DIOXIN REGISTRY REPORT
of
THE DOW CHEMICAL COMPANY
Midland, Michigan

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PURPOSE OF SURVEYS:

The purpose for the visits to Dow Chemical Company, Midland, Michigan was to collect information for use in the Dioxin Registry, walk through all relevant production buildings which are still standing, and audit Dow Chemical record systems.

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Abstract

The Dow Chemical Company in Midland, Michigan is a large, integrated chemical plant, which through the years (1935-1983) along with many other chemicals, produced 2,4,5-trichlorophenol (2,4,5-TCP), several derivatives of 2,4,5-TCP, pentachlorophenol (PCP) and several derivatives of PCP. The NIOSH Dioxin Registry Study is a compilation of demographic and work history information for all U.S. production workers who have synthesized products known to be contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and hexachlorodibenzo-p-dioxins (HxCDD). 2,4,5-TCP and its derivatives as well as PCP and its derivatives contain these dioxin isomers; therefore, the Dow Chemical Company plant in Midland, Michigan, has been included in the NIOSH Dioxin Registry Study.

A history and description of the processes, personnel, and records systems are included in this report. An account of the procedures used to review the personal record system, industrial hygiene reports and data, and analytical dioxin data is included. In addition, a descriptive summarization of the industrial hygiene and analytical dioxin data is provided.

The Dow Chemical Company's records for general personnel, medical, workers' compensation, industrial hygiene and analytical dioxin data provide an excellent base from which work histories can be constructed and potential exposures to TCDD and HxCDD can be estimated for Dow Chemical Company employees included in the Dioxin Registry.

Introduction

The National Institute for Occupational Safety and Health (NIOSH), Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), Industrywide Studies Branch (IWSB), is conducting an investigation of health effects resulting from occupational exposure to polychlorinated dibenzo-p-dioxins, and in particular the isomers 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) or hexachlorodibenzo-p-dioxins (HxCDD). This study, referred to as the Dioxin Registry, is a compilation of demographic and work history information for all U.S. production workers who have synthesized products known to be contaminated with TCDD or HxCDD. The Registry, initiated in 1979, was prompted by animal studies showing TCDD to be acutely toxic and a chloracnegen, as well as a carcinogen and teratogen.[1-7] TCDD is a contaminant found in 2,4,5-trichlorophenol and/or its sodium salt, which are raw materials used to produce chemical compounds such as 2,4,5-trichlorophenoxyacetic acid (2,4,5-T acid) and 2,2'methylenebis (3,4,6-trichlorophenol) (hexachlorophene). Currently, there are fourteen production facilities and approximately 7000 workers included in the Registry. The first use of the Registry will be to conduct a mortality study for which the comparison group will be the U.S. male population. This study will evaluate the causes of death among workers exposed to products contaminated with 2,3,7,8-TCDD and/or HxCDD. The Registry will also be used in a morbidity study of workers from two sites from which worker exposure data has been included in the Registry.

The Dow Chemical Company located in Midland, Michigan is one of the 14 sites included in the Dioxin Registry. Presented is a compilation of information and data collected from Dow on its 2,4,5-TCP, 2,4,5-TCP derivatives, pentachlorophenol (PCP), and PCP derivative processes which operated over a forty year period.

History and Description of the Facilities (Information Relevant to the Dioxin Registry)

The Dow Chemical Company produced 2,4,5-TCP, derivatives of 2,4,5-TCP, PCP and derivatives of PCP, from 1935 to 1983 at its large, integrated chemical plant located in Midland, Michigan. The facility is known as the Michigan Division. Appendix A, Table 1 list the buildings, dates, products and organizational units for each process relevant to the Dioxin Registry. The following subsections describe the history and relevant details about the buildings which housed the 2,4,5-TCP, TCP derivatives, PCP and PCP derivative production processes. Figures and tables referred to in the following subsections can be found in Appendix A.

A) 2,4,5-Trichlorophenol and Sodium 2,4,5-Trichlorophenate

Dow initiated the production of 2,4,5-TCP on a developmental basis in 1942 in 199A Building. Routine commercial manufacturing of 2,4,5-TCP began in April, 1946. The sodium salt of 2,4,5-TCP, sodium

2,4,5-trichlorophenate (NaTCP), was synthesized in 199 Building and the acidification and finishing to form 2,4,5-TCP was done in 349 Building. Building layout diagrams for 199 and 349 Buildings are shown in Figures 1 and 2, respectively. In June of 1966, 804 Building was completed and housed a new and significantly changed 2,4,5-TCP production process. A building layout diagram for 804 Building Complex is shown in Figure 3. The NaTCP process in 199 Building and the acidification to form 2,4,5-TCP in 349 Building were shut down in the fall of 1966. The 2,4,5-TCP process change was brought about due to the need for more production capacity, the problems with chloracne which were associated with an old process (discussed in subsequent sections of this report), and the availability of a "better" process. The 199 Building was dismantled in 1968. Production in 804 Building complex ceased in February 1979. Most of the 2,4,5-TCP produced was used in herbicide production, with small amounts used in the production of antimicrobials, such as Hi-Purity TCP, Dowicide® (2,4,5-TCP), Dowicide® B (NaTCP), and the insecticide, ronnel (o,o-dimethyl-o-(2,4,5-trichlorophenyl)-phosphorothioate). The 804 Bldg. 2,4,5-TCP process equipment was demolished on Sept. 31, 1987.

There are no records available which document the amounts of 2,4,5-TCP or its sodium salt equivalent produced in 199 Building. The evidence that is available suggests that production levels during the first ten years of operation varied between 50,000 and 500,000 pounds annually. Production levels ranged from 400,000 to 2.5 million pounds annually for the second ten years. The production during a given year was seasonal. Peak production occurred during late fall and winter months, and little (if any) production during the summer months.

Production of 2,4,5-TCP in 804 Building complex during the years (1966-1979) in which it operated varied from about 2.5 to 9.0 million pounds annually. There were no identifiable patterns of production during these years other than when 2,4,5-TCP was demanded as an intermediate or as a product. On the average from ten to thirty percent of the actual annual production was marketed outside Dow as a chemical intermediate or as a pesticide.

B) <u>2,4,5-Trichlorophenoxyacetic Acid and Acid Esters</u>

The 2,4,5-trichlorophenoxyacetic acid (2,4,5-T acid) was first produced in 267 Building, Organic Semi Plant, in 1948. The product obtained commercial status in 1950 when the process was shifted from the pilot plant area of 267 Building to the then vacated 2,4-dichlorophenoxyacetic acid (2,4-D acid) facilities in the same building. The production of 2,4,5-T acid continued in 267 Building until it was terminated in May 1971. A building layout diagram of 267 Building is shown in Figure 4. 267 Building was demolished in December 1973. Table 2 summarizes the company estimates for the percent of the time in each year that the 2,4,5-T acid process was operated.

Most of the 2,4,5-T acid produced was converted to butyl, Dowanol® PIB (a mixture of butyl and isobutyl ethers of propylene glycol) or isooctyl esters. The butyl esters were manufactured in the acid ester plant in 489 Building while the less volatile esters were produced in 267 Building.

The production records for the manufacture of 2,4,5-T acid in 267 Building have long since been destroyed. However, based upon reconstruction of events and recall of Dow management, the following estimates have been made:

1950-1955	0-200,000 pounds/year
1956-1960	100,000-750,000 pounds/year
1961-1965	400,000-2.0 million pounds/year
1966-1971	500,000-3.5 million pounds/year

No 2,4,5-T acid was produced in 1968 and little was produced in 1969. About 70-75% of the 2,4,5-T acid manufactured was further processed into esters, about 5% was converted to amine salt formulations, and the balance was sold as a dry powder. About 80% of the esters produced were further converted to formulations in 489 Building while the balance was sold to formulators. There is no record of who purchased the 2,4,5-T powder or the esters.

C) <u>Silvex Acids and Silvex Acid Esters</u>

The Silvex acid [2(2,4,5-trichlorophenoxy)-propionic acid] process was initiated in the pilot plant unit for phenoxy herbicides in 267 Building in 1958. These facilities became and remained as the manufacturing facility for Silvex acid, as improvements and expansions were made, until cessation of production in 1971. As stated before, 267 Building was demolished in December, 1973.

The production of Silvex acid has been estimated by the company as follows:

Years	Annual number of pounds
1958-1961	100,000-600,000
1962-1966	300,000-900,000
1967-1971	500,00-1,500,000

About 80% of the Silvex acid was converted to esters with the remaining 20% dried and packaged as a powder. Both of these operations also took place in 267 Building.

D) <u>Direct Esters</u>

The Direct Ester Plant was a multi-product plant, block operated (one product made at a time) to manufacture esters of 2,4-D, 2,4,5-T and Silvex. The Direct Ester Plant was built in 1966, as an addition onto

489 Building, and started up with the manufacture of 2,4-D esters. A building layout diagram for 489 Building is shown in Figure 5. In the third quarter of 1967, 2,4,5-T ester production was initiated and continued until February, 1979. In 1972, the production of Silvex esters was initiated and continued until November, 1978. The Direct Ester Plant was demolished in 1980. During the years of production, 2,4-D esters represented approximately 50 to 80% of the ester produced in the Direct Ester Plant with the balance of production attributed to 2,4,5-T and Silvex esters. Table 3 summarizes the company's estimates of the percent of the time the direct ester process was used to produce 2,4,5-T esters during each year.

Actual production records are no longer available for the period of operation of this plant. Estimates of production levels (million pounds/year) have been made by the company as based on evidence available and are shown as follows:

	2,4,5-T Esters	Silvex Esters
1967-1971	2 to 5	0
1972-1979	4 to 6	0.5 to 2.5

Some esters were sold directly to formulators but most were formulated in 489 Building. Customers receiving technical esters included Amchem (Union Carbide) for 2,4,5-T esters and Chevron for Silvex esters. End users of the formulations are not known since these were marketed through distributors.

E) <u>Formulations of Phenoxy Herbicides</u>

The formulations and packaging operations for all 2,4-D, and 2,4,5-T products have been located in 489 Building since synthesis began in 1950. Formulations and packaging of Silvex ester began in 1958, also in 489 Building. Until the cessation of 2,4,5-T manufacture in 1971, 267 Building was the sole source of 2,4,5-T for amine formulations. After the shut-down of the active ingredient plant, 2,4,5-T acid was purchased as needed during the period from 1971 to abandonment of the product in 1982. Purchases were made from Vertac Corporation (U.S.A) and Chemic Linz (Austria).

Production records for the period of manufacture of the amine formulation are not available except for the years 1980 through 1982. However, all evidence indicates that the annual production rates varied considerably from zero to as high as 500,000 pounds of active ingredient formulated to amine products. From 1978 to 1983, less than 300,000 pounds of 2,4,5-T was formulated annually. No amines of Silvex were produced for commercial markets by Dow. The production quantities of 2,4,5-T and Silvex ester formulation during early years were not recorded. During the period 1977-1982, the amount of technical esters (as 2,4,5-T and Silvex) converted to formulated products ranged from near zero to 1.8 million pounds per year for 2,4,5-T and zero to 650,000 pounds per year for Silvex.

F) Ronnel

The manufacture of ronnel [0,0-dimethyl-0-(2,4,5-trichlorophenyl)-phosphorothioate] was quite sporadic. Developmental quantities were produced in 267 Building from 1955 to 1957. The process was moved to 338 Building in January 1957 and was block operated with Zytron® [0-methyl-0-(2,4-dichlorophenyl)-phosphorothioate] which was discontinued in 1965. A building layout diagram of 338 Building is shown in Figure 6. A ronnel production run in 338 Building rarely, if ever, exceeded six months operation in order to meet market demands. ronnel production in 338 Building ceased in March, 1972 and 338 Building was subsequently demolished. Ronnel production was moved to 840 Building in March, 1973 and continued until December, 1977 when the product was discontinued. A building layout diagram of 840 Building is shown in Figure 7. Ronnel runs in 840 Building were even shorter than those done in 338 Building. The 840 Building was dedicated to manufacture of ronnel. Formulations of ronnel also were manufactured in 54 and 326 Buildings.

Production records for ronnel during the period of its manufacture no longer exist. From evidence gained through interviews with company officials the following estimates of annual production are as follows:

1955-1957	Up to 20,000 pounds/year
1958-1965	20,000 to 600,000 pounds/year
1966-1970	600,000 to 1.3 million pounds/year
1970-1977	1.3 to 2.2 million pounds/year

G) Erbon

The manufacture and esterification of Erbon [2-(2,4,5-trichlorophenoxy)-ethyl 2,2-dichloropropionate] was conducted in 441 Building starting in 1955 and continued until 1964. A building layout diagram of 441 Building is shown in Figure 8. While the manufacture of Erbon continued in 441 Building, the esterification of Erbon was moved to 649 Building in 1965. 2,2-dichloropropionic acid was also manufactured in 649 Building. The production of Erbon ceased in December, 1974 and since that time the process has been dismantled and replaced by totally different operations.

The manufacturing operations were performed sporadically on more or less a seasonal basis. As a herbicide, manufacture for the season generally occurred in the months from February through May with the length of a manufacturing run varying according to anticipated demand. Actual production figures are no longer available. However, recall by Dow management indicates that the ranges of annual production were:

1955-1960	Up to 200,000 pounds/year
1961-1965	120,000 to 230,000 pounds/year
1966-1974	60,000 to 210,000 pounds/year

H) Dowicide® Antimicrobials

The 265 Building was constructed in 1935 with equipment to flake and dry pentachlorophenol (PCP) and tetrachlorophenol (TetCP) products installed in 1936-1937. Actual commercial production of these products probably began in 1937. For the time period 1935 to 1941, PCP and TetCP were produced in 206 Building on a developmental basis and piped to 265 Building for finishing.

In 1940, a building addition was constructed on to 265 Building to house the chlorination facilities. Chlorination operations began in late 1941 in 265 Building with the TetCP and PCP processes. A building layout diagram of 265 Building is shown in Figure 9.

Production of dichlorophenol was initiated in 1946 in 265 Building to supply the growing demand for 2,4-D. The direct chlorination of phenol to produce 2,4-dichlorophenol also produced 4-mono- and 2,4,6-trichlorophenol which required separation by distillation in 349 Building. Materials returned from 349 Building included the mixed fractions of mono-, di- and trichlorophenols which were used as "penta starters" in the TetCP and PCP processes. Small amounts of 4-mono- and 2,4,6-trichlorophenol were recovered for use and sale as Dowicide®.

PCP was also produced in 466 Building from 1950 through 1966. This process was the same type of process as the PCP process in 265 Building and was used to supplement the PCP produced in 265 Building. A building layout diagram of 466 Building is shown in Figure 10.

PCP was given the trade designation, Dowicide® 7. PCP was also reacted with sodium hydroxide to produce sodium pentachlorophenate (NaPCP) which was given the trade designation, Dowicide® G. TetCP was given the trade designation, Dowicide® 6, and was produced from 1941 until it was discontinued in 1974.

In 1965, a prilling tower was installed in 265 Building to produce PCP prills. Flaked and prilled PCP products were co-manufactured until about 1971 when the flaking operations were discontinued. The prilling operation continued until 1978.

NaPCP was initially dried on double drum dryers which produced NaPCP as powder. In 1966 the double drum dryers were replaced by fluid bed dryers which produced NaPCP as a bead type product. The production of NaPCP was discontinued in 1976.

In 1973, a distillation step was added to PCP production process. The distillation took place in 349 Building and the PCP produced was given the trade designation of Dowicide® EC-7. The entire PCP production process was moved to 349 Building in 1978 and all PCP produced was molded into blocks. PCP production ceased in December, 1980. No flaking or prilling of PCP was done for the time period 1978 through 1980.

2,4,5-TCP and its sodium salt were also finished in 265 Building from 1946 through 1978, when the production of 2,4,5-TCP ceased. From 1946 to 1966, NaTCP was produced in 199 Building and acidified and distilled in 349 Building. From 349 Building, the 2,4,5-TCP was finished by flaking in 265 Building. In 1966, the 2,4,5-TCP processes were moved to the 804 Building. The NaTCP produced was acidified and distilled in 804 Building eliminating the need to send the product to 349 Building. 2,4,5-TCP produced in 804 Building was finished by flaking in 265 Building. The flaked 2,4,5-TCP was given the trade designation of Dowicide® 2. 2,4,5-TCP was also reacted with sodium hydroxide to form NaTCP which was given a trade designation of Dowicide® B. 2,4,5-TCP produced in 804 Building was sometimes redistilled, in 349 Building, before flaking, and was known as Hi-Purity TCP.

Other products flaked and dried in 265 Building included ortho-phenylphenol (Dowicide® 1) and its sodium salt (Dowicide® A). These products were produced in 265 Building from 1936 until 1976, at which time these operations were moved to another building.

Production records for the chlorophenols are no longer available. In general, there was no apparent "season" for the production of chlorophenols, and manufacture was geared to demand. The recall of Dow management indicates the approximate range of production was:

2,4,6-trichlorophenol (Dowicide® 2S)	1946-74:	Up to about 100,000 lb/year
Tetra-and Pentachlorophenols (Dowicide® 6 and 7)	1941-46:	Up to 3 million lb/year
	*1946-53:	2 to 7 million lb/year
	*1953-66:	5 to 10 million lb/year
	1967-78:	8 to 12 million lb/year

* Included production from 466 Building

The production records of 2,4,5-TCP as Dowicide® 2 are no longer available; but, the output of 265 Building has been estimated by Dow management as follows:

1946-65: 50,000 to 300,000 lb/year as supplied by 199 Building.
1966-77: 500,000 to 3 million lb/year as supplied by 804 Building.

Description of Department and Personnel Operations

Dow personnel are organized into organizational units. One or more production processes make-up an organizational unit. By process, the following subsections describe the organizational units and the job titles in the organizational units for the production processes being studied. Appendix B, Tables 4 through 14 is a compilation of job titles and descriptions for the processes of interest and will be referred to throughout these subsections. Table 4, Generic Job Title Descriptions lists generic job titles and descriptions which are applicable across organizational units through the years. Whenever the word "generic" appears in the job descriptions in Tables 5 through 14 use Table 4 to obtain job descriptions for those job titles.

A) TCP Processes

Synthesis of NaTCP began in 1942 in 199A Building on a pilot plant basis. It continued in pilot plant basis until 1945. During this time period, the NaTCP process was part of the OCPN/PEA (ortho-chloro-paranitroaniline/phenyl ethyl alcohol) organizational unit. Table 5, Early 2,4,5-Trichlorophenol Operation Job Titles and Descriptions, lists the job titles, dates the job titles were effective, and a short description of the job titles relevant to the early NaTCP process.

In 1946, full-scale commercial production of NaTCP began. The NaTCP operation was located in 199 Building was a part of the Aniline organizational unit. Table 6, Old 2,4,5-Trichlorophenol Operation Job Titles and Descriptions, lists the job titles, dates the job titles were effective, and a short description of the job titles relevant to the old NaTCP process. Aniline production workers are included in Table 6 because the aniline process was in close proximity to the NaTCP process and because workers of the aniline process also worked in the NaTCP process.

Four operators, plus a head operator, were responsible for operating the NaTCP process. These individuals also operated other processes in 199 Building, such as aniline and p-chloro-o-nitrophenol processes. Most of the operators' time was split between NaTCP and aniline production duties. The Reactor Operator was responsible for sampling the waste oil, attaching the waste oil streams to dumpsters, or flushing the stills.

The acidification and distillation of NaTCP to form 2,4,5-TCP was performed in 349 Building. These operations were a part of the Bisphenol organization unit from 1946 to 1965, changed to the Chlorophenol organizational unit from 1965 to 1972, the Dowicide® Still Operations organizational unit from 1972 to 1978, and finally the Pentachlorophenol Production organizational unit from 1978 to 1980. Table 7, Chlorophenol Distillation Operation Job Titles and Descriptions, lists the job titles; dates the job titles were effective; and a short description of the job titles relevant to TCP acidification and distillation. Also included in Table 7 are job titles involved in the distillation of other chlorophenols which were produced in either the 349 Building or the 265 Building.

In June 1966, a new completely automated batch TCP process was put into operation. This new TCP process was located in the 804 Building complex and was known as the Trichlorophenol organizational unit.

Table 8, New 2,4,5-Trichlorophenol Operation Job Titles and Descriptions, lists the job titles, dates the job titles were effective and a short description of the job titles relevant to the new 2,4,5-TCP process in 804 Building complex. Two TCP operators per shift, seven days a week, were responsible for operating the new TCP process. Supervisory and technical personnel were directly involved in plant operations.

B) 2,4,5-T acid and Silvex acid and "Acid-Ester" Processes

Commercial production of 2,4,5-T acid began in 1950 and continued until 1971 in 267 Building as a part of the Organic Semi-Plant organizational unit. Table 9, 2,4,5-T Acid and Acid Ester and Silvex Acid and Ester Production Job Titles and Description, lists the job titles, dates the job titles were effective, and a short description of the duties associated with the job titles. Table 9 also lists the various organizational units that these processes were a part of through the years of their operation. Pilot plant operations of 2,4,5-T acid date back to 1947. Four operators per shift ran the 2,4,5-T acid operations seven days each week (four shifts per week). A fifth operator per shift was added when the 2,4,5-T acid products were dried. A flow diagram of the 2,4,5-T acid and 2,4,5-T acid ester processes is shown in Figure 14, which also shows the various operators' areas of responsibility. The Reactor Operator was responsible for operating the reactor where the sodium salt of 2,4,5-T acid was produced. The Salt Wheel Operator ran the centrifugation, bleaching reaction, and filtration operations. The Acid Wheel Operator was responsible for the acidification operation and a centrifugation. Both of these centrifuge operations were open and were manually scraped out. The Ester Operator ran the esterification reaction, a distillation process, a filtration process, and was responsible for the storage of esters. The Dryer Operator ran the dryer and packaged the crystalline 2,4,5-T acid. Packaging of 2,4,5-T acid was done manually. The dried product was released from a hopper into 300-pound fiber packs and weighed. An exhaust ventilation hood was in place, but the area was reported to be quite dusty. Job transfers into and out of 267 Building were reportedly very common.

The Silvex acid process was operated in 267 Building from 1958 to 1971. The equipment was independent from that utilized for 2,4,5-T acid and ester production. Job titles and descriptions were similar to those of the 2,4,5-T jobs, with the following exceptions. The Salt Wheel Operator ran a steam stripper instead of a centrifuge, and he also was responsible for the acidification reaction. The Acid Wheel Operator ran a filter box and centrifuge which were used for washing the Silvex acid. He manually loaded the centrifuge by shovel. Figure 15, a flow diagram of the Silvex acid and ester processes shows the operators' areas of responsibility.

C. 2,4,5-T, 2,4-D and Silvex Esters by the "Direct Ester" Processes and Formulations

The 489 Building housed the "direct-ester" process for 2,4,5-T esters and 2,4-D ester from 1967 until February 1979. The production of Silvex esters by this method was added in 1972 and terminated in 1978.

The same equipment was used for all three processes. Two operators per shift, seven days each week were responsible for running the entire "direct-ester" operation. They worked in all areas of the "direct-ester" operation, mainly utilizing control panels.

Table 10, 2,4-D, 2,4,5-T, and Silvex "Direct-Ester" Production Job Titles and Description lists job titles, dates job titles were effective, and a short description of the job titles relevant to the "direct-ester" operations. Table 10 also includes the job titles associated with the various formulations which also took place in 489 Building.

D. Ronnel Process

The ronnel process was operated in 267 Building from 1955 to 1957, in 338 Building 1957 to 1972, and in 840 Building from 1973 to 1977. This process was small, utilizing only two operators, and was operated only three months per year. There was no particular type of job to which the ronnel operators moved during the other months. The procedure which was generally followed in the Midland, Michigan facility involved "bumping" less senior persons within the department first, so transferring to other departments was less common. Table 11, Ronnel Production Job Titles and Descriptions, list the job titles, dates job titles were effective, and a short description of the job titles relevant to ronnel operations for the years 1963 to 1977. The job titles, O-methyl/ron. Operator (1963-70), clopidol Operator 1973, ronnel Operator (1974-77) and Dursban® insecticide Operator (1975-76) were the most likely to operate the ronnel operations during those time periods. From Table 9, the job titles, Prim. Pool Operator (1960-62), Spec. Pool Operator (1961-63), Sr. Pool Operator (1960-63), and ronnel Operator (1970, 1972) were the most likely to operate the ronnel operations during those time periods. For the time periods from 1955 to 1959 the company was unable to determine who worked on the ronnel operation.

E. Erbon Processes

The Erbon process was operated in 441 Building from 1955-1974. This process was smaller than the ronnel process and operated on a seasonal demand basis of about 3 to 4 months each year of its operation. There was one operator per shift responsible of its operation. Table 12, Erbon Production Job Titles and Descriptions, lists the job titles, dates the job titles were effective and a short description of the job titles relevant to the Erbon process. From this table, the Reactor and Still Operators were identified as working from 1961 to 1974 on the Erbon process. For the time period 1955 to 1960, no specific job title could be identified for the Erbon process.

F. Dowicide® Processes

The Dowicide® antimicrobial operations in 265 Building involved the production of several different products including pentachlorophenol (PCP), tetrachlorophenol (TetCP), 2,4,6-trichlorophenol (2,4,6-TCP), 2,4-dichlorophenol (2,4-D), and ortho-phenylphenol (OPP). These chlorophenols were produced by direct chlorination of phenol, with subsequent distillation. Drying and flaking operations for the above mentioned products plus 2,4,5-TCP were also a part of the Dowicide® processes. PCP and TetCP were also produced in 206 Building on a pilot plant basis from 1937 to 1941 and in 466 Building from 1950 to 1966.

The PCP and TetCP operations in 466 Building were supplemental to the operations in 265 Building and were not run continuously. The PCP process also was ran in 349 Building from 1978 to 1980. PCP distillation was conducted in 349 Building from 1973 to 1980.

Table 13, Dowicide® Production Job Titles and Descriptions, lists the job titles, dates the job titles were effective, and a short description of the job titles relevant to Dowicide® production in 265 Building for the years the Dowicide® operations were conducted. Table 13 also includes job titles for workers in 349 building for the years 1972 to 1978.

Table 14, PCP Production Job Titles and Descriptions, lists the job titles, dates the job titles were effective, and a short description of the job titles relevant to PCP and TetCP operations in 466 Building for the years those operations were conducted.

Description of the Personnel Records

The following record systems at Dow are maintained independently by the appropriate departments: general personnel, payroll, group insurance, medical, and workers' compensation.

The general personnel records for hourly and salaried employees are maintained by the Personnel Office. The records for current employees engaged in manufacturing are located in the Employment Office of the Michigan Division, and records for administrative employees are kept in the U.S. Area Employment Office. Three years after the separation of employees, the records are transferred to the U.S. Record Center for long-term storage.

The records include the following:

1. Annual Census Lists - complete from 1940
2. Monthly Census Lists - complete from 1965
3. Work History cards - complete from 1940
4. Personnel Files - destroyed six years after termination

The annual census list shows, by department, all individuals assigned to that department on January 1. The full list, therefore, records all individuals employed at the Michigan facility on that date each year. Individuals who worked in a department during a year, but not through January 1 of that year, cannot be conveniently tracked. For each individual the census list provides the master number, the clock number, name and job classification. The master number is a unique life-time number assigned by Dow, and is the primary source for identifying workers. Clock numbers are reassigned after termination and are not as useful. Many of the job classifications clearly describe the process to which a worker was assigned, but other titles are general ones which require independent efforts to decide whether it is possible to associate a worker with a particular process. Monthly census lists, by department, exist from 1965 forward and are similar to the annual lists.

Once the master number of an individual is known, the work history card can be obtained. These cards are complete from 1940 forward and are kept for 75 years. They contain demographic information as well as a detailed chronology of job status changes and pay changes. Yellow typed cards were used until 1963, when a computerized system was initiated for updating work history cards. The computer tapes are regularly destroyed, but hard copies of the updated work history records are maintained by the Personnel Office. One difference between the pre- and post-1963 cards is the absence of person-to-notify data in the demographic information on the computer-made cards.

The personnel files are kept only six years after separation. Active files contain the application and transcript, hiring/personal data sheet, an employee agreement, notices of transfer or status change or separation, tuition refund information, long-term disability notices, and exit interviews or appropriate comments. The sample files observed during this site visit belonged to individuals terminated longer than three years; they contained only an application form and the company status change (separation) notice.

The medical records are maintained by the Medical Department. This department retains the records for 3 years after employee termination. The records are then transferred to the long-term storage facility, which retains them for 75 years after termination.

The workers' compensation records are maintained by the Workers' Compensation Office. These records are only retained briefly by this office after employee termination. They are then transferred to long-term storage, where they are kept for 25 years after termination.

No detailed information was obtained by NIOSH about the payroll records or the group insurance records.

Several approaches could have been taken to identify the workers who should be included in the Dioxin Registry, but the following method was used: The master number of all workers ever employed in a relevant department was obtained from the annual and/or monthly census lists. The work history cards were then obtained and examined for relevant job titles. Workers employed only in processes not of interest for the Registry were excluded by a determination that no relevant job titles appeared on the work history card. This approach required prior identification of all job titles associated with the processes of interest. The company prepared this information. Salaried and hourly individuals were separately identified.

Maintenance workers presented different problems. In January 1968, there were 1,196 maintenance personnel at the Midland facility. Prior to 1969, maintenance was a centralized operation, from which individuals worked in all parts of the Michigan facility. From 1965 to 1969, the maintenance organization was gradually reorganized into division-wide Field Service Units (FSUs). As of July 1981, maintenance personnel have been assigned to production departments. Because it was not possible to identify which maintenance people worked in the departments of interest, maintenance workers were excluded from the cohort with one exception, certain maintenance workers who were identifiable and were included in the cohort. Plant mechanics were always assigned to each department, and these individuals, who appear with the department on the census lists, were included in the NIOSH cohort.

Descriptions of the Processes

The processes used to produce TCP, TCP derivatives, PCP, and PCP derivatives are listed in Appendix A, Table 1 along with the buildings in which they were located, the products produced, and the years that the products were manufactured. The following subsections contain descriptions of these processes, including the operating conditions where available, the equipment used for each step, and the operations of each step. Figures referred to in these subsections can be found in Appendix C.

A) "Old" NaTCP Synthesis

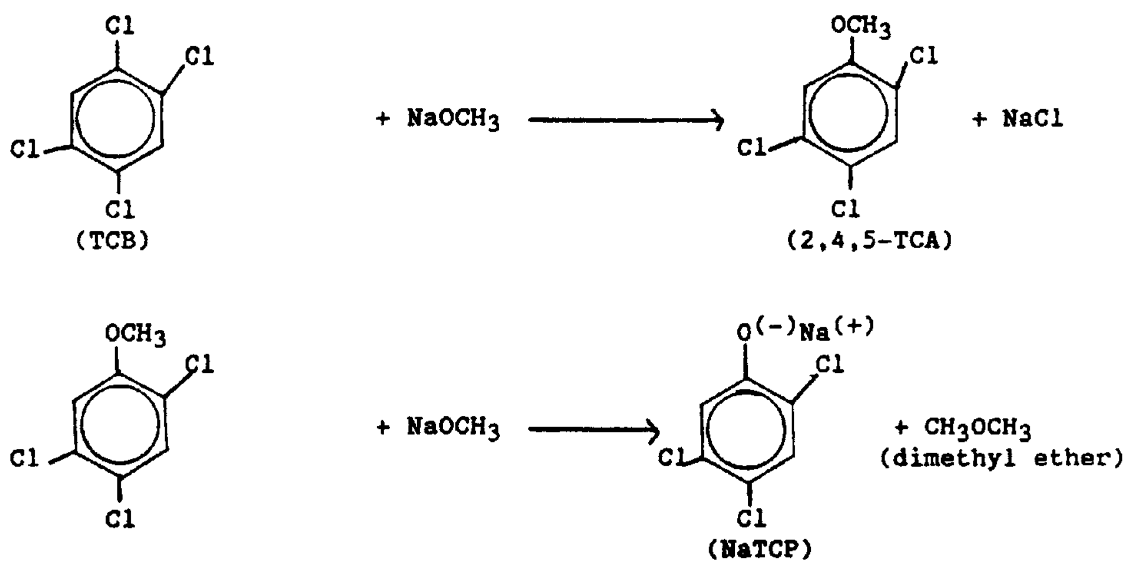
The Dow Chemical Company produced NaTCP in 199 Building using the following raw materials: methanol (CH_3OH), caustic soda (NaOH) (flaked, until 1962; flaked and aqueous solution, 1962-1966) and 1,2,4,5-tetrachlorobenzene (TCB). CH_3OH and water (H_2O) were used as solvents in the process. Only one major change was made in this process from start-up until it was shut down in 1966. This change, made in 1952, involved the substitution of a coil reactor for the batch "tumbling" reactor used in the dechlorination of TCB. A block flow diagram of this process is provided in Figure 11.

The first step in this process occurred in the pre-heater. Methanol and caustic were added to the pre-heater; sometimes water was added when highly concentrated caustic solution or flaked caustic was used. A reaction between the caustic and the methanol, which was present in excess quantities, occurred as follows:

$$NaOH + CH_3OH \longleftrightarrow \underset{\text{(sodium methylate)}}{NaOCH_3} + H_2O$$

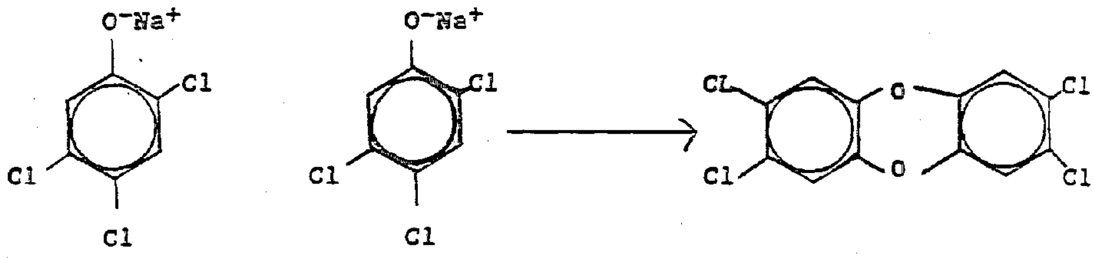
The resulting solution of methanol, water, and sodium methylate was then pumped to the dechlorination reactor, which already had molten TCB pumped into it.

As stated above, the dechlorination reactor was originally a batch unit, but was changed to a continuous-flow coil reactor in 1952. The contents in the dechlorination reactor underwent a two-step reaction with the sodium methylate reacting with TCB to form sodium 2,4,5-trichlorophenate (NaTCP). The coil reactor was operated at 180°C to 200°C (sometimes as high as 215°C), at 600 pounds per square inch gauge (psig), and a retention time of 30 minutes (min). The exothermic reaction proceeded by the following reaction mechanism:



The by-product dimethyl ether (DME) was vented to the atmosphere. After the 30 min retention period, the contents of the coil reactor, including water, methanol, NaTCP, salt (NaCl), unreacted 2,4,5-trichloroanisole

(TCA), and TCDD (and any other dioxin isomers which might be formed), were pumped to the alcohol recovery operation. The company believes that the source of the TCDD in NaTCP and its derivatives was due to the following reaction between two trichlorophenate ions during the dichlorination step:



(TCDD)

The company has measured levels of TCDD in its 2,4,5-TCP and its derivatives (see Chemical and Toxicological Analyses of Products, Process Streams, and Wastes for Chlorinated Dibenzo(p)dioxins later in the report).

The alcohol recovery step involved a steam stripping distillation which removed most of the methanol and some water from the product-stream. Water was pumped into the unit so that sufficient solvent was present to keep the NaTCP and NaCl in solution. The methanol was recovered from the product-stream and subsequently reused in future NaTCP batches. The alcohol recovery step was operated at atmospheric pressure and a temperature no greater than 105°C (221°F). The product-stream output from this step contained NaTCP, salt, water, some methanol, some unreacted TCA, TCDD and any other chlorinated dibenzo(p)dioxins which might have been formed. The product-stream output was pumped from the alcohol recovery to the next process step, the decantation vessel.

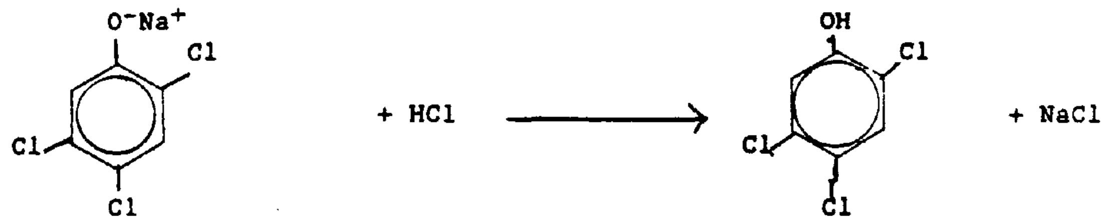
In the decantation operation, the contents of the decantation vessel were permitted to settle, and two layers were formed. An oil layer, composed mainly of TCA and believed by the company to contain most of the dioxin contaminant, was pumped or pressure forced from the vessel into closed dumpsters. The dumpsters were hauled to the Midland plant's central incinerator unit, where the contents were burned. An aqueous layer containing NaTCP, salt, and residual methanol was pumped to the next purification step.

Phenate stripping was the final step in the NaTCP process. In this operation, the remaining methanol, methoxys, and lower chlorinated phenols (mono- and di-) were stripped from the NaTCP solution. The stripping step was operated at atmospheric pressure and at a temperature no greater than 105°C (221°F). The methanol removed was disposed of in deep wells. The resulting aqueous NaTCP solution, which also contained NaCl, was pumped to 349 Building for acidification and finishing.

B) "Old" TCP Acidification and Distillation

Dow Chemical produced 2,4,5-TCP in the 349 Building using an aqueous, salt-containing, NaTCP solution, which was the product of the "old" NaTCP synthesis process at the 199 Building and aqueous hydrochloric acid (HCl). This process was not changed during the entire period of use. Figure 12 provides a flow diagram for this process.

This process began with the mixing of the NaTCP solution and hydrochloric acid in a reactor vessel. Once both solutions were pumped into the vessel, a mildly endothermic reaction occurred, as shown:



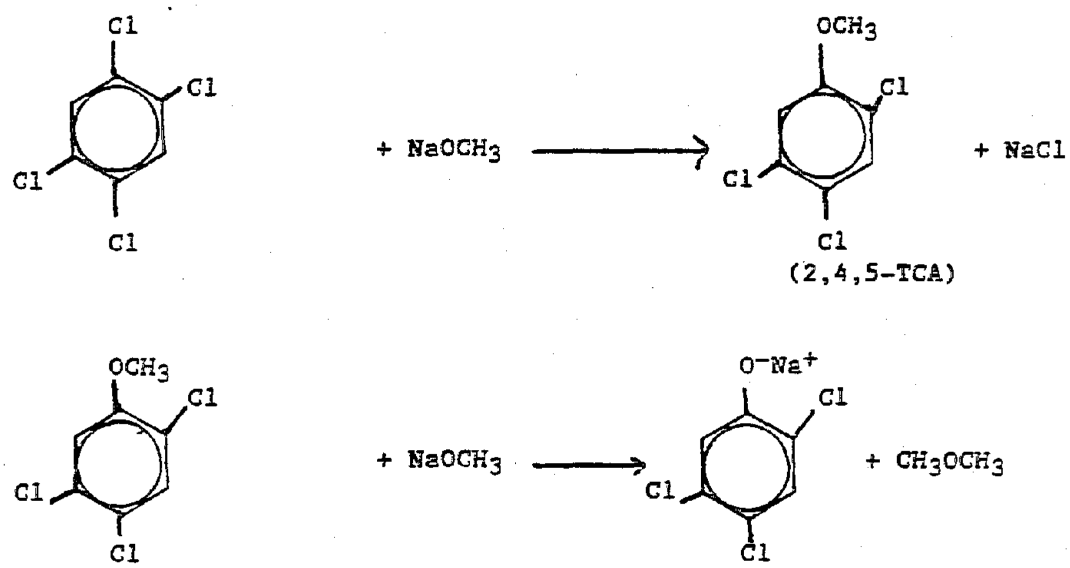
(2,4,5-TCP)

The reaction proceeded essentially to completion. The contents of the vessel were then allowed to settle, and layers formed. An aqueous layer (consisting of water, salt, and any excess HCl) plus an organic layer (consisting of 2,4,5-TCP and small amounts of impurities) were separated by decantation. The 2,4,5-TCP was then transferred directly to 267 Building for use in the 2,4,5-T Acid or Silvex Acid Processes, or it was pumped to a distillation unit for further purification. The bottoms from this distillation contained methoxys and other chlorophenols (besides 2,4,5-TCP). This mixture was pumped to dumpster tanks which were hauled to the central incinerator, where the contents were burned. The overhead product, purified 2,4,5-TCP, was transferred to 265 Building for use in the production of Dowicide® 2, or to 267 or 338 Building (depending upon the year) for use in the synthesis of ronnel. 2,4,5-TCP was also pumped directly to the Hi-Purity TCP Process, also located in 349 Building.

C) "New" TCP Synthesis

Dow Chemical produced 2,4,5-TCP in 804 Building complex using the following raw materials: methanol, caustic solution, TCB, and HCl (aqueous). Water and methanol were used as solvents in various stages of the process. This process in 804 Building complex replaced the "Old NaTCP Synthesis Process" and the "Old TCP Acidification Process" because it could be run with less risk of chloracne problems, it provided additional capacity which was needed, and it was a more efficient process. The process was an automated, batch process and was not changed significantly during the period of its use. A block flow diagram of the process is shown in Figure 13.

The first step of this process involved a three step reaction which occurred in a closed, agitated, jacketed, batch reactor. TCB and methanol were pumped to the reactor and while the reaction proceeded, caustic solution was continuously added. Water also was used as a solvent. The following sequence of reactions took place, with the dechlorination of TCB being highly exothermic:



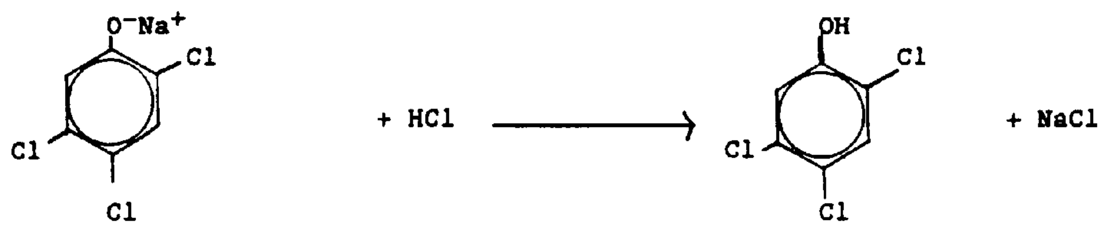
This reaction occurred at an operating temperature of less than or equal to 152°C (305°F) and a pressure of less than 300 psig.

The resulting solution contained water, salt, NaTCP, TCA (because the reaction does not proceed to completion), and methanol. Methanol had been added in excess of the stoichiometrically required amount so that enough methanol would be present to act as a solvent for the sodium methylate intermediate. The DME by-product was vented to the atmosphere.

The solution was pumped to the next step in the process, the decantation vessel. In the decantation vessel, two layers formed, an organic layer consisting mainly of TCA and an aqueous layer containing NaCl, NaTCP, and methanol. This step was operated at a temperature less than 105°C and at atmospheric pressure. The organic layer, or "waste oil," was pumped from the decantation vessel and transferred to the Midland facility's central incineration unit for burning. This was usually accomplished by pumping the oil into dumpsters which were hauled to the incinerator.

The aqueous stream from the decanting vessel was pumped to the alcohol recovery step. It is significant that the order of the decantation and alcohol recovery steps were reversed as compared to the "old" NaTCP process. This was done so that any dioxin contaminants produced in the reactor would be removed as early as possible in the process. Most of the TCDD contaminant produced was separated out with the "waste oil." The alcohol recovery step involved distillation which removed most of the methanol from the aqueous stream. This was accomplished at a temperature of less than 105^{o}C and at atmospheric pressure. The recovered methanol was recycled to the batch reactor where it was used in subsequent batches. The bottoms product, an aqueous solution of salt and NaTCP containing some impurities, was pumped to the phenate stripping operation for further purification. This purification operation removed "waste oil" from the product stream, by distillation. This "waste oil" was disposed of in the same manner as the waste oil from the decantation step. The product stream, an aqueous solution of NaCl and NaTCP, was pumped to the acidification reactor for next step in the process.

The acidification of NaTCP to form 2,4,5-TCP was included in the "new" TCP process, which was a departure from the procedure used in the "old" NaTCP process; the "old" TCP acidification was a separate process in a separate building. In this step, aqueous HCl was added to the vessel containing the aqueous solution of NaTCP and NaCl. A reaction between NaTCP and HCl occurred, as shown:

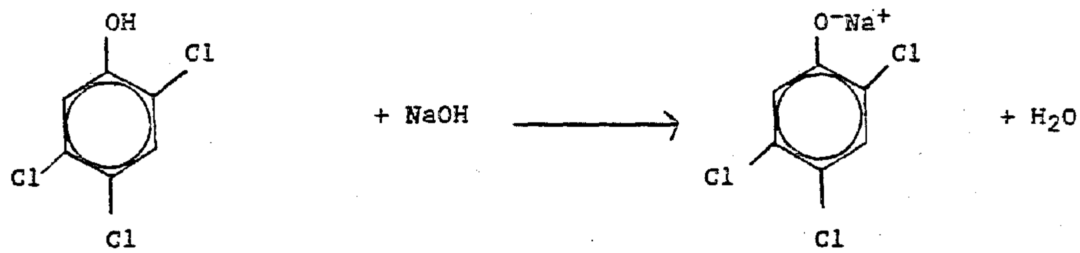


The resulting solution of 2,4,5-TCP, NaCl, water, and any excess HCl was pumped to a decantation vessel where the contents were allowed to settle. Two layers, an organic layer of 2,4,5-TCP which contained some residual NaCl and an aqueous brine containing any excess HCl, were formed and then separated. The 2,4,5-TCP layer was pumped to another vessel where it was mixed with water. The residual NaCl content of the 2,4,5-TCP dissolved in the water, and the vessel contents were then allowed to settle. After the aqueous and organic layers formed, a second decantation was performed. The "waste brine" (salt water) solutions decanted from each of the last operations were combined and pumped to a deep well disposal. In later years, the "waste brine" was carbon treated and sent to the waste treatment plant. The 2,4,5-TCP product was ready for use in the production of any of the 2,4,5-TCP derivatives.

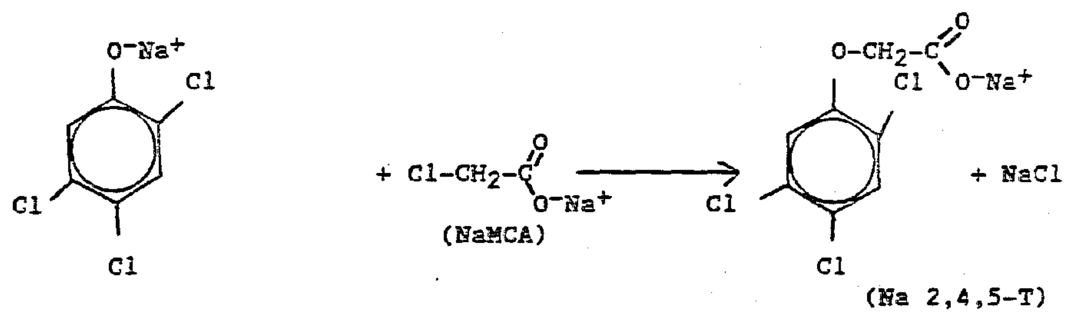
D) <u>2,4,5-T Acid Synthesis</u>

Dow Chemical produced 2,4,5-T acid in 267 Building using the following raw materials: 2,4,5-TCP, caustic solution, sodium monochloroacetate (NaMCA), sodium hypochlorite, and HCl (aqueous). Water was used extensively as a solvent in this process. The process remained the same from its start-up until its eventual replacement by the "direct-ester" process; there were no major changes during the years it was operated. The maximum temperature achieved at any point in this process was 105°C (221°F). The operating pressure at all steps was approximately atmospheric pressure, as the vessels were vented to the atmosphere. Otherwise, each vessel was entirely closed while in operation except for the centrifuges, the dryer outlet, and the adjacent packaging operation. A flow diagram of this process is provided in Figure 14.

The first step in the synthesis process involved a two-step reaction. Water (the solvent), caustic solution and 2,4,5-TCP were pumped to the reactor vessel. The 2,4,5-TCP was neutralized by the caustic in the following exothermic reaction:



The resulting sodium salt (NaTCP) then reacted with the NaMCA, which was added after the formation of NaTCP, to form sodium 2,4,5-trichlorophenoxyacetate (Na 2,4,5-T) via the following endothermic reaction:



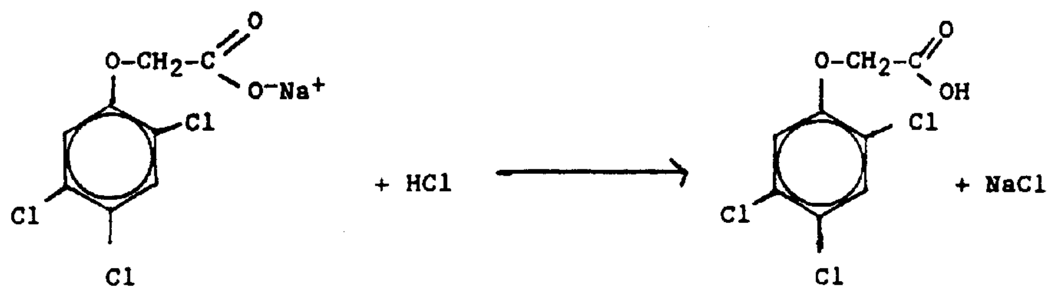
The resulting aqueous solution containing Na 2,4,5-T, NaCl, water, unreacted NaTCP and 2,4,5-TCP was cooled. The Na 2,4,5-T crystallized when cooled, while the other products tended to remain in solution. The entire slurry was pumped to 40 inch basket centrifugal filters to remove most of the aqueous solution of NaCl from the crystalline Na 2,4,5-T.

The centrifuge was an open unit, and the Salt-wheel Operator used a tool to manually plow out the crystalline Na 2,4,5-T which dropped to a tank below. The wet Na 2,4,5-T, which still contained some unreacted NaTCP and TCP and small amounts of NaCl, was reslurried in water and pumped to a reactor vessel.

The bleaching operation was the next step in the process. Sodium hypochlorite was pumped to the vessel, and reactions occurred which converted the unreacted NaTCP and TCP into water soluble by-products (non-aromatics). The slurry of Na 2,4,5-T in an aqueous solution containing residual NaCl and other water-soluble by-products was then pumped to a filtration process.

For the filtration process, the product stream was heated to re-dissolve the Na 2,4,5-T into solution. This solution then ran through a "polishing filter" which removed color impurities (probably iron compounds). The filtered solution of water, Na 2,4,5-T, and water-soluble by-products (including residual NaCl) was pumped to another reactor vessel.

HCl (aqueous) was pumped to the reactor vessel after the Na 2,4,5-T solution had been added. The 2,4,5-T acid product was formed via the following reaction mechanism:



(2,4,5-T acid)

The 2,4,5-T acid was insoluble in water, therefore it crystallized. The resulting slurry, consisting of 2,4,5-T, an aqueous solution of salt by-product, and other water-soluble by-products carried through from the preceding steps (especially the bleaching operation), was pumped to a final centrifugation step.

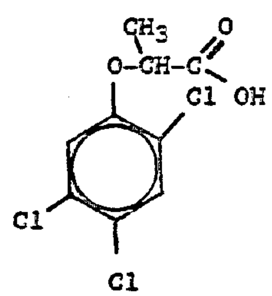
Centrifugation was the final step for all of the 2,4,5-T acid produced. The slurry entered a 48 inch basket centrifugal filter where the aqueous solution of salt and other water-soluble materials were separated from the 2,4,5-T acid crystals. The Acid-wheel Operator used a plow to manually work the materials in the centrifuge. After being manually removed from the centrifuge, the wet 2,4,5-T was transferred either to the Acid-Ester Process or to the dryer. About 70-75% of the 2,4,5-T acid manufactured was further processed to esters, about 5% was converted to amine salts formulations, and the balance was sold as dry powder.

The flash dryer was an enclosed heating unit with a closed recirculating air system. All residual moisture was removed from the 2,4,5-T acid crystals by this unit. The dryer conveyed dry 2,4,5-T acid into a packaging hopper at the packaging station.

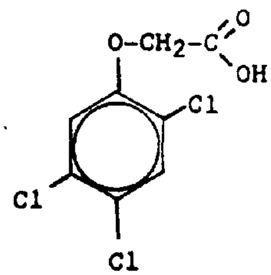
Packaging of 2,4,5-T acid was an "open", manual operation. Dust exposure was characteristic of this operation. The dryer operator loaded each Fibre-Pak into position under the hopper outlet and on a scale. The operator then attached a flexible hose from the hopper to the top of the drum, and controlled the flow of 2,4,5-T acid into the drum. When the proper package weight was reached, the operator stopped the flow, removed the drum from the station, and clamped the fibre-Pak lid in place. Drums of 2,4,5-T acid were then transported to the warehouse.

E) <u>Silvex Acid Synthesis</u>
Dow Chemical produced Silvex in 267 Building using a process very similar to the process used to produce 2,4,5-T acid. A flow diagram of this process is provided in Figure 15. This process was not significantly changed during the years it was in operation. There were several specific differences between the Silvex and 2,4,5-T acid processes, and these are explained in the following paragraphs; the processes were otherwise identical.

The first and most important difference between these processes was the identity of the chemical compounds involved. Silvex (also known as 2,4,5-TP) has a chemical structure of



as opposed to 2,4,5-T's



Sodium alpha-mono-chloropropionate was used as the reacting agent for producing Silvex instead of sodium monochloroacetate used to produce 2,4,5-T. Analogous propionic-substituted compounds occurred as intermediates in the Silvex process in place of all acetic-substituted compounds found in the 2,4,5-T acid process.

Another difference between the processes was the use of a steam-stripping operation in the Silvex process in place of the first centrifugation found in the 2,4,5-T process. Because the sodium salt of Silvex (Na-Silvex) was more soluble than the salt of 2,4,5-T, too great a portion of the Na-Silvex would be lost with the water soluble by-products if the stream was centrifuged.

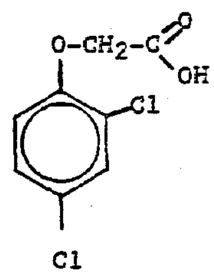
The lack of a polishing filter in the Silvex process was another difference between the two processes. This difference also made the intentional re-dissolving of the Na-Silvex crystals unnecessary at this point in the process.

Another major difference between the processes was the replacement of the second centrifuge found in the 2,4,5-T process with a two-step separation procedure in the Silvex process. The slurry consisting of the Silvex and the aqueous solution of by-products entered an open box filter where it was manually spread out by the Acid Wheel Operator. The acid product was trapped and the aqueous solution ran out the bottom of the unit. The Acid-Wheel Operator then shoveled the wet Silvex filter cake into a small 20 inch centrifugal basket filter where it was washed with water. The operator used a tool to manually work the materials in the centrifuge. Subsequently, the wet Silvex was transferred to the dryer or to the esterification ("acid-ester") process. Approximately 80% of the Silvex produced was esterified and the remaining 20% dried and packaged.

The final difference between the two processes involved the type of dryer used. The Silvex process made use of a tray dryer. The wet Silvex acid was laid out manually by the Dryer Operator into 4 ft. x 4 ft. trays. Dry air maintained below 100°C (212°F) was blown across the surface of the wet Silvex removing the moisture to the atmosphere above the building roof.

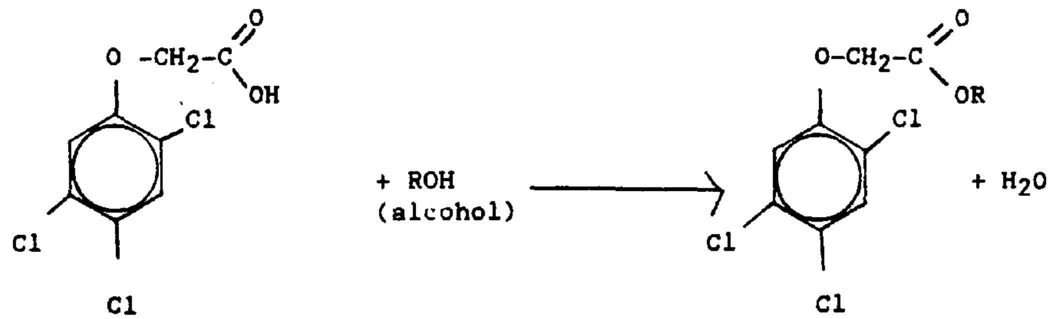
F) <u>Acid-Ester Synthesis</u>

Dow Chemical produced various esters of 2,4,5-T, Silvex and 2,4-D using the Acid-Ester Process. The raw materials for this process included one of the three acids listed above, and one of several alcohols. The 2,4,5-T, Silvex, and 2,4-D were the products of the 2,4,5-T Acid, Silvex Acid, and 2,4-D Acid Processes, respectively at the Midland site as previously discussed in this report. The Acid-Ester Process was not significantly altered during the time which it was operated. The Acid-Ester Process at 489 Building (which produced 2,4-D esters and 2,4,5-T N-butyl ester) and the Acid-Ester Process at 267 Building (which produced 2,4,5-T esters other than the N-butyl ester, and Silvex esters) are both included in the description to follow. The following paragraphs describe the production of esters of 2,4,5-T. However, this description also applies to the production of Silvex esters and 2,4-D esters except for the obvious differences in chemical structure between each of these substances. The chemical structure of 2,4-D is:



The appropriate propionic-substituted compound would replace, at each step in the production of Silvex esters, the acetic-substituted compound found in 2,4,5-T production. Similarly, the appropriate dichlorinated compound would replace, at each step in the production of 2,4-D esters, the trichlorinated compound found in the production of 2,4,5-T. Figures 14 and 15, respectively, depict flow diagrams for the 2,4,5-T Acid and Silvex Acid Processes. The segment of each diagram which applies to the Acid-Ester Process corresponds to the Ester Operator's area of responsibility in these figures.

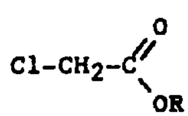
The first step in the esterification of 2,4,5-T acid involved the reaction between 2,4,5-T acid and one of the following alcohols: isooctyl alcohol, butanol, or Dowanol PIB (a mixture of butyl and isobutyl ethers of propylene glycol). Butanol was never used with Silvex. Wet 2,4,5-T acid plowed from the final centrifugal basket filters dropped down to a screw conveyor which transported it to the ester reactor. An alcohol and a catalyst were added to the 2,4,5-T acid in the ester reactor. The mixture was heated to start the following endothermic reaction:



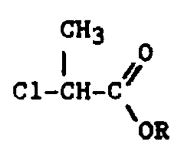
(2,4,5-T ester)

During the reaction period, the water produced was continuously removed by azeotropic distillation with the alcohol refluxed back to the reactor. When the reaction was completed, the excess alcohol was evaporated from the ester. Finally,the ester was filtered through a "polishing filter" which removed small amounts of organometallic impurities and improved the clarity of the ester. Once the esters were filtered they were pumped to a tank farm for storage.

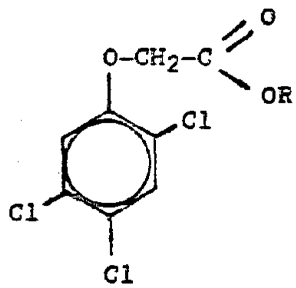
G) <u>Direct Ester Synthesis</u>
Dow Chemical produced various esters of 2,4,5-T, Silvex, and 2,4-D using the Direct-Ester Process. The Direct-Ester plant was a multi-product block operation located at the northeast end of 489 Building. The process differed from the conventional processes for phenoxy ester manufacture in that the final product was produced without having to manufacture the parent phenoxyalkanoic acid. One product (an ester of one alcohol and one of these phenoxyalkanoic acids) could be made at one time. The raw materials used in this process included the following substances: caustic solution, HCl, TCP (when 2,4,5-T or silvex esters were being produced), 2,4-dichlorophenol (DCP) (when 2,4-D esters were being produced), alcohol ester of monochloroacetic acid (when 2,4,5-T and 2,4-D esters were being produced), or an alcohol ester of alpha-monochloropropionic acid (when Silvex esters were being produced). The alcohol ester of monochloroacetic acid (MCA) has a chemical structure:



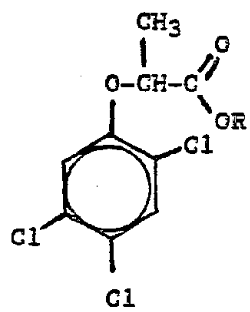
and the alcohol ester of alpha-monochloropropionic has a chemical structure:



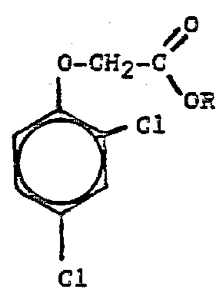
In each structure shown, "R" is a group derived from ROH, which represents the alcohol used to produce the ester. The alcohols used included butyl, isobutyl, and mixtures of these; Dowanol PIB (a mixture of butyl and isobutyl ethers of propylene glycol); Dowanol EB (2-butoxyethanol); and isooctyl alcohols. The same alcohol (ROH) used to produce the MCA ester or 2-CP ester was used in the direct-ester process as a solvent. The process was not significantly changed during the years it was operated. All operations in the process were conducted at temperatures equal to or less than 105°C (221°F), except as specifically noted. The fully automated process was operated in glass lined enclosed vessels from the first step through the final distillation. The paragraphs that follow describe the production of 2,4,5-T esters, which have a chemical structure of:



but the description also applies to the production of Silvex esters, which have a chemical structure of:

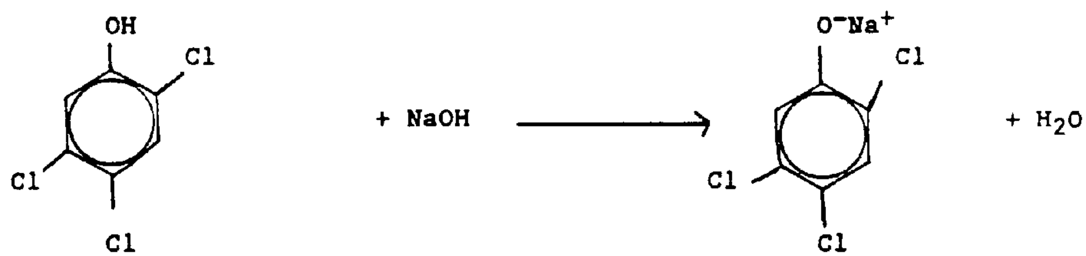


and 2,4-D esters, which have a chemical structure of



The only parameter in the process which changes as the product changed was the chemical formula of the chlorophenol and/or its chlorophenoxy derivatives. This change can be seen by comparing the chemical structures of the products and raw materials listed above. The Direct-Ester Process was so named because it permitted the synthesis of an ester of a chlorophenoxyalkanoic acid directly from the appropriate chlorophenol without the isolation of the chlorophenoxyalkanoic acid. Flow diagrams are shown in Figures 16 and 17 for 2,4,5-T direct ester and Silvex direct ester processes, respectively.

