U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
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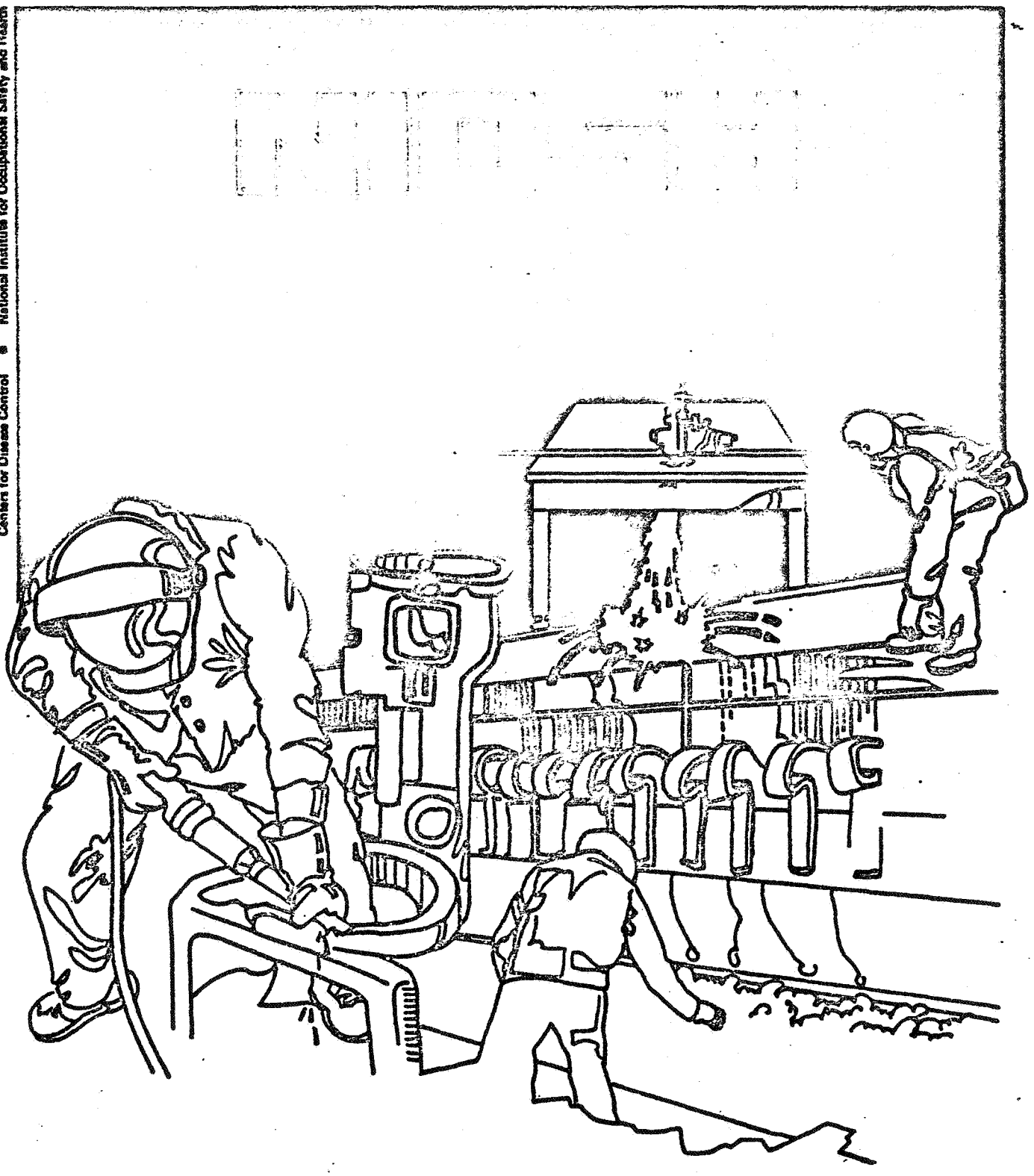

Health Hazard Evaluation Report

HETA 82-342-1223
WILLIAM BLOUNT HIGH SCHOOL
MARYVILLE, TENNESSEE

HETA 82-342-1223
November 1982
William Blount High School
Maryville, Tennessee

NIOSH INVESTIGATORS:
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I. SUMMARY

On July 27, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the Tennessee Department of Public Health for assistance in evaluating a reported outbreak of illness including skin discoloration among students at the William Blount High School (WBHS), Blount County, Tennessee. The outbreak was suspected to be associated with formaldehyde from urea formaldehyde foam insulation in the school. On July 28-30, 1982, NIOSH investigators conducted an environmental-medical survey.

