MINISTERE DE L'ECOLOGIE, DE L'ENERGIE, DU DEVELOPPEMENT DURABLE ET DE L'AMENAGEMENT DU TERRITOIRE

Gas Boilers

Accidentology feedback

ARIA
dgpr srt barpi



CONTENT

The Courbevoie thermal power station accident dated 30 March 1994 (ARIA 5132) has left a deep scar on the minds of the people due to the seriousness of the consequences and the extent of damage in a highly urbanised zone. Accidents in exclusively gas or mixed combustion facilities involve power stations, low-power boilers or facilities that supply steam, hot or superheated water required for a process. Unlike heavy oil boilers, the risk lies in the gravity of the effects resulting from an explosion.

The sample from the ARIA database comprises 121 accidents[1], that occurred in France between 15/06/1972[2] and 05/02/2007, can be divided as follows:

- 41 accidents involving gas boilers rooms and boilers (natural gas, coke oven gases, LPG, etc.).
- 80 accidents involving gas boilers rooms and boilers where the fuel is not known or is not gas operated but whose feedback can be applied to gas operated facilities.

In addition, 37 accidents of the same type that occurred abroad between February 1973 to July 2007 were also listed due to their peculiarity, seriousness or the lessons learnt.

Process type facilities (industrial furnaces), recovery boilers (refuse incineration plants), combustion turbines and engines are excluded from the sample. Accidents solely involving fuel storage sites have not been included as well.

Activities included in the sample study:

NAF (Official French Nomenclature of activities) code	No.	%	NAF code	No.	%
01 - Agriculture, hunting and related activities	1	0,85	35 - Production and distribution of electricity, gas, steam and air conditioning	34	29
10 - Food industry	9	7,7	38 – Collection, treatment and disposal of waste, recovery	1	0,85
11 - Beverage industry	1	0,85	42 - Civil engineering	1	0,85
13 - Textile industry	1	0,85	43 - Specialized construction works	1	0,85
16 - Wood and wood item manufacturing industry	3	2,6	45 - Automobile and motor cycle trade and repair	1	0,85
17 - Paper and cardboard industry	2	1,7	46 - Wholesale trade except automobile and motor cycle	3	2,6
18 - Publishing, printing, copying	1	0,85	47 - Retail trade automobile and motor cycle	1	0,85
19 - Coking, refining industry	2	1,7	49 - Land and pipeline transport	1	0,85
20 - Chemical industry	11	9,4	56 - Restaurant	1	0,85
21 - Pharmaceutical industry	1	0,85	64 - Financial service activities, except insurance and pension funds	1	0,85
22 - Rubber and plastic industry	2	1,7	74 - Other professional, scientific and technical activities	1	0,85
23 - Manufacturing of other non-metallic mineral products	5	4,3	84 - Public administration and defense, compulsory social security	1	0,85
24 - Metallurgy	1	0,85	85 - Education	9	7,7
25 - Manufacturing of metal products, except machinery and equipment	8	6,8	86 - Health and social services	5	4,3
29 - Automobile industry	1	0,85	93 - Recreation, cultural and sporting activities	3	2,6
30 - Production of other transport equipment	1	0,85	96 - Other personal services	1	0,85
31 - Production of furniture	1	0,85	**Number of accidents whose NAF code is known**	**117**	**100**
33 - Repair and installation of machinery and equipment	1	0,85			

1 A brief summary of accidents whose ARIA number has been put in bold in the text has been included at the end of the document. The full list of the summaries of 158 accidents used for this study is available in french at www.aria.developpement-durable.gouv.fr, in the "Analysis and Feedback" section.

2 Collection of information started on 1 January 1992 ever since the ARIA database has been set up. However, a few accidents prior to this date could be listed depending upon the information available

Gas boiler accidentology is marked by a high proportion of explosions and fires. In fact, the specific ignition characteristics of gas fuels and their ability to spread in service shafts and other piping (ARIA **25923**, **32777**) create an explosive atmosphere in rather confined environments.

The fault in majority of the cases lies in the cooling system (29%) and fuel supply (26.5%) the main reason behind the release of dangerous materials and explosions.

Five malfunctions recorded in the fuel supply resulted in an explosion in the boiler room due to the air / gas mixture within the explosivity limits (ARIA **3212**, **6323**, **6343**, 6347, **28389**).

The "Miscellaneous" accidents correspond to five near-accidents (ARIA 5063, **6552**, 7768, 20085, 30425) and the flooding of a boiler subsequent to the steep rise in the level of water body (ARIA 19230).

Typology and equipment behind the 121 accidents:

Equipment / part of facility where the accident originates Typology (not mutually exclusive)	Fuel supply	Combustion chamber	Heat transfer fluid systems and related equipment	Flue system	Electrical equipment	Utilities/heat distribution network	Miscellaneous	Not known	Total number of accidents
Explosions	12	3	11	1	-	-	2	14	43
Fires	6	-	6	1	8	-	4	14	39
Release of dangerous materials outside adapted containers	15	-	12	3	1	11	5	16	63
Bursting / Abrupt breakage of equipment	-	-	1	-	-	8	-	-	9
Other types	2	-	1	1	-	-	-	1	6
Total number of accidents	**22**	**3**	**24**	**5**	**8**	**12**	**9**	**38**	**121**
Proportion as compared to accidents where the faulty part of the facility is known	**26,5%**	**3,5%**	**29%**	**6%**	**9,5%**	**14,5%**	**11%**		

High pressures in confined environments create favourable conditions for the release of significant quantities of mechanical energy. The cases studied show that the accidents may be accompanied by effects of high external overpressure and projection of debris over large distances (several hundred meters).

Nine accidents result in 17 victims: 15 technicians, 1 fireman, and 1 inhabitant (ARIA **164, 5132, 6082, 6538, 16316, 17103, 18195, 19223, 25754**).

The recorded disasters have social (technical unemployment, evacuation, etc.) or environmental repercussions, and result in damage to residences and facilities, and spill over of products in purification networks and facilities.

Due to the characteristics of fuels, gas boiler accidents pollute the natural environment to a relatively lesser extent. The environmental consequences most often include surface water pollution (10 cases) and harm to plants and animals (4 cases) by products used for the "secondary" operations. These cases have been included in the fifth part of this document.

