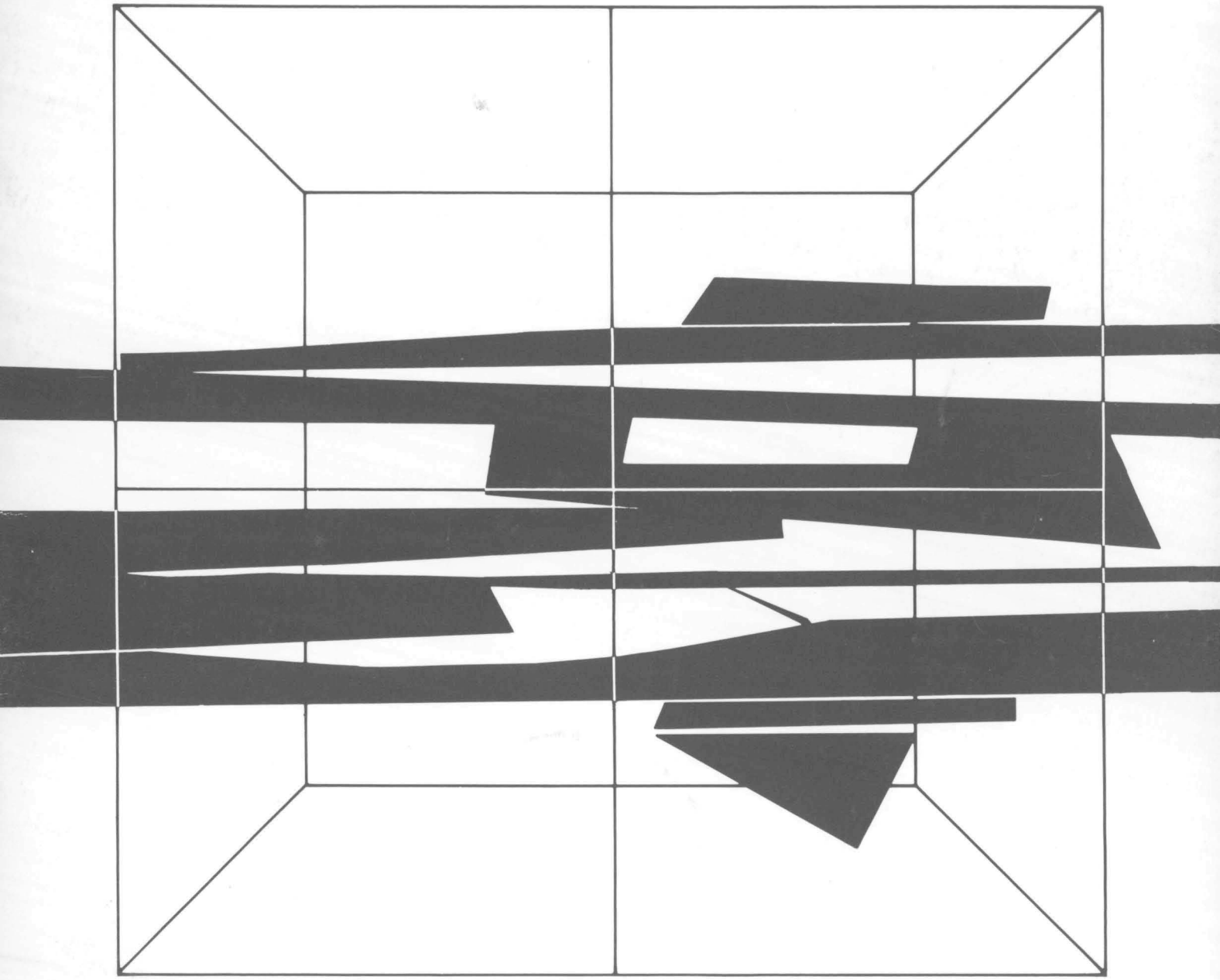
Environmental Status Report 1985-1986
Vinyl Chloride Industry

Report EPS 1/AP/2
July 1988



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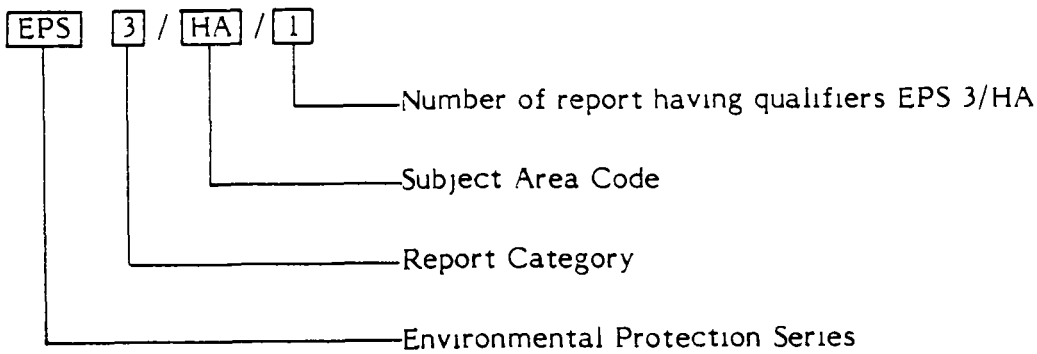

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ENVIRONMENTAL STATUS REPORT
1985-1986
VINYL CHLORIDE INDUSTRY

by

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Report EPS 1/AP/2
July 1988

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ABSTRACT

This report reviews the results of measures taken by industry to reduce vinyl chloride emissions to the atmosphere and describes other environmental protection practices relating to effluent discharges, hazardous wastes handling, and safety and accident prevention. This second national status report reviews compliance by the vinyl chloride and polyvinyl chloride (VC/PVC) industry with the Federal Vinyl Chloride National Emission Standards Regulations during 1985 and 1986. The first status report covered the period 1979 to 1984. Provincial legislation specifically limiting the emissions of vinyl chloride exists in Quebec and Alberta. Ontario, the only other province in which this industry is located, does not have any specific legislation, but enforces the federal regulations.

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ACKNOWLEDGEMENTS

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Credit is also given to D.W. Bissett, Chief of the Chemical Industries Division and to A. Stelzig, Head of the Organic Chemicals Section, who provided guidance and reviewed this report; to Vicky Jones and Daniel J. Faber who edited this report, to the French Editing Unit, and to the word processing staff for their typing and revisions.

