JAMES D. MADDEN, P.E.

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DETAILED CURRICULUM VITAE

TABLE OF CONTENTS

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DETAILED CURRICULUM VITAE

PRIMARY AREAS OF FORENSIC PRACTICE

The Forensic Practice consists of Investigation, Analysis and Reconstruction of Mechanical Accidents, including Traffic Accidents and other Mechanical Accidents, with or without a Chemical Component; and Safety Analysis of Equipment and Facilities associated with these accidents, including the use of Human Factors when applicable. This practice includes: traffic accidents, including roadway design, and roadway condition and traffic control devices; accidents involving consumer products and industrial equipment accidents, including guarding and warnings; chemical and gas accidents; fires, explosions and carbon monoxide poisonings; commercial facility and industrial facility accidents and construction accidents; and, building and property accidents, including slips, trips and falls. Typical services, when appropriate for the work, include consultation; on-site investigation and data collection; preliminary evaluation; calculations; testing; research; accident analysis; equipment and facilities analysis; accident reconstruction; verbal and written reports; and, expert testimony in depositions, arbitrations and trials. The Forensic Practice has included the preparation of **over 600 written reports**; preparation of **over 60 affidavits** in response to motions, or in place of written reports; testimony in **over 90 discovery depositions;** and, testimony in **over 75 trials**. The Forensic Practice has also included verbal reports, in addition to, or in place of written reports; video depositions for presentation in trial; and, testimony in arbitrations.

QUALIFICATIONS SUMMARY

In summary, qualifications for investigating and reconstructing mechanical accidents, including those with a chemical component, and qualifications for performing safety analyses related to these accidents include: over 40 years of engineering experience, including 17 years of engineering design, industrial operations, and construction assistance, and ***25*** years of forensic engineering; 2 engineering degrees; Professional Engineer license (PE); and designation as a Diplomate Forensic Engineer by the National Academy of forensic Engineers. This engineering experience includes application of mechanical engineering and chemical engineering in research, industrial operations, equipment design, and facilities design, full-time from 1966 to 1983 (part-time 1963 to 1966), with emphasis on safety analyses, safety design and safety operations. This engineering experience also includes, full-time since 1983: investigating, analyzing and reconstructing hundreds of mechanical and mechanical-chemical accidents, with associated safety analyses of equipment and facilities, including accidents involving: industrial equipment and consumer products; chemicals and gases; fires and explosions and hazardous combustion; industrial, commercial and construction operations and facilities; building and property safety, including slips, trips and falls; and, traffic accidents.

Qualifications for investigating and reconstructing incidents involving **equipment and consumer products**, including guarding and warnings, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees, having taken extensive coursework in the engineering of equipment; (2) having designed and specified equipment extensively during 17 years of industrial operation and design engineering work; and, (3) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 175** incidents involving consumer products and industrial, commercial and construction equipment - including hands-on inspection of involved consumer products, and hands-on inspection of involved industrial and commercial equipment, on-site, in use, in their industrial or commercial facilities.

Qualifications for investigating and reconstructing incidents involving **chemicals, gases and materials**, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees, having taken 4 college level courses in Physics and 8 college level courses in Chemistry, including Physical Chemistry (the physics of chemicals); (2) having designed for the use of chemicals, gases and materials, and participated in industrial operations involving chemicals, gases and materials, during 17 years of industrial operation and design engineering work; and, (3) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 20** incidents involving chemicals and gases - including hands-on inspection of the involved chemicals and gases and their containers, and experimentation with involved chemicals and gases.

Qualifications for investigating and reconstructing **fires, explosions and incidents of hazardous combustion**, including incidents leading to carbon monoxide poisoning, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees, having taken 4 college level courses in Physics and 8 college level courses in Chemistry, including Physical Chemistry, the physics of chemicals [fire and explosion are chemical reactions covered in Chemistry courses]; (2) having designed facilities and equipment for the use of combustion (controlled fire), including flares, furnaces and boilers, during 17 years of industrial operation and design engineering work; (3) having designed facilities and equipment to prevent or respond to fire, including fire fighting systems, and fire and explosion suppression systems, during 17 years of industrial operation and design engineering work; and, (4) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 45** incidents involving fires, explosions and/or hazardous combustion, including incidents leading to carbon monoxide poisoning - including hands-on inspections of facilities, industrial and residential equipment, and consumer products involved in fires and explosions, and incidents of hazardous combustion, including incidents leading to carbon monoxide poisoning.

Qualifications for investigating and reconstructing incidents involving **industrial, commercial, and construction operations** and **commercial and industrial facility design**, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees, having taken extensive coursework in engineering design of industrial facilities and equipment, and also in the operation of industrial equipment and facilities; (2) having worked in industrial facilities, and having designed industrial facilities during 17 years of industrial operation and design engineering work, and having assisted in construction of industrial facilities during that time; (3) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 155** incidents involving industrial, commercial, and construction operations, and commercial and industrial facility design and operation - including hands-on inspection of involved industrial and commercial facilities.

Qualifications for investigating and reconstructing incidents involving **building and property safety**, including **slips, trips, and falls,** and analyzing safety of associated buildings and property, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees and as part of refresher and additional college credit work taken in the 1980s, having taken 8 college level courses in physics and engineering mechanics, the scientific bases for reconstruction of slips, trips and falls; (2) having designed facilities and analyzed facilities for safety during 17 years of industrial operation and design engineering work; and, (3) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 150** incidents involving premises issues, including slips, trips and falls - including hands-on inspections of involved buildings and properties.

Qualifications for investigating and reconstructing **traffic accidents**, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees and as part of refresher and additional college credit work taken in the 1980s, having taken 16 college level courses in mathematics, physics and engineering mechanics, the scientific bases for traffic accident reconstruction; (2) having taken 7 courses over eight 40-hour instruction weeks at the Northwestern University Traffic Institute which were specifically designed to teach investigation and reconstruction of traffic accidents; and, (3) in addition to consultations, having investigated and reconstructed, during 25 years of forensic practice, **over 450** traffic accidents - including hands-on inspections of involved vehicles and accident sites.

