HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
HETA 86-420-L2051
GENERAL FOAM CORPORATION
WEST HAZLETON, PENNSYLVANIA
JUNE 1990

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, Ohio 45226

HETA 86-420
JUNE 1990
GENERAL FOAM CORPORATION
WEST HAZLETON, PENNSYLVANIA

NIOSH INVESTIGATORS:
Leo M. Blade, C.I.H.
Fred D. Richardson, M.D., M.S.P.H.
Anne T. Fidler, Sc.D.

INTRODUCTION/BACKGROUND

On June 23, 1986, NIOSH received a request from Local Union #15371 of the United Steelworkers of America, representing employees at General Foam Corporation in West Hazleton, Pennsylvania, to evaluate the exposures of personnel working in that facility's foam production departments to toluene diisocyanate (TDI). Subsequent discussions with a union representative indicated concerns about the possible health hazards of day-to-day exposures to TDI, methylene chloride, and other chemicals used in the process.

The facility has two foam production departments, each in one of this facility's two buildings. Each of these departments has one continuous foam-pouring line that produces long blocks of foam that are cut into lengths ranging from a few feet to 200 ft. Both foam-pouring lines produce a variety of polyurethane foams from formulations incorporating polyester or polyether polyols, a mixture of two isomers of TDI (2,4- and 2,6-TDI), various amine catalysts, and other chemicals such as a blowing agent (either methylene chloride or trichlorofluoromethane). Other operations such as fabricating are conducted in other areas of the buildings.

Six amine catalysts were identified as present at this facility from the inspection of Material Safety Data Sheets during an initial survey. These are: 2,2'-oxybis(N,N-dimethylethylamine), also known as A-99, or bis(2-dimethylaminoethyl)ether; triethylenediamine, also known as 1,4-diazabicyclo(2,2,2)octane or DABCO; n-cetyl-N,N-dimethylamine; diethanolamine (DEOA); N-ethylmorpholine (NEM); and, N-cocomorpholine (NCM).

The initial environmental and medical survey was conducted at this facility on November 6 and 7, 1986. Observations and findings from this survey indicated that further evaluation was needed. However, a need was identified by NIOSH laboratory researchers for development of air sampling and analytical methods to be used for the amine catalysts, as well as additional evaluation of the method designed for all isocyanates present (i.e., both monomeric 2,4- and 2,6-TDI, and isocyanate-bearing oligomers formed from 2,4- and 2,6-TDI), prior to the follow-up visit. This resulted in a delay of the follow-up visit. NIOSH investigators conducted a follow-up environmental and medical survey at the plant on March 14 through 18, 1988.

On several occasions since the initiation of this evaluation, the NIOSH investigators have provided interim documentation to the Local Union and to General Foam management, informing them of recent activities and problems encountered. Copies of several interim documents are contained in

Appendices A, B, C, and D. Additional details on the background information and the nature of the HHE request, the facility, its operations, and its employees are contained in Appendices B and D. The chronology of this evaluation is documented in Appendices A, B, C, and D, although the problems causing delays are best described in Appendices B and C (excluding the response letter of April 1988). Further details about the survey strategies and the rationale for these are contained in Appendices A, B, C, and D (excluding the status letters of February and June 1987 and August 1988).

METHODS

The methods used during the initial medical and environmental survey of November 1986 are described in Appendix B. The medical-survey methods used during the follow-up survey of March 1988 are described in Appendix D, while Appendix C provides much information about the concurrent environmental-survey methods. However, the specifics on each air sampling and analytical method are not provided in Appendix C; this information appears in Table I.

Air sampling for toluene diisocyanate and other isocyanates, as indicated in Table I, was conducted using two different methods. NIOSH Method 5521, which is capable of detecting isocyanate-bearing oligomers in addition to monomeric TDI, was used to measure any such oligomers which might form from the 2,4- and 2,6-TDI monomers used in the foams. However, this method requires impingers containing a toluene-based solution to collect the samples. NIOSH Method 2535 uses a solid adsorbent medium to collect the samples, which is more suitable for personal monitoring, but is only sensitive to the monomeric TDI. Area sampling for isocyanates often utilized both methods in a "side-by-side" configuration, to allow comparison of results of the two methods.

As indicated in Table I, air sampling for amine catalysts was also conducted using two different methods, for reasons similar to the above. The solid-sorbent method was only suitable for DABCO, A-99, and NEM. As with isocyanates, area sampling for amines often utilized both methods in a "side-by-side" configuration.

EVALUATION CRITERIA

A. Medical Criteria

The evaluation criteria used for the medical study are fully described in Section III of Appendix D.

B. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without

experiencing adverse health effects. It is, however, important to note that not all workers are protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criteria. Also, some substances are absorbed by direct contact with skin and mucous membranes, potentially increasing the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Treshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH RELs and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH RELs and ACGIH TLVs usually are based on more recent information than are the OSHA Permissible Exposure Limits (PELs). The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agent may be used; the NIOSH RELs, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The OSHA PELs and ACGIH TLVs for 2,4-TDI are identical at 0.005 ppm for an 8-hr TWA and 0.02 ppm for a 15-min STEL. No PEL or TLV has been promulgated for 2,6-TDI, or for total isocyanates. NIOSH, in its Current Intelligence Bulletin #57 of December 1989, considers TDI (both the 2,4- and 2,6- isomers) to be a potential occupational carcinogen and recommends reducing exposures to the lowest feasible concentrations. Prior to that time, the NIOSH REL was based upon respiratory effects and was 0.005 ppm for an 8-hr TWA and 0.02 ppm for a 10-min ceiling for the total of all isocyanates. This is similar to the United Kingdom's Health and Safety Executive standard.

Evaluation criteria are available for only three of the six amine catalysts identified as present at this facility. One of these, diethanolamine (DEOA), is assigned both a TLV and a PEL of 3 ppm for an 8-hr TWA. Another, N-ethylmorpholine (NEM), is assigned both a TLV and a PEL of 5 ppm (for an 8-hr TWA) which each carry the "skin" notation to indicate that dermal adsorption is an important route of exposure. DEOA is a secondary amine and is likely more reactive than NEM, a tertiary amine, perhaps leading to its more restrictive criterion. The other amines at this facility are tertiary, perhaps indicating the use of the TLV for NEM for approximate comparison with the levels of these other amines. However, the validity of such approximate comparisons is uncertain. Therefore, in this case, it is good practice to instead use the more restrictive DEOA TLV of 3 ppm as an approximate criterion for the other amines.

The remaining amine assigned an evaluation criterion is 2,2'-oxybis(N,N-dimethylethylamine), also known as A-99, or bis(2-dimethylaminoethyl)ether. Bis(2-dimethylaminoethyl)ether comprises 5% of Niax(R) Catalyst ESN; NIOSH and OSHA, in their joint Current Intelligence Bulletin #26 of May 1978, recommend minimizing exposure to Niax(R) Catalyst ESN and its individual components due to an association between this product and urological disorders and nervous system effects.

Methylene chloride is assigned by ACGIH a TLV of 50 ppm for an 8-hr TWA, with both "skin" and "A2" designations. The latter denotes a "suspect human carcinogen." NIOSH recommends treating this compound as a potential human carcinogen and reducing exposure to the lowest feasible concentration. The OSHA PEL remains at 500 ppm for an 8-hr TWA, with a ceiling of 1000 ppm which may be exceeded (up to a peak of 2000 ppm) for a maximum of 5 min in any 2-hr period.

Some formulations of foam produced in this facility contain diisodecyl phthalate as a plasticizer. Although evaluation criteria are not available for this compound, other phthalates (e.g., dibutyl, diethyl, dimethyl, and di-2-ethylhexyl) have OSHA PELs and ACGIH TLVs of 5 mg/m^3 for an 8-hr TWA.

RESULTS AND DISCUSSION

A. Medical Findings

The findings from the medical study are fully described in Section IV of Appendix D.

B. Isocyanates

The results from the air sampling for toluene diisocyanate and other isocyantes are presented in Tables II, III, IV, and V. As mentioned earlier, this sampling was conducted using two different methods. In the

data tables, samples in the "ICY-N" numbered series were collected and analyzed with modified NIOSH Method 5521, while those in the "TDI-N" numbered series were collected and analyzed with modified NIOSH Method 2535.

NIOSH Method 5521, which is capable of detecting isocyanate-bearing oligomers in addition to monomeric TDI, was used to measure any such oligomers which might form from the 2,4- and 2,6-TDI monomers used in the foams, as well as the 2,4- and 2,6-TDI monomers themselves. No oligomers were detected. NIOSH Method 2535 is only sensitive to the monomeric TDI.

