Chapter Five
GROWING PAINS (1960-1970)

"Summertime and the livin' is easy" might have been the theme song for Union Carbide in the early 1950s. However, by the 1960s, things had changed. Heavy competition had arrived and many of Carbide's dominant positions were being challenged. Scientific Design, Inc., a process engineering contractor, was marketing an ethylene oxide (and glycol) process worldwide that was very similar to the Union Carbide process. The Shell Oil Company had developed and was licensing an oxygen-based (as opposed to air-based) oxide process that was competitive—in fact, the oxygen-based oxide processes eventually became the process of choice and Union Carbide developed one as well. Many others were making polyethylene, vinyl chloride, vinyl resins, phenolic resins, etc. The technologies for these processes had become available through expiring patents and diffusion occasioned by the movement of people. Engineering contractors, privy to much technology, facilitated newcomers. However, entry into the market and plant expansions were often not rational. As a result, there was often surplus capacity and markets were frequently chaotic with much price competition. Some in the Company felt that the bloom was off the rose insofar as the basic petrochemicals business was concerned.

The 1960s were also an era of cultural and political upheaval. An unpopular and growing war in Vietnam had created a general air of discontent and triggered violent protests. There was overt opposition to the "establishment"—both political and business. The Institute and South Charleston Plants were organized in 1967 and 1968 by the Oil Chemical, and Atomic Workers' union (OCAW). There was also increasing public challenge to environmental problems. The political turmoil did not reach directly into Union Carbide (except for the environmental problems), but the Company was experiencing growing pains.

The question that faced the Company was whether to stay with established positions and fight or to seek new opportunities. Diversification was all the rage at the time, and the conglomerate ITT (formerly International Telephone and Telegraph) under Harold Geneen was the personification of diversification and was the favorite of the stock market. The answer that the Company settled on, influenced

by the pressures of the market and the spirit of the times, was to diversify and seek new opportunities. Linde had a knack for incubating new products outside its main product line—such as olefins, polyethylene, silicones, molecular sieves—and this lesson surely was not lost on the planners. The extent to which diversification was right or wrong for Union Carbide is moot, but it affected just about everything that happened at Carbide after that.

Union Carbide's business had always been cyclical, being tied to the ups and downs of the economy—especially the steel and automobile businesses—but in the absence of serious competition, margins had usually been good. Now, margins were smaller and frequently unappealing. Fields that looked greener were specialty products, where there was more value added and more room for profit. It is interesting to note that while Union Carbide was contemplating new business areas, others coveted Union Carbide's green fields. Indeed, the PYROFAX gas business was sold to Texas Eastern Transmission Company in 1962. PYROFAX, which had carried the Chemicals Company in the early years, was no longer attractive, because there was no longer low-cost byproduct liquified petroleum gas (LPG) from chemicals feedstocks and the Company was having to buy LPG on the open market for resale.

There was no dearth of opportunities. Perhaps just the opposite was true. Union Carbide had grown successfully in the past by exploiting its own technologies, and Research and Development was still liberally generating new opportunities. Coupled with the search for outside opportunities, there simply were not the resources, people or money, to exploit all the things people would like to do and still maintain a healthy position in established businesses. Inasmuch as the glamour areas were the new opportunities, some of the established areas withered, for example vinyl resins, phthalate plasticizers, polystyrene, and phenolic resins. Ironically, the two vinyl resin processes that survived were the earliest ones, the solvent resins process (at Texas City) and the polyvinyl acetate process (at South Charleston).

The Company did diversify and with some success, but this was mostly as home-grown adjuncts to established lines—such as polyurethane foams, latexes, TEMIK (a systemic insecticide), and molecular sieves. Other real strengths in the 1960s included a new low-pressure oxo process (LPO), a butane oxidation process for making acetic acid, and a new, impregnated ethylene oxide catalyst that increased existing ethylene oxide capacity by 300 million pounds per year.

Low Pressure Oxo

In the late 1960s, the Company developed a low-pressure oxo (LP Oxo) process that uses a rhodium catalyst and that has proved to be a real winner—over half of the world's butanol is made by this process today. The process enjoys a huge advantage over the high-pressure process in that it operates at about 200 psi instead of 6,000 psi and produces normal butyraldehyde (the desired product) in a ratio of ten to one over isobutyraldehyde (the byproduct) instead of the six to four in the high-pressure process. The operation is also very trouble-free. Research and development for the process was done primarily by Union Carbide. However, Davy Power Gas Company, an engineering firm in the United Kingdom, and the Johnson-Matthey Company, a precious metals company, also participated. A joint venture for licensing was set up with Davy being the primary marketer and Johnson-Matthey supplying the rhodium catalyst and reprocessing the spend catalyst. Union Carbide converted most of its high-pressure units to the LP Oxo process in the 1970s. It won another prestigious KIRKPATRICK CHEMICAL AND METALLURGICAL ENGINEERING AWARD for the LPO process in 1977. In 1998, Dr. David W. Bryant of the South Charleston Technical Center received the Perkin Medal for his contributions to the LP Oxo process.

Losers

Unfortunately, too many of the other new directions that were tried were ill-advised. These included a foray into making men's hats from polyurethane foam (SURFEL) just as men's hats were going out of style; getting into and out of the mattress business (the Englander Mattress Company) to promote the sale of polyurethane foam and losing a big bundle in the process; a failed attempt at getting into manufactured housing where the Company was going to revolutionize home construction but where it dropped another large amount instead; getting into the diaper business in which the Company had a good product (DRYDEES) but had production problems and was out of its league in retail marketing against a 600-pound gorilla (Proctor and Gamble); and getting into and out of the pharmaceuticals business (Neisler Laboratories) where the Company hoped to exploit its skills with fine chemicals in a "synergistic" fashion, but where a match never occurred. There were other things like fish farming, which was backed into from Linde's

Oceans Systems, solid rocket fuels, the mining of oölitic aragonite (limestone) from the sea, a wet coal mine, and others, most of which are better forgotten now.