Qualifications for use of **Human Factors** in analysis of accidents and analysis of the safety of equipment and facilities, in addition to qualifications described above, include: (1) as part of the work for the engineering degrees, minoring in Normal Psychology, one of the two bases for Human Factors (the other being Engineering, another aspect of the engineering degrees); (2) having used Human Factors as an integral part of design during 17 years of industrial operation and design engineering work; and, (3) having used Human Factors in analysis of many of the previously listed accidents, equipment and facilities which have been analyzed during 25 years of forensic practice**.**

Additional qualifications for all forensic work includes: extensive use and interpretation of **codes and standards** for over 40 years, including 25 years in forensic practice; extensive use and interpretation of **warnings** for over 40 years, including 25 years in forensic practice; extensive **safety design** for 17 years; and extensive **analysis of equipment and facilities for safety** for over 40 years, including ***25*** years in forensic practice.

PROFESSIONAL ENGINEER LICENSE

Licensed as a Professional Engineer: license earned by taking the National Council of Engineering Examiners' (NCEE) examination in Fundamentals of Engineering, and MECHANICAL ENGINEERING and CHEMICAL ENGINEERING sections of the National Council of Engineering Examiners' examination in Principles and Practices of Engineering. Registered under Ohio Certificate Number E-49787.

FORENSIC ENGINEER CERTIFICATION

Certified as a Diplomate Forensic Engineer in accordance with the standards of the Council of Engineering Specialty Boards (CESB). Senior Member No. 476 in the National Academy of Forensic Engineers.

CRASH DATA RETRIEVAL (CDR) CERTIFICATION

Certified as a Crash Data Retrieval (CDR)[1] Technician 1 and a Crash Data Retrieval (CDR) Technician[1] 2, and Certified as a Crash Data Retrieval (CDR)[1] Data Analyst, under the Vetronix/Bosch Certification program as administered by the Collision Safety Institute and Northwestern University Center for Public Safety.

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[1] Crash Data Retrieval (CDR) is the term for the retrieval of crash data, pre-crash data, and other recorded data from passengers cars, SUVs and light trucks using a specific software and hardware system designed for this purpose. The system, which has been developed, expanded and managed, originally by Vetronix and currently by Bosch. The system was designed in conjunction with vehicle manufacturers, with the involvement of the National Highway Traffic Safety Administration (commonly called NHSTA) which has placed certain requirements on the system. This system accesses selected control modules in many vehicles for the crash and event related data recorded in the Event Data Recorders (EDR) associated with Airbag Control Modules (ACM), Powertrain Control Modules (PCM) or Roll-over Sensors (ROS) in these vehicles. This data is retrieved either directly from the modules or through the Diagnostic Link Connector (DLC) using equipment specifically designed for this purpose. The specific components of vehicles associated with Crash Data Retrieval and the names and acronyms assigned to these components, can vary by vehicle manufacturer.

CURRENT AND FORMER MEMBERSHIP IN PROFESSIONAL SOCIETIES

Society of Automotive Engineers (SAE)
National Fire Protection Association (NFPA)
American Institute of Chemical Engineers (AIChE)
American Society of Mechanical Engineers (ASME)
International Code Council (ICC), formerly
Building Officials & Code Administrators International (BOCA)
American Society of Agricultural Engineers (ASAE)
National Society of Professional Engineers (NSPE)
National Academy of Forensic Engineers (NAFE)
American Society of Civil Engineers (ASCE)
Institute of Transportation Engineers (ITE)

RECOGNITION

Inducted into Sigma Pi Sigma National Physics Scholastic Honor Society
Inducted into Tau Beta Pi National Engineering Scholastic Honor Society
Inducted into Sigma Xi National Research Honor Society
Recipient of a National Science Foundation Undergraduate Research Grant
Recipient of a NASA Fellowship for Graduate Study

LISTINGS

Marquis' Who's Who in Science and Engineering
American Association of Engineering Societies' Who's Who in Engineering

TECHNICAL EDUCATION

1963, 1966: Earned a Bachelor of Science in Chemical Engineering degree (1963) and a Master of Engineering degree (1966) from the University of South Carolina, Columbia, South Carolina. The Bachelor's degree program in Chemical Engineering contained the elements of a double major in Mechanical Engineering and Chemistry. Degree work included substantial coursework in mathematics, physics, chemistry, engineering mechanics and normal psychology, in additional to extensive coursework in engineering principles, processes, and equipment.

1970 to 1978: Participated in the American Institute of Chemical Engineers (AIChE) seminars on the prevention of fires and explosions and protection against overpressure failures; Attended the AIChE continuing education course on Fire and Explosion Hazards Evaluation.

1983, 1986, 2011, 2012: Earned Certificates of Successful Completion from the Northwestern University Traffic Institute, Evanston, Illinois, by successfully passing the required examination in each course subject matter, for 9-1/2 full-time (40 hour) weeks of coursework and fieldwork in traffic accident investigation and reconstruction in the following 10 courses:

1983: (1) Technical Accident Investigation (2 weeks); (2) Vehicle Dynamics (1 week);(3) Traffic Accident Reconstruction [later renamed Traffic Accident Reconstruction I] (2 weeks);

1986: (4) Continued Case Studies in Traffic Accident Reconstruction [later renamed Traffic Accident Reconstruction II] (1 week); (5) Microcomputer-Assisted Traffic Accident Reconstruction (1 week); (6) Motorcycle Accident Reconstruction (2 days); (7) Vehicle Lamp Examination (3 days);

2011: (8) Crash Data Retrieval (CDR)[2] Technician 1 Certification (1 day); (9) Crash Data Retrieval (CDR)[2] Technician 2 Certification (1 day)

2012: (10) Crash Data Retrieval (CDR)[2] Data Analyst Certification (1 week).

1985 to 1987: Earned college course credits through the Mechanical Engineering Department at Cleveland State University, Cleveland, Ohio, for 3 courses in Engineering Mechanics (Statics, Dynamics, and Kinematics) and 1 course in Materials Science. Also took, during this same time period, a continuing education course in Metallurgy at Cleveland State University.

1986 to 1988: Attended the Society of Automotive Engineers (SAE) course on Product Liability, and participated in Society of Automotive Engineers (SAE) seminars on Traffic Accident Investigation and Reconstruction.

1995, 2002, 2007: Participated in Expert Witness Seminar presented by "The Testifying Expert" periodical. Participated in Engineering Seminars presented by the National Academy of Forensic Engineers.

2008 through present: Participated in Seminars on engineering and other technical subjects presented by numerous education groups, over an average of at least 15 contact hours each year.

