# Fire in an electrical service room in a chemical plant and release of toxic gas

October 25, 2004

**Lannemezan - [Hautes-Pyrénées]**
**France**

Electrical breakdown
Domino effects
Chemistry
Hydrazine unit
Ammonia
Monitoring / Control
Organisation
Process control
Safety data information package
Property damage
Operating losses
Expert evaluation

## THE INSTALLATIONS IN QUESTION

### The site

The site is classified "SEVESO" for the use, storage and manufacture of very toxic, toxic and flammable products.

The establishment essentially produces hydrazine (15,000 tons per year). One of the largest applications of this product is anti-corrosion protection of industrial boilers, thermal and nuclear power stations.

Part of this production is used at the site to produce hydrazine hydrate "derivatives" which are then used in a variety of activity sectors such as agrochemical, pharmaceutical, and chemical synthesis.

### The unit concerned

The hydrazine unit's electrical substation consists of:

- a 13kV/380V transformer, in a separate building,
- an intermediate switchboard C3 which includes certain hydrazine outgoing feeders, the 2 UPS supply lines, the incoming generator line and its tripping device, the outgoing line to the back-up C2 switchboard. All this equipment is located in the same building, but in separate rooms.
- an electric switchboard C2, in a room adjacent to the control room and the hydrazine technical room, which supplies the majority of the hydrazine outgoing lines made up of a normal C2 switchboard and a backup C2 switchboard (supplied from station C3)

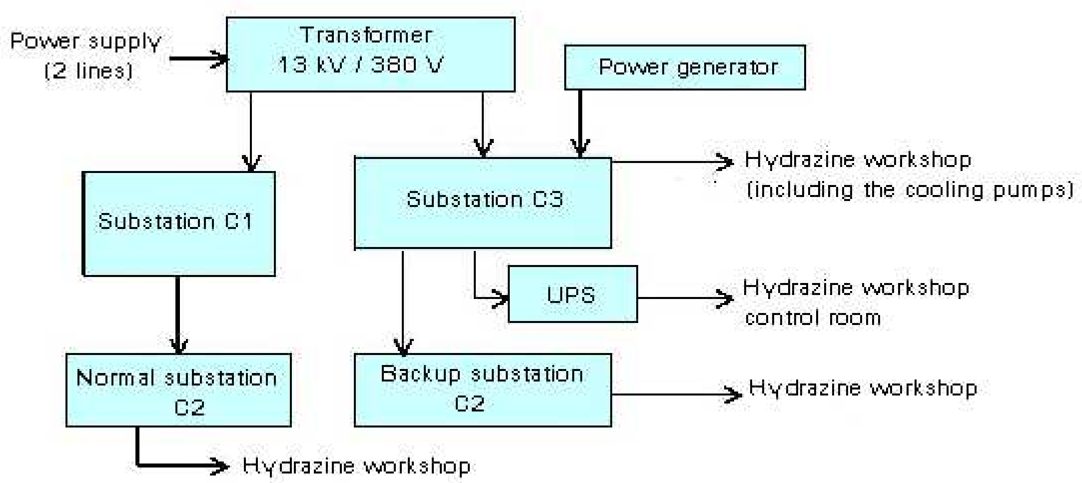



*Figure 1 -* Workshop's electrical supply system

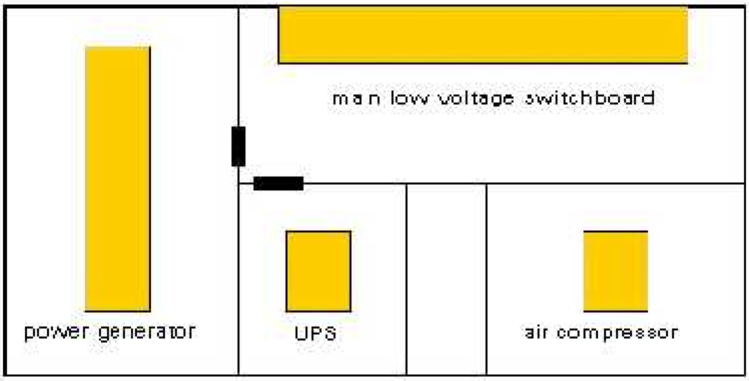



***Figure 2*** - Electrical service room C3

The electric power generator is shut down in a normal operating situation. It starts automatically if the normal electrical network is lost and allows the "backup" motors to start in order to safely shut down the workshop.

## THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

### The accident of October 25, 2004

**12.59 pm**: an electrical fault appears on one of the pumps in the hydrazine unit's cooling system. A fault on a UPS appears in the control room appears at the same time. An operator goes to station C3 and reports smoke.

**1.00 pm**: the fire alarm is triggered in room C3.

**1.02 pm**: **complete electrical disconnection on the hydrazine unit and control room**. When the power is cut, the valves of the hydrazine unit move to secure position. The Internal Contingency Plan/External Special Intervention Plan siren becomes inoperative as there is no monitoring and control.

**1.03 pm**: the Internal Contingency Plan is put into motion.

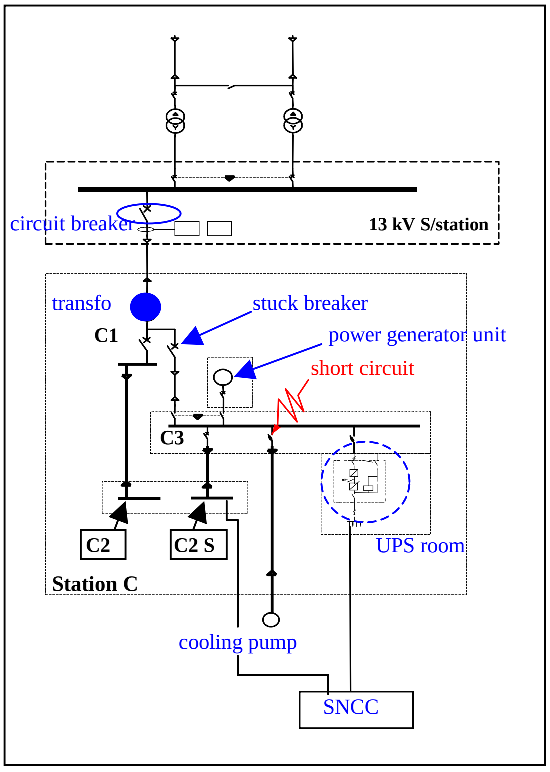
**1.10 pm**: an operator enters the 13 kV station and reports that the circuit breaker is open.

**1.20 pm**: the plant firefighters intervene at station C3 with $CO_2$ extinguishers.

**1.50 pm**: the fire is brought under control at station C3. Plant access is closed to all external personnel.

**2.10 pm**: **a valve on the hydrazine unit opens and releases the ammonia**. The unit's reaction section is cooled down by spraying.

**2.15 pm**: a water curtain is set up to combat the emissions. The Special Intervention Plan panels on the road in front of the plant are activated. Ammonia measurements are taken at the site's borders, down wind, by the site's HSE (Hygiene, Safety, Environment) department to see if the Special Intervention Plan must be initiated.




**2.30 pm - 3.15 pm**: the town halls of the neighbouring communities and companies are informed of the incident.

**2.40 pm**: **the burst disk opens** (0.5 bar) on the hydrazine unit's vent treatment tower. Water curtains are installed around the tower and a mobile cannon is set up to combat the ammonia release exiting the tower's vent.

**15.40 pm**: releases stop.

## Consequences

The electrical column where the short circuit took place was destroyed by the fire and the entire electrical switchboard C3 was badly damaged.

During the incident, approximately 280 kg of ammonia was released, a large portion of which was brought to the ground by spraying set up by the plant's firefighters. The water used to combat the releases was collected in the shop's retaining basin. Measurements conducted in the site's environment showed very low ammonia levels (3 ppm).

It cost 430 k€ to rebuild the electrical substation. The plant was shut down for a week: operating losses were in the thousands of euros.

## 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.


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

The 280 kg of ammonia released represents 0.14 % of the corresponding Seveso threshold (200 tons - toxic), which equals level 2 of the "quantities of dangerous materials" index according to parameter Q1 (Q1 between 0.1% and 1%).

Two parameters are involved in determining the level of the "Economic consequences" rating: €15 and €16.
- Level 1 of the parameter €15 characterises the 430 k€ corresponding to the cost of rebuilding the substation (€15 between 0.1 M€ and 0.5 M€).
- The parameter €16 reaches level 2: as the operator had estimated production losses between 0.5 and 2 M€.

