Health Consultation

Review of Total Facility Air Permit

INTERPLASTIC CORPORATION

MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

EPA FACILITY ID: MND006151336

MAY 21, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

FOREWORD

This document summarizes potential public health concerns at an industrial or hazardous waste site in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation:

! Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it's found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

! Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

! Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with industrial and hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies — including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

! Soliciting community input: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us*.

Please write to: Community Health Educator
Site Assessment and Consultation Unit
Minnesota Department of Health
625 Robert St. North
Box 64975
St. Paul, MN 55164-0975

OR call us at: (651) 201-4897 *or* 1-800-657-3908
(toll free call—press "4" on your touch tone phone)

Introduction
Interplastic Corporation (Interplastic) is a plastic resin manufacturer in northeast Minneapolis, Hennepin County, Minnesota. MDH was asked to aid the MPCA in evaluating emissions from the facility and their potential health impacts in the surrounding community.

MDH has previously reviewed documents, permits and data on Interplastic at the request of the Minnesota Pollution Control Agency (MPCA) and the City of Minneapolis (Minneapolis). MDH authored documents on Interplastic include: a 1994 health consultation in response to a request from a resident on general issues of health concern (MDH, 1994b); comments on a 1994 Environmental Assessment Worksheet (EAW) for the City of Minneapolis (MDH, 1994a); a 1998 health consultation in response to a request from the MPCA to evaluated monitoring data from a single air release from the facility (MDH, 1998a); and a 1999 health consultation that evaluated the proposed Interplastic total facility air permit at the request of the MPCA (MDH, 2000b).

This health consultation contains a review of additional MDH comments and activities for adoption of the final total facility air permit for the Interplastic facility, including MDH comments on issues related to assessment of pollution from an industrial source.

MDH has made numerous recommendations related to air emissions from this facility in the past. These recommendations were made because there has been a need for air emissions data and air quality data from Interplastic, and there was very little data available. The new air permit requires Interplastic to make much new data available for review. Therefore, previous recommendations related to air emissions may no longer be relevant.

In a previous health consultation, MDH made recommendations related to the discharge of water from Interplastic (MDH, 2000b). These recommendations remain pertinent to this facility. However, they are not related to air emissions from Interplastic, and will not be discussed in this document. MDH continues to recommend:
1. Investigate generation, use, and discharge of water from the Interplastic facility
2. Monitor discharges from Interplastic into the storm and sanitary sewers.

Site Background
The Interplastic facility is located at 2015 N.E. Broadway, Minneapolis. It is located on several acres in northeast Minneapolis which were used as a dump and later for manufacturing. Currently, the site itself has relatively little exposed soil. The majority of the site is covered by buildings, pavement, gravel haul roads, and railroad spurs. Interplastic's principal business is the production of unsaturated polyester resins. Since 1966 Interplastic has operated a plastic resin manufacturing plant at this location.

Historically, there have been numerous complaints from the surrounding community about odors emanating from the Interplastic facility. Generally, the complaints were thought to be related to the shutdown of the large thermal oxidizer which processes emissions from manufacturing processes at the facility. However, in 1998, additional potential pollution sources were identified. These include a hotbox which is used to bake and solidify waste resins, and the storm sewers which may have transferred some wastes or waste water offsite. The hotbox was connected to the thermal oxidizer, and manufacturing area access to the storm sewers was also restricted in 1998 (MPCA, 1998).

Demographics

The area surrounding the site is zoned for light industry and manufacturing. However it is our understanding that Interplastic has a non-conforming use exemption. The nearest residential area is approximately 0.3 miles to the south and west (Figure #1). The residential area consists of fairly large, older, 2-story homes, streets covered by a canopy of trees, small local schools, and playgrounds/parks interspersed throughout the neighborhood. About 850 people live within ½ mile of Interplastic, and about 13,000 live within a mile of the facility (1990 census).

About 0.2 miles north of the site, in an area called 'The Quarry', there is a new, large retail and grocery shopping area.

Regulatory Interest

A number of potential public health and environmental concerns are associated with the Interplastic site. The site was listed on the Minnesota Permanent List of Priorities (Superfund) in 1990 for groundwater and soil contamination. This contamination appears to have been caused by organic solvents in buried drums and underground storage tank leaks on-site (Mpls, 1995). The contamination and potential issues related to public health were discussed in the 1994 MDH Health Consultation (MDH, 1994b). A soil vapor extractor (SVE) was installed at the site in 1999 to remove volatile organic compounds (VOCs) from contaminated soil. Volatile compounds from the SVE are processed through a second, smaller SVE-dedicated thermal oxidizer.

Because the site is an operating facility, there are a number of regulatory divisions within MPCA and other governmental agencies which are responsible for overseeing site activities. Therefore, data regarding the site are not located in one place. The process of reviewing and evaluating overall site activities and conditions requires coordination with many different agencies and programs. Currently there are at least 2 groups at the MPCA which are working with Interplastic: the Superfund group, and the air permitting group.

The MPCA Metro Area, Major Facilities, Air Section is responsible for ensuring that air emissions from Interplastic are at levels which are not harmful to human health and the environment. During the air permitting process, MDH was asked to aid the MPCA in evaluating emissions from the facility and their potential health impacts in the surrounding community.

Air emission regulatory process at Interplastic

Interplastic was first issued an air permit by MPCA in 1986. This permit was amended in 1989, for installation of a thermal oxidizer; in 1989 to incorporate odor controls; and in 1991 to allow connection of storage tanks to the thermal oxidizer. Interplastic also received a permit for installation and operation of a pilot plant (reactor and thinning tank used for small-scale operations) onsite in 1992. In September 1999 as part of the on-site Superfund cleanup, the MPCA approved an Installation and Operation Permit for a soil vapor extractor (SVE) and a thermal oxidizer (MPCA, 2000).

In 1996 Interplastic was informed by the MPCA that it should apply for a total facility air permit. In 1997 Interplastic applied for a total facility air permit. Issuance of this permit was delayed until November 2000 because of many points of contention between Interplastic and MPCA. Details of these interactions are included in the November 2000 MPCA Findings of Fact (MPCA, 2000). Issues of contention included the determination of emissions factors for manufacturing processes conducted at the facility and requirements to control various emissions sources (e.g. the hotbox) by attaching them to a thermal oxidizer.

The draft total facility air permit was put on public notice in September 1999. MDH was generally pleased with the draft permit (MDH, 2000b). Comments from Interplastic were primarily focused on the MPCA requirement that all process equipment be attached to pollution control equipment. MPCA staff offered that, as an alternative, the company could conduct comprehensive monitoring of ambient air near their facility. The monitoring data could provide data to evaluate potential public health impacts associated with the facility (MPCA, 2000). The revised total facility air permit was put on public notice on July 11, 2000.

On November 28, 2000, the MPCA Citizen's Board denied Interplastic a contested case hearing on the proposed permit and approved the permit.

