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TOXICOLOGICAL DATA AND INDUSTRIAL EXPERIENCE
WITH VINYL CHLORIDE

TESTIMONY OF

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PUBLIC HEARING ON VINYL CHLORIDE
OCCUPATIONAL SAFETY AND HEALTH
ADMINISTRATION
DEPARTMENT OF LABOR
WASHINGTON, D. C.

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INTRODUCTION

I AM V. K. ROWE OF DOW CHEMICAL U.S.A. CURRENTLY I AM A RESEARCH SCIENTIST CONCERNED WITH THE OVER-ALL BROAD ASPECTS OF DOW'S HEALTH AND ENVIRONMENTAL RESEARCH. PRIOR TO BEING NAMED TO THIS POST IN LATE 1973, I WAS DIRECTOR OF OUR TOXICOLOGY LABORATORY AND INDUSTRIAL HYGIENE RESEARCH.

I SHALL SUMMARIZE FOR THE RECORD THE FOLLOWING: (1) SCOPE OF THE VINYL CHLORIDE INDUSTRY; (2) THE BASIC TOXICOLOGICAL INFORMATION; (3) THE HEALTH PARAMETERS STUDIED IN VINYL CHLORIDE WORKERS; (4) OUR INDUSTRIAL HYGIENE EXPERIENCE IN ALL OF OUR PLANTS; (5) ANALYTICAL AND MONITORING PROCEDURES; (6) ITEMS FOUND EFFECTIVE IN MAINTAINING SAFE OPERATING CONDITIONS; AND FINALLY (7) SOME SUGGESTIONS FOR THE FUTURE. I BELIEVE IT WILL BE APPARENT THAT THE INDUSTRY LEARNING CURVE FOR VINYL CHLORIDE IS FAR ADVANCED.

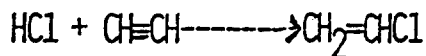
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I. SCOPE OF THE VINYL CHLORIDE INDUSTRY

DOW CHEMICAL U.S.A. BEGAN PRODUCING VINYL CHLORIDE MONOMER ON A VERY MODEST SCALE IN MIDLAND, MICHIGAN, IN 1939 AND PRODUCTION REMAINED RELATIVELY LOW THROUGHOUT THE WAR PERIOD. IN 1946, PRODUCTION OF VINYL CHLORIDE BEGAN IN OUR TEXAS DIVISION AT FREEPORT, TEXAS. CAPACITY WAS EXPANDED AT THIS LOCATION THROUGH 1956. IN 1958 OUR SECOND MONOMER PLANT WAS BROUGHT ON STREAM IN PLAQUEMINE, LA., AND A THIRD WAS ADDED IN 1969 AT OUR OYSTER CREEK DIVISION. IN 1952 DOW WAS ONE OF SEVEN U.S. PRODUCERS OF THE MONOMER AS REPORTED IN THE FIRST U.S. TARIFF COMMISSION REPORT ON VINYL CHLORIDE. TODAY THERE ARE TEN PRODUCERS OF VINYL CHLORIDE MONOMER; DOW BEING ONE OF THE LARGE MERCHANT SUPPLIERS. IN ADDITION TO PRODUCING MONOMER, DOW OPERATES A SMALL POLYMERIZATION PLANT.

THE QUANTITY OF VINYL CHLORIDE PRODUCED IN THE U.S. HAS GROWN QUITE RAPIDLY. PRODUCTION INCREASED FROM APPROXIMATELY 321 MILLION POUNDS IN 1952 TO 1 BILLION POUNDS IN 1960; 2 BILLION POUNDS IN 1965; 4 BILLION IN 1970, TO AN ESTIMATED 5.3 BILLION IN 1973. THIS MONOMER GROWTH RATE ILLUSTRATES THE HIGH DEMAND FOR THE PLASTICS PRODUCED FROM VINYL CHLORIDE (SEE FIGURE 1). VINYL CHLORIDE IS THE SECOND LARGEST VOLUME MONOMER PRODUCED IN THE UNITED STATES. THERE ARE TWO COMMERCIAL PROCESSES FOR PRODUCTION OF THE MONOMER. ONE ROUTE INVOLVES THE ADDITION OF HYDROGEN CHLORIDE TO ACETYLENE.



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U.S. PRODUCERS OF VINYL CHLORIDE

Year	Total U.S. Production Million Pounds *	Allied Chemical	American Chemical	B. F. Goodrich	Continental	Dow	Tenneco	Monochem	PPG	Shell Chemical	Ethyl Corp.	Diamond	Union Carbide	General Tire	Monsanto	Cumberland Chem.	Goodyear	U. S. Rubber
1973**	5,333	X	X	X	X	X	X	X	X	X	X							
1972**	5,109	X	X	X	X	X	X	X	X	X	X							
1971	4,336	X	X	X	X	X	X	X	X	X	X							
1970	4,040	X	X	X	X	X	X	X	X		X	X						
1969	3,736	X	X	X	X	X	X	X	X		X	X	X					
1968	2,969	X	X	X	X	X	X	X	X		X	X	X	X	X			
1967	2,424	X	X	X		X	X	X	X		X	X	X	X	X	X	X	
1966	2,500	X	X	X		X	X	X			X	X	X	X	X	X	X	
1965	2,000	X	X	X		X		X			X	X	X	X	X	X	X	
1964	1,615	X	X	X		X		X			X	X	X	X	X	X	X	
1963	1,435	X	X	X		X		X			X	X	X	X	X	X	X	
1962	1,313	X	X	X		X		X			X	X	X	X	X	X	X	
1961	1,044	X	X	X		X					X	X	X	X	X	X	X	X
1960	1,037	X	X	X		X					X	X	X	X	X	X	X	X
1959	978	x		x		x					X	X	X		X		X	X
1958	691	X		X		X					X		X		X		X	X
1957	627	X		X		X							X		X		X	X
1956	597	X		X		X						X	X		X		X	X
1955	529			X		X						X	X		X		X	X
1954	393			X		X						X	X		X		X	X
1953	402			X		X						X	X		X		X	X
1952	321			X		X						X	X		X		X	X