PROFESSIONAL EXPERIENCE SUBSEQUENT TO START OF FULL-TIME FORENSIC PRACTICE ● ACCIDENT INVESTIGATION AND RECONSTRUCTION, AND SAFETY ANALYSIS OF EQUIPMENT AND FACILITIES ASSOCIATED WITH ACCIDENTS ● 1983 to Present

Have performed, and currently perform, accident investigation, analysis, and reconstruction, and also safety analysis of equipment and facilities involved in accidents, making use of Human Factors when applicable. Work includes consultation, on-site inspection and data collection, preliminary evaluation, calculations, testing, research, preparation of verbal and written reports and affidavits, and expert testimony in depositions, arbitrations and trials in the areas noted in the "Primary Areas of Forensic Practice" and "Qualifications Summary" on page 1 of this Curriculum Vitae. Have conducted experiments with equipment, vehicles, persons and facilities for safety analysis and accident reconstruction. Have used industry, technical society and government codes, standards and recommended practices extensively during the foregoing activities; and, continue to use these codes, standards and recommended practices in current forensic work.

Matters have been handled for both plaintiffs and defendants through attorneys, insurance companies and claims services.

For additional information, see the section in this Curriculum Vitae titled "Examples of Issues and Accidents Handled in Forensic Practice and Facilities and Equipment Associated with These Accidents.

PROFESSIONAL EXPERIENCE BETWEEN RECEIPT OF MASTER'S DEGREE AND START OF FULL-TIME FORENSIC PRACTICE ● INDUSTRIAL OPERATIONS AND ENGINEERING DESIGN ● 1966 to 1983

Employed by manufacturing companies and engineering design and construction companies in **industrial facilities operations**; **engineering design** and consulting; and, construction assistance. Involved in industrial operation of facilities, which included machinery, tanks, pressure vessels, piping, instrumentation, and other

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[2] See footnote on page 3 for a description of Crash Data Retrieval (CDR) system.

equipment. **Designed and specified machinery, tanks, pressure vessels, piping, instrumentation, and other equipment, as well as associated facilities.** These facilities and this equipment were used for: (1) the manufacture, storage and transportation of chemicals, pharmaceuticals and plastics; (2) the production, storage and distribution of natural gas and its components; (3) the production, storage and transportation of petroleum products; (4) the treating and disposal of industrial wastes; and, (5) the production and distribution of utilities, including instrument air, plant air, nitrogen and steam. Also designed and specified machinery, tanks, pressure vessels, piping, instrumentation, and other equipment and facilities, for the protection of property, personnel, and the environment: (1) from equipment and machinery hazards and failures; (2) from fires and explosions; (3) from vessel and piping overpressure and failures, and, (4) from gas, liquid and solid discharges to the atmosphere. This protection was achieved through both prevention of the hazards and control of the consequences of the hazards. **Designed facilities to provide and assure safety**, including: (1) pressure relief equipment and systems for gases and liquids; (2) fire protection and suppression systems, including water and foam systems; and, (3) ground flares and elevated flare stacks for burning hazardous materials. Provided technical assistance during construction of industrial, manufacturing and related facilities. Assisted with initial operation ("startup"and "shake-out") of industrial facilities and field revisions of industrial facilities.

Conducted experiments and testing with chemicals, and machinery and other equipment, in industrial facilities, as part of the design process. **Designed and presented courses** on technical subjects to design engineers on safety relief device design and safety relief system design. Participated in and organized, supervised and managed groups of engineers in the writing of design manuals for equipment and machinery, piping, valving and instrumentation to meet applicable codes, and also a design manual for design of boiler systems to meet the ASME Boiler Code and other applicable codes.

Performed general safety design integral with equipment and industrial facilities design. Conducted audits of designs, with special attention to the safety of the equipment and systems in such designs, and assured the technical quality of the engineering design, including safety design, through formal technical reviews and approval of designs, and the associated specified equipment, systems, and facilities. Interpreted and used industry and governmental codes and standards extensively during the foregoing activities, and advised other engineers in their use.

In addition to direct design of facilities, supervised other engineers designing equipment and facilities, and managed engineering design projects for industrial facilities, manufacturing and related facilities.

See the sections in this Curriculum Vitae titled "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations And Design Engineering - 1966 Through 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations And Design Engineering - 1966 Through 1983", for additional information.

PROFESSIONAL EXPERIENCE BETWEEN RECEIPT OF BACHELOR'S AND MASTER'S DEGREES • RESEARCH, INDUSTRIAL OPERATIONS AND ENGINEERING DESIGN • 1963 through 1966, including during breaks in graduate study

Performed research for the Atomic Energy Commission. Employed by manufacturing companies in research conducted in operating industrial facilities which were manufacturing chemicals and plastics. Employed by manufacturing companies in operation of manufacturing and other industrial facilities; and, in engineering design. Conducted experiments with equipment and chemicals in laboratories for university research and in industrial and manufacturing facilities for industrial research.

EMPLOYMENT SUBSEQUENT TO START OF FULL-TIME FORENSIC PRACTICE 1983 to Present

1983 - Present **Madden Accident Analysis and Forensic Engineering*; Forensic Engineer; Accident investigation and Reconstruction Engineer; Safety Engineer***

Full-time since 1983, investigating, analyzing, and reconstructing mechanical accidents, including traffic accidents and other mechanical accidents, with or without a chemical component; and analyzing the safety of equipment and facilities associated with these accidents, utilizing Human Factors where applicable.

Accidents handled include: traffic accidents; accidents involving consumer products and industrial equipment, and warnings issues; chemical and gas accidents; fires, explosions and hazardous combustion; accidents involving commercial and industrial facilities, and operations; and, building and property safety.

Typical activities include consultation, on-site inspection and data collection; preliminary evaluation; calculations; testing; research; accident analysis; equipment and facilities analysis; accident reconstruction; verbal and written reports, and affidavits; and, expert testimony in depositions, arbitrations and trials.

EMPLOYMENT BETWEEN RECEIPT OF MASTER'S DEGREE AND START OF FULL-TIME FORENSIC PRACTICE ● 1966 to 1983

1966 - 1967 **Monsanto** ***- Process Engineer; Equipment, Piping, Instrumentation, and Facilities Design Engineer***

Provided technical assistance, participated in industrial operations, conducted studies, and designed and installed equipment and facility improvements for the facilities associated with an area of an industrial manufacturing facility, for the manufacture of acrylonitrile, which included fluidized bed reactors, a steam generation system, and support equipment, machinery, piping and instrumentation.

