

## Accident on a cooling box of a feed chute of a furnace in a refuse incineration plant

22 July 1999

Saint Ouen [93]

FRANCE

Waste  
Incineration  
Explosion  
Organisation/  
modification  
Communication  
Works  
Successive Incidents  
Precursory signs  
Water-jacket

### FACILITIES CONCERNED

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#### The facility:

The refuse incineration plant includes three furnace-boiler units having a maximum hourly capacity of 28 tonnes, i.e. 600 tonnes per day. The plant has a workforce of 122 people.



### THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

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#### The accident:

On 22 July 1999 at 3.00 pm, an explosion occurred when a technician was on a routine round of inspection near furnace 1. The operator sustained serious burns and was thrown off 3 m above the walkway he was crossing. The explosion took place at the cooling box of the furnace's feed chute that was recently modified.

**Consequences:**

The accident resulted in the stoppage of furnace 1, as well as furnace 2 on which similar modifications were made. The activities of the plant were drastically disrupted as since furnace 2 by itself did not have the required capacity to treat all the waste, the domestic waste needed to be transported by large straight trucks (75 trips per day) either to other incineration plants in the Paris region or to landfills. Operations were back to normal in the factory only in September 1999.

**European scale of industrial accidents**

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available:

Dangerous materials released		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human and social consequences		<input checked="" type="checkbox"/>	<input type="checkbox"/>				
Environmental consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Economic consequences		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

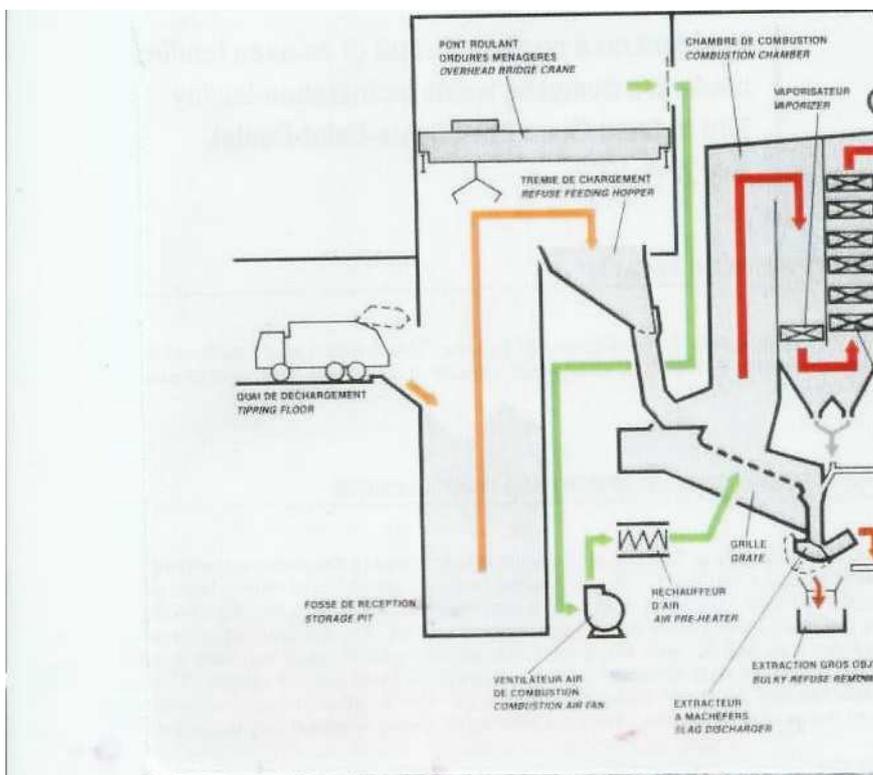
The parameters that comprise these indices and the corresponding rating method are available at the following address: <http://www.aria.ecologie.gouv.fr>.

Level 1 attributed to the human and social consequences index is explained by the serious injury caused to 1 employee (parameter H4).

However, the unavailability of statistical information makes it impossible to rate the economic consequences index.

**ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT**

The lower part of each feed chute of the furnaces must be cooled to avoid heating and deterioration of metal plates exposed to thermal radiation from the furnace (temperature of 1000 °C). A "water jacket" system comprising 20 2.5m long cooling boxes containing water flowing at a pressure of 3 bar between the plates (8 and 16 mm thick) is used for cooling. The waterway is fitted with valves at the inlet and outlet of each cooling box divided into four compartments by three baffle plates.



Water leakage was detected between 4 and 8 July when the facility was stopped for standard maintenance. According to the operator, leakage is usual given the constraints to which the metal plates are subjected (expansion resulting in cracks). To overcome this repeated malfunctioning, the operator removed the waterway in one of the cooling boxes of furnace 1 and filled the cooling box with insulating concrete. The same operation was carried out on one of the cooling boxes of furnace 3 to observe how well the new procedure worked, since this furnace was scheduled for technical overhaul in two months. The amount of concrete used to fill the cooling box was not controlled. The drain valve was left open during drying to avoid any rise in pressure and was maintained in open position.

The facility was re-commissioned on 8 July and was reported by the operator to have functioned normally without any malfunctions until the accident. The explosion took place at the level of the concrete-filled cooling box that was severely damaged, the outer plate was ripped out and the inner plate bent towards the furnace, indicating that the explosion actually occurred in the cooling box where the valve was closed. A closer observation revealed that the inner plate was also ripped apart and the flames from the furnace inflicted serious burns on the technician. According to the initial analysis the explosion is undoubtedly due to an abrupt vaporisation of water in a closed space.