Recorded consequences of 121 events:

		Number of accidents	%
Human consequences	Fatal	9	7 %
	Serious injury	14	11,5 %
	Evacuation of inhabitants	15	12 %
Environmental consequences		14	11,5 %
External material damage		10	8 %

a / Gas leak before the boiler

Several accidents are subsequent to loss of air-tightness before the boiler at the valves and branch connections of the gas fuel supply pipes: obsolete leaking joint (ARIA 6560), defective (ARIA **17103**, 24680) or broken (ARIA **25923**) pipe fittings, etc. Moreover, movable joints and cut-off elements must be handled with rigour and in compliance with the operating guidelines specific to each valve type: two accidents have been recorded following inappropriate handing of the sliding gate valve (or «follower ring valve») that opens the pipe to the outside (ARIA **5132**, **6133**). After a maintenance operation on a boiler, a technical caused a significant gas leak by opening the gas supply without blocking the flange or carrying out an air-tightness test with compressed air or nitrogen (ARIA 31337). On boilers fuelled with LPG stored in tanks, vaporizers are sometimes another source of leakage (ARIA **11158**).

The rupture of supply pipes causes massive quantities of flammable gas to leak. There are several causes for instance an error in handling a power lift truck moving wooden pallets piled up before a pipe (ARIA **4472**).

The leaks are responsible for explosions (six out of 12 recorded leaks in the gas pipe on site lead to an explosion), fires (five cases on 12 recorded of which three are subsequent to explosions) and result in casualties and significant material damage. The ignition sources may directly be the boiler, an electrical connection or operations involving hot spots, etc. The explosion of the Courbevoie boiler, subsequent to a significant leak in the valve on the supply pipe of the boiler causing the death of two people tragically illustrates this scenario (ARIA **5132**).

In the case of mixed gas / carbon boilers, the concomitant risk of ignition of natural gas and carbon dust really needs to be taken into account during risk analysis. In case of a gas leak on a boiler supply pipe, the explosion of carbon particles suspended in air by the high flow of the leak is likely to increase the intensity of the explosion (ARIA **5132**).

Abroad

In 1987 in the United States, lightning struck an urban natural gas boiler and punctured a valve at the burner gas inlet (ARIA 6541).

b / Explosion in the boiler combustion chamber

The accident concentration of gas inside the combustion chamber can result in conditions conducive to explosion. Such accidents generally occur when the boiler is restarted or commissioned. Several scenarios could lead to such a situation:

- leaving the gas supply open following an error in procedure (ARIA **164**), malfunctioning of the regulator compressor valve (ARIA **6323**), solenoid valve (ARIA **3212**) or even any fault in the piping itself (ARIA **6343**)
- very low pressure of the gas in the injectors (ARIA 6347)
- blow-off of flame (ARIA **28389**, 32175)
- error in understanding, deactivating safety measures (ARIA **6343**, **28349**)
- pre-ventilation defect before restarting the boiler (ARIA **6538**).

Surveillance and safety equipment have led to several accidents or collateral accidents, they must be managed with great rigour. Without having the required information to analyse faults, the workers often force the boiler to start causing the gas accumulated in the firebox to explode (ARIA **6323**). In Dunkerque, the breakdown of the flame control camera did not allow to detect that the flame was extinguished (ARIA **28389**). In Lyon, a technician, unable to establish the reasons of the emergency shutdown of a burner due to the breakdown of regulatory control devices, restarts the boiler causing the gas in the firebox to explode (ARIA **6343**).


ADEME - J. Deya

a / Heat transfer fluid system accidents

Several cases of explosions, destruction or fires inside the boilers recorded in the sample study are due to the abrupt vaporisation of the heat transfer fluid in its circuit following:

- crack or rupture of the piping (coils, tubes, etc.) with or without failure of the safety device (ARIA 1015, 1465, 8055, 8725, 16806, 19079) ;
- pollution of heat transfer fluid (ARIA 6338, 7768, **25754**).

In Le Havre, the presence of hydrocarbons in the feed water of a new boiler caused the temperature of the metal piping to increase beyond the calculated values used in the test. The new boiler used to pre-heat a fuel oil tank, exploded at the end of the tests and was projected about 10m backward, killing one employee and injuring 17 others (ARIA **25754**).

Leakage or spill over of heat transfer fluids outside the boiler pollutes the surroundings or the rain water sewer system. There could be several reasons: maintenance operations such as draining the heat transfer fluid circuit (ARIA **7592**), act of vandalism (ARIA **15805**), partial rupture of a draining header of a primary circuit (ARIA 25832) or a spill over of excessively hot water into a river leading to a high incidence of death of aquatic fauna (ARIA 2780).

The integrity of the heat transfer fluid circuit and its supply must be ensured and the characteristics of the heat transfer fluid monitored that may deteriorate due to accidental mixing (ARIA **29808**) or following several heating cycles.

The natural environment is also affected by accidental release of maintenance products used in circuits (cleaners, etching agents, antiscalant) (ARIA 25894, 28569, **28911**).

The opening of safety valves of the steam system following a steam surge (ARIA 31242) or a mechanical malfunctioning of the valve (ARIA 30953) sometimes results in severe noise annoyance for the surrounding environment.

Moreover, hot water and steam distributing pipes rupture onsite (ARIA 316, **6339**, **19223**, 30899) or outside (ARIA **18195**, 19943, 20961, 25402, 26159, 31063) due to several reasons: land subsidence, obsolescence of pipes, mechanical and thermal constraints (high pressures and temperatures) and faults due to inappropriate operating practices. Even though these accidents do not result in casualties, they lead to evacuation of the general public and cut-off of heat and hot water supply.

Lastly, pipes transporting hot heat transfer fluids are a source of ignition for flammable products or fuel upon contact. Thus in a power station, lubricating oil dripping from a defective solder ignited upon contact with a pipe transporting superheated steam and resulted in a fire (ARIA **8726**).

Abroad

In 2000 in Zambia, a pipe clogged with rust caused heat to accumulate in the boiler leading to a serious fire that destroyed the refinery (ARIA 19434).

In 1994 in Germany, the rupture of a superheated steam pipe at 550°C during adjustment resulted in six deaths and one injury among staff in an urban boiler. Nine days before the accident, an inspection body had proceeded to re-testing the part of the circuit involved at a pressure lower than the working pressure and the report was forged (ARIA 5954).


MEEDDAT - L. Mignaux

b / Other accident scenarios

The emission of fumes rich in carbon monoxide generated by a poor combustion in the boiler (ARIA 2670, 7789, 16794, 19508, 21885, 25932, 26019, **29006**), and further compounded for instance by a defective chimney (ARIA 26872) have led to poisoning of both operators and public. The poor draught of a chimney could lead to the accumulation of gas and the explosion of the boiler (ARIA **6348**, **22980**). The ignition of a thermally insulated metal lining by hot fumes must also be noted (ARIA 24021).

If the boilers are not defective, they are at times responsible for igniting a flammable cloud coming from an external source: propane leak from a tanker truck (ARIA 6610) or natural gas following an accidental extraction of a pipe by workers digging a hole (ARIA 31468, **32777**), emission of solvent vapours from a tank being cleaned (ARIA 8052), etc.

