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ARIA
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BARPI
DGPR SRT
Médiathèque interactive de référence
en accidentologie industrielle

Synthesis

May 2021

Accident trends in the waste sector

2017

2019

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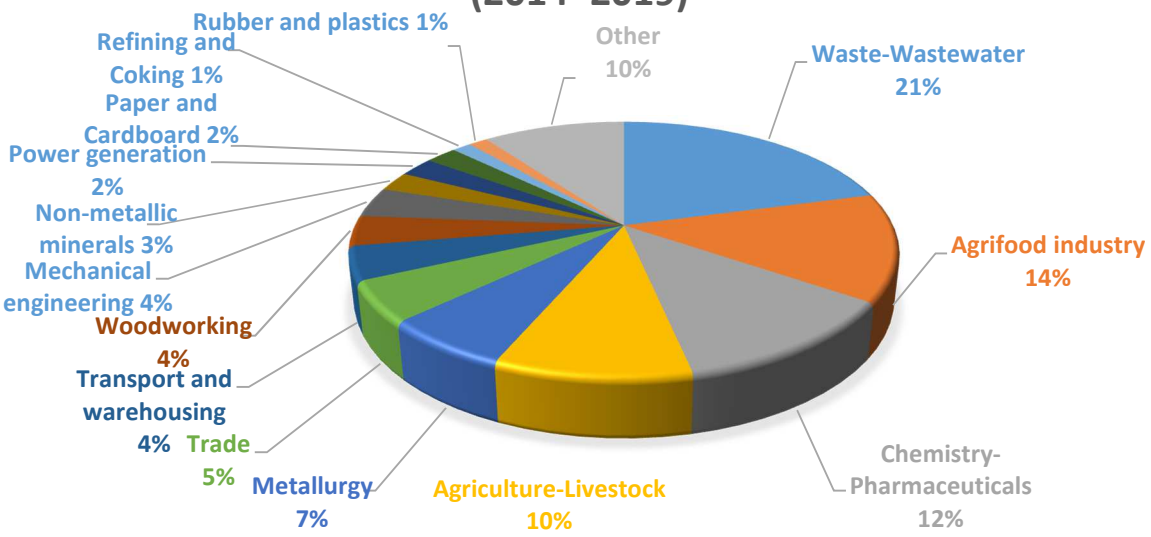
INTRODUCTION

The last 6 years data published in the *Inventory of Technological Incidents and Accidents in 2019* confirm that the waste and the wastewater sector is a major source of accidents at French facilities classified as presenting risks to the environment. Moreover, the sector has seen the greatest increase in the number of such events. The proportion of accidents occurring in the waste and wastewater sector increased considerably between 2010 and 2019, from 14.5% of all accidents recorded to 24.2%.

In 2019 alone, the sector accounted for nearly a quarter of the events at French facilities recorded in the ARIA database.

BREAKDOWN OF ACCIDENTS BY SECTOR OF ACTIVITY (2014–2019)



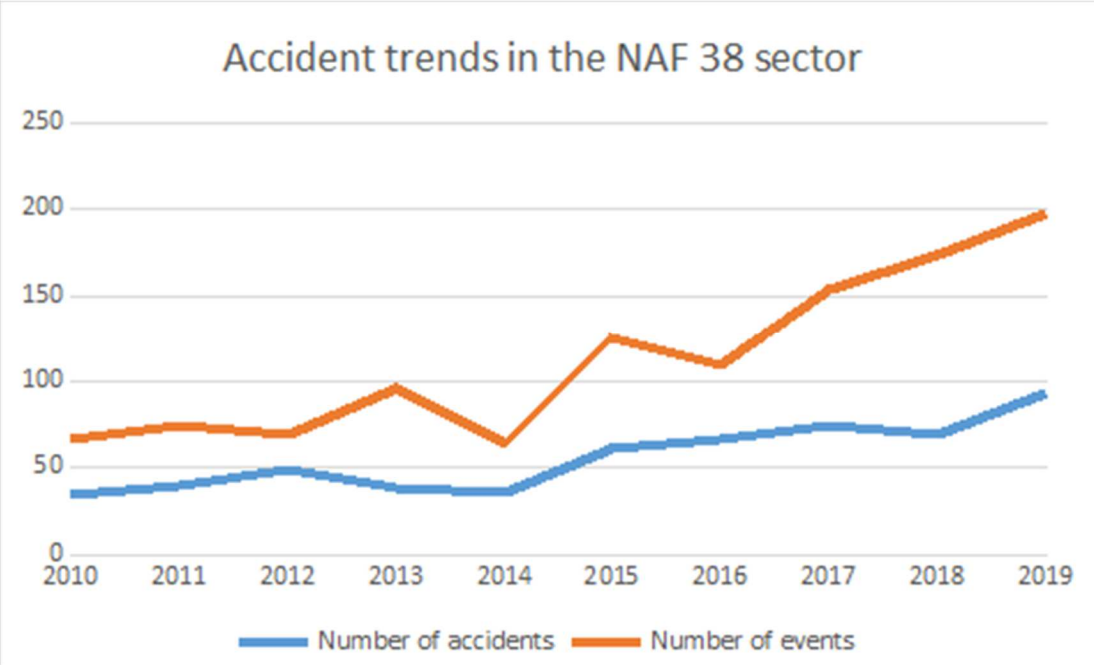
A comprehensive large-scale analysis of accidents and incidents in the waste sector over the last 10 years is proposed in this document. It is followed by detailed analyses of smaller samples of the various activities in the sector and which can be distinguished within it.

1 COMPREHENSIVE LARGE-SCALE ANALYSIS OF THE WASTE SECTOR

This comprehensive study focuses on a sample of events recorded in the ARIA database over the last 10 years and corresponding to the sector of activity identified in France by NAF code 38: waste collection, treatment and disposal; recovery.
NAF 38 comprises the following activities:

- 38.1: Waste collection;
- 38.2: Waste treatment and disposal;
- 38.3: Recovery.

As of September 2020, the ARIA database contained 10,412 events that had occurred at classified facilities in France between 1st January 2010 and 31 December 2019.
Of these events, 1,693 occurred at NAF 38 facilities and 564 (or one-third) of those were accidents.[1]



No major accidents were recorded between 2010 and 2019.

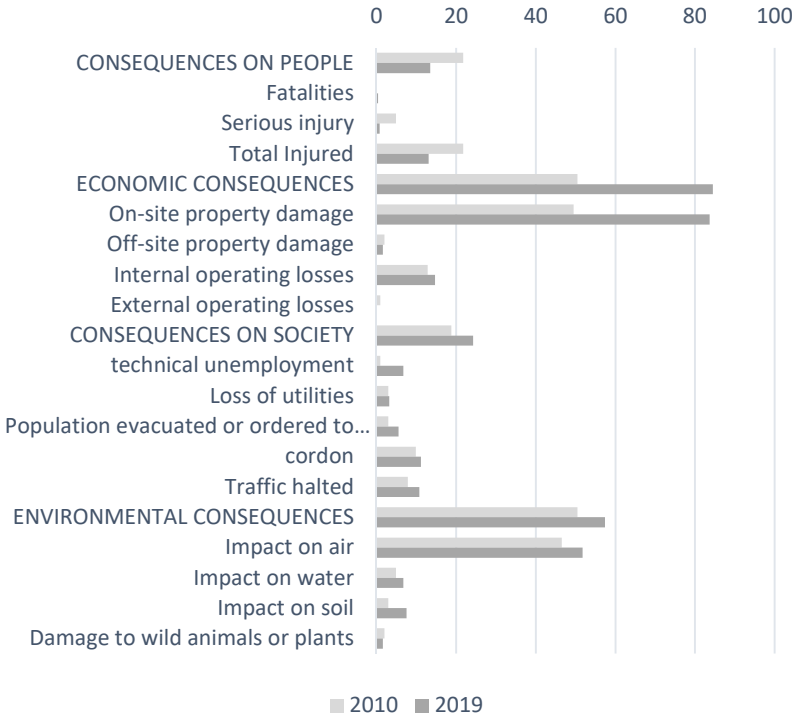
[1] The definition of accident is provided in the appendix to this document.

Economic consequences in most cases

Consequences of NAF code 38 events over the period 2010–2019

Most of the events had economic consequences and the data contained in the ARIA database show that the percentage of events with an economic consequence increased between 2010 and 2019.[2] The consequences on society and the environment increased at a much lower pace. The human impact also decreased.

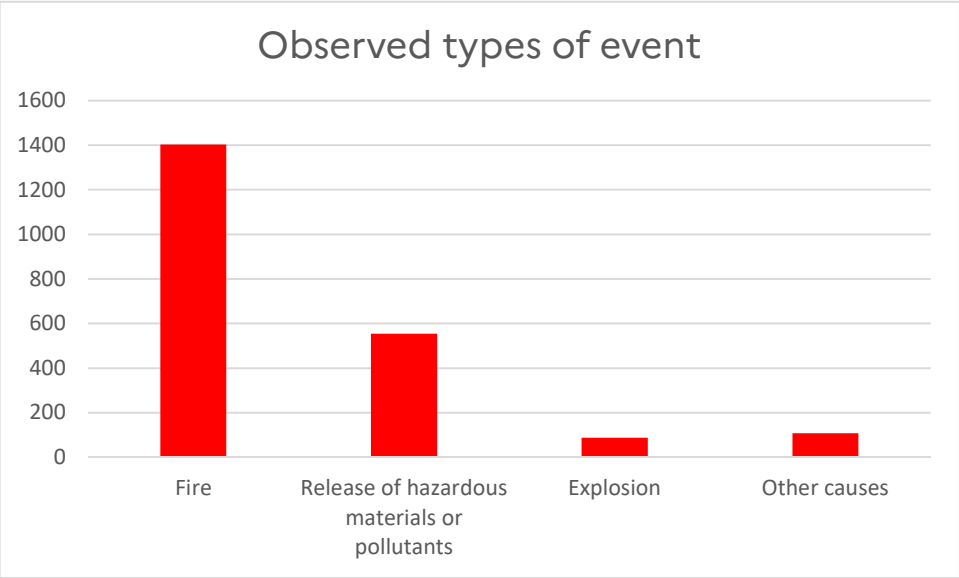
Percentage of consequences as a function of the number of events



[2] The quality of the feedback provided to BARPI can affect the number of events recorded as having economic consequences.

ONE MAIN TYPE OF EVENT: FIRE

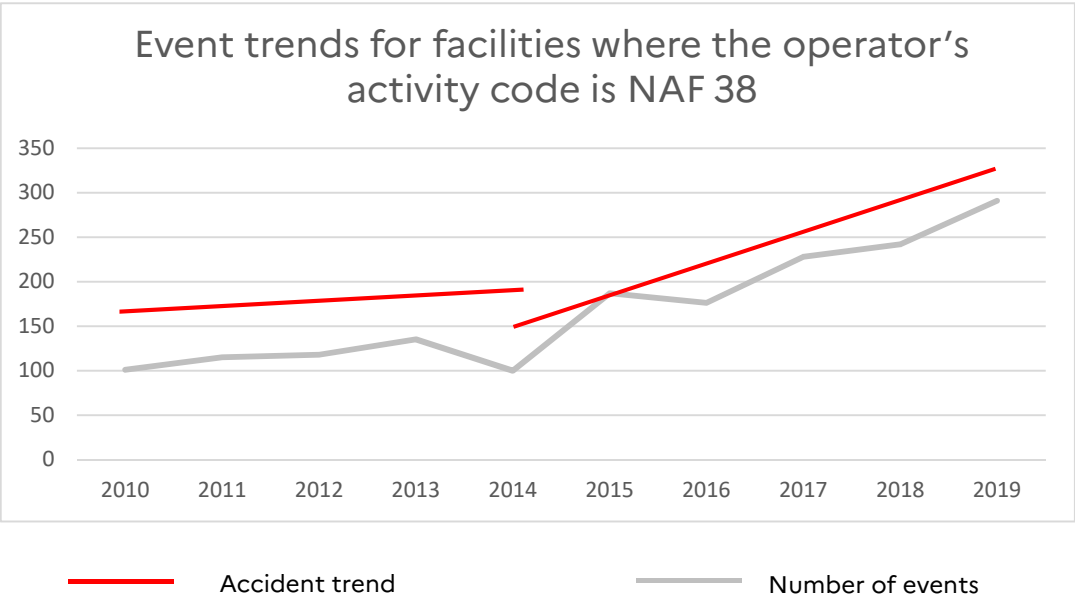
The majority of events in the waste and wastewater sector are fires, accounting for 83% of the events recorded in the database.



Other types include an accident involving heavy equipment (ARIA 49927), perforation of a geomembrane by a bucket loader (ARIA 50685, 50692) and a leachate pump that was intentionally turned off (ARIA 54966).