1 INTRODUCTION

This report reviews the results of measures taken by the vinyl chloride and polyvinyl chloride (VC/PVC) industry to reduce vinyl chloride emissions to the atmosphere and describes other environmental protection practices related to effluent discharges, hazardous wastes handling, and safety and accident prevention. It also describes the efforts and actions taken by industry to implement the recommendations made in the first report on this industrial sector (1) and the results achieved. The first status report covered the period 1979-1984 and was published in September 1986.

This second status report covers the compliance by this industry, for the years 1985 and 1986, with the Federal Vinyl Chloride National Emission Standards Regulations which were published in March 1979 and became effective on July 1, 1979.

National minimum monitoring and reporting requirements for vinyl chloride emissions were established through consultation with industry and provinces during the preparation of the first report (1). These requirements appear in its appendix. Provinces may impose more stringent requirements.

Emissions that exceed the limits set in the regulations have been classified into two categories for the purpose of monitoring and reporting: major incidents (over 100 kg -- to be reported to the province as soon as possible and to Environment Canada within 20 days); and other incidents (less significant -- to be reported to Environment Canada on a quarterly basis). Major incidents between 1980 and 1986 are summarized in Table 1.

During 1985 and 1986 this industrial sector spent more than $4.8 million on projects related to environmental protection.

1.1 Conclusions

All VC/PVC plants have established continuous monitoring programs for regulated sources of vinyl chloride emissions and report regularly to the appropriate provincial agencies and to Environment Canada, either directly or indirectly. The results of the continuous monitoring of these sources show a compliance rate close to 100 per cent.

The number of major incidents decreased slightly during 1985 (10) and 1986 (9), compared to 14 major incidents in 1984.

All VC/PVC plants have established procedures, offered employee training courses, and introduced new processes to reduce vinyl chloride incidents. Accident

TABLE 1 MAJOR INCIDENTS INVOLVING VINYL CHLORIDE RELEASES FROM 1980 TO 1986

	B.F. Goodrich Inc.			Esso Chemicals	Dow Chemical Canada Inc.		
Year	Quebec	Ontario	Alberta	Ontario	Ontario	Alberta	Totals
1986							
Incidents	1	0	0	4	2	2	9
tonnes	4.5	0	0	0.4	3.8	0.3	9.0
1985							
Incidents	3	0	0	6	1	0	10
tonnes	0.9	0	0	1.4	0.2	0	2.5
1984							
Incidents	5	1	1	6	NA	1	14
tonnes	3	2	5	5		1.1	16.1
1983							
Incidents	8	1	0	11	NA	0	20
tonnes	4	1	0	45*		0	50.0
1982							
Incidents	3	2	0	7	NA	NA	12
tonnes	8	2	0	5			15.0
1981							
Incidents	18	12	2	9	NA	NA	41
tonnes	30	9	4	3			46.0
1980							
Incidents	8	8	1	0	NA	NA	17
tonnes	17	9	6	0			32.0

* 40 tonnes due to power failure

prevention, emergency preparedness, and community awareness programs have also been implemented. In general the magnitude and number of incidents have decreased, but there is still room for improvement. Although all PVC plants strip process effluents before treatment or atmospheric exposure, effluent monitoring is not as rigorous as air emission point source monitoring. Ontario will require its plants to monitor effluents routinely for specific priority pollutants through the MISA (Municipal and Industrial Strategy for Abatement) program.

1.2 Recommendations

Management at all vinyl chloride/polyvinyl chloride plants should:

1) continue existing monitoring programs and implement any additional programs and procedures required to ensure continued compliance;
2) improve employee training, preventive maintenance programs, operating procedures, control technology and back-up systems, to further reduce the number of accidental releases of vinyl chloride to the atmosphere;
3) continue to carry out annual stack surveys required by the regulations;
4) monitor process effluents for vinyl chloride on a regular basis; and
5) continue to implement programs related to accident prevention, emergency preparedness and response, and community awareness.

Environment Canada also proposes that:

6) the vinyl chloride regulations be amended to include the "minimum monitoring and reporting requirements", after consultation with provinces and industry.

2 VINYL CHLORIDE EMISSIONS

2.1 Polyvinyl Chloride Plants

2.1.1 B.F. Goodrich Canada Inc. - Shawinigan, Québec. Throughout 1986, this plant was undergoing a major expansion which included the replacement of old and smaller reactors and batch strippers with new, larger equipment. This change to new technology has improved efficiency and, at the same time, created an environmentally cleaner operation.

The expansion cost $12 million, of which $3 million (25 per cent) was related to environmental protection; for example: old polymerizers were replaced with larger, safer units, the polymer charging system was modernized, a continuous wastewater stripper was installed, and a second continuous slurry stripping facility was built.

B.F. Goodrich continues to monitor all sources of vinyl chloride emissions. The monitoring results have been reported in the format requested for quarterly reports since the beginning of 1985. The results of the routine monitoring show that the emissions from reactor openings were within the limits over 99 per cent of the time; those from sources downstream from the stripper were within the limits between 97.5 and 100 per cent of the time; and those from the vent gas absorber (VGA) were within the limits between 95.1 and 98.5 per cent of the time in 1985 and 1986, respectively (Table 2).

This plant carried out an annual compliance test in 1985 according to procedures described in the Standard Reference Method (2). The test results were in compliance with the limits set in the regulations. No annual compliance test was carried out in 1986 because the expansion work being performed at the plant would have made the test results non-representative of the actual operation. A compliance test was scheduled after completion of the expansion.

The production capacity of this plant increased from 48 000 tonnes in 1984 to 60 000 tonnes in 1986 while the estimated total emissions of vinyl chloride were reduced from 0.0275 kg VC/100 kg PVC produced to 0.0243 kg/100 kg PVC produced, a reduction of 11 per cent per unit of production.

The number of major incidents in 1984 was five, with 3000 kg of vinyl chloride emitted to the atmosphere. This was reduced to three incidents totalling 900 kg in 1985 and one 4550-kg incident in 1986. The increase in the quantity of vinyl chloride emitted from this plant during 1986 was caused by a failure in the cooling system; to correct this situation and avoid future problems, an emergency control valve was installed.