The approved permit allows Interplastic to pursue different options to assure that public health is not adversely impacted by emissions from their facility (from MPCA, 2000). These options include:

- Connect uncontrolled emissions to control equipment.
- Further quantify and characterize emissions.

Additionally, it requires characterization of capture efficiency of significant release processes, and thermal oxidizer destruction efficiency.

MDH supported the proposed total facility air permit for Interplastic before the MPCA Citizen's Board on November 28, 2000. A copy of the MDH testimony is attached (Attachment 1). MDH supported the permit because it assures that: either emissions from Interplastic will be controlled; or that emissions and ambient air concentrations of chemicals of concern near the facility will be fully characterized and then controlled below levels of public health concern. Additionally, MDH testimony addressed statistical issues related to characterizing potential exposures from irregular air emissions by intermittent sampling of ambient air at a single location.

Chemicals of concern, emissions and existing health criteria

Interplastic uses styrene, maleic anhydride, phthalic anhydride, methyl methacrylate, ethylene glycol and other organic compounds in batch processes to produce unsaturated polyester resins at their northeast Minneapolis facility. The unsaturated resins manufactured at the plant, as well as most of the raw materials used at the facility are known to be hazardous. Byproducts of the manufacturing process include hazardous wastes which are solidified and converted to nonhazardous waste by catalyst addition and baking in the ‘hotbox’ at high temperature. In addition, there may be hazardous waste created from tanker and vessel cleaning, laboratory equipment, and the cleaning of small tools, filters, pumps, and other machinery.

MPCA has identified styrene, maleic anhydride, phthalic anhydride, ethylbenzene, methyl methacrylate, acetone, ethylene glycol and dicyclopentadiene as chemicals of concern for the manufacturing processes at the Interplastic facility. However, due to lack of information, MPCA has only estimated emissions for styrene, maleic anhydride, phthalic anhydride and methyl methacrylate. Other chemicals of concern may be emitted from manufacturing processes, but they have not been itemized at this time. Emissions quantities are expected to vary depending on the emission source and time-dependent stage of the batch manufacturing process.

A thermal oxidizer is used to control emissions of organic vapors from the facility. Nitrogen oxides are emitted as a result of burning natural gas in the thermal oxidizer. The facility also emits a large amount of particulate matter (PM). MDH is most concerned in the respirable fraction of PM, those particles less than 10 microns in size (PM_{10}).

Table 1 is a listing of Interplastic’s emissions as cited in the air permit. Potential emissions are the total emissions which could be released from the facility assuming that the facility is operating at full capacity for the entire year. It also assumes that the emission control equipment, including emission capture ratios and thermal oxidizer destruction efficiency, is maintained during all operating hours.

Table 1

Emission	Potential emissions (PTE)	‘Actual’ Emissions
Nitrogen oxides (NO_X)	42.1 tons per yr	9.3 tons per yr
Particulates (PM)	32.6 tons per yr	5.9 tons per yr
Particulates less than 10 microns (PM_{10})	32.6 tons per yr	5.9 tons per yr
Styrene	65.7 tons per yr	22.3 tons per yr
Maleic anhydride	3.4 tons per yr	1.6 tons per yr
Phthalic anhydride	3.4 tons per yr	2.0 tons per yr
Methyl methacrylate	7.1 tons per yr	1.1 tons per yr
Additional VOCs	4.5 tons per yr	3.4 tons per yr

Not all volatile organic compound (VOC) emissions from Interplastic are itemized in the Technical Support Document for the Draft Air Emissions Permit.

Chemicals which are emitted from Interplastic are dispersed, or diluted by air as they move offsite. MDH has reviewed available air sampling data, as well as modeled data, which characterize possible exposures to hazardous chemicals off-site. Table 2, below, includes acute and chronic health criteria for which there are estimated emissions.

Table 2

Compound (odor threshold)	**Acute** health-based values (legal limits)	**Human Endpoint** (**primary**) [animal]	**Chronic** health-based values (legal limits)	**Human Endpoint** (**primary**) [animal]
dicyclopentadiene (11 ppb - 60 µg/m^3)			subchronic HRV - 3 µg/m^3	Eyes, skin, respiratory irritation, CNS [**kidney**, lung]
ethyl benzene (2,300 ppb - 10,000µg/m^3)	10,000 µg/m^3 - HRV	respiratory, eye irritation, neurological [CNS, pulmonary, liver, kidney, eye irritation]	1,000 µg/m^3 - IRIS-RfC	blood [blood, liver, kidney, **developmental**] Cancer Class: D not classifiable as a human carcinogen
maleic anhydride (285 ppb - 1,140 µg/m^3)		Nasal irritant, resp. sys, double vision, dermal	10 µg/m^3 - proposed REL, 2000	Respiratory system
methyl methacrylate (80 ppb - 300 µg/m^3)		CNS, respiratory irritation, eyes, dizziness [CNS, pulmonary, liver, kidneys, eyes-irritation]	700 µg/m^3 - HRV	Respiratory system; nervous system [Degeneration/atrophy of olfactory epithelium]
nitrogen oxides	470 µg/m^3 - NO_2 REL	irritate eyes, **nose, throat, decreased pulmonary function, chronic bronchitis**	(100 µg/m^3 - NO_2 NAAQS) 20 µg/m^3 - NO_2 proposed REL, 1997	Respiratory system
particulates (PM_{10})	(150 µg/m^3 - 24 hr NAAQS)		(50 µg/m^3 - NAAQS)	Respiratory system
phthalic anhydride (53 ppb - 326 µg/m^3)		irritate **eyes, skin,** resp. sys, nasal ulcer, bleeding, dermal (liver, kidney)	20 µg/m^3 - REL	Eye and respiratory irritation, asthma, and bronchitis
styrene (320 ppb - 1384 µg/m^3)	21,000 µg/m^3 - REL	mucus membrane, eye irritation, gastrointestinal	1,000 µg/m^3 - HRV	**CNS**, kidney, blood [CNS, liver, kidney, eye and nasal irritation] Cancer Class: C possible human carcinogen

HRVs - MDH draft Health Risk Values are air concentrations that MDH has determined to be safe exposure levels for the general public, including sensitive individuals (MDH, 2000a).

RELs - Reference Exposure Levels were developed by the California Office of Environmental Health Hazard Assessment (OEHHA) as safe exposure levels for the general public, including sensitive individuals (CA OEHHA, 2001).

RfCs - Reference Concentrations established by the EPA as safe, chronic exposure levels for the general public, including sensitive individuals (EPA IRIS, 2000).

NAAQS - National Ambient Air Quality Standards (NAAQS) criteria are concentrations of specific pollutants, not to be exceeded from 0 to 3 times (standard dependent) during a specified averaging period (EPA, 1997). (24-hour PM_{10} NAAQS is not to be exceeded 98 % of the time.)

