

## Other Gases

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### REVIEW OF CHLORINE INCIDENTS 1992-1998

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#### Introduction

This note presents the results of a review of chlorine incidents reported to HSE over the period 1992-1998. It also provides details of the main sources of guidance on the storage, handling and use of chlorine.

Chlorine and chlorine-based derivatives are reactive materials which are used in the chemical manufacture of a wide range of products such as paper, textiles, dyes, medicines, solvents, paints and plastics. Their oxidizing, bleaching and disinfectant properties are utilised in water treatment plants, swimming pools, food processing and in cleaning agents.

Chlorine is a highly toxic gas and exposure to levels as low as 1 ppm for a few minutes can cause eye, nose and throat irritation. Exposure to concentrations above 30 ppm, even for a short period can be dangerous causing severe breathing difficulties. Exposure to 1000 ppm may be fatal after a few breaths.

Commercial chlorine is supplied as a liquid in drums or in bulk or as a gas in cylinders. The main hazard is exposure to the gas resulting from spillage or leaks.

The use of chlorine derivatives such as sodium hypochlorite is generally encouraged where appropriate particularly for bleaching and disinfection systems. This reduces the risk of a major release of chlorine affecting large numbers of people. However, the risk of exposure to chlorine is not completely eliminated as the gas can be produced by mixing the chlorinating product with an incompatible material such as an acid.

#### Incidents involving the release or unintentional production of chlorine gas

The information for the review was extracted from the MARCODE database (1992-1995) and from the FOCUS investigation database (1996-1998). All the incidents have been reported to HSE under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations) and have been investigated by HSE inspectors.

267 incidents were identified which involved the release or unintentional production of chlorine gas. These resulted in over 100 major injuries but there were no fatalities over the seven year period of the review. The incidents are very diverse and are categorised in terms of the activity involved:

- chemical processing;
- transport;
- foundries;
- swimming pools;
- water treatment plants;
- food processing (includes dosing of products and disinfection);
- laboratories (schools) and ;

- cleaning agents.

The details are summarised in the table below.

### Summary of chlorine incidents 1992 - 1998

ACTIVITY	YEAR							
	1992	1993	1994	1995	1996	1997	1998	Total
Chemical processes	13	7	8	10	2	5	6	51
Transport	0	8	3	1	1	0	2	15
Foundry	2	0	3	0	0	1	1	7
Water treatment	3	9	5	4	1	3	1	26
Swimming pools	12	9	14	11	4	3	6	59
Food processing	7	6	5	7	8	4	2	39
Laboratory/school	2	2	4	2	0	1	2	13
Cleaning agents	15	8	10	9	8	6	1	57
<b>TOTAL</b>	<b>54</b>	<b>49</b>	<b>52</b>	<b>44</b>	<b>24</b>	<b>23</b>	<b>21</b>	<b>267</b>

### Main causes of the incidents

Exposure to chlorine gas can occur in two ways: accidental release from a process or storage facility handling gaseous or liquid chlorine or the unintentional mixing of a chlorine derivative with an incompatible material.

Only 51 of the incidents involved the use of chlorine gas or liquid. This reflects the trend towards the use of chlorine derivatives for bleaching and disinfection systems. The use of chlorine gas or liquid is now largely limited to chemical manufacturing processes and major water treatment plants. Small scale bleaching and disinfection systems such as those in food processing plants and swimming pools are encouraged to use sodium hypochlorite or other chlorine derivatives.

The causes of releases from systems handling chlorine gas or liquid were typical of process plant, in general. They included:

- corroded pipework;
- failure of seals and valves;
- mechanical damage;
- failure to isolate effectively;
- failure to follow procedures;
- operator error.

The vast majority of the leaks were minor, some originating from routine operations such as cylinder or drum changing. They often resulted in injury or ill-health because operators and fitters failed to wear respiratory protective equipment.