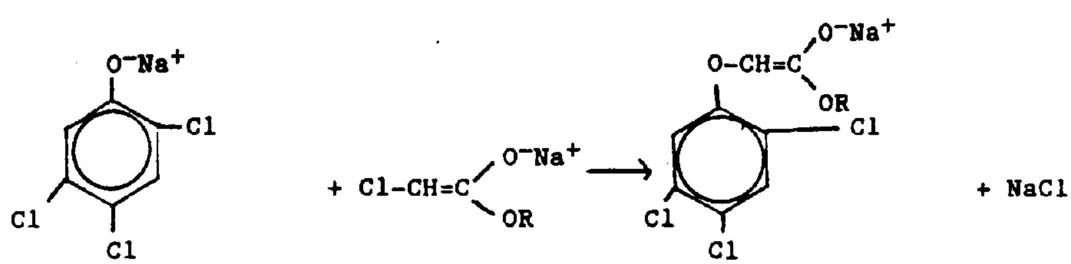
The first operation in the direct esterification of 2,4,5-T esters was a reaction to neutralize the 2,4,5-TCP. Caustic solution, 2,4,5-TCP, and alcohol as a solvent (either isooctyl alcohol, butanol, Dowanol PIB, or Dowanol EB), were pumped into a reactor vessel. An exothermic reaction occurred between the caustic and the 2,4,5-TCP, via the following reaction mechanism:



The resulting solution of NaTCP, alcohol, and water was pumped to the next step in the process.

Azeotropic distillation to remove the water from the product stream was the next step in the process. This water was pumped to the water treatment plant. The azeotropic distillation operated under vacuum, and produced an overhead product mainly consisting of water, with the alcohol being refluxed back to the product stream. The remaining bottoms-product stream, consisting of NaTCP and alcohol, was pumped into the reactor vessel.

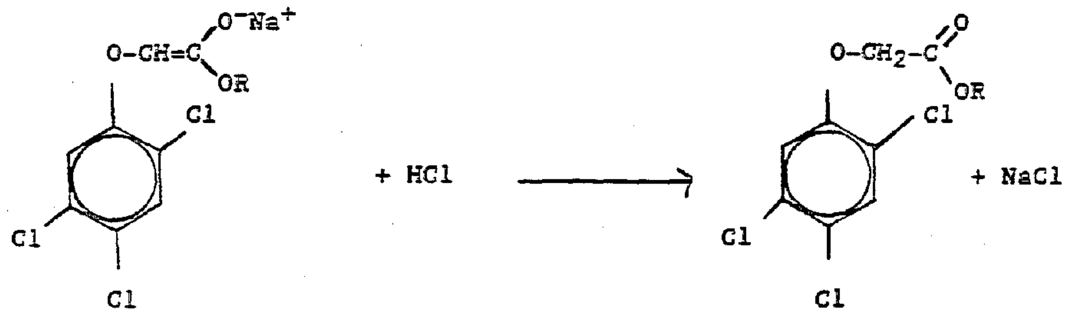
The alcohol ester of MCA acid was added to the reactor vessel. This compound reacted with the NaTCP via the following reaction mechanism:



NaTCP was used in excess and therefore some unreacted NaTCP remained at the end of the reaction step. The resulting solution of 2,4,5-T ester, NaTCP, NaCl, and alcohol were pumped to another vessel for decantation and NaTCP reclamation.

In the decantation vessel the mixture was allowed to settle and form organic and aqueous layers. The aqueous layer containing NaCl, NaTCP, and small amounts of alcohol (which was slightly miscible with water) was decanted off into an acidification vessel.

HCl was pumped into the acidification vessel and following reaction took place between the NaTCP and HCl:



Following this reaction the contents were allowed to settle forming an aqueous layer (containing NaCl and HCl) and an organic layer (containing 2,4,5-TCP). The 2,4,5-TCP was decanted off and recovered for reuse. The aqueous layer was sent to deep well disposal and in later years to the water treatment plant for disposal.

The organic layer containing 2,4,5-T esters and alcohol from the first decantation was pumped to a distillation unit. The distillation unit was a steam stripping operation which removed the excess alcohol. The distillation unit was operated at temperatures up to 150°C (302°F) and under a vacuum. At these elevated temperatures, the retention time was minimized and alkalinity conditions were optimized. Automatic computer control equipment was installed for this step in 1976. The alcohol removed in this step was recovered for reuse.

The final step in the process involved an activated charcoal filtration system, which was added in 1976. The 2,4,5-T ester was pumped from the distillation unit to the activated charcoal filtration system where organic impurities, particularly dioxins, were removed from the 2,4,5-T esters by the activated charcoal. The activated charcoal was changed each time a different product was to be produced. The spent charcoal was incinerated.

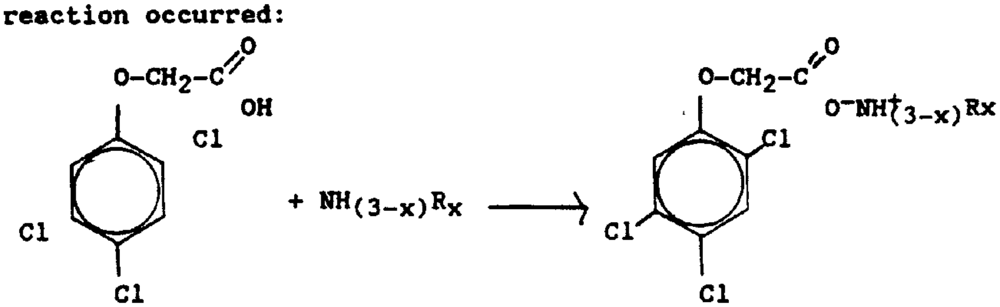
Following the charcoal filtration the 2,4,5-T esters were pumped to a quarantine tank. The quarantine tanks were dedicated check tanks where the various direct ester products were held while samples from the tanks were analyzed for TCDD. Dow set a self-imposed standard for TCDD content (see Chemical and Toxicological Analyses of Products, Process, and Wastes for Polychlorinated Dibenzo-p-dioxins and Chloracnegens for details on specifications used for product TCDD content).

When a given batch of direct esters met the Dow TCDD standard specification it was pumped from the quarantine tank to the tank farm storage area where it was sold or used for formulations.

H) Formulation and Packaging

Dow Chemical formulated and packaged various products based upon 2,4,5-T acid, 2,4-D acid, the various esters of these two compounds, and the esters of Silvex. Esters of 2-methyl-4-chlorophenoxyacetic acid (MCPA) were also formulated. The 2,4,5-T and 2,4-D acids were formulated into aqueous amine formulations. 2,4-D acid, dimethylamine, ethanolamine, and isopropanolamine were used as raw materials to formulate 2,4-dichlorophenoxyacetic acid dimethylamine salt, 2,4-dichlorophenoxyacetic acid ethanolamine salt and 2,4-dichlorophenoxyacetic acid isopropanolamine salt, respectively. 2,4,5-T and triethylamine were used to formulate 2,4,5-trichlorophenoxyacetic acid triethylamine salt. Surfactants and chelators were also added to amine formulations of both 2,4-D and 2,4,5-T. Beginning in 1971, all 2,4,5-T acid used in the amine formulation process was purchased from Vertac Corporation (U.S.A.) and Chemie Linz (Austria). Dow Chemical required that all 2,4,5-T acid supplied by these companies contain less than 0.1 ppm of TCDD; all of the material received and used met this specification. Raw materials for each ester formulation included one of the above named technical esters, petroleum solvents, emulsifiers, and surfactants. The formulation and packaging processes were not significantly changed over time of operation. The formulation steps were simple mixing operations conducted in enclosed vessels. Elevated temperatures and pressures were not used. A block flow diagram of the formulation and packaging operations may be found in (Figure 18).

Amine formulations were produced by introducing an aqueous amine solution, either 2,4,5-T or 2,4-D acid, a surfactant and a chelator into the amine formulation vessel. The contents were mixed and the following reaction occurred:



"R" represents one of many possible substitute groups. This reaction mechanism depicts the formation of an amine salt of 2,4,5-T, but an analogous reaction with 2,4-D. No amines of Silvex were produced for commercial markets.

The process of formulating the ester products involved a simple blending procedure where technical esters were dissolved in petroleum solvents; emulsifiers and surfactants also were added. The blending occurred in ester formulation tanks.

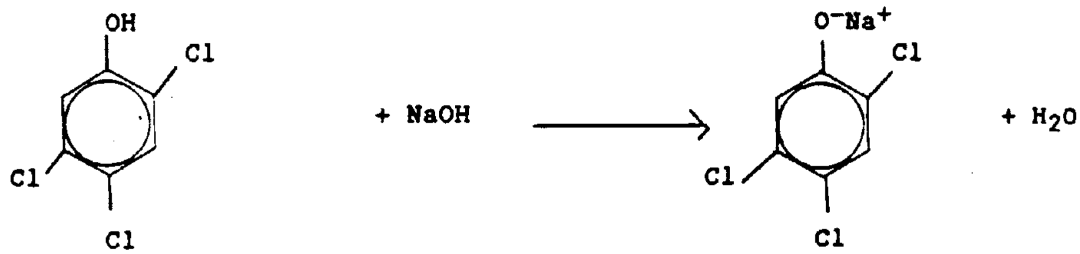
The amine and ester formulations were conducted in stirred tanks and block operated. The tanks were not dedicated to any given amine or ester formulation; instead, all amine formulations were done in the same tanks and all ester formulations were done in separate set of tanks.

After a product was formulated, it was pumped to one of several packaging locations. The first location to which a product could be sent was directly to a tank car for shipment. The second location was the 30- and 50-gallon drum filling line. This operation was under constant supervision of the operator. The fill nozzle was mechanically inserted into the drum under the control of the operator. The operator watched the filling to insure that the drum did not overflow. The drums were capped and transported to the warehouse. The remaining two locations to which a formulation might have been pumped were the 5-gallon and 1-gallon packaging lines. Both were fully automated. Containers moved along the line while the container to be filled was positioned under the fill nozzle. The nozzle was automatically inserted into the container and a pre-determined amount of liquid was injected into the container. Each container was capped. The 1-gallon containers from the high-speed line were boxed and transported to the warehouse. The 5-gallon containers were also transported to the warehouse. Years ago, the filling of the various containers just described was done manually but the company is not sure when these operations were automated.

I) Ronnel Synthesis and Formulation

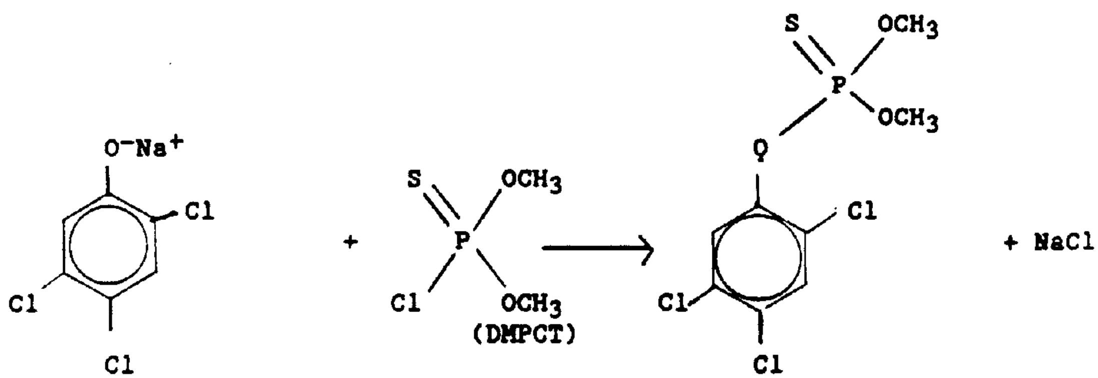
Dow Chemical synthesized ronnel using the following raw materials: 2,4,5-TCP, caustic solution (NaOH), O,O-dimethylphosphoro-chloridothioate (DMPCT), HCl. Water and methylene chloride ($MeCl_2$) were used as solvents at various steps in the process. This process was not significantly changed during its years of production. The temperature at each step in this process did not exceed 105°C (221°F), except as specifically noted. A flow diagram of this process is shown in Figure 19.

The initial step in this process was the neutralization of 2,4,5-TCP. NaOH in excess, 2,4. -TCP, and water were added to a reactor, and the following exothermic reaction occurred:



This reaction occurred at approximately atmospheric pressure, and the temperature was controlled to approximately 105°C (221°F). The 2,4,5-TCP used in this reaction was partially composed of recycled TCP from the TCP recovery step discussed later in this subsection. The resulting solution of water and NaTCP was then ready for the next step in the process.

The esterification reaction was the next step. DMPCT and the solvent $MeCl_2$ (some of which was recovered solvent from a distillation discussed later in this subsection) were added to the aqueous NaTCP solution. The NaTCP reacted with the DMPCT to form crude ronnel, as shown:



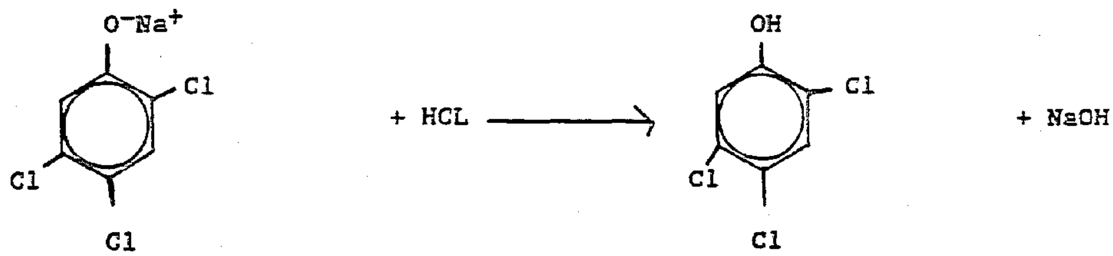
This reaction was endothermic. The solution resulting from this reaction contained water, unreacted NaOH, unreacted NaTCP, NaCl, $MeCl_2$, and ronnel. This solution was pumped to a decantation vessel.

The solution was allowed to settle in the decantation vessel. An aqueous layer and a $MeCl_2$-based organic layer formed. The aqueous layer, containing NaCl, unreacted NaTCP, and small amounts of $MeCl_2$ (which is slightly soluble in water), was decanted to the TCP recovery operation. The $MeCl_2$-based organic layer, containing crude ronnel and a small amount of NaCl was pumped to the next step in the process.

This step involved washing and centrifugation of the organic layer to remove the remaining NaCl. Water was added to the organic layer and the solution was cooled to below 41°C (106°F). The ronnel crystallized at this temperature. The centrifugation was performed at this point. The brine was removed by this step and pumped to the waste water treatment facility. The remaining solution of $MeCl_2$ and ronnel was then pumped to a final distillation process.

A simple distillation removed the $MeCl_2$ from the ronnel in the final step. The solution was heated to a temperature of less than 105°C (221°F). The $MeCl_2$ boiled off as an overhead where it was recycled to the esterification reactor for reuse as a solvent. The resulting molten ronnel solution was either pumped to 50 gallon drums and allowed to solidify, or pumped to the ronnel formulation process.

The aqueous phase from the decantation operation (discussed above) was pumped to an acidification/decantation vessel for the recovery of 2,4,5-TCP. HCl was added, and a reaction occurred between the unreacted NaTCP and the HCl, as follows:



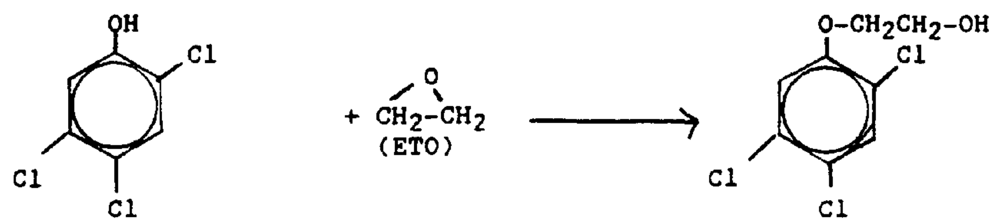
Any unreacted NaOH present from the initial reaction in the process was neutralized as follows: $NaOH + HCl \longrightarrow NaCl + H_2O$. The resulting solution of 2,4,5-TCP, NaCl, water, and a small quantity of $MeCl_2$ was allowed to settle to form aqueous and 2,4,5-TCP layers. The aqueous layer, containing NaCl (and a very small quantity of $MeCl_2$) was decanted off and pumped to the waste water treatment facility (after being combined with the waste brine from the washing and centrifugation discussed above). The 2,4,5-TCP layer, which also contained a very small quantity of $MeCl_2$, was decanted and pumped to the initial reactor vessel for re-use as a raw material (see above discussion).

Dow Chemical formulated products containing ronnel. The materials used included ronnel and one of several inert materials. This process was a simple mixing operation, and was never significantly changed. The process consisted of adding ronnel and an inert material to a formulating vessel, mixing the contents, and transporting the formulation to a packaging operation.

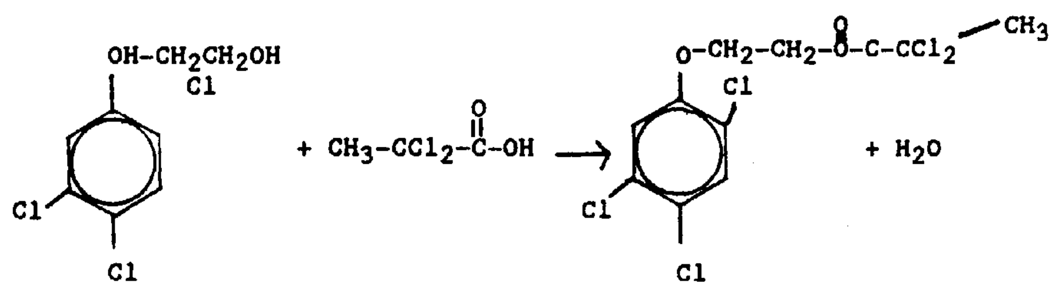
J) <u>Erbon Synthesis and Formulation</u>

Dow Chemical produced Erbon, a coined name for the chemical [2-(2,4,5-trichlorophenoxy)-ethyl 2,2-dichloropropionate]. Erbon was the active ingredient of Erbon R and Baron formulations. Erbon was produced and formulated in 441 Building from 1955 to 1964. From 1965 to 1974, the esterification and formulation was done in 649 building; production of Erbon continued at 441 Building during this time. Erbon manufacturing was performed sporadically on a more or less seasonal basis generally between the months of February and May. In 1974 Dow stopped manufacturing Erbon. A flow diagram of the Erbon process is shown in Figure 20.

Erbon was produced using the following raw materials: 2,4,5-TCP, ethylene oxide (EtO), and 2,2-dichloropropionic acid. The first step in this process involved a reaction with molten 2,4,5-TCP and EtO in a closed agitated kettle. This was a batch type reaction with the following exothermic reaction occurring:



The duration of this reaction, the temperature and the pressure at which the reaction took place are not known by Dow personnel. Once this reaction was complete, 2,2-dichloropropionic acid was added to esterify the [2-(2,4,5-trichlorophenoxy)ethanol] intermediate. The following reaction mechanism took place:



After the esterification step, adjuvants and a solvent (i.e. kerosene) were added to the contents in the agitated kettle to produce a marketable formulation. These formulations were packaged in 2, 5, and 50 gallon containers. All the equipment used to produce and formulate Erbon was block operated as a multipurpose chemical process.

K) <u>Dowicide® Synthesis, Finishing, and Packaging of Dowicide® Antimicrobials</u>

Dow Chemical produced several chemical compounds known as Dowicide® antimicrobials in 265/349 Buildings. The following is a list of Dowicide® antimicrobials, their chemical, names and the years of production.

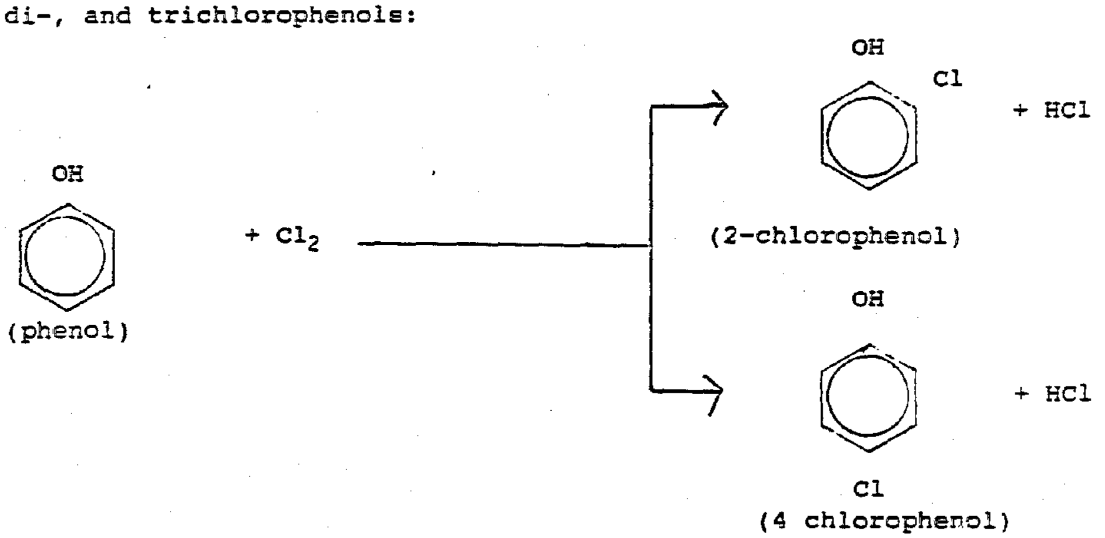
Dowicide® 2 = 2,4,5-trichlorophenol (1946-1978)
Dowicide® B = sodium 2,4,5-trichlorophenate (1946-1977)
Dowicide® 2S = 2,4,6-trichlorophenol (1946-1974)
Dowicide® 6 = tetrachlorophenol (1937-1974)
Dowicide® 7 and EC7 = pentachlorophenol (1941-1980)
Dowicide® G = sodium pentachlorophenate (1941-1976)

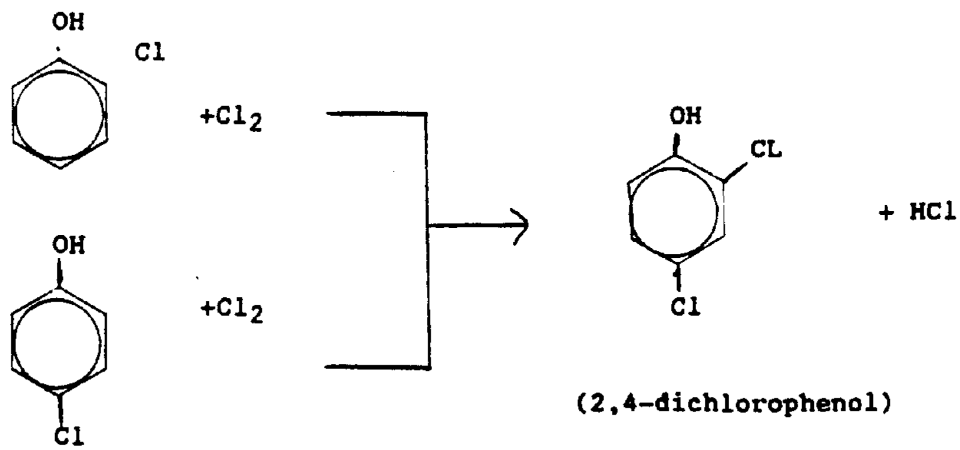
Other than Dowicide® 2 and B, the above Dowicide® Products were produced by direct chlorination of phenol under elevated temperatures and pressure. The following discussion will describe the procedure for producing pentachlorophenol (PCP), and from this a discussion of how the other Dowicides® were produced.

The raw materials used in the production of PCP were phenol, chlorine gas (Cl_2), and aluminum chloride catalyst ($Al\ Cl_3$). The production of PCP was a batch type process. A flow diagram of the PCP production process is shown in Figure 21.

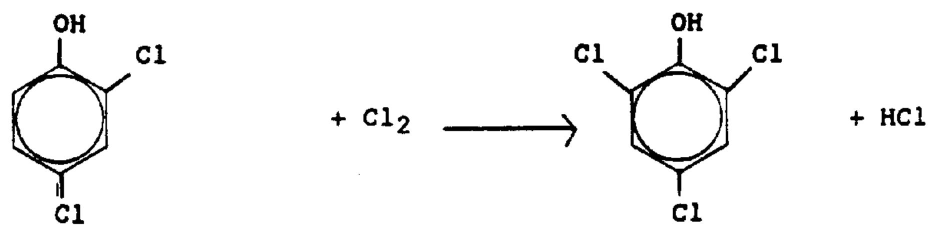
The first step in the PCP process involved the drying of phenol to remove any residual water that may have been present. This particular step took place only from 1978 to 1980. Before 1978, the phenol drying was not conducted.

Next, phenol was added to the first chlorinator. The first chlorinator was a closed steel vessel equipped with a gas vent collection system. Once the phenol had been added, Cl_2 was bubbled through it. The following reaction mechanisms took place producing a mixture of mono-, di-, and trichlorophenols:





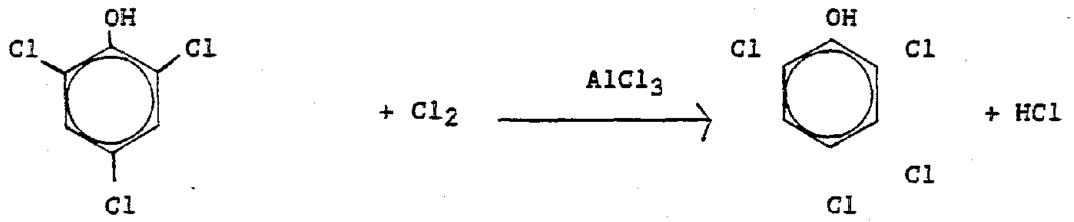
(2,4-dichlorophenol)



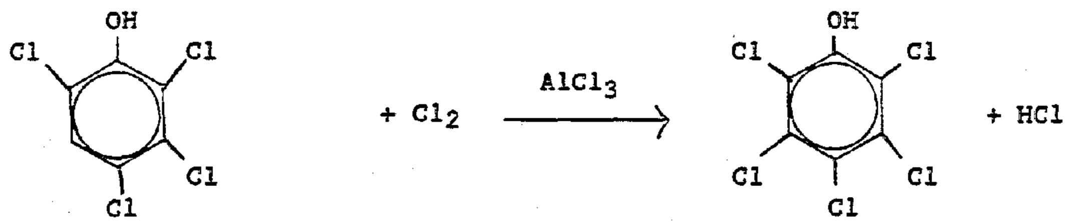
(2,4,6-trichlorophenol)

These reactions were carried out at approximately 60-70°C (140-153°F) and 25 psig. Approximately 94% of the contents in the first chlorinator at the end of chlorination was 2,4-dichlorophenol and 6% was 2,4,6-trichlorophenol. Very little 2-chlorophenol or 4-chlorophenol was present. The duration of this chlorination for a full batch took approximately 60 hours to complete, but also depended on the amount of phenol being chlorinated. The hydrogen chloride (HCl) produced during chlorination was vented out to a vessel where it was neutralized with caustic to form a brine which was deep well disposed. After 1978, the HCl gas produced was extracted with monochlorobenzene and used elsewhere in other processes.

The contents from the first chlorinator were pumped to the second chlorinator where $AlCl_3$ was added and Cl_2 gas was bubbled throughout the contents. The temperature of the second chlorinator was gradually raised to approximately 165°C (329°F) with a pressure maintained at approximately 25 psig. The following reaction mechanisms took place:



(2,3,4,6-tetrachlorophenol)



(pentachlorophenol)

These reactions did not go to completion; tetrachlorophenol persisted during the reaction and was carried with the PCP during subsequent processing. For example, technical grade PCP contained 4 to 12% tetrachlorophenol, which was listed as a active ingredient in the PCP product. The HCl gas generated in the second chlorinator was handled in the same manner as the HCl gas generated in the first chlorinator.

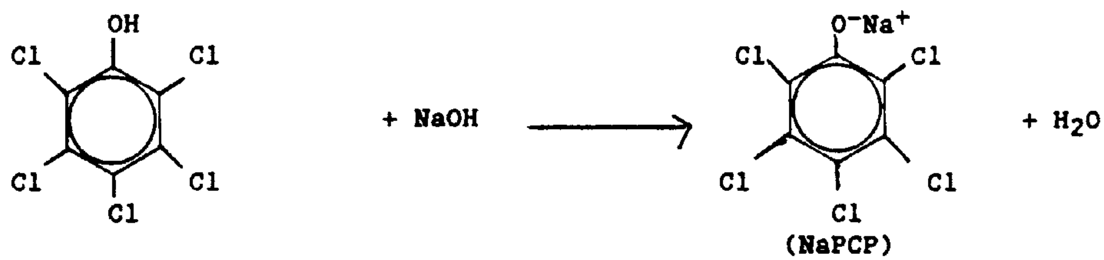
The contents from the second chlorinator were pumped to a distillation unit where lower chlorinated phenol (such as di- and trichlorophenols) and any contaminants were boiled off and either recycled back to the first chlorinator or disposed. The distillation operation took place at approximately 230°C (446°) and under a slight vacuum. This step was added to the process in 1973, before this time the contents in the second chlorinator was transferred directly to the various finishing operations.

One finishing operation was the flaking of PCP. Molten PCP was transferred to a pan in a flaker. A water cooled rotating drum was partially immersed in the molten PCP. The PCP would solidify on the drum surface and as the drum rotated the PCP was scraped off the drum's surface and fell into a hopper as flakes. From the hopper the PCP flakes dropped down chutes to be packaged in either fiber packs or 50-gallon steel drums. PCP flaking operations took place from 1937 to 1971.

Another finishing operation involved prilling or pelletizing of PCP. This operation was accomplished in a prilling tower from 1965 to 1978. Molten PCP coming from either the distiller or the second chlorinator was sprayed into the top of the prill tower. Air was blown from the bottom of the tower upward causing the PCP mist to be suspended until it gained enough mass (approximately 1/8" in diameter spheres) to fall to the bottom of the tower. From there the prills were transferred by screw conveyor to packaging operations where they were packaged in fiber packs or drummed in 50 gallon steel drums.

When the PCP process was moved to 349 Building in 1978, the prill finishing operations were discontinued. The PCP produced from 1978 to 1980 was finished by pouring the molten PCP into molds to form blocks. The block sizes were either one-half ton or one ton.

PCP was also converted into its water soluble sodium salt, sodium pentachlorophenate (NaPCP). This conversion was accomplished by taking the contents from the distiller or the second chlorinator, depending on the year, and treating it stoichiometrically with NaOH to produce the sodium salt. The reaction mechanism that took place was as follows:



After PCP had been neutralized to NaPCP, it was finished with double-drum dryers. The double-drum dryers consisted of two rotating water heated drums turning away from each other. The NaPCP was pumped over head and dropped down to form a pool between the drums. The water in the NaPCP was vaporized off and the NaPCP crystallized on the surface of the drums. The NaPCP was scraped off the drum surfaces by knifes. These crystals dropped down into a hopper and were screw conveyed to be packaged in either fiber packs or 50 gallon steel drums. Crystallization of NaPCP by this process took place from 1941 to 1966.

NaPCP was finished by fluid bed dryer from 1966 to 1976 when Dow stopped producing NaPCP. The NaPCP solution was pumped from the neutralization step to a de-watering unit where a majority of the water was removed to form a wet cake of NaPCP. The wet cake then entered the fluid bed dryer and collected on top of a perforated plate above a plenum chamber. Warm air entered the plenum chamber and rose up through the perforated plate. This dried the wet cake and formed a bead-like product of NaPCP. The air/water vapor was vented out the top of the dryer. The beads of NaPCP were removed from the dryer via hopper and screw conveyor. The NaPCP was packed in fiber packs or 50 gallon steel drums.

Di-, tri, and tetrachlorophenols were produced in a similar manner as PCP. In the case of di- and trichlorophenol, the contents in the first chlorinator were pumped to a distillation unit in 349 Building instead of to the second chlorinator. In the distillation unit the di- and trichlorophenols were separated from each other by distillation and the trichlorophenol was finished in the same manner as PCP. Prior to 1976, the dichlorophenol was used to supply the 2,4-D plant.

When tetrachlorophenol was being produced, the reaction time in the second chlorinator was shorter and the temperature was raised to approximately 120°C (248°F) instead of 165°C (329°F) as in the case of PCP. Tetrachlorophenol was finished in the same manner as PCP. From each other by distillation and the trichlorophenol was finished in the same manner as PCP. Prior to 1976, the trichlorophenol was used to supply the 2,4-D plant.

Dowicide® 2 and B were also finished in 265 Building. Molten 2,4,5-TCP was pumped to 265 Building from either 349 Building or 804 Building. In 265 Building, the 2,4,5-TCP was finished by flaking in the same manner as PCP. Dowicide® B was finished in the same manner as Dowicide® G, in a double drum dryer.

Dow also produced a product known as Hi-Purity TCP which was purified by distillation and was produced from 1966 to 1977 in 349 Building. Most of the Hi-Purity TCP was used as a raw material in the production of ronnel while some was sold as a Dowicide® antimicrobial.

History of Chloracne Incidence

Chloracne is a skin condition characterized by the appearance of folliculitis, blackheads, acne, cysts, and scar formation due to an exposure to a chloracnegen. The disease may be mild or severe, localized or widespread, but under any circumstances it is a disorder with a prolonged course. Lesions (blackheads and cysts) of chloracne first appear on the sides of the forehead and around the lateral aspects of the eyelids. Cysts and lesions are frequently present behind the ears. As exposure to the chloracnegen continues, the lesions can affect widespread areas, except for the palms and soles[8].

According to a review of Dow industrial hygiene records, chloracne was not seen in 199 Building where NaTCP was synthesized until February 1964, when a total of 49 individuals out of 61 workers, "developed acne-like lesions over several months. The company attributes the outbreak to increased 2,4,5-TCP production, which began in November 1963. This production increase pushed the process to its capacity and resulted in a considerable increase in equipment becoming plugged and needing to be cleaned, and sampling of process streams was done more frequently than usual. Also, it is possible that the temperature of the process may have been increased during this period. Records of rabbit-ear toxicity tests of waste oil from April 1964 show that the activity was significantly higher than usual, causing death in some rabbits. The identity of the acnegen was unknown at that time, but soon thereafter (by 1965) was determined by Dow to be TCDD.

The rabbit ear test for chloracnegens was performed by applying 0.1 ml of material to a specific location on a rabbit's ear on a daily basis for 4 weeks (5 days per week). The acnegenic activity was rated by the severity of the folliculitis which occurred, with zero representing no folliculitis (less than 1 ug of TCDD) and four representing severe folliculitis (greater than 100 ug of TCDD). In 1964 the capability to quantify levels of TCDD was developed by the company. The method of analysis was vapor phase chromatography (VPC).

Long experience with rabbit-ear tests had led Dow researchers to the opinion that the rabbits were more sensitive to acnegens than were humans. In order to find out how much more sensitive rabbits were as compared to humans, the company contracted with a dermatologist from the University of Pennsylvania to study chloracne in prison volunteers.[9] The dermatologist applied measured amounts of TCDD to the skin of each volunteer and covered the wet area with a gauze bandage so the material would not be brushed off. One volunteer received 4 ug of TCDD and six volunteers received 8 ug of TCDD. None of the volunteers developed chloracne at the site of application or anywhere else.

This terminated the contract between Dow and the dermatologist. Before a new contract was agreed upon, the dermatologist went ahead and applied 7500 ug of TCDD to the backs of 15 volunteers. Within three to four weeks chloracne appeared at the site of application. The progress of the chloracne was characteristic, starting as a rash and proceeding to cysts and pimples. After about six months, the chloracne disappeared. No liver problems ever developed. While applications of 7500 ug of TCDD was against Dow's wishes this demonstrated that a single application of TCDD between 8 and 7500 ug could cause chloracne. The experiments also showed that the rabbit was 10 to 100 times more sensitive to TCDD than were humans.

The company instituted equipment changes, protective clothing procedures, and medical surveillance in the NaTCP process area until the process was shut down in 1966. The process was changed and transferred to a new building (804 Building) in 1966. Along with many aspects, the 2,4,5-TCP process in 804 Building was designed and built to minimize TCDD contaminant formation and to remove the TCDD formed early in process steps. Despite these precautions two chloracne cases occurred in 804 Building in 1971. Poor work practice was the explanation for the occurrence.

265 Building had a history of chloracne cases. An early publication by Milton Butler,[10] an independent physician from Saginaw, Michigan, indicated that between the years 1935 and 1937 21 of 26 employees involved in the packaging of Dowicide® P (50% sodium tetrachlorophenate and 50% ortho-chlorophenylphenol) had chloracne. In medical examinations conducted in 1966 for 28 workers from 265 Building, 24 workers were found to have chloracne, varying from slight to severe acne, leading to a Task Force being formed in 1967 to study the workers' chloracne problems in 265 Building. This task force was made up of persons from Production, Research, Safety and Medical departments of Dow U.S.A., Midland Division. Many efforts had been employed to decrease the exposure to chloracnegens. Despite all this, the incidence of chloracne had not decreased to any large extent. In order to make some headway against the chloracne problem, an industrial hygienist was assigned to 265 Building on an eight hour a day, continuous basis in 1971. Industrial hygiene activities continued in 265 and later in 265/349 Buildings until their eventual closings in 1978 and 1980, respectively.

Epidemiology Studies by Dow Chemical

Dow Chemical has conducted and published several studies of workers employed in processes relevant to the Dioxin Registry. The population of workers at the Michigan facility has been a very stable one. Cook, et. al.,[11] examined and reported on the mortality experience of 61 male workers engaged in production, sampling or maintenance in the trichlorophenol process area between November, 1963 and December, 1964. The study concluded that within the limitations posed by cohort size and length of follow-up, TCDD does not appear to have adversely affected mortality experience.

Ott, et al[12] conducted a study which examined mortality outcome among 204 male production workers engaged in the production of 2,4,5-T acid between March, 1950 and May, 1971 in the job classification of reactor operator, salt wheel operator, acid wheel operator and dryer operator. Length of employment in these job classifications ranged from less than one year to a maximum of approximately ten years. Within the scope of this mortality study, it was concluded that no adverse effects were observed with respect to occupational exposure to 2,4,5-T acid or its feed stock, 2,4,5-TCP.

To determine whether paternal exposure to TCDD or other polychlorinated dioxins might be associated with adverse pregnancy outcome, Townsend, et. al.[13] conducted an interviewer-administered questionnaire survey among wives of Dow Michigan Division employees who had been potentially exposed to dioxins. Wives of employees who had no dioxin exposure and whose hire dates were comparable to those of the workers in the potentially exposed group were used as comparison group. The results of this study were that overall, no statistically significant associations were found between any exposure and pregnancy outcome, either before or after stratificaton by pertinent sets of up to nine covariables.

Available medical and morbidity surveillance findings from 1976 to 1978 for two worker cohorts potentially exposed to TCDD were compared with those of matched unexposed employees. The medical surveillance findings were derived from a screening program offered to all active workers and included an analysis of various medical history questions and blood chemistry results.

Group medical insurance claims served as the source of morbidity surveillance data and the period prevalence of selected diseases were analyzed. Bond, et. al.[14] reported few significant differences between the exposed and unexposed workers. Among the cohort of workers potentially exposed during the manufacture of 2,4,5-T acid, a significantly greater frequency of x-ray proven ulcers were reported and significantly more members of this group had diagnosed diseases of the digestive system.

Mortality patterns were analyzed for the time period 1940 through 1979 of 2,189 workers with potential occupational exposures to polychlorinated dioxins by Cook, et. al.[12] Special attention was directed toward TCDD and deaths due to soft-tissue sarcoma, non-Hodgkins lymphoma, Hodgkins disease, liver cancer, stomach cancer, and nasal or nasopharyngeal cancer. With United States white males as the comparison population for this worker cohort, the standardized mortality ratio for all causes of death was 91 and for total malignant neoplasms was 96. Among the malignancy categories of particular interest, none demonstrated a significant deviation from the expected. Nor were any significant trends noted for any specific cause of death category when analyzed by estimated cumulative exposure to TCDD.

Ott et. al.[16] reevaluated the mortality patterns of the chemical workers previously studied by Cook, et. al.[15] In this reevaluation, 2192 workers (up from 2189 workers) engaged in the manufacture of higher chlorinated phenols and derivative products from 1940 through 1982 (three years more than Cook, et. al[15]) and had potential occupational exposures to chlorinated dibenzo-p-dioxins were studied. Relative to United States white male mortality experience, there were no statistically significant deviations from expected for the following categories: all causes, total malignant neoplasms, or specific malignancies of particular interest: stomach cancer, liver cancer, connective and other soft-tissue cancer, the lymphomas or nasal and nasopharyngeal cancer. Similar to the previous evaluation of these workers, this study did not support a casual association between chronic human disease as measured by mortality and exposures to the higher chlorinated phenols, derivative products or their unwanted contaminants, the chlorinated dibenzo-p-dioxins.

Chemical and Toxicological Analyses of Products, Process Streams and Wastes for Polychlorinated Dibenzo-p-Dioxins, and Chloracnegens

A) Analytical and Toxicological Chronology for Chlorinated Dibenzo(p)dioxins

Provided in Appendix D are abstracts of the various analytical methods used to analyze various substances for polychlorinated dibenzo-p-dioxins and dibenzofurans. Included in the abstracts are Dow Analytical Method Numbers, dates the methods were reported, and brief descriptions of what was involved in conducting the analysis.

The following is a brief chronological summary of the Dow Chemical Company's analytical and toxicological capabilities:

Late 1930's: The rabbit ear test was developed and used until the early 70's to detect the presence of chloracne inciters, and chloracnegens. No cases of chloracne were observed in operators making 2,4,5-TCP until early 1964. Cases of chloracne have been documented for process workers in 265 Building throughout the years the processes were operated.

September-December 1964: The principal source of chloracne in 2,4,5-TCP was learned to be 2,3,7,8-tetrachlorodibenzo(p)dioxin (TCDD). A Vapor Phase Chromatography (VPC) analytical method to measure the presence of TCDD in 2,4,5-TCP down to 1 part per million (ppm) was developed.

1966: Dow set a self-imposed 2,4,5-TCP product specification that TCDD content would not exceed 1 ppm.

1970: The VPC analytical method was improved to measure TCDD in 2,4,5-TCP at a sensitivity of 0.5 ppm. The self-imposed TCP product specification was revised so that TCDD content would not exceed 0.5 ppm. The VPC analytical method was further validated to detect TCDD in 2,4,5-T acid to a sensitivity of 1 ppm. 2,4,5-T acid product specification was set to 1.0 ppm maximum TCDD.

1971: A Gas Chromatograph - Mass Spectrometric (GC-MS) method was developed to measure TCDD in both 2,4,5-TCP and 2,4,5-T acid to a sensitivity of 50 parts per billion (ppb). Specifications for TCDD content in both products were set at 0.1 ppm maximum.

1972: The GC-MS method was improved and validated to determine TCDD levels in 2,4,5-T esters and Silvex esters to a sensitivity of 50 ppb. Specifications were set for these products to allow no more than 0.1 ppm of TCDD.

1974: Improvements in the GC-MS method allowed TCDD to be measured with a detection limit of 20 ppb in all 2,4,5-TCP products and derivatives.

Specifications for 2,4,5-TCP products and derivatives were revised in 1975 to reflect this capability.

1975-Present: The GS-MS method was further improved to measure most chlorinated dibenzo(p)dioxins on an isomer specific basis in many chemicals to a detection limit of 1 ppb.

Dow Chemical has stated that, prior to about 1979, TCDD measurements may not have been isomer specific even though these measurements were reported as such.

B) Chemical and Toxicological Analyses of the Products, Process Streams, and Wastes

At the request of NIOSH investigators, Dow personnel conducted a thorough review of all their files and collected copies of all the documents containing analytical data for polychlorinated dibenzo-p-dioxins and dibenzofurans in products, process streams or waste effluents. NIOSH investigators audited these documents to become familiar with the documents and instructed Dow personnel in how the data from the documents was to be abstracted and summarized. Each data point abstracted had the following information associated with it:

1. the year the sample was collected,
2. a description of the sample,
3. the analyte analyzed in the sample,
4. the type of sample,
5. the building number where the sample was collected
6. and the analytical method used.

These data were sorted and summarized by the following hierarchy: building number; sample description; sample type; analyte; and year. The summarization of these data are in Appendix E, Tables 15 through 24. Table 15 lists the symbols with definitions used in Tables 16 through 24. Tables 16 through 24 are the summarized data for Buildings 199, 804, 349, 267, 489, 338, 840, 441, and 265 respectively. The summary statistics presented in these tables include

1. number of sample results
2. number of non-detectable (ND) sample results
3. mean of the limit of detection (LOD) for the ND sample results
4. mean of the sample results (including ND values assigned the LOD/2)
5. standard deviation
6. minimum detectable sample result
7. maximum detectable sample result

Arithmetic means were calculated because the environmental data will be used in the NIOSH exposure matrix to estimate cumulative exposure.[18] In addition, because the data were highly left censored, sample results less than the LOD were assigned one-half the LOD (LOD/2) for the calculation of the mean.[19] Due to limited space in the table, the reported ND value is the mean of the ND values for each sample type.

In general, the analytical methods used to obtain an analytical result were known and provided to NIOSH by Dow. In reorganizing and summarizing these analytical data, NIOSH investigators elected not to include this information in the summary Tables 16 through 24 because the methods primarily depended on the year of analysis (see subsection A, Analytical and Toxicological Chronology for Chlorinated Dibenzo-p-dioxins).

Overall Tables 16 through 24 demonstrate that TCDD and/or other polychlorinated dibenzo-p-dioxins and dibenzofurans were measured in 2,4,5-TCP, 2,4,5-TCP derivatives, PCP and PCP derivatives. The highest concentrations of TCDD were found in the caustic insoluble waste oil from the NaTCP process in 199 Building (Table 16). Detectable levels of TCDD were found in 2,4,5-T acid, esters and amines and in Silvex acid and esters (Tables 19 and 20). Detectable levels of TCDD also were found in ronnel and Erbon (Tables 21 through 23). While no TCDD was ever measured in PCP, Table 24 clearly demonstrates that detectable levels of HxCDD, HpCDD and OCDD were measured. Polychlorinated dibenzofurans also were measured in PCP (Table 24).

The rabbit-ear test was compared to the VPC analysis and it was discovered that samples containing from 1 to 10 ug of TCDD caused slight to moderate folliculitis, while samples containing from 10 to 100 ug of TCDD caused moderate to severe folliculitis (see Table 25). Table 26 shows a historical account of rabbit ear testing results for various chlorophenols and their sodium salts. While the 1936-37 2,4,5-TCP and its sodium salt did not produce folliculitis in the rabbit, the waste (caustic insolubles oils) did produce folliculitis in the rabbit ear testing.

Past Industrial Hygiene Monitoring

Dow Chemical's industrial hygiene program was initiated in the late 1930's. The industrial hygiene and toxicological functions were organized together in a research unit of the company. Originally the industrial hygiene function was carried out by personnel who were also responsible for animal toxicology. In 1942, the first full time industrial hygienist was assigned. A safety engineer joined the industrial hygiene staff in 1948 and a health physicist was added to the staff in 1955.[17] As a result of such an organization, industrial hygiene reports have been written for 2,4,5-TCP, 2,4,5-TCP derivatives, PCP, and PCP derivatives processes starting in the early 1940's through 1980.

A thorough review of the Dow industrial hygiene files was conducted. Forty reports and miscellaneous data were identified as pertaining to 2,4,5-TCP, 2,4,5-TCP derivatives, PCP, and PCP derivatives production processes. These materials were reviewed by Dow personnel, sensitive information such as personal identifiers were removed, and then copied and sent to NIOSH. The sections that follow briefly describe the nature and types of data for each building identified as containing 2,4,5-TCP, 2,4,5-TCP derivatives, PCP or PCP derivatives production processes. The company has stated that the lack of industrial hygiene data for a given building and/or process implies that there were no perceived exposure problems. For example, there is very little data available prior to 1964 on the NaTCP process in 199 Building because the 2,4,5-TCP process was not considered a health concern at that time.

Appendix F contains Tables 27 through 55, which are the summarization of industrial hygiene data from processes of interest. Table 27 lists the symbols with definitions used in Tables 28 through 55. Tables 28 through 55 summarize the data found in the industrial hygiene files and reports. A table was created for area air, breathing zone air, personal air, and surface wipe samples for each building. Area air samples were collected by a sampling device in a fixed location in the work area. Breathing zone air samples were collected in a worker's breathing zone by a second individual placing the sampling device in the worker's breathing zone. These types of samples were usually short term (20 minutes) and with a high sampling flow rate [1 to 2 cubic feet per minute (cfm)]. Personal samples were samples collected in the breathing zone by a sampling device attached to the worker and worn continuously during the entire workshift. Surface wipe samples were collected by wiping process surfaces and equipment with filter paper. The Dow industrial hygiene reports also contained some analytical data for polychlorinated dibenzo-p-dioxin, dibenzofurans, and rabbit ear folliculitis from products, process streams and waste effluents. These data were summarized by the building from which they came and included in this section as well. However, some of the results may also be included in the analytical data found in Appendix E which was previously discussed.

The data contained in Tables 28 through 55 are summarized by year, sample description, analyte, and sample type. The descriptive summary statistics reported in the tables include the number of sample results, the number of non-detectable (ND) sample results, the mean of the analytical limit of detection (LOD) for the ND sample results, the arithmetic mean, the standard deviation, the minimum detectable sample result, the maximum detectable sample result, and the units of the values reported. For calculation of the mean and standard deviation, each ND result was assigned the value of one-half their limit of detection.[19]

The air samples for chloracnegens were taken to determine the potential of airborne exposure to chloracnegens. The samples were collected by drawing air through a glass fiber filter at approximately seven cubic feet per minute for one to five days. A portion of the samples were extracted with a solvent and the extract was applied to rabbit ears for a four week period to determine the chloracnegenic potential. Additional samples were analyzed for TCDD content by vapor phase chromatography (VPC). The detection limit varied from 0.1 ug to 5 ug per sample. The air sampling was conducted in process and/or controlled areas of the plants. In general, air sampling for chloracnegens were discontinued by 1966 because skin contact was recognized as the primary route of exposure.

Wipe testing, a more plausible indicator of dermal exposure potential, was conducted to determine the chloracnegenic contamination and degree of cleanliness in the plants. In general, dry filter papers were used to wipe equipment and surface areas within a plant. For a portion of the samples, the filters were extracted with a solvent and the extract was applied to rabbit ears for four weeks to determine the chloracnegenic potential. The remaining wipe samples were analyzed for TCDD content by VPC. In later years, wipe samples were analyzed for TCDD, HxCDD, HpCDD and OCDD content by GC-ECD and GC-MS. The limit of detection ranged from 0.1 ug to 5 ug per sample. Tracking wipe test results over time helped to indicate the degree of control. It is difficult to fully relate wipe test results to individual exposure. Wipe tests were taken on floors, walls, valves, railings, benches, equipment, etc.

A) <u>199 Building</u>

Tables 28 through 33 summarize the data collected from 199 Building. Tables 28 and 29 pertain to the aniline processes which were also housed in 199 building. These data are included in this report to demonstrate what confounding exposures the workers in 199 Building may have had due to the fact that the aniline and NaTCP processes were in close proximity to each other. Tables 30 through 33 pertain to the NaTCP process.

Sampling was conducted in this building for airborne exposures to raw materials, products, and chloracnegens. Sampling was also conducted for chloracnegens by wipe samples.

In the late 1940's it was discovered, by using the rabbit-ear test, that a chloracnegen was present in the NaTCP process. Eventually, testing for chloracnegenic activity (and later for the presence of TCDD) was conducted quarterly, and whenever equipment was decontaminated. The testing was also conducted on an "as required" basis. During the demolition of 199 Building in 1968, testing for TCDD contamination was also conducted.

A 1958 survey was the first focus of the Dow industrial hygiene staff on the NaTCP process. Area air samples and breathing zone samples were collected and analyzed for TCB, 1,2,4-trichlorobenzene, monochlorobenzene, methanol, caustic, 2,4,6-trichloroanisole, and NaTCP. The results for these samples are shown in Table 30 and 31. Two observations were made of the workers activities during this survey which indicated why a lot of these workers would later develop chloracne.

The first observation stated that:

"The process operator is required to take a sample of the crude NaTCP product each hour. This is done in an area near the cooling coils. It is also in the general area of the control panels and the operator's desk, where most of his time is spent. The actual time required for taking the sample is only seconds".

The second observation noted:

"An operation which is done approximately once a shift is the draining of the unreacted organics from the stripper column to a dumpster tank located outside the building. This is an operation which takes approximately ten to fifteen minutes and requires that the operator remain in the area to determine the proper time to shut off the flow of the draining liquor. The majority of the vapors consisted of 2,4,5- and 2,4,6-trichloroanisole".

Industrial hygiene reports from mid-1963 to mid-1964 describe the following sequence of events relating to the outbreak of chloracne among the workers in the NaTCP process in 1964. In July 1963, it was reported that the equipment had become plugged as a result of a process shutdown (so that the workers had to clean the system). In November 1963, the process was pushed to capacity due to high demand for NaTCP. This resulted in a greater output of waste oil, a need for more frequent sampling of the products and process streams, and more frequent problems with the plugging of equipment. It was concluded that greater worker exposures to chloracnegen-containing materials probably occurred at this time. In February 1964, several cases of chloracne were reported among the NaTCP operators and a supervisor. In April 1964, it was noted that the waste oil from the process had a much greater chloracnegenicity than it had previously shown over the years. This finding indicated that the process operating temperature may have been higher during this period, so that greater production volume could be achieved. Therefore the chloracne problem was probably a result of increased levels of TCDD contamination in the NaTCP and other materials, as well as increased exposure potential due to greater work activity with Na TCP and other materials. During 1964, the results of wipe samples collected from various surfaces in the area verified the presence of chloracnegen as based on the results of the rabbit ear test. Surface wipe samples were also analyzed for TCDD using VPC. These surface wipe sample results are listed in Table 32. Detectable levels of TCDD ranging from 0.1 to 110 ug/wipe were found on 33 of the 134 (25%) samples .

As a result of the chloracnegen surface contamination, the onset of chloracne in the NaTCP process personnel, and the unanticipated severity of response to the waste oil in the rabbit ear test, a number of process and operating changes were made. These process changes included the replacement of leaking equipment (i.e. pumps, vessels, etc.), welded joints rather than pipe threaded joints, and an increased use of personal protective gloves, respirators and clothing. Improved personal hygiene (thorough and frequent washing of exposed skin by the workmen) was also instituted. Another operating change involved the institution of a program of regular and frequent surface wipe sampling for chloracnegens and TCDD, to test the "cleanliness" of the work area.

Table 33 is a summary of analytical data for products, process streams, and waste from 199 Building. These data were obtained from Dow IH data and were reported separate from the analytical data for 199 Building in Table 16 to avoid duplication of data.

B) <u>804 Building</u>
2,4,5-TCP was produced in 804 Building complex from 1966 to 1979. Industrial hygiene measurements for TCDD, 2,4,5-TCP and other chemicals were collected at this location. Tables 34, 35 and 36, summarize all available data collected at this location.

An evaluation of workers' exposures to chemical and physical agents for all job classifications was performed between May and June 1978. Area air (Table 34) and personal air sampling (Table 35) for airborne TCB, TCA and 2,4,5-TCP were collected on silica gel sample tubes at an air flow rate of 0.1 liter per minute (lpm). Silica gel tube samples were desorbed and analyzed for TCA, TCB and 2,4,5-TCP using GC-ECD. Personal and area air sampling for airborne TCDD, HxCDD, HpCDD, and OCDD were collected on membrane filters at an airflow rate of 1.5 lpm. The analytical determinations of dioxins on the membrane filters were performed by extracting the dioxins from the filter into a known volume of solvent. TCDD then was measured by GC-MS and HxCDD, HpCDD, and OCDD were measured by GC-ECD.

As a result of the 1978 survey, 27 area air samples from seven locations in the 804 Building complex were collected and analyzed for TCB, 2,4,5-TCA and 2,4,5-TCP with detectable results ranging from 0.003 to 0.008, 0.003 to 0.003 and 0.003 to 0.8 ppm, respectively. These results are listed in Table 34. Similarly, 27 personal samples in the job classifications TCP Operator, Spare, Sr. Production Engineer, Plant Superintendent and Alternate were collected and analyzed for TCB, 2,4,5-TCA and 2,4,5-TCP. The detectable TCB, 2,4,5-TCA and 2,4,5-TCP personal sample results ranged from 0.003 (Production Engineer) to 0.01 (TCP Operator), 0.002 (Spare) to 0.004 (TCP Operator) and 0.003 (Production Engineer) to 1.7 (TCP Operator)ppm, respectively. These results are listed in Table 35.

"Cleanliness" surface wipe samples for TCDD were collected quarterly. Of the 950 area wipe samples collected, 186 had detectable levels of TCDD ranging from .01 to 60 ug/wipe, and are shown in Table 36. The waste oil dumpster area was one site where positive samples for TCDD were frequently found. This area needed continued care and quick clean-up of any spills.

C) <u>349 Building</u>
Hi-Purity TCP was produced in this building. Later, in 1978, PCP was also produced in 349 Building. Table 37 summarizes the results of area air sampling for 2,4,5-TCP in the TCP distillation area. Table 38

summarizes personal air samples for PCP for the job titles Dowicide Operator, Handyman, and Spare. These workers were involved in the production of PCP. The PCP production process was moved from 265 Building to 349 Building in 1978. For the most part industrial hygiene sampling data involving PCP operations in 349 Building were summarized as a part of 265 Building in Tables 51 through 54 because until 1978 PCP production centered in 265 Building. The PCP production activities for these two buildings overlapped for the time period 1972 to 1978. Surface wipe samples collected in 349 Building are summarized in Table 39. For the most part, the surface wipe samples collected in 349 Building yielded no folliculitis in rabbit ears or non-detectable levels of TCDD. Only 1 of 55 wipe samples tested positive in rabbit ears and only 2 of 49 yielded detectable levels of TCDD. Table 40 is a summarization of analytical data found in the industrial hygiene records. For the years of 1964 and 1965, 11 color still tar waste samples were analyzed for TCDD with 10 of the samples having detectable levels ranging from 5 to 3600 ug/g. In 1972, waste oil for the newly installed PCP still showed detectable levels for HxCDD,HxCDF,HpCDD, HpCDF, OCDD and OCDF of 35, 80, 60, 140, 350 and 50 ug/g, respectively.

D) <u>267 Building</u>

The Dow Chemical Company produced 2,4,5-T acid, Silvex, and various esters of these products (using the Acid-Ester Process) in 267 building. From 1955 to 1957, ronnel was also synthesized in this building. Industrial hygiene measurements were collected in the 2,4,5-T acid and Acid-Ester process areas and are summarized in Tables 41, 42, and 43.

An industrial hygiene survey was completed in 1970 to evaluate employee exposures to 2,4,5-T acid and the raw material 2,4,5-TCP. Area air samples were collected throughout the 2,4,5-T acid process areas. The results of these area air measurements for 2,4,5-T acid, 2,4,5-TCP and 2,4-D acid are listed in Table 41. Forty-four samples were collected throughout the various work areas and analyzed for 2,4,5-TCP. Sample results ranged between 0.1 to 27 mg/M^3, with one non-detectable sample (LOD=0.10 mg/M^3). Similarly 36 samples were collected and analyzed for 2,4,5-T acid with 17 non-detectable results (LOD ranged from <0.09 to 0.21 mg/m^3). The detectable samples ranged of 0.09 to 6.21 mg/M^3. Only 1 of 35 samples collected and analyzed for 2,4,-D acid had detectable levels. The result for the detectable 2,4,-D acid sample, which was from the lunch-room, was 4.1 mg/M^3.