Clinical interviews were conducted with the students initially thought to be affected, and available skin biopsies were obtained. To confirm other reports of illness, NIOSH investigators reviewed medical records and conducted a telephone survey of the 34 individuals with reported health problems who were on a list generated by a concerned parent. School attendance records were also obtained. A total of 23 area air samples were collected for evaluation of formaldehyde vapor concentrations in the school. The levels measured are considered to represent a worst possible case situation since ventilation systems were not and had not been operating in the two weeks prior to sampling, and temperature and humidity conditions favored high formaldehyde levels originating from the insulation.

No pattern, "outbreak" or predominant health problems were apparent from personal interviews, medical records and the telephone survey. None of the documented health problems was suggestive of formaldehyde-associated disease. There was only a low prevalence (less than 20%) of eye and nose irritation, symptoms which might be most commonly noted at low formaldehyde concentrations. No unusual diseases were found except two probable cases of Henoch-Schonlein purpura. Average daily attendance at WBHS was similar to that at the other Blount County High School.

The time-weighted average formaldehyde concentrations inside the school ranged from 0.02 parts per million (ppm) to 0.17 ppm (0.03 mg/M^3 to 0.20 mg/M^3), with an arithmetic mean of 0.07 ppm (0.09 mg/M^3). These formaldehyde concentrations do not appear to be excessively high and are at or below levels commonly found in buildings regardless of whether or not urea formaldehyde foam insulation is present. No volatile organic compounds were identified as being released during heating of a bulk sample of the foam insulation between 104-140°F (40-60°C).

No health hazard due to formaldehyde generated from urea formaldehyde foam insulation was found by NIOSH at William Blount High School. No other sources of environmental contamination were identified.

KEYWORDS: SIC 8211 (Schools), Formaldehyde, urea formaldehyde foam insulation, indoor air contaminants, office environment

II. INTRODUCTION/STATEMENT OF REQUEST

On July 27, 1982 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Tennessee Department of Public Health for assistance in investigating a reported outbreak of illness in a high school in Blount County, Tennessee. The initial reports related to skin discoloration, some possible cases of Henoch-Schonlein Purpura, and other health effects in individuals at the William Blount High School, Maryville (Blount County). Parents suspected an association with formaldehyde from urea formaldehyde foam insulation in the school's exterior walls.

NIOSH conducted an environmental and medical survey on July 28-30, 1982 and a telephone survey of others with reported illness during the following three weeks. Letters describing findings of the investigation were sent to the Tennessee Department of Health on August 9 and September 27, 1982.

III. BACKGROUND

A. Description of facility

William Blount High School, located in rural Maryville, Tennessee, is a brick and concrete block two story structure. The main building is totally separate from a nearby vocational education building, which is also a part of the high school. Construction of William Blount High School began in 1977 with erection of the concrete block walls completed in 1978. Urea formaldehyde foam insulation was installed in the exterior walls as they were built and the walls were capped with a concrete filled U-block at the top. The exterior wall surfaces were sealed with a black mastic prior to putting up the external brick facing. The roof, a galvanized steel deck with two inch fiberboard insulation and a built up top surface, was installed in 1979. During the summer months of 1979 the building was completed which included painting all of the interior wall surfaces with an epoxy resin paint. Wool carpeting and seamless flooring were also installed at this time. Classes began in August, 1979.

Each classroom is served by an independent ventilation unit connected to a central control system which operates between the hours of 6 a.m. and 4 p.m. Hot and cold water are pumped to each unit from a main boiler or chiller unit for the purposes of heating and cooling. The first and second floors have independent air intake and exchange systems to serve the individual classroom units. There were no chemical emission sources in the immediate vicinity except for a laboratory hood exhaust located on the roof over 100 feet away from the second floor end wall having the air intake louvers. The lab hood exhaust - air intake configuration was not considered to present a problem.

An inventory of cleaning products used in the school did not identify any unusual or improperly applied substances and all cleaning was reportedly done after regular school hours. Inspection of the science rooms and their adjacent storage areas did not result in the identification of any significant sources of formaldehyde emmissions. A material present in the labs which was apparently used for biological specimens was noted to contain ethylene glycol. Insect extermination in the building was limited to the home economics area and was conducted once a month outside of regular school hours.