Organization

There were more than 115,000 employees in all of Union Carbide by the end of the 1960s (which included about 14,000 people in the Nuclear Division at Oak Ridge, Tennessee, and Paducah, Kentucky.) To cope with the management of such a large venture, the Corporation was divided up into four groups in 1964. These were: Group 1—Chemicals and Plastics including the Chemicals Division, the Olefins Division, the Plastics Division, and the Silicones Division; Group 2—Carbon Products, Gases, and Metals including the Carbon Products Division, the Linde Division, the Mining and Metals Division, and the Stellite Division; Group 3—Consumer and Related Products including the Consumer Products Division, the Fibers and Fabrics Division, and the Food Products Division; and Group 4—International, including Union Carbide Canada, Limited, and the Union Carbide International Company. Other free standing groups included the Nuclear Division and the Realty Division. (In 1968, the numbering changed to roman numerals, and the groups became Group I, Group II, Group III, and Group IV.) In May of 1966, the International Company was dissolved and in its place three world area companies were formed. These new companies were Union Carbide Europe, Union Carbide Eastern, and Union Carbide Pan America—which included Union Carbide Canada. (In 1970, Union Carbide Canada was detached from Union Carbide Pan America and tied in to the senior officer serving on the Union Carbide Europe board.)

To deal with the its own problems of size and complexity, Group I established a matrix organization in 1964. A matrix organization keeps intact the large functional elements of a company (such as research & development, engineering, manufacturing, distribution, sales, etc.), but sets up small dedicated groups organized by business area to direct (but not administer) the efforts of the functional groups across the board to the needs of a business area. At Union Carbide these groups were called "business teams" and they had a responsibility for individual business areas. The matrix system was in use at the time in other large organizations, such as the aircraft industry. In Chemicals and Plastics, however, there were two matrices rather than one. The first matrix involved operations groups struc-

tured around a group of products. These groups were responsible for the development, manufacture, distribution, and sale of products. The second matrix involved marketing groups, and was concerned with specific markets and servicing those markets. A typical Operations Team consisted of an Operations Manager, reporting to a Vice President/General Manger, plus a Production Manager, a Product Manager, a Technology (R&D) Manager, an Engineering Manager, and a Distribution Manager. The five sub-managers were administratively part of the functions that they represented. There was no other staff. The Market Area Teams were organized along similar lines but were more loosely structured. The matrix organization was in use to 1980.

Sales and Facilities

World-wide sales for the Corporation increased from about $1.5 billion in 1960 to about $3 billion in 1970. Earnings, however, stayed flat owing, in part, to severe price erosion and averaged $180 million per year over the decade. Construction expenditures for the period amounted to about $3 billion, about one-quarter of it overseas.

Chemicals and Plastics operations reached capacity levels in 1966, and much new capacity was under construction. Major chemicals and plastics complexes were built in 1964 at Bombay, India, and in 1965 at Antwerp, Belgium. Each of these sites already had a polyethylene unit. Other major chemicals and/or plastics facilities were built in 1961 at Cubatao, Brazil, in 1962 in Japan, in 1963 at Stenungsund, Sweden, and in 1963 in Australia. Substantial expansions were made at many of these sites over the remainder of the decade.

In the United States, there were numerous expansions at existing plants, a notable one being a 1.2 billion pounds per year olefins unit at Texas City (Olefins Unit No. 3) which came on stream in 1969. At the time, this was the largest olefins unit ever built. It was designed to operate mainly on refinery off gases. The in-house designed and managed unit came in on time and within budget and started up flawlessly. It was a fully automated plant run by computer and was able to control production rate, product quality, and maximize gross margin.

Progress also was being made on the waste abatement front. The Company pioneered the development and use of an automated gas chromatograph to monitor waste waters. In this fashion, specific organics in the wastewater could be iden-

tified and traced back to the source and corrective action taken. The Company also developed clay-lined solid waste landfills with leachate collectors. These were prototypes for what became an industry standard.

Two major new plant sites were opened up for Chemical and Plastics in the 1960s. The first plant was at Taft, Louisiana. It was designed and built in the period 1964-1965 and started up in 1966-1968. The second was at Ponce, Puerto Rico, and was designed and built in 1969-1971 and started up in 1972.

The Taft Plant was built at a site on the Mississippi River above New Orleans. The site was chosen to provide access to river transport (barges) and deepwater shipping (tankers). It was also to be designated a free-trade zone where foreign naphtha could be shipped in and products exported on a tax-free basis. Naphtha was the feedstock of choice for the plant, because concentrates and refinery off gases were less available and becoming more expensive. The facilities involved were an Olefins Unit, Ethylene Oxide and Glycol Units, an Ethyleneamines Unit, an Acrylic Acid and Derivatives Unit, a Peracetic Acid and Derivatives Unit, a Glyoxal Unit, and a Caprolactone and Caprolactam Unit, plus all of the necessary infrastructure. The Olefins Unit was purchased from the Lummus Company, because Lummus had experience cracking naphtha and Union Carbide did not. Numerous contractors were involved with the plant, and there were difficulties in construction and startup. Eventually, however, the plant became a top-notch operation.

The plant at Ponce, Puerto Rico, came into being to take advantage of access to low-cost foreign feedstocks (naphtha), assured low-cost power (one-half cent per kwh), and a seventeen-year tax holiday on earnings. It was to be put on the site of the existing smaller complex. The Carbon Products Division also built a new electrodes plant at Yabucoa, on the east end of Puerto Rico, on the basis of the same incentives. The new plant at Ponce was one of the largest ever built and would include a billion pounds per year Union Carbide designed naphtha-based Olefins Unit, an Ethylene Oxide and Glycol Unit, a Polyethylene Unit, a Cumene Unit, a Butadiene Unit, a Glycol Ethers Unit, a Phenol-Acetone Unit, and a Bisphenol-A Unit. Also included in the project were utilities, waste treatment facilities, field storage facilities, and a deep water (tanker) terminal.