AN INCREASING ACCIDENT RATE

The number of accidents recorded between 2010 and 2019 rose sharply as of 2014.



In order to conduct a detailed analysis of the causes of events in the waste sector, we propose focussing on the recent events shown in the graph on the opposite page. The period 2017–2019 therefore totals a sample of 769 recent events that are big enough to be representative and allow a meaningful analysis of accident trends in the waste sector.

The breakdown of these events by activity is as follows:

Type of activity where the event occurred	Number of events recorded in the ARIA database[3,4]
Non-hazardous waste sorting/transit/consolidation facilities (shredders excluded)	208
Waste storage facilities	146
ELV facilities	90
Composting	63
Incineration plants	57
WEEE management facilities	41
Methanation facilities	17
Household waste recycling centres	26
Hazardous waste sorting/transit/consolidation facilities	23
Non-hazardous waste sorting / transit / consolidation facilities (shredders included)	22
Other non-hazardous waste disposal sites	21
Other hazardous waste disposal sites	46
Transport of hazardous materials	6
Other[5]	10

A thematic analysis of activities involved in the greatest number of events is set out in the following pages. The exceptions to this are facilities that have been the subject of a previous publication, i.e.:

- Waste storage facilities;
- Non-hazardous waste sorting / transit / consolidation facilities;
- ELV facilities;
- WEEE management facilities.

Each topic in this publication is discussed in separate chapters and each chapter ends with a conclusion. Its general conclusion summarises the conclusions at the end of each chapter and highlights general and specific points.

Other topics are discussed in previous BARPI publications, i.e.:

- Incineration plants ;
- Composting ;
- Methanation facilities (extraction 2011, Flash May 2018, Flash March 2021)

Household waste recycling centres, and in particular the issue of their access by the general public, will be the subject of a future publication.

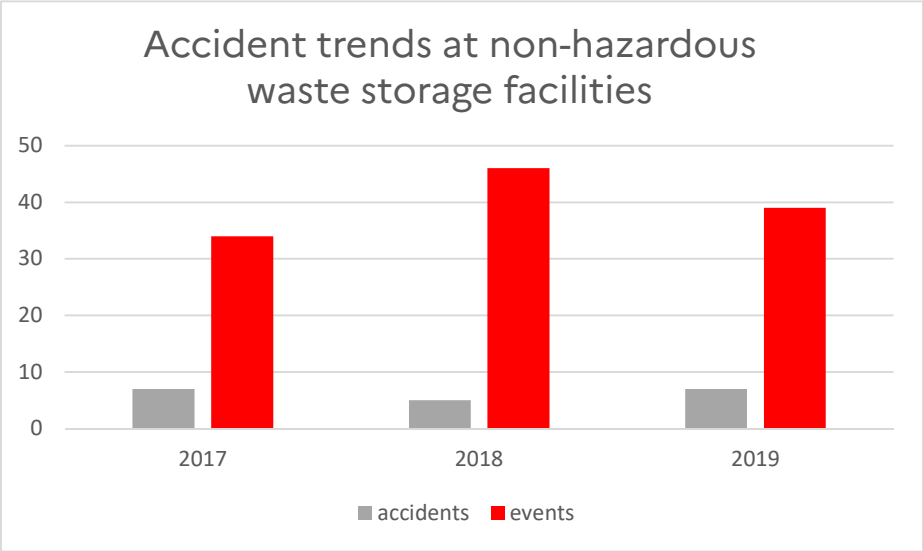
[3] As at 7 September 2020.
[4] Some events are listed in several categories due to an inability to determine where exactly they occurred on a given site (e.g. in the case of an event at a combined hazardous/non-hazardous waste sorting, transit and consolidation facility, the data in the ARIA database do not indicate if the event happened at the hazardous waste portion or the non-hazardous waste portion of the facility).
[5] ' Other ' comprises animal by-product processing facilities and wood waste boilers.

2 ACCIDENT TRENDS AT WASTE STORAGE FACILITIES (2017–2019)

Between 1st January 2017 and 31 December 2019, 146 events were recorded at waste storage facilities, among the events occurring at a facility where the operator's activity code was NAF 38 (waste collection, treatment and disposal; recovery).

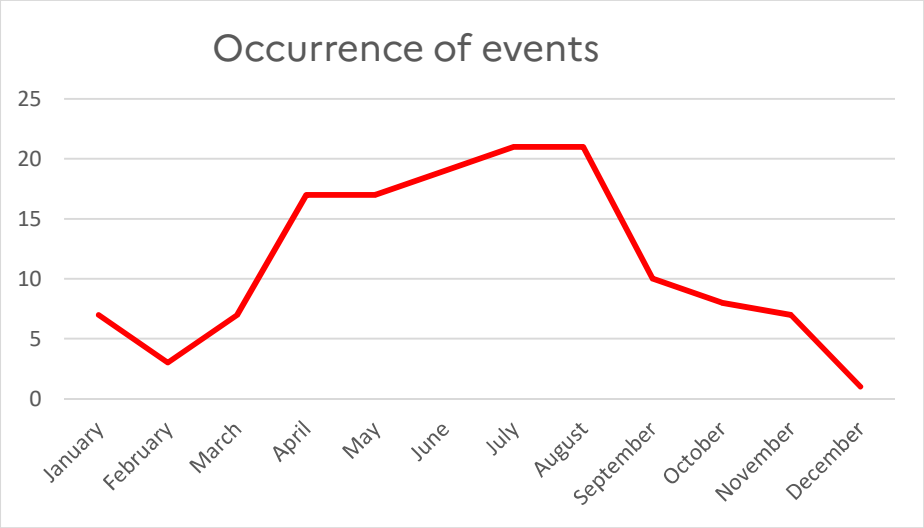
Of these events, five occurred at hazardous waste storage facilities, two at extractive industry waste storage facilities and one at an inert waste storage facility. Non-hazardous waste storage facilities accounted for 138 events. The accident trends at these facilities are explained in detail in the following pages.

As for all NAF 38 activities, the number of events tended to increase between 2017 and 2019. However, the number of accidents remained steady.



The event occurrence rate increased during the period from April to August, the months with the highest temperatures.

It is important to note that 2019 was the second-warmest year on record, according to the World Meteorological Organization.



Of these events, 18 (13%) were listed as accidents. This is well below the percentage of accidents reported for NAF 38, which was 33% for the 2010–2019 period.

FIRES THE MAIN TYPE OF EVENT

Fire was the observed in more than 90% of the 138 events recorded.

The breakdown of types of event[6] is as follows:

	Number of events	Percentage of recorded events
Fire	**126**	**91.3**
Release of hazardous materials or pollutants	**19**	**13.7**
Prolonged release	16	11.4
Into the soil/secondary containment	*3*	*2.2*
To atmosphere	*14*	*10.1*
Into water	*5*	*3.6*
Explosion	**2**	**1.4**
Other	**5**	**3.6**

[6] An event may be of one or more recorded types.

Fire was also involved in the two explosion events.

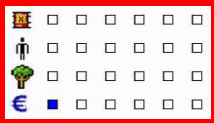
One explosion event was caused by the presence of distress flares (ARIA 49807) and the other occurred when the batteries of a compactor located in a waste cell exploded (ARIA 51064).

In 12 events, hazardous materials or pollutants were released in the smoke from the fire.

The seven other events involved the release of leachate (ARIA 49620), the release of bentonite during the manufacture of a passive barrier system (ARIA 51048), the release of chlorine from waste (ARIA 50727) and chronic pollution from a disused household waste landfill (ARIA 51758).

Compactor fire at a waste storage facility

ARIA 51064 – 06/02/2018 – Changé



At around 6:10 p.m., a fire broke out on a compactor in a cell at a non-hazardous waste storage facility. One of the facility's firefighters attempted to put the fire out with extinguishers, but the compactor's two batteries exploded. The internal emergency plan was activated. Firefighters extinguished the fire with foam, as water proved ineffective. The internal emergency plan was lifted at 8:00 p.m. The area was monitored closely overnight. The compactor was destroyed. The property damage amounted to €460,000.

The loss adjuster was unable to identify the cause of the fire. Maintenance carried out by the manufacturer under contract had not revealed any issues. The periodic inspection conducted two months earlier by an inspection body had not found any issues either. The only thing of note is that, at the end of the day, the compactor's motor was hot because it had been running all day long.

Focus on fire (126 events)

Alert

In 26 of the events involving fire (20% of cases), the alert was given by a person not connected with the facility , i.e. residents (ARIA 50893, 52503), motorists (ARIA 49690, 53979) and outside contractors (ARIA 52052). **Fire detection is therefore necessary and important at these facilities.**

Fire at a waste storage facility

ARIA 52503 – 17/07/2018 – Retzwiller

At 6:45 p.m., a fire broke out the surface of a 10m² non-empty cell at a non-hazardous waste storage facility. A neighbouring resident alerted the firefighters....

Extinguishing methods

In 82 of these events (more than two-thirds), the flames were covered by inert materials available on site . **This proves the benefit of stockpiling sufficient amounts of materials near fire-prone areas and of having heavy equipment drivers on hand when fires break out.** This is not always the case (ARIA 51962).

Fire at a non-hazardous waste storage facility

ARIA 51962 – 21/07/2018 – Villeherviers

On a Saturday afternoon, a fire broke out in a cell at a non-hazardous waste storage facility. The fire spread to the active barriers (geomembrane, geodrain and geotextile membrane) on two sides of the cell. Neighbouring residents gave the alert. The firefighters arrived. The operator called in an outside company to smother the flames with earth. ...

Fires can also be smothered without water **simply by covering them with inert materials** (ARIA 50003, 51558, 54532).

ARIA 52029 – 03/08/2018 – St Florentin

Difficulties encountered by firefighters services

The following difficulties can complicate the task for firefighters services:

- access difficulties in six events (padlocked access in ARIA 49479) ;
- water supply difficulties in 10 events: the need for a continuous stream of fire trucks (ARIA 54120), a site without a water supply system (ARIA 49529) and the pumping-in of seawater requiring a change of suction point depending on the tide (ARIA 51290) ;
- adverse weather conditions due to extreme heat (ARIA 49807) or strong winds (ARIA 54123) ;
- difficulties in locating a biogas pipeline (ARIA 49621).

It is therefore necessary to:

- **ensure that facilities are accessible in the event of fire, such as by providing first responders with the operator's contact details;**
- **have a sufficient number of adequately-sized fire cisterns;**
- **be able to provide first responders quickly with a map of the facility's infrastructure.**

Fire at a non-hazardous waste storage facility

ARIA 51962 – 21/07/2018 – Villeherviers

At around 4:00 a.m., a fire broke out in an operating cell at a landfill … However, the firefighters encountered several difficulties requiring improvements to be made by the operator:

- They had trouble finding the exact location of the biogas pipe running through the landfill cell. Its location must be made visible and its shut-off valves must be marked on a layout drawing.
- They had not been provided with a plot plan. Such a plan (showing access points, water supply points, etc.) should be provided at the site entrance and be detachable for reference when responding to emergencies.
- They had difficulty telling the effluent ponds and the stormwater ponds apart (only the latter may be used to fight fires). Signs indicating the types of pond and their water capacity should be posted. Openings could be made in the lower portion of the fence on all four sides to make it easier to slip fire-engine hoses through.

ARIA 50074 – 29/07/2017 – Fresnes-sur-Marne

Context

In 68 events, or more than half the cases, fires broke out while facilities were operating at reduced capacity (i.e. at night or on Sundays and other non-business days). **Fire detection is therefore of particular importance, especially during such periods of reduced capacity.**

THE SIGNIFICANT ECONOMIC AND ENVIRONMENTAL CONSEQUENCES OF FIRES

Over the period studied, no fatalities were reported and five people were injured (four with minor injuries) during five events. The local social consequences were limited, with just nine events being concerned. No workers were furloughed over the period studied according to the information in ARIA.

There were economic consequences in 89 events (nearly 65%), with nearly all consisting of damage to on-site property.

Fire was involved in almost all these events. The property damage reported was to:

- the passive and active barrier systems of non-empty cells or adjacent cells (ARIA 50306, 52140, 53842, 54401) ;
- membrane bioreactors placed over cells (ARIA 49611) ;
- leachate collection systems: well (ARIA 49153), sump pump (ARIA 54300), electrical room of the treatment facility (ARIA 52617) ;
- biogas systems: manifolds (ARIA 52443), cogeneration plant (ARIA 49956), transformers (ARIA 51504) ;
- surveillance systems: thermal imaging camera (ARIA 52045), CCTV camera and infrared sensors (ARIA 54569) ;
- fire hydrants (ARIA 55233) ;
- debris containment netting (ARIA 49831) ;
- heavy equipment, especially compactors (ARIA 53722).

