OxyChem® File - PASADENA **MEMO**

Industrial Hygiene

To: Distribution January 31, 1991

From: S. B. Kemp SBK/jcc

Subject: **Pasadena Assessment**

Attached is the final report of the Pasadena Industrial Hygiene Assessment. The assessment was conducted by a team of certified industrial hygiene consultants and OxyChem industrial hygiene staff.

I want to take this opportunity to formally thank the employees of the Pasadena plant for their cooperation in assisting to help this project go smoothly. This cooperative attitude is indicative of their successes in the past, and is, I am certain, the critical element in OSHA granting Star status.

SBK/jcc
Enclosure
Distribution: (Executive Summary)

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EMPLOYEE EXPOSURE MONITORING AT THE OCCIDENTAL CHEMICAL CORPORATION PVC RESINS PLANT PASADENA, TEXAS

Prepared for
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Foreword

This report was prepared under the management and supervision of the **RiskFocus** Division of VERSAR Inc., located in the Washington, D.C. metropolitan area. **RiskFocus** provides comprehensive *stewardship* for product integrity and registration, worker safety, waste disposal, regulatory interpretation and compliance, and risk communication.

Authorship of this report is credited to Edward A. Guida, PE, CIH. Significant contributions in sample collection and providing employee exposure observations were provided by Robert McKinley, CIH, Occusafe; John Davis, CIH, Occusafe; and Thomas Olendorf, IH, Occidental Chemical Corporation. Report quality assurance is credited to Robert G. Tardiff. Further information about this report may be obtained by writing directly to the Director, **RiskFocus** Division or by calling (703) 642-6884.

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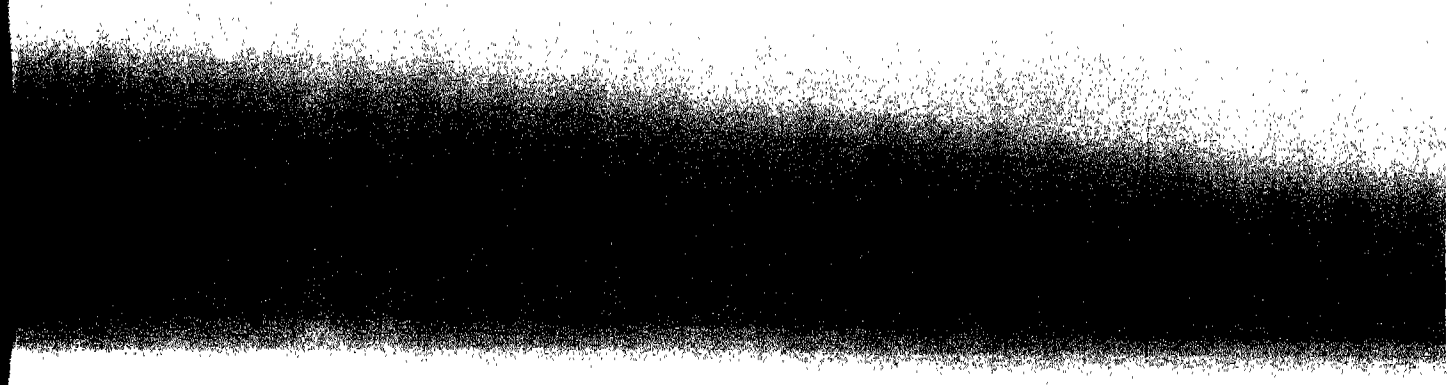

- Collection of air samples for chemicals, noise dosimetry, and measurement of area noise levels;
- Analysis of the air samples and noise data; and
- Evaluation of the sample results in relation to established criteria.

Exposure monitoring representative of employee exposures in the plant was conducted for chemical substances including PVC dusts, welding and zinc oxide fumes, and organic chemicals used in the laboratories and solution preparation area. Air sampling was accomplished using OSHA, NIOSH, or equivalent methodology. Noise monitoring was conducted using noise dosimeters. An area noise survey of the plant was also conducted to provide data that could be useful in developing recommendations to reduce noise levels.

Time weighted average airborne PVC dust levels exceeding the OSHA PEL were measured in the Dryer area. While dust levels in the PVC Loading area did not exceed the PEL, dusty conditions were observed for short periods of time. The high dust levels in both areas were caused by the use of compressed air to clean screens and magnets (Dryers) and the tops of rail cars (Loading area). Airborne dust can irritate or injure the eyes and obscure vision, and cause slipping on walking surfaces where dusts accumulate.

The Dryer operator was using a single-use disposable respirator ("paper mask") for protection against the airborne PVC dusts. These respirators, although certified by NIOSH, cannot be fit tested with a challenge agent. As a result, the quality of protection is unknown. **RiskFocus** recommended that Dryer operators be fit-tested and issued a NIOSH approved dust cartridge respirator, and that alternate cleaning methods be investigated to reduce the dust levels.

The results of the noise dosimetry revealed average noise levels that exceeded PELs in the Dryer, PVC Loading (including the rail car cleaners), Liquid Loading, the Bagging machine, and Recovery areas. These areas have been designated and posted as hazardous noise areas where hearing protection is required. Consistent wear of hearing protection was observed.

The Dryer blower noise was remarkable in that the noise was 108 dBA and was a pure tone at 600 Hz. While past efforts to reduce the noise emission have not been successful, efforts are continuing. Continued use of hearing protection with the highest Noise Reduction Rating (NRR) in this area was recommended.

The area noise survey confirmed where noise levels exceeding 85 dBA were possible and validated the posting of the hazardous noise warning signs. No additional recommendations resulted from these measurements.