In numerous industrial sites, the boilers are also involved in accidents caused due to other facilities or equipment of the site: electrical faults (ARIA 4933, **16466**, 18204, 24845, 27370, 28565, 31492) resulting in fires, and pollution of water bodies by an accidentally drained foam compounds (ARIA **32801**). These facilities are also exposed to natural phenomena such as ground movement (ARIA 5063, 10785) and floods (ARIA 19230).

Abroad

In 1980 in the United States a boiler in a boiler room that was shutdown urgently following an instrumentation failure exploded on restarting undoubtedly due to insufficient drain and pre-scavenging (ARIA 6535).

In 2000 in the United States, a leak in a propane tank of a soft drink bottling plant causing the gas cloud to explode upon contact with a boiler resulting in a BLEVE of the tank (ARIA 18967).

In 1994 in Pakistan, a short circuit in a power station triggered a fire in the underground cable network in generation units leading to the emergency shutdown of a 210 MW generating unit and other major damage (ARIA 5539).

In 1994 in Germany, a lubricating oil leak in a mechanical gear box of a gas turbine caused it to explode resulting in four deaths and six injuries including two serious injuries involving the staff of the power plant and a subcontracting company (ARIA 5958).

Commissioning, maintenance, overhaul, tests and restart operations require special attention. 31.5% of accidents (37 accidents) take place during these operations while they correspond to lower time proportions in the service life of the facilities. This high proportion just shows how crucial these transitory phases are and must not be considered as just routine operations. It is symptomatic that eight out of nine accidents resulting in victims and 24 explosions and bursting of equipment take place in these circumstances.

It must also be noted that the accidents take place when there is less staff: at night, lunchtime, and bank holidays (ARIA 6645, 8055, 12686, 16806, 19257, 22980, etc.). The safety devices must be functional and in proper working order especially to monitor the level of heat transfer fluid and initiate the emergency shutdown of the facility subsequent to a fault. This recommendation is even more applicable for boilers operated without technicians.

Circumstances and defective equipment:

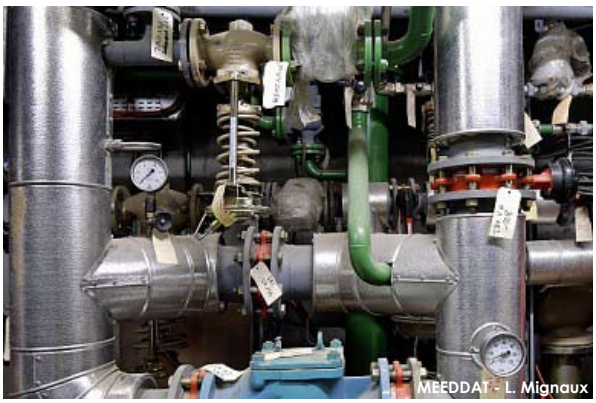
Defective equipment/part of facility / Circonstances	Fuel supply	Combustion chamber	Heat transfer fluid system and related equipment	Flue circuit	Electrical equipment	Distribution of utilities (steam, heat, etc.)	Miscellaneous	Not known	Total number of accidents	%
Maintenance / overhaul / test in progress	5	0	5	1	1	3	1	3	**19**	**15,5 %**
Boiler restart / change	6	2	2	0	0	1	0	3	**14**	**11,5 %**
Commissioning	1	0	1	0	0	0	0	2	**4**	**3,5 %**
Abandoned facility	0	0	1	0	0	0	0	0	**1**	**1 %**
General operations / unspecified circumstances	10	1	15	4	7	8	8	30	**83**	**68,5%**
Total number of accidents	**22**	**3**	**24**	**5**	**8**	**12**	**9**	**38**	**121**	**100 %**
Proportion with respect to accidents whose defective facility is known	**26,5 %**	**3,5 %**	**29 %**	**6 %**	**9,5 %**	**14,5 %**	**11 %**			


MEEDDAT - L. Mignaux

Without going into cases of malice (ARIA **15805**), the analysis of accidents shows that the initial causes rarely originate from purely technical aspects. Insufficient risk analysis, organisational failure, change management, insufficient or poorly adapted training, absence or non-compliance with guidelines, poor maintenance, inspection or vigilance are often the real reasons.

19 out of 37 accidents during the operational and transitory phases (51 %) are due to clearly identified human or organisational failures. Accidents occurs because technicians failed to follow the distribution of tasks and responsibilities (ARIA **5132**), they received inappropriate operating guidelines (ARIA **6133**), ignored warning messages or did not comply with the operating procedures and the safety rules (ARIA **164, 5132, 6343, 6538**, 31337). In the absence of information required to analyse these faults, the technicians sometimes force the boiler to start (ARIA 6323, 28349). Lack of training, routine, taking risks less seriously is rather likely in several cases. Taking the feedback into account could have avoided some accident sequences from taking place (ARIA **6133**, **5132**). Manufacturing defects (ARIA **25754**), problems in settings and handling errors (ARIA **7592**, 7768, 23421, 23893, 28569, **32801**) during maintenance (ARIA 6347, **17103**, 32175), possibly due to lack of monitoring and inspection have also been reported. Apart from operating procedures, the technicians must be informed on the risks related to the products handled (ARIA 25894).

Nine other accidents clearly involve organisational and human factors in normal operating period: 3 result from basic errors (ARIA **4472, 16371, 32777**) probably due to ergonomic, training or inspection problems and five from poor maintenance (ARIA 6338, 6560, 11158, 19508, **25923**) or monitoring (ARIA 6645).


MEEDDAT - L. Mignaux

Accidentology has illustrated numerous examples of accidents related to an overall organisational failure and poor or unsuitable operating conditions. Currently, safety management in industrial facilities is governed by a set of well established principles:

- Organisation of duties and responsibilities of staff including subcontractors
- Regular and adapted training of staff
- Identification and assessment of accident risks
- Total control of processes by guidelines and procedures enabling operations under the best possible safety conditions in both steady and transient state
- Work management, analysis of risk beforehand upon receipt of project including consultation with all involved players, accreditation of the players and organisation and supervision of project
- Use of organisational measures to manage change in facilities
- Feedback management within the same group and more generally within the same line of work
- Inspection of discrepancies observed between the overall organisation of the working of the facility and practices followed
- Involvement of the management in safety management.

Further to the explosion of the Courbevoie boiler room on 30 March 1994, an expert group worked on the feedback specific to the safety of gas boilers while laying emphasis on a certain technical and organisational aspects of which some are of significant importance given the accidentology records.

