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Inland Manufacturing Division
Dayton, Ohio

August 28, 29 and 30, 1961

Toluene Diisocyanate (TDI)
Solvent Vapor
Trichloroethylene
Cement Solvent
Asbestos Dust
Noise

No. 6157

Reported by: J. R. Vander Roest

Industrial Hygiene

Inland Manufacturing Division
Dayton, Ohio

At the request of Dr. R. L. Johnston an industrial hygiene survey was made at the Inland Manufacturing Division on August 28, 29 and 30, 1961. Pertinent matters were discussed with Dr. R. L. Johnston, Dr. E. Pfanner, Mr. H. I. Newsome and Mr. S. A. Wright, who assisted in the survey. The Industrial Hygiene Department was represented by J. R. Vander Roest.

SUMMARY, CONCLUSIONS AND SUGGESTIONSToluene Diisocyanate (TDI)

Atmospheric concentrations of TDI at crash pad and seat pad production operations were well below the permissible limit. No changes are suggested.

Solvent VaporTrichloroethylene

Trichloroethylene vapor concentrations at steering wheel finishing operations were generally below the permissible limit. Temporary peak concentrations exceeding the permissible limit were associated with removing the wheels from the degreasers and indicate that a longer drying time in the exhaust ventilated hoods is desirable.

Trichloroethylene is used to flush the nozzle of one of the foaming machines in the crash pad production department. Concentrations of trichloroethylene vapor at this operation were well below the permissible limit. Liquid trichloroethylene from the nozzle falls into a pail inside of a cardboard box on the floor. In the event that concentrations become objectionable during closed operating conditions of colder weather, providing local exhaust ventilation to the floor receptacle should be considered.

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Cement Solvent

Aromatic hydrocarbon solvent vapor concentrations from cement used on bushings at bushing assembly machines were not excessive. No changes are suggested.

Asbestos Dust

Dust tests were below the permissible limit at forming, slitting and grinding operations associated with brake lining production. Copious dust deposits in the vicinity of the forming presses indicate the need for improved exhaust ventilation on these units.

Noise

Sound measurements were made at several representative operations designated by management. The measurements indicate that the suggested hearing damage risk criteria are exceeded in several of the octave bands at some of the operations. Remedial measures are discussed in the body of the report.

DISCUSSION

Toluene Diisocyanate (TDI)

Crash pads and seat pads are produced from polyurethane foam containing toluene diisocyanate (TDI).

Crash pads are produced in Department 76, Building 28, on four foaming machines. Once the foaming machine is started, the necessary amount of foam is automatically released through a nozzle. After the proper amount of foam has been deposited between the fabric and backing, the parts are placed in a mold on a conveyor which carries them through an oven for curing. When the molds emerge from the oven, the parts are removed and packed for shipment after inspection. Slot exhaust ventilating ducts were located below the nozzles of the foaming machines, along the conveyor and at the openings of the oven.

Toluene Diisocyanate (Cont'd)

Seat pads are produced on both sides of a wide conveyor in Department 75, Building 28. Foam runs into the molds continuously from a nozzle on each side of the conveyor. A thin sheet of plastic and a perforated metal lid are then placed over the mold in that order. After passing through the curing oven the lids are removed and the pads are taken out of the molds and placed on an adjacent conveyor. Flashing is trimmed from the pads prior to the final cure oven. Two ten foot long exhaust slots, parallel to and above the center of the conveyor, were located just ahead of and behind the foam nozzles. A similar duct has been positioned above the conveyor where pads are removed from the molds and the molds are cleaned with a scraper and a compressed air jet. There was also a slot exhaust duct on the pad conveyor where pads are placed after removal from the molds. A flexible exhaust duct, six inches in diameter, had been provided for the scrap drum, near the nozzles, on each side of the conveyor.

No toluene diisocyanate was detected in any of the tests made at various operations in both Departments. Information was offered that low results from tests at these operations were also obtained by plant personnel. Ventilation appeared to be adequate and no changes are suggested.

It was stated that the prepolymer foaming method, formerly used, had been replaced by a "one shot" method. The changeover resulted in the elimination of objectionable fumes that emanated from the curing oven at times.

Installation of a similar but larger seat pad production unit, located just south of the present unit, was in the final stages. Exhaust ventilating equipment appeared to be ample, although it was not in operation.

Permissible Limit for Toluene Diisocyanate (TDI)

The commonly accepted limit for TDI is 0.02 part per million parts of air by volume.

