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SUMMARY 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 condition, and traffic control devices; consumer product and industrial equipment accidents, including guarding and warnings; chemical and gas accidents; fires, explosions and CO poisonings; commercial and industrial facility accidents, and construction accidents; and building and property accidents, including slips, trips and falls. Typical services 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 place of written reports, when so requested, or in response to motions; testimony in **over 90 discovery depositions;** and, testimony in **over 75 trials**. The Forensic Practice has also included verbal reports in place of written reports, when so requested; 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 doing 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 **consumer products and equipment**, 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 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 equipment and consumer products, including hands-on inspection of the consumer products, and hands-on inspection of involved 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 and production 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, gases and materials, including hands-on inspection of, and experimentation with, involved chemicals, gases and materials.

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 for use of fire, including flares, furnaces and boilers, and to prevent fire, including fire fighting systems and fire and explosion suppression systems, 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 45** incidents involving fires, explosions and/or hazardous combustion, including incidents leading to carbon monoxide poisoning, with 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 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 the 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 10 courses, over 9-1/2 (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 in forensic practice, including hands-on inspections of involved vehicles and accident sites.

Qualifications for use of **Human Factors** in analysis of accidents and 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, FORENSIC ENGINEER CERTIFICATION, CRASH DATA RETRIEVAL (CDR) CERTIFICATION

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.

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.

Certified as a Crash Data Retrieval (CDR)[1] Technician 1 and a Crash Data Retrieval (CDR)[1] Technician 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.

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 and LISTINGS

Have been inducted into Sigma Pi Sigma National Physics Scholastic Honor Society; Tau Beta Pi National Engineering Scholastic Honor Society; and, Sigma Xi National Research Honor Society ● **Have been a recipient of** a National Science Foundation Undergraduate Research Grant and a NASA Fellowship for Graduate Study ● **Have been listed in** Marquis' Who's Who in Science and Engineering and 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

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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.

(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); and,
2012: (10) Crash Data Retrieval $(CDR)^2$ Data Analyst Certification.

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 3 Engineering Seminars presented by the National Academy of Forensic Engineers

2008 through the 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 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 section titled "**Primary Areas of Forensic Practice**" 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

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

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 sections in this Curriculum Vitae titled "**Qualifications Summary**" and "**Examples of Issues and Accidents Handled in Forensic Practice, and Facilities and Equipment Associated with These Accidents**". For more details beyond that contained in this Curriculum Vitae, request a copy of the Detailed Curriculum Vitae.

PROFESSIONAL EXPERIENCE BETWEEN 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** and the **engineering design** of industrial facilities, as well as, in engineering consulting and construction assistance. **Designed and specified machinery, vessels, piping, instrumentation, and other industrial equipment and facilities**, for: the manufacture, storage and transportation of chemicals, pharmaceuticals and plastics; the production, storage and distribution of natural gas and its components; the production, storage and transportation of petroleum products; the treating and disposal of industrial wastes; the production and distribution of utilities, including instrument air, plant air, nitrogen and steam. Designed and specified machinery, vessels, piping, instrumentation, and other equipment and facilities, for the protection of property, personnel, and the environment, from equipment and machinery hazards and failures, from fires and explosions, from vessel and piping overpressure and failures, and, from gas, liquid and solid discharges to the atmosphere, through both prevention of the hazards and control of the consequences of the hazards. **Designed facilities to provide and assure safety**, including pressure relief equipment and systems for gases and liquids; fire protection and suppression systems, including water and foam systems; and, ground flares and elevated flare stacks for burning hazardous materials.

Conducted **operational testing** of machinery and other equipment in industrial facilities, as part of the design process. Conducted **industrial operation studies** in manufacturing facilities, including studies to develop the data required to design additional facilities. 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 changes; Participated in **startup and commissioning** of manufacturing facilities; Designed and presented **courses** on technical subjects to design engineers. 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 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. **Assured the technical quality of engineering designs, especially of safety design, 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. Conducted audits of designs, with special attention to the safety of such designs, and approved such designs. Used and interpreted industry, technical society and government **codes and standards** extensively during design of industrial facilities, piping, valving, instrumentation, equipment and machinery, and advised and instructed other engineers on the proper use of these Codes in their design.

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

Request a copy of the Detailed Curriculum Vitae for examples of Equipment, Systems and Facilities designed while in Industrial Operations and Engineering Design, as well as a **detailed employment history** prior to 1983.

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 machine 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 products and equipment** analyzed include: infant products • recreational equipment • motor vehicles • household and residential maintenance and utility equipment • commercial equipment • construction, heavy maintenance and mining equipment • farm and garden equipment • industrial equipment ● Request a copy of the Detailed Curriculum Vitae for examples of specific equipment.

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 residences • multiple-family residences, including apartment buildings • retail stores • warehouses • industrial and manufacturing facilities • auditoriums • restaurants and lounges • outdoor facilities. ● **Examples of features and fixtures** 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 • other exterior walking surfaces • and, features and fixtures nearby, on, or within the above listed features.

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 on the **Detailed Curriculum Vitae**) • 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 • laundry • restaurants • scrap salvage facilities • outdoor storage facilities • and, similar industrial and commercial facilities. ● **Employees and non-employees**: Analyses have been done 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 • residential and recreational equipment • industrial and commercial facilities. ● Request a copy of the Detailed Curriculum Vitae for examples of specific equipment

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, such as furnaces**,** but which create severe hazards from the combustion, 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 system 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 • multi-family housing, including 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 chemicals in bottles, including cleaning and drain-opening chemicals • industrial and commercial chemicals in large size containers • industrial and commercial chemicals in application equipment.

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; involving out-of-control slides and yaws; involving rollovers and/or launches, including off embankments; involving off-road travel, intended or unintended, and abrupt changes in travel surfaces; involving adverse roadway conditions and road-edge dropoffs • accidents: between vehicles and pedestrians or bicycles; between motorcycles and other vehicles; between vehicles or bicycles and railroad trains at railroad grade crossings. • accidents involving multiple collisions between the same vehicles. ● **Examples of vehicles involved in traffic accidents handled:** 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 traffic accidents:** accident site inspection, measurement and photography • inspection, measurement and photography of damaged vehicles and vehicle components, including lamps and lamp filaments • 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 • 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 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 • 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 and the relation of the accident factors to the accident causation, and whether or not the accident could have been avoided.