II. Introduction

RiskFocus was retained to study the employee occupational exposures to PVC dusts, welding fumes, certain organic chemicals, and noise at the Occidental Chemical Corporation PVC Resins Plant (referred to in this report as the Pasadena Plant) in Pasadena, Texas. Two Certified Industrial Hygienists (CIHs) from Occusafe, Inc., and one Associate Industrial Hygienist from OxyChem Corporate Industrial Hygiene participated in the exposure monitoring activities. The objective of this study was to collect air samples and accomplish noise dosimetry during normal work activities that were representative of the employees' occupational exposures. Area noise levels were also measured to complement the noise dosimetry and to provide data generally useful in developing recommendations to reduce the harmful effects of hazardous noise.

The Pasadena Plant manufactures polyvinyl chloride (PVC) resins used for the production of pipes, wire insulation, automobile components, conduits, and home siding. The primary raw material is vinyl chloride monomer (VCM). The resin is transported from the plant via rail cars (90%), via trucks in bulk form (5%), and via trucks in bags (5%).

In 1990, about 185 full-time individuals were employed at this plant. PVC manufacture is a 24-hour per day process; production employees are assigned work groups and are scheduled to rotating shifts.

This report describes the results of the employee exposure monitoring conducted at the Pasadena PVC Plant. Section II, Methods and Criteria, describes the monitoring methods used including quality assurance and evaluation criteria. In Section III, Findings and Discussion, the results of the noise measurements and exposure monitoring in relation to criteria are discussed. The adequacy of existing means of controlling workplace levels are also discussed. In Section IV, conclusions regarding the employee exposures are reviewed and, where appropriate, recommendations are made to assure control of exposures at or below regulatory standards. The air sampling, noise dosimetry, and area noise level measurement summary tables are included in Appendix A. Air sampling and noise dosimetry/measurement procedures are described in Appendix B. Sampling and Analysis methodology is described in Appendix C. Quality control procedures are outlined in Appendix D.

III. Methods and Criteria

Sampling and analytical methods used for this study were either NIOSH- or OSHA-validated methods or methods identified by the IH laboratory as being equally valid methods. The individual sample results were used to calculate time-weighted-average (TWA) environmental measurements that were representative of employee exposure without regard to protective equipment worn. The TWA measurements were assessed by comparing the TWA levels to OSHA permissible exposure limits (PELs) to identify environmental conditions that could overexpose employees to chemicals or noise in the absence of, or failure to use, protective measures.

A. Sampling and Analysis

1. Air Sampling

Personal air samples for dusts, fumes, and organic chemicals were collected in job categories or in specific work areas to measure representative occupational exposures to these substances. Sampling and laboratory analysis followed validated or equivalent methods. Observations were made regarding work activities during the

sampling periods to be used in the assessment of typical exposures in the plant. Descriptions of the air sampling, including work activities, have been included in Appendix B, Air Sampling and Noise Dosimetry Procedures.

2. Air Sampling Trains

The air sampling trains consisted of DuPont Model Alpha 1's connected to the appropriate sampling media with tygon tubing. Filter cassettes were used to sample for dusts, fumes, and aerosols; they were installed in a cassette holder and connected to the tygon tubing with luer fittings. Sorbent tubes, used to sample for organic vapors, were installed in a tube holder and connected to the tubing with brass fittings.

3. Sampling and Analysis Methodology

The methods used to collect the samples of the substances listed below conformed to the appropriate NIOSH- or OSHA-validated, or equivalent, method. Brief descriptions of each method are included in Appendix C, Sampling and Analysis Methodology.

- PVC dusts;
- Welding fumes including zinc oxide fumes; and
- Organic Chemicals:
  - Carbon disulfide;
  - Isobutanol;
  - Isopropanol;
  - Cyclohexanone;
  - Dioctylphthalate;
  - Acetone; and
  - Varnish Makers' and Printers' (VM&P) Naphtha.

4. Noise Dosimetry and Area Noise Level Measurements

The Metrosonics Model db-3100s were used for personal noise dosimetry and area noise measurements. Noise dosimetry was performed by job category or in specific work areas to measure representative occupational noise exposures. Area noise levels were measured to be used in the assessment of typical noise levels found in this plant. The dosimetry procedures are described in Appendix B. The sampling and analysis of noise dosimetry are described in Appendix C.

B. IH Survey Criteria

Air and noise sample results were compared to OSHA permissible exposure limits (PELs).[1] PELs and any exceedance of a PEL are presented in the tables in Appendix A.

For working shifts greater than 8 hours, the PELs are adjusted to provide equivalent protection to exposed employees. The arithmetic adjustment for air contaminant PELs follows:

$$PEL_{SL} = \frac{PEL_8 \times 8}{SL}$$

Where: PEL_{SL} is the PEL for the longer shift length;
PEL_8 is the 8 hour TWA PEL;
8 is the shift length for the PEL_8; and
SL is the longer shift length in hours.

[1] OSHA, *Air Contaminants--Permissible Exposure Limits, OSHA 3112* (Title 29 Code of Federal Regulations Part 1910.1000), US Department of Labor, Occupational Safety and Health Administration, 1989.

Noise PELs cannot be adjusted for shift length arithmetically, as can the PELs for air contaminants, because the noise intensity to exposure duration relationship is exponential. The PELs for noise exposures for all shift lengths were calculated using the following logarithmic calculation.[2]

$$PEL_{SPL} = 90 + \frac{5\ (LOG\ 8 - LOG\ T)}{LOG\ 2}$$

Where: T is the shift length in hours;
90 is the noise PEL_8;
8 is the 8-hour shift length for the 90 dBA PEL_8;
5 is the doubling rate for the OSHA criterion; and
PEL_{SPL} is the noise PEL for the shift length.