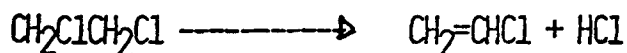
*Source: U.S. Tariff Commission Annual Reports (Reporting of quantity of vinyl chloride began in 1952)

**U.S. Tariff Commission - Monthly Reports (subject to revision)
1973 quantity estimates from 11 month data.

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HOWEVER, THE PRINCIPAL PROCESS, USED BY DOW AND MOST OTHER PRODUCERS IN THE U.S., INVOLVES THE THERMAL DEHYDROHALOGENATION OF ETHYLENE DICHLORIDE.



VINYL CHLORIDE IS ONE OF THE PUREST ORGANIC COMPOUNDS PRODUCED COMMERCIALY. A TYPICAL ANALYSIS OF VINYL CHLORIDE PRODUCED BY DOW SHOWS LESS THAN 20 PPM OF TOTAL ORGANIC IMPURITIES. THESE TRACE ORGANIC IMPURITIES ARE ACETYLENE, 1,3-BUTADIENE, METHYL CHLORIDE, AND VINYL ACETYLENE.

NEARLY ALL VINYL CHLORIDE MONOMER SHIPPED BY DOW IS UNINHIBITED; HOWEVER, A SMALL AMOUNT IS INHIBITED WITH 25-75 PPM PHENOL. THE PHENOL IS SUBSEQUENTLY REMOVED BY USE OF A CAUSTIC WASH.

I WISH TO EMPHASIZE THE DIVERSITY OF PLANT AND PROCESS OPERATIONS IN PRODUCING AND USING VINYL CHLORIDE. COMMERCIAL PLANTS FOR PRODUCING VINYL CHLORIDE RANGE IN CAPACITY FROM MODEST SIZE UP TO SEVERAL HUNDRED MILLION POUNDS. SOME ARE NEW PLANTS, SOME ARE 15 TO 20 YEARS OLD.

THREE DISTINCTLY DIFFERENT POLYMERIZATION PROCESSES HAVE BEEN COMMERCIALIZED TO PROVIDE THE WIDE VARIETY OF ESSENTIAL PLASTIC MATERIALS PRODUCED FROM

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VINYL CHLORIDE (SUSPENSION, EMULSION, AND BULK PROCESSES). POLYMERIZATION RECIPES AND SCHEDULES ARE OF NECESSITY QUITE VARIED. POLYMERIZATION PLANTS ARE BOTH OPEN-AIR AND ENCLOSED.

I WILL CITE MANY OF OUR PLANT PRACTICES, BUT STRONGLY RECOMMENDED THAT OSHA RECOGNIZE THE DIVERSITY OF MONOMER MANUFACTURING AND POLYMERIZATION OPERATIONS IN CONSIDERING THE ESTABLISHMENT OF A WORKPLACE STANDARD OR STANDARDS. OTHER PRODUCERS AND PROCESSORS WILL HAVE DIFFERENT TYPES OF JOBS, DIFFERENT EQUIPMENT, AND DIFFERENT ENGINEERING, MONITORING, AND PROCEDURAL APPROACHES. DOW STRONGLY BELIEVES THAT A STANDARD SHOULD EMPHASIZE IN OBJECTIVE TERMS WHAT IS TO BE ACCOMPLISHED SO THAT A NUMBER OF ENGINEERING AND PROCEDURAL APPROACHES MAY BE EMPLOYED UNDER THE STANDARD, DEPENDING ON THE PARTICULAR PLANT SITUATION.

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II. TOXICOLOGY OF VINYL CHLORIDE

EARLIEST STUDIES ON VINYL CHLORIDE WERE LIMITED TO ACUTE EXPOSURES, AS TYPICAL OF TOXICITY STUDIES OF THE DAY. THESE OBSERVATIONS LED TO ITS CONSIDERATION AS A SURGICAL ANESTHETIC. GENERALLY, THESE STUDIES SHOWED VINYL CHLORIDE TO BE LOW IN ACUTE TOXICITY, TO BE ANESTHETIC IN ACTION, AND TO HAVE LITTLE CAPACITY TO CAUSE LIVER INJURY FROM EXPOSURES OF A FEW HOURS. MASTROMATEO ET AL. (1960) AND LESTER ET AL. (1963) REPORTED ON ACUTE EXPOSURES OF ANIMALS AND HUMANS.

THEY REPORTED VERY LITTLE EFFECT UNTIL EXPOSURE CONCENTRATIONS APPROACHED 10,000 PPM WHEN HUMANS REPORTED DIZZINESS AFTER 5 MINUTES EXPOSURE. NO DEATHS OCCURRED IN RATS EXPOSED FROM 1/2 TO 2 HOURS TO 100,000 PPM. EXPOSURES TO 150,000 TO 200,000 PPM FOR 1/2 TO 2 HOURS CAUSED ANESTHETIC DEATHS AS DID HIGHER CONCENTRATIONS FOR SHORTER PERIODS OF TIME.

