

AIR QUALITY SURVEY
(TAGA 6000)
REICHHOLD LIMITED,
NORTH BAY
JULY, 1989

APRIL 1991



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Report prepared for:

The Northeastern Region
Ontario Ministry of the Environment

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REICHHOLD LIMITED, NORTH BAY

JULY, 1989

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Ontario Ministry of the Environment

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Executive Summary

During the weeks of July 4, 10, and 17, 1989, the Air Resources Branch performed an air quality survey in North Bay, as requested of the Ministry's Northeastern Region. The primary objective was to determine the ambient concentration of phenol downwind of Reichhold Limited following the installation of a new scrubber in plant No.3. The Environment Ontario's mobile Trace Atmospheric Gas Analyzer (TAGA 6000) was used for this survey.

The survey crew noted a "phenolic" odour downwind of Reichhold on several monitoring days. The strength of this odour was generally considered slight, and the odour episodes were brief. The monitoring results indicate that Reichhold was a source of phenol. However, only 12 of the thirty-four half-hour average concentrations exceeded the analytical detection limits, which averaged $2.9 \mu\text{g}/\text{m}^3$. Phenol levels, averaged over a half-hour period, were only a fraction of the Ministry standard of $100 \mu\text{g}/\text{m}^3$. The maximum phenol concentration based on half-hour averages was $5 \mu\text{g}/\text{m}^3$, in residential areas immediately downwind of the plant. Instantaneous levels of phenol were measured as high as $67 \mu\text{g}/\text{m}^3$, which is sufficient to cause the faint odours. Phenol levels recorded during this survey were significantly lower than those measured by the TAGA 3000 in November 1988, prior to the new scrubber installed in plant No.3.

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1.0 Introduction

At the request of the Northeastern Region, the Air Resources Branch conducted a mobile air monitoring survey in the vicinity of Reichhold Limited, Wallace Rd., North Bay, Ontario. The Northeastern Region expressed special interest in the odours emanating from the manufacture of phenolic resins in plant No. 3. Odours resulting from the manufacture of these resins has been the source of ongoing citizens' complaints. A previous air quality survey conducted by the Air Resources Branch in November 1986 found phenol concentrations as high as $36 \mu\text{g}/\text{m}^3$ for a half-hour average, with instantaneous maximum concentrations as high as $150 \mu\text{g}/\text{m}^3$. In the fall of 1988, the company installed a new phenol scrubber in plant No. 3 (See Appendix, Page 11). Also, since the previous study, Reichhold has developed resins with lower free phenol content. The results of this survey could provide insight as to the effectiveness of these new changes. Thus the primary objective was to determine the ambient concentration of phenol downwind of Reichhold, particularly plant No.3. The mobile TAGA 6000 is a state-of-the-art air monitoring unit based on the analytical principles of MS/MS. It is capable of measuring, *in situ*, a variety of air borne contaminants, including phenol.

The survey was conducted between the period of July 4 and July 20, 1989. Mr. Frank Driscoll, an Environmental Officer with the Northeastern Region assisted the survey crew in the execution of the survey.

2.0 The TAGA 6000 "Fingerprinting" Technique

The Trace Atmospheric Gas Analyzer (TAGA) model 6000 is a specialized tandem mass spectrometer (MS/MS) with a unique air sampling inlet system and ion source (See Figure 1). Ambient air is sampled directly at a high flow rate (100 l/min.) into the ion source, which operates at atmospheric pressure. Ionisation of trace contaminants is achieved by chemical ionisation (CI) initiated by a corona discharge. Selective ionisation of chemical classes is achieved through addition of the appropriate CI reagent to the flowing air sample. For example, atmospheric water vapour highlights ketones, aldehydes, alcohols and acids, oxygen highlights phenols, chlorophenols and acids, benzene highlights aromatic compounds and sulphurous species, and ammonia highlights amines, amides and nitrosamines.

The ionisation of pollutants yields a mixture of pseudo-molecular ions, often referred to as parent ions, which are immediately subject to MS/MS analysis. In this technique, parent ions, selected in Q1 undergo collisional activated dissociation (CAD) with an inert gas, Argon. The resulting fragment ions, or daughter ions, are characteristic of the compound which produced the parent ion. The daughter ion spectra are computer searched against a library of known CAD spectra. Pollutants can be identified in a matter of minutes with this technique.

