DIOXIN REGISTRY REPORT

WALK-THROUGH SURVEY OF PENTACHLOROPHENOL PRODUCTION FACILITY

AT

VULCAN MATERIALS COMPANY
Chemical Division
Wichita, Kansas

DATE OF SURVEY:
August 22-26, 1983

SURVEY CONDUCTED BY:
David Marlow
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REPORT WRITTEN BY:
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PURPOSE OF SURVEY:	To obtain personnel and medical records for those employees who worked in the pentachlorophenol production process, conduct an industrial hygiene survey of the process and collect past industrial hygiene data pertaining to the process. This information will be used in the cohort mortality study of production workers.
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EMPLOYEE REPRESENTATIVE:	Gerald Walters, President, International Union of Operating Engineers, Local #119-AFL-CIO
NIOSH REPRESENTATIVES:	Marilyn Fingerhut, Epidemiologist, IWSB David Marlow, Industrial Hygienist, IHS, IWSB
STANDARD INDUSTRIAL CLASSIFICATION:	2865 - Primary Manufacturer

ABSTRACT

A site visit was conducted at Vulcan Materials Company, in Wichita, Kansas from August 22-26, 1983. This plant produces pentachlorophenol, beginning in 1958 through the present. It was determined during this visit that the pentachlorophenol workers are suitable for inclusion in the Dioxin Registry.

The report includes a description of the review and microfilming of personnel and medical records for those persons who worked in the pentachlorophenol production process. The report also includes a description of the pentachlorophenol process, a summary of analyses of pentachlorophenol product for hexa-, hepta-, and octachlorodibenzo-p-dioxins, and industrial hygiene sampling results for airborne concentrations of pentachlorophenol, hexa-, hepta-, and octachlorodibenzo-p-dioxin from company records and from a survey conducted by a NIOSH industrial hygienist during the site visit.

INTRODUCTION

The Dioxin Registry defines a cohort of workers who are identified by company records as having worked in the production of chemicals with a known potential for chlorodibenzo(p)dioxins contamination. Because production of these chemicals is not labor-intensive, all U.S. production sites with adequate personnel records are included in the Registry.

Vulcan Materials Company produces pentachlorophenol which has a known potential for contamination by hexachlorodibenzo(p)dioxins (HxCDD), heptachlorodibenzo(p)dioxins (HpCDD) and octachlorodibenzo(p)dioxin (OCDD).

Technical grade pentachlorophenol, which is known to be contaminated with chlorinated dibenzo-p-dioxins and dibenzofurans has been shown to cause adverse effects in rat livers.[1,2] Irritation of the eyes, nose and upper respiratory tract, sneezing, coughing, weakness, anorexia, weight loss, sweating, headaches, dizziness, nausea, vomiting, dyspnea, chest pains, and dermatitis have been seen in humans exposed to technical grade pentachlorophenol.[3] A good overview of the toxicity and health effects of pentachlorophenol can be found in an article by Williams.[4]

From August 22-26, 1983, representatives of NIOSH personnel conducted a site visit at Vulcan Materials Company in Wichita, Kansas. Personnel, industrial hygiene, and medical records were reviewed and microfilmed. In addition, an industrial hygiene survey was conducted during two eight-hour shifts to assess the current level of exposure to pentachlorophenol of the workers associated with the pentachlorophenol production process.

DESCRIPTION OF THE PENTACHLOROPHENOL PRODUCTION FACILITY

Pentachlorophenol (PCP) production was initiated in the Agricultural Chemical Section of Frontier Chemical in Wichita, Kansas in January 1958 and has continued to the present time. The PCP operation is located in a structure of approximately 5000 square feet. The structure is a four level steel structure enclosed on two sides with sheet metal panels. The control room is located on the fourth level. The reactor area, and adjacent outside loading and unloading areas, are located on approximately 1/6 of an acre.

DESCRIPTION OF THE PENTACHLOROPHENOL PRODUCTION PROCESS

Vulcan produces PCP in a batch process. The raw materials used in the process are phenol, crude phenol (partially chlorinated phenol), anhydrous aluminum chloride (as a catalyst), and sodium hydroxide for neutralization purposes.

Phenol and crude phenol are shipped to the plant in train tank cars. The phenol arrives at the plant frozen and is melted by heat in the tank car to 50°C with low pressure steam. The phenol is pumped from the tank car to insulated storage tanks where it is maintained at 50°C. The crude phenol has a higher freeze point than phenol and requires heat to melt it only during the winter months. The crude phenol is pumped from the tank cars to

insulated storage tanks, separate from the phenol storage tanks, and maintained at 30°C. When producing a batch of PCP the feedstock is either crude phenol or phenol, never a mixture of the two. Crude phenol is used continuously to produce PCP until the stock is used up. Then phenol is used until more crude phenol arrives at the plant. Vulcan used crude phenol in 1978 to 1983; before this time phenol was solely used as the feedstock. Table 1 list the years and the approximate usage of crude phenol. The only difference in operating conditions between a batch of PCP produced by phenol as compared to a batch of PCP produced by crude phenol is that the primary chlorinator is run approximately 5°C higher for a crude phenol batch.

Table 1

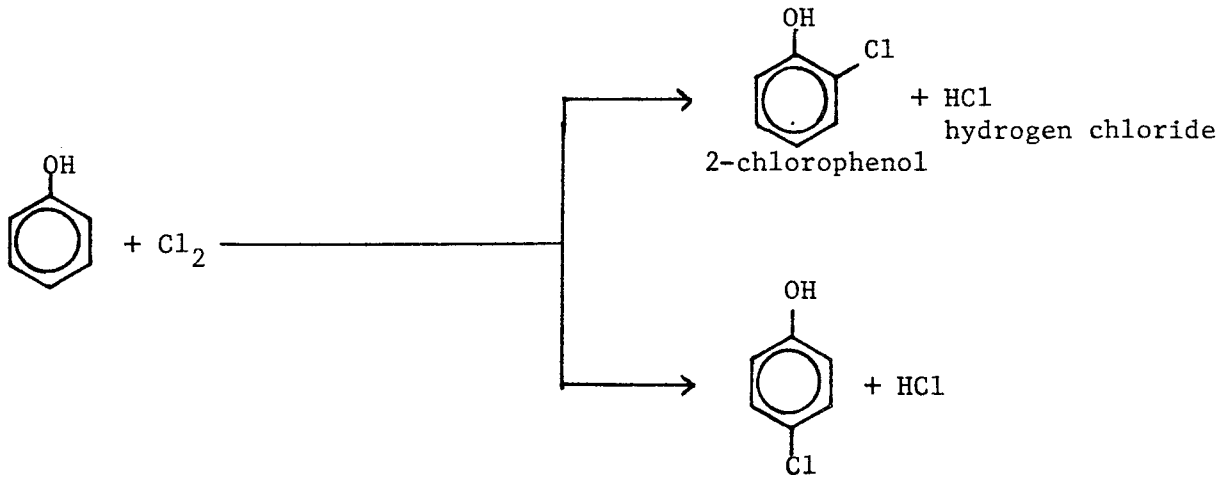
Years and Approximate Percentages
of Usage of Crude and Pure Phenol
Vulcan Materials Company
Wichita, Kansas

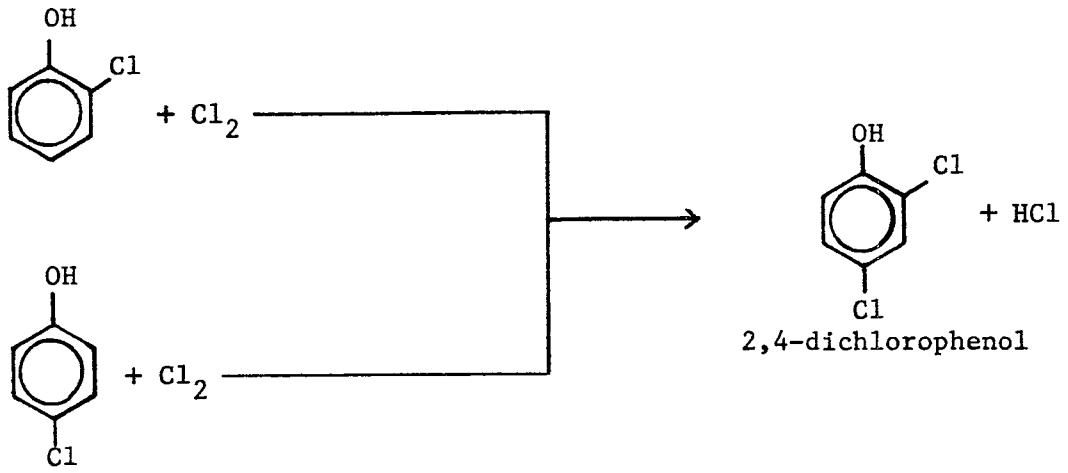
YEAR	APPROXIMATE % USAGE CRUDE	PURE
1978	50	50
1979	60	40
1980	60	40
1981	60	40
1982	75	25
Through: July 1983	85	15

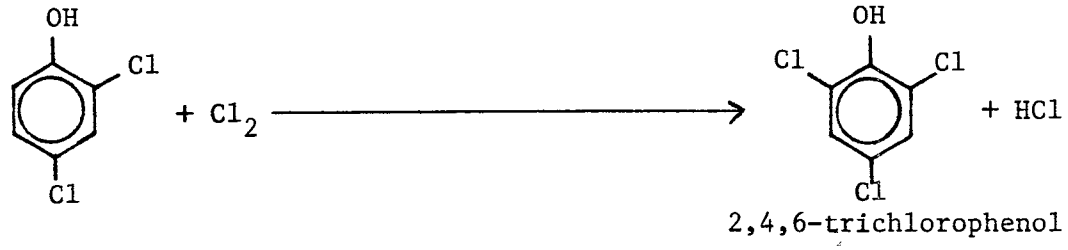
All of the chlorine used as a feedstock is produced at another site within the plant. The chlorine is in a liquid state and is pumped to the PCP process where it is vaporized in a steam heat exchanger.

The first step in the process takes place in the primary chlorinator. Phenol or crude phenol is pumped into the primary chlorinator from the respective storage tanks. Once the phenol or crude phenol has been added to the chlorinator, chlorine gas is injected into the mixture.

The chlorine reacts with the phenol producing chlorinated phenols, hydrogen chloride and heat. The primary reactions that take place in this step are as follows:

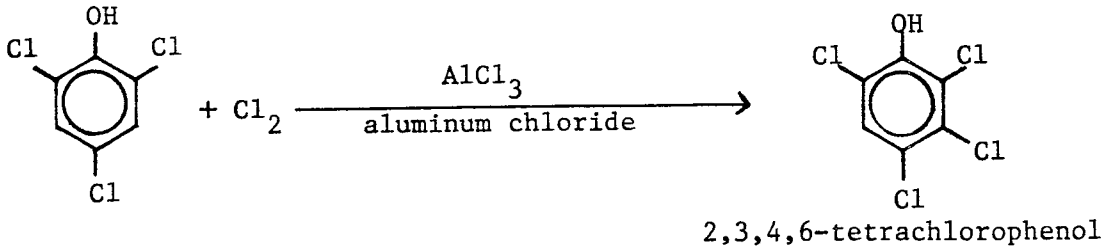


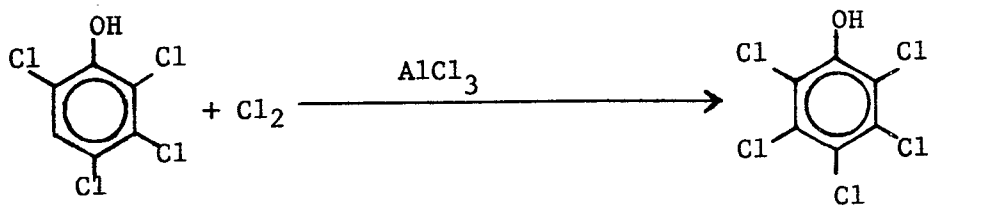




The hydrogen chloride produced is vented off from the top of the reactor to the hydrochloric acid operation (discussed later in this description). As the process progresses, the mixture in the chlorinator is circulated through a cooler then back to the chlorinator. The contents in the chlorinator are cooled to prevent a rapid buildup of heat. The chlorination in the primary chlorinator continues until a predetermined specific gravity is obtained. This point is determined by an automatic meter which gives a readout in the control room. Periodically a sample is drawn from the reactor and the specific gravity is measured by a hydrometer. This is done to check that the automatic meter is reading properly. When the predetermined specific gravity has been obtained the chlorine injection is stopped.

The next step in the process takes place in the secondary chlorinator. Hot and cold oils are circulated through the reactor's jacket to heat and cool the reactor. Aluminum chloride catalyst is added to the mixture and chlorine is injected into the mixture through dip tubes. The chlorine reacts with chlorophenols in the following exothermic reactions:





pentachlorophenol

The chemical reactions shown to take place in the primary and secondary chlorinator are not specific. For example, trichlorophenols are formed in the primary chlorinator and some dichlorophenols are formed in the secondary chlorinator. The reactions shown are the predominant reactions for the respective reactors.

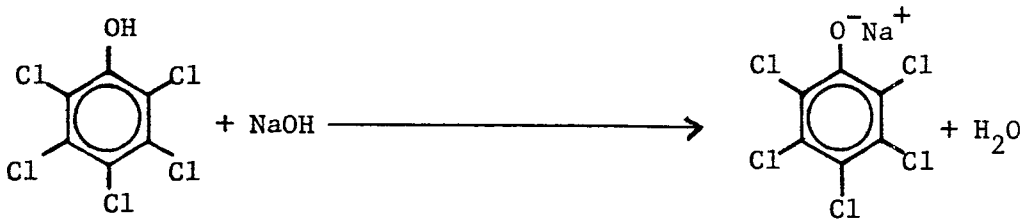
The hydrogen chloride produced, and any unreacted chlorine in the secondary chlorinator are vented from the secondary chlorinator and sparged into the mixture in the primary chlorinator.

The temperature in the secondary chlorinator is controlled by circulating cold oil through the reactor jacket, and by circulating the mixture in the reactor through a water cooled cooler. The cooler is taken out of service when the freeze point of the mixture of chlorophenols reaches a specified temperature. This is to prevent the mixture from solidifying in the cooler. When the cooler is out of service, the chlorine injection rate is reduced to keep the temperature from rising too rapidly.