Participated in the commissioning (construction assistance) and start-up (initial operation) of one of these facilities.

1967 - 1970 **UNION CARBIDE** ***- Process Engineer; Project Engineer; Equipment, Piping, Instrumentation and Facilities Design Engineer***

Performed process and project engineering on engineering design projects, including all aspects of: (1) process design; (2) piping and instrumentation; (3) process and mechanical specification of machinery, vessels, tanks and other equipment; (4) bid review, recommendations and coordination with vendors of machinery and other equipment, for the supply of this equipment; (5) supervision of technical aspects of detail design with the detail design contractor; and, (6) assistance with engineering problems at the construction site. These functions were performed for a high density polyethylene manufacturing facility.

Performed industrial operations studies in the same high density polyethylene manufacturing facility. Performed drainage studies, and the design of surface and sub-surface drainage facilities and an industrial waste collection system including trenching (flumes), sewers and recovery equipment at the same high density polyethylene manufacturing facility.

1970 - 1973 **M. W. KELLOGG / PULLMAN-KELLOGG** ***- Systems Engineer; Equipment, Piping, Instrumentation and Facilities Design Engineer; Safety Design Engineer***

Performed process systems engineering and safety design for engineering design projects, including: (1) developing Piping and Instrumentation Diagrams (Mechanical Flow Diagrams); and, (2) specifying piping, instruments, machinery and other equipment. Performed this work for the design of a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

As a specialty, designed safety and air pollution control systems, including flares, vents, foam fire protection and fire suppression systems, etc.

1973 - 1974 Litwin ***- Senior Process Engineer; Equipment, Piping, Instrumentation, and Facilities Design Engineer***

Provided all aspects of process design and safety design on engineering design projects, including: (1) heat and material balances; (2) process flow diagrams; (3) mechanical flow diagrams (Piping and Instrumentation Diagrams); (4) specifying machinery, other equipment, instrumentation and piping; (5) and, assisting as required with associated activities (detailed design, purchasing, project engineering and project management). Performed this work for the design of a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

Conducted operation and design studies of an operating plastics manufacturing facility to establish design parameters for additional manufacturing facilities. Was the Engineer on the marketing team to market this plastics manufacturing facility design in foreign markets.

1974 - 1977 M. W. KELLOGG / PULLMAN-KELLOGG ***- Principal Systems Engineer; Equipment, Piping, Instrumentation, Facilities Design Engineer; Safety Design Engineer***

Performed process systems engineering, and supervised and managed groups of engineers performing the process systems engineering on engineering design projects, assuring quality design, including safety design, for a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. See "Employment - 1970-1973 -M. W. Kellogg ..." above in this Curriculum Vitae for details of the design work. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

Was the Engineering Representative onsite at a Venezuelan industrial complex during the latter stages of construction: (1) providing solutions for the engineering aspects of construction problems; (2) providing additional designs for equipment and systems to be added; and, (3) providing consultation on industrial operations for the operations staff. This complex consisted of manufacturing facilities, and other industrial facilities, for (1) the production, storage and distribution of chemical and plastics products; and, the production and distribution of utilities, including water, air and steam.

Lead a team of engineers conducting facility-wide safety studies to design additional safety facilities for a manufacturing facility, and other industrial facilities, in Saudi Arabia.

Designed and conducted courses on the design of safety relief devices (safety relief valves, rupture discs and the like) and safety relief systems, including the piping, valves, and instrumentation of these systems. Supervised and managed groups of engineers writing Design Manuals for equipment and machinery, piping, valves, and instrumentation to meet applicable codes, and also writing a Design Manual for Boiler Systems to meet the ASME Boiler Code and other applicable safety standards.

1977 - 1983 DAVY POWERGAS / DM INTERNATIONAL / DAVY MCKEE

- **1977, 1978** ***Senior Project Engineer; Safety Assurance Engineer***

Performed engineering design. Assured the technical quality of the engineering design, including safety design, through hands-on technical review of the design. Directed the efforts of the engineering disciplines in their engineering design work. Integrated the work of the engineering disciplines with the remainder of the project groups. Performed this work for the design of a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

- **1978, 1979** ***Supervising Project Engineer; Safety Assurance Engineer***

Performed engineering design. Assured the technical quality of the engineering design, including safety design, through formal technical reviews of the design. Assured the performance of Project Engineers and the Engineering Department in the design of manufacturing facilities and other industrial facilities. Performed this work for the design of a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

- **1979, 1980** ***Manager, Equipment Engineering Section; Safety Assurance Engineer***

Supervised, managed and participated in the design activities of the Equipment Engineering Section which designed, specified, and requisitioned pumps, compressors, turbines, furnaces, boilers, vessels, tanks, heat exchangers, heaters, and similar machinery and equipment.

- **1980 - 1983** ***Project Manager and Project Engineering Manager; Safety Assurance Engineer***

Performed engineering design. On projects where acting as Project Manager, in addition, provided the overall management of the project and the administration of the project contract. This included the coordination of engineering, procurement and construction and the assurance of the design quality, including safety design. Also monitored and controlled schedule, cost and budget, and served as primary contact with the client's project representatives.

On projects where acting as the Project Engineering Manager, in addition, provided the overall supervision of the engineering portions of the project. This included assurance of the quality of the design, including safety design, and other activities similar to those listed above, as they related to the engineering portion of the project.

Both as Project Manager and Project Engineering Manager, worked on a number of manufacturing facilities, and other industrial facilities, which contained equipment, and other facility components. The manufacturing facilities, and other industrial facilities, and the equipment, and other facility components, are listed among the items on the lists elsewhere in this Curriculum Vitae under the headings of "Examples of Equipment, Systems and Facilities Designed and Specified While in Industrial Operations and Design Engineering -1966 to 1983" and "Examples of Engineering Design Projects Handled While in Industrial Operations and Design Engineering - 1966 to 1983".

EMPLOYMENT BETWEEN RECEIPT OF BACHELOR'S AND MASTER'S DEGREES •

1963 through 1966, including during breaks in graduate study

1963 - 1966 ***(parttime)*** **ATOMIC ENERGY COMMISSION** ***- Research Assistant***

Performed research on radioactive materials in a research laboratory at the University of South Carolina.