B. History of reported health problems

In March 1982, local newspapers carried stories about two students with skin abnormalities. Attention focused around two female students with skin abnormalities who took typing class in the same room (at different periods or times of the day) with the same typing teacher. The two individuals had gone to grade school together but were not close friends. They had played basketball together for several years prior to the opening of the school but had no other social activities in common. The first or "index" student came to the attention of a Knoxville hematologist in December 1981 with onset of skin problems one month previously. The second student had dermatologic complaints dating back to March, 1980 and saw him in January, 1982. An article concerning formaldeyde was shown to the physician by one of the mothers, prompted a visit to the school, and the observation that it was insulated with urea formaldehyde foam. Concern developed in the community that the skin discoloration might have been related to the urea formaldehyde foam. This led to considerable coverage in the local media and an investigation by the Consumer Product Safety Commission in May 1982. This was conducted following claims by the parents that a number of students at the school were suffering from "formaldehyde sensitivity"[1] as a result of the urea formaldehyde foam being used as insulation. Continued concern prompted the school board and the director, Blount County Health Department, to ask the State Department of Health for assistance. This in turn, prompted the request to NIOSH.

IV. EVALUATION DESIGN AND METHODS

A. Medical

The study was designed to determine: (1) if there was, in fact, an outbreak of illness; (2) if the reported health problems were related to formaldehyde; and (3) if there was an environmental hazard at the school. NIOSH investigators held detailed discussions with the Knoxville hematologist who had seen three students with skin problems. Following written consent, the medical records of these individuals were obtained as well as photographs (slides and

prints) of the affected areas that had been taken in previous weeks. Interviews were conducted with these individuals and their mothers. An attempt was made to remove the skin discoloration observed in one individual by rubbing with alcohol and cotton. NIOSH assessed school attendance records for recent years, available at the Court House in Maryville. Microscopic slides of skin biopsies performed on the first two patients were obtained from a dermatopathologist in Augusta, Georgia.

NIOSH attempted to seek other possibly affected individuals in addition to those assessed during the site visit (and to investigate the possibility of disease outbreak). A list, previously generated by a concerned parent, of other individuals with reported health problems was obtained while in Maryville. NIOSH contacted all 34 individuals that were on the list (32 students, 2 staff) or their mothers or both, by telephone. The individuals were asked to volunteer any health problems, their date of onset, whether they were documented by a physician, whether they had resolved, and whether the interviewee felt the problems were related to the school. NIOSH interviewers inquired about specific health problems on the list that were not spontaneously volunteered. When applicable, physicians were contacted by phone or medical records were obtained.

B. Environmental

Evaluation of formaldehyde gas concentrations associated with off-gassing of the insulation inside the school was conducted by obtaining area air samples in a number of classroom and non-classroom areas.

Sampling was conducted by drawing air through an absorbing reagent for a known time period at a specified flow rate with the use of a small sampling pump. The collection medium was 20 milliliters of 1% sodium bisulfite solution and sampling times ranged from 2 to about 7 hours. A total of 23 samples were collected. All samples were analyzed with a spectrophotometer at a wavelength of 580 nanometers. NIOSH Method P&CAM 125[2] was followed in the preparation of the samples, standards and blanks. An estimated detection limit of two (2) micrograms of formaldehyde per sample was obtained. A 1% sodium bisulfite solution was used as the absorbing reagent since it provides greater collection efficiency than distilled water.

A bulk sample of the insulation was obtained from a wall where plumbing repairs had been made. Additionally a bulk sample of material obtained by the hematologist, a portion of which was used in conducting patch tests, was also submitted for confirmation as urea formaldehyde foam. The primary interest in obtaining these was to determine the potential release of any volatile organics in a heated environment of about 120-125°F (49-52°C).

A small portion of the bulk used in patch testing was mixed with potassium bromide and pressed into a pellet for infrared analysis. Portions of this bulk were also heated in a micro-tube furnace operating at a temperature between 104-140°F (40-60°C). Various sorbent tubes and detector tubes were then used to sample the effluent stream from the heated sample portions. Minimum sampling time was 30 minutes and flowrates varied between 100-300 cubic centimeters per minute. The sorbent tubes were desorbed with different solvents and screened by gas chromatography (equipped with a flame ionization detector) using a 30 meter DB-1 bonded phase fused silica capillary column (splitless mode).

A portion of the bulk insulation obtained from the wall was extracted with methylene chloride and the solvent analyzed by gas chromatography for organic compounds.

V. EVALUATION CRITERIA

Toxicity from exposure to urea formaldehyde foam appears to be related primarily to the presence of formaldehyde gas in the environment.[3] The effects of formaldehyde can be acute or chronic.[3-8] With acute effects, the first signs or symptoms noted on exposure to formaldehyde are irritant effects on the eye and upper respiratory tract (burning of eyes, tearing or lacrimation, rhinnorhea or runny nose, mild throat irritation). These can occur at concentrations as low as about 0.1 parts per million (ppm). Dermatitis associated with formaldehyde vapor, solutions or formaldehyde-containing resins has been documented. Formaldehyde is a primary irritant to the skin but can also cause allergic contact dermatitis (ACD), in concentrations below those likely to cause primary irritant effects.