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ACUTE INHALATION OF TOXICITY
OF VINYL CHLORIDE

<u>SPECIES</u>	<u>CONCENTRATION (PPM)</u>	<u>DEATH OR OTHER EFFECT</u>
RATS, MICE, AND GUINEA PIGS	100,000 = (10%)	No DEATHS IN 0.5 HR ⁽¹⁾
	200,000	1/15 (1/5 MICE)
	300,000	11/15 (5/5 RATS AND MICE 1/5 GUINEA PIGS)
GUINEA PIGS	400,000	2/5 (1 IMMEDIATELY, 1 IN 24 HRS)
RATS	100,000	No DEATHS IN 2 HRS ⁽²⁾
	150,000	1 OF 2 DIED IN 2 HRS ⁽²⁾
HUMANS	NONE	1/6 SLIGHT DIZZINESS IN 5 MIN ⁽²⁾
	4,000	0/6
	8,000	1/6 SLIGHTLY UNSTEADY
	12,000	2/6 (1 SLIGHTLY UNSTEADY, 1 REELING)
	16,000	INTOXICATION OF VARYING DEGREE
	20,000	INTOXICATION OF VARYING DEGREE, MORE SEVERE

(1) MASTROMATEO ET AL., AIHA J. 21, 394 (1960)

(2) LESTER, GREENBERG AND ADAMS, AIHA J. 24, 265 (1963)

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SOME LUNG CONGESTION AND EDEMA WERE PRESENT AFTER 42 MINUTES EXPOSURE TO 150,000 PPM, BUT LIVER AND KIDNEY INJURY WERE NOT APPARENT.

SINCE 1962, NUMEROUS NON U.S. ARTICLES ON VINYL CHLORIDE HAVE APPEARED, PARTICULARLY IN THE RUSSIAN LITERATURE. SEVERAL OF THESE STUDIES INVOLVED ACUTE EXPOSURES AND THE OBSERVED EFFECTS WERE GENERALLY SUBTLE REVERSIBLE CHANGES.

THE CHRONIC TOXICITY OF VINYL CHLORIDE HAS BEEN STUDIED BY SEVERAL INVESTIGATORS. TORKELSON, OYEN, AND ROWE (1961) REPORTED THE FOLLOWING RESULTS.

RESULTS OF REPEATED SEVEN-HOUR DAILY EXPOSURES TO VINYL CHLORIDE

EXPOSURE PPM	MONTHS	<u>DOGS</u>	<u>GUINEA PIGS</u>	<u>RATS</u>	<u>RABBITS</u>
500	4.5	NOT EXPOSED	NOT EXPOSED	SLIGHT LIVER & KIDNEY HISTOPATHOLOGY (CENTRAL LOBULAR GRANULAR DEGENERATION AND INTERSTITIAL & TUBULAR CHANGES)	NOT EXPOSED
200	6	NO EFFECT	NO EFFECT	SLIGHT LIVER WEIGHT INCREASE	SLIGHT LIVER HISTOPATHOLOGY (CENTRAL LOBULAR DEGENERATION & NECROSIS WITH VACUATION AND SOME PERIportal CELLULAR INFIL- TRATION)
100	6	NO EFFECT	NO EFFECT	SLIGHT LIVER WEIGHT INCREASE	NO EFFECT
50	6	NO EFFECT	NO EFFECT	NO EFFECT	NO EFFECT

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THEY CONCLUDED THAT WORKERS EXPOSURE SHOULD BE LIMITED TO LESS THAN 100 PPM WITH A TIME-WEIGHTED AVERAGE NOT TO EXCEED 50 PPM.

LESTER, GREENBERG, AND ADAMS TOOK EXCEPTION TO CONCLUSIONS OF TORKELSON, ET AL AND RECOMMENDED 500 PPM AS A TIME-WEIGHTED AVERAGE EXPOSURE.

RESULT OF REPEATED SEVEN-HOUR EXPOSURE OF MALE AND FEMALE
RATS TO VINYL CHLORIDE

EXPOSURE CONDITIONS

RESULT

50,000 PPM - 19 DAYS

INCOORDINATION. NORMAL HEMATOLOGY. INCREASE LIVER WEIGHT. NORMAL GROSS PATHOLOGY. SLIGHT LIVER HISTOPATHOLOGY.

20,000 PPM - 90 DAYS

NORMAL HEMATOLOGY. INCREASED LIVER WEIGHT. NORMAL GROSS PATHOLOGY. SLIGHT LIVER HISTOPATHOLOGY, WHICH WAS CONSIDERED TO BE WITHIN NORMAL LIMITS.

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BECAUSE OF THESE CONFLICTING REPORTS, THE TLV COMMITTEE OF THE ACGIH IN 1963 CHOSE TO CHANGE THEIR TLV FROM 500 PPM AS A MAXIMUM TIME-WEIGHTED AVERAGE FOR INDUSTRIAL EXPOSURE TO 500 PPM AS A CEILING VALUE. (AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENE, 1963).

BECAUSE OF THE REPORT OF ACROOSTEOLYSIS IN HUMANS, PROFESSOR P. L. VIOLA OF THE REGINA ELEVA INSTITUTE FOR CANCER RESEARCH IN ROME, ITALY, ATTEMPTED TO PRODUCE THE DISEASE IN ANIMALS. HE EXPOSED RATS 4 HOURS PER DAY, 5 DAYS PER WEEK TO 30,000 PPM (3%) VINYL CHLORIDE VAPOR. (VIOLA, MARCH 1970). IN HIS FIRST REPORT ON THE RESULTS OF 12 MONTHS EXPOSURE, HE DESCRIBED METAPLASTIC CHANGES IN THE BONES WHICH HE CONSIDERED SIMILAR TO THE HUMAN DISEASE ACROOSTEOLYSIS. HE MADE NO MENTION OF HAVING OBSERVED CANCER IN THESE ANIMALS UNTIL THE TENTH INTERNATIONAL CANCER CONGRESS IN MAY 1970. IN THE ABSTRACTS OF THIS MEETING, (VIOLA, 1970), AND SUBSEQUENTLY IN MAY 1971, VIOLA, BIGOTTI, AND CAPUTO (1971) REPORTED TUMORS OF THE SKIN, LUNGS, AND BONES OCCURRING FIRST AFTER 10 MONTHS EXPOSURE. THE AUTHORS SUMMARIZED THIS WORK AS FOLLOWS:

