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Specialist Team Survey

For

MONSANTO COMPANY

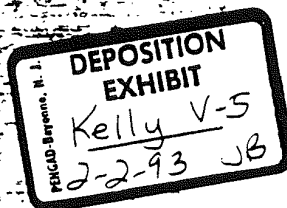
At

Organic Division J. F. Queeny Plant

St. Louis, Missouri

ENGINEERING REPORT

from  The Travelers
Insurance Companies



PROTECTED MATERIAL: MONSANTO
INSURANCE COVERAGE LITIGATION

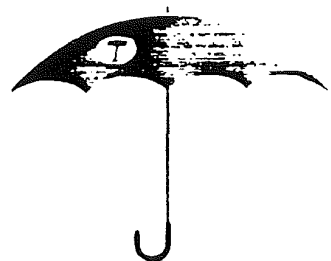
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ENGINEERING DIVISION

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Introduction

From May 24 to 28, 1971, a team of Travelers Engineering Specialists conducted a survey at the Organic Division C. F. Queeny Plant in St. Louis, Missouri to assist Monsanto in its loss control activities. This plant was chosen for a team visit to:

- Evaluate the property loss potentials from the standpoint of a catastrophe, such as a fire or explosion.
- Evaluate casualty losses including workmen's compensation exposures and general liability exposures such as products liability, pollution, and commercial automobile liability.
- Determine the effectiveness of the controls exercised by the St. Louis plant management in their loss prevention efforts.

The survey team consisted of the following engineers:

Francis W. Hodson, Travelers Chemical Specialist

William H. Joy, Jr., Travelers Fire Specialist

Reginald F. Scott, Jr., Travelers Machinery and Pressure Vessel Specialist

Kenneth W. Macon, Travelers Engineering Representative, St. Louis

Richard J. Skissiah, Marsh & McLennan, Property Specialist, Chicago

Each specialist is an expert in his field with years of formal education, advanced technical training, and practical loss control experience. These engineers combined their expertise to evaluate the exposures that could result in a fire, an explosion, or a run-away process reaction at the C. F. Queeny plant.

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Mr. D. E. Hunie, J. F. Queeny Plant Manager, welcomed the survey team to St. Louis. After this preliminary meeting, the survey team met with General Superintendents Emery Kimball, Baxter Tilford, G. A. Hippe, Elmer Malone, and Ed Tack for an overview of the operations in the St. Louis plant.

During the survey and the plant tour, additional technical support was provided by:

Len Stokloriar, Utilities Superintendent

Jim Rogers, Maintenance General Superintendent

Ron Wise, Technical Services General Superintendent

Harvey Morgan, Safety Director

Lon Malm, TSD Superintendent

John Zoloudek, Supv. Maintenance Utilities and Rotating Equipment

R. E. Truschert, Mechanical Department Operations Superintendent

During the survey, the specialists considered the machinery and equipment supporting the production operation, the available utilities, water supply, and process systems (including the critical reactions resulting from the possible misapplication of chemicals, temperature, and pressure variations). They surveyed the plant layout (including piping systems, standby or secondary utilities, and roadway accessibility), the personnel, employment practices, training facilities, and employee records.

On completion of the survey, the team of engineers met with Mr. Harvey Morgan to discuss their findings. Mr. Morgan was advised that formal recommendations for the J. F. Queeny plant would be issued from The Travelers Home Office.

Monsanto will benefit from the specialist team survey conducted at the C. F. Queeny plant by complying with the recommendations made in the interest of protecting Monsanto's property, personnel and members of the general public from accidents.

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MANUFACTURING

The J. F. Queeny plant manufactures pharmaceuticals, additives, and intermediate chemicals in varying quantities for shipment in tank car lots and by truck/trailer in 55 gallon drums and palletized bags. With the exception of ethylene (which is reacted with vinyl chloride to produce a water based latex material - this is run at the elevated pressure of 1,700 psig), all reactions are carried out under moderate pressures and temperatures. The reactor used for the ethylene is a thick shelled unit designed for 4,000 psig. Most processes consist of small, manually loaded batch type operations produced in 2,000 gallon vessels. However, two products - Iasso and Maleic Acid - are continuous large scale processes.

Brief descriptions of the major processes and products (including the observations of the survey team) are in the Appendix. These provide the basis for many of the recommendations.

