Incident Title	**Batch Reactor Toxic Material Release**	
Incident Type	Runaway Reaction	
Date	10th July 1976	
Country	Italy	
Location	Seveso (Lombardy)	
Fatalities	**Injuries**	**Cost**
0	~ 500	Unknown

Incident Description

Credit: Wikimedia Commons

An exothermic reaction occurred in a trichlorophenol (TCP) reactor after a batch process for production of chemical intermediates used in herbicide and disinfectant manufacture was halted for the weekend. The process involved reacting tetrachlorobenzene with sodium hydroxide in an ethylene-glycol solvent followed by distillation to remove the solvent. The reactor overheated and the pressure rose until a bursting disc ruptured discharging its contents to atmosphere. A thick white cloud containing a small but significant quantity of the ultra-toxic compound 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) drifted slowly over neighbouring communities.

The response to the incident was chaotic due to ignorance of the scale of potential hazards and poor information exchange/communication between local and regulatory authorities. Around 200 people developed skin lesions (chloracne), many more suffered other effects and around 80,000 animals were slaughtered to stop dioxin compounds entering the food chain.

Incident Analysis

Basic cause of the release was an unexpected exothermic reaction which overheated the reactor contents until a bursting disc (BD) ruptured and vented the contents of the reactor to atmosphere.

Critical factors included: 1) Turbine exhaust steam used for reactor heating was unnecessarily hot, 2) The reactor's stirrer and the steam supply to its external dual-purpose heating/cooling coil had been switched off before completion of the distillation step (prolonging reaction mixture retention time), 3) The cooling water supply to the external coil had not been turned on (operators thought the reactor would cool by itself), 4) The company did not inform the authorities about the presence of ultra-toxic TCDD in the release until 10 days after the event.

Root causes included: 1) Inadequate hazard identification (exothermic side reactions producing dioxins, turbine exhaust steam temperature rises as load reduces), 2) Inadequate process control (absence of automatic temperature and pressure control), 3) Violation of operating procedure (shutdown after only partial solvent removal was prohibited), 4) Inadequate communication (between company, local authorities and national regulatory authority), 5) Inadequate emergency response planning (company and external emergency responders).

Lessons Learned

1) Quantitative reaction hazard assessment data (thermal stability tests, calorimetry, etc) must be used to inform design of appropriate safeguards.
2) Production planning for batch operations should be designed so that all operations can be safely concluded within the time available.
3) Pressure relief systems for batch reactors used for hazardous chemical manufacture should discharge to appropriate containment systems.
4) The Seveso Directives, first adopted by the European Commission in 1982 (Directive 82/501/EEC) require operators of industrial plants to make information on major hazard identification, control and mitigation available to the regulator and are implemented in the UK by the Control of Major Accident Hazards (COMAH) Regulations.

More Information

1) "Lessons from Seveso", D. C. Wilson, Chemistry in Britain (1982).
2) "Seveso – 40 Years On", M. Hailwood, IChemE Loss Prevention Bulletin 251 (2016): https://www.icheme.org/media/2078/lpb251_pg14.pdf.

Industry Sector	Process Type	Incident Type
Agrochemicals (Manufacture)	Herbicide	Runaway Reaction
Equipment Category	**Equipment Class**	**Equipment Type**
Not equipment related	Not applicable	Not applicable

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