No personal exposures exceeding the OSHA PEL or ACGIH TLV for 2,4-TDI (both are 0.005 ppm) were detected. Area levels exceeding this concentration were measured at the cutter-saw station in Plant 2. However, the cited evaluation criteria apply to 8-hr TWA exposures, and the workforce was potentially exposed to the measured levels only during the briefer periods because the foam-pour schedule did not require a full shift. This is often the case at this facility. The exposure periods were approximated by the sampling periods. The remainder of the 8-hr shifts may be assumed to be free of exposure (concentration = zero) for the purposes of calculating TWAs. Only sample TDI-42 has a calculated 8-hr TWA of 2,4-TDI exceeding 0.005 ppm, at 0.007 ppm. Nevertheless, the potential for overexposure compared to these criteria does exist, in the event of an 8-hr pour schedule, for a worker spending a large proportion of the time near the cutter-saw area monitoring location (on the control panel).

NIOSH recommends reducing TDI exposures (the total of both 2,4- and 2,6-isomers) to the lowest feasible concentrations. Prior to 1989, the NIOSH REL was 0.005 ppm for an 8-hr TWA for the total of all isocyanates. Measured area concentrations and personal exposures from 19 samples in this facility equalled or exceeded the earlier REL value. In fact, for 6 of these 19 samples, even the calculated 8-hr TWAs exceed the earlier REL. Because the current recommedation is to reduce exposures to the more restrictive "lowest feasible concentrations," it is not necessary to elaborate on the specific sample results in excess of the earlier value.

It is more important to focus on the areas and jobs with the relatively high levels so that controlling exposures can be targeted by greatest need. These areas and jobs are: the cutter-saw station and operator (in both Plants, especially Plant 2); the curing area (Plant 4), as indicated by sample ICY-27 which was collected on the Friday of the week of the survey when large pore-diameter foams were produced; the rack-control/shuttle-control operators and materials expediters (Plant 2) (Foreman "A" works mainly in this part of the Plant); and, the compounder and band saw operator (Plant 4). Sources in the specific areas indicated likely contribute to Plant-wide levels and to exposures of those not confined to specific locations (e.g., foreman and production manager in Plant 4 with relatively high exposures).

C. Amines

The results from the air sampling for amines, using impingers containing aqueous sulfuric acid, are presented in Table VI. As mentioned earlier, sampling for amines was also conducted using solid adsorbent media (Thermosorb^{TM} A tubes). These tubes were used to collect 57 samples. Despite the extensive testing of this method (see Appendix B), the field samples were found to have poor and erratic recoveries of the analytes from the sorbent tubes. Therefore, no results are reported. Raw analytical results (instrument responses) were adjusted for variables (e.g., air volume sampled) and compared qualitatively with side-by-side impinger-sample results. A qualitative correlation is believed to exist, so the adjusted responses were used qualitatively to investigate the relative exposures of individuals considered to have positive visual-acuity test results (see Appendix D, Section IV.B), and to help establish groups of relatively "low-exposed" and "high-exposed" workers. These qualitative procedures are subsequently discussed further.

Almost all foam formulations poured at this facility contained DABCO, A-99, or both. The results in Table VI reflect this, as the only other amine detected was NCM. The relatively low levels of NCM reflect its infrequent use and low volatility.

No amine concentrations in air exceeding the approximate criterion discussed above of 3 ppm were measured. The highest concentration of DABCO, A-99, and NCM measured were 0.93 mg/m^3 (0.21 ppm), 1.72 mg/m^3 (0.263 ppm), and about 0.21 mg/m^3 (0.020 ppm), respectively. Calculated 8-hr TWAs are even smaller. As discussed previously, NIOSH and OSHA recommend minimizing exposure to A-99 as one of the components of Niax$^{(R)}$ Catalyst ESN. The greatest exposures to A-99 occur in Plant 4, from the cutter-saw area to the end of the foam-pouring line and in the storage areas, during the pouring of the filter foams and other large pore-diameter foams (normally on Friday, as during the survey [March 18]). The qualitative assessment of the sorbent-tube data tends to confirm this statement. No impinger samples were collected in the curing area, but the qualitative assessment of the sorbent-tube data suggests that levels were highest in that area on that day.

D. Methylene Chloride

The results from the air sampling for methylene chloride are presented in Table VII. All methylene chloride-containing foam formulations poured at this facility are poured in Plant 2. No methylene chloride area air concentrations or inhalation exposures exceeding the OSHA PEL were detected. Two exposure levels exceeding the ACGIH TLV of 50 ppm were measured among Plant 2 materials expediters. However, if 8-hr TWAs are calculated for these two concentration levels, only one, at 59 ppm (for sample MeCl-10), exceeds the TLV.

Methylene chloride is designated a "suspect human carcinogen" by ACGIH, and, in agreement, NIOSH recommends reducing exposure to the lowest feasible concentration. Therefore, it is important to note the jobs and areas with the relatively high concentrations so that controlling exposures can be targeted by greatest need. These include the materials expediters and utility man and the adjacent rack areas.

E. Phthalates

Six area air samples for diisodecyl phthalate and other phthalates were collected in Plant 2, two each at the pour head station, cutter saw station, and north racks. Results were all below the analytical limit of detection (LOD). The LODs for the samples ranged between about 1 and 4 mg/m^3, depending upon sample air volume. Therefore, all concentrations were below the evaluation criteria of 5 mg/m^3 for most phthalates discussed above.

F. Medical and Environmental Correlation

As described in Section V of Appendix D, two participants (7%, N=27) met the case definition of probable work-related asthma. One of these individuals was exposed to levels between about 0.0025 and 0.005 ppm of TDI (total of both isomers) on the two days sampled (which were two of his three symptomatic days) and was known to work mainly in areas of Plant 2 with typical area concentrations in this range and higher. The other individual worked in Plant 4 near areas that typically had area concentrations around 0.002 ppm. Although the levels of TDI exposure experienced by these workers during the survey were moderately low, it is still likely that their asthma may be work-related. After prior sensitization to a substance such as TDI, exposure to even a small amount may trigger an asthmatic response.

In Table 3 of Appendix D, visual symptom reports for Plant 2 and Plant 4 workers are compared. There was no difference in the proportion of workers reporting any visual symptoms between these two groups. Based on a review of the industrial hygiene sampling results for amines (including the qualitative assessment of the sorbent-tube data), all individuals were categorized with respect to exposure as either "low-exposed" (Plant 2, all jobs; and Plant 4, compounder, and foam machine operator and assistant) or "high-exposed" (Plant 4, all other jobs). These relative exposure categories are based upon the previously-discussed finding that those with jobs in Plant 4, from the cutter-saw area to the end of the foam-pouring line and in the storage areas, likely experience the greatest exposures to amines (apparently A-99) which occur each week. There was no difference in the proportion of workers reporting any visual symptoms between the two exposure groups. These findings were similar to those in Table 3 of Appendix D.

Section V of Appendix D states that the visual acuity data suggest that personnel in both Plants are experiencing work-related vision changes. Because of the problems with the analysis of the sorbent-tube samples for amines, precise exposure estimates for each individual on the day of visual-acuity testing cannot be made. Therefore an accurate dose-response relationship cannot be established. It should be noted that of the six participants considered to have had post-shift visual-acuity changes (i.e., positive visual-acuity test results), three worked in Plant 4 and are believed (based on impinger sampling and the qualitative assessment of the sorbent-tube data) to have had relatively high exposures to amines on the day that visual-acuity changes were assessed (Friday, March 18, when the large pore-diameter foams were poured and the highest levels of amines were experienced); in fact, two of these three are believed to have been exposed to some of the highest concentrations of amines encountered during the survey. However, two of the six with post-shift visual-acuity changes worked in Plant 2 and are similarly believed to have had very low levels of exposure, and the remaining one worked in Plant 4 and is believed to have had intermediate exposures. Although a definite dose-response relationship between exposure to amines and impaired visual acuity was not demonstrated, it is possible that differences in individual susceptibility to the effects of amines may have contributed to the development of deficits in visual acuity or of visual symptoms.

CONCLUSIONS

Based on the information collected during this investigation, a potential health hazard does exist from airborne exposures to TDI (both the 2,4- and 2,6- isomers) which NIOSH considers to be a potential occupational carcinogen. NIOSH recommends reducing exposures to the lowest feasible concentrations. The study results cannot establish an association between amine exposure levels and visual symptoms or deficits in visual acuity tests among the employees studied. However, NIOSH recommends minimizing exposure to A-99 as one of the components of Niax(R) Catalyst ESN. Only one of ten samples for methylene chloride exceeded the 8-hr TWA TLV of 50 ppm, which may have been an outlier, so it is unclear as to the extent of the hazard from this compound at this facility. However, NIOSH also recommends reducing exposures to this compound to the lowest feasible concentration.

RECOMMENDATIONS

1. Work practices and engineering controls should be used to reduce, to the extent feasible, worker exposures to TDI, A-99, and methylene chloride. Product substitution for methylene chloride should be investigated.