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CORROSION CONTROL

Corrosion Control tabulates the resistance of material to corrosion. They establish the wear rates of internal tank coatings and plastic liners. In conjunction with operating supervision, this department develops equipment inspection requirements and sets inspection frequencies. They have at their disposal a large amount of instruments (including a stereo microscope) to test the equipment and to analyze failures. A comprehensive investigation and review is conducted on each unscheduled equipment failure.

All pressure vessels purchased are ASME code certified. All repair welding or modification work complies with the standards set by the ASME. For certification of competency, welders are sent to the Jackson Welding School in St. Louis for training in MIG, MIG, and Meltarc welding. Procedures are developed by staff metallurgical engineers. St. Louis testing laboratories are used for weldment analysis and x-ray examination of finished welds.

Safety and relief valves are tested on the bench every year and are sent to Consolidated Pressur for complete overhaul every other year. Turbine overspeeds are tested on a regular basis.

All equipment data, drawings, and overhaul reports are kept on microfilm. Duplicate copies of these microfilms are stored off the site.

These programs and controls should provide a firm basis for developing a high percentage of reliability. During our survey of the J. F. Queeny plant, we got the impression that these plans are not yet fully developed; however, they are making definite progress toward this goal. The mechanical equipment in the plant was well maintained; however, more extensive monitoring for vibration shutdown on high speed rotating equipment should be provided.

PERSONNEL

The J. F. Queeny plant employs approximately 1,000 people working three shifts. Pre-employment and periodic physicals (including x-rays and audiometric tests) are given to all employees. A full medical facility (including a four bed hospital and physical therapy facilities) is available for emergency and follow-up treatment. One doctor is on duty during the day shift; another doctor is employed on a part time basis for the other shifts. A nurse is on duty on each shift. A radiologist is also on the staff.

At all times while in the plant, all employees must wear personal protective equipment (safety glasses, safety shoes, safety hat, and approved clothing with sleeves rolled down). Chemical goggles must be worn when handling Class I chemicals. To protect employees who are exposed to toxic chemicals, urine and blood samples are regularly taken from these people.

Management and supervisory safety meetings are held and records are maintained. Overall employee safety is evaluated by a process safety audit team. The St. Louis plant has operated approximately 1,000,000 man hours without a disabling injury.

UTILITIES

Steam

The J. F. Queeny plant is provided with steam by four 70,000 pound per hour boilers, one 200,000 pound per hour boiler, and three small waste heat units on the reactors at the maleic acid plant capable of producing 60,000 pounds per hour. The gas-fired boilers are equipped with full F.I.A. flame failure and gas train cutoffs which meet Travelers combustion safeguard requirements. Most of the manufacturing areas of the plant are unheated. However, those which are heated, are heated with steam and they are properly arranged.

Electric Power

Union Electric supplies electric power to the St. Louis plant over two 33 KV feeders, reduced to 6.9 KV at the Union Electric substation adjacent to the J. F. Queeny complex. Eleven substations are located throughout this plant site. These substations are on a loop feed and are all double ended with manual load transfer. The plant has two small turbo generators (3,500 KW at 6.9 KV and 1,500 KW at 4-0 KV) for emergency power.

Air

Air is supplied by two steam turbine driven centrifugal compressors rated at 70,000 CFM and one 10,500 CFM centrifugal compressor driven by a 2,000 horsepower motor. The maleic acid process requires large volumes of air, thus making the compressor units highly critical because they are all necessary for full production. None of these units are equipped with temperature or vibration

monitors to shut off the drivers under abnormal conditions. To reduce this exposure, Monsanto has ordered such a unit which will be installed at a separate location. Central plant air is provided at 70 psi from Building L.

Water

Water is supplied to the J. F. Queeny plant from St. Louis. Cooling towers are provided for reusing the water.

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PLANT PROTECTION

Description of Facilities

The J. F. Queeny plant, a multi-product operation, is located in an industrial area on approximately 85 acres of land on the south side of St. Louis, next to the Mississippi River. The entire plant is fenced and is patrolled by security guards. There is no public access to the property.

Most of the 50 major buildings are noncombustible. The older buildings are steel frame construction with concrete floors and nonbearing brick exterior walls. The newer buildings are light noncombustible construction with exterior metalized or asbestos covered walls. A few of the buildings are brick joist ordinary construction.