C. Quality Assurance (QA)[3]

QA consists of quality control (QC) and quality assessment activities to ensure the quality and integrity of the employee exposure measurement data. The QC procedures, which include calibration, documentation, and validated methods, are outlined in Appendix D.

Quality assessment was performed throughout the exposure monitoring and data management by CIHs observing monitoring preparations and ensuring that

[2] This formula was derived from the Reference Duration formula used by OSHA to calculate exposure durations shown in Table G-16a, Appendix A: Noise Exposure Computation, *Occupational Noise Exposure*, Title 29 Code of Federal Regulations, Part 1910.95, amended March 8, 1983.

[3] Taylor, John Keenan; *Quality Assurance of Chemical Measurements*, Lewis Publishers, Chelsen, MI; 1988; p. 2.

calibration, documentation, review of activities, data report generation (dosimetry), and data reduction were properly accomplished.

The adjusted PELs for these substances are 10 mg/m^3 for total dust and 3.33 mg/m^3 for respirable dust. All measured dust levels were well below the adjusted PELs.

The results of this air sampling activity indicated that airborne dust levels in this work area during the loading activities were below PELs; however, cleaning the rail cars with compressed air entrains PVC dust in the air. Some PVC dust is suspended into the air during loading due to displacement when the resin flows into the rail car. These airborne dust levels can irritate or injure the eyes, obscure vision; dust accumulations on walking surfaces can cause slipping and falls. Wind direction can increase or decrease employee contact with dusts. Each loader wears a hard hat and safety glasses, and carries hearing protection for use when needed.

2. Rail Car Cleaners

The TWA PVC dust level measurements are summarized in Table 2, Car Cleaners. Airborne concentrations were 0.09 mg/m^3 and 0.14 mg/m^3 for total dust and 0.036 mg/m^3 and 0.25 mg/m^3 for respirable dust. The car cleaners worked 9-hour shifts during this IH survey. The adjusted PELs for these exposures are 13.33 mg/m^3 for total dust and 4.44 mg/m^3 for respirable dust. All measured dust levels were well below the adjusted PELs.

3. Dryer Operators

The TWA PVC dust level measurements are summarized on Table 3, Dryer Operators. Airborne concentrations ranged from 0.55 mg/m^3 to 10.25 mg/m^3 for total dust and 0.17 mg/m^3 to 0.46 mg/m^3 for respirable dust. The dryer operators worked 12-hour shifts. The adjusted PELs are 10 mg/m^3 for total dust and 3.33 mg/m^3 for respirable dust. All night-shift exposure levels and day-shift respirable dust concentrations were well below the applicable adjusted PELs. One dust measurement (sample numbers 91514 and 91526) exceeded the adjusted PEL; one measurement (sample numbers 91515 and 91527) exceeded one-half of the adjusted PEL. The IH

Laboratory noted loose particulates on the filter; these results could be underestimates of the actual airborne dust levels.

These high airborne PVC dust levels were measured during cleaning of dryer magnets and screens with compressed air. The airborne dust levels observed during these operations were also high; the air sample results confirmed these observations. Personal protection worn during this cleaning operation included a single-use disposable dust respirator, the 3M Model 8710 (NIOSH certification number TC-21C-132[4]). Employees were observed wearing other personal protective equipment including hard hats, safety glasses, and hearing protection.

Although the 3M 8710 respirator is NIOSH certified, the protection provided by this equipment is questionable because it cannot be fit-tested with a challenge agent. This respirator is a "paper mask," and the quality of the face to respirator seal cannot be determined. The use of a properly fit-tested NIOSH-certified dust cartridge respirator provides better protection against airborne dusts.

Dust levels need to be reduced during magnet and screen cleaning. Engineering controls for dust emission should be investigated. Engineering controls can reduce the reliance on respiratory protection.

Blowing components with compressed air for cleaning can increase airborne dust levels to the point of exceeding the OSHA PEL as well as causing possible eye and footing problems. A vacuum system would be a suitable alternative because it cleans components and collects PVC resin in a single step without suspending excessive dust levels in the air. Furthermore, area clean-up would be minimized. The existing vacuum system in the Dryer building should be investigated for possible

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[4] NIOSH, *Certified Equipment List as of December 31, 1989*, US DHHS, 1990.

modifications so it could be used to clean build-ups of fugitive resin emissions in the magnet area.

4. PVC Plant QC Laboratory

TWA chemical substance measurements are summarized in Table 4, PVC Plant QC Lab. Most of the exposures were below sample detection limits; the highest concentration was for acetone (1.2 ppm). The laboratory technicians work 12-hour shifts. The PELs shown in Table 5 were adjusted for the longer shift length. No airborne levels for these chemical substances above the adjusted PELs were measured during this survey.

Cyclohexanone can be readily absorbed through the skin, as evidenced by the "Skin" notation on the PEL. The laboratory technicians wore protective eye wear and gloves when using cyclohexanone to prevent skin contact.

5. PVC Baggers

The TWA PVC dust level measurements are summarized in Table 5, PVC Baggers. The total dust concentration was 0.82 mg/m^3, and the respirable dust concentration was 0.18 mg/m^3. The baggers worked 10- and 12-hour shifts. The adjusted PELs for these exposures are 12 mg/m^3 (10-hour shift) for the total dust and 3.33 mg/m^3 (12-hour shift) for the respirable dust. These airborne dust levels are below the applicable adjusted PELs.