Towards the end of the chlorination step in the secondary chlorinator, samples are drawn from the reactor for crystal point measurements. Usually, three or four crystal point samples per batch are taken. Once a specified crystal point is obtained the chlorination is stopped. The contents in the secondary chlorinator at this point in the batch is approximately 94 to 96% pentachlorophenol. The contents of the secondary chlorinator are then transferred to the flaker hold tank, a glass-lined jacketed vessel with a mixing agitator.

The next step in the process takes place in the flaker. Molten PCP is transferred from the flaker hold tank to a pan in the flaker. In the flaker there is a large water cooled nickel drum which rotates through the molten PCP. The PCP solidifies on the drum's surface in a layer 2 to 4 millimeters thick. As the drum completes a revolution, the solidifed PCP on the drum's surface is scraped off by a flaker knife into a closed conveyor. The conveyor transfers the flaked PCP to the flaker surge drum.

The flaker is a completely enclosed system. The PCP vapors and dusts are vented from the flaker to the flaker scrubber. In the flaker scrubber, the PCP vapors and dust react with a weak solution of sodium hydroxide to form sodium pentachlorophenate as follows:



sodium pentachlorophenol

When the solution of sodium pentachlorophenate becomes saturated, it is drained into a trench system and from there is pumped from the sump to a deep well disposal. The scrubber is then recharged with fresh sodium hydroxide.

The final step in the PCP process takes place in the kiln, a closed cylindrical, jacketed rotating vessel. PCP flakes are gravity fed from the flaker surge drum to the kiln. The kiln is then closed up, steam is circulated through the kiln's jacket and hot air is blown through the PCP flakes as the kiln slowly rotates.

This is a Vulcan patented process that produces a shiny polished appearance on the surface of the PCP flakes. This process reduces sublimation of the flakes and minimizes PCP vapors and dust. The polished flakes are transferred by a closed bucket conveyor from the kiln to the bulk storage bin.

The air blown through the flakes in the kiln is treated with a weak solution of sodium hydroxide in the kiln scrubber. This process is similar to the flaker scrubber process and the PCP vapors and dust react with the sodium hydroxide to form sodium pentachlorophenate. When the kiln scrubber solution becomes saturated with sodium pentachlorophenate, it is disposed of in the deep well system where the flaker scrubber solution was also sent.

The glazed PCP flakes in the bulk storage tank are ready for packaging. The glazed PCP flakes are either bagged, boxed, or loaded into trailer and hopper cars. Bagging is accomplished by placing a specially designed bag on a pneumatic-operated bagging machine. The glazed PCP flakes are transferred by conveyor from the bulk storage tank to a hopper and are gravity fed to the bagging machine. The bagging machine automatically loads the bags to a desired weight. In the boxing operation, an empty box (with a plastic liner) is placed on a scale. A loading chute from the hopper is opened and the PCP flakes are gravity fed into the box to a desired weight.

When trailers or hopper cars are loaded, they are spotted underneath a rotating, telescopic, enclosed, conveyor belt. The PCP flakes are fed from the bulk storage tank to the trailers and hopper cars by the conveyor belt.

There is an extensive network of dust and fume collecting ductwork throughout this packaging and loading area. This system collects the dust and fumes from these various operations and deposits then in 55 gallon drums, which are periodically changed.

One ton blocks of PCP are also produced. This is accomplished by draining molten PCP from the flaker hold tank into molds. The molds are placed on scales and the PCP is poured into the mold to a desired weight. After the molds have been filled they are taken to a special area where they are allowed to cool. Three days are required for the PCP to solidify in the molds. Once the PCP has solidified, the molds are broken down and the blocks of PCP are lifted out using forklifts. The blocks are taken to a warehouse where they are wrapped in plastic and are placed in storage ready for sale.

The hydrogen chloride (HCl) generated as a by-product in the reaction between phenols or chlorophenols and chlorine in the primary and secondary chlorinators is vented from the top of primary chlorinator through pipes to the vent condenser. In the vent condenser, the HCl vapors saturated with unreacted chlorine and chlorophenols are cooled. A portion of the chlorophenol in the HCl is condensed to a liquid and drained back to the primary chlorinator. From the vent condenser the HCl is transferred by pipes to the coil condenser where the vapors are further cooled. This causes any remaining chlorophenols to solidify on the coils of the coil condenser. When the coils become completely covered with chlorophenols, it is taken out of service and heated up, causing the chlorophenols to melt off of the coil. The melted chlorophenols are pumped by pipe to the primary chlorinator. The cooled down HCl is then transferred by pipe to the HCl absorber and packed tails tower where the HCl is absorbed in water to produce a hydrochloric acid solution of about 18%.

The hydrochloric acid produced is contaminated with chlorophenols and chlorine, and therefore can not be sold. The hydrochloric acid is disposed of in a deep well disposal system. From the HCl absorber the solution is cycled through the tails tower where some unreacted chlorine is vented to the vent scrubber. In the vent scrubber the chlorine reacts with a weak solution of sodium hydroxide. When this solution becomes saturated it is disposed of in a deep well.

The process described summarizes the current procedure that Vulcan uses to produce PCP. There have been three major changes in the process procedures. The first two change were made in the mid 1960's. The first change involved discontinuing the practice of adding approximately 2% by weight of oil to the final product to reduce dust exposure and replacing it with the polishing process. The second change involved adding aluminum chloride catalyst to the secondary chlorinator, instead of the primary chlorinator, to reduce the amount of aluminum chloride used. The third change, which took place in the late 1960's or early 1970's, was to produce a double batch in the primary chlorinator. Half of the double batch would be transferred to the second chlorinator, the other half would remain in the primary chlorinator ready to produce another double batch. Before this time the entire batch was transferred from the primary chlorinator to the secondary chlorinator.

DESCRIPTION OF WORKER DUTIES IN THE PENTACHLOROPHENOL PRODUCTION PROCESS

The pentachlorophenol process operates 3 eight hour shifts per day, seven days per week. For each shift, a minimum of two workers are involved in the process, a first class and a third class operator. Table 2 lists the duties of the operators.

Based on the process description, the industrial hygiene exposure data and the analytical composition data on chlorinated dibenzo(p)dioxins, and the nature of the task, the highest potential for exposure to chlorinated dibenzo(p)dioxins for the first class operator is through the tasks of taking samples from the primary and secondary chlorinators. For the third class operator, the tasks of cleaning the flaker, the loading of the flaked PCP into the kiln, the bagging and boxing of glazed PCP, the loading of glazed PCP in trailers and hopper cars, and the duties of general house keeping represent the tasks with the highest potential for exposure to chlorinated dibenzo(p)dioxins.

In addition to the first and third class operators there have been other job titles associated with the pentachlorophenol production process. For some years there was a second class penta operator. His job description and duties would have been the same as those for the first class operator. There was also a fourth class operator associated with the pentachlorophenol production operations. Fourth class operators were employees in training and their job description and duties would have been the same as those for the third class operator.

Table 2

Job Descriptions for Pentachlorophenol Operators
Vulcan Materials Company
Wichita, Kansas

A. The Duties of the First Class Penta Operator

1. Operates the primary and secondary chlorinators. This is done primarily from the control room but the first class operator occasionaly has to go out into the process to do jobs such as opening or closing valves.
2. Collects samples from the primary and secondary chlorinator which are collected to determine the extent of the reaction for the given chlorinator.
3. Operates equipment used to collect and dispose of the hydrochloric acid which is formed as a by product in the production of PCP.

B. The Duties of the Third Class Penta Operator

1. Performs all packaging operations, bagging and boxing
2. Loads PCP into trailers and hopper cars
3. Loads, operates, and unloads the kiln
4. Operates and cleans the flaker
5. Operates the scrubber operations
6. Performs general housekeeping of the pentachlorophenol process area

PAST EXPOSURE AND DIOXIN MEASUREMENTS

Industrial Hygiene Exposure Measurements

Vulcan has had a formal plant industrial hygiene program since 1976. Since that time, their industrial hygienists have sampled for airborne concentrations of PCP. Recently (1983), they have sampled for airborne concentrations of HxCDD, HpCDD, and OCDD.

Table B-1, Appendix B, lists the past personal breathing zone samples of the first class penta operators for PCP. Table B-2, Appendix B, lists the past personal breathing zone samples of the third class penta operators for PCP. Table B-3 summarizes the results of Tables B-1 and B-2. Table B-4 lists the past area air samples taken for PCP.

The air samples collected and analyzed for PCP can be grouped into three categories: the caustic bead sampling method, filter sampling method and silica gel (SiO_2) sampling. The caustic bead sampling method was used in 1977 and involved drawing air through a glass tube containing sodium hydroxide (caustic) beads with airborne PCP being collected on the beads. This was an experimental sampling method and problems such as moisture uptake were associated with the method. The results from these types of PCP samples are not necessarily reliable. In 1978, a few air samples of airborne PCP were collected using a 0.8 um pore size cellulose ester filter. These particular samples would collect particulate PCP but would probably not collect PCP vapors and therefore do not provide a complete scenario of PCP exposure. During 1980, the Vulcan industrial hygienists were using a cellulose ester filter backed up with a SiO_2 sampling tube. During 1982 a SiO_2 tube alone was used for airborne PCP collection. The PCP samples are collected at an air sampling rate of one liter per minute (lpm). The total air volume of the samples should be greater than 50 liters and less than 300 liters. The current method of analysis for PCP involves the desorption of PCP collected on SiO_2 with laboratory grade acetonitrile. The acetonitrile extract is analyzed by high pressure liquid chromatography (HPLC) with a 254 nanometer fixed wavelength ultraviolet (UV) detector. Through these years of use, the SiO_2 tube sampling method for PCP proved to be a reliable method and by March 1982 Vulcan's laboratory had statistically validated the method. One finding from the validation test was the difference in percent (%) PCP recovered using a cellulose ester filter backed up by a SiO_2 tube as compared to using a SiO_2 tube alone. For the filter + SiO_2 method the % PCP recovered was 35.27 for the filter and 27.26 for the SiO_2 tube. For the SiO_2 tube used alone, the % PCP recovered was 99.41.

Examination of Table B-3 (the summary of Tables B-1 and B-2) shows an arithmetic mean (AM) time weighted average (TWA) and geometric mean (GM) TWA exposure concentrations to PCP of 0.14 ($\pm$ 0.27) milligrams per cubic meter (mg/M^3) and 0.04 ($\pm$ 5.68) mg/M^3, respectively, for 9 TWA samples of the first class penta operators collected during the time period of October 1980 through April 1981. For the 16 TWA samples collected during the time period of April 1982 through August 1983, the AM TWA and GM TWA exposure values for the first class penta operators were 0.03 ($\pm$ 0.02) mg/M^3 and 0.02

(± 2.44) mg/M^3, respectively. For the third class penta operators the AM TWA and GM TWA exposure values for PCP were 0.11 (± 0.11) mg/M^3 and 0.07 (± 2.60) mg/M^3, respectively, for 16 TWAs collected during the time period of October 1980 through May 1981. There were three TWA samples collected (sample numbers W-462, W-463, and W-466), for the third class operators, which were intentionally spiked with PCP. These TWA sample values were omitted from the summary mentioned above. The 21 TWA exposure values collected during the time period of April 1982 through August 1983 for the third class penta operator have a AM TWA and GM TWA exposure values of 0.05 (± 0.05) and 0.03 (± 2.58), respectively.

When there was a less than value reported, one half of that value was used when calculating a TWA.[5,6] For the first class penta operators for the time period of April 1982 through August 1983, one TWA was calculated in this manner. One TWA for the third class penta operator during each time period of October 1980 through May 1981 and April 1982 through August 1983 was calculated in the same manner. When calculating the arithmetic and geometric means and standard deviations of the reported TWAs if a less than value was reported for a given TWA, one half that value would be used. One less than TWA value was reported for the first class operator for the time period of April 1982 through August 1983, and one less than TWA value was reported for the third class operator for the time period of April 1982 through August 1983.

On two different occasions (August 8-9, 1983 and August 24-25, 1983) the Vulcan industrial hygienist had sampled for airborne HxCDD, HpCDD, and OCDD. Table B-5 lists the results of personal breathing zone samples for HxCDD, HpCDD, OCDD for the first and third class penta operators. Table B-6 lists the results for area air samples for HxCDD, HpCDD, and OCDD. These samples were collected using either a SiO_2 tube or a 0.8 um mixed cellulose ester filter backed up by a SiO_2 tube. The air sampling rate was approximately 1.0 lpm. Analysis for dioxins was done using a slightly modified procedure of the EPA method 163,[7] the analysis of soil for 2,3,7,8-tetrachlorodibenzo(p)dioxin.

A review of Table B-5 reveals that the first class penta operators had an AM TWA of 11.6 (± 20.0) micrograms per cubic meter (ug/M^3) for HxCDD, 194 (± 376) ug/M^3 for HpCDD and 281 (± 524) ug/M^3 for OCDD. For the third class penta operator, the AM TWA for HxCDD, HpCDD, and OCDD were 5.65 (± 6.93) ug/M^3, 95.6 (± 157) ug/M^3, and 511 (± 807) ug/M^3, respectively. These values were calculated in the same manner as the PCP samples in that whenever a less than value was reported one half of that value was used to calculate the arithmetic means.

Dioxin and Dibenzofuran Measurements of Pentachlorophenol Product

In 1972, Vulcan started analyzing their PCP products and process streams for dioxins and dibenzofurans. In 1972 and 1975 studies were carried out in an effort to determine at what point in the process the polychlorinated dibenzo(p)dioxins (PCDD) were being formed. The results of this profile are listed in Table B-7 and summarized in Table B-8. These analyses were made at a time when OCDD was the only available standard. The company states

that the 1972 and 1975 analyses had the following limitations: 1) there is no information available indicating exactly how the samples were prepared for dioxin analysis, 2) the clean-up procedures varied, 3) there was no set procedure for the analysis of HxCDD and HpCDD and 4) that HxCDD and HpCDD were not analyzed for in 1972 because the company's main interest was to try to determine where in the process was the dioxins were being formed. The 1975 data indicates analytical problems due to the erratic results reported for the three dioxins. The company states these erratic results were due largely to sample preparation and the unavailability of known standard materials. The quantitation of the results were done on either electron capture or flame ionization detector equipped gas chromatographs. The data reported in Table B-7 are a combination of the dioxins and dibenzofurans; the chromatographic column used could not separate the dioxins from the dibenzofurans.