Public Fire Protection

The St. Louis Class 2 Public Fire Department, which is located two blocks away, would respond to an alarm from the J. F. Queeny plant. Normally, they would send a battalion chief, two pumps, and one ladder truck.

Private Fire Protection

The plant Safety Department, headed by Mr. Harvey Morgan, Safety Director, is responsible for safety, fire protection, and medical. Milton Pierce, who has 10 or 15 years of experience at this plant, heads the fire protection unit.

The St. Louis plant employs a driver and two firemen for the day shift and a driver for each of the other shifts. The two full-time firemen also inspect and

recharge the portable fire extinguishers, which are liberally distributed throughout the plant.

Portable fire fighting equipment includes a chemical fire truck with 1,000 pounds of purple K dry chemical and a 400 gallon water booster tank. This truck carries 1,000 feet of 2½ inch hose and 150 feet of 1½ inch hose with all the necessary connectors and fog nozzles. Standard equipment includes dry chemical extinguishers, air packs, portable lights, and two-way radios. An International Scout is used for maintenance work. This plant also has a National foam trailer with 150 gallons of 6 percent Aerefoam 30, proportioner, and nozzles.

Water Supply: The plant's underground piping system consists of a complete grid supplied through several connections to the grid belonging to the City of St. Louis. There are two 2,500 gallon per minute fire pumps driven by diesel power at 105 psi horizontal centrifugal pumps. These two fire pumps take suction from a manifold supplied by a 12 inch connection to a 20 inch city water main and a 12 inch connection to the same grided 20 inch city water main. At the opposite "East" end of the property, there are two 1,000 gpm at 100 psi fire pumps taking suction from two manifolded 100,000 gallon ground level storage tanks with automatic 6 inch fill lines capable of delivering 1,000 gpm make up rate. These pumps are both automatic: one is driven by electricity and the other driven by steam turbine. All four fire pumps are arranged to start in sequence by pressure drop.

A 100 gpm jockey pump maintains 90 to 100 psi on the underground systems. The pressure in the underground system is monitored at both pump houses and when the pressure drops below 95 psi, the steam turbine pump goes on immediately. If the

pressure is not restored to at least 105 psi, the electric pump will start 40 seconds after the steam turbine. If the pressure requirement is not satisfied, the number 2 diesel pump will come on in 25 seconds followed 25 seconds later by the number 1 diesel pump, if necessary. Alarms are monitored at the fire house. Both diesel drivers are completely supervised for such things as failure to start, power, abnormally high cooling water, and low oil pressure. The electrical fire pump is supervised for power supply; the steam driven pump is supervised for low steam pressure. All four pumps are regularly checked to make sure they are running properly.

Automatic Sprinkler Protection: All manufacturing buildings are protected by dry pipe automatic sprinkler systems with an occasional deluge system and one or two wet pipe systems. The regular maintenance crew takes care of the sprinkler systems. All systems are provided with water flow supervision, including Potter Central Station supervision and remote supervision to the plant fire station and the plant guard house.

All warehouse buildings are protected by dry pipe sprinkler systems. Stock is not piled high. Private fire hydrants are distributed liberally throughout the entire plant approximately 250 feet apart. A number of strategically located monitor nozzles are distributed throughout the property.

Disaster Control Program

Employees are instructed to report fires by dialing 222. This sounds an alarm at the guard office, the Safety Director's office, and the plant fire station. The guard sounds the plant fire alarm system and telephones the public fire department.

Employees are trained to follow a pre-planned evacuation program. Signs are posted in all the departments and buildings indicating the location of the evacuation center for each department.

At the sounding of the plant fire alarm, the general superintendent of each department reports to the emergency control center. This is primarily a communication center supplied with radios to be operated by the General Superintendent of Maintenance, the General Superintendent of PC and D, and the Safety Director (who has a radio which keeps him in contact with the safety engineers and the fire vehicles). In the emergency control room, there is an override for the plant public address system. The city battalion chief is in charge of operations at the fire scene. He is assisted by the plant personnel.

No provisions have been made for relocating the disaster control headquarters off the plant grounds. J. F. Queeny plant management feels that they would be flexible enough to move off the premises if conditions warranted because of the portable equipment they use.

Rescue Squad

The primary responsibility of the 45 employees on the plant rescue squad is life safety. They receive orders from the plant fire chief and are at his disposal in case of an emergency. During the explosion in Building II, the rescue squad removed all 27 victims in three minutes.