6. Solution Preparation

TWA measurements for VM&P maphtha and isobutanol are summarized in Table 6, Solution Preparation. The airborne levels of VM&P naphtha and isobutanol were below the sample detection limit of 1.0 ppm. Employees using this substance worked 10-hour shifts. The adjusted PELs are 240 ppm for VM&P naphtha and 40 ppm for isobutanol. The airborne levels for these chemical substances were well below the adjusted PELs.

7. PVC Maintenance — Welding

TWA measurements for welding and zinc oxide fumes are summarized in Table 7, PVC Maintenance. The airborne concentrations of welding fumes were 0.023 mg/m^3 and 0.061 mg/m^3; the levels of zinc oxide fumes were 0.005 mg/m^3 and 0.055 mg/m^3. These welders worked 12-hour shifts. The adjusted PEL for welding fumes and for zinc oxide is 3.33 mg/m^3. The fume levels measured were well below the adjusted PEL.

8. QC and Environmental Laboratory

The short term exposure limit (STEL) and TWA carbon disulfide (morning) measurements are summarized in Table 8, QC and Environmental Lab. The STEL measurement was less than 0.23 ppm and the TWA measurement was 0.26 ppm. The laboratory technician worked 8-hour shifts. The STEL-PEL is 12 ppm, the TWA-PEL is 4 ppm. The airborne carbon disulfide levels were well below the PELs.

The PEL for carbon disulfide has a "Skin" notation indicating that it can readily be absorbed through the skin. The technician wore gloves and performed the work in a laboratory hood thereby preventing skin contact and controlling airborne exposures.

B. Noise Dosimetry

The TWA noise measurements are summarized in Table 9. For the purpose of this survey, only TWA data are used to evaluate exposures to noise. The TWA noise measurement integrates all noise measured above 80 dBA by the dosimeter. For those shifts in excess of 8 hours, the exposure limits shown in Table 9 have been adjusted accordingly.

Noise levels exceeding 85 dBA were found in several areas of this plant. Levels of 85 dBA or higher were measured in the following areas: Dryer, PVC Loading, Liquid Loading, PVC Bagging, Reactor, and Recovery.

A hearing conservation program is in place at the Pasadena Plant. Hazardous noise areas were posted, and hearing protection was worn by employees and visitors. Many forms of hearing protection were available including several kinds of ear plugs, semi-insert hearing protectors, and ear muffs. The employees carried hearing protection as a part of their safety equipment ensemble, and consistent use of hearing protection in the designated hazardous noise areas was observed during this survey.

The available hearing protection devices were judged to be adequate to protect employees from the adverse effects of the high intensity noise at this location. The lowest noise reduction rating (NRR) noted on a hearing protection device (the semi-insert hearing protector) equalled 22 dBA. Using the OSHA method to estimate protection,[5] the adjusted NRR equalled 15 dB. The highest TWA noise measured was 97 dBA on a PVC Rail Car Loader during a night shift (sample number 91558). Reducing this exposure by 15 dB results in a level of 82 dBA, or 5 dB below the PEL-TWA_{12} of 87 dBA. Use of ear plugs and/or ear muffs with higher NRRs would improve the level of protection.

In the Dryer area of the plant, noise levels were noticeably higher and of a unique quality. At Dryers numbers 1 and 3, blowers emit a pure tone of 600 Hertz (Hz) at about 108 dBA. Employees working in the Dryer area and the rail car loading area (which includes rail car loaders and rail car cleaners) are exposed to this noise emission. TWA levels in excess of the OSHA PEL in these areas were the

[5] Which involved subtracting 7 dB from the NRR before subtracting the NRR from the measured noise exposure from OSHA, *Occupational Noise Exposure*, Appendix B, Title 29 Code of Federal Regulations Part 1910.95, US Department of Labor, Occupational Safety and Health Administration, 1983.

result of these high-level noise emissions. Personnel working in these areas were observed wearing hearing protection devices.

According to OxyChem, efforts to control the noise emissions from the Dryer blowers are ongoing. It is our understanding that past efforts with passive noise suppression devices have not been effective because of maintenance problems and clogging with PVC resin. OxyChem engineers are continuing to investigate alternative methods to reduce the noise emissions.

During the day shift on December 13, 1990, one of the Liquid Loading employees was exposed to a TWA noise level of 92 dBA. A night shift TWA measurement for an employee in this area was 77 dBA. The difference in level was attributed to different tasks performed during each shift. The lower level resulted from work activities that included filling tank trucks and operating a locomotive for about one hour, and working in the Liquid Loading control room and office for the remainder of the shift. The higher level was the result of work in the Liquid Loading area during the work shift that included filling tank cars, switching rail cars, operating a "trackmobile," and other rail movement conditions of varying noise intensity. This employee wore hearing protection during his activities in the Liquid Loading area and while operating the trackmobile.

The PVC Baggers worked where TWA noise levels were measured as 89 dBA and 91 dBA for 12-hour work shifts (samples numbers 91564 and 91571). Both levels exceeded the OSHA PEL_{12} of 87 dBA. The Bagging machine area had been designated a hazardous noise area, and the Baggers were observed wearing hearing protection devices.

The Recovery operator worked where the TWA noise level was recorded as 88 dBA (sample number 91551) which exceeded the PEL_{12} of 87 dBA. The Recovery

operator worked a 12-hour shift. The Recovery area had been designated a hazardous noise area, and hearing protection was worn by personnel.

C. Area Noise Survey

The area noise survey confirmed where noise levels exceeding the PELs were possible, and validated the posting of hazardous noise signs in specific areas of the plant. The survey data are summarized in Table 10, Area Sound Level Measurements Summary.