TABLE 2 ROUTINE MONITORING RESULTS FOR 1985-1986 AT B.F. GOODRICH INC., SHAWINIGAN, QUÉBEC

	Reactor Openings		Suspension resin Continuous stripping		Suspension resin Batch stripping		Copolymer resin Batch stripping		Vent Gas Absorber	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.
1985 (month)										
1	97.3	100.0	100.0	100.0	100.0	100.0	not operating		100.0	91.7
2	98.3	100.0	100.0	96.3	100.0	100.0	not operating		100.0	99.2
3	96.3	100.0	100.0	100.0	100.0	100.0	not operating		97.6	99.4
4	90.3	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	93.7
5	97.3	100.0	100.0	96.4	100.0	100.0	not operating		96.5	92.8
6	95.1	100.0	100.0	100.0	100.0	100.0	not operating		100.0	98.7
7	94.9	100.0	100.0	100.0	100.0	100.0	not operating		100.0	96.1
8	98.0	100.0	100.0	100.0	100.0	100.0	not operating		91.9	81.6
9	83.2	100.0	100.0	100.0	96.7	100.0	100.0	100.0	100.0	96.4
10	94.4	99.0	100.0	93.5	100.0	100.0	100.0	100.0	100.0	93.5
11	88.4	98.0	100.0	90.0	100.0	100.0	100.0	100.0	100.0	99.2
12	94.4	100.0	100.0	100.0	100.0	100.0	not operating		100.0	99.3
Average for 1985	94.0	99.7	100.0	98.0	99.7	100.0	100.0	100.0	98.8	95.1
1986 (month)										
1	97.7	100.0	100.0	96.4	100.0	96.4	100.0	100.0	100.0	94.4
2	97.5	97.4	100.0	96.4	100.0	100.0	100.0	100.0	100.0	89.2
3	98.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4	99.5	98.4	100.0	100.0	100.0	96.7	100.0	100.0	100.0	99.8
5	92.9	98.1	100.0	100.0	100.0	89.7	100.0	100.0	100.0	100.0
6	98.8	100.0	100.0	100.0	100.0	95.0	100.0	100.0	100.0	99.8
7	97.7	100.0	100.0	100.0	100.0	100.0	not operating		100.0	100.0
8	87.1	100.0	100.0	93.5	100.0	100.0	not operating		100.0	99.9
9	92.5	100.0	100.0	83.3	100.0	96.4	100.0	100.0	100.0	99.9
10	96.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
11	90.1	98.8	100.0	100.0	100.0	100.0	100.0	100.0	39.4	98.9
12	95.4	98.4	100.0	100.0	100.0	100.0	not operating		100.0	99.9
Average for 1986	95.4	99.3	100.0	97.5	100.0	97.9	100.0	100.0	95.0	98.5

In this plant, the VGA is the major air pollution control equipment. Its purpose is to collect the vinyl chloride that is not condensed by the process recovery condensers. A back-up brine condenser is used when the VGA is out of order (less than 2 per cent of time in 1985 and 1986), but this condenser is not designed to meet the 10 ppm emission limit. During a visit by officials from Environment Canada and Environment Quebec in 1985, it was recommended that the stream emitted from the condenser be monitored during its use to assess its efficiency. At the time of the expansion, new equipment was added to improve control of vinyl chloride emissions. Additional improvements have been incorporated into the plant's five-year development plan to specifically address the need for an adequate back-up system on the VGA.

2.1.2 B.F. Goodrich Canada Inc. - Niagara Falls, Ontario. This B.F. Goodrich plant monitors all the sources of vinyl chloride emissions, and reported the results on a regular basis. The monitoring results have been reported in the format requested since January 1986 and were sent to Environment Canada on a quarterly basis.

Results of routine monitoring show that the emissions from reactor openings were within the limits 100 per cent of the time in 1985 and 99.9 per cent of the time in 1986, and that emissions from sources downstream from the stripper were in compliance more than 99.4 per cent of the time in 1985 and 100 per cent of the time in 1986. Finally the emissions from the VGA were in compliance 98.8 per cent of the time in 1985 and 98.6 per cent of the time in 1986 (Table 3).

When this plant carried out its annual compliance test in 1982, using procedures described in the Standard Reference Method (2), the results were in compliance with the limits set in the regulations. In 1985 and 1986, B.F. Goodrich did not conduct any compliance tests, although these are required by the regulations on an annual basis. Follow-up action is underway.

The production capacity of this plant passed from 76 500 tonnes in 1984 to 85 700 tonnes in 1986. Its estimated emissions of vinyl chloride dropped from 0.052 kg VC/100 kg PVC produced in 1984 to 0.029 kg VC/100 kg PVC produced in 1986; a reduction of 44 per cent during the two years covered by this report.

Only one major incident has occurred at this plant. In 1984 2000 kg of vinyl chloride were emitted to the atmosphere; no incidents occurred in 1985 or 1986. During these two years B.F. Goodrich experienced four minor incidents totalling 13.8 kg of vinyl chloride emitted to the atmosphere. This represents a substantial improvement.

TABLE 3 ROUTINE MONITORING RESULTS FOR 1985-1986 AT B.F. GOODRICH INC., NIAGARA FALLS, ONTARIO

	Reactor Openings*		Suspension resin Cont. stripping		Dispersion resin Cont. stripping		Copolymer resin Batch stripping		Vent Gas Absorber	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.
1985 (quarter)										
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.2	100.0	97.0
2	100.0	100.0	100.0	100.0	100.0	98.2	100.0	98.3	100.0	100.0
3	100.0	100.0	100.0	99.5	100.0	100.0	100.0	100.0	100.0	100.0
4	100.0	99.9	100.0	99.6	100.0	100.0	99.5	100.0	100.0	98.2
Average for 1985	100.0	100.0	100.0	99.8	100.0	99.6	99.9	99.4	100.0	98.8
1986 (month)										
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	96.3
2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.1
3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.6
4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.1
5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.5
6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	93.2
9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10	100.0	98.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.5
11	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
12	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Average for 1986	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.6

* B.F. Goodrich requested that operating parameters be monitored for the reactor openings instead of making actual measurements; however, approximately 10% were measured and results were reported for both.

