

Explosion i ett aluminiumgjuteri i metallindustri.

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Olyckan inträffade på en fabrik för halvfabrikatsframställning av aluminium mot slutet av ett produktionspass. Under en storm inträffade två kraftiga explosioner i en aluminiumgjutform inom loppet av fem sekunder. Explosionerna föregicks av ett kraftigt ljusfenomen, förmodligen en elektrisk urladdning av okänt slag. En motor till en lift uppvisade otvetydiga spår av en kraftig elektrisk urladdning, som kan ha varit den utlösande faktorn. Den tillsatta haverikommissionen slöt sig till att den första explosionen orsakades av att heta droppar av aluminium finfördelats till en dimma i luften där de reagerat mycket våldsamt med luftsytret. Explosionens intensitet uppskattades till motsvarande 200 kg TNT. Den var såpass kraftig att den noterades av flera seismografer i området. Det var denna explosion som orsakade större delen av skadegörelsen. Bl.a. totalförstördes gjutformen, och kringflygande splitter dödade fyra människor. Fönster krossades 700 m bort. Aluminiumsmälta som rann över gjutformen och ned i det kringgårdande kylvattnet orsakade den andra explosionen, en våldsam förångning av vatten. Denna explosion uppskattades till en intensitet motsvarande 100 kg TNT.

Inblandade ämnen och mängder

	CAS Nr.	Mängd
aluminium		150-300 kg

Skador:

Människor:	Fyra människor dog, varav en som befann sig 35 meter bort, då splitter med stor kraft slungades vida omkring. Ytterligare 25 skadades och fick sändas till sjukhus.
Materiella:	Produktionsanläggningen skadades svårt, men även kringliggande byggnader blev skadade. Kostnaderna för olyckan uppskattades till 115 miljoner franska Francs för byggnader och utrustning, och 105 miljoner Francs för förlorad produktion.
Miljö/ekologi:	Inga effekter rapporterade.
Infrastruktur:	Inga.

Erfarenheter redovisade (Ja/Nej): Ja

Se "Experience Feedback from an Uncommon Lightning Accident" av J.P. Pineau och J. Chaineaux.

Report Profile

Identification of Report:

country: FA ident key: 1800_020_01

reported under Seveso I directive as major accident reports: SHORT+FULL

Date of Major Occurrence: Time of Major Occurrence

start: 24/03/1986 start: 17:50:00

finish: finish:

Establishment:

name:

address:

industry: 2011 metal refining and processing (includes foundries, electrochemical refining, plating, etc.)

Metal (Aluminium Production)

Seveso II status: not applicable: Yes art. 6 (notification): No

art. 7 (MAPP): No

art. 9 (safety report): No

Date of Report:

short: full:

Authority Reporting:

name:

address:

Authority Contact:

rep_cont_name:

rep_cont_phone:

rep_cont_fax:

Additional Comments:

a) - not applicable -

b) - not applicable -

c) - not applicable -

d) - not applicable -

e) - not applicable -

Short Report

country: FA ident key: 1800_020_01

Accident Types:

release: No explosion: Yes

water contamination: No other: No

fire: No

description:

ACCIDENT CASE HISTORY DESCRIPTION:... see Appendix Short Report / description of accident types

Substance(s) Directly Involved:

toxic: No explosive: Yes

ecotoxic: No other: No

flammable: No

description:

- Aluminium Alloy: amount involved = 1,200 Kg (150`300 Kg were involved in the first explosion).

Immediate Sources of Accident:

storage: No transfer: No

process: Yes other: No

description:

The accident occurred during the shut-down of an aluminium alloy foundry in a metal industry for the aluminium production. The factory, located in the centre of France, in Issoire, employed 1,500 people and in 1986 produced 100,000 tonnes/y... see Appendix Short Report / description of immediate sources

Suspected Causes:

plant or equipment: No **environmental:** Yes

human: No **other:** No

description:

CAUSES:... see Appendix Short Report / description of suspected causes

Immediate Effects:

material loss: Yes

human deaths: Yes

human injuries: Yes **community disruption:** No

other: No

ecological harm: No

national heritage loss: No

description:

EFFECTS ON PEOPLE:... see Appendix Short Report / description of immediate effects

Emergency Measures taken:

on-site systems: Yes **decontamination:** No

external services: No **restoration:** No

sheltering: No **other:** No

evacuation: No

description:

INTERNAL TO THE ESTABLISHMENT:

After the accident, the gas feeding and the electricity were cut-off.