Control rooms in the steam generating plant were relatively quiet. Boilers and supporting equipment emitted noise as high as 101 dBA, thereby justifying identifying these areas as hazardous noise areas and requiring the use of hearing protection devices. Noise dosimetry showed that average noise levels were below the PELs because the employees assigned to this work area did not spend a majority of their working day outside of the control rooms.

Little or no high noise emissions were measured in the maintenance shops. These employees performed tasks throughout the plant, and hence were potentially exposed to noise in other locations. These employees follow hearing conservation procedures, and carry hearing protection devices with them as they move about the plant.

Noise emissions from the PVC Bagging equipment ranged from 86 dBA to 95 dBA. The highest noise levels existed at the bag loading station: a compressed air device emitted 95 dBA. This work area had been identified as a hazardous noise area; the dosimetry and these sound level emission measurements confirmed the appropriateness of this designation.

Equipment in the Refrigeration Compressor and the Recovery areas emit high intensity noise. A noise level exceeding the adjusted PEL was measured in the Recovery Area with noise dosimetry. These areas are posted as hazardous noise areas where hearing protection is required.

The PVC Loading and Dryer areas are affected by the blowers at Dryers #1 and #3. A peak noise level of 108 dBA was measured at the Dryer area. A level of 106 dBA was measured at the Loading area. These areas are posted as hazardous noise areas, and hearing protection devices are required to be worn in these locations.

V. Conclusions and Recommendations

Conclusions regarding employee exposures at the Pasadena Plant will be presented by exception. Where measurements were found to be below the applicable limits, existing employee protection strategies were considered adequate, and no further comments are provided. Recommendations to protect employees from levels exceeding PELs are provided, where needed.

A. Air Sampling

1. PVC Loading

No PVC dust levels exceeding the PELs were measured during this survey. However, air entrainment of PVC dust in the work environment was observed during rail car cleaning with compressed air and during loading.

Recommendation:

Provide effective means to clean the rail cars that minimize airborne dust and prevent the build-up of dust residuals on walking surfaces.

2. Dryer Operators

Dryer operators levels of dusts (total) were above the PEL during magnet cleaning with compressed air. High dust entrainment in the environment during this cleaning operation was also observed. Personal protection included single use disposable dust respirators. The adequacy of this respiratory protection is questionable. The quality of the face to facepiece seal was unknown.

Reduction of airborne levels of PVC dust during screen and magnet cleaning is needed. Feasible engineering controls should be investigated and installed to reduce airborne dust levels and to reduce the reliance on respiratory protection. A properly fitted NIOSH-certified cartridge dust respirator should assure that employees are protected from airborne dust levels until feasible engineering controls are identified and installed.

Recommendations:

Fit-test Dryer operators with NIOSH-certified cartridge dust respirators. Issue respirators according to the results of the fit-tests.

Provide effective means to clean the screens and magnets to minimize airborne dust and prevent the build-up of dust residuals on walking surfaces.

B. Noise Dosimetry

Noise levels exceeding the PELs were measured in the Dryer, the PVC Loading, Liquid Loading, the Bagging machine, and Recovery areas. Two Dryer blowers emitted a noise level as high as 108 dBA, which affected the Loading area; the Bagging machine emitted 86-95 dBA; the Recovery equipment emitted 79-92 dBA. These areas were designated hazardous noise areas, and signs were posted requiring

the wearing of hearing protective devices. Wearing of hearing protection devices was observed consistently.

Dryer blower noise was the highest noise level encountered during this monitoring survey. The sound emitted was a pure tone at 600 Hz.

Recommendations:

Employees should wear properly fitted ear plugs and/or ear muffs when working in this area.

Continue efforts to reduce the noise emissions at the blowers.

C. Area Noise Survey

The area noise survey confirmed where exposures to noise levels exceeding the PELs are possible, and validated the posting of hazardous noise signs in specific areas of the plant. At the Dryers, the sound levels exceeded 100 dBA, and maximal hearing protection procedures would be advisable. No additional recommendations are needed.

References

VI. References

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Appendices

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Appendices

Appendix A

Air Sampling and Noise Dosimetry Summary Tables

TABLE 1. PVC Loaders

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (mg/m^3)	Permissible Exposure Limit (mg/m^3)	Exposure Limit Exceeded?
91503 91508	12/10/90	N/12	671	452-78-8742	PNOC - total	0.64	10	No
91501 91509	12/10/90	N/12	665	456-29-7955	PNOC - total	0.20	10	No
91511 91523	12/11/90	D/12	658	464-66-8596	PNOC - total	0.17	10	No
91512	12/11/90	D/12	374[2]	458-90-7831	PNOC - total	0.74	10	No
91534 91542	12/11/90	N/12	660	530-42-9020	PNOC - resp.	0.09	3.33	No
91533 91541	12/11/90	N/12	660	453-66-6287	PNOC - resp.	0.06	3.33	No
91546 91608	12/12/90	D/12	542	458-90-7831	PNOC - resp.	0.11	3.33	No
91605 91607	12/12/90	D/12	612	464-66-8596	PNOC - resp.	0.10	3.33	No

[1] N: night; D: day.
[2] Sampling stopped; no loading to shift end.

TABLE 2. Car Cleaners

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (mg/m^3)	Permissible Exposure Limit (mg/m^3)	Exposure Limit Exceeded?
91530 91629	12/13/90	D/9	489	453-29-8362	PNOC - total	0.09	13.33	No
91531 91630	12/13/90	D/9	490	456-27-2692	PNOC - total	0.14	13.33	No
91545 91610	12/12/90	D/9	478	456-27-2692	PNOC - resp.	0.25	4.44	No
91606 91609	12/12/90	D/9	495	453-29-8362	PNOC - resp.	0.036	4.44	No

[1] N: night; D: day.