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"RATS (AR/IRE WISTAR STRAIN) EXPOSED FOR 12 MONTHS TO VAPORS OF VINYL CHLORIDE DEVELOPED TUMORS OF THE SKIN, LUNGS, AND BONES. THE CUTANEOUS TUMORS, WHICH ALWAYS APPEARED IN THE AREA IN WHICH SUBMAXILLARY AND PAROTID GLANDS ARE LOCATED, HAVE BEEN HISTOLOGICALLY RECOGNIZED AS EPIDERMOID CARCINOMAS, PAPILLOMAS, AND MUCOEPIDERMOID CARCINOMAS. THE MORPHOLOGICAL CHARACTERISTICS OF LUNG TUMORS, WHICH OCCURRED IN A LOWER PERCENTAGE, WERE MAINLY OF THE ADENOCARCINOMA TYPE, WITH THE EXCEPTION OF A SINGLE EPIDERMOID TUMOR ORIGINATING FROM THE EPITHELIAL COVERING CELLS. IN A MINOR NUMBER OF RATS, A LARGE PROLIFERATION OF CARTILAGINOUS TISSUE DIAGNOSED AS OSTEOCHONDROMA DEVELOPED IN THE METACARPAL AND METATARSAL REGIONS OF THE FOUR LIMBS."

THIS REPORT BY VIOLA ET AL. IS APPARENTLY THE EARLIEST AND ONLY PUBLICATION IN WHICH CARCINOGENIC ACTIVITY HAS BEEN ASCRIBED TO VINYL CHLORIDE. ALTHOUGH THERE ARE POSSIBLE DEFICIENCIES IN VIOLA'S STUDY, SUCH AS THE QUALITY OF THE VINYL CHLORIDE SAMPLE USED IN THE STUDY, THE PRESENCE OF FOOD AND BEDDING IN THE EXPOSURE CHAMBER, AND THE EXCESSIVE EXPOSURE CONCENTRATION USED, THE REPORT NEVERTHELESS GAVE RISE TO SERIOUS CONCERN AND RESULTED IN THE INITIATION OF ADDITIONAL ANIMAL STUDIES AND EPIDEMIOLOGICAL STUDIES WHICH ARE CURRENTLY UNDERWAY (MCA PRESS RELEASE).

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III. HEALTH PARAMETERS STUDIED IN WORKERS

DOW IS COOPERATING WITH THE MANUFACTURING CHEMISTS ASSOCIATION WHICH HAS RETAINED TABERSHAW-COOPER TO DO AN INDUSTRY-WIDE STUDY OF THE HEALTH OF WORKERS EXPOSED TO VINYL CHLORIDE. CURRENTLY, WE HAVE APPROXIMATELY 320 EMPLOYEES IN VINYL CHLORIDE OPERATIONS. WE HAVE SUBMITTED TO TABERSHAW-COOPER EMPLOYEE RECORDS COVERING 916 PERSONNEL WHO HAVE BEEN INVOLVED IN VINYL CHLORIDE OPERATIONS OVER THE YEARS. THIS STUDY IS INCOMPLETE AND WILL BE REPORTED AT AN APPROPRIATE DATE. HOWEVER, WE CAN MAKE THE FOLLOWING PRELIMINARY COMMENTS ON THE HEALTH PARAMETERS OF DOW VINYL CHLORIDE WORKERS.

PRELIMINARY DATA FROM DOW MANUFACTURING UNITS REVEAL NO DEATHS DUE TO CANCER OF THE LIVER.

PRELIMINARY DATA LIKEWISE REVEAL NO DEATHS DUE TO CIRRHOSIS OF THE LIVER. WE HAVE NO CASES OF ACROOSTEOLYSIS.

AT THE PRESENT TIME, WE ARE UNAWARE OF ANY LIVING EMPLOYEE WHO HAS BEEN EXPOSED TO VINYL CHLORIDE SUFFERING FROM CANCER OF THE LIVER. LIKEWISE, WE KNOW OF NO CASE OF CIRRHOSIS OF THE LIVER IN EMPLOYEES EXPOSED TO VINYL CHLORIDE. HOWEVER, THIS INFORMATION IS INCOMPLETE AND IS BEING SUBJECTED TO A CRITICAL SEARCH.

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PRELIMINARY STUDIES IN TWO MAJOR MANUFACTURING LOCATIONS, WITH THE LONGEST HISTORY OF VINYL CHLORIDE PRODUCTION, REVEAL NO INCREASE IN ABNORMAL LIVER FUNCTION TESTS ABOVE THAT EXPECTED IN A SIMILAR UNEXPOSED POPULATION.