Air Monitoring at Interplastic

<u>Data from a single high-release event</u>

There are some data from a thermal oxidizer shutdown event, reported by Interplastic, on September 29, 1997 which suggest that high-release events may cause concern for public health. These data were reviewed by MDH in a 1998 health consultation (MDH, 1998a). Sample data from that event showed high ambient concentrations of styrene (1,400 micrograms per cubic meter ($\mu g/m^3$) (Interplastic, 1997), inside the fenceline. Analyzed concentrations of ethylbenzene and methyl methacrylate were well below levels of concern. However, MDH expressed concerns about meteorological conditions, protocols, and reporting procedures which made it impossible to draw conclusions about the potential exposures to hazardous compounds during this event (MDH, 1998b). Furthermore, dicyclopentadiene was not quantifiable due to the lack of a laboratory standard (Interplastic, 1997). No community odor complaints related to Interplastic were logged during this event.

California has an acute REL for styrene of 21,000 $\mu g/m^3$, well above the level captured during the 1997 event. Since this acute REL is only 1/10th of the Occupational Safety and Health Administration (OSHA) TWA, MDH has some concerns that it may not be appropriate for use in a screening assessment. MDH will review the styrene acute REL within the next 6 months.

<u>Intermittent 24 hour monitoring and community complaints</u>

In 1998, MPCA began intermittent air sampling on a rooftop south-southeast of Interplastic. Staff collected 24 hour samples on a rotating 1 day-in-six schedule. Analysis of samples showed styrene concentrations at the monitoring station to be about 2 $\mu g/m^3$ when the wind was not from the facility toward the station. The ten highest 24 hour concentrations of styrene sampled in ambient air ranged from 75 to 140 $\mu g/m^3$. Wind direction for the ten highest sampling days was directly from Interplastic for 21 - 70 percent of the 24 hour sampling periods. MPCA expects the ten highest sampled concentrations would be significantly lower if the capture efficiency from the manufacturing processes is required to be 100% and the destruction efficiency of the thermal oxidizer is at least 95% (MPCA, 2000).

MDH logged no complaints from community residents on any of the ten highest concentration days. Therefore, MDH and MPCA believe that none of the samples with the highest concentrations of styrene, were acquired during a high release event at Interplastic.

Direct information is not available on the frequency of high-release ‘events’ that occur at Interplastic. According to MDH records, in 1998 the company reported 18 events (16 thermal oxidizer shutdowns or breakdowns and 2 spills). Also, Interplastic was identified as the source of strong odors in 42 community complaints logged during 1998. Sixteen of those complaints noted that the exposed individuals suffered adverse health effects from their reported exposures. Only 3 of the community complaints were recorded during company identified ‘events’. Therefore, events which are not reported by the company are associated with the majority of the community complaints (MDH, 2000b). These unreported events could include irregular emission caused by emissions breaking through the thermal oxidizer and / or emissions which are uncontrolled or directly vented.

Modeling potential public exposures from emission data

The MPCA has developed Screening Emission Rates (SERs) which are maximum average chemical emissions rates conservatively modeled to result in average annual, 24-hour, 8-hour, or 1-hour ambient air concentrations no higher than a known health standard. The model assumes that the emission stack is not built according to good engineering practices (non-GEP), and therefore, emissions may be subject to downwash. Additionally, the SER model assumes that exposures may occur very near the stack. While Interplastic's main stack (thermal oxidizer) is at a similar height as neighboring buildings, subject to downwash, and less than 50 feet of the nearest offsite structure, MDH recognizes that emissions from Interplastic have only been modeled with a conservative screening model, and that releases have not been well characterized.

Application of the SER screening model shows possible exceedances of some health criteria. Therefore, site-specific emissions and meteorological data need to be further investigated. The actual emissions from the Interplastic facility are a subject of some controversy, with the company reporting substantially less release of all compounds than MPCA-estimated emissions.

Styrene and volatile organic compounds

Short-term styrene releases from Interplastic (15 lbs/hr or 1/8760th of the annual emissions) may exceed the 1-hour average SER using the California REL (under review by MDH). However, assuming one hour emissions are 1/8760th of the annual emissions could underestimate maximum hourly emissions from batch processes.

The styrene emission rates in the air permit assume that emissions are captured by pollution control equipment, and that the destruction efficiency of the thermal oxidizer is greater than 95%. Reports from community members suggest that pollution control equipment may not be functioning under optimal conditions during high-release events. Therefore, emission rates may be underestimated.

The chronic health standard applied to the annual averaged SER is the draft HRV of 1000 $\mu g/m^3$. The reported potential emissions (PTE; 65.7 tons per year) do not exceed the MPCA annual average SER for styrene (155 tpy). However, if significant emissions occur when the thermal oxidizer is not functioning properly, emissions during those periods could be 20 times greater than the assumed rate.

Interplastic emissions also contain significant quantities of other VOCs. Not all VOC emissions have been identified or characterized. Exposure levels in areas adjacent to the facility should be estimated for all VOCs, and potential health risks should be calculated.

Maleic anhydride and phthalic anhydride
Interplastic has the potential to emit (PTE) maleic anhydride and phthalic anhydride in quantities of about 3.4 tons per year (tpy). Using the proposed chronic REL of 10 μg/m^3 for maleic anhydride and the chronic REL of 20 μg/m^3 for phthalic anhydride as health criteria (CA OEHHA, 2001), SERs for the two compounds are 1.6 tpy and 3.1 tpy, respectively. 'Actual' emissions are assumed to be about 1.6 tpy maleic anhydride and 2.0 tpy phthalic anhydride. Using dispersion factors from the SER model, offsite annual releases at the PTE show screening level exceedances of the California chronic RELs by 2.1 and 1.1 times, respectively. Annual releases at the rate of the 'actual' emission rate could lead to exceedances of the chronic REL for maleic anhydride.

MDH will review acute health effects data on maleic anhydride and phthalic anhydride within the next six months so that short-term exposure to these compounds can be evaluated.

Since maleic anhydride and phthalic anhydride have similar health effects, exposures to both should be considered to have additive effects.

Additionally, MDH has concern about public exposure to these two compounds because their odor thresholds are above health criteria (Table 2).

Nitrogen oxides
Industrial facilities typically emit large amounts of nitrogen oxides (NO_x). Nitrogen dioxide (NO_2) is regulated by a National Ambient Air Quality Standard (NAAQS). NAAQS are promulgated by the Environmental Protection Agency (EPA, 1997). Using the NO_2 NAAQS as a health effects surrogate in screening model calculations of NO_x emissions from industrial facilities yields a non-GEP stack SER of 15 tpy. This screening suggests exceedance of the annual NO_2 NAAQS of 100 μg/m^3 near many facilities that use large amounts of natural gas, including Interplastic. Most NO_x emissions from Interplastic are from natural gas use by the thermal oxidizer which controls organic emissions. Therefore, exceedance of the NO_2 SER should be considered qualitatively in the context of local NO_x pollution and policy.