The consequences therefore mainly affected the infrastructure of waste cells.

Fire at a non-hazardous waste storage facility

ARIA 54401 – 15/09/2019 – Soings-en-Sologne

At 6:15 p.m., a fire broke out in a 10,500 m³ cell at a non-hazardous waste storage facility. The flames consumed 700 m³ of household waste.... One side of the cell's active barrier system burnt all the way through to the passive safety barrier. Biogas collection equipment also sustained damaged....

In addition to damage from fire, the active barrier systems of cells may be perforated by site vehicles (ARIA 50685, 50962).

Managing burnt waste from fires at non-hazardous waste storage facilities is fairly straightforward. Burnt waste is left in the landfill cell and firewater is treated with the leachate from the cell that caught fire.

Environmental consequences were reported in 47 events (about 38%). In most cases (39 events), **an impact on the air was recorded on account of the smoke from the fire**.

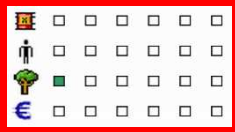
Soil was impacted in six events:

- the consequences of fire were damaged passive and active barrier systems that created a risk of soil and groundwater pollution (ARIA 52112), impact on a market gardening area located next to a non-hazardous waste storage facility (ARIA 53956) ;
- consequences of the release of leachate (ARIA 49620, 52961) ;
- illegal waste storage facility (ARIA 51107).

Consequences on water were reported in four events, half of which related to releases of leachate (ARIA 49620, 50682).

Leachate released at a non-hazardous waste storage facility

ARIA 49620 – 15/04/2017 – Manses



Leachate was released at a non-hazardous waste landfill. The landfill's workers saw that the Coume-de-Millas, a stream, was contaminated. They installed a cofferdam on the stream and pumped the water into it and directed it (via a tank) into the leachate storage pond. A total of 600 m^3 of leachate was released into the stream and the landfill's on-site pond. The stream's water and that of the Bessous was tested for contaminants.

The release was caused by a failure of the leachate evaporation system's PLC. In the system, leachate is pumped from the storage pond to a tank. However, the PLC failed to turn off the pump. This caused the tank to overflow. A portion of the leachate flowed out from the tank platform and the other portion flowed out from the landfill's on-site pond via its overflow.

Following the accident, the company in charge of servicing the PLC changed its program to prevent the same thing happening again.

CONFIRMED OR SUSPECTED DISRUPTIONS — A STRONG INFLUENCE OF EXTERNAL HAZARDS

Confirmed or suspected disruptions[7] were reported in 89 events (nearly two-thirds of the events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected disruption was recorded
Equipment failures	14	15.7
Human intervention	21	23.6
Losses of process control	31	34.8
External hazards	40	44.9
Latent hazards	32	36.0
Malicious acts	10	11.2

In nearly half the events, the disruption was caused by an external hazard. Virtually all were caused by natural hazards, with extreme heat — which can be either a triggering or an aggravating factor — being the primary example.

The ARIA database contains 26 fires where extreme heat is identified as the disruptor. In 14 of these, extreme heat is blamed as an aggravating factor.

Latent hazards and loss of process control are identified in 10 events as being confirmed or suspected disruptions.

Latent hazards and loss of process control mainly consist of:

- prohibited items found in storage cells, such as distress flares (ARIA 50308), chemicals (ARIA 49625) and batteries (ARIA 52278) ;
- heating (ARIA 54183) , ignition (ARIA 53490) or accidental fire (ARIA 50308).

Implementing or heightening screening procedures to identify any non-compliant incoming waste would avoid such fires in the future.

Fire at a non-hazardous waste storage facility

ARIA 53490 – 23/09/2019 – Courlaoux

An employee of a non-hazardous waste storage facility saw a flash of light when the compactor was passing over newly delivered waste (sorting refusals) in an operating cell. He gave the alert and removed the culprit, an LR20 battery, from the cell. The battery was placed in an area away from the waste pile....

While the waste was being compacted, a tooth on the sheepsfoot compactor crushed the battery, creating an electrical arc. The employee's swift action prevented the heat from the arc spreading to the rest of the newly delivered waste and onto the entire waste pile.

[7] An event may have one or more confirmed or suspected disruptions.

In most cases, the human intervention consisted of one or more required actions that either were not implemented at all (covering of waste: ARIA 53523, 53537 and 53842) or were implemented incorrectly:

- use of heavy equipment: poor manoeuvring of a compactor (ARIA 49927), perforation of the active barrier with the teeth of a bucket loader (ARIA 50685, 50962) ;
- waste compaction (ARIA 49618, 51819) ;
- acceptance of waste: inadequate incoming checks (ARIA 53499) or acceptance outside business hours (ARIA 54123) ;
- while performing work: poorly made welds (ARIA 50599), failure to cover areas adjacent to work areas (ARIA 50352) ;
- leachate management : incorrectly labelled valves (ARIA 53307) or loose clamps (ARIA 50682).

Drawing up and following operating procedures would prevent such fires occurring.

Fire at a non-hazardous waste storage facility

ARIA 53523 – 24/04/2019 – Fresnes-sur-Marne

A fire broke out in a 200 m² non-empty cell of a non-hazardous waste storage facility. The operator used three of the facility's heavy equipment vehicles to cover the waste with 1 m of sand. Smoke rose into the sky and spread over a long distance. Because the smoke spread into flight paths, the nearby airport was informed of the incident. A drone rigged with a thermal imaging camera was used to survey the area and ensure that the sand had eliminated all hot spots. A meeting was held with the mayor two days later.

After visiting the site, the inspection authorities for classified facilities found that the daily procedure for covering waste had not been followed.

CONFIRMED OR SUSPECTED CAUSES — THE ORGANISATIONAL FACTORS BEHIND UNWANTED EVENTS

Confirmed or suspected causes[8] were reported in 57 events (more than 40% of events). Only organisational factors were reported and these consisted primarily of risk management (54 events). No human or imponderable factors were reported.

The breakdown of organisational factors is as follows:

	Number of events	Percentage of events for which a confirmed or suspected cause was recorded
Organisational factors	**57**	**100**
Risk management	54	94.7
Organisation of inspections	23	40.4
Learning from experience feedback	26	45.6
Choice of equipment and processes	14	2.5
Human factors	/	/
Imponderable factors	/	/

Twenty-six waste cell fires occurred at non-hazardous waste storage facilities where one or more fire events had already occurred and the operators had not learnt the lessons of these events.

It should be noted that 87 of the 138 events recorded over the period 2017–2019 occurred at sites where an event had already been reported during the very same period:

- one facility was affected by eight events;
- another facility was affected by six events;
- five facilities were each affected by five events;
- four facilities were each affected by three events;
- eighteen facilities were affected by two events.

The recurrence of events at certain facilities shows that feedback on experience is not sufficiently taken into account.

[8] An event may have one or more confirmed or suspected causes.

In 23 events, one of the confirmed or suspected causes was the organisation of inspections. The following points are worth noting in the case of cell fires at non-hazardous waste storage facilities:

- inadequate inspection of incoming waste (ARIA 51820, 53499) with no checking of the temperature of specific incoming waste (ARIA 54183) ;
- insufficient caution during periods of extreme heat (ARIA 51819, 53956) or during non-business hours (ARIA 52443) ;
- insufficient site surveillance coupled with inadequate inspections intended to quickly detect fires (ARIA 50893), surveillance camera malfunctions (ARIA 52443, 54431) or the absence of enhanced inspections following repeated fires (ARIA 49077) ;
- inadequate waste compaction in a biogas well, causing the waste mass to partially collapse and become exposed to the air (ARIA 50204).

Particular attention must be paid to inspections, whether they are conducted on incoming waste or as part of monitoring activities during or outside operating hours.

Fire at a non-hazardous waste storage facility

ARIA 51819 – 23/06/2018 – Lieoux

One Saturday at around 6:45 a.m., a fire broke out in a cell at a landfill....

The fire started during a period of high heat while the landfill was closed. Two of the site's three compactors were down, limiting the efficiency of compaction operations. The presence of residual air pockets may have increased the risk of fire. A meeting with firefighters was planned to discuss the feedback from the accident and the response.

Another fire had occurred at this site one year earlier (ARIA 49621).

Following this new event, the operator:

- had the two downed compactors repaired;
- had on-call technicians monitor the site every weekend during the summer;
- reiterated the instructions on the compaction of waste: compaction must be continuous and compactors must be parked at weekends so as to keep access to the unloading dock and the waste pile clear;
- distributed walkie-talkies to his technicians for fast communication;
- looked into installing a thermal imaging camera to speed up response in the event of another fire breaking out.

CONCLUSIONS

Fire is the primary cause of accidents at non-hazardous waste storage facilities. More often than not, fires occur in late spring and over the summer and, in almost half of cases, start when a facility is operating at reduced capacity.

Fire detection is therefore essential in ensuring that emergency services are alerted as quickly as possible and can access a site without difficulty. Particular attention should therefore be paid to:

- the siting and maintenance of systems used to detect fires and notify alarms to operators;
- the existence of fire procedures and their understanding by operators;
- the thoroughness of the fire procedure, which must specify in particular who opens a facility's access gate if an accident occurs outside business hours;
- the clearing of brush around sites and the proper maintenance of fences to reduce the risk of foul play.

Sufficient quantities of non-combustible absorbent materials must be stored near accident-prone areas and heavy equipment drivers must be on hand. Particular attention must therefore be paid to:

- the quantity of non-combustible absorbent materials available on site;
- the locations of non-combustible absorbent materials in relation to areas where work is being performed;
- the number of site vehicles that can be used and the procedure to be followed by their drivers in the event of an accident (on-call procedure, time required to reach the site, etc.);
- covering waste as often as specified and in accordance with the defined procedure;
- placing intermediate coverings in accordance with regulatory requirements;
- the availability of fire cisterns or the proper connection of internal or external means of emergency response.

Periods of extreme heat and the types of incoming waste, which can be sources of ignition or heat, must not be overlooked. The following points therefore merit highlighting:

- proper management of incoming waste with, in particular, ensuring that waste is sorted by source and type and that maximum daily capacities are not exceeded;
- following prior information and acceptance procedures and, where applicable, verifying that certificates of prior separate collection or sorting operations have been provided;
- the incoming inspection procedure (weighbridge CCTV cameras, inspection during unloading operations, etc.);
- the procedures to be followed when prohibited items are found and when waste is refused as well as the refusals register;
- enhancing certain measures during periods of extreme heat and taking the associated procedures into account;
- recording meteorological data and monitoring weather forecasts;

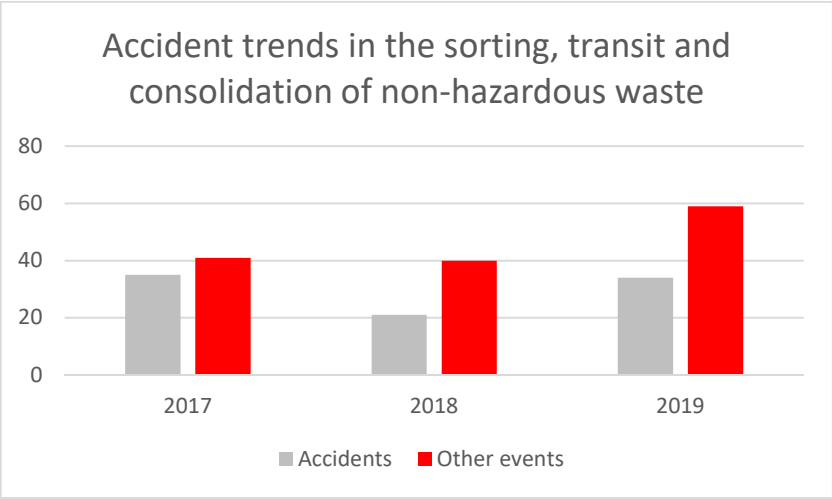
- how waste cells are used and the size of the facility.

Due to the abundance of recurring accidents in the sector, it is essential that businesses take feedback on experience into account. The management of the organisation of inspections (incoming, site surveillance during and outside business hours) is the key to decreasing the frequency of accidents.

3 Accident trends at non-hazardous waste sorting, transit and consolidation facilities (2017–2019)

Between 1st January 2017 and 31 December 2019, 230 events occurred at non-hazardous waste sorting, transit and consolidation facilities where the operator's activity code is NAF 38 (waste collection, treatment and disposal; recovery).

As for all activities in the waste sector, the breakdown of these events over the period trended upwards.