In general, except for the lack of annual compliance tests in 1985 and 1986, this plant is commended for its good performance during these two years.

In 1985, the stripping system in the original plant was upgraded at a cost of $140 000.

2.1.3 Esso Chemicals Canada - Sarnia, Ontario. During this period monitoring at this plant evolved from spot sampling and remote lab analysis to a system using portable hand-held analysers and finally to a field-based permanent gas chromatograph system. Esso Chemicals started to monitor regularly and report the sources of vinyl chloride emissions during the last quarter of 1985. The monitoring results were reported using the new format requested for the quarterly reports and were sent to the Ontario Ministry of the Environment with a copy to Environment Canada.

The results of routine monitoring (Table 4) show that the emissions from reactor openings were within the limits 91.8 per cent of the time in 1986, while the per cent of openings analyzed increased to 85 per cent from a low of 4 to 7 per cent during the fourth quarter of 1985. Results for 1987 show even higher compliance and percent of openings analyzed.

Emissions from sources downstream from the strippers, measured as residual concentration of vinyl chloride in the slurry, were in compliance 94.1 and 89.6 per cent of the time, respectively, for the continuous and batch strippers in 1986. In the last quarter of 1985 the compliance rates for these sources were, respectively, 80 and 91 per cent.

The emissions from the incinerator stack were not monitored on a continuous basis during 1985 and 1986. The sampling/analytical system on the incinerator stack was operational during 1987. Prior to continuous monitoring of the incinerator stack, spot sampling had indicated that emissions were within the limits at times of sampling. Modifications have been made to the incinerator system to allow the material normally incinerated to be recycled to a gas holder during incinerator outages. This has proved to be beneficial, since no vinyl chloride emissions have been associated with incinerator downtime since installation of the recycle system.

This plant carried out annual compliance tests in 1985 and 1986, according to procedures described in the Standard Reference Method (2). The results of both tests were generally in compliance with the limits.

The estimated vinyl chloride emissions decreased from 0.7 kg/100 kg PVC produced in 1984 to 0.2 kg/100 kg PVC produced in 1986, a reduction of 71 per cent during the two years covered by this report.

TABLE 4 ROUTINE MONITORING RESULTS FOR 1985-1986 AT ESSO CHEMICALS CANADA, ONTARIO

	Reactor Openings		Suspension resin Continuous stripping		Suspension resin Batch stripping		Incinerator Stack Venting	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.	hours	kg
1985 (month)								
10	7.0	85.0	100.0	80.0	100.0	93.0	14.0	70.0
11	4.0	100.0	100.0	83.0	100.0	93.0	0.3	3.0
12	16.0	68.0	100.0	75.0	100.0	86.0	0.0	0.0
Average* 1985	9.0	84.3	100.0	79.3	100.0	90.7	14.3	73.0
1986 (month)								
1	90.4	100.0	96.7	93.3	96.7	100.0	0.0	0.0
2	73.5	93.3	100.0	82.1	100.0	96.4	14.0	140.0
3	81.7	97.9	100.0	83.8	100.0	93.5	3.5	45.0
4	72.0	95.0	100.0	97.0	100.0	83.0	0.0	0.0
5	86.0	91.0	100.0	87.0	100.0	80.0	0.0	0.0
6	81.0	93.0	100.0	93.0	100.0	97.0	0.0	0.0
7	86.4	78.6	100.0	100.0	100.0	51.6	0.0	0.0
8	84.9	64.5	100.0	100.0	100.0	83.3	0.0	0.0
9	92.1	97.1	100.0	96.4	100.0	93.3	0.0	0.0
10	76.3	98.6	100.0	100.0	100.0	100.0	0.0	0.0
11	100.0	94.1	100.0	96.6	100.0	96.6	0.0	0.0
12	98.3	98.3	100.0	100.0	100.0	100.0	0.0	0.0
Average for 1986	85.2	91.8	99.7	94.1	99.7	89.6	17.5	185.0

* Fourth quarter only.

The incinerator stack was not monitored on a continuous basis, the sample delivery system suffered extensive corrosion damage and most of it had to be replaced. This work was completed in late December and commissioning/trials began in January, 1987.

The number of major incidents in 1984 was six with 5 tonnes of vinyl chloride emitted to the atmosphere; in 1985 six major incidents occurred with 1.4 tonnes of vinyl chloride emitted; and in 1986 four major incidents emitted 0.4 tonnes. This indicates a substantial decrease in emissions incidents from previous years.

Esso Chemicals spent $340 000 in 1985 and $267 000 in 1986 on capital projects in the PVC plant related to environmental protection.

2.1.4 B.F. Goodrich Canada Inc. - Ft. Saskatchewan, Alberta. This B.F. Goodrich plant monitors vinyl chloride emissions from the different point sources as indicated by the licence to operate issued by Alberta Environment. The results of routine monitoring (Table 5) show that emissions from reactor openings were within the limits 100 per cent of the time during 1985 and 1986. The emissions downstream of the stripping operation were within the limit of 0.04 kg VC/100 kg PVC at all times over the two-year period. The vinyl chloride concentration in the incinerator stack is limited to 10 ppm; the results of routine monitoring show that this limit was met continuously during 1985 and 1986. To standardize reporting across the industry, starting July 1985, the vinyl chloride concentration was averaged over a three-hour period.

No major incidents occurred during 1985 or 1986. However, the records show that an estimated 600 kg of vinyl chloride leaked inside the building from a partially open flange in October 1985. The water deluge system functioned automatically and limited emissions of vinyl chloride to the atmosphere. Ambient air monitors are located in work areas and at the plant boundaries to sample and analyze the ambient air in order to detect and control leaks and fugitive emissions.

Manual tests according to the procedures described in the Standard Reference Method (2) were performed annually by Environment Alberta and all results were within the limits.

2.2 Vinyl Chloride Plants

2.2.1 Dow Chemical Canada Inc. - Ft. Saskatchewan, Alberta. This plant is required by Alberta Environment to monitor its three sources of vinyl chloride and report the results of its monitoring on a monthly basis. Table 6 shows that the three sources were in compliance 100 per cent of the time during the two-year period. Results of monthly manual tests performed by the plant according to the Standard Reference Method (2) were all within regulatory limits.