Immediate Lessons Learned:

prevention: No **other:** Yes

mitigation: No

description:

The mechanism of the accident could be established by comparing reports, clues furnished by the materials and by work of technical experts. An inquiry commission was rapidly formed after the accident and worked in close contact with and und... see Appendix Short Report / description of immediate lessons learned

A Occurrence Full Report

country: FA **ident key:** 1800_020_01

1 Type of Accident

remarks: During a storm at the end of the working period (most employees had already left the plant), two very powerful, successive explosions occurred (code 1303) in less than 5 seconds in the fusion cavity of the furnace, causing extensive damages... see Appendix Full Report A / type of accident

2 Dangerous Substances

remarks: The total establishment and the potential directly involved inventories of

molten aluminium alloy refer to the amount involved in the accident, that is the quantity (150`300 Kg) dispersed in the air by the action of the shock wave produced ... see Appendix Full Report A / dangerous substances

3 Source of Accident

illustration: - not applicable -

remarks: The accident occurred during the shut-down of an aluminium alloy foundry (codes 3104 and 4007) in a metal industry for the aluminium production (code 2001). The factory, located in the centre of France, in Issoire, employed 1,500 people and... see Appendix Full Report A / source of accident - remarks

4 Meteorological Conditions

precipitation none: fog: rain: hail: snow:

No No No No No

wind speed (m/s):

direction (from):

stability (Pasquill):

ambient temperature (°C):

remarks: The accident occurred during a storm.

5 Causes of Major Occurrence

main causes

technical / physical 5107 operation: unexpected reaction/phase-transition

5201 environment: natural event (weather, temperature, earthquake, etc.)

- not applicable -

- not applicable -

- not applicable -

human / organizational 5501 other: not identified

- not applicable -

- not applicable -

- not applicable -

- not applicable -

remarks: The first explosion was caused by molten aluminium alloy droplets dispersed in air by the action of the shock wave produced by a lightning (code 5201). This fog then exploded (as a detonation equivalent to 200 Kg of TNT) as a result of the ... see Appendix Full Report A / causes of major occurrence

6 Discussion about the Occurrence

- not applicable -

Type of Accident country: FA ident key: 1800_020_01

event:

major occurrence 1303 explosion: rapid phase-transition explosion (rapid change of state)

initiating event 1303 explosion: rapid phase-transition explosion (rapid change of state)

associated event - not applicable -

Dangerous substances

country: FA ident key: 1800_020_01

a) total establishment inventory

CAS number: identity: Molten Aluminium Alloy

name from Seveso I Directive: - not applicable -

name from Seveso II Directive: - not applicable -

category from Seveso II: - not applicable -

other hazards (1): - not applicable -

other hazards (2): - not applicable -

maximum quantity (tonnes): 1,2

use of substance as: NORMAL FINISHED PRODUCT

b) substance belongs to relevant inventory directly involved: Yes

actual quantity: 1,2 potential quantity: 1,2

c) substance belongs to relevant inventory indirectly involved: No

actual quantity: -1 indir_pot_quant: -1

Source of Accident - Situation country: FA ident key: 1800_020_01

situation

industry

initiating event 2011 metal refining and processing (includes foundries, electrochemical refining, plating, etc.)

associated event - not applicable -

activity/unit

major occurrence 3104 process: physical operations (mixing, melting crystallizing, etc.)

initiating event 3104 process: physical operations (mixing, melting crystallizing, etc.)

associated event - not applicable -

component

major occurrence 4007 machinery/equipment (pump, filter, column separator, mixer, etc.)

initiating event 4007 machinery/equipment (pump, filter, column separator, mixer, etc.)

associated event - not applicable -

B Consequences Full Report

country: FA ident key: 1800_020_01

1 Area concerned

affected

extent of effects installation: Yes

establishment: Yes

off-site; local: Yes

off-site; regional: No

off-site; transboundary: No

illustration of effects - not applicable -

remarks The seismic wave generated by the first explosion was recorded by several seismo... see Appendix

Full Report B / area concerned - remarks

2 People

establishment popul. emergency personnel off-site population

total at risk

immediate fatalities 4

subsequent fatalities

hospitalizing injuries 25

other serious injuries

health monitoring

remarks 4 people (three in the immediate proximity to the casting area and one 35 metres... see Appendix

Full Report B / people

3 Ecological Harm

pollution/contamination/damage of:

- **residential area (covered by toxic cloud)** Suspected

- **common wild flora/fauna (death or elimination)** Suspected

- **rare or protected flora/fauna (death or elimination)** Suspected

- **water catchment areas and supplies for consumption or recreation** Suspected

- **land (with known potential for long term ecological harm or** Suspected

preventing human access or activities)

- **marine or fresh water habitat** Suspected

- **areas of high conservation value or given special protection** Suspected

remarks In the Original Report there is no evidence of significant ecological harms... see Appendix

Full Report B / ecological harm

4 National Heritage Loss

effects on:

- **historical sites** not applicable - **historic monuments** not applicable

- **historic buildings** not applicable - **art treasures** not applicable

remarks No data available.