Using the area air sample results listed in Table 41 and determining the time spent in the various work areas of the 2,4,5-T acid process, estimates of worker time-weighted average (TWA) exposures were calculated for four job titles. These personal exposure estimates are listed in Table 42. Estimates of 2,4,5-T acid exposure ranged from 0.16 mg/M^3 (48" Wheel Operator) to 0.81 mg/M^3 (Reactor Operator) while estimates of 2,4,5-TCP exposure ranged from 1.60 mg/M^3 (Drier Operator) to 9.70 mg/M^3 (48" Wheel Operator) for the four job titles studied.

Surface wipe samples, collected in 1965, were analyzed in the same manner as those collected in 199 Building. The surface wipe samples collected in 267 Building were a direct result of the chloracne problem in 199 Building because the NaTCP produced in 199 Building was used as a raw material to produce 2,4,5-T acid in 267 Building. Results of these surface wipe testing are shown in Table 43. Forty-nine surface wipe samples were collected throughout the work areas of 267 Building. These samples were analyzed for TCDD with 44 of the 49 having non-detectable TCDD levels (mean LOD=1.0 ug/wipe). The detectable sample results ranged from 2 to 20 ug/wipe. Analytical TCDD concentration data for 2,4,5-T acid process streams and products were found in industrial hygiene documents for 267 Building and these values are summarized in Table 44.

E) <u>489 Building</u>

Processes in this building included the 2,4-D synthesis process, the D/T Acid-Ester process from 1967 to 1979, and the Direct-Ester process. Formulation and packaging of phenoxyalkanoic herbicides were also performed in 489 Building. The Direct-Ester process produced esters of 2,4,5-T, Silvex, and 2,4-D. Industrial hygiene sampling was conducted in the Direct-Ester process area and in formulation areas and data was available for the years 1977, 1978 and 1979. Area air samples were collected and analyzed for 2-butoxyethanol (glycol ether EP), 1-isobutyoxy-2-propanol (glycol ether PIC), 2,4-dichlorophenol (2,4-DCP), 2,4-D acid, trichlorophenols (TCPs) 2,4,5-T esters, carbon monoxide (CO) and methyl-chlorophenoxy-acetic acid (MCPA) and summarized in Table 45. Breathing zone air samples were collected and analyzed for Silvex and total dusts and the results are summarized in Table 46. Personal samples were collected and analyzed for gly ether EB, 2,4-DCP, 2,4-D acid, TCPs, 2,4,5-T ester, CO, and MCPA and are summarized in Table 47.

Airborne EB, PIB, and isooctanol vapors were collected on silica gel at an airflow rate of 0.1 pm, then desorbed and analyzed using GC-ECD methods. Airborne 24-DCP, 24-D acid and TCPs were collected with both activated alumina adsorber tubes and midget impingers containing caustic solution at air flow rates of 0.1 lpm for the tubes and 0.5 lpm for the impingers. Both the alumina tubes and the impinger solution were analyzed using GC-ECD. Airborne 2,4,5-T ester samples were collected using midget impingers containing isooctane at an airflow rate of 0.30 lpm. The analyses were done using GC-ECD techniques. CO air concentrations were measured using long-term detector tubes. Airborne MCPA was collected on membrane filters at an airflow rate of 3 lpm. Gravimetric analyses were conducted on the filter and the results reported as MCPA.

A comprehensive survey of the workers' exposures to airborne contaminants in 489 Building was conducted from October 1977 through March 1979. The results of the area air samples are summarized in Table 45. Only 20 of 122 chemical analyses conducted on area air samples collected throughout 489 Building had non-detectable results. All 20 area air samples collected in the Direct-Ester process areas and analyzed for 2,4,5-T ester had detectable results, ranging from 0.001 to 10.0 mg/M^3. Table 46 lists the result of a breathing zone sample for an operator loading wet Silvex into an esterifier, which was 2 mg/m^3 of Silvex. The personal air sample results are summarized in Table 47. Of the 27 chemical analyses conducted on personal air samples collected from workers in 489 Building only 6 had non-detectable results. Eight personal samples were collected for the Direct Ester Operators and analyzed for 2,4,5-T ester. Six of eight personal samples collected had non-detectable results (LOD=<0.3 mg/m^3) with the two detectable sample results being 1.0 mg/m^3.

Surface wipe samples also were collected in the direct-ester process and 2,4,5-T ester purification areas of 489 Building. These sample results are summarized in Table 48. In 1977, nine surface wipe samples were collected in the 2,4,5-T ester purification area following the removal of spent carbon from the activated-charcoal filtration column. All nine samples had non-detectable results (LOD=0.1 ug/wipe). Five surface wipe samples were collected in the direct-ester process area in 1979. The five wipe samples were analyzed for 2,4-DCP, HxCDD, HpCDD, and OCDD. No detectable levels of HxCDD, HpCDD, or OCDD were found in these samples. Two of the five 2,4-DCP measurements had detectable levels, 6 and 46 ug/wipe.

F) <u>338 and 840 Buildings</u>

Ronnel was synthesized in 338 Building from 1958 to 1972 and in 840 Building from 1973 to 1977. Area air samples were collected in 338 Building in 1966. These samples were grab samples where air was collected in a small bag from various areas of the ronnel process. The air in the bags was analyzed for methylene chloride (MC), a raw material used in ronnel production, using infrared analysis. These results are summarized in Table 49. Detectable sample results for MC measurements throughout 338 Building ranged from 2 to 4300 ppm.

Surface wipe samples were collected in the ronnel process area in 338 Building in 1971. These surface wipe samples were collected in the same manner as were the dioxin surface wipe samples, but were analyzed for ronnel using GC-ECD analytical methods. The summarization of the surface wipe samples results are listed in Table 50. A total of 36 wipe samples was collected with all samples having detectable results ranging from 12 to 26,000 ug/wipe.

Industrial hygiene sampling data was not available for the ronnel process in 840 Building. When the ronnel process was moved to 840 Building, its operation was very sporadic.

G) 441 Building

Erbon was synthesized in 441 Building from 1955 to 1974. Industrial hygiene sampling data was not available for the Erbon process in this building.

H) 265 Building

Dowicide® products were produced, finished, and packaged in 265 Building. Dowicide® products relevant to the Dioxin Registry are 2,4,5-TCP, NaTCP, PCP, NaPCP, 2,4,6-TCP, and TetCP. The industrial hygiene sampling data for 265 Building is summarized into Tables 51, 52, 53, and 54.

Table 51 summarizes all area air samples collected in 265 Building, and in 265/349 Building after 1972. Area air samples in Table 51 date from 1949 through 1980. Breathing zone samples collected in 265 Building are summarized in Table 52 and contain data from 1949 to 1966. Personal air samples collected in 265 and 265/349 Buildings are summarized in Table 53 and date from 1972 through 1980. Surface wipe samples collected in 265 and 265/349 Building are summarized in Table 54 and contain data from 1965 through 1980. Table 55 contains analytical chloracnegenic data for products produced in 265 Building and date from 1964 through 1968.

The first air samples collected in 265 Building were for TetCP, NaPCP, PCP, OPP, and NaOPP in 1949 and 1950. The samples were collected using a large impinger containing caustic at an airflow rate of one cubic foot per minute (cfm). The analyses were carried out using UV spectrophotometry. By 1950, a departmental policy was implemented requiring the workers to wear eye protection and rubber gloves when collecting chlorinated phenol samples from the chlorinators. The procedure for collecting these samples involved draining the sample from the chlorinator to a small cup which was attached to the end of a piece of chain. The practice of allowing the sample cup to swing at the end of the chain while carrying it resulted in the contamination of the workers shoes, pant legs, and the floor. A 1967 industrial hygiene report summarized the industrial hygiene activity from late 1964 through 1967. Dust samples collected during this time were collected on glass fiber filters at an airflow rate of 7 cfm. The samples were then weighed, extracted with a solvent and then either tested on rabbit ears or analyzed for (2,4,6-TCP and/or 2,3,5-TCP,) 2,4,5-TCP, OPP, TetCP and NaPCP using VPC. In addition to the dust samples collected on filters, some dust samples were also collected using electrostatic precipitation. For 1965, 19 of these filter samples were tested on rabbit ears and are listed in Table 51. Fifteen of the 19 samples tested produced no folliculitis response. Three of four positive responses showed very slight folliculitis. One sample produced severe folliculitis. This sample was collected in the packaging area near the fluid bed dryer scrubber.

On March 23, 1966, proceedings of the Biochem-Medical-Safety conference held by Dow researchers detailed chloracne problems in 265 Building. 28 of the 34 workers from 265 Building had skin examinations. Of that 28, 7 had no problems, 15 had slight chloracne and 6 had moderate to severe chloracne. Dow also stated during these proceedings that chloracne had existed in 265 Building for over 30 years.

An interim summary of environmental conditions in the 265 Building dated July 2, 1971 indicated that quarterly surface wipe sampling had begun by 1969. A new type of bagging system for PCP prills was installed which reduced dust levels in the air. Clean clothing, the washing of skin after specific contamination, the use of protective gloves, and daily showers all continued to be necessary at that time. This was especially the case in the last 6-9 months because of a large influx of new workers.

The chloracne problems continued in 265 Building throughout the 1960s. Much data had been gathered from 265 Building and much work had been carried out to decrease the exposure to chloroacnegens. Despite all this effort, the incidence of chloracne had not decreased to any large extent. In order to make some headway against this problem Dow management had an industrial hygienist assigned to 265 Building on an 8-hour per day, continuous basis from April 1971 through January 1972. As a result of this extended residence, an extensive industrial hygiene report was generated. Area and breathing zone air samples were collected. Time distributions for areas and tasks were determined for each job classification. Combining area air and breathing zone sample results with the time distributions, eight hour TWA values were estimated for the various job classifications in 265 Building. The area air samples were collected using midget impingers containing isooctane at an air flow rate of approximately 0.5 lpm. The isooctane was acidified to convert the sodium salts to their respective phenols and the solution was analyzed using GLC-ECD for 2,4,5-TCP, 2,4,6-TCP, TetCP and PCP.

Thirteen job classification exposures to 2,4,5-TCP, 2,4,6-TCP, PCP, and TetCP were estimated. These estimates are included in Table 53. For all job classification the range of 2,4,5-TCP estimated exposure was 0.002 (Master Clerk) to 0.172 (Miller-Flaker Operator) mg/M^3. Similarly for PCP, the range was 0.006 (Master Clerk) to 0.109 (PCP Blender - Flaker Operator) mg/M^3.

The next major Dow report on the environmental conditions in 265 and 349 Buildings was a "Summary of Industrial Hygiene Activities at 265 and 349 Buildings from December 1975 to December 1978". Personal and area air samples were collected for phenol and mono-, di-, tri-, tetra-, and penta- isomers of chlorophenol. Area air samples were also collected for TCDD, HxCDD, OCDD, HxCDF and OCDF. Surface wipe samples were collected throughout 265 and 349 Buildings and analyzed for TCDD, HxCDD, HpCDD, OCDD, HxCDF and OCDF. Airborne phenol and chlorinated phenol vapors were collected on silica gel adsorbent tubes at an airflow rate of 0.10 lpm. The adsorbent was desorbed with a known quantity of solvent and analyzed for O- and p- isomers of chlorophenol, the 2,4- and 2,6- isomers of DCP, PCP, phenol, TetCP and the 2,4,5- and 2,4,6-isomers of TCP using GC-FID. Airborne particulate were collected on membrane filters at an airflow rate of one lpm. The filters were analyzed gravimetrically for total dust and selected filters were also analyzed for PCP and TetCP by GC-FID. Area air samples for TCDD, HxCDD, OCDD, HxCDF and OCDF were collected with three types of sample media: membrane filter, XAD-2 resin solid adsorbent and midget impingers containing n-decane. These samples were analyzed using GC-MS. Surface wipe samples were collected by wiping approximately 100 square centimeters of surface with a dry filter paper (Whatman #2, 5.5 cm) with as much pressure as could be applied without tearing the paper. The contaminants from these samples were extracted into known quantities of solvent and determined by GC-ECD and quantitated by GC-MS.

In 1976, six area air samples were collected in 265/349 Building and analyzed for HxCDD, as shown in Table 51. All six air samples had non-detectable results at a detection limit of 0.2 ug/M^3. Surface wipe samples also were collected in 265/349 Building and analyzed for HxCDD for the years 1976, 1977, and 1978. Table 54 lists these results. In 1976, 93 of the 133 surface wipe samples collected and analyzed for HxCDD were non-detectable at a range of detection limits between 0.1 to 0.8 ug/wipe. Detectable HxCDD wipe samples ranged from 0.1 to 5.5 ug/wipe. Similarly in 1977, 132 of the 196 HxCDD surface wipe samples were non-detectable (LOD=0.1 ug/wipe) and the detectables ranged from 0.1 to 9.0 ug/wipe. The HxCDD wipe sample results in 1978 were 129 of 170 non-detectable (LOD=0.1ug/wipe) and detectables ranging from 0.1 to 7.1 ug/wipe.

A report was generated in 1978 for 265 and 349 Buildings entitled the "Evaluation of Employees' Exposures to Airborne Concentrations of Several Chlorodibenzo-p-dixoins, PCP, TetCP and HCB in 265 and 349 Buildings". Personal and area air samples were collected on membrane filters at an airflow of 2 lpm and analyzed for HxCDD, HpCDD and OCDD by GC-EC and quantitated by GC-MS. Both personal and area air samples were collected for PCP, TetCP and HCB using silica gel adsorption tubes at an air flow rate of 0.1 lpm. The tubes were desorbed with a known quantity of solvent, methylated and analyzed by GC-ECD. Ninety-two area air samples were collected and analyzed for HxCDD in 1978 and are listed in Table 51. Seventy-six of the 92 HxCDD air sample results were non-detectable at a detection limit of 0.03 ug/M^3. The detectable HxCDD air sample results ranged from 0.06 to 6.8 ug/M^3. Five personal samples were collected and analyzed for HxCDD in 1978. All five sample results in Table 54, were non-detectable at a detection limit of 0.03 ug/M^3.

A final report on exposure conditions for 265 and 349 Buildings was "A Comprehensive Evaluation of Employees' Exposures to Contaminants at 349 Building, March 1979 through December 1980." By this time, most of production operations were being conducted in 349 Building with 265 Building being used only as a warehouse. Workers' exposures to airborne concentrations of 2,4-DCP, TetCP, PCP, 2,4,5-TCP, HCB, HxCDD, HpCDD, OCDD, nonychlorophenoxyphenol (NCPP) and octachlorophenoxyphenol (OCPP) were measured. Area air samples were collected and analyzed for HCB, HxCDD, HpCDD and OCDD. 2,4-DCP, 2,4,5-TCP, TetCP, PCP and HCB were collected on silica gel adsorption tubes at an airflow rate of 0.1 lpm. The collected vapors were desorbed with a known quantity of solvent and determined by GC-ECD. HxCDD, HpCDD and OCDD were collected on membrane filters at an airflow rate of 2.0 lpm. The collected contaminants were extracted with a known quantity of solvent and analyzed using GC-ECD and quantitated using GC-MS. Surface wipe samples for HxCDD, HpCDD, OCDD and HCB contaminants were collected as previously discussed and analyzed in the same manner as the area air sample for dioxins.

Seventy-six area air samples were collected for HxCDD in 265/349 in 1979 and 1980 and are listed in Table 51. Fifty-nine of the 76 area air samples analyzed for HxCDD were non-detectable with the limit of detection of 0.001 ug/M^3. The detectable HxCDD results ranged from 0.001 to 0.035 ug/M^3. Forty-six personal air samples in eleven job classifications were collected and analyzed for HxCDD and are listed in Table 54. Twenty-six of the 46 personal HxCDD air sample results were non-detectable at a limit of detection of 0.001 ug/M^3. The detectable results ranged from 0.001 to 0.058 ug/M^3. A total of 305 surface wipe samples were collected and analyzed for HxCDD for this time period. These results are included in Table 55. Of these, 246 yielded non-detectable results for HxCDD with the range of the limit of detection between 0.01 to 0.2 ug/wipe. The detectable HxCDD surface wipe sample results ranged from 0.03 to 8.4 ug/wipe.

I) <u>466 Building</u>

Pentachlorophenol production in 466 Building supplemented that which was produced in 265 Building. No industrial hygiene data relevant to PCP production was available for 466 Building.

Potential Exposures and Controls Used

Various methods were employed by Dow Chemical to reduce employee exposures to 2,4,5-TCP, 2,4,5-TCP derivatives, PCP, and PCP derivatives. In response to the chloracne problem in 199 Building, several changes were made during 1964-1965. They included: the replacement of all connections in the piping and equipment with welded joints, to eliminate the seepage of materials out of the process; the required use of gloves and protective clothing, and respirators as needed; the institution of better work practices and of personal hygiene procedures; the institution of a medical surveillance program; and, a program of regular cleanliness tests (surface wipe tests for acnegen testing and dioxin measurements). Similar changes also occurred in 265 Building (process for Dowicide®) in 1965-1966.

Engineering control measures also were employed on the 2,4,5-T acid processes and the Dowicide® product processes to reduce exposure potential. The packaging area in 267 Building had local exhaust ventilation to limit workers' inhalation exposures to airborne 2,4,5-T acid and Silvex dust. The exhaust air from the ventilation system was filtered to remove dust, and was recirculated. The flakers used in the Dowicide® product process also had local exhaust ventilation. These control measures were used to limit employees' inhalation exposures to 2,4,5-TCP, NaTCP, PCP, and NaPCP dusts in 265 Building and later in 349 Building. Additionally, vacuum systems were employed, rather than sweeping to collect the dust and debris in the finishing and package area of these processes.

Conclusions

All workers who can be shown by company records to have worked in one or more processes listed in Table 1 were considered suitable for inclusion in the Dioxin Registry. Based on the extensive analytical data (Tables 16 through 24) it can be seen that TCDD was found in 2,4,5-TCP and 2,4,5-TCP derivatives and HxCDD was found in PCP and PCP derivatives. Area and personal air samples (Tables 28 through 56) show that workers involved in these processes were exposed to the raw materials, intermediates, products, and more than likely waste materials. In 265 Building, area and personal air samples showed those workers were also exposed to HxCDD, HpCDD, and OCDD. Surface wipe samples, while difficult to fully relate to personal exposure, illustrated that a potential existed for skin exposure to TCDD, HxCDD, HpCDD, and OCDD in these workers. In addition, the presence of chloracne in workers in 199 Building and 265 Building indicates that substantial exposure to chloracnegens (TCDD and/or HxCDD) occurred. Based on process descriptions, analytical analyses of products, process streams, and wastes for polychlorinated dibenzo-p-dioxins, job descriptions, and industrial hygiene data and information, it will be possible to construct an exposure matrix to estimate potential exposure to dioxins for the workers from Dow included in the Dioxin Registry.

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APPENDIX A

Dow Building Layouts
Figures 1 through 10
and
Tables 1 through 3

The Dow Chemical Company
Midland, Michigan

Figure 1

199 Building Layout
1946 - 1966
The Dow Chemical Company
Midland, Michigan

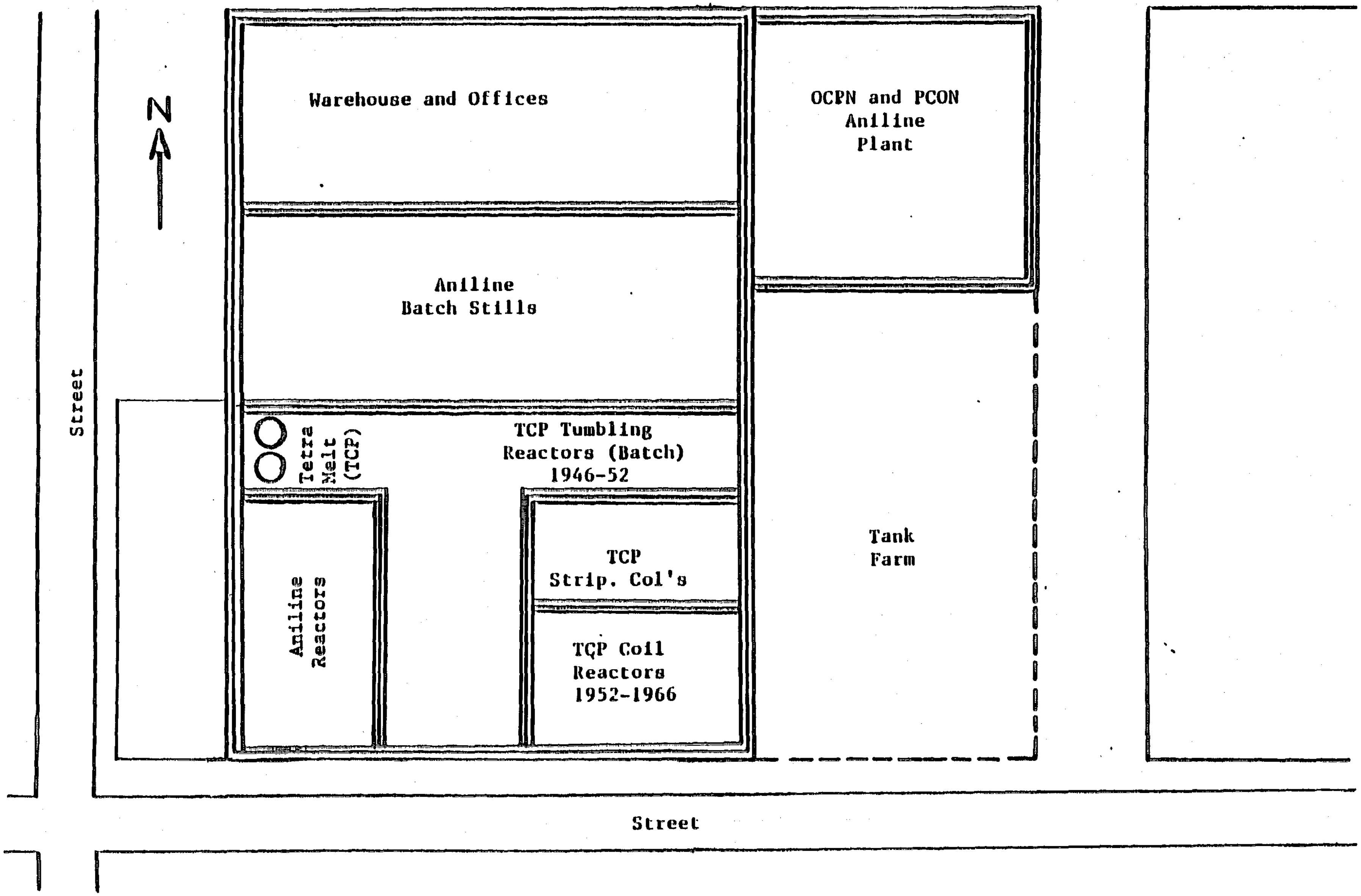


Figure 2

349 Building Layout
Dowicides Manufacture
1946-1980
The Dow Chemical Company
Midland, Michigan

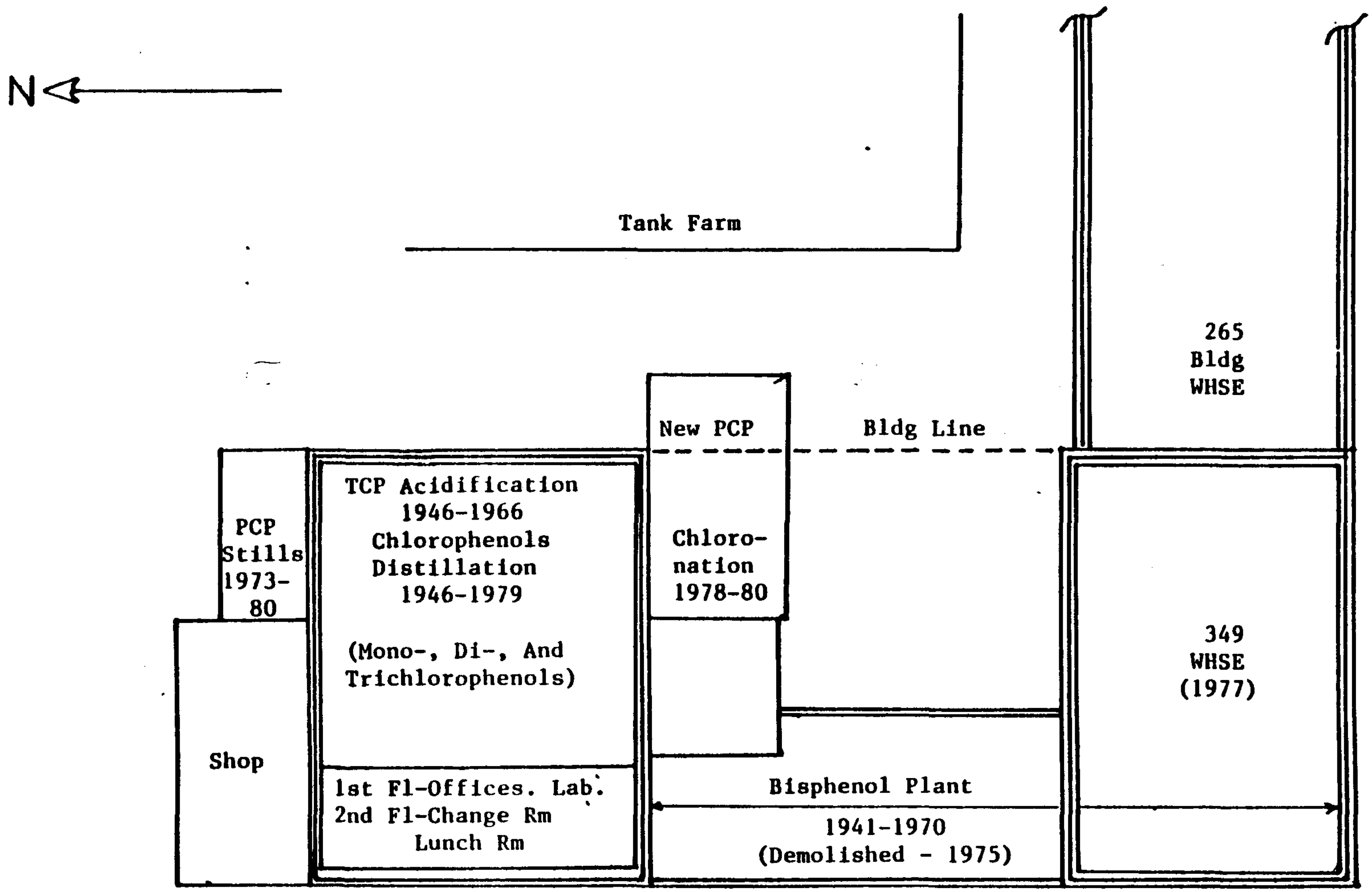


Figure 3

804 Building
2,4,5-Trichlorophenol Plant Layout
1966-1979
The Dow Chemical Company
Midland, Michigan

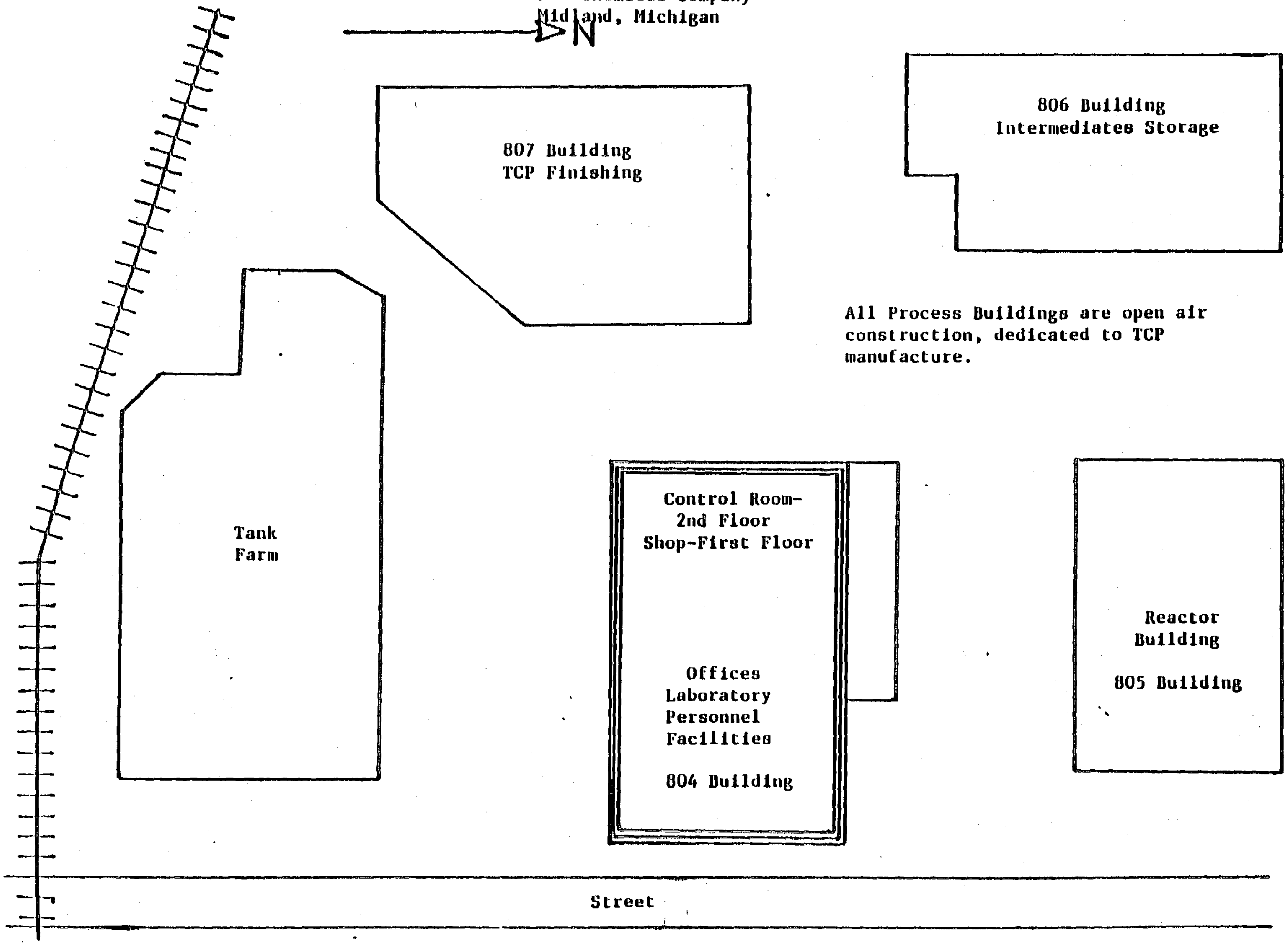


Figure 4
267 Building, Organic Semi Plant Layout, 1946-1973
The Dow Chemical Company
Midland, Michigan

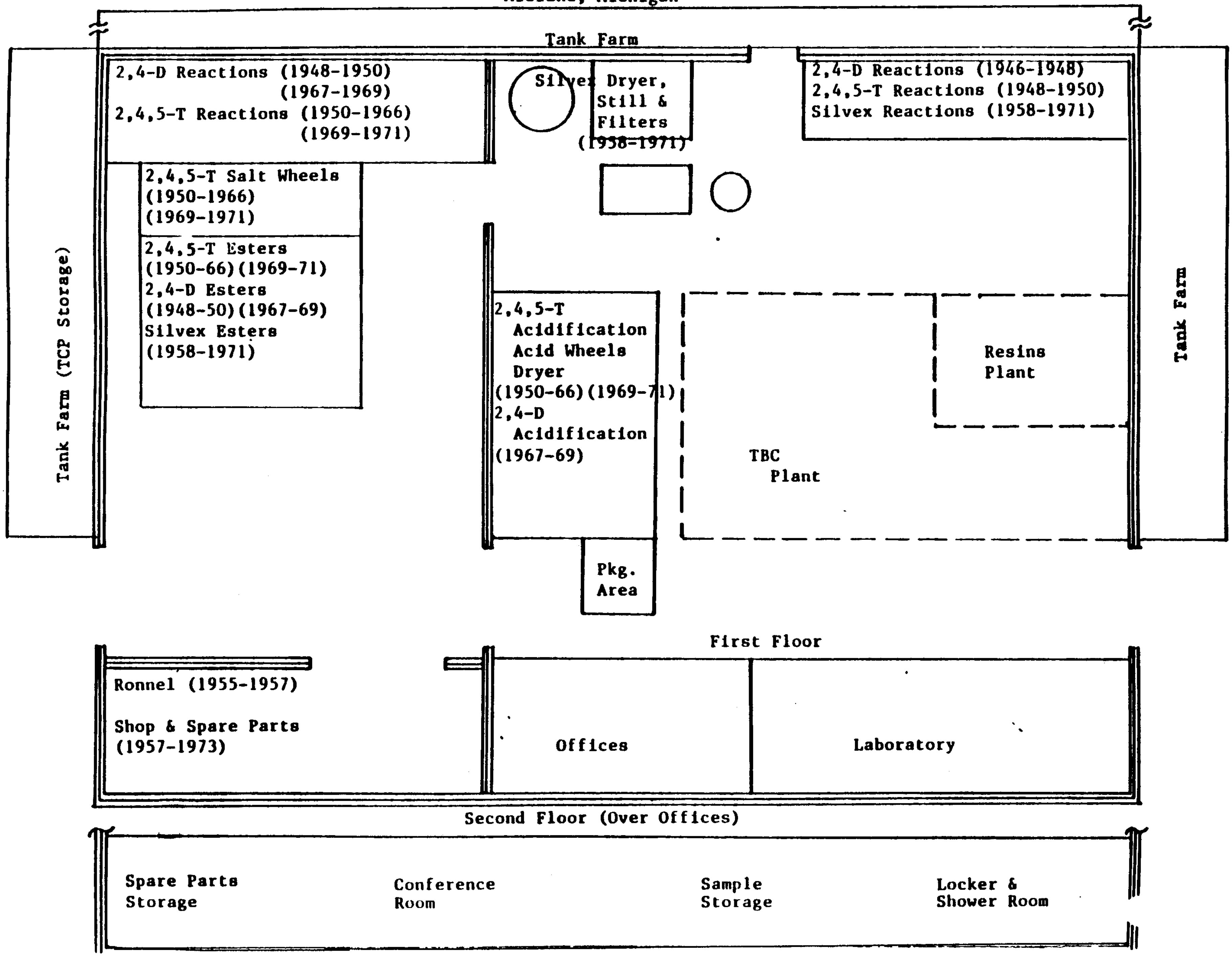


Figure 5
489 Building Layout, 2,4-D Plant Layout, 1950-1983
The Dow Chemical Company
Midland, Michigan

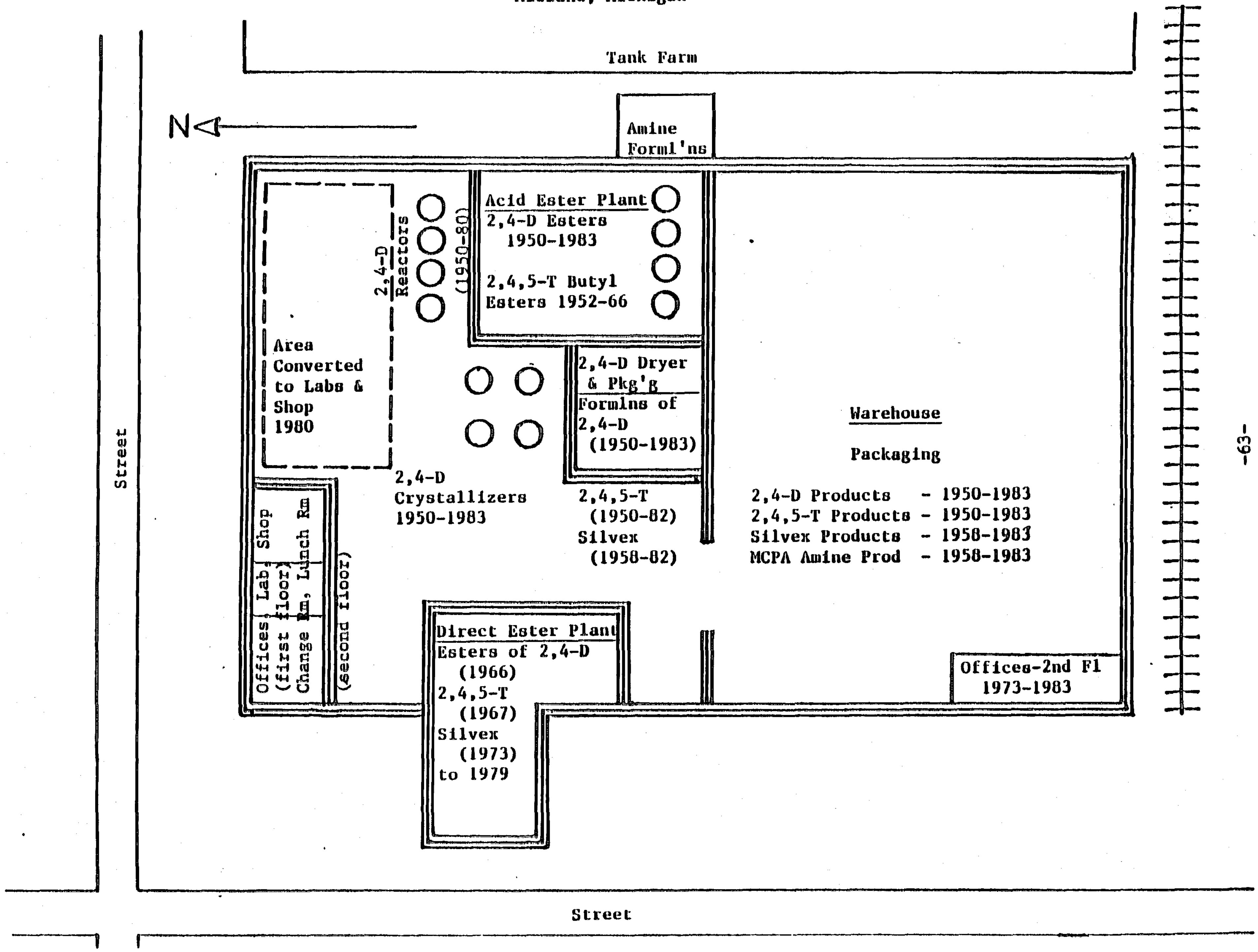


Figure 6

338 Building Layout (Ronnel)
1957-1972 (Demolished)
The Dow Chemical Company
Midland, Michigan

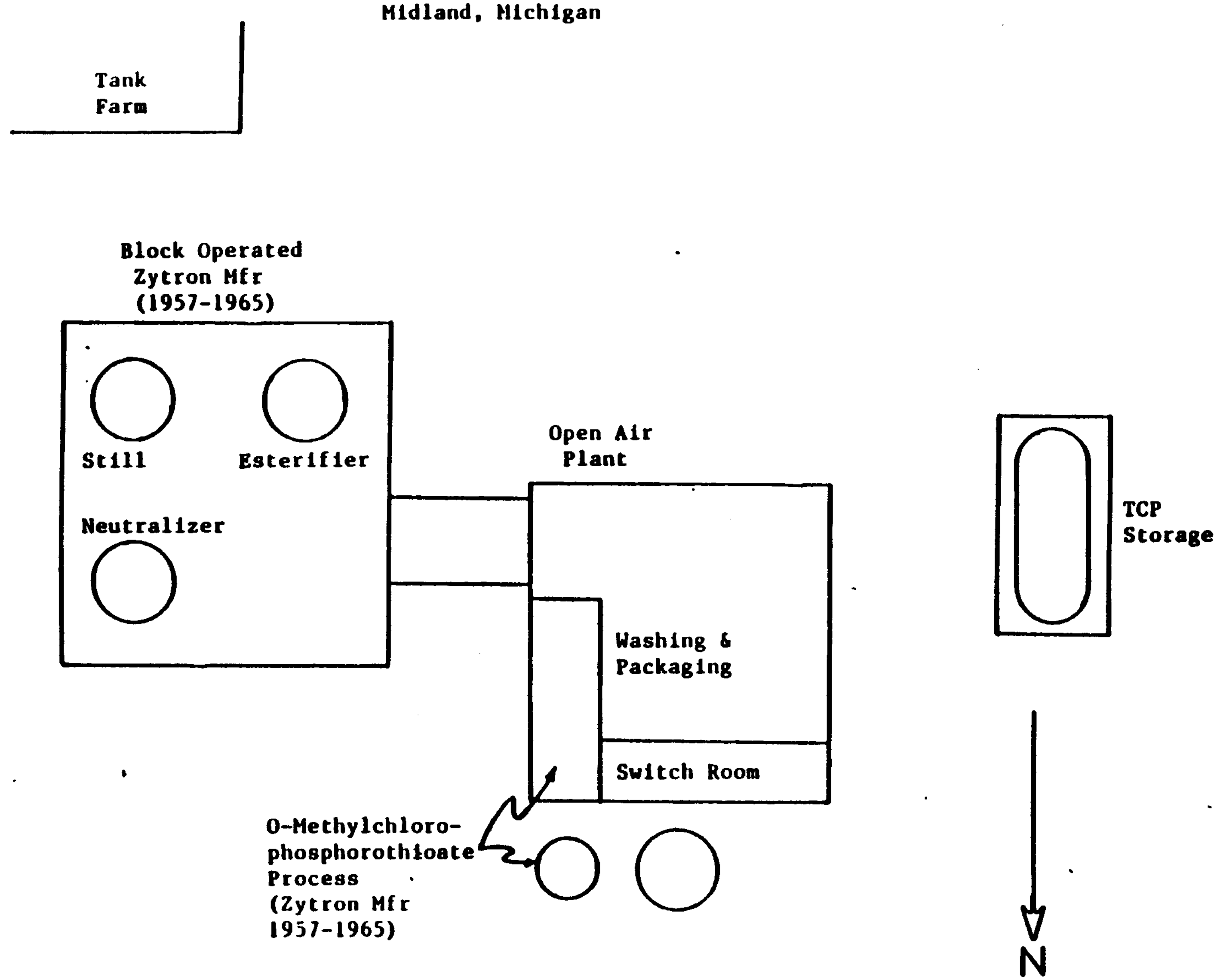


Figure 7

840 Building Layout (Ronnel)
1973-1977
The Dow Chemical Company
Midland, Michigan

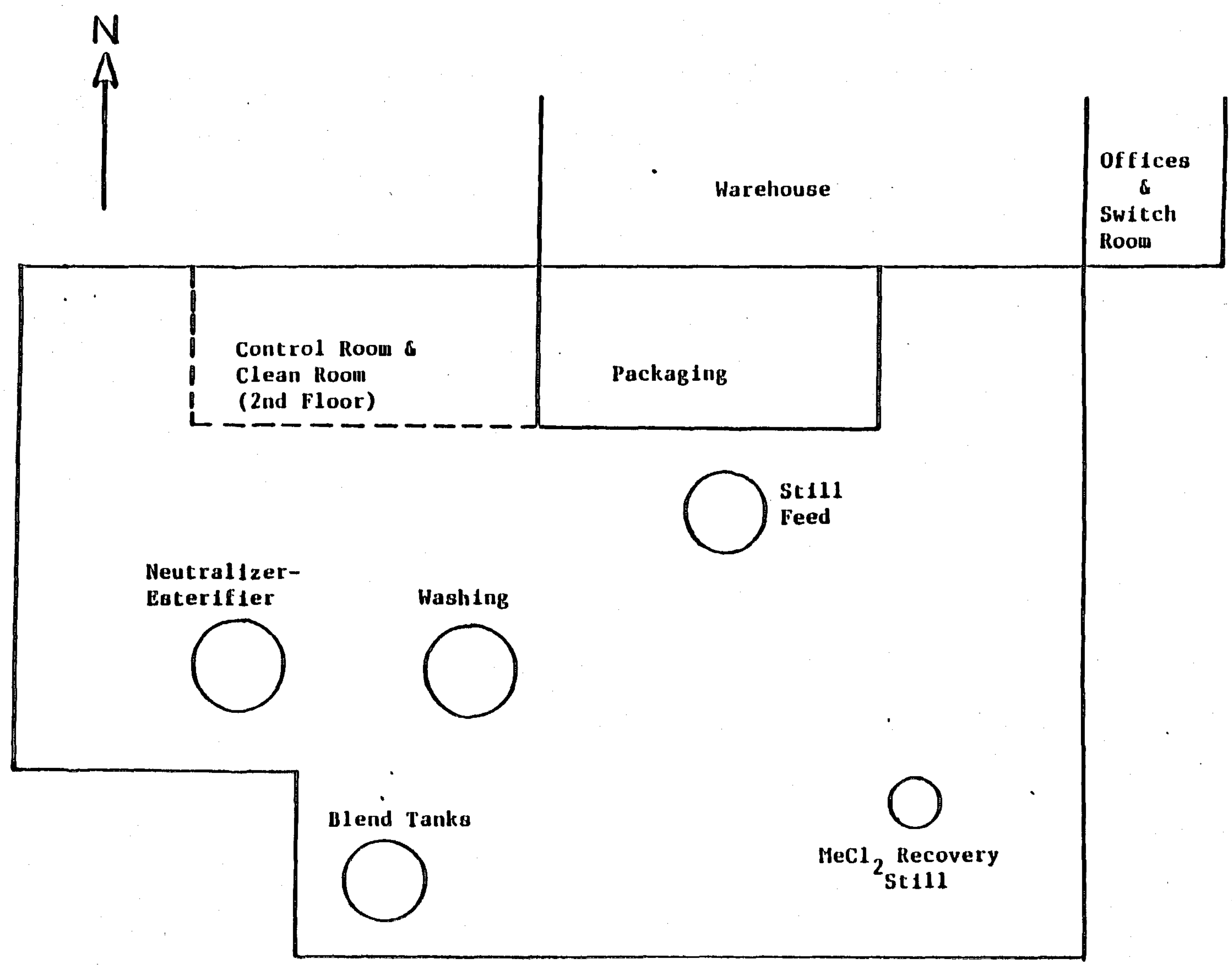


Figure 8
441 Building Layout (Erbon)
1955-1974
The Dow Chemical Company
Midland, Michigan

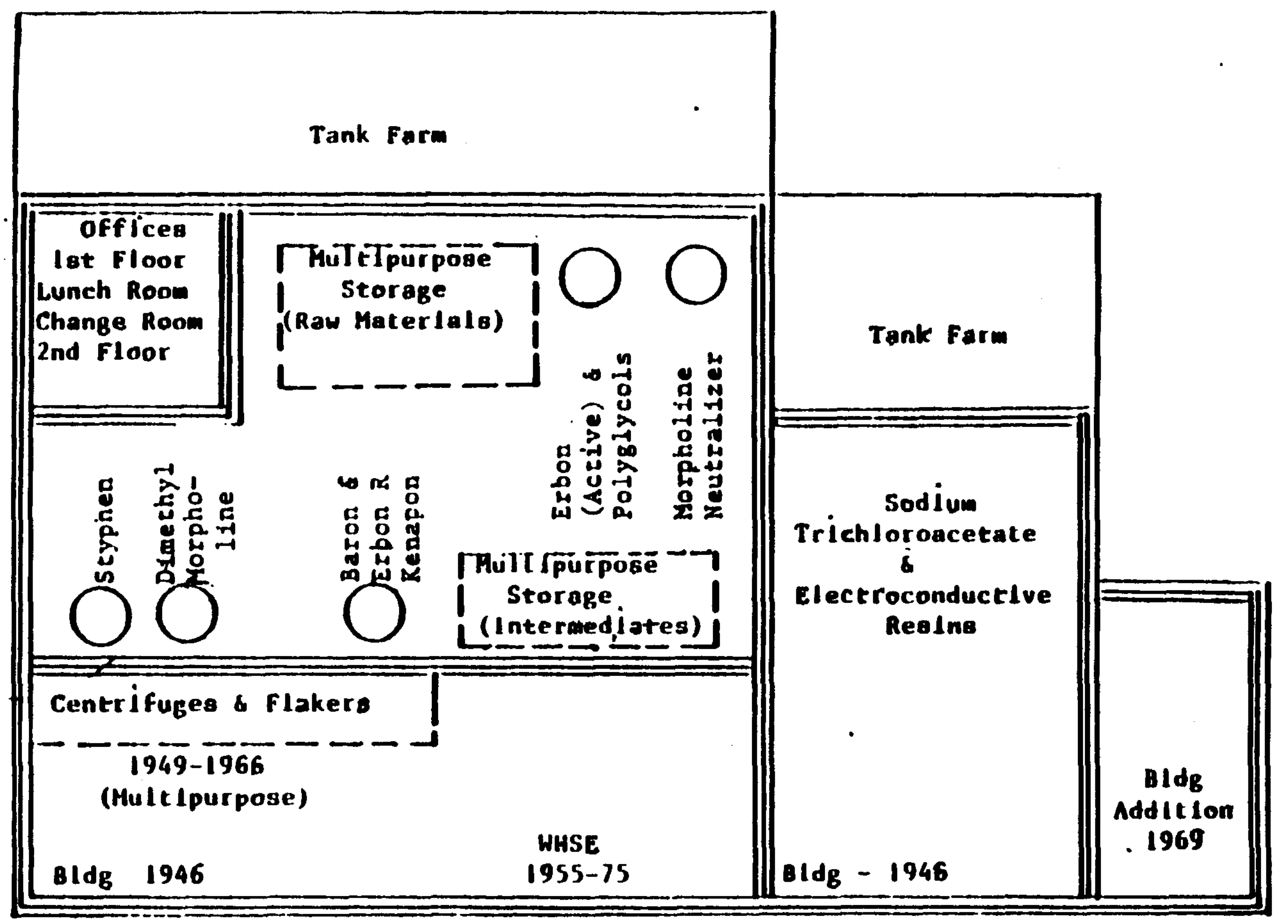
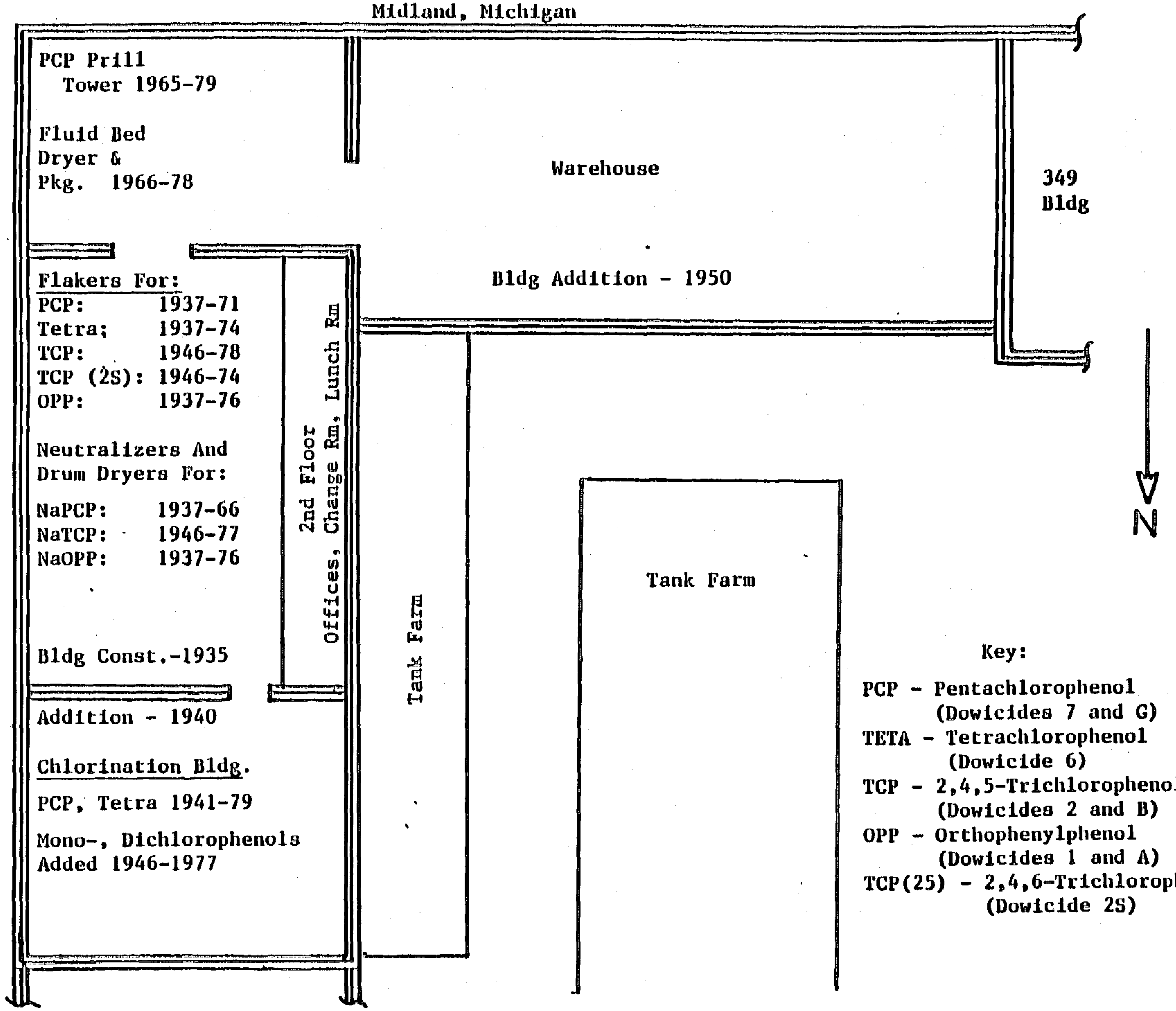


Figure 9

265 Building Layout, Dowicides Plant
1935-1982 (Demolished)
The Dow Chemical Company
Midland, Michigan

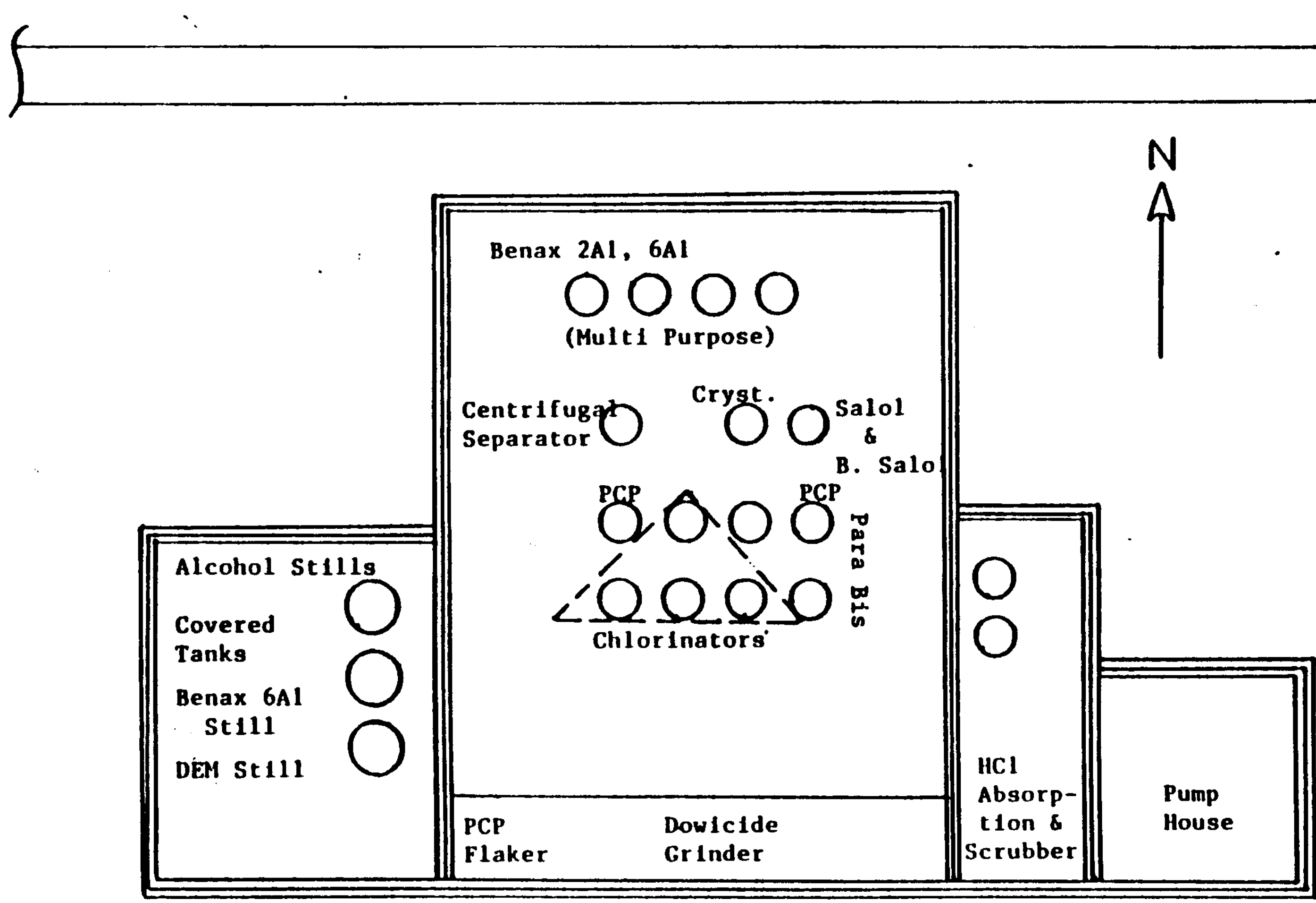


Key:

PCP - Pentachlorophenol (Dowicides 7 and G)
TETA - Tetrachlorophenol (Dowicide 6)
TCP - 2,4,5-Trichlorophenol (Dowicides 2 and B)
OPP - Orthophenylphenol (Dowicides 1 and A)
TCP(25) - 2,4,6-Trichlorophenol (Dowicide 2S)

Figure 10

466 Building (Pentachlorophenol)
Multiproduct Plant Layout
1950-1973 (Demolished)
The Dow Chemical Company
Midland, Michigan



<u>Chemicals Mfd in 466 Bldg.</u>

PCP - 1950 to 1966

Salol & Butyl Salol

Diethylmalonate

Cyanacetic Acid

Zn Trichlorophenol (Dowicide 9) 1950-

Tetrachlorobenzene

Benax 2Al, @AO, 6Al

Chloromethyl Diphenyloxide

ET-395 (CMDPO Blend)

Coumarin

P-77 Plasticizer

Bleach

Polyhydric Aromatics

Chloromethyl Ether

Table 1

Buildings, Dates, Products and Organizational Lists
for the Processes Relevant to the Dioxin Registry
The Dow Chemical Company
Midland, Michigan

Building	Organization Units of Buildings and Their Dates (Relevant to Study Only)		Process	Products and Their Dates of Production	
199A	OCPN/PEA	1942-1945	Development NaTCP	NaTCP	1942-Mar 1946
199	Aniline	April 1946 - Fall 1966	Old NaTCP, Batch	NaTCP	April 1946 - 195[illegible]
			Old NaTCP, Continuous	NaTCP	1952 - Fall 1966
804 (Complex)	Trichlorophenol	June 1966-February 1979	New TCP	TCP	June 1966 - Feb
489	2,4-D Production	1950 - 1983	Acid Ester	Butyl Ester of 2,4,5-T	1952 - 1966
			Direct Ester	All	
				Esters of 2,4,5-T*	3Q 1967-Feb 1979
				All Silvex Esters*	1972-Nov 1978
				All Esters of 2,4-D	3Q 1966 - Feb 197
			Amine Formulation	Amines of 2,4-D*	1950-1983
				Amines of 2,4,5-T*	1950-1983
				Amines of MCPA**	1958-1983
			Ester Formulation	All 2,4,5-T Ester Formulations	1950-1982***
				All Silvex Ester Formulations	1958-1982***
				All 2,4-D Ester Formulations	1950-1983
				MCPA Ester Formulations	1983
			Acid-Ester(D/Butyl T)	N-Butyl Ester of 2,4,5-T*	1952 - April 1967
				All Esters of 2,4-D*	1950 - 1983
			2,4-D Acid	2,4-D Acid	1950 - 1980

* Usually produced "D" products
** Intermittent operation
*** Operated regularly only to 2 Quarter 1979, then intermittently

Table 1 (continued)

Buildings, Dates, Products and Organizational Lists
for the Processes Relevant to the Dioxin Registry
The Dow Chemical Company
Midland, Michigan

Building	Organization Units of Buildings and Their Dates (Relevant to Study Only)		Process	Products and Their Dates of Production	
338	Chemical Products Develop Dept	1957 - 1963	Ronnel	Ronnel	1957 - Feb 1970
	Korlan^R-Zytron^R	Jan 1963 - Feb 1963			Apr 1971 - Mar 1972
	Ronnel-Zytron^R	Feb 1963 - Feb 1970			
	Cyclic Products	Mar 1970 - Mar 1972			
840	Animal Health	May 1973 - Sept 1974	Ronnel	Ronnel	Mar 1973 - Dec 1977
	Dursban^R/Ronnel	Sept 1974 - Dec 1977			
265	Dowicide^R	1937 - 1978	Dowicide^R 2	Dowicide^R 2 (Flaked TCP)	1946 - 1978
			Dowicide^R B	Dowicide^R B (Crystalline NaTCP)	1946 - 1977
265	Dowicide^R	1937 - 1978	PCP Finishing	Pentachlorophenol	1935 - 1978
			PCP Productionn	Pentachlorophenol (Dowicide^R 7)	1941 - 1978
				Sodium Pentachlorophenate (Dowicide^R G)	1941 - 1976
349	Bisphenol	1946 - 1965	Old TCP Acidification	TCP (Unpurified)	Apr 1946 - Fall 196
	Chlorophenol	1965 - 1972	TCP Distillation	TCP (Purified)	Apr 1946 - Fall 196
				Hi-Purity TCP	1966 - 1979
	Dowicide^R	1972 - 1978	PCP Distillation	Pentachlorophenol	1973 - 1980
	Pentachlorophenol	Aug-1978 - Dec 1980	PCP Production	Pentachlorophenol (Dowicide^R EC-7)	1978 - 1980

Table 1 (continued)

Buildings, Dates, Products and Organizational Lists
for the Processes Relevant to the Dioxin Registry
The Dow Chemical Company
Midland, Michigan

Building	Organization Units of Buildings and Their Dates (Relevant to Study Only)		Process	Products and Their Dates of Production	
441	Emco Ester NaTCA & Baron Plt Dow ECR Plt	1955 - 1957 1957 - 1970 1970 - Dec 1974	Erbon	Erbon and Erbon Formulation	Jan 1955 - Dec 1974
466	Pentachlorophenol Benax	1947 - 1963 1963 - Apr 1966	Pentachlorophenol Chlorination	Crude PCP**	Nov 1950 - Apr 1966
			Flaked PCP	Flaked PCP	1947 - Apr 1966
			Crystalline NaPCP	Crystalline NaPCP	1947 - Apr 1966
			Zinc Trichlorophenate	Zinc Trichlorophenate	1951 - 1958
206	Dowicides	1935 - 1941	Tetra/Pentachlorophenol (Developmental)	Tetra/Pentachlorophenol Sodium Pentachlorophenate	Jan 1935 - Dec 1941
649			Erbon	Erbon	Jan 1965 - Dec 1974

Table 1 (continued)

Buildings, Dates, Products and Organizational Lists
for the Processes Relevant to the Dioxin Registry
The Dow Chemical Company
Midland, Michigan

Building	Organization Units of Buildings and Their Dates (Relevant to Study Only)		Process	Products and Their Dates of Production	
267	Organic Semi Plant	1948 - 1957	2,4-D Acid	2,4-D Acid	1948 - 1950
	Chemical Production	Jan 1957 - 1963			Q 1967 - 2Q 1969
	Organic Chemical Products		1963 - 1968		
	Cyclic Products	1968 - 1971	2,4,5-T Acid (Pilot)	2,4,5-T Acid	1948 - 1950
			2,4,5-T Acid	2,4,5-T Acid	Mar 1950 - Apr 1967 Oct 1969 - May 1971
			Silvex Acid	Silvex Acid	1958 - May 1971
			Acid-Ester (T/Silvex/D)	All (Except N-Butyl)	
				Esters of 2,4,5-T	Mar 1950 - Apr 1967 4Q 1969 - 2Q 1971
				All Silvex Esters	1958 - 2Q 1971
				All Esters of 2,4-D	1948 - 1950 1Q 1967 - 2Q 1969
			Developmental Ronnel*		Ronnel*
1955 - Jan 1957					

* Usually produced "D" products

Table 1 - Symbol Codes

OCPN/PEA = ortho-chloro-para-aniline/phenethyl alcohol
Aniline = Benzeneamine
NaTCP = Sodium 2,4,5-trichlorophenate
TCP = 2,4,5-trichlorophenol
2,4-D = 2,4-dichlorophenoxyacetic acid
2,4,5-T = 2,4,5-trichlorophenoxyacetic acid
Silvex = 2-(2,4,5-trichlorophenoxy)propionic acid
MCPA = 2-methyl-4-chlorophenoxyacetic acid
Ronnel = 0,0-dimethyl 0-(2,4,5-trichlorophenol)ester of phosphorothioic acid
Dowicide® 2 = 2,4,5-trichlorophenol
Dowicide® B = Sodium 2,4,5-trichlorophenate
Dowicide® 7 = Dowicide® EC-7 = PCP = pentachlorophenol
Dowicide® G = NaPCP = Sodium pentachlorophenate
Erbon = 2,2-dichloropropanoic acid 2-(2,4,5-trichlorophenoxy)ethyl ester
Zinc Trichlorophenate = Dowicide® 9-B seed protectant = Zinc(II)Salt(2:1) trichlorophenol
Korlan® = Formulation containing ronnel
Zytron® = 0-methyl 0-(2,4-dichlorophenyl)ester of phosphorothoic acid
Dursban® = 0-0-diethyl 0-(3,5,6-trichloro-2-pyridinyl)ester of phosphorothioic acid
Baron® = Formulation containing Erbon

Table 2

2,4,5-T Production as a Percent of Time
267 Building
The Dow Chemical Company
Midland, Michigan

Year	% Running Time
1950	6
1951	2.4
1952	6
1953	1
1954	0
1955	2.5
1956	17
1957	2.1
1958	6
1959	19
1960	18
1961	9
1962	34
1963	44
1964	37
1965	22
1966	63
1967	13
1968	0
1969	Not available
1970	82
1971	34

Table 3

2,4,5-T Ester Production Direct-Ester Process,
as a Percent of Time
489 Building
The Dow Chemical Company
Midland, Michigan

Year	2,4,5-T Ester % Running Time
1967	Not available
1968	Not available
1969	Not available
1970	18
1971	41
1972	47
1973	36
1974	36
1975	27
1976	49
1977	46
1978	33
1979	14

APPENDIX B

Dow Job Titles and Descriptions
Tables 4 through 14

The Dow Chemical Company
Midland, Michigan

Table 4

Generic Job Title Descriptions Applicable Across
Organizational Units Through the Years
The Dow Chemical Company
Midland, Michigan

Job Titles	Description
Superintendent Superintendent, Plt. Supt.	In production areas, some were very active and were known to have exposures.
Professional/Technical Techn. Supv., Project Supv., Project Lead., Proc. Dev. Supv., Lab Project Ld., Group Leader, Engineer Prodn. Engr., Prod. Dev. Engr., Sr. Prodn. Engr., Dept. Maint. Engr., Sr. P. Dev. Engr., Res. Dev. Engr., Chem. Engineer, Prod. Chem. Engr., Chemist, Prod. Chemist, Organic Chemist, Paint Chemist, Biologist, Environmental Supervisor, Tech. Assist.	Occasionally in all production areas of a organizational unit.
Plant Supervisory Prodn. Supt., Prod. Supv., Semi-plant Supv., Prod. Pl. Supt., Warehouse Supervisor, Main. Supervisor, Sr. Prod. Supv., Assist. Supt., Assist. Pr. Pl. Sp., Assist. Plt. Supt., Pr. Plt. Assist. Sp., General Foreman	Trouble shooting activities in process areas throughout organizational unit--not routinely in process area.
Clerks Shipping Clerk, Mast. Ship. Clerk, Clerk, Assist. Ship. Clerk	Primarily handled clerical work and will be included only if additional information on exposure is provided.
Plant Maintenance Plt. Mech., Jrny. Mech., Repair Man, Plant Repair Mech. Draftsman, Plt. Mech. Crew Leader	Routine inplant maintenance throughout the unit.
Utility Man, Utility Man Cl. 1, Utility Man Cl. 2	Same as above except lower skill levels and less experience.