2. The control measures should focus on the areas and jobs mentioned in the previous sections. These areas and jobs are: the cutter-saw stations, where local exhaust ventilation is recommended; the curing area (Plant 4), the rack-control/shuttle-control and rack areas (Plant 2), and the compounding area (Plant 4), where additional dilution ventilation is recommended instead of local exhaust ventilation because sources of airborne contaminants in these areas are not localized; the band saw station (Plant 4), where local exhaust ventilation is recommended; and, the foam line from the tunnel to the end in Plant 4, due to amine exposures when pouring the large pore-diameter foams, where local exhaust ventilation is recommended.

REFERENCES

1. Eller, P.M. (ed.). NIOSH Manual of Analytical Methods, Third Edition, with Supplements. DHHS(NIOSH) Publication No. 84-100, National Institute for Occupational Safety and Health, Cincinnati, Ohio, (February) 1984 through (May 15) 1989.

TABLE I

Summary of Long-term Sampling and Analytical Methods
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Contaminant	NIOSH Method Number [1]	Collection Medium	Volumetric Air Flow Rate (L/min) Used	Desorbing Solvent or Solution	Type of Analysis Used
Isocyanates, monomers and oligomers	5521*	Impinger - 1-(2-methoxyphenyl)-piperazine in toluene	1.0	Methanol (after acetylation of excess reagent and evaporation of toluene)	High-performance liquid chromatograhy (HPLC) with electrochemical and ultraviolet (UV) detection
Toluene Diisocyanate (TDI), 2,4- and 2,6-	2535*	Sorbent tube - N-([4-nitrophenyl]methyl)propylamine on glass wool	0.5	Methanol	HPLC with UV detection
Amines	**	Impinger - aqueous 0.1N sulfuric acid solution	0.8		Reaction with potassium hydroxide (KOH), gas chromatograhy (GC) with a nitrogen-phosphorus detector (NPD)
Amines	**	Sorbent tube - Thermosorb™ A	0.1	Methanol	Reaction with KOH, GC with a NPD
Methylene chloride	1005*	Sorbent tubes (two) in series - charcoal	0.02	Carbon disulfide (CS_2)	GC with flame-ionization detection (FID)
Diisodecyl phthalate and other phthalates	5020*	Filter - glass-fiber, followed by sorbent tube - Florisil®	0.2	CS_2	GC with FID

* With modifications.
** Not a NIOSH-evaluated method.

TABLE II

Results of Area Air Sampling in Plant 2 for Toluene Diisocyanate and Other Isocyanates[#]
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Plant 2 Area	Date 1988	Sample Number[#]	Time (military) Start	Time (military) Stop	Air Volume (Std. L)	Toluene Diisocyanate (TDI)[#] Concentration (ppm) (2,4-TDI)	(2,6-TDI)	Total[#]
Pour Head Station	15 March	TDI-5[#]	9 16	13 31	133	0.001**	0.001**	0.002**
		ICY-4[#]	9 16	13 31	255	0.00029	0.00055	0.00084
	16 March	ICY-11	8 52	14 31	356	0.00043	0.00055	0.00098
	17 March	TDI-40	9 04	12 54	110	0.001**	0.0019	0.003**
		ICY-17	9 04	12 54	228	0.00080	0.0020	0.0028
	18 March	ICY-24	8 24	13 27	291	0.00030	0.00023**	0.00053**
Cutter Saw Station	15 March	TDI-3	9 14	13 30	133	0.0051	0.015	0.020
		ICY-3	9 14	13 30	256	0.0043	0.0099	0.0142
	16 March	TDI-25	8 47	14 29	171	0.0017	0.0067	0.0084
		ICY-10	8 47	14 28	327	0.0032$	0.0077$	0.0109$
	17 March	TDI-42	9 00	12 58	114	0.014	0.033	0.047
		ICY-16	9 00	12 58	214	0.0075	0.017	0.024
Rack Traffic Control Station	15 March	TDI-1	9 13	13 29	133	<0.0003*	0.0049	0.0049
		ICY-2	9 13	13 29	256	0.00023**	0.0021	0.0023**
	16 March	TDI-24	8 44	14 26	174	<0.0002	0.0021	0.0021
		ICY-9	8 44	14 26	328	0.00016**$	0.0015$	0.0017**$
	18 March	ICY-23	8 33	13 32	302	0.00060	0.0022	0.0028
At North Rack	15 March	TDI-4	9 12	13 28	133	<0.0003	0.0004**	0.0004**
		ICY-1	9 12	13 28	256	<0.000088	0.00041	0.00041
	17 March	TDI-41	8 58	13 02	120	<0.0004	<0.0004	<0.0008
		ICY-15	8 58	13 02	239	0.00018**	0.00076	0.00094**
	18 March	ICY-22	8 35	13 24	289	0.00018**	0.00034**	0.00052**
At TDI Pump	15 March	TDI-2	9 17	13 32	133	0.001**	0.0011	0.002**
		ICY-5	9 17	13 32	255	0.00061	0.0010	0.0016

\# Samples in "TDI-X" numbered series collected and analyzed with modified NIOSH Method 2535. Samples in "ICY-X" numbered series collected and analyzed with modified NIOSH Method 5521; the latter were also analyzed for isocyanate-bearing oligomers formed from 2,4- and 2,6-TDI, but none were detected.

* "Less than" symbol (<) indicates that result is below the analytical Limit of Detection (LOD).

** Result is below the analytical Limit of Quantitation (LOQ); for "totals," at least one value used is below the LOQ.

$ Impinger-solution volume evaporated to less than 5 mL during sampling.

TABLE III

Results of Area Air Sampling in Plant 4 for Toluene Diisocyanate and Other Isocyanates[#]
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Plant 4 Area	Date 1988	Sample Number[#]	Time (military) Start	Time (military) Stop	Air Volume (Std. L)	Toluene Diisocyanate (TDI)[#] Concentration (ppm) (2,4-TDI)	(2,6-TDI)	Total[#]
At Pour Head	16 March	TDI-26[#]	8 31	13 12	141	0.001**	0.0018	0.003**
		ICY-8[#]	8 31	13 12	275	0.00061[$]	0.0021[$]	0.0027[$]
	17 March	TDI-44	9 54	11 32	45	<0.001*	0.002**	0.002**
		ICY-21	8 33	11 32	166	0.00055	0.0019	0.0024
	18 March	TDI-46	8 59	12 51	116	0.0004**	0.001**	0.001**
		ICY-29	8 59	12 51	227	0.00062	0.0020	0.0026
Cut-Off Saw Station	16 March	TDI-27	8 35	14 20	176	<0.0002	0.0050	0.0050
		ICY-7	8 35	14 20	324	0.00022[$]	0.0041[$]	0.0043[$]
	17 March	TDI-37	8 41	11 23	78	<0.001	0.0018	0.0018
		ICY-19	8 41	11 23	156	0.00048	0.0022	0.0027
	18 March	TDI-45	8 54	12 56	121	0.001**	0.0017	0.003**
		ICY-28	8 54	12 56	237	0.00041	0.00077	0.00118
Rack-Control (Main) Station	16 March	ICY-6	8 37	14 15	318	0.00014**[$]	0.0012[$]	0.0013**[$]
Shuttle Control Station	18 March	TDI-54	8 52	13 06	127	<0.0003	0.0004**	0.0004**
		ICY-25	8 52	13 06	241	0.00058	0.0017	0.0023
Sprayer Station	17 March	TDI-38	8 39	11 27	79	<0.001	0.0027	0.0027
		ICY-20	8 39	11 27	160	0.00055	0.0024	0.0029
Band Saw Station (Testing)	18 March	ICY-26	8 51	13 02	246	0.00063	0.0016	0.0022
Short Block Cure & Store	17 March	TDI-39	8 44	11 57	95	<0.0004	<0.0004	<0.0008
		ICY-18	8 44	11 57	156	<0.00014	<0.00022	<0.00036
Curing Area	18 March	ICY-27	8 56	12 40	222	0.0040	0.0076	0.0116

Samples in "TDI-X" numbered series collected and analyzed with modified NIOSH Method 2535. Samples in "ICY-X" numbered series collected and analyzed with modified NIOSH Method 5521; the latter were also analyzed for isocyanate-bearing oligomers formed from 2,4- and 2,6-TDI, but none were detected.

* "Less than" symbol (<) indicates that result is below the analytical Limit of Detection (LOD).

** Result is below the analytical Limit of Quantitation (LOQ); for "totals," one or both values are below the LOQ.

$ Impinger-solution volume evaporated to less than 5 mL during sampling.

