Fire in a cement plant

07/09/2020

Montalieu-Vercieu (ISERE)

France

Fire
Scaling
Maintenance
Extinguishment

AFFECTED FACILITIES

Site:

The site's principal affected activity is a cement manufacturing plant that produces cement via the "dry process", using a mixture of marly and limestone rocks mined from quarries located nearby. After firing, these rocks provide clinker, which, when crushed, is the main ingredient in cement.

The site is also a co-incinerator of both hazardous and non-hazardous waste.

The site's manufacturing staff work on a 5 x 8 basis.

The site covers 42 hectares on the banks of the Rhône and is surrounded by an industrial zone, residential properties, and farmland.

For the waste co-incineration part, the site uses as combustibles:

- hazardous waste such as solvents, oils, impregnated sawdust, and contaminated water;
- non-hazardous waste such as automotive shredder residue (ASR), solid recovered fuel (SRF), dry wastewater treatment plant sludge, meal, wood waste, etc.

These combustibles are stored either in silos, or in pits.

The affected facility is the solid fuel storage facility.

The site is subject to the authorisation regime for both cement manufacturing and heat treatment of hazardous and non-hazardous waste.

Unit involved:

The incident began in the automotive shredder residue storage pit (volume: 650 m^3). It is filled with a mixture of shredded tyres (granulometry 0-50mm), accounting for 60% of the mix and automotive shredder residue, i.e., all shredded, scrap non-metallic vehicle parts (seat, bumpers, interior trims, etc.). This mixture has an average NCV (net calorific value) of 23GJ/t.

Next to this pit is a 650m^3 pit of impregnated sawdust. This sawdust has a minimum granulometry of 30mm and is impregnated with non-pumpable industrial waste. The impregnated sawdust is prepared on pre-treatment platforms and delivered to the cement manufacturing plant ready for use. It has an average NCV of 13 GJ/t.

Adjoining this pit is an unused, inaccessible, and supposedly empty zone.

Near this storage zone is the animal meal silo. It is a metal, hermetically sealed, 400m^3 silo. It stores up to 230t of animal meal. This meal is prepared in knackery plants and is inactivated at 133°C at 3 bars for 20 minutes before being transported to the cement manufacturing plant. It is injected into the heart of the flame at 2,000°C and immediately destroyed.

THE ACCIDENT, HOW IT HAPPENED, ITS EFFECTS AND CONSEQUENCES

The accident:

On the morning of Monday 7 September 2020, a fire broke out in an ASR (automotive shredder residue) and shredded tyre mix storage pit then spread to the impregnated sawdust storage pit and an inaccessible neighbouring pit that was supposedly empty but in which combustible fine dust had built up.

The estimated stocks at the time of the fire were as follows:

- 50 tonnes of ASR/shredded tyres;
- 200 tonnes of sawdust;
- 100 tonnes of fine dust.

The chronology of the event is described below.

At 7.25 a.m., a sub-contracted cleaner detected the fire. They noticed smoke above the grab in the tyre and ASR waste mix storage zone (known as “zone 1”) and reported it to the console operator. The console operator checked the camera and saw naked flames above the grab. The rest of the manufacturing team (electrical roundsman, manufacturing shift manager, and plant production manager) were informed and headed to the scene.

Upon arriving, the manufacturing team noted:

- that the position of the grab was the standard waiting position (grab right at the bottom of the zone, above the injection hopper);
- oil runoff from the grab to the hopper.

Access from the top of the grab on the 3rd floor was not possible. This would in fact have exposed staff to combustion gases in an enclosed space with a build-up of fine dust and access only via the safety ladder.

So, the grab was manoeuvred manually and moved down to the entrance of the pit in low position. The manufacturing team used an extinguisher and successfully put out the fire. However, a fire broke out along the pit in several places due to the burning oil that had fallen when the grab touched the combustibles stored in the pit.