Results of Tests - TDI

Test No.	TDI in ppm	Remarks
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Samples 1 through 3, inclusive, taken along south conveyor of the north seat pad installation with both sides of the conveyor in operation. Building 28, Department 75.

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|---|---------------|--|
| 1 | None Detected | Breathing zone of man clamping lids on molds after cutting plastic sheet with heat knife. Exhaust slot ten feet long over center of conveyor. |
| 2 | None Detected | Breathing zone of man cleaning molds with scraper and air jet after pads had been removed near exit of oven. Twenty-four inch pedestal fan directed west causing gusty air flow. |
| 3 | None Detected | Sample taken in breathing zone of man on north side of south trimming table. No local exhaust ventilation at this operation. No objectionable odors. |

Sample 4 through 6, inclusive, taken at crash pad production operations in Building 27, Department 76.

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|---|---------------|--|
| 4 | None Detected | Breathing zone of No. 4 foamer operator producing Pontiac Bonneville crash pads. Exhaust slot below nozzle and above waste box. General air flow 50 feet per minute from open monitor in north wall. |
| 5 | None Detected | Sample taken in breathing zone of No. 3 foamer operator. Local exhaust duct in back of nozzle. |
| 6 | None Detected | Breathing zone of man unloading crash pads from molds on conveyor near oven exit. Exhaust slots at oven exit and along conveyor where parts are removed. |

Solvent Vapor

Trichloroethylene

In Department B, Building 20, the plastic surfaces of steering wheels are finished by processing them through trichloroethylene degreasers. Two special types of degreasers are used.

A Manpro Corporation Bar-L Model No. B-100, with a cylindrical tank slightly larger than a 55-gallon drum, is the smaller of the two degreasers. Steering wheels are placed on an "L" shaped arm and lowered hydraulically into the vapor for thirty seconds. The wheels rotate on the upward and downward strokes and while they are suspended at the bottom. An exhaust hood above the unit captures vapor from the wheels where they hang to partially dry in the loading position. A very good vapor level is maintained by a cooling coil of seven turns of copper tubing about one foot from the top of the tank.

A larger Detrex Corporation degreaser, Model VS-800S, is used for continuously finishing steering wheels. The unit, which is 50" x 30" x 30", rests on the floor. Extensions of the tank sides and a top completely enclose the area above the tank with the exception of a 3-1/2' x 2' loading and unloading opening on each of two sides. Surrounding the degreaser is a large platform which permits access to loading openings. Overhead conveyors carry wheels to and from the loading positions. A continuous vertical conveyor, following a rectangular path inside the enclosure, carries the wheels downward into the vapor, across to the opposite side and upward out of the vapor. The wheels rotate while in the vapor phase. Some of the trichloroethylene evaporates from the wheels as they travel through the exhausted enclosure. Face velocity of air flow into the loading openings varied from 50 to 75 fpm.

Concentrations of trichloroethylene vapor were generally below the permissible limit at both degreasers but there were brief periods when the limit was exceeded. Peak concentrations were believed to be caused by residual trichloroethylene evaporating from the wheels after they were removed from the degreasers. A longer period of evaporation within the influence of the degreaser exhaust ventilation should reduce the amount of solvent released after removal.

Trichloroethylene (Cont'd)

In order to increase production, two more Manpro degreasers have been installed on the Detrex loading platform. When these two units are put in operation, the area should be observed and a decision made regarding the desirability of a prolonged drying time.

Dupont Triclene D was used in both areas.

In Department 76, Building 27, the nozzle of the No. 4 foamer is automatically rinsed with trichloroethylene immediately after each shot. The 80 cc of solvent used runs into a five gallon open pail inside of a cardboard waste box. Some of the trichloroethylene drips and splashes onto the waste foam and cardboard resulting in a large evaporative surface. The slot exhaust below the nozzle was too high to be effective but general conditions of ventilation were favorable. Concentrations of trichloroethylene vapor were well below the permissible limit. Local exhaust ventilation on the waste receptacle may be necessary if complaints indicate an increase in concentrations during colder weather.

Permissible Limit for Trichloroethylene

The generally recognized permissible limit for trichloroethylene is 100 parts per million parts of air by volume.