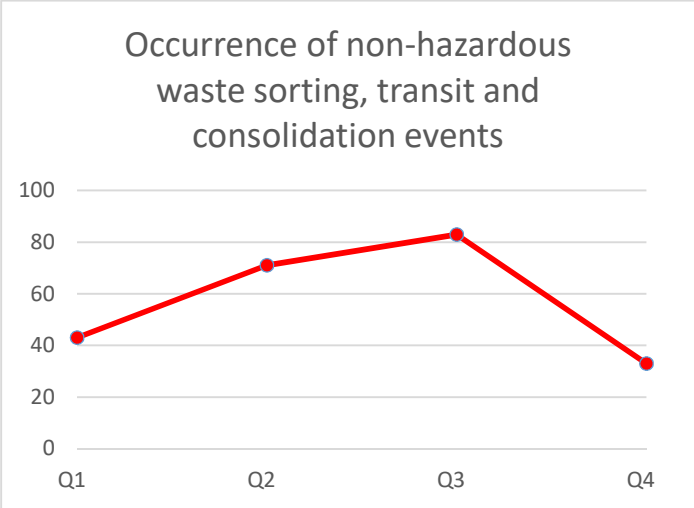


The graph opposite shows that events at non-hazardous waste sorting, transit and consolidation facilities occurred more frequently in the summer, i.e. the warmest period of the year.

It is important to note that 2019 was the second warmest year on record, according to the World Meteorological Organization.

Nearly 40% of these events were listed as accidents. This is above the overall percentage of 33% for waste sector accidents over the period studied.

No major accidents were recorded in the ARIA database for the period.



FIRES : THE MAIN TYPE OF EVENT

Fire was observed in more than 90% of cases. The breakdown of types of event[9] is as follows:

	Number of events	Percentage of recorded events
Fire	**213**	**92.6**
Release of hazardous materials or pollutants	**46**	**20**
Prolonged release	43	18.7
Into the soil/secondary containment	*4*	*1.7*
To atmosphere	*38*	*16.5*
Into water	*11*	*4.8*
Explosion	**6**	**2.6**
Other	**10**	**4.4**

The neighbouring vicinity was affected by heavy smoke in nearly one-sixth of events.

Most explosions were accompanied by fire. In three events (ARIA 54818, 54816, 54387), the explosions were triggered by prohibited waste items (mobile phone batteries, tablets, calculators, aerosols) in a baler. Explosions occurred at the same facility on two separate occasions (ARIA 54818, 54816).

FOCUS ON FIRE (213 EVENTS)

Alert

An analysis of the events for which data were available (144 events) shows that, in 25% of cases of fire (36 events), the alert was given by a person not connected with the facility. Such persons were the employees of a nearby company (ARIA 54341, 54358, 54376, 54306), passers-by (ARIA 54688) and local residents (ARIA 54195, 53532). **It is therefore essential that such facilities are protected by fire detection systems.**

Difficulties encountered by first responders

Various factors hindered the response of emergency services:

- In 13 events, locked doors or gates (ARIA 54358, 49168, 53978, 55624) or excessive piles of waste (ARIA 50270) prevented them from accessing facilities or accident locations easily.

ARIA 53625 – 10/05/2019 – Limoges

- They had difficulty getting water in 18 events, primarily because the fire cisterns or water networks were

[9] An event may have one or more recorded causes.

insufficient. In one case, the site's water fire cistern was unusable (ARIA 54421). In another, a fire hydrant failed (ARIA 50159).

It is therefore necessary to:

- **ensure that facilities are accessible in the event of fire, such as by providing first responders with the operator's contact details;**
- **have a sufficient number of adequately sized fire cisterns.**

Storage capacities and conditions

Ensuring that capacities are not exceeded and that waste is stored under appropriate conditions plays an important role in mitigating the consequences of fire. In five events, the inspection authorities for classified facilities found that waste was stored in excess quantities (ARIA 53711, 51843, 51284, 50359, 49312). Although the information available for these events in the ARIA database does not clearly establish the aggravating factor of the fire, it is acknowledged that large piles of incorrectly segregated waste facilitate the spread of fire throughout a facility. In addition, as mentioned above, waste piles form physical barriers that can hamper emergency responders' efforts. There was one instance of positive experience feedback. In the event in question, the small amounts of properly segregated waste prevented the flames from spreading to the ancillary storage cells and facilities (ARIA 49596).

It is therefore essential that prescribed waste storage capacities and conditions are met.

Context

In more than 40% of cases (88 events), fires started while facilities were operating at reduced capacity or were closed (i.e. at night or on Sundays and other non-business days).

Such periods of reduced or zero capacity require the implementation of reinforced measures.

Fire at a waste transfer facility

ARIA 49168 – 21/01/2017 – Amiens

At around 6:00 p.m. one Saturday, a fire broke out in a 1000 m² building containing paper, cardboard and plastics. **The operator of the neighbouring company** heard crackling noises and saw heat radiating from the building. ... He called the firefighters.

When they arrived, the building was engulfed in flames. **Finding the site's gate closed, they were forced to break through the side fence**. They managed to prevent the fire from spreading to the neighbouring company's buildings. ... The mains power supply was cut off.

The sorting plant's operator arrived and opened the gate to let the firefighters reach the fire more easily. As the power had been cut, the door to the room housing the heavy equipment needed to move the waste away could not be opened. A hole was broken into a party wall so that the door could be opened by hand....

The risk of the building's metal structure collapsing hindered the firefighters' efforts. In addition, they were forced to keep as far away as possible from the bales of cardboard due to the risk of the tensioned baling wires snapping. The fire was contained at around 10:00 p.m. ....

The facility was completely vacant when the fire started. The security company had not conducted any patrols on the day of the accident. The operator suspected vandalism....

CONSEQUENCES

Consequences[10] were recorded for 201 events (nearly 90% of cases).

Consequences for people

Although no fatal events were recorded between 2017 and 2019, one person was seriously injured (ARIA 54654: a crane operator sustained burns to the face and hands while working at a metal recycling company). On the other hand, minor injuries were reported in 26 events. In one of these events, emergency responders treated 29 residents and a firefighter for inhalation of or irritation from smoke containing high concentrations of fine particulates produced by a fire at a 100,000 m³ wood waste storage facility (ARIA 50082).

Economic consequences

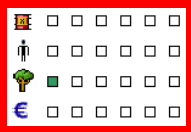
Nearly 85% of events had economic consequences, most of which consisted of on-site property damage. In more than 20% of cases, fire destroyed a facility building.

Environmental consequences

More than 45% of events had environmental consequences. Most of these consequences (40%) were on air (releases of smoke from fire for extended periods). The water and soil matrices were primarily impacted by fire, with fire water runoff containment issues being the factor in more than 60% of events. In these cases, the facilities' containments were either ineffective or undersized (ARIA 52075, 49312) or absent altogether (ARIA 49740). In another case, the isolation valves on the facilities' rainwater networks could not be closed (ARIA 53949, 53684). **Sufficiently large and operational containment systems are a must. Installing a system for sending fire water runoff to a settling pond for recycling in a closed loop would be a plus.**

Fire at a waste sorting facility

ARIA 53949 – 06/07/2019 – Gennevilliers



At around 9:30 p.m., a smouldering fire began on a 200 m³ pile of construction waste at a 5,000 m² sorting centre … The firefighters had difficulty opening the smoke vents because the openers were located inside the building. The fire was contained shortly before 11:00 p.m. …

The operator was unable to close one of the two isolation valves. Part of the fire water runoff flowed into the River SEINE after passing through the oil and sand separator. A temporary plug was fitted at 12:30 a.m. This allowed 13 m³ of fire water runoff to be pumped up. The fire burnt 80 t of solid waste, which was collected and sent to a storage facility. The extent of the damage suffered by the building was evaluated …

Following the accident, the operator fitted push button actuators on the isolation valves and instituted on-call schedules with the wastewater management company so that the valves can be shut off quickly and temporarily and wastewater can be pumped in an emergency….

[10] An event may have one or more consequences.

CONFIRMED OR SUSPECTED DISRUPTIONS

Confirmed or suspected disruptions[11] were reported in 133 events (nearly 60% of the events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected disruption was recorded
Equipment failures	**18**	**13.5**
Human intervention	**43**	**32.3**
Losses of process control	**61**	**45.9**
External hazards	**29**	**21.8**
Latent hazards	**42**	**31.6**
Malicious acts	**24**	**18**

Loss of process control and latent hazards

Loss of process control (either confirmed or suspected) associated with a latent hazard was the cause of 21 events, 20 of which involved fire.

One example is the presence of non-compliant waste in a process or stored materials:

- metal in a paper shredder (ARIA 55073) ;
- a firecracker or other firework going through a trommel screen (rotary sorter) (ARIA 54021) ;
- an aerosol can in the feed hopper of a sorting line (ARIA 52203) ;
- prohibited items (e.g. a motorcycle fuel tank ARIA 52975) during the unloading of a skip (ARIA 49648) ;
- chemicals (ARIA 52409), calcium hydroxide (ARIA 51284) hidden in non-hazardous waste.

Implementing or heightening screening procedures to identify non-compliant incoming waste would avoid such fires in the future.

Fire at a waste sorting facility

ARIA 52975 – 17/04/2017 – La Londe-les-Maures

A fire broke out shortly after a skip of bulky items from a waste disposal site had been unloaded...

The fire was caused by a motorcycle fuel tank in the skip. The flammable liquid inside the tank heated up and ignited while the skip was being emptied.

There are also cases of overheating:

- wood and metal dust igniting due to friction with an overband separator (ARIA 54403) ;
- material on shredder knives (ARIA 49740) or between a material handling grapple and metal waste (ARIA 49647).

[11] An event may have one or more confirmed or suspected disruptions.

Human intervention

Human intervention that was required but performed incorrectly accounted for more than 20% of non-hazardous waste sorting, transit and consolidation events. It consisted primarily of inadequate controls of incoming waste (ARIA 53776, 53378, 53156, 51596, 49429) and insufficient supervision of hot-spot work (ARIA 53046, 52636, 50628).

Fire at a waste sorting facility

ARIA 52636 – 16/11/2018 – Mouzeuil-Saint-Martin

A fire broke out at around 11.30 a.m. …. Five workers and two firefighters were sickened by the smoke.

… The fire damaged the conveyor belt, electrical wiring, detection system, wall lights, sprinkler heads and stormwater downpipes …

The fire may have been caused by welding and grinding operations carried out that morning by a contractor. The flames appeared near the site of the operations 15 minutes after they ended. Glowing particles may have been thrown and come into contact with material trapped in the interstices of the conveyor structure…

The fire allowed the operator to identify areas of improvement:

- the area must be watered prior to work ;
- the conveyor must be watered after work ;
- a fire watch must be posted for two hours after work is completed;
- two members of the contractor's staff (instead of one) must take part in this type of work.

External hazards

Extreme heat and wind were the primary external hazards. All 17 events caused by extreme heat involved fires between the months of May and August.

Implementing or heightening checks to look for hot spots in stored waste during periods of extreme heat would avoid such fires in the future.

Malicious acts

Although they were not the main cause, it is important to underscore that malicious acts accounted for nearly 20% of events. This is well above the overall percentage of malicious acts in the waste sector (8.5%) and considerably higher than that for environmentally classified facilities as a whole (around 3%). That said, the malicious acts remained unconfirmed in more than 80% of cases.

In addition to the obligation for facilities to be surrounded by a fence, it would be wise to install anti-intrusion or video surveillance systems to protect facilities from trespassers or dispel doubts in cases of suspected intrusion.

ARIA 51565 – 16/05/2018 – Bourges

CONFIRMED OR SUSPECTED CAUSES

Confirmed or suspected causes[12] were reported in 93 events (40% of the events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected cause was recorded
Organisational factors	**91**	**97.8**
Risk management	87	93.5
Organisation of controls	56	60.2
Learning from experience feedback	27	29
Choice of equipment and processes	27	29
Human factors	**3**	**3.2**
Imponderable factors	**10**	**10.7**

Organisational factors, specifically risk management, were blamed in nearly all these events. The breakdown of these factors shows that the main cause was the organisation of controls, followed by learning from experience feedback and the choice of equipment and processes.

Exceeding maximum permissible amounts was an aggravating factor (ARIA 50082, 50359, 50596, 51596, 51586, 51843, 53711) because the fire suppression equipment in these cases was no longer adequate.

Organisation of controls

The organisation of controls was identified as the confirmed cause in more than 60% of events. In most events, **inadequate control of incoming waste** was the cause (e.g. ARIA 53373). In some cases, **checks at storage facilities** were not stepped up or conducted at all during **vulnerable periods** , such as reduced capacity (e.g. ARIA 54149) or extreme heat (e.g. ARIA 53949). In one case, both situations occurred concurrently (e.g. ARIA 52969).