The whole operation came off extremely well. To quote from Union Carbide's Annual Report for 1972: "Although the Ponce petrochemicals facility was described by its builders as the most complex job they had ever undertaken, the

project was finished ahead of schedule and on budget. It was the petrochemicals industry's largest single project, capable of producing four billion pounds of products per year. The startup of this plant was considered one of the most trouble-free in the industry in recent years, and the plant has operated at rates in excess of design capacity. It is expected to generate earnings in 1973 of 20 to 25 cents a share." Unfortunately, as the energy crisis struck in 1973, the economics changed. Foreign raw materials became expensive and power costs increased by a factor of ten. That plus the costs of operating offshore eventually rendered the plant uneconomic and it was shutdown for the most part in January of 1985.

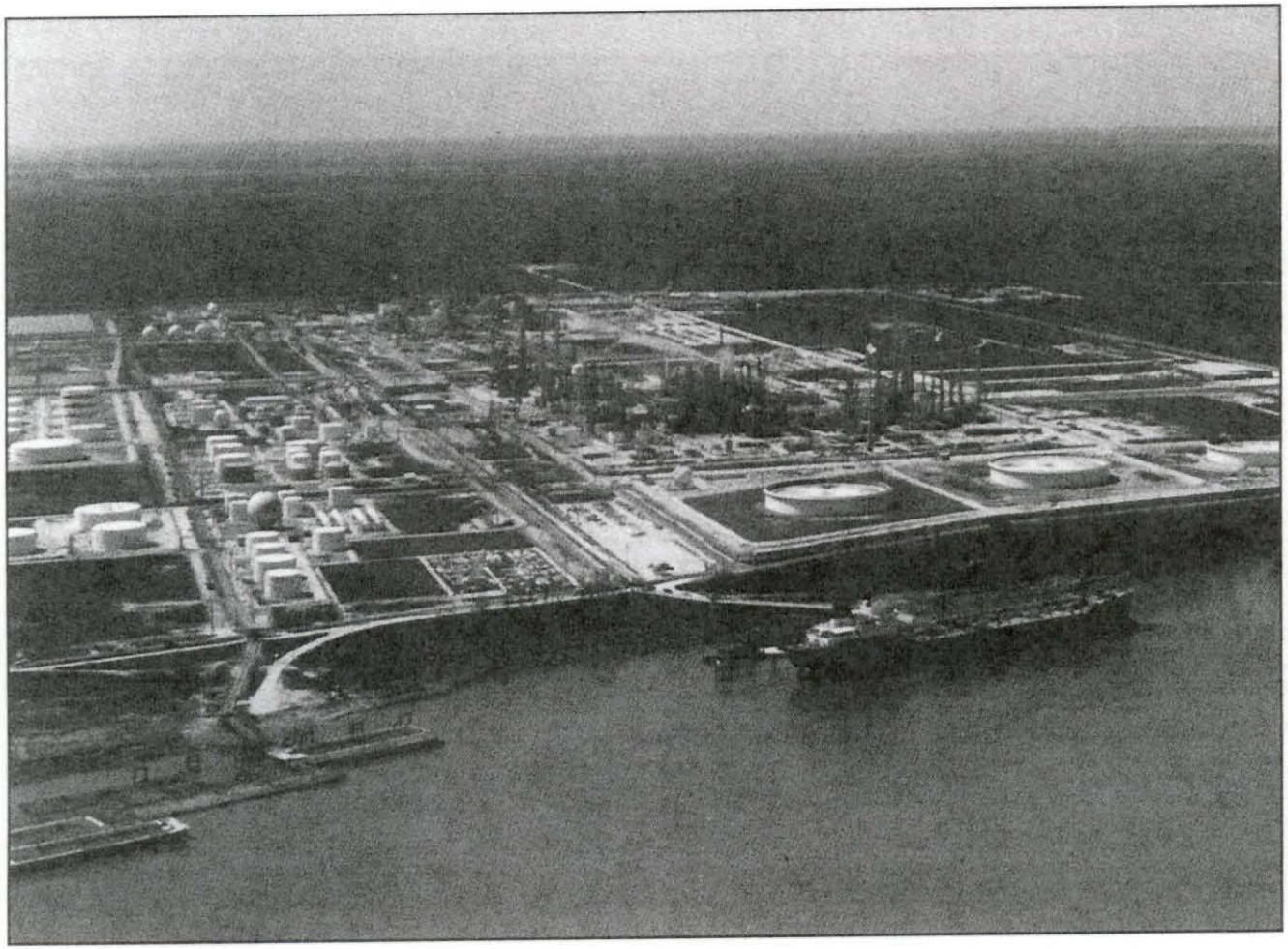

Figure XXV
Taft Plant in 1968

Figure XXVI
Ponce Plant in 1972

Chapter Six
ENERGY CRISES AND INFLATION (1970-1980)

The story of the 1970s was one of turmoil driven by energy crises and inflation. These were factors that no one controlled and that affected the whole world. Energy equated with oil, but in Union Carbide's case energy meant more than just heat and power—it also meant raw materials. It was especially significant for the Company, because—apart from the nuclear operations—it used one half of one percent of all the energy in the United States. However, on the bright side, the 1970s were also the time that the Company's low-pressure polyethylene process (UNIPOL) came to fruition.

The first energy crisis occurred in late 1973 and was both a crisis and a panic—it happened and people scrambled to cope not knowing what they were in for. There had been a recession in 1970, but the economy had come out of it and was booming in 1973. Production was full out and raw materials were in short supply. The Organization of Oil Producing and Exporting Countries (OPEC) took advantage of this situation and began to raise oil prices. Inasmuch as OPEC controlled much of the world's crude oil supply, they were able to do so effectively. The price of crude oil rose from about $2 a barrel in 1972 (an extremely low price by any measure even then) to $7 a barrel in late 1973 and then to $11 a barrel in early 1974. Spot prices went as high as $17 a barrel. (For comparison, crude oil prices today—1997—are about $18 - $20 a barrel.) The shortage of oil in the United States was exacerbated by a partial embargo by Saudi Arabia on shipments to the States in retaliation for American support of Israel in the Yom Kippur War in 1973.

Domestic feedstock prices were less volatile. The Federal Government had imposed wage and price controls earlier, and "old" oil produced in the United States was subject to price controls. "New" oil, that is, oil discovered after a certain date, was not subject to the same controls. As a result, there were significant dislocations. Anyone with access to "old" oil had a decided advantage. However, anyone dependent on foreign or "new" oil was hurting. This was especially true of the Ponce Plant which had been operating on Venezuelan naphtha—which went almost overnight from being a bargain to being a premium priced product.