Owing to the system's unique features of direct air sampling, and atmospheric pressure chemical ionisation, the technique is highly sensitive to many organic and inorganic compounds in real-time. Through the use of benzene chemical ionisation, the TAGA can detect compounds whose ionisation potential is lower than that of benzene. These species are generally aromatic compounds, including phenol.

2.1 Quantization of Target Compounds

Accurate quantization of a target compound is achieved by calibrating the response of the TAGA to known gas-phase concentrations of the target compound. Selected daughter ions characteristic of the target compound are monitored in the "multiple reaction monitoring" (MRM) mode. A typical monitoring period for obtaining quantitative data is thirty minutes; this conforms to the period specified for Ministry standards and guidelines. The TAGA's response is calibrated at least twice a day: before monitoring begins, and after it concludes for the day. Additional calibrations are preformed if target compound concentrations exceed Ministry standards or guidelines.

For this survey, phenol was measured using five parent/daughter ion pairs: 94/39, 94/40, 94/55, 94/65, and 94/66. Calibration factors were determined for each parent/daughter ion pair by injecting known amounts of phenol at five concentration levels: 170, 101, 34, 24, and 14 $\mu\text{g}/\text{m}^3$. The phenol standard was generated by injecting

a phenol/benzene solution directly into the TAGA air inlet line through a heated injector (240°C), using a motorized syringe drive. The slopes of the concentration/response curves provided the calibration factors which were used to determine the half-hour average concentrations. Daily calibration factors are averaged, and the measurement errors are estimated from the standard deviations of the calibration factors. The real time detection limit for phenol averaged $2.9 \mu\text{g}/\text{m}^3$ over the duration of this survey.

2.2 Survey Strategy

The basic survey strategy was to position the mobile TAGA unit downwind of Reichhold during an odour episode and measure the instantaneous concentration of phenol every 5 seconds for thirty minute periods. Mr. Frank Driscoll of Northeastern Region provided the phenolic resin production schedule for plant No. 3 on a daily basis. Most of the TAGA monitoring periods were scheduled to coincide with phenolic resin production. Air monitoring was performed at locations upwind (background), as well as downwind (source) of Reichhold. The upwind data was used to correct the downwind measurements for the background contribution.

The selection of monitoring sites is based upon several observations:

- 1) wind direction and wind speed
- 2) plume tracking data (phenol measurements while mobile)
- 3) odour characteristics
- 4) type of chemicals detected (fingerprint), and
- 5) accessibility and road network.

The mobile TAGA unit is equipped with a meteorological station which allows monitoring of wind speeds and wind directions at a height of 10 metres. Meteorological data is simultaneously recorded with the air quality measurements.

3.0 Results and Discussion

The mobile TAGA 6000 unit conducted ambient air monitoring in North Bay on July 4, 5, 6, 7, 10, 18, 19, and 20, 1989. A total of thirty-four (34) half-hour averages for phenol were determined at 6 locations downwind of Reichhold. Monitoring was conducted in the residential areas to the west, south and east of Reichhold, within a distance of approximately 500 metres from plant No. 3 (See Map 1). The survey activities are summarised in Table 1, which includes information regarding monitoring periods, sampling locations, local meteorological conditions, phenol concentrations, and relevant comments.

3.1 July 5

July 5 was a warm, sunny day with winds from the west at 5–10 kmph. Background levels were established approximately 200 metres upwind of Reichhold, in the parking lot of Doublerink Arena on Wallace Rd., before downwind monitoring began. Following background sampling and phenol calibration, the TAGA unit was moved downwind to a location approximately 200 metres east of the Reichhold plant (Site A). Phenolic odours were not perceived at the time of sampling. Mass spectral analysis of the ambient air at this location using the fingerprinting technique showed that there were no pollutants significantly in excess of the background levels. Three half-hour averages for phenol taken at this location between 14:30 and 16:04 showed that phenol was not detected (ND) at a detection limit of $3.5 \mu\text{g}/\text{m}^3$ (Samples 01–03). Plant No. 3 was not operating at the time of sampling.