Table 4

Generic Job Title Descriptions Applicable Across
Organizational Units Through the Years
The Dow Chemical Company
Midland, Michigan

Job Titles	Description
First Line Supervision Foreman, Tech. Foreman, Operations Foreman, Shift Foreman, Head Operator Subforeman, Provsnl. Foreman, Crew Leader, Prv. Shift Foreman	Responsible for process operations, or portions of process operations, troubleshooting, about half-time in processing areas.
Multi-job Operating Crew Spare, Alternate	Fill-in operators. Could have been assigned to any of the operator classifications on a day-to-day basis or perform maintenance on a limited basis.
Analytical Anal. Tech. Cl. 1, Anal. Tech. Cl. 2, Lab. Assist., Sr. Lab. Tech., Lab. Tech., Lab. helper, Cl. 1 Test. Tech., Test. Tech. Cl. 2, Cl. 1 Spec. Test., Cl. 2 Spec. Test., Cl. 1 Spec. Anal., Cl. 2 Spec. Anal.	Performed lab analyses of samples from process streams, quality assurance; normally would not have collected sample. Some judgement will be necessary by organizational unit.
Janitors Janitors, Handyman, Jan.-Hdyman, Janitor-Handyman	Clean up, lunch rooms, etc., not generally in process area. Handyman may do some material handling.

Table 5

Early 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1942-1946
199 (199A) Building
The Dow Chemical Company
Midland, Michigan

Organizational Unit
OCPN/PEA (1942 - 1945)

A full-scale commercial production plant for manufacturing 2,4,5-trichlorophenol (TCP) was brought on-stream in April, 1946. Prior to that date (from about 1942 through 1945), low volume quantities of TCP were produced on a sporadic basis. From work history records and interviews with a former supervisor, an organization unit, OCPN/PEA (ortho-chloro-paranitroaniline/phenyl ethyl alcohol), was identified in connection with the early TCP operations. The organization unit was located in 172 and 199 Building, with the TCP process being in 199 Building. A trichloro operator was associated with the unit between 1942 and 1945. Annual January Census list for the years 1942 through 1946 have been used to identify employees and job classifications assigned to the unit for inclusion in the Dioxin Registry.

Job Title	Dates	Description
Supt.	1942 - 1946	Generic
Asst. Supt.	1942 - 1946	Generic
Chem. Engr.	1942	Generic
Chemist	1942 - 1943	Generic
Foreman	1945 - 1946	Generic
Sub-Forman	1942 - 1944	Generic
Lab. Helper	1942 - 1943	Located in 172 Building, worked on TCP analysis.
Plant Repair	1943	Generic
Plant Mech.	1946	Generic
Handyman	1944-1946	Generic

Table 5

Early 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1942-1946
199 (199A) Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Alternate Op.	1945-1946	Probably worked on TCP process.
Relief Op.	1942	Probably worked in 199A Building.
Class 2 Operator	1946	Possibly worked on TCP process.
Class 3 Operator	1944	Possibly worked on TCP process.
Asst. Operator	1943-1945	Worked on TCP and OCPN process (more on OCPN).
Oper. Helper	1942	Probably worked on TCP process.
Trichlor. Operator	1943-1945	Operated TCP process.
Janitor	1942-1946	Potentially exposed to TCP.

Table 6

Old 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1946-1966
199 Building
The Dow Chemical Company
Midland, Michigan

Organizational Unit
Aniline (April 1946-Fall 1966)

The organizational unit, aniline, contained TCP process. Date of 2,4,5-trichlorophenol (TCP) production April, 1946 through Fall 1966. The aniline and TCP operation were both in 199 Building in close proximity to one another.

Job Title	Dates	Description
Superintendent	1946-1966	Generic
Asst. Superintendent	1946-1966	Generic
Foreman	1953-1960	Generic
T. Foreman	1955	Generic (probably foreman for TCP Process)
Jrny. Mech.	1946-1951	Generic
Mech. Draftman	1951-1953	Generic (most time spent as plant mechanic)
Plant Mechanic	1946-1966	Generic
Utility Man.	1946	Generic
Sub-Foreman	1946-1953	Generic
Head Operator	1946-1966	Generic (time spent among all processes in dept.)
Alternate Operator	1946-1950 1958-1966	Generic
Alt Head Operator	1949-1958	Generic
Cl. 2 Alt. Op.	1948	Generic

Table 6

Old 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1946-1966
199 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Analyst Tech. Coor.	1954-1966	Generic (inventory work, performing aniline process analyses and small amount of TCP process analyses)
Cl. 2 Analyst Tech.	1950-1954	Generic (Performed lab analyses on mostly aniline and some TCP processes)
Cl. 1 Special Analyst.	1946-1949	Generic (Basically same as Cl. 2 Analyst Tech.)
Janitor-Handyman	1950-1954	Clean-up, janitor work and material handling.
Handyman	1946-1950, 1954	Generic (Clean-up and material handling)
Janitor	1946-1949 1954-1958	Generic (Clean-up and janitor work)
Recovery Operator	1946-1966	Primarily worked on aniline process in recovery operations, cleaned presses, treated tanks, etc.
Reactor Operator	1946-1966	Ran aniline reactors and TCP reactors, and support activities including unplugging of lines.
Press Filt. Op.	1949-1950	Moved materials, cleaned and changed filter in the aniline process.
Press Operator	1946-1948	Probably cleaned filter press used in aniline operations; little time spent in TCP process.
Reactor Press and Filter	1950	See reactor operator and press operator.

Table 6

Old 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1946-1966
199 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
TCP Mixer Operator	1955-1966	Primarily mixed caustic with methanol in the first step of the TCP process, performed material transfer and some sampling of process streams.
Top Mixer Operator	1953	Probably same as TCP mix operator, except would have worked on other processes also.
Mixer Operator	1946-1949	Job redefined to be press and filter operator (aniline process in proximity to TCP process).
Tri. Ch. Ph. Opr.	1946-1952	Ran TCP process; mixed starting materials; transferred to reactors; unloaded reactor; did some sampling of process streams; ran the Methocel® still.
Still Operator	1946-1966	Operated stills, ammonia towers and transferred material in the aniline process.
Catalyst Operator	1946-1949	Mixed catalysts in the aniline operations.
Operator Analyst	1950-1954 1956 1964-1966	Operations in aniline process and maintenance throughout the plant; sample analysis.
Transfer Man	1946-1950	Received aniline process raw materials.

Table 6

Old 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1946-1966
199 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Head Packer	1946-1950	Aniline process; loading.
Packer	1946-1949	Aniline process; loading.
Head Pack Tsfr.	1950-1960 1962-1966	Aniline process; loading.
Flaker Operator	1947-1954	Aniline process
Chlor & Greasing Operator	1948	Lubricated equipment in 199 Building
Phenol Recovery Oper.	1950	Primarily worked on aniline process in recovery operations, cleaned presses, treated tanks, etc.
Mixer man	1948	Job redefined to be press/filter operator-aniline process

Table 7

Chlorophenol Distillation Operation
Job Titles and Descriptions
1946-1972
349 Building
Dow Chemical Company
Midland, Michigan

Organizational Unit
Bisphenol 1946-1965
Chlorophenol 1965-1972
Dowicide® Still Operations 1972-1978
Pentachlorophenol Production 1978-1980

Sodium 2,4,5-trichlorophenate (NaTCP) was piped from 199 Building to 349 Building where neutralization with hydrochloric acid was carried out and where distillation removed other chlorophenols which were returned to the raw material streams for further chlorination. Additional removal of dioxin contamination would have also occurred beyond the steps carried out in 199 Building. Beginning in 1967, about one year after 804 Building came on stream, molten 2,4,5-trichlorophenol (TCP) rather than NaTCP was sent to 349 Building. TCP distilled at this time was known as hi-purity TCP. The hi-purity TCP product for use in ronnel production would have contained less residual chlorophenols. Other chlorophenol (mono-, di-, tri) were also finished in this area. Pentachlorophenol (PCP) was distilled in 349 Building after 1972. In addition, bisphenol was manufactured in a separate section of 349 Building (20-foot separation but with common lunchroom) and other processes may have existed in the building over the years (e.g., sodium sulfonates). At most, employees assigned to these other processes would have experienced intermittent low exposure to TCP and related products.

Bisphenol (1946 - 1965) (Maintenance 1965 - 1972)
(This organizational unit existed before 1946 and after 1965; TCP neutralization and distillation occurred between 1946 and 1965 in this unit; in 1965, the distillation operations were reorganized under the chlorophenol organizational unit.)

Job Title	Dates	Description
Superintendent	1947-1965	Generic
Assist. Pr. Pl. Sp.	1952	Generic
Assist. Supt.	1963-1965	Generic
Prod. Dev. Engr.	1965	Generic
Chemical Engineer	1947-1962	Generic
Chemist	1947-1963	Generic
General Foreman	1963-1965	Generic

Table 7

Chlorophenol Distillation Operation
Job Titles and Descriptions
1946-1972
349 Building
Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Foreman	1947-1965	Generic
Sub-Foreman	1947-1958	Generic
Crew Leader	1962-1965	Generic
Head Operator	1948-1965	Generic
Alternate	1956-1962 1967-1972	Generic
Utility Man Cl. 1	1952-1972	Generic
Utility Man Cl. 2	1959-1966	Generic
PA Tr. Stl. Oper.	1955-1965	Started-up and operated stills, sampled lines and performed analytical work for TCP.
Still Oper.	1945-1958 1960	Basically same job as PA Tr. Stl. Oper.
Assist. Still Oper.	1949	Same job as PA Tr. Stl. Oper.
Janitor-Handyman	1955 1957 1965	Clean-up and some maintenance in TCP operations.
Handyman	1946-1949 1952-1959	Same job as janitor-handyman.
Lorry Oper. Handyman	1966-1969 1970-1972	Drives forklift truck and did low skill maintenance, some work in TCP operations.
Cl. 1 Spec. Analyst	1952-1972	Laboratory work; potential TCP exposure.

Table 7

Chlorophenol Distillation Operation
Job Titles and Descriptions
1946-1972
349 Building
Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Assist. Oper.	1948-1958	Presumably asst. still operator, therefore would have same job as still op.
Cl. 2 Operator	1945-1957	Could possibly have worked on TCP at some point.

Chlorophenol (1965-1972)
The establishment of the Chlorophenol Unit was an organizational change, not a change in operating personnel or location of process. In 1972, the same operations were reassigned to the Dowicide® antimicrobials unit.

Job Title	Dates	Description
Superintendent	1965-1972	Generic
Assist. Supr.	1968-1972	Generic
Prod. Dev. Engr.	1965-1968	Generic
General Foreman	1965-1971	Generic
Foreman	1966-1968 1971	Generic
Utility Man Cl. 1	1965-1972	Generic
Head Operator	1965-1970	Generic
Spare	1968-1973	Generic
Alternate	1965-1967	Generic
Para-Tri-Stl. Op.	1965-1970	Same job as PA Tr. Stl. Oper. in Bisphenol organizational unit.
Still Operator	1968-1972	Same job as PA Tr. Stl. Oper. in Bisphenol organizational unit.

Table 7

Chlorophenol Distillation Operation
Job Titles and Descriptions
1946-1972
349 Building
Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Jan.-Handyman	1965-1972	Maintenance and drumming; potential TCP contact.
Shipper	1965	Handled bags of pentachlorophenol; at most, low intermittent TCP exposure.

Table 8

New 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1966-1979
804 Building
The Dow Chemical Company
Midland, Michigan

Origanizational Unit
Trichlorophenol (June 1966-February 1979)

In June 1966, a new significantly changed 2,4,5-trichlorophenol (TCP) process was brought into operation in 804 Building. The origanization unit of which the TCP process was a part of was known as trichlorophenol. The process operated until February, 1979. There were no other processes involved in this origanizational unit.

Job Title	Dates	Description
Superintendent	1967 1969-1973 1977-1979	Generic
Prodn. Supt.	1974-1977	Generic
Techn. Supr.	1973	Generic
Assist. Superintendent	1967-1969	Generic
Prod. Chemist	1972	Generic
Sr. Prodn. Engineer	1976 1978-1979	Generic
Prod. Chem. Engr.	1970	Generic
Prod. Dev. Engr.	1968-1970	Generic
Foreman	1967-1972 1974-1978	Generic
Utility Man Cl. 1	1967-1972	Generic (Maintenance on pumps and miscellaneous clean-up).
Spare	1972-1979	Generic
Alternate	1978-1979	Generic

Table 8

New 2,4,5-Trichlorophenol Operation
Job Titles and Descriptions
1966-1979
804 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Trichlor Operator (Trichlphnl. Oper.)	1967-1979	Ran TCP process; loaded reactors; ran finishing operations, collected TCP process samples, and transferred materials.
Loader Lorry Operator	1974-1976	Handled raw materials, made equipment preparation, and operated forklift truck.

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Organizational Unit
Organic Semi-Plant 1950-1956 (Unit predates the 1950's)
Chemical Production 1957-1963
Organic Chemical Products 1961-1968

Cyclic Products 1968-1971 (Unit postdates 1971)

Commercial production of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T acid) began in 1950. Pilot plant operations date back to 1947. As implied by the unit name, "Organic Semi-Plant", this unit was involved with experimental and pilot plant work for a number of organic chemicals. The TCPA operator was specifically assigned to the 2,4,5-T acid pilot operations. The size of the 2,4,5-T acid work force expanded considerably in 1950, with the start-up of the full-scale production. These operations included an esterification process and, by 1958, production of 2-(2,4,5-trichlorophenoxy)propionic acid (silvex). (Note: Silvex operator first appears on 1962 census list.) Commercial production of 2,4,5-T acid and Silvex ceased in 1971. The Organic Semi-Plant included diversified operations spanning several buildings. Thus, it is unlikely that professional/technical personnel would have been assigned to multiple production areas as could be the case for maintenance employees. However, it is very difficult to determine on a one-to-one basis whether or not supervisor x or chemist y was assigned to latex versus 2,4,5-T acid operations prior to 1958.

Job Title	Dates	Description
Superintendent	1969-1971	Generic
Prod. Pl. Supt.	1950-1969	Generic
Assist. Superintendent	1969-1973	Generic
Assist. Plt. Supt.	1958-1969	Generic
Semi Plant Supr	1962	Generic
Pr. Plt. Assist. Sp.	1950 -1959	Generic
Proc. Dev. Supr.	1956-1960	Generic
Dept. Mnt. Eng.	1957-1959	Generic

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Organic Chemist	1957-1960	Generic
Chemist	1948-1963	Generic
Res. Dev. Engr.	1950-1960	Generic
Sr. P. Dev. Engr.	1956	Generic
Prod. Dev. Engr.	1948-57,1965-1967	Generic
Engineer	1950-1960	Generic
Chem. Engr.	1950-1963	Generic
Group Leader	1950-1957	Generic
Lab. Proj. Ld.	1956-1959	Generic
Project Lead.	1950-1956	Generic
Shipping Clerk	1948-1968	Clerical with some 2,4,5-T acid sampling (less than 1/4 of time)
Prod. Dev. Techn.	1968-1969	Generic
Anal. Tech. Cl. 2	1951-1963	Up to 10% of time running 2,4,5-T acid analyses
General Foreman	1968-1971	Generic
Foreman	1950-1971	Generic
Provsnl. Foreman	1968	Generic
Shift Foreman	1968-1971	Generic
Prv. Shift Foreman	1968	Generic
Crew Leader	1950-1953 1957-1958	Generic

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Cooler Operator	1962	Unknown
Alternate	1965-1968	Generic
Plt. Mech. Cr. Leader	1953-1959	Generic
Plant Mechanic	1948-1959 1963-1971	Generic
Spec. Welder	1948-1959	Generic
Jrny. Welder	1948-1959	Generic
TCPA Operator (TCPAA)	1948-1950	Operated 2,4,5-T acid pilot plant operations; wheel operator and drier operator jobs.
Oven Wheel Op.	1948-1950	Previously TCPA operator, basically dried 2,4,5-T acid.
2,4,5-T Reactor Op.	1951-1971	Transferred raw materials to 2,4,5-T acid reactor and ran the reactor.
2,4,5-T Ac. Wh. Op.	1951-1971	Ran acidification operations and a centrifugation operation in the 2,4,5-T acid process.
2,4,5-T Na Wh. Op. (2,4,5-T Na Sl. Op)	1951-1971	Ran a centrifugation, bleaching reaction and filtration operations in the 2,4,5-T acid process.
2,4,5-T Drier Op.	1951-1971	Ran a drier which dried 2,4,5-T acid and packaged the dried 2,4,5-T acid.

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
2,4,5-T Ester Op.	1953-1971	Operated esterification process, added 2,4,5-T acid and higher alcohols, handled solid 2,4,5-T acid; silvex was made in same equipment.
Spare	1956-1971	Generic, worked as an alternate in 2,4,5-T acid process.
Silvex Operator	1962-1971	Operated reactors and handled Silvex.
Tray Handler	1962-1971	Loaded silvex trays by shovel, pulled trays out of oven and dumped dried silvex into fiberpaks.
Lorry Operator	1951-1961	Clerical and fork lift truck driver and repackaging of 2,4,5-T acid.
Tank Car Loader	1958-1971	Unloaded and sampled 2,4,5-trichlorophenol (TCP) and cleaned presses.
Operator Handyman	1958-1965	Not known. Part of Organic Chemical Production.
Tank Carman	1950-1956	Unloaded tank cars including TCP.
Ronnel Operator	1970-1972	Operated ronnel reactors in 338 Building.
Phenate Op.	1964-1972	Made up sodium 2,4,5-trichlorophenate from TCP.

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
MCP Reactor Operator	1953-1962 1959-1962	Ran methyl chlorophenoxyacetic acid reactors (same equipment used to produce 2,4,5-T).
MCP Wheel Op.	1954-1959 1963-1971	Same as the MCP reactor operator until 1963; probably ran Silvex reactors from 1962 to 1972.
Class 1 Operator	1948-1971	Ran reaction and distillation operations in semi-plant; TCP or 2,4,5-T contact unlikely.
Class 2 Operator	1948-1971	Same as Class 1 Operator except lower labor grade.
LA 1 Operator	1965	Probably an error in census system. Most likely a Class 1 Operator.
Prim. Pool Operator	1957-1962	Developmental work for multiple chemical including ronnel; TCP exposure possible.
Spec. Pool Operator	1957-1963	Same as Prim. Pool Operator.
Sr. Pool Operator	1960-1963	Same as Prim. Pool Operator.
Still Operator	1954-1971	Operated TCB stills, filled cans and drums with TCB and possibly some esters.
Janitor-Handyman	1950-1971	10-15% of time unloading 2,4,5-T acid trailers, filled containers in 339 Building, janitor work and some maintenance.

Table 9

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester and
2-(2,4,5-Trichlorophenoxy)propionic Acid and Acid Ester
Production Job Titles and Descriptions
1948-1971
267 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Matl. Hd. Check	1952-1959	Assigned to 267 Building, primarily drove pick-up; supply delivery; 10% time in maintenance.
Handyman	1948-1959	Shipper, janitor work, equipment clean-up, presumably 267 Building.

Table 10

2,4-Dichlorophenoxyacetic Acid Esters, 2,4,5-Trichlorophenoxyacetic Acid Ester, and 2-(2,4,5-Trichlorophenoxy)propionic Acid Ester "Direct-Ester" Production Job Titles and Descriptions
1950-1983
489 Building
The Dow Chemical Company
Midland, Michigan

Organizational Unit
2,4-D Production (1950-Present)

Production of 2,4-dichlorophenoxyacetic acid (2,4-D acid) dated back to 1945. The earliest 2,4,5-trichlorophenoxyacetic acid (2,4,5-T acid) ester production could have predated 1950 on a pilot plant scale; however, commercial productions of 2,4,5-T acid in 267 Building began in 1950 and, therefore, any appreciable 2,4,5-T acid ester production in 489 Building would have occurred after 1950. Prior to the introduction of the direct-ester operations in 1966, the product mix in 489 Building was predominantly 2,4-D acid and its ester (less than 10% and probably 3 to 4% was 2,4,5-T acid related product).

The direct-ester process was placed in operation in 1966, but it was 1967 before 2,4,5-T direct-esters were manufactured. 2-(2,4,5-trichlorophenoxy)propionic acid (Silvex) direct-ester were produced in the direct-ester process after 1971. With the direct-ester operations, the percentage of 2,4,5-T acid related products increased to as much as 30% of the total production time.

In 489 Building formulation work, 2,4,5-T acid was used in liquid formulations; packaging of dried products in 489 Building would have been 2,4,-D acid related. Tordon® operations took place in a separate building. 2,4,5-T acid was used in one Tordon formulation that was produced infrequently.

Job Title	Dates	Description
Superintendent	1969-1979	Generic
Prod. Pl. Supr.	1950-1971	Generic
Production Supr.	1974-1979	Generic
Assist. Supt.	1966-1968 1969-1974	Generic
Prod. Pt. Assist. Supt.	1950 1957-1969	Generic
Projt. Supt.	1979	Generic

Table 10

2,4-Dichlorophenoxyacetic Acid Esters, 2,4,5-Trichlorophenoxyacetic Acid Ester, and 2-(2,4,5-Trichlorophenoxy)propionic Acid Ester "Direct-Ester" Production Job Titles and Descriptions
1950-1983
489 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Maint. Supr.	1969	Generic
Projt. Supervisor	1978-1980	Generic
Techn. Supr.	1973	Generic
Prod. Chem. Engr.	1971-1974	Generic
Chem. Engr.	1950-1957	Generic
Prod. Chemist	1975	Generic
Production Engr.	1975	Generic
Prod. Dev. Engr.	1968, 1970	Generic
Tech. Assist.	1971-1973	Generic
General Foreman	1970-1979	Generic
Foreman	1950-1979	Generic
Shift Foreman	1966-1982	Generic
Provsnl. Foreman	1974	Generic
Crew Leader	1951-1975	Generic
Head Operator	1965-1968	Generic
Alternate (Alternate Operator)	1956, 1959, 1966	Generic
Spare Op.	1968-1982	Generic
Plant Mechanic	1963-1979	Generic
Utility Man Cl. 2	1975	Generic

Table 10

2,4-Dichlorophenoxyacetic Acid Esters, 2,4,5-Trichlorophenoxyacetic Acid Ester, and 2-(2,4,5-Trichlorophenoxy)propionic Acid Ester "Direct-Ester" Production Job Titles and Descriptions
1950-1983
489 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Cl. 2 Analyst. Tech. (Anl. Tk. Cl. 2)	1953-1979	Lab analyses of entire product line; perhaps 30% 2,4,5-T acid related analyses after direct ester process come on line.
Operator Analyst	1950-1951	Same as Cl. 2 Analyst. Tech.
Cl. 1 Spec. Analyst.	1950-1953	Lab analyses entire product line.
Cl. 1 Spec. Tester	1950-1952	Lab analyses entire product line.
D.E. Operator	1967-1979	Operated direct ester process and associated equipment (included 2,4,5-T and Silvex direct esters).
Assist. D.E. Operator	1966-1977	Made material transfers, cleaned filters, operated auxiliary equipment (included 2,4,5-T and Silvex direct esters).
Ester Operator	1950	Made esters by acid ester process; probably 2,4,5-T acid ester 3 to 4% of the time.
2,4-D Ester Op.	1951-1971	Same as ester operator.
Assist. Ester Op.	1952-1971	Same as ester operator.
DMA Operator	1953-1969	Made water-soluble formulations of 2,4-D acid; ran DMA (dimethylamine) reactor; aminization of 2,4,5-T acids.

Table 10

2,4-Dichlorophenoxyacetic Acid Esters, 2,4,5-Trichlorophenoxyacetic Acid Ester, and 2-(2,4,5-Trichlorophenoxy)propionic Acid Ester "Direct-Ester" Production Job Titles and Descriptions
1950-1983
489 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
2,4,5-T Ester Op.	1967-1979	Operated direct ester process & associated equipment (included 2,4,5-T & Silvex esters
Tordon® Operator	1964-1975	Formulations of picloram; only one formulation (low volume) was with 2,4,5-T acid (597 Building).
Tordon® Ester Op.	1967-1975	Formulation and filter-cleaning; mostly 2,4-D acid and Tordon® (597 Building).
Tordon® Form. Opr.	1967-1970	Same as Tordon® Ester Operator.
Set-Up Man	1968-1982	Set up packaging machinery for drumming entire product line including 2,4,5-T acid formulations (blew out lines, Changed transfer hoses, sampling).
Machine Op.	1976-1978	Probably drummed 1 and 5 gallon cans for entire product line.
Formulation Oper.	1974-1982	Formulated products throughout the entire product line.
Matl. Handler	1968-1982	Filled cans and drums, entire product line.
Loader-Checker	1969-1982	Handled material with fork-lift trucks and filled drums a small percent of the time.

Table 10

2,4-Dichlorophenoxyacetic Acid Esters, 2,4,5-Trichlorophenoxyacetic Acid Ester, and 2-(2,4,5-Trichlorophenoxy)propionic Acid Ester "Direct-Ester" Production Job Titles and Descriptions
1950-1983
489 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Drum Filler	1951-1969	Filled cans and drums; entire product line.
Clerk-Tank Car Unloader	1950-1981	Handled tank cars between tank farm and building, cleaned sparkler filters, some 2,4,5-T acid involved.
Lorry O-Handyman	1953-1969	Drives forklift trucks and possible some maintenance throughout the plant.
Janitor-Handyman	1950-1953 1962-1982	Cleaned sparkler filters and handled materials; possible contact with all products.

Table 11

Ronnel (O,O-Dimethyl-O-(2,4,5-trichlorophenyl)-phosphorothioate)
Production Job Titles and Descriptions
1955-1977
267, 338, 840 Buildings
The Dow Chemical Company
Midland, Michigan

Organizational Unit
Organic-Semi Plant (1955-1957)
Chem. Prod. Dev. Dept. January 1957-January 1963 (Korlan basically same product as Ronnel)
Ronnel-Zytron February 1963- February 1970
Cyclic Products (Ronnel) March 1970-March 1973
Animal Health May 1973-September 1974
Dursban®/Ronnel September 1974-September 1980 (Ronnel production ceased at the end of 1977)

The Ronnel process was reassigned to different organizational units on numberous occasions during its time of production, and has changed buildings three times. The process was developed in the organic semi-plant in 267 Building in 1955 and became part of the Chemical Production Development unit in 338 Building in 1957. In 1963, ronnel was briefly referred to as Korlan®-Zytron and then as Ronnel-Zytron. In 1971, Ronnel operators were assigned to Cyclic Products. For a one-month period in 1972 ronnel was produced by personnel from the Dursban® plant. In 1973, the ronnel process was moved to 840 Building and became part of the organizational unit, Animal Health. Finally the Ronnel operations were made part of the Dursban®-Ronnel unit. Note that Ronnel followed Clopidol so that the Clopidol operator worked only on Ronnel from 1973 forward. Job titles, dates and descriptions involving Ronnel operations for the years prior to 1963 and between 1971 and 1972 have already been covered in the Table 9.

Ronnel/Zytron (1963 - 1970)

Job Title	Dates	Description
Asst. Supt.	1963	Generic
Chemical Engr.	1963	Generic
Foreman	1963-1967	Generic
Shift Foreman	1970	Generic (covered multiple processes.
O-methyl/Ron. Op.	1963-1970	Operated reaction part of system (all closed vessels) (O-methyl chlorophosphorothioate) and operated Ronnel process, some lab work.

Table 11

Ronnel (O,O-Dimethyl-O-(2,4,5-trichlorophenyl)-phosphorothioate)
Production Job Titles and Descriptions
1955-1977
267, 338, 840 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Zytron Op./Phenate Op.	1964-1967	Made amine esters and sodium phenate salt of 2,4-dichlorophenoxyacetic acid; reacting, sampling, filtering and drumming.
Phenate Oper.	1967-1969	Made up phenate solutions, loaded caustic soda and 2,4,5-trichlorophenol (245 TCP), ran analyses of 245 TCP.
Sr. Pool Oper.	1963	Generic

Cyclic Products (1970 - 1973)

Job Title		
Phenate Oper.	1970-1972	Made up phenate solutions, loaded caustic soda and 2,4,5-trichlorophenol (245 TCP), ran analyses of 245 TCP.
Ronnel Oper.	1970-1972	Ran ronnel process

Ronnel/Clopidol (1973 - 1974)

Job Title	Dates	Description
Production Superv.	1973-1974	Generic
Tech. Suipervisor	1973	Generic
Asst. Chemist	1974	Generic
Foreman	1973-1974	Generic
Shift Foreman	1973-1974	Generic
Utility Man Cl. 1	1973	Generic
Spare	1973	Generic

Table 11

Ronnel (O,O-Dimethyl-O-(2,4,5-trichlorophenyl)-phosphorothioate
Production Job Titles and Descriptions
1955-1977
267, 338, 840 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Clopidol Operator	1973	Mostly worked as a Ronnel Operator.
Ronnel Oper.	1974	Ran ronnel process.
Asst. Clopidol	1973	Probably same as Ronnel Operator.
Handyman	1973	Generic

Dursban®/Ronnel (1974 - 1977)

Job Title	Dates	Description
Production Engineer	1975	Generic
Asst. Chemist	1975	Generic
Shift Foreman	1975	Generic
Spare	1975-1980	Generic
Alternate	1980	Generic
Utility Man Cl. 1	1974-1976	Generic
Handyman	1975-1976	Generic
Ronnel Op.	1974-1977	Operated ronnel process.
Dursban® Insectcide Op.	1975-1976	Probably operated ronnel process.

Table 12

Erbon (2-(2,4,5-trichlorophenoxy)-ethyl 2,2-dichloropropionate)
Production Job Titles and Descriptions
1955-1974
441 Building
The Dow Chemical Company
Midland, Michigan

<u>Organizational Unit</u>
Emco Ester (1955-1957)
SODTCA (sodium trichloroacetate)/Erbon Plant (1957-September 1970)
Dow ECR Resins (September 1970-December 1974)

Erbon was produced from 1955 to 1974 in 441 Building. Production of erbon ceased by 1975. During its years of production in 441 Building, erbon was a part of three different organizational units shown above with appropriate dates listed. Erbon production was performed sporadically, based on product demands and represented a small fraction of the efforts for a given organizational unit. Approximately 30% of an operator's time was devoted to erbon production. The remaining time was devoted to other operations, namely morpholine production. Sodium trichloroacetate and electroconductive (ECR) resins were also produced in 441 Building by personnel on the same organizational unit lists. Chloromethyl ether was a raw material used in the ECR process. Erbon was handled only in Liquid form.

The size of 441 Building workforce varied from 25 in 1957 to 40 in 1970. However, the majority of the operating personnel would have been assigned to sodium trichloroacetate or ECR resins on a full-time basis.

Job Title	Dates	Description
Plant Mech.	1955-1974	Generic, erbon exposure, likely.
Handyman	1955-1974	Generic
Head Op.	1955-1974	Generic (erbon exposure possible)
Spare Op.	1972-1974	Generic (all processes)
Alternate Op.	1969-1972	Generic
L. & S. Oper.	1955-1960	Ran Leveronic and styphen processes on batch basis (erbon exposure possible).
Reactor and Still Op.	1960-1974	Ran up to six processes, including erbon, added ethylene oxide sampled and anlyzed 2,4,5-trichlorophenol, and filled drums.

Table 13
Dowicide® Products Production Job Titles and Description
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Organizational Unit
Dowicide® Production (1935-1978)
Pentachlorophenol (1978-1980)

The Dowicide® antimicrobials operations in 265 Building involved the production of several different products including pentachlorophenol (PCP), tetrachlorophenol (TetCP), 2,4,6-trichlorophenol (246TCP) and ortho-phenylphenol. The chlorophenols were made by direct chlorination of phenol, with subsequent distillation. Drying or flaking operations include all of the above products plus 2,4,5-trichlorophenol (245 TCP). Packaging and warehouse operations also took place in 265 Building. Operations in 265 building shut down in August 1978. The Dowicides organizational department changed names to Pentachlorophenol in August 1978. PCP production and some redistillation of TCP continued in 349 building until December 1980. Although Dowicide products, such as pentachlorophenol (1935-1941), were also produced in 206 Building, no 245 TCP was used in that building. Tetrachlorophenol and pentachlorophenol were manufactured in 265 Building during 1941. Ortho-phenylphenol and chlorophenyl phenol were also made in 206 Building.

Job Title	Dates	Description
Superintendent	1952-1964 1973-1980	Generic
Assist. Superintendent	1952-1965 1968-1974	Generic
Warehouse Supervisor	1969-1975	Generic
Chemist	1939	Generic
Chem. Engr.	1942, 1978	Generic
Prod. Engr.	1975-1980	Generic
Prod. Dev. Engr.	1966	Generic
Environmental Supervisor	1977	Generic
Project Super.	1977-1980	Generic
Prod. Supervisor	1974-1980	Generic
Main. Supervisor	1974	Generic
Tech. Supervisor	1973	Generic

Table 13
Production Job Titles and Description for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
General Foreman	1972-1977	Generic
Foreman	1945-1980	Generic
Prorsnl Foreman	1971	Generic
Subforeman	1935-1946	Generic
Shift Foreman	1971-1980	Generic
Crew Leader	1947-1967	Generic
Alternate	1956-1972	Generic
Head Oper.	1935, 1946-1974	Generic
Spare Oper.	1951-1956 1967-1980	Generic
Utilityman	1948-1958	Generic
Utilityman Class 1	1972-1979	Generic
Utilityman Class 2	1958-1972	Generic (10-15% of time sampling, rest maintenance throughout the building).
Sr. Prod. Clerk	1970-1975	Clerical work; some sampling and analysis (small % of time on 245 TCP and PCP).
Sr. Clerk	1946-1959, 1967	Same as Sr. Prod. Clerk.
Shipper Handyman	1960-1962	Made up special orders of products, maintained clerical records.
Packer and Shipping Clerk	1944	Clerical work and shipping; no 245 TCP handling involved.

Table 13
Production Job Titles and Descriptions for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Chlorinator Operator (1st Chlorinator Op.) (2nd Chlorinator Op.)	1943-1979 1947 1947-1975	Operated the chlorinators, unplugged lines, operated scrubbers (PCP and 245 TCP as a minor contaminant only), lab sampling.
Assistant Op.	1941, 1943-1946	Ran flaker, operated and cleaned out chlorinators.
Operator	1935-1942	Probably operated chlorinators, flakers and dryers.
Class 2 Operator	1943, 1945	Probably the same as operator.
Operator Helper	1935-1942	Probably assisted the operators.
Relief Man	1942	Probably assisted the operators.
Flake Bed Drier Operator	1963-1979	Operated fluid bed dryer; filled packs; operated fork-lift trucks (primary PCP).
Blender-Flaker Operator	1965-1975	Blended mixtures of products (probably wore respirators).
Finishing Operator	1975-1980	Operated PCP finishing (block casting).
Dow Dry Operator (Dowicide® Drier Oper.) (Drier Op.)	1943-1973	Operated dryers for Dowicide® antimicrobials other than PCP.
Dowicide® Operator	1942, 1978-1980	Operated batch chlorinators and stills.
Still Operator	1973-1980	Started-up and operated PCP stills, sampled lines and performed analytical work on 245 TCP.

Table 13
Production Job Titles and Descriptions for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Flaker Miller (Miller Flaker Op.)	1947-1948, 1951-1956, 1960-1975	Ran flakers and hammer mills; potential exposure to all Dowicide® materials.
Flaker Operator	1943-1951	Ran flakers; potential exposure to all Dowicide® materials.
Mill. Flake, Operator PE Tet 2S Gr	1956-1960	Probably ran hammer mill for PCP, TetCP, and 245 TCP.
Mill. Flake Op. A I II Grinder	1956-1960	Probably ran hammer mill for ortho-phenylphenol.
Priller Operator	1972-1975	Operated prillers for PCP, high potential for exposure to PCP but wore a respirator during bagging operations.
Miller Shift Miller	1945-1948 1966	Operated hammer mill to break up products; cleaned mill; potential exposure to all Dowicides® antimicrobials.
Handyman	1945-1950 1974-1980	As of more recent period drummed 245 TCP part of time; loaded dumpsters, unplugged lines; high potential exposure to dioxins.
Janitor-Handyman	1962-1973	Janitor work tended to be in nonproduction areas; handyman could have been involved in maintenance work within plant.
Head Packer Head Packer and Inspector	1942-1960 1937-1940	Head packer spent less time doing actual packaging and more time supervising.

Table 13
Production Job Titles and Descriptions for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Shift Packer Packer Packer Helper	1959-1972 1939-1974 1939-1943	Loaded fiber packs; potential exposure to all Dowicide® materials.
Pel. Mil. S. Pk.	1956-1960	Ran pelletizer and packaged the resultant products (worked with sodium salts from fluid bed dryer), primarily PCP.
Warehouseman	1975-1979	Loaded with forklift trucks, handled tubs of PCP (in plastic sacks the could leak); low potential for exposure to 245 TCP which would have been handled in fiberpacks.
Janitor	1936-1959	Cleaned up, could have worked in warehouse area.
Master Clerk	1959-1979	Clerical work; no material handling.
Shipping Clerk	1943-1947	All clerical work.
Assistant Shipping Clerk	1942	All clerical work.

Table 13
Production Job Titles and Descriptions for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Pentachlorophenol (1978 - 1980)
This department was previously called Dowicides - the name was changed in 1978. Pentachlorophenol production ceased in December 1980

Job Title	Dates	Description
Superintendent	1978-80	Generic
Production Supervisor	1978-80	Generic
Foreman	1978-80	Generic
Shift Foreman	1978-80	Generic
Chemical Engineer	1978-79	Generic
Production Engineer	1978-80	Generic
Utilityman Cl 1	1978	Generic
Spare	1978-80	Generic
Chlorinator Operator	1978	Operated chlorinator, unplugs lines, operates scrubber (Penta TCP as a minor contaminent only); lab sampling.
Finishing Operator	1978-80	Operated penta finishing (block casting).
Dowicides Operator	1978-80	Operated batch continuous chlorinators and stills

Table 13
Production Job Titles and Descriptions for Dowicide®
1935-1980
265, 206, & 349 Buildings
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Handyman	1978-80	As of more recent period drummed TCP part of time; loaded dumpsters, unplugged lines; high potential exposure to dioxins.
Warehouse Operator	1980	Loaded forklift trucks; handled tubs of pentachlorophenol (in plastic sacks that could leak); low potnetial exposure to TCP which would have been handled in fiberpacks.
Pentachlorophenol Operator	1980	Operated penta finishing (block casting).
Project Manager	1980	Generic
Sr. Operations Foreman	1980	Generic
Operations Foreman	1980	Generic

Table 14

Pentachlorophenol Production
Job Titles and Description
1947-1966
466 Building
The Dow Chemical Company
Midland, Michigan

Organizational Unit
Pentachlorophenol (1947-1963)
Benax® surfactant (1963-1966)

A pentachlorophenol (PCP) process was operated in 466 Building from November 1950 until April 1966. However, it appears that production was not continuous, gaps occurred in 1954-1955 and in 1959. This is mostly likely due to the fact that these units served to supplement PCP production in 265 Building. It also appears that flaking of PCP and other products received from 265 Building may have occurred prior to 1950. Despite the name of the unit, PCP production was only one of three major processes within the unit, the others being butyl salol and Dowfax® (dodecyl diphenyl oxide disulfonate) production. In addition, a number of lesser products were produced including for a short period of time (approximately 1951 - 1958) zinc trichlorophenate. Except for the special analyst, class 1 who spent up to 40% of his time analyzing zinc trichlorophenate, the jobs associated with zinc trichlorophenate process are known only through presumption. It is probable that the rotary drier fluid operator and the grinder-blender operator ran the zinc trichlorophenate process as well as the PCP process. The organization unit continued after cessation of PCP production.

Job Title	Dates	Description
Superintendent	1951-1965	Generic
Plant Superintendent	1965	Generic
Assistant Supr.	1949-1957, 1966	Generic
Chemist	1952	Generic
Prod. Dev. Engr.	1965-1966	Generic
Foreman	1947-1966	Generic
Subforeman	1951-1962	Generic
Shipper	1953-1966	Handled packages of PCP as they were shipped.

Table 14

Pentachlorophenol Production
Job Titles and Description
1947-1966
466 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Special Anal. Cl. 1	1956	Analyzed zinc trichlorophenate up to 40% of the time; grinding of lab quantities.
Anal. Cl. 1	1955	Presumably the same as the special analyst.
Handyman	1948 1956-1965	Generic
Janitor-Handyman	1950-1966	Generic
Head Operator	1951	Generic
Chlor. Op.	1951-1953, 1956-1958, 1960-1966	Operated chlorinators for the production of PCP, added raw materials, transferred PCP.
Assist. Chlor. Op.	1950-1951	Assisted the chlorinator operator in the PCP process.
Flaker Oper. (Micronizer Op.)	1947-1961	May have flaked PCP received from 265 Building.
Rot. Dri. Fl. Op.	1953, 1955-1956	Operated rotary driers for PCP process, handle PCP and perhaps zinc trichlorophenate.
Fl. Bed Drier Op.	1960-1963	Operated fluid bed driers presumably for NaPCP.
Grinder-Blender Op.	1951-1958	Operated grinder and blender, presumably handled PCP and possible zinc trichlorophenate.

Table 14

Pentachlorophenol Production
Job Titles and Description
1947-1966
466 Building
The Dow Chemical Company
Midland, Michigan

Job Title	Dates	Description
Miller	1947	Operated mills & blenders presumably handled PCP
Mill and Blender Op.	1948-1963	Operated mills and blenders, presumably handled PCP.
Contain. Fill. (Containr. FLR)	1951 1956-1958	Filled containers, presumably handled PCP.
Pak Filler	1952 1956-1958	Presumably filled packs with PCP and NaPCP.

APPENDIX C

Dow Process Flow Diagrams
Figures 11 through 21

The Dow Chemical Company
Midland, Michigan

Figure 11

2,4,5-Trichlorophenol Block Flow Diagram
1946-1966 (199 Building)
The Dow Chemical Company
Midland, Michigan

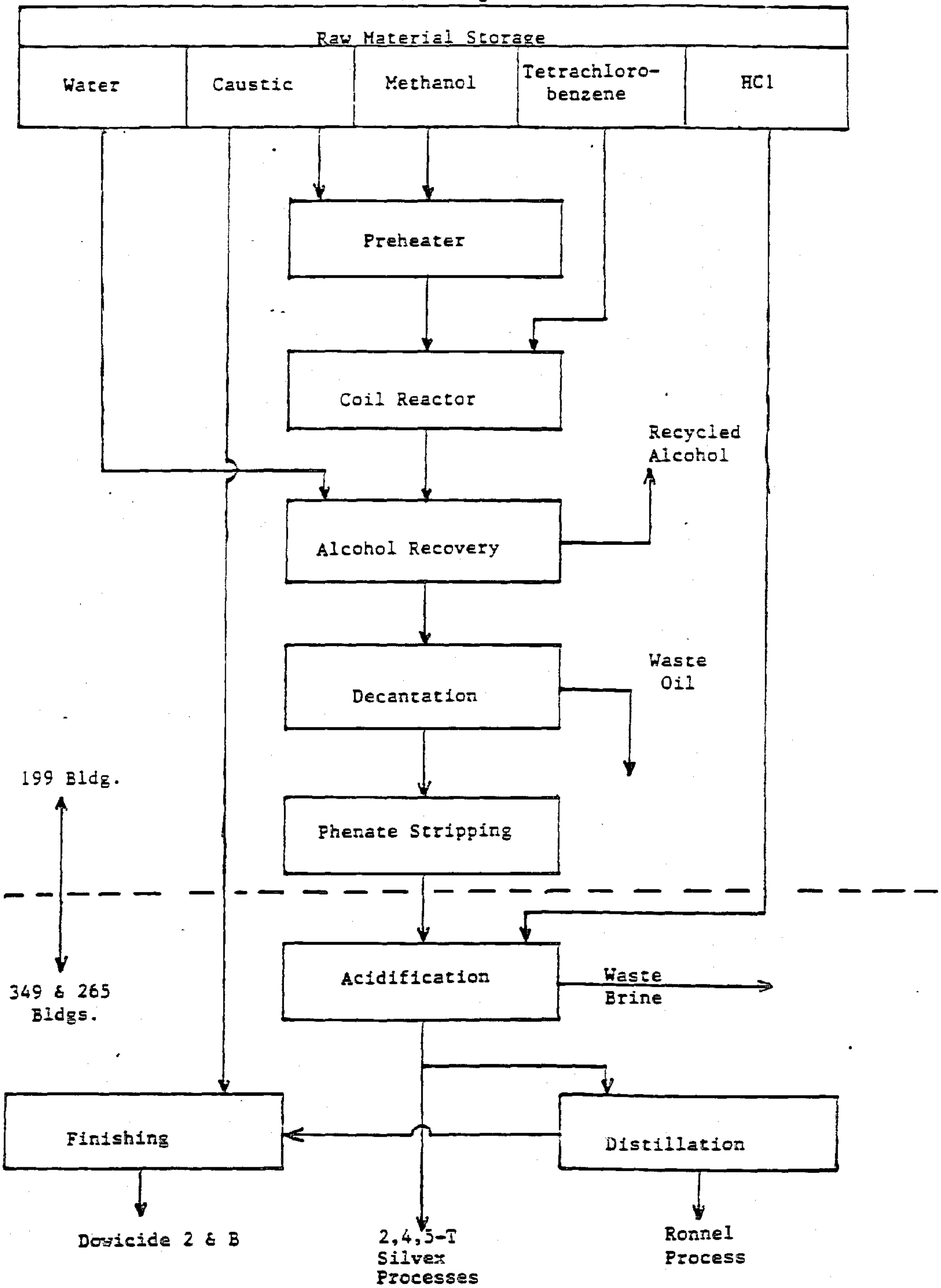


Figure 12

2,4,5-Trichlorophenol Neutralization, Flaking and Distillation Block Flow Diagram
265/349 Building, 1946-1978
The Dow Chemical Company
Midland, Michigan

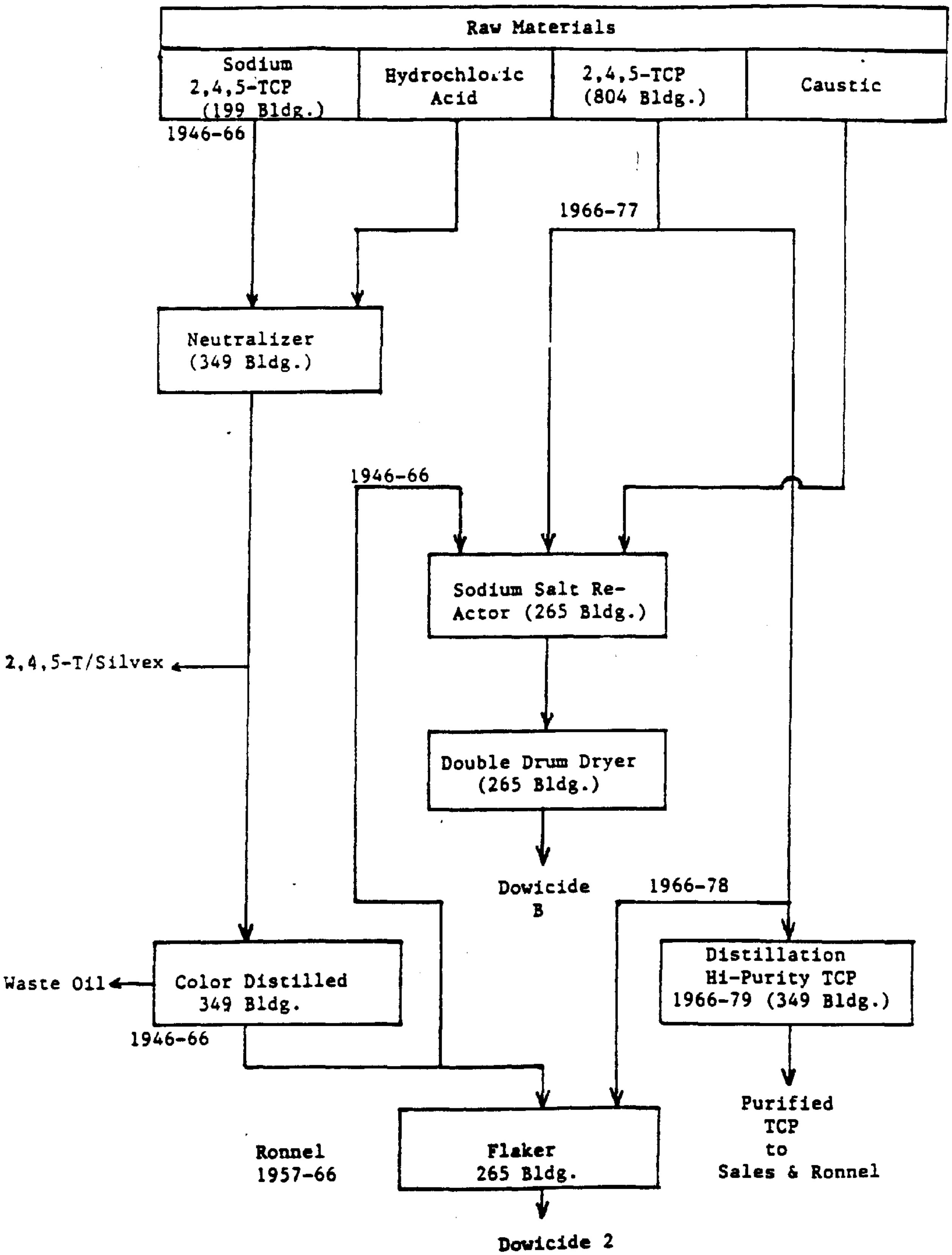
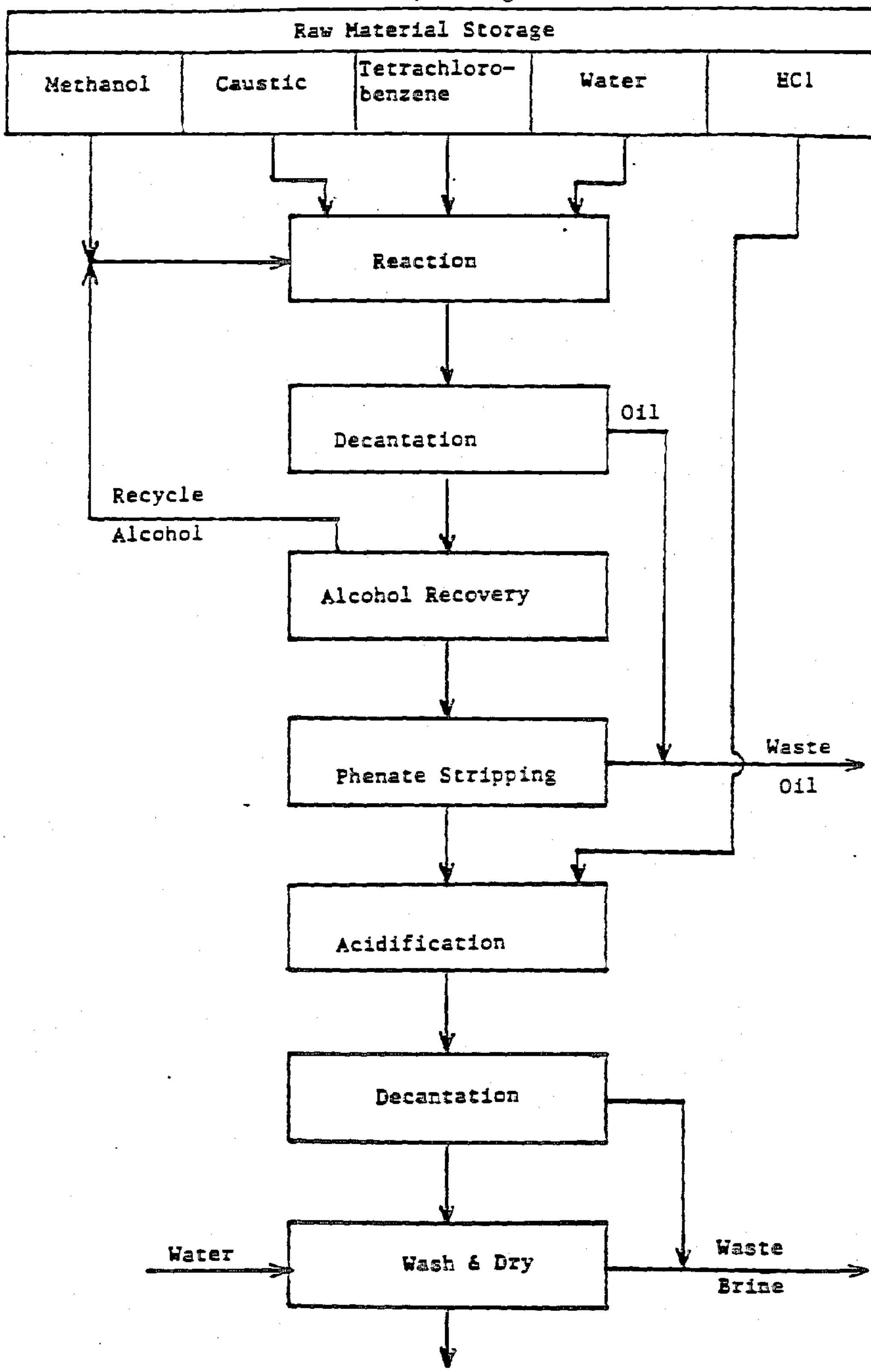