Allergic effects include skin sensitization and possibly, asthma or asthma-like symptoms.[9-10] There is considerable evidence that formaldehyde can produce skin sensitization in man, especially in persons occupationally exposed through skin contact.[8] Eczematous dermatitis, when acute is characterized by redness, edema, weeping and crusting with itching. In the chronic form, the affected skin areas may become thickened, lichenified and fissured.[11]

The Committee on Toxicology in its report Formaldehyde - An Assessment of Its Health Effects which was prepared for the Consumer Product Safety Commission suggested that less than 20 percent of an exposed human population would react to formaldehyde exposures below 0.25 ppm with slight irritation of the eyes, nose, and throat, and possibly a slight decrease in nasal-mucus flow.[13] No evidence has been presented of a threshold level for the irritant effects of formaldehyde in human populations.

Concern about formaldehyde's potential carcinogenicity is based primarily on recent studies by the Chemical Industry Institute of Toxicology (CIIT) in which laboratory rats and mice exposed to formaldehyde vapors developed nasal cancer.[5]

Evaluation criteria for indoor levels of formaldehyde vary depending upon the application of the specific exposure limit, the symptoms and health effects to be prevented, the health of the exposed population, and the duration of exposure. Occupational exposure limits have been promulgated by several sources. They are intended for an eight hour workday, 40 hour work week and represent a level to which nearly all workers may be repeatedly exposed during a working lifetime without adverse effect. These levels generally are higher than the exposure levels addressing continuous exposures or sensitive populations. Table I presents a number of different evaluation criteria for environmental formaldehyde levels. NIOSH recommends that occupational exposure be reduced to the lowest feasible limit. Most standards addressing indoor non-occupational formaldehyde exposure levels are recommended or consensus standards. These recommendations are concerned with maintaining levels of formaldehyde below those associated with primary irritant effects.

VI. RESULTS

A. Medical

The average daily attendance at William Blount High School (95.0%) during the 1981-82 academic year was similar to that of Heritage, the other William Blount county high school (94.0%). Similar rates were also observed during the 1980-81 academic year.

A total of 34 individuals were interviewed (32 students, 2 staff) including the three patients previously seen by the local hematologist, who were assessed with personal clinical interviews during the site visit. This represented all persons indicated on the parent generated list. A summary of data related to those contacted including complaints, and physician diagnosis are listed in Appendix I.

Of the 32 students interviewed, the current age ranged from 15 to 20 years (mean 17.1 years). The number of years of attendance at the school was one year in 4 individuals, two years in 9 and three years in 19. Six of the students were male and 26 were female.

All but four of the 34 had consulted a physician for the problems reported by telephone or during interview. No pattern, "outbreak" or predominant problems were apparent. The majority of reported health effects was attributable to well-recognized diseases that might be expected occasionally in any group of individuals, including infectious mononucleosis in two, other infections in four, probable vascular (migraine) headache in five, possible Henoch-Schonlein purpura in two, and one case each of Crohn's disease, nephrotic syndrome, colonic polyp, peptic-ulcer disease, allergies with onset prior to attendance at the school and a trauma-related problem. The more serious problems noted on the parent's list

(nasal cancer, possible brain tumor) were not substantiated. Although the cause for some of the nonspecific symptoms (arthralgias, headache, fatigue) was not apparent to the attending physicians (in some cases following extensive medical investigations), most of the physicians felt that these were not different from health problems seen in individuals from other schools. Moreover, such symptoms were often not related in time to the school year in terms of onset or resolution.

None of the documented health problems were suggestive of formaldehyde-associated disease. Essentially no one reported eye and nose irritation, symptoms which might be the most commonly noted at low formaldehyde concentrations.

Two of the students had unusual skin discoloration, which was green at times. This was recurrent in one individual and occurred on only two occasions in the other. NIOSH investigators observed a small area of green discoloration on the forearm of the latter student during the site visit. The discoloration rubbed off with cotton and rubbing alcohol, imparting some green discoloration to the cotton. The green material could not be analyzed because there was insufficient quantity for analysis and because the material was tightly bound to the cotton. For the former "case", a pathology slide of the skin biopsy performed earlier in 1982 was obtained from the dermatopathologist in Augusta, Georgia. This, along with photographs (prints and slides), of the individuals seen by the hematologist were reviewed by a dermatologist and dermatopathologist at the University of Cincinnati Medical Center. They noted the minimal presence of pigment in the superficial portion of the stratum corneum with no evidence of pigmentation, inflammatory reaction or pathological process in the deeper portion of the biopsy. This was felt compatible with a superficial material, possibly applied to the skin.