Applying dispersion factors used in the SER model to Interplastic emissions of NO_x (as NO_2) (PTE, 42.1 tpy; 'actuals', 9.3 tpy) estimates ambient air annual average concentrations of 270 μg/m^3 for releases at the PTE and 60 μg/m^3 for emissions at the 'actual' emission rate. Additionally, there are many sources of NO_x in the area of Interplastic, including area, point, and mobile sources. NAAQS regulates the total concentration of a pollutant in air, not just that from one facility. Therefore, NO_2 background concentration must be considered when determining NAAQS compliance. Typical annual averaged background NO_2 concentrations in the Twin Cities are about 38 μg/m^3 (estimated from MPCA, 1997a). Therefore, annual NO_2 ambient air concentrations (or NO_x as NO_2) may exceed the NAAQS near this facility.

Dispersion factors from the SER model suggest that hourly NO_x emissions from Interplastic could occasionally lead to NO_x ambient air concentrations of about 23,000 μg/m^3. California has an acute REL for NO_2 of 470 µg/m^3 (CA OEHHA, 2001). It represents a 1-hour safe exposure level. If NO_2 is used as a surrogate for NO_x, safe levels of exposure may be exceeded offsite by about 50 times.

Particulate matter

Industrial facilities typically emit large amounts of particulate matter (PM). Total PM less than 10 µm (PM_{10}) are regulated by the EPA NAAQS (EPA, 1997). The PM_{10} annual average NAAQS is 50 µg/m^3, and the 24-hour averaged NAAQS is 150 µg/m^3. NAAQS regulates the total concentration of a pollutant in air, not just pollution from one facility. Therefore, PM_{10} background concentration must be considered when determining NAAQS compliance. The annually averaged PM_{10} background for the northeast Minneapolis is assumed to be about 28 µg/m^3 (estimated from MPCA, 1997a); 24-hour average background concentrations may be about 50 µg/m^3 (estimated from MPCA, 1997a).

The annual SER model estimates Interplastic's contribution to PM_{10} in ambient air may be as much as 208 µg/m^3 using the potential emissions of 32.6 tpy and 38 µg/m^3 using annual emissions of 5.9 tpy. This screening suggests that PM_{10} concentrations in ambient air near the facility may be above the annual NAAQS of 50 µg/m^3.

The results of modeling 24-hour PM_{10} data suggest a maximum 24-hour exposure of 2,100 µg/m^3 may be possible. This (screening) modeled concentration exceeds the 24-hour NAAQS for PM_{10} by 14 times. Since multiple sources (point or non-point) in the area of the Interplastic facility contribute to ambient levels of particulate material, it may be necessary to conduct modeling and monitoring to determine the level of contribution by Interplastic and the associated health risk.

The reported 'Actual' PM_{10} emissions from Interplastic are significantly lower than their PTE. If the 'actual' emissions are determined to reasonably reflect the limited potential emission capability of this facility, the permit could reflect this discrepancy with an enforceable Limited PTE.

Particulate matter less than 2.5 microns in size ($PM_{2.5}$) is an easily respired portion of PM_{10}. Scientific data are accumulating on the relationship between $PM_{2.5}$ and human health effects (Klemm et al., 2000; Lippmann & Schlesinger, 2000). MPCA and Interplastic should begin to investigate $PM_{2.5}$ emissions from the facility.

General Discussion - Monitoring and modeling facility emissions

<u>Number of monitoring samples needed</u>

MPCA has conducted intermittent sampling at a location south-southeast and adjacent to Interplastic for over 1 year. Twenty-four hour samples were taken once every six days, or about 60 times in a year. The data acquired were described above. Apparently, sampling did not capture ambient air during an elevated emission event. MDH expressed concerns about monitoring in a letter from Environmental Health Division Director Patricia Bloomgren to James Warner, Metro District Director for MPCA, in a letter dated July 1, 1999:

> "While monitoring can demonstrate actual ambient air levels and hence possible exposures at a specific location and time, these data rarely effectively describe potential exposure levels of the public in a large area over time."

The successful use of monitoring to characterize pollutants in ambient air is a function of the probability of sampling characteristic concentrations or uncharacteristic events. Air monitoring near facilities with continuous or short-time oft-repeated processes (e.g. power plants or dry cleaners) may provide data representative of potential exposure concentrations at the location of the sampling equipment. However, determining potential exposures to hazardous pollutants in ambient air may be problematic if the pollutant has a less predictable or less constant source.

Emissions from industrial facilities often vary significantly over time. Diurnal fluctuations result from changes in temperature, humidity, or sunlight. Also, changing emission rates are associated with batch processes, loading or unloading materials and products, changes in operations, changes in emission control capture or treatment efficiencies, or changes in fugitive emissions. These fluctuations are unlikely to be captured or characterized by a limited number of sampling events over 24-hour periods at a single location.

It is instructive to estimate the probability that ambient air may be sampled during a high-release event (see Appendix A, attached). In 1998, MDH logged 42 community complaints of odors from Interplastic. These complaints occurred on 30 different days over the year. If it is assumed that highly odorous emissions occur randomly on 30 different days in a year, the probability that an event occurs on any one day is 30/365 or 0.082. Therefore, about 27 random (24 hr) samples would need to be collected to be reasonably certain ($90\%^{+}$) that the air near the facility was sampled on a day when a large emission took place. In addition, if there is only one sampling location, there is no guarantee that the facility was upwind from the sampling location during the elevated emission event. The probability that the wind direction is in the direction of the monitoring station is a function of the sampling location and the prevailing wind directions. The probability that both optimal wind direction and event occur on the same day is determined by multiplying their respective probabilities. Therefore depending on site-specific characteristics, it may be necessary to take 225 - 1200 samples to assure ($90\%^{+}$) that an event is captured. Iterative calculations (see attached Appendix A spreadsheet), using 1999 meteorological data for Rosemont MN, suggest that it would take 322 samples at the current monitoring station location to be 90% sure that the air was sampled at least once during a high-release event when the wind was from the facility toward the monitoring station.

Also, even if the monitoring station is downwind during a high-release event, the highest off-site ambient air concentration may be closer to the source, or further away from the source than the monitoring station. The distance between the source and the location of the maximum ambient air concentration can vary under different emission, stack, and meteorological conditions. Therefore, even in excess of 322 samples may not identify or effectively characterize an acute event.

In addition during an event, changes in meteorological conditions will also affect ambient levels. Wind direction and wind speed can both change during an event. This will have obvious effects on pollutant concentrations in ambient air near a point source. As noted in a previous section, wind direction during the 10 highest 24-hour sampling periods occurred on days when the wind was from the facility toward the monitoring station for only 21-70 % of the time.

Furthermore, if the event extended over only a fraction of the 24 hour sampling time, the sample would be diluted.

Each sample taken at an air monitoring station is a single data point or snapshot taken at a single location and a single time period. It describes an air concentration which is likely to be below the ambient air concentration which could occur at a different location or at a different time. To determine the maximum potential exposure, sampling should take place both when emissions are at a maximum level and at a location where ambient air is maximally impacted by the release. Identifying the time and location of the maximum, or a reasonable maximum, pollutant concentration with a single monitoring station is not possible.