The movement of oil prices dragged along other energy costs such as gas and coal. Federal wage and price controls were somewhat of a boondoggle and complicated the picture—in any event they were removed in 1974. Prices of manufactured goods for domestic consumption were increased where possible to compensate for the increased energy costs. As a result, inflation set in and the Consumer Price Index increased by over 110 percent in the 1970s. There was an illusion of prosperity at times as sales rose dramatically. However, the increase was sales income and not sales volume, and selling prices did not rise fast enough to cover increased costs. Eventually the piper would have to be paid, and the payment came in the form of a recession in 1975.

There was a second oil crisis in 1978. Iran was taken over by religious militants who were not much interested in things temporal. In the process of their revolution, they destroyed much of Iran's oil producing capacity. They also went to war with neighboring Iraq, which hampered that country's ability to ship oil. The combination of those events served to produce oil shortages and cause price increases again. The price of oil shot up to $23 a barrel in 1979 and then to $30 a barrel in 1980. Again there was inflation followed by recession.

There were serious consequences to the oil crises beyond the impact of cost. One was that unstable circumstances made it difficult to measure the health of current businesses. Another was that major uncertainties made it difficult to plan. As a result, the tendency was to get your head down and wait things out. Nonetheless, a Feedstock and Energy Council was established at the Corporate level to assure raw material supplies, and strong efforts were made to identify business opportunities and better allocate resources. But it was a hard time to invest; speculators profited but almost everybody else lost. One thing was apparent, however, and that was the need for energy conservation. With cheap energy, there had not been much incentive to save. Now, with expensive energy, it was obvious what had to be done, and much time and effort was put into making existing plants more energy efficient.

Several plants were shutdown or sold during this period. The plant in Whiting, Indiana, was shutdown in 1975. It had been in operation for forty years and was producing high-pressure polyethylene and isopropanol at the end. The plant in Antwerp, Belgium, was sold to British Petroleum in 1978 along with much of Union Carbide's chemicals and plastics business in Europe. This divestiture reflected a desire to concentrate on operations where the Company had a leading or

strong position. The problem in Europe was the lack of a strong raw material base. (However, the Company did not pull out of Europe entirely—other operations and export sales continued.)

In 1973, the Company shutdown a Wulff Process Unit that had been recently constructed for Union Carbide do Brasil near San Paulo. The purpose of the unit had been to make ethylene and acetylene for a high-pressure polyethylene unit and a vinyl chloride unit. The Wulff process makes ethylene and acetylene as co-products of the high temperature cracking of naphtha in a regenerative furnace. The concept was a good one, but the project was a costly failure. The problem was poor design. The basic process was purchased from the Wulff Acetylene Company of Maywood, California, and translated into hardware by Union Carbide. Unfortunately, the process had not been sufficiently developed and was not able to run at more than 15-20 percent of capacity. The primary deficiencies were low yields of ethylene and acetylene and low on-stream time for the furnaces due to coking and fouling. Heroic efforts were made to revive the unit but to no avail. The Wulff Unit and the Vinyl Chloride Unit were taken out of service and scrapped. It was an expensive venture, and a $23 million write-off was taken. Ethylene was purchased instead for the Polyethylene Unit. (Oil-poor Brazil for a long time made its ethylene by dehydrating ethanol, which was made from sugar cane.)

UNIPOL — Low-pressure Polyethylene

The bright and rising star of the 1970s (and the 80s and 90s) was Union Carbide's low-pressure, gas-phase, fluid-bed polyethylene process called UNIPOL. The UNIPOL process came into its own in the 1970s as the high-pressure polyethylene process reached its peak. (The low-pressure process operates at several hundred psi compared to 30,000 psi to 50,000 psi for the high-pressure process.) Polyethylene had always been a substantial money maker for the Company, but the UNIPOL process represented an order of magnitude improvement over older processes in that capital costs were substantially lower and energy costs were also substantially lower. Further, the process accommodates the manufacture of a wide range of polyethylene and polypropylene products.

The UNIPOL process did not spring full-fledged from under a cabbage leaf. It came instead from sustained efforts to invent and develop new processes and catalysts that would yield superior economics. The Company had started studies

on low-pressure catalysts in the mid-1950s after Phillips Petroleum and Karl Zeigler, among others, had demonstrated that the catalytic polymerization of polyethylene was feasible. Union Carbide secured licenses from Phillips and Ziegler at that time and built plants to make low-pressure polyethylene. The Phillips and Ziegler units made high-density polyethylene and were based on solution and slurry polymerization, respectively. Union Carbide's efforts, however, focused on gas-phase polymerization and organometallic catalysts. Catalyst work was done under Dr. Wayne Carrick, Dr. Fred Karol, and Joseph J. Smith at Bound Brook and under Dr. Thomas Wilson at South Charleston. Process development work was done at South Charleston. In a prescient moment, James M. Davison, a process development engineer, postulated in 1956 "a dry polymerization process wherein the olefin is blown through the catalyst on polymer keeping the particles in a fluid state. The olefin would be vaporized if a fluid or used directly if a gas. This 'fluidized bed' technique would lead to more efficient heat transfer and enable continuous addition of catalyst and removal of polymer." This fluidized bed process became a reality, and the characteristic bulbous-top fluidized-bed reactor became the hallmark of the UNIPOL process.

Catalyst studies and bench-scale and pilot-scale process studies culminated in a successful process which made not only high-density polyethylene but also—eventually—low-density polyethylene at considerable advantage over competing processes. Although the Company had made considerable improvements in its high-pressure process, especially with regard to capacity, conversion, and a simplified recycle, the advantages of the UNIPOL process, which yielded superior products and required only half the capital and a quarter of the energy, changed the entire focus to the new low-pressure process.