C. G. KRAMER, M.D. AND J. E. MUTCHLER PUBLISHED IN THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION JOURNAL IN 1972, A STUDY OF VINYL CHLORIDE WORKERS IN ONE LOCATION. FINDINGS SUGGEST THAT REPEATED EXPOSURE TO VINYL CHLORIDE AT TWA LEVELS OF 300 PPM OR ABOVE FOR A WORKING LIFETIME TOGETHER WITH A VERY LOW LEVEL OF VINYLIDENE CHLORIDE MAY RESULT IN SLIGHT CHANGES IN CERTAIN PHYSIOLOGICAL AND CLINICAL LABORATORY PARAMETERS. THE POSSIBILITY OF SOME IMPAIRMENT IN LIVER FUNCTION MUST BE CONSIDERED, EVEN THOUGH NO OVERT CLINICAL DISEASE WAS EVIDENT IN ANY OF THE INDIVIDUALS STUDIED. THIS STUDY SHOWED A DEFINITE DOSE-RESPONSE CORRELATION BETWEEN THE INTENSITY OF EXPOSURE AND THE DEVIATION FROM NORMAL VALUES.

WE WILL CONTINUE TO COOPERATE WITH THE MANUFACTURING CHEMISTS ASSOCIATION IN THE TABERSHAW-COOPER STUDIES. ADDITIONAL IN-DEPTH STUDIES WILL BE CONTINUED WITHIN THE VARIOUS MANUFACTURING UNITS OF THE COMPANY AND WILL BE REPORTED UPON WHEN COMPLETE.

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IV. INDUSTRIAL HYGIENE MEASUREMENTS OF VINYL CHLORIDE IN WORKPLACE AIR
DOW HAS MONITORED THE WORKPLACE ENVIRONMENT BY A VARIETY OF
TECHNIQUES, INCLUDING:

- (A) CONTINUOUS MONITORING OF REPRESENTATIVE OR SELECTED
WORKPLACE AREAS BY A COMBUSTION - CONDUCTIVITY
ANALYZER.
- (B) "GRAB" SAMPLES OF WORKPLACE AIR COLLECTED IN
IMPERVIOUS PLASTIC BAGS OR ACTIVATED CARBON "SLUGS"
(ABSORPTION). ANALYSIS OF SUCH SAMPLES IS NOW BY
GAS CHROMATOGRAPHY, BUT YEARS AGO ANALYSIS WAS BY
DETERMINATION OF TOTAL CHLORIDE OR BY INFRARED
SPECTROSCOPY.
- (C) PERSONNEL MONITORS BASED ON ABSORPTION ON ACTIVATED
CARBON SLUGS, FOLLOWED BY GAS CHROMATOGRAPHIC ANALYSIS.

MONOMER PLANT #1 STARTED OPERATION IN 1946. HISTORICALLY, SPOT
SAMPLING WAS CONDUCTED. LOADING OF TANK CARS, COLLECTION OF
SAMPLES FOR PRODUCT ASSAY AND DISTILLATION OPERATIONS WERE THE
ONLY TASKS WHICH NEEDED ATTENTION IN THE EARLY OPERATION OF
THIS PLANT. IN 1972, AN EXTENSIVE INDUSTRIAL HYGIENE SURVEY
WAS CONDUCTED. MULTIPLE GRAB SAMPLES WERE COLLECTED IN IMPERVIOUS
PLASTIC BAGS AND ANALYZED BY GAS CHROMATOGRAPHY. THE FOUR
CONTROL OPERATOR CLASSIFICATIONS HAD TWA VALUES BETWEEN 0.2
AND 1.3 PPM. MAINTENANCE EMPLOYEES HAD A TWA VALUE OF 1.7 PPM
AND THE SUPERVISORY EMPLOYEES HAD A TWA OF 1.3 PPM. THE LOADING

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OPERATIONS HAD A TWA VALUE OF 45 PPM AND THE LABORATORY EMPLOYEES WHO COLLECT SAMPLES FROM STORAGE TANKS HAD A TWA OF 14 PPM.

PERSONNEL MONITORING IS PRESENTLY BEING CARRIED OUT ON A SYSTEMATIC AND PERIODIC BASIS IN THIS PRODUCTION UNIT. IN 1973, ALL TWA VALUES WERE BELOW 10 PPM EXCEPT FOR THE LABORATORY EMPLOYEES WHO HAD TWA EXPOSURES OF UP TO 30 PPM, A LEVEL WELL BELOW OUR INDUSTRIAL HYGIENE GUIDELINE OF 50 PPM.

MONOMER PLANT #2 STARTED OPERATION IN 1958. LIMITED SURVEYS WERE CONDUCTED IN 1965 AND REVEALED TWA'S RANGING FROM 9 TO 60 PPM. AN IN-DEPTH SURVEY WAS CARRIED OUT IN 1973. ALL TWA VALUES WERE BELOW 10 PPM EXCEPT FOR THE LABORATORY EMPLOYEES. THEIR VALUES WERE BETWEEN 10 AND 15 PPM.

MONOMER PLANT #3 BEGAN OPERATION IN 1969. IN A 1973 - 1974 PERSONNEL MONITORING STUDY, TWA VALUES RANGED FROM LESS THAN 1 PPM TO 10 PPM.

OUR POLYMER PLANT #1 WAS OPERATED FROM 1946 TO 1972. BETWEEN 1950 AND 1959 SEVERAL INDUSTRIAL HYGIENE SURVEYS WERE CONDUCTED. A NUMBER OF JOB CLASSIFICATIONS (POLYMERIZER OPERATORS, DRIER OPERATORS, MONOMER STILL OPERATORS, AND MONOMER TRANSFER OPERATORS) HAD WORKPLACE ENVIRONMENTAL LEVELS RANGING FROM 50 TO 385 PPM VINYL CHLORIDE. AFTER INSTALLATION OF A CONTINUOUS ANALYZER

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FOR THE WORKPLACE AIR IN 1959, IMPROVEMENTS WERE ACHIEVED. VINYL CHLORIDE TWA VALUES RANGED FROM 25 TO 85 PPM DURING THE PERIOD 1960-1967.