TABLE IV

Results of Personal Breathing-Zone Air Sampling in Plant 2 for Toluene Diisocyanate (TDI)
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Date 1988	Sample Number	Plant 2 Job (Area)	Time (military) Start	Time (military) Stop	Air Volume (Std. L)	Toluene Diisocyanate (TDI) Concentration (ppm) (2,4-TDI)	(2,6-TDI)	Total
15 March	TDI-10	Compounder	9 28	13 07	114	<0.0004*	0.0005**	0.0005**
15 March	TDI-11	Foam Machine Operator "A"	9 23	12 32	98	0.001**	0.001**	0.002**
16 March	TDI-22	Foam Machine Operator "A"	10 14	13 28	101	0.001**	0.0017	0.003**
15 March	TDI-12	Foam Machine Operator "B"	9 26	13 10	116	0.001**	0.001**	0.002**
15 March	TDI-8	Cut-Off Saw Operator	9 33	11 56	74	0.001**	0.0066	0.008**
16 March	TDI-20	Cut-Off Saw Operator	10 09	13 24	98	0.0022++	0.0061++	0.0083++
15 March	TDI-9	Utility Man (Rack Control Station)	9 37	13 14	113	<0.0004	0.0050	0.0050
15 March	TDI-7	Materials Expediter "A"	9 41	12 50	98	<0.0004+	0.0040+	0.0040+
16 March	TDI-19	Materials Expediter "A"	10 05	13 30	103	<0.0004+@	0.0047+@	0.0047+@
16 March	TDI-21	General Helper	10 27	13 39	100	0.001**	0.0032	0.004**
15 March	TDI-6	Foreman "A"	9 46	13 10	106	<0.0004+	0.0052+	0.0052+
16 March	TDI-23	Foreman "A"	10 01	13 27	105	<0.0004+	0.0025+	0.0025+
17 March	TDI-43	Foreman, Pour Head	9 12	12 44	95	0.001**@@	0.0024@@	0.003**@@

* "Less than" symbol (<) indicates that result is below the analytical Limit of Detection (LOD).
** Result is below the analytical Limit of Quantitation (LOQ); for "totals," one or both values are below the LOQ.
\+ Worker had, and sometimes used, a respirator.
++ Management representative accused worker of tampering (by placing a hot piece of foam near the sampler's air inlet).
@ Sample cassette covered with foam dust at end of sampling period.
@@ Worker must lean inside curing tunnel once or twice during the running of each grade of foam, but always wears an organic vapor respirator when doing this.

TABLE V

Results of Personal Breathing-Zone Air Sampling in Plant 4 for Toluene Diisocyanate (TDI)
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Date 1988	Sample Number	Plant 4 Job	Time (military) Start	Time (military) Stop	Air Volume (Std. L)	Toluene Diisocyanate (TDI) Concentration (ppm) (2,4-TDI)	(2,6-TDI)	Total
16 March	TDI-18	Compounder	9 25	14 03	139	0.001**	0.015	0.016**
18 March	TDI-47	Compounder##	11 29	12 53	40	<0.001*	0.002**	0.002**
16 March	TDI-17	Foam Machine Operator	9 27	14 07	140	0.001**	0.0004**	0.001**
18 March	TDI-57	Foam Machine Operator	9 47	13 45	117	<0.0004	0.001**	0.001**
16 March	TDI-16	Foam Machine Assistant	9 30	14 33	155	<0.0003	0.001**	0.001**
16 March	TDI-14	Foreman	9 35	14 39	149	0.0004**	0.0080	0.0084**
18 March	TDI-50	Foreman	11 18	13 33	68	0.001**	0.0023	0.003**
18 March	TDI-52	Production Manager	9 16	12 23	94	0.001**	0.0054	0.006**
16 March	TDI-15	Band Saw Operator	9 39	14 16	139	0.001**	0.012	0.013**
18 March	TDI-56	Band Saw Operator	9 07	13 50	142	0.001**	0.0019	0.003**
16 March	TDI-13	Cut-Off Saw Operator	9 44	14 35	143	<0.0003	0.0058	0.0058
18 March	TDI-53	Cut-Off Saw Operator	9 10	13 56	146	0.001**	0.0019	0.003**
16 March	TDI-35	Shuttle Control Operator	9 46	14 13	136	<0.0003	0.0012	0.0012
18 March	TDI-55	Materials Expediter "A"#	9 04	13 28	129	0.001**#	0.0042#	0.005**#
18 March	TDI-51	Materials Expediter "B"#	9 24	13 42	129	0.0014#	0.0028#	0.0042#
18 March	TDI-49	Materials Expediter "C"#	9 30	13 55	133	0.0016#	0.0034#	0.0050#
18 March	TDI-48	Materials Expediter "D"#	9 31	13 16	113	0.0015#	0.0031#	0.0046#

* "Less than" symbol (<) indicates that result is below the analytical Limit of Detection (LOD).
** Result is below the analytical Limit of Quantitation (LOQ); for "totals," one or both values are below the LOQ.
# Working in Plant 4 Curing Area during part of shift, and when there wears an organic vapor respirator "when it gets bad."
Working "on the line" this day.

TABLE VI

Results of Long-Term Area Air Sampling for Amines using Impingers Containing Aqueous Sulfuric Acid
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Date (1988)	Sample Number	Sample Location: Plant No.	Sample Location: Area	Sampling Time (military): Start	Sampling Time (military): Stop	Air Volume (Std. L)	Concentration (mg/m^3): DABCO	Concentration (mg/m^3): A-99	Concentration (mg/m^3): Cocomorpholine
March 15	AI-4	2	Pour Head Station	9 16	13 31	214	<0.19	<0.19	<0.09
March 15	AI-3	2	Cutter Saw Station	9 14	13 30	215	0.25**	<0.19	<0.09
March 15	AI-2	2	Rack Traffic Control Station	9 13	13 29	215	0.42**	<0.19	<0.09
March 15	AI-1	2	At North Rack	9 12	13 28	215	0.93	<0.19*	0.21**
March 15	AI-5	2	Amine Pump Room	9 17	13 32	214	<0.19#	<0.19#	<0.09#
March 17	AI-10	4	At Pour Head	8 33	11 32	150	0.73	0.29	<0.13
March 17	AI-9	4	Sprayer Station	8 39	11 27	124	0.48**	<0.32	<0.16
March 17	AI-8	4	Cut-Off Saw Station	8 41	11 23	118	0.35**	<0.34	<0.17
March 17	AI-7	4	Short Block Cure & Store	8 44	11 57	147	0.82	<0.27	0.14**
March 17	AI-6	4	Shuttle Control Station	8 48	12 00	144	0.59**	<0.21	<0.14
March 18	AI-15	4	At Pour Head	8 59	12 51	186	0.48**#	0.25**#	<0.11#
March 18	AI-14	4	Cut-Off Saw Station	8 54	12 56	194	0.43**#	1.60#	<0.10#
March 18	AI-13	4	Shuttle Control Station	8 52	13 06	198	0.56#	1.72#	<0.10#

* "Less than" symbol (<) indicates that result is below the analytical Limit of Detection (LOD).
** Result is below the analytical Limit of Quantitation (LOQ), indicating that the reported value lacks precision.
# Accuracy estimated at ±10%, due to the use of estimated impinger-solution volumes to calculate total analyte mass.

TABLE VII

Results of Long-Term Air Sampling in Plant 2 for Methylene Chloride
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
15 through 18 March 1988

Date 1988	Sample Number	Plant 2 Job and/or Area	Time (military) Start	Time (military) Stop	Air Volume, Actual (L)	Concentration (ppm)
15 March	MeCl-4	AREA/Pour Head Station	0916	1331	5.0	4
15 March	MeCl-5	AREA/Cutter Saw Station	0914	1330	5.2	21
17 March	MeCl-8	AREA/Near North and East Racks	0933	1208	2.9	34
17 March	MeCl-6	Foam Machine Operator "B"	0910	1146	3.2	4
15 March	MeCl-3	Foam Machine Assistant	0951	1234	3.3	16
15 March	MeCl-2	Materials Expediter "B"	0953	1259	3.5	14
15 March	MeCl-1	Materials Expediter "C"	0956	1223	3.1	43
17 March	MeCl-7	Materials Expediter "C"	0929	1208	3.2	55
17 March	MeCl-10	Materials Expediter "A"	0920	1210	3.4	166
17 March	MeCl-9	Utility Man (Rack Control Station)	0917	1206	3.4	40

APPENDIX A

October 28, 1986, Correspondence Describing Initial Survey Strategy
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
14 through 18 March 1988

October 28, 1986
HETA 86-420

[redacted]
General Foam Corp.
Valmont Industrial Park
West Hazelton, Pennsylvania 18201

Dear [redacted]:

As discussed by telephone on October 27, 1986, with [redacted], the plant nurse and the individual responsible for safety and health at your facility, the National Institute for Occupational Safety and Health (NIOSH) received on June 23, 1986, a valid request for a Health Hazard Evaluation (HHE) from the union representing the employees in your plant, United Steelworkers of America Local 15371. The request concerns possible hazards associated with polyurethane foams made with toluene diisocyanate (TDI) in the Foam Production Department of Plants #2 and #4. NIOSH is authorized and mandated to conduct HHEs in places of employment under Section 20(a)(6) of the Occupational Safety and Health Act (29 U. S. C. 669(a)(6)).