There were also deficiencies in periodic inspections and maintenance of equipment. Examples included a radiation detection gantry at a site entrance (e.g. ARIA 54329) and fire suppression equipment, such as an inoperative fire hose rack, a fire door that did not close and smoke vents that did not open (e.g. ARIA 53378).

Finally, failures in the supervision of subcontractors and checks following hot-spot work were also identified (e.g. ARIA 52636).

Learning from experience feedback

In around 30% of events, the root cause was failure to learn from feedback on experience, with 31 facilities experiencing at least two events and eight facilities experiencing three events. Recurring factors were identified in six cases:

- type of disruption: non-compliant waste (ARIA 49314, 50831, 51024, 50332, 55018, 55022, 54023, 55067, 55137), malicious acts (ARIA 50315, 50316, 50826) ;
- location of the source of fire: balers (ARIA 54387, 54816, 54818), open-air waste storage facilities (ARIA 49777, 50398, 51843).

Choice of equipment and processes

In most events, a lack of equipment or inadequate equipment was the cause:

- fire detection systems: absence of a detection system with alarm (ARIA 53684), absence of a thermal imaging camera to monitor areas for storing

[12] An event may have one or more confirmed or suspected causes.

combustible waste (ARIA 53538), fire detection system not suited to the type of fire involved (ARIA 51557), equipment placed at heights that did not allow for adequate control (ARIA 51030) ;

- fire suppression systems: absence of a water runoff collection system (ARIA 53684), limited area of coverage of a sprinkler system (ARIA 52636) ;
- anti-intrusion systems: absence of an anti-intrusion system (ARIA 53532), incompletely fenced site and poorly configured video surveillance system (ARIA 50359) ;
- environmental protection systems: storage area not protected by a liner (ARIA 51843).

* * *

Focus on shredding activities at waste sorting, transit and consolidation facilities

Of the 230 events recorded at non-hazardous waste sorting, transit and consolidation facilities, 22 events specifically involved shredding activities.

In 95% of these events, fire was involved. As with fires during non-hazardous waste sorting, transit and consolidation activities in general, the main consequences were economic and environmental.

Organisational factors, in particular in the organisation of controls, was identified as the main cause.

One example is inadequate control of waste prior to shredding , as in the case of an explosive shell or gas cylinder (ARIA 49051), prohibited waste (ARIA 49652) and a distress flare (ARIA 50280). **Non-compliant waste, such as scrap metal, is a notorious source of fire** because of heat from friction between such materials and shredder knives (ARIA 53378, 52202, 53776).

Checks must be conducted to ensure waste to be shredded is suitable. Likewise, fire detection and suppression systems should be installed alongside or over shredders.

Another example is inadequate checks in the case of hot-spot work, with a fire being sparked by a grinder used to cut a hopper between the shredder and the associated screen (ARIA 50351).

In addition to the issue of non-compliant waste, shredding operations can create hot spots through friction between waste and the shredder's internal components and spark fires in shredded waste. **Shredded waste must be monitored using thermal imaging cameras.**

Fire at a waste shredding facility

ARIA 52202 – 28/02/2018 – Saint-Paul

A fire broke out at around 11:45 a.m. during a metal shredding operation but was put out by the shredder's fire prevention system.

The fire was sparked by non-compliant waste (heavy scrap metal) in the shredder's feed hopper. As it could not be torn apart by the shredder's hammers, the heavy scrap metal became stuck in the cutting chamber. The resulting friction caused the fire to ignite.

The operator subsequently implemented the following measures:

- reminder of the instructions for loading the shredder, particularly regarding prohibited materials;
- changed the shredder loading procedure and added an additional control required after unloading operations and before feeding materials into the shredder; ...

CONCLUSIONS

Non-hazardous waste sorting, transit and consolidation operations were the source of the largest number of events in the waste sector over the period studied.

Fire, the main type of event, was caused by non-compliant waste and high summer temperatures while facilities were operating at reduced capacity or were closed (weekends and public holidays). Such fire events can often result in extensive property damage if the actions of emergency responders are hindered and if environmental consequences are recurrent. Lastly, a large proportion of these fires was attributed to malicious acts.

Special attention should be paid to the following points of vigilance:

Fire detection

- siting, adequacy and maintenance of systems used to detect fires and notify operators of fire alarms, *particularly on shredders ;*
- implementation or intensification of checks for hot spots in stored waste, *particularly shredded waste and waste awaiting shredding*;
- existence of fire procedures and their understanding by operators;

Fire suppression

- siting, adequacy and maintenance of fire suppression systems *on shredders;*
- identification in fire procedures of the various roles and who exactly is responsible for opening a facility's access gate in the event of a fire outside business hours;
- availability of the fire cistern or possibility of connecting onsite or offsite internal fire suppression equipment;
- clearing of access routes on sites (equipment, waste piles);

Fire risk prevention

- measures for detecting non-compliant waste (incoming controls of waste, weighbridges monitored by CCTV cameras, controls during unloading, etc.), *particularly in the case of shredding operations* ;
- intensification of certain measures during periods of extreme heat*;*
- recording of meteorological data and monitoring of weather forecasts ;
- fence maintenance;
- presence of an anti-intrusion or video surveillance system;
- ensuring that capacities are not exceeded and compliance with waste storage regulations;

Impact mitigation

- availability, appropriate sizing and maintenance of fire water runoff containment systems along with the possibility of isolating stormwater collection systems;
- maintenance of shutoff valves on containment systems or stormwater collection systems;
- identification in fire procedures of the various roles and who exactly is responsible for closing outlets in the event of a fire;

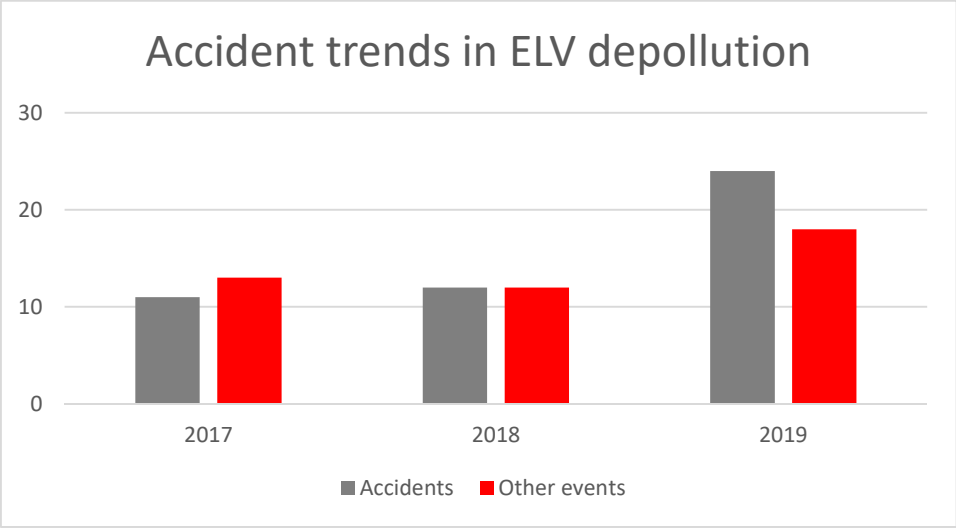
Due to the abundance of recurring accidents in the sector, it is essential that businesses take feedback on experience into account. Management of the organisation of controls (incoming, site surveillance during and outside business hours) is the key to decreasing the frequency of accidents.

ARIA 50082 – 22/07/2017 – Biguglia

4 ACCIDENTS TRENDS IN END-OF-LIFE VEHICLE (ELV) DEPOLLUTION (2017–2019)

Between 1st January 2017 and 31 December 2019, 90 events occurred in end-of-life vehicle (ELV) depollution activities where the operator's activity code is NAF 38 (waste collection, treatment and disposal; recovery).[13]

As for all activities in the waste sector, the breakdown of these events over the period trended upwards.

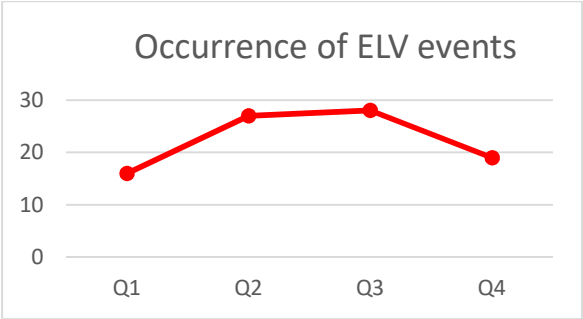


Over the three-year period studied, the number of accidents caught up with that of the other types of event and surpassed it in 2019. It is important to note that in 10% of the events recorded, the facilities were not in compliance with regulations. In most cases, these facilities were not known to government inspectors.

The graph opposite shows that ELV events occur more frequently in the summer, i.e. the warmest period of the year.

It is important to note that 2019 was the second warmest year on record, according to the World Meteorological Organization.

No major accidents were identified in the ARIA database for the period 2017–2019.



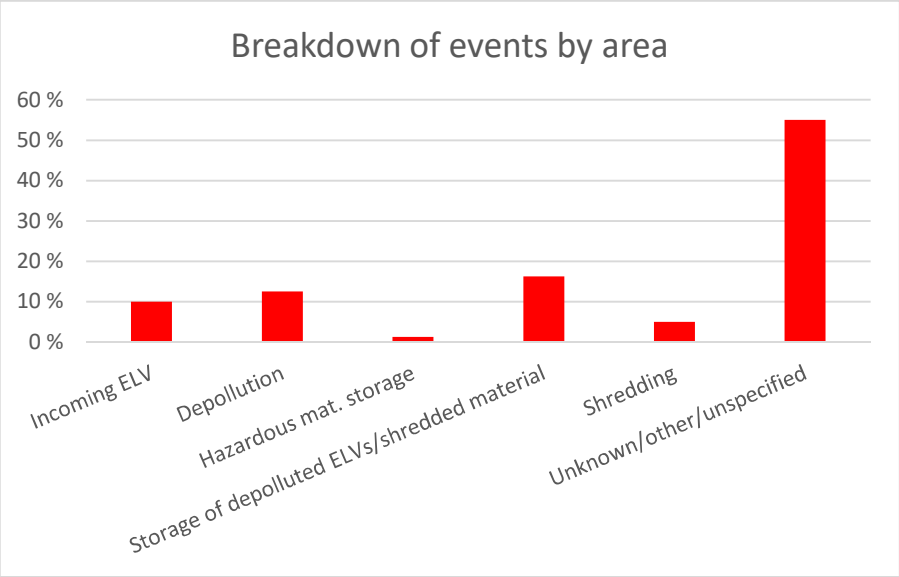
[13] For the purposes of study, ELV operators with NAF code 45 (sale and repair of motor vehicles and motorcycles) were put in the same category as operators with NAF code 38.

A typical ELV facility consists of:

- an area for incoming vehicles;
- a depollution area;
- an area for storing depolluted vehicles;
- an area for storing recovered hazardous materials;
- a shredding area (where applicable).

Each area poses its own specific risks.

The graph below shows the breakdown of events by area. In more than half the events, the area that sparked the fire was not specified.



ARIA 54371 – 11/09/2019 – Saint-Romain-le-Puy

FIRES : THE MAIN TYPE OF EVENT

Fire was reported in 90% of cases. The breakdown of types of event[14] is as follows:

	Number of events	Percentage of recorded events
Fire	**81**	**90**
Release of hazardous materials or pollutants	**32**	**35.6**
Prolonged release	21	23.3
Into the soil/secondary containment	*7*	*7.8*
To atmosphere	*19*	*21.1*
Into water	*11*	*12.2*
Explosion	**11**	**12.2**

The neighbouring vicinity was affected by heavy smoke in more than one-fifth of events.

Eighty percent of the explosions were accompanied by fire. In four events (ARIA 54071, 51772, 54113, 49640), fire caused gas cylinders to explode. In one event (ARIA 53376) fire caused an LPG tank to explode. In two cases (ARIA 55787, 49850) the equipment itself exploded (overpressure in a shredder, explosion in a shredder).

Focus on fire (81 events)

Fires accounted for 90% of events at ELV facilities.

Alert

In about 10% of the fires, the alert was given by a person not connected with the facility, such as a neighbour (ARIA 51358) or a person driving nearby (ARIA 49832). **It is therefore necessary that such facilities are protected by fire detection systems.**

Difficulties encountered by first responders

In 25% of events, the response of emergency services was hindered:

- Mainly by difficulty in obtaining water: in most cases, facilities lacked both fire cisterns and fire hydrants (ARIA 52393, 54071, 54029, 51918, 49640). In two cases, the water supply was limited by an undersized fire cistern (ARIA 49832) or because there were problems turning on the other half of the supply pumps (ARIA 52327) .
- Or because there were difficulties reaching the facility or the seat of the fire: a disc cutter had to be used to open the gate of one facility (ARIA 53067); difficulty reaching the fire cistern and containment pond (ARIA 54244); a firefighter was injured by a guard dog while trying to enter a closed site (ARIA 52904); access routes cluttered by ELVs (ARIA 51719, 51090).