B. Environmental

The results of the long term (i.e. about 7 hour) area samples are presented in Table II by location. The time weighted formaldehyde concentrations inside the school ranged from 0.02 parts per million (ppm) to 0.17 ppm (0.03 milligrams/meter cubed (mg/m^3) to 0.20 mg/m^3). The average (arithmetic mean) value was 0.07 ppm (0.09 mg/m^3).

Short term (i.e. about 2 hours) area samples are presented by location in Table III. Concentrations ranged from 0.01 ppm (0.01 mg/m^3) to 0.11 ppm (0.14 mg/m^3). The time weighted average over the total sampling period combining three short term samples ranged from 0.02 ppm (0.03 mg/m^3) to 0.07 ppm (0.09 mg/m^3). A sample of about three hours in duration obtained above the suspended ceiling tile in room 213 demonstrated a concentration of 0.005 ppm (0.006 mg/m^3).

The infrared spectrum of the bulk sample, obtained for the conduct of patch tests, matched that of the urea formaldehyde molding compound reference spectra. Minor differences in the spectra were noted and most likely are associated with variations in the formulations of the two substances being compared.

No volatile organic compounds were identified as being released by the bulk samples between 104-140°F (40-60°C) when using five different sampling methods. No methylene chloride extractable organic compounds were identified from the bulk insulation sample obtained directly from the wall in the band room.

VII. DISCUSSION AND CONCLUSIONS

The sampling conducted during NIOSH's visit to William Blount High School is considered to represent a worst possible case situation as it pertains to the release of formaldehyde vapors from the urea formaldehyde foam insulation present in the exterior walls. This consideration is made in light of the following conditions existing at the time of the survey: ventilation systems in the second floor classrooms had reportedly been shut off for the previous two weeks to permit the installation of clean filters and were not operated prior to or during the sampling period; interior relative humidity values ranged from 51 to 76 percent and temperatures ranged from 70-82°F (21-28°C) presenting conditions of fairly high humidity and temperatures, conditions reported in the literature to favor higher interior formaldehyde levels; activity in the classrooms was minimal (summer vacation) further reducing mixing or influx of air; in the case of the band room closet a covering over the insulation was removed and samples obtained within 16 inches (40.6 centimeters)of the material and an air sample above the suspended ceiling was obtained along the unpainted concrete block.

The concentrations measured were generally at or below 0.1 ppm (0.12 mg/m^3) and were not noticeably higher in rooms with exterior walls compared to those with uninsulated walls. The two highest concentrations were obtained in two different rooms - one with two outside walls and one without any exterior walls. The presence of carpeting did not appear to influence formaldehyde levels. The fact that the ventilation systems had not been running is considered significant. The normal operation cycle of the ventilation systems is from 6 a.m. to 4 p.m., conditions which allow operation of the systems for about 1.5 to 2 hours prior to the beginning of the school day. Additionally the age of the insulation is such that the initial off-gassing of formaldehyde resulting in higher airborne concentrations most likely took place before the school was occupied.

NIOSH has documented formaldehyde levels in office settings ranging from nondetectable up to 0.13 ppm.[17-22] Formaldehyde concentrations in residential environments are reported to range from less than 0.10

ppm up to 3.68 ppm.[23] An ongoing formaldehyde monitoring study of conventional homes (as compared to mobile homes) and an assessment of the formaldehyde-releasing potential of construction materials and home furnishings indicate that low level formaldehyde contamination concentrations usually less than 0.1 ppm) occurs in most homes.[24] A large number of commercial products use or contain formaldehyde and a general listing is presented in Table V.

In summary the concentrations of formaldehyde found in the second floor classroom areas of Wm. Blount High School do not appear to be excessively high when compared to levels documented by other investigators, in fact the levels are most likely at or below those which could be found in homes located in the surrounding area, including those without urea formaldehyde foam insulation.

No outbreak was discernible among the 34 people interviewed, although two possible cases of Henoch-Schonlein purpura may be somewhat greater than one would expect in a school of 1600 persons. Although case reports have suggested a link between this entity and several meditions[25-31], its etiology remains unknown; Henoch-Schonlein purpura has not been associated with any environmental contaminants including formaldehyde. Moreover, no significant exposure to formaldehyde (or any other contaminant) was documented in the school.