Since 1975, Vulcan's research and development laboratory had analyzed their PCP product for dioxins. The results of these analyses are listed on Table B-9 and summarized in Table B-10, the arithmetic mean concentration of HxCDD, HpCDD, and OCDD is 97 ($\pm$ 192) parts per million (ppm), 540 ($\pm$ 266) ppm and 1375 ($\pm$ 560) ppm, respectively. The sample preparation in Table B-9 were unknown for the 1975 data. The 1976 analysis of a PCP product composite was done on samples prepared by separation of neutral components by two separate procedures. The first procedure involved alumina and sodium hydroxide preparations, and the second was with alumina only. The 1981 and 1982 results were obtained on samples using alumina and sodium hydroxide clean-up procedures. The 1983 samples were carried out using current technology with the modified EPA Procedure 613[7] being used. All quantitation was done on either flame ionization or electron capture detectors. All data from 1981-1983 was quantitated using electron capture detection.

In June 1983, Vulcan sent 11 PCP product samples to the Brehm Laboratory at Wright State University. Using a modified EPA Procedure 613[7], the Brehm Laboratory analyzed the PCP product samples for tetrachlorodibenzofuran (TCDF), tetrachlorodibenzo(p)dioxin (TCDD), pentachlorodibenzofuran (PCDF), pentachlorodibenzo(p)dioxin (PCDD), hexachlorodibenzofuran (HxCDF), HxCDD, heptachlorodibenzofuran (HpCDF), HpCDD, octachlorodibenzofuran (OCDF), and OCDD. Table B-11 lists and summarizes the results of these analyses. The arithmetic mean for the 11 PCP product samples are as follows: TCDF = 4.58 ($\pm$ 3.92) ug/g; TCDD = 0.129 ($\pm$ 0.074) ug/g; PCDF = 24.8 ($\pm$ 18.1) ug/g; PCDD = 0.369 ($\pm$ 0.210) ug/g; HxCDF = 111 ($\pm$ 52.0) ug/g; HxCDD = 15.0 ($\pm$ 7.69) ug/g; HpCDF = 348 ($\pm$ 63.2) ug/g; HpCDD = 529 ($\pm$ 178) ug/g; OCDF = 934 ($\pm$ 407) ug/g; OCDD = 2820 ($\pm$ 837) ug/g. On a cover memorandum attached to the results sent to Vulcan by the Brehm Laboratory, the Brehm Laboratory states that the chlorinated dibenzofuran analyses could be artifically high due to the presence of quantities of chlorinated diphenylethers which, upon introduction into the mass spectrometer, can yield fragment ions which are identical in mass to those which were monitored as indicators of the chlorinated dibenzofurans.

A comparison of analytical results for TCDD, PCDD, HxCDD, HpCDD and OCDD for PCP product samples between three laboratories was conducted by Vulcan. The results of these comparisons are listed in Table B-12. The three laboratories in this comparison were Vulcan's research and development laboratory, Brehm Laboratory at Wright State University, Dayton, Ohio and the University of Umea, Umea, Sweden. The University of Umea's laboratory was asked to be involved in this analysis in an effort to resolve the difference between Vulcan and Brehm Laboratories on 1,2,3,4-tetra- and pentachlorodibenzo(p)dioxin. Dr. Christopher Rappe is a professor and chairman of the Department of Organic Chemistry at the University of Umea. He is a well-known member of international groups working on dioxins and furans. Dr. Rappe, using his own method of sample preparation, could not detect TCDD and PCDD at a detection level of 0.005 ppm. Dr. Rappe stated that the clean-up procedure he used for neutral component separation was a method superior to that of Vulcan and Brehm laboratories. Dr. Rappe feels that reactions with strong hydroxide solution (used both by the Vulcan and Brehm laboratories) may in fact form dioxins from the chlorophenols, and that the column technology may not be adequate for final clean-up and removal of interferring components. All three labs used gas chromatography/mass spectrometry (GC/MS) for quantitation. The GC columns used were capillary columns which were able to separate the furans from the dioxins. The sample preparations used by the Brehm and Vulcan laboratories were identical, the modified EPA Method 613[7] along with GC/MS quantitation. The principal modifications of this method were:

1. Use of a smaller sample size,
2. Elimination of a drying agent (not needed due to the absence of water found in dirt samples),
3. Reduction in extraction time,
4. Changes in rinse volumes and addition of additional rinse cycles, and
5. Use of a different solvent for solutioning of the dioxins for injection into the mass spectrometer.

Vulcan also has had their PCP product analyzed on three different occasions by other laboratories, twice by Dow Chemical Company and once by the Laboratory Services Division of Agriculture, Canada. The results of these analyses are listed on Table B-13. The 1975 data was obtained by W. Crummett, Dow Chemical Company. The analytical protocols are unknown by Vulcan. The 1977 data was reported by R. Stehl, Dow Chemical Company. The analytical protocols are unknown by Vulcan. The 1983 data from the Laboratory Division of Agriculture, Canada was analyzed by GC/MS, but sample clean-up procedures are unknown by Vulcan.

DESCRIPTION OF MEDICAL AND SAFETY PROGRAMS

Medical Program

Vulcan has a medical surveillance program for all employees which has been coordinated since 1979 by a medical services contractor, Tabershaw Occupational Medicine Associates, Rockville, Maryland. The company has employed a full-time nurse since 1969. Until 1979, physician services had been provided through a local physician who was responsible for pre-employment examinations and for other medical services.

Safety Program

Vulcan has a well-organized safety program. There is a formal set of general safety rules which includes the entire facility and a set of specific safety rules for each department in the facility. Figure A-1, Appendix A, illustrates the safety information provided to the workers in the Organic Department, which includes the PCP process. Monthly Management/Union safety meetings are held and periodic walk-through inspections of the plant are conducted. In addition, all new employees go through a safety orientation program, illustrated in Figure A-2. During this orientation, the new employees are familiarized with the safety rules for the facility, with particular focus placed on those areas where the new employee will be working. For example, new PCP employees are informed of the proper procedures for handling PCP, various routes of potential exposure to PCP, and the resultant health effects due to exposure to PCP.

DESCRIPTION AND USE OF RECORD SYSTEMS

Personnel Records

The Wichita personnel department maintains personnel files for all current employees and for approximately 1800 terminated employees. The active files are kept in the personnel department, and the terminated records are kept in two file cabinets of four drawers each in a basement storage room. The entire personnel file of each individual is retained for five years following termination. At that time, the contents of the file are destroyed, with the exception of a summary card which lists the work history of the individual. The personnel files contain, generally in reverse chronological order, the summary work history card, employee status forms which note termination or job title changes, change of address forms, worker compensation accident reports, rating sheets and application forms. For current employees, both hourly and salaried, summary cards are kept in alphabetical order in a separate card file. In 1980, the company introduced a computerized system for payroll and personnel data input. The Employee Data System (EDS) replaced the summary work history cards.

Company representatives stated that the company has never destroyed any personnel records; therefore summary cards exist for all hourly workers ever employed in the pentachlorophenol department. However, very few personnel files for terminated salaried employees were found in the personnel department. Two possible explanations were suggested: 1) The files of salaried individuals who transfer to other Vulcan facilities are sent to the new location of employment. 2) It is possible that the files of terminated salaried individuals were sent in the past to the corporate headquarters in Birmingham. In the case of pentachlorophenol production, however, very few salaried individuals had been assigned to the process area.

Prior to this site visit, company representatives had reviewed all summary work history cards and seniority lists for indications of employment in pentachlorophenol production and had prepared five lists of individuals:

1) Active Hourly Penta Operators
2) Active Salaried Employees (ever employed in Penta)
3) Ex-Employees Who Worked in Penta and Have Medical Records
4) Ex-Employees Who Worked in Penta and Do Not Have Medical Records
5) Ag-Chem Operators (persons who may have worked in Penta prior to 1962).

An audit by NIOSH personnel of every file of the terminated salaried employees and 5% of the summary cards for active and terminated employees found no discrepancies between the information provided on the lists and the information in the personnel records.

Method of Identification of Employment in Pentachlorophenol Production

Table 3 summarizes the types and periods of production associated with the job titles of interest to the Dioxin Registry. These categories were constructed following a review of work history cards and conversations with company representatives. Pentachlorophenol production was initiated in January 1958 in the Organic Department. In May 1959, the seniority lists from three production plants were merged and the workers were placed in the Agricultural Chemicals Department (AgChem). The three plants were 2,4-Dichlorophenoxyacetic acid (2,4-D), Benzene Hexachloride (BHC) and Pentachlorophenol (Penta). Production of 2,4-D ceased by late 1960; BHC production and bagging of inventories terminated in April, 1962. In January 1969, production of Anhydrous Hydrochloric Acid was initiated, and production was carried out by Class II operators of the Penta/Anhydrous HCl Department. The seniority system which established the method of bidding for promotion is illustrated in Figure 2.

The criteria to be used in constructing detailed work histories for pentachlorophenol workers are listed here:

A. January 1, 1958 - December 31, 1968. Include Ag Chem Operator (all classes). Exclude BHC and 2,4-D Operators who appear between 1958 and 1962.

B. January 1, 1969 - November 10, 1980. Include Penta Operator Classes I, III and IV. Exclude Penta Class II Operator.

C. November 11, 1980 - present. Include all Chem Loc: 003/CCR541.

In summary, persons with the job titles listed in Table 3 were involved in pentachlorophenol production.

Maintenance workers work throughout the Wichita plant and do not have records of assignment to the pentachlorophenol area. Therefore, they are not included in the Dioxin Registry.

Table 3

A Listing of the Possible Production Activities
Associated with the Ag Chem and Penta Job Titles
Vulcan Materials Company
Wichita, Kansas

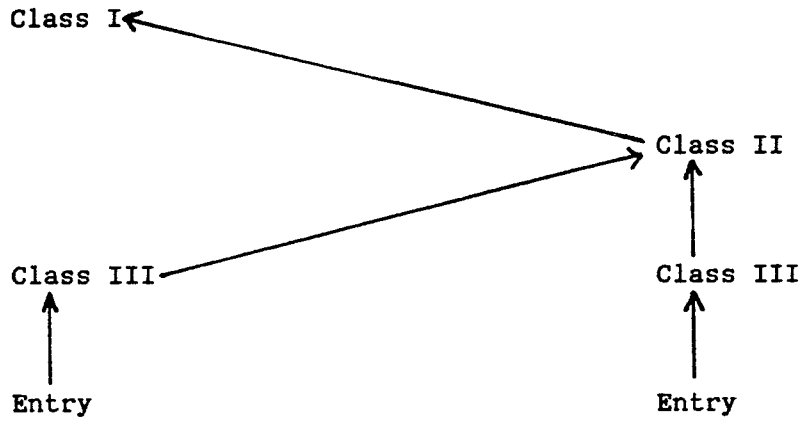
Years	Department	Job Title	Production of Pentachloro-phenol	BHC 2,4-D	Anhydrous HCl
Jan 58-May 59	Organic	Ag Chem Oper (all classes)	X	X	
Jun 59-Apr 62	Ag Chem	Ag Chem Oper (all classes)	X		
May 62-Dec 68	Ag Chem	Ag Chem Oper (all classes)	X		
Jan 69- Nov 10, 1980	Penta/ Anhydrous HCl	Penta Class I	X		
		Penta Class II			X*
		Penta Class III	X		X
		Penta Class IV	X		X
Nov 11, 1980- Present	Chem 003/ CCR 541	Operator (all classes)	X		X*

* Exclude from Dioxin Registry

Figure 2

Progression Through the Penta/Anhydrous HCl
Plant from January 1969 to the Present Time

Pentachlorophenol Production	Anhydrous HCl Production



The salaried positions of interest are those of Day Supervisor and North Area Shift Foremans. Only two Day Supervisors have supervised the pentachlorophenol process, and both have been identified. Shift foremen were not included unless their personnel records indicated that they had been assigned to the North Area. Since most records did not list the area of assignment, most shift foreman were not included.

Medical Records

All medical files for active hourly and salaried individuals are maintained in the Nurse's Office. No medical files remain for individuals terminated prior to 1976. The records of hourly individuals who terminated after 1976 are maintained in one file of 4 drawers in alphabetical order in the basement storage room. No medical records exist in Wichita for any terminated salaried individuals; it is unclear whether any salaried persons were terminated between 1976 and the present. The medical records of salaried individuals who transfer within the company are sent to the new location.

Each medical file for the current employees has two sections: a past history which has been organized into numerous subsections, and a current file containing information dating back three years. All information in all files has been organized and computerized recently by Tabershaw Occupational Medicine Associates, Rockville, Maryland. Plantwide medical examinations were conducted by this group in 1979 and by TOMA-coordinated physician in 1982. Exam frequencies are established by the medical consultant. The company plans to microfilm all medical record except the most recent three years. Microfilmed hard copies will be stored in an underground salt mine in Hutchinson, Kansas. All data are accessible by computer or by microfilm. The medical data are organized into the following situations.

Identifying Data
Scheduled Encounters
Unscheduled Encounters
Laboratory
X-Ray and ECF
Audio and Vision

Pulmonary Function Testing
Administrative

Forms which are located in the Administrative section include Workers Compensation Records, Accident Reports and non-occupational medical information. Figure A-3, Appendix A, reproduces a Dermatology Form. These were filled out during many of the 1980 examinations, but few were filled out during the 1982 examinations.

WORKER COMPENSATION RECORDS

Worker Compensation records for the years 1963 to the present are maintained at the corporate headquarters in Birmingham, Alabama. No records exist for earlier years. On May 5, 1984 Marilyn Fingerhut reviewed all claims for the Wichita plant and microfilmed claims for skin conditions submitted by pentachlorophenol workers.

DESCRIPTION OF INDUSTRIAL HYGIENE SURVEY METHODS

During the visit to Vulcan's Wichita facility an industrial hygiene survey of the PCP production process was conducted. This survey was conducted during the two first shifts on August 25th and 26th. Personal breathing zone and area air samples were collected and analyzed for PCP. Bulk samples of PCP product and process streams were also collected.

Personal breathing zone samples were collected using Gilian® HFS 113UT personal sampling pumps calibrated at an air sampling rate of 1.0 liters per minute (lpm). The collection media used was a 37 millimeter (mm) in diameter, 2 micron pore size, Zefluor filter backed up by a 260/520 milligram (mg) silica gel (SiO_2) sampling tube. The collection media was changed approximately halfway through the shifts. Personal breathing zone samples were collected for the first and third class penta operators.

Area air samples were collected by using Gilian® HFS 113UT sampling pumps calibrated at 1.0 lpm or by using a Dupont® P-2500A sampling pumps calibrated at 0.5 lpm. The collection media used was a 37 mm in diameter, 2 micron pore size, Zefluor filter backed up by a 260/520 mg SiO_2 sampling tube. The collection media was changed approximately half way through the shift when the Gilian® pumps were used. When the Dupont® sampling pumps were used, the collection media was not changed during the shift. In addition to the above mentioned area air sampling, three air samples were collected using the Gilian® sampling pumps calibrated at 3.25 lpm and using just a Zefluor filter.