Design and manufacture of equipment

- Location of such facilities taking into account the risks underlying the various possible accident scenarios and especially the extent of impact on persons in the surroundings likely to be exposed
- Boiler design taking into account high pressures that could be attained in special conditions as well as related activities.
- Optimal assembly quality in the start guarantees lasting tightness of the facilities.
- Location, position and choice of appropriate cut-off and control elements: they must be adapted to the product and operations during which they will be used and remote controlled to guarantee optimal conditions to operate, test, inspect, ensure maintenance.
- Choice of control devices that allows as far as possible to view the position of the elements (open, closed, etc.) as well as nature of the fluid in question.
- Use of gas detection devices controlled by local visual and/or sound alarm systems carried over to the control room, ensuring the safety of the facility (cutting-off fuel supply, and switching off electricity to ATEX non-compliant equipment).
- Setting up locking or immobilising system on sensitive controls likely to be activated inadvertently or intentionally (to shorten a procedure for instance); implementing appropriate procedures to avoid sudden unlocking of these devices (by getting the key from the appropriate department supervisor, etc.).
- Taking into account the regulation automatisms of the ventilation conditions (air/gas control) of all operating phases including exceptional operating conditions such as reduced output or transfer phase from start up to full output.

Operation of facilities

- Increasing the awareness of operating teams on the specific risks related to maintenance operations so that the safety guidelines are not violated despite an excellent knowledge of the facilities.
- Updating knowledge levels and ensuring strict compliance with guidelines especially in rigorous procedures.
- Exercising extreme rigour in operation, maintenance and implementation of transient phases to ensure optimal safety of the facility.
- Ensuring availability of precise and updated guidelines at all times.
- Special training of technicians to handle unusual circumstances such as contingencies and transitory phases: action to be taken for the emergency shutdown of units, performance of additional manual operations that are added to an existing procedure or an automatism.
- Regular inspections using procedures and methods adapted of the tightness of devices under pressure (flanges, joints, valves, reducing piece, etc.), measuring instruments and safety devices.
- For gas / carbon mixed facilities, cleaning of carbon dust and clear separation of zone with high risk of gas accumulation and zones with high risk of dispersion and ignition of carbon dust.

SELECTION OF FRENCH EVENTS LISTED IN THE TEXT [1]

ARIA 164 - 27/04/1989 - 39 - TAVAUX
20.13 - Production of other basic inorganic chemicals
In a chemical plant, a 17.x7.5 x 18 m, 696 plate electrostatic dust removal filter of a 116 MW carbon boiler exploded. The accident occurred when the boiler was restarted after being shut down for 15 days for maintenance. The explosion took place due to the accumulation of 440 m³ of gas in the boiler following the gas supply of a back-up burner (300 m³/h) left open for 1 hour and 20 minutes before the accident and discovered only 1 hour and 30 minutes after. One manual valve and two automatic check valves were left open (no visual inspection, check valves unautomated with compressed air fine control, warning messages ignored). The explosion resulted in one death and eight injured among the technicians. The shattering of glass and projection of material were observed as far as 250 m. Material damage was assessed at 20 MF.

ARIA 1015 - 20/07/1989 - 13 - MARTIGUES
20.14 - Production of other basic organic chemicals
A 1962 boiler producing 100 t/h of steam at 82 bars and 475°C exploded three days after it was restarted after being shut down for 3 months for maintenance. The resulting energy broke 23 tubes out of 470 (A37 steel, 63 to 76 mm in diameter and 4 to 5 mm in thickness) at less than 20 mm from the upper and lower water tanks. The screen was opened and moved. Tube debris and refractory aggregates were projected at a distance of 100 m, causing mild injuries to an operator. The accident may have occurred due to an acid deposit (metallic sulphates) in the heterojunction causing several corroded tubes (2 mm) to burst at the same time. The perforation of either of the tubes may have subsequently caused them to erode. The cost of repair was assessed at 15 MF.

ARIA 3212 - 08/04/1991 - 71 - LE CREUSOT
25.30 - Production of steam generators excluding boilers for central heating
Equipped with an automatic regulation system and operated without constant supervision since 8/2/91, a superheated water boiler (19.2 MW, 160 °C, 11 bars) exploded in the manual operation mode while attempting to switch over to a low power boiler. The accident resulted from the accumulation of gas in the furnace when two solenoid valves in series controlling the supply to burners were accidentally opened: an electrical fault from the previous wiring, inadvertently retained during the implementation of an automated mode, triggered the control relay common to both valves. No casualties had been reported. The significant material damage was however limited to the unit.

ARIA 4472 - 04/05/1993 - 45 - MALESHERBES
18.1 – Printing and related services
A gas leak caused an explosion and started fire in a propane boiler of a printing press (500 people). Two employees sustained burns, including one who sustained second degree burns and was transported to the military hospital in CLAMART by a helicopter. One employee was unwell due to the fumes released. The leak results from the rupture of a propane supply pipe that passes through the far end of the equipment room near the quick cut-off and control element regulated from the outside by a palm button. An error in operating the power lift truck to move the wooden pellets piled up in front of the pipe may be the cause of the leak. The boiler was supplied by a 35,000 kg tank of liquefied propane.

ARIA 5132 - 30/03/1994 - 92 - COURBEVOIE
35.30 - Production and distribution of steam and conditioned air
An explosion occurred at 1.30 am in a residential boiler (500 MW, 6,000 m²). The energy dissipated in the ground is estimated to be equivalent to 50 kg of TNT. The boiler room commissioned in 1987 comprises five boilers (2 carbon boilers, 2 carbon/gas mixed boilers and 1 gas boiler). During the previous shift, several attempts to restart the mixed boiler proved unsuccessful. Since the boiler would not restart and the gas inlet manometer indicated zero pressure, the night shift supervisor instructed the opening of the two valves by a quarter turn from the sectioning of the gas inlet on the main circuit. The pressure reading was still zero so he asked the boiler operator to open the guillotine valve and then a butterfly valve to supply the mixed boiler with gas. This led to a major gas leak. A gas boiler was urgently shutdown and the explosion occurred when two operators were just about to cut off supply to the gas pressure regulator station at 110 m from the building.
One of the five employees was killed. A 10 year old girl living 50 m from the plant dies four days later after sustaining injuries. 59 other inhabitants were also injured. The facility was destroyed. The neighbouring districts suffered significant damage. 500 people were laid off temporarily and 250 inhabitants relocated. While waiting for their connection to adjacent networks, 140,000 users and 2.2 Mm² of offices were deprived of heating and hot water. The functioning of main air-conditioned IT network in the station was disturbed. The damage was estimated at 544 MF (83 M euro). According to the results of an investigation 3,750 Nm3 of gas was released until the city gas authorities cut off supply 30 min after the explosion.
The defective manometers could have been damaged by the overpressure prior to the accident. The operations performed by the shift supervisor ought to have been only carried out by the maintenance team. In the event of an emergency, the technicians of the station ought to have sought assistance from the city gas authorities. The throttle valve was not designed to operate under pressure and the butterfly valve before the throttle valve was operated by the boiler operator while the guillotine valve was still in intermediate position, where it is not air-tight as the flanges are slightly spread out. The gas cloud ignited upon contact with the carbon boiler that was operating at the time of the accident. Moreover, there was no mention of a gas leak or explosion scenario in the danger analysis of the site. The risks underlying carbon dust were not dealt with either. The behaviour of dust particles probably increased the intensity of the explosion.
On 5 May 2004, the examining magistrate of the Versailles Court of Appeal quashed the indictment.