Results of Tests for Trichloroethylene

Test No.	Trichloroethylene in ppm	Remarks
7	15-25	Breathing zone of operator of Manpro degreaser during two 15 minute periods of normal operation. Face velocity of hood varied from 0 to 100 fpm.
8	145	Source zone test taken one inch above wheel just removed from Manpro degreaser. Brief peak reading with rapid rise and fall.

Results of Tests for Trichloroethylene (Cont'd)

Test No.	Trichloroethylene in ppm	Remarks
9	20-45	Breathing zone of north loader of Detrex degreaser during two 15 minute periods of normal operation. The lower concentration prevailed most of the time.
10	185	Very brief peak concentrations under same condition as Test 9. These results seemed to be associated with dragout on some wheels. Pedestal fans in the area did not appear to effect the unit.
11	35	Maximum concentration found at breathing zone level immediately after nozzle rinse at No. 4 foamer. Air flow through open windows 50 fpm and gusty.

Cement Solvent

In Building 50, Department 72, two types of cement are used on bushings at bushing assembly machines. The cements are applied to metal and rubber parts of the bushings at the beginning of the assembly operation. The cement used at machines No. 2 and No. 5 consists of 55% S.C. No. 100 Amasco solvent and 45% chlorinated rubber, while the cement used at machines No. 4 and No. 6 contains equal parts of S.C. No. 6 Amasco solvent and chlorinated rubber.

The solvent portions of both cements are aromatic hydrocarbons, however, the S.C. No. 6 has a much slower evaporation rate and other characteristics which differ from the S.C. No. 100. The permissible limit for both of these substances in parts per million parts of air by volume is 200. Concentrations of solvent vapor in the breathing zones of the machine operators and in the aisle west of the machines ranged from 25 to 50 parts per million. A temporary concentration of 200 ppm resulted when the operator of the No. 5 machine washed his hands and arms with the S.C. No. 100 solvent. On a time weighted average, all tests were below the permissible limit and no changes are required.

Cement Solvent (Cont'd)

There is no practical method of resolving a mixed solvent vapor into its various components to determine the concentration of each.

Asbestos Dust

Brake linings are produced in Department 16, Building 11. The mix, consisting of asbestos, fillers and binders, is trucked to this department. Operations include forming the mix into slabs, baking, splitting the slabs to necessary width and grinding to specified thickness.

The slitters and grinders had been provided with adequate local exhaust ventilation, but there was no exhaust ventilation on the forming machines. One operator stated that without an adjacent pedestal fan, the loading position would be untenable. Heavy accumulations of dust on surfaces in the area were noted. Although a dust test at this operation was below the permissible limit, the pedestal fans now in use should be replaced by suitable exhaust ventilation. Mr. K. E. Robinson, of this office, made specific recommendations regarding the provision of exhaust ventilation on the forming machines, in a letter dated January 25, 1960, to Mr. H. L. Avery.

Results of tests at slitting and grinding operations were below the permissible limit.

Permissible Limit for Asbestos Dust

The permissible limit is considered to be that of asbestos even though it is recognized that other substances are included in the formulation. The permissible limit for asbestos is 5,000,000 particles per cubic foot of air.

Results of Tests for Asbestos Dust

Test No.	Particles of Dust per Cubic Foot of Air	Remarks
12	3,000,000	Breathing zone of operator of Dry Mix (forming) Press No. 509. Air flow gusty from pedestal fan blowing north. Area appeared dusty.

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Results of Tests for Asbestos Dust (Cont'd)

Test No.	Particles of Dust per Cubic Foot of Air	Remarks
13	1,000,000	Breathing zone of operator of slitler and Gardner Grinder in southwest corner of Department 16. Pedestal fan directed west past operator. Local exhaust on machines.
14	1,000,000	Breathing zone of Blackman grinder operator in northeast corner of Department 16. Air flow 500 fpm, eight inches from exhaust slot.

Noise

Sound measurements were made at certain noisy operations indicated by management. Several measurements were made at representative bushing assembly operations in Department 72, Building 50. Various rubber and metal bushings are assembled rapidly by impact on a row of press-like machines. An overhead belt conveyor moves the parts to large duct-like hoppers, two of which supply each machine. Metal parts falling into these metal ducts produce the most noise when the ducts are empty. It would be possible to line the ducts or change the design to reduce the noise. However, the impact noise, occurring every 2-1/2 seconds, on each of the bushing assembly machines is only slightly quieter. Methods of attenuating impact noise of this type, and syntron vibrator noise on hoppers, have not been developed.

