LONGENECKER and ASSOCIATES

EXPERIENCE SUMMARIES FOR KEY PERSONNEL

Raymond Crawford, Ph.D., P.E.

EXPERIENCE SUMMARY

Dr. Crawford has over 30 years of diverse Management, Engineering, Licensing, Safety and Operations experience in the nuclear industry. Ray has supported licensing of nuclear facilities, as well as site remediation, interim storage and disposal of nuclear materials; he has established design and operation guidelines for the development and implementation of NRC and DOE licensed activities; he has performed safety reviews and compliance inspections of nuclear facilities for power production as well as the storage of waste materials; and he has worked with engineering designers, plant operators and senior management to ensure compliance with regulatory requirements in design and operations. Ray successfully integrates objectives, opportunities and resources to complete projects on-time and within budget. He communicates clearly and concisely. He has the leadership ability to build multi-disciplinary teams that generate and effectively implement solutions to complex technical issues. Dr. Crawford is experienced in Safety Analysis and relevant DOE and NRC regulatory requirements. He is a registered professional engineer in Illinois with diverse project engineering, safety analysis and regulatory experience.

RELEVANT SKILLS

Dr. Crawford successfully demonstrated the skills and capabilities summarized below during his work assignments for nuclear facilities:

- Safety reviews for hazard identification and screening evaluations, Accident Analysis, preparation of preliminary and final Safety Analysis Reports, and development of scenario consequences.
- Evaluation of fissile material operations, preparation of Criticality Safety Analyses, and performing field inspections.
- Performed qualitative accident analyses, developed and evaluated design basis events, performed quantitative accident analyses, selection of work controls, and performed analyses of safety structures, systems, and component (SSC).
- Prepared preliminary and final Hazard Evaluation Reports for chemically hazardous facilities.
- Prepared annual updates to Safety Analysis Reports. Implemented improvements in the safety review process and provided training to engineering staff.
- Performed probabilistic risk assessment of engineered systems and operations. Analysis of event consequences required application of complex atmospheric transport models.
- Trained and experienced in the use of engineering analysis processes (e.g., fluid flow, heat transfer, chemical reactions and materials science).
- Developed project concept; defined project scope of work; estimated project cost; estimated project schedule with intermediate milestones; designed and/or oversee testing, Installation, and repair of equipment; project execution with safety first, quality always and on-time delivery.
- Analyze contracts; control expenditures; approved design changes; coordinate and direct planning of engineering projects; assist workers engaged in engineering and/or construction projects to assure contract and regulatory compliance.
- Accept responsibility for quality work performance; deliver excellence in assigned tasks; strive for continual process improvement; respond positively to constructive change.

DETAILED EXPERIENCE

As Senior Consultant for Longenecker & Associates, Dr. Crawford supports the United States Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM) by providing Systems Engineering, Project Management, and Process Safety expertise to the DOE Team. As a member of the Sandia Lead-Lab Team, Ray supports the Quality Assurance transition effort for scientific activities at the Repository. At the Office of National Transportation (ONT), Ray works to define, implement, and control Project requirements. At the Office of Repository Development (ORD), Ray performs safety reviews of surface facility design and operation as documented in the Safety Analysis Report License Application for the Yucca Mountain Project. Ray supports the DOE Team and contractor Staff on Task Team evaluation of critical issues involving nuclear criticality, technical specifications, handling used fuel in air environments, and evaluation of alternate surface facility designs.

As Manager of Nuclear Safety for Fluor Hanford on the Spent Nuclear Fuel Project, Dr. Crawford demonstrated leadership to develop and execute processes, procedures, analyses and client relationships necessary to assure safe, compliant project operation and activities during remediation activities. This responsibility includes identification of accident scenarios, analysis of external events, nuclear criticality analyses, preparation of safety analysis documents, and other tasks supporting construction, and facility operations. As Manager, Nuclear Safety, Ray provided project leadership during the transition to newly approved 10 CFR 830, Subpart b, safety management requirements. These first-of-a-kind activities at Hanford, approved by DOE, resulted in significant project schedule achievements and cost savings.

As Manager of Nuclear Criticality and System Safety for Fluor Fernald, Dr. Crawford demonstrated leadership to develop and execute processes, procedures, and analyses to assure safe, compliant project activities during various phases of site remediation. This responsibility included: Accident investigations, Identification and analysis of accident scenarios, preparation of safety analysis documents; Safety analyses of hazardous activities; Development of a Basis for Interim Operations approved by the Department of Energy, including the downgrading of five nuclear facilities below Hazard Category 3, elimination of unnecessary nuclear criticality controls, elimination of unnecessary site procedures, and implementation of a process for maintaining the approved authorization/safety basis. Ray was a key participant in the development of a site report for the control of fugitive dust during remediation activities, and a Nuclear Criticality Evaluation report of the Fernald site waste containing enriched uranium. Ray performed safety analyses to evaluate the potential consequences of the pyrophoric behavior of uranium and thorium metal during handling and processing. These first-of-a-kind activities at Fernald, approved by DOE, resulted in significant project schedule achievements and cost savings.

As Project Director at Fluor Daniel, Dr. Crawford directed projects, performed safety analyses, and provided expert witness testimony supporting Utility construction costs. Ray provided consultation for development and implementation of Reliability Centered Maintenance programs at Utility nuclear power plants; and provided nuclear licensing support for major plant modifications. Ray was responsible for the development and implementation of in-house programs to review and evaluate equipment failure rates for improvements to current nuclear projects. Ray provided NRC licensing support for major modifications. He planned and implemented in-house Quality Assurance Management audits of engineering operations, and Safety Audits of Department of Energy projects. Dr. Crawford was responsible for developing strategic plans for marketing engineering services and maintaining client relations. These activities resulted in more than $5 million in revenue for Fluor Daniel.