It is therefore necessary to:

- **ensure that ELV facilities are protected by fire cisterns;**
- **ensure that facilities are accessible in the event of fire, such as by providing first responders with the operator's contact details.**

[14] An event may have one or more recorded causes.

Storage capacities and conditions

Ensuring that capacities are not exceeded and that waste is stored under appropriate conditions plays an important role in mitigating the consequences of fire. Storage of excess quantities of waste was identified in three events. As mentioned above, waste piles form physical barriers that can hamper emergency responders' efforts (ARIA 51719, 51090). In the third event (ARIA 52393), overcapacity at the facility was singled out. Although the information available for these events in the ARIA database does not clearly establish the aggravating factor of the fire, it is acknowledged that large piles of incorrectly segregated waste facilitate the spread of fire throughout a facility.

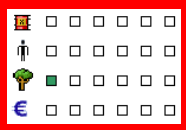
It is therefore essential that prescribed waste storage capacities and conditions are met.

Context

In more than 40% of cases (34 events), fires were started while facilities were operating at reduced capacity or were closed (i.e. at night or on Sundays and other non-business days). **Such periods of reduced or zero capacity require the implementation of enhanced monitoring.**

Fire at an ELV centre

ARIA 51719 – 12/06/2018 – Coueron



A pile of end-of-life vehicles caught fire at an ELV centre at around 12:00 p.m. A huge plume of black smoke rose from the pile …. It took two hours and around 50 firefighters to put out the fire …. Their efforts were hampered by clutter at the facility (one of its two access routes was crowded with vehicles) ….

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ARIA 54112 – 27/07/2019 – Auxerre

CONSEQUENCES

Consequences[15] were recorded for 88 events (nearly 100% of cases).

Consequences on people

No fatal events were recorded between 2017 and 2019. Only one serious injury was reported (ARIA 53376 – an employee sustained severe burns following the explosion and fire of an LPG tank). On the other hand, minor injuries were reported in 17 events. In just one of these events, five people not affiliated with the facility were slightly sickened by smoke from the fire (ARIA 53365).

Fire at an ELV centre

ARIA 53376 – 28/03/2019 – Florange

An explosion followed by a fire occurred at around 5:20 p.m. on an LPG tank at an ELV depollution facility. Firefighters extinguished it fire with a fire hose. One employee was taken to hospital with severe burns.

According to the media, the fire started while the employee was working on a vehicle….

Economic consequences

Nearly 90% of events had economic consequences, most of which consisted of on-site property damage. In about 25% of cases, fire destroyed a facility building.

Environmental consequences

Environmental consequences were reported in 75% of events. Most of these consequences (60%) were on air (releases of smoke from fire for extended periods).

The water and soil matrices were impacted less often. When they were, the cause was a problem with the containment system: in one case, the system was undersized and allowed fire water runoff to spill out (ARIA 53802). In most cases, however, the total lack of a fire water containment system was to blame (ARIA 54029, 53365, 51080, 49640, 49607).

Sufficiently large and operational containment systems are a must. Designing systems that send fire water runoff to settling ponds for recycling purposes should be a priority.

ARIA 54112 – 27/07/2019 – Auxerre

[15] An event may have one or more consequences.

CONFIRMED OR SUSPECTED DISRUPTIONS

Confirmed or suspected disruptions[16] were reported in 45 events (nearly half of the events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected disruption was recorded
Equipment failures	**10**	**22.2**
Human intervention	**18**	**40**
Losses of process control	**12**	**26.7**
External hazards	**9**	**20**
Latent hazards	**8**	**17.8**
Malicious acts	**10**	**22.2**

Human intervention

Human interventions that were required but performed incorrectly accounted for more than 30% of events at ELV facilities.

In more than 50% of cases, the fire started while a person was working on a vehicle (ARIA 53376, 52775, 49856). The following specific operations were identified:

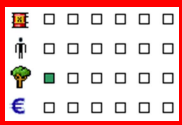
- starting up vehicles in order to move them (ARIA 53365, 51918) ;
- emptying vehicles: fuel spilt on the ground during emptying was ignited by a spark from a pump (ARIA 49607), fuel emptied directly into a plastic bucket conducting static electricity (ARIA 53687) ;
- using a blowtorch (ARIA 53257).

Conducting a risk analysis of the ELV depollution process and then creating procedures specifically suited to it would prevent some fires.

In the other cases, fire was caused by insufficiently supervised hot spot work conducted near waste: grinding operations (ARIA 54211) and maintenance welding (ARIA 53727).

Fire at an illegal ELV facility

ARIA 49607 – 08/01/2017 – Basly



A fire started at an illegal ELV facility while the operator was emptying a vehicle fuel tank with a pump. The flames spread to ELVs, auto parts that had been dismantled and stripped of hazardous substances, and a storage area containing oil and various liquids….

It is thought that a spark from the pump ignited fuel that had spilt on the ground during emptying.

[16] An event may have one or more confirmed or suspected disruptions.

Loss of process control

One out of three events involving loss of process control was caused by overheating of automotive shredder residue (ASR) (ARIA 52201, 52138, 50201) or overheating of scrap metal stockpiles awaiting shredding (ARIA 51793). Batteries left inside ELVs can also cause fire (ARIA 51018)

Shredder fires were caused by ELVs that had been improperly depolluted (i.e. still contained flammable fluids) or had not been depolluted at all (ARIA 51692, 49652, 49730, 49850).

Implementing or heightening checks to look for hot spots in shredded waste (especially) or waste awaiting shredding would avoid such fires in the future.

Malicious acts

Although they were not the main cause, it is important to underscore that malicious acts accounted for nearly 20% of events. This is well above the overall percentage of malicious acts in the waste sector (8.5%) and considerably higher than that for environmentally classified facilities as a whole (around 3%). That said, malicious acts were not confirmed in any cases over the period.

In addition to the obligation for facilities to be surrounded by a fence, it would be wise to install anti-intrusion or video surveillance systems to protect facilities from trespassers or dispel doubts in cases of suspected intrusion.

ARIA 51080 – 22/11/2017 – Ferrières-en-Bray

CONFIRMED OR SUSPECTED CAUSES

Confirmed or suspected causes[17] were reported in 28 events (about 30% of the events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected cause was recorded
Organisational factors	**28**	**100**
Risk management	28	100
Organisation of controls	*10*	*35.7*
Choice of equipment and processes	*12*	*42.9*
Human factors	**2**	**7.1**

Organisational factors were blamed in all these events. Their breakdown shows that the choice of equipment and processes as well as the organisation of controls were the main culprits.

Organisation of controls

Inadequate controls were blamed in the vast majority of events:

- monitoring of stored waste to detect hot spots, particularly during periods of reduced activity (ARIA 54029, 52201, 52138, 51719, 49543, 52015) ;
- control of incoming waste (ARIA 49850).

In one case, both situations occurred concurrently (ARIA 52015).

Choice of equipment and processes

In most events, a lack of equipment or inadequate equipment was the cause:

- fire suppression systems: absence of fire cisterns (ARIA 54029, 52393), absence of fire extinguishers suited to the type of fire (ARIA 54211), non-fire retardant PPE (ARIA 53390), conveyor belt made of a non-fire retardant material (ARIA 52138), facility layout that promotes the spread of fire (ARIA 52015) ;
- fire water runoff containment systems: facilities without liners to prevent leaching (ARIA 54029, 52393, 49607), undersized secondary containments (ARIA 53802) ;
- stormwater and wastewater treatment facilities: absence of a hydrocarbon separator (ARIA 49607, 49551), undersized facilities (ARIA 52292) and facilities without alarm reporting systems (ARIA 52292, 49642).

ARIA 54029 - 07/07/2019 – Mamoudzou

[17] An event may have one or more confirmed or suspected causes.

Focus on shredding activities at ELV facilities

Amongst the 90 events listed for ELV facilities, 11 involved shredding activities (ARIA 52201, 49850, 50201, 51793, 49730, 52138, 55787, 49972, 51692, 51823, 53802).

The main cause was inadequate vehicle depollution, resulting in flammable and even explosive liquids (refrigerant, oil, fuel, batteries) being left inside vehicle shells before shredding.

Conducting a risk analysis of the vehicle depollution process and then creating procedures to address these risks can help to ensure workers depollute vehicles effectively.

In addition to the issue of non-compliant incoming waste, shredding operations can create hot spots, particularly through friction, inside shredders and spark fires in shredded waste.

Shredders must be protected by fire detection and suppression systems and shredded waste must be monitored using thermal imaging cameras.

Shredder overpressure accident at an ELV facility

ARIA 55787 – 13/10/2017 – Castine-en-Plaine

An overpressure accident occurred on an ELV facility shredder at around 4:05 p.m. A plume of dust was visible outside the facility. The shredder was turned off. The shredder residue bunkers were emptied and isolated. Repairs were carried out for three to four days.

It is thought that an LPG tank caused the overpressure.

CONCLUSIONS

Over the period studied, the main cause of adverse events at ELV facilities was fire from insufficiently depolluted vehicles and self-heating of waste stored on site. This self-heating was caused in particular by high summer temperatures and while facilities were operating at reduced capacity or were closed (weekends and public holidays). Such fire events can often result in serious property damage if the actions of emergency responders are hindered and if environmental consequences are recurrent. Lastly, a large proportion of these fires was attributed to malicious acts.

Special attention should be paid to the following points of vigilance:

Fire detection

- siting, adequacy and maintenance of systems used to detect fires and notify operators of fire alarms, *particularly on shredders ;*
- implementation or intensification of checks for hot spots in stored waste, *particularly shredded waste and waste awaiting shredding*;
- existence of fire procedures and their understanding by operators;

Fire suppression

- siting, adequacy and maintenance of fire suppression systems *on shredders;*
- identification in fire procedures of the various roles and who exactly is responsible for opening a facility's access gate in the event of a fire outside business hours;
- availability of the fire cistern or possibility of connecting onsite or offsite internal fire suppression equipment;
- clearing of access routes on sites (equipment, waste piles);

Fire risk prevention

- intensification of certain measures during periods of extreme heat*;*
- recording of meteorological data and monitoring of weather forecasts ;
- fence maintenance;
- presence of an anti-intrusion or video surveillance system;
- ensuring that capacities are not exceeded and compliance with waste storage regulations;

Impact mitigation

- availability, appropriate sizing and maintenance of fire water runoff containment systems along with the possibility of isolating stormwater collection systems;
- maintenance of shutoff valves on containment systems or stormwater collection systems;
- identification in fire procedures of the various roles and who exactly is responsible for closing outlets in the event of a fire;
- risk analysis of the vehicle depollution process resulting in the creation of adequate procedures to ensure workers depollute vehicles effectively;
- effectiveness of the depollution process.

Special recommendations

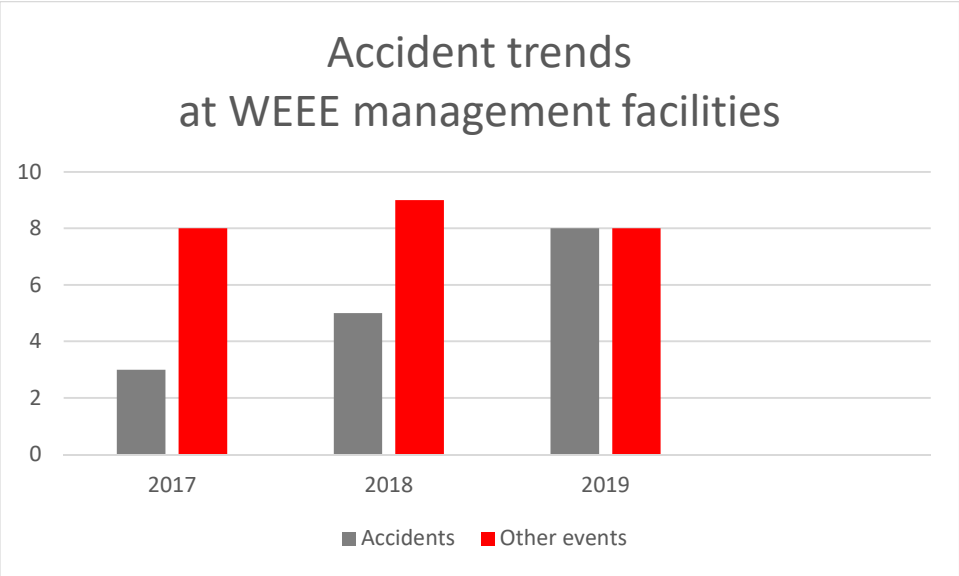
- identify and segregate the areas at ELV facilities in order to prevent the spread of fire and implement preventive measures specific to each hazard;
- define on-site storage rules to limit the number of non-depolluted ELVs.

