thirty events involving fire were reported: ARIA 57972, 57957, 56768, 54857, 56668, 53825, 53748, 52957, 51079, 50975, 49465, 49109, 48648, 47697, 47556, 47484, 43443, 42164, 41420, 41027, 38757, 36235, 35768, 35594, 35555, 30431, 30417, 27570, 23039, 17902),
- Bitumen processing plants (roughly a dozen events, specifically involving an explosion followed by fire): ARIA 58550, 57857, 56313, 54684, 49554, 47756, 46386, 37219, 34255, 31604, 24855, 22459),
- Chemical storage facilities (half a dozen situations identified involving fire: ARIA 53253, 43042, 39728, 36045, 33676, 33171).

ARIA 52957 – 01/02/2019 – LOIR-ET-CHER
A fire broke out on a tank containing 0.3 t of a mixed acid solution feeding a phosphating production line. The security guard raised the alarm. **The tank eventually ruptured, spilling product into a retention basin**. The fire resulted in an economic loss of €40,000.
The fire is believed to have been caused by a faulty electrical component on the level sensor and the combustible nature of the tank (PE plastic). The line involved had been out of operation for maintenance since 20/12/2018. On 28/12/2018, the preventive maintenance was completed after 4 hours of testing. The line had been in preheating mode just 6 minutes before the fire broke out.
Following the fire, a variety of actions were implemented:
. modification of the tank's materials (stainless steel);
. replacement of the control relays (as a preventive measure);
. modification of technology used to measure bath level;
. installation of a preventive maintenance system with a thermal camera.

ARIA 57857 – 04/07/2021 – GIRONDE
An explosion occurred in a metal bitumen tank (15 m high) in a company that manufactures, stores and distributes bitumen emulsion. The top of the tank was blown off and **landed more than 45 m away on the grounds of the neighbouring facility**. Upon arriving at the site, the operator switched off the electricity to the entire facility. The site was shut down.
The tank in question was destroyed, and two other tanks were damaged in the explosion.
The **amount of bitumen** in the tank was less than indicated by the sensor (10 tonnes) and **insufficient to cover the resistors completely**. The system began heating the fluid and caused the temperature in the tank to rise because the temperature sensor was not immersed in the bitumen. The heating system thus operated at its maximum level. The temperature rise caused a fire to break out, which ignited the combustion gases. The course of the accident implies that the level sensor had failed.


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ARIA 39728 – 03/02/2011 – RHÔNE
A fire broke out in a chemical warehouse that was inactive at the time. The flames had spread through the **area used to store acids, bases and peroxides and included 28 storage tanks**. This area is separate from the flammable products area.
The site's Internal emergency Plan (IOP) and the prefecture's Special Intervention Plan (SIP) were initiated. Six tanks containing hydrochloric acid, potash, flocculant, alkaline solutions and soda were destroyed, and the flames damaged five others.
Overheating of a heating element in an empty soda tank over several hours caused the incident, as the product low-level detector had not switched off its power supply. The energy produced melted and then ignited the tank filled with HDPE (high-density polyethene). The material of which tank is made of then also fuelled the fire.
The operator implemented the following preventive measures:
- no heating device on product storage tanks not requiring it;
- preference is given to steel or stainless steel tanks with electric or hot water heating;
- the new plastic tanks are heated by hot water only;
- the heating power must not allow a tank to ignite,
- the reliability of the controller used to regulate the tank heating systems must be improved.

Having the right equipment assets must not overshadow the importance of organisational and human factors

ARIA 47756 – 07/03/2016 – CÔTE D'OR

AT 4:50 p.m., **an explosion, followed by a fire, occurred in a facility producing bituminous road paving products**. The equipment involved was a 50 m³ soaker containing less than 300 kg of bitumen residues. The fire was put out at 8:20 p.m. The damage was limited to the soaker unit and the neighbouring tank, which was damaged by the blast.

At the time of the blast, the plant was being started, although no production was underway. To calibrate the temperature probes in light of an upcoming CE marking audit scheduled to take place two days later, the temperature of the soakers had to be raised to 160°C. **The procedure for safety heating the soakers prohibits heating if no product is present**. For this reason, **the heating had been switched to manual "forced operation" mode**. Before performing this action, **the manufacturer was consulted, who strongly advised against the proposed operation** for the following reasons:

. heating an empty tank is dangerous;
. forced operation mode excludes all heating safety devices;
. non-production conditions are not suitable for CE marking tests.

The inspection was postponed until the next production test.

Despite this, all the heating stages of the soakers were switched on, and then **the soaker exploded after 5.5 hours of continuous heating**. The system had correctly detected that the authorised thresholds were exceeded, and an alert message was displayed on the screen. However, **in forced operation mode, automatic actions are not possible**. The start of the tank heating system has not been admitted by none of the technicians (activation of each heating stage in the control room, i.e. 8 manual actions).

The probes and thermometers were not monitored while heating was in progress.


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The repetitious nature of these events shows that lessons learnt from feedback can be applied to the same activity but can also be extrapolated to other sectors.
The typology of events highlighted for tanks equipped with a heating system highlights the following lessons:

✓ **Design of facilities:**

The events point to three interacting elements that need to be taken into account when designing installations, particularly in terms of their compatibility with the operating conditions:

- the nature of the products stored: flammable or non-flammable, likely to generate decomposition products that are themselves flammable or even explosive, requiring or not requiring temperature control;
- the materials used for the storage tanks: flammable or non-flammable, and must be resistant to the products stored;
- the heating elements: essential or non-essential, electric or using a thermal fluid (steam, hot water, heat transfer fluid, etc.), sized for a specific heating power.

✓ **Reliable control equipment:**

- products are present in the tanks to prevent heating if tanks are empty (level and weighing sensors, etc.)
- temperature of the thermal fluids used, the products contained in the tank, the atmosphere in the tank, etc. (appropriately positioned probes and sensors);
- heating is controlled by the presence of product and by temperature control;
- no contact between the heating elements and the tank's walls;
- monitoring of all of the installation's operating and safety parameters.

✓ **Regulated operating conditions**:

- preventive maintenance of facilities and equipment to prevent failures;
- operating and intervention instructions (concerning the start-up of facilities in manual or automatic mode, shut-down of heating systems before intervention requiring tank emptying, after all interventions, etc.)
- training of personnel in procedures and operating instructions;
- monitoring and supervision of the installations during operations (the night prior, at night, early in the morning);
- verification that all instrumentation and control channels are operating correctly, that the servo-control and command logic is functioning correctly, and verification of automatic operation programmers.