The process for high-density polyethylene was commercialized in 1968 and the process for low-density polyethylene was commercialized in 1975. Plant expansions based on the UNIPOL process of almost a billion pounds per year were announced in November of 1977—450 million pounds per year at Seadrift, Texas, and 500 million pounds per year at a new plant called Star, which was located immediately adjacent to the Taft Plant in Louisiana. Union Carbide was awarded another KIRKPATRICK CHEMICAL ENGINEERING ACHIEVEMENT AWARD in 1979 for development of the UNIPOL process. Dr. Karol was awarded the 1989 PERKIN MEDAL for his efforts on catalyst research

Successful application of the UNIPOL process to the polymerization of

polypropylene took place in 1982 in a cooperative development with the Shell Chemical Company. A joint venture with Shell was announced in 1983, and a Polypropylene Unit was built at Seadrift utilizing the new process. The new facility started up quickly and yielded high-quality products that encompassed a broader range than previously available.

The gas-phase UNIPOL process continued to lead the revolution in the polyethylene industry in the 1980s and 1990s with a new mode of operation (condensing) that increased reactor capacity by over fifty percent. Further enhancement in the 1990s permitted the manufacture of a complete range of low-density and high-density resins with controlled molecular weight and compositional distribution. The process was further extended successfully to the manufacture of vulcanizable ethylene-propylene rubbers. It was quite a show. In 1993, the President of the United States awarded the United States National Medal of Technology to Dr. William H. Joyce, President of Union Carbide Corporation, in recognition of his leadership in the development, commercialization, and success of the UNIPOL process.

Consistent with its past policy of not licensing core technologies, Union Carbide had not licensed its high-pressure polyethylene technology. However, inasmuch as the Company did not invest at a rate high enough to maintain market share, other producers were able to enter the market even though they did not have state-of-the-art technology. In the case of high-density polyethylene, a decision was made in the 1970s to license, because the Company did not have a dominant position in the market and because incremental income could be realized from the superior technology. As a result, licenses for the new high-density process were granted in the early 1970s to Czechoslovakia, the Soviet Union, and Gulf Chemical Company.

In 1977, as the full impact of the technological breakthroughs became evident, the Company elected to exploit the situation by aggressively licensing the low-pressure polyethylene process. (It was at this time that the term UNIPOL was coined to identify the new process.) The decision to license was done in light of the fact that potential earnings from both licensing and investing in new plant were projected to significantly exceed earnings from investing in new plant alone—especially inasmuch as the total new capacity projected was beyond the Company's ability to finance it. Licensing income was projected to be significant, because it was to be based on taking a share of the savings achieved by the licensee.

As a result, a Licensing Department was established in 1977 and licensing discussions initiated with potential clients. The first UNIPOL license for low-density (and high-density) polyethylene was signed in 1979 with the Exxon Chemical Company. Exxon abandoned a mature polyethylene project to take on the new process. During the first five years of the licensing program, Union Carbide licensed more than fifty percent of all the new low-density polyethylene capacity in the world. By 1993, about ten million tons per year, half the world's low-density polyethylene capacity, was based on UNIPOL technology. (In one novel case, a 120,000 metric ton UNIPOL process plant was built in 1981 aboard a barge in Nagoya, Japan, for IPAKO, SA, of Argentina, and the barge taken aboard a ship, the Super Servant I, for a trip of 15,000 miles to Bahia Blanca in Argentina for docking and operation.)

Chemical Hygiene Fellowship

The Chemical Hygiene Fellowship (CHF) was formed in 1937 under a contract between the Mellon Institute in Pittsburgh and Union Carbide and Carbon Chemicals Corporation. The purpose of the Fellowship was to conduct "a study of the hygienic aspects of synthetic aliphatic compounds and of the materials and products of the companies affiliated with the donor with particular reference to their industrial applications." The major responsibility of the Fellowship was Union Carbide chemicals products. The aims of the Fellowship were to protect the safety of industrial production, transportation, and handling before information based on human experience had been accumulated. This included definition of safe handling procedures, protective equipment, and medical scrutiny of workers.

The Chemical Hygiene Fellowship operated as a service to the Marketing and Sales Departments from 1937 to 1962. After 1962, it was administered by the Chemicals and Plastics Research and Development Department. In the mid 1970s, the staff of the Chemical Hygiene Fellowship was doubled and a new facility constructed at Bushy Run, near Pittsburgh. In 1980, Union Carbide assumed management of the laboratory (from Mellon) and the name was changed to the Bushy Run Research Center.

The Chemical Hygiene Fellowship was a pioneer in the application of toxicology to product development at the outset. It was integrated step-by-step with the activities of chemists, engineers, and marketing experts. It was applied widely

to materials that would be successfully developed as well as to those that fell by the wayside. It required the standardization of toxicological methods and the development of procedures for deriving sound inferences from the results. Range-Finding Tests were developed for new products that are now generally accepted procedures by applied toxicologists. These included estimates of the hazards of swallowing, breathing, skin penetration, and skin and eye contact. These practices, originally voluntary, are now required by law. The Chemical Hygiene Fellowship also determined and published data on threshold limits of exposure. This resulted in a large collection of toxicological data, which had the advantage of providing experience with hundreds of substances others had never encountered and provided a base for predictions about new substances based on structure.

Results of the work done by the Fellowship were made available to the scientific community through publication and information sharing. The success of the Chemical Hygiene Fellowship was largely due to the wisdom, persistence and dedication of Drs. Henry F. Smyth, Jr. and Charles P. Carpenter. The laboratory was terminated in 1995 as demand decreased and alternate resources became available to industry at large.

Chapter Seven
TRANSFORMATION (1980-1990)

The 1980s were the most turbulent years in the history of Union Carbide. There was solid growth in polyethylene and UNIPOL licensing (captive polyethylene capacity would grow to over three billion pounds per year by the early 1990s), there was solid growth in ethylene oxide/glycol (the Company was the world's largest producer by a factor of two), and there was growth in low-pressure oxo (LPO) manufacture and licensing (few oxo plants in the world had been built since 1979 other than with the Company's LPO process.) Two events, however, overshadowed everything else. One was the sabotage of the plant at Bhopal, India and the resulting disaster. The other was the attempted takeover and subsequent restructuring of the Company.