Controlling the risk of fire from the vehicle depollution process and organising checks for hot spots in stored waste (during periods of reduced capacity and extreme heat) are the two main ways to reverse accident trends at ELV facilities.

5 Accident trends at waste electrical and electronic equipment (WEEE) management facilities (2017–2019)

Between 1st January 2017 and 31 December 2019, 41 events occurred at waste electrical and electronic equipment (WEEE) facilities where the operator's activity code is NAF 38 (waste collection, treatment and disposal; recovery).

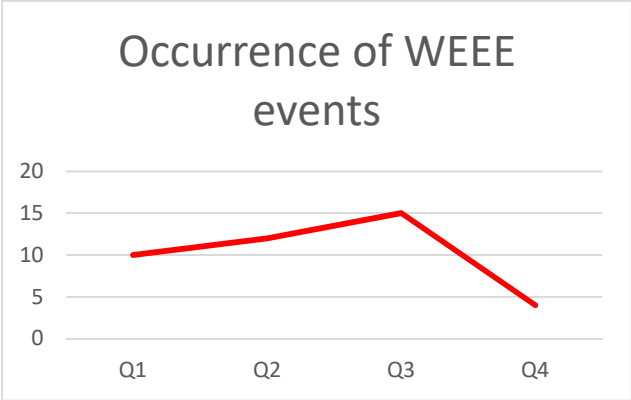
As for all activities in the waste sector, the breakdown of these events over the period trended upwards. More specifically, the number of accidents at WEEE facilities rose sharply in 2019.



Unlike other activities, WEEE processes are carried out in closed buildings, meaning that accident trends are less affected by seasonal changes.

Nearly 40% of these events were listed as accidents. This is above the overall percentage of 33% for waste sector accidents over the period studied.

No major accidents were recorded in the ARIA database for the period.



FIRES : THE MAIN TYPE OF EVENT

Fire was recorded in 100% of cases and was occasionally accompanied by another type of event. The breakdown[18] is as follows:

	Number of events	Percentage of recorded events
Fire	**41**	**100**
Release of hazardous materials or pollutants	**9**	**22**
Prolonged release	9	22
Into the soil/secondary containment	*1*	*2.4*
To atmosphere	*8*	*19.5*
Into water	*1*	*2.4*
Explosion	**2**	**4.9**

The neighbouring vicinity was affected by heavy smoke in nearly one-fifth of events.

The first explosion event was caused by a shredder (ARIA 49238) and the second one, which triggered multiple explosions, was caused by a fire that started in a storage building (ARIA 53716).

Focus on fire (41 events)

Fires accounted for 100% of events at WEEE facilities. In each case, the alert was given by the operator.

Difficulties encountered by firefighters

Various factors hindered the response of firefighters:

- mainly difficulty in obtaining water: in one case, the facility lacked a fire cistern, forcing firefighters to pump in water from a nearby canal. In the two other cases, one facility's fire cistern was clogged with algae that rendered pumping impossible (ARIA 52020) and the other facility's fire cistern was only one-third full (ARIA 51724) ;
- difficulty in reaching the scene: in one case, the door of a building on fire had to be broken down because the facility's electricity meter had been destroyed by the flames (ARIA 53941).

It is therefore necessary to:

- **have a sufficient number of maintained fire cisterns;**
- **ensure that facilities are accessible in the event of fire.**

Storage capacities and conditions

Ensuring that capacities are not exceeded and that waste is stored under appropriate conditions plays an important role in mitigating the consequences of fire. Exceeding capacity (ARIA 53716) and failing to store waste under appropriate conditions (ARIA 53941) were identified in two cases as confirmed factors in the spread of fire. In another case, the inspection authorities for classified facilities identified storage of excess quantities of waste (ARIA 51724) but the available data did not clearly establish the aggravating factor of the fire.

It is acknowledged that large piles of incorrectly segregated waste facilitate the spread of fire throughout a facility. In addition, waste piles form physical barriers that can hamper emergency responders' efforts.

It is therefore essential that prescribed waste storage capacities and conditions are met.

[18] An event may have one or more recorded causes.

Context

In more than 40% of cases (16 events), fires were started while facilities were operating at reduced capacity or were closed (i.e. at night or on Sundays and other non-business days).

Such periods of reduced or zero capacity require the implementation of reinforced measures.

Fire at a waste electrical and electronic equipment (WEEE) sorting centre

ARIA 51724 – 12/06/2018 – Saran

At around 3:35 p.m., an explosion followed by flashover occurred in a 6000 m² building of a waste sorting/transit facility whilst small household appliances (hoovers, toasters, microwave ovens, etc.) stored in a concrete cubicle were being handled with a telescopic machine....

The facility's WEEE operations were halted. The prefecture issued an emergency order to supervise the post-accident phase and conditions for the resumption of operations. It also issued a formal notification order after several deviations were found:

- waste was not stored in accordance with the site's layout plan: WEEE was stored in excess of the authorised height of 2 m, bales of plastic waster were stored in areas that should have been kept clear to prevent the spread of fire;
- the fire cistern was only one-third full;
- access to the fire-hose reels was obstructed by waste;
- part of the building did not have a fire detection and suppression system.

According to the operator, the fire was caused by the presence of batteries contained in the WEEE. The inspection authorities identified the risks associated with the way in which this waste is managed. The small household appliances are collected in wire mesh containers from waste disposal sites and transported to the sorting/transit facility, where they are stored in bulk in the concrete cubicles. They are then picked up by machinery and loaded into lorries with large-capacity walking-floor trailers for shipment to their final destination. Some waste, such as oil heaters and petrol tools, is collected at the same time as the appliances. However, the integrity of such waste cannot be guaranteed during handling operations. The batteries in the appliances therefore form an ignition source that creates a risk of fire (and release of toxic fumes).

...

CONSEQUENCES

Consequences[19] were recorded for 36 events (nearly 85% of cases).

Consequences on people

No fatal events were recorded between 2017 and 2019. Only one serious injury was reported (ARIA 49238 – an employee sustained injuries following an explosion of a shredder). Six events involved minor injuries to persons other than member of the general public.

Economic consequences

Nearly 90% of events had economic consequences, most of which consisted of on-site property damage. In 17% of cases, fire destroyed a facility building.

Environmental consequences

Environmental consequences were reported in 47% of events. Most of these consequences (nearly 50%) were on air (releases of smoke from fire for extended periods).

The water and soil matrices were impacted in a small number of events (about 5%). Issues with containing fire water runoff were not found in any of the accidents over the period studied.

Fire at a WEEE recycling company

ARIA 49370 – 11/03/2017 – Toulouse

At around 8:30 p.m., a shredder used for fractions containing non-ferrous metals caught fire at a company that recycles major domestic refrigeration appliances. The employees alerted their managers and the firefighters. The flames spread to the belt conveyors and then to the rest of the equipment used to separate plastic and non-ferrous fractions (induction separator, magnetic drum, intermediate belt conveyors). They then travelled up the dust extraction pipe located under the roof and ignited part of the rooftop photovoltaic panels. The firefighters extinguished the fire at around 11:30 p.m.

The fire damaged 400 m² of the operations building (the metal cladding panels were damaged and the equipment and lubricant tanks in the area were destroyed). Fifteen workers were furloughed for at least one week. The areas of the facility that were not affected by the fire (dismantling and depollution of major domestic refrigeration appliances) were expected to partially resume operations within six weeks.

…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[19] An event may have one or more consequences.

CONFIRMED OR SUSPECTED DISRUPTIONS

Confirmed or suspected interferences[20] were reported in 30 events (more than 70% of events). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected disruption was recorded
Equipment failures	**10**	**33.3**
Human intervention	**16**	**53.3**
Losses of process control	**15**	**50**
External hazards	**3**	**10**
Latent hazards	**13**	**43.3**
Malicious acts	**5**	**17**

Human intervention

Human interventions that were required but performed incorrectly accounted for 30% of WEEE events and consisted primarily of:

- inadequate depollution of equipment sent to treatment facilities (particularly small mixed appliances): presence of lithium cells, batteries and condensers (ARIA 52937, 52395, 49889, 50362);
- inadequate inspection of incoming waste or waste awaiting shredding (ARIA 53259, 49238, 54040).

Implementing or heightening screening procedures to identify non-compliant items hidden in incoming waste would avoid such fires in the future. It is important to note that the miniaturization of batteries in electrical and electronic equipment makes it harder to detect them.

Loss of process control and latent hazards

The combination of these two factors resulted in two main scenarios:

- spontaneous ignition of a lithium cell or lithium battery in a pile of small appliances awaiting treatment (ARIA 52856, 53100, 52946, 52020, 52856), in shredded or pre-shredded small electrics (ARIA 53158, 52938, 52937) or whilst small electrics were being unloaded (ARIA 52395, 52396).
- non-compliant waste, particularly lithium-ion batteries, mixed in with waste sent to the shredder (ARIA 54040, 49889).

Heightening checks of incoming small mixed WEEE as well as implementing or heightening screening procedures to identify non-compliant waste prior to shredding would avoid such fires in the future.

WEEE fire at a metal recycling facility

ARIA 52856 – 05/01/2019 – Marquette-lez-Lille

At around 10:10 a.m. ... a 100 m³ pile of small household appliances awaiting depollution caught fire. The fire was contained at around 12:00 p.m. ....

The operator thought that the fire may have been caused by a lithium-ion battery that broke during unloading. Another possibility considered was that a part fell off balance and created a short circuit. As unloading had last taken place at 3:00 p.m. on the previous day, the fire may have smouldered all night long.

[20] An event may have one or more confirmed or suspected disruptions.

Malicious acts

Although they were not the main cause, it is important to underscore that malicious acts accounted for nearly 15% of events. This is well above the overall percentage of malicious acts in the waste sector (8.5%) and considerably higher than that for environmentally classified facilities as a whole (around 3%). That said, malicious acts remained unconfirmed in 80% of cases.

In addition to the obligation for facilities to be surrounded by a fence, it would be wise to install anti-intrusion or video surveillance systems to protect facilities from trespassers or dispel doubts in cases of suspected intrusion.

CONFIRMED OR SUSPECTED CAUSES

Confirmed or presumed causes[21] were recorded in 28 events (i.e. nearly 70% of events, a very high percentage). Their breakdown is as follows:

	Number of events	Percentage of events for which a confirmed or suspected cause was recorded
Organisational factors	**27**	**96.4**
Risk management	24	85.7
Organisation of controls	*16*	*57.2*
Learning from experience feedback	*9*	*32.2*
Choice of equipment and processes	*8*	*28.6*
Human factors	**1**	**3.6**
Imponderable factors	**3**	**10.7**

Organisational factors, specifically risk management, were blamed in nearly all these events. The breakdown of these factors shows that the main cause was the organisation of controls, followed by learning from experience feedback and the choice of equipment and processes.

Organisation of controls

The organisation of controls was identified as the confirmed cause in nearly 70% of events. In most, **insufficient control of incoming mixed small WEEE** was to blame (ARIA 52946, 52020, 52938, 52937, 52856). **Screening for non-compliant waste prior to shredding** was sometimes lacking (ARIA 50362, 49889, 49520, 49238).

Learning from experience feedback

Failure to learn from feedback on experience was the root cause in more than 30% of events. Indeed, events recurred at seven facilities over the period studied:

- two events occurred at two facilities (ARIA 51459, 53841, 51935, 53100) ;
- three events occurred at four facilities (ARIA 49238, 50146, 52071, 49606, 49520, 52946, 54843, 54849, 54729) ;
- six events occurred at just one facility (ARIA 52395, 52396, 49740, 52937, 52938, 53158).

Fire at a WEEE treatment facility

ARIA 52937 – 14/11/2018 – Lons-Le-Saunier

At around 9:00 p.m. smoke was seen coming from a cell containing pre-shredded (prior to being placed in the cutter) small mixed WEEE.... The firefighters extinguished the fire....

A short-circuited battery in the waste may have caused the fire. An unusual amount of batteries was found in the pile of appliances that had caught fire....

The facility had been the scene of several other fires.... Another accident occurred yet again 10 days later. (ARIA 52938)

[21] An event may have one or more confirmed or suspected causes.