While conducting the industrial hygiene survey, bulk samples were collected. Four bulk samples were collected: 1) PCP product (finished product, "Glazd"®); 2) PCP product (Un"Glazd"®); 3) Sample taken from the second chlorinator; 4) Sample taken from the first chlorinator.

EVALUATION CRITERIA

The current exposure criteria for airborne concentration of PCP are the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL),[8] and the American Conference of Governmental Industrial Hygienist (ACGIH) recommended threshold limit value (TLV) of 0.5 mg/M^3 for an eight hour time weighted average (TWA).[9] There are no PELs or recommended TLVs for airborne concentrations of HxCDD, HpCDD or OCDD. Along with the potential airborne exposure to the above mentioned chemical there is a potential contribution to the overall exposure by cutaneous routes including mucous membranes and eyes, either by airborne or more particularly, by direct contact with the above mentioned substances.

RESULTS, ANALYSES, AND DISCUSSION OF INDUSTRIAL HYGIENE SAMPLING

A total of nineteen air samples were collected during the two days of sampling. Eight of the nineteen samples were personal breathing zone air samples for the first and third class penta operators. From the eight personal breathing zone samples, four TWA's were calculated, two each for both the first and third class penta operators. Eleven area air samples were collected at various sites throughout the PCP production process. Three of the eleven area air samples were collected using just a Zefluor filter as the sampling media at a sampling rate of 3.25 lpm. The remaining eight area air samples were samples which used a sampling media of a Zefluor filter backed up by a silica gel sampling tube at an air sampling rate of 1.00 lpm.

All the air samples were submitted to Southern Research Institute for determination of PCP. The collected compounds were desorbed from the filter and silica gel for 15 minutes with 4 milliliters (ml) of acetonitrile and analyzed by HPLC with UV detection. The column and instrument conditions were an amine-bonded phase Micro-Guard Bio-Sil column, 3 cm X 0.46 cm ID, a mobile phase consisting of 2.25 volume percent glacial acetic acid and 97.75 volume percent acetonitrile, flow rate of 1.0 milliliter per minute, an UV detector fixed at 254 nanometers and the injection volume was 100 microliters. The limits of detection and quantitation for PCP was 0.33 micrograms per sample (ug/sample) and 1.00 ug/sample, respectively.

The results of the air samples are listed in Table B-14, Appendix B. The TWA PCP concentrations for the first class penta operator were 0.031 and 0.030 milligrams per cubic meter (mg/M^3) and for the third class penta operator the TWA PCP concentrations were 0.005 and 0.026 mg/M^3. In calculating the TWA PCP concentrations if a measurement was reported as being a less than value, one half of that less value was used to calculate the TWA. This type of sample treatment was used only once for the personal breathing zone air samples. The same treatment of data was also used in calculating TWA PCP concentrations for the area air samples.

During the two days of sampling, the Vulcan industrial hygienist collected side by side air samples. Table B-15 compares the results of this side by side sampling for the personal breathing zone air samples. This comparison shows that there was good agreement between NIOSH and Vulcan personal breathing zone air sample results for the third class penta operators' TWA PCP measurements; but for the first class penta operators' TWA PCP measurement NIOSH's sample results were substantially higher than the Vulcan sample results. Also included in Table B-15 are Vulcan's personal breathing zone air samples for HxCDD, HpCDD, and OCDD associated with their PCP measurements.

Four bulk samples were collected during the survey. The bulk samples were PCP product ("Glazd"®), flaked PCP (Un"Glazd"®), a sample taken from the secondary chlorinator, and a sample taken from the primary chlorinator. The samples taken from the primary and secondary chlorinators were collected during the end of reaction period when the first class penta operator would take samples to determine the completeness of the reaction for the

respective chlorinators. These bulk samples were analyzed for di- and/or tri-, tetra-, penta-, hexa-, and octachlorodibenzo(p)dioxins and octachlorodibenzofuran (OCDF) by the laboratories at Southern Research Institute. Standards needed for the quantitation of heptachlorodibenzo(p)dioxin and chlorinated dibenzofurans (excluding OCDF) were not available and therefore those substances could not be quantitated. The dioxin and furan contaminates were isolated using a two-step isolation procedure using alumina. Quantitation of the dioxins and furans was achieved by using HPLC with a UV detector. Two columns in series; octadecyl (C_{18}), 25 cm X 0.26 mm ID each, reversed-phase were used to perform the separation of the various dioxins and furans. The mobile phase was 50 volume percent methanol and 50 volume percent acetonitrile. The flow-rate program was 0.6 ml/min for 10 min. and 1.4 ml/min for 35 min. The UV detector was fixed wavelength of 245 nm and the injection volume was a 20 microliter aliquot. The results of the analyses are listed in Table B-16.

CONCLUSIONS

The PCP workers at Vulcan Materials Company, Wichita, Kansas are suitable for inclusion in the Dioxin Registry. Included will be all individuals employed between 1958 and the present time who held job titles listed in Table 3. Medical data for current employees has been retained, organized, microfilmed and computerized. No medical files exist at Wichita for persons who terminated prior to 1976. Based on the review of the PCP production process, the industrial hygiene data, the analytical data of the analysis of PCP for dioxins and the job descriptions, it will be possible to construct a potential exposure matrix for the PCP workers.

RECOMMENDATIONS

While the safety program and practices were excellent, there were a few points in the process where good work practices should be emphasized. For example, when cleaning the flaker, the third class operator should cover all exposed skin areas and wear a respirator which will protect against PCP and particulate inhalation. In addition, when new third class operators are trained, emphasis should be made on the proper techniques in the operation and cleaning of the flaker. The other point in the process where good work practices should be emphasized is the loading of the kiln with flaked PCP. The same personal protection equipment should be worn during the kiln loading operations as is worn when cleaning the flaker. Full personal protection equipment should also be worn by the first class operators when they take samples from the primary and secondary chlorinators. Particular attention should be made in keeping the hood area clean where the freeze point measurements are made.

Consideration should be made to start a wipe sample monitoring program for surface contamination with HxCDD, HpCDD and OCDD. By doing this type of monitoring, problematic points in the process can be focused upon, and engineering controls be added to reduce contamination and the potential of exposure to dioxins.

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APPENDIX A

SAFETY RULES AND PROCEDURES; MEDICAL DERMATOLOGY FORM

WICHITA PLANT SAFETY MANUAL
ORGANIC DEPARTMENT SAFETY RULES
Section 410

ORGANIC DEPARTMENT SAFETY RULES

All employees of the Organic Department are expected to work safely, cooperate, and participate in the safety program; constant vigilance on the part of each employee, strict adherence to standard operating instructions, and the formation of safety conscious habits are all indispensable to our safety program.

General

The following rules apply to all Vulcan employees working in the Organic Department.

1. Know and abide by the Wichita Plant Safety Rules and those rules which apply to the specific section in which you are working.

2. Know the location and proper use of all safety equipment.

3. Hard hats, safety glasses, and MSA-type pocket repsirators are to be worn to and from the change room and are to be worn by all personnel in the area at all times except when in one of the control rooms or offices or the Racon Warehouse. This equipment must be kept in good working order. Cover goggles must be carried by all operators, except Racon warehouse employees, preferably attached to helmet for ready use.

4. Any other safety equipment issued to you or your plant must be inspected at the scheduled times and the appropriate action taken to repair or replace defective equipment.

5. When performing activities with hazardous materials such as muriatic, sulfuric, hydrofluric acids, aluminum chloride, zinc chloride, caustic cell liquor, phenol, liquid chlorinated phenols, Anhydrous HCl liquids or vapors, or any mixtures of the above, all personnel shall wear cover goggles in addition to his safety glasses. Such activities include but are not limited to:

   a. Handling, obtaining, or testing samples.

   b. Any transfer or handling of hazardous materials.

   c. Starting or stopping pumps.

   d. Opening of lines or equipment even though it is believed that the lines or equipment have been drained and depressured.

   e. Repressuring lines or equipment if they have been opened for any reason.

   f. Entering or in cover goggle areas as marked in all plants.

6. For all process chemicals, personnel should be aware of potential hazards and must maintain a safe distance, if possible, when repressurizing equipment which has been taken out of service for maintenance or any other reason. If a safe distance cannot be obtained, goggles and any other

necessary protective equipment must be used when starting or stopping pumps or pressurizing lines or equipment.

7. All gas cylinders are to be kept in chained racks.

8. Observe posted speed limits and all safety precautions while operating mobile equipment. Only trained forklift operators may operate forklifts.

9. Safety wire all quick couplers when using these hose connections. Grasp hose firmly to prevent whipping. Always bleed pressure off before disconnecting the hose.

10. Use handrails when climbing or descending stairs.

11. Do not climb or work from a ladder unless it is securely tied at the top or held by someone at the bottom.

12. Do not work with both hands while standing on a ladder. Always use one hand for holding on. Manlifts are available if required.

13. While working on top of tanks, watch for loose material, water, snow or ice, that might cause you to slip or fall. Always face nearest outside edge of tank. Use handrails if available. Safety harness and rope is available if required.

14. Department housekeeping is an operating responsibility. All hoses, drums, tools and other equipment are to be returned to their proper place when not in use. Trash should be picked up and disposed of properly.

15. The doors to the electrical switch gear rooms are to be kept closed at all times. These rooms must be kept clean, dry and cool.

16. The electrical breaker/starter must be tagged and locked out before its equipment can be worked on.

17. The entire Organic Department area is a no smoking, no open flame area. Smoking is allowed in the control rooms and offices only.

18. Hot work permits are required throughout the Organic Department, except Racon. Racon will require hot work permits in some areas of their plant. Hot work is defined as including: welding, cutting with a torch, drilling, chipping, the use of a non-explosion proof motor, any and all work that generates heat or may cause sparks. The issuance of a hot work permit does not allow smoking of cigarettes, cigars or pipes.

19. In the event of the release or spillage of any flammable materials, anyone is authorized to stop all hot work in an area. Hot work will not be resumed until the area has been rechecked and found safe by supervision.

20. An anti-spark wrench is provided in each plant and should be used whenever opening or closing valves on lines containing flammable materials.

21. Know the characteristics of the chemicals in your work area; which are flammable; which react violently with what other material; and the proper treatment if exposed to these materials. Do not hesitate to ask your supervisor any questions you may have about the chemicals in your area.

22. Operators will wear a full-face mask when working in any area that exposes him to toxic fumes or vapors.

23. Horseplay is strictly forbidden.

24. You are expected to be familiar with the different disaster signals and the response procedures in the event of a signal. You will be instructed in these duties by your supervisor.

25. Notify your supervisor when the following occur:

    a. Unauthorized personnel in the area.
    b. Personnel in the area without proper safety equipment.
    c. Personnel in the area not following proper safety procedure.
    d. Any unsafe condition is discovered.

26. All food and drink must be taken to and consumed in the control rooms only.

27. Use of colored safety glasses before sunrise or after sunset or on dark days is strictly prohibited.

Those operators assigned to Penta/Anhydrous HCl have these additional safety rules which must be followed when working in Penta.

1. All food and drink must be taken to and consumed in the control rooms only.

2. Wash before eating, smoking, or using the rest room facilities.

3. No smoking except in control room.

4. Leave cigaretts, cigars, and pipes in control room. Do not carry these items on your person while in Penta Plant.

5. Do not leave food, lunch boxes, or food trays in bagging room.

6. Safety shoes or boots must be worn in Anhydrous HCl. Rubber safety shoes or boots should be worn in Penta Plant.

7. All operators should shower and change clothes at end of shift.

8. Wash after bagging.

9. Wear cover goggles, approved respirator with dust filter, and disposable jacket or rain coat while cleaning the kiln transition piece or cleaning uder the flaker drum. Remove disposable jacket or rain jacket before entering control room.

10. Wear cover goggles and approved respirator with dust filter while cleaning the flaker scrubber vent line.

11. Shower and change clothes if you or your clothes have been exposed to large amounts of Penta dust.

In addition to the general department safety rules the following safety procedures have been developed for specific hazards. These procedures are to be followed when handling the materials noted.

Revised 3-16-82

SPECIAL PROCEDURE FOR PREPARATION OF EQUIPMENT AND LINES FOR MAINTENANCE THAT HAVE CONTAINED PHENOLS OR CHLORINATED PHENOLS

All lines and equipment must be depressured, drained, tagged and locked out prior to maintenance.

After maintenance has disconnected and blinded off sections of lines or equipment, then the equipment or lines removed from service must be thoroughly washed with hot water, before proceeding with repairs. Heat exchangers should be washed with a 120° to 140°F mixture of half cell liquor and half water: then, washed thoroughly with hot water. Operators will wear hoods, gloves, rubber boots, and acid suits while washing lines and equipment. Full face gas masks will be worn anytime there is toxic fumes.

OPERATORS CLOTHING

Class A Clothing	Type of Work
Approved Full Face Mask & Canister Approved 12" Gloves Approved Acid Jacket & Overalls Approved Rubber Boots	Operations of a routine or non-routine nature which are potentially more hazardous than those requiring cover goggles and regular work clothing. Examples are: a) Bleeding, depressuring or draining to atmosphere phenol, chlorinated phenols, caustic and muratic acid lines and equipment for maintenance. b) Connecting, or disconnecting phenol tank cars. Connecting phenol trailers. c) Washing process equipment or lines which have contained phenols, acid, or caustic. d) Sampling phenols cars or trailers. e) Washing phenol, chlorinated phenol, acid, or caustic spills down.

Class B Clothing	Type of Work
Approved Acid Hood Approved 12" Gloves Approved Acid Jacket & Overalls Approved Rubber Boots Approved Full Face Mask & Canister	Any job in which there is a possibility of phenol or chlorinated phenols leaking or spraying out. Examples are: a) Disconnecting unloading hose from phenol trailer b) Removing drain plugs from primary and phenol pumps. c) Opening up phenol or chlorinated phenol lines or equipment.

Class C Clothing	Type of Work
Fuel-handler's Suit Air Pack	Emergencies when it is necessary to enter a heavy concentration of acid vapors or an acid spray.

Mechanics' Clothing Classification

Maintenance mechanics will wear the same classification of clothing as operators. Class B clothing will be worn when working on lines or equipment, which despite the best efforts of operations to prepare it, may contain some hazardous material such as phenol, chlorinated phenols, acids or caustic.