Figure 13

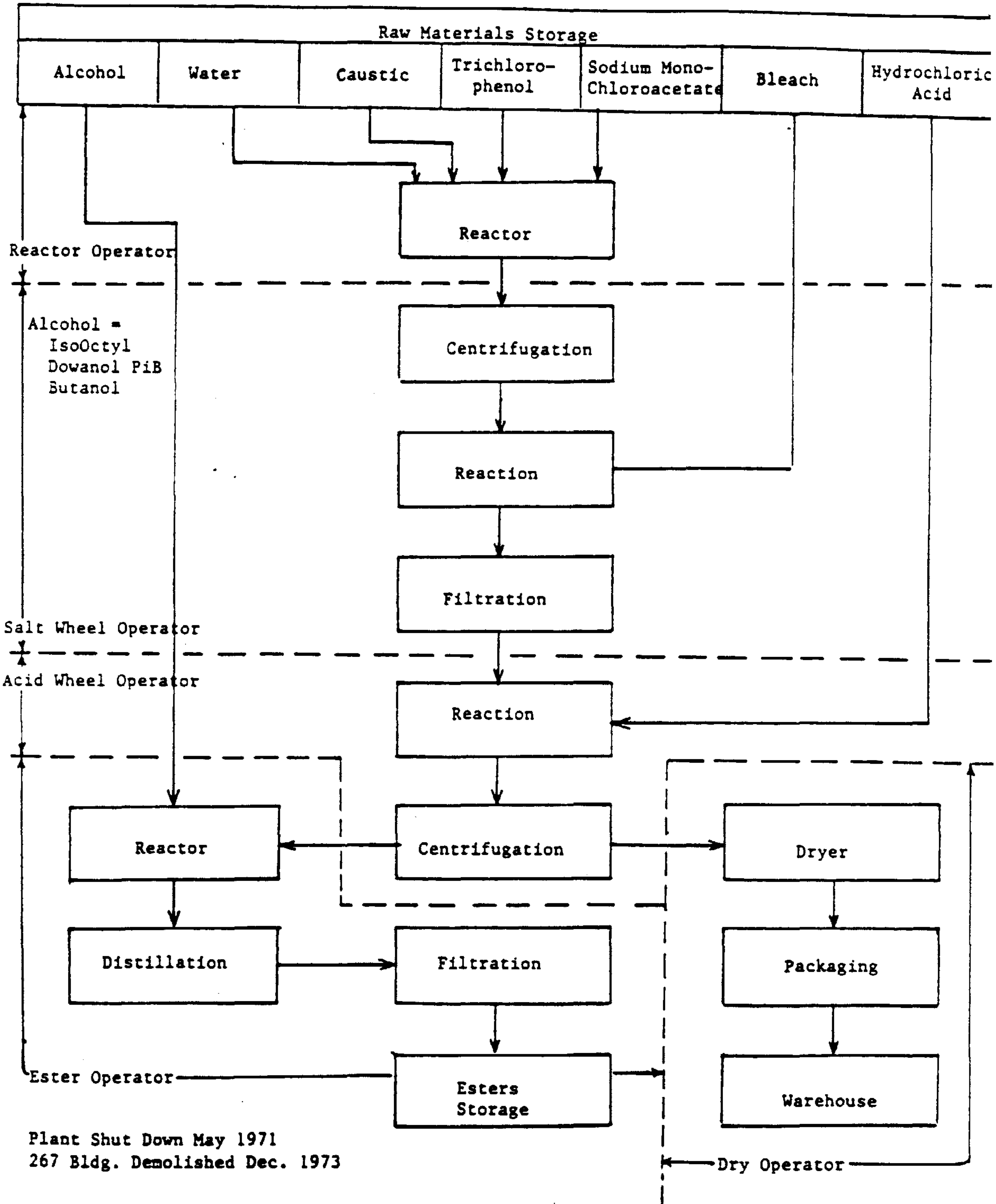
2,4,5-Trichlorophenol Block Flow Diagram
804 Building, 1966-1979
The Dow Chemical Company
Midland, Michigan



2,4,5-TCP To
2,4,5-T (267,489), Silvex (267,489),
Ronnel (267,338,840), Flaking (265),
Distillation (349)

Figure 14

2,4,5-Trichlorophenoxyacetic Acid and Acid Ester Block Flow Diagram
267 Building, 1950-1971
The Dow Chemical Company, Midland, Michigan



Plant Shut Down May 1971
267 Bldg. Demolished Dec. 1973

Figure 15

Silvex Acid and Acid Ester Block Flow Diagram
267 Building, 1958-1971
The Dow Chemical Company
Midland, Michigan

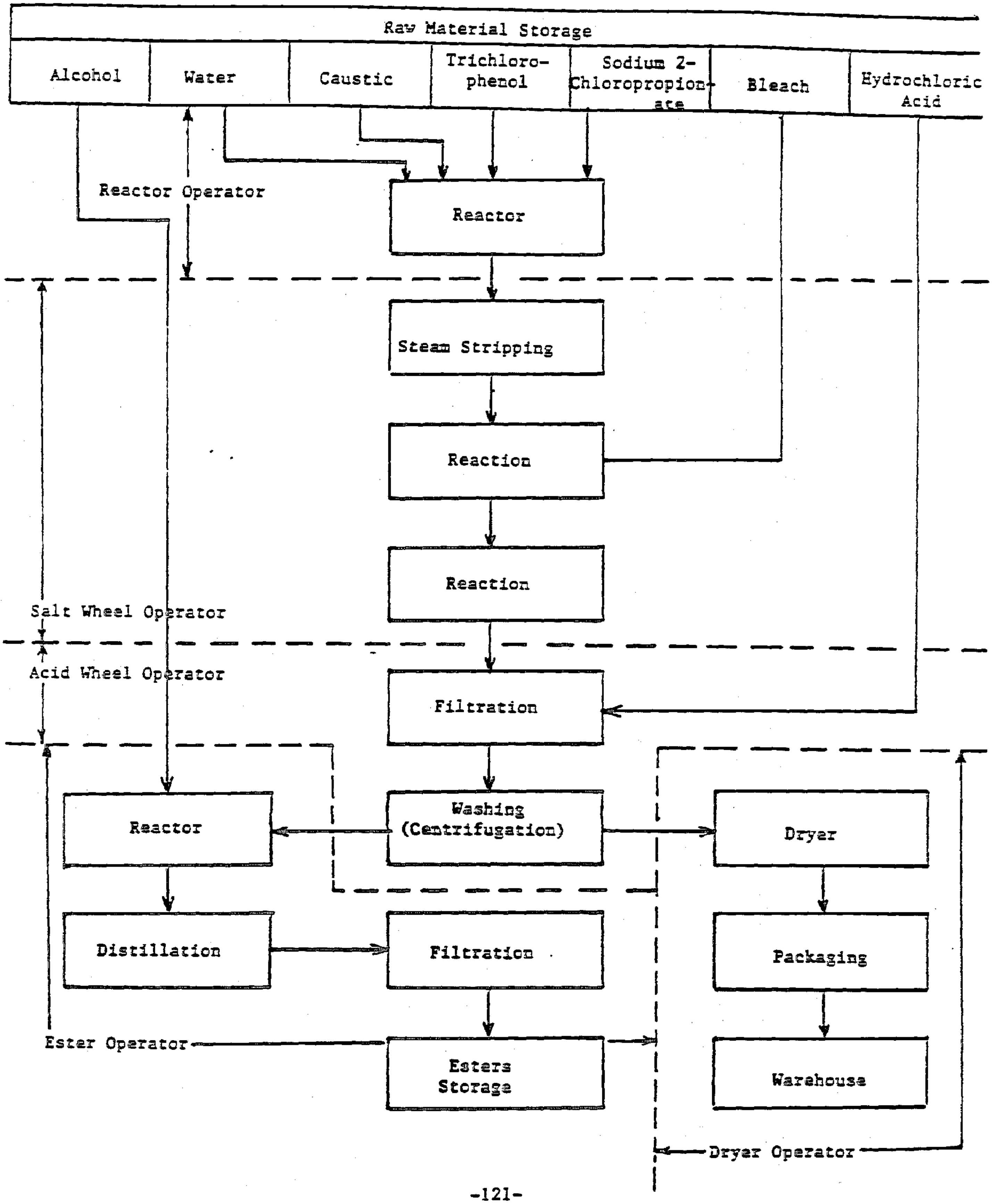
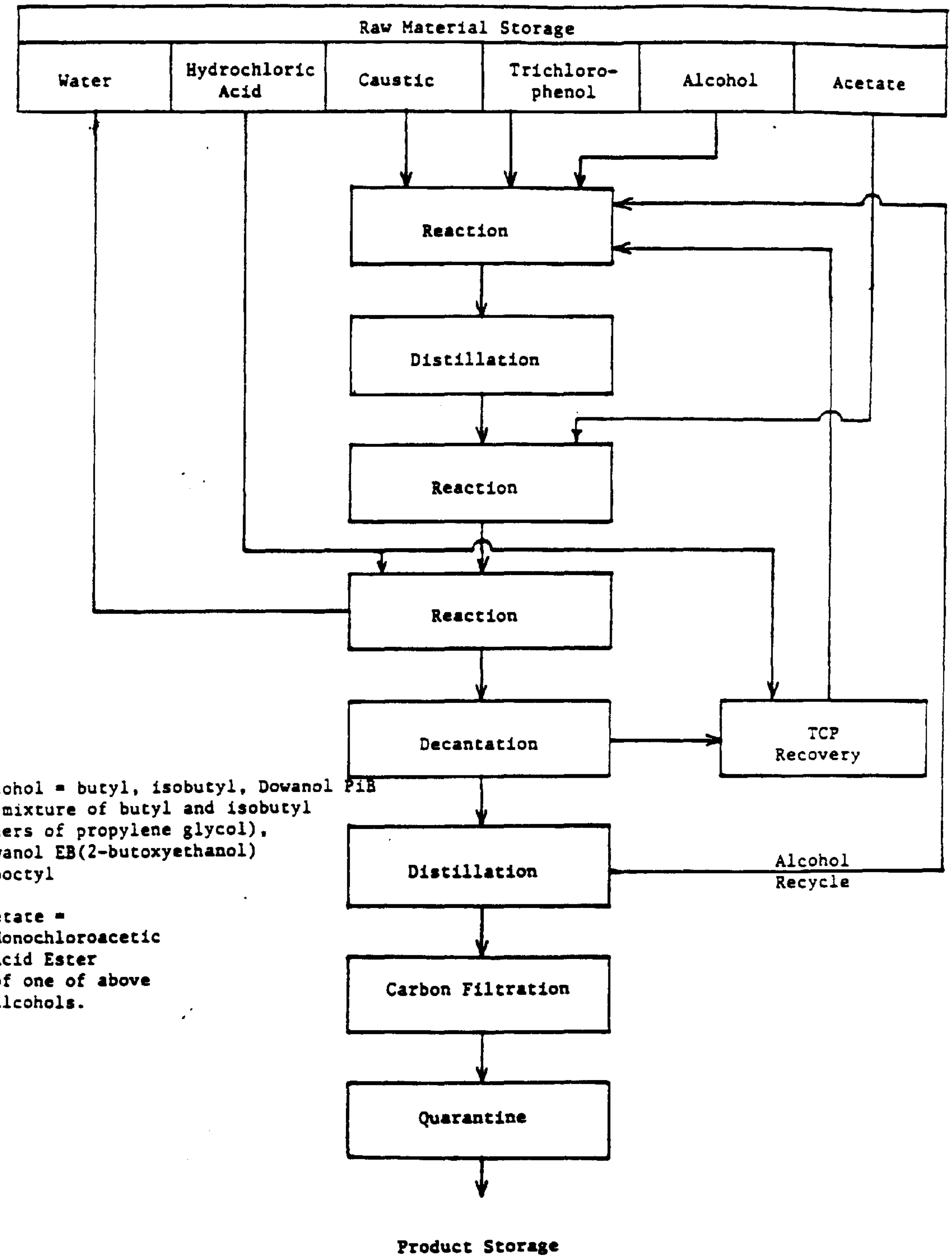


Figure 16
2,4,5-Trichlorophenoxyacetic Acid Direct Ester
Block Flow Diagram, 1967-1979, 489 Building
The Dow Chemical Company
Midland, Michigan

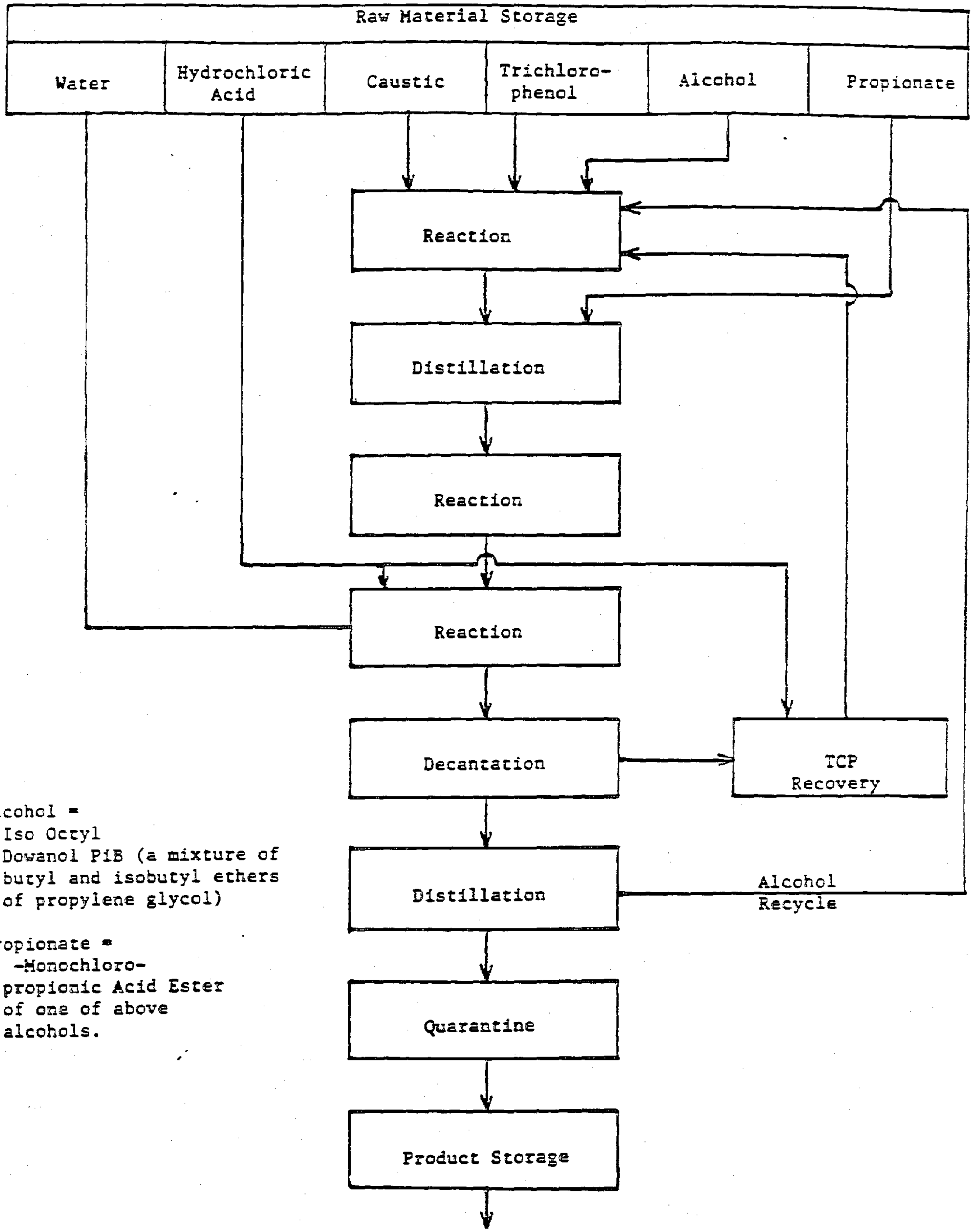


Alcohol = butyl, isobutyl, Dowanol PiB (a mixture of butyl and isobutyl ethers of propylene glycol), Dowanol EB(2-butoxyethanol) isooctyl

Acetate = Monochloroacetic Acid Ester of one of above alcohols.

Figure 17

Silvex Direct Ester Block Flow Diagram
1972-1978, 489 Building
The Dow Chemical Company
Midland, Michigan

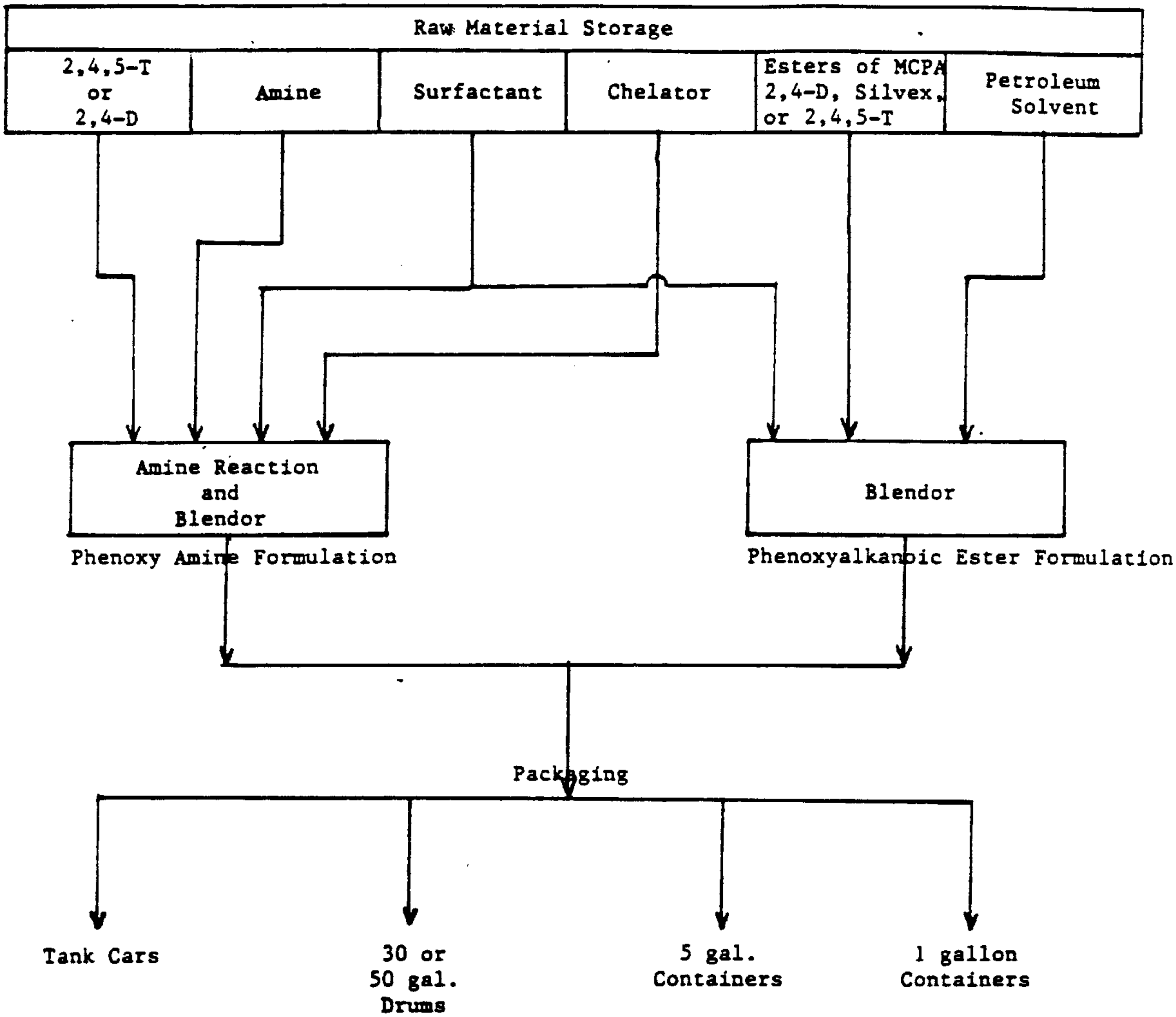


Alcohol =
Iso Octyl
Dowanol PiB (a mixture of butyl and isobutyl ethers of propylene glycol)

Propionate =
-Monochloro-propionic Acid Ester of one of above alcohols.

Figure 18

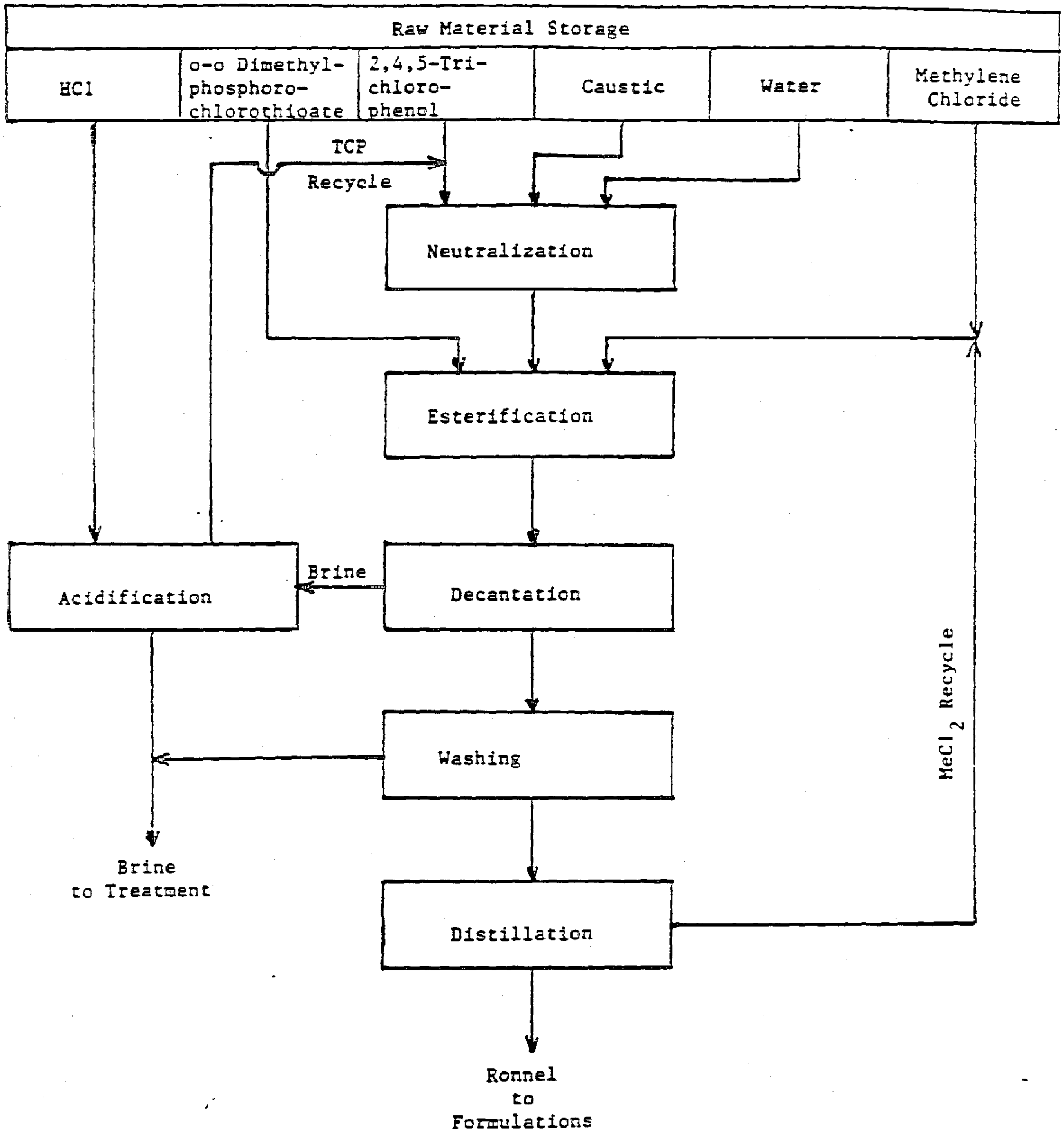
Formulation and Packaging Processes for Phenoxy
Herbicides Block Flow Diagram
489 Building, 1950-1983
The Dow Chemical Company
Midland, Michigan



2,4,5-T = 2,4,5-Trichlorophenoxyacetic Acid
2,4-D = 2,4-Dichlorophenoxyacetic Acid
Silvex = 2(2,4,5-Trichlorophenoxy)propionic Acid
MCPA = 2-Methyl-4-chlorophenoxyacetic Acid
Amine = Dimethyl amine or Ethanolamine or Isopropanolamine for 2,4-D
Triethylamine for 2,4,5-T

Figure 19

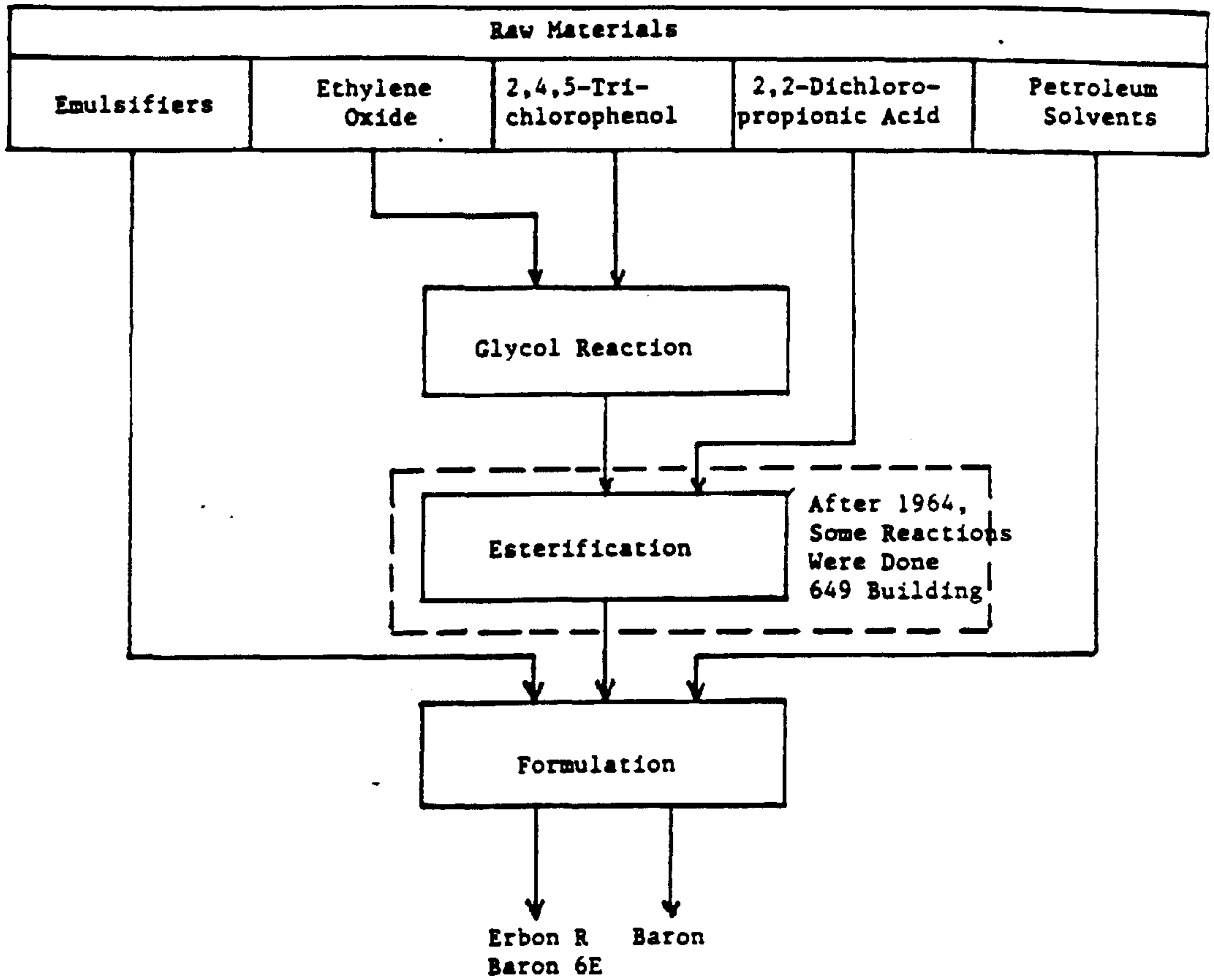
Ronnel Block Flow Diagram
1955-57: 267 Bldg., 1958-72: 338 Bldg., 1973-77: 840 Bldg.
The Dow Chemical Company
Midland, Michigan



Ronnel = o,o-Dimethyl o-(2,4,5-Trichlorophenyl) Ester of Phosphorothioic Acid

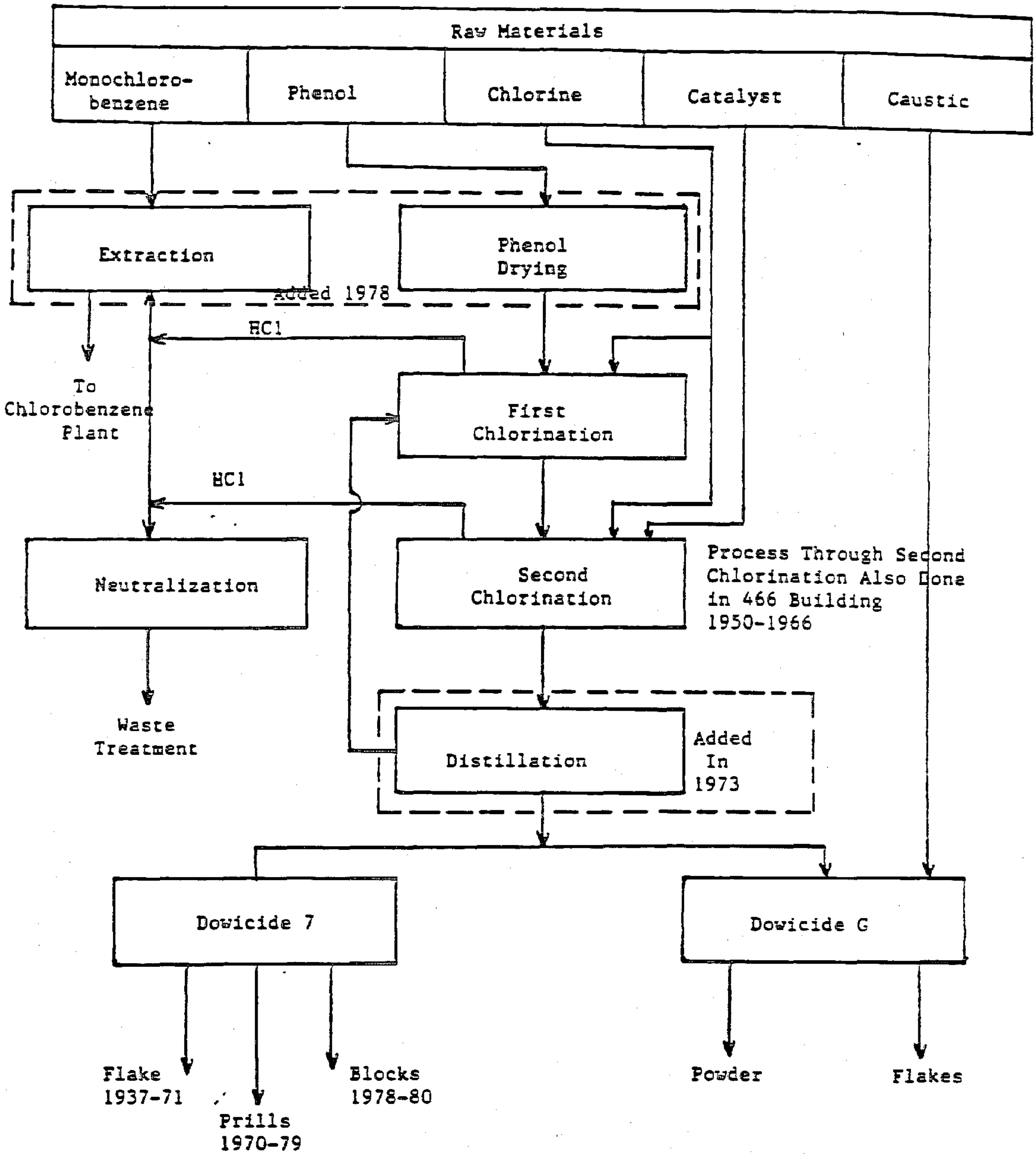
Figure 20

Erbon Block Flow Diagram
1955-1974
441, 649 Building
The Dow Chemical Company
Midland, Michigan



Erbon = 2-(2,4,5-Trichlorophenoxy)ethyl 2,2-Dichloropropionate

Figure 21
Pentachlorophenol Block Flow Diagram
1937-1980
265, 349, 466 Buildings
The Dow Chemical Company
Midland, Michigan



Appendix D

Dow Analytical Method Abstracts
Abstracts 1 through 46

The Dow Chemical Company
Midland, Michigan

ANALYSIS METHOD NUMBER 1

METHOD MLW.64.19
DATE 7 April 1965

PURPOSE The determination of compounds capable of causing chloracne in 2,4,5-Trichlorophenol process samples by gas-liquid chromatography

DESCRIPTION Determination of 2378 TCDD; 1378 TCDD; and the sum of 237-trichloro-8-methoxy-dibenzo-p-dioxin and 22'44' 5-pentachloro-5-methoxydiphenyloxide in 245 TCP process samples. The compounds are separated by means of GLC with flame ionization detection. Concentration levels of 10 ppm to % amounts may be determined by this procedure with and accuracy of +/- 10%.

ANALYSIS METHOD NUMBER 2

METHOD No. 8747b
DATE 31 July 1975

PURPOSE Determination of 245 TCP and 2378 TCDD in 245 TCP

DESCRIPTION Procedure applicable to the assay of 245 TCP in the range of 85 to 100% and determination of 2378 TCDD concentrations associated with 245 TCP. The assay is obtained by the addition of 246 trichlorophenol as an internal standard and analysis by GLC with thermal conductivity detection. The 2378 TCDD concentrations are determined by a benzene extraction of an aqueous caustic solution of 245 TCP and examination of the extract by GC-MS. TCDD recoveries are 108 +/- 20% by this procedure with a precision of +/- 20%. The limit of detection is 0.01 to 0.02 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 3

METHOD MLW.65.10
DATE 7 July 1965

PURPOSE Determination of 2378 TCDD in 245 TCP "Gas Chromatographic Method"

DESCRIPTION Procedure applicable to the determination of 2378 TCDD in 245 TCP. The 2378 TCDD concentrations are determined by a chloroform extraction of an aqueous caustic solution of 245 TCP and examination of the extract by GLC with flame ionization detection. TCDD recoveries are 90 to 105% for samples prepared at concentrations of 1 to 5 ppm. The accuracy of this method is +/- 5% with a lower detection limit of 0.5 ppm.

ANALYSIS METHOD NUMBER 4

METHOD ML-AM-71-48

DATE 24 September 1971

PURPOSE: Determination of 2378 TCDD in 245 -Trichlorophenoxyacetic acid and related materials.

DESCRIPTION Procedure applicable to the determination of 2378 TCDD and other related chlorinated materials in 245-T Acid; 24-D acid and related acidic and phenolic materials and esters of these acids (245 TCP; tetrachlorophenol; pentachlorophenol; and esters of these acids). The 2378 TCDD is separated from the sample matrix by an organic solvent extraction (benzene or hexane) of an aqueous caustic solution of the sample or by silica gel column chromatography of non-ionizable samples such as esters. The resulting residue is concentrated and a portion examined by GC-MS. TCDD recoveries should be 100% +/- 15% in spiked samples over a range of 0.1 ppm to over 5 ppm. The precision of this procedure for duplicate samples should be +/- 15%.

ANALYSIS METHOD NUMBER 5

METHOD ML-AM-72-37
DATE 26 June 1972

PURPOSE Determination of 2378 TCDD in 245 TCP

DESCRIPTION Procedure applicable to the determination of 2378 TCDD in 245 TCP. The 2378 TCDD is separated from the sample matrix by an organic solvent extraction (benzene) of an aqueous caustic solution of the sample. The resulting residue is concentrated and a portion examined by GC-MS. TCDD recoveries in spiked samples over a range of 0.05 ppm to over 1 ppm should be 100% +/- 15%. By this procedure with a precision of duplicate samples of +/- 15%. The lower limit of detection is 0.05 ppm.

ANALYSIS METHOD NUMBER 6

METHOD ML-AM-73-45
DATE 14 June 1973

PURPOSE Determination of chlorinated dibenzo-p-dioxin purified PCP by liquid chromatography

DESCRIPTION Applicable to the determination of Hexachlorodibenzo-p-dioxin (HCDD) in the range of 0.5 to 10 ppm and octachlorodibenzo-p-dioxin (OCDD) in the range of 5 to 60 ppm in purified PCP preservative. The HCDD and OCDD are separated from the sample matrix by a solvent extraction (benzene) of an aqueous caustic sample solution followed by ion exchange separation and residue concentration. A portion of the concentrated extract is examined by reverse-phase partition liquid chromatography with ultraviolet detection. HCDD and OCDD recoveries of spiked purified PCP samples was 93 to 104%. The results for a single determination on a given sample should be accurate within +/- 20% relative error. The instrument response was calibrated using external standards.

ANALYSIS METHOD NUMBER 7

METHOD ML-AM-73-55
DATE 24 September 1973

PURPOSE Determination of chlorinated dibenzo-p-dioxins in purified sodium salt of PCP by liquid chromatography

DESCRIPTION Applicable for the determination of HCDD in the range of 0.5 to 10 ppm and OCDD in the range of 5 to 60 ppm in the sodium salt of PCP antimicrobial. The HCDD and OCDD are separated from the sample matrix by a solvent extraction (benzene) of a aqueous caustic sample solution followed by ion exchange separation and residue concentration. A portion of the concentrated extract is examined by reverse-phase partition liquid chromatography with ultraviolet detection. HCDD and OCDD recoveries of spiked sodium salt of PCP samples was 94 to 103%. The results for a single determination on a given sample should be accurate within +/- 20% relative error. The instrument response was calibrated using external standards.

ANALYSIS METHOD NUMBER 8

METHOD ML-AM-73-76
DATE 14 December 1973

PURPOSE Determination of HCDD and OCDD in Dowicide G-ST Brand of purified sodium salt of PCP by GC-MS.

DESCRIPTION Applicable to the determination of HCDD and OCDD at the ppm level in Dowicide G-ST Brand of purified NA PCP. A sample of Dowicide G-ST Brand of purified NA PCP is dissolved in 1:1 benzene/methanol (V/V) and is transferred to an ion exchange column where the HCDD and OCDD are separated from the sample matrix. The column eluent is concentration and a portion of this concentrate is evaluated by GC-MS. The recovery for HCDD and OCDD in spiked samples is 90% +/- 30% by this procedure with a precision of +/- 10% for duplicate samples.

ANALYSIS METHOD NUMBER 9

METHOD ML-AM-74-40
DATE 8 November 1974

PURPOSE Determination of 2378 TCDD in 0,0-Dimethyl-0-(2,4,5-trichlorophenyl)Phosphorothioate (Ronnel).

DESCRIPTION Applicable to the determination of 2378 TCDD in 0,0-Dimethyl-0-(2,4,5-trichlorophenyl)Phosphorothioate. An appropriate sample (5 grams of material slurried with 15 ml of 20% benzene in hexane) is put through a clean-up procedure (silica gel and alumina columns) to separate the 2378 TCDD from the sample matrix. The final cleanup eluent is concentrated and a portion of this concentrate is evaluated by GC-MS. The recovery for spiked samples is 90 to 95% by this procedure with a precision of +/- 20% for duplicate samples. The limit of detection using this method is 5 to 10 ppb. The instrument response was calibrated using external standards.

ANALYSIS METHOD NUMBER 10

METHOD No. 87619b
DATE 17 December 1975

PURPOSE The determination of 2378 TCDD in 245-T acid butoxy ethanol esters

DESCRIPTION Applicable to the analysis of 245-trichlorophenoxyacetic acid (245-T acid); butoxy ethanol esters. Procedures are given for the determination of the assay of 245-T acid; butoxy ethanol esters and free acid. The acid equivalent is calculated from the assay. Also a procedure is given for the determination of 2378 TCDD, The 2378 TCDD is separated from the sample matrix by silica Gel column chromatography. The eluent is concentrated and a portion of the final residue is examined by GC-MS. The precision of this procedure is within 20% of the amount present and a detection limit of 0.01 ppm.

ANALYSIS METHOD NUMBER 11

METHOD No. 90110a
DATE 17 September 1974

PURPOSE Determination of 2378 TCDD in weed and brush killer formulations of the triethylamine salt of 2,4,5 trichlorophenoxyacetic acid.

DESCRIPTION Applicable to the analysis of the weed and brush killer which are a formulation of the triethylamine salt of 245-T acid. Procedures are given for the determination of 245-T acid equivalent by extraction with methyl isobutyl ketone and apparent specific gravity at 20 DEG C. From these data the concentration of the active ingredient (triethylamine salt of 245-T acid); inert ingredients and the pounds of 245-T acid equivalent per gallon are calculated. Also a procedure is given for the determination of 2378 TCDD. The 2378 TCDD is separated from the sample matrix by silica gel column chromatography. The eluent is concentrated and a portion of the final residue is examined by GC-MS. The precision of this procedure is within 20% of the amount present, detection limit 0.01 ppm.

ANALYSIS METHOD NUMBER 12

METHOD ML-AM-75-34
DATE 20 May 1975

PURPOSE Determination of 2378 TCDD in 245-T acid and related materials

DESCRIPTION Applicable to the determination of 2378 TCDD and other related chlorinated materials in 245-T acid and also 2,4-D; and related acids and phenolic materials and esters of these acids. The 2378 TCDD (and related compounds) are separated from the sample matrix by: 1) the extraction of an aqueous caustic solution of chlorinated phenols, 2) or by ion exchange chromatography of chlorinated phenoxyacetic acids in 1:1 benzene/methanol (v/v), 3) or by silica gel column chromatography of non-ionizable samples such as esters in 20% benzene in hexane. The residues from these separation techniques are concentrated and a portion of the concentrate evaluated by GC-MS. the precision of this procedure for duplicate samples is +/- 20%. The lower limit of detection is 0.01 to 0.02 ppm.

ANALYSIS METHOD NUMBER 13

METHOD ML-AL-75-01028
DATE 14 August 1975

PURPOSE Determination of 2378 TCDD in propylene glycol butyl ether ester of 245-T acid.

DESCRIPTION Applicable to the determination of 2378 TCDD in propylene glycol butyl ether ester of 245-T acid. A sample of the ester of 245-T is dissolved in hexane and transferred to a silica gel column where the 2378 TCDD is separated from the sample matrix. The column eluate is concentrated and a portion of the concentrate evaluated by GC-MS. The precision of this procedure is +/- 20% of the amount present. The lower limit of detection was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 14

METHOD ML-AL-76-00943
DATE 23 July 1976

PURPOSE Determination of 2378 TCDD in 0,0-Dimethyl-o-245-trichlorophenyl phosphorothioate (fenchlorphos-common name) (Ronnel).

DESCRIPTION Applicable to the determination of 2378 TCDD in fenchlorophos. The 2378 TCDD is separated from the sample matrix by silica gel and alumina column chromatography. The final column eluate is concentrated and a portion of the concentrate is evaluated by GC-MS. The precision of this procedure is +/- 20% of the amount present. The lower limit of detection is 0.01 ppm.

ANALYSIS METHOD NUMBER 15

METHOD ML-AL-77-02453A
DATE 14 December 1977

PURPOSE Determination of 2378 TCDD in 245-Trichlorophenol

DESCRIPTION Applicable to the determination of 2378 TCDD in 245-TCP. The 2378 TCDD is separated from the sample matrix by an organic solvent (hexane) extraction of an aqueous caustic solution of 245-TCP followed by basic alumina column chromatography of the extract. The alumina column eluate is concentrated and portion of the concentrate is evaluated by GC-MS. The lower limit of detection is 0.6 to 1 ppb (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 16

METHOD MLW.65.11
DATE 22 June 1965

PURPOSE Determination of 2378 TCDD in 245-T Acid by GLC

DESCRIPTION Applicable to the determination of 2378 TCDD in 245-T acid. The 2378 TCDD is separated from the sample matrix by means of an extraction with chloroform. The chloroform extract is concentrated and a portion of it is evaluated by GLC with flame ionization detection. the accuracy of this method is +/- 5% relative; with a lower detection limit of 0.05 ppm.

ANALYSIS METHOD NUMBER 17

METHOD ML-AM-73-56
DATE 5 September 1973

PURPOSE Determination of HCDD and OCDD in purified PCP by GC-MS

DESCRIPTION Applicable to the determination of HCDD and OCDD in purified PCP, the HCDD and OCDD _ are separated from the sample matrix by ion exchange chromatography of a solution of purified PCP in 1:1 benzene/methanol (v/v). The eluent is concentrated and a portion of the concentrate is analyzed by GC-MS. The precision of this procedure for duplicate samples is +/- 10% with recoveries of HCDD and OCDD in spiked samples of 90% +/- 30%.

ANALYSIS METHOD NUMBER 18

METHOD ML-AL-75-00449
DATE 17 March 1975

PURPOSE Determination of 2378 TCDD in 245-TCP

DESCRIPTION Applicable to the determination of 2378 TCDD in 245-TCP. The 2378 TCDD is separated from the sample matrix by the extraction of an aqueous caustic solution of 245-TCP with benzene. A portion of this extract is then evaluated by GC-MS. The precision of this procedure is +/- 20% with recoveries of spiked samples of 108% +/- 20%. The limit of detection is 0.01 to 0.02 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 19

METHOD ML-AL-87-064
DATE 7 November 1974

PURPOSE Determination of 2378 TCDD in Ronnel

DESCRIPTION This analytical method describes experiments used to determine which clean-up steps of method ML-AM-73-97 could be eliminated to achieve a 2378 TCDD detection limit of at least 0.01 ppm in fenchlorophos insecticide. (treatment with KOH; treatment with H_2SO_4; silica gel column and alumina column). In conclusion the combination of silica gel column followed by alumina column eliminated interferences which allowed the determination of 2378 TCDD at 0.005 ppm with a much shorter preparation time than that given in method ML-AM-73-97.

ANALYSIS METHOD NUMBER 20

METHOD ML-AM-73-97
DATE 14 February 1974

PURPOSE Determination of 2378 TCDD in Fish and Soil

DESCRIPTION Applicable to the determination of 2378 TCDD in fish and soil from 10 to 1000 parts per trillion (PPT) by weight. The 2378 TCDD is separated from the complex sample matrix by putting an appropriate sample through a cleanup procedure designated to eliminate interfering substances. This cleanup procedure consists of treatment with potassium hydroxide and ethanol; sample digestion, extraction with hexane; extract washes with sulfuric acid; extract concentration; silica gel and alumina column chromatography; and eluent concentration. A portion of the final solution is then evaluated by GC-MS. Recoveries of 2378 TCDD in spiked samples varied from 0% to 140%. The limit of detection varied from 6 to 9 PPT (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 21

METHOD No. 87575D
DATE 18 August 1977

PURPOSE ANALYSIS OF 245-T acid and propylene glycol butyl ether esters

DESCRIPTION Applicable to the analysis of 245-T acid; propylene glycol butyl ether esters. Procedures are given for the determination of the acid equivalent as 245-T acid and free acidity. The assay is calculated from the acid equivalent. Also a procedure is given for determination of 2378 TCDD. The 2378 TCDD is separated from the sample ma:rix by silica gel column chromatography. The eluate is concentrated and a portion of th final residue is examined by GC-MS. The precision of this procedure is within 20% of the amount present and a detection limit of 0.01 ppm.

ANALYSIS METHOD NUMBER 22

METHOD No. 87621B
DATE 18 August 1977

PURPOSE Determination of 2378 TCDD in 245-T acid and butoxy propyl esters. Assay of 245-T acid and butoxy propyl esters.

DESCRIPTION Applicable to the analysis of 245-T acid; butoxy propyl esters. Procedures are given for the determination of the acid equivalent as 245-T acid and free acidity. The assay is calculated from the acid equivalent. Also a procedure is given for the determination of 2378 TCDD. The 2378 TCDD is separated from the sample matrix by silica gel column chromatography. The eluate is concentrated and a portion of the final residue is examined by GC-MS. The precision of this procedure is within 20% of the amount present and a detection limit of 0.01 ppm.

ANALYSIS METHOD NUMBER 23

METHOD ML-AL-30-683
DATE 29 November 1971

PURPOSE Determination of chlorinated dibenzo-p-dioxins and chlorinated dibenzo-furans in chlorinated phenols.

DESCRIPTION Determination of chlorinated dibenzo-p-dioxin and dibenzo-furans in various chlorinated phenolic materials ie; (pentachlorophenol; distilled pentachlorophenol; distilled tetrachlorophenol; sodium pentachlorophenate; 2346 tetrachlorophenol; 246 trichlorophenol). The dioxins and furans are separated from the sample matrix by the following techniques. 1) dissolution of acidic materials in aqueous caustic followed by extraction with benzene or hexane. 2) sorption of acidic components onto anion exchange resin with elution of chlorinated dioxins/furans. 3) sorption of polar components (esters etc.) onto silica gel with elution of chlorinated dioxins/furans. The resulting solvent containing the residue are concentrated and then analyzed by gas chromatography-mass spectrometry. Detection sensitivity of about 1 ppb in the sample has been achieved by this procedure.

ANALYSIS METHOD NUMBER 24

METHOD ML-AM 75-3
DATE 22 November 1974

PURPOSE Determination of compounds in purified pentachlorophenol

DESCRIPTION Determination of PCP; the tetrachlorophenols; HCDD; OCDD; in purified PCP preservative. The phenolic constituents are determined by analysis of a sample dissolved in methylene chloride with GC with flame ionization detection using an internal standard technique. Data obtained by this procedure indicate a standard deviation of 0.23% for PCP; and 0.18% for tetrachlorophenols. Values obtained for PCP vary from the average by +/- 0.5% & +/- 0.4% for tetrachlorophenols at the 95% confidence level. The HCDD and OCDD's are separated from the sample matrix by the extraction of an alkaline solution with benzene, the extract is cleaned up by ion exchange chromatography and concentrated. The extract is injected into a liquid chromatograph and the dioxins separated by reverse-phase partition chromatography with UV detection. HCDD can be determined in the range of 0.5 to 10 ppm; and OCDD in the range of 5 to 60 ppm in purified PCP, recoveries from 93 to 104% were obtained from spiked samples with an accuracy of +/- 20% relative error for a single determination.

ANALYSIS METHOD NUMBER 25

METHOD ML-AL 67-210
DATE 24 April 1973

PURPOSE Determination of chlorinated dibenzo-p-dioxins in purified PCP by liquid chromatography.

DESCRIPTION Determination hexachlorodibenzo-p-dioxin (HCDD); and octachlorobenzo-p-dioxin (OCDD) in purified PCP. The HCDD's and OCDD are separated from the sample matrix by the extraction of an alkaline aqueous solution with benzene. The extract is cleaned up by ion exchange chromatography and concentrated. The concentrated extract is injected in a liquid chromatograph and the dioxins are separated by reverse-phase partition chromatography with ultraviolet detection. Recoveries from 93 to 104% were obtained from spiked samples with an accuracy of +/- 20% relative error for a single determination. Sensitivity at the 0.5 ppm level was achieved for both dioxins.

ANALYSIS METHOD NUMBER 26

METHOD ML-AL 75-01585
DATE 18 December 1975

PURPOSE Gas chromatographic separation of hexachlorodibenzo-p-dioxin isomers

DESCRIPTION A procedure for the gas chromatographic separation of various isomers of hexachlorodibenzo-p-dioxin; and the preparation of bonded chromatographic packings materials. The gas chromatographic separation and flame ionization detection permitted the assignment of structure based on retention time. The isomers which were investigated strongly suggest an elution order determined by hydrogen-bonding.

ANALYSIS METHOD NUMBER 27

METHOD ML-AL 76-00764
DATE 31 May 1976

PURPOSE Dioxin analytical studies; improved selectivity for automated dioxin separation and collection system.

DESCRIPTION Procedure describes the experiments and results used to improve the sample clean up procedure for use on the automated dioxin separation and collection system. The modifications will allow the determination of 2378 TCDD at the 5 ppb level. Several other techniques for achieving increased TCDD detection via automated procedures are discussed as possible future direction.

ANALYSIS METHOD NUMBER 28

METHOD ML-AL 27-635
DATE 7 April 1971

PURPOSE Total analysis of pentachlorophenol - Batch 9822 and 9931

DESCRIPTION This analytical method describes a procedure for the determination of 2378 TCDD and HCDD in pentachlorophenol. The dioxins are separated from the sample matrix by passing a solution of pentachlorophenol through a ion-exchange resin column; the residue is concentrated and injected onto a liquid-liquid (reverse-phase) chromatographic column. Multiple fractions from the column are collected and concentrated. A portion of the concentrated fractions are injected onto a gas chromatograph utilizing electron capture detection for measurement of dioxins.

ANALYSIS METHOD NUMBER 29

METHOD ML-AL 87-453
DATE 7 November 1974

PURPOSE .Determination of 2378 Tetrachlorodibenzo-p-dioxin in 2-(245-trichlorophenoxy) proprionic acid; propylene glycol (C3H60 to C9H1803) butyl ether esters. A herbicide.

DESCRIPTION Procedure for the determination of 2378 TCDD in a herbicide. The 2378 TCDD is separated from the sample matrix buy using a silica gel column cleanup step followed by sample concentration. A portion of the sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 91% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 30

METHOD ML-AL 81-176
DATE 1 July 1974

PURPOSE The examination of 245-trichlorophenol and esters of 245-trichlorophenoxyacetic acid for clorinated dibenzo-p-dioxin.

DESCRIPTION A procedure for the determination of chlorinated dibenzo-p-dioxin (27-dichloro-;trichloro-;2378-tetrachloro-;pentachloro-; hexachloro-;heptachloro-; and octachloro-dioxin) in 245-trichlorophenol and esters of 245-trichlorophenoxyacetic acid (245-T). The dioxins are separated from the 245-T esters by using a silica gel column cleanup step followed by sample concentration and gas chromatography-mass spectrometry evaluation. The dioxins are separated from the 245-trichlorophenol by the solvent (benzene) extraction of an aqueous caustic solution of the sample followed by the entire procedure previously described for the 245-T esters.

ANALYSIS METHOD NUMBER 31

METHOD ML-AL-87-442
DATE 5 November 1974

PURPOSE Determination of 2378-tetrachlorodibenzo-p-dioxin in brush killer herbicide (contains esters of butyl ethers of propylene glycol and polypropylene glycols with 24-dichlorophenoxyacetic acid and 245-trichlorophenoxyacetic acid).

DESCRIPTION Procedure for the determination of 2378 TCDD in brush killer. The 2378 TCDD is separated from the sample matrix by using a silica gel column cleanup step followed by sample concentration. A portion of the sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 93% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 32

METHOD ML-AL 87-564
DATE 14 November 1974

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in brush killer T.

DESCRIPTION Procedure for the determination of 2378 TCDD in brush killer T. The 2378 TCDD is separated from the sample matrix by using a silica gel column cleanup followed by sample concentration. A portion of the sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 86% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 33

METHOD ML-AL-87-563
DATE 14 November 1974

PURPOSE Determination of 2378 tetrachlorodibenzo-]-dioxin in brush and weed killer. (An emulsifiable solution containing a mixture of the butyl esters of propylene and polypropylene glycol as an ester of 245-trichlorophenoxyacetic acid).

DESCRIPTION A procedure for the determination of 2378 TCDD in brush and weed killer. The 2378 TCDD is separated from the sample matrix by using a silica gel column cleanup step followed by sample concentration. A portion of the sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 91% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 34

METHOD ML-AL 87-586
DATE 21 November 1974

PURPOSE Determination of 2378 Tetrachlorodibenzo-p-dioxin in brush and weed killer concentrate. (concentrate of an emulsifiable solution containing a mixture of the butyl esters of propylene and polypropylene glycol as an ester of 245-T acid).

DESCRIPTION Determination of 2378 TCDD in brush and weed killer concentrate. The 2378 TCDD is separated from the sample matrix by using a silica gel column cleanup step followed by sample concentration. A portion of the sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 80% +/- 20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 35

METHOD ML-AL 87-441
DATE 5 November 1974

PURPOSE Determination of 2378 Tetrachlorodibenzo-p-dioxin in butoxy propyl ester mix #1.

DESCRIPTION Determination of 2378 TCDD in butoxy propyl ester mix #1. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 91% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 36

METHOD ML-AL-87-451
DATE 6 November 1974

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in herbicide. (Propylene glycol (C3H60 to C9H1803) butyl ether esters of 245 trichlorophenoxyacetic acid).

DESCRIPTION Determination of 2378 TCDD in a herbicide. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 81% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 37

METHOD ML-AL- 76-00862
DATE 30 June 1976

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in herbicide 155 mixture (active ingredient is picloram).

DESCRIPTION Determination of 2378 TCDD in 155 mixture. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 103% +/-20% (two standard deviation) at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.002 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 38

METHOD ML-AL 87-452
DATE 7 November 1974

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in the amine salt of 245-T weed and brush killer.

DESCRIPTION Determination of 2378 TCDD in the weed and brush killer. The 2378 TCDD is separated from the sample matrix by the extraction of an aqueous solution of the sample with hexane followed by a clean up with silica gel column and sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 86% +/-20%. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 39

METHOD ML-AL-75-01030
DATE 15 August 1975

PURPOSE Determination of 2378 Tetrachlorodibenzo-p-dioxin in propylene glycol butyl ether ester of 2-(245-trichlorophenoxy) propionic acid.

DESCRIPTION Determination of 2378 TCDD in propylene glycol butyl ether ester of 2-(245-Trichlorophenoxy) propionic acid. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 95% +/-20% at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 40

METHOD ML-AL 76-00979
DATE 27 September 1976

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in Korlan® 8

DESCRIPTION Determination of 2378 TCDD in Korlan® 8. The 2378 TCDD is separated from the sample matrix by using a silica gel column followed by an alumina column clean up step and sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 91% +/-20% (two standard deviations) with a detection limit of 0.01 ppm.

ANALYSIS METHOD NUMBER 41

METHOD ML-AL 75-1190
DATE 19 September 1975

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in Dowanol ETCP

DESCRIPTION Determination of 2378 TCDD in Dowanol ETCP. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 87% +/-20% at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 42

METHOD ML-AL 75-01177
DATE 7 November 1975

PURPOSE Determination of 2378 Tetrachlorodibenzo-p-dioxin in Erbon herbicide.

DESCRIPTION The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 101% +/-20% at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.01 ppm (defined as 2.5 times the noise level.)

ANALYSIS METHOD NUMBER 43

METHOD ML-AL 75-01046
DATE 22 August 1975

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in butoxy ethanol ester of 245 trichlorophenoxyacetic acid

DESCRIPTION Determination of 2378 TCDD in butoxy ethanol ester of 245 Trichlorophenoxyacetic acid. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentration evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 97% +/-20% at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

ANALYSIS METHOD NUMBER 44

METHOD ML-AL 75-00340
DATE 13 March 1975

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in Dowanol ETCP

DESCRIPTION Determination of 2378 TCDD ion Dowanol ETCP. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recovery by this procedure was 94.5%.

ANALYSIS METHOD NUMBER 45

METHOD ML-AL 76-01278
DATE 10 November 1976

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in Korlan® 24E

DESCRIPTION Determination of 2378 TCDD in Korlan® 24E. The 2378 TCDD is separated from the sample matrix by using a silica gel column followed by an alumina column clean up step and sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry (GS-MS). The average recovery is 94% +/-12% defined as two standard deviations. The detection limit is 0.002 ppm defined as 2.5 times the average noise level.

ANALYSIS METHOD NUMBER 46

METHOD ML-AL 75-00636
DATE 2 May 1975

PURPOSE Determination of 2378 tetrachlorodibenzo-p-dioxin in butyl esters of 245 trichlorophenoxyacetic acid.

DESCRIPTION Determination of 2378 TCDD in butyl esters of 245 trichlorophenoxyacetic acid. The 2378 TCDD is separated from the sample matrix by using a silica gel column clean up step followed by sample concentration. A portion of the clean sample concentrate is evaluated by gas chromatography-mass spectrometry. TCDD recoveries were 95% +/-20% at the 0.02 to 0.1 ppm level. The precision of this procedure is within 20% of the amount present. The detection limit was 0.01 ppm (defined as 2.5 times the noise level).