TABLE 5 ROUTINE MONITORING RESULTS FOR 1985-1986 AT B.F. GOODRICH INC., ALBERTA

	Reactor Openings		Bulk resin Continuous stripping		Incinerator Stack	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.
1985 (month)						
1	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	100.0	100.0	100.0	100.0	100.0
3	100.0	100.0	100.0	100.0	100.0	100.0
4	100.0	100.0	100.0	100.0	100.0	100.0
5	100.0	100.0	100.0	100.0	100.0	100.0
6	100.0	100.0	100.0	100.0	100.0	100.0
7	100.0	100.0	100.0	100.0	100.0	100.0
8	100.0	100.0	100.0	100.0	100.0	100.0
9	100.0	100.0	100.0	100.0	100.0	100.0
10	100.0	100.0	100.0	100.0	100.0	100.0
11	100.0	100.0	100.0	100.0	100.0	100.0
12	100.0	100.0	100.0	100.0	100.0	100.0
Average for 1985	100.0	100.0	100.0	100.0	100.0	100.0
1986 (month)						
1	100.0	100.0	100.0	100.0	100	100
2	100.0	100.0	100.0	100.0	100	100
3	100.0	100.0	100.0	100.0	100	100
4	100.0	100.0	100.0	100.0	100	100
5	100.0	100.0	100.0	100.0	100	100
6	100.0	100.0	100.0	100.0	100	100
7	100.0	100.0	100.0	100.0	100	100
8	100.0	100.0	100.0	100.0	100	100
9	100.0	100.0	100.0	100.0	100	100
10	100.0	100.0	100.0	100.0	100	100
11	100.0	100.0	100.0	100.0	100	100
12	100.0	100.0	100.0	100.0	100	100
Average for 1986	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 6 ROUTINE MONITORING RESULTS FOR 1985-1986 AT DOW CHEMICAL CANADA INC., ALBERTA

	Burner F-390		Burner F-391		Burner F-600	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.
1985 (month)						
1	100.0	100.0	100.0	100.0	100.0	100.0
2	100.0	100.0	100.0	100.0	100.0	100.0
3	100.0	100.0	100.0	100.0	100.0	100.0
4	100.0	100.0	100.0	100.0	100.0	100.0
5	100.0	100.0	100.0	100.0	100.0	100.0
6	100.0	100.0	100.0	100.0	100.0	100.0
7	100.0	100.0	100.0	100.0	100.0	100.0
8	100.0	100.0	100.0	100.0	100.0	100.0
9	100.0	100.0	100.0	100.0	100.0	100.0
10	100.0	100.0	100.0	100.0	100.0	100.0
11	100.0	100.0	100.0	100.0	100.0	100.0
12	100.0	100.0	100.0	100.0	100.0	100.0
Average for 1985	100.0	100.0	100.0	100.0	100.0	100.0
1986 (month)						
1	100.0	100.0	100.0	100.0	100	100
2	100.0	100.0	100.0	100.0	100	100
3	100.0	100.0	100.0	100.0	100	100
4	100.0	100.0	100.0	100.0	100	100
5	100.0	100.0	100.0	100.0	100	100
6	100.0	100.0	100.0	100.0	100	100
7	100.0	100.0	100.0	100.0	100	100
8	100.0	100.0	100.0	100.0	100	100
9	100.0	100.0	100.0	100.0	100	100
10	100.0	100.0	100.0	100.0	100	100
11	100.0	100.0	100.0	100.0	100	100
12	100.0	100.0	100.0	100.0	100	100
Average for 1986	100.0	100.0	100.0	100.0	100.0	100.0

This plant spent $180 000 during 1985 and 1986 for projects related to environmental protection, including diversion of process water for ethylene dichloride recovery rather than incineration as well as improvements to the stack analyzer.

Ambient air monitors are located in work areas and at the plant limits to sample and analyse the ambient air in order to detect and control leaks and fugitive emissions.

There were no incidents in 1985 and two incidents in 1986 emitting 300 kg of vinyl chloride to the atmosphere. Both incidents were reported to Alberta Environment as required by the conditions of the operating licence.

2.2.2 Dow Chemical Canada Inc. - Sarnia, Ontario. At the request of regulatory agencies in 1985, this plant started to monitor and report vinyl chloride emissions from the scrubber in January 1986 and from incinerators in July and August of the same year. The results of routine monitoring of the scrubber showed a compliance rate varying between 97 to 100 per cent of the time. The thermal oxidizer (TOX) and thermal oxidizer with heat recovery (THROX) incinerators were within the limits 100 per cent of the time during the third and fourth quarters of 1986 (Table 7).

To standardize the reporting and monitoring procedures, it had been agreed that the concentration of vinyl chloride would be averaged over a three-hour period; however, this plant averaged the monitoring results over 24 hours during the third quarter of 1986. This was corrected for fourth quarter data.

In 1985, this plant had seven incidents, one of which was considered major, resulting in 207 kg of vinyl chloride being emitted to the atmosphere. In 1986, 11 incidents were reported; two were considered major, releasing respectively 141 and 3615 kg. During this last incident 3615 kg of vinyl chloride and 2360 kg of hydrogen chloride were released to the atmosphere. This incident prompted the Ontario Ministry of the Environment to prosecute Dow Chemical. The company was found guilty of exceeding hydrogen chloride standards and was fined five thousand dollars.

The majority of these incidents were due to streams containing vinyl chloride being emitted through the scrubber instead of being directed to one of the incinerators. Although this plant has established automatic rerouting of vent flows to the THROX unit (in the event that the TOX unit is not available), further work should be considered to eliminate venting through the scrubber, at any time, of any stream containing more than 10 ppm of vinyl chloride.

TABLE 7 ROUTINE MONITORING RESULTS FOR 1985-1986 AT DOW CHEMICAL CANADA INC., ONTARIO*

	TOX		THROX		T1-9/12 Scrubber	
	% anal.	% compl.	% anal.	% compl.	% anal.	% compl.
1986 (month)						
1	n.a.		n.a.		95.0	100.0
2	n.a.		n.a.		96.0	100.0
3	n.a.		n.a.		92.8	98.5
4	n.a.		n.a.		98.0	98.7
5	n.a.		n.a.		97.7	97.9
6	n.a.		n.a.		95.6	100.0
7	n.a.		97.2	100.0	99.4	100.0
8	99.3	100.0	98.1	100.0	99.3	97.0
9	99.2	100.0	99.8	100.0	99.2	100.0
10	93.2	100.0	99.6	100.0	93.2	97.6
11	98.4	100.0	92.4	100.0	98.4	100.0
12	98.5	100.0	97.6	100.0	98.5	100.0
Average for 1986	97.7	100.0	97.5	100.0	96.9	99.1

* No routine monitoring was conducted at this plant until January 1986.

