

What are the effects of heavy rains and flooding on industrial facilities?

Spells of scorching heat always give way to episodes of intense rainfall and what are known as Cévennes rain events. France has experienced many such rain events that have caused flooding that affected industrial facilities. The repercussions of these events, which can be described as NaTech events, are considerable. Many businesses have reported extensive material damage and operating losses and have been forced to lay off their employees for up to several weeks or months. The environment has taken a hit as well, with hazardous or polluting substances in particular being released.

Although well known, the risk of flooding is sometimes underestimated or even overlooked at industrial facilities. Yet, taking it into account can make facilities, not to mention the companies that operate them, less vulnerable. Adequately sizing stormwater networks, retention ponds and pumping equipment, installing electrical and IT systems at high locations, and protecting storage areas of hazardous products and waste are all aspects that must be included in the design and operation of industrial facilities. The risk of flooding must be baked into a site's operating procedures. In addition, monitoring of weather warnings is essential and must lead to the implementation of predefined mitigation measures that factor in potential delays between a given forecast and responding to the event itself.

ARIA 48825 – 30/05/2016 – LOIRET

After **four days of intense rain**, the **retention pond** at a logistics centre and another operated by the local authority filled with rainwater and overflowed. The lack of gullies in the nearby road allowed runoff to accumulate and exacerbate the flooding. Stormwater also built up at the loading bays, which are located at a low point around the site. However, this protected the surrounding area from flooding.

The electrical networks were down for an entire day during the flood event. The site's substation, located along the site's property line at a point below the road, flooded, causing the lifting pumps to fail. **Three diesel generators were brought in. They supplied the site with electricity for 25 days** and were used to pump up the standing water after an attempt using farming equipment (two 18 m³ tanks) failed. Firefighters were called in to find a better solution.

The site's phone lines remained intact (the IP PBX is protected in the computer room by an inverter) and the lines used to send remote alarm signals are direct analogue lines (PSTN).

The flood left the site inoperative for 36 hours. Lorries waiting to enter the site parked, with the municipality's consent, in the three streets that were closed to traffic.

The material damage was extensive: destroyed fence, structural subsidence and soil movement. The operating losses and material damage were estimated **at more than €100 million.**[...]

Flooding in France

In France, flooding is the most prevalent natural hazard in terms of the extent of the damage it causes, the number of municipalities affected, the extent of flood-prone areas and the populations residing in them.

Whether urban, rural, flat, hilly or coastal, the entire country is at risk of flooding.

It is a seasonal occurrence and is caused by rainfall that can be sudden, intense and sustained.

Slightly more than 17 million permanent residents of France, 16.8 million of whom live in metropolitan France, are exposed to the various consequences of river flooding. More than 9 million jobs are exposed to the risk of river flooding.



ARIA 48365 – 31/05/2016 – LOIRET

During an episode of heavy rainfall, the River Oeuf burst its banks and flooded the pumping station of a sugar refinery. The surface water entered the well and leached into the groundwater. The power supply was cut off. The well was unusable for 15 days and 14,720 m³ of water were purged out. This 100-year flood had not been factored into the site's risk analysis. In order to avoid a similar accident in the future, the operator is undertaking wetland rehabilitation projects in collaboration with the government's water department.

ARIA 44063 – 18/06/2013 – HAUTES-PYRENEES

The Gave de Pau river flooded a metallurgical plant following heavy rains. The plant's three furnaces were quickly shut down and emptied to avoid an explosion. The induction furnaces' cooling system was damaged. The furnaces were kept offline for an estimated period of four months. The press reported that 70% of the raw materials and finished products were unusable (cost: €4 million). Operating losses and equipment damage were estimated at €11 million. The accident was due to a dyke that had been breached by flooding in October 2012.

Feedback on the consequences of heavy rain-induced flooding allows us to draw the following lessons:

✓ **Flood risks must be identified:** flood risk maps, particularly those in flood risk prevention plans, must be consulted. It should be remembered that flooding — particularly from heavy rains — of sites located in areas deemed not subject to flooding is not an exceptional event.

Identifying this risk entails determining its potential intensity, i.e., the flow rate and velocity (which can have an impact on which objects are carried away by the current, debris jams, bank erosion, etc.), the height and duration of submersion (which may result in damage either directly from the water or indirectly due to the static pressure exerted by the water) and the rate of water rise.

✓ **Potential difficulties must be anticipated:**

- Impact of water: on buildings and facility structures (particularly tanks and pipes), stored products or waste (especially if they are hazardous, polluting or react with water), electrical and IT equipment and manufacturing processes;
- Power infrastructure disruptions: whether on or off site (e.g., flooding of a transformer serving an industrial facility) during a rainfall event and sometimes several days afterwards. The operation of facilities that must be shut down progressively must be anticipated. Preventive shutdowns of utilities are often recommended;
- Internal and external means of communication: PSTN services are frequently shut down during intense rainy episodes. GSM services may also be shut down;
- Site access: automatic gate systems may be out of service (due to power outages, for example), there may be debris jams, access roads may be cut off, a site's internal roads may have to be cleared to allow emergency access or enable diesel generators to be set up;
- Objects that could cause debris jams: objects such as empty pallets should not be stored outdoors and the number of objects that may be carried away by floodwaters should be kept to a minimum;
- Surface water infiltration: special attention must be paid to boreholes that may make it easy for surface water to contaminate groundwater;
- Ancillary systems at risk of being rendered inoperative: special attention must be paid to fire detection and extinguishing systems, wastewater treatment plants, etc.

✓ **Mitigation measures adapted to the vulnerability of the facilities and the kinetics of the event must be implemented.** Such measures can be of several types: resistance measures (preventing water from entering the site with flood barriers, check valves on water drainage networks, self-powered pumping systems, etc.), management measures intended to limit damage from the onrush of water (by raising or moving sensitive materials, hazardous products, IT equipment, etc.) and thus reduce the time needed to normal operations and, finally, an ultimate phase of transitioning the facilities to a safe fallback state. **The appropriate equipment** (waders, torches and head torches, lifting pumps, diesel generators, etc.) **and the necessary human resources** able to go to the site (especially when events occur at night or on non-business days when travel is strongly discouraged) **must be planned in advance.** Staff training and awareness-raising in flood-risk management is essential, as is including this risk in a site's ad hoc procedures (particularly regarding the maintenance of water networks, gutters, drainpipes, etc.). It is wise to designate a fallback area beforehand.

It is important to bear in mind that flood events can occur in entire geographical areas that are of varying extents and home to multiple industrial facilities that could be affected. In addition, emergency services will prioritize providing assistance to the general public and difficult weather conditions at night complicate air-rescue operations.

Lastly, getting a site back to normal operations after pumping (which sometimes requires the use of large-capacity equipment) and clean-up operations have been completed can take time. There may be many layoffs during this period.

Anticipating flood events due to heavy rainfall is therefore vital and must be combined with monitoring of weather warnings and forecast maps that give 24-hour warnings of approaching dangerous weather.