1963 (3 months) **E. I. DuPont -** ***Research Engineer***

Performed research in a laboratory in a manufacturing facility.

1964 ***(3 months)*** **UNION CARBIDE -** ***Manufacturing Engineer***

Performed studies of the operation of industrial equipment in a manufacturing facility.

1965 ***(3 months)*** **MONSANTO -** ***Process Engineer; Facilities Engineer***

Performed studies of the operation of industrial equipment in a manufacturing facility.

TECHNICAL EMPLOYMENT BEFORE RECEIPT OF BACHELOR'S DEGREE • 1960 through 1963

1960 - 1963 ***(part-time)*** **UNIVERSITY OF SOUTH CAROLINA -** ***Mathematics grader***

Graded homework and tests in undergraduate mathematics courses, up to and including calculus and partial differential equations.

1962 ***(3 months)*** **UNIVERSITY OF SOUTH CAROLINA -** ***recipient of a National Science Foundation Research Grant***

Performed research in heat transfer and fluid flow for the National Science Foundation.

NON-TECHNICAL EMPLOYMENT • 1955 through 1966

1955 - 1958 ***(part-time and full-time in summers)*** **GROCERY STORE - clerk**

Stocked inventory for customer purchase, restored order to stocked inventory ("blocking"), maintained inventory, served customers from a sales stand, operated cash registers (prior to the scanning era).

1958 & 1959 ***(3 months each year)*** **DEPARTMENT STORES -** ***clerk***

Stocked inventory for customer purchase, restored order to stocked inventory, maintained inventory, served customers, operated cash registers (prior to the scanning era).

1960 ***(3 months)*** **SERVICE STATION -** ***attendant***

Pumped gasoline (prior to self-service era), sold and installed automotive products, performed vehicle maintenance.

1961 ***(3 months)*** **CAB COMPANY -** ***driver***

Drove a taxicab in a city.

1962 - 1966 ***(part-time)*** **UNIVERSITY OF SOUTH CAROLINA -** ***Dormitory Counselor***

Supervised undergraduate dormitories; counseled undergraduate students.

EXAMPLES OF ISSUES AND ACCIDENTS HANDLED IN FORENSIC PRACTICE, AND FACILITIES AND EQUIPMENT ASSOCIATED WITH THESE ACCIDENTS ● 1983 to Present

CONSUMER PRODUCTS, AND INDUSTRIAL, COMMERCIAL, AND CONSTRUCTION EQUIPMENT, AND ASSOCIATED ACCIDENTS ● Work in this area generally covers **guarding, warnings**, **mechanical failure**, and **safety design issues**, for example: pinchpoints. Many different pieces of equipment, including various types of industrial, commercial and construction equipment, and various types of consumer products, have similar or identical parts associated with these safety issues. These components and their inclusive equipment are analyzed based on accepted engineering and safety principles for the use and performance of these parts in industrial, commercial and construction equipment, and consumer products. Such analyses are performed to determine whether industrial, commercial and construction equipment and consumer products involved in accidents were defective in design, manufacture, and/or warnings, in regard to safety, and/or were not appropriately guarded; and, whether such equipment conformed to appropriate accepted engineering practices, codes, standards and regulations, including state and federal regulations for safety. Reconstruction of accidents involving industrial equipment and consumer products determines whether such equipment caused or contributed to the accident. Work in this area also generally includes determining whether revision of the equipment was required for safety. ● **examples of consumer products (including residential and recreational products, and vehicles)** analyzed include: residential maintenance equipment (walk-behind and riding lawnmowers, snowblowers, trimmers, ladders, etc.) • infant products (strollers, highchairs, etc.) • recreational equipment (swimming pools and decks, grills, playground equipment, exercise equipment, bicycles, etc.) • motor vehicles (automobiles, motorcycles, trucks, etc.) • household and residential utility items (chairs, space heaters, furnaces, etc.). ● **examples of industrial, commercial, and construction equipment (including mining and farm and garden equipment)** analyzed include: commercial equipment for use by the public (chairs, coffeemakers, vending machines, display stands, car washes, etc.) • construction, heavy maintenance and mining equipment (scaffolding, hand tools, front end loaders, excavators and similar mobile vehicles and equipment, etc.) • commercial and light maintenance equipment (clothes washing/cleaning and pressing equipment, food preparation equipment, buffers, etc.) • farm and garden equipment (tractors and trailers, lawnmowers, harvesters, trimmers, etc.) • industrial equipment (forklifts, towmotors, and similar mobile equipment, cranes, hoists, banders, grinders, punch presses, forming presses, drill presses, printing presses, conveyors, industrial heating equipment, wood-working machinery, plastics and rubber processing equipment, including blow-molders and calanders, etc).

GENERAL BUILDING AND PROPERTY FEATURES AND ASSOCIATED ACCIDENTS ● Work in this area generally covers building and property physical features and characteristics associated with hazards, such as stairs and ramps, inadequate slip-resistance of surfaces, trip hazards, inadequately guarded openings and hazardous areas, and inadequate warnings of hazards. Buildings and properties have similar features associated with these safety issues, which are analyzed based on accepted engineering and safety principles for the use of buildings and properties. Such analyses are performed to determine whether buildings and properties were defective in design in regard to safety; and whether buildings and properties conformed with appropriate accepted engineering practices, standards, regulations and codes, especially state and federal building codes and requirements, including ADA requirements. Reconstruction of such accidents determines whether building and property features and/or conditions caused or contributed to the accident, including those accidents commonly called slips, trips and falls. Work in this area also generally includes determining whether revision of the facilities was required for safety. ● **examples of facilities** analyzed include: single-family and multiple-family residences, including apartment buildings • retail stores • warehouses • industrial and manufacturing facilities • auditoriums • restaurants and lounges • outdoor facilities. ● **examples of features and features** analyzed include: glass doors and panels • windows and window assemblies • interior and exterior steps, stairs and ramps, and their handrails and guardrails • elevators • interior and exterior balconies • floors • roofs • sidewalks, parking lots, and other exterior walking surfaces • and, features and fixtures nearby, on, or within the above features and fixtures.