Security

The City of St. Louis has allowed the J. F. Queeny plant to block off some public streets and put a fence around the entire property. The gates across

these public streets are monitored by remote control to allow fire department and motor vehicle access to the plant.

All employees and visitors are issued badges which (when they are inserted into a reading device at the gate) will activate a computer which, in turn, will either open or refuse to open the gate. From the central guard office, all gates are monitored by closed circuit television cameras. All gates can be opened by hand in the event of a power failure. In case of an emergency, guards automatically open all gates.

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EXPOSURES TO LOSS

Common Hazards

In several of the manufacturing buildings, wiring was poorly maintained. There were numerous violations of code requirements in Class I, Division 1 and Division 2 locations. In some locations, unapproved man fans had been installed in violation of the code.

Smoking is restricted to designated areas only. "No Smoking" rules are strictly enforced. Personnel entering the manufacturing areas are required to leave cigarettes and lighters outside the area.

Housekeeping is good with only a few areas, such as Building T, where conditions were poor.

An adequate permit program is in effect for welding and entering tanks.

Chemicals and Flammable Liquids

Numerous Class I chemicals are used throughout the plant in the manufacturing processes. Phosphoric oxychloride decomposes when it comes in contact with water. Benzoyl peroxide, a powerful oxidizing agent, was stored in excessive amounts and was being handled improperly in the manufacturing area. Two hundred pounds of benzoyl peroxide were stored with possible contaminants. Numerous carbon dioxide and nitrogen blankets were found on vessels, converters, reactors, and mills throughout the manufacturing area. In Building DD, nitrol is kept in buggies under specially designed automatic sprinklers until the stability of the batch can be verified.

All stationary tanks containing flammable liquids were properly diked; however, there are numerous tank cars and tank trailers used to carry flammable liquids throughout the property. Flammable liquid process supply piping (both overhead and above ground) passes throughout the manufacturing area. These overhead lines are not identified and, in many cases, are subject to accidental damage.

Ethylene oxide unloading facilities are provided with water spray for temperature control. A flow switch would help guard against the possibility of an undetected piping failure. There is an unattended ethylene unloading area adjacent to the ethylene oxide facility and the perimeter fence. A failure of the manifold piping in Area 2899 could result in a large gas release.

Electronic Data Processing Machinery

Computer equipment is located on the 7th floor of Building 333. This is an 8 story unsprinklered building of fire resistive construction. Present computer equipment (owned by IBM) consists of a model 1800 enclosure unit, an 1801 process controller, an 1800 data acquisition and control system, and an 1810 disk storage. A Monsanto-owned scientific computer (model DAITE-3) is also in the computer room.

Substandard conditions in this area include power cables run on the floor, no automatic fire detection or protection system, no cut-off from other offices on the floor (only eye-level glass partitions are provided), the absence of independent heating and air conditioning systems, an inadequate number of dry chemical fire extinguishers, an excessive amount of combustibles in the computer areas, and the absence of "No Smoking" restrictions.

The new maleic anhydride process will be controlled from this room by computer. As more processes are put on computer control, proper protection of this room will become more critical.

Natural Forces

The J. F. Queeny plant is located in an area subject to tornadoes, severe thunder storms, and hail storms.

This plant is in a Zone II earthquake area and would probably sustain moderate damage should an earthquake occur in the St. Louis area.

The danger of flooding is remote. The flood stage on the Mississippi is 30 feet at this location. The plant grade is 42 feet. The flood record in this area indicates that the 1875 flood may have reached 42 feet; however, each major flood following that has never gone over 38.94 feet. The levees which have been continued southward past this location have alleviated much of the danger of flooding.

Riots, Vandalism, and Malicious Mischief

This Monsanto location is not in an area which would normally be subject to riots. To reduce the dangers of vandalism and malicious mischief, the J. F. Queeny plant has developed a tight security system. The management has taken every precaution to secure the plant property from unauthorized entry.

Explosion

Reactors and vessels are adequately protected by rupture disks which minimize the possibility of explosion. Factors which contribute to the possibility of

an explosion include handling numerous flammable liquids and solvents and the flammable liquid piping that is exposed to damage.