The decade started off reasonably well. First there was a move of the Corporate headquarters in 1981 from New York City to Danbury, Connecticut. The move was made in response to problems that many people were experiencing in commuting to mid-town Manhatten from the suburbs. Typically, commutes took an hour-and-a-half or more each way and were limiting to both business activities and personal lives. The prospect of long, time consuming commutes also made it increasingly difficult to get people to transfer to New York. The new location was suburban, almost rural, and very pleasant, and access to the new office was much easier. Plans also had been afoot in the late 1970s and early 1980s to refocus business efforts on more profitable endeavors. To that end, the sale of most of the metals business had been completed by 1981. Despite a persistent recession in 1981-1982, consolidated sales for the Corporation reached over $10 billion in 1981, and earnings were respectable.

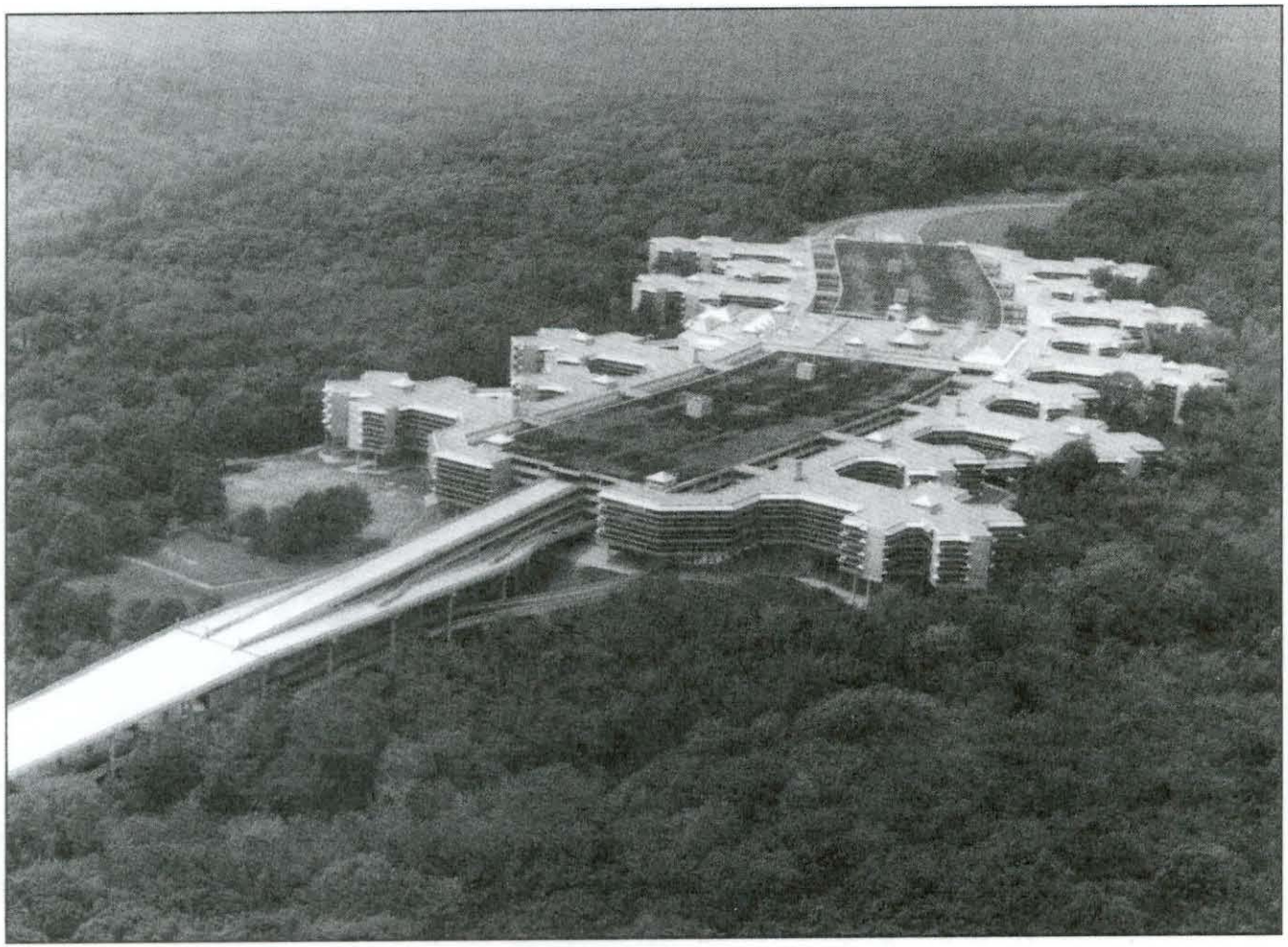

Figure XXVII
Union Carbide Corporate Offices at Danbury, CT (1981 - Present)

Major Projects

Several major projects were completed and placed in service in 1983. One was the Canadian Prentiss Plant, near Red Deer, Alberta, a large, new, free-standing ethylene oxide-ethylene glycol plant based on purchased ethylene and built to serve the Asian export market. The initial capacity of the plant was 500 million pounds per year of glycol, which was later expanded to 660 million pounds per year. The product was shipped in dedicated unit trains from Red Deer to the port of Prince Rupert on the Pacific Coast for transfer to seagoing tankers. Despite severe weather conditions—it gets cold in Red Deer, the frost line is nine feet deep—the whole operation came off well. (A second ethylene oxide/glycol plant of similar size was built in the early 1990s at Prentiss as a joint venture with three Asian companies to yield a total capacity of 1.3 billion pounds per year of ethylene glycol.) Another project completed in 1983 was a major grass roots silicones plant in Termoli, Italy, that was built to serve the European market for silanes. This project was also successful. It was on schedule, within budget, and ran well. A third project was a new, 35,000-ton, multicompartmented tanker, the Chemical Pioneer, that was completed and delivered in September of 1983. The tanker, which could carry over nine million gallons of products, went into service transporting chemicals from the Taft and Texas City plants on the Gulf Coast to Eastern U. S. markets. It replaced two older, smaller tankers, one of which had been built during World War II. The new tanker was replete with tank cleaning devices and self-contained waste facilities.

The year 1984, however, was the start of a wild ride that would last for several years.