ARIA 6082 - 08/12/1994 - 44 - BASSE-GOULAINE
10.13 - Preparation of meat products
In a prepared meat products plant, a firetube boiler with a steam production capacity of 1t/h exploded. It had a capacity of 2,790 l, a heating surface of 27 m² and used domestic fuel. It was set up in 1979 to supply five industrial pressure cookers and was rated at 10 bars. A hissing sound was heard at the relief valves just before the explosion that destroyed the building scattering the debris in an area of 200 m². Three employees died (a body was found at 250 m with the front face of the boiler), three other injured including one in serious condition. The body of the boiler (3 t) was projected 150 m to the north, the fire tube and the hot water tank at 200 m to the south. The boiler was stopped and drained for maintenance (relief valve, drain valve) three days before was restarted the morning. A possible cause of this accident could have been an inappropriate operation involving the accidental filling of the heating unit with cold water triggering a sudden evaporation upon contact with the heating tube whose temperature was already high. An expertise report dating back to 1995 stated that a partial draining of the fire tube could have led to damage from an energy perspective. This report however does not confirm that the draining was the real cause.

ARIA 6133 - 13/07/1986 - 13 - FOS-SUR-MER
24.1 – Iron metallurgy
A boiler was put out of service on 11/6 for repairs and the gas supply pipes of the blast furnace and coking plant drained. Each of the pipes was insulated with a sliding gate valve. The first pipe was insulated. During operations on the second valve, and after moving the seats aside, the escaping gas ignited when the gate was sliding. The leak was stopped by closing the anti-rolling compressor valve of the hydraulic insulation penetration seal of the station. The fire was extinguished after four hours and thirty minutes. The significant damage (piping, valves, and building) was estimated at 2.5 MF. Since the accident, the procedure requires operations on the sliding gate valve with gas supply cut off.

1 The parameters that comprise the indices of the european scale of industrial accidents and the corresponding rating method are available at: www.aria.developpement-durable.gouv.fr .

ARIA 6323 - 29/01/1993 - 92 - CLICHY
35.30 - Production and distribution of steam and conditioned air
A gas operated water tube boiler (57 t/h, 24 bar) in residential heating station stopped following a power line disturbance. The other functional boiler was not stopped. Following the malfunctioning of the pressure release valve of the spring relief pressure reducing valve of the ignition circuit, the technician tried to re-commission the boiler three times before stabilising the pressure by trying to open a valve and obtain ignition authorisation at the control console. During transfer from start-up to normal operation mode, an explosion took place after the main supply valve was opened. The combustion chamber was destroyed along with the building roof and wall. No casualties were reported.

ARIA 6339 - 01/11/1990 - 51 - CHALONS-EN-CHAMPAGNE
86.10 – Hospital activities
A cast iron valve on a steam pipe exploded under pressure in a hospital boiler during maintenance. The technician involved sustained serious injuries.

ARIA 6343 - 07/10/1994 - 69 - LYON
86.10 - Hospital activities
A 20.88 MW gas boiler under video surveillance exploded. Following the detection of an operational fault in the generator burner, and its emergency shutdown, a technician on duty proceeded to inspecting the boiler. Since the regulatory control devices were not operational, the reason for the breakdown could not be established. The technician nevertheless triggered the automatic restart sequence that was followed by an explosion 30 seconds later soon after the start of the pre-sweeping out operation (injection of air into the furnace). The investigation revealed the presence of foreign bodies (metal particles and carbon deposits) inside the gas filter and gas supply valves of the boiler, a mark on the disc of the 1st valve (leak?), significant loss of load on the air vent (22 m long, 12 square elbows). These faults have seemingly allowed gas to leak into the generator for 30 min following the emergency shutdown of the boiler. The attempt to restart the boiler with an air injection in the furnace helped reach the upper explosive limit and caused the explosion in the combustion chamber.

ARIA 6348 - 09/12/1993 - 86 - POITIERS
86.10 - Hospital activities
An explosion took place in the smoke flue of a 2.5 MW gas boiler installed in the boiler room of a hospital. The accident resulted in significant material damage on the boiler (access doors and covers ripped out, masonry destroyed, joints and chimney interiors blown away). Two theories had been propounded as to the origin of the accident: malfunctioning of the burner cycle or more likely poor combustion and smoke evacuation conditions. The flue shape (large horizontal volume) and the presence of unfavourable weather conditions (storm) may have contributed to the accumulation of CO, with ignition of the other boiler connected to the same flue. Inspecting the gas solenoid valve helps ensure its air tightness.

ARIA 6538 - 15/06/1972 - NC -
19.20 – Crude oil refining
In a steam generation plant, there were problems in starting the boiler. The operator repeated the start-up procedure, but failed to provide sufficient pre-ventilation. The air-gas mixture exploded during the attempt to re-ignite the boiler. The technician was killed and the boiler destroyed.

ARIA 6552 - 20/09/1989 - NC -
35.30 - Production and distribution of steam and conditioned air
In an industrial boiler room, two boilers (5 & 6) were connected to the same metal chimney. Following the breakdown of one of the boilers, it was decided to disconnect the corresponding smoke flue. The operations were carried out in compliance with the manufacturer specifications. However, a major deformation appeared on the 3rd and 4th shell with the risk of the chimney collapsing. The train traffic was stopped for 8 hours on a railway line passing through the site during the indispensable temporary slinging of the chimney and its support by a 200 tonne crane.

ARIA 7592 - 09/10/1995 - 60 - PRECY-SUR-OISE
23.99 – Production of other non metallic mineral products
While draining the contents of a boiler into a tank, 500 to 1,000 l of heating oil spilled over into the OISE canal. The river was polluted over several hundred metres long and 50 m wide. Fish mortality was not observed but the plants suffered severe impacts. The administrative authorities took note of the facts and suggested appropriate measures.