As Project Director at United Engineers & Constructors, Dr. Crawford directed projects to develop and implement utility engineering programs for (1) control of design, installation, and

testing of modifications at operating nuclear stations, (2) control of construction drawing releases, (3) an integrated approach to the design and construction of plant facilities and modifications, and (4) budgetary cost estimates for corporate facility improvement and modification programs. He directed projects for the conceptual design of four utility service buildings, including the pre-architectural space planning. Ray was responsible for coordinating the marketing of engineering services, as well as development and maintenance of client relations. These activities resulted in $1 million in revenue for United Engineers & Constructors, Inc.

As Engineering Director at UE&C, Dr. Crawford supervised multidisciplinary engineering groups, including Mechanical, Civil/Structural, Architectural Design, Electrical, and Instrumentation and Control, engaged in design of nuclear plant modifications. He provided technical expertise, knowledge of safety and regulatory requirements and management oversight to the design, construction, and testing of plant modifications. Ray provided leadership for the Engineering team during this new field office start-up operation.

As Operations Manager at NUTECH Engineers, Dr. Crawford was responsible for management, marketing and business operation of a 75-person engineering and computer services office in Chicago, IL. Ray developed and implemented service contracts, budgets, invoicing, business and marketing plans for an operation with annual revenues of 5.6 million dollars. As an external member of a utility's Nuclear Review Board, reporting to the utility Vice President of Nuclear Operations, he conducted performance-based assessments of fire protection, radiological environmental monitoring, quality assurance, technology transfer, and emergency preparedness. He was responsible for coordinating the marketing of engineering services, as well as maintenance of client relations. Ray provided leadership for this field office during difficult business consolidation transitions.

As Engineering Director at NUTECH Engineers, Dr. Crawford supervised multidisciplinary engineering groups, including Mechanical, Electrical, and Welding and Materials, engaged in nuclear plant modifications. He provided licensing support for plant modification design and assisted in resolution of licensing issues by working with regional and national NRC offices. Ray's leadership in broadening the scope of Nutech engineering services significantly benefited the Company and helped stabilize field office operations.

As Operations Manager at Science Applications, Inc., Dr. Crawford was responsible for management, marketing and business operations of a 25-person engineering and computer services office. He identified, developed, and implemented service contracts, budgets, invoicing, business and marketing plans for an operation with annual revenue of two million dollars. Ray was responsible for PRA analysis of nuclear power systems; the evaluation of mini-computer systems for real-time data acquisition and graphics display of nuclear plant operation conditions, radiation dose monitoring and dose projections; the assessment of postulated pipe breaks, e.g. erosion/corrosion programs, potentially affecting the function of safety and non-safety systems, and the development of analytical models and test programs to demonstrate safe, reliable relief valve performance. Ray provided NRC licensing support and assisted in resolution of licensing issues by working with utility staff, as well as regional and national NRC offices. Ray was responsible for coordinating and marketing of engineering services and maintaining client relations. His leadership in broadening the scope of SAIC engineering services significantly benefited the Company and helped stabilize field office operations.

As Associate at Sargent & Lundy, Dr. Crawford supervised 30 engineers responsible for safety analysis and licensing support for containment, balance of plant and engineered safeguards systems at more than twelve nuclear plant sites having reactors of BWR and PWR design. He was responsible for benchmark and implementation of a fuel management computer program

evaluating the fuel cycle for commercial nuclear power plants, as well as other proprietary computer programs used for safety analysis of system transients. As Chairman of the Mark II Containment Utility Owners Group Technical Steering Committee (a national utility owners group), he led development of analytical methods and confirmatory test programs for containment loads resulting from safety/relief valve discharge and post-LOCA suppression pool dynamics. Ray provided Nuclear Regulatory Commission (NRC) licensing support, assisted in the resolution of licensing issues and presented licensing positions to the NRC Staff, the Advisory Committee on Reactor Safeguards (ACRS) and the Atomic Safety and Licensing Board (ASLB). These assignments resulted in NRC approval, thus allowing plant operations to begin with minimum delay.

Dr. Crawford worked at several National Laboratory Agencies. Ray was responsible for applied research in predictive analytical modeling of fuel element failure propagation during normal and abnormal nuclear system transient conditions, and developed analytical methods for safety and system analysis of the sodium cooled fast breeder reactor (LMFBR). Ray lead the development of event and fault trees to identify fuel element failure modes, developed thermal-hydraulics computer program to predict flow conditions in fuel bundles, thermodynamic properties of sodium at high temperature and pressure conditions, performed risk assessment of selected systems and components, evaluated hydrogen-cooled nuclear rocket propulsion systems and developed probabilistic fracture mechanics models to predict failure modes of components. Ray tested the effects of impulsive loads on fuel subassembly housings and evaluated both in-reactor and out-of-reactor test data to confirm analytical models and to investigate potential accidents sequences.

EDUCATION

- University of California (Los Angeles), Ph.D., Engineering
- Wayne State University, M. S., Chemical Engineering
- Wayne State University, B.S., Chemical Engineering

PROFESSIONAL LICENSES/CERTIFICATES

- Professional Engineer, Illinois, Certification 62-36744
- Licensed Reactor Operator, Research Reactor, OP-2425 (currently inactive)

PROFESSIONAL ASSOCIATIONS

- American Chemical Society
- American Institute of Chemical Engineers
- American Nuclear Society