VIII. RECOMMENDATIONS

Current conditions in the school do not appear to present an acute or irritant health hazard associated with formaldehyde vapor exposure. The levels observed are considered to represent a worst possible case and the operation of the ventilation system along with normal infiltration and system design air changes is considered sufficient to keep formaldehyde concentrations at a low level, most likely below the documented levels presented here.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Tennessee Department of Public Health
2. Blount County Health Department
3. NIOSH, Region IV
4. OSHA, Region IV
5. Superintendent of Schools, Blount County
6. Consumer Product Safety Commission

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Formaldehyde Exposure Evaluation Criteria

Wm Blount High School
Maryville, Tennessee
HETA 82-342

Type of Exposure	Country	Exposure Limit, ppm[1]	Duration	Reference or Status	Source[3]
Indoor Air	United States	0.1	continuous	advisory	a-ASHRAE
Indoor Air	Denmark	0.12	ceiling	advisory	b
Indoor Air	Netherlands	0.1	ceiling	law	b
Indoor Air	Sweden	0.1-0.4	ceiling	advisory	b
Indoor Air	West Germany	0.1	ceiling	advisory	b
Occupational	United States	3	8 hr TWA	law	c-OSHA
		5	ceiling	law	c-OSHA
		10	30 min	law	c-OSHA
Occupational	United States	Lowest feasible[4]	8-10 hr TWA	advisory	d-NIOSH
Occupational	United States	Lowest feasible[4]	8 hr TWA	advisory	e-ACGIH
Occupational	Denmark	0.1	TWA	law	b
Occupational	Sweden	2.5	ceiling	law	b
Occupational	West Germany	1.0	TWA	law	b

1 Exposure limits are given in parts per million = ppm. 0.1 ppm (about 0.122 milligrams per cubic meter).
2 Duration indicates type of exposure: ceiling values are not to be exceeded; occupational values are for an 8 hour time weighted average (TWA) exposure.
3 a: American Society of Heating, Refrigeration, and Airconditioning Engineers, 1981, ref. 12
b: National Academy of Sciences report, 1980, ref 13
c: Occupational Safety and Health Administration, ref 14
d: National Institute for Occupational Safety and Health, 1981, ref 5
e: American Conference of Governmental Industrial Hygienists, 1981, ref 16
4 Neither NIOSH nor the ACGIH no longer recommend any specific exposure limit based on a recent animal study indicating formaldehyde may have carcinogenic potential in man. These groups advise keeping formaldehyde exposures at the "lowest feasible limit."

Table II

Formaldehyde Concentrations By Location
Wm Blount High School
Maryville, Tennessee
HETA 82-342
July 29, 1982

Location	Sample Description[a] Ventilation	Carpet	Exterior Walls	Direction	Volume (L)	Formaldehyde Concentration in ppm (mg/m^3)[b]	
Rm 201 center-desk	off	no	0	--	421	0.12	(0.14)
Rm 202 center-desk	off	no	2	NW,SW	428	0.17	(0.20)
Rm 204 center-desk	off	no	1	NW	420	0.08	(0.10)
Student Affairs Office-desk	off	yes	0	--	412	0.09	(0.11)
Rm 206 center-desk	off	yes	0	--	424	0.04	(0.04)
Rm 213 back filing cabinet	off	yes	1	SE	407	0.05	(0.06)
Rm 213 front center desk	off	yes	1	SE	404	0.04	(0.05)
Rm 214 front desk	on	yes	0	--	398	0.02	(0.03)
Rm 219 center-desk	off	yes	1	SE	406	0.05	(0.06)
Commons - locker area	off	yes	0	--	358	0.07	(0.09)
Band room closet (exposed insulation)	on	yes	1	NE	376	0.08	(0.10)
						Arithmetic mean: 0.07 ± 0.04	(0.09 ± 0.05)
Outside-dock[c]	--	--	--	SW	348	0.01	(0.01)
Outside-dock[c]	--	--	--	SW	335	N.D.	N.D.

a Sample description includes columns for carpeting and presence or absence; number of urea formaldehyde foam insulated exterior walls; direction exterior walls face for a specified room; and the volume of the sample in liters (L).

b Concentrations are presented in parts per million (ppm) with milligrams per cubic meter (mg/m^3) in parenthesis. Note the values may not be directly convertible by calculation due to rounding.

c Outdoor concentrations should be considered below the analytical limits of detection due to reported sample concentrations for the outdoor samples falling within a range equal to that of the blanks. Secondly the single reported outdoor value comes from the second of two impingers in series, the first reporting no detectable formaldehyde. N.D. = none detected, in this case values fell at or below the value subtracted for the blanks.