As a result, the overall "Environmental consequences" rating is 2.

# ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

The electrical fault on one of the hydrazine unit's cooling pumps led to a short circuit on one of the columns of the switchboard C3 and started a fire. The fire then spread to all columns of table C3 via the sub-floor (electrical cables).

The circuit breaker upline from the switchboard did not function as it was "stuck".. The electrical problem then shifted to the transformer.

The 13kV/380V transformer caused a homopolar fault which shut off power to all C substations.

The electrical generator started, but the switchover to the "backup" switchboard couldn't take place as the electrical cables had been damaged in the fire. The hydrazine unit then secured itself as a result of the loss of electrical power.

As the smoke from the fire had entered the room via the open door and the sub-floor, the UPS, located in the neighbouring room, switched to standby (as soon as T=40°C), disconnecting the power of the SNCC ("Système Numérique de Contrôle Commande", digital monitoring and control system) and the programmable safety controllers. Electricity was lost in 4 minutes time.

Even though the valves stopped the input of raw materials automatically, the excess of the materials introduced allowed the reaction to continue for a moment inside the reactor. As the reaction was exothermic and the cooling inoperative, the reaction heat could not be dissipated. The pressure in the reactor increased to the valve's adjustment pressure, then the opening pressure of the burst disc placed on the vent treatment tower resulted in the release of the ammonia mixture and steam to the atmosphere.

## ACTIONS TAKEN

The plant was shut down after the accident. The Classified Installations Inspectorate, located near the site, arrived around 3.30 pm. The Inspectorate sent a letter to the operator on October 26, 2004 requesting that a detailed report of the accident be submitted (analysis of the circumstances and the causes, possible environmental impacts, measures taken immediately and those foreseen for the near future) before the plant be restarted. An update was also requested of the danger study, the Internal Contingency Plan and the Safety Management System with consideration of the lessons learned from the accident.

The various studies were conducted within the company to analyse the accident, identify the causes and propose solutions:

- An expert assessment was conducted shortly after the accident,
- A fault tree was drawn up,
- In order to restart the installations, a temporary switchboard was installed to replace panel C3, in a room geographically separated from the UPS and power generator rooms. The UPS was replaced, the power generator cleaned and the circuit breaker overhauled,
- Definitive replacement of switchboard C3 was programmed for the plant's major shutdown in April 2005. This operation was preceded by a study bearing on the reliability of the power supply and how the common modes, insulation of the UPS / power generator /switchboard rooms are handled, the opportunity of a dual UPS power supply, and the connection of MV Bucchols transformer safety devices.

## LESSONS LEARNED

The operator shed light on four essential points:

1. **The digital monitoring and control system (SNCC) must be able to remain operational at least during the first ½ hour** to ensure that the unit itself is sufficiently secured should common modes fail on the electrical circuit supplied by the main substation. In this manner, a second independent electrical network can take over and supply the SNCC.

The UPS is kept in the existing room, physically separated from the substation (door closed and hermetic sub-floor) and its backup power supply (2$^{nd}$ network) rendered independent from that of the hydrazine workshop.

2. **Heating faults must be eliminated** (the cause of the short circuit) and improve selectivity. The new substation thus includes:
    - A panel capable of performing an IR thermography IR (panel in front of the rack open) of all active parts during their operation,
    - Installation of fail safe racks in the table to test and maintain the "'sensitive" circuit breakers in operation,
    - The use of Bucchols safety devices with the transformers (low voltage),
    - Minimise cable lengths and potential hazards (heating, short circuit…),

- Study of the installation of a charging bench to regularly test the electrical generator,
- More balanced distribution of motor outputs on the switchboards.

3. **The organisation,** particularly relative to the maintenance operations, **must be improved** by:
   - Bolstering preventive maintenance of protective devices and switchboards,
   - Performing a regular technical inspection/audit of the electrical installations,
   - Organising technical discussion meetings between electrical installation specialists (sharing of experience, regulatory and technical watch).

4. **The securing conditions and certain characteristics of the reaction** must **be reviewed** by:
   - Maintaining the reactor cooling process: installation of 2 independent available water sources to cool the reaction down,
   - Revaluating the reaction heat that was underestimated when the workshop was designed. Laboratory testing conducted by the operator showed that the calorific potential of the reaction was underestimated by 50%.