Choice of equipment and processes

The majority of events were due to the absence or inadequacy of systems for detecting, suppressing and preventing the spread of fire:

- no thermal imaging camera to detect heating (ARIA 53841) ;
- non-segregated combustibles that facilitated the spread of fire (ARIA 54040) ;
- ignitable rubber curtains on a shredder (ARIA 50013) ;
- undersized containment (ARIA 53716).

* * *

FOCUS ON SHREDDING ACTIVITIES AT WEEE MANAGEMENT FACILITIES

Amongst the 41 events listed for WEEE facilities, 22 involved shredding operations (ARIA 49238, 54040, 53158, 52938, 52937, 50362, 49889, 49520, 53259, 51728, 50013, 49606, 49370).

The main cause was inadequate depollution of electrical and electronic equipment, which resulted in batteries (particularly lithium-ion batteries) being left undetected in waste awaiting shredding. During shredding, these items can produce electric arcs and spark a fire.

Conducting a risk analysis of the depollution process and then creating procedures to address these risks can help to ensure workers depollute electrical and electronic equipment effectively.

In addition to the issue of non-compliant incoming waste, shredding operations can create hot spots, particularly through friction, inside shredders and spark fires in shredded waste.
Shredders must be protected by fire detection and suppression systems and shredded waste must be monitored using thermal imaging cameras.

Fire at a waste sorting facility

ARIA 54040 – 16/07/2019 – Berville-sur-Seine

At around 6:00 p.m., … a 5000 m² outdoor shredding and storage area containing 600 t of shredded plastic waste caught fire. A plume of black smoke was visible.... A road was closed to traffic.... The fire was successfully extinguished and the cordon was lifted at 7:00 a.m. two days later. The fire burnt 600 t of waste, damaged four machines and resulted in 12 employees being furloughed....

According to one of the facility's managers, the fire started in a shredder while plastic from waste electrical and electronic equipment (WEEE) was being shredded. The fire may have been started by the combination of a lithium-ion battery unexpectedly hidden in the waste sent to the shredder and the high temperatures that day. The fire then spread to plastic waste stored nearby.

CONCLUSIONS

The main cause of fire at WEEE treatment facilities was self-ignition of lithium-ion batteries and non-rechargeable batteries contained in small mixed WEEE during their handling (unloading, transfer), shredding or storage. Self-ignition especially occurred during periods of high summer temperatures or while facilities were operating at reduced capacity or were closed (weekends and public holidays). Such fire events can often result in extensive property damage if the actions of emergency responders are hindered and if environmental consequences are recurrent. Lastly, a large proportion of these fires was attributed to malicious acts.

Special attention should be paid to the following points of vigilance:

Fire detection

- siting, adequacy and maintenance of systems used to detect fires and notify operators of fire alarms, *particularly on shredders and at mixed small appliance storage areas ;*
- implementation or intensification of checks for hot spots in stored waste, *particularly shredded waste and waste awaiting shredding*;
- existence of fire procedures and their understanding by operators;

Fire suppression

- siting, adequacy and maintenance of fire suppression systems *on shredders;*
- availability of the fire cistern or possibility of connecting onsite or offsite internal fire suppression equipment;

Fire risk prevention

- measures for detecting non-compliant waste (incoming controls of waste, weighbridges monitored by CCTV cameras, controls during unloading, etc.), *particularly in the case of shredding operations* ;
- intensification of certain measures during periods of extreme heat*;*
- recording of meteorological data and monitoring of weather forecasts ;
- fence maintenance;
- presence of an anti-intrusion or video surveillance system;
- ensuring that capacities are not exceeded and compliance with waste storage regulations;

Impact mitigation

- risk analysis of the depollution process resulting in the creation of adequate procedures to ensure workers depollute the appliances effectively;
- effectiveness of the depollution process.

Due to the abundance of recurring accidents in the sector, it is essential that businesses take experience feedback into account. The management of the organisation of controls (incoming, site surveillance during and outside business hours) is the key to decreasing the frequency of accidents.

General Conclusions

The waste treatment sector is a major source of accidents at industrial facilities in France and the number of events is increasing steadily, accounting for nearly one out of five over the period 2017–2019 and nearly one out of four in 2019.

The sector is diverse for three reasons: the types of waste managed, their potential to be hazardous and the types of facilities and processes used. It encompasses not just basic transport operations and more or less complex or mechanized sorting operations, but also mechanical, biological and thermal treatment operations and even storage.

Nevertheless, accidents in the sector share a number of specific characteristics. They mainly involve fire, particularly during the hottest months of the year. Although the understanding of the disruptions is less developed than it is for classified facilities as a whole, the data in the ARIA database show that losses of process control and external hazards (particularly extreme heat) are the prime immediate causes. It is also important to note that the number of confirmed or suspected malicious acts was higher in the waste treatment sector than in other sectors.

Root cause analysis shows that events were caused by organisational factors, particularly risk management. Fires were caused by either prohibited waste items or by waste that was stored in quantities above the limits allowed at treatment facilities.

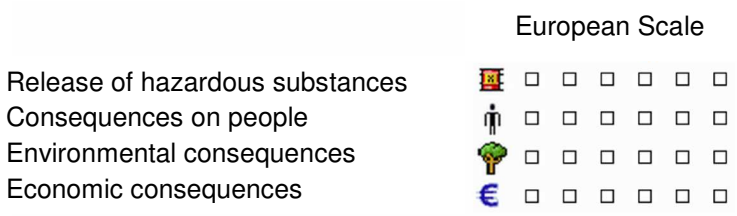
The environmental consequences of these events are significant and have soared in recent years.

Of significant note was the recurrence of events at the same facility, particularly at those that store non-hazardous waste or that sort, transport and consolidate non-hazardous waste.

The various analyses presented in the summary identify the points of vigilance and points for improvement that operators should take into account in the future.

APPENDIX: METHODOLOGY FOR RECORDING ACCIDENTS IN THE ARIA DATABASE

This methodology is designed to differentiate events that have affected protected interests (accidents) from those that could have affected them (incidents). It is based on the European Scale of Industrial Accidents, the benchmark for 2012/18/EU, the European Directive that defines major accidents that must be notified to the European Commission (Annex VI of the Directive. In recent years, France has notified between six and seven accidents, on average). This scale ranks the consequences of accidents into four areas: release of hazardous substances, human consequences, environmental consequences, economic consequences. Each area is rated on a scale from 0 to 6.



In the ARIA database, an accident is defined as an event that meets at least one of the following four criteria:

- Its consequences (human, economic or environmental) are rated at least at 1 on the European scale.
- Release of hazardous substances is rated at least at 3 on the European scale. This corresponds to a release greater than 1% of its associated Seveso threshold.
- Is not listed on the European scale due to lack of information (e.g. unknown costs of damage) or to consequences not included in the European scale but which caused:
    - off-site property damage;
    - off-site environmental damage;
    - major site damage along with furloughing of workers or re-assignment of workers to other jobs;
    - calculated livestock or crop losses amounting to more than €100,000 (equivalent to level 1 on the European scale);

- According to expert opinion, following a case-by-case analysis, is considered an accident owing to indirect consequences or the inconvenience caused (population subjected to unpleasant odours or polluting fumes, etc.). The baseline for classifying an event as an accident is two hours.

Trade unions are consulted during these case-by-case analyses.

The criteria in the European Scale of Industrial Accidents accident scale are presented below. The boxes corresponding to the criteria for defining major accidents in Directive 2012/18/EU are orange coloured. A major accident is also any accident directly involving a dangerous substance giving rise to effects outside the territory of the country concerned (effects defined in the Helsinki Convention of 1992) (see Annex VII of Directive 2012/18/EU).

5 %

Dangerous material released		1	2	3	4	5	6
Q1	Quantity Q of substance actually lost or released in relation to the « Seveso » threshold	Q < 0,1 %	0,1 % ≤ Q < 1 %	1 % ≤ Q < 10 %	10 % ≤ Q < 100 %	De 1 à 10 fois le seuil	≥ 10 fois le seuil
Q2	Quantity Q of explosive substance having actually participated in the explosion (equivalent in TNT)	Q < 0,1 t	0,1 t ≤ Q < 1 t	1 t ≤ Q < 5 t	5 t ≤ Q < 50 t	50 t ≤ Q < 500 t	Q ≥ 500 t

* Utiliser les euils hauts de la directive Seveso en vigueur. En cas d'accident impliquant plusieurs substances visées, le plus haut niveau attaint doit être retenu

Human and social consequences		1	2	3	4	5	6
H3	Total number of death: including - employees - external rescue personnel - persons from the public	- - - -	1 1 - -	2 – 5 2 – 5 1 -	6 – 19 6 – 19 2 – 5 1	20 – 49 20 – 49 6 – 19 2 – 5	≥ 50 ≥ 50 ≥ 20 ≥ 6
H4	Total number of injured with hospitalisation ≥ 24 h: including - employees - external rescue personnel - persons from the public	1 1 1 -	2 – 5 2 – 5 2 – 5 -	6 – 19 6 – 19 6 – 19 1 – 5	20 – 49 20 – 49 20 – 49 6 – 19	50 – 199 50 – 199 50 – 199 20 – 49	≥ 200 ≥ 200 ≥ 200 ≥ 50
H5	Total number of slightly injured cared for on site with hospitalisation < 24 h : including - employees - external rescue personnel - persons from the public	1 – 5 1 – 5 1 – 5 -	6 – 19 6 – 19 6 – 19 1 – 5	20 – 49 20 – 49 20 – 49 6 – 19	50 – 199 50 – 199 50 – 199 20 – 49	200 – 999 200 – 999 200 – 999 50 – 199	≥ 1000 ≥ 1000 ≥ 1000 ≥ 200
H6	Total number of homeless or unable to work (outbuildings and work tools damaged)	-	1 – 5	6 – 19	20 – 99	100 – 499	≥ 500
H7	Number N of residents evacuated or confined in their home > 2 hours x nbr of hours (persons x hours)	-	N < 500	500 ≤ N < 5 000	5 000 ≤ N < 50 000	50 000 ≤ N < 500 000	N ≥ 500 000
H8	Number N of persons without drinking water, electricity, gas, telephone, public transports > 2 hours x nbr of hours (persons x hours)	-	N < 1 000	1 000 ≤ N < 10 000	10 000 ≤ N < 100 000	100 000 ≤ N < 1 million	N ≥ 1 million
H9	Number N of persons having undergone extended medical supervision (≥ 3 months after the accident)	-	N < 10	10 ≤ N < 50	50 ≤ N < 200	200 ≤ N < 1 000	N ≥ 1 000

Environmental consequences		1	2	3	4	5	6
Env10	Quantity of wild animals killed, injured or rendered unfit for human consumption (t)	Q < 0,1	0,1 ≤ Q < 1	1 ≤ Q < 10	10 ≤ Q < 50	50 ≤ Q < 200	Q ≥ 200
Env11	Proportion P of rare or protected animal or vegetal species destroyed (or eliminated by biotope damage) in the zone of the accident	P < 0,1 %	0,1% ≤ P < 0,5%	0, 5 % ≤ P < 2 %	2 % ≤ P < 10 %	10 % ≤ P < 50 %	P ≥ 50 %
Env12	Volume V of water polluted (in m^3) *	V < 1000	1000 ≤ V < 10 000	10 000 ≤ V < 0.1	0.1 Million ≤ V< 1 Million	1 Million ≤ V< 10 Million	V ≥ 10 Million
Env13	Surface area S of soil or underground water surface requiring cleaning or specific decontamination (in ha)	0,1 ≤ S < 0,5	0,5 ≤ S < 2	2 ≤ S < 10	10 ≤ S < 50	50 ≤ S < 200	S ≥ 200
Env14	Length L of water channel requiring cleaning or specific decontamination (in km)	0,1≤ L < 0,5	0,5 ≤ L< 2	2 ≤ L< 10	10 ≤ L < 50	50 ≤ L< 200	L ≥ 200

Economic consequences		1	2	3	4	5	6
€15	Property damage in the establishment (C expressed in millions of € - Reference 93)	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C< 10	10 ≤ C< 50	50 ≤ C < 200	C ≥ 200
€16	The establishment 's production losses (C expressed in millions of € - Reference 93)	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C< 10	10 ≤ C< 50	50 ≤ C < 200	C ≥ 200
€17	Property damage or production losses outside the establishment (C expressed in millions of € - Reference 93)	-	0,05 < C < 0,1	0,1 ≤ C < 0,5	0,5 ≤ C < 2	2 ≤ C < 10	C ≥ 10
€18	Cost of cleaning, decontamination, rehabilitation of the environment (C expressed in millions of € - Reference 93)	0,01 ≤ C < 0,05	0,05 ≤ C < 0,2	0,2 ≤ C < 1	1 ≤ C < 5	5 ≤ C < 20	C ≥ 20

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