Appendix E
Dow Analytical Summary Data
Tables 15 through 26
The Dow Chemical Company
Midland, Michigan

Table 15
Symbols and Definitions for Appendix E
The Dow Chemical Company
Midland, Michigan

Symbol	Definition
124679-HxCDD	1,2,4,6,7,9-hexachlorodibenzo-p-dioxin
1367-TCDD	1,3,6,7-tetrachlorodibenzo-p-dioxin
1368-TCDD	1,3,6,8-tetrachlorodibenzo-p-dioxin
245-T acid	2,4,5-trichlorophenoxyacetic acid
245-T amine	amines of 2,4,5-T
245-T ester	esters of 2,4,5-T
245-TCP (TCP)	2,4,5-trichlorophenol
246-TCP	2,4,6-trichlorophenol
27-DCDD	2,7-dichlorodibenzo-p-dioxin
3478-TCDD	3,4,7,8-tetrachlorodibenzo-p-dioxin
CIO	caustic insoluble oils (from NaTCP process)
Erbon	2-(2,4,5-trichlorophenoxy)-ethyl 2,2-dichloropropionate
FBD	fluid bed dryer
HpCDD	heptachlorodibenzo-p-dioxins
HpCDF	heptachlorodibenzofurans
HxCDD	hexachlorodibenzo-p-dioxins
HxCDF	hexachlorodibenzofurans
LOD	limit of detection for a given sample result
Max. Det.	maximum detectable sample result
Mean when ND=LOD/2	arithmetic mean when all NDs are set equal to one half the LOD
MeOH	methanol
Min. Det.	minimum detectable sample result
NaPCP	sodium pentachlorophenate
NaTCP (phenate)	sodium 2,4,5-trichlorophenate
ND	non-detectable sample result
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
Pc	process stream sample
PCDD	pentachlorodibenzo-p-dioxins
PCDF	pentachlorodibenzofurans
PCP	pentachlorophenol
Pr	product sample
Ronnel	O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphoroate
SD when ND=LOD/2	standard deviation when all NDs are set equal to one half the LOD
Silvex	2-(2,4,5-trichlorophenoxy) propionic acid
Silvex ester	esters of silvex
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TetCP	tetrachlorophenols
TriCDD	trichlorodibenzo-p-dioxins
ug/g	micrograms of analyte per gram of sample
Wa	waste effluent sample

Table 16
Dow Analytical Data (ug/g)
199 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1962	199	TCP ClO	TCDD	Wa	28	1	<0.1	2104	976	0.7	4000
1963	199	TCP ClO	TCDD	Wa	1	0	---	3.5	---	3.5	3.5
1964	199	TCP ClO	TCDD	Wa	9	0	---	1184	3194	1.6	9680
1965	199	TCP ClO	TCDD	Wa	47	0	---	2204	1450	71	7500
1965	199	Na TCP reactor	TCDD	Pc	43	5	<1	2.75	3.40	1	16

Table 17
Dow Analytical Data (ug/g)
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1966	804	TCP tars	TCDD	Wa	16	0	---	50	53	1	170
1967	804	2,4,5-TCP	TCDD	Pr	21	21	<0.50*	---	---	---	---
1967	804	TCP tars	TCDD	Wa	80	0	---	52	22	12	108
1968	804	2,4,5-TCP	TCDD	Pr	3	3	<1.0	---	---	---	---
1970	804	TCP tars	TCDD	Wa	6	0	---	80	69	0.5	190
1971	804	2,4,6-TCP	HpCDD	Pr	2	2	<0.5	---	---	---	---
1971	804	2,4,6-TCP	HpCDF	Pr	2	1	<0.5	1.1	---	2	2
1971	804	2,4,6-TCP	HxCDD	Pr	2	0	---	11	---	6	16
1971	804	2,4,6-TCP	HxCDF	Pr	2	0	---	23	---	11	35
1971	804	2,4,6-TCP	OCDD	Pr	2	2	<0.5	---	---	---	---
1971	804	2,4,6-TCP	TCDD	Pr	3	0	---	0.8	0.6	0.06	1.3
1971	804	2,4,6-TCP	TCDF	Pr	1	0	---	8	---	8	8
1971	804	Na TCP reactor	TCDD	Pc	4	4	<0.5	---	---	---	---
1971	804	Phenate after neutralizer	TCDD	Pc	2	0	---	0.02	---	0.02	0.02
1971	804	Phenate before neutralizer	TCDD	Pc	2	2	<0.01	---	---	---	---
1971	804	TCP decanter	TCDD	Pc	3	0	---	0.40	0.24	0.15	0.73
1971	804	TCP drier	TCDD	Pc	8	0	---	0.03	0.01	0.02	0.05
1971	804	TCP drier feed	TCDD	Pc	8	0	---	0.04	0.01	0.02	0.06
1971	804	TCP flash still bottoms	TCDD	Pc	2	0	---	0.07	---	0.05	0.08
1971	804	TCP flash still feed	TCDD	Pc	2	0	---	0.1	---	0.09	0.1
1971	804	TCP oil	TCDD	Wa	5	0	---	37	3	31	40
1971	804	TCP reactor	TCDD	Pc	11	1	<0.1	0.33	0.11	0.09	1.1
1971	804	TCP solids	TCDD	Wa	3	1	<0.05	8.6	26.0	4.4	47
1971	804	TCP stripper bottoms	TCDD	Pc	10	8	<0.01	0.01	0.004	0.01	0.01
1971	804	TCP stripper feed	TCDD	Pc	10	5	<0.01	0.01	0.01	0.01	0.02

Table 17
Dow Analytical Data (ug/g)
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1971	804	TCP tars	TCDD	Wa	12	1	<0.5	32	61	1.175	188
1972	804	2,4,5-TCP	27-DCDD	Pr	4	4	<0.05	---	---	---	---
1972	804	2,4,5-TCP	HpCDD	Pr	4	4	<0.1	---	---	---	---
1972	804	2,4,5-TCP	HxCDD	Pr	4	3	<0.05	0.05	0.05	0.13	0.13
1972	804	2,4,5-TCP	OCDD	Pr	4	4	<0.1	---	---	---	---
1972	804	2,4,5-TCP	TCDD	Pr	92	67	<0.04*	0.02	0.01	0.01	0.06
1972	804	2,4,6-TCP	HpCDD	Pr	1	1	<1.0	---	---	---	---
1972	804	2,4,6-TCP	HxCDD	Pr	1	1	<1.0	---	---	---	---
1972	804	2,4,6-TCP	HxCDF	Pr	1	0	---	50	---	50	50
1972	804	2,4,6-TCP	OCDD	Pr	1	1	<1.0	---	---	---	---
1972	804	Na TCP reactor	TCDD	Pc	5	4	<0.05	0.04	0.03	0.1	0.1
1972	804	TCP tars	HpCDD	Wa	1	1	<2	---	---	---	---
1972	804	TCP tars	HpCDF	Wa	1	1	<2	---	---	---	---
1972	804	TCP tars	HxCDD	Wa	1	1	<1	---	---	---	---
1972	804	TCP tars	HxCDF	Wa	1	1	<1	---	---	---	---
1972	804	TCP tars	OCDD	Wa	1	1	<3	---	---	---	---
1972	804	TCP tars	OCDF	Wa	1	1	<3	---	---	---	---
1972	804	TCP tars	TCDD	Wa	61	1	<0.2	1.3	2.3	0.1	12
1973	804	2,4,5-TCP	27-DCDD	Pr	1	1	<0.01	---	---	---	---
1973	804	2,4,5-TCP	HxCDD	Pr	2	2	<0.01	---	---	---	---
1973	804	2,4,5-TCP	OCDD	Pr	2	2	<0.05	---	---	---	---
1973	804	2,4,5-TCP	PCDD	Pr	2	2	<0.1	---	---	---	---
1973	804	2,4,5-TCP	TCDD	Pr	260	251	<0.02*	0.01	0.01	0.003	0.05
1973	804	2,4,5-TCP	Tri-CDD	Pr	2	2	<0.01	---	---	---	---
1973	804	Na TCP reactor	TCDD	Pc	22	18	<0.03*	0.03	0.06	0.03	0.3

Table 17
Dow Analytical Data (ug/g)
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1973	804	TCP oil	TCDD	Wa	1	0	---	0.9	---	0.9	0.9
1973	804	TCP sludge	TCDD	Wa	1	0	---	0.08	---	0.08	0.08
1973	804	TCP solids	TCDD	Wa	1	0	---	69	---	69	69
1973	804	TCP tars	TCDD	Wa	27	0	---	11.6	27.9	0.2	140
1974	804	2,4,5-TCP	HxCDD	Pr	8	8	<0.04	---	---	---	---
1974	804	2,4,5-TCP	TCDD	Pr	272	262	<0.16*	0.001	0.005	0.02	0.04
1974	804	Na TCP reactor	HxCDD	Pc	2	2	<0.1	---	---	---	---
1974	804	Na TCP reactor	TCDD	Pc	15	6	<0.03*	0.03	0.03	0.02	0.12
1974	804	TCP brine	TCDD	Wa	1	1	<0.1	---	---	---	---
1974	804	TCP reactor	TCDD	Pc	4	0	---	0.05	0	0.05	0.05
1974	804	TCP sludge	TCDD	Wa	1	0	---	0.7	---	0.7	0.7
1974	804	TCP tars	TCDD	Wa	6	3	<6.9	9.7	9.4	10	20
1974	804	TCP water	TCDD	Wa	1	1	<1.0	---	---	---	---
1975	804	2,4,5-TCP	HxCDD	Pr	4	4	<0.1	---	---	---	---
1975	804	2,4,5-TCP	OCDD	Pr	4	4	<0.1	---	---	---	---
1975	804	2,4,5-TCP	TCDD	Pr	97	94	<0.01*	0.006	0.006	0.01	0.06
1975	804	2,4,6-TCP	1368-TCDD	Pr	1	1	<0.01	---	---	---	---
1975	804	2,4,6-TCP	TCDD	Pr	1	1	<0.01	---	---	---	---
1975	804	Na TCP reactor	TCDD	Pc	3	2	<0.01	0.03	0.06	0.08	0.08
1975	804	TCP tars	TCDD	Wa	1	0	---	0.68	---	0.68	0.68
1976	804	2,4,5-TCP	TCDD	Pr	182	154	<0.01*	0.007	0.010	0.0005	0.05
1976	804	Na TCP reactor	HxCDD	Pc	13	11	<0.03*	0.02	0.01	0.04	0.04
1976	804	Na TCP reactor	OCDD	Pc	8	0	---	1.6	0.1	0.3	3.5
1976	804	Na TCP reactor	TCDD	Pc	65	21	<0.009*	0.02	0.02	0.006	0.09
1976	804	TCP sludge	TCDD	Wa	2	1	<0.01	0.02	---	0.03	0.03

Table 17
Dow Analytical Data (ug/g)
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1976	804	TCP storage tank residues	TCDD	Wa	2	1	<0.01	0.02	---	0.03	0.03
1976	804	TCP tars	TCDD	Wa	2	0	---	8.3	---	8.3	8.3
1977	804	2,4,5-TCP	TCDD	Pr	142	133	<0.01*	0.007	0.004	0.006	0.02
1977	804	2,4,5-TCP purified	TCDD	Pr	6	3	<0.0004*	0.0003	0.0007	0.0000	0.0013
1977	804	Na TCP reactor	TCDD	Pc	84	25	<0.01	0.02	0.02	0.01	0.09
1977	804	TCP carbon	TCDD	Wa	1	0	---	0.21	---	0.21	0.21
1977	804	TCP solids	TCDD	Wa	5	0	---	3.25	6.03	0.02	14
1977	804	TCP tars	HpCDD	Wa	3	0	---	23.8	22.9	7.4	50
1977	804	TCP tars	HxCDD	Wa	3	0	---	1.1	0.8	0.5	2
1977	804	TCP tars	OCDD	Wa	3	0	---	107	47	54	144
1977	804	TCP tars	TCDD	Wa	22	5	<0.09*	2.7	2.6	0.1	10
1978	804	2,4,5-TCP	TCDD	Pr	274	269	<0.01*	0.005	0.001	0.001	0.01
1978	804	TCP brine	TCDD	Wa	10	8	<0.0005*	0.0002	0.0003	0.0000	0.0000
1978	804	TCP carbon	TCDD	Wa	1	0	---	0.043	---	0.043	0.043
1978	804	TCP sludge	HpCDD	Wa	1	0	---	0.02	---	0.02	0.02
1978	804	TCP sludge	HxCDD	Wa	1	0	---	0.01	---	0.01	0.01
1978	804	TCP sludge	OCDD	Wa	1	0	---	0.107	---	0.107	0.107
1978	804	TCP sludge	TCDD	Wa	7	1	<0.4	0.04	0.09	0.0002	0.06
1978	804	TCP solids	TCDD	Wa	3	0	---	0.37	0.55	0.043	1
1978	804	TCP tars	HpCDD	Wa	4	0	---	8.8	11.2	0.7	25
1978	804	TCP tars	HxCDD	Wa	4	0	---	0.6	0.7	0.1	1.6
1978	804	TCP tars	OCDD	Wa	4	0	---	51	51	5	112
1978	804	TCP tars	TCDD	Wa	15	3	<0.1	2.3	1.7	0.005	6
1978	804	TCP treated brine	TCDD	Wa	1	1	<10	---	---	---	---
1978	804	TCP water	TCDD	Wa	5	2	<0.00006	0.003	0.004	0.002	0.007

Table 18
Dow Analytical Data (ug/g)
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1963	349	2,4,5-TCP	TCDD	Pr	1	1	<1.0	---	---	---	---
1964	349	2,4,5-TCP	TCDD	Pr	5	3	<0.57*	1.2	2.5	0.8	6
1964	349	TCP wet	TCDD	Pc	1	0	---	4.8	---	4.8	4.8
1964	349	TCP tars	TCDD	Wa	1	0	---	41	---	41	41
1964	349	TCP oil	TCDD	Wa	1	0	---	3.8	---	3.8	3.8
1965	349	2,4,5-TCP	TCDD	Pr	14	13	<1.0	0.5	0.1	0.8	0.8
1965	349	2,4,5-TCP purified	TCDD	Pr	10	10	<1.0	---	---	---	---
1965	349	TCP #1 cut	TCDD	Pc	1	1	<1.0	---	---	---	---
1965	349	TCP #2 cut	TCDD	Pc	1	1	<1.0	---	---	---	---
1965	349	TCP #3 cut	TCDD	Pc	1	1	<1.0	---	---	---	---
1965	349	TCP #4 cut	TCDD	Pc	1	1	<1.0	---	---	---	---
1965	349	TCP 20x20 tank liquor	TCDD	Pc	27	10	<1.0	1.5	1.1	1	4.2
1965	349	TCP B13 tank	TCDD	Pc	1	0	---	28	---	28	28
1965	349	TCP brine	TCDD	Wa	2	0	---	5	---	5	5
1965	349	TCP caustic	TCDD	Wa	3	3	<1.0	---	---	---	---
1965	349	TCP filtered sludge	TCDD	Wa	1	1	<1.0	---	---	---	---
1965	349	TCP oil	TCDD	Wa	16	0	---	67.8	147.7	0.6	614
1965	349	TCP rundown tank	TCDD	Pc	5	5	<1.0	---	---	---	---
1965	349	TCP scrubber water	TCDD	Wa	1	1	<1.0	---	---	---	---
1965	349	TCP sludge	TCDD	Wa	1	0	---	260	---	260	260
1965	349	TCP still feed	TCDD	Pc	3	3	<1.0	---	---	---	---
1965	349	TCP tank liquid	TCDD	Pc	1	0	---	0.6	---	0.6	0.6
1965	349	TCP tars	TCDD	Wa	14	4	<1.0	927	1435	5	3600
1965	349	TCP water	TCDD	Wa	4	4	<1.0	---	---	---	---
1965	349	TCP wet	TCDD	Pc	9	0	---	21	12	5	41

Table 18
Dow Analytical Data (ug/g)
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1966	349	TCP tars	TCDD	Wa	1	1	<5.0	---	---	---	---
1967	349	2,4,5-TCP	TCDD	Pr	162	162	<1.0	---	---	---	---
1968	349	2,4,5-TCP	TCDD	Pr	81	81	<1.0	---	---	---	---
1970	349	2,4,5-TCP	TCDD	Pr	57	54	<0.49*	0.28	0.19	0.63	1.3
1971	349	2,4,5-TCP	TCDD	Pr	143	65	<0.36*	0.10	0.12	0.01	0.1
1972	349	2,4,5-TCP	27-DCDD	Pr	4	4	<0.05	---	---	---	---
1972	349	2,4,5-TCP	HpCDD	Pr	4	4	<0.1	---	---	---	---
1972	349	2,4,5-TCP	HxCDD	Pr	4	4	<0.05	---	---	---	---
1972	349	2,4,5-TCP	OCDD	Pr	4	4	<0.1	---	---	---	---
1972	349	2,4,5-TCP	TCDD	Pr	159	98	<0.04*	0.03	0.02	0.01	0.1
1973	349	2,4,5-TCP	27-DCDD	Pr	4	4	<0.01	---	---	---	---
1973	349	2,4,5-TCP	HxCDD	Pr	5	5	<0.01	---	---	---	---
1973	349	2,4,5-TCP	OCDD	Pr	4	4	<0.05	---	---	---	---
1973	349	2,4,5-TCP	PCDD	Pr	4	4	<0.1	---	---	---	---
1973	349	2,4,5-TCP	TCDD	Pr	100	93	<0.02*	0.010	0.005	0.003	0.03
1973	349	2,4,5-TCP purified	TCDD	Pr	11	11	<0.01*	---	---	---	---
1973	349	2,4,5-TCP	Tri-CDD	Pr	5	5	<0.01	---	---	---	---
1974	349	2,4,5-TCP	HxCDD	Pr	2	2	<0.1	---	---	---	---
1974	349	2,4,5-TCP	TCDD	Pr	8	7	<0.02	0.01	0.00	0.02	0.02
1974	349	Na TCP	HxCDD	Pr	2	2	<0.1	---	---	---	---
1974	349	Na TCP reactor	TCDD	Pc	5	0	---	0.05	0.04	0.02	0.12
1974	349	PCP scrubber solution	HxCDD	Wa	1	1	<0.5	---	---	---	---
1974	349	PCP scrubber solution	TCDD	Pc	10	10	<0.1	---	---	---	---
1975	349	2,4,5-TCP	HxCDD	Pr	2	2	<0.08	---	---	---	---
1975	349	2,4,5-TCP	TCDD	Pr	7	5	<0.01	0.01	0.01	0.03	0.03

Table 18
Dow Analytical Data (ug/g)
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1975	349	2,4,5-TCP purified	HxCDD	Pr	1	1	<0.1	---	---	---	---
1975	349	2,4,5-TCP purified	OCDD	Pr	1	1	<0.2	---	---	---	---
1975	349	2,4,5-TCP purified	TCDD	Pr	5	5	<0.01	---	---	---	---
1976	349	2,4,5-TCP	TCDD	Pr	61	56	<0.009*	0.006	0.006	0.0025	0.03
1976	349	2,4,5-TCP purified	TCDD	Pr	11	6	<0.007*	0.003	0.003	0.0001	0.0038
1976	349	PCP tars	TCDD	Wa	1	1	<0.04	---	---	---	---
1976	349	TCP tars	367-TCD	Wa	2	0	---	1.1	---	0.6	1.6
1976	349	TCP tars	368-TCDD	Wa	1	0	---	3.3	---	3.3	3.3
1976	349	TCP tars	TCDD	Wa	17	0	---	10.2	6.3	1.8	19
1977	349	2,4,5-TCP	TCDD	Pr	99	99	<0.01	---	---	---	---
1977	349	2,4,5-TCP purified	TCDD	Pr	12	10	<0.004*	0.002	0.002	0.0002	0.001
1977	349	PCP scrubber solution	HxCDD	Wa	1	0	---	0.2	---	0.2	0.2
1977	349	PCP tars	HxCDD	Wa	1	0	---	58	---	58	58
1977	349	PCP tars	OCDD	Wa	1	0	---	4500	---	4500	4500
1977	349	TCP tars	TCDD	Wa	1	0	---	3.1	---	3.1	3.1
1978	349	2,4,5-TCP purified	TCDD	Pr	5	5	<0.01	---	---	---	---
1978	349	PCP tars	HpCDD	Wa	1	0	---	280	---	280	280
1978	349	PCP tars	HxCDD	Wa	1	0	---	260	---	260	260
1978	349	TCP tars	OCDD	Wa	1	0	---	70	---	70	70
1978	349	TCP tars	TCDD	Wa	1	0	---	0.034	---	0.034	0.034
1965	349	Na PCP water	TCDD	Wa	2	2	<1.0	---	---	---	---
1965	349	Na PCP caustic	TCDD	Wa	5	5	<1.0	---	---	---	---
1972	349	Na PCP slurry	HpCDD	Wa	1	0	---	1200	---	1200	1200
1972	349	Na PCP slurry	HpCDF	Wa	1	0	---	2200	---	2200	2200
1972	349	Na PCP slurry	HxCDD	Wa	1	0	---	40	---	40	40

Table 18
Dow Analytical Data (ug/g)
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1972	349	Na PCP slurry	HxCDF	Wa	1	0	---	900	---	900	900
1972	349	Na PCP slurry	OCDD	Wa	1	0	---	1400	---	1400	1400
1972	349	Na PCP slurry	OCDF	Wa	1	0	---	1500	---	1500	1500
1972	349	Na PCP slurry	TCDD	Wa	1	1	<0.05	---	---	---	---
1975	349	PCP chlorinator	HxCDD	Pc	8	0	---	17	10	4	36
1975	349	PCP chlorinator	OCDD	Pc	8	0	---	682	560	85	160
1976	349	PCP scrubber phenol	HxCDD	Wa	1	0	---	6	---	6	6
1976	349	PCP scrubber phenol	OCDD	Wa	1	1	<56	---	---	---	---
1976	349	PCP tars	TCDD	Wa	1	1	<0.04	---	---	---	---
1977	349	PCP	HpCDD	Pr	1	0	---	9	---	9	9
1977	349	PCP	HxCDD	Pr	7	2	<0.1	0.2	0.2	0.1	0.7
1977	349	PCP	OCDD	Pr	7	0	---	12	15	3	45
1977	349	PCP tars	HpCDD	Wa	1	0	---	1826	---	1826	1826
1977	349	PCP tars	HxCDD	Wa	3	0	---	146	205	0.2	380
1977	349	PCP tars	OCDD	Wa	2	0	---	5730	---	4500	6960
1977	349	PCP tars	TCDD	Wa	1	0	---	3.1	---	3.1	3.1
1978	349	PCP	HpCDD	Pr	10	0	---	4.0	5.6	0.2	16
1978	349	PCP	HxCDD	Pr	9	4	<0.1	0.4	0.7	0.1	2.1
1978	349	PCP	OCDD	Pr	10	0	---	14	18	3	63
1978	349	PCP tars	HpCDD	Wa	2	0		300	---	220	380
1978	349	PCP tars	HxCDD	Wa	2	0	---	150	---	130	170
1978	349	PCP tars	OCDD	Wa	2	0	---	185	---	120	250
1978	349	PCP tars	TCDD	Wa	3	2	<0.5	0.8	1.0	2	2

Table 19
Dow Analytical Data (ug/g)
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1957	267	2,4,5-T acid	TCDD	Pr	1	1	<0.5	---	---	---	---
1964	267	Silvex	TCDD	Pr	1	1	<0.1	---	---	---	---
1965	267	2,4,5-T acid	TCDD	Pr	27	23	<1.0*	0.6	0.4	1	1.8
1965	267	Silvex ester	TCDD	Pr	1	1	<0.1	---	---	---	---
1967	267	Silvex ester	TCDD	Pr	1	1	<0.1	---	---	---	---
1969	267	2,4,5-T acid	HpCDD	Pr	11	10	<0.2	0.11	0.03	0.2	0.2
1969	267	2,4,5-T acid	HxCDD	Pr	11	3	<0.1	0.16	0.10	0.13	0.41
1969	267	2,4,5-T acid	OCDD	Pr	10	8	<0.3	0.20	0.11	0.4	0.43
1969	267	2,4,5-T acid	TCDD	Pr	26	12	<0.5	0.10	0.10	0.06	0.44
1969	267	Silvex ester	TCDD	Pr	2	2	<0.1	---	---	---	---
1970	267	2,4,5-T acid	TCDD	Pr	15	11	<0.6*	0.3	0.2	0.1	0.4
1970	267	Silvex	HxCDD	Pr	1	1	<0.2	---	---	---	---
1970	267	Silvex	TCDD	Pr	9	8	<0.5	0.28	0.08	0.49	0.49
1971	267	2,4,5-TCP	2367-TCDD	Pr	3	0	---	0.02	0.01	0.01	0.03
1971	267	2,4,5-T acid	TCDD	Pr	5	1	<0.1	0.11	0.06	0.08	0.21
1971	267	2,4,5-T acid	HxCDD	Pr	1	1	<0.1	---	---	---	---
1971	267	2,4,5-T acid	HpCDD	Pr	1	1	<0.1	---	---	---	---
1971	267	Silvex ester	HxCDD	Pr	1	1	<0.05	---	---	---	---
1971	267	Silvex ester	PCDD	Pr	1	1	<0.05	---	---	---	---
1971	267	Silvex ester	OCDD	Pr	1	1	<0.05	---	---	---	---
1971	267	Silvex ester	TCDD	Pr	1	1	<0.05	---	---	---	---
1972	267	2,4,5-T acid	TCDD	Pr	35	3	<0.05	0.09	0.04	0.05	0.21
1973	267	2,4,5-T ester	TCDD	Pr	1	0	---	0.05	---	0.05	0.05
1973	267	2,4,5-T acid	TCDD	Pr	35	3	<0.05	0.09	0.04	0.05	0.21
1974	267	2,4,5-T ester	TCDD	Pr	1	0	---	0.06	---	0.06	0.06

Table 19
Dow Analytical Data (ug/g)
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1974	267	2,4,5-T ester	HxCDD	Pr	1	1	<0.01	---	---	---	---
1974	267	2,4,5-T ester check tank	TCDD	Pc	2	0	---	0.04	---	0.03	0.04
1975	267	2,4,5-T ester	TCDD	Pr	2	0	---	0.06	---	0.04	0.08

Table 20
Dow Analtical Data (ug/g)
489 Building
The Dow Chemical Compnay
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1965	489	2,4,5-T ester	TCDD	Pr	1	0	---	2.8	---	2.8	2.8
1966	489	2,4,5-T ester	TCDD	Pr	4	4	<0.7*	---	---	---	---
1967	489	2,4,5-T ester	TCDD	Pr	3	3	<0.05	---	---	---	---
1968	489	2,4,5-T ester	TCDD	Pr	14	14	<0.8*	---	---	---	---
1969	489	2,4,5-T ester	TCDD	Pr	1	1	<1.0	---	---	---	---
1970	489	2,4,5-T ester	TCDD	Pr	9	8	<1.0	0.47	0.17	0.23	0.23
1971	489	2,4,5-T amine	TCDD	Pr	3	3	<0.05	---	---	---	---
1971	489	2,4,5-T ester	HxCDD	Pr	1	0	---	0.17	---	0.17	0.17
1971	489	2,4,5-T ester	OCDD	Pr	1	1	<0.05	---	---	---	---
1971	489	2,4,5-T ester	PCDD	Pr	1	0	---	0.17	---	0.17	0.17
1971	489	2,4,5-T ester	TCDD	Pr	7	0	---	0.16	0.17	0.05	0.54
1972	489	2,4,5-T amine	TCDD	Pr	6	4	<0.05	0.03	0.01	0.05	0.05
1972	489	2,4,5-T ester	27 DCDD	Pr	1	1	<0.05	---	---	---	---
1972	489	2,4,5-T ester	HxCDD	Pr	3	3	<0.05	---	---	---	---
1972	489	2,4,5-T ester	OCDD	Pr	1	1	<0.05	---	---	---	---
1972	489	2,4,5-T ester	PCDD	Pr	1	1	<0.05	---	---	---	---
1972	489	2,4,5-T ester	TCDD	Pr	148	111	<0.06*	0.07	0.12	0.05	0.71
1972	489	Silvex ester	TCDD	Pr	17	16	<0.05	0.01	0.01	0.05	0.05
1972	489	Silvex ester formulation	TCDD	Pr	5	5	<0.05	---	---	---	---
1973	489	2,4,5-T ester	27 DCDD	Pr	6	6	<0.013*	---	---	---	---
1973	489	2,4,5-T ester	HpCDD	Pr	3	3	<0.01	---	---	---	---
1973	489	2,4,5-T ester	HxCDD	Pr	10	0	---	0.20	0.18	0.05	0.63
1973	489	2,4,5-T ester	OCDD	Pr	7	5	<0.013*	0.01	0.01	0.02	0.02
1973	489	2,4,5-T ester	PCDD	Pr	4	1	<0.01	0.3	0.2	0.4	0.4
1973	489	2,4,5-T ester	TCDD	Pr	147	73	0.50*	0.04	0.04	0.01	0.13
1973	489	2,4,5-T ester	Tri-CDD	Pr	6	1	<0.001	0.006	0.007	0.001	0.03

Table 20
Dow Analtical Data (ug/g)
489 Building
The Dow Chemical Compnay
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1973	489	2,4,5-T ester 1st reaction	TCDD	Pc	7	0	---	0.08	0.03	0.05	0.12
1973	489	2,4,5-T ester 2nd reaction	TCDD	Pc	1	0	---	0.11	---	0.11	0.11
1973	489	2,4,5-T ester 3rd reaction	TCDD	Pc	1	0	---	0.09	---	0.09	0.09
1973	489	2,4,5-T ester carbon	TCDD	Wa	1	1	<0.05	---	---	---	---
1973	489	2,4,5-T ester check tank	TCDD	Pc	322	124	<0.05	0.06	0.03	0.05	0.22
1973	489	2,4,5-T ester formulation	TCDD	Pr	19	19	<0.05	---	---	---	---
1973	489	2,4,5-T ester stripper	TCDD	Pc	23	10	<0.05	0.06	0.04	0.036	0.12
1973	489	Silvex ester	TCDD	Pr	36	15	<0.06*	0.15	0.25	0.06	1.5
1973	489	Silvex ester formulation	HxCDD	Pr	1	0	---	1.00	---	1	1
1973	489	Silvex ester formulation	OCDD	Pr	1	1	<0.05	---	---	---	---
1973	489	Silvex ester formulation	PCDD	Pr	1	0	---	0.20	---	0.2	0.2
1973	489	Silvex ester formulation	TCDD	Pr	15	15	<0.05	---	---	---	---
1974	489	2,4,5-T amine	TCDD	Pr	6	6	<0.04*	---	---	---	---
1974	489	2,4,5-T ester	27 DCDD	Pr	3	3	<0.005	---	---	---	---
1974	489	2,4,5-T ester	HxCDD	Pr	18	0	---	0.52	0.47	0.09	2
1974	489	2,4,5-T ester	OCDD	Pr	7	5	<0.05	0.2	0.3	0.6	0.7
1974	489	2,4,5-T ester	PCDD	Pr	4	1	<0.05	0.4	0.2	0.5	0.5
1974	489	2,4,5-T ester	TCDD	Pr	156	89	<0.0*	0.036	0.053	0.006	0.107
1974	489	2,4,5-T ester 1st reaction	TCDD	Pc	45	1	<0.05	0.03	0.01	0.009	0.08
1974	489	2,4,5-T ester 2nd cut alcohol	TCDD	Pc	1	1	<0.01	---	---	---	---
1974	489	2,4,5-T ester check tank	HxCDD	Pc	6	0	---	0.19	0.09	0.12	0.33
1974	489	2,4,5-T ester check tank	OCDD	Pc	6	5	<0.05	0.5	1.2	2.8	2.8
1974	489	2,4,5-T ester check tank	PCDD	Pc	7	2	<0.05	0.11	0.06	0.1	0.17
1974	489	2,4,5-T ester check tank	TCDD	Pc	738	56	<0.05*	0.04	0.02	0.01	0.17
1974	489	2,4,5-T ester check tank	Tri-CDD	Pc	7	7	<0.05	---	---	---	---
1974	489	2,4,5-T ester flash tank	TCDD	Pc	1	1	<0.05	---	---	---	---

Table 20
Dow Analtical Data (ug/g)
489 Building
The Dow Chemical Compnay
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1974	489	2,4,5-T ester formulation	1368-TCDD	Pr	1	0	---	0.03	---	0.03	0.03
1974	489	2,4,5-T ester formulation	27-DCDD	Pr	5	4	<0.05	0.04	0.03	0.1	0.1
1974	489	2,4,5-T ester formulation	HpCDD	Pr	1	1	<0.1	---	---	---	---
1974	489	2,4,5-T ester formulation	HxCDD	Pr	3	1	<0.05	0.31	0.43	0.1	0.8
1974	489	2,4,5-T ester formulation	OCDD	Pr	3	2	<0.03*	0.03	0.04	0.07	0.07
1974	489	2,4,5-T ester formulation	TCDD	Pr	41	23	<0.0*	0.02	0.01	0.008	0.03
1974	489	2,4,5-T ester reactor tars	TCDD	Wa	1	1	<1.0	---	---	---	---
1974	489	2,4,5-T ester stripper	TCDD	Pc	58	3	<0.05	0.05	0.04	0.02	0.19
1974	489	Silvex ester	HxCDD	Pr	1	0	---	0.15	---	0.15	0.15
1974	489	Silvex ester	TCDD	Pr	35	5	<0.05	0.02	0.01	0.02	0.18
1974	489	Silvex ester	OCDD	Pr	1	1	<0.05	---	---	---	---
1974	489	Silvex ester formulation	HxCDD	Pr	3	1	<0.05	0.22	0.20	0.23	0.42
1974	489	Silvex ester formulation	OCDD	Pr	3	3	<0.05	---	---	---	---
1974	489	Silvex ester formulation	TCDD	Pr	10	4	<0.04*	0.02	0.01	0.01	0.02
1975	489	2,4,5-T amine	TCDD	Pr	5	1	<0.01	0.04	0.03	0.01	0.065
1975	489	2,4,5-T amine after purificatio	TCDD	Pc	1	0	---	0.07	---	0.07	0.07
1975	489	2,4,5-T amine reactor	TCDD	Pc	2	0	---	0.05	---	0.04	0.05
1975	489	2,4,5-T amine w/carbon	TCDD	Pc	1	1	<0.01	---	---	---	---
1975	489	2,4,5-T amine wo/carbon	TCDD	Pc	1	0	---	0.07	---	0.07	0.07
1975	489	2,4,5-T ester	HxCDD	Pr	9	0	---	0.09	0.07	0.02	0.21
1975	489	2,4,5-T ester	TCDD	Pr	98	4	<0.02*	0.08	1.47	0.002	0.7
1975	489	2,4,5-T ester 1st reaction	TCDD	Pc	37	0	---	0.05	0.07	0.02	0.46
1975	489	2,4,5-T ester 2nd reaction	TCDD	Pc	1	0	---	0.04	---	0.04	0.04
1975	489	2,4,5-T ester 3rd reaction	TCDD	Pc	1	0	---	0.04	---	0.04	0.04
1975	489	2,4,5-T ester check tank	TCDD	Pc	460	1	<0.01	0.11	0.28	0.005	2.8
1975	489	2,4,5-T ester flash tank	TCDD	Pc	1	0	---	0.05	---	0.05	0.05

Table 20
Dow Analtical Data (ug/g)
489 Building
The Dow Chemical Compnay
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1975	489	2,4,5-T ester formulation	TCDD	Pr	58	2	<0.02*	0.03	0.01	0.01	0.07
1975	489	2,4,5-T ester pre-purified	TCDD	Pc	7	0	---	0.051	0.020	0.027	0.085
1975	489	2,4,5-T ester stripper	TCDD	Pc	46	0	---	0.07	0.10	0.02	0.72
1975	489	Silvex ester	TCDD	Pr	9	0	---	0.02	0.01	0.01	0.04
1975	489	Silvex ester	HxCDD	Pr	2	0	---	0.06	---	0.03	0.08
1975	489	Silvex ester	27-DCDD	Pr	1	1	<0.02	---	---	---	---
1975	489	Silvex ester formulation	HxCDD	Pr	1	1	<0.02	---	---	---	---
1975	489	Silvex ester formulation	TCDD	Pr	11	1	<0.5	0.03	0.08	0.01	0.03
1976	489	2,4,5-T amine	TCDD	Pr	5	0	---	0.02	0.01	0.01	0.03
1976	489	2,4,5-T ester	1368-TCDD	Pr	11	7	<0.002	0.003	0.006	0.002	0.02
1976	489	2,4,5-T ester	27 DCDD	Pr	8	6	<0.01	0.006	0.002	0.01	0.01
1976	489	2,4,5-T ester	HpCDD	Pr	11	8	<0.007*	0.004	0.003	0.004	0.008
1976	489	2,4,5-T ester	HxCDD	Pr	11	5	<0.01	0.01	0.01	0.01	0.03
1976	489	2,4,5-T ester	OCDD	Pr	11	5	<0.014*	0.02	0.01	0.02	0.03
1976	489	2,4,5-T ester	TCDD	Pr	146	10	<0.01	0.02	0.02	0.01	0.08
1976	489	2,4,5-T ester 1st reaction	TCDD	Pc	14	0	---	0.028	0.020	0.006	0.012
1976	489	2,4,5-T ester check tank	TCDD	Pc	405	0	---	0.027	0.016	0.002	0.08
1976	489	2,4,5-T ester formulation	TCDD	Pr	37	0	---	0.023	0.054	0.01	0.066
1976	489	2,4,5-T ester stripper	TCDD	Pc	9	0	---	0.044	0.027	0.016	0.08
1976	489	Silvex ester	1368-TCDD	Pr	1	1	<0.002	---	---	---	---
1976	489	Silvex ester	27-DCDD	Pr	1	1	<0.01	---	---	---	---
1976	489	Silvex ester	HpCDD	Pr	1	1	<0.01	---	---	---	---
1976	489	Silvex ester	HxCDD	Pr	2	1	<0.1	0.0005	---	0.01	0.01
1976	489	Silvex ester	OCDD	Pr	1	0	---	0.02	---	0.02	0.02
1976	489	Silvex ester	TCDD	Pr	18	0	---	0.02	0.02	0.01	0.09
1976	489	Silvex ester formulation	TCDD	Pr	14	0	---	0.02	0.01	0.01	0.03

Table 20
Dow Analtical Data (ug/g)
489 Building
The Dow Chemical Compnay
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1977	489	2,4,5-T amine	TCDD	Pr	15	6	<0.02*	0.01	0.01	0.01	0.02
1977	489	2,4,5-T ester	TCDD	Pr	287	69	<0.01	0.02	0.02	0.002	0.12
1977	489	2,4,5-T ester check tank	1368-TCDD	Pc	3	0	---	0.02	0.00	0.02	0.02
1977	489	2,4,5-T ester check tank	TCDD	Pc	446	11	<0.01	0.07	0.05	0.02	0.5
1977	489	2,4,5-T ester carbon	TCDD	Wa	2	0	---	25.1	---	10.2	40
1977	489	2,4,5-T ester flash tank	TCDD	Pc	1	0	---	0.23	---	0.23	0.23
1977	489	2,4,5-T ester formulation	TCDD	Pr	39	12	<0.01	0.01	0.01	0.01	0.03
1977	489	2,4,5-T ester stripper	TCDD	Pc	2	0	---	0.05	---	0.05	0.05
1977	489	Silvex ester	TCDD	Pr	10	2	<0.01	0.02	0.01	0.02	0.05
1977	489	Silvex ester formulation	TCDD	Pr	15	7	<0.01	0.02	0.03	0.01	0.14
1977	489	Silvex ester formulation	HxCDD	Pr	1	0	---	0.02	---	0.02	0.02
1978	489	2,4,5-T amine	TCDD	Pr	15	15	<0.01	---	---	---	---
1978	489	2,4,5-T ester	TCDD	Pr	317	146	<0.01*	0.010	0.010	0.001	0.06
1978	489	2,4,5-T ester brine	TCDD	Wa	1	1	<0.00001	---	---	---	---
1978	489	2,4,5-T ester check tank	TCDD	Pc	94	2	<0.01	0.08	0.13	0.003	0.91
1978	489	2,4,5-T ester formulation	TCDD	Pr	32	9	<0.01	0.009	0.004	0.01	0.02
1978	489	2,4,5-T ester reactor tars	HpCDD	Wa	1	0	---	4	---	4	4
1978	489	2,4,5-T ester reactor tar	HxCDD	Wa	1	0	---	11	---	11	11
1978	489	2,4,5-T ester reactor tar	OCDD	Wa	1	0	---	43	---	43	43
1978	489	2,4,5-T ester reactor tars	TCDD	Wa	4	0	---	0.009	0.003	0.005	0.01
1978	489	Silvex ester	TCDD	Pr	10	6	<0.01	0.007	0.003	0.01	0.01
1978	489	Silvex ester formulation	TCDD	Pr	14	10	<0.01	0.008	0.002	0.01	0.01

Table 21
Dow Analytical Data (ug/g)
338 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1966	338	Ronnel	27-DCDD	Pr	1	1	<0.5	---	---	---	---
1966	338	Ronnel	TCDD	Pr	1	0	---	0.073	---	0.073	0.073
1967	338	Ronnel	TCDD	Pr	1	1	<0.5	---	---	---	---
1969	338	Ronnel	TCDD	Pr	4	4	<0.15*	---	---	---	---
1969	338	Ronnel	TCDD	Pr	5	5	<0.38*	---	---	---	---

Table 22
Dow Analytical Data (ug/g)
840 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD If ND=LOD/2	Min Det Sample	Max Det Sample
1973	840	Ronnel	TCDD	Pr	12	8	<0.0325*	0.01099	0.01110	0.00029	0.0009
1974	840	Ronnel	TCDD	Pr	7	7	<0.0108*	---	---	---	---
1975	840	Ronnel	TCDD	Pr	8	8	<0.0058*	---	---	---	---
1976	840	Ronnel	TCDD	Pr	47	44	<0.0092*	0.00464	0.00206	0.0014	0.01
1977	840	Ronnel	HpCDD	Pr	6	0	---	0.00095	0.00017	0.00068	0.00124
1977	840	Ronnel	HxCDD	Pr	6	0	---	0.00100	0.00018	0.00074	0.0013
1977	840	Ronnel	OCDD	Pr	6	0	---	0.00031	0.00005	0.00022	0.00037
1977	840	Ronnel	TCDD	Pr	99	84	<0.0061*	0.00305	0.00269	0.00006	0.02
1978	840	Ronnel	TCDD	Pr	34	34	<0.0081*	---	---	---	---

Table 23
Dow Analytical Data (ug/g)
441 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1973	441	Erbon	TCDD	Pr	2	2	<0.05	---	---	---	---
1974	441	Erbon	TCDD	Pr	72	26	<0.014*	0.013	0.010	0.004	0.04
1975	441	Erbon	TCDD	Pr	25	10	<0.01	0.069	0.090	0.064	0.22

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1969	265	PCP	OCDD	Pr	1	0	---	15	---	15	15
1969	265	PCP	TCDD	Pr	1	1	<0.5	---	---	---	---
1970	265	PCP	HpCDD	Pr	1	0	---	120	---	120	120
1970	265	PCP	HxCDD	Pr	1	0	---	10	---	10	10
1970	265	PCP	OCDD	Pr	1	0	---	120	---	120	120
1970	265	PCP	TCDD	Pr	1	1	<0.5	---	---	---	---
1971	265	Na PCP sludge	HpCDD	Wa	1	0	---	6600	---	6600	6600
1971	265	Na PCP sludge	HpCDF	Wa	1	0	---	220	---	220	220
1971	265	Na PCP sludge	HxCDD	Wa	1	0	---	370	---	370	370
1971	265	Na PCP sludge	HxCDF	Wa	1	0	---	40	---	40	40
1971	265	Na PCP sludge	OCDD	Wa	1	0	---	5400	---	5400	5400
1971	265	Na PCP sludge	TCDD	Wa	1	1	<0.1	---	---	---	---
1971	265	Na PCP sublimate	OCDD	Wa	2	0	---	35500	---	25000	46000
1971	265	Na PCP sublimate	HpCDF	Wa	2	0	---	465	---	290	640
1971	265	Na PCP sublimate	HxCDF	Wa	2	0	---	103.5	---	57	150
1971	265	PCP	HpCDD	Pr	8	0	---	206	68	125	310
1971	265	PCP	HpCDF	Pr	7	0	---	187	119	80	430
1971	265	PCP	HxCDD	Pr	8	1	<0.5	7	12	4	12
1971	265	PCP	HxCDF	Pr	8	1	<1	49	34	30	90
1971	265	PCP	OCDD	Pr	17	0	---	2224	1014	200	4800
1971	265	PCP	OCDF	Pr	7	0	---	181	126	80	450
1971	265	PCP	TCDD	Pr	2	2	<0.28*	---	---	---	---
1971	265	PCP	TCDF	Pr	7	7	<0.04*	---	---	---	---
1971	265	PCP sublimate	TCDD	Wa	2	2	<0.15*	---	---	---	---
1971	265	PCP sublimate	HpCDD	Wa	2	0	---	28500	---	18000	39000

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1954	265	PCP	HpCDD	Pr	1	0	---	1000	---	1000	1000
1954	265	PCP	OCDD	Pr	1	0	---	1000	---	1000	1000
1954	265	PCP	TCDD	Pr	1	1	<0.05	---	---	---	---
1954	265	PCP	HxCDD	Pr	1	1	<1	---	---	---	---
1965	265	2,4,6-TCP P-17	TCDD	Pc	1	0	---	14	---	14	14
1965	265	2,4,6-TCP reactor	TCDD	Pc	2	2	<1	---	---	---	---
1965	265	Na 2,4,6-TCP catch-all	TCDD	Pc	1	1	<1	---	---	---	---
1965	265	Na 2,4,6-TCP reactor	TCDD	Pc	1	1	<1	---	---	---	---
1965	265	Na PCP caustic	TCDD	Wa	5	5	<1	---	---	---	---
1965	265	Na PCP scrubber water	TCDD	Wa	3	3	<1	---	---	---	---
1965	265	Na TCP	TCDD	Pr	1	0	---	3	---	3	3
1965	265	Na TCP reactor	TCDD	Pc	43	5	<1	2.7	3.4	1	16
1965	265	PCP	TCDD	Pr	10	10	<0.43*	---	---	---	---
1965	265	PCP scrubber phenol	TCDD	Wa	2	2	<1	---	---	---	---
1965	265	PCP scrubber water	TCDD	Wa	12	12	<1	---	---	---	---
1965	265	PCP starter	TCDD	Pc	3	2	<1	7.7	12.4	22	22
1965	265	TCP D2-DPM	TCDD	Pc	2	1	<1	1	---	2	2
1965	265	TCP P-24	TCDD	Pc	1	1	<1	---	---	---	---
1965	265	TetCP	TCDD	Pr	1	0	---	34	---	34	34
1966	265	PCP	HpCDD	Pr	1	0	---	230	---	230	230
1966	265	PCP	HxCDD	Pr	1	0	---	30	---	30	30
1966	265	PCP	OCDD	Pr	1	0	---	390	---	390	390
1966	265	PCP	TCDD	Pr	1	1	<0.5	---	---	---	---
1969	265	PCP	HpCDD	Pr	1	0	---	70	---	70	70
1969	265	PCP	HxCDD	Pr	1	0	---	35	---	35	35

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1971	265	PCP sublimate	HxCDD	Wa	2	0	---	4100	---	3800	4400
1971	265	PCP tars	HpCDD	Wa	1	0	---	15000	---	15000	15000
1971	265	PCP tars	HpCDF	Wa	1	0	---	160	---	160	160
1971	265	PCP tars	HxCDD	Wa	1	0	---	1600	---	1600	1600
1971	265	PCP tars	HxCDF	Wa	1	1	<14	---	---	---	---
1971	265	PCP tars	OCDD	Wa	1	0	---	53000	---	53000	53000
1971	265	PCP tars	TCDD	Wa	1	1	<0.1	---	---	---	---
1971	265	TetCP	HpCDD	Pr	4	0	---	35	31	10	80
1971	265	TetCP	HpCDF	Pr	4	0	---	145	37	100	190
1971	265	TetCP	HxCDD	Pr	4	0	---	13	10	5	28
1971	265	TetCP	HxCDF	Pr	4	0	---	81	23	55	100
1971	265	TetCP	OCDD	Pr	4	0	---	21	7	14	30
1971	265	TetCP	OCDF	Pr	4	0	---	44	17	25	65
1971	265	TetCP	TCDD	Pr	4	4	<0.39*	---	---	---	---
1971	265	TetCP	TCDF	Pr	3	0	---	3.0	1.8	1.6	5
1971	265	TetCP ENS28-24-	HpCDD	Pc	2	0	---	2.25	---	0.5	4
1971	265	TetCP ENS28-24-	HpCDF	Pc	2	0	---	5.5	---	2	9
1971	265	TetCP ENS28-24-	HxCDD	Pc	2	0	---	5.8	---	1.6	10
1971	265	TetCP ENS28-24-	HxCDF	Pc	1	0	---	3	---	3	3
1971	265	TetCP ENS28-24-	OCDD	Pc	2	0	---	0.45	---	0.2	0.7
1971	265	TetCP ENS28-24-	OCDF	Pc	2	0	---	0.55	---	0.2	0.9
1971	265	TetCP ENS28-24-	TCDD	Pc	2	2	<0.05	---	---	---	---
1971	265	TetCP ENS28-24-	TCDF	Pc	2	2	<0.05	---	---	---	---
1972	265	Na PCP	HpCDD	Pr	2	1	<0.5	13.5	---	27	27
1972	265	Na PCP	HpCDF	Pr	2	1	<0.5	0.5	---	1	1

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1972	265	Na PCP	HxCDD	Pr	4	1	<0.5	20.8	20.8	5.9	42
1972	265	Na PCP	HxCDF	Pr	2	1	<1	0.9	---	1.8	1.8
1972	265	Na PCP	OCDD	Pr	4	0	---	783	895	2	1770
1972	265	Na PCP	OCDF	Pr	2	2	<0.75*	---	---	---	---
1972	265	Na PCP	TCDD	Pr	1	1	<0.05	---	---	---	---
1972	265	Na PCP sludge	HxCDF	Wa	1	0	---	900	---	900	900
1972	265	Na PCP sludge	HpCDF	Wa	1	0	---	2200	---	2200	2200
1972	265	Na PCP sludge	OCDF	Wa	2	0	---	776	---	52	1500
1972	265	Na PCP sublimate	OCDF	Wa	2	0	---	730	---	710	750
1972	265	PCP	HpCDD	Pr	2	0	---	206.5	---	1	520
1972	265	PCP	HpCDF	Pr	2	1	<0.5	92.5	---	185	185
1972	265	PCP	HxCDD	Pr	2	1	<0.05	30	---	60	60
1972	265	PCP	OCDD	Pr	2	0	---	907	---	14	1800
1972	265	PCP	OCDF	Pr	2	1	<0.5	77.5	---	155	155
1972	265	PCP	TCDD	Pr	1	0	---	0.08	---	0.08	0.08
1972	265	PCP tars	OCDF	Wa	1	0	---	860	---	860	860
1972	265	TetCP	HpCDD	Pr	1	0	---	59	---	59	59
1972	265	TetCP	HpCDF	Pr	1	0	---	120	---	120	120
1972	265	TetCP	HxCDD	Pr	1	0	---	4	---	4	4
1972	265	TetCP	HxCDF	Pr	1	0	---	100	---	100	100
1972	265	TetCP	OCDD	Pr	1	0	---	28	---	28	28
1972	265	TetCP	OCDF	Pr	1	0	---	25	---	25	25
1973	265	Na PCP	HxCDD	Pr	53	8	<0.5	25	25	1	120
1973	265	Na PCP	OCDD	Pr	66	0	---	737	916	8	4100
1973	265	Na PCP	TCDD	Pr	15	11	<0.05	0.06	0.07	0.07	0.24

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1973	265	PCP	HpCDD	Pr	4	0	---	69.4	99.0	0.7	214
1973	265	PCP	HpCDF	Pr	1	1	<0.5	---	---	---	---
1973	265	PCP	HxCDD	Pr	83	57	<0.34*	5.6	13.1	0.4	86
1973	265	PCP	HxCDF	Pr	1	1	<0.5	---	---	---	---
1973	265	PCP	OCDD	Pr	72	3	---	117.2	288.0	0.5	1600
1973	265	PCP	OCDF	Pr	1	1	<0.5	---	---	---	---
1973	265	PCP	TCDD	Pr	6	6	<0.05	---	---	---	---
1974	265	PCP	HxCDD	Pr	157	153	---	0.8	4.8	0.1	50
1974	265	PCP	OCDD	Pr	153	4	---	54.0	378.2	0.2	3300
1974	265	PCP tars	HxCDD	Wa	11	11	<0.3*	---	---	---	---
1974	265	PCP tars	OCDD	Wa	10	10	<0.5	---	---	---	---
1975	265	2,46-TCP SPB-446-2-2	1368-TCDD	Pc	1	0	---	44	---	44	44
1975	265	2,46-TCP SPB-446-2-2	1368-TCDD	Pc	1	0	---	4.3	---	4.3	4.3
1975	265	2,46-TCP SPB-446-2-2	1368-TCDD	Pc	1	0	---	0.8	---	0.8	0.8
1975	265	Na PCP	124679-HxCDD	Pr	4	0	---	0.4	0.3	0.8	0.8
1975	265	Na PCP	3478-TCDD	Pr	4	0	---	0.0	0.0	0.2	0.8
1975	265	Na PCP	HxCDD	Pr	65	1	<0.02	6.0	11.0	0.2	40
1975	265	Na PCP	OCDD	Pr	53	0	---	117.7	257.3	1.3	1300
1975	265	Na PCP	TCDD	Pr	13	6	<0.01	0.004	0.004	0.001	0.01
1975	265	Na PCP feed	HxCDD	Pc	2	0	---	6.7	---	6	7.4
1975	265	Na PCP feed	OCDD	Pc	2	0	---	63.5	---	34	93
1975	265	Na PCP reactor	HxCDD	Pc	1	0	---	65.4	---	65.4	65.4
1975	265	Na PCP reactor	OCDD	Pc	1	0	---	2391	---	2391	2391
1975	265	Na PCP water	OCDD	Wa	15	0	---	161	257	1	800
1975	265	Na PCP water	HxCDD	Wa	15	2	<0.2	1.41	1.75	0.25	5

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1975	265	PCP	HpCDD	Pr	2	0	---	118.05	---	1.1	235
1975	265	PCP	HpCDF	Pr	2	0	---	140.25	---	0.5	280
1975	265	PCP	HxCDD	Pr	126	61	<0.28*	6.18	29.21	0.05	318
1975	265	PCP	HxCDF	Pr	2	0	---	19.64	---	0.28	39
1975	265	PCP	OCDD	Pr	103	2	<1.0	156	503	1	2600
1975	265	PCP	OCDF	Pr	2	0	---	115.1	---	0.2	230
1975	265	PCP	PCDD	Pr	2	2	<0.12	---	---	---	---
1975	265	PCP	PCDF	Pr	2	1	<0.2	0.015	---	0.03	0.03
1975	265	PCP	TCDD	Pr	6	6	<0.07*	---	---	---	---
1975	265	PCP	TCDF	Pr	2	1	<0.2	0.22	---	0.44	0.44
1975	265	TetCP	HpCDD	Pr	1	0	---	55	---	55	55
1975	265	TetCP	HpCDF	Pr	1	0	---	500	---	500	500
1975	265	TetCP	HxCDD	Pr	1	0	---	6	---	6	6
1975	265	TetCP	HxCDF	Pr	1	0	---	230	---	230	230
1975	265	TetCP	OCDD	Pr	1	0	---	39	---	39	39
1975	265	TetCP	OCDF	Pr	1	0	---	135	---	135	135
1975	265	TetCP	PCDD	Pr	1	1	<0.2	---	---	---	---
1975	265	TetCP	PCDF	Pr	1	1	<0.2	---	---	---	---
1975	265	TetCP	TCDD	Pr	2	2	<0.105	---	---	---	---
1975	265	TetCP	TCDF	Pr	1	1	<0.2	---	---	---	---
1976	265	Na PCP	3478-TCDD	Pr	3	0	---	1.07	1.84	1.07	1.07
1976	265	Na PCP	HxCDD	Pr	106	2	<0.2	7.6	38.6	0.1	400
1976	265	Na PCP	OCDD	Pr	104	1	<5.0	358.1	3360.3	3.7	2000
1976	265	Na PCP	TCDD	Pr	22	7	<0.01	0.02	0.02	0.003	0.05
1976	265	Na PCP water	OCDD	Wa	3	1	<4.0	187	301	39	520

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1976	265	Na PCP water	HxCDD	Wa	3	1	<0.2	1.7	2.3	0.6	4.3
1976	265	PCP	HxCDD	Pr	198	15	<1.3*	0.97	4.50	0.04	60
1976	265	PCP	OCDD	Pr	209	10	<1.0	27.5	110.6	0.6	1200
1976	265	PCP	TCDD	Pr	2	2	<0.03	---	---	---	---
1976	265	PCP tars	HxCDD	Wa	2	0	---	6	---	6	6
1976	265	PCP tars	OCDD	Wa	2	2	<56	---	---	---	---
1976	265	TetCP	HxCDD	Pr	1	0	---	18	---	18	18
1977	265	Na PCP	HpCDD	Pr	93	0	---	9.9	16.0	0.2	100
1977	265	Na PCP	HxCDD	Pr	134	0	---	5.0	7.6	0.2	52
1977	265	Na PCP	OCDD	Pr	159	0	---	174.6	432.8	0.3	2135
1977	265	Na PCP FBD	HxCDD	Pc	3	0	---	4.6	3.8	1.8	10
1977	265	Na PCP FBD	OCDD	Pc	2	0	---	170.5	---	24	317
1977	265	Na PCP feed	OCDD	Pc	1	0	---	236	---	236	236
1977	265	Na PCP reactor	HxCDD	Pc	10	0	---	4.56	3.32	0.27	8
1977	265	Na PCP reactor	OCDD	Pc	9	0	---	122	164	12	517
1977	265	Na TCP	TCDD	Pr	2	2	<0.01	---	---	---	---
1977	265	PCP	HpCDD	Pr	138	15	<0.38*	1.65	2.51	0.06	17.3
1977	265	PCP	HpCDF	Pr	1	0	---	0.15	---	0.15	0.15
1977	265	PCP	HxCDD	Pr	161	25	<0.244	0.49	0.78	0.025	6
1977	265	PCP	HxCDF	Pr	1	0	---	0.13	---	0.13	0.13
1977	265	PCP	OCDD	Pr	186	18	<0.57*	19.62	117.21	0.03	1086
1977	265	PCP	TCDD	Pr	3	3	<0.04*	---	---	---	---
1977	265	TetCP	HpCDD	Pr	1	0	---	80	---	80	80
1977	265	TetCP	HpCDF	Pr	2	1	<0.5	50	---	100	100
1977	265	TetCP	HxCDD	Pr	2	1	<0.5	14	---	28	28

Table 24
Dow Analytical Data (ug/g)
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Bldg. No.	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min Det Sample	Max Det Sample
1977	265	TetCP	HxCDF	Pr	2	1	<0.5	28	---	55	55
1977	265	TetCP	OCDD	Pr	1	0	---	30	---	30	30
1977	265	TetCP	OCDF	Pr	1	0	---	25	---	25	25
1977	265	TetCP	TCDD	Pr	2	2	<0.05	---	---	---	---
1977	265	TetCP ENS28-24-	HpCDD	Pc	1	1	<0.5	---	---	---	---
1978	265	Na PCP	HpCDD	Pr	157	0	---	2.6	2.6	0.2	11.2
1978	265	Na PCP	HxCDD	Pr	115	5	<0.2	0.4	0.2	0.1	1.2
1978	265	Na PCP	OCDD	Pr	160	0	---	36.8	56.0	0.2	350
1978	265	PCP	HpCDD	Pr	173	5	<0.028*	1.0	0.7	0.1	3.7
1978	265	PCP	HxCDD	Pr	115	30	<0.067*	0.28	0.25	0.01	1.2
1978	265	PCP	OCDD	Pr	185	0	---	2.5	5.5	0.2	47.7
1978	265	PCP tars	TCDD	Wa	1	0	---	1.2	---	1.2	1.2
1978	265	PCP tars	HpCDD	Wa	3	0	---	293	81	220	380
1978	265	PCP tars	OCDD	Wa	3	0	---	147	93	70	250
1978	265	PCP tars	HxCDD	Wa	3	0	---	187	67	130	260

Table 25
Rabbit Ear Test Evaluation
The Dow Chemical Company
Midland, Michigan

Chloracne Testing		Interpretation
Rabbit Ear		TCDD Level (ug/g)
Folliculitis Response	Grade	
Very slight	1	1
Slight	2	1-10
Moderate	3	10-100
Severe	4	>100

Table 26
Historical Rabbit Ear Testing of Chlorophenol Products
The Dow Chemical Company
Midland, Michigan

Chemical Name	Year	Response*	Remarks
Trichlorophenol	1936	None	Mixture of 2,4,5- & 2,4,6-isomers
& Na salt B)	1937	None	
2,4,5-Trichlorophenol	1957	None	
& Na salt	1963	None	
	1965 to present	None**	Product specification of <1 ppm 2,3,7,8-TCBD; typical analysis, <0.5 ppm.
2,4,6-Trichlorophenol	1949	Reported "similar to 2,4,5-isomer"	
	1965	None	
	1968	None	
Tetrachlorophenol	1937	Active	
	7/65	None	
	11/65	Slight	
	7/68	Slight	
	12/68	Slight	
	5/69	Slight	

*None: tested on rabbit ear, no folliculitis.
Active: tested on rabbit ear, response not graded.
Slight: tested on rabbit ear, minimal folliculitis.
**Some samples in 1965 were active but product was recycled and retested before release.

Table 26 (Continued)

Chemical Name	Year	Response*	Remarks
Tetrachlorophenol, Na salt	1938	Active	
	1940	Active	
Pentachlorophenol	1936	Slight	
	1937	Active	
	1938	Active	
	1957	Active	
	1965	Active	Usually slight, some active, occasionally moderate. 2,3,7,8-TCDD analyzed <10 ppm for 4 samples, <1 ppm for 12 samples. (1965–1968)
	1966	Active	
	1967	Active	
	1968	Active	
	1969	Slight	The limit of sensitivity was improved from 10 ppm to 1 ppm.
Pentachlorophenol, Na salt	1936	Slight	
	1937	Active	
	1953	None	
	1965 to present	Usually slight or moderate	<u>G Beads</u>: none in 1966 & 1967, moderate in 1968, none in 1969.

*None: tested on rabbit ear, no folliculitis.
Active: tested on rabbit ear, response not graded.
Slight: tested on rabbit ear, minimal folliculitis.
Moderate: tested on rabbit ear, definite folliculitis.