3.2 July 6

Monitoring on July 6 was conducted in the evening hours, between 21:00 and 24:00. It was a warm, humid, overcast evening with winds from the west at 5–15 kmph. Upwind sampling and calibration was performed approximately 400 metres west of Reichhold. Three half-hour averages for phenol were recorded downwind of Reichhold between 21:40 and 23:40 (Sites A and B, Samples 04–06). There was a slight intermittent odour which was non-phenolic. Ambient phenol levels were below the detection limit of $5.6 \mu\text{g}/\text{m}^3$. Plant No. 3 was producing resin BD023 only during the first half-hour sampling period. The plant was off line during the last hour of sampling.

3.3 July 7

July 7 was a clear, dry day. It was considerably cooler than the preceding two days. Winds were from the north to northeast at 5–10 kmph. Background levels were recorded at a location approximately 500 metres north of Reichhold on Johnston Rd. Three half-hour averages for phenol and cresols were recorded downwind of Reichhold between 14:41 and 16:12 (Site C, Samples 07–09). Odours were not perceived by the survey crew. Half-hour average concentrations of phenol were less than $4 \mu\text{g}/\text{m}^3$, with instantaneous concentrations of phenol peaking at $12 \mu\text{g}/\text{m}^3$. Cresols, or methyl phenols, were not detected above the detection limit of $0.75 \mu\text{g}/\text{m}^3$. Resin BD023 was produced in plant No.3 at the time of sampling.

3.4 July 10

July 10 was partly cloudy and humid, with wind from the north to northwest at 5 kmph. Upwind samples were taken on Johnston Rd., at the same location as July 7. Seven half-hour averages for phenol were recorded downwind of Reichhold between 15:50

and 19:42 (Site D, Samples 10–16). The survey crew noted intermittent phenolic odours ranging from slight to moderate in intensity. Phenol was not detected at a detection limit of $3.4 \mu\text{g}/\text{m}^3$, based on the half-hour average. Instantaneous levels of phenol were in the 10 to $20 \mu\text{g}/\text{m}^3$ range. Plant No. 3 produced resin BD802 on this day.

3.5 July 18

July 18 was sunny, warm and dry, with west winds at 5–20 kmph. Background levels were established in the Doublerink Arena parking lot on Wallace Rd. Four half-hour averages for phenol were recorded downwind of Reichhold between 14:56 and 16:59 (Site E, Samples 17–20). The survey crew noted intermittent phenolic odours ranging from slight to moderate in intensity. Net concentrations of phenol ranged from ND to $4.2 \mu\text{g}/\text{m}^3$, with a detection limit of $1.6 \mu\text{g}/\text{m}^3$. Instantaneous maximum concentrations of phenol ranged from 24 to $43 \mu\text{g}/\text{m}^3$. Plant No. 3 produced resin BD802 on this day.

3.6 July 19

July 19 was partly cloudy and damp, but there was no rain. Winds were from the east to northeast at 5–10 kmph. Upwind sampling was conducted on Trapper Glen Rd., approximately 100 metres east of Reichhold. Eleven half-hour averages for phenol were recorded downwind of Reichhold between 9:16 and 15:09 (Site F, Samples 21–31). The survey crew noted intermittent phenolic odours ranging from slight to moderate in intensity. Net half-hour concentrations of phenol ranged from ND to $5.0 \mu\text{g}/\text{m}^3$, with a detection limit of $1.9 \mu\text{g}/\text{m}^3$. Instantaneous maximum concentrations of phenol ranged from 5 to $67 \mu\text{g}/\text{m}^3$. Plant No. 3 produced resin BD802 on this day.

3.7 July 20

July 20 was cool, clear and dry with winds from the east to southeast at 2–10 kmph. Background levels were established on K&K Dr., approximately 150 metres northeast of Reichhold. Three half-hour averages for phenol were recorded downwind of Reichhold between 10:35 and 12:06 (Site F, Samples 32–34). The survey crew noted intermittent phenolic odours ranging from slight to moderate in intensity. The half-hour average concentrations of phenol were below the detection limit of $1.5 \mu\text{g}/\text{m}^3$. The maximum instantaneous phenol level was $9 \mu\text{g}/\text{m}^3$. Resin BD802 was produced in plant No.3 during the sampling periods.