At 7.36 a.m., the site's central control room operator called external emergency services and attempted to set off the deluge system. However, a faulty valve prevented the system from setting off. This valve is located by the pit. The production team unsuccessfully attempted to operate it manually. An unsuccessful attempt was made to set off the deluge system using the emergency button.

The production team got the small fire at the entrance to the pit under control but could not do anything about the second fire, which was totally inaccessible for them. The fire spread very quickly, including to the adjoining storage zone where impregnated sawdust was stored (called "zone 2") and to an unused zone (called "zone 3" and adjoining zone 2) which contained dust from operations in zone 2 that had built up since it was opened.

A thick plume of black smoke rose above the building.

At 7.45 a.m., the first SDIS teams reached the site. They decided to protect an adjacent silo adjoining the building that was filled with approx. 20t of animal meal. The firefighters set up a foam hose to manage the incident and a water hose to protect the silo.

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Right at the start of the firefighters' emergency response at 8.00 a.m., the valve upstream from a settling tank was closed to route the water used on the fire to the site's retention basin.

At 8.15 a.m., more than ten firefighting and emergency response vehicles were on site. A command post was set up. Staff were evacuated, rounded up, and counted.

At 08.20, entry to the site was prohibited for all lorries (including vehicles coming to load cement).


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At 09.00, the furnace was shut down preventively.

At around 09.15, the fire was brought under control by the firefighting and emergency response teams. Any risk of subsequent spread was ruled out.

At 09.20, the emergency services authorised the re-opening of the site to lorries.

The emergency services then focused on preventing the spread of the incident via systems (belts, pipes, galleries) and fought against fires breaking back out.

CO measurements were taken in the atmosphere (result: 2ppm).

Measurements were taken on the residual water routed to the retention basin, showing no impact in terms of pH, suspended solids, or conductivity.

At 14.00, the furnace was turned back on, and production resumed at 16.30.

At 16.00, the measures put in place by SDIS were lifted and the last monitoring team left the site at 21.00. The operator was asked to monitor the site, including organising rounds. The emergency equipment remained deployed overnight.

The next morning, puffs of smoke were detected, and the emergency services were called out again.

The incident was deemed to have ended the following day at around 16.40.

Consequences:

The fire generated a large volume of waste. The firefighting and emergency response teams recommended quickly clearing out the waste and emptying the pits. So, the stocks sprayed with foam were emptied out mechanically, without exposing staff to any emissions.


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Damaged property included:

- equipment, structures and electrical systems in the ASR and sawdust storage and distribution zones (unavailable for several months);
- electrical systems for unloading animal meal (unavailable for several weeks).

The estimated amount of damage exceeded €2.5 million.

European industrial accident scale:

By applying the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the "SEVESO" Directive and based on available information, this accident can be characterised by the following 4 indices:

Hazardous substances discharged	☐ ☐ ☐ ☐ ☐ ☐
Human and social consequences	☐ ☐ ☐ ☐ ☐ ☐
Environmental consequences	☐ ☐ ☐ ☐ ☐ ☐
Economic consequences	■ ■ ■ ☐ ☐ ☐

The parameters associated with these indices and their rating scale are available at the address: http://www.aria.developpement-durable.gouv.fr.