General Liability Exposures

The entire plant is fenced and patrolled by security guards. Visitors to the plant are provided with an escort and protective equipment. All common carriers bringing vehicles into the plant are issued safety rules, are provided with protective equipment, are told about the "No Smoking" rule, and are instructed to drive at the proper speeds.

The vessels and transfer lines on the Slay Terminal bridge carry butanol, toluene, benzene, steam, and sulphuric acid. The area below these lines is open to the public and a rupture (even a minor one on the sulphuric line) could create problems.

Automobile Exposures

Security and Fire Department drivers must submit driving records and receive driver training. However, in other departments, driver selection and training is left to the individual department heads. Because of this decentralized system, it is difficult to determine the effectiveness of their controls.

Aircraft and Vehicle

There is no exposure to loss from aircraft. Since numerous vehicles use the streets and alleyways for deliveries, the possibility of damage exists.

Public Exposure

The UVU Building is exposed moderately by the Benjamin Moore Paint Company located 75 feet North of the plant; however, there is no other significant exposure.

Pollution

Pollution Control has spent over three million dollars during the period from 1965 to 1969 and has projected expenditures over ten million for the period of 1970 through 1974.

Air Pollution is partially controlled. This plant has 3,247 vents to the atmosphere. Approximately 75 percent of them have no pollution potential, 375 have a low potential, and 275 have a high potential. Approximately 325 of the vents are equipped with pollution control devices.

Monsanto has an odor control program with an odor panel and personnel who respond immediately to any public complaints. They have installed many scrubbers, collectors, and odor control devices. They plan to have the C. F. Queeny plant odor free by 1972.

Water Pollution is partially controlled. Monsanto provides individual and total samples to the Metropolitan Sanitary District (MSD). A large city sewer crosses the plant property and flows into the Mississippi River. All curb drains in the plant empty into this sewer. Large spills from some of the chemical tanks could reach a curb drain and, ultimately, the Mississippi River.

Recently, Monsanto has installed a large neutralization basin on the plant. They bleed off 1,000 gallons per minute of water waste from the city sewer through the neutralization basin to the MSD Bissel Plant which has primary treatment only. A lime neutralization system is used to control pH. Most of the in-process drains from J. F. Queeny plant buildings go to this neutralization basin. It is possible for flammables, corrosives, and toxic materials to reach the basin. If there was a large spill of such materials, Monsanto would be required to notify the MSD. Liquid wastes are monitored and records are maintained.

Before wastes are discharged into the Mississippi River, they receive primary treatment from the St. Louis MSD. By 1975-76, the City of St. Louis hopes to install a secondary system.

Landfill areas located across the Mississippi River are used jointly with the Krummrich Plant for the disposal of corrosive and toxic liquids and solid wastes. This cannot continue much longer because the State of Illinois is somewhat concerned about this disposal method. Test wells at the landfill sites do not reveal contamination; however, when liquids are discarded in this manner, it is difficult to predict what might happen.

CONCLUSIONS

The survey team agrees that a severe exposure to loss exists because of the proximity of the plant buildings. Several operating units could be destroyed by an explosion or fire. This is especially true in the older areas of the plant. Currently, buildings L, M, O, R, and S are being razed. When this program is completed, the exposure to loss of multiple units will decrease.

The principle liability exposure is associated with large spills of toxic or corrosive chemicals within the plant or during the transportation of materials to the plant.

The practice of conducting safety audits will further reduce the exposure to loss. The J. F. Queeny plant has a positive loss prevention program and a good attitude toward safety. However, we feel there is a need for additional concentrated effort in your safety activities to reduce loss potentials as soon as possible.

To assist you in further controlling exposures to loss, we submit the following recommendations based on our team survey of the J. F. Queeny plant.

RECOMMENDATIONS

71-1. All electrical appliances, equipment, fixtures, and wiring should be upgraded to meet the requirements of the National Electrical Code for Hazardous Operations. We found evidence of some equipment and fixtures in the buildings which were not properly maintained and there was evidence of open wiring.