TABLE 3. Dryer Operators

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (mg/m^3)	Permissible Exposure Limit (mg/m^3)	Exposure Limit Exceeded?
91502 91510	12/10/90	N/12	663	465-96-3795	PNOC - total	0.55	10	No
91504 91506	12/10/90	N/12	670	436-94-0482	PNOC - total	1.72	10	No
91515 91527	12/11/90	D/12	626	462-27-7547	PNOC - total	7.5[2]	10	No
91514 91526	12/11/90	D/12	649	237-72-5255	PNOC - total	10.25[2]	10	Yes
91516 91537	12/11/90	N/12	659	457-72-9074	PNOC - resp.	0.27	3.33	No
91507 91540	12/11/90	N/12	675	461-70-7987	PNOC - resp.	0.46	3.33	No
91547 91611	12/12/90	D/12	606	462-27-7547	PNOC - resp.	0.17	3.33	No
91548 91612	12/12/90	D/12	596	237-72-5255	PNOC - resp.	0.54	3.33	No

[1] N: night; D: day.
[2] Loose particles in Sample - may be underestimation.

TABLE 4. PVC Plant QC Lab

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (ppm)	Permissible Exposure Limit (ppm)	Exposure Limit Exceeded?
91529 91538	12/11/90	N/12	422[2]	467-56-4285	Isopropanol Acetone	<1.0 1.2	267 500	No No
91536 91539	12/11/90	N/12	660	453-66-1628	Cyclohexanone	<0.03	16.7(S)[3]	No
91620 91628 91631	12/13/90	D/12	532	453-64-9742	Dioctyl phthalate (DOP)	<0.005[4]	3.33[4]	No
91616	12/13/90	D/12	209	459-82-3507	Acetone	<1.0	500	No
91626	12/13/90	D/12	344	453-64-9742	Cyclohexanone	0.17	16.7(S)[3]	No

[1] N: night; D: day.
[2] Pump failed during collection of sample 91529; duration for sample 91538.
[3] S: Skin notation
[4] mg/m^3

TABLE 5. PVC Baggers

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (mg/m^3)	Permissible Exposure Limit (mg/m^3)	Exposure Limit Exceeded?
91513 91525	12/11/90	D/10	587	573-35-6332	PNOC - total	0.82	12.0	No
91615 91624	12/13/90	D/12	612	464-06-6489	PNOC - resp.	0.18	3.33	No

[1] N: night; D: day.

TABLE 6. Solution Preparation

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (ppm)	Permissible Exposure Limit (ppm)	Exposure Limit Exceeded?
91618 91627	12/13/90	D/10	501	460-94-6563	VM & P Naphtha	<1.0	240	No
91528	12/11/90	D/10	542	452-50-3755	Isobutanol	<1.0	40	No

[1] N: night; D: day.

TABLE 7. PVC Maintenance

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (mg/m^3)	Permissible Exposure Limit (mg/m^3)	Exposure Limit Exceeded?
91517 91521	12/11/90	D/12	478	423-40-5365	Welding fume Zinc Oxide	0.021 0.005	3.33 3.33	No No
91602	12/12/90	D/12	444	450-94-8237	Welding fume Zinc Oxide	0.058 0.055	3.33 3.33	No No

[1] N: night; D: day.

TABLE 8. QC and Environmental Lab

Sample Number	Sampling Date	Work[1] Shift/ Length	Sample Duration (Min.)	Employee ID	Material	TWA (ppm)	Permissible Exposure Limit (ppm)	Exposure Limit Exceeded?
91617	12/13/90	D/8	15[2]	434-72-8393	Carbon disulfide	<0.23	12(S)[3]	No
91617 91619	12/13/90	D/8	203[4]	434-72-8393	CS_2	0.25	4(S)[3]	No

[1] N: night; D: day.
[2] STEL Sample
[3] S: Skin notation
[4] TWA with STEL sample, morning exposure measurement, no afternoon exposure.

TABLE 9. Employee Noise Exposures
Pasadena PVC Plant

Sample Number	Sampling Date	Work[1] Shift/ Length	Work Area	Job Title	Sampling Time (hrs:min)	TWA (dBA)	Permissible Exposure Limit (dBA)	Exposure Limit Exceeded?
91555	12/10/90	N/12	Dryer area	Operator technician	11:02	93	87	Yes
91556	12/10/90	N/12	Dryer area	Operator technician	12:01	88	87	Yes
91574	12/13/90	D/8	F-8 boiler area	Boiler operator	7:30	81	90	No
91559	12/10/90	N/10	Liquid loading	Operator technician	8:30	77	88	No
91569	12/13/90	D/8	Liquid loading	Liquid loader	7:02	92	90	Yes
91562	12/11/90	D/8	Maintenance main	Maintenance technician	6:24	79	90	No
91561	12/11/90	D/8	Offsites	Steam plant operator	5:21	83	90	No
91557	12/10/90	N/12	PVC loading	Operator technician	8:52	88	87	Yes
91558	12/10/90	N/12	PVC loading	Operator technician	11:19	97	87	Yes
91563	12/11/90	D/12	PVC loading	PVC loader	6:49	87	87	No
91564	12/11/90	D/12	PVC loading	PVC Bagger	6:51[2]	89	87	Yes
91571	12/13/90	D/12	PVC loading	PVC Bagger	9:58	91	87	Yes
91572	12/13/90	D/8	PVC loading	Car cleaner	7:00	91	90	Yes
91573	12/13/90	D/8	PVC production	Car cleaner	7:52	89	90	No
91565	12/11/90	D/12	PVC production	Dryer operator	9:28	96	87	Yes
91566	12/11/90	D/12	PVC production	Bottom reactor operator	9:27	87	87	No
91567	12/11/90	D/12	PVC production	Recovery operator	9:24	86	87	No
91552	12/10/90	N/12	Reactor bottom	Operator technician	7:52[2]	85	87	No
91553	12/10/90	N/12	Reactor deck	Operator technician	10:49	86	87	No
91554	12/10/90	N/12	Reactor deck	Operator technician	10:57	85	87	No
91551	12/10/90	N/12	Recovery	Operator technician	10:34	88	87	Yes

[1] N: night; D: day.
[2] Microphone had become disconnected for part of dosimetry period.