## ACTION TAKEN

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The Central Laboratory of the Police Department was on the site the following day. The Inspection Authorities of Classified Facilities was only notified the second day following the accident.

Since furnace 3 was stopped as a precautionary measure, the operator requested permission for re-commissioning it as early as 26 July given all modifications and repair work carried out. A technical expert report was prepared the very day by an external design office. The inner sheet of the cooling box filled with concrete was removed to observe its position, the concrete was subsequently removed and repair work was carried out (the inner side of the outer wall was reinforced with concrete).

The Inspection Authorities of Classified Facilities was not in favour of re-commissioning furnace 3 and required an accident report to be submitted beforehand as provided by article 38 of the amended decree of 21/9/77. The operator was informed that furnace 3 will be re-commissioned only after approval granted by the Prefect on the basis of a report that precisely analyses the accident, draws from its consequences and proves that the repair work carried out on furnace 3 enables risk free operation. The same procedure shall apply to furnace 1 that will be reworked after completion of the judiciary police investigation ordered by the attorney general.

The accident report was sent on 27 July along with the expert's report prepared by an inspection authority and request for approval from the Prefect to re-commission furnace 3. The report showed that incidents had already occurred on the cooling boxes of furnace 3 (unsoldered plate and valve shut) and furnace 1 (valve shut whose opening caused a strong steam jet). These precursory incidents ought to have led the operator to take the necessary measures and draft strict and clear guidelines. The repair work carried out on furnace 3 after the accident was not subjected to an expert analysis by an inspection authority. In view of the documents, the Inspection Authorities of Classified Facilities recommended the Prefect to not grant approval for re-commissioning the furnace. This proposal was followed by a letter from the Prefect informing the operator of the unfavourable decision with regard to re-commissioning the furnace and stating that the furnace would only be re-commissioned after review by an inspection authority.

With regard to furnace 1, its re-commissioning will be planned only after the completion of the judiciary investigation; approval from Prefect, and presentation of a detailed cause flowchart on the circumstances of the accident by the operator.

After studying the new report and subsequent to an on-site meeting, the Inspection Authorities of Classified Facilities recommended the Prefect to order the re-commissioning of furnace 3 subject to compliance with several technical, administrative and organisational provisions.

- Measurement and recording of the cooling box plate temperature
- Regular inspection of the inner walls of the furnace
- Display and understanding of operating and inspection guidelines
- Installation of valves on cooling boxes with waterway. Failing which, water intake and outlet valves on the cooling boxes and valves upstream and downstream regulating the entire set up must be permanently maintained in open position unless when the risk resulting from not being able to operate them is higher.
- Maintain the prohibition on re-commissioning furnace 1 without the written permission of the Prefect that shall be delivered subject to the conclusions of the judiciary investigations communication subsequent to the submission of a risk analysis report, detailed analysis on the cause of the accident, analysis on the feedback as well as the description of implemented measures and repair work and overhaul carried out on the cooling boxes and a report of an inspection authority by the operator.

Furnace 3 was re-commissioned on 4 August. On 5 August, an alarm was sounded as the temperature of the plate of the modified cooling box exceeded 250 °C. The furnace was stopped. After cooling, it was observed that a part of the concrete did not hold. The procedure however was respected this time: temperature alarm sounded, furnace stopped,

incident report submitted. The Inspection Authorities of Classified Facilities ordered a new enquiry and subjected the re-commissioning of furnace 3 to the risk analysis required for furnace 1.

The analysis provided by the operator showed that:

- the most likely reason of the 'accident is the vaporisation related to the sudden introduction of water in the cooling box
- the faults observed on the facility were reported to the supervisory staff that failed to properly understand the potential danger of the facility at that moment

The analysis of risks related to the use of "water jacket" highlights that the main risks encountered are due to:

- an abrupt increase in pressure in the tanks caused by an incorrect arrangement of individual isolating valves in the tanks
- a gradual increase in pressure in the tanks

The following modifications are made in the tanks of furnace 3 to eliminate the risks:

- the valves installed on each cooling box are removed
- the isolating valves at the waterway inlet and outlet of each feed chute are fitted with travel stops
- the boiler can only be switched on if these valves are in open position and the facility will be shut down following any sudden closure of the valves despite being locked in position with guidelines provided and presence of instruction plates.

An expansion balloon can be used to counteract the effect of the gradual increase in pressure. Moreover, the waterways of the cooling boxes exposed to thermal radiation of the furnace are first fitted with safety discs and then with valves since the operator must regularly shut down the furnaces to replace these discs.

Specific "water jacket" operating guidelines have been drafted and it was decided to consult an external body before making any modification on the facility. This decision was applied to the overhaul of furnaces 1 and 3.

## LESSONS LEARNT

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The accident is subsequent to:

- a series of "close-to-accident" situations whose gravity was not taken into account by the operator
- a series of technical modifications on equipment carried out by the operating staff without technical assistance and support from outside and without risk analysis
- random and hurried repair work after the accident without inspection authority or external assistance to rapidly re-commission the facility

Despite the pressure related to re-commissioning the facility, it is advisable to take the necessary time to obtain the analysis of the causes, ensure that the absence of residual risks has been properly validated and the repair work has been correctly performed. Many accidents are a result of a poor evaluation of risks related to hasty modifications.

The accident highlights:

- once again the importance of the organisational factor: insufficient analysis of risk relating to intermediary phases (works, maintenance, modifications, etc.) and a poor awareness of risks pertaining to the entire facility
- the importance of having feedback on basic incidents and incidents and failures and improve reporting of such information