- 71-2. A program of tank labeling should be established. Labels should identify the contents of the tanks and provide information about the reactivity, toxicity, and flammability of the materials.
- 71-3. Process lines within the plant should be identified to indicate the material in transfer. All tanks containing toxic, corrosive, and flammable material should be diked to prevent accidental release to public sewers or public waters.
- 71-4. The practice of disposing liquid wastes to a landfill site should be evaluated. We question the advisability of this type of disposal because of the possibility of contaminants entering surface and subsurface waters.
- 71-5. The Tank Entry Permit should include the signed approval of the maintenance department when maintenance work is being done.
- 71-6. Tank Entry Permits and "Do Not Operate" tags should carry the signature of a qualified representative of the department involved.
- 71-7. The relief valve on the oxygen supply line in the II Building relieves directly into the room. It should relieve to the exterior of the building.
- 71-8. The storage of organic peroxides should be reviewed. We observed 40 lbs. of benzoyl peroxide stored in Building BB for use in oil additives processing. 200 lbs. of this granular material was stored in another building adjacent to a liquified petroleum gas cylinder and other organic materials. Only the minimum quantity (preferably a one-half day supply).

needed for the operation should be stored in a manufacturing area at any one time. Larger quantities of benzoyl peroxide should be stored in the specially designed building of noncombustible construction.

71-9. Public automobiles should not be permitted to park under flammable and corrosive chemical pipelines between the terminal and the Monsanto plant. This area should be fenced or appropriately posted to eliminate public parking.

71-10. The supervisory training program should be expanded. We observed crane operations where the work was not properly evaluated and supervised. A pipe section being removed from the II Building swung around and came in contact with pipelines and reactors. We observed one crane operation where the boom came in contact with an overhead electrical cable. A coal dump truck was unloading materials at the power house with the box in contact with overhead chemical lines. It was difficult, at times, to find the supervisors in the operating area.

71-11. The computer room should be cut off from the adjoining offices by a noncombustible enclosure. A products of combustion type fire detection system and an automatic fire extinguishing system should be installed.

71-12. A separate heating and air conditioning system should be provided for the computer room to isolate it from the office building system.

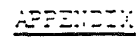
71-13. All unnecessary combustibles such as furniture, card storage, etc., should be removed from the computer room.



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EXTRACTED MATERIAL: MONSANTO



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PROCESS AND PRODUCT INFORMATION

ONCB & PNCB - Buildings P and Q - organic residues from the Monsanto Humminic Plant (located across the Mississippi River) are distilled and crystallized to produce ONCB (ortho-nitrochlorobenzene) and PNCB (para-nitrochlorobenzene). The ONCB is transferred to storage and sales. The PNCB is used in the PHP process in the II Building.

Maleic Anhydride - The process is a vapor phase oxidation of benzene (transferred from a lined storage tank to a vaporizer, over a vanadium pentoxide catalyst in a tube type reactor operating at 450°C and 20 psi.

The manufacture of Maleic Acid is a new continuous process designed to produce 105 million lbs./yr. through two plants. The reaction products (maleic anhydride-maleic acid mixture, carbon dioxide, water, and some unreacted benzene) are passed through a heat exchanger using an eutectic salt waste heat recovery boiler. Vapors are absorbed in water to yield a crude maleic acid. Maleic acid is stripped of water using xylene as an azeotrope. Xylene is recovered and recycled and crude maleic anhydride is processed in a refining column. The new unit is in an open air structure, separated from other operations and will be computer controlled. It has not been accepted by Monsanto from the contractor.

They have not had rupture discs problems but have experienced a melt down of one of the older reactors in the past.

Femaleic Acid - Building III - This is produced by the catalytic isomerization of maleic acid with hydrochloric acid in two 1,000 gallon glass lined jacketed reactors. Vacuum is used for evaporative cooling. The exothermic heat could

relieve through a 12" rupture disc or through the condenser. The reaction rate is controlled by the addition of hydrochloric acid. The reactor can be dumped or flooded with water. The resulting mass is centrifuged, flash dried, sifted, graded, and air conveyed to bulk loading or bag packaging. Food grade fumaric acid is used as preservative or the product is sold to resin manufacturers. Production is 2.3 million lbs./yr.

Phthalate Esters - Building C-4 - Processes involve such materials as phthalic anhydride, butanol, ethanol, and sulfuric acid in batch reactors to produce 10-12 products which are transferred to a central liquid handling facility for shipment in tank truck, tank car, and drum quantities.

Bisphenol - A (BPA) - Building CC - Phenol, acetone, toluene, and mercaptans react in a semi-continuous process without imposed pressure to produce BPA. After purification it is dried and bagged as a flaked product.