ARIA 8726 - 16/02/1982 - 71 - BLANZY
35.13 – Electricity supply
In a 250 MW thermal power station, 13,000 litres of lubricating oil caught fire upon contact with a pipeline transporting superheated steam. The smoke covered the control room. A flash was produced with the oil vapours accumulated below the roof that caused considerable damages. The high pressure oil caused vibrations during the pumping of the inlet valves of the turbine driven feed pump. These vibrations were transmitted to the copper low pressure tubes (diameter 22 cm) carrying lubricating oil. The rupture of a solder was the main reason behind the accident. The oil stream projected droplets that caught fire at the various local hot spots of the pipe resulting in an upward oriented vertical blowpipe flame fuelled at 250 to 300 l/min for 45 min, operating time of the pump. The repairs lasted for over a month. The damage was assessed at 10 MF. Corrective measures were implemented during operations to avoid another accident.

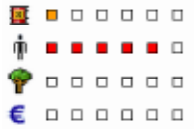
ARIA 11158 - 14/01/1997 - 53 - BAZOUGES
23.61 – Production of concrete elements for construction
A gas boiler exploded in a facility manufacturing concrete elements for construction. After having detected the smell of gas the previous day, the operator called upon the services of a boiler maintenance company that had sealed a small leak at the gas heating device on the morning of the accident. Since the smell persisted, the operator subsequently had a gas supply company intervene urgently. The explosion occurred before the gas company arrived. The company's heating system was damaged resulting in an internal operational loss. The operator planned to set up gas detectors along with an automatic cut-off valve in the boiler room. The natural gas supplier was also consulted for direct connection to the natural gas network instead of a gas tank to supply the boiler.

ARIA 15805 - 29/05/1999 - 51 - REIMS
30.20 - Construction of locomotives and other railway equipment running on rails
On the site of an abandoned plant, an act of vandalism or theft led to the spillage of several hundred litres of cooling fluid contained in an un-drained boiler. The liquid flowed into an internal gutter of the boiler room and then reached the public way through a pipe running through the wall of the premises. The sanitation department recovered around 500 litres of liquid in a rain water network. A list of abandoned products and waste material was drawn up for disposal.

ARIA 16316 - 09/01/1985 - 94 - CHAMPIGNY-SUR-MARNE
47.52 – Hardware, paints and glass in wholesale speciality shops
A fire followed by gas cylinder explosion took place in a hardware and drug shop. One person died and 21 sustained injuries. The window panes were shattered within a radius of 200 m and 12 cars were damaged. A problem in the gas boiler was the cause of the accident.

ARIA 16371 - 17/09/1999 - 79 - AIRVAULT
23.51 – Cement production
In a cement works, a fire broke out in a boiler room releasing huge quantities of smoke. Two boilers (1 electric and 1 gas) that could not be operated at the same time were used to warm-up a highly viscous fuel. When the gas boiler was operating, the electric boiler was switched on leading to the overheating of the residual cooling fluid. There was no major environmental impact. The clinker production was stopped but not the production of cement as the plant could operate on the existing clinker stock while awaiting the necessary repair operations.

ARIA 16466 - 14/09/1999 - 54 - MONT-SAINT-MARTIN
42.11 - Construction of roads and highways
A fire broke out in the thermal fluid boiler of a road material hot pre-coating facility. The firemen brought the fire under control within 1 hour and 30 minutes and watered the nearby tar tanks out of precaution. The cooling fluid used in the facility spilled into the buffer tank meant for the purpose. A short circuit in the electrical cabinet was the cause of the accident. An expert analysis was carried out on the boiler before re-commissioning.



ARIA 17103 - 05/04/1997 - 57 - SARREGUEMINES
46.74 – Plumbing and heating hardware and supplies wholesale shop
An explosion occurred in a building when the gas network and boilers were being installed. The bodies of three persons were found below the wreckage. In the judicial investigation that followed, two experts highlighted faults at the joints between the gas columns and boilers. The owner was given a six month suspended sentence and fined 50,000 F (judgement dated 06/12/99).

ARIA 18195 - 07/07/2000 - 75 - PARIS
40.3Z - Production et distribution de chaleur
35.30 - Production and distribution of steam and conditioned air
A high pressure heating pipeline running below a pavement ruptured when the pavement collapsed following violent storms. Steam leak occurred and the pipeline exploded an hour later during operations being carried out by the staff of the heating company along with firemen and policemen. The explosion resulted in a 10m x 4m crater, projected several people, smashed glass panes and damaged vehicles in the proximity. Two firemen were seriously injured of whom one died shortly after. 21 other people also sustained injuries. Rescue services arrived in great numbers (150 firemen from 19 fire stations, dog squads, etc.). A danger area was demarcated and a neighbouring day-care centre was evacuated.

ARIA 19223 - 15/11/2000 - 75 - PARIS
35.30 - Production and distribution of steam and conditioned air
While re-commissioning a steam pipeline (180°C and 22 bar) running through an underground tunnel, an explosion caused steam to be released. The workers undertaking repair operations at this phase were trapped in the tunnel by the steam and temperature flow. The workers in the technical tunnel (- 25 m) were killed on the spot (3 persons), as well as the ones at 10 m below ground level; eight out of nine other workers in other zones or at the upper level (at 3 m below ground level) sustained severe burns. The team was carrying out a delicate operation of increasing pressure on a 4.5 km section along with tests on the line. The operator presented the overall procedure as standard. Investigations were carried out to determine the causes of the accident.

ARIA 22980 - 26/07/2002 - 43 - JULLIANGES
16.10 – Wood sawing and planing
A central heating wood-fed boiler exploded in a sawmill after six employees left for their lunch break. The children playing in the vicinity sounded the alert after the accident occurred. The stones comprising the boiler chimney were projected nearby. The rabble was recovered as far as 150 m according to the press. Vehicles parked nearby were damaged. An electric line was damaged and the technical department had to be called in to restore electricity supply in the neighbourhood. The sawmill used a central heating boiler that produced hot water (no steam) between 80 and 90° to heat the wood drying building. High temperature conditions (40 to 50°) are required to prepare the wood before transferring it to the oven. The sawmill recycles the wooden chips and sawdust used as fuel for the boiler. Following the explosion, the on-site operations could not be resumed due to the extent of damage. According to the operator, the explosion occurred due to gas accumulation in the furnace due to poor draught. The manufacturer modified the supply to the boiler to cut off in the event of a fault. A problem on the boiler exhaust valve is also suspected (leak and rapid evaporation of water in the furnace). An inspection of the exhaust valve has been added to the periodical maintenance operations. Site reconstruction operations were to last between six to eight months.