Persons wearing Class A clothing must wash protective clothing after use.

Persons wearing Class B clothing must shower thoroughly before removing clothing.

Do not enter control room with contaminated clothing or tools.

All tools exposed to phenols, chlorinated phenols, acids, or caustic must be thoroughly washed after use.

Care of Phenol Spills

Phenol or chlorinated phenol spills must be hosed down thoroughly with a 50-50 mix of cell liquor and water; then, wash equipment and area thoroughly with water.

12-21-79

Figure A-2

WICHITA PLANT SAFETY MANUAL
NEW EMPLOYEE SAFETY ORIENTATION
Section 403

INTRODUCTION

Safety orientation for new Vulcan employees is a very important part of maintaining an active safety program. Regardless of the area in which he will be employed or his experience level, he will be informed of the Vulcan Wichita Safety program. This section will outline the timing, subjects covered, and training aids to be used to accomplish this objective.

The sequence of this safety training is necessary to satisfy training requirements placed on Vulcan. This also enables a new employee to contribute to our safety program as soon as possible.

PURPOSE OF SAFETY ORIENTATION

New employee safety orientation has several objectives: 1) to inform all new employees of the importance of our safety program in the Wichita Plant, 2) to give them an understanding of the reason for our safety program, 3) to show how safety is an integral part of all their activities, 4) to show our interest in their personal safety and that they are expected, as part of their responsibility, to place a high priority on safety and safety training, 5) to provide them with basic information which they need to perform their jobs safely.

NEW EMPLOYEE SAFETY ORIENTATION SYLLABUS

I. Introduction

A. Outline of the manner in which new employee orientation will take place.

B. Brief explanation of Vulcan Materials, Chemicals Division; importance of Wichita plant and, where the new employees' jobs fit into the organization.

C. Explanation of our safety program: 1) economic, legal, and ethical aspects of a safety program, 2) how safety is an integral part of all activities and how it reduces, potential for injuries or accidents, 3) how training will take place, starting with programmed text, through various visual aids, and continued on the job with safety meetings, safety contacts and refresher training.

II. Programmed Text

Every new Wichita plant employee receives "New Employee Safety Orientation" the first day they report to work. New office or engineering personnel receive safety orientation either on the first day, or as soon as possible after they report to work.

The programmed text is a workbook divided into five sections:

SAFETY REFRESHER TRAINING

Safety Services conducts a safety refresher training session every three months. All new employees who have completed their probationary period (hired in previous quarter) are scheduled to attend. This is an eight hour program. Topics include:

A. Safety Responsibilities

   1. Safety Services Group

   2. Line Management

B. Medical Management and First Aid

C. Hands-on Fire Extinguisher Training

D. Emergency Alarm System and Emergency Response

E. Permit Procedures

   1. Confined Space

   2. Safe Work Permit

   3. Electrical Lock Out

   4. Tag Out

   5. Fuse Changing

F. Hazardous Substance Review: A videotape program with work book.

G. Hands-on Respiratory Equipment

   1. Air Pak

   2. Air Line Respirator

H. Emergency Showers and Eye Wash

FUTHER SAFETY TRAINING

Safety training is on-going throughout an employee's career. Whenever new procedures are developed, special training is required. Monthly safety training takes place in safety meetings. OSHA mandated annual training, such as a refresher on respiratory protection equipment is scheduled by Safety Services, or can be arranged by supervision.

A. General Safety Rules

B. Chemical Hazards

C. Emergency Signal System

D. Fire Extinguishers

E. Respiratory Protection

After a brief explanation, the new employee works through the programmed text.

III. Review and Amplification of Programmed Text Subjects

After completion of the programmed text, items from the text and from the new employee check list are reviewed. (Appendix A)

A. Explanation of general plant safety rules with emphasis on medical management and injury reporting.

B. Demonstration of required personal protective equipment, with emphasis on pocket respirator.

C. Review chemical hazards, with emphasis on caustic hazards and personal protective equipment.

D. Explanation and demonstration of Emergency Signal System. Brief explanation of emergency response and employees' potential involvement.

E. Brief review of types of fire extinguishers with a film.

F. Review difference between escape respiratory protection equipment and life sustaining equipment. Demonstration of Robertshaw and full-face respirators. Explanation of future training with respiratory equipment.

G. Review types of "Danger", "Caution", and "Warning" signs found throughout the plant.

H. Review the various safety permit procedures.

IV. Departmental Safety Check List

This check list (see Appendix B) is distributed. The new employee is told that, as part of the on-the-job training, he must learn and demonstrate the skills and topics to his department supervision.

V. Diagnostic Test (Appendix C)

A test is given to determine the new employees' grasp of the material. A question and answer session follows. The result of his test performance is sent to his supervisor.

AUDIO-VISUAL TRAINING AIDS USED.

A. New Employee Orientation

1. "Introduction to Vulcan-Wichita" - slide-tape
2. "First Aid and Chenical Exposure to the Eyes" - slide-tape
3. "Using Fire Extinguisher" - film
4. "You and What You Do" - film

B. Safety Refresher Training

1. "Confined Space" - Slides-tape and film
2. "Safe Work Permit" - Slide-tape
3. "Electrical Lock Out" - Videotape
4. "Fuse Changing" - Videotape
5. "Hazardous Substances" - Videotape
6. "Caustic" - Videotape

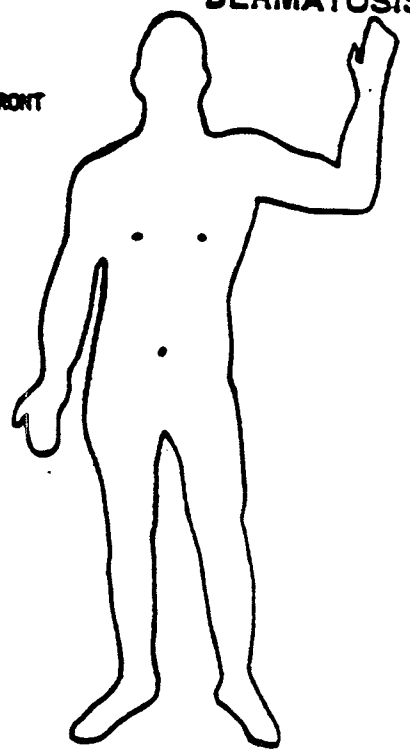
1-25-82

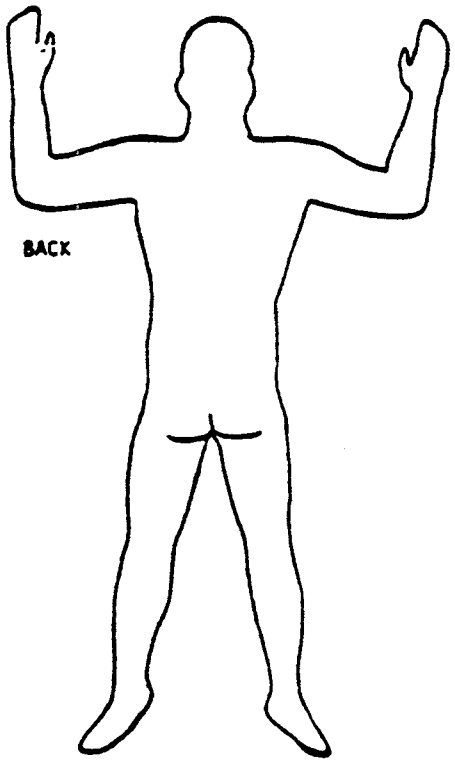
Figure A-3

	Needs to be seen by M.D	Yes	No
D0100	**Fungal Disease**	☐	☐
D0101	☐ Tinea pedis	D0102 ☐ Tinea versicolor	
D0103	☐ Tinea ungium	D0104 ☐ Tinea cruris	
D0105	☐ Other *(SPECIFY)* _____		
D0106	Describe degree and site: _____		
D0107	_____		
D0110	**Acne**	☐	☐
D0111	☐ Comedones	D0112 ☐ Blackheads	
D0113	☐ Cystic	D0114 ☐ Acne vulgaris	
D0115	☐ Acneiform	D0116 ☐ Other *(SPECIFY)* _____	
D0117	Describe degree and site: _____		
D0118	_____		
D0120	**Benign masses**	☐	☐
D0121	☐ Skin tags # _____	D0122 ☐ Nevi # _____	
D0123	☐ Papilloma # _____	D0124 ☐ Epithelioma # _____	
D0125	☐ Lipoma # _____	D0126 ☐ Other *(SPECIFY)* _____ # ___	
D0127	Describe degree and site: _____		
D0128	_____		
D0130	**Keratoses**	☐	☐
D0131	☐ Actinic # _____	D0132 ☐ Non-actinic # _____	
D0133	☐ Telangiectatic base	D0134 ☐ Atrophic area	
D0135	Describe degree and site: _____		
D0136	_____		
D0140	**Malignant tumors**	☐	☐
D0141	☐ Basal cell (D0142 ☐ Eroded ulcer) (D0143 ☐ Pearly papule w/telangiectasis)		
D0144	☐ Squamous cell (D0145 ☐ Fungating mass)		
D0146	☐ Melanoma		
D0147	Describe degree and site: _____		
D0148	_____		
D0150	**Folliculitis**	☐	☐
D0151	Describe degree and site: _____		
D0152	_____		
D0160	**Eczema**	☐	☐
D0161	☐ Acute eczema	D0162 ☐ Nummular eczema	
D0163	☐ Chronic eczema	D0164 ☐ Neurodermatitis	
D0165	☐ Psoriasis	D0166 ☐ Urticaria	
D0167	☐ Other *(SPECIFY)* _____		
D0168	Describe degree and site: _____		
D0169	_____		
D0170	**Other**	☐	☐
D0171	☐ Vitiligo	D0172 ☐ Warts # _____	
D0173	☐ Seborrheic keratoses # ___	D0174 ☐ Liver spots # _____	
D0175	☐ Chloracne # _____	D0176 ☐ Other *(SPECIFY)* _____ # ___	
D0177	Describe degree and site: _____		
D0178	_____		

DERMATOSIS

FRONT





BACK

COMPANY/PLANT:

NAME:

SEX: SSN:

DOB:

WORKER—ID:

* D0180 SIGNATURE OF EXAMINER _____

D0181 DATE _____

APPENDIX B

SAMPLING RESULTS

Table B-1*

First Class Penta Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
4/20/77	W-P-018	390	< 0.04	< 0.04	Caustic Bead	--
4/21/77	W-P-020	320	< 0.04	< 0.04	Caustic Bead	--
4/25/77	W-P-022	435	< 0.03	< 0.03	Caustic Bead	--
4/26/77	W-P-023	450	< 0.03	< 0.03	Caustic Bead	--
5/2/77	W-P-027	450	< 0.03	< 0.03	Caustic Bead	--
5/4/77	W-P-030	195	0.10	0.10	Caustic Bead	--
5/5/77	W-P-031	460	< 0.03	< 0.03	Caustic Bead	--
5/9/77	W-P-034	390	0.04	0.04	Caustic Bead	--
5/10/77	W-P-036	465	< 0.03	< 0.03	Caustic Bead	--
5/13/77	W-P-038	460	< 0.03	< 0.03	Caustic Bead	--
5/16/77	W-P-040	465	0.04	0.04	Caustic Bead	--
4/20/78	WP-2-78	240	N.D.		Filter	--
4/20/78	WP-4-78	60	N.D.		Filter	--
4/21/78	WP-5-78	93	N.D.		Filter	M
4/21/78	WP-8-78	90	N.D.		Filter	M
10/2/80	W-457	282	0.10	0.10	NIOSH S297	AS
10/6/80	W-461	97	0.11	0.11	NIOSH S297	G
10/21/80	W-464	306	0.14	0.14	Filter + SiO_2	G
10/22/80	W-465	359	0.03	0.03	Filter + SiO_2	AS;H;G
10/23/80	W-467	382	0.14	0.14	Filter + SiO_2	G;RB

Table B-1* (continued)

First Class Penta Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
4/6/81	W-576	314	0.84	0.84	Filter + SiO_2	G
4/7/81	W-582	341	0.02	0.02	Filter + SiO_2	G
4/8/81	W-589	392	0.01	0.01	Filter + SiO_2	G
4/9/81	W-593	349	0.005	0.005	Filter + SiO_2	G
4/13/81	W-601	338	0.01	0.01	Filter + SiO_2	G
4/14/81	W-606	345	0.02	0.02	Filter + SiO_2	G
4/12/82	W-1108-1	188	0.02	0.06	SiO_2	G
4/12/82	W-1108-2	203	0.09		SiO_2	G
4/13/82	W-1111-1	181	0.02	0.04	SiO_2	G
4/13/82	W-1111-2	220	0.06		SiO_2	G
4/15/82	W-1115-1	190	0.01	0.02	SiO_2	G;AS
4/15/82	W-1115-2	225	0.02		SiO_2	G
4/16/82	W-1128-1	196	0.04	0.03	SiO_2	G
4/16/82	W-1128-2	207	0.02		SiO_2	G
8/16/82	W-1571	130	0.01		SiO_2	G
8/16/82	W-1660	420	0.02		SiO_2	G
11/17/82	W-1163-1	220	0.03	0.08	SiO_2	G
11/17/82	W-1163-2	220	0.13		SiO_2	G
11/18/82	W-1669-1	205	0.14	0.08	SiO_2	G
11/18/82	W-1669-2	230	0.02		SiO_2	G

Table B-1* (continued)

First Class Penta Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
11/19/82	W-1674-1	210	0.06	0.04	SiO_2	G
11/19/82	W-1674-1	215	0.03		SiO_2	G
11/19/82	W-1675-1	215	0.02	0.03	SiO_2	G
11/19/82	W-1675-2	210	0.04		SiO_2	G;AS
3/30/83	W-1814-1	200	0.06	0.04	SiO_2	G
3/30/83	W-1814-2	195	0.02		SiO_2	G
3/31/83	W-1827-1	210	0.05	0.05	SiO_2	G
3/31/83	W-1827-2	195	0.06		SiO_2	G;GL
4/11/83	W-1841-1	210	0.006	0.006	SiO_2	G;GL
4/11/83	W-1841-2	225	0.008		SiO_2	G;GL
4/12/83	W-1844-1	210	0.03	0.02	SiO_2	G;GL
4/12/83	W-1844-2	220	0.02		SiO_2	G;GL
4/13/83	W-1847-1	220	0.01	0.02	SiO_2	G;GL
4/13/83	W-1847-2	230	0.04		SiO_2	G;GL
8/9/83	W-1914	300	0.01	0.01	SiO_2	G;GL
8/10/83	W-1921	330	0.008	0.008	SiO_2	G;GL