3.8 Fingerprint Spectra

Chemical "fingerprinting" was performed downwind of Reichhold on July 5, 6 and 18. Analysis of the fingerprint spectra reveals that there were no chemical species of

significance downwind of Reichhold during fingerprint acquisition. The odours detected by the survey crew downwind of Reichhold were quite transient. It is difficult to acquire representative fingerprint spectra during conditions which cause transient odours; this may have reduced the number of species observed.

4.0 Summary and Conclusions

The net concentration of phenol recorded downwind of Reichhold ranged from ND to $5 \mu\text{g}/\text{m}^3$. The maximum instantaneous concentration of phenol reached $67 \mu\text{g}/\text{m}^3$ on July 19, but only for very brief periods. This transient behaviour was likely the result of variable meteorological conditions.

It is apparent from the results of this air quality survey that the ambient air concentration of phenol never approached the Ministry standard of $100 \mu\text{g}/\text{m}^3$ (over a half-hour average) at any time during monitoring operations. In fact 70 per cent (or 24 of 34) of the half-hour averages for phenol were below the analytical detection limits which averaged $2.9 \mu\text{g}/\text{m}^3$. This observation was supported by the odour observations; phenolic odours were never perceived to be strong. Aside from when plant No.3 was off line, the odours were least noticeable when resin BD023 was produced. The free phenol content of resin BD023 was approximately five times lower than that of resin BD802. Odours were perceived to be more prevalent when BD802 was manufactured. It is noteworthy that the higher levels of phenol were also recorded on those days when resin BD802 was produced.

During the last (November 1986) air quality survey of Reichhold, the TAGA 3000 detected levels of phenol which were seven times higher, yet still below the Ministry standard (Report # ARB-001-87-AQM). Since the fall of 1988 Reichhold added a new phenol scrubber system to plant No. 3, and increased the height of the stack from which phenol is discharged by 9.3 metres. Also, product development has led to a profound reduction in the free phenol content of all resins manufactured by Reichhold. All of these changes could significantly lower the concentration of phenol in the vicinity of the plant. The results of this survey indicate that there has been a reduction in both the ambient phenol levels and the occurrence (and intensity) of phenolic odours.

5.0 Acknowledgements

The author thanks Frank Driscoll and Ray Potvin of the Northeastern Region, MOE, for his assistance in execution of this survey, and their valuable comments.