Dr. Frederick Richardson and I will conduct an initial survey at your facility in preparation for a complete environmental evaluation of the appropriate area and a possible medical evaluation of affected employees. We intend to make our initial visit on Wednesday and Thursday, November 5 and 6, 1986. A brief opening conference with appropriate plant personnel, including a union representative, will be needed, followed by a brief plant tour. I will then need to take a limited number of environmental measurements, inspect the Material Safety Data Sheets for the chemicals used in the plant, etc., while Dr. Richardson conducts brief medical interviews with a number of the employees to determine if a prevalence of symptoms consistent with exposure to the chemicals exists. Finally, a brief closing conference will be needed.

We realize that Pennsylvania OSHA has recently inspected your facility, and we have consulted with their inspector. We intend to do an evaluation that is supplemental to, not repetitive of, that inspection based on discussions with the OSHA inspector, our own understanding of the situation, and the wishes expressed recently by the requesting union. If you have any questions about this matter or would like more details or a discussion, please call me at (513) 841-4374. I will call you early next week to verify the times and other details. Thank you in advance for your cooperation with this HHE.

Sincerely yours,

Leo M. Blade
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

APPENDIX B

Interim Correspondence of December 2, 1986, and February 24 and June 29, 1987
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
14 through 18 March 1988

December 2, 1986
HETA 86-420

[redacted]
United Steelworkers of America
c/o General Foam Corporation
Valmont Industrial Park
West Hazleton, Pennsylvania 18201

Dear [redacted]:

This letter will provide a brief summary of activities conducted during the NIOSH health hazard evaluation (HHE) at General Foam Corporation in West Hazleton, Pennsylvania, on November 6 and 7, 1986. A similar letter has been sent to [redacted], Plant Manager, General Foam Corporation.

On June 23, 1986, NIOSH received a request (from you) to evaluate potential exposures of General Foam personnel working in the Plant #2 and #4 foam production departments to airborne toluene diisocyanate (TDI). Potential exposures to high concentrations of TDI were reportedly experienced by some of the workers due to a spill which occurred earlier this year. The material was cleaned up, but the incident heightened the concern of some of the workers about the possible effects of day-to-day exposures to TDI and other chemicals used in the process. Recent discussions with a union representative focused on the reported concerns over methylene chloride exposure levels.

Our initial environmental and medical survey was conducted at the facility on November 6 and 7, 1986. The environmental survey consisted of an inspection of plant facilities and processes, inspection of the Material Safety Data Sheets (MSDSs) for the substances used in the plant, and limited sampling of the airborne TDI concentrations in the facility. Two short-term area air samples were collected for TDI, using Drager detector tubes and pump, along the Plant #2 foam production line. None was detected (although the detection limit is 0.02 ppm). The OSHA standard is a ceiling of 0.02 ppm. Short-term limits recommended by the American Conference of Governmental Industrial Hygienists and by NIOSH are also 0.02 ppm.

The medical evaluation consisted of twenty interviews that were unstructured and approximately fifteen minutes in duration per person. Personnel interviewed included: 12 operators from production line #2, 1 crane operator that works in close proximity to line #2, 1 person that has both line #2 and fork lift responsibilities, and 6 operators from production line #4.

The following is a list of symptoms reported among these employees (with the number reporting each):

1) shortness of breath, wheezing, cough (with or without sputum production) persisting post-shift but dissipating prior to the next day's shift (9 persons);
2) post-shift fatigue in excess of that perceived by employees to be normal, with similar fatigue not precipitated by daily exertion at sites away from the workplace (5 persons);
3) sinus congestion that persists post-shift but dissipates prior to the next day's shift (5 persons);
4) decreased visual capability that persists for a short time post-shift but dissipates prior to the next day's shift ("filter foam" production, 5 persons);
5) oral membrane irritation (4 persons);
6) eye irritation (3 persons);
7) intranasal irritation (3 persons);
8) sore throat (3 persons);
9) no symptoms (3 persons);
10) dizziness (2 persons);
11) reddening of the face that persists post-shift but dissipates prior to the next day's shift (1 person);
12) frequent headaches (1 person);
13) decreased sensation in and around the lips with intermittent skin loss from the same surfaces (1 person).

The NIOSH medical officer was informed that annual pulmonary function tests are performed on all personnel. Approximately 37% of the pulmonary function test data collected by the plant medical staff since 1977 were not found, suggesting that some of the testing was not completed and/or not recorded. Data reviewed by the medical officer were not adequate for the generation of "predicted" values, which would be useful for the analysis of future data.

These facts, in conjunction with the finding of persons reporting pulmonary and/or ocular symptoms, indicate that further medical evaluation needs to be performed. Further evaluation will include the administration of a short questionnaire to all production workers in Plants #2 and #4; and, physical examination (including visual acuity) and pulmonary function testing on selected symptomatic and non-symptomatic individuals, as identified by the questionnaire.

The above medical follow-up will be conducted in conjunction with a complete environmental survey to provide data on exposure levels during the time of the medical testing as well as to fulfill the original request for an environmental analysis.

Although, as discussed by telephone on November 26, 1986, we were considering December 15 through 19, 1986, for the follow-up visit, we will be unable to proceed at that time. A need for additional evaluation of the sampling and analytical methods to be used for the amine catalysts and the total reactive isocyanate groups has been identified by NIOSH laboratory researchers, who will conduct the necessary studies prior to the follow-up visit. This will result in a delay of the follow-up visit until approximately February 1, 1987. If you have any questions or would like further information in the interim, please contact Mr. Blade at (513) 841-4374, or Dr. Richardson at (513) 841-4386.

Sincerely yours,

Leo M. Blade
Industrial Hygienist
Industrial Hygiene Section

Fred D. Richardson, M.D., M.S.P.H.
Medical Officer
Medical Section
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations, and Field Studies

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
National Institute for
Occupational Safety & Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

June 29, 1987
HETA 86-420

[redacted]
General Foam Corporation
Valmont Industrial Park
West Hazleton, Pennsylvania 18201

Dear [redacted]:

This letter will serve as a second interim status report on the NIOSH health hazard evaluation (HHE) at your facility. A similar letter has been sent to [redacted], President, Local Union #15371, United Steelworkers of America.

In my letter dated February 24, 1987, I indicated that additional evaluation of the sampling and analytical methods to be used for the amine catalysts had been undertaken by NIOSH laboratory researchers, and that the results of this evaluation were needed prior to the follow-up visit. I stated that this would result in a further delay of the follow-up visit until May 1987, if no unexpected problems were encountered. However, the results of that evaluation were unsatisfactory, necessitating additional study. The study approach has been revised by the laboratory researchers, and the results of the first phase of the revised study look promising. This phase involves the determination of the recoveries of known amounts of amines in liquid solutions directly injected onto the sampling media. The second phase of the study, using the sampling media to sample controlled test atmospheres containing airborne amines, will be conducted during July. Additionally, work on the first phase to address some remaining problems with recoveries will also be conducted during the remainder of June, and during July. The laboratory researchers believe that the final results of the evaluation will become available during August.

I will inform you when I receive the final results of the current evaluation; if it is successful, we can discuss a date for the follow-up visit at that time. If you have any questions or would like further information in the interim, please contact me at (513) 841-4374, or Dr. Richardson at (513) 841-4386.

Sincerely yours,

Leo M. Blade
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
National Institute for
Occupational Safety & Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

February 24, 1987
HETA 86-420

[redacted]
Plant Manager
General Foam Corporation
Valmont Industrial Park
West Hazleton, Pennsylvania 18201

Dear [redacted]:

This letter will serve as a brief interim status report on the NIOSH health hazard evaluation (HHE) at your facility. A similar letter has been sent to [redacted], President, Local Union #15371, United Steelworkers of America.

In my letter dated December 2, 1986, I indicated that a need for additional evaluation of the sampling and analytical methods to be used for the amine catalysts had been identified by NIOSH laboratory researchers, who agreed to conduct the necessary studies prior to the follow-up visit. This resulted in a delay of the follow-up visit. The researchers have developed an extensive study plan for the laboratory evaluation of three sampling media for the six amine compounds identified as being utilized at your facility, under various conditions and incorporating chromatographic analytical methods.

The study plan includes a schedule calling for commencement on approximately February 2, 1987, and completion on approximately April 3, 1987. This will result in a further delay of the follow-up visit until approximately May 1, 1987, if no unexpected problems are encountered. However, because of inconsistent results which have been obtained in the past when measuring amine levels in industrial situations, the laboratory researchers believe that such an extensive study is needed at this time to allow an accurate assessment of the conditions at your facility.

If you have any questions or would like further information in the interim, please contact me at (513) 841-4374, or Dr. Richardson at (513) 841-4386.

Sincerely yours,

Leo M. Blade
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

APPENDIX C

Follow-up Survey Response Letter of April 20, 1988,
and Status Letter of August 17, 1988
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
14 through 18 March 1988

April 20, 1988
HETA 86-420

[redacted]
Plant Manager
General Foam Corporation
Valmont Industrial Park
West Hazleton, Pennsylvania 18201

Dear [redacted]:

This letter will provide a brief summary of activities conducted during the NIOSH health hazard evaluation (HHE) follow-up visit at your facility on March 14 through 18, 1988. A similar letter has been sent to [redacted], President, Local Union #15371, United Steelworkers of America.