Table B-1* (continued)

First Class Penta Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
8/24/83	W-1935-1	205	< 0.009	< 0.009	SiO_2	R;G;AS
8/24/83	W-1935-2	229	< 0.008		SiO_2	G;GL
8/25/83	W-1943-1	211	< 0.008	< 0.008	Ft + SiO_2	R;G;GL;AS
8/25/83	W-1943-2	239	< 0.007		Ft + SiO_2	G;GL;R

* Table B-1 was constructed from documents received from the company
N.D. = non-detectable, limit of detection not known
TWA = time weighted average
mg/M^3 = milligrams per cubic meter
caustic bead = sodium hydroxide beads sampling tube
filter = 0.8 micron pore size cellulose ester filter
SiO_2 = silica gel sampling tube
Ft = teflon filter

Personal Protection Equipment Key:
M = MSA emergency respirator
AS = acid suit
G = gloves
AS&H = acid suit with hood
RB = rubber boots
GL = goggles
H = hard hat
S = safety glasses
PC = protective coat
R = half-faced respirator
C = Tyuek coveralls

Table B-2*

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
4/21/77	W-P-019	460	< 0.03	< 0.03	Caustic Bead	--
4/25/77	W-P-021	435	0.03	0.03	Caustic Bead	--
4/26/77	W-P-024	420	< 0.03	< 0.03	Caustic Bead	--
4/27/77	W-P-025	455	< 0.03	< 0.03	Caustic Bead	--
4/27/77	W-P-026	450	< 0.03	< 0.03	Caustic Bead	--
5/2/77	W-P-028	435	0.03	0.03	Caustic Bead	--
5/4/77	W-P-029	195	0.11	0.11	Caustic Bead	--
5/5/77	W-P-032	455	< 0.03	< 0.03	Caustic Bead	--
5/8/77	W-P-033	390	< 0.04	< 0.04	Caustic Bead	--
5/10/77	W-P-035	465	< 0.03	< 0.03	Caustic Bead	--
5/13/77	W-P-037	465	0.04	0.04	Caustic Bead	--
5/16/77	W-P-039	470	0.07	0.07	Caustic Bead	--
5/17/77	W-P-042	165	0.13	0.13	Caustic Bead	--
4/20/78	WP-1-78	120	N.D.		Filter	--
4/20/78	WP-3-78	180	N.D.		Filter	--
4/21/78	WP-6-78	85	N.D.		Filter	--
4/21/78	WP-9-78	155	N.D.		Filter	--
5/10/78	WP-12-78	46	0.419		Filter + Charcoal	--
5/10/78	WP-14-78	120	N.D.		Charcoal	--
5/10/78	WP-13-78	46	N.D.		Filter + Charcoal	--
5/10/78	WP-15-78	120	N.D.		Charcoal	--

Table B-2* (continued)

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
9/19/78	WP-17-78	15	0.04	0.04	Filter	--
9/19/78	WP-18-78	15	0.05		Filter	--
9/19/78	WP-19-78	20	0.01		Filter	--
9/19/78	WP-20-78	19	0.05		Filter	G
10/4/78	WP-22-78	15	0.03	0.02	Filter	RB;G;S
10/4/78	WP-23-78	20	0.02		Filter	RB;G;S
10/4/78	WP-24-78	23	0.02		Filter	RB;G;S
10/4/78	WP-25-78	26	0.01		Filter	RB;G;S
10/4/78	WP-26-78	16	0.03		Filter	RB;G;S
10/4/78	WP-27-78	10	0.01		Filter	RB;G;S
10/7/80	WP-462-1	181 +	0.12	1.85	Filter + SiO_2	G
10/7/80	WP-462-2	205 +	3.37		Filter + SiO_2	G
10/21/80	WP-463-1	209 +	4.50	2.52	Filter + SiO_2	G,M
10/21/80	WP-463-2	192 +	0.36		Filter + SiO_2	G
10/22/80	WP-466-1	159 +	4.65	3.17	Filter + SiO_2	G
10/22/80	WP-466-2	207 +	2.04		Filter + SiO_2	
10/23/80	WP-468-1	260	0.45	0.37	Filter + SiO_2	G;RB;PC
10/23/80	WP-468-2	122	0.19		Filter + SiO_2	
12/3/80	WP-469-1	85	0.40	0.22	Filter + SiO_2	G
12/3/80	WP-469-2	72	0.17		Filter + SiO_2	G
12/3/80	WP-469-3	150	0.06		Filter + SiO_2	G
12/3/80	WP-469-4	99	0.34		Filter + SiO_2	G

Table B-2* (continued)

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
12/5/80	WP-471-2	172	0.06	0.09	Filter + SiO_2	G
12/5/80	WP-471-3	120	0.14		Filter + SiO_2	G
12/16/80	WP-473-1	153	0.09		Filter + SiO_2	R;PC;G
12/16/80	WP-473-2	125	< 0.01	0.05	Filter + SiO_2	G
12/16/80	WP-473-3	132	0.05		Filter + SiO_2	R;AS;G
12/17/80	WP-474-1	144	0.07		Filter + SiO_2	R;G,PC
12/17/80	WP-474-2	160	0.11	0.07	Filter + SiO_2	R;G;PC
12/17/80	WP-474-3	91	0.02		Filter + SiO_2	R;G;PC
4/6/81	W-575	338	0.22	0.22	Filter + SiO_2	R;G;PC
4/7/81	W-580	365	0.06	0.06	Filter + SiO_2	R;G;PC
4/8/81	W-592	359	0.04	0.04	Filter + SiO_2	R;G;PC
4/10/81	W-598	315	0.30	0.30	Filter + SiO_2	R;G;C
4/13/81	W-602	309	0.01	0.01	Filter + SiO_2	R;G;C
4/14/81	W-605	344	0.03	0.03	Filter + SiO_2	R;G;C
4/24/81	W-619	329	0.07	0.07	Filter + SiO_2	R;G;C
5/11/81	WP-623-1	188	0.05	0.04	Filter + SiO_2	R,C
5/11/81	WP-623-2	205	0.04		Filter + SiO_2	R;C
5/12/81	WP-627-1	148	0.02	0.04	Filter + SiO_2	R;C;G
5/12/81	WP-627-2	221	0.06		Filter + SiO_2	R;C;G

Table B-2* (continued)

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
5/14/81	WP-631-1	206	0.06	0.12	Filter + SiO_2	R;C;G
5/14/81	WP-631-2	180	0.18		Filter + SiO_2	R;C;G
5/15/81	WP-705-1	182	0.04	0.04	Filter + SiO_2	G
5/15/81	WP-705-2	228	0.04		Filter + SiO_2	G
4/12/82	W-1107-1	185	0.05	0.05	SiO_2	G
4/12/82	W-1107-2	209	0.05		SiO_2	G
4/13/82	W-1110-1	187	0.02	0.18	SiO_2	G
4/13/82	W-1110-2	220	0.32		SiO_2	G
4/15/82	W-1113-1	190	0.07	0.05	SiO_2	G
4/15/82	W-1113-2	220	0.04		SiO_2	G
4/15/82	W-1114-1	190	0.02	0.01	SiO_2	G
4/15/82	W-1114-2	220	0.01		SiO_2	G
4/16/82	W-1126-1	193	0.10	0.06	SiO_2	G
4/16/82	W-1126-2	225	0.02		SiO_2	G
4/16/82	W-1127-1	190	0.06	0.04	SiO_2	G
4/16/82	W-1127-2	225	0.02		SiO_2	G
11/16/82	W-1658	425	0.04	0.04	SiO_2	G
11/16/82	W-1659	425	0.05	0.05	SiO_2	G;C
11/17/82	W-1661-1	215	0.12	0.09	SiO_2	G;C
11/17/82	W-1661-2	220	0.06		SiO_2	G

Table B-2* (continued)

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
11/18/82	W-1667-1	200	0.05	0.19	SiO_2	G
11/18/82	W-1667-2	230	0.31		SiO_2	G;C
11/18/82	W-1668-1	200	0.03	0.03	SiO_2	G
11/18/82	W-1668-2	230	0.03		SiO_2	G;C
11/19/82	W-1673-1	215	0.03	0.02	SiO_2	G
11/19/82	W-1673-2	210	0.02		SiO_2	G;C
3/30/83	W-1813-1	200	0.05	0.04	SiO_2	G
3/30/83	W-1813-2	195	0.02		SiO_2	G
3/31/83	W-1828-1	210	0.02	0.03	SiO_2	G
3/31/83	W-1828-2	195	0.04		SiO_2	G
4/11/83	W-1842-1	210	0.02	0.02	SiO_2	G;GL
4/11/83	W-1843	225	0.03		SiO_2	G;GL
4/12/83	W-1845	210	0.01	0.03	SiO_2	G;GL
4/12/83	W-1846	220	0.05		SiO_2	R;G;GL
4/13/83	W-1848-1	220	0.02	0.02	SiO_2	G;GL
4/13/83	W-1848-2	230	0.03		SiO_2	G;GL
8/9/83	1915	300	0.04	0.04	SiO_2	G;GL
8/10/83	1922	330	< 0.006	< 0.006	SiO_2	G;GL
8/24/83	1936-1	219	0.01	0.01	SiO_2	G
8/24/83	1936-2	225	0.01		SiO_2	G

Table B-2* (continued)

Third Class Operators' Personal Breathing
Zone Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Time (min.)	Sample Conc. (mg/M^3)	TWA	Sampling Method	Personal Protective Equipment Used
8/25/83	1944-1	205	0.03	0.02	Ft + SiO_2	R;G;GL;C
8/25/83	1944-2	272	0.01		Ft + SiO_2	R;G;GL;C

* = Table B-2 was constructed from documents received from the company
+ = sample tampered with
N.D. = non-detectable, limit of detection not known
TWA = time weighted average
mg/M^3 = milligrams per cubic meter
Caustic bead = sodium hydroxide beads sampling tube
Filter = 0.8 micron pore size celluose ester filter
SiO_2 = silica gel sampling tube
Charcoal = activated charcoal sampling tube
Ft = teflon filter

Personal Protection Equipment Key:
M = MSA emergency respirator
AS = acid suit
G = gloves
AS&H = acid suit with hood
RB = rubber boots
GL = goggles
H = hard hat
S = safety glasses
PC = protective coat
R = half-faced respirator
C = Tyuek coveralls

Table B-3*

Summary of Past Personal Breathing Zone
Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sampling Dates	Sample Description	Number of TWA	Range (mg/M^3)	Number of Nondetectable	Limit of Detection (mg/sample)	Arithmetic Mean (mg/M^3)	Arithmetic Standard Deviation (mg/M^3)	Geometric Mean (mg/M^3)	Geometric Standard Deviation (mg/M^3)	Sampling Method
10/21/80-4/14/81	First Class Penta Operator	9	0.005-0.84	0	0.002	0.14	0.27	0.04	5.68	F+SiO_2
4/12/82-8/24/83	First Class Penta Operator	16	< 0.009-0.08	1	0.002	0.03	0.02	0.02	2.44	SiO_2
10/7/80-5/15/81	Third Class Penta Operator	16	0.01-0.37	0	0.002	0.11	0.11	0.07	2.60	F+SiO_2
4/12/82-8/24/83	Third Class Penta Operator	21	< 0.006-0.32	1	0.002	0.05	0.05	0.03	2.58	SiO_2

* Table B-3 was constructed from documents received from the company.
TWA = time weighted averages
mg/M^3 = milligrams per cubic meter
F = 0.8 micron pore size celluose ester filter
SiO_2 = silica gel sampling tube

Table B-4*

Area Air Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Location	Sample Time (min)	Sample Conc. (mg/M^3)	TWA	Sampling Method
3/22/77	W-P-004	4th floor N.W. corner	465	N.D.		I/1M NaOH
3/22/77	W-P-005	4th floor Control Rm.	465	N.D.		I/1M NaOH
3/23/77	W-P-006	1st floor near auger which leads from flaker to dump tank	225	0.40	0.40	I/1M NaOH
3/23/77	W-P-007	3rd floor above flaker on 2nd floor	215	0.40	0.40	I/1M NaOH
3/24/77	W-P-008	1st floor N. wall near doorway	280			I/1M NaOH
3/24/77	W-P-009	2nd floor behind flaker	280	0.61	0.61	I/1M NaOH
3/28/77	W-P-010	Penta Blend Room	120	< 0.21	< 0.21	Caustic Bead
4/4/77	W-P-014	2nd floor on top of the flaker	120	0.50	0.50	Caustic Bead
4/4/77	W-P-015	2nd floor on top of the flaker	120	0.58	0.58	I/CH_3CN
4/4/77	W-P-016	2nd floor on top of the flaker	120	0.62	0.62	I/1M NaOH
4/27/78	WP-10-78	Inside the hood of the crystal point apparatus	353	0.27	0.27	Filter+Charcoal
4/27/78	WP-11-78	2nd floor near N. side of flaker	339	0.11	0.11	Filter+Charcoal
8/31/78	WP-16-78	In Penta bagging house	76	< 0.07	< 0.07	A/CH_3CN
10/1/80	W-455	Penta Blend Room	342	0.04	0.04	NIOSH S297
10/1/80	W-456	In Penta bagging house	338	0.06	0.06	NIOSH S297
10/2/80	W-458	Penta Blend Room	411	0.02	0.02	NIOSH S297
10/2/80	W-459	Penta Blend Room	340	< 0.03	< 0.03	Filter + SiO_2
10/6/80	W-460	Penta Blend Room	169	< 0.01	< 0.01	Filter + SiO_2
12/3/80	W-470	Foreman's Office	452	< 0.01	< 0.01	Filter + SiO_2
12/5/80	W-472	Foreman's Office	395	< 0.01	< 00.1	Filter + SiO_2
4/2/81	W-571	Penta Bagging House	351	0.85	0.85	Filter + SiO_2
4/2/81	W-572	1st floor N.E. of the flaker bin	351	0.26	0.26	Filter + SiO_2
4/2/81	W-573	2nd floor N.E. of the "dog leg"	351	0.09	0.09	Filter + SiO_2

Table B-4* (continued)