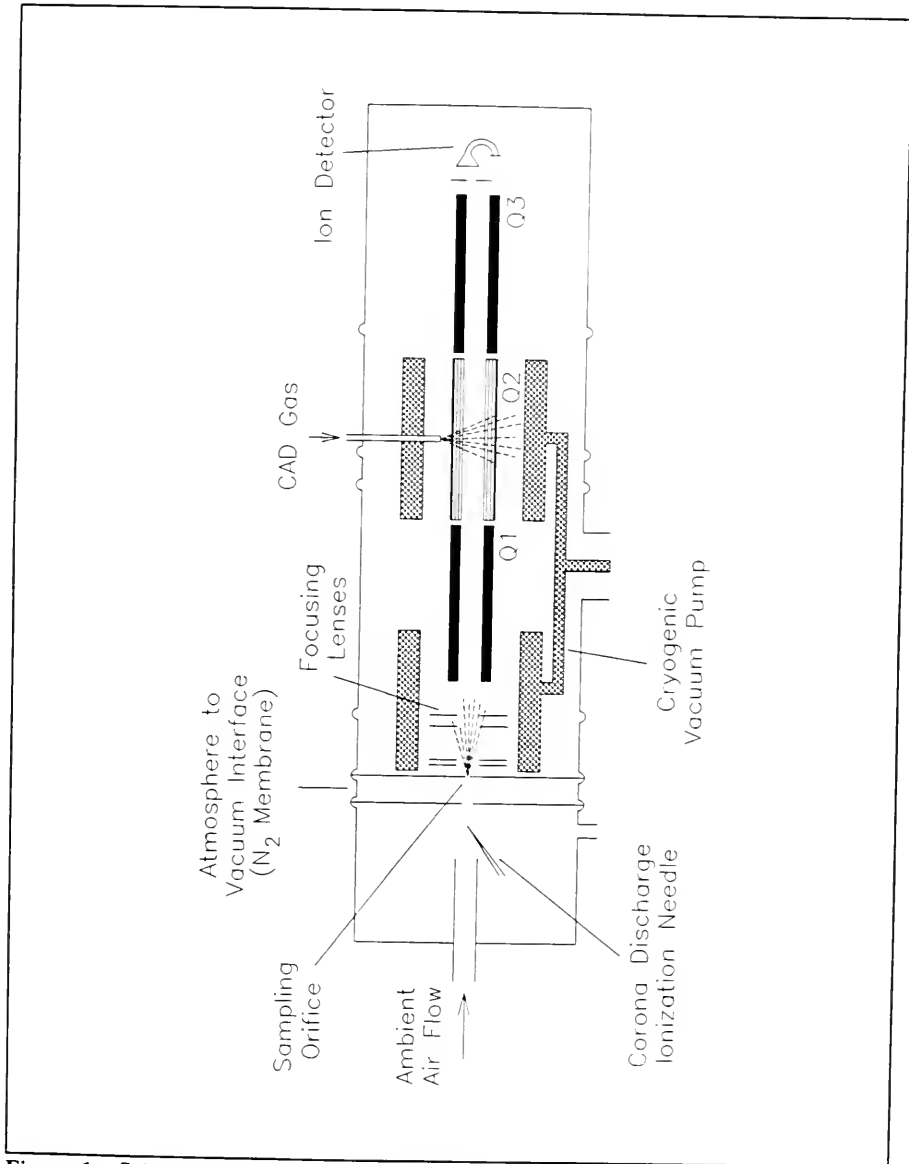
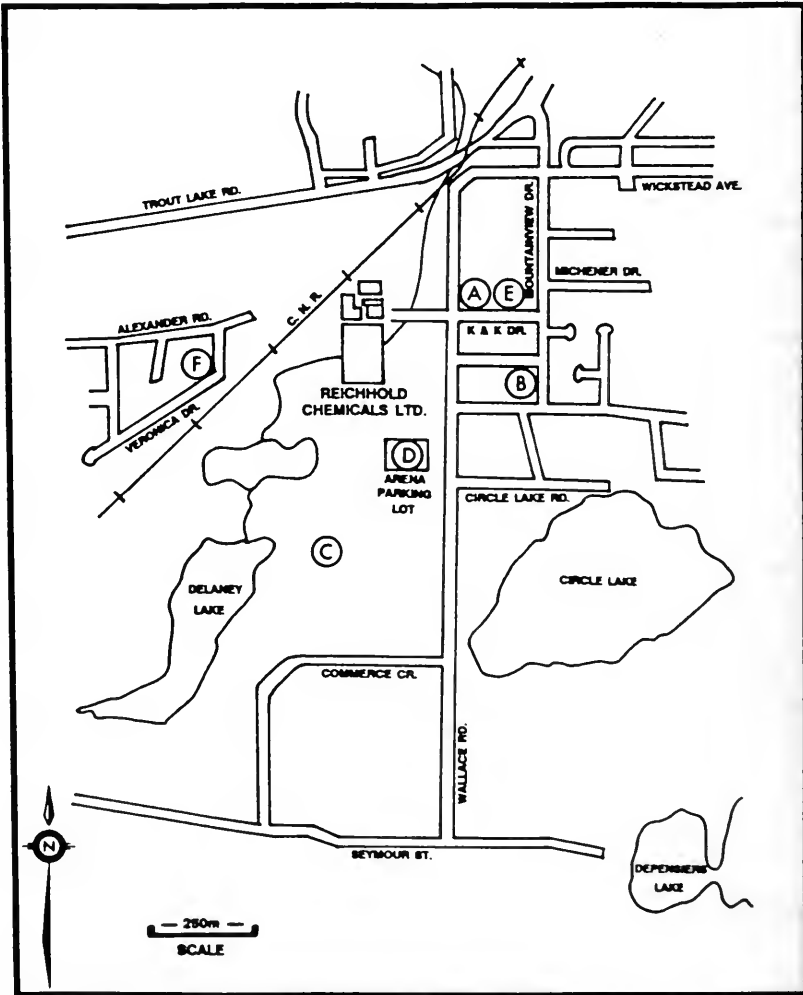