Environmental sampling for maximum concentrations of pollutants in ambient air is similar to determining the chances that a single identified individual will be exposed to a contaminant. It is not the same as determining the chance that *any* individual may be exposed. While sampled ambient air concentrations may exceed health criteria in one sample out of 1000, ambient air concentrations at some location in the vicinity of a monitoring station may exceed acute criteria much more often.

Sampling time and health criteria averaging times

Care also needs to be taken when characterizing potential acute exposures due to differences in sample collection time and averaging times for health criteria.

Acute criteria are usually applied to exposures of one hour or less. Exposures to high concentrations of some chemicals for very short lengths of time may have significant health effects. Chronic criteria are applied to exposures of a year or longer. Sample collection time at air monitoring stations is often 24 hours; with enough sample data (see above) chronic exposures may be calculated from these data. However, without further information, it can be problematic to estimate acute exposures from 24 hour data.

Sampling over time periods shorter than 24 hours is not economically feasible unless the sampling is worst-case hotspot sampling or “plume chasing.”

Modeling limitations

Some variables that affect exposure are difficult to model as well. Hence, even models which are considered to be conservative may sometimes underestimate pollutant concentrations in air. Current Gaussian dispersion models, under optimum meteorological conditions, typically predict pollutant concentrations in air within a factor of two (MPCA, 1997b). Generally, long-distance atmospheric transport models are considered reliable. But, modeling becomes more problematic as the exposure point-of-interest approaches a source and also as averaging times are reduced, e.g. from annual to hourly.

Meteorological conditions can cause the formation of tropospheric boundary layers which can effectively decrease the mixing of pollutants in ambient air. This has been demonstrated by constant monitoring of radioactivity (radon) in air over 24 hour periods (Porstendorfer et al., 1994). Data demonstrate that the nighttime formation of a boundary layer, and other meteorological conditions which cause the formation of an inversion, will significantly increase the retention of radon in the breathable air zone. These data demonstrate that gaseous pollutants can be retained in the lower troposphere by boundary layers.

Formation of boundary layers may result in bimodal distribution of pollutants even if emissions from a point source are constant (i.e. there may be 2 distinctly different wind direction dependent background concentrations for a pollutant, as well as 2 distinctly different concentrations resulting from facility releases depending on whether or not there is an inversion). The strength or elevation of a boundary layer may, in some locations, have a seasonal dependence. Under these circumstances, modeling the magnitude and frequency of short-term, or peak, pollutant concentrations may be even more complex.

The EPA recently used the ASPEN (assessment system for population exposure nationwide) model to estimate annual average pollutant concentrations in all census tracts in the US (EPA, 1998). Results of this study were compared to annual monitoring data from areas not known to be pollution hot-spots. This comparison showed that in areas where both modeling and monitoring data were available, the ratio of predicted (modeled) to sampled concentrations ranged from 0.20 to 1.08 (Rosenbaum et al., 1999). Only one of 14 hazardous air pollutants (HAPs) for which there were sufficient data, showed a modeled concentration in excess of the sampled median concentration. Discussions by the authors of this study attribute this bias to: nighttime boundary layers (which they are not able to properly model); the possibility that local emissions were underestimated; and the lack of inputs into the model which adequately describe long distance transport (>50 km) (Rosenbaum et al., 1999).

While the ASPEN model was developed to determine annual average concentrations of a HAP and was not meant to identify local pollution hot-spots, sample data used in the comparison was also thought to be from 'average' locations. The ASPEN model is based on the ISCLT (Industrial source complex long term) model and the HEM (human exposure model). Gaussian plume-dispersion models, such as these and other related models, are often used to estimate maximum annual and short-term average concentration of pollutants in ambient air near industrial facilities. These models are limited in their ability to incorporate intermittent releases and meteorological anomalies. Therefore, they may underestimate or ignore these uncertainties, which may result in an underestimation of ambient air concentrations of pollutants under some circumstances.

Special Issue: Children's Health

The Agency for Toxic Substances and Disease Registry's (ATSDR's) Children's Health Initiative and MDH are concerned about children's exposures to hazardous chemicals. Children may be exposed to a proportionally greater amount of any contamination due to their typically higher respiratory rate, and their greater surface area to weight ratio. Both of these characteristics create a greater absorption potential for children during respiratory or dermal exposure. Furthermore, children who are developing and growing may be more susceptible to chemical toxicity.

Health-based criteria used by the EPA, MDH, ATSDR, and other governmental entities are at levels meant to protect the population, including sensitive subpopulations, such as children. Therefore if potential levels of exposure are below MDH levels of concern, effects on children's health should be negligible. This Health Consultation discusses MDH testimony on an air permit for an industrial facility. MDH supported the permit because it requires additional characterization of emissions from the facility, or further control of emissions. These outcomes are beneficial for children, other sensitive sub-populations, and public health in general.

Conclusions

This site represents an Indeterminate Public Health Hazard because there are not sufficient data available to characterize public exposures to hazardous chemicals emitted from Interplastic.

Screening modeling of potential and actual emissions from Interplastic indicate possible exceedance of available acute and chronic health criteria for nitrogen oxides, and PM_{10} in ambient air near the facility. Additionally, acute health criteria for styrene, as well as chronic criteria for maleic anhydride and phthalic anhydride may be exceeded. Also significant VOC releases from Interplastic need to be itemized and characterized. Currently, there are no available acute health criteria for maleic anhydride and phthalic anhydride, and the acute health criteria for styrene are under review by MDH.

It is difficult, and expensive, to determine the health impact of point source emissions by offsite monitoring when high-release events are transient and sporadic. Prior to undertaking offsite sampling, consideration should be given to the probability of successfully sampling important events.

In November 2000, MDH testified before the MPCA Citizen's Board on the need to accurately determine emission amounts from Interplastic. Complaints from the community suggest that emissions are sometimes at levels of health concern. Also, offsite sampling near this facility cannot realistically be expected to determine whether or not air pollutants exceed levels of concern for acute exposures. Therefore, additional information is needed from the company.

The MPCA Citizen's Board approved the total facility air permit for Interplastic which was proposed by MPCA staff and supported by MDH. The permit requires Interplastic to control all significant emission points and certify destruction of captured emissions, or to monitor and characterize releases.

Recommendations
MDH supports the new air permit and recommends that its provisions be implemented. Other recommendations:

- Potential emissions from Interplastic should be restricted to levels which will not cause exceedances of levels of acute or chronic health concern in the surrounding community.
- A complete review of emission sources should be conducted, including a review of emission control equipment during periods of:
  - normal emissions
  - occasional and temporary emissions
  - emissions resulting from non-optimal thermal oxidizer operation
  - emissions when thermal oxidizer is off-line
  - normal and irregular vented, uncontrolled or fugitive emissions
  - exposures which may result from emissions should be characterized and estimated
- Chemical composition of all significant emissions should be determined including:
  - maleic anhydride, phthalic anhydride, nitrogen oxides, PM_{10}, styrene, dicyclopentadiene, ethylbenzene, methyl methacrylate
  - additional, non-itemized VOCs which may be emitted (e.g. benzene and styrene oxide)
- All emissions including those from the ‘hotbox’ and any similar equipment should be controlled.
- Background levels for PM_{10}, NO_xs, benzene and other VOCs, and HAPs should be investigated.
- PM emissions from the Interplastic facility should be characterized to develop an understanding of the effects of $PM_{2.5}$ exposure in the surrounding community and the facility’s contribution.
- Regular monitoring of normal emissions from the Interplastic facility, upstream and/or downstream of pollution control equipment should occur
- Types of identified emission events reported and/or monitored should be expanded to include any significant irregular, accidental, or unplanned emissions which may potentially lead to exceedances of health-based criteria
- Handheld or portable, realtime meters (e.g. PID, FID, FTIR) should be used to determine area of maximum ambient concentration of emissions during elevated emission events.