Annual testing of the TOX and THROX units was carried out in 1985 and 1986. Both tests indicated that these units, when operating under normal conditions, meet the limit set in the regulation for vinyl chloride. Sampling of the third source of vinyl chloride (T-9/12 scrubber stack) was carried out in July 1987, and the test indicated that, under normal operating conditions, emissions from this unit were below the limit set in the regulations for vinyl chloride (average: 1.25 ppm; maximum: 2 ppm vinyl chloride). However, emissions from this stack exceed the limits in situations where a process upset results in venting of vinyl chloride.

During 1985-86, Dow Chemical spent a total of $900 000 to install:

a) continuous analyzers on the TOX and THROX stacks to comply with monitoring/reporting requirements;
b) a new computer control system for the TOX unit to improve its reliability;
c) automatic rerouting of vent flows to the THROX unit in the event that the TOX unit is not available;

d) a continuous stack analyzer and flow rate measurement on the T-9/12 stack; and

e) a continuous analyzer on the three water effluent streams from the vinyl chloride plant.

3 OTHER ENVIRONMENTAL ISSUES

The federal regulations on vinyl chloride address atmospheric emissions. However, other environmental concerns, such as toxic substances in liquid effluents, hazardous wastes, and safety and accident prevention, are also gaining attention.

3.1 Vinyl Chloride in Effluents

Effluents containing vinyl chloride should be steam stripped before being exposed to the atmosphere because of the high volatility of this substance. While Environment Canada has not yet regulated vinyl chloride in effluents, the U.S. Environmental Protection Agency has set a limit of 10 ppm vinyl chloride to process effluents before treatment or exposure to the atmosphere. The Province of Alberta has a 10 ppm limit for vinyl chloride in process effluents and Ontario may consider establishing a limit for vinyl chloride through the Municipal Industrial Strategy for Abatement program (MISA).

Although these effluents are not federally regulated, the VC/PVC industry has taken steps to reduce the level of vinyl chloride in effluents before exposing them to the atmosphere. Below are examples of what each plant is achieving by way of control and monitoring of vinyl chloride in effluents.

3.1.1 B.F. Goodrich Canada Inc. - Shawinigan, Québec. Process effluents from the production of PVC are stripped to below 10 ppm vinyl chloride before mixing with other streams. The discharge from this stripping process is monitored daily for vinyl chloride. In 1986 the wastewater stripping system was upgraded at a cost of $400 000.

The final combined effluent, which discharges into a major water course, is monitored periodically and reports are submitted to Québec Ministry of the Environment (MENVIQ). In late 1985 MENVIQ conducted an extensive characterization of the plant effluents as a step toward the development of an appropriate wastewater treatment plant. Table 8 compares the net concentrations of specific effluent parameters between the end of 1984 and the end of 1986.

3.1.2 B.F. Goodrich Canada Inc. - Niagara Falls, Ontario. The process liquid effluent from the production of PVC is stripped to well below 10 ppm vinyl chloride before being discharged to the treatment system. The treated effluent is monitored regularly (three times a week) for vinyl chloride; the average concentration in 1986 was 0.04 ppm.

The final effluent, which is discharged into the Welland River, is monitored regularly and reports are submitted monthly to the Ontario Ministry of Environment. Table 8 compares the concentrations of some of these parameters for the fourth quarter of 1984 and the fourth quarter of 1986. In 1985 the stripping system in the original plant was upgraded at a cost of $140 000.

3.1.3 Esso Chemicals - Sarnia, Ontario. The final effluent, which discharges into the St. Clair River, is sampled once a day for vinyl chloride. The results were reported monthly internally and were available for examination by the Ontario Ministry of Environment; all amounts in excess of the guidelines were reported immediately. Samples were taken twice a day of the water stripper effluent and the final PVC plant sewer catch basin. All of these results were quality control charted statistically. All process water expected to contain significant amounts of dissolved vinyl chloride were steam stripped before discharge into the sewers.

3.1.4 B.F. Goodrich Canada Inc. - Ft. Saskatchewan, Alberta. Vinyl chloride in water effluents from process areas were steam stripped and analyzed once per week.

3.1.5 Dow Chemical Canada Inc. - Ft. Saskatchewan, Alberta. No process water comes into contact with vinyl chloride in this plant. All produced water and storm water collected within the process areas of the operating plant was collected and processed through organic strippers. Treated water was either recycled and reused on-site or disposed into deep underground formations via a disposal well licensed by Alberta Environment and the Energy Resources Conservation Board. No water from the vinyl chloride monomer/ethylene dichloride (VCM/EDC) process areas was discharged with the site effluent to the North Saskatchewan River.

3.1.6 Dow Chemical Canada Inc. - Sarnia, Ontario. The process used has no effluent that has been in direct contact with vinyl chloride and so there is no potential for vinyl chloride to be present in any effluent stream unless equipment failure or other severe process upset occurs. Effluents that could have been contaminated with chlorinated organics from the scrubber T-9/12 and process area runoff were steam stripped. The steam stripper discharge is monitored continuously by a chlorinated organics analyzer. All three plant discharges were monitored continuously by a chlorinated organics analyzer and daily grab samples were also obtained.