ORIGIN, CAUSES, AND CIRCUMSTANCES OF THE ACCIDENT

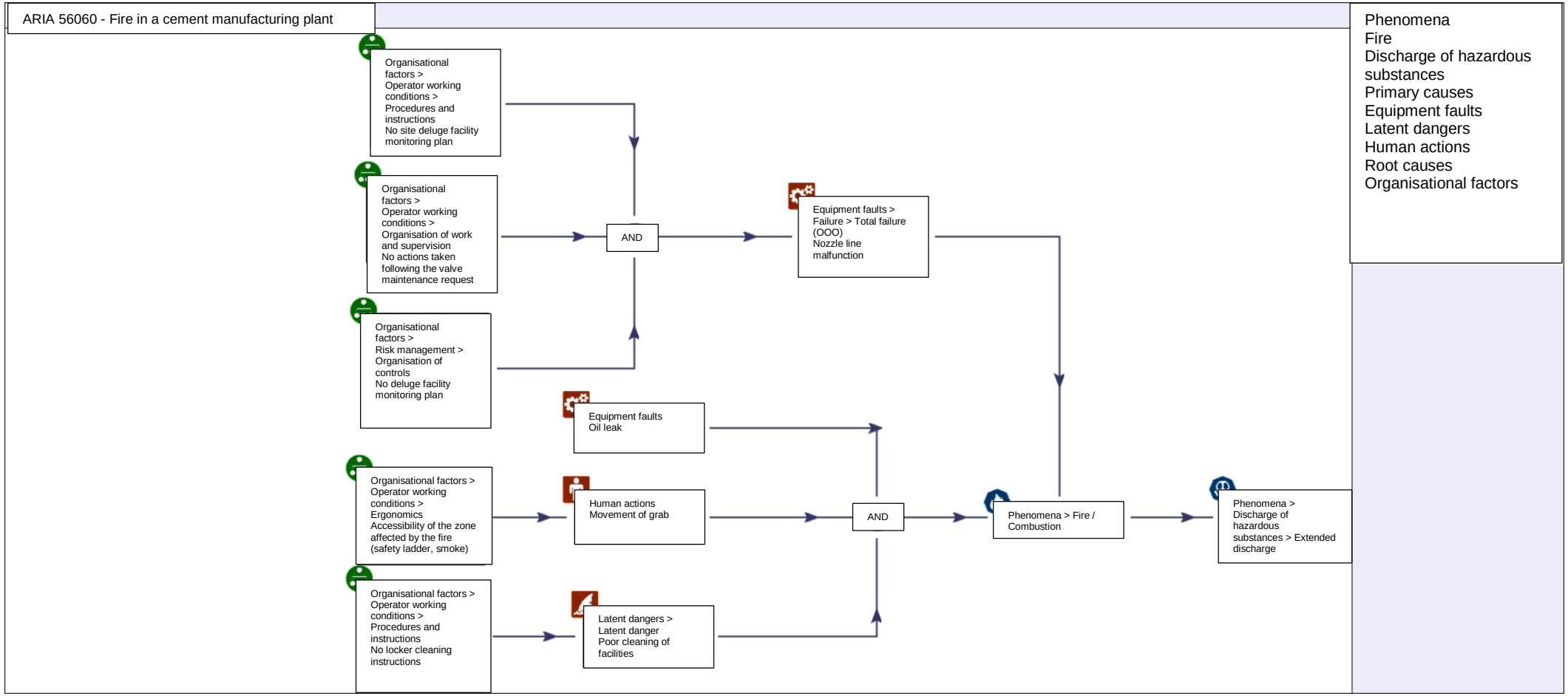
The incident originated from an oil leak from the grab's hydraulic system positioned above the ASR storage pit. The type of failure that led to the leak (electrical, mechanical, etc.) has not been determined.

Furthermore, the inability to access the top of the pit to extinguish the fire (access only via the safety ladder and presence of potentially toxic smoke) and the absence of operational fixed systems to extinguish the fire by the grab led operators to move the grab. Moving the grab above the waste pit caused burning particles to fall, spreading the fire.

Furthermore, the non-activation of the firefighting systems set up over the pits caused the fire to spread from pit to pit. This was due to the inaccessibility of the manual valves to douse the pits located in the hazard zone, malfunctioning of nozzle lines, and failure of the valve supplying the deluge system. This failure was due to there being:

- no plan to monitor the site's deluge systems (regular checks, testing);
- no action taken following a request to service the deluge system valve submitted 9 months earlier.

Finally, failure to clean the facilities led to the build-up of combustible substances in a supposedly empty pit.