5 Material Loss

establishment losses off site losses

costs (direct costs to operator) (social costs)

in ECU FF ECU FF

material losses 2,2E+08

response, clean up, restoration

remarks The north side of the foundry was considerably damaged, as well as other buildin... see Appendix

6 Disruption of Community Life

establishment/plant evacuated disabled/unoccupiable destroyed

- **nearby residences/hotels** No No No

- **nearby factories/offices/small shops** No No No

- **schools, hospitals, institutions** No No No

- **other places of public assembly** No No No

interruption of utilities etc. no / yes duration

- **gas** No

- **electricity** No

- **water** No

- **sewage treatment works** No

- **telecommunications** No

- **main roads** No

- **railways** No

- **waterways** No

- **air transport** No

significant public concern none local level national level

- **off site populations** No Yes No

- **media interest** No No No

- **political interest** No No No

remarks The seismic wave generated by the first explosion was recorded by several seismo... see Appendix

7 Discussion of Consequences

C Response Full Report

country: FA **ident key:** 1800_020_01

1 Emergency Measures

taken - on site - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

still - on site - not applicable - - not applicable -

required

- not applicable - - not applicable -

- not applicable - - not applicable -

- **off site** - not applicable - - not applicable -

- not applicable - - not applicable -

- not applicable - - not applicable -

continuing contamination or danger

-on site not applicable

-off site not applicable

remarks - not applicable -

2 Seveso II Duties

pre-accident evaluation

Article item not due yet not done done/submitted evaluated

6 notification No No No No

7 policy (MAPP) No No No No

9 safety report No No No No

9, 10, 11 update No No No No

11 internal plan No No No No

11 external plan No No No No

13 informing public No No No No

9, 12 siting policy No No No No

post-accident evaluation

Seveso II duty was actual were actual compared with actual

contingency consequences consequences, the

addressed? addressed? predicted extent was?

Article item

7 policy (MAPP) not applicable not applicable not applicable

9 current safety report not applicable not applicable not applicable

11 internal plan not applicable not applicable not applicable

11 external plan not applicable not applicable not applicable

13 informing public not applicable not applicable not applicable

9, 12 siting policy not applicable not applicable not applicable

evaluation of safety organisation

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- **written policy objectives** No

- **specified management** No

structure

- **specified responsibilities** No

- **specified working procedures** No

- **specified procedures for** No

assessment/auditing of

management system

- specified procedures for No

review and update of

management policy

- specified general training No

procedures

- specified emergency No

training procedures

evaluation of ecological impact control

organisational element element existed did element relate to actual circumstances of

yes / no no / partly / yes adequate?

- ecological status review No

before incident

- potential ecological No

consequences assessment

- ecological impact review No

after incident

- ecological restoration No

procedures

- subsequent review of No

restoration success

remarks - not applicable -

3 Official Action Taken

legal action

- not applicable -

other official action

- not applicable -

4 Lessons Learned

measures to prevent recurrence

- not applicable -

measures to mitigate consequences:

- not applicable -

useful references:

The mechanism of the accident ... see Appendix Full Report C / lesson learned - references

5 Discussion about Response

- not applicable -

Appendices for the FA / 1800_020_01 report

Appendix Short Report / description of accident types:

ACCIDENT CASE HISTORY DESCRIPTION:

During a storm at the end of the working period (most employees had already left the plant), two very powerful, successive explosions occurred in less than 5 seconds in the fusion cavity of the furnace, causing extensive damages to the foundations of the furnace. The first explosion, undoubtedly in the form of a detonation equivalent to 200 Kg of TNT, fractured material, destroyed the casting frame and caused the essential part of the damages noted. It also caused the break of a cable in an ingot lowering machine

and caused plates and aluminium alloy not dispersed by the electric arc to fall into the casting pit. The second explosion was equivalent to 100 Kg of TNT and occurred two seconds later. The first explosion could have generated a pressure of 10 to 20 bar on the sides of the pit, and the generated seismic wave was recorded by several seismographs in the region and furnished an energy undoubtedly at least 1,000 times greater than that of the electric arc produced in the building.

Appendix Short Report / description of immediate sources:

The accident occurred during the shut-down of an aluminium alloy foundry in a metal industry for the aluminium production. The factory, located in the centre of France, in Issoire, employed 1,500 people and in 1986 produced 100,000 tonnes/year of semi-finished products, including thick plates, thin sheets and aluminium alloy profiles, mainly for the aeronautic, land or water transport markets. 200 people were working in the foundry just before the accident. The six casting furnaces in the foundry building were in normal operation.