Appendix F
Dow Industrial Hygiene Summary Data
Tables 27 through 55
The Dow Chemical Company
Midland, Michigan

Table 27
Symbols and Definitions for Appendix F
The Dow Chemical Company
Midland, Michigan

Symbol	Definition
1,2,4-TriCB	1,2,4-trichlorobenzene
2-CP	2-chlorophenol
235-TCP (2,3,5-TCP)	2,3,5-trichlorophenol
24-D	2,4-dichlorophenoxyacetic acid
24-DCP	2,4-dichlorophenol
245-T (2,4,5-T acid)	2,4,5-trichlorophenoxyacetic acid
245-T ester (2,4,5-T ester)	esters of 2,4,5-T
245-TCA (TCA) (anisole)	2,4,5-trichloroanisole
245-TCP (2,4,5-TCP) (TCP)	2,4,5-trichlorophenol
246-TCP (2,4,6-TCP)	2,4,6-trichlorophenol
26-DCP	2,6-dichlorophenol
4-CP	4-chlorophenol
4ClOPP	4-chloro-,2-phenylphenol
A	area air sample
CIO	caustic insoluble oil (Na 2,4,5-TCP waste effluent)
CO	carbon monoxide
Chloracnegen	non specific material which has the potential to cause chloracne
Cl2	chlorine
CuO	cuprous oxide
DPA	diphenylamine
Dust	total particulate
EB	butoxy ethanol
FBD	fluid bed drier
HCB	hexachlorobenzene
HCl	hydrochloric acid
HpCDD	heptachlorodibenzo-p-dioxins
HpCDF	heptachlorodibenzofurans
HxCDD	hexachlorodibenzo-p-dioxins
HxCDF	hexachlorodibenzofurans
LOD	lowest limit of detection for a given analytical method and sample set
MC	methylene chloride
MCB	monochlorobenzene
MCPA	(4-chloro-o-toloxy) acetic acid
Max Det	maximum detectable sample result
Mean if ND=LOD/2	mean calculated using 1/2 of all applicable LOD's for the ND values and all the detected sample results in a given sample set
MeOH	methanol
Min Det	minimum detectable sample result
Na	not applicable
NA	not available

Table 27
Symbols and Definitions for Appendix F
The Dow Chemical Company
Midland, Michigan

Symbol	Definition
NCPP	nonylchlorophenoxyphenol
ND	non-detectable sample result
NFR	no ear folliculitis response
Na TCP (Na 2,4,5-TCP)	sodium 2,4,5-trichlorophenate
NaOH	sodium hydroxide
NaOPP	sodium ortho-phenylphenate
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
OCPP	octachlorophenoxyphenol
OPP	ortho-phenylphenol
P	personal breathing zone sample
PCP	pentachlorophenol
PIB	propylene glycol isobutyl ether
Pc	process stream sample
Pr	product sample
REFR	rabbit ear folliculitis response
Ronnel	0,0-dimethyl 0-(2,4,5-trichlorophenyl) phosphorothioate
STE	short term exposure sample
Silvex	2-(2,4,5-trichlorophenoxy) propionic acid
TCB	1,2,4,5-tetrachlorobenzene
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TWA	time weighted average sample
TetCP	tetrachlorophenols
W	surface wipe sample
mg/M3	milligrams analyte per cubic meter of air
ng/M3	nanograms analyte per cubic meter of air
ppm	parts analyte per million parts of air
ug/wipe	micrograms analyte per wipe sample

Table 28
Dow Chemical Industrial Hygiene Data
Area Air Samples
199 Building, Aniline Process
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1944	Acid tub area	HCl	A	1	0	----	40	----	40	40	ppm
1944	Ammonia towers area	Ammonia	A	22	0	----	74.0	182.3	1	894	ppm
1944	Ammonia towers area	Aniline	A	12	0	----	1.77	1.63	0.3	6	ppm
1944	Aniline batch still area	Annonia	A	4	0	----	11.3	15.5	1	38	ppm
1949	Aniline batch still area	Annonia	A	11	0	----	82.0	87.5	9.4	286	ppm
1956	Aniline batch still area	Annonia	A	24	0	----	17.8	13.1	3.24	52	ppm
1944	Aniline batch still area	Aniline	A	12	0	----	1.10	1.33	0.2	5	ppm
1949	Aniline batch still area	Aniline	A	17	0	----	0.87	0.51	0.34	1.95	ppm
1956	Aniline batch still area	Aniline	A	28	0	----	0.69	0.36	0.21	1.75	ppm
1944	Aniline batch still area	CuO	A	2	0	----	1.02	----	0.54	1.5	mg/M3
1944	Aniline batch still area	MCB	A	2	0	----	1.80	----	1.4	2.2	ppm
1949	Aniline batch still area	MCB	A	5	0	----	51.8	25.9	30	99	ppm
1956	Aniline batch still area	MCB	A	7	2	<4.89	7.60	4.34	4.89	14.2	ppm
1944	Aniline batch still area	Phenol	A	6	0	----	33.6	38.5	2.8	109	ppm
1956	Aniline batch still area	Phenol	A	1	0	----	1.20	----	1.2	1.2	ppm
1944	Aniline reactor area	Ammonia	A	3	1	<1.0	15.33	20.98	1	45	ppm
1949	Aniline reactor area	Ammonia	A	9	0	----	76.5	65.0	0.25	171	ppm
1956	Aniline reactor area	Ammonia	A	9	0	----	16.3	8.2	4.67	32.6	ppm
1944	Aniline reactor area	Aniline	A	3	0	----	0.20	0.14	0.1	0.4	ppm
1949	Aniline reactor area	Aniline	A	1	0	----	0.52	----	0.52	0.52	ppm
1956	Aniline reactor area	Aniline	A	6	0	----	0.94	0.60	0.197	2.08	ppm
1956	Aniline reactor area	DPA	A	1	1	<0.4	0.20	----	----	----	mg/M3
1944	Aniline reactor area	MCB	A	6	1	<1.0	4.15	4.51	0.9	13.9	ppm

Table 28
Dow Chemical Industrial Hygiene Data
Area Air Samples
199 Building, Aniline Process
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1944	Creamer area	Ammonia	A	1	0	----	13.0	----	13	13	ppm
1944	Creamer area	CuO	A	4	0	----	4.62	5.10	0.09	13	mg/M3
1944	Cu filter press area	Ammonia	A	4	0	----	46.3	56.7	7	144	ppm
1944	Cu filter press area	Aniline	A	4	0	----	2.85	3.47	0.4	8.8	ppm
1944	Kelly filter area	Ammonia	A	3	0	----	52.3	39.0	19	107	ppm
1944	Kelly filter area	Anline	A	3	0	----	2.83	1.65	0.5	4	ppm
1944	Kelly filter area	MCB	A	5	0	----	10.6	9.5	1.4	24	ppm
1944	Loading tank cars	Ammonia	A	1	0	----	7.80	----	7.8	7.8	ppm
1944	Loading tank cars	Aniline	A	5	0	----	13.3	17.4	1.5	47	ppm
1949	Loading tank cars	Aniline	A	1	0	----	2.26	----	2.26	2.26	ppm
1956	Loading tank cars	Aniline	A	1	0	----	1.97	----	1.97	1.97	ppm

Table 29
Dow Chemical Industrial Hygiene Data
Breathing Zone Samples
199 Building, Aniline Process
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1949	Aniline batch still area	Ammonia	Bz	8	0	----	48.9	34.0	13.9	118	ppm
1956	Aniline batch still area	Ammonia	Bz	24	1	<1.0	43.0	45.0	2.08	173.5	ppm
1949	Aniline batch still area	Aniline	Bz	11	0	----	2.18	1.98	0.298	5.3	ppm
1956	Aniline batch still area	Aniline	Bz	26	0	----	1.95	1.62	0.132	6.1	ppm
1949	Aniline batch still area	MCB	Bz	2	0	----	103.2	----	79.3	127	ppm
1956	Aniline batch still area	MCB	Bz	16	3	<4.89	30.4	36.9	1.22	123.81	ppm
1956	Aniline batch still area	Phenol	Bz	9	0	----	6.46	10.37	1.06	33.8	ppm
1949	Aniline reactor area	Ammonia	Bz	5	0	----	92.4	42.8	12.8	133	ppm
1956	Aniline reactor area	Ammonia	Bz	6	1	<1.0	55.2	61.6	5.5	173.5	ppm
1949	Aniline reactor area	Aniline	Bz	6	0	----	0.53	0.79	0.1	2.26	ppm
1956	Aniline reactor area	Aniline	Bz	8	0	----	2.85	4.58	0.18	14.82	ppm
1949	Aniline reactor area	Chlorine	Bz	4	4	?	----	----	----	----	ppm
1949	Aniline reactor area	HCl	Bz	6	0	----	0.54	0.70	0.05	1.56	ppm
1944	Aniline reactor area	Phenol	Bz	5	0	----	12.0	12.9	1.2	35.3	ppm
1944	Creamer area	CuO	Bz	2	0	----	20	----	10.6	29.4	mg/M3
1949	Kelly filter area	DPA	Bz	2	0	----	87.4	----	45.8	129	mg/M3
1949	Loading tank cars	Ammonia	Bz	1	0	----	17.5	----	17.5	17.5	ppm
1949	Loading tank cars	Aniline	Bz	1	0	----	7	----	7	7	ppm
1956	Loading tank cars	Aniline	Bz	3	0	---	0.45	0.23	0.17	0.725	ppm
1956	TCP reactor area	NaTCP	Bz	3	0	----	1.81	0.83	0.926	2.92	ppm
1956	TCP stripper column area	Benzene	Bz	1	1	<5.0	----	----	----	----	ppm

Table 30
Dow Chemical Industrial Hygiene Data
Area Air Samples
199 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Sample	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1963	TCB melt area	TCB	A	3	2	<0.8	0.30	0.04	0.3	0.3	ppm
1958	TCP reactor area	1,2,4-TriCP	A	3	2	<0.1	0.17	0.16	0.4	0.4	ppm
1958	TCP reactor area	2,4,6-TCA	A	3	3	<0.1	----	----	----	----	ppm
1958	TCP reactor area	MCB	A	3	0	----	8.23	3.02	6.1	12.5	ppm
1958	TCP reactor area	NaTCP	A	3	0	----	0.13	0.07	0.06	0.22	ppm
1958	TCP reactor area	TCA	A	3	3	<0.1	----	----	----	----	ppm
1958	TCP reactor area	TCB	A	3	1	<0.1	3.49	4.27	0.91	9.5	ppm
1964	TCP reactor area	TCDD	A	3	3	<1.5	----	----	----	----	ng/m3
1965	TCP reactor area	TCDD	A	86	69	<16.1	8.27	18.72	0.3	58	ng/m3

Table 31
Dow Chemical Industrial Hygiene Samples
Breathing Zone Samples
199 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1963	TCB melt area	TCB	Bz	2	1	<0.85	----	----	----	----	ppm
1964	TCB melt area	TCB	Bz	3	0	----	0.28	0.18	0.05	0.50	ppm
1958	TCP reactor area	1,2,4-TriCP	Bz	4	3	<0.1	0.26	0.37	0.9	0.9	ppm
1958	TCP reactor area	2,4,6-TCA	Bz	3	2	<0.1	4.40	6.15	13.1	13.1	ppm
1958	TCP reactor area	MCB	Bz	4	1	<0.1	15.6	10.6	15	30	ppm
1958	TCP reactor area	MeOH	Bz	1	0	----	191	----	191	191	ppm
1958	TCP reactor area	NaOH	Bz	2	1	<1.0	0.75	----	1	1	ppm
1958	TCP reactor area	NaTCP	Bz	4	0	----	0.45	0.49	0.07	1.3	ppm
1958	TCP reactor area	TCA	Bz	3	2	<0.1	0.52	0.66	1.45	1.45	ppm
1958	TCP reactor area	TCB	Bz	4	3	<0.1	0.46	0.71	1.7	1.7	ppm

Table 32
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
199 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1964	Aniline still room	Chloracnegen	W	7	6	NFR	----	----	1	1	REFR
1964	Locker and lunch rooms	Chloracnegen	W	3	2	NFR	----	----	1	1	REFR
1964	Office area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1964	Protective equipment	Chloracnegen	W	7	4	NFR	----	----	1	2	REFR
1964	Shop area	Chloracnegen	W	6	3	NFR	----	----	1	1	REFR
1964	TCP reactor room	Chloracnegen	W	20	11	NFR	----	----	1	1	REFR
1964	TCP stripper column room	Chloracnegen	W	45	18	NFR	----	----	1	2	REFR
1964	Aniline still room	TCDD	W	5	4	<0.18	0.13	0.09	0.3	0.3	ug/wipe
1964	Office area	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1964	Protective equipment	TCDD	W	2	1	<0.1	0.08	----	0.1	0.1	ug/wipe
1964	Shop area	TCDD	W	4	4	<0.28	----	----	----	----	ug/wipe
1964	TCP reactor room	TCDD	W	9	5	<0.16	0.71	1.38	0.2	4.5	ug/wipe
1964	TCP stripper column room	TCDD	W	18	9	<0.19	1.71	4.13	0.1	16	ug/wipe
1965	Lab area	Chloracnegen	W	7	6	NFR	----	----	1	1	REFR
1965	Locker and lunch rooms	Chloracnegen	W	9	9	NFR	----	----	----	----	REFR
1965	Office area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1965	Shoe wipe samples	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1965	Shop area	Chloracnegen	W	8	7	NFR	----	----	1	1	REFR
1965	TCP reactor room	Chloracnegen	W	52	44	NFR	----	----	1	4	REFR
1965	TCP stripper column room	Chloracnegen	W	10	6	NFR	----	----	1	2	REFR
1965	Lab area	TCDD	W	7	7	<0.47	----	----	----	----	ug/wipe
1965	Locker and lunch rooms	TCDD	W	8	8	<0.76	----	----	----	----	ug/wipe
1965	Office area	TCDD	W	2	2	<0.2	----	----	----	----	ug/wipe
1965	Shop area	TCDD	W	6	5	<0.52	0.55	0.67	2	2	ug/wipe
1965	TCB melt area	TCDD	W	1	1	<2.0	----	----	----	----	ug/wipe

Table 32
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
199 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	TCP reactor area	TCDD	W	42	33	<1.08	1.65	3.07	0.5	15	ug/wipe
1965	TCP stripper column room	TCDD	W	24	18	<0.56	7.21	23.22	1	110	ug/wipe
1966	Lab area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1966	Locker and lunch rooms	Chloracnegen	W	5	4	NFR	----	----	4	4	REFR
1966	Office area	Chloracnegen	W	2	1	NFR	----	----	2	2	REFR
1966	Shoe wipe samples	Chloracnegen	W	2	1	NFR	----	----	1	1	REFR
1966	Shop area	Chloracnegen	W	4	1	NFR	----	----	1	3	REFR
1966	TCP reactor room	Chloracnegen	W	42	16	NFR	----	----	1	4	REFR
1966	TCP stripper column room	Chloracnegen	W	8	1	NFR	----	----	1	4	REFR

Table 33
Dow Chemical Industrial Hygiene Data
Product, Process Stream, and Waste Analyses
199 Building
The Dow Chemical Compant
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1964	NaTCP reactor	TCDD	Pc	2	1	<5.0	3.85	----	5.2	5.2	ug/g
1964	NaTCP	TCDD	Pr	13	9	<1.0	1.54	3.05	0.6	12	ug/g
1965	NaTCP	TCDD	Pr	56	13	<1.0	2.39	2.71	1	14	ug/g
1962	Caustic Insoluble Oil	TCDD	Wa	1	0	----	0.7	----	0.7	0.7	ug/g
1964	Caustic Insoluble Oil	TCDD	Wa	7	0	----	1522	3338	3.8	9680	ug/g
1965	Caustic Insoluble Oil	TCDD	Wa	42	0	----	2245	1213	71	7500	ug/g

Table 34
Dow Chemical Industrial Hygiene Data
Area Air Samples
804 Building
The Dow Chemical Building
Midland, M ichigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	Intermediate storage area	TCB	A	3	3	<0.002	----	----	----	----	ppm
1978	Intermediate storage area	245-TCA	A	3	2	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Intermediate storage area	245-TCP	A	3	1	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Office	TCB	A	3	3	<0.002	----	----	----	----	ppm
1978	Office	245-TCA	A	3	3	<0.002	----	----	----	----	ppm
1978	Office	245-TCP	A	3	3	<0.002	----	----	----	----	ppm
1978	Lunch room	TCB	A	3	3	<0.002	----	----	----	----	ppm
1978	Lunch room	245-TCA	A	3	3	<0.002	----	----	----	----	ppm
1978	Lunch room	245-TCP	A	3	2	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Shop area	TCB	A	3	3	<0.002	----	----	----	----	ppm
1978	Shop area	245-TCA	A	3	0	----	0.003	0.000	0.003	0.003	ppm
1978	Shop area	245-TCP	A	3	0	----	0.003	0.000	0.003	0.003	ppm
1978	Lab area	TCB	A	3	2	<0.002	0.002	0.002	0.005	0.005	ppm
1978	Lab area	245-TCA	A	3	2	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Lab area	245-TCP	A	3	0	----	0.005	0.002	0.003	0.008	ppm
1978	Control room	TCB	A	7	5	<0.002	0.002	0.002	0.003	0.008	ppm
1978	Control room	245-TCA	A	7	4	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Control room	245-TCP	A	7	2	<0.002	0.003	0.002	0.003	0.006	ppm
1978	TCP tank car loading	TCB	A	5	5	<0.002	----	----	----	----	ppm
1978	TCP tank car loading	245-TCA	A	5	5	<0.002	----	----	----	----	ppm
1978	TCP tank car loading	245-TCP	A	5	0	----	0.264	0.287	0.05	0.8	ppm
1978	Intermediate storage area	TCDD	A	6	6	<0.025	----	----	----	----	ug/M3
1978	Intermediate storage area	HxCDD	A	6	6	<0.025	----	----	----	----	ug/M3
1978	Intermediate storage area	HpCDD	A	6	6	<0.025	----	----	----	----	ug/M3
1978	Intermediate storage area	OCDD	A	6	5	<0.025	0.015	0.007	0.03	0.03	ug/M3

Table 35
Dow Chemical Industrial Hygiene Data
Personal Air Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No.of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	TCP Operator	TCB	P	6	4	<0.002	0.003	0.003	0.004	0.01	ppm
1978	TCP Operator	245-TCA	P	6	4	<0.002	0.002	0.001	0.004	0.004	ppm
1978	TCP Operator	245-TCP	P	6	2	<0.002	0.021	0.036	0.007	0.1	ppm
1978	Spare	TCB	P	4	3	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Spare	245-TCA	P	4	0	----	0.002	0.000	0.002	0.002	ppm
1978	Spare	245-TCP	P	4	0	----	0.008	0.002	0.005	0.01	ppm
1978	Sr. Production Engineer	TCB	P	4	3	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Sr. Production Engineer	245-TCA	P	4	2	<0.002	0.002	0.001	0.002	0.004	ppm
1978	Sr. Production Engineer	245-TCP	P	4	0	----	0.004	0.001	0.003	0.004	ppm
1978	Plant Superintendent	TCB	P	3	3	<0.002	----	----	----	----	ppm
1978	Plant Superintendent	245-TCA	P	3	1	<0.002	0.002	0.001	0.003	0.003	ppm
1978	Plant Superintendent	245-TCP	P	3	0	----	0.004	0.000	0.004	0.005	ppm
1978	Alternate	TCB	P	1	1	<0.002	----	----	----	----	ppm
1978	Alternate	245-TCA	P	1	1	<0.002	----	----	----	----	ppm
1978	Alternate	245-TCP	P	1	0	----	0.006	----	0.006	0.006	ppm
1978	TCP operator(tank car loading)	TCB	P	9	8	<0.002	0.002	0.003	0.01	0.01	ppm
1978	TCP operator(tank car loading)	245-TCA	P	9	9	<0.002	----	----	----	----	ppm
1978	TCP operator(tank car loading)	245-TCP	P	9	1	<0.002	0.348	0.500	0.06	1.7	ppm

Table 36
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1977	Anisole decantation area	TCDD	W	4	2	<0.1	0.80	1.27	0.1	3	ug/wipe
1978	Anisole decantation area	TCDD	W	4	0	----	10.1	10.2	0.5	25	ug/wipe
1979	Anisole decantation area	TCDD	W	5	2	<0.1	1.40	1.61	0.2	3.7	ug/wipe
1969	Control room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Control room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Control room area	TCDD	W	2	1	<1.0	0.75	----	1	1	ug/wipe
1971	Control room area	TCDD	W	4	2	<0.19	0.11	0.05	0.06	0.2	ug/wipe
1972	Control room area	TCDD	W	4	3	<0.07	0.04	0.02	0.07	0.07	ug/wipe
1973	Control room area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1975	Control room area	TCDD	W	1	1	<0.05	----	----	----	----	ug/wipe
1976	Control room area	TCDD	W	3	3	<0.15	----	----	----	----	ug/wipe
1977	Control room area	TCDD	W	4	4	<0.2	----	----	----	----	ug/wipe
1978	Control room area	TCDD	W	2	2	<0.1	----	----	----	----	ug/wipe
1979	Control room area	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1969	Intermediate storage area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Intermediate storage area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Intermediate storage area	TCDD	W	2	2	<1.0	----	----	----	----	ug/wipe
1971	Intermediate storage area	TCDD	W	4	2	<0.15	0.09	0.06	0.03	0.18	ug/wipe
1972	Intermediate storage area	TCDD	W	3	2	<0.06	0.02	0.02	0.01	0.01	ug/wipe
1975	Intermediate storage area	TCDD	W	3	3	<0.01	----	----	----	----	ug/wipe
1977	Intermediate storage area	TCDD	W	27	24	<0.15	0.09	0.07	0.1	0.4	ug/wipe
1979	Intermediate storage area	TCDD	W	4	2	<0.1	0.08	0.02	0.1	0.1	ug/wipe
1969	Laboratory area	Chloracnegen	W	4	4	NFR	----	----	----	----	REFR
1970	Laboratory area	Chloracnegen	W	4	4	NFR	----	----	----	----	REFR
1970	Laboratory area	TCDD	W	8	5	<1.0	0.75	0.35	1	1.5	ug/wipe

Table 36
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	Laboratory area	TCDD	W	16	11	<0.19	0.09	0.04	0.02	0.2	ug/wipe
1972	Laboratory area	TCDD	W	16	11	<0.08	0.06	0.07	0.01	0.3	ug/wipe
1973	Laboratory area	TCDD	W	12	12	<1.0	----	----	----	----	ug/wipe
1975	Laboratory area	TCDD	W	4	4	<0.05	----	----	----	----	ug/wipe
1976	Laboratory area	TCDD	W	13	12	<0.12	0.09	0.14	0.5	0.5	ug/wipe
1977	Laboratory area	TCDD	W	19	18	<0.19	0.09	0.08	0.1	0.1	ug/wipe
1978	Laboratory area	TCDD	W	18	18	<0.1	----	----	----	----	ug/wipe
1979	Laboratory area	TCDD	W	7	7	<0.08	----	----	----	----	ug/wipe
1969	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Locker room area	TCDD	W	2	1	<1.0	0.75	----	1	1	ug/wipe
1971	Locker room area	TCDD	W	4	3	<0.16	0.08	0.02	0.04	0.04	ug/wipe
1972	Locker room area	TCDD	W	4	3	<0.07	0.04	0.02	0.06	0.06	ug/wipe
1973	Locker room area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1975	Locker room area	TCDD	W	1	1	<0.05	----	----	----	----	ug/wipe
1976	Locker room area	TCDD	W	3	3	<0.15	----	----	----	----	ug/wipe
1977	Locker room area	TCDD	W	12	12	<1.6	----	----	----	----	ug/wipe
1978	Locker room area	TCDD	W	14	14	<0.1	----	----	----	----	ug/wipe
1979	Locker room area	TCDD	W	9	9	<0.07	----	----	----	----	ug/wipe
1969	Lunch room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Lunch room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Lunch room area	TCDD	W	2	1	<1.0	0.75	----	1	1	ug/wipe
1971	Lunch room area	TCDD	W	4	2	<0.19	0.13	0.10	0.02	0.3	ug/wipe
1972	Lunch room area	TCDD	W	4	3	<0.07	0.05	0.03	0.08	0.08	ug/wipe
1973	Lunch room area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe

Table 36
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1975	Lunch room area	TCDD	W	1	1	<0.05	----	----	----	----	ug/wipe
1976	Lunch room area	TCDD	W	5	5	<0.59	----	----	----	----	ug/wipe
1977	Lunch room area	TCDD	W	15	15	<0.58	----	----	----	----	ug/wipe
1978	Lunch room area	TCDD	W	10	10	<0.1	----	----	----	----	ug/wipe
1979	Lunch room area	TCDD	W	6	6	<0.08	----	----	----	----	ug/wipe
1977	Office area	TCDD	W	2	2	<0.1	----	----	----	----	ug/wipe
1971	Packaging area	TCDD	W	2	1	<0.18	2.55	----	5	5	ug/wipe
1972	Packaging area	TCDD	W	4	4	<0.08	----	----	----	----	ug/wipe
1973	Packaging area	TCDD	W	2	2	<1.0	----	----	----	----	ug/wipe
1975	Packaging area	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1976	Packaging area	TCDD	W	2	0	----	2.67	----	0.4	7.6	ug/wipe
1977	Packaging area	TCDD	W	1	0	----	0.4	----	0.4	0.4	ug/wipe
1978	Packaging area	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1971	Personal protection equipment	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Personal protection equipment	TCDD	W	2	2	<1.0	----	----	----	----	ug/wipe
1971	Personal protection equipment	TCDD	W	4	4	<1.8	----	----	----	----	ug/wipe
1979	Personal protection equipment	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1969	Reactor area	Chloracnegen	W	5	5	NFR	----	----	----	----	REFR
1970	Reactor area	Chloracnegen	W	5	5	NFR	----	----	----	----	REFR
1970	Reactor area	TCDD	W	9	7	<1.0	0.63	0.25	1	1.2	ug/wipe
1971	Reactor area	TCDD	W	19	13	<0.23	0.10	0.07	0.02	0.29	ug/wipe
1972	Reactor area	TCDD	W	27	20	<0.07	0.05	0.04	0.05	0.2	ug/wipe
1973	Reactor area	TCDD	W	29	28	<1.0	0.55	0.27	2	2	ug/wipe
1975	Reactor area	TCDD	W	9	9	<0.1	----	----	----	----	ug/wipe
1976	Reactor area	TCDD	W	26	24	<0.15	0.10	0.11	0.25	0.4	ug/wipe

Table 36
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1977	Reactor area	TCDD	W	27	23	<0.20	2.38	11.30	0.1	60	ug/wipe
1978	Reactor area	TCDD	W	35	29	<0.09	0.26	1.16	0.05	7	ug/wipe
1979	Reactor area	TCDD	W	33	30	<0.10	0.11	0.35	0.06	2.1	ug/wipe
1969	Shop area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Shop area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1970	Shop area	TCDD	W	3	1	<1.0	1.33	0.50	1	2.5	ug/wipe
1971	Shop area	TCDD	W	4	2	<0.34	0.35	0.22	0.34	0.7	ug/wipe
1972	Shop area	TCDD	W	7	6	<0.08	0.04	0.01	0.06	0.06	ug/wipe
1973	Shop area	TCDD	W	6	6	<1.0	----	----	----	----	ug/wipe
1975	Shop area	TCDD	W	3	3	<0.56	----	----	----	----	ug/wipe
1976	Shop area	TCDD	W	7	5	<0.17	0.23	0.27	0.4	0.8	ug/wipe
1977	Shop area	TCDD	W	20	15	<0.23	0.21	0.27	0.1	1.2	ug/wipe
1978	Shop area	TCDD	W	14	12	<0.10	0.06	0.02	0.1	0.1	ug/wipe
1979	Shop area	TCDD	W	10	9	<0.09	0.06	0.06	0.2	0.2	ug/wipe
1977	TCP finishing area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1971	TCP finishing area	TCDD	W	2	2	<2.1	----	----	----	----	ug/wipe
1972	TCP finishing area	TCDD	W	4	2	<0.55	0.35	0.05	0.32	0.98	ug/wipe
1973	TCP finishing area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1976	TCP finishing area	TCDD	W	17	10	<0.21	0.44	0.79	0.2	3.2	ug/wipe
1977	TCP finishing area	TCDD	W	29	25	<0.54	0.10	0.22	0.1	1.2	ug/wipe
1978	TCP finishing area	TCDD	W	16	11	<0.10	0.18	0.25	0.1	1	ug/wipe
1979	TCP finishing area	TCDD	W	7	6	<0.08	0.05	0.02	0.08	0.08	ug/wipe
1969	Waste oil dempster area	Chloracnegen	W	4	4	NFR	----	----	----	----	REFR
1970	Waste oil dempster area	Chloracnegen	W	5	5	NFR	----	----	----	----	REFR
1970	Waste oil dempster area	TCDD	W	15	9	<1.0	1.11	1.24	1	5.1	ug/wipe

Table 36
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
804 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	Waste oil dempster area	TCDD	W	39	24	<0.41	0.26	0.42	0.02	2	ug/wipe
1972	Waste oil dempster area	TCDD	W	42	24	<0.08	0.34	1.02	0.02	6.1	ug/wipe
1973	Waste oil dempster area	TCDD	W	26	24	<1.0	1.12	2.24	6	11	ug/wipe
1975	Waste oil dempster area	TCDD	W	5	5	<0.10	----	----	----	----	ug/wipe
1976	Waste oil dempster area	TCDD	W	23	19	<0.11	0.28	0.60	0.8	2.8	ug/wipe
1977	Waste oil dempster area	TCDD	W	38	30	<0.09	0.81	2.54	0.1	13	ug/wipe
1978	Waste oil dempster area	TCDD	W	24	16	<0.10	1.35	5.78	0.1	29	ug/wipe
1979	Waste oil dempster area	TCDD	W	10	8	<0.55	0.06	0.05	0.07	0.2	ug/wipe

Table 37
Dow Chemical Industrial Hygiene Data
Area Air Samples
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1964	TCP distillation area	245-TCP	A	2	0	----	516	----	32	1000	mg/M3

Table 38
Dow Chemical Industrial Hygiene Data
Personal Air Samples
The Dow Chemical Company
Midland, Michigan

Year	Sample Decription	Analyte	Sample Type	No. of Samples	No. of NDS	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Dowicide Operator	PCP	P	16	0	----	0.10	0.16	0.02	0.52	mg/M3
1980	Handyman	PCP	P	17	0	----	1.38	1.75	0.11	6.8	mg/M3
1980	Spare	PCP	P	12	0	----	3.57	5.12	0.09	17	mg/M3

Table 39
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	Bisphenol control room	TCDD	W	6	6	<0.20	----	----	----	----	ug/wipe
1966	Bisphenol control room	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1966	Bisphenol control room	TCDD	W	2	2	<1.0	----	----	----	----	ug/wipe
1969	Bisphenol control room	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1975	Bisphenol control room	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1965	Bisphenol process area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1965	Bisphenol process area	TCDD	W	6	6	<0.20	----	----	----	----	ug/wipe
1966	Bisphenol process area	Chloracnegen	W	8	8	NFR	----	----	----	----	REFR
1966	Bisphenol process area	TCDD	W	8	8	<1.0	----	----	----	----	ug/wipe
1969	Bisphenol process area	Chloracnegen	W	9	9	NFR	----	----	----	----	REFR
1975	Chlorinator area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1965	Laboratory area	TCDD	W	1	1	<0.20	----	----	----	----	ug/wipe
1966	Laboratory area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1966	Laboratory area	TCDD	W	2	2	<1.0	----	----	----	----	ug/wipe
1965	Locker room area	TCDD	W	2	2	<0.20	----	----	----	----	ug/wipe
1966	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1966	Locker room area	TCDD	W	1	0	----	2	----	2	2	ug/wipe
1969	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1975	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1965	Lunch room area	TCDD	W	2	2	<0.20	----	----	----	----	ug/wipe
1966	Lunch room area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1966	Lunch room area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1969	Lunch room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1969	Office area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1975	PCP distillation area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR

Table 39
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	Shop area	Chloracnegen	W	4	3	NFR	----	----	1	1	REFR
1965	Shop area	TCDD	W	3	3	<0.10	----	----	----	----	ug/wipe
1966	Shop area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1966	Shop area	TCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1965	TCP distillation area	TCDD	W	9	8	<0.2	270	763	2420	2420	ug/wipe
1969	TCP distillation area	Chloracnegen	W	7	7	NFR	----	----	----	----	REFR
1966	Warehouse area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1966	Warehouse area	TCDD	W	1	1	<1.0	----	----	----	----	ug/wipe

Table 40
Dow Chemical Industrial Hygiene Data
Product, Process Stream, and Waste Analyses
349 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1964	TCP from neutralizer	TCDD	Pc	1	0	----	4.8	----	4.8	4.8	ug/g
1965	TCP from neutralizer	TCDD	Pc	11	2	<5.5	17.7	12.6	5	41	ug/g
1964	TCP color still feed	TCDD	Pc	1	0	----	3.8	----	3.8	3.8	ug/g
1965	TCP color still feed	TCDD	Pc	13	1	<1.0	26.0	14.1	6	53	ug/g
1965	TCP brine	TCDD	Pc	1	0	----	5.0	----	5	5	ug/g
1965	NaTCP	TCDD	Pc	32	12	<1.0	10.3	45.1	0.6	260	ug/g
1963	245-TCP	TCDD	Pr	2	2	<1.0	----	----	----	----	ug/g
1964	245-TCP	TCDD	Pr	8	6	<0.78	1.1	1.8	0.8	6	ug/g
1965	245-TCP	TCDD	Pr	105	81	<1.1	1.0	2.2	0.5	20	ug/g
1964	Color still tars	TCDD	Wa	2	0	----	54	----	41	67	ug/g
1965	Color still tars	TCDD	Wa	9	1	<1.0	763	1263	5	3600	ug/g
1972	Waste oil decanter tars	HpCDD	Wa	1	0	----	60	----	60	60	ug/g
1972	Waste oil decanter tars	HpCDF	Wa	1	0	----	140	----	140	140	ug/g
1972	Waste oil decanter tars	HxCDD	Wa	1	0	----	35	----	35	35	ug/g
1972	Waste oil decanter tars	HxCDF	Wa	1	0	----	80	----	80	80	ug/g
1972	Waste oil decanter tars	OCDD	Wa	1	0	----	350	----	350	350	ug/g
1972	Waste oil decanter tars	OCDF	Wa	1	0	----	50	----	50	50	ug/g
1972	Waste oil decanter tars	TCDD	Wa	1	0	----	15	----	15	15	ug/g
1972	Waste oil decanter tars	TCDF	Wa	1	0	----	50	----	50	50	ug/g

Table 41
Dow Chemical Industrial Hygiene Data
Area Air Samples
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/	Min. Det. Sample	Max. Det. Sample	Units
1970	2,4,5-T finishing/packaging area	245-T	A	12	5	<0.21	0.91	1.67	0.24	0.21	mg/M3
1970	2,4,5-T reactor area	245-T	A	8	6	<0.15	0.47	0.93	0.42	2.9	mg/M3
1970	40" Na wheel area	245-T	A	5	2	<0.11	0.18	0.19	0.09	0.55	mg/M3
1970	48" Acid wheel area	245-T	A	9	4	<0.09	0.27	0.28	0.13	0.75	mg/M3
1970	Lunch room area	245-T	A	2	0	----	0.10	----	0.09	0.10	mg/M3
1970	2,4,5-T finishing/packaging area	245-TCP	A	13	0	----	2.55	3.48	0.19	14	mg/M3
1970	2,4,5-T reactor area	245-TCP	A	12	1	<0.10	2.04	1.47	0.05	4.5	mg/M3
1970	40" Na wheel area	245-TCP	A	6	0	----	2.45	0.84	0.75	3.4	mg/M3
1970	48" Acid wheel area	245-TCP	A	11	0	----	7.52	8.40	0.54	27	mg/M3
1970	Lunch room area	245-TCP	A	2	0	----	0.33	----	0.1	0.55	mg/M3
1970	2,4,5-T finishing/packaging area	24-D	A	11	11	<0.15	----	----	----	----	mg/M3
1970	2,4,5-T reactor area	24-D	A	8	8	<0.13	----	----	----	----	mg/M3
1970	40" Na wheel area	24-D	A	5	5	<0.09	----	----	----	----	mg/M3
1970	48" Acid wheel area	24-D	A	9	9	<0.13	----	----	----	----	mg/M3
1970	Lunch room area	24-D	A	2	1	<0.10	2.07	----	4.1	4.1	mg/M3

Table 42
Dow Chemical Industrial Hygiene Data
TWA Personal Exposure Estimates from Area Air Data
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1970	40" Na Wheel Operator	245-T	P	----	----	----	0.47	----	----	----	mg/M3
1970	48" Acid Wheel Operator	245-T	P	----	----	----	0.16	----	----	----	mg/M3
1970	Dryer Operator	245-T	P	----	----	----	0.45	----	----	----	mg/M3
1970	Reactor Operator	245-T	P	----	----	----	0.81	----	----	----	mg/M3
1970	40" Na Wheel Operator	245-TCP	P	----	----	----	2.10	----	----	----	mg/M3
1970	48" Acid Wheel Operator	245-TCP	P	----	----	----	9.70	----	----	----	mg/M3
1970	Dryer Operator	245-TCP	P	----	----	----	1.60	----	----	----	mg/M3
1970	Reactor Operator	245-TCP	P	----	----	----	2.10	----	----	----	mg/M3
1970	40" Na Wheel Operator	24-D	P	----	----	----	0.35	----	----	----	mg/M3
1970	48" Acid Wheel Operator	24-D	P	----	----	----	0.35	----	----	----	mg/M3
1970	Dryer Operator	24-D	P	----	----	----	0.38	----	----	----	mg/M3
1970	Reactor Operator	24-D	P	----	----	----	0.38	----	----	----	mg/M3

Table 43
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Decsription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. det. Sample	Max. Det. Sample	Units
1965	2,4,5-T finishing/packaging area	TCDD	W	1	1	<1.0	----	----	----	----	ug/wipe
1965	2,4,5-T ester area	TCDD	W	8	8	<32	----	----	----	----	ug/wipe
1965	2,4,5-T reactor area	TCDD	W	2	2	<7.0	----	----	----	----	ug/wipe
1965	40" Na wheel area	TCDD	W	9	8	<2.4	1.7	1.7	6	6	ug/wipe
1965	48" Acid wheel area	TCDD	W	14	12	<3.9	4.4	6.5	18	20	ug/wipe
1965	Silvex area	TCDD	W	6	6	<2.6	----	----	----	----	ug/wipe
1965	Locker room area	TCDD	W	2	1	<5.0	2.3	----	2	2	ug/wipe
1971	TCP tank farm area	TCDD	W	7	6	<0.5	0.1	1.0	3	3	ug/wipe

Table 44
Dow Chemical Industrial Hygiene Data
Products and Process Stream Analyses
267 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	2,4,5-T acid	TCDD	Pr	109	88	<1.0	1.06	0.29	0.5	1.25	ug/g
1965	2,4,5-T isooctyl ester	TCDD	Pr	1	0	----	2.80	----	2.8	2.8	ug/g
1965	Na 2,4,5-T (from filter press)	TCDD	Pc	1	1	<4.0	----	----	----	----	ug/g
1965	Purified 2,4,5-TCP	TCDD	Pc	13	12	<1.0	1.00	0.00	1	1	ug/g

Table 45
Dow Chemical Industrial Hygiene Data
Area Air Samples
489 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	2,4-D filter wheel area	24-D	A	4	0	----	0.08	0.03	0.038	0.12	ppm
1978	2,4-D filter wheel area	24-DCP	A	4	0	----	0.08	0.02	0.059	0.11	ppm
1978	2,4-D filter wheel area	TCPs	A	4	0	----	0.26	0.09	0.14	0.37	ppm
1978	Control room	245-T ester	A	3	0	----	0.53	4.85	0.2	1.1	mg/M3
1977	Control room	glycol ether EB	A	2	0	----	0.75	----	0.7	0.8	ppm
1979	Control room	glycol ether EB	A	3	0	----	2.10	0.57	1.6	2.9	ppm
1977	Control room	glycol ether PIB	A	2	2	<0.30	----	----	----	----	ppm
1978	High bay area	245-T ester	A	11	0	----	2.54	3.33	0.1	10	mg/M3
1977	High bay area	glycol ether EB	A	8	0	----	18.1	10.3	6.3	38	ppm
1979	High bay area	glycol ether EB	A	14	0	----	44.8	18.2	5.4	77	ppm
1977	High bay area	glycol ether PIB	A	8	7	<0.30	0.18	0.08	0.4	0.4	ppm
1977	Inside 2,4-D vessel	glycol ether EB	A	3	1	<0.20	0.30	0.16	0.3	0.5	ppm
1977	Inside 2,4-D vessel	glycol ether EB	A	2	1	<0.30	0.18	----	0.2	0.2	ppm
1978	Low bay area	245-T ester	A	6	0	----	1.23	1.23	0.3	3.7	mg/M3
1977	Low bay area	glycol ether EB	A	5	0	----	0.68	0.28	0.4	1.1	ppm
1979	Low bay area	glycol ether EB	A	5	0	----	4.48	1.09	3	5.5	ppm
1977	Low bay area	glycol ether PIB	A	5	5	<0.30	----	----	----	----	ppm
1978	Near drumming/filling lines	CO	A	13	0	----	21.9	14.3	5	50	ppm
1978	Near material handler	245-T ester	A	7	2	<0.001	0.001	0.001	0.001	0.004	mg/M3
1978	Next to bulk tank manhole	24-D	A	1	0	----	0.013	----	0.013	0.013	ppm
1978	Next to bulk tank manhole	24-DCP	A	1	0	----	0.014	----	0.014	0.014	ppm
1978	Next to bulk tank manhole	TCPs	A	1	0	----	0.036	----	0.036	0.036	ppm
1978	ext to Clerk/Tank Car Load	MCPA	A	1	0	----	0.35	----	0.35	0.35	mg/M3
1978	Packaging area	24-D	A	3	0	----	0.022	0.018	0.007	0.047	ppm
1978	Packaging area	24-DCP	A	3	0	----	0.009	0.004	0.005	0.015	ppm
1978	Packaging area	TCPs	A	3	0	----	0.020	0.011	0.007	0.034	ppm

Table 46
Dow Chemical Industrial Hygiene Data
Breathing Zone Samples
489 Building
The Dow Chemical Comapny
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean if ND=LOD/2	SD if ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	Loading esterifier with silvex	Silvex	Bz	1	0	---	2	---	2	2	mg/M3
1971	Loading esterifier with silvex	Tot.Dust	Bz	1	0	---	13.2	---	13.2	13.2	mg/M3

Table 47
Dow Chemical Industrial Hygiene Data
Personal Air Samples
489 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	Assistant Operator	24-D	P	1	0	----	0.069	----	0.069	0.069	ppm
1978	Assistant Operator	24-DCP	P	1	0	----	0.049	----	0.049	0.049	ppm
1978	Assistant Operator	TCPs	P	1	0	----	0.073	----	0.073	0.073	ppm
1978	Clerk/Tank Car Operator	MCPA	P	1	0	----	0.3	----	0.3	0.3	mg/M3
1978	Crystallizer Operator	24-D	P	1	0	----	0.087	----	0.087	0.087	ppm
1978	Crystallizer Operator	24-DCP	P	1	0	----	0.049	----	0.049	0.049	ppm
1978	Crystallizer Operator	TCPs	P	1	0	----	0.093	----	0.093	0.093	ppm
1977	Direct Ester Operator	245-T ester	P	6	6	<0.3	----	----	----	----	ppm
1978	Direct Ester Operator	245-T ester	P	2	0	----	1	----	1	1	ppm
1977	Direct Ester Operator	Glycol ether EB	P	6	0	----	1.6	1.5	0.4	4.5	ppm
1979	Direct Ester Operator	Glycol ether EB	P	4	0	----	3.7	0.8	2.8	5	ppm
1978	Loader/Checker	CO	P	2	0	----	15	----	14	16	ppm

Table 48
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
489 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1977	2,4,5-T ester purification area	TCDD	W	9	9	<0.1	----	----	----	----	ug/wipe
1979	Direct ester process area	24-DCP	W	5	2	<3.0	16.4	17.6	6	46	ug/wipe
1979	Direct ester process area	HpCDD	W	5	5	<1.0	----	----	----	----	ug/wipe
1979	Direct ester process area	HxCDD	W	5	5	<1.0	----	----	----	----	ug/wipe
1979	Direct ester process area	OCDD	W	5	5	<1.0	----	----	----	----	ug/wipe

Table 49
Dow Chemical Industrial Hygiene Data
Area Air Samples
338 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Desription	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1966	Enclosed room on 1st floor	MC	A	5	0	----	25	----	2	110	ppm
1966	General 1st floor open area	MC	A	6	0	----	51	----	2	1422	ppm
1966	General 2nd floor open area	MC	A	4	0	----	12	----	2	29	ppm
1966	Lunch room	MC	A	9	0	----	685	----	24	4300	ppm
1966	Near centrifuge	MC	A	1	0	----	3	----	3	3	ppm

Table 50
Dow Chemical Industrial Hygiene Data
Surface Wipe Data
338 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. sample	Max. Det. Sample	Units
1971	Centrifugal decantation room	Ronnel	W	5	0	----	518	696	42	1900	ug/wipe
1971	Control room	Ronnel	W	6	0	----	395	763	26	2100	ug/wipe
1971	Lab area	Ronnel	W	3	0	----	4180	4859	41	11000	ug/wipe
1971	Ozonator room	Ronnel	W	1	0	----	120	----	120	120	ug/wipe
1971	Process area	Ronnel	W	18	0	----	2745	5945	29	26000	ug/wipe
1971	Shoe bottoms of IH after samplin	Ronnel	W	1	0	----	560	----	560	560	ug/wipe
1971	TCP storage area	Ronnel	W	2	0	----	18	----	12	24	ug/wipe

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1980	Block casting area	235-TCP	A	1	1	<0.00006	-----	-----	-----	-----	ppm
1980	Block casting area	245-TCP	A	1	0	-----	0.014	-----	0.014	0.014	ppm
1980	Block casting area	246-TCP	A	1	0	-----	0.003	-----	0.003	0.003	ppm
1980	Block casting area	24-DCP	A	1	0	-----	0.004	-----	0.004	0.004	ppm
1980	Block casting area	26-DCP	A	1	0	-----	0.0003	-----	0.0003	0.0003	ppm
1979	Block casting area	HCB	A	3	3	<0.0009	-----	-----	-----	-----	mg/M3
1980	Block casting area	HCB	A	8	5	<0.0002	0.0068	0.0095	0.009	0.023	mg/M3
1979	Block casting area	HpCDD	A	1	0	-----	0.06	-----	0.06	0.06	ug/M3
1980	Block casting area	HpCDD	A	8	1	0.001	0.015	0.013	0.008	0.047	ug/M3
1979	Block casting area	HxCDD	A	1	0	-----	0.019	-----	0.019	0.019	ug/M3
1980	Block casting area	HxCDD	A	8	3	<0.001	0.0011	0.0005	0.001	0.002	ug/M3
1979	Block casting area	OCDD	A	1	0	-----	0.21	-----	0.21	0.21	ug/M3
1980	Block casting area	OCDD	A	8	0	-----	0.109	0.044	0.059	0.19	ug/M3
1979	Block casting area	PCP	A	3	0	-----	0.840	1.033	0.099	2.3	mg/M3
1980	Block casting area	PCP	A	8	0	-----	0.971	0.980	0.12	3.4	mg/M3
1979	Block casting area	TetCP	A	3	0	-----	0.151	0.141	0.042	0.35	mg/M3
1980	Block casting area	TetCP	A	8	0	-----	0.2105	0.2015	0.0137	0.694	mg/M3
1980	Block preparation area	HCB	A	24	0	-----	0.008	0.004	0.003	0.016	mg/M3
1980	Block preparation area	PCP	A	24	0	-----	0.524	0.370	0.055	1.302	mg/M3
1980	Block preparation area	TetCP	A	24	0	-----	0.041	0.017	0.012	0.078	mg/M3
1980	Block pulling area	235-TCP	A	3	2	<0.00006	0.00004	0.00002	0.00007	0.00007	ppm
1980	Block pulling area	245-TCP	A	3	0	-----	0.0005	0.000081	0.0004	0.0006	ppm
1980	Block pulling area	246-TCP	A	3	0	-----	0.0063	0.0026	0.004	0.01	ppm
1980	Block pulling area	24-DCP	A	3	0	-----	0.0107	0.0066	0.005	0.02	ppm
1980	Block pulling area	26-DCP	A	3	0	-----	0.0017	0.0005	0.001	0.002	ppm

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1979	Block pulling area	HCB	A	12	9	<0.0005	0.06685	0.146678	0.02	0.45	mg/M3
1980	Block pulling area	HCB	A	8	5	<0.0005	0.0036	0.0081	0.0006	0.025	mg/M3
1979	Block pulling area	HpCDD	A	9	0	----	0.125	0.167	0.006	0.58	ug/M3
1980	Block pulling area	HpCDD	A	7	2	<0.002	0.003	0.002	0.002	0.007	ug/M3
1979	Block pulling area	HxCDD	A	9	3	<0.011	0.009	0.005	0.004	0.018	ug/M3
1980	Block pulling area	HxCDD	A	7	7	<0.001	----	----	----	----	ug/M3
1979	Block pulling area	OCDD	A	9	0	----	0.446	0.384	0.035	1.3	ug/M3
1980	Block pulling area	OCDD	A	7	0	----	0.031	0.014	0.015	0.055	ug/M3
1979	Block pulling area	PCP	A	12	0	----	1.861	3.901	0.029	14	mg/M3
1980	Block pulling area	PCP	A	8	0	----	0.113	0.041	0.052	0.19	mg/M3
1979	Block pulling area	TetCP	A	12	0	----	0.766	1.570	0.024	5.802	mg/M3
1980	Block pulling area	TetCP	A	8	0	----	0.060	0.066	0.001	0.21	mg/M3
1980	Block storage area	235-TCP	A	5	2	<0.00007	0.00009	0.00006	0.00007	0.0002	ppm
1980	Block storage area	245-TCP	A	5	0	----	0.0011	0.0015	0.0001	0.0001	ppm
1980	Block storage area	246-TCP	A	5	0	----	0.0036	0.0018	0.0001	0.005	ppm
1980	Block storage area	24-DCP	A	5	0	----	0.0058	0.0024	0.001	0.007	ppm
1980	Block storage area	26-DCP	A	5	1	<0.003	0.0021	0.0008	0.001	0.003	ppm
1979	Block storage area	HCB	A	3	2	<0.0003	0.010	0.014	0.03	0.03	mg/M3
1980	Block storage area	HCB	A	8	5	<0.0005	0.0004	0.0002	0.0006	0.0009	mg/M3
1979	Block storage area	HpCDD	A	2	0	----	0.028	----	0.025	0.031	ug/M3
1980	Block storage area	HpCDD	A	7	0	----	0.003	0.002	0.001	0.006	ug/M3
1979	Block storage area	HxCDD	A	2	2	<0.002	----	----	----	----	ug/M3
1980	Block storage area	HxCDD	A	7	6	<0.001	0.0007	0.0002	0.001	0.001	ug/M3
1979	Block storage area	OCDD	A	2	0	----	0.071	----	0.065	0.077	ug/M3
1980	Block storage area	OCDD	A	7	0	----	0.027	0.019	0.01	0.065	ug/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1979	Block storage area	PCP	A	3	0	----	0.143	0.017	0.12	0.10	mg/M3
1980	Block storage area	PCP	A	9	0	----	0.130	0.056	0.09	0.29	mg/M3
1979	Block storage area	TetCP	A	2	0	----	0.195	----	0.15	0.24	mg/M3
1980	Block storage area	TetCP	A	8	0	----	0.022	0.031	0.0006	0.070	mg/M3
1980	Chlorination area	235-TCP	A	12	1	<0.0001	0.0007	0.0008	0.0001	0.003	ppm
1971	Chlorination area	245-TCP	A	22	1	<0.006	0.061	0.067	0.006	0.312	mg/M3
1976	Chlorination area	245-TCP	A	8	4	<0.018	0.011	0.011	0.01	0.02	mg/M3
1980	Chlorination area	245-TCP	A	11	1	<0.0002	0.0015	0.0524	0.0002	0.005	ppm
1971	Chlorination area	246-TCP	A	22	0	----	0.257	0.279	0.014	0.910	mg/M3
1976	Chlorination area	246-TCP	A	8	1	<0.24	0.27	0.18	0.04	0.50	mg/M3
1980	Chlorination area	246-TCP	A	12	0	----	0.0097	0.0108	0.002	0.04	ppm
1965	Chlorination area	24-DCP	A	2	0	----	0.015	----	0.01	0.02	ppm
1966	Chlorination area	24-DCP	A	1	0	----	0.8	----	0.8	0.8	ppm
1976	Chlorination area	24-DCP	A	16	3	<0.017	0.065	0.081	0.01	0.31	ppm
1980	Chlorination area	24-DCP	A	12	0	----	0.0180	0.0191	0.002	0.068	ppm
1980	Chlorination area	26-DCP	A	12	3	<0.002	0.0041	0.0030	0.002	0.01	ppm
1976	Chlorination area	2-CP	A	8	3	<0.043	0.063	0.083	0.02	0.28	ppm
1965	Chlorination area	4ClOPP	A	13	0	----	1.626923	3.967596	0.22	15.30	mg/M3
1976	Chlorination area	4-CP	A	8	2	<0.03	0.04	0.02	0.02	0.09	ppm
1950	Chlorination area	Cl2	A	6	6	<2.03	----	----	----	----	ppm
1980	Chlorination area	HCB	A	12	11	<0.001	0.0006	0.0009	0.0007	0.0007	mg/M3
1950	Chlorination area	HCl	A	4	4	<1.07	----	----	----	----	ppm
1980	Chlorination area	HpCDD	A	12	2	<0.002	0.005	0.006	0.001	0.025	ug/M3
1976	Chlorination area	HxCDD	A	3	3	<0.22	----	----	----	----	ug/M3
1980	Chlorination area	HxCDD	A	12	10	<0.001	0.001	0.0004	0.001	0.002	ug/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1976	Chlorination area	HxCDF	A	3	2	<0.32	0.12	0.10	0.04	0.04	ug/M3
1976	Chlorination area	OCDD	A	3	2	<0.32	0.13	0.10	0.06	0.06	ug/M3
1980	Chlorination area	OCDD	A	12	0	----	0.021	0.015	0.004	0.047	ug/M3
1976	Chlorination area	OCDF	A	3	3	<0.22	----	----	----	----	ug/M3
1965	Chlorination area	OCIP	A	5	0	----	2.05	3.24	0.04	8.5	mg/M3
1971	Chlorination area	PCP	A	22	2	<0.015	0.087	0.102	0.018	0.333	ug/M3
1976	Chlorination area	PCP	A	8	0	----	0.613	1.470	0.01	4.5	mg/M3
1980	Chlorination area	PCP	A	12	0	----	0.039	0.042	0.006	0.14	mg/M3
1950	Chlorination area	Phenol	A	6	0	----	2.86	2.51	0.26	7.8	ppm
1965	Chlorination area	Phenol	A	11	0	----	1.46	3.04	0.3	11.07	ppm
1976	Chlorination area	Phenol	A	8	0	----	0.30	0.20	0.11	0.69	ppm
1976	Chlorination area	TCDD	A	3	3	<0.22	----	----	----	----	ug/M3
1971	Chlorination area	TetCP	A	22	0	----	0.246	0.293	0.03	1.142	mg/M3
1976	Chlorination area	TetCP	A	8	0	----	0.420	0.644	0.04	2.1	mg/M3
1980	Chlorination area	TetCP	A	12	4	<0.005	0.015	0.022	0.003	0.081	mg/M3
1966	Chlorination area	Total Particulate	A	1	0	----	0.002	----	0.002	0.002	mg/M3
1971	Chlorination area, torch burning	245-TCP	A	1	0	----	6.79	----	6.79	6.79	mg/M3
1971	Chlorination area, torch burning	HpCDD	A	1	1	<0.1	----	----	----	----	ug/M3
1971	Chlorination area, torch burning	HxCDD	A	1	1	<0.1	----	----	----	----	ug/M3
1971	Chlorination area, torch burning	OCDD	A	1	0	----	0.95	----	0.95	0.95	ug/M3
1971	Chlorination area, torch burning	PCP	A	1	0	----	68.69	----	68.69	68.69	mg/M3
1971	Chlorination area, torch burning	TetCP	A	1	0	----	23.61	----	23.61	23.61	mg/M3
1971	Flaker area	245-TCP	A	21	0	----	0.300	0.718	0.005	3.37	mg/M3
1971	Flaker area	246-TCP	A	21	1	<0.004	0.045	0.045	0.002	0.159	mg/M3
1966	Flaker area	24-DCP	A	2	0	----	0.9	----	0.3	1.5	ppm

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1950	Flaker area	NaOPP	A	1	0	----	0.46	----	0.46	0.46	mg/M3
1949	Flaker area	NaPCP	A	1	0	----	0.078	----	0.078	0.078	mg/M3
1950	Flaker area	NaPCP	A	1	0	----	0.078	----	0.078	0.078	mg/M3
1965	Flaker area	OPP,NaPCP	A	3	0	----	2.23	0.83	1.57	3.41	mg/M3
1971	Flaker area	PCP	A	21	0	----	0.088	0.061	0.02	0.259	mg/M3
1971	Flaker area	TetCP	A	21	0	----	0.120	0.141	0.02	0.633	mg/M3
1966	Flaker area	Total Particulate	A	2	0	----	0.001	----	0.0004	0.002	mg/M3
1971	Fluid bed dryer area	245-TCP	A	18	5	<0.002	1.267	5.266	0.009	0.208	mg/M3
1971	Fluid bed dryer area	246-TCP	A	18	3	<0.005	0.014	0.010	0.004	0.031	mg/M3
1966	Fluid bed dryer area	24-DCP	A	2	2	<0.1	----	----	----	----	ppm
1965	Fluid bed dryer area	Chloracnegen	A	3	3	NFR	----	----	----	----	REFR
1965	Fluid bed dryer area	OPP,NaPCP	A	2	0	----	2.12	----	2.08	2.16	mg/M3
1971	Fluid bed dryer area	PCP	A	18	2	<0.013	0.139	0.135	0.023	0.509	mg/M3
1976	Fluid bed dryer area	PCP	A	3	0	----	0.430	0.610	0.007	1.3	mg/M3
1971	Fluid bed dryer area	TetCP	A	18	0	----	0.070	0.046	0.011	0.158	mg/M3
1965	Fluid bed dryer area	Total Particulate	A	4	0	----	59.32	35.32	0.289	86.8	mg/M3
1966	Fluid bed dryer area	Total Particulate	A	2	2	<0.000002	----	----	----	----	mg/M3
1971	Locker room area	245-TCP	A	6	1	<0.002	0.082	0.082	0.002	0.195	mg/M3
1971	Locker room area	246-TCP	A	6	0	----	0.016	0.005	0.01	0.024	mg/M3
1980	Locker room area	HCB	A	1	1	<0.0002	----	----	----	----	mg/M3
1971	Locker room area	PCP	A	6	1	<0.002	0.031	0.019	0.008	0.05	mg/M3
1980	Locker room area	PCP	A	1	0	----	0.027	----	0.027	0.027	mg/M3
1971	Locker room area	TetCP	A	6	0	----	0.032	0.022	0.012	0.063	mg/M3
1980	Locker room area	TetCP	A	1	0	----	0.012	----	0.012	0.012	mg/M3
1965	Lunchroom area	245-TCP	A	1	0	----	0.18	----	0.18	0.18	ppm