Figure 1: Schematic of the TAGA 6000 system

MAP OF THE PLANT LOCATION AND THE
MONITORING SITES - NORTH BAY 1989



Map 1 - Monitoring Sites for Mobile TAGA Unit

North Bay (Reichhold) TAGA Survey 1989

Date	Sample Number	Monitoring Period	Site ¹	Meteorology ²			Phenol ³ Conc'n.	Det. ⁴ Limit	Max ⁵ Conc'n.	Error ⁶ (RSD)%	Comments
				AT	WS	WD					
July 5	S01	14:30-15:00	A	28	5-10	W	ND	3.5	8	10	No odour
	S02	15:04-15:34	A	28	5-10	W	ND	3.5	12	10	plant #3
	S03	15:34-16:04	A	28	5-10	W	ND	3.5	15	10	not running
July 6	S04	21:40-22:10	A	25	10-15	W	ND	5.6	10	7	slight odour, BD023
	S05	22:29-22:59	B	27	5-10	W	ND	5.6	9	7	No odour, plant #3 off
	S06	23:10-23:40	B	27	5-10	W	ND	5.6	9	7	No odour, plant #3 off
July 7	S07	14:41-15:11	C	24	5-10	N-NW	3.8	2.9	12	9	No odour, BD023
	S08	15:12-15:42	C	24	5-10	N-NW	3.2	2.9	12	9	No odour, BD023
	S09	15:42-16:12	C	24	5-10	N-NW	3.2	2.9	11	9	No odour, BD023
July 10	S10	15:50-16:20	D	27	5	N-NW	ND	3.4	18	4	Intermittent faint odour, BD802
	S11	16:20-16:50	D	27	5	N-NW	ND	3.4	10	4	No odour, BD802
	S12	16:50-17:20	D	27	5	N-NW	ND	3.4	13	4	Moderate odour, BD802
	S13	17:21-17:51	D	27	5	N-NW	ND	3.4	20	4	Moderate odour, BD802
	S14	17:51-18:21	D	27	5	N-NW	ND	3.4	16	4	No odour, BD802
	S15	18:41-19:11	D	27	5	N-NW	ND	3.4	15	4	Moderate odour, BD802
July 18	S16	19:12-19:42	D	27	5	N-NW	ND	3.4	13	4	No odour, BD802
	S17	14:56-15:26	E	28	5-20	W	1.9	1.6	24	11	Slight odour, BD802
	S18	15:28-15:58	E	28	5-20	W	2.1	1.6	26	11	Slight odour, BD802
	S19	15:58-16:28	E	28	5-20	W	4.2	1.6	43	11	Moderate odour, BD802
	S20	16:29-16:59	E	28	5-20	W	ND	1.6	17	11	No odour, BD802
	S21	09:16-9:46	F	18	5-10	E-NE	ND	1.9	13	5	No odour, BD802
July 19	S22	09:46-10:16	F	18	5-10	E-NE	5.0	1.9	67	5	Slight - moderate odour, BD802
	S23	10:16-10:46	F	20	5-10	E-NE	4.0	1.9	38	5	Slight - moderate odour, BD802
	S24	11:07-11:37	F	20	5-10	E-NE	ND	1.9	35	5	Slight - moderate odour, BD802
	S25	11:37-12:07	F	22	5-10	E-NE	ND	1.9	24	5	Slight - moderate odour, BD802
	S26	12:07-12:37	F	22	5-10	E-NE	3.9	1.9	33	5	Intermittent moderate odour, BD802
	S27	12:37-13:07	F	23	5-10	E-NE	ND	1.9	23	5	Intermittent moderate odour, BD802

Table 1 - Phenol Half-hour Average Concentrations

North Bay (Reichhold) TAGA Survey 1989

Date	Sample Number	Monitoring Period	Site ¹	AT	Meteorology ²		Phenol ³ Conc'n.	Det. ⁴ Limit	Max. ⁵ Conc'n.	Error ⁶ (RSID%)	Comments
					WS	WD					
July 19	28	13:08-13:38	F	23	5-10	E-NE	ND	1.9	20	5	Intermittent slight odour, BD802
	29	13:38-14:08	F	23	5-10	E-NE	ND	1.9	15	5	Intermittent slight odour, BD802
	30	14:08-14:38	F	23	5-10	E-NE	3.3	1.9	46	5	Intermittent slight odour, BD802
	31	14:39-15:09	F	23	5-10	E-NE	ND	1.9	5	5	Intermittent slight odour, BD802
July 20	32	10:35-11:05	F	23	2-10	E-SE	ND	1.5	9	9	Moderate odour, BD802
	33	11:06-11:36	F	23	2-10	E-SE	ND	1.5	4	9	Slight-moderate odour, BD802
	34	11:36-12:06	F	23	2-10	E-SE	ND	1.5	ND	9	No odour, BD802