Table III

Short Term Formaldehyde Sampling Results

Wm Blount High School
Maryville, Tennessee
HETA 82-342
July 29, 1982

Sample Description[a]					Formaldehyde Concentration in ppm (mg/m^3)[b]	
Location	Ventilation	Sampling Duration	Volume (L)			
Rm 213 front center-desk	off	09:16 - 11:21	119		0.02	(0.03)
		11:23 - 13:21	100		0.01	(0.01)
		13:41 - 15:37	116		0.11	(0.14)
				TWA[c]	0.05	(0.06)
Rm 219 center-desk	off	09:28 - 11:27	113		0.02	(0.02)
		11:29 - 13:29	120		0.04	(0.05)
		13:30 - 15:31	121		0.01	(0.02)
				TWA	0.02	(0.03)
Band room closet (exposed insulation)	on	10:29 - 12:27	112		0.07	(0.08)
		12:28 - 14:28	120		0.09	(0.11)
		14:30 - 16:47	137		0.06	(0.08)
				TWA	0.07	(0.09)
Rm 213 above suspended ceiling	off	07:54 - 10:56	173		0.005	(0.006)

a Sample description includes whether ventilation systems were on or off; the time over which the sample was obtained; and the volume in liters (L).

b Formaldehyde concentrations are given in parts per million (ppm) and milligrams per cubic meter (mg/m^3).

c TWA = time weighted average calculated over the total sampling time.

Table IV

Summary Table of Bulk Insulation Analyses for Contaminants
Volatized at Temperatures of 104-140°F (40-60°C)

Wm Blount High School
Maryville, Tennessee
HETA 82-342

Sorbent[1]	Extraction Solvent	Results[2]
Ammonia detector tube	--	N.D.
Hydrogen cyanide detector tube	--	N.D.
Tenax	Methylene Chloride	No GC Peaks Detected
Silica Gel	Ethanol	No GC Peaks Detected
BEA Coated Tube (for formaldehyde)	Isooctane	No Formaldehyde Detected
Bulk Insulation Sample[3]	Methylene Chloride	No GC Peaks Detected

1 Detector tubes are direct reading, no extraction solvent required.
BEA: benzylethanolamine coated tube used in NIOSH Method P&CAM 354, ref 16

2 N.D.: None Detected
None of the extraction solvents produced any detectable contaminant peaks during analysis. GC: Gas Chromatogram

3 Bulk insulation sample was extracted directly, no sorbent tube used.

Table V

Product Uses of Formaldehyde*

Wm Blount High School
Maryville, Tennessee
HETA 82-342

Adhesives	Insulation, Foam & Some Others
Cosmetics	Intermediate Chemicals
Deodorants	Laminates
Detergents	Leathers, Fur & Hair
Dyes	Lubricants, Synthetic
Embalming Fluids	Paints
Explosives	Paper
Fertilizers	Pharmaceuticals
Fiberboard, Plywood (indoor-outdoor), Particle board	Plastics/moldings (Automobile Appliances, and Sporting Equipment)
Hardware, Garden	Rubber
Filters	Surface Coatings
Food	Textiles
Friction Materials	Urethane Resins
Fuels	Watersoftening Chemicals
Fungicides	

* Source: NIOSH Current Intelligence Bulletin 34, ref 5

APPENDIX I

Summary of Data Related to Contacted Subjects

Wm. Blount High School
Maryville, Tennessee
HETA 82-342

Subject	Complaints	Date of Onset	Physician's Diagnosis
1	Recurrent colds, "bronchitis", loss of voice,	4/81	Compatible with Henoch-Schonlein Purpura
	skin lesions: small eczematous patches, ecchymoses/purpura, large areas of blue-green discoloration	11/81	
	arthralgias, abdominal pain, hematuria, hemoptysis, fainting episodes		
2	Weight loss, arthralgias, hematuria,	3/80	Possibly compatible with Henoch-Schonlein Purpura
	Fainting episodes, abdominal pains		
	skin lesions: red scaly eczematous lesions, ecchymoses/bruises, green discoloration (on 2 occasions)	9/82	
3	Flu-like illness	2/82	*
	skin lesions: red flat pruritic rash over much of body, blanched with pressure	4/82	Vasculitis-type rash, etiology undetermined
	arthralgias	5/82	
4	Headache	8/81	*
	Skin lesions: red rash on forehead, legs	9/81	
	and arms, bruise on legs	5/82	
	Abdominal cramps	11/81	
5	Menstrual cycle irregularities - long cycle	1/82	*