TABLE 8 CONCENTRATIONS OF POLLUTANTS IN EFFLUENTS

		BEFORE TREATMENT (ppm)				AFTER TREATMENT (ppm)				TREATMENT			
		4th quarter 1984		4th quarter 1986		4th quarter 1984		4th quarter 1986		Steam stripping		Secondary treatment	
		average	maximum	average	maximum	average	maximum	average	maximum	yes	no	yes	no
BFG Que.	VC	n.a.	n.a.	n.a.	n.a.	<1	<1	<1	<1	x			x
	COD	31.00	121.00	39.00	56.00	n.t.	n.t.	n.t.	n.t.				
	SS	5.00	20.00	12.00	31.00	n.t.	n.t.	n.t.	n.t.				
	Cl	10.00	16.00	4.00	6.00	n.t.	n.t.	n.t.	n.t.				
	O&G	<10	<10	<10	<10	n.t.	n.t.	n.t.	n.t.				
BFG Ont.	VC					0.02	0.11	0.01	0.14	x			
	COD					38.00	67.00	25.00	85.00				
	SS					24.00	54.00	6.00	49.00				
	Cl					n.a.	n.a.	n.a.	n.a.				
	O&G					n.a.	n.a.	n.a.	n.a.				
Esso Ont.	VC									x			
	COD												
	SS												
	Cl												
	O&G												
BFG Alta.	VC					0.29	1.07	0.36	1.79	x			
	COD	n.a.	n.a.										
	SS												
	Cl												
	O&G												
Dow Alta.										No process effluent from the VC operation (see Section 3.1.5).			
Dow Ont.										No process effluent from the VC operation (see Section 3.1.6).			

n.a. = not available; n.t. = no treatment; VC = vinyl chloride; COD = Chemical Oxygen Demand; SS = suspended solids; Cl = chlorine; O&G = oil and grease.

3.2 Hazardous Wastes

Vinyl chloride and polyvinyl chloride plants produce hazardous wastes which are disposed of either on-site, usually by incineration, or off-site through a contractor. The disposal of hazardous wastes within a province falls within provincial jurisdiction and requires a license. Information on the hazardous wastes generated by different plants and methods of disposal is presented below.

3.2.1 B.F. Goodrich Canada Inc. - Shawinigan, Québec. In 1986 this plant generated 20 tonnes of hazardous wastes which were incinerated by a contractor; no solid hazardous wastes were generated.

3.2.2 B.F. Goodrich Canada Inc. - Niagara Falls, Ontario. In 1986 this plant generated one tonne of liquid hazardous wastes which was incinerated by a contractor; no solid hazardous wastes were generated.

3.2.3 Esso Chemicals - Sarnia, Ontario. In 1986 this plant generated 11 tonnes of hazardous liquid wastes which were incinerated off-site at Tricil Limited. This plant generated 293 tonnes of solid waste polyvinyl chloride resin which was disposed of off-site in a secure landfill (Tricil Limited).

3.2.4 B.F. Goodrich Canada Inc. - Ft. Saskatchewan, Alberta. No hazardous wastes were produced at this plant.

3.2.5 Dow Chemical Canada Inc. - Ft. Saskatchewan, Alberta. Most of the hazardous wastes generated from this plant were treated via high-temperature incineration in an on-site thermal oxidizer. The remaining solid wastes were disposed of in an on-site landfill, constructed with double liners and complete with a leachate collection system in addition to a leak detection network. Both facilities are operated under provincial licence issued by Alberta Environment.

3.2.6 Dow Chemical Canada Inc. - Sarnia, Ontario. Hazardous wastes generated from the vinyl/chloroethane plant in 1986 were 1 909 tonnes, all of which were incinerated on-site.

3.3 Safety and Accident Prevention

In 1986 Environment Canada published a report prepared by a government/industry task force entitled: "Bhopal Aftermath Review: An Assessment of the Canadian Situation". This report examined the potential for a major chemical

accident in Canada, the existing accident prevention measures, and the emergency response capability and associated preparedness.

The task force presented 21 conclusions and recommendations covering a wide range of activities, from risk analysis, buffer zones, emergency response plans, community awareness/emergency response programs, lessons learned from near misses, data availability, right-to-know, etc.

The Appendix shows a comprehensive submission from one company regarding the implementation of the Bhopal Aftermath Review report recommendations. Since vinyl chloride is a toxic gas, all companies are encouraged to examine these recommendations in detail and to take appropriate action. Table 9 presents a general summary of actions taken by the VC/PVC industry towards some of these recommendations.

3.4 Fugitive Emissions

This issue was addressed in the first status report (1). Plants should continue to implement measures to reduce fugitive emissions. Detection of leaks and prompt repair is essential for good results. Preventive maintenance programs are also important to avoid leaks before they happen.

3.5 Emergency Venting

In general, emergency venting has been reduced during the last two years because plants have taken steps to prevent such venting. In one case, venting of vinyl chloride was a routine procedure during maintenance of the control equipment. Now the company, Esso Chemicals, has taken steps to reroute the vent stream to a gas holder during maintenance instead of venting, avoiding unnecessary emissions.

TABLE 9 IMPLEMENTATION OF THE BHOPAL REPORT RECOMMENDATIONS

Recommendations	B.F. Goodrich Canada Inc.			Esso Chemicals	Dow Chemical Canada Inc.	
	Quebec	Ontario	Alberta	Ontario	Alberta	Ontario
1- Risk assessment	yes	yes	yes	yes	yes	yes
3- Safety Audits	yes 1/year	yes	yes 1/2 years	yes 1/2 years + 1/month	yes 100/year	yes several
4- First steps to hazard reduction	yes	in effect	yes	minimize inventories; information exchange; training of workers	yes	complete
6- Contingency planning	in progress	yes	yes	yes	yes	yes
9- Lessons from accidents	in progress	yes			yes	yes
10- Chemical training for first responders	in progress	yes	yes	yes	yes	yes
13- Community Awareness/ Emergency Response	in progress	yes	yes	yes	yes	yes
15- Simulation Exercises	in progress	planned	yes	yes CVECO:1/year Plant:4/year	yes site:4/year unit:14/year	yes several
17- Technology Development	no	no	yes	no	yes	yes
19- Advanced Preparedness	yes	no	yes	yes	yes	yes
20- Safety Training	yes	yes	yes	yes	yes	yes

CVECO: Chemical Valley Emergency Control Organization

4 IMPLEMENTATON OF PREVIOUS RECOMMENDATIONS

The previous vinyl chloride status report (1) included five recommendations for the vinyl chloride/polyvinyl chloride industry in Canada. It was recommended that the industry:

1) implement "minimum monitoring and reporting requirements" (1),
2) carry out annual stack surveys using the standard reference method (2) in the presence of an inspector,
3) develop and use technologies and personnel training in order to reduce accidental releases of vinyl chloride,
4) adopt aggressive programs to reduce fugitive emissions, and
5) control and monitor vinyl chloride in liquid effluents before exposing the effluent to the atmosphere.