Public Health Action Plan

- MDH expects to review new data as they become available, and to develop new recommendations.
- MDH will develop acute health-based values for styrene, maleic anhydride and phthalic anhydride. Additional health-based values may be reviewed upon request.
- MDH will continue to work with MPCA, the company, and the community to characterize Interplastic emissions and potential impacts on human health.

This consultation was prepared by:

Carl Herbrandson, Ph. D.
Toxicologist
Site Assessment and Consultation Unit
Environmental Surveillance and Consultation Section
Minnesota Department of Health

References

California Office of Environmental Health Hazard Assessment (2001). Reference Exposure Levels. Office of Environmental Health Hazard Assessment, CA OEHHA, Sacramento, CA. http://www.oehha.org/air/hot_spots/index.html (1/22/01).

Environmental Protection Agency (1997). National Ambient Air Quality Standards. Office of Air Quality Planning and Standards, EPA, Washington, D.C. http://www.epa.gov/airs/criteria.html July 2000.

Environmental Protection Agency (1998) Cumulative Exposure Project. EPA, Washington, D.C. http://www.epa.gov/CumulativeExposure/air/air.htm

Environmental Protection Agency (2000). Integrated Risk Information System. Office of Health and Environmental Assessment, Environmental Criteria Office, EPA IRIS, Cincinnati, OH. http://www.epa.gov/iris/ (June 2000).

Interplastic Corporation (1997) Air Monitoring Plan Quarterly Report. Peterson, S. L., Interplastic, Minneapolis, MN. November 12, 1997.

Klemm, R. J., Mason, R. M., Jr., Heilig, C. M., Neas, L. M., Dockery, D. W. (2000) Is daily mortality associated specifically with fine particles? Data reconstruction and replication of analyses. J Air Waste Manag Assoc 50:7 p1215-22.

Lippmann, M., Schlesinger, R. B. (2000) Toxicological bases for the setting of health-related air pollution standards. Annu Rev Public Health 21 p309-33.

Minnesota Department of Health (1994a). Memo to: Orange, M., Minneapolis City Planning Department, St. Paul, MN. From: Daniel Symonik, MDH. Subject: Comments on Draft Environmental Assessment Worksheet (EAW) for Interplastic Corporation dated 11/16/94. December 28, 1994.

Minnesota Department of Health (1994b). Public Health Consultation for the Interplastic Site. St. Paul. Health Consultation. Site Assessment and Consultation, MDH, ATSDR: 1994.

Minnesota Department of Health (1998a). Interplastic Corporation: Review of Air Monitoring Data, September 29, 1997 Event. St. Paul, MN. Health Consultation. Site Assessment and Consultation, MDH, ATSDR: June 24, 1998.

Minnesota Department of Health (1998b). Memo to: Gates, B., Sullivan, D., Minnesota Pollution Control Agency, St. Paul, MN. From: Herbrandson, C., MDH. Subject: Review of monitoring data from event - 9/29/97: Interplastic Corporation. January 15, 1998.

Minnesota Department of Health (2000a) Health Risk Values (draft). MDH, Environmental Surveillance and Assessment Section, St. Paul, MN. April 2000.

Minnesota Department of Health (2000b). Interplastic Corporation: Recommendations for Draft Air Permit. St. Paul, MN. Health Consultation. MDH, ATSDR: June 9, 2000.

Minnesota Pollution Control Agency (1997a) Minnesota Air: Air quality and emission trends. Oliaei, F., MPCA, St. Paul, MN. September 1997.

Minnesota Pollution Control Agency (1997b) Letter to: Orange, M., Minneapolis Planning. Concerning: Models used in regulatory decision making. From: McCourtney, M. A., Minnesota Pollution Control Agency, January 14, 1997.

Minnesota Pollution Control Agency (1998) Meeting with: City of Minneapolis, Hennepin County, Minnesota Department of Health. Concerning: Interplastic. Dec 17, 1998.

Minnesota Pollution Control Agency (2000) Findings of fact, conclusions of law and order: In the matter of Interplastic Corporation's Title V Total Facility Operating Permit -

Minneapolis, MN. MPCA, Major Facilities, St. Paul, MN. November 28, 2000.
Minneapolis Planning Department (1995) Environmental Assessment Worksheet for the Interplastic Corporation Minneapolis facility. Vol I: Mpls, Minneapolis. July 1995.
Porstendorfer, J., Butterweck, G., Reineking, A. (1994) Daily variation of the radon concentration indoors and outdoors and the influence of meteorological parameters. Health Phys 67:3 p283-7.
Rosenbaum, A., Axelrad, D., Woodruff, T., Wei, Y., Ligocki, M., Cohen, J. (1999) National Estimates of Outdoor Air Toxics Concentrations. Journal of the Air & Waste Management Association 49 p1138-1152.