Appendix 1 continued:

Subject	Complaints	Date of Onset	Physician's Diagnosis
6	Infectious mononucleosis	8/79**	Infectious mononucleosis
	?Enlarging ovary	1980	Ultrasound: small enlarging ovary-no relation to school
	Weight loss, decreased appetite, ? hernia	9/79	Upper GI series: negative
7	Headaches, poor motor control of legs, weak right arm, dizziness, fainting	10/81	Seen by neurologist and psychologist: Probable vascular headaches, migraines Psychosomatic ailments
	Blue arm		Markedly cyanotic arm due to reflex dystrophy
8	Tired, excessive fatigue, headache	11/80	Did not know: ? School pressure
9	Headaches	9/81	Multiple nonspecific problems with no findings: ? stress/ school
	Dizziness, ? vertigo	10/81	
	Abdominal pain, ? ovarian cyst	1/82	Undetermined, ultrasound negative
10	Repeated sore throats, ear infections	1979-11/81	Strep throat
	Irregular menstrual cycle	10/81	Menometrorrhagia, endometritis, cystic left ovary
	"kidney infection", dysuria	11/81	cystitis, no culture done
	rash	11/81	*
11	Fainted in class (one day after basketball game, exhausted)	2/82	*
12	Headaches	8/79**	secondary to sinus infection

Appendix 1 continued:

Subject	Complaints	Date of Onset	Physician's Diagnosis
13	Crohn's Disease	7/79**	Crohn's Disease
	Rash (not at school for 6-8 prior to rash	2/82	Possible allergy to liquid diet
14	Headache,	9/80	Vascular headaches, migraines
	Fainting episodes	9/80	Likely vasovagal episodes
	Weight loss, nausea	12/81	10 lb weight loss documented, now gained back
	Fatigue	6/81	Mild anemia, responsive by 9/82 to iron
15	Headache (admitted to hospital)	12/81	Probably vascular, - migraine headache responded to Elavil & Zomax
	Myalgias, arthralgias of lower extremities	12/81	collagen vascular work-up negative
	Polyuria/Kidneys	9/81	urinalysis normal 5/82
16	Headache	11/80	Tension headache
	Mild increased blood pressure		Secondary to headaches
	Blood in urine	10/80	Focal glomerulitis (Berger's Disease)
	Dysuria		Minimal episodic urethral syndrome
	Menstrual irregularity	10/80	No significant problem
17	Nausea, vomiting	9/81	Colon surgery: resection of polyp
	headache, dizziness	9/81	
	? blood in stool: - polyp	3/82	
18	Nephrotic syndrome	9/80	Nephrotic syndrome
	Hair loss	12/80	secondary to cyclophosphamide therapy for nephrosis

Appendix 1 continued:

Subject	Complaints	Date of Onset	Physician's Diagnosis
27	Recurrent strep throat	1/82	Documented strep throat
	Cystitis (X2)	12/81, 3/82	Routine infections (E. coli)
	Headache	12/81	Secondary to infections
28	Ulcers, raw spots on right eye	3/80	Superficial keratitis - secondary to dry eyes
	Dry eyes, positive Schirmer's test	1/81	Dry eyes - no cause (idiopathic)
	Headaches, persistent	1/81	No diagnosis
29	Polyarthralgias, joint stiffness	1/81	Oligoarthritis, possibly psoriatic
	seborrhea, nail pitting	12/81	mild psoriasis
	dizziness	1/81	? inner ear problem
30	Headaches	2-3/81	Vascular, migraine
31	Shortness of breath, chest pains, weakness weight loss	10/81	Hospitalized 4/82; no pulmonary problems found; Final diagnoses: urinary tract infection, proteinuria possibly secondary to UTI, anxiety
32	Allergies - (symptoms of nasal congestion, sore throat)	7/78**	Allergic rhinitis allergies to food & plants, molds, animals, dust, positive skin tests

Appendix 1 continued:

Subject	Complaints	Date of Onset	Physician's Diagnosis
33	Headache	1/82	*
	Skin: rash, itchy, pruritic, round lesions, dark red with lighter red inside - legs, abdomen, back	2 /82	*
	bruise-like lesions - sides of legs,	3/82	*
	swelling, discomfort, both ankles	5/82	Blood tests and X-rays negative, felt not related to school
34	High blood pressure	8/78**	Prior to working at WBHS
	Hepatitis	3/82	Undetermined

* Did not see a physician

** Preceded opening of William Blount High School