Silicones II

Problems started with a large new methylchlorosilanes plant, Silicones II, that was built in 1981-1982 at South Charleston on the site of the old No. 3 Olefins Unit. New processes were involved, and considerable difficulties were encountered in starting up the plant and operating it. Those problems, coupled with second thoughts about making a product that was essentially a commodity intermediate when the rest of the business was specialty chemicals, resulted in the plant being shutdown in 1984, dismantled, and written off. It was a major loss.

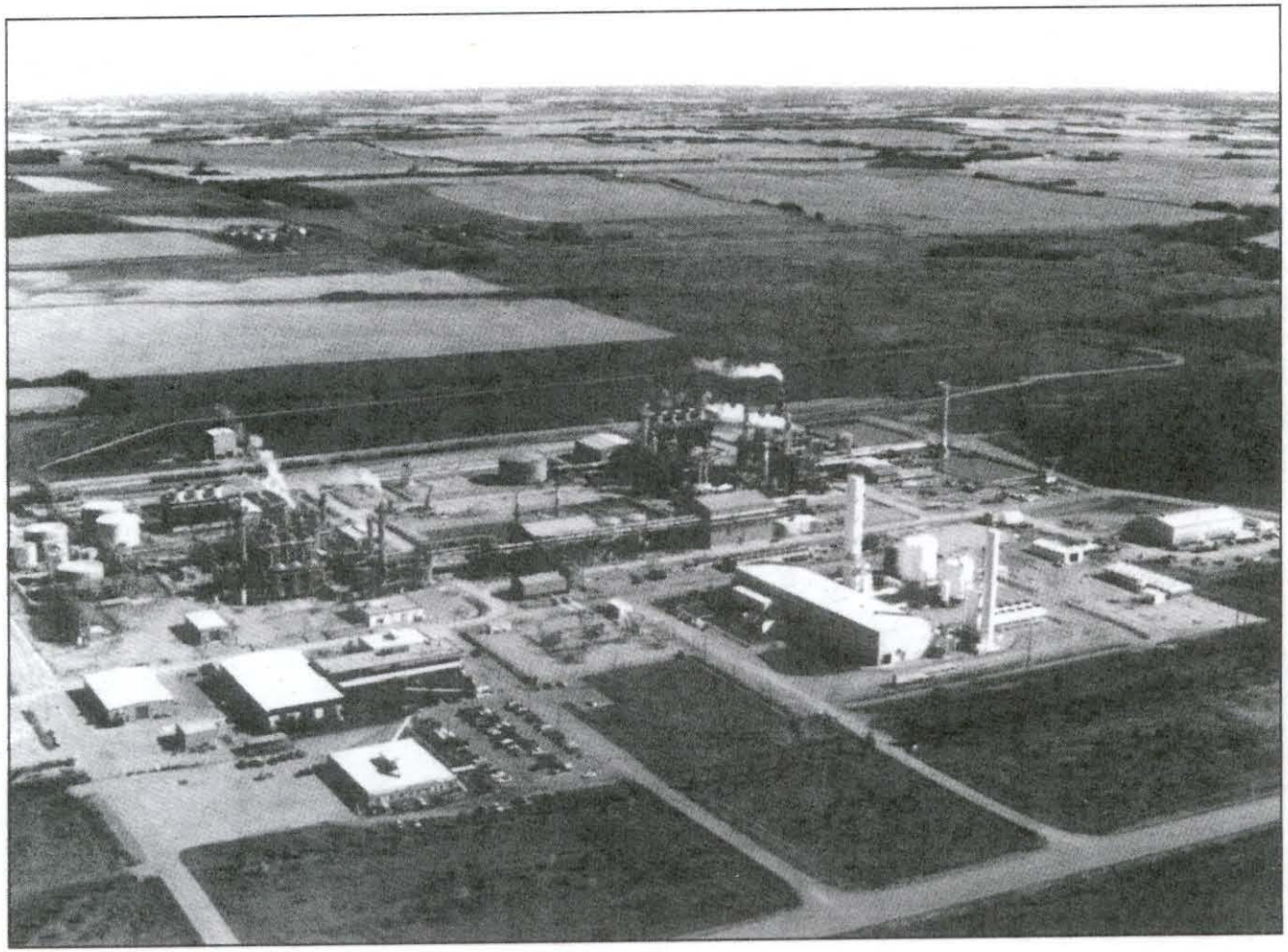

Figure XXVIII
Prentiss (Alberta) Plant in 1994

Bhopal

A massive tragedy struck in the early hours of December 3, 1984, at Union Carbide India's carbamate insecticide plant at Bhopal, India. Toxic gas was discharged into the atmosphere from a 15,000-gallon tank of methyl isocyanate and spread downwind in the darkness through squatters' huts and shanties located around the plant. Methyl isocyanate is an intermediate in the manufacture of the carbamate insecticide SEVIN. Several thousand people were killed and thousands more were injured—no one knows the actual number. Most of the people affected were very poor. (The plant had been built in an open field outside the town, and the squatters' settlement came later.)

The gas release came in darkness at a shift change and was an act of sabotage by a disgruntled employee who apparently sought to discredit his supervisor by ruining a tank of methyl isocyanate. (It is unlikely that he was aware that the consequences would be so terrible—his own parents lived nearby.) It was eventually determined that the employee had removed a pressure gage from a storage tank, connected a water hose to the tank at that point, and injected several hundred gallons of water into the tank. The water reacted with the methyl isocyante in the tank, overpressured the tank, and caused the release of toxic methyl isocyanate gas through an emergency relief system. The plant, which was being operated entirely by Indian nationals at the time, had been producing, using, and storing methyl isocyanate for five years without any problems.

As the tragedy unfolded, the first reaction at Union Carbide (as everywhere) was shock and horror. The second reaction was to provide direct and massive relief for the victims. This was in the form of medical services, a technical team, equipment, and money (nearly two million dollars) that were dispatched almost immediately to the site. Warren M. Anderson, the Chairman of the Board, also went immediately to the site. Anderson was not grandstanding, he hoped that his involvement would be beneficial. The Government of the State of Madyha Pradesh (in which Bhopal is located) rejected most of the aid and placed Anderson and the Chairman and the Managing Director of Union Carbide India Limited (UCIL) under arrest. Six other UCIL employees were also charged. Anderson subsequently was released from arrest and permitted to return to the United States. However, the charges against him were not dropped.