TABLE 10. Area Sound Level Measurements Summary

Area	Location	Noise Source	dBA
Steam Plant	Control Room	Background	59-60
	Steam Plant Area	Equipment	82-96
F-8 Boiler	Control Room Desk	Background	67
	Boiler Area	Equipment	83-101
PVC Maintenance Shop	Shop Area	Background, Equipment	60-82
Main Machine Shop	Office	Background	61
	Shop Area	Background	63-68
PVC Bagging Machine	Bagger Station	Vacuum, Conveyor	90-91
	Bagger Station	Compressed Air	95
	Stacking End of Conveyor	Conveyor	86-87
	Weighing Scale	Conveyor, Compressed Air	86-88
Refrigeration Compressor Area	Area	Equipment	85-95
PVC Loading	Locomotive RE1255	Locomotive	87-92
	Locomotive RE506	Locomotive	80-81
	Area	Dryer Blowers	90-106
Recovery Area	Area	Equipment	79-92
Dryer Area	Area	Blowers, Equipment	87-108

Appendix B

Air Sampling and Noise Dosimetry Procedures

A. Air Sampling Procedures

1. PVC Loading

Seven day-shift and eight night-shift personal air samples for PVC dusts (identified as PNOCs) were collected on rail car loaders. Four of the day-shift and four of the night-shift samples were for respirable dust collected using cyclones.

The PVC Loading area is an outdoor environment and these employees load PVC resin material into Rail Cars from overhead silos. The loader controls the resin flow through a flexible duct from the silo to the rail car loading port. Other employees operate the locomotive to process rail cars through the loading area. The loader clears apparent "clumping" with a long rod. Loaders also clean the loading area with compressed air and wash the tops of the rail cars.

2. Rail Car Cleaners

Eight day-shift air samples for PVC dusts were collected on the rail car cleaners. Four of these air samples were for respirable dust collected using cyclones.

Rail car cleaning is an outdoor task done in the general area of PVC Loading. The cleaning process is performed with a vacuum system and does not generate high airborne dust levels; cleaners are exposed to the dusts generated from the loading process.

3. Dryer Operators

Eight day-shift and eight night-shift air samples for PVC dusts were collected on the Dryer operators. Half of these air samples were for respirable dust collected using cyclones.

There are six dryer buildings at the Pasadena plant. Dryer operators check the dryer operations, adjust the steam on the screens, clean the screens and magnets with compressed air, and scrape the bins.

4. PVC Plant QC Laboratory

Eleven personal air samples for acetone, dioctylphthalate, isopropyl alcohol (isopropanol), and cyclohexanone were collected on the laboratory technicians.

The laboratory technicians conduct various quality control tests on the raw materials and finished products. They use laboratory quantities of several chemicals and they accomplish most of their procedures under laboratory ventilation hoods. The use of isopropanol, acetone, cyclohexanone, and dioctylphthalate was considered the most significant potential hazard in this laboratory.

5. PVC Baggers

Four day-shift personal air samples for PVC dusts were collected on the PVC Baggers. Two of the samples were for respirable dust collected using cyclones.

About 5% of the PVC resin material shipped from the Pasadena Plant is shipped in bags by truck. The bagging operation includes the filling of bags with resin, marking the bags, and placing the bags on shipping pallets.

6. Solution Preparation

Two air samples for varnish makers' and printers' naphtha (VM&P naphtha) and one air sample for isobutanol were collected on Solution Preparation employees.

Solution preparation operations during the sampling involved the preparation of LD Catalyst and LB Catalyst and the use of AK 20 Catalyst. VM&P naphtha and isobutanol were the regulated substances identified in this process area.

7. PVC Maintenance — Welding

Three day-shift personal air samples for welding fumes and zinc oxide were collected on PVC Maintenance Shop welders.

Operations performed during this sampling involved welding on stainless steel using tungsten inert gas (TIG), referred to as heliarc by the shop personnel, "stick" welding on stainless steel, and a small amount of TIG welding on galvanized steel.

8. QC and Environmental Laboratory

Two day-shift personal air samples for carbon disulfide were collected on a laboratory technician during the processing of VCM monitors. One sample was collected for 15 minutes to measure the "short term exposure limit" (STEL). The other sample was collected during the remainder of the morning; afternoon work did not involve exposure to carbon disulfide.

The laboratory technician oversees the collection of VCM air sampling in the Pasadena Plant. Reiszner diffusion monitors are used to measure employees' exposures to VCM. The technician issues the monitors, prepares and maintains documentation, and analyzes the air samples. The analysis procedures include desorbing the activated charcoal collection media with carbon disulfide and processing the carbon disulfide with a GC/FID.

B. Noise Dosimetry Procedures

Noise dosimetry was performed on employees throughout the plant during the week of December 10, 1990; day and night-shift exposures were measured. Metrosonics Model db-3100 noise dosimeters were used to measure exposures during full working shifts. While the Metrosonics dosimeters with the Metrosonics computer software was capable of extensive evaluation of the collected noise data, only the TWA noise level measurement capability was used to evaluate average noise levels at the Pasadena Plant. The data has been retained on the Pasadena Plant Safety Department computer for future reference and data analysis. Three shift lengths were encountered during the noise dosimetry: 8-hour work shifts, a 10-hour work shift, and 12-hour work shifts.