INDUSTRIAL AND COMMERCIAL FACILITIES, AND CONSTRUCTION SITES, THE DESIGN OF THESE FACILITIES AND SITES, AND OPERATIONS AT THESE FACILITIES AND SITES, AND ASSOCIATED ACCIDENTS ● Work in this area generally covers industrial and commercial facility and construction site issues which are more specific to industrial and commercial facilities and construction sites than the general physical features and characteristics of buildings and properties which are associated with common hazards such as stairs, and which were described above in the section titled "General Building and Property Features and Associated Accidents". Work in this area generally determines whether the facility design, facility operations, equipment, and/or procedures conformed with appropriate accepted engineering practices, codes, standards and regulations specifically for safety of industrial, commercial, and construction facilities. Reconstruction of such accidents determines whether the facilities or equipment caused or contributed to the accident. Work in this area also generally includes determining whether revision of the facilities, operation, equipment or procedures was required for safety. ● **examples of issues** for industrial and commercial facilities and construction sites that have been addressed include: evaluating safety design and safety procedures for industrial facility operations, including manufacturing facility operations, against accepted safety standards • determining applicability and compliance with OSHA Regulations for industrial and construction activities, facilities and sites • determining applicability and compliance with state regulations for industrial and construction activities, facilities and sites, such as the Industrial Commission of Ohio Specific Safety Requirements • determining applicability and compliance with industry, technical organization and (other) governmental codes, standards and recommended practices for industrial, commercial and construction activities and facilities and sites • determining application of generally accepted standards for the safety of equipment and facilities • determining whether equipment was properly installed • determining whether safety equipment (including guarding) and safety instrumentation and safety procedures had been in place and were properly used • determining whether ventilation was properly used, where this is a safety issue • determining whether drainage and sewer connections were effective and safe, where this is a safety issue. ● **examples of accidents** analyzed include: accidents involving industrial, commercial and construction equipment (examples of such equipment are listed in the section titled "Consumer Products, and Industrial, Commercial, and Construction Equipment, and Associated Accidents") • exposures to chemical vapors • operations resulting in asphyxiation • liquid spills causing burns • runaway chemical reactions not fully protected by overpressure protection devices • incorrect discharge of fire protection sprinkler system • falls from scaffolding and ladders • falls through walking surface openings • falls through failed walking surfaces • falls into flumes (persons and persons on equipment) • tank explosions, including during cutting • rupture of natural gas pipeline with fire and explosion • restaurant, and commercial laundry operations, resulting in fire and/or explosion. ● examples of facilities in which analyzed accidents occurred include: indoor and outdoor construction sites • steel mills • steel processing facilities • metal working facilities • rubber and plastics processing facilities • facilities manufacturing plastic, rubber, wood and metal products, for consumer, commercial, and industrial use • chemical manufacturing facilities • warehouses • commercial laundry • restaurants • scrap salvage facilities • outdoor storage facilities • and, similar industrial and commercial facilities. ● **employees and non-employees**: Analyses have been performed for accidents involving both persons not employed by the owner and/or operator of the facility, or construction contractor/sub-contractor; and persons employed by the owner and/or operator of the facility, or construction contractor/sub-contractor. Analyses have included actions taken as exceptions to Worker's Compensation, such as **Intentional Tort** actions in Ohio.

FIRES AND EXPLOSIONS ● Work in this area generally covers determining causes of fire and explosion;

and determining whether facilities and/or equipment conformed with appropriate accepted engineering practices, codes, standards and regulations in regard to safety, including fire codes; whether materials of construction were safe; whether equipment was properly installed in regard to safety; whether fuel and ignition sources were properly separated; and, whether safety equipment, facilities and procedures were in place and were properly used. Work in this area also generally includes determining whether revision of facilities or equipment was required for safety. ● **examples of facilities and equipment** analyzed include: residential and recreational facilities (single-family and multi-family residences, motorhomes) • residential and recreational equipment (motorboats, incinerators, space heaters, furnaces, etc.) • industrial and commercial facilities (natural gas pipeline, gasoline storage tanks, hydrogen tankers, hydrogen loading facilities, gasoline service stations, marinas, commercial laundry, restaurant, scrap and metal processing facilities, various other industrial facilities, etc.).

HAZARDOUS COMBUSTION IN EQUIPMENT USING CONTROLLED FIRE, GENERALLY ASSOCIATED WITH CARBON MONOXIDE POISONING AND EQUIPMENT EXPLOSIONS ● Work in this area generally covers equipment that is specifically designed for combustion, but which create severe hazards from the combustion, or the combustion in an out-of-control condition; generally by creating hazardous discharges, or exploding. Equipment which is specifically designed for combustion includes residential and industrial furnaces and incinerators and their associated instrumentation and auxiliary equipment. Work in this area generally determines whether equipment and/or systems were defective in design, manufacture or installation in regard to safety, and/or lacked adequate warnings; and, whether equipment and/or systems conformed with appropriate accepted engineering safety practices, standards and regulations, including fired-equipment codes and general fire codes. Reconstruction of accidents involving combustion equipment and combustion systems determines whether such equipment and/or systems caused or contributed to the accident. Work in this area also generally includes determining whether revision of the combustion equipment, combustion system, or associated facilities was required for safety. ● **examples of systems and equipment** analyzed include: gas-fired residential furnaces, wood-burning residential furnaces and residential heat circulation systems involved in carbon monoxide poisonings • space heaters involved in carbon monoxide poisonings • gas-fired trash-burning incinerators involved in explosions and fires • gas-fired industrial furnace/boiler involved in explosion and fire. ● **examples of facilities** analyzed include single family housing • mid-rise apartment buildings • industrial facilities.

CHEMICAL AND GASES, AND ASSOCIATED ACCIDENTS ● Work in this area generally covers contact with chemicals and gases which results in injury and/or property damage, and chemical explosion (a rapid uncontrolled chemical reaction) which results in injury and/or property damage. Work in this area generally determines whether containment systems or packaging for chemicals and gases were defective in design, manufacture or installation in regard to safety, and/or lacked adequate warnings; or, whether the manner that chemicals or gases were used was hazardous, and whether the hazardous use of the chemicals was due to the instructions for use, deviation from the instructions for use, or as a result of a lack of safe instructions for use. Reconstruction of accidents involving chemicals and gases determines whether such chemicals and gases caused or contributed to an accident. Work in this area also generally includes determining whether revision of the packaging, containment, method of use and/or the instructions for use was required for safety. ● **examples of chemicals, packaging and containments** analyzed include: household cleaning chemicals in bottles • industrial and commercial cleaning chemicals in barrels • and, industrial and commercial cleaning chemicals used in cleaning equipment at the time of accident.