Concurrence

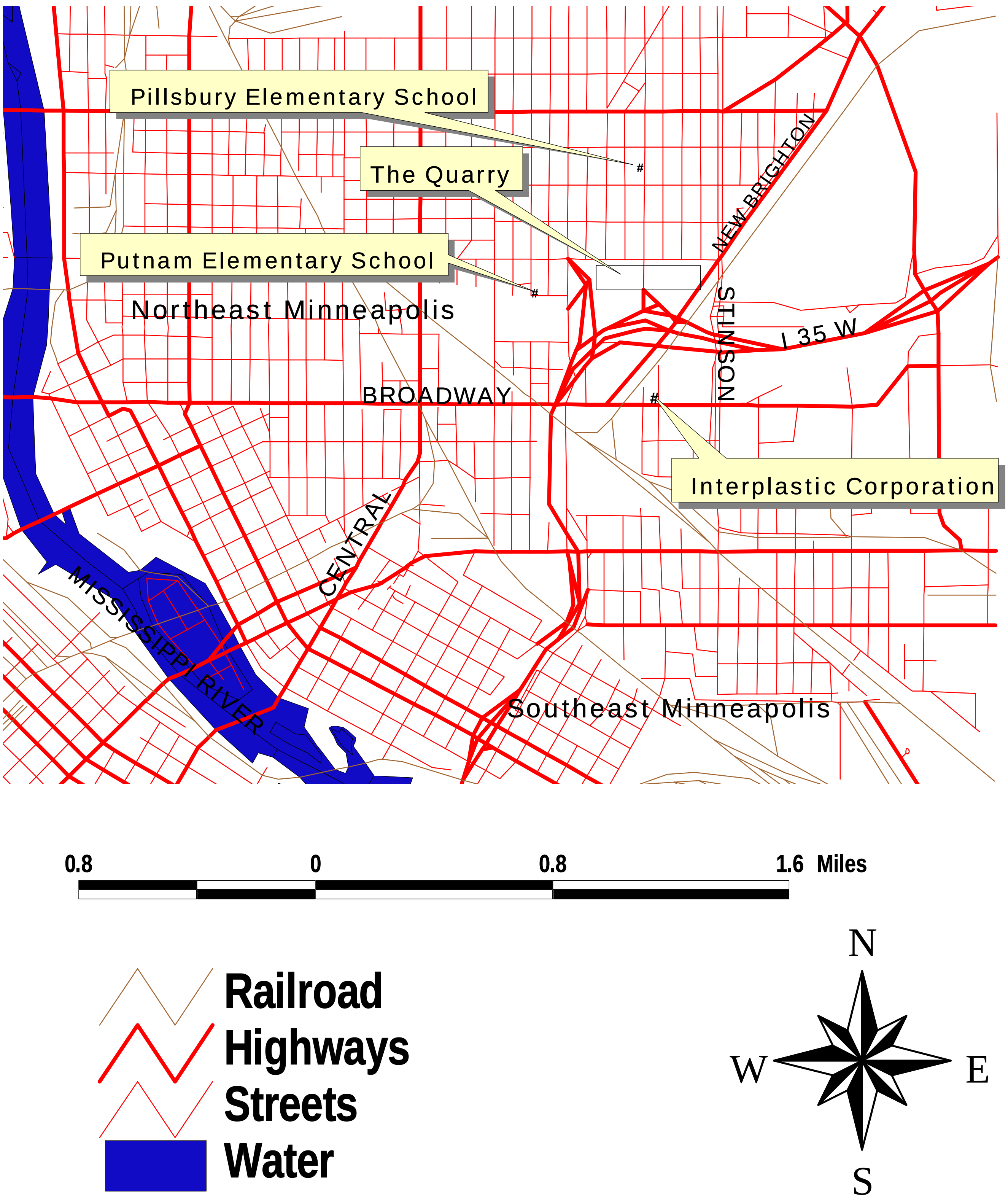
This Interplastic Corporation Health Consultation was prepared by the Minnesota Department of Health (MDH) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR endorses the actions proposed by MDH to reduce emissions as prudent public health policy.

Alan W. Yarbrough
Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Richard Gillig
Chief, State Program Section, SSAB, DHAC, ATSDR

Figure 1
Interplastic Corporation
Northeast Minneapolis, MN



Minnesota Department of Health

Speaking Points for the MPCA Board Permitting Committee Item on the Total Facility Air Emissions Operating Permit for Interplastic Corporation
November 28, 2000

MDH supports the Air Permit for Interplastic Corporation proposed by MPCA staff. This proposed permit is the culmination of many years work by MPCA to acquire data on the air emissions from the Interplastic facility in Northeast Minneapolis and to use these data to regulate emissions.

! Air emissions, specifically attributable to Interplastic, have prompted a large number of complaints from citizens of Northeast. Complainants generally cite sweet chemical odors. Citizens have also, on occasion, expressed concern about smoke coming from the facility, accompanied by the presence of fire trucks.

! Many complainants reported health effects including breathing problems, allergic reactions, and eye, nose and throat irritation.

! MDH is concerned about long-term emissions, as well as possible elevated short-term emissions which may cause the reported health effects.

From available information MDH believes large short-term releases from Interplastic, which could be generating complaints, could be caused by:
" high emissions at certain times during batch manufacturing processes;
" ‘blow-by’ or overloading of the thermal oxidizer;
" temporary uncoupling of emission controls from hook-ups (e.g. the ‘hot-box’ which evaporates vapors from wastes).

! MDH supports the issuance of this permit because it requires a thorough characterization of all emissions and control to levels below health concern.

(•) Within the last 2 months, the MDH draft chronic HRV for styrene was changed from 200 $\mu g/m^3$ to 1,000 $\mu g/m^3$. While this lowers MDH concern about possible health effects related to *chronic* styrene exposures, it does not diminish our concern about possible exceedances of *chronic and acute* health criteria for other organics, including maleic anhydride and phthalic anhydride, and *acute* styrene criteria.

(•) MDH is not surprised that the background monitoring station installed near Interplastic has not recorded levels of styrene which would be sufficiently elevated to generate complaints (i.e. above odor threshold).

Using a single sampling location, a large number of samples (about 1600) would have to be taken to be reasonably sure that an intermittent event (20 times per year) would be sampled. Furthermore, while acute health effects may occur after a chemical exposure of less than an hour, the sampling protocols average air concentrations over 24 hours.

Carl Herbrandson, PhD, MDH, Site Assessment and Consultation Unit, 651/215-0925

Appendix A - Probability Calculations

If a facility has a high emission event 30 random times a year, the probability that an event occurs on any one day is 30/365 or 0.08219. For the purpose of this estimation, it is assumed that only one event can occur per day and that the probability that an event occurs on any day is not affected by previous events (i.e. it is truly random). Therefore, the probability that an event occurs on any day is the same as the probability of an event occurring on any other day.

The probability that the wind is from a specific direction can be estimated using meteorological data from the site of interest over an extended period of time. There is no known source of precise meteorological data for NE Minneapolis. For the purposes of these probability calculations, 1999 meteorological data from Station #423 of the MPCA Pinebend Monitoring Network, Rosemont, MN were used. These data are hourly data and the probabilities calculated were hourly. As mentioned in the text, this use of hourly data adds an additional uncertainty to the estimations of exposure from a single event since wind direction can change over a 24 hour period.

Since the air monitoring station near Interplastic is south-southeast of the facility, the probability that dispersed emissions are being sampled is a function of the probability that the wind is from the north-northwest. The temperature of the escape gasses, wind velocity, and nearby buildings may also alter the actual probability that emissions are being sampled. The probability that the wind is from the north-northwest is 0.096766 (MPCA Station #423; 1999 hourly data).

The probability that 2 circumstances occur at the same time is equal to the product of the probabilities of the occurrence each circumstance. Therefore, the probability (p) that a high emission event occurs at Interplastic and that the wind is from the north-northwest on any one day, is 0.08219 * 0.096766 = 0.007953.

The probability that wind direction and a high emission event coincide on a second day is also 0.007953. However, we are interested in the probability that an event was sampled at least once over a number of sample days (n). This cummulative probability, that a successful sampling occurred during either the first or the second sampling (p_2), is equal to the probability of success on the first day (p_1; 0.007953), plus the probability of success on a single day (p) times the probability that the first day was not successful ($1 - p_1$) (i.e. $p_2 = 0.007953 + 0.007953 * (1 - 0.007953) = 0.01424$). This calculation is comparable to calculating the probability that heads will occur at least once when a coin is flipped 2 times: 0.5 + 0.5 * (1 - 0.5) = 0.75 .