OUR PRESENT POLYMERIZATION PLANT, POLYMER PLANT NUMBER TWO, BEGAN OPERATION IN 1953. HISTORICALLY THE TWA VALUES HAVE BEEN DECREASED OVER THIS PERIOD OF TIME. IN THE EARLY HISTORY, TWA VALUES OF 105-240 PPM WERE OBSERVED. DURING 1973, TWA VALUES FOR VINYL CHLORIDE IN THE AIR WERE IN THE 1 TO 25 PPM RANGE.

WE EMPHASIZE THAT THERE IS SOME VARIATION IN TWA VALUES FROM DAY TO DAY FOR A GIVEN TYPE OF OPERATION. FOR EXAMPLE, OPERATORS INVOLVED IN PUMPING REACTORS SHOWED VALUES RANGING FROM 1 TO 34 PPM. SIMILARLY, THREE OPERATORS INVOLVED IN LOADING OPERATIONS HAD TWA VALUES RANGING FROM 8 TO 31 PPM. WE ENCOURAGE RECOGNITION THAT SUCH VARIATION WILL OCCUR IN NORMAL DAY TO DAY OPERATIONS INVOLVING TRANSFER OF MONOMER.

WE ARE INCLUDING REPORTS ON A NUMBER OF OUR INDUSTRIAL HYGIENE MONITORING STUDIES AS WRITTEN SUPPLEMENTS TO THIS STATEMENT. THESE ARE LABELED APPENDIX II.

IN SUMMARY, THE INDUSTRIAL HYGIENE DATA SHOW THAT LEVELS OF EXPOSURE BELOW 50 PPM ARE ATTAINABLE IN BOTH PRODUCER AND USER PLANTS OF VINYL CHLORIDE.

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IT MUST BE NOTED, HOWEVER, THAT WITH OLDER PLANTS THE ACHIEVEMENT OF SUCH GOALS MAY BE DIFFICULT, AND IN ALL PROBABILITY WILL REQUIRE MAJOR MODIFICATIONS THAT WILL TAKE TIME TO ACCOMPLISH.

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V. SAFETY IN THE VINYL CHLORIDE INDUSTRY

THE OPERATION OF A SAFE PLANT INVOLVING THE HANDLING OF TOXIC, HAZARDOUS MATERIALS REVOLVES AROUND:

1. ESTABLISHMENT OF SAFE, PRACTICAL ALLOWABLE ENVIRONMENTAL LEVELS.
2. IMPLEMENTING APPROPRIATE ENGINEERING AND OPERATING PROCEDURES TO ACHIEVE OR BETTER THESE LEVELS.
3. PROVIDING ANALYTICAL MONITORING CAPABILITY TO INSURE THE ENVIRONMENT IS MAINTAINED BELOW THE ESTABLISHED LEVELS AND TO DETECT EXCURSIONS ABOVE SUCH LEVELS.
4. INITIATING APPROPRIATE CORRECTIVE ACTION WHEN BREAKDOWNS OCCUR AND GUIDELINES ENVIRONMENTAL LEVELS ARE EXCEEDED.
5. DEVELOPING AND SUPPORTING AN APPROPRIATE MEDICAL SURVEILLANCE PROGRAM.

DOW HAS A SAFETY PHILOSOPHY THAT THE SAFETY OF OUR EMPLOYEES, OUR CUSTOMERS AND OUR NEIGHBORS IS OF PRIME AND OF UTMOST IMPORTANCE. THIS SAFETY PHILOSOPHY PERMEATES OUR OPERATIONS. TO ACHIEVE OUR GENERAL SAFETY GOALS FOR VINYL CHLORIDE OPERATIONS AND TO ACHIEVE A GOAL THAT INDUSTRIAL EXPOSURE TO VINYL

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CHLORIDE SHOULD BE KEPT BELOW 50 PPM ON A TIME WEIGHTED AVERAGE, WE HAVE IMPLEMENTED THE FOLLOWING DESIGN AND ENGINEERING PRINCIPLES FOR VINYL CHLORIDE OPERATIONS:

1. PROCESSING SYSTEMS ARE CLOSED WITH NO OPEN VESSEL OPERATION.
2. CURRENT BUILDINGS WHERE VINYL CHLORIDE IS MANUFACTURED OR POLYMERIZED ARE OPEN TO THE ATMOSPHERE OR HAVE VENTILATION TO MINIMIZE CONCENTRATION BUILD-UPS.
3. ENGINEERING DESIGN EMPHASIZES REASONABLE PROCESS AUTOMATION AND REASONABLE REMOTE OPERATION IN ORDER TO MINIMIZE PERSONNEL EXPOSURE.
4. VENT EXHAUST SYSTEMS ARE SELECTIVELY LOCATED TO MINIMIZE THE POSSIBILITY OF PERSONNEL EXPOSURE.
5. THE NUMBER AND QUANTITY OF SAMPLES FOR CONTROL ANALYSES ARE MINIMIZED.

CAREFUL APPLICATION OF THE ABOVE PRINCIPLES HAS LED ESSENTIALLY TO THE ATTAINMENT OF OUR GOAL OF TWA VALUES OF LESS THAN 50 PPM IN OUR OPERATIONS.