ARIA 56060 - Fire in a cement manufacturing plant
Organisational factors > Operator working conditions > Procedures and instructions No site deluge facility monitoring plan
Organisational factors > Operator working conditions > Organisation of work and supervision No actions taken following the valve maintenance request
Organisational factors > Risk management > Organisation of controls No deluge facility monitoring plan
AND
Equipment faults > Failure > Total failure (OOO) Nozzle line malfunction
Equipment faults Oil leak
Organisational factors > Operator working conditions > Ergonomics Accessibility of the zone affected by the fire (safety ladder, smoke)
Human actions Movement of grab
AND
Phenomena > Fire / Combustion
Phenomena > Discharge of hazardous substances > Extended discharge
Organisational factors > Operator working conditions > Procedures and instructions No locker cleaning instructions
Latent dangers > Latent danger Poor cleaning of facilities
Phenomena
Fire
Discharge of hazardous substances
Primary causes
Equipment faults
Latent dangers
Human actions
Root causes
Organisational factors

ACTIONS TAKEN

Following the event, the operator:

- disposed of the water used on the fire contained in the containment basin on the site as aqueous liquid combustibles that cannot be used to generate energy;
- tested all the fixed firefighting systems within a month and set up periodic tests. The performance of a functional test of the installations after work has also added to the organization procedures;
- drew up a fire safety plan within 2 months for each facility on its site where combustibles are found (products, waste);
- reviewed its maintenance procedures. In particular, the following measures were implemented once a week for the grab: checking the oil levels, checking for leaks, blowing out the cart and the grab pump well. Weekly cleaning was also carried out in the fuel dosing room;;
- clarified the management of intervention requests in order to prioritize actions related to fire protection;
- kept a log of faulty firefighting systems;
- updated its crisis management procedure taking account of the lessons learnt from this event.

The inspection of the classified facilities requires additional systems monitoring actions:

- regular checks and real-life testing of fire safety systems;
- setup of a procedure to prevent the build-up of combustible substances outside zones intended for this purpose.

Additional site clean-up actions were also required such as:

- providing evidence of disposal of residues found in pits;
- purging of the drains to the containment basin prior to its reconnection to the Rhône River via the hydrocarbon separator.

Furthermore, for its new facility, the operator plans to rebuild the facility with a more suitable and more robust fire safety system by:

- setting up a temperature monitoring system in the pits (8 thermal imaging cameras with different alert thresholds);
- instrumenting the grab's on-board equipment;
- adapting the firefighting system to different possible scenarios;
- reporting the location of and identifying valves on the fire safety system:
- planning escape routes in emergency response zones.

LESSONS LEARNT

This event highlights several fire risk anticipation issues.

Firstly, it demonstrates how important it is to identify risks properly. To do so, the operator must firstly determine all the combustibles found on its site. This inventory must be exhaustive and not be limited to products and waste. This example shows that combustibles can be from utilities (hydraulic fluid used to control the grab) or made of dust.

So, it is necessary to ensure:

- the maintenance and design of the facilities, as well as adjusting and regularly checking that hydraulic lines meet operating conditions,
- regular cleaning of facilities and parts supposed to be “empty”.

The operator must also identify sources of ignition. These records must go beyond the simple standard operation of the facilities and properly identify risks in fail-soft modes. So, this accident shows that moving the grab above a zone filled with combustibles (the only possible option for operators to attempt to extinguish the incident) contributed to its spread. Burning particles actually fell into the pit and caused a fire to break out.

Then, this event shows how important it is to take measures to reduce the scope of an incident, particularly so-called “active” measures and to properly scale them.

The facility did have a fire protection system. However, several failures were pinpointed:

- inappropriate location of manual quenching valves;
- absence of a fixed system on equipment accessible only via a safety ladder, exposed to hazardous smoke in case of incident;
- malfunctioning of the deluge line.

This last point demonstrates the attention that must be paid by operators to organisational measures, particularly regarding procedures and instructions to maintain fire safety systems. So, if the request to carry out maintenance on the deluge system valve submitted several months before the event had been followed by action, it could have worked on the day of the event.

More regular testing of the fire safety system also could have highlighted this fault.