TRAFFIC ACCIDENTS, INCLUDING TRAFFIC CONTROL DEVICES AND ROADWAY DESIGN ● Work in this area generally covers investigating and reconstructing traffic accidents, to determine how the accident happened and how the factors in the accident were related to the causation of the traffic accident, including roadway design, roadway condition and traffic control devices.

EXAMPLES OF TYPES OF TRAFFIC ACCIDENTS HANDLED

- Single vehicle accidents and two vehicle collisions: at various angles, such as: head-on, rear-end, sideswipe, intersection, and at other impact angles between the vehicles.
- Accidents involving more than two vehicles with chain collisions.
- Accidents involving out-of-control slides and yaws.
- Accidents involving rollovers and/or launches, including off embankments.
- Accidents involving off-road travel, intended or unintended, and abrupt change in travel surfaces.
- Accidents involving adverse roadway conditions and road-edge dropoffs.
- Collisions between vehicles and pedestrians or bicycles.
- Collisions between motorcycles and other vehicles.
- Collisions between vehicles or bicycles and railroad trains at roadway-railroad grade crossings.
- Accidents involving multiple collisions between the same vehicles.

EXAMPLES OF VEHICLES INVOLVED IN ANALYZED TRAFFIC ACCIDENTS

- Automobiles • pick-up trucks • vans • utility vehicles.
- Motorcycles • off-road motorbikes • bicycles.
- Articulated truck assemblies, including tractor trucks with semi-trailers and trucks with independently supported trailers.
- Large non-articulated trucks, such as garbage trucks, dump trucks and tank trucks, including those with tandem (two rear) axles and triaxle (three rear) axles.
- School buses • city buses • railroad trains.
- Agricultural equipment, including farm tractors and trailers

EXAMPLES OF ACTIVITIES PERFORMED FOR ANALYZED TRAFFIC ACCIDENTS

- Accident site inspection, measurement and photography.
- Inspection, measurement and photography of damaged vehicles and vehicle components, including lamps and lamp filaments to determine if lamps were on at collision.
- Sight distance and nighttime visibility studies.
- Skid testing of vehicles and determination of "drag" factors.
- Sight photogrammetry • graphical photogrammetry from photographs.
- Evaluation of roadway surface condition, skidmarks, yawmarks, scuff marks, other tiremarks, gouges, other roadway and off-roadway surface damage, and debris.
- Evaluation of vehicle and vehicle component damage, including evaluation of vehicle lamp and lamp filament condition to determine if lamps were on at collision.
- Evaluation of mechanical injuries to pedestrians and vehicle occupants.
- Evaluation of roadway design and pre-accident condition (for safety) and traffic control devices, such as lane lines, warning and other signs, traffic control lights and other signals (for suitability).
- Preparation of scale site drawings and use in accident analysis.
- Data Analysis of Crash Data Retrieval (CDR) data from involved vehicles
- Determination of the pre-collision movements of vehicles and pedestrians in relation to time, distance and each other.
- Analysis of the movements (dynamics) of vehicles, pedestrians, and vehicle occupants, relative to each other, during accidents.
- Determination of acceleration and maneuverability capabilities of vehicles, particularly related to possible accident activities.
- Complete traffic accident reconstruction, both manually and by computer, to address the required

issues.

EXAMPLES OF ISSUES ADDRESSED FOR ANALYZED TRAFFIC ACCIDENTS

- Speeds of vehicles at various points before and during an accident.
- Locations of vehicles, pedestrians, bicycles, etc., before and at various times during an accident.
- Sight distance, nighttime visibility and weather-impeded visibility.
- Appropriateness of roadway design and traffic control devices (such as lane lines, warning and other signs, and traffic control and pedestrian control signals), and their relation to an accident.
- The relation of the condition of roadway facilities to an accident.
- Answers to questions, such as:
  - Were all vehicles moving at collision? If not, which ones were?
  - Did vehicles stop at stop signs or red lights before collision?
  - Which vehicle was left of center first, and at collision?
  - Which vehicle occupant was driving when the accident occurred?
  - Were the headlights and/or other vehicle lights on at collision?
  - The accident causation, the relation of the accident factors to the accident causation and whether or not the accident could have been avoided.

EXAMPLES OF EQUIPMENT, SYSTEMS, AND FACILITIES DESIGNED AND SPECIFIED WHILE IN INDUSTRIAL OPERATIONS AND DESIGN ENGINEERING - 1966 through 1983

- Piping and tubing ranging from approximately 1/4 inch to 48 inches in diameter; for water, steam, pneumatic and hydraulic systems, gases, chemicals, etc.
- Valves ranging from approximately 1/4 inch to 48 inches in size - including hand-controlled, remote-controlled (with electrical, hydraulic or pneumatic control and power), and automatically controlled

  valves (with electrical, hydraulic or pneumatic control and power) - including gate valves, globe valves, needle valves, butterfly valves, ball valves, rotary valves, etc.
- Safety and overpressure relief valves • rupture discs • overpressure blowout panels • etc.
- Complete overpressure relief systems and complete hazardous chemical (liquid and gas) relief systems, including the associated piping, valves and instrumentation.

- Surface and open subsurface drainage and spill containment systems, including the grading and surfacing and the trenches (flumes).
- Gravity and pressure sewer systems.
- Liquid and solid waste disposal facilities, including flotation and settling clarifiers.

- Control systems - including automatic and manual control systems - including local and remote control systems - including pneumatic, electrical and hydraulic control systems, including those specifically designed to assure the safety of the operation of equipment and systems.
- Fire suppression systems, including water, foam and inert gas systems.
- Ground flares and elevated flare stacks for burning hazardous gases and liquid chemicals.
- Non-burning vent stacks for disposal of non-hazardous gases to meet EPA anti-pollution regulations.