After initially being barred from the site, members of the technical team were allowed in the plant for a couple of weeks, mostly to help safely convert the remaining methyl isocyanate to innocuous SEVIN. While there, however, they were also allowed to take samples from residues in the tank, which permitted the determination that the reaction had been caused by the injection of one or two thousands of pounds of water into the tank. After three weeks, the technical team was again excluded from the plant by the Government of India and would not be able to reenter it for over a year.

The Company also sent in an independent medical team to treat the victims and offered $5 million in aid with no strings attached. These funds were also rejected. (The money was then given to the Indian Red Cross.) Despite repeated assurances of "no strings attached," the Government of India continued to reject all relief that originated with Union Carbide, even if provided by a third party. For example, the Company designated $2.2 million for Arizona State University to build and operate a rehabilitation center in Bhopal. When the Government of India learned that Union Carbide had provided the funds, it bulldozed the center.

It was obvious that others' objectives were not relief for the victims, but rather, vilifying and punishing Union Carbide and extorting from it as much money as possible. The main players in this drama were the Government of India and American plaintiff lawyers. Despite the fact that India has a well-established court system that is based on similar principles to those in the United States, both the Government of India and the American plaintiff lawyers sought to bring class-action suits against the Company in the United States where the prospect of a rich payout was better. Bhopal has been called the "greatest ambulance chase" in history as American lawyers flocked to India within days and indiscriminately began signing up claimants for class-action suits. At one time in the city of 650,000 people, there were nearly 500,000 claimants. Most of the claims, of course, were spurious.

The Government of India sought to be the representative for the victims (rather than the American lawyers) and brought suit in Federal Court in New York. However, the U. S. Courts established that India was the proper venue for litigation. The Government of India therefore brought suit in India. They sought criminal charges against Union Carbide officials and claims of $3 billion. (American lawyers had been seeking $50 billion.)

The Company mounted an intense investigation that proceeded independently and in parallel with a Government of India investigation. The Company's investigation was difficult, because the government was uncooperative and because employees had been intimidated by local authorities and were reluctant to testify. Some UCIL employees were also anxious to hide any personal liability that they may have incurred in dealing with the emergency. Eventually, however, the facts were discerned and reported by Carbide. They were corroborated independently by Arthur D. Little, Inc., a highly reputable consulting firm from Cambridge, Massachusetts.

The suit against the Company was concluded in 1989. The Supreme Court of India directed a settlement of $470 million and nullification of the criminal charges. It was the largest award ever made in India and was described by the Court as "just, equitable, and reasonable." The Court also directed that the Government of India make payments to the victims. Union Carbide paid the $470 million promptly—within ten days of the Court decree. However, a new administration of the Government of India, encouraged by political activists, challenged the settlement and sought to reinstate the $3 billion claim and criminal charges against Union Carbide officials. In the process the victims were mostly ignored. Two years later, in 1991 the Indian Supreme Court upheld the original cash settlement and only then did substantial money start to flow to the victims. The criminal case was permitted to remain open.

Union Carbide closed out the Indian Agricultural Products business and sold the rest of its operations in India. (Owing to the outstanding criminal charges, Union Carbide still cannot have any direct participation in India despite its 70-year plus history as a good and useful citizen in India.) Union Carbide had owned only 50.9 percent of Union Carbide India Limited. About 25 percent of UCIL was owned by the Government of India and the rest was publicly held. The Company's proceeds of the sale of its stake in UCIL were pledged to a trust in London to build a hospital in Bhopal and to minister to the victims there. There is about $100 million in the trust.

There were several tragedies along the way at Bhopal. The first, of course, was the death and injury of so many people, for which Union Carbide accepted moral responsibility despite the fact that the event was an act of sabotage. The second was the neglect of aid for the victims by the Government of India. Aid took second priority to greed and politics. (There was considerable political unrest in

India at the time owing to the assassination earlier of Indira Ghandi, the Prime Minister.) A third tragedy was the loss of domestically produced SEVIN that had contributed to India's being self-sufficient in food. Inasmuch as the typical farm in India is only a couple of acres it is farmed largely by hand. SEVIN is an insecticide that can be applied safely without special equipment. Domestically produced SEVIN was also important because it was rupee-based and India lacks foreign exchange to import SEVIN

Union Carbide's reputation and collective psyche suffered greatly in the aftermath of Bhopal, "the worst industrial accident in history." The irony was that Union Carbide was a good corporate citizen and always had a high concern for the safety and health of its employees and others. It has also been a leader in industry programs in the pursuit of employee safety and health. Perhaps one good thing to come out of it all has been an increased awareness of risk and an increased emphasis on safety not only by Union Carbide, but also by the chemical industry as a whole. As noted in 1990 by Robert D. Kennedy, the Chairman of Union Carbide, the Company has accepted that "Bhopal has placed a special obligation on it to meet the highest standards for health, safety, and environmental excellence", and it has established programs to meet those standards.

Divestitures And Restructuring

As indicated earlier, the Company had begun to refocus its efforts on its stronger lines. It had started to divest areas that didn't fit, and by the early 1980s, almost a billion and a half dollars worth of businesses had been sold. In 1984, the Company also relinquished the operations of the nuclear facilities at Oak Ridge, Tennessee, and Paducah, Kentucky, to the Martin-Marietta Corporation. Carbide's involvement had lasted forty years and was no longer critical to national needs. The operation had been conducted for the Federal Government essentially as a civic endeavor and no profit was involved.

The process of "restructuring" was greatly accelerated by the events at Bhopal. Investors dumped Union Carbide stock in 1985 in anticipation of liabilities accruing to Bhopal, and the stock plunged to half its year earlier value. The stock already had been low and the reaction to Bhopal took it to less than half of its book value. Inasmuch as the Company was worth far more and coupled with the fact that it had a large, overfunded pension reserve (of about $1 billion), the Com-