On June 23, 1986, NIOSH received a request from the union representing your employees (Local Union #15371, United Steelworkers of America) to evaluate potential exposures among General Foam personnel working in the Plant #2 and #4 foam production departments to airborne toluene diisocyanate (TDI). Some of the workers were reportedly concerned about the possible effects of day-to-day exposures to TDI and other chemicals used in the process, including methylene chloride.

Our initial environmental and medical survey was conducted at the facility on November 6 and 7, 1986. This survey was summarized in my letter to you dated December 2, 1986. As noted in that correspondence, a further medical evaluation was needed in conjunction with a complete environmental survey. A need for additional evaluation of the sampling and analytical methods to be used to measure some of the chemicals in the work environment (the amine catalysts and the total reactive isocyanate groups) was subsequently identified by NIOSH laboratory researchers, who then conducted the necessary studies during 1987. This resulted in a delay of the follow-up visit, as explained in my letters to you dated February 24 and June 29, 1987.

Our follow-up environmental and medical survey was conducted at your facility on March 14 through 18, 1988. The environmental survey consisted of a plant tour on March 14 to re-familiarize the NIOSH investigators with the facility, and comprehensive air sampling for selected chemical contaminants in the work environment on March 15 through 18. The sampling strategy was designed to characterize the work environment in general, and employee exposure levels to the extent feasible. A particular emphasis was placed on characterizing exposures to those substances believed to affect the physiological parameters measured by the medical study described below, to facilitate the correlation of the medical findings with the environmental exposures.

The air sampling was performed using portable air-sampling pumps connected to one of various types of collection media, each appropriate for a specific group of chemicals. Both personal breathing-zone and general area samples were collected; all were long-term in duration, running for two hours or

more. The samples included 49 (30 personal, 19 area) for toluene diisocyanate vapor (both the 2,4 and 2,6 isomers), 26 (all area) for all isocyanates present, 13 (all area) for all amines present, 57 (29 personal, 28 area) for the amines known as A-99 and DABCO, 10 (7 personal, 3 area) for methylene chloride, and 6 (all area) for phthalate plasticizers. All samples were submitted to the NIOSH analytical laboratories or contract analytical laboratory on March 25 and March 22, respectively. Analytical results should be available in 4 to 6 weeks.

Medical evaluations were performed as per the protocol distributed to management and union representatives. Respiratory evaluation included pre- and post-shift spirometry (single trial), a post-shift auscultation of the lungs, self-testing of peak expiratory flow rates for a one-week period, and completion of a questionnaire concerning work history and historical respiratory problems. Twenty-one persons, from both Plant 2 and Plant 4 Foam Production, participated in pulmonary testing (seven that reported work-related respiratory problems in the initial survey, and fourteen randomly selected from the remainder of the foam production personnel).

All 27 persons available from Plants 2 and 4 participated in pre- and post-shift visual acuity testing. All Plant 4 participants performed post-shift tests on Friday only. Each visual acuity test participant completed a questionnaire about history of work-related visual problems.

Each participant will receive a report of his medical evaluation. The company and union will receive a composite medical evaluation in our final report.

No preliminary results from the environmental or medical studies are available at this time. One observation made in the plant should be noted, however. At the Plant 4 foam line cut-off saw, which is on a second-level platform, relatively short blocks of foam are cut and then thrown off the platform to the floor so that the band-saw operator can use them for testing. This practice constitutes a safety hazard, since the area below the platform carries pedestrian traffic. Therefore, the means of moving the blocks down to the floor should be changed, or the target area roped off.

If you have any questions or would like further information, please contact Mr. Blade at (513) 841-4374, or Dr. Richardson at (513) 841-4386.

Sincerely yours,

Leo M. Blade
Industrial Hygienist
Industrial Hygiene Section

Fred Richardson, M.D.
Medical Officer
Medical Section
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard

August 17, 1988
HETA 86-420

Staff Representative, District No. 9
United Steelworkers of America
1306 Northeastern Bank Building
67 Public Square
Wilkes-Barre, Pennsylvania 18701

Dear Mr. :

This letter is in response to your correspondence of July 25, 1988, regarding the status of the NIOSH health hazard evaluation (HHE) at General Foam Corporation in West Hazleton, Pennsylvania, where a follow-up environmental and medical survey was conducted on March 14 through 18, 1988. The April 20, 1988, correspondence from Dr. Fred Richardson and me to President, Local Union #15371, United Steelworkers of America, and to Plant Manager, General Foam Corporation, indicated that all air samples were submitted to the NIOSH analytical laboratories or contract analytical laboratory on March 25 and March 22, 1988, respectively. It also indicated that analytical results of these samples should be available 4 to 6 weeks later. Please understand that this was an estimated time to our receipt of those results, and additional work (calculations, tabulation, and interpretation) is always necessary upon receipt of such results before a report can be produced and sent. In any case, all results were not received until July 1, 1988.

Unanticipated difficulties were encountered by one of the NIOSH analytical laboratories when the analyses were attempted on the 57 samples (29 personal breathing-zone, 28 general area) for the amines known as A-99 and DABCO. Due to these problems, the laboratory, in its analytical report, did not quantify results for any of these 57 samples. Further discussion is planned with analytical laboratory personnel to determine if portions of these data are usable, and the best available results of all sampling conducted will then be reported.

Dr. Richardson, the medical officer for this HHE, has left NIOSH. This has resulted in a delay in the analysis of the medical survey data. Participants will soon be informed of their individual test results, and the medical survey findings will be reported to the company and union.

If you have any questions or would like further information, please contact me at (513) 841-4374.

Sincerely yours,

Leo M. Blade
Industrial Hygiene Engineer
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies

cc:
P. Kanjorski, M.C.
C. Fulmer, USWA Local 15371
M. Piskorick, USWA Local 15371
D. Lichard, General Foam Corp.

APPENDIX D

Interim Report No. 1 of September 1988
General Foam Corporation
West Hazleton, Pennsylvania
HETA 86-420
14 through 18 March 1988

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

INTERIM REPORT NO. 1
HETA 86-420

GENERAL FOAM CORPORATION
HAZLETON, PENNSYLVANIA

SEPTEMBER 1988

I. INTRODUCTION

On June 23, 1986, NIOSH received a request from the United Steelworkers of America to evaluate the potential for exposure to airborne toluene diisocyanate (TDI) of General Foam Corporation (GFC) personnel working in plant lines #2 and #4 foam production. The products in lines #2 and #4 are based upon the same primary chemical constituents. Production of less dense (air volume per cubic inch of product) products in line #4 had specifically been reported to be associated with visual disturbances. Our initial environmental and medical survey was conducted at the facility on November 6 and 7, 1986. During the survey, aerosolized amines were also found to be a potential source of exposure.

The initial medical evaluation consisted of interviews of 20 randomly selected persons: 18 of the approximately 30 persons employed in foam production on lines #2 and #4, and two persons performing jobs near the #2 line. Employees reported experiencing mild bronchospasm, respiratory, and other mucous membrane irritation and visual acuity changes (#4 personnel only).

This report presents the medical/epidemiological analysis of data collected during our follow-up visit. The final report is pending completion of analysis of industrial hygiene data.

II. EVALUATION DESIGN AND METHODS

A. Asthma

A screening questionnaire was administered to all persons exposed to the #2 and #4 line foam production processes to identify persons who might have occupational asthma. All persons responding affirmatively to one or more of the following questions were considered possible cases.

1. Within the past month have you experienced any wheezing that you believe to be associated with work?

2. Within the past month have you experienced any shortness of breath or difficulty breathing that you believe to be associated with work?

3. Within the past month have you experienced any pain or tightness in your chest that you believe to be associated with work?

The study sample size was predetermined to be twice the number of potential cases (equal number of cases and controls) if there were at least 10 potential cases. If the number of potential cases was fewer than 10, additional asymptomatic persons (persons responding "no" to all of the above questions, controls) were asked to participate to bring the size of the study sample to 20.

Clinical evaluation of participants consisted of lung function tests (spirometry and peak expiratory flow rates (PEFRs)). The person performing the spirometry was unaware of the case status of the examinee and was instructed not to solicit such information.