Appendix C

Sampling and Analysis Methodology

A. Air Sampling Methods

1. Welding Fumes and Zinc Oxide

Welding fumes and zinc oxide were collected on 0.8 micron (µm) pore size, mixed cellulose ester (MCE), 37 millimeter (mm) diameter filter and analyzed by atomic absorption (AA) according to OSHA ID Method 121. The IH Laboratory analyzed welding fumes and zinc oxide on the same filter.

2. Particulates Not Otherwise Classified (PNOCs)

PNOCs were collected on pre-weighed 5.0 µm, polyvinyl chloride (PVC), 37 mm filters. A cyclone attached to the air sampling filter cassette was used to separate and collect the respirable particulates on the filter. Total PNOCs (particles of all sizes) were collected on a filter cassette without the cyclone. These samples were collected and gravimetrically analyzed by measuring the filter weight increase according to NIOSH Methods 0500 (total) and 0600 (respirable). For this project, PVC dusts were collected as PNOCs (respirable and total), and air concentrations of PVC dust were compared to PNOC permissible exposure limits as a surrogate.

3. Carbon Disulfide

Carbon disulfide was collected on charcoal sorbent tubes and analyzed by gas chromatograph according to NIOSH Method 1600 (modified).

4. Cyclohexanone

Cyclohexanone was collected on charcoal sorbent tubes and analyzed by a gas chromatograph with a flame ionization detector (GC/FID) according to the laboratory's equivalent to OSHA Method 7.

5. Acetone

Acetone was collected on charcoal sorbent tubes and analyzed by GC/FID according to the laboratory's equivalent to OSHA Method 07.

6. Dioctylphthalate (DOP)

DOP was collected on a 37 mm glass fiber filter and analyzed according to a method provided by the IH Laboratory.

7. Isopropanol

Isopropanol was collected on charcoal sorbent tubes and analyzed by GC/FID according to laboratory's equivalent to OSHA Method 07. Isopropanol was sampled on the same charcoal tube as acetone.

8. Isobutanol

Isobutanol was collected on charcoal sorbent tubes and analyzed by GC/FID according to laboratory's equivalent to OSHA Method 07.

B. Calculations

Time-weighted-average (TWA) exposure measurements were calculated over the sampling period by the following equation:

$$TWA = \frac{(X_1 \times T_1) + (X_2 \times T_2) + \ldots (X_n \times T_n)}{T_1 + T_2 + \ldots T_n}$$

Where: TWA is the time-weighted-average exposure measurement;
X is the air sample result for sample n[1]; and
T is the sample collection duration for sample n.

C. Noise Dosimetry

Time-weighted-average noise exposures were measured with the Metrosonics Model db-3100 Noise Dosimeters, Model CL304 calibrator, and data system. The dosimeters were configured to integrate the noise according to 8- or 12-hour work shifts. The electronic data was "downloaded" into the data system for report generation.

The Metrosonics dosimeters are Type II sound level meters with time integration electronic data logging capabilities. The dosimeters provided TWA sound pressure levels in A-weighted decibels (dBA). The configuration also included "slow" response, a criterion level of 90 dBA, and a doubling rate of 5 dBA to conform to the OSHA Occupational Noise Exposure standard (29 CFR 1910.95).

[1] Where the sample result was less than the quantitation limit, the quantitation limit was divided by the square root of 2 to use it in this calculation according to procedures described in *Applied Occupational and Environmental Hygiene* (5) 1, pp. 46-51.

D. Area Noise Measurements

Area noise was measured with the Metrosonics Model db-3100 Noise Dosimeter, in the noise survey mode, and the Model CL304 calibrator. This mode measured A weighted sound in decibels (dBA) at slow response.[2]

[2] OSHA, *Occupational Noise Exposure*, 29 CFR 1910.95, US DoL, amended March 8, 1983.

Appendix D

Quality Control Procedures

The following quality control procedures were used to ensure the quality and integrity of employee exposure measurement data.

A. Calibration

Each air sampling train, noise dosimeter, and noise dosimeters used as sound-level-meters was calibrated using the procedures set forth below before and after measurement/sampling and intermittently during measurement/sampling.

The air sampling trains were calibrated with precision, variable area rotameters. The rotameter measurement range was matched to the sampling technique such that rotameter readings exceeded 20 percent of full scale. Rotameter records indicated that these rotameters had been calibrated against a primary reference standard, the Buck Bubble Meter Calibrator, within six months prior to the survey.

Noise measurement equipment was calibrated using electronic calibrators provided with the dosimeters. Equipment records indicated that these calibrators had been calibrated at the factory within the twelve months prior to the Pasadena Plant survey.

B. Chain-of-Custody

All records were prepared and maintained using chain-of-custody procedures throughout sample collection, handling, shipping, and IH Laboratory analysis.

C. Sample Numbers

Each air sample and noise dosimetry measurement was given a unique identification number. These numbers were used to prepare exposure measurement data collection forms, Chain-of-Custody records, and time-weighted-average measurement determinations. Each blank sample was also given an identification number.

D. Blank Sample Media

Blank sample media were submitted to the IH laboratory along with the air samples. The laboratory was blind as to the origin of the sample blank. The average blank values were subtracted from the air sample results during data reduction.

E. Methods

The air sampling methods used for this survey were either NIOSH- or OSHA-validated methods or methods deemed to be equivalent by the IH laboratory performing the analysis. These methods were described in Appendix C.