WE BELIEVE THAT GOOD OPERATING PROCEDURES MUST BE TAILORED TO EACH SPECIFIC PLANT, THAT PLANT SIZE, AND THE NATURE OF THE PROCESS AND PLANT LOCATION ALL WILL INFLUENCE THE EXACT PROCEDURES TO BE CARRIED OUT. I WILL MENTION

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A FEW OF THE MORE IMPORTANT OPERATING PROCEDURES AND TECHNIQUES INVOLVED FOR ONE OF OUR MONOMER PRODUCTION PLANTS TO ILLUSTRATE THE COMPLEXITY OF GOOD PLANT OPERATION. ,

1. EMPLOYEES ARE FAMILIARIZED WITH EMERGENCY PROCEDURES AND SIGNALS; FOR EXAMPLE, WIND DIRECTIONAL SIGNALS, HORN EMERGENCY CALLS, AND EVACUATION ROUTES.
2. COLLECTION OF ANALYTICAL SAMPLES OF VINYL CHLORIDE FROM STORAGE TANKS INVOLVES A CLOSED LOOP SAMPLING SYSTEM IN ORDER TO RETURN VINYL CHLORIDE TO THE PROCESS RATHER THAN VENTING VAPOR IN THE WORKPLACE ENVIRONMENT. LABORATORY SAMPLES OF VINYL CHLORIDE ARE HANDLED IN HOODS AND SAMPLE CYLINDERS ARE GROUNDED WHEN DISCHARGED. ON-LINE GAS CHROMATOGRAPHY IS BEING USED EXTENSIVELY TO MONITOR PRODUCT PURITY AND PROCESS OPERATION; THIS HAS REDUCED MARKEDLY THE NUMBER OF MANUAL SAMPLE COLLECTIONS REQUIRED.
3. SPECIALLY DESIGNED VAPOR EQUALIZING LINES CONNECTED BACK TO THE STORAGE TANK ARE EXPLOYED IN THE LOADING OF TANK CARS.
4. ENVIRONMENTAL MONITORING OF AIR IS BEING CONDUCTED BY A NUMBER OF TECHNIQUES. GAS DETECTOR ALARMS ARE LOCATED THROUGHOUT THE PLANT AT A NUMBER OF STRATEGIC

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LOCATIONS TO WARN OF ANY FLAMMABLE CONCENTRATIONS. PORTABLE DETECTOR INSTRUMENTS ARE AVAILABLE FOR CHECKING PLANT AREAS OR PROCESS EQUIPMENT PRIOR TO NON-ROUTINE OPERATIONS AND PROCEDURES. AIR QUALITY SURVEYS WERE CONDUCTED IN MONOMER PLANT NUMBER 1 IN 1971. DURING THE FIRST QUARTER OF 1974, A CONTINUOUS ANALYZER SYSTEM FOR 12 STRATEGIC LOCATIONS IN THE PLANT WILL BE INSTALLED. THIS WILL PROVIDE CONTINUOUS BACKGROUND INFORMATION AND PROVIDE INSTANTANEOUS SIGNALS FOR ANY UNUSUALLY HIGH CONCENTRATIONS THAT MIGHT OCCUR DUE TO LEAKS, SPILLS OR OTHER NON-ROUTINE SITUATIONS.

IN OUR POLYMERIZATION OPERATIONS, WE HAVE NOT HAD PROBLEMS OF WORKER ILLNESS FROM THE CLEANING OF POLYMERIZATION VESSELS. WE UTILIZE HIGH PRESSURE WATER JETS AFTER EACH POLYMERIZATION REACTION TO PREVENT POLYMER BUILD-UP. OUR EMULSION POLYMERIZATION KETTLES REQUIRE MANUAL CLEAN-OUT EVERY TWO OR THREE MONTHS. AFTER WATER CLEANING OF THE VESSEL, ALL LINES ARE BLANKED TO PREVENT ANY MATERIAL FROM ENTERING THE VESSEL; THE ATMOSPHERE IS TESTED FOR OXYGEN SUPPLY, AND A CONTINUOUS VINYL CHLORIDE MONITORING PROBE IS PUT INTO THE VESSEL. CONCENTRATIONS MUST BE BELOW 50 PPM PRIOR TO VESSEL ENTRY. AIR PURGE IS MAINTAINED ON THE VESSEL DURING THE CLEANING OPERATION.

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VI. ANALYTICAL METHODOLOGY

FOUR METHODS ARE AVAILABLE FOR ENVIRONMENTAL MONITORING OF AIR FOR THE PRESENCE OF VINYL CHLORIDE:

1. COMBUSTION-CONDUCTIVITY
2. GAS CHROMATOGRAPHY
3. INFRARED SPECTROPHOTOMETRY
4. FLAME IONIZATION SPECTROPHOTOMETRY

GAS CHROMATOGRAPHY IS VERY SPECIFIC, BUT REQUIRES ABOUT 10 MINUTES PER SAMPLE. FLAME IONIZATION DETECTORS HAVE NO SPECIFICITY-RESPONDING TO ALL CARBON-CARBON OR CARBON-HYDROGEN BONDS, BUT ARE PORTABLE AND THE MEASUREMENT IS INSTANTANEOUS. THE COMBUSTION-CONDUCTIVITY METHOD RESPONDS TO ANY MATERIAL WHICH BURNS TO PRODUCE IONS. IT RESPONDS RAPIDLY. INFRARED ANALYZERS ARE VERY SPECIFIC, RESPOND QUICKLY AND ARE PORTABLE. ALL OF THESE TECHNIQUES HAVE ADEQUATE SENSITIVITY, DETECTING CONCENTRATIONS OF 1 PPM.

PERSONNEL MONITORING IS ACHIEVED THROUGH USE OF ABSORPTION TUBES FILLED WITH ACTIVATED CARBON. THE ABSORBED CHLORINATED HYDROCARBONS ARE DETERMINED BY GAS CHROMATOGRAPHY AFTER THERMAL RELEASE OR EXTRACTION BY CARBON DISULFIDE.