Area Air Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Location	Sample Time (min)	Sample Conc. (mg/M^3)	TWA	Sampling Method
4/2/81	W-574	3rd floor N.W. of point where catalyst is added to the 2nd chlorinator	351	0.03	0.03	Filter + SiO_2
4/6/81	W-577	2nd floor N. of the flaker	313	0.10	0.10	Filter + SiO_2
4/6/81	W-578	1st floor	332	0.47	0.47	Filter + SiO_2
4/7/81	W-579	4th floor-control room	370	0.72	0.72	Filter + SiO_2
4/7/81	W-580	Penta Bagging House	349	0.54	0.54	Filter + SiO_2
4/7/81	W-583	Foreman's Office	375	< 0.03	< 0.03	Filter + SiO_2
4/8/81	W-590	In kiln charging area	354	< 0.01	< 0.01	Filter + SiO_2
4/8/81	W-591	Foreman's Office	367	< 0.01	< 0.01	Filter + SiO_2
4/9/81	W-594	Penta Blend Room	353	< 0.01	< 0.01	Filter + SiO_2
4/9/81	W-599	Penta Blend Room	326	0.02	0.02	Filter + SiO_2
4/12/82	W-1109-1	2nd floor N. of flaker	189	0.13	0.08	SiO_2
4/12/82	W-1109-2	2nd floor N. of flaker	197	0.03		SiO_2
4/13/82	W-1112-1	Penta Bagging House	191	0.02	0.02	SiO_2
4/13/82	W-1112-2	Penta Bagging House	215	0.02		SiO_2
8/16/82	W-1572	Near a clean-up operation	128	0.01	0.01	SiO_2
3/30/83	W-1815	Inside Penta Bagging House	200	0.04	0.06	SiO_2
3/30/83	W-1821	Inside Penta Bagging House	195	0.08		SiO_2
3/30/83	W-1816	1st floor N. wall	200	0.06	0.04	SiO_2
3/30/83	W-1822	1st floor N. wall	195	0.03		SiO_2
3/30/83	W-1817	2nd floor W. wall	200	0.06	0.04	SiO_2

Table B-4* (continued)

Area Air Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Location	Sample Time (min)	Sample Conc. (mg/M^3)	TWA	Sampling Method
3/30/83	W-1823	2nd floor W. wall	195	0.03		SiO_2
3/30/83	W-1818	2nd floor N.E. wall behind flaker	200	0.04	0.04	SiO_2
3/30/83	W-1824	2nd floor N.E. wall behind flaker	195	0.04		SiO_2
3/30/83	W-1819	3rd floor W. wall near secondary chlorinator sample port	200	0.06		SiO_2
3/30/83	W-1825	3rd floor W. wall near secondary chlorinator sample port	195	0.04	0.04	SiO_2
3/30/83	W-1820	4th floor W. wall	200	0.07	0.06	SiO_2
3/30/83	W-1824	2nd floor N.E. wall	195	0.04		SiO_2
3/31/83	W-1829	Penta Bagging House	210	0.02	0.02	SiO_2
3/31/83	W-1830	1st floor N. wall	210	0.02	0.02	SiO_2
3/31/83	W-1831	2nd floor above flaker bin	210	0.06	0.06	SiO_2
3/31/84	W-1832	3rd floor N. wall near secondary chlorinator sample port	210	0.04	0.04	SiO_2
3/31/83	W-1834	Penta Blend Room	210	0.07	0.07	SiO_2
3/31/83	W-1835	Penta Bagging House	195	0.04	0.04	SiO_2
3/31/83	W-1836	1st floor W. wall	195	0.06	0.06	SiO_2
3/31/83	W-1837	4th floor near catalyst addition point and primary chlorinator sample port	195	0.07	0.07	SiO_2
3/31/83	W-1838	3rd floor W. wall	195	0.05	0.05	SiO_2
3/31/83	W-1839	Penta Blend House (storage)	195	0.02	0.02	SiO_2
3/31/83	W-1840	Penta Blend House	195	0.12	0.12	SiO_2
8/8/83	1916	3rd floor, near 2nd chlorinator sample port	300	0.013	0.010	SiO_2

Table B-4* (continued)

Area Air Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Location	Sample Time (min)	Sample Conc. (mg/M^3)	TWA	Sampling Method
8/8/83	1917	Above Flaker Bin	300	<0.01	<0.010	SiO_2
8/10/83	1923	3rd floor near N. door	330	0.005	0.005	SiO_2
8/10/83	1924	2nd floor N. of Flaker	330	0.013	0.013	SiO_2
8/11/83	1925	Inside Penta Blend Bldg.	420	0.010	0.010	SiO_2
8/11/83	1926	Inside Penta Bagging Rm.	420	0.016	0.016	SiO_2
8/11/83	1927	Behind Flaker Bin N. Wall	420	0.014	0.014	SiO_2
8/11/83	1928	N.E. of dog leg near 2nd chlorinator sample port	420	0.024	0.024	SiO_2
8/11/83	1929	N. of 1st chlorinator sample port	420	0.014	0.014	SiO_2
8/24/83	1937	Near 2nd chlorinator sample port	198	*0.010	0.010	SiO_2
8/24/83	1938-1	Inside Bagging Room	203	0.021	0.017	SiO_2
8/24/83	1938-2	Inside Bagging Room	232	0.014		SiO_2
8/24/83	1939-1	Near Dust Collection Sys.	197	<0.010	<0.010	SiO_2
8/24/83	1939-2	Near Dust Collection Sys.	235	<0.010		SiO_2
8/24/83	1940-1	Near 2nd Chlorinator sample port	198	<0.010		SiO_2
8/24/83	1940-2	Near 2nd Chlorinator sample port	233	<0.010	<0.010	SiO_2
8/24/83	1941-1	On top of flaker	188	0.010	0.019	SiO_2
8/24/83	1941-2	On top of flaker	235	0.019		SiO_2
8/24/83	1942-1	Inside Bagging Room	207	0.052	0.052	Ft + SiO_2
8/24/83	1942-2	Near Kiln Charging Area	235	0.011	0.011	Ft + SiO_2
8/25/83	1945-1	2nd floor N. of flaker	209	0.048	0.037	Ft + SiO_2
8/25/83	1945-2	2nd floor N. of flaker	246	0.028		Ft + SiO_2

Table B-4* (continued)

Area Air Samples for Pentachlorophenol
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample No.	Sample Location	Sample Time (min)	Sample Conc. (mg/M^3)	TWA	Sampling Method
8/25/83	1946-1	N. of 2nd chlorinator sample port	203	0.055	0.028	Ft + SiO_2
8/25/83	1946-2	N. of 2nd chlorinator sample port	248	<0.010		Ft + SiO_2
8/25/83	1947-1	N. of 2nd chlorinator sample port	203	0.012	0.011	Ft + SiO_2
8/25/83	1947-2	N. of 2nd chlorinator sample port	248	0.010		Ft + SiO_2

* Table B-4 was constructed from documents received from the company.
N.D. = non-detectable, limit of detection not known
TWA = time weighted average
mg/M^3 = milligrams per cubic meter
I/1M NaOH = impinger containing a one molar sodium hydroxide absorbing solution
Caustic Bead = sodium hydroxide beads sampling tube
I/CH_3CN = impinger containing an acetonitrile absorbing solution
Filter = 0.8 micron pore size, celluose ester filter
Charcoal = activated charcoal sampling tube
SiO_2 = silica gel sampling tube
Ft = teflon filter

Table B-5*

Results of Past Personal Breathing Zone Samples
for HxCDD, HpCDD, and OCDD
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample Number	Sample Description	Sample Time (min.)	Dioxin Concentration (ng/M^3)			Dioxin TWA (ng/M^3)			Sampling Method Used	Personal Protection Equipment Used
				HxCDD	HpCDD	OCDD	HxCDD	HpCDD	OCDD		
8/9/83	1914	Class I Operator	300	<2.82	<2.82	0.84	<2.82	<2.82	0.84	SiO_2	G;GL
8/10/83	1921	Class I Operator	330	<2.64	14.3	20.0	<2.64	14.3	20.0	SiO_2	G;GL
8/24/83	1935-1	Class I Operator	205	86.0	1591	2236	41.6	758	1067	SiO_2	G;GL
8/24/83	1935-2	Class I Operator	229	<3.85	11.5	21.2				SiO_2	G;GL
8/25/83	1943-1	Class I Operator	211	<3.94	4.73	23.4	<3.75	3.17	37.6	$Ft+SiO_2$	R;G;GL;AS
8/25/83	1943-2	Class I Operator	239	<3.58	<3.58	50.2				$Ft+SiO_2$	R;G;GL;AS
8/9/83	1915	Class III Penta Operator	300	<2.99	<2.99	29.9	<2.99	<2.99	29.9	SiO_2	G;GL
8/10/83	1922	Class III Penta Operator	330	16.0	331	1710	16.0	331	1710	SiO_2	G;GL
8/24/83	1936-1	Class III Penta Operator	219	<3.91	31.2	70.3	<3.90	16.4	34.9	SiO_2	R;G;C
8/24/83	1936-2	Class III Penta Operator	225	<3.89	<3.89	0.39				SiO_2	R;G;C;RB
8/25/83	1944-1	Class III Penta Operator	205	<4.44	<4.44	361	3.17	33.7	268	$Ft+SiO_2$	R;G;GL;C
8/25/83	1944-2	Class III Penta Operator	272	4.44	57.4	198				SiO_2	R;G;C;RB

Table B-5 (continued)

* Table B-5 was constructed from documents received from the company.
ng/M^3 = nanograms per cubic meter
TWA = time weighted average
HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
SiO_2 = silica gel sampling tube
Ft = teflon filter

Personal Protection Key:
G = gloves
GL = goggles
R = half-faced respirator
AS = acid suit
RB = rubber boots
C = Tyuek coveralls

Table B-6*

Results of Past Area Air Samples for HxCDD, HpCDD, and OCDD
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample Number	Sample Description	Sample Time (min.)	Dioxin Concentration (ng/M^3)			Dioxin TWA (ng/M^3)			Sampling Method Used
				HxCDD	HpCDD	OCDD	HxCDD	HpCDD	OCDD	
8/8/83	1916	3rd floor near 2nd chlorinator sampling pt	300	< 3.27	< 3.27	0.98	< 3.27	< 3.27	0.98	SiO_2
8/8/83	1917	Above Flaker Bin	300	< 3.70	< 3.70	1.48	< 3.70	< 3.70	1.48	SiO_2
8/10/83	1923	3rd floor near North door exist	330	< 2.67	< 2.67	< 2.67	< 2.67	< 2.67	< 2.67	SiO_2
8/10/83	1924	2nd floor North of Flaker Near Exist	330	< 2.64	< 2.64	33.0	< 2.64	< 2.64	33.0	SiO_2
8/11/83	1925	Inside Penta Blend Building	420	< 2.17	16.9	28.2	< 2.17	16.9	28.2	SiO_2
8/11/83	1926	Inside Penta Bagging Room	420	13.6	7.54	775	13.6	7.54	775	SiO_2
8/11/83	1927	Behind Penta Blend Building	420	< 2.07	< 2.07	13.7	< 2.07	< 2.07	13.7	SiO_2
8/11/83	1928	NE of Dog leg Near 2nd Chlorinator Sampling Port	420	< 2.22	< 2.22	< 2.22	7.34	< 2.22	7.34	SiO_2

Table B-6* (continued)

Results of Past Area Air Samples for HxCDD, HpCDD, and OCDD
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample Number	Sample Description	Sample Time (min.)	Dioxin Concentration (ng/M^3)			Dioxin TWA (ng/M^3)			Sampling Method Used
				HxCDD	HpCDD	OCDD	HxCDD	HpCDD	OCDD	
8/11/83	1929	North of 1st Chlorinator Sampling Port	420	<2.07	<2.07	6.62	<2.07	<2.07	6.62	SiO_2
8/24/83	1937-1	Near 2nd Chlorinator Sampling Port	198	<3.51	14.0	42.1	<3.51	14.0	42.1	Ft+SiO_2
8/24/83	1938-1	Inside Bagging Room	203	<4.16	<4.16	79.0	<3.92	<3.92	38.4	SiO_2
8/24/83	1938-2	Inside Bagging Room	232	<3.72	<3.72	2.97				SiO_2
8/24/83	1939-1	Near Dust Collection System	197	<5.62	<5.62	10.7	<5.19	<5.19	5.19	SiO_2
8/24/83	1939-2	Near Dust Collection System	235	<4.83	<4.83	0.48				SiO_2
8/24/83	1940-1	Near 2nd Chlorinator Sampling Port	198	<5.02	<5.02	15.1	<4.68	11.8	17.4	SiO_2
8/24/83	1940-2	Near 2nd Chlorinator Sampling Port	233	<4.39	19.7	19.3				SiO_2

Table B-6* (continued)

Results of Past Area Air Samples for HxCDD, HpCDD, and OCDD
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample Number	Sample Description	Sample Time (min.)	Dioxin Concentration (ng/M^3)			Dioxin TWA (ng/M^3)			Sampling Method Used
				HxCDD	HpCDD	OCDD	HxCDD	HpCDD	OCDD	
8/24/83	1941-1	On top of flaker	188	<4.81	<4.81	6.25	<4.33	<4.33	6.06	SiO_2
8/24/83	1941-2	On top of flaker	235	<3.94	<3.94	5.90				SiO_2
8/24/83	1942-1	Located in Charging Area of Kiln	207	<4.01	7.63	193	<3.80	91.8	339	Ft+SiO_2
8/24/83	1942-2	Located in Charging Area of Kiln	235	<3.62	166	467				Ft+SiO_2
8/25/83	1945-1	2nd Floor N. of Flaker	209	<4.80	<4.80	224	23.6	21.4	216	Ft+SiO_2
8/25/83	1945-2	2nd Floor N. of Flaker	246	41.7	37.5	210				Ft+SiO_2

Table B-6* (continued)

Results of Past Area Air Samples for HxCDD, HpCDD, and OCDD
Vulcan Materials Company
Wichita, Kansas

Sample Date	Company Sample Number	Sample Description	Sample Time (min.)	Dioxin Concentration (ng/M^3)			Dioxin TWA (ng/M^3)			Sampling Method Used
				HxCDD	HpCDD	OCDD	HxCDD	HpCDD	OCDD	
8/25/83	1946-1	N. of 2nd Chlorinator Sampling Port	203	<5.49	11.0	137				Ft+SiO_2
8/25/83	1946-2	N. of 2nd Chlorinator Sampling Port	248	<4.60	<4.60	33.1	<5.00	6.22	80.0	Ft+SiO_2
8/25/83	1947-1	N. of 2nd Chlorinator Sampling Port	203	<4.18	<4.18	75.2				Ft+SiO_2
8/25/83	1947-2	N. of 2nd Chlorinator Sampling Port	248	<3.50	5.95	36.4	<3.81	4.21	53.9	Ft+SiO_2

* Table B-6 was constructed from documents received from the company.
ng/M^3 = nanograms per cubic meter
TWA = time weighted average
HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
SiO_2 = silica gel sampling tube
Ft = teflon filter

Table B-7*

Dioxin Profile During Chlorination
Vulcan Materials Company
Wichita, Kansas

This table was removed for confidential reasons.