NOTE: Some open wiring indicated that electrical equipment and fixtures should be upgraded for hazardous operations. After a 30 year operating history, this operation may be closed down by the end of 1971.

Toluene Sulfonic Acid - (TSA) - Building EE - Vaporized toluene is sulfonated with sulfuric acid in a batch reactor operating at 20 psi.

NOTE: A phenol residue trailer used to transport waste phenol across the River to a landfill site at the Hrumrick Plant is located at the south end of this building.

Phosphate Esters - Building ¹⁵15 - Phosphorus oxychloride, phenol, or 2-ethyl hexanol are reacted in batch reactors under slight negative pressure to produce phosphate esters. The heat of reaction is removed from the reactor by using kerosene as a heat transfer medium. Phosphorus oxychloride decomposes when in contact with water. Trichloroethylene may be substituted for kerosene as a coolant. Liquid phosphate esters are washed, dehydrated, and filtered. A phenol stripping unit is associated with this process.

Phthalate Esters - Building 7 - Diphenyl phthalate may be a typical product involving reactions of material such as phthalic anhydride, toluene sulfonyl-chloride, caustic and sulfuric acid.

NOTE: This is one of the oldest buildings in the plant
and reflects poor housekeeping.

Phthalyl Chloride - Building 00 - This product is made in a batch reaction by reacting phthalic anhydride with phosphorus pentachloride in Pfaudler reactors, using nitrogen as a blanket. Routine inspection is provided for glass lined equipment. Rupture discs relieve to the outside atmosphere.

Maleate and Fumaric Esters - Building 00 - Maleic and fumaric acids are reacted with butanol in the presence of hydrochloric acid as a catalyst.

Para-Nitrophenetole - Building 11 - Para-nitrochlorobenzene (PNCB) is reacted with ethanol, methanol, and 30 psi air with an oxygen rich atmosphere (21%). Downstream from the reactor (Churn), alcohol and PNCB is recovered in a washing and denaturation process. The PNP product is an intermediate. Extensive inerting using nitrogen is necessary. Two cryogenic tanks at the south end of the building supply oxygen and nitrogen.

Para-chloroaniline (PCA) is also an intermediate produced in this building. It is the most toxic material used in the plant and produces cyanosis.

NOTE: The II Building was involved in an explosion on September 4, 1970 which resulted in one fatality. In 28 days, 27 people were treated at a hospital, (12 were hospitalized for sometime) and one man is still out but will return to work soon on limited duty. The remaining people are back to full duty. The explosion was the result of an alcohol spill in which approximately 300 gallons of material was released. The entire north end of the building was blown out and some of the equipment and much of the piping was damaged. Liability damage was limited. The only information we could obtain is that the loss was less than \$2,000,000.

While making this survey, we observed riggers using a crane to remove piping from an upper floor of this building in a poorly supervised procedure. The piping was swung out of the building and struck a reactor. One man was working directly under the load. We also observed a relief valve from a nitrogen and oxygen supply line to a reactor which vented directly into the building. This building was still under construction because of the explosion; however, it was back in operation.

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Salicylic Acid - Building M and SSS - Phenol is dissolved in 50% caustic soda. The sodium phenate formed is pumped to a converter (ball mill), dried under vacuum, and a carbon dioxide blanket. The dry sodium phenate is slurried with water and acidified with carbon dioxide to form salicylic acid. Excess phenol is stripped with steam. Salicylic acid is precipitated, centrifuged, drum dried, and packaged in 55 gallon drums or transferred to aspirin manufacturing.

Aspirin - Building CC - Salicylic acid and acetic anhydride are batch reacted. Aspirin (acetylsalicylic acid) is crystallized from the acetic acid by-product. The aspirin is cooled at 30°C, centrifuged, flash dried to remove acetic acid odor, and transferred to a tower for gravity handling. Some aspirin is mixed with starch in a roll compacter to obtain proper sticking characteristics. Aspirin that will not be made into tablets by pharmaceutical houses will not contain starch. Both products are subjected to close quality control which includes magnetic separators, sampling of blenders, and final drum samples which are retained for two years. They have no adverse FDA history.

Kali Color - Building M - Salicylic acid is reacted with sulfuric acid using perchloroethylene as a carrier. The product is centrifuged and dried.