1. See Map 1 for downwind monitoring locations.

2. Meteorological conditions at 10 metres: AT=ambient temperature, WS=wind speed in km/hr, WD=wind direction.

3. In $\mu\text{g}/\text{m}^3$.

4. In $\mu\text{g}/\text{m}^3$, based on 3σ , where σ =standard deviation of background signal.

5. Maximum instantaneous concentration of phenol, in $\mu\text{g}/\text{m}^3$.

6. Uncertainty in phenol concentration, based on relative standard deviation of replicate calibration runs.

Table 1 Cont'd

Appendix - Details of Manufacturing Process and Plant Operation

The following information on the plant manufacturing process and plant operation of Reichhold Ltd was provided by the Northeast Region.

Background Information:

Reichhold Limited owns and operates a plant at 281 Wallace Road, North Bay, which manufactures urea and phenol formaldehyde resins for the forest product industry.

The plant has been the source of odour complaints from the neighbouring residents since 1985. The company, through its own studies, has identified phenolic compounds as the major odour causing contaminant, and spray dry plants number two and three as the major source of these contaminant emissions.

District staff have been dealing with Reichhold Limited, and a program has been undertaken for reducing odorous emissions. This program has led to the installation of a pack bed scrubber on number three spray dry plant.

The primary purpose for the Northeastern Region's request for the TAGA 6000 survey is to assist in determining the effectiveness of this scrubber. Should the pollution control equipment prove effective in eliminating or reducing the odour causing contaminants to acceptable levels, similar equipment will be installed on spray dryer plant number two.

Process and Scrubber Design:

Liquid phenolic resin containing 30 to 40 percent solids are atomized at elevated temperatures at the top of the dryer, and drying is accomplished as the droplets fall concurrently with hot air flowing at approximately 28 m³/second. Humid air and powdered resin exit the chamber and the solids are recovered by four primary cyclones. The humid air stream exhausted from the tops of the cyclones, discharges into a wet venturi scrubber.

The venturi scrubber removes particulate, phenol and formaldehyde using an atomized caustic solution, which is generated by the pressure drop in the venturi.

Liquid droplets are then removed in a cyclonic de-mister section, and the air stream exhausted to the packed bed scrubber.

The pack bed scrubber has a diameter of 4.3 metres, a packing section height of 2.4 metres, and a de-mister section of 0.3 metres.

The scrubber is located on the roof of spray dry plant number three and is used to cleanse the exhaust from the venturi scrubber and the fabric filter bag house at a volumetric flow rate of 41 m³/second, and exiting through a stack extending 34 metres above grade. The stack height prior to installation of the scrubber was 24.7 metres above grade.

The scrubbing medium is a caustic solution. The solution pH is controlled and recorded by a Leeds and Northrup pH metre. Make up water for the scrubber system is introduced at the pack bed scrubber, and overflows through the venturi basin. Suspended solution is ultimately disposed of at an on-site waste water treatment facility.

Plant Number Three Production Data

Date (1989)	Time	Production Times (On to Off)	Product
July 05	14:30 to 16:30	not running	
July 06	21:30 to 24:00	20:45 to 22:23	BD-023
July 07	14:30 to 16:30	12:45 to 17:00	BD-023
July 10	15:30 to 19:45	11:40 to 12:00 ¹	BD-802
		13:00 to 20:20	BD-802
July 18	14:30 to 17:00	13:30 to 17:00	BD-802
July 19	09:15 to 13:15	09:15 to 13:15	BD-802
	13:00 to 15:15	13:00 to 15:15	BD-802
July 20	10:30 to 15:45	10:30 to 12:40 ²	BD-802

Notes: 1. Between 12:00 and 13:00 the plant was off resin.
2. Between 12:40 and 13:20 the plant was off resin.