To identify airway obstruction we asked all participants to perform pulmonary function tests to assess forced vital capacity (FVC) and one-second forced expiratory volume (FEV_1), using an Ohio Medical Model 822 dry rolling sealed spirometer, attached to a Spirotech 220B dedicated computer. All spirometry for an individual was performed on the same day, both pre-shift and post-shift. We considered as indicative of work-related asthma a decrease of 10 percent or greater in FEV1 from pre-shift to post-shift .[1,2,3]

To identify non-immediate type pulmonary obstruction we obtained serial determination of PEFR using the Wrights' portable mini-peak flow meters. Each participant was instructed to self-test every 3 hours while awake for 1 week, and during the night if awakened for any reason. Three exhalations were recorded during each test, and the average of the three efforts was the PEFR determination for that test. Any wheezing, shortness of breath, chest tightness, or cough experienced concurrently with each PEFR determination was also supposed to be recorded by the participant. We considered the participant to have significant pulmonary function variability as measured by PEFRs if the value of PEFR variability (1.0 - (daily minimum PEFR/daily maximum PEFR)) was greater than or equal to 0.20 for any of the days recordings.[2,4]

We considered a temporal relationship between exposure of participants to the workplace and a decline in pulmonary function to be of importance in development of an epidemiologic case

definition of "probable asthma." On the basis of the data collected we classified participants as "probable cases" of work-related asthma on the basis of meeting all of the following criteria:

1. Persons with any pulmonary function test (spirometry or PEFR) change consistent with those described above as abnormal.

2. Responding affirmatively to one or more of the above listed pulmonary screening questions when re-questioned in the full pulmonary history questionnaire.

3. Reporting a history of precipitation of symptoms by work-related activities and/or substances.

4. Reporting a decrease of symptoms when away from work.

5. Reporting no previous history of asthma or other lung disease.

We recognized that this leads to a relatively specific case definition in that it does not include individuals who may experience symptoms, yet not associate these symptoms with work. However, based on interviews with workers during our initial visit, lack of ability to associate symptoms and precipitating agents and/or settings did not seem to be a problem among the employees.

In addition, we reviewed 14 medical files of present and previous employees of GFC that were provided by a physician from the local area.

B. Eye Effects

We administered a visual symptom questionnaire to all persons available on line #2 and #4 foam production processes. To evaluate visual acuity changes associated with corneal exposure to aerosolized chemicals, we performed pre-shift and post-shift visual acuity examinations using a Bausch & Lomb Ortho-Rater. Measures of far and near visual acuity of the right, left, and both eyes are provided on a scale of 1 to 12, with 1 representing worst and 12 representing best performance. Vision is judged as "adequate," "borderline," or "inadequate" for most industrial and clerical jobs. The comparison score ranges for these categories are provided in the Appendix. Since some variation in performance is expected, we considered only a decrease in score of at least 2 over the course of the day to be significant.

III. EVALUATION CRITERIA

A. Asthma

Asthma is a common condition, yet it is frequently unrecognized. While it may not be difficult to recognize physical signs in a

person in respiratory distress, there is no universal definition that describes a singular set of signs, symptoms, and/or illness history that allows for appropriate labeling of a person as asthmatic. Characteristic features of asthma are reversibility of airflow obstruction, and either bronchoconstriction in response to specific stimuli or bronchodilation in response to specific treatment.[4] Occupational asthma may be considered to be reversible airway disease occurring in response to exposure to agents in the work environment.

Among the methods by which clinical identification of obstructive disease may be accomplished are spirometry and serial determination of PEFR. Changes in pulmonary function test and PEFR that return to pre-exposure (pre-shift) values, as measured by these instruments, have been seen in other studies.[2,4-10]

An asthmatic response to a precipitating stimulus may be immediate or delayed. Immediate response is one in which a measurable change in pulmonary function status occurs over the work-shift if exposure to the precipitating agent has occurred at the workplace. An immediate type of response should be detectable by both methods of pulmonary function testing employed in this study, unless there has been recovery of pulmonary function by the time of the post-shift test. A person with a "delayed" pattern of response may not show a change in pulmonary status as detectable by pre/post-shift spirometry, but will experience pulmonary effects sometime later while away from work.[2,7,11,12] For these persons, we could expect no significant decrease in cross-shift spirometry values but could anticipate a notable change in PEFRs recorded away from work.

There is evidence of diurnal changes in pulmonary function test performance in persons without lung disease.[2,4,5,7,12,14] However, the peak respiratory performance capability should not vary by greater than 10 percent on any day.

TDI and MDI as respiratory sensitizers have been documented in numerous sources. Likewise, there are numerous reports that provide evidence that chemical-specific antibody development can be a component of the sensitization response in some cases.[15-17] However, the sensitivities of these antibody tests are too low to be used as screening tools in this type of setting.[10,15,18-20]

B. Visual

Amines are alkaline compounds. The effect of alkaline agents on the cornea is immediate irritation or burning. The pH of the agent and exposure dose determine the potential extent of damage. Even injuries that initially appear mild may progress to opacification, vascularization, ulceration, or perforation of the cornea.[21] Fat solubility of amines favors their absorption by the cornea. Even small amounts may precipitate local protein denaturation causing

corneal epithelial edema and visual hazing due to light scattering (diffraction) referred to as the Tyndall effect.[22] Foggy vision, hazy vision, and halo phenomenon have been reported among workers exposed to aerosolized amines.[23-25] Halo vision refers to hazy or blurry vision that may progress to the perception of halos (primarily blue) around light. It occurs 15 minutes to 1 hour after exposure to tertiary amines. This disturbance usually lasts for 1 to 4 hours after cessation of exposure. Vision can be so impaired that working around machinery or driving vehicles may be hazardous.[25]

Under experimental conditions, exposure to tertiary amines has produced corneal edema documented by pachymetry (ophthalmologic measurement of corneal thickness), which rapidly subsided.[26] The corneal response to low vapor concentrations of amines are rapidly reversible. Post-exposure detection of corneal opacity due to recurrent exposure at low levels may not be possible if the time between cessation of exposure and examination is at all prolonged. Decreased visual acuity is the most readily measured effect of corneal edema.

IV. RESULTS

A. Respiratory

All 27 employees on the #2 and #4 foam production lines completed the screening questionnaire. Of these persons, seven responded affirmatively to one or more questions regarding a history of respiratory symptoms at work. These seven persons, and an additional 14 randomly selected persons without symptoms, participated in performance of the medical study.

Two persons met the case definition of "probable" work-related asthma, both of whom had also been identified by the screening questionnaire.

Table 1 presents the results of the screening and follow-up questionnaire, as well as pulmonary function tests (cross-shift FEV_1) and PEFR (maximum percent variability during the week). Although only two individuals were identified both by questionnaire and lung function studies, 12 of 21 (57%) complained of symptoms consistent with work-related asthma.

To investigate a possible cumulative affect of exposure over the course of the week, the presence of a linear trend in PEFR variability was assessed (i.e., increasing variability from the beginning of the week (before exposure) to the end of the week (after several days of potential exposure). No such trend was noted in any individual.

There was no significant association between the presence of symptoms and work on line #2 or #4, or the duration of time employed in one's current job, although the persons with symptoms had worked longer than those without symptoms (Table 2).

We were able to review medical files of 14 GFC employees who had received medical evaluation for respiratory complaints by a non-GFC affiliated physician. Only two of the individuals are currently employed in GFC line #2 and #4 foam production processes. Evidence of some obstructive disease was provided in the objective tests performed upon one of these two individuals.

B. Visual

Pre- and post-shift visual acuity tests were performed and a visual symptom/work history questionnaire was completed by 26 line #2 and #4 foam production personnel. All post-shift visual acuity tests for line #4 personnel were performed immediately after the completion of the foam pour on Friday, the day on which visual problems in line #4 personnel were reported to be greatest.

Visual symptoms reported by participants are listed in Table 3. Eighteen of 26 (69%) workers on both lines complained of halo vision resulting in the appearance of colored rings around lights. The colors observed are reported in Table 4. As has been previously reported,[25] the most common color reported was blue (31%). There are no statistically significant associations between the occurrence of these symptoms and working on either line #2 or line #4. For each visual symptom, except difficulty working due to impaired vision, persons with the symptom had worked longer on the curing lines than those without symptoms, though the difference was statistically significant only for watery eyes (p=.03, Mann-Whitney sign rank test).

Results of the visual acuity test revealed six individuals who had at least one pre- to post-shift difference of 2 or more in either far or near acuity. These persons were considered to have had positive test results. There was no statistically significant association between the occurrence of visual symptoms and vision test results, though more than twice as many persons with blurry vision also had positive vision tests as those without symptoms (Relative Risk = 2.7, 95% Confidence Interval = 0.6 - 12.3). The reasons for this lack of association may include the fact that the reporting of symptoms does not necessarily mean that the individual experienced the symptoms on the day of testing. In addition, there were no associations between visual acuity results and either the line on which people worked or the length of time they had worked there.

As with the results of the respiratory evaluation, further analysis of the visual data may be performed after completion of the industrial hygiene analysis.

V. DISCUSSION

Industrial hygiene review of chemicals used in foam production found the inventory replete with agents that may precipitate pulmonary irritation. However, among all constituents used in the process, only TDI has been associated with asthma.

Two participants (7 percent of the 27 persons working on either line #2 or #4) in our respiratory evaluation met our case definition of probable work-related asthma. This compares to a prevalence of asthma in the general population of one to four percent.[27] These persons warrant receiving additional diagnostic evaluation (chemical specific challenge test, bronchodilator symptom reversal, immunotoxicologic testing).