Appendix Short Report / description of suspected causes:

CAUSES:

The mechanism of the accident could be established by comparing reports, clues furnished by the materials and by work of technical experts. An inquiry commission was rapidly formed after the accident and worked in close contact with and under the supervision of administrative and judicial authorities. The analysis of statements and interviews indicated that a luminous phenomenon in the foundry followed, almost immediately, by the first explosion and 2 seconds later by a second explosion. The examination of material in the foundry shop near the presumed starting point of the explosion showed that the motor of a mobile hoist located 15 metres from the supposed point of explosion presented indisputable traces of the passage of lightning-related current. In addition, it was possible to determine numerous possibilities for the routing of the current leading to the starting point of the explosion. In particular, the casting pit itself, where the explosion started, was the best grounding point in proximity to the motor. It was supposed that the molten aluminium alloy could have led to: either an explosion of aluminium alloy droplets dispersed in air (which involves a suspension process) or a reaction of molten aluminium with water. The first was opted for. The molten aluminium was suspended in air by the action of the shock wave produced by the electric arc. The shock wave dispersed 150'300 Kg (of a total of 1,200 Kg) of molten aluminium alloy around the casting frame in the form of a fog of fine droplets. Only a part of the energy of the shock wave was used in this dispersion process. The fog then exploded (as a detonation equivalent to 200 Kg of TNT) as it formed as a result of the droplets/air reaction. The second explosion was equivalent to 100 Kg of TNT and occurred two seconds later, as a result of the rapid vaporization of cooling water in contact with the molten metal, which fell from the upper part of the casting pit.

Appendix Short Report / description of immediate effects:

EFFECTS ON PEOPLE:

4 people (three in the immediate proximity to the casting area and one 35 metres away) were killed and 25 others were injured (and hospitalized) by the explosion.

MATERIAL LOSS:

The north side of the foundry was considerably damaged, as well as other buildings and equipments farther away, especially because of the projection of missiles from the casting frame (up to 700 metres). The cost of the accident has been estimated in about 220 millions of French Francs, including 115 millions for the buildings and equipment and 105 millions for lost production.

Appendix Short Report / description of immediate lessons learned:

The mechanism of the accident could be established by comparing reports, clues furnished by the materials and by work of technical experts. An inquiry commission was rapidly formed after the accident and worked in close contact with and under the supervision of administrative and judicial authorities. It made use of the services of experts in the following fields: explosions, use of natural gas, prevention, meteorology and storms, metallurgy, civil, mechanical and electrical engineering, combustible dust.

Appendix Full Report A / type of accident:

During a storm at the end of the working period (most employees had already left the plant), two very powerful, successive explosions occurred (code 1303) in less than 5 seconds in the fusion cavity of the furnace, causing extensive damages to the foundations of the furnace.

Appendix Full Report A / dangerous substances:

The total establishment and the potential directly involved inventories of molten aluminium alloy refer to the amount involved in the accident, that is the quantity (150'300 Kg) dispersed in the air by the action of the shock wave produced by the lightning that caused the first explosion plus the quantity which fell from the upper part of the casting pit and, reacting with cooling water, caused the second explosion.

Appendix Full Report A / source of accident - remarks:

The accident occurred during the shut-down of an aluminium alloy foundry (codes 3104 and 4007) in a metal industry for the aluminium production (code 2001). The factory, located in the centre of France, in Issoire, employed 1,500 people and in 1986 produced 100,000 tonnes/year of semi-finished products, including thick plates, thin sheets and aluminium alloy profiles, mainly for the aeronautic, land or water transport markets.

Appendix Full Report A / causes of major occurrence:

The first explosion was caused by molten aluminium alloy droplets dispersed in air by the action of the shock wave produced by a lightning (code 5201). This fog then exploded (as a detonation equivalent to 200 Kg of TNT) as a result of the droplets/air reaction (code 5107). The second explosion occurred two seconds later, as a result of the rapid vaporization of cooling water in contact with the molten metal (code 5107), which fell from the upper part of the casting pit.

Appendix Full Report B / area concerned - remarks:

The seismic wave generated by the first explosion was recorded by several seismographs in the region.

Appendix Full Report B / people:

4 people (three in the immediate proximity to the casting area and one 35 metres away) were killed and 25 others were injured (and hospitalized) by the explosion.

Appendix Full Report B / ecological harm:

In the Original Report there is no evidence of significant ecological harms.

Appendix Full Report B / material loss:

The north side of the foundry was considerably damaged, as well as other buildings and equipments farther away, especially because of the projection of missiles from the casting frame (up to 700 metres). The cost of the accident has been estimated in about 220 millions of French Francs, including 115 millions for the buildings and equipment and 105 millions for lost production.

Appendix Full Report B / disruption of community life:

The seismic wave generated by the first explosion was recorded by several seismographs in the region.

Appendix Full Report C / lesson learned - references:

The mechanism of the accident could be established by comparing reports, clues furnished by the materials and by work of technical experts (as shown in "EXPERIENCE FEEDBACK FROM AN UNCOMMON LIGHTNING ACCIDENT" of J.P. Pineau and J. Chaineaux).