The main cause of incidents involving chlorine derivatives was the unintentional mixing of incompatible materials such as sodium hypochlorite and acid, releasing chlorine gas. Most water disinfectant systems involve dosing with sodium hypochlorite and hydrochloric acid in a controlled way. Although the hypochlorite and the acid may be segregated, they are still on the same premises, in the same building and often in the same room. There is scope for human error - primarily emptying chemicals into the wrong tank or container. The most common cause of incidents at swimming pools was topping up the hypochlorite tank with hydrochloric acid or vice versa.

The causes of incidents at food processing plants is not so clear cut as there is a wider selection of processes and substances available. Most incidents were due to careless cross-contamination or failure to follow procedures eg discharging incompatible materials to drain. There were a number of offloading incidents where the driver offloaded into the wrong tank. These are potentially the most serious incidents as they can involve the mixing of large

quantities of incompatible materials. Other transport incidents occurred when hypochlorite was loaded into a tanker on top of an acid heel and there were two incidents during tanker cleaning.

### **Other incidents**

The majority of the laboratory incidents occurred in schools during experiments to produce chlorine. Only small quantities of the gas were involved. Exposure to chlorine resulted because of faulty fume cupboards or while cleaning up after the experiment. Staff and pupils claimed to be affected.

A large number of incidents involved the mixing of incompatible cleaning agents and water treatment chemicals. This indicates a lack of understanding of the hazards of these materials.

### **Guidance**

The main sources of guidance on chlorine are HSE, Eurochlor and CIA.

#### ***HSE guidance***

HSE has recently revised HSG28 and HSG40, the two main pieces of guidance on chlorine installations. HSE has also published a new guidance note on swimming pools, HSG179. It contains a chapter on pool water treatment systems. It recommends against the use of chlorine gas for pool water treatment but does not prohibit it.

HSG28 Safety advice for bulk chlorine installations;

HSG40 Chlorine from drums and cylinders;

HSG179 Managing health and safety in swimming pools.

Chlorine - its safe use in foundries IAC (L) 36 (Rev) 01.09.93

#### ***HSE Internal Guidance***

Advice on bulk chlorine installations OC/272/4 1991

Summary of worldwide major incidents involving commonly encountered hazardous substances CHID circular CC/TECH/HI/1

Land-use planning advice on developments near chlorine installations OC 318/9

Measures for reducing off-site risks at water treatment works OC 847 8 11.06.96

Electrochlorination plant for the treatment of swimming-pool water

FIC 331 1 (rev) (2 parts) 18.04.88 Also FIC 357/6

Hose or coupling failure events during off-loading a chlorine road tanker. Definition of representative hole sizes D Keeley and J Wilday HSE/HSL 1997

Fault tree analysis of a chlorine vessel J H Gould, HSE Loss Prevention Bulletin, Feb 1996, no 127, 12-16

#### ***Eurochlor references***

Euro Chlor is a major group within the European Chemical Industry Council (CEFIC). It represents the interests of chlorine producers in Europe. The aim of Euro Chlor is to promote the best practices in safety, health and environmental protection throughout the industry. The group has published a wide range of reports, available from Euro Chlor, Avenue E Van Nieuwenhuysse 4, Box 2, B-1160 Brussels, Belgium Tel +32 2 676 72; Fax +32 2 676 72 41.

Publications include:

Acceptable levels of nitrogen trichloride in liquid chlorine

76/55 9th edition Sept 1990

Accidents on the users' premises and guidelines for the safe handling and use of chlorine Eurochlor Third Technical Seminar Proceedings Dec 2-3 1993 93/199

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Guidelines for the safe handling and use of chlorine 1st edition, December 1994 (currently under revision)

#### ***CIA references***

The Chemical Industries Association (CIA) runs a chlorine committee dealing with technical matters. The committee contributed extensively to the HSE guidance and have also released a limited number of chlorine publications of their own, available from Chemical Industries Association (CIA) Kings Buildings, Smith Square, London, SW1P 3JJ Tel: 0171 834 3399.

General guidance on emergency planning within the CIMAH Regulations for chlorine installations 1986 Robinson BW and UK Chlorine Producers

Inter-company collaboration for chlorine emergencies CIA 1992 ISBN 0 900 623

The Chlorine Institute Inc, 2001 L Street, NW, Washington DC 20036 USA have also produced a number of publications but these are not widely available in this country.