The "minimum monitoring and reporting requirements" have been adopted by all the plants. The two plants in Alberta have also conformed to Alberta Environment's request for more frequent reporting of routine monitoring results.

The second recommendation, relating to annual stack surveys in the presence of an inspector, has not been implemented by two plants. B.F. Goodrich at Shawinigan, Québec did not carry out a survey in 1986 because of the expansion work it was conducting at the plant. The B.F. Goodrich plant at Niagara Falls, Ontario has been advised by Environment Canada that a stack survey should be scheduled in the near future.

The other recommendations, relating to programs to reduce accidental releases and fugitive of vinyl chloride, and the control and monitoring of vinyl chloride in the effluents, have been implemented by all the plants to some extent.

Table 10 summarizes the implementation of the recommendations by the different plants.

TABLE 10 IMPLEMENTATION OF PREVIOUS RECOMMENDATIONS

Recommendations	B.F. Goodrich Inc.			Esso Chemicals	Dow Chemicals Inc.	
	Quebec	Ontario	Alberta	Ontario	Ontario	Alberta
1 - Monitoring/ Reporting	yes	yes	yes +	yes	yes	yes +
2 - Annual Testing	1985[a]	--[b]	1985 & 1986	1985 & 1986	1985 & 1986	1985 & 1986[c]
3 - Programs to Reduce Emissions	yes	yes	yes	yes	yes	yes
4 - Fugitive Emissions	yes	yes	yes	yes	yes	yes
5 - VC in Effluents	yes	yes	yes	yes	yes	yes

a The annual test for 1986 was postponed due to expansion work at the plant.

b Environment Canada brought this to the attention of the Ontario Ministry of Environment, to notify the plant.

c Manual stack testing was carried out monthly as requested by Alberta Environment.

REFERENCES

1. Environment Canada, Environmental Status Report 1979-1984 Vinyl Chloride Industry, EPS 1/AP/1, September 1986.

2. Environment Canada, Standard Reference Methods for Source Testing: Measurement of Emissions of Vinyl Chloride from Vinyl Chloride and Polyvinyl Chloride Manufacturing, EPS 1-AP-77-1, 1978.

APPENDIX

IMPLEMENTATION OF THE BHOPAL AFTERMATH REVIEW REPORT RECOMMENDATIONS - AN EXAMPLE OF A PLANT SUBMISSION

IMPLEMENTATION OF THE BHOPAL AFTERMATH REVIEW REPORT RECOMMENDATIONS - AN EXAMPLE OF A PLANT SUBMISSION

Risk Assessment

PVC plant risk assessments are carried out either on a five-year cycle or after a major unit change. The last risk assessment at the PVC plant was in 1985, which was after the last major expansion and was also specifically carried out in the "Bhopal Aftermath" climate.

The goal of full community involvement is gradually being accomplished. This plant is actively involved in CVECO, CAER and now is working on implementing WHMIS.

This will be fully accomplished when WHMIS is fully implemented.

Safety Audits and Assessments

A five-star audit was carried out at the PVC plant in 1987.

An internal Plant Safety Operational Index Audit (PSOI) is carried out on each unit every two years. This was done in 1987 for the PVC plant.

The department Safety Coordinator did monthly safety "mini audits" on the PVC plant.

First Steps to Hazard Reduction

The inventory of vinyl chloride at the PVC plant is minimized. The Sarnia PVC plant is in the fortunate position of being connected to the supplier by pipeline, and therefore, the vinyl chloride monomer inventory is equivalent to less than a day at normal unit consumption (approximately 1/2 day).

Information on accidents or significant near misses will be exchanged via industry organizations like the vinyl council. Another complementary method would be through a vinyl chloride bulletin circulated by Environment Canada.

Safety related training is accomplished in a number of ways:

1) initial intensive training is mandatory, including 3 days of Safety Training,
2) annual retraining takes place on "Key" safety issues,
3) there are monthly safety meetings.

In addition, the full site implementation of WHMIS will institutionalize, formalize, and keep up-to-date the information system related to hazardous chemicals.

Contingency Planning

Plans are in place on a site-wide basis as well as a unit basis.

Spill Reporting and Analysis

VCM spills and incidents are reported to the Ontario MOE, as is required by the "Spills Bill", and is followed up by a written report to the MOE with copies to Environment Canada within 20 days.

Lessons from Accidents

On the local level, plant safety coordinators share information and lessons learned in their meetings every two months. Some information exchange also occurs through OPA and through the CCPA SHARE program.

Chemical Training for First Responders

The chemical plant site fully participates in TERP and TEAP (Transportation Emergency Response Plan, and Transportation Emergency Assistance Plan), CVECO and CAER. All of these plans and organizations result in a significant inventory of highly trained and knowledgeable people being available 24 hours a day, 365 days a year.

CAER

This plant site is an active participant in CAER. In Sarnia, between CAER and CVECO the recommendations under this section are essentially covered. Full implementation of WHMIS will be icing on the cake.

Chemical Incident Simulation Exercises

Between CAER and CVECO, at least one major "community wide" simulation is run per year. At the PVC plant, at least four simulation exercises per year are run.

Advanced Emergency Preparedness Activities

Emergency preparedness is handled on a community basis by CAER and CVECO in Sarnia.

The public warning system has recently been upgraded in Sarnia. Under the auspices of CAER, the question of common air dispersion model for the Sarnia area is currently being worked.

In the aftermath of CAER and CVECO simulations, audits were performed and changes were made to improve the system. These exercises and audits involved provincial, municipal and industrial participation.

On the site basis, this plant has an Emergency Response System which is defined by an Emergency Manual. The emergency response procedures described in the Emergency Manual are examined and updated on a yearly basis.

Professional Safety Training

This plant on a site-wide basis is committed to a system of "total loss control" based on the I.L.C.I. 5-Star system. This system involves training, development, testing and auditing of safety systems at all levels and in all parts of our operation, including the PVC organization. The I.L.C.I. system specifically tests and audits management practices and control in this area. This would be part of an I.L.C.I. 5-Star audit. (PVC had a 5-Star audit in 1987).