Noise at the Cumberland vinyl grinder in Department 1, Building 23, exceeded the tentative hearing damage risk criteria in six of the eight octave bands, with the noise predominating in the higher frequencies. A well-designed enclosure around this unit would probably reduce the sound to acceptable levels. One man tends the unit but he does not remain continuously at the machine.

Mandrels, around which high pressure lines are braided, are straightened in a small machine in Department 13, Building 27.

Noise (Cont'd)

Noise in the hearing zone of the operator slightly exceeded the criteria mentioned in three octave bands for most of the mandrels, but frequently there are mandrels that cause louder high frequency noise. The operator is the only man in the vicinity.

Since there are no practical methods to reduce the noise at some of these operations, and considering the small number of people and the expense involved in building enclosures at others, it is suggested that ear protection in the form of ear plugs, be provided the employees in question.

Enclosures around the machine in the Braider Room have reduced noise levels below the hearing damage risk criteria. It is believed that even better attenuation would be obtained if the openings were made as small as possible.

Permissible Limit for Noise

There is no generally accepted limit for noise in factories. A tentative hearing damage risk criteria, suggested by Bolt, Beranek and Newman, a group of noise consultants, may be found in the following table of noise tests. It should be pointed out that there is a strong move in the field to lower the level to 85 db in the 300-600 and 600-1200 octave bands instead of the 94 now being suggested.

Noise Level Measurements

See Table appended to this report.

EXPLANATORY NOTES

Method of Tests

TDI samples were collected in a solution of acetic and hydrochloric acid. Analysis was according to the method of K. Marcali, described in Analytical Chemistry, Volume 29, No. 4, April, 1957.

Tests for trichloroethylene were made with a Davis Halide Meter.

Method of Tests (Cont'd)

Solvent vapor concentrations were measured with a Davis Vaportester Model M-6. Molecular weight of the solvent was determined by the Victor Meyer method. The instrument was calibrated by using a dynamic apparatus to produce known concentrations of air-vapor mixtures. Essentially the dynamic apparatus operated by continuously injecting the solvent into a predetermined moving stream of air which vaporizes the solvent and assures a constant supply of the mixture.

Asbestos dust samples were collected with an M.S.A. Midget Impinger with butyl alcohol as the entrapping liquid. Counts were made in accord with the procedure outlined in U.S. Public Health Bulletin No. 217.

Measurements relating to noise were made with a Hermon Hosmer Scott Sound Level Meter Type 410-B, Serial No. 956, and Octave Band Analyzer Type 420-A, Serial No. 258.

Production Rate

Production was reported to be normal.

Bldg.	Dept. No.	Location and Remarks	Over-all Noise Level	Frequency Analysis							
			Decibels C	Decibels per Octave Band							
				20- 75	75- 150	150- 300	300- 600	600- 1200	1200- 2400	2400- 4800	4800- 9600
		Tentative Hearing Dam- age Risk Criteria (Bolt, Beranek and Newman).		110	102	96	94	94	94	94	94
50	72	Impact noise when met- al and rubber are join- ed at No. 5 bushing as- sembly machine. Impact every 2-1/2 seconds. in hearing zone of oper- ator.	112	98	89	100	103	108	109	100	103
50	72	Same as above, except at machine No. 4.	112	88	89	92	99	104	107	109	105
50	72	Syntron vibrator at bot- tom of bushing parts hopper containing part No. 76516 (inner shell).	96	86	85	92	89	90	92	94	90
50	72	Above vibrator with hopper empty.	100	93	84	89	92	94	92	91	84
50	72	Above parts dropping into hopper chute.	112								

Bldg.	Dept. No.	Location and Remarks	Over-all Noise Level	Frequency Analysis,							
			Decibels C	Decibels per Octave Band							
				20- 75	75- 150	150- 300	300- 600	600- 1200	1200- 2400	2400- 4800	4800- 9600
50	72	Parts No. 764322 (outer shell) dropping into empty hopper chutes at machine No. 1. This happens from one to three times per day.	114								
27	13	Hearing zone of mandrel straightener operator. Exceptionally loud wire passing through straightener.	101- 110	80	79	86	95	96	98	93	81
27	13	Hearing zone level between No. 1 and No. 2 machines in Braider Room.	95	87	82	90	88	88	90	88	80
23	1	Cumberland vinyl grinder - close to unit.	116	92	95	97	101	111	111	104	95

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