- Gas blowers • fans • ejectors • etc.
- Compressors (for gases, including air and nitrogen) - including centrifugal, reciprocating and screw compressors.
- Pumps (for liquids, including water and chemicals) - including centrifugal, positive displacement,

sump pumps, etc.
- Vacuum pumps (for gases - creates and maintains a vacuum).
- Turbines, motors, and engines to drive machinery - including steam-driven and gas-expansion turbines, electric motors, and gas-fired and oil-fueled engines. Machinery driven includes compressors, pumps, blowers, conveyors, plastics processing equipment, and similar powered equipment.
- Steam and electricity co-generation systems (which generate steam and electricity at the same time).
- Furnaces • direct-fired boilers • waste-heat boilers (including steam generators) - including their safety instrumentation, control instrumentation, and fuel and piping systems.
- Heaters and heat exchangers - including liquid to liquid, liquid to gas and air, gas and air to gas and air - including shell and tube, double pipe and multipipe, plate and bayonet heat exchangers - including air coolers, tank coils, vessel jacketing, kettle reboilers, thermo-siphon reboilers, etc.
- Refrigeration systems - including machinery (compressors, etc.), controls, safety systems and piping.
- Dryers for solids - including rotary, fluidized bed, spray dryers, etc.
- Dehumidifiers to remove liquids from gases.
- Pressure and vacuum vessels and tanks (liquids and gases).
- Atmospheric storage tanks (liquids) and storage bins (solids, particulates).
- Distillation, absorption and solvent extraction columns - including trayed and packed columns.
- Plastics compounders, extruders, choppers, and similar plastics processing equipment.
- Conveyors - including belt, pneumatic, screw and bucket conveyor, etc.
- Liquid and gas filters and bag houses • impingement separators • cyclone separators • etc.
- Traveling cranes, winches, etc.
- Control systems • signage, including warning signs • control system layouts • alarm panel layouts.
- Equipment and machinery layouts • building and structure specifications.
- Materials of construction for piping, equipment, machinery, etc.

EXAMPLES OF ENGINEERING DESIGN PROJECTS HANDLED WHILE IN INDUSTRIAL OPERATIONS AND DESIGN ENGINEERING - 1966 through 1983

SAFETY DESIGN, INCLUDING SPECIAL SAFETY SYSTEMS

- Safety design: a routine, integral part of the design of all industrial and manufacturing equipments and facilities
- Pressure relief systems for numerous industrial and manufacturing facilities.
- Gas and liquid burning flare stacks for numerous industrial and manufacturing facilities.
- Fire suppressant systems, including water, inert gas and foam systems for several facilities.

AIR AND WATER POLLUTION DESIGN

- Gas vent stacks for numerous industrial and manufacturing facilities.
- Water pollution control design for an acrylonitrile manufacturing.
- Water pollution control facility for a high density polyethylene manufacturing facility.

UTILITY SYSTEM DESIGN (steam, water, plant and instrument air, nitrogen, etc.)

- Utility distribution facilities design (piping and instrumentation) for numerous industrial and manufacturing facilities.
- Utility production facilities design for the production of steam (boilers), water, plant and instrument air, nitrogen, etc. for use in:
- a petrochemical, utilities and storage complex, a large group of industrial, manufacturing, utilities

and storage facilities.

- a lube oil manufacturing facility
- a substitute natural gas (SNG) manufacturing and storage facility.
- a pharmaceutical manufacturing facility.
- a polystyrene manufacturing facility.

INDUSTRIAL AND MANUFACTURING FACILITY DESIGN

- Grassroots" (totally new, starting with the ground preparation) plastics manufacturing facilities including: (1) low density polyethylene manufacturing facilities; (2) polypropylene manufacturing facilities; (3) a polystyrene (styrene) manufacturing facility; and, (4) extrusion and compounding facilities (used to knead plastics) for grassroots high density polyethylene manufacturing facilities.
- Petroleum processing facilities including: (1) a lube oil manufacturing facility; (2) a crude oil topping facility; (3) a naphtha reforming (reformulation) facility; and, (4) a gas oil separation facility with stabilization.
- Chemical production grassroots facilities including: (1) herbicide manufacturing facilities; (2) ethyl hexanol manufacturing facilities; (3) a MTBE and paraxylene absorption manufacturing facility; (4) a MTBE and Dimersol manufacturing facility; (5) a Benzene hydrofining unit; and, (6) a fire retardant manufacturing facility.
- Natural gas processing grassroots facilities including: (1) a natural gas processing facility and export terminal; (2) an underground peak shaving natural gas storage facility; (3) a natural gas saturates facility; and, (4) a natural gas and hydrocarbon liquids processing facility.
- Downsizing and modernization of: (1) a natural gas separation facility; and, (2) a natural gasoline facility.
- Tank farms (a large number of large tanks and associated equipment, piping and instrumentation in a stand-alone facility) for: (1) a facility for revaporization of liquified natural gas; and, (2) for a facility to produce substitute natural gas (SNG).
- Renovation of solvent recovery and refining facilities for a high density polyethylene manufacturing facility.
- Dry ice expanded tobacco manufacturing facility.

EXAMPLES OF OTHER TECHNICAL ACTIVITIES HANDLED WHILE IN INDUSTRIAL OPERATIONS AND DESIGN ENGINEERING - 1966 through 1983

- Conducted equipment operational testing in manufacturing facilities.
- Performed industrial operation studies in manufacturing facilities, including studies to develop the data required to design additional similar facilities.
- Performed drainage studies in industrial and manufacturing facilities to develop the data required for the design of surface facilities and trenches/flumes and sewers for the drainage required.
- Designed specialized safety and air pollution control systems, including flares, vents, foam fire protection systems and the like.
- Assisted with construction of industrial and manufacturing facilities, including providing technical assistance to Construction personnel at the construction site and providing construction site engineering design services and supervision of construction.

- Participated in the startup and commissioning of manufacturing facilities.
- Designed and presented courses to Design Engineers covering the design of safety relief devices and safety relief systems.
- Organized and supervised the writing of Design Manuals for equipment, machinery, piping, valving and instrumentation to meet applicable codes and a Design Manual for the design of boiler systems to meet the ASME Boiler Code and other applicable codes.
- Assured the technical quality of engineering designs, especially of the safety design of equipment and facilities, design of safety facilities and warnings; through hands-on reviews and formal technical reviews and approvals of engineering designs of industrial and manufacturing facilities, piping, valving, instrumentation, equipment and machinery.
- Made use of industry, technical society and government codes, standards and recommended practices extensively during design of industrial and manufacturing facilities, piping, valving, instrumentation, equipment and machinery, and advised and instructed others on the proper use of these Codes in their design, particularly assigned engineers.