Similarly, the cumulative probability, p_n, that wind direction and a high emission event coincided at least once during n samplings will be equal to $p_{n-1} + p * (1 - p_{n-1})$. Using iterative calculations, the results of which are shown on the attached spreadsheet, $p_n > 0.90$ when n $ 322.

An alternative method for calculating the number of samples necessary to be 90% certain, an elevated emission event occurs at the same time the wind is from the north-northwest and a sample is being taken, is via direct calculation. p (0.007953) is the probability that both circumstances occur during a single sampling event. Therefore, 1-p is the probability that both circumstances will not occur during sampling. The following equation can be used to find the 90% confidence limit that both circumstances occur during sampling:

$(1-p)^n = 0.1$ (Snedecor & Cochran, 1980)

To solve for n (the number of sampling events):

$\log((1-p)^n) = \log(0.1)$

$n \log(1-p) = -1$

$n \log(1-0.007953) = -1$

$n = 321.11$

Therefore, 322 sampling events are needed to be 90 % certain that at least one sample captured an elevated emission event, with the wind from the north-northwest.

Snedecor, G. W., Cochran, W. G. (1980) Statistical Methods, The Iowa State University Press, Ames, Iowa: Seventh Edition.

Probability of sampling during an event and with wind from the NNW

$p_{(wind\ from\ NNW)}$ =	0.08693
$p_{(high\ emission\ event)}$ =	0.08219

# of Samples (n)	Cummulative Probability (p_n)	n	p_n	n	p_n	n	p_n	n	p_n
1	0.007145	76	0.420	151	0.661	226	0.802	301	0.884
2	0.014	77	0.424	152	0.664	227	0.804	302	0.885
3	0.021	78	0.428	153	0.666	228	0.805	303	0.886
4	0.028	79	0.432	154	0.669	229	0.806	304	0.887
5	0.035	80	0.437	155	0.671	230	0.808	305	0.888
6	0.042	81	0.441	156	0.673	231	0.809	306	0.889
7	0.049	82	0.445	157	0.676	232	0.811	307	0.889
8	0.056	83	0.449	158	0.678	233	0.812	308	0.890
9	0.062	84	0.452	159	0.680	234	0.813	309	0.891
10	0.069	85	0.456	160	0.683	235	0.815	310	0.892
11	0.076	86	0.460	161	0.685	236	0.816	311	0.892
12	0.082	87	0.464	162	0.687	237	0.817	312	0.893
13	0.089	88	0.468	163	0.689	238	0.819	313	0.894
14	0.096	89	0.472	164	0.691	239	0.820	314	0.895
15	0.102	90	0.476	165	0.694	240	0.821	315	0.896
16	0.108	91	0.479	166	0.696	241	0.822	316	0.896
17	0.115	92	0.483	167	0.698	242	0.824	317	0.897
18	0.121	93	0.487	168	0.700	243	0.825	318	0.898
19	0.127	94	0.490	169	0.702	244	0.826	319	0.898
20	0.134	95	0.494	170	0.704	245	0.827	320	0.899
21	0.140	96	0.498	171	0.707	246	0.829	321	0.89992
22	0.146	97	0.501	172	0.709	247	0.830	322	0.90063
23	0.152	98	0.505	173	0.711	248	0.831	323	0.901
24	0.158	99	0.508	174	0.713	249	0.832	324	0.902
25	0.164	100	0.512	175	0.715	250	0.833	325	0.903
26	0.170	101	0.515	176	0.717	251	0.835	326	0.903
27	0.176	102	0.519	177	0.719	252	0.836	327	0.904
28	0.182	103	0.522	178	0.721	253	0.837	328	0.905
29	0.188	104	0.526	179	0.723	254	0.838	329	0.905
30	0.194	105	0.529	180	0.725	255	0.839	330	0.906
31	0.199	106	0.532	181	0.727	256	0.840	331	0.907
32	0.205	107	0.536	182	0.729	257	0.842	332	0.908
33	0.211	108	0.539	183	0.731	258	0.843	333	0.908
34	0.216	109	0.542	184	0.733	259	0.844	334	0.909
35	0.222	110	0.546	185	0.735	260	0.845	335	0.909
36	0.228	111	0.549	186	0.737	261	0.846	336	0.910
37	0.233	112	0.552	187	0.738	262	0.847	337	0.911
38	0.239	113	0.555	188	0.740	263	0.848	338	0.911
39	0.244	114	0.558	189	0.742	264	0.849	339	0.912
40	0.249	115	0.562	190	0.744	265	0.850	340	0.913
41	0.255	116	0.565	191	0.746	266	0.852	341	0.913
42	0.260	117	0.568	192	0.748	267	0.853	342	0.914
43	0.265	118	0.571	193	0.749	268	0.854	343	0.915
44	0.271	119	0.574	194	0.751	269	0.855	344	0.915
45	0.276	120	0.577	195	0.753	270	0.856	345	0.916
46	0.281	121	0.580	196	0.755	271	0.857	346	0.916
47	0.286	122	0.583	197	0.756	272	0.858	347	0.917
48	0.291	123	0.586	198	0.758	273	0.859	348	0.918
49	0.296	124	0.589	199	0.760	274	0.860	349	0.918
50	0.301	125	0.592	200	0.762	275	0.861	350	0.919
51	0.306	126	0.595	201	0.763	276	0.862		
52	0.311	127	0.598	202	0.765	277	0.863		
53	0.316	128	0.601	203	0.767	278	0.864		
54	0.321	129	0.603	204	0.768	279	0.865		
55	0.326	130	0.606	205	0.770	280	0.866		
56	0.331	131	0.609	206	0.772	281	0.867		
57	0.336	132	0.612	207	0.773	282	0.868		
58	0.340	133	0.615	208	0.775	283	0.869		
59	0.345	134	0.617	209	0.777	284	0.870		
60	0.350	135	0.620	210	0.778	285	0.870		
61	0.354	136	0.623	211	0.780	286	0.871		
62	0.359	137	0.626	212	0.781	287	0.872		
63	0.363	138	0.628	213	0.783	288	0.873		
64	0.368	139	0.631	214	0.784	289	0.874		
65	0.373	140	0.634	215	0.786	290	0.875		
66	0.377	141	0.636	216	0.788	291	0.876		
67	0.381	142	0.639	217	0.789	292	0.877		
68	0.386	143	0.641	218	0.791	293	0.878		
69	0.390	144	0.644	219	0.792	294	0.879		
70	0.395	145	0.646	220	0.794	295	0.879		
71	0.399	146	0.649	221	0.795	296	0.880		
72	0.403	147	0.651	222	0.796	297	0.881		
73	0.408	148	0.654	223	0.798	298	0.882		
74	0.412	149	0.656	224	0.799	299	0.883		
75	0.416	150	0.659	225	0.801	300	0.884		