AT DOW, MOST OF OUR ENVIRONMENTAL MONITORING HAS BEEN WITH COMBUSTION-CONDUCTIVITY ANALYZERS. WE HAVE USED THESE ANALYZERS FOR CONTINUOUS MONITORING SINCE 1959 WITH EXCELLENT RESULTS.

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VII. RECOMMENDATIONS FOR GOVERNMENT-INDUSTRY ACTION

1. DOW URGES OSHA TO RECOGNIZE THE VOLUNTARY INDUSTRY ACTION TO LOWER THE LEVELS OF EXPOSURE TO VINYL CHLORIDE AND THE LEAD ROLE OF INDUSTRY IN OBTAINING DATA ON THE VINYL CHLORIDE PROBLEM.
2. DOW BELIEVES THE INDUSTRY RECOGNIZES THE NEED TO MAINTAIN ENVIRONMENTAL LEVELS BELOW THE OSHA STANDARD OF 500 PPM AND EVEN BELOW THE ACGIH RECOMMENDATION OF 200 PPM.
3. DOW BELIEVES THAT IT IS INDUSTRY'S AND GOVERNMENT'S RESPONSIBILITY TO INFORM ALL EMPLOYEES OR PERSONS WORKING WITH VINYL CHLORIDE ABOUT ITS HAZARDS AND TO DEVELOP AND IMPLEMENT TRAINING PROGRAMS TO HELP PREVENT OVER-EXPOSURE AND INSURE PROPER REACTION IN EMERGENCY SITUATIONS. WE BELIEVE INFORMED EMPLOYEES WILL CO-OPERATE IN ELIMINATING OVER- EXPOSURE AND SUGGEST METHODS FOR IMPROVEMENT.
4. BASED UPON THE MEDICAL AND TOXICOLOGICAL DATA AVAILABLE TO US AT THIS TIME, DOW BELIEVES THAT AN EIGHT-HOUR TWA OF 50 PPM IS A SATISFACTORY ENVIRONMENTAL STANDARD FOR VINYL CHLORIDE.

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5. DOW IS SUPPORTING AND ACTIVELY COOPERATING IN LONG-TERM INHALATION, METABOLISM AND EPIDEMIOLOGICAL STUDIES IN ORDER TO OBTAIN THE MOST PRECISE DATA POSSIBLE RELATING TO THE POTENTIAL FOR OCCUPATIONAL HEALTH ASSESSMENT.
 - (A) WE WILL STRONGLY SUPPORT INDUSTRY-GOVERNMENT EVALUATION OF THE DATA AS IT BECOMES AVAILABLE.
 - (B) RESULTS OF THE EPIDEMIOLOGICAL SURVEY OF VINYL CHLORIDE WORKERS INITIATED ABOUT A YEAR AGO BY MCA VIA CONTRACT WITH TABERSHAW-COOPER WILL BE AVAILABLE IN THE NEAR FUTURE. IT SEEMS REASONABLE TO EXPECT THAT THESE RESULTS WILL PROVIDE ADDITIONAL AND SUBSTANTIVE BASIS FOR RULE-MAKING.

6. DOW BELIEVES RULE-MAKING SHOULD NOT BE BASED ON CONDITIONS THAT EXISTED IN THE PAST BUT SHOULD BE BASED ON CONDITIONS AS THEY EXIST TODAY. BASED ON NIOSH ACTIVITY AND ON WIDESPREAD VOLUNTARY ACTIONS BY INDUSTRY, WE BELIEVE THERE IS NO NEED FOR A TEMPORARY EMERGENCY STANDARD. REALISTICALLY, WE BELIEVE A TEMPORARY EMERGENCY STANDARD WOULD RESULT IN POLARIZATIONS RATHER THAN CONSTRUCTIVE DEFINITION OF AREAS OF CONCERN AND CONSTRUCTIVE PROBLEM SOLVING.

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WORK WITH VINYL CHLORIDE, THAT PERSON MIGHT
WELL BE REMOVED TO ANOTHER JOB NOT INVOLVING
SUCH EXPOSURE. WE RECOMMEND NIOSH ASSISTANCE
IN DEFINING THE PRIORITY OF HEALTH PARAMETERS
FOR STUDY.

8. DOW SUPPORTS OSHA'S ESTABLISHMENT OF A PERMANENT HEALTH STANDARD
FOR VINYL CHLORIDE BY REGULAR RULEMAKING PROCEDURES.
9. WE RECOMMEND THAT THE STANDARD STATE WHAT SHOULD BE ACCOMPLISHED,
LEAVING THE "HOW-TO-ACHIEVE COMPLIANCE" TO INDIVIDUAL PLANT
IMPLEMENTATION.

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ABSTRACT

Cancer Mortality in U.S. Counties with Plastics
and Related Industries

IMD

Thomas J. Mason, Ph.D.

Utilizing the Census of Manufacturers, 1963, in individual counties of the U.S. with establishments primarily engaged in manufacturing plastics materials and synthetic resins (SIC 2821), synthetic rubbers (SIC 2822), and cellulosic (SIC 2823) and synthetic (SIC 2824) organic fibers were selected. Site specific cancer mortality rates were calculated for the upper 25% of these counties when ranked on the proportion of the total county population employed in these industries.

Cancer mortality was found significantly deficient for many anatomic sites for the aggregate when compared to the total United States. However, there were significant excesses detected in white males for the subcategories. For plastics the excesses were in lip, testis, skin cancer other than melanoma, eye, and other endocrine glands. For synthetic rubbers the excesses were in nasal sinuses, lung, prostate, bladder, melanoma, and other skin cancer.

For synthetic fibers the excess was in multiple myeloma. The relative contributions of industry, urbanization, and other possibly confounding variables are discussed.

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