ARIA 25754 - 28/11/1984 - 76 - LE HAVRE
35.13 – Electricity supply
A new boiler in a power station (10 t of steam/h) exploded. This auxiliary boiler was meant to supplement the supply of steam required to heat heavy storage fuels and to cool the burners of segment 3. This corrugated tube boiler has a 3 pass design. The combustion gases are transported to the back of the boiler and then brought to the front through internal smoke ducts before being transferred to the chimney at the back via the upper ducts. The boiler was supposed to operate as a buffer on the network along with another boiler of the same type (stopped on the day of the accident) and a steam transformer producing bled steam for turbo-alternator units. The accident took place at the end of the boiler start-up tests that were monitored by a technician from the product manufacturing company and two technicians of the boiler room. During the accident, one of the ends of the corrugated tube got detached from the condenser tube plate creating a breach at the rear end of the boiler. The water in the boiler, under the action of the immediate vaporisation of the high pressure steam (about 13 bars), escaped through this breach hurling the boiler backwards by a few dozen meters causing it to lodge into the slag-remover of a 250 MW boiler. The vapour escaping from the boiler passed through the fuel shuffling bay, destroyed the walls of the mechanical workshop and while vaporising partly at atmospheric pressure occupied significant volume causing burns to the staff in the workshop. One person died and 17 were injured in the explosion, they were all inside the mechanical workshop. Even though the boiler specifications were not in accordance with some calculation codes, they did however comply with the ISO code and the NFE 32.104 French standard.
The supply water contained hydrocarbons heavier than water at the operating temperature of the boiler. They were deposited on the firetube resulting in a switch over to film vaporisation. This consequently brought about an increase in the metal temperature beyond the maximum temperature guaranteed in the specifications of the steel used. In fact there were chances of the vapour circuit being polluted by the fuel oil during heating: the vapour condensates may have been recovered in tanks used to supply the boiler. Since the actual operating conditions at the time of the explosion were not known with full certainty, the presence of fuel oil in the supply water and specifications not compliant with calculation codes caused the accident to take place.

ARIA 25923 - 18/11/2003 - 57 - HAUCONCOURT
46.71 – Wholesale of fuel and related products
In an LPG filling station at around 2.15 pm, a site technician was performing a piercing operation in an "automated" work station outside the gas risk area: the work station is connected to the administrative building by three electric cables placed side by side ending in the crawl space. During the piercing operation, a flash was produced that burnt the technician who pressed the nearest emergency stop button. The device sounded a safety alert in the site (stopped operation of facilities and automatic sprinkling in sensitive sites). The technicians managed to quickly put out the start of the fire. One of the two technicians lifts a floor board of the premises and then another one before being burnt by the second flash that was rapidly extinguished with a dry chemical extinguisher. The two technicians who sustained burns (in their faces, hand, etc.) were hospitalised. The premises were damaged and the functioning of the centre was temporarily interrupted. Normal supply was restored to the safety installations around 7.00 pm after checks.
The accident may have occurred due to a leak in the propane pipeline supplying the heating boiler in the administrative building. The copper tube (diameter: 22 mm) travels above ground from the storage tank (11.6 m³, to heat the administrative building + filling hall, direct supply from filling hall) and then underground (diameter: 14 mm) and reaches the boiler room through the crawl space: a joint screwed into the underground part was broken resulting in an underground leak and accumulation of gas throughout the length of tube until the crawl space. From there, it continued via the unblocked electrical sheaths and headed for the automated premises. The drilling machine was the ignition point for the first flash. In the second case, a hot point could have remained and the lifting of the board could have created an air draft that reignited the remaining gas. Upon the recommendation of the inspection authorities, a formal notice was issued by the prefecture requiring the regular inspection of the piping, follow-up and inspection of resistance and air-tightness and the updating of the internal contingency plan. The operator has also planned to implement other measures on the site: setting up of a 1.7m³ tank dedicated to heating the administrative building and filling of the heating tanks by tanker trucks. The following operations were also planned on the site: drawing up a list of all underground pipelines, planning out their aerial layout and plugging electrical supply sheaths outside the zone.

ARIA 28389 - 17/07/2004 - 59 - DUNKERQUE
35.13 - Distribution of electricity
An accident took place when starting a boiler after a long shutdown period in a power plant (2x 312 MW). The injection of coking gas supplying the boilers put out the flame of the propane igniter. Since the flame surveillance camera was out of control, the roundsman on duty did not see that the flame was extinguished and tried to get the camera running. The operations supervisor did not observe that the propane ignition sequence has been abnormally shortened due to the absence of an alarm. With the available information, the staff thought that the coking gas injection command failed to work and decided to light on another burner. The coking gas already injected into the boiler formed a pocket that exploded when the second burner was ignited. No casualties have been reported but there was significant material damage especially in the boiler and its vicinity. The other segment was not damaged. After the accident was analysed, several malfunctions were observed in addition to the ones already mentioned: absence of flame that did not trigger the closing of the coking gas supply as not adapted to cold engine start (shunt by technician), gas flow rate recorder stayed at '0', switch not in the correct "gas" position. Following the accident and its feedback, several measures have been implemented on an organisational and technical level: ignition using fuel and not exclusively gas, surveillance camera mandatory conditioning start up, automatic cut off of propane and coking gas supply upon defects in the flames on both propane and coking gas burners at the same time.

ARIA 28911 - 21/09/2004 - 84 - L'ISLE-SUR-LA-SORGUE
20.52 – Manufacture of glue
Fifty litres of sodium hydroxide (NaOH) leaked from the supply of a boiler demineralisation unit of a flue production plant. The damaged floor beneath the demineralisation columns made it easier for the washing water rich in sodium hydroxide to seep into an old rain water network that empties into the SORGUE river. The rise in the pH led to the precipitation of calcium carbonate creating a major whitish turbidity in the river that disappeared in an hour. Following this accident, the company has planned to refloor and leakproof the unit, repair the piping, modify the automate program to avoid water hammer when closing the valves and reducing the discordance temperature.

ARIA 29006 - 24/01/2005 - 47 - SAINT-PARDOUX-DU-BREUIL
01.11 – Cereal (except rice), pulses and oilseed farming
Two glasshouse employees headed to the hospital due to discomfort after a day's work. The firemen who were informed by the hospital authorities, were looking for people effected with carbon monoxide poisoning caused by the malfunctioning of the glasshouse heating system. 38 people were hospitalised. Access to the glasshouse was prohibited until it was not ventilated and inspected by specialised companies. The policemen sealed the boiler room.