Table B-8*

Summary of Dioxin Profiles During Chlorination
Vulcan Materials
Wichita, Kansas

This table was removed for confidential reasons.

Table B-9+

Dioxins in Pentachlorophenol Product
Vulcan Materials Company
Wichita, Kansas

This table was removed for confidential reasons.

Table B-10+

Summary of Dioxin in Pentachlorophenol Product
Vulcan Materials Company
Wichita, Kansas

Year	Number of Samples	Dioxin Concentrations (ppm)								
		Range of HxCDD	Mean of HxCDD	Standard Deviation of HxCDD	Range of HpCDD	Mean of HpCDD	Standard Deviation of HpCDD	Range of OCDD	Mean of OCDD	Standard Deviation of OCDD
1975	3	589-608	600	10	198-350	278	76	2205-2486	2302	160
1976	2*	<10-25	15	--	375-547	461	--	1245-2083	1664	--
1981	2	25-76	50	--	884-1171	1028	--	1041-1445	1519	--
1982	3	16-30	26	9	556-653	604	48	1028-1325	1131	168
1983	7	<0.5-40	20	15	142-868	508	239	723-1389	958	248
1975-1983	17	<0.5-608	97	192	142-1171	540	266	723-2486	1375	560

* Composite samples analyzed with two different sample preparations and quantitated on flame ionization gas chromatography.
HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
+ Table B-10 was constructed from documents received from the company.

Table B-11*

Results Obtained for Vulcan Pentachlorophenol Samples Analyzed
for Chlorinated Dibenzo-p-dioxins (CDD) and Dibenzofurans (CDF)
Brehm Laboratory, Wright State University
Dayton, Ohio

Vulcan Sample Description/ Date	Concentrations of CDD and CDF (ug/g)											
	TCDF2	TCDD3	PCDF	PCDD	HxCDF	HpCDD	HpCDF	HpCDD	OCDF	OCDD	$\frac{\text{OCDD}}{\text{HxCDD}}$	$\frac{\text{OCDD}}{\text{HpCDD}}$
Batch AF039 6-82	1.46	0.025	6.74	0.016	50.5	9.30	353	504	1280	2630	283	5.22
Batch BC007 3-3-83	1.11	0.140	7.65	0.470	46.8	5.90	242	312	413	1767	299	5.66
Batch BD029 4-12-83 4X12	4.50	0.029	42.3	0.100	152	20.0	477	687	1532	3206	160	4.67
Batch BD058 4-23-83	0.853	0.045	10.3	0.140	92.0	7.30	315	363	1100	2545	349	7.01
Batch BD066 4-27-83	0.280	0.089	4.34	0.250	56.9	8.40	310	396	650	2297	273	5.80
Batch BD072 4-28-83	2.40	0.219	8.60	0.470	68.8	10.7	341	421	695	2162	202	5.14
Batch BD074 4-29-83	4.40	0.144	26.7	0.450	134	13.8	319	380	503	2314	168	6.09
Batch BD075 4-29-83	11.2	0.145	56.7	0.460	204	15.2	315	476	608	2125	140	4.46
Batch BD076 4-29-83	7.50	0.240	33.7	0.700	115	19.5	376	741	724	4058	208	5.48
Batch BD079 4-30-83	11.0	0.160	40.0	0.500	156	27.7	352	748	1371	4156	150	5.56
Batch BD080 5-1-83	5.70	0.180	36.0	0.500	147	27.1	430	794	1400	3757	139	4.73
Arithmetic Mean	4.58 (±3.92)	0.129 (±0.074)	24.8 (±18.1)	0.369 (±0.210)	111 (±52.0)	15.0 (±7.69)	348 (±63.2)	529 (±178)	934 (±407)	2820 (±837)	216 (±73.5)	5.44 (±0.726)
Geometric Mean	2.84 (±3.22)	0.102 (±2.23)	13.8 (±2.85)	0.265 (±3.022)	99.4 (±1.67)	13.2 (±1.69)	343 (±1.20)	503 (±1.40)	852 (±1.58)	2713 (±1.33)	205 (±1.40)	5.40 (±1.14)

* Table B-11 is a reconstruction of a document received from the company.

Table B-11 (continued)

1. Three internal standards were employed during these analyses. The recoveries obtained for the internal standards are: $^{37}Cl_4$ - 2,3,7,8-TCDD (range: 45%-64%, mean=54%); $^{37}C;_4$ - 1,2,3,4,6,7,8-HpCDD (range: 40%-70%, mean=53%); $^{37}Cl_8$ - OCDD (range: 35%-70%, mean=50%).

2. While not all of the 38 TCDF isomers are available in this laboratory for use as calibration standards, the 2,3,7,8-TCDF as well as two additional TCDF isomers are available and are employed in calibrating the gas chromatographic-mass spectrometric system. The levels of TCDF listed in this table comprise the total concentration of TCDF present; however, our results indicate that no 2,3,7,8-TCDF was present above the limit of 0.5 ug/g.

3. All of the 22 TCDD isomers are available in this laboratory for use as calibration standards. The TCDD levels listed in this table comprise the total concentration of TCDD present and this appears to be entirely the 1,2,3,4-TCDD isomer. No 2,3,7,8-TCDD was found to be present in these samples above the minimum detectable concentration of 0.05 ug/g.

TCDF = tetrachlorodibenzofuran
TCDD = tetrachlorodibenzo(p)dioxin
PCDF = pentachlorodibenzofuran
PCDD = pentachlorodibenzo(p)dioxin
HxCDF = hexachlorodibenzofuran
HxCDD = hexachlorodibenzo(p)dioxin
HpCDF = heptachlorodibenzofuran
HpCDD = heptachlorodibenzo(p)dioxin
OCDF = octachlorodibenzofuran
OCDD = octachlorodibenzo(p)dioxin
ug/g = micrograms per gram

Table B-12*

Comparison Analyses
Vulcan Materials Company
Wichita, Kansas

Batch No.	TCDD (ppm)			PCDD (ppm)			HxCDD (ppm)			HpCDD (ppm)			OCDD (ppm)		
	B	V	U1	B	V	U	B	V	U	B	V	U	B	V	U
BD072	0.219	0.010	0.005	0.470	0.010	0.005	10.7	12.5	8.0	421	731	N.A.	2162	2270	N.A.
BD072[2]	0.100	N.A.	N.A.	0.050	N.A.	N.A.	7.4	N.A.	N.A.	340	N.A.	N.A.	1600	N.A.	N.A.
BD072[3]	0.060	0.010	N.A.	0.050	0.010	N.A.	7.0	N.A.	N.A.	410	N.A.	N.A.	260	N.A.	N.A.
BD072[4]	0.040	0.023	N.A.	0.050	0.010	N.A.	6.0	15.3	N.A.	345	849	N.A.	690	2600	N.A.
BD066	0.089	0.010	0.005	0.25	0.010	0.005	8.4	N.A.	3.4	396	N.A.	N.A.	2297	N.A.	N.A.
BD058	0.045	0.010	0.005	0.140	0.010	0.005	7.3	N.A.	2.5	363	N.A.	N.A.	2545	N.A.	N.A.

[1] B = Brehm Labs
V = Vulcan Chemicals
U = University of Umea
[2] Sample re-submitted in January, 1984
[3] Sample work-up by Vulcan, analysis by Brehm
[4] Sample work-up by Vulcan, analysis by Brehm and Vulcan. Sample spiked with 11 ppb 1,2,3,4-Tetra-CDD
* Table B-12 is a reconstruction of a document received from the company
N.A. = Sample not analyzed or not submitted
TCDD = tetrachlorodibenzo(p)dioxin
PCDD = pentachlorodibenzo(p)dioxin
HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
ppm = parts per million

Table B-13*

Vulcan Pentachlorophenol Samples Analyzed by Other Laboratories
Vulcan Materials Company
Wichita, Kansas

Year	Sample	Analyzed By	Dioxin Concentration (ppm)		
			HxCDD	HpCDD	OCDD
1975	1	Dow Chemical	10	--	1700
	2	" "	N.D. <0.3	--	N.D. <1.0
	3	" "	15	--	2500
	4	" "	16	--	3600
1977	6 (Samples)	" "	1-10	--	600-1600
1983	AD034	Agriculture Canada	0.75	222.5	1202.8
	AD032	" "	2.14	333.4	1459.2
	AD038	" "	1.59	293.6	1807.8
	AD032	" "	0.64	174.3	1268.1

HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
* Table B-13 is a reconstruction of a document received from the company.

Table B-14

Results of Personal Breathing Zone and Area Air
Samples for Pentachlorophenol
August 24-25, 1983
Vulcan Materials Company
Wichita, Kansas

Sample Date	Job Title or Location of Area Sample	Sample Time (min.)	Conc. of PCP on filter (mg/M3)	Conc. of PCP on SiO2 (mg/M3)	Total PCP Conc. (mg/M3)	TWA PCP Conc. (mg/M3)	Field Sample Number VF&VT
8/24/83	First Class Penta Oper.	208	<0.004	0.019	0.019	0.031	20
8/24/83	First Class Penta Oper.	105	<0.0	0.055	0.055		7
8/25/83	First Class Penta Oper.	203	<0.005	0.052	0.052	0.030	16
8/25/83	First Class Penta Oper.	240	<0.004	0.012	0.012		2
8/24/83	Third Class Penta Oper.	220	<0.004	0.008	0.008	0.005	18
8/24/83	Third Class Penta Oper.	223	<0.004	<0.004	< 0.004		5
8/25/83	Third Class Penta Oper.	206	<0.025	0.022	0.047	0.026	14
8/25/83	Third Class Penta Oper.	238	<0.004	0.008	0.008		9
8/24/83	Near Secondary Chlorinator Sampling Port	198	<0.005	0.009	0.009	0.014	17
8/24/83	Near Secondary Chlorinator Sampling Port	229	<0.004	0.019	0.019		11
8/25/83	Near Secondary Chlorinator Sampling Port	450	<0.002	--	<0.002	<0.002	15
8/24/83	On top of flaker	232	<0.004	0.139	0.139	0.088	3
8/24/83	On top of flaker	188	<0.005	0.024	0.024		19
8/25/83	North wall near the flaker	457	0.013	--	0.013	0.013	6

Table B-14 (continued)

Results of Personal Breathing Zone and Area Air
Samples for Pentachlorophenol
August 24-25, 1983
Vulcan Materials Company
Wichita, Kansas

Sample Date	Job Title or Location of Area Sample	Sample Time (min.)	Conc. of PCP on filter (mg/M3)	Conc. of PCP on SiO2 (mg/M3)	Total PCP Conc. (mg/M3)	TWA PCP Conc. (mg/M3)	Field Sample Number VF&VT
8/24/83	In Kiln Charging Area	232	0.008	0.109	0.117	0.256	8
8/24/83	In Kiln Charging Area	187	<0.005	0.429	0.429		21
8/24/83	In the Bagging Area	435	<0.005	0.050	0.050	0.050	12
8/24/83	Near Dust Collection Unit	435	<0.005	0.014	0.014	0.014	1
8/25/83	On top of bucket conveyor between kiln and bulk storage	458	<0.002	--	<0.002	<0.002	4

TWA = time weighted average
mg/M^3 = milligrams per cubic meter
PCP = pentachlorophenol
SiO_2 = silica gel sampling tube
VF = teflon filter portion of sampling media
VT = silica gel sampling portion of sampling media
Limit of Quantification = 1.00 micrograms PCP per sample
Limit of Detection = 0.33 micrograms PCP per sample

Table B-15*

Comparison of NIOSH and Vulcan
Personal Breathing Zone Samples
August 24-25, 1983
Vulcan Materials Company
Wichita, Kansas

		NIOSH Results		Vulcan Results				
Sample Date	Job Title	Field Sample Number VF&VT	PCP TWA (mg/M3)	Field Sample Number	PCP TWA (mg/M3)	HxCDD TWA (ng/M3)	HpCDD TWA (ng/M3)	OCDD TWA (ng/M3)
8/24/83	First Class Penta Operator	20; 7	0.031	1935-1 1935-2	<0.009	41.6	758	1067
8/25/83	First Class Penta Operator	16; 2	0.030	1943-1 1943-2	<0.008	<3.75	3.17	37.6
8/24/83	Third Class Penta Operator	18; 5	0.005	1936-1 1936-2	0.01	<3.90	16.4	34.9
8/25/83	Third Class Penta Operator	14; 9	0.026	1944-1 1944-2	0.02	3.17	33.7	268

* The Vulcan portion of the table was constructed from documents received from the company.

TWA = time weighted average
mg/M^3 = milligrams per cubic meter
ng/M^3 = nanograms per cubic meter
PCP = pentachlorophenol
HxCDD = hexachlorodibenzo(p)dioxin
HpCDD = heptachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
VF = teflon filter portion of sampling media
VT = silica gel sampling tube portion of sampling media

Table B-16

Quantitative Results for Chlorinated Dibenzo(p)dioxins
and Octachlorodibenzofurans in Bulk Samples Collected
During the Industrial Hygiene Survey
Vulcan Materials Company
Wichita, Kansas

Field Sample	Sample Description	Batch #	Concentration (ug/g)					
			Di&TriCDD	TCDD	PCDD	HxCDD	OCDD	OCDF
2	Pentachlorophenol (Finished Product, "Glazd"R)	073	25.2	< 1.0	< 1.0	7.55	690	76.5
3	Pentachlorophenol (Un"Glazd"R)	073	17.1	< 1.0	< 1.0	10.2	893	127
4	Sample from the 2nd Chlorinator	074	1.0	< 1.0	< 1.0	< 1.0	40.2	16.8
5	Sample from the 1st Chlorinator	074	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

ug/g = micrograms per gram
Di&TriCDD = Di- and/or Trichlorodibenzo(p)dioxin
TCDD = tetrachlorodibenzo(p)dioxin
PCDD = pentachlorodibenzo(p)dioxin
HxCDD = hexachlorodibenzo(p)dioxin
OCDD = octachlorodibenzo(p)dioxin
OCDF = octachlorodibenzofuran