The visual acuity data suggested that personnel on both lines #2 and #4 are experiencing work-related vision changes. The problems have reportedly been qualitatively more significant in line #4 persons, on Fridays, when large pore-diameter foam is produced. Though for all but one symptom, a higher percentage of workers on line #4 reported eye symptoms, these differences were not statistically significant.

All participants in the medical evaluation have been individually notified of their own test results. The final report will be issued after completion of the industrial hygiene results.

IV. REFERENCES

1. Merchant JA (et al, eds): Occupational Respiratory Diseases, p161-166, DHHS Publication No 86-102, 1986.

2. Burge SP: Single and serial measurements of lung function in the diagnosis of occupational asthma. Eur J Resp Dis 63 (Supp 123): 47-59, 1982.

3. Miller A, Thornton JC (et al): Spirometric abnormality in a normal male reference population: further analysis of the 1971 Oregon Survey. Amer J Ind Med 1: 55-68, 1980.

4. Rees J: ABC of asthma (definition and diagnosis). Br Med J 288: 1370-1372, 1984.

5. Connolly CK: Diurnal rhythms in airway obstruction. Br J Dis Chest 73: 357-366, 1979.

6. Dimich HD, Sterling TD: Ventilatory function changes over a work-shift. Br J Ind Med: 38, 152-155, 1981.

7. Burge SP: Could you be overlooking occupational asthma? J Resp Dis 97-112, 1982.

8. Weill H: Small plants and their medical problems - the furniture industry: respiratory health effects of isocyanates, DHHS Publication No 80-139, 53-55, 1980.

9. Baur X, Dewair M, Rommelt H: Acute airway obstruction followed by hypersensitivity pneumonitis in isocyanate (MDI) workers. J Occup Med 26: 285-287, 1984.

10. Zammit TM, Sherkim M (et al): Asthma caused by diphenylmethane diisocyanate in foundry workers (clinical, bronchial provocation, and immunologic studies). Am Rev Resp Dis 128: 226-230, 1983.

11. Axford AT (et al): Accidental exposure to isocyanate fumes in a group of firemen. Br J Ind Med 33: 65-71, 1976.

12. Burge SP, O'Brien IM, Harries MG: Peak flow rate records in the diagnosis of occupational asthma due to isocyanates. Thorax 34: 317-323, 1979.

13. Hetzel MR, Clark T: Comparison of normal and asthmatic circadian rhythms in peak expiratory flow rate. Thorax 35: 732-738, 1980.

14. Enarson DA, Yeung M: Determinants of changes in FEV_1 over a work-shift. Br J Ind Med 42: 202-204, 1985.

15. Tse KS, Johnson A (et al): A study of serum antibody activity in workers with occupational exposure to diphenylmethane diisocyanate. Allergy 40: 314-320, 1985.

16. Karol MH, Hauth BA: Use of hexyl isocyanate antigen to detect Antibodies to hexylmethylene diisocyanate (HDI) in sensitized guinea pigs and in a sensitized worker. Fund Appl Tox 2: 108-113, 1982.

17. Patterson R, Harris KE (et al): An animal model of occupational immunologic asthma due to diphenylmethane. J Lab Clin Med 99: 615-623, 1982.

18. Butcher BT, O'Neill LE (et al): Radioallergosorbent testing with p-tolyl monoisocyanate in toluene diisocyanate workers. Clin Allergy 13: 31-34, 1983.

19. Baur X: Immunologic cross-reactivity between different albumin-bound isocyanates. J Allergy Clin Immunol 71: 197-205, 1983.

20. Patterson R, Beltrani VS (et al): Creating an indoor environmental problem from a non-problem: a need for cautious evaluation of antibodies against hapten-protein complexes. New Eng Reg Allergy Proc 6: 135-139, Spring 1985.

21. Doull J, Klaassen CD, Amdur MO (eds): Casarett and Doull's Toxicology, 2nd edn, p277-278, MacMillan Publishing Co, New York, 1980.

22. Mellerio J, Weale RA: Hazy vision in amine plant operatives. Br J Ind Med 23: 153-154, 1966.

23. Proctor NH, Hughes JP: Chemical Hazards of the Workplace, J B Lippincott Company, Philadelphia, 1978.

24. Akesson B, Bengtsson M, Floren I: Visual disturbances by industrial triethylamine exposure. Int Arch Occup Environ Health 57: 297-302, 1986.

25. Albrecht WN, Stephenson RL: Health hazards of tertiary amine catalysts. Scand J Work Environ Health, In press.

26. Akesson B (et al): Visual disturbances after experimental human exposure to triethylamine. Br J Ind Med 42: 848-850, 1985.

27. Last J (et al, eds): Maxcy Rosenau Public Health and Preventive Medicine, 12th edn, Appleton-Century-Crofts, Norwalk CT, 1986.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Medical Officer:	Fred Richardson, M.D. Medical Officer Medical Section
Industrial Hygienist:	Leo Blade Industrial Hygienist Industrial Hygiene Section
Assistance in preparation of report:	Anne T. Fidler, Sc.D. Supervisory Epidemiologist Medical Section Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies

Distribution:

Director, NIOSH
Director, DSHEFS
R. Lemen, NIOSH/W
Mr. Edward J. Baier, OSHA
NIOSH Regional Office
OSHA Regional Administrator
Bruce D. Reinold
Clem Fulmer, United Steel Worker's Union, Local #1537
HETAB File No. 87-300

Table 1

HETA 86-420
General Foam Company
Hazelton, Pennsylvania

March 1988

Results of Lung Function Studies
and Questionnaire Responses Regarding Symptoms of Work-Related Asthma

ID#	Screening Quest.	PFTs cross-shift FEV_1	PEFR max. variability	Work-Related Symptoms
1	-	---	---	---
2	+	- 3.1%	8.0%	+
3	-	+ 4.9%	11.9%	-
4	-	+ 1.0%	6.0%	-
5	-	- 1.9%	17.2%	+
6	-	---	---	---
7	-	- 1.1%	15.7%	-
8	-	+ 0.5%	9.6%	+
9	+	+ 0.2%	11.7%	+
10	-	- 1.0%	15.2%	-
11	+	-17.8%	31.9%	+
12	+	- 2.0%	13.4%	+
13	-	---	---	---
14	-	- 0.4%	8.4%	-
15	-	---	---	---
16	-	+ 4.5%	10.4%	+
17	-	---	---	---
18	-	---	10.7%	-
19	-	- 3.0%	4.3%	+
20	+	- 5.3%	22.2%	+
21	+	+ 5.3%	9.6%	+
22	-	+ 0.3%	6.8%	-
23	-	+ 2.7%	13.8%	-
24	+	+ 1.5%	9.0%	+
25	-	+ 4.3%	13.7%	-
26	-	---	---	---
27	+	+ 8.0%	6.7%	+

Table 2

HETA 86-420
General Foam Company
Hazelton, Pennsylvania

March 1988

Comparison of Persons
With and Without Symptoms of Work-Related Asthma

	Number	# on Line #2	# on Line #4	Time in Current Job Median (Range)
With Symptoms	12	6 (60%) *	6 (54%)	10 yrs (2 mos - 22 yrs) **
No Symptoms	9	4 (40%)	5 (46%)	2.7 yrs (1 day - 27 yrs)
TOTAL	21	10	11	7 yrs (1 day - 27 yrs)

* Test of association between presence of symptoms and work on line #2 or #4:
Odds Ratio = 1.25; p=.85

** Test of association between presence of symptoms and time in current job:
Mann-Whitney test: p=.65

Table 3

HETA 86-420
General Foam Company
Hazelton, Pennsylvania

March 1988

Visual Evaluation: Comparison of Line #2 and Line #4

Symptoms	Line #2 (N=12)	Line #4 (N=14)	RR *	p-value **
blurred vision	3 (25%)	8 (57%)	2.3	.21
hazy vision	5 (42%)	10 (71%)	1.6	.45
halo vision (all)	8 (67%)	12 (86%)	1.2	.81
halo vision (colors)	8 (67%)	10 (71%)	1.1	.77
itchy eyes	4 (33%)	5 (36%)	1.0	.87
watery eyes	6 (50%)	8 (57%)	1.1	.69
difficulty driving post-shift	4 (33%)	6 (43%)	1.2	.93
difficulty working due to impaired vision	4 (33%)	2 (14%)	0.4	.50

* RR: Relative Risk; i.e., percentage of persons with symptoms on Line #4 divided by the percentage of persons with symptoms on Line #2.

** p-value: A p-value of less than .05 denotes a relative risk that is "statistically significant."

Table 4

HETA 86-420
General Foam Company
Hazelton, Pennsylvania

March 1988

Halo Vision (spectrum of colors reported)

Color	Number reporting
Blue	8
Green	4
Red	4
Yellow	4
Gray	3
Violet	1
Orange	1
Non-specified	1
TOTAL	26