ARIA 29808 - 10/05/2005 - 08 - BAZEILLES
16.21 – Production of veeners and particle board
An explosion followed by a start of fire occurred in the boiler room of a particle board manufacturing company subject to authorisation. Prior to the explosion, the press coupled with the boiler has already stopped and been restarted on several occasions. Just before 5.00 pm, the boiler 2 control room operator noticed that the entire facility had stopped operating and a "white smoke/vapour» was released at the cooling oil pump. He immediately warned the area manager by telephone. A few seconds later, there was an explosion followed by a start of fire in the oil drain tank sector connected to the boilers primary circuit. Boiler room 2 was evacuated. The automatic foam sprinkler system brought the fire under control. The firemen on site assisted by external rescue teams put out the flames 15 minutes later in the secondary furnaces and marked out a danger area of 300m around the building whose sidings were on the verge of collapsing. To avoid the fire fighting water from polluting, the operated isolated the rain water collection tank from the water body where it emptied. The technician in the boiler control room who was under a state of shock was hospitalised. The siding sheets were ripped out during the explosion, two electrical cabinets and facilities related to the drain tanks were damaged by the flames. Even though the main frame of the building was not damaged, the operator feared that the explosion might have weakened the end restraints of the sidings. The inspector of classified facilities recommended the prefect to issue the operator an official notice ordering the update of the site contingency plan. Ten days before the accident, a start of fire had already broken out on the press of the plant (n° ARIA 29729). According to the expert analysis, water in the primary circuit of the boiler degraded the physico-chemical characteristics of the cooling fluid. The sudden overflowing of the hot oil into the drain tanks triggered foaming upon contact with the water in the tanks resulting in an overpressure in one of the tanks and opening of its rupture disc. The cloud that was vaporised exploded on contact with a hot surface.

ARIA 31242 - 21/12/2005 - 69 - SAINT-FONS
20.14 – Manufacture of basic organic chemicals
In a chemical plant, failure of a sensor resulted in disturbances in a boiler supplying a hydroquinone/catechol workshop. Two boilers were shutdown under emergency conditions. During their re-start, a vapour surge led to the opening of a valve whose tare pressure was set at 45 bar and the release of a large vapour cloud along with a loud noise that lasted 20 min. The police and the firemen were on site to gather information on the situation given the proximity of the accident site to a high speed traffic lane.

ARIA 32777 - 05/02/2007 - 45 - SAINT-JEAN-DE-LA-RUELLE
35.2 - Production and distribution of gas fuels
A civil works company performing earthworks using a power shovel hit the service line of a natural gas boiler causing an explosion followed by a fire. The piping was ripped off at the gas inlet flange. The boiler that is jointly owned by a building is half buried. The company has sent a formal start of works notification (DICT) to the gas department and was in possession of a network plan. A foreman claimed having seen flames coming out of the service shaft of the boiler room. The gas would have most likely travelled through PVC sheath of the piping that was ripped off and spread to the boiler room via a crack in the service shaft. The boiler that used atmosphere burners was supplied with air by a pipe that went to the ground since the upper ventilation comprised a 2mx2m chimney rooted in the flat ceiling. The gas ignited on contact with an electrical engine or a burner flame. Six persons including four workers on site sustained light injuries.

ARIA 32801 - 09/11/2006 - 2A - AJACCIO
35.21 - Production of gas fuels
Around 8.30 pm during a maintenance operation on a fire foam production device of a unit in a power station, the technicians inadvertently disconnected the emulsifier suction valve thinking of the automatic shutdown due to under voltage. Since the valve was a fail-safe type, it remained open allowing the aspiration of the product. The technicians then proceeded to testing the water pipe without the foam supply after manually opening the water valve and closing the valve at the foot of the emulsifier tank that retained the emulsifier in the tank. Further to this concluding test, the two valves were returned to their original position. Moreover, during a previous operation, the technicians had forgotten to close the valve draining the water from the fire circuit of the same unit. The supply pipes were consequently emptied of the water resulting in the siphoning of 1,000 l of the A3F emulsifier (agent forming a floating film) in the effluents retention drain. The product was then diluted in the last 390 m³ settling tank before being disposed off in the SALIVE river. The time that the 95% biodegradable product diluted in the decantation system of the plant crosses all the tanks allows the slowing down of the propagation speed of the product until its release into the river.
A dam has been built on the SALIVE and traces of foam have been recovered with adapted absorbents. The release of industrial water in the river has been stopped and the COD is measured in the settling tanks (1280 mg/l) and water bodies (326 mg/l). The SALIVE river passing through the plant and is channelled in a cup shaped civil engineering structure where the initial waste is stored. This allowed about 28 m³ of waste to be pumped as of 10/11/2006 and released into the sewage networks after obtaining permission from the city water authority. A treatment system using activated carbon from the COD was set up at the outlet of the flocculation system of the plant on 21/11 and 22/11. The release of industrial water in the SALIVE river was resumed and that of sewage was stopped.
For beginning 2007, the operator has planned to draft a procedure to de-commission the emulsifier network, to conduct training on the test mode requirements and operation of solenoid valves and launch a corporate campaign on the need to refurbish the facilities back to the original state as required by the test mode. The inspection authorities of classified facilities were informed on the how the accident was managed by reports dated 10/11/2006, 14/11/2006 and 21/11/2006.

TECHNOLOGICAL ACCIDENTS ONLINE

Safety and transparency are two justifiable requirements of our society.

Therefore, since June 2001 the website www.aria.developpement-durable.gouv.fr of the Ministry for ecology and sustainable planning and development has been giving lessons learnt from the analysis of technological accidents to professionals and general public. The main sections of the website are presented in French and in English.

Under the general sections, the Internet user can, for example : inquire for the state's action, access to wide extracts of the ARIA database, discover the presentation of the European scale of industrial accidents, inquire for the parameter concerning the dangerous substances used to complete the "on the spot communication" in case of accident or incident.

Accidents description, which is the raw material of any method of experience feedback, constitutes an important part of the event, consequences, origin, circumstances, established or presumed causes, actions taken and lessons leamt.

Hundred detailed and illustrated technical reports present accidents selected for their particular interest. Numerous analysis grouped by technical subjects or by activities are also available. The section dedicated to the technical recommendations develops various topics: chemical, pyrotechnics,surface treatment, silos, type storage, fire license, waste treatment, handling ... A multicriteria research engine enables to reach information about accidents arisen in France or abroad.

The website www.aria.developpement-durballe.gouv.fr grows richer constantly. Currently, more than 32 000 accidents are online and new topics will be regularly added.

The summaries of the accidents presented in this document are available in french at:

www.aria.developpement-durable.gouv.fr

Bureau d'analyse des risques et pollutions industriels
2 rue Antoine Charial
69426 Lyon Cedex 03
Téléphone : 04 37 91 44 89

Service des risques technologiques
Direction générale de la prévention des risques
Ministère de l'Ecologie, de l'Energie, du Développement Durable et de l'Aménagement du territoire
20 avenue de Ségur
75302 Paris 07 SP
Téléphone : 01 42 19 20 21

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Ministère de l'Écologie, de l'Énergie, du Développement durable et de l'Aménagement du territoire