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1971	Lunchroom area	245-TCP	A	3	1	<0.002	0.005	0.004	0.004	0.01	mg/M3
1976	Lunchroom area	245-TCP	A	1	0	----	0.02	----	0.02	0.02	mg/M3
1965	Lunchroom area	246-TCP	A	1	0	----	0.05	----	0.05	0.05	ppm
1971	Lunchroom area	246-TCP	A	2	0	----	0.656	----	0.358	0.954	mg/M3
1976	Lunchroom area	246-TCP	A	1	0	----	0.03	----	0.03	0.03	mg/M3
1976	Lunchroom area	24-DCP	A	1	0	----	0.03	----	0.03	0.03	ppm
1976	Lunchroom area	26-DCP	A	1	1	<0.01	----	----	----	----	ppm
1976	Lunchroom area	2-CP	A	1	1	<0.03	----	----	----	----	ppm
1976	Lunchroom area	4-CP	A	1	1	<0.02	----	----	----	----	ppm
1965	Lunchroom area	Chloracnegen	A	2	1	NFR	----	----	1	1	REFR
1980	Lunchroom area	HCB	A	5	4	<0.0002	0.0002	0.0002	0.0006	0.0006	mg/M3
1980	Lunchroom area	HpCDD	A	3	0	----	0.004	0.002	0.001	0.006	ug/M3
1980	Lunchroom area	HxCDD	A	3	2	<0.002	0.001	0.001	0.002	0.002	ug/M3
1980	Lunchroom area	OCDD	A	3	0	----	0.049	0.044	0.013	0.11	ug/M3
1965	Lunchroom area	OPP	A	1	0	----	0.05	----	0.05	0.05	mg/M3
1965	Lunchroom area	PCP	A	1	0	----	5.71	----	5.71	5.71	mg/M3
1971	Lunchroom area	PCP	A	2	0	----	0.018	----	0.007	0.029	mg/M3
1976	Lunchroom area	PCP	A	1	0	----	0.02	----	0.02	0.02	mg/M3
1980	Lunchroom area	PCP	A	5	0	----	0.019	0.007	0.014	0.033	mg/M3
1976	Lunchroom area	Phenol	A	1	0	----	0.03	----	0.03	0.03	ppm
1965	Lunchroom area	TCDD	A	2	2	<1.0	----	----	----	----	mg/M3
1965	Lunchroom area	TetCP	A	1	1	<0.01	----	----	----	----	mg/M3
1971	Lunchroom area	TetCP	A	2	0	----	0.041	----	0.036	0.046	mg/M3
1976	Lunchroom area	TetCP	A	1	0	----	0.03	----	0.03	0.03	mg/M3
1980	Lunchroom area	TetCP	A	5	0	----	0.012	0.007	0.001	0.022	mg/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	Lunchroom area	Total Particulate	A	3	0	-----	80.44	67.11	0.134	164.4	mg/M3
1971	Office area	245-TCP	A	2	0	-----	0.006	-----	0.001	0.01	mg/M3
1971	Office area	246-TCP	A	2	0	-----	0.031	-----	0.027	0.035	mg/M3
1971	Office area	PCP	A	2	0	-----	0.045	-----	0.03	0.06	mg/M3
1971	Office area	TetCP	A	2	0	-----	0.049	-----	0.03	0.068	mg/M3
1965	Packaging area	245-TCP	A	2	0	-----	0.33	-----	0.16	0.49	ppm
1971	Packaging area	245-TCP	A	19	2	<0.002	0.056	0.078	0.003	0.325	mg/M3
1976	Packaging area	245-TCP	A	3	3	<0.043	-----	-----	-----	-----	mg/M3
1965	Packaging area	246-TCP	A	2	1	<0.01	0.008	-----	0.01	0.01	ppm
1971	Packaging area	246-TCP	A	19	3	<0.021	0.025	0.029	0.005	0.137	mg/M3
1976	Packaging area	246-TCP	A	3	3	<0.36	-----	-----	-----	-----	mg/M3
1976	Packaging area	24-DCP	A	3	3	<0.033	-----	-----	-----	-----	ppm
1976	Packaging area	26-DCP	A	3	3	<0.033	-----	-----	-----	-----	ppm
1976	Packaging area	2-CP	A	3	3	<0.033	-----	-----	-----	-----	ppm
1976	Packaging area	4-CP	A	3	3	<0.057	-----	-----	-----	-----	ppm
1965	Packaging area	Chloracnegen	A	11	9	NFR	-----	-----	1	4	REFR
1965	Packaging area	NaOPP,NaTCP	A	1	0	---	1.5	-----	1.5	0.15	mg/M3
1949	Packaging area	NaPCP	A	2	0	-----	0.190	-----	0.113	0.266	mg/M3
1950	Packaging area	NaPCP	A	2	0	-----	0.190	-----	0.113	0.266	mg/M3
1965	Packaging area	OPP	A	2	2	<0.01	-----	-----	-----	-----	mg/M3
1965	Packaging area	PCP	A	2	0	-----	0.39	-----	0.34	0.43	mg/M3
1971	Packaging area	PCP	A	19	1	<0.063	0.062	0.040	0.01	0.15	mg/M3
1976	Packaging area	PCP	A	4	0	-----	5.23	6.83	0.2	17	mg/M3
1976	Packaging area	Phenol	A	3	1	<0.02	0.02	0.01	0.02	0.04	ppm
1965	Packaging area	TCDD	A	6	3	<1.0	1.4	1.0	2	3	mg/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1976	Still control room area	245-TCP	A	5	4	<0.018	0.009	0.004	0.01	0.01	mg/M3
1976	Still control room area	246-TCP	A	5	3	<0.11	0.127	0.088	0.23	0.24	mg/M3
1976	Still control room area	24-DCP	A	5	0	----	0.030	0.015	0.02	0.06	ppm
1976	Still control room area	26-DCP	A	5	4	<0.015	0.008	0.002	0.01	0.01	ppm
1976	Still control room area	2-CP	A	5	5	<0.014	----	----	----	----	ppm
1976	Still control room area	4-CP	A	5	5	<0.022	----	----	----	----	ppm
1980	Still control room area	HCB	A	4	2	<0.0002	0.0003	0.0003	0.0003	0.0007	mg/M3
1980	Still control room area	HpCDD	A	3	1	<0.001	0.002	0.001	0.002	0.003	ug/M3
1980	Still control room area	HxCDD	A	3	3	<0.001	----	----	----	----	ug/M3
1980	Still control room area	OCDD	A	3	0	----	0.046	0.025	0.02	0.08	ug/M3
1976	Still control room area	PCP	A	5	0	----	0.016	0.005	0.01	0.02	mg/M3
1980	Still control room area	PCP	A	4	0	----	0.023	0.007	0.013	0.031	mg/M3
1976	Still control room area	Phenol	A	5	0	----	0.04	0.02	0.02	0.07	ppm
1976	Still control room area	TetCP	A	5	1	<0.01	0.015	0.005	0.01	0.01	mg/M3
1980	Still control room area	TetCP	A	4	0	----	0.016	0.004	0.011	0.021	mg/M3
1971	Tank farm area	245-TCP	A	2	0	----	0.012	----	0.005	0.019	mg/M3
1971	Tank farm area	246-TCP	A	2	0	----	0.029	----	0.02	0.038	mg/M3
1971	Tank farm area	PCP	A	2	0	----	0.012	----	0.01	0.013	mg/M3
1971	Tank farm area	TetCP	A	2	0	----	0.0115	----	0.01	0.013	mg/M3
1980	Tar dempster area	235-TCP	A	8	5	<0.0002	0.0003	0.0003	0.0001	0.001	ppm
1980	Tar dempster area	245-TCP	A	8	0	----	0.0010	0.0006	0.0004	0.002	ppm
1980	Tar dempster area	246-TCP	A	8	0	----	0.0347	0.0366	0.0005	0.094	ppm
1980	Tar dempster area	24-DCP	A	8	0	----	0.0273	0.0245	0.008	0.08	ppm
1980	Tar dempster area	26-DCP	A	8	0	----	0.0075	0.0038	0.003	0.013	ppm
1980	Tar dempster area	HCB	A	15	4	<0.0005	0.0474	0.1558	0.0005	0.63	mg/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1980	Tar dempster area	HpCDD	A	17	0	-----	0.024	0.082	0.001	0.35	ug/M3
1976	Tar dempster area	HxCDD	A	3	3	<0.23	-----	-----	-----	-----	ug/M3
1980	Tar dempster area	HxCDD	A	17	16	<0.001	0.003	0.008	0.035	0.035	ug/M3
1976	Tar dempster area	HxCDF	A	3	3	<0.23	-----	-----	-----	-----	ug/M3
1976	Tar dempster area	OCDD	A	3	2	<0.33	0.13	0.09	0.06	0.06	ug/M3
1980	Tar dempster area	OCDD	A	17	0	-----	0.093	0.277	0.008	1.2	ug/M3
1976	Tar dempster area	OCDF	A	3	3	<0.23	-----	-----	-----	-----	ug/M3
1980	Tar dempster area	PCP	A	15	1	<0.001	0.033	0.056	0.003	0.22	mg/M3
1976	Tar dempster area	TCDD	A	3	3	<0.23	-----	-----	-----	-----	ug/M3
1980	Tar dempster area	TetCP	A	15	0	-----	0.006	0.008	0.001	0.021	mg/M3
1980	Warehouse area	235-TCP	A	3	1	<0.00006	0.0030	0.0042	0.0001	0.009	ppm
1971	Warehouse area	245-TCP	A	8	5	<0.002	0.004	0.005	0.004	0.016	mg/M3
1980	Warehouse area	245-TCP	A	3	0	-----	0.0012	0.0013	0.0002	0.003	ppm
1971	Warehouse area	246-TCP	A	9	0	-----	0.012	0.009	0.003	0.031	mg/M3
1980	Warehouse area	246-TCP	A	3	0	-----	0.0077	0.0046	0.003	0.014	ppm
1980	Warehouse area	24-DCP	A	3	0	-----	0.0167	0.0137	0.006	0.036	ppm
1980	Warehouse area	26-DCP	A	3	0	-----	0.0027	0.0005	0.002	0.003	ppm
1980	Warehouse area	HCB	A	6	5	<0.0004	0.0003	0.0003	0.001	0.001	mg/M3
1980	Warehouse area	HpCDD	A	3	0	-----	0.004	0.003	0.001	0.008	ug/M3
1980	Warehouse area	HxCDD	A	3	3	<0.001	-----	-----	-----	-----	ug/M3
1980	Warehouse area	OCDD	A	3	0	-----	0.028	0.022	0.007	0.059	ug/M3
1971	Warehouse area	PCP	A	9	0	-----	0.023	0.022	0.003	0.063	mg/M3
1976	Warehouse area	PCP	A	2	0	-----	0.01	-----	0.01	0.01	mg/M3
1980	Warehouse area	PCP	A	6	0	-----	0.038	0.027	0.01	0.095	mg/M3
1971	Warehouse area	TetCP	A	9	0	-----	0.050	0.063	0.004	0.217	mg/M3

Table 51
Dow Chemical Industrial Hygiene Data
Area Air Samples
265 and 349 Buildings
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max.Det. Sample	Units
1976	Warehouse area	TetCP	A	2	0	----	0.003	----	0.002	0.003	mg/M3
1980	Warehouse area	TetCP	A	6	0	----	0.017	0.013	0.0017	0.04	mg/M3
1976	Warehouse area	Total Particulate	A	2	0	----	0.355	----	0.32	0.39	mg/M3

Table 52
Dow Chemical Industrial Hygiene Data
Breathing Zone Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1950	Adding NaOH and OPP to reactor	NaOPP	Bz	1	0	----	0.304	----	0.304	0.304	mg/M3
1966	Chlorination area	24-DCP	Bz	1	0	----	30	----	30	30	ppm
1965	Chlorination area	Total Particulate	Bz	9	0	----	11.2	25.2	1.26	82.6	mg/M3
1965	Chlorination area	Dust, vapors	Bz	1	0	----	0.04	----	0.04	0.04	mg/M3
1949	Drumming and bagging operations	NaPCP	Bz	5	3	<2.03	0.650	0.489	0.0837	0.116	mg/M3
1949	Drumming and bagging operations	OPP	Bz	1	0	----	0.316	----	0.316	0.316	mg/M3
1950	Filling bags	OPP	Bz	1	0	----	0.316	----	0.316	0.316	mg/M3
1950	Filling fiber packs	NaOPP	Bz	2	2	----	1.035	----	0.15	1.92	mg/M3
1965	Flaking, drying & packaging area	NaOPP	Bz	4	0	----	2.19	0.67	1.4	2.69	mg/M3
1965	Flaking, drying & packaging area	NaOPP, NaTCP	Bz	3	0	----	0.99	0.62	0.26	1.41	mg/M3
1965	Flaking, drying & packaging area	NaPCP	Bz	5	0	----	44.7	66.0	2.75	173.5	mg/M3
1965	Flaking, drying & packaging area	NaPCP,OPP,246-TCP	Bz	6	0	----	2.38	1.33	0.93	4.12	mg/M3
1965	Flaking, drying & packaging area	NaPCP, TetCP	Bz	4	0	----	3.28	0.24	3.05	3.69	mg/M3
1949	Near NaPCP double drum dryer	NaPCP	Bz	1	0	----	0.078	----	0.078	0.078	mg/M3
1965	Prilling, flaking & packaging	NaPCP, 245-TCP	Bz	4	0	----	32.2	47.4	3.69	114.2	mg/M3
1965	Prilling, flaking & packaging	NaPCP, NaOPP	Bz	4	0	----	3.10	1.63	1.45	5.04	mg/M3
1965	Prilling, flaking & packaging	PCP, NaTCP, OPP	Bz	10	0	----	0.85	0.81	0.12	2.48	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	2nd Class Chlorinator Operator	245-TCP	P	----	----	----	0.042	----	----	----	mg/M3
1971	2nd Class Chlorinator Operator	246-TCP	P	----	----	----	0.205	----	----	----	mg/M3
1971	2nd Class Chlorinator Operator	PCP	P	----	----	----	0.048	----	----	----	mg/M3
1971	2nd Class Chlorinator Operator	TetCP	P	----	----	----	0.165	----	----	----	mg/M3
1971	Chlorinator Operator	245-TCP	P	----	----	----	0.053	----	----	----	mg/M3
1976	Chlorinator Operator	245-TCP	P	16	3	<0.03	0.015	0.004	0.01	0.02	ppm
1971	Chlorinator Operator	246-TCP	P	----	----	----	0.249	----	----	----	mg/M3
1976	Chlorinator Operator	246-TCP	P	16	0	----	0.23	0.12	0.08	0.51	ppm
1976	Chlorinator Operator	24-DCP	P	16	2	<0.02	0.32	0.75	0.08	3.2	ppm
1976	Chlorinator Operator	26-DCP	P	16	8	<0.01	0.02	0.04	0.01	0.19	ppm
1976	Chlorinator Operator	2-CP	P	16	5	<0.04	1.26	4.58	0.02	19	ppm
1976	Chlorinator Operator	4-CP	P	16	6	<0.03	0.18	0.57	0.02	2.4	ppm
1976	Chlorinator Operator	HCB	P	5	5	<0.0001	----	----	----	----	mg/M3
1976	Chlorinator Operator	HpCDD	P	5	1	<0.03	0.16	0.15	0.08	0.44	ug/M3
1976	Chlorinator Operator	HxCDD	P	5	5	<0.03	----	----	----	----	ug/M3
1976	Chlorinator Operator	OCDD	P	5	0	----	0.42	0.33	0.12	1	ug/M3
1971	Chlorinator Operator	PCP	P	----	----	----	0.05	----	----	----	mg/M3
1976	Chlorinator Operator	PCP	P	21	0	----	0.12	0.15	0.01	0.72	mg/M3
1976	Chlorinator Operator	Phenol	P	16	0	----	0.91	2.36	0.03	10	ppm
1971	Chlorinator Operator	TetCP	P	----	----	----	0.211	----	----	----	mg/M3
1976	Chlorinator Operator	TetCP	P	21	0	----	0.15	0.08	0.02	0.42	mg/M3
1976	Chlorinator Operator STE	245-TCP	P	5	1	<0.01	0.02	0.01	0.02	0.04	ppm
1976	Chlorinator Operator STE	246-TCP	P	5	0	----	0.69	0.38	0.26	1.2	ppm
1976	Chlorinator Operator STE	24-DCP	P	5	0	----	0.52	0.30	0.16	0.96	ppm
1976	Chlorinator Operator STE	26-DCP	P	5	3	<0.05	0.04	0.02	0.06	0.07	ppm

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1976	Chlorinator Operator STE	2-CP	P	5	2	<0.19	0.42	0.64	0.09	1.7	ppm
1976	Chlorinator Operator STE	4-CP	P	5	1	<0.07	0.20	0.18	0.11	0.55	ppm
1976	Chlorinator Operator STE	PCP	P	5	0	----	0.23	0.15	0.05	0.48	mg/M3
1976	Chlorinator Operator STE	Phenol	P	5	0	----	1.09	0.98	0.34	3	ppm
1976	Chlorinator Operator STE	TetCP	P	5	0	----	0.38	0.12	0.26	0.59	mg/M3
1980	Dowicide Operator	HCB	P	11	5	<0.0003	0.008	0.008	0.011	0.025	mg/M3
1980	Dowicide Operator	HpCDD	P	6	0	----	0.015	0.023	0.002	0.066	ug/M3
1980	Dowicide Operator	HxCDD	P	6	6	<0.002	----	----	----	----	ug/M3
1980	Dowicide Operator	NCPP	P	1	0	----	6	----	6	6	ug/M3
1980	Dowicide Operator	OCDD	P	6	0	----	0.245	0.428	0.024	1.2	ug/M3
1980	Dowicide Operator	OCPP	P	1	0	----	3.3	----	3.3	3.3	ug/M3
1980	Dowicide Operator	PCP	P	11	0	----	0.65	0.65	0.024	2	mg/M3
1980	Dowicide Operator	TetCP	P	11	0	----	0.03	0.01	0.013	0.06	mg/M3
1971	Dryer Operator	245-TCP	P	----	----	----	0.067	----	----	----	mg/M3
1971	Dryer Operator	246-TCP	P	----	----	----	0.041	----	----	----	mg/M3
1971	Dryer Operator	PCP	P	----	----	----	0.07	----	----	----	mg/M3
1971	Dryer Operator	TetCP	P	----	----	----	0.09	----	----	----	mg/M3
1976	Finishing Operator	245-TCP	P	3	3	<0.03	----	----	----	----	ppm
1976	Finishing Operator	246-TCP	P	3	3	<0.21	----	----	----	----	ppm
1976	Finishing Operator	24-DCP	P	3	3	<0.03	----	----	----	----	ppm
1976	Finishing Operator	26-DCP	P	3	3	<0.02	----	----	----	----	ppm
1976	Finishing Operator	2-CP	P	3	3	<0.02	----	----	----	----	ppm
1976	Finishing Operator	4-CP	P	3	3	<0.04	----	----	----	----	ppm
1978	Finishing Operator	HCB	P	3	3	<0.0001	----	----	----	----	mg/M3
1979	Finishing Operator	HCB	P	3	0	----	0.057	0.005	0.05	0.06	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Finishing Operator	HCB	P	7	7	<0.001	----	----	----	----	mg/M3
1979	Finishing Operator	HpCDD	P	3	0	----	0.010	0.004	0.006	0.016	ug/M3
1980	Finishing Operator	HpCDD	P	5	1	<0.002	0.017	0.020	0.004	0.056	ug/M3
1979	Finishing Operator	HxCDD	P	3	2	<0.002	0.004	0.004	0.009	0.009	ug/M3
1980	Finishing Operator	HxCDD	P	5	2	<0.002	0.002	0.002	0.001	0.007	ug/M3
1980	Finishing Operator	NCPP	P	2	0	----	1.53	----	0.26	2.8	ug/M3
1979	Finishing Operator	OCDD	P	3	0	----	0.082	0.027	0.062	0.12	ug/M3
1980	Finishing Operator	OCDD	P	5	0	----	0.203	0.146	0.085	0.46	ug/M3
1980	Finishing Operator	OCPP	P	2	0	----	0.92	----	0.15	1.7	ug/M3
1978	Finishing Operator	PCP	P	3	0	----	0.28	0.08	0.18	0.38	mg/M3
1979	Finishing Operator	PCP	P	3	0	----	0.51	0.25	0.18	0.8	mg/M3
1980	Finishing Operator	PCP	P	7	0	----	1.85	1.88	0.24	4.9	mg/M3
1976	Finishing Operator	Phenol	P	3	0	----	0.06	0.01	0.05	0.08	ppm
1978	Finishing Operator	TetCP	P	3	0	----	0.16	0.05	0.11	0.22	mg/M3
1979	Finishing Operator	TetCP	P	3	0	----	0.13	0.04	0.08	0.18	mg/M3
1980	Finishing Operator	TetCP	P	7	0	----	0.19	0.18	0.04	0.48	mg/M3
1976	Finishing Operator	Total Particulate	P	11	0	----	0.60	0.39	0.07	1.2	mg/M3
1971	Fluid Bed Dryer Operator	245-TCP	P	----	----	----	0.018	----	----	----	mg/M3
1971	Fluid Bed Dryer Operator	246-TCP	P	----	----	----	0.02	----	----	----	mg/M3
1971	Fluid Bed Dryer Operator	PCP	P	----	----	----	0.066	----	----	----	mg/M3
1976	Fluid Bed Dryer Operator	PCP	P	8	0	----	0.15	0.25	0.006	0.76	mg/M3
1971	Fluid Bed Dryer Operator	TetCP	P	----	----	----	0.058	----	----	----	mg/M3
1976	Fluid Bed Dryer Operator	TetCP	P	3	0	----	0.01	0.01	0.003	0.02	mg/M3
1976	Fluid Bed Dryer Operator	Total Particulate	P	9	0	----	0.67	0.63	0.16	2.2	mg/M3
1980	Foreman (block casting & pulling)	HCB	P	2	2	<0.0002	----	----	----	----	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Foreman (block casting & pulling)	HpCDD	P	2	0	----	0.019	----	0.017	0.02	ug/M3
1980	Foreman (block casting & pulling)	HxCDD	P	2	0	----	0.002	----	0.001	0.003	ug/M3
1980	Foreman (block casting & pulling)	NCPP	P	2	0	----	0.27	----	0.13	0.4	ug/M3
1980	Foreman (block casting & pulling)	OCDD	P	2	0	----	0.21	----	0.15	0.27	ug/M3
1980	Foreman (block casting & pulling)	OCPP	P	2	0	----	0.20	----	0.08	0.31	ug/M3
1980	Foreman (block casting & pulling)	PCP	P	2	0	----	0.96	----	0.76	1.15	mg/M3
1980	Foreman (block casting & pulling)	TotCP	P	2	0	----	0.10	----	0.087	0.11	mg/M3
1980	Foreman (chlorination area)	HCB	P	1	1	<0.0003	----	----	----	----	mg/M3
1980	Foreman (chlorination area)	HpCDD	P	1	0	----	0.004	----	0.004	0.004	ug/M3
1980	Foreman (chlorination area)	HxCDD	P	1	1	<0.001	----	----	----	----	ug/M3
1980	Foreman (chlorination area)	OCDD	P	1	0	----	0.089	----	0.089	0.089	ug/M3
1980	Foreman (chlorination area)	PCP	P	1	0	----	0.057	----	0.057	0.057	mg/M3
1980	Foreman (chlorination area)	TotCP	P	1	0	----	0.025	----	0.025	0.025	mg/M3
1976	Handyman	245-TCP	P	2	2	<0.03	----	----	----	----	ppm
1976	Handyman	246-TCP	P	2	2	<0.22	----	----	----	----	ppm
1976	Handyman	24-DCP	P	2	0	----	0.08	----	0.03	0.13	ppm
1976	Handyman	26-DCP	P	2	0	----	0.02	----	0.02	0.02	ppm
1976	Handyman	2-CP	P	2	1	<0.02	0.10	----	0.18	0.18	ppm
1976	Handyman	4-CP	P	2	2	<0.03	----	----	----	----	ppm
1978	Handyman	HCB	P	4	4	<0.0001	----	----	----	----	mg/M3
1979	Handyman	HCB	P	16	3	<0.0003	0.041	0.016	0.02	0.12	mg/M3
1980	Handyman	HCB	P	4	4	<0.0003	----	----	----	----	mg/M3
1979	Handyman	HpCDD	P	12	0	----	0.120	0.202	0.012	0.76	ug/M3
1980	Handyman	HpCDD	P	6	0	----	0.009	0.005	0.003	0.017	ug/M3
1979	Handyman	HxCDD	P	12	6	<0.002	0.010	0.015	0.006	0.058	ug/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Handyman	HxCDD	P	6	3	<0.002	0.001	0.001	0.001	0.003	ug/M3
1979	Handyman	OCDD	P	12	0	----	0.498	0.701	0.073	2.7	ug/M3
1980	Handyman	OCDD	P	6	0	----	0.141	0.072	0.069	0.25	ug/M3
1976	Handyman	PCP	P	2	0	----	0.04	----	0.02	0.05	mg/M3
1978	Handyman	PCP	P	4	0	----	0.22	0.16	0.02	0.41	mg/M3
1979	Handyman	PCP	P	16	0	----	3.23	8.05	0.067	33	mg/M3
1980	Handyman	PCP	P	4	0	----	0.38	0.42	0.073	1.1	mg/M3
1976	Handyman	Phenol	P	2	0	----	0.05	----	0.02	0.08	ppm
1976	Handyman	TetCP	P	2	0	----	0.03	----	0.02	0.04	mg/M3
1978	Handyman	TetCP	P	4	0	----	0.08	0.04	0.04	0.15	mg/M3
1979	Handyman	TetCP	P	16	0	----	0.39	0.69	0.057	2.6	mg/M3
1980	Handyman	TetCP	P	4	0	----	0.05	0.04	0.022	0.11	mg/M3
1971	Janitor	245-TCP	P	----	----	----	0.03	----	----	----	mg/M3
1971	Janitor	246-TCP	P	----	----	----	0.026	----	----	----	mg/M3
1980	Janitor	HCB	P	2	2	<0.001	----	----	----	----	mg/M3
1980	Janitor	HpCDD	P	2	0	----	0.007	----	0.005	0.008	ug/M3
1980	Janitor	HxCDD	P	2	1	<0.001	0.006	----	0.011	0.011	ug/M3
1980	Janitor	NCPP	P	1	0	----	0.2	----	0.2	0.2	ug/M3
1980	Janitor	OCDD	P	2	2	----	0.088	----	0.078	0.097	ug/M3
1980	Janitor	OCPP	P	1	0	----	0.08	----	0.08	0.08	ug/M3
1971	Janitor	PCP	P	----	----	----	0.024	----	----	----	mg/M3
1980	Janitor	PCP	P	2	0	----	0.06	----	0.026	0.1	mg/M3
1971	Janitor	TetCP	P	----	----	----	0.039	----	----	----	mg/M3
1980	Janitor	TetCP	P	2	0	----	0.023	----	0.014	0.032	mg/M3
1971	Master Cleck	245-TCP	P	----	----	----	0.002	----	----	----	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	Master Clock	246-TCP	P	----	----	----	0.006	----	----	----	mg/M3
1971	Master Clock	PCP	P	----	----	----	0.006	----	----	----	mg/M3
1971	Master Clock	TetCP	P	----	----	----	0.014	----	----	----	mg/M3
1971	Miller-Flaker	245-TCP	P	----	----	----	0.172	----	----	----	mg/M3
1971	Miller-Flaker	246-TCP	P	----	----	----	0.022	----	----	----	mg/M3
1971	Miller-Flaker	PCP	P	----	----	----	0.04	----	----	----	mg/M3
1971	Miller-Flaker	TetCP	P	----	----	----	0.046	----	----	----	mg/M3
1971	PCP Blender-Flaker Operator	245-TCP	P	----	----	----	0.016	----	----	----	mg/M3
1971	PCP Blender-Flaker Operator	246-TCP	P	----	----	----	0.019	----	----	----	mg/M3
1971	PCP Blender-Flaker Operator	PCP	P	----	----	----	0.109	----	----	----	mg/M3
1971	PCP Blender-Flaker Operator	TetCP	P	----	----	----	0.076	----	----	----	mg/M3
1980	Pipe Coverer	NCPP	P	1	0	----	0.2	----	0.2	0.2	ug/M3
1980	Pipe Coverer	OCPP	P	1	0	----	0.19	-----	0.19	0.19	ug/M3
1980	Production Engineer	HCB	P	1	1	<0.0002	----	----	----	----	mg/M3
1980	Production Engineer	HpCDD	P	1	0	----	0.004	----	0.004	0.004	ug/M3
1980	Production Engineer	HxCDD	P	1	1	<0.001	----	----	----	----	ug/M3
1980	Production Engineer	OCDD	P	1	0	----	0.053	----	0.053	0.053	ug/M3
1980	Production Engineer	PCP	P	1	0	----	0.023	----	0.023	0.023	mg/M3
1980	Production Engineer	TetCP	P	1	0	----	0.02	----	0.02	0.02	mg/M3
1980	Production Supervisor	HCB	P	1	1	<0.0001	----	----	----	----	mg/M3
1980	Production Supervisor	HpCDD	P	1	0	----	0.008	----	0.008	0.008	mg/M3
1980	Production Supervisor	HxCDD	P	1	0	----	0.001	----	0.001	0.001	ug/M3
1980	Production Supervisor	OCDD	P	1	0	----	0.073	----	0.073	0.073	ug/M3
1980	Production Supervisor	PCP	P	1	0	----	0.021	----	0.021	0.021	ug/M3
1980	Production Supervisor	TetCP	P	1	0	----	0.01	----	0.01	0.01	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Senior Office Assistant	HCB	P	2	1	<0.0001	0.0004	----	0.0008	0.0008	mg/M3
1980	Senior Office Assistant	HpCDD	P	2	0	----	0.0045	----	0.002	0.007	ug/M3
1980	Senior Office Assistant	HxCDD	P	2	2	<0.002	----	----	----	----	ug/M3
1980	Senior Office Assistant	OCDD	P	2	0	----	0.064	----	0.05	0.078	ug/M3
1980	Senior Office Assistant	PCP	P	2	0	----	0.031	----	0.01	0.051	mg/M3
1980	Senior Office Assistant	TetCP	P	2	0	----	0.007	----	0.005	0.008	mg/M3
1971	Shift Packer	245-TCP	P	----	----	----	0.045	----	----	----	mg/M3
1971	Shift Packer	246-TCP	P	----	----	----	0.021	----	----	----	mg/M3
1971	Shift Packer	PCP	P	----	----	----	0.046	----	----	----	mg/M3
1971	Shift Packer	TetCP	P	----	----	----	0.048	----	----	----	mg/M3
1971	Spare Operator	245-TCP	P	----	----	----	0.161	----	----	----	mg/M3
1971	Spare Operator	246-TCP	P	----	----	----	0.032	----	----	----	mg/M3
1980	Spare Operator	HCB	P	3	2	<0.0002	0.002	0.003	0.006	0.006	mg/M3
1980	Spare Operator	HpCDD	P	4	0	----	0.038	0.038	0.006	0.077	ug/M3
1980	Spare Operator	HxCDD	P	4	1	<0.003	0.003	0.002	0.001	0.006	ug/M3
1980	Spare Operator	NCPP	P	2	0	----	1.4	----	0.2	2.6	ug/M3
1980	Spare Operator	OCDD	P	4	0	----	0.52	0.58	0.06	1.5	ug/M3
1980	Spare Operator	OCPP	P	2	0	----	0.75	----	0.1	1.4	ug/M3
1980	Spare Operator	PCP	P	3	0	----	0.85	1.06	0.03	2.7	mg/M3
1971	Spare Operator	PCP	P	----	----	----	0.067	----	----	----	mg/M3
1971	Spare Operator	TetCP	P	----	----	----	0.083	----	----	----	mg/M3
1980	Spare Operator	TetCP	P	3	0	----	0.037	0.034	0.013	0.085	mg/M3
1976	Still Operator	245-TCP	P	6	5	<0.08	0.02	0.01	0.04	0.04	ppm
1976	Still Operator	246-TCP	P	6	6	<0.2	----	----	----	----	ppm
1976	Still Operator	24-DCP	P	6	4	<0.51	0.03	0.03	0.07	0.09	ppm

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1976	Still Operator	26-DCP	P	6	6	<0.51	----	----	----	----	ppm
1976	Still Operator	2-CP	P	6	5	<0.02	0.01	0.00	0.02	0.02	ppm
1976	Still Operator	4-CP	P	6	6	<0.03	----	----	----	----	ppm
1976	Still Operator	PCP	P	6	0	----	0.07	0.07	0.01	0.21	mg/M3
1976	Still Operator	Phenol	P	6	0	----	0.05	0.02	0.01	0.08	ppm
1976	Still Operator	TetCP	P	6	0	----	0.05	0.02	0.02	0.07	mg/M3
1976	Still Operator STE	245-TCP	P	2	2	<6.2	----	----	----	----	ppm
1976	Still Operator STE	246-TCP	P	2	2	<6.3	----	----	----	----	ppm
1976	Still Operator STE	24-DCP	P	2	2	<5.1	----	----	----	----	ppm
1976	Still Operator STE	26-DCP	P	2	2	<5.1	----	----	----	----	ppm
1976	Still Operator STE	2-CP	P	2	2	<5.1	----	----	----	----	ppm
1976	Still Operator STE	4-CP	P	2	2	<8.0	----	----	----	----	ppm
1976	Still Operator STE	PCP	P	2	0	----	0.27	----	0.15	0.39	mg/M3
1976	Still Operator STE	Phenol	P	2	1	<0.51	2.08	----	3.9	3.9	ppm
1976	Still Operator STE	TetCP	P	2	1	<0.04	1.51	----	3	3	mg/M3
1980	Superintendent	HCB	P	1	1	<0.0001	----	----	----	----	mg/M3
1980	Superintendent	HpCDD	P	1	0	----	0.019	----	0.019	0.019	ug/M3
1980	Superintendent	HxCDD	P	1	1	<0.001	----	----	----	----	ug/M3
1980	Superintendent	OCDD	P	1	0	----	0.16	----	0.16	0.16	ug/M3
1980	Superintendent	PCP	P	1	0	----	0.017	----	0.017	0.017	mg/M3
1980	Superintendent	TetCP	P	1	0	----	0.005	----	0.005	0.005	mg/M3
1971	TetCP Blender-Flaker	245-TCP	P	----	----	----	0.024	----	----	----	mg/M3
1971	TetCP Blender-Flaker	246-TCP	P	----	----	----	0.077	----	----	----	mg/M3
1971	TetCP Blender-Flaker	PCP	P	----	----	----	0.051	----	----	----	mg/M3
1971	TetCP Blender-Flaker	TetCP	P	----	----	----	0.072	----	----	----	mg/M3

Table 53
Dow Chemical Industrial Hygiene Data
Personal Air Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1971	Utility Man	245-TCP	P	----	----	----	0.069	----	----	----	mg/M3
1971	Utility Man	246-TCP	P	----	----	----	0.076	----	----	----	mg/M3
1971	Utility Man	PCP	P	----	----	----	0.068	----	----	----	mg/M3
1971	Utility Man	TetCP	P	----	----	----	0.109	----	----	----	mg/M3
1971	Warehouse Packer	245-TCP	P	----	----	----	0.002	----	----	----	mg/M3
1971	Warehouse Packer	246-TCP	P	----	----	----	0.005	----	----	----	mg/M3
1971	Warehouse Packer	PCP	P	----	----	----	0.009	----	----	----	mg/M3
1971	Warehouse Packer	TetCP	P	----	----	----	0.03	----	----	----	mg/M3

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Block casting area	HCB	W	3	1	<0.1	1.0	0.8	1	1.9	ug/wipe
1977	Block casting area	HpCDD	W	1	0	----	0.1	----	0.1	0.1	ug/wipe
1978	Block casting area	HpCDD	W	12	2	<0.2	0.5	0.4	0.2	1.3	ug/wipe
1979	Block casting area	HpCDD	W	3	2	<0.1	0.6	0.8	1.7	1.7	ug/wipe
1980	Block casting area	HpCDD	W	3	1	<0.1	0.8	0.7	0.5	1.7	ug/wipe
1977	Block casting area	HxCDD	W	2	2	<0.25	----	----	----	----	ug/wipe
1978	Block casting area	HxCDD	W	12	10	<0.1	0.06	0.02	0.1	0.1	ug/wipe
1979	Block casting area	HxCDD	W	7	6	<0.09	0.08	0.09	0.3	0.3	ug/wipe
1980	Block casting area	HxCDD	W	4	3	<0.1	0.1	0.1	0.2	0.2	ug/wipe
1977	Block casting area	OCDD	W	4	1	<30	27.5	20.3	0.9	50	ug/wipe
1978	Block casting area	OCDD	W	12	0	----	6.7	7.3	0.3	25	ug/wipe
1979	Block casting area	OCDD	W	7	1	<0.1	3.0	3.0	1.1	9.0	ug/wipe
1980	Block casting area	OCDD	W	4	0	----	6.2	6.6	0.4	17	ug/wipe
1977	Block casting area	TCDD	W	2	2	<0.4	----	----	----	----	ug/wipe
1980	Block pulling area	HCB	W	2	1	<0.1	0.1	----	0.2	0.2	ug/wipe
1980	Block pulling area	HpCDD	W	2	0	----	1.2	----	1.1	1.3	ug/wipe
1979	Block pulling area	HxCDD	W	2	1	<0.02	0.02	----	0.03	0.03	ug/wipe
1980	Block pulling area	HxCDD	W	6	3	<0.05	0.07	0.07	0.05	0.2	ug/wipe
1979	Block pulling area	OCDD	W	2	0	----	3.3	----	0.5	6	ug/wipe
1980	Block pulling area	OCDD	W	6	0	----	6.2	5.6	0.7	18	ug/wipe
1965	Chlorination area	Chloracnegen	W	33	33	NFR	----	----	----	----	REFR
1967	Chlorination area	Chloracnegen	W	34	33	NFR	----	----	2	2	REFR
1968	Chlorination area	Chloracnegen	W	17	17	NFR	----	----	----	----	REFR
1969	Chlorination area	Chloracnegen	W	47	47	NFR	----	----	----	----	REFR
1975	Chlorination area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1976	Chlorination area	Chloracnegen	W	3	2	NFR	----	----	2	2	REFR
1977	Chlorination area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1976	Chlorination area	HpCDD	W	9	5	<1.0	11.4	21.0	0.2	65	ug/wipe
1977	Chlorination area	HpCDD	W	27	1	<0.1	5.3	9.6	0.2	39	ug/wipe
1978	Chlorination area	HpCDD	W	25	4	<0.1	4.8	8.0	0.3	30	ug/wipe
1979	Chlorination area	HpCDD	W	2	0	----	52.1	----	4.1	100	ug/wipe
1976	Chlorination area	HxCDD	W	15	8	<0.5	0.8	1.1	0.3	3.1	ug/wipe
1977	Chlorination area	HxCDD	W	32	17	<0.3	0.6	1.6	0.1	9	ug/wipe
1978	Chlorination area	HxCDD	W	25	12	<0.1	0.7	1.3	0.2	4.8	ug/wipe
1979	Chlorination area	HxCDD	W	7	2	<0.1	1.4	2.8	0.1	8.4	ug/wipe
1976	Chlorination area	HxCDF	W	3	0	----	4.7	5.2	0.5	12	ug/wipe
1976	Chlorination area	OCDD	W	16	2	<9.5	42.0	41.6	1	130	ug/wipe
1977	Chlorination area	OCDD	W	32	3	<30.0	29.9	31.3	0.2	120	ug/wipe
1978	Chlorination area	OCDD	W	25	1	<0.1	43.1	76.6	1	310	ug/wipe
1979	Chlorination area	OCDD	W	7	0	----	22.7	28.9	3.1	80	ug/wipe
1976	Chlorination area	OCDF	W	3	0	----	12.9	15.7	1.3	35	ug/wipe
1976	Chlorination area	TCDD	W	12	12	<0.2	----	----	----	----	ug/wipe
1977	Chlorination area	TCDD	W	1	1	<0.1	----	----	----	----	ug/wipe
1980	Control room area	HCB	W	4	2	<0.1	0.1	0.1	0.1	0.2	ug/wipe
1979	Control room area	HpCDD	W	3	1	<0.1	1.9	2.2	0.6	5	ug/wipe
1980	Control room area	HpCDD	W	5	2	<0.1	0.3	0.2	0.3	0.5	ug/wipe
1979	Control room area	HxCDD	W	17	16	<0.5	0.05	0.02	0.1	0.1	ug/wipe
1980	Control room area	HxCDD	W	16	14	<0.5	0.1	0.1	0.3	0.3	ug/wipe
1979	Control room area	OCDD	W	15	1	<0.1	7.4	19.9	0.2	81	ug/wipe
1980	Control room area	OCDD	W	15	2	<0.02	1.8	3.0	0.03	11	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	Finishing area	Chloracnegen	W	22	19	NFR	----	----	2	3	REFR
1966	Finishing area	Chloracnegen	W	1	0	----	----	----	2	2	REFR
1967	Finishing area	Chloracnegen	W	15	13	NFR	----	----	2	2	REFR
1968	Finishing area	Chloracnegen	W	7	7	NFR	----	----	----	----	REFR
1969	Finishing area	Chloracnegen	W	26	24	NFR	----	----	2	2	REFR
1965	Fluid bed dryer area	Chloracnegen	W	23	22	NFR	----	----	3	3	REFR
1967	Fluid bed dryer area	Chloracnegen	W	18	12	NFR	----	----	2	3	REFR
1968	Fluid bed dryer area	Chloracnegen	W	22	21	NFR	----	----	2	2	REFR
1969	Fluid bed dryer area	Chloracnegen	W	44	40	NFR	----	----	2	3	REFR
1975	Fluid bed dryer area	Chloracnegen	W	1	0	----	----	----	2	2	REFR
1976	Fluid bed dryer area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1977	Fluid bed dryer area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1976	Fluid bed dryer area	HpCDD	W	1	0	----	17	----	17	17	ug/wipe
1977	Fluid bed dryer area	HpCDD	W	8	0	----	9.7	6.2	0.4	20	ug/wipe
1978	Fluid bed dryer area	HpCDD	W	2	0	----	0.4	----	0.3	0.6	ug/wipe
1976	Fluid bed dryer area	HxCDD	W	3	1	<0.2	1.0	0.7	1	1.9	ug/wipe
1977	Fluid bed dryer area	HxCDD	W	8	1	<0.1	0.5	0.4	0.1	1.6	ug/wipe
1978	Fluid bed dryer area	HxCDD	W	2	2	<0.1	----	----	----	----	ug/wipe
1976	Fluid bed dryer area	HxCDF	W	1	0	----	6.3	----	6.3	6.3	ug/wipe
1976	Fluid bed dryer area	OCDD	W	3	0	----	35.0	13.1	18	50	ug/wipe
1977	Fluid bed dryer area	OCDD	W	9	0	----	50.3	26.6	3.6	91	ug/wipe
1978	Fluid bed dryer area	OCDD	W	2	0	----	3.2	----	2.8	3.6	ug/wipe
1976	Fluid bed dryer area	OCDF	W	1	0	----	4.9	----	4.9	4.9	ug/wipe
1976	Fluid bed dryer area	TCDD	W	2	2	<0.25	----	----	----	----	ug/wipe
1977	Fluid bed dryer area	TCDD	W	2	2	<0.22	----	----	----	----	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1979	Lab area	HpCDD	W	4	3	<0.1	0.4	0.5	1.3	1.3	ug/wipe
1979	Lab area	HxCDD	W	8	8	<0.1	----	----	----	----	ug/wipe
1979	Lab area	OCDD	W	8	2	<0.1	4.0	5.0	0.6	13	ug/wipe
1965	Locker room area	Chloracnegen	W	3	2	NFR	----	----	2	2	REFR
1966	Locker room area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1967	Locker room area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1968	Locker room area	Chloracnegen	W	3	2	NFR	----	----	2	2	REFR
1969	Locker room area	Chloracnegen	W	7	7	NFR	----	----	----	----	REFR
1975	Locker room area	Chloracnegen	W	2	1	NFR	----	----	2	2	REFR
1976	Locker room area	Chloracnegen	W	5	5	NFR	----	----	----	----	REFR
1977	Locker room area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1980	Locker room area	HCB	W	26	20	<0.1	0.1	0.1	0.1	0.4	ug/wipe
1976	Locker room area	HpCDD	W	48	33	<1.0	2.7	7.8	0.2	42	ug/wipe
1977	Locker room area	HpCDD	W	79	23	<0.1	3.2	6.8	0.1	34	ug/wipe
1978	Locker room area	HpCDD	W	76	46	<0.1	1.1	3.8	0.1	27	ug/wipe
1979	Locker room area	HpCDD	W	7	4	<0.1	0.2	0.2	0.4	0.6	ug/wipe
1980	Locker room area	HpCDD	W	26	16	<0.1	0.4	1.3	0.1	6.8	ug/wipe
1976	Locker room area	HxCDD	W	64	52	<0.4	0.3	0.5	0.2	3	ug/wipe
1977	Locker room area	HxCDD	W	92	68	<0.2	0.1	0.2	0.1	1	ug/wipe
1978	Locker room area	HxCDD	W	76	69	<0.1	0.1	0.1	0.1	1.1	ug/wipe
1979	Locker room area	HxCDD	W	37	35	<0.07	0.04	0.02	0.04	0.05	ug/wipe
1980	Locker room area	HxCDD	W	54	46	<0.07	0.04	0.02	0.03	0.1	ug/wipe
1976	Locker room area	HxCDF	W	5	2	<1.0	0.8	0.3	0.8	1.3	ug/wipe
1976	Locker room area	OCDD	W	63	25	<5.4	14.0	25.8	0.2	120	ug/wipe
1977	Locker room area	OCDD	W	92	11	<27.3	25.4	41.3	0.1	180	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	Locker room area	OCDD	W	75	13	<0.1	10.7	28.7	0.1	170	ug/wipe
1979	Locker room area	OCDD	W	37	7	<0.09	1.8	3.2	0.05	14	ug/wipe
1980	Locker room area	OCDD	W	54	9	<0.05	2.2	8.1	0.04	60	ug/wipe
1976	Locker room area	OCDF	W	5	2	<1.0	1.4	0.8	1.5	2.3	ug/wipe
1976	Locker room area	TCDD	W	51	51	<0.2	----	----	----	----	ug/wipe
1977	Locker room area	TCDD	W	1	1	<0.05	----	----	----	----	ug/wipe
1965	Lunchroom area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1967	Lunchroom area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR
1969	Lunchroom area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1976	Lunchroom area	Chloracnegen	W	3	2	NFR	----	----	2	2	REFR
1980	Lunchroom area	HCB	W	9	7	<0.1	0.07	0.05	0.1	0.2	ug/wipe
1976	Lunchroom area	HpCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1979	Lunchroom area	HpCDD	W	5	4	<0.1	0.3	0.6	1.5	1.5	ug/wipe
1980	Lunchroom area	HpCDD	W	9	5	<0.08	0.1	0.2	0.1	0.5	ug/wipe
1976	Lunchroom area	HxCDD	W	9	4	<0.4	0.3	0.2	0.1	0.7	ug/wipe
1979	Lunchroom area	HxCDD	W	19	18	<0.08	0.04	0.02	0.03	0.03	ug/wipe
1980	Lunchroom area	HxCDD	W	20	19	<0.05	0.03	0.02	0.08	0.08	ug/wipe
1976	Lunchroom area	HxCDF	W	7	1	<1.0	1.6	1.0	0.2	4.4	ug/wipe
1976	Lunchroom area	OCDD	W	9	1	<1.0	45.0	40.2	6.0	130	ug/wipe
1979	Lunchroom area	OCDD	W	19	10	<0.09	2.5	6.0	0.1	27	ug/wipe
1980	Lunchroom area	OCDD	W	20	0	----	0.9	1.9	0.06	6.4	ug/wipe
1976	Lunchroom area	OCDF	W	7	0	----	2.6	1.9	0.5	5.8	ug/wipe
1976	Lunchroom area	TCDD	W	10	10	<0.1	----	----	----	----	ug/wipe
1965	Office area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1967	Office area	Chloracnegen	W	3	2	NFR	----	----	2	2	REFR

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1969	Office area	Chloracnegen	W	8	8	NFR	----	----	----	----	REFR
1976	Office area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1976	Office area	HpCDD	W	3	2	<1.0	12.7	17.2	37	37	ug/wipe
1977	Office area	HpCDD	W	6	1	<0.1	3.5	5.4	0.1	15	ug/wipe
1978	Office area	HpCDD	W	7	3	<0.2	0.9	1.1	0.2	2.6	ug/wipe
1979	Office area	HpCDD	W	3	2	<0.1	6.0	8.5	18	18	ug/wipe
1976	Office area	HxCDD	W	5	2	<0.5	0.4	0.2	0.3	0.7	ug/wipe
1977	Office area	HxCDD	W	7	4	<0.1	0.2	0.3	0.1	0.7	ug/wipe
1978	Office area	HxCDD	W	7	7	<0.1	----	----	----	----	ug/wipe
1979	Office area	HxCDD	W	12	11	<0.1	0.05	0.01	0.1	0.1	ug/wipe
1980	Office area	HxCDD	W	3	1	<0.02	0.1	0.1	0.04	0.2	ug/wipe
1976	Office area	HxCDF	W	1	0	----	0.8	----	0.8	0.8	ug/wipe
1976	Office area	OCDD	W	5	1	<1.0	55.6	48.7	1.5	110	ug/wipe
1977	Office area	OCDD	W	7	0	----	21.4	24.5	0.4	60	ug/wipe
1978	Office area	OCDD	W	7	0	----	5.7	6.4	1.4	21	ug/wipe
1979	Office area	OCDD	W	12	0	----	18.6	51.7	0.4	190	ug/wipe
1980	Office area	OCDD	W	3	0	----	3.5	3.4	0.5	8.3	ug/wipe
1976	Office area	OCDF	W	1	0	----	1.0	----	1	1	ug/wipe
1976	Office area	TCDD	W	4	4	<0.2	----	----	----	----	ug/wipe
1965	Packaging area	Chloracnegen	W	7	3	NFR	----	----	2	3	REFR
1966	Packaging area	Chloracnegen	W	1	1	NFR	----	----	----	----	REFR
1967	Packaging area	Chloracnegen	W	7	6	NFR	----	----	2	2	REFR
1968	Packaging area	Chloracnegen	W	5	5	NFR	----	----	----	----	REFR
1969	Packaging area	Chloracnegen	W	12	12	NFR	----	----	----	----	REFR
1975	Packaging area	Chloracnegen	W	2	2	NFR	----	----	----	----	REFR

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1976	Packaging area	HpCDD	W	2	0	-----	1.5	-----	1	2	ug/wipe
1977	Packaging area	HpCDD	W	6	0	-----	4.5	6.3	0.1	23	ug/wipe
1978	Packaging area	HpCDD	W	8	6	<0.1	0.2	0.2	0.4	0.6	ug/wipe
1976	Packaging area	HxCDD	W	4	3	<0.2	0.2	0.1	0.3	0.3	ug/wipe
1977	Packaging area	HxCDD	W	7	5	<0.2	0.2	0.3	0.3	1	ug/wipe
1978	Packaging area	HxCDD	W	8	7	<0.1	0.06	0.02	0.1	0.1	ug/wipe
1976	Packaging area	OCDD	W	4	2	<10.0	6.8	2.3	4	5	ug/wipe
1977	Packaging area	OCDD	W	9	2	<30.0	22.0	28.7	0.4	92	ug/wipe
1978	Packaging area	OCDD	W	8	4	<0.1	1.0	1.3	0.5	3.9	ug/wipe
1976	Packaging area	TCDD	W	2	2	<0.4	-----	-----	-----	-----	ug/wipe
1977	Packaging area	TCDD	W	8	8	<0.1	-----	-----	-----	-----	ug/wipe
1976	Personal protection equipment	Chloracnegen	W	1	1	NFR	-----	-----	-----	-----	REFR
1980	Personal protection equipment	HCB	W	1	0	-----	3.7	-----	3.7	3.7	ug/wipe
1980	Personal protection equipment	HpCDD	W	1	0	-----	3.3	-----	3.3	3.3	ug/wipe
1976	Personal protection equipment	HxCDD	W	3	0	-----	2.5	2.1	0.8	5.6	ug/wipe
1979	Personal protection equipment	HxCDD	W	4	3	<0.02	0.2	0.3	0.6	0.6	ug/wipe
1980	Personal protection equipment	HxCDD	W	2	1	<0.02	0.1	-----	0.1	0.1	ug/wipe
1976	Personal protection equipment	HxCDF	W	3	0	-----	6.0	3.0	1.6	8.9	ug/wipe
1976	Personal protection equipment	OCDD	W	3	0	-----	65.0	23.9	32	88	ug/wipe
1979	Personal protection equipment	OCDD	W	4	0	-----	8.0	11.6	0.6	26	ug/wipe
1980	Personal protection equipment	OCDD	W	2	0	-----	17.7	-----	0.3	35	ug/wipe
1976	Personal protection equipment	OCDF	W	3	0	-----	10.2	6.3	4.5	19	ug/wipe
1976	Personal protection equipment	TCDD	W	3	2	<0.1	0.047	0.005	0.04	0.04	ug/wipe
1976	Shop area	Chloracnegen	W	3	3	NFR	-----	-----	-----	-----	REFR
1980	Shop area	HCB	W	12	9	<0.1	0.2	0.3	0.3	0.9	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1976	Shop area	HpCDD	W	6	5	<1.0	5.1	10.2	28	28	ug/wipe
1977	Shop area	HpCDD	W	13	1	<0.1	2.9	4.4	0.1	15	ug/wipe
1978	Shop area	HpCDD	W	13	4	<0.2	0.9	1.3	0.3	5	ug/wipe
1979	Shop area	HpCDD	W	5	3	<0.1	1.9	3.2	0.8	8.3	ug/wipe
1980	Shop area	HpCDD	W	12	4	<0.1	0.3	0.3	0.1	1.2	ug/wipe
1976	Shop area	HxCDD	W	6	5	<0.5	0.3	0.1	0.4	0.4	ug/wipe
1977	Shop area	HxCDD	W	15	10	<0.1	0.2	0.2	0.1	0.7	ug/wipe
1978	Shop area	HxCDD	W	13	13	<0.1	----	----	----	----	ug/wipe
1979	Shop area	HxCDD	W	30	27	<0.08	0.11	0.27	0.1	1.4	ug/wipe
1980	Shop area	HxCDD	W	18	16	<0.07	0.04	0.03	0.1	0.1	ug/wipe
1976	Shop area	HxCDF	W	2	2	<1.0	----	----	----	----	ug/wipe
1976	Shop area	OCDD	W	7	1	<1.0	45.6	40.7	1	100	ug/wipe
1977	Shop area	OCDD	W	15	0	----	24.2	22.7	0.4	61	ug/wipe
1978	Shop area	OCDD	W	13	0	----	11.9	15.1	0.6	58	ug/wipe
1979	Shop area	OCDD	W	30	4	<0.1	6.2	13.2	0.1	73	ug/wipe
1980	Shop area	OCDD	W	18	0	----	3.5	4.9	0.06	19	ug/wipe
1976	Shop area	OCDF	W	2	1	<1.0	3.2	----	5.8	5.8	ug/wipe
1976	Shop area	TCDD	W	6	6	<0.6	----	----	----	----	ug/wipe
1975	Still control room area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1976	Still control room area	HpCDD	W	6	3	<1.0	2.5	3.9	0.2	11	ug/wipe
1977	Still control room area	HpCDD	W	17	1	<0.1	1.8	2.6	0.1	11	ug/wipe
1978	Still control room area	HpCDD	W	16	1	<0.1	17.0	40.6	0.4	170	ug/wipe
1979	Still control room area	HpCDD	W	4	0	----	8.6	10.7	2.3	27	ug/wipe
1976	Still control room area	HxCDD	W	10	8	<0.4	0.3	0.2	0.4	0.7	ug/wipe
1977	Still control room area	HxCDD	W	21	18	<0.2	0.1	0.1	0.2	0.4	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	Still control room area	HxCDD	W	16	7	<0.1	0.6	1.3	0.2	5.4	ug/wipe
1979	Still control room area	HxCDD	W	5	3	<0.1	0.1	0.1	0.1	0.3	ug/wipe
1976	Still control room area	HxCDF	W	1	1	<0.1	-----	-----	-----	-----	ug/wipe
1976	Still control room area	OCDD	W	10	3	<12.3	16.5	15.0	2	43	ug/wipe
1977	Still control room area	OCDD	W	21	2	<30.0	22.5	31.9	0.8	97	ug/wipe
1978	Still control room area	OCDD	W	16	0	-----	83.4	102.3	6	300	ug/wipe
1979	Still control room area	OCDD	W	5	0	-----	77.8	116.4	7	310	ug/wipe
1976	Still control room area	OCDF	W	1	0	-----	0.6	-----	0.6	0.6	ug/wipe
1976	Still control room area	TCDD	W	7	7	<0.1	-----	-----	-----	-----	ug/wipe
1976	Tar dempster area	Chloracnegen	W	1	1	NFR	-----	-----	-----	-----	REFR
1977	Tar dempster area	Chloracnegen	W	2	2	NFR	-----	-----	-----	-----	REFR
1980	Tar dempster area	HCB	W	1	0	-----	0.5	-----	0.5	0.5	ug/wipe
1976	Tar dempster area	HpCDD	W	3	0	-----	1.7	1.6	0.5	4	ug/wipe
1977	Tar dempster area	HpCDD	W	7	0	-----	4.7	5.2	1.2	18	ug/wipe
1978	Tar dempster area	HpCDD	W	8	0	-----	12.3	8.7	2.5	25	ug/wipe
1979	Tar dempster area	HpCDD	W	1	0	-----	23	-----	23	23	ug/wipe
1980	Tar dempster area	HpCDD	W	1	0	-----	2.8	-----	2.8	2.8	ug/wipe
1976	Tar dempster area	HxCDD	W	10	7	<0.6	0.2	0.3	0.2	1	ug/wipe
1977	Tar dempster area	HxCDD	W	10	5	<0.3	0.2	0.2	0.1	0.5	ug/wipe
1978	Tar dempster area	HxCDD	W	8	0	-----	1.6	2.2	0.1	7.1	ug/wipe
1979	Tar dempster area	HxCDD	W	11	0	-----	0.7	0.8	0.1	2.4	ug/wipe
1980	Tar dempster area	HxCDD	W	5	0	-----	1.3	1.8	0.2	4.8	ug/wipe
1976	Tar dempster area	HxCDF	W	4	3	<0.1	0.1	0.1	0.3	0.3	ug/wipe
1976	Tar dempster area	OCDD	W	10	3	<18.0	9.7	6.3	1.8	23	ug/wipe
1977	Tar dempster area	OCDD	W	10	2	<30.0	35.9	28.2	7.1	92	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1978	Tar dempster area	OCDD	W	8	0	----	90.9	67.0	12	190	ug/wipe
1979	Tar dempster area	OCDD	W	11	0	----	63.5	81.5	5	300	ug/wipe
1980	Tar dempster area	OCDD	W	5	0	----	43.3	68.6	0.8	180	ug/wipe
1976	Tar dempster area	OCDF	W	4	1	<0.1	0.4	0.2	0.3	0.7	ug/wipe
1976	Tar dempster area	TCDD	W	7	7	<0.2	----	----	----	----	ug/wipe
1977	Tar dempster area	TCDD	W	8	5	<0.05	0.35	0.81	0.1	2.5	ug/wipe
1965	Warehouse area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1967	Warehouse area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1968	Warehouse area	Chloracnegen	W	3	3	NFR	----	----	----	----	REFR
1969	Warehouse area	Chloracnegen	W	6	4	NFR	----	----	2	2	REFR
1980	Warehouse area	HCB	W	2	0	----	0.2	----	0.1	0.3	ug/wipe
1976	Warehouse area	HpCDD	W	3	3	<1.0	----	----	----	----	ug/wipe
1977	Warehouse area	HpCDD	W	2	0	----	2.0	----	2	2	ug/wipe
1978	Warehouse area	HpCDD	W	3	2	<0.1	2.2	2.2	6.5	6.5	ug/wipe
1980	Warehouse area	HpCDD	W	2	0	----	1.9	----	0.2	3.5	ug/wipe
1976	Warehouse area	HxCDD	W	4	3	<0.5	0.3	0.2	0.6	0.6	ug/wipe
1977	Warehouse area	HxCDD	W	2	2	<0.1	----	----	----	----	ug/wipe
1978	Warehouse area	HxCDD	W	3	2	<0.1	0.1	0.1	0.3	0.3	ug/wipe
1979	Warehouse area	HxCDD	W	12	10	<0.08	0.09	0.13	0.1	0.5	ug/wipe
1980	Warehouse area	HxCDD	W	6	3	<0.05	0.04	0.03	0.04	0.1	ug/wipe
1976	Warehouse area	HxCDF	W	1	0	----	1.1	----	1.1	1.1	ug/wipe
1976	Warehouse area	OCDD	W	4	0	----	18.5	24.1	1.3	60	ug/wipe
1977	Warehouse area	OCDD	W	2	0	----	11.0	----	10	12	ug/wipe
1978	Warehouse area	OCDD	W	3	0	----	12.8	17.1	0.6	37	ug/wipe
1979	Warehouse area	OCDD	W	8	0	----	3.5	2.3	1.2	7.4	ug/wipe

Table 54
Dow Chemical Industrial Hygiene Data
Surface Wipe Samples
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1980	Warehouse area	OCDD	W	6	0	----	5.2	8.4	0.2	24	ug/wipe
1976	Warehouse area	OCDF	W	1	0	----	2.1	----	2.1	2.1	ug/wipe
1976	Warehouse area	TCDD	W	4	4	<0.1	----	----	----	----	ug/wipe

Table 55
Dow Chemical Industrial Hygiene Data
Product Analyses
265 Building
The Dow Chemical Company
Midland, Michigan

Year	Sample Description	Analyte	Sample Type	No. of Samples	No. of NDs	LOD	Mean when ND=LOD/2	SD when ND=LOD/2	Min. Det. Sample	Max. Det. Sample	Units
1965	2,4,5-TCP	Chloracnegen	Pr	2	1	NFR	----	----	1	1	REFR
1966	2,4,5-TCP	Chloracnegen	Pr	1	1	NFR	----	----	----	----	REFR
1968	2,4,5-TCP	Chloracnegen	Pr	2	1	NFR	----	----	1	1	REFR
1965	2,4,6-TCP	Chloracnegen	Pr	1	1	NFR	----	----	----	----	REFR
1968	2,4,6-TCP	Chloracnegen	Pr	3	3	NFR	----	----	----	----	REFR
1965	NaPCP	Chloracnegen	Pr	4	0	NFR	----	----	1	1	REFR
1966	NaPCP	Chloracnegen	Pr	3	1	NFR	----	----	1	3	REFR
1967	NaPCP	Chloracnegen	Pr	4	3	NFR	----	----	1	1	REFR
1968	NaPCP	Chloracnegen	Pr	9	2	NFR	----	----	1	3	REFR
1964	NaTCP	Chloracnegen	Pr	1	1	NFR	----	----	----	----	REFR
1965	NaTCP	Chloracnegen	Pr	1	0	NFR	----	----	1	1	REFR
1966	NaTCP	Chloracnegen	Pr	1	1	NFR	----	----	----	----	REFR
1968	NaTCP	Chloracnegen	Pr	1	1	NFR	----	----	----	----	REFR
1965	PCP	Chloracnegen	Pr	5	2	NFR	----	----	1	3	REFR
1966	PCP	Chloracnegen	Pr	2	1	NFR	----	----	1	1	REFR
1967	PCP	Chloracnegen	Pr	3	1	NFR	----	----	1	3	REFR
1968	PCP	Chloracnegen	Pr	7	1	NFR	----	----	1	3	REFR
1965	TetCP	Chloracnegen	Pr	2	1	NFR	----	----	1	1	REFR
1968	TetCP	Chloracnegen	Pr	1	0	NFR	----	----	1	1	REFR