Methyl Salicylate - Building P - Methanol and salicylic acid are heated in the presence of sulfuric acid. Alcohol is removed by distillation.

Phenacetin - Building H - Para-phenetidin plus acetic anhydride in the presence of ethyl alcohol produces phenacetin which must be stripped from acetic acid. The product is decolorized with charcoal, dissolved in ethyl alcohol, cooled, crystallized, centrifuged, flash dried, sifted, and packaged. There is a dust and ethyl alcohol explosion potential. Inerting is done with carbon dioxide.

Ethacol - Building K - Anisidine, ortho-phenetidin, and sodium nitrite are reacted in the presence of 50% copper sulfate to produce ethacol, a liquid intermediate used in the manufacture of ethovan.

Ethovan - Building C - Ethacol plus nitrobenzene sulfonate react to produce ethovan (ethyl vanillin). Oleum, nitrobenzene, plus sulfuric acid are used in the production of nitrobenzene sulfonate. The final product undergoes distillation and benzene extraction.

Phenolphthalein - Buildings K and H - This is a fusion reaction between phenol and phthalic anhydride in a small batch process which requires quenching, precipitation, drying, and packaging. Operations are in an old building with process changes estimated at 7 to 8 months away.

Toluene Sulfonyl Chloride - Building HHH - Toluene reacts with chlorosulfonic acid to produce para-ortho and meta isomers of toluene sulfonyl chloride.

These are separated by distillation. The ortho-isomer is reacted with ammonia to yield ortho-toluene sulfamide. Some of these intermediates are for in-plant use, others are refined and go to sales.

Saccharin - Building YY - Ortho-toluene sulfamide is oxidized with permanganate, treated with sulfuric acid, and saccharin crystallized out. The product is blended and milled before packaging in 2½ lb. to 100 lb. packages.

Toluene sulfamides are refined using methanol in a recrystallization process. The methanol product is centrifuged and dried. The methanol is recovered.

Nitrol - Building DD - This product is used as a rubber additive. It involves reactions between aniline, formaldehyde, and nitropropane at atmospheric pressure. The product is dried under a vacuum, oil is added, and the final product centrifuged and dried. The product is thermally unstable in various stages of production (including the final product) since it contains its own oxygen. Its stability is checked carefully by laboratory analysis since it can decompose at normal temperatures. It is held in buggies equipped with sprinklers and alarms during this phase. As a final product, it is blended with clay. The product has a fire history, thus flooding with water is essential.

BMT - Building DD - This is an intermediate product used in the production of L-DOPA (a material used to treat Parkinson disease). It involves reactions between PVO and sodium hydroxide with further reduction by hydrogen and a metal catalyst. A trailer is used for transporting the water soluble product to Building W for crystallization.

NOTE: Electrical equipment and fixtures in this building were not all suitable for hazardous operations: the hydrogen meter was located above the reactor, some lamps above the equipment were not properly supported, and fan fans with extension cords were in use.

The process has some fire experience.

Trichlorocarbanilide (TCC) - Building FF - This is a bacteriostat in bar soap. It involves reactions between dichloroaniline and para-chlorophenylisocyanate (CPCPI) in a monochlorobenzene solvent. The product (TCC) is separated from MCB by centrifuge and is dried as a solid for grinding and packaging.

Interim Production Facility - Building W - This building is used for trial production to prove stability. It involves semi-permanent laboratory production. We observed an emulsification reaction involving vinyl chloride (at 100 psi) and ethylene (at 1,750 psi) with a catalyst in a high pressure agitated reactor. The ethylene was being supplied from cylinders on a tank truck and the vinyl chloride from a tank car.

NOTE: In another area of this building, we observed a methanol leak from a reactor to a sewer.

TRANSCRIPT OF PROCEEDINGS

IN THE SUPERIOR COURT
OF THE STATE OF DELAWARE
IN AND FOR NEW CASTLE COUNTY

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MONSANTO COMPANY,	:
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Plaintiff,	:
	:
v.	:
	:
AETNA CASUALTY & SURETY COMPANY,	:
al.,	:
	:
Defendants.	:
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Civil Action Number
88C-JA-118-1-CV
NON-ARBITRATION
CASE

KELLY DEPOSITION EXHIBITS

PROTECTED MATERIAL: MONSANTO
INSURANCE COVERAGE LITIGATION

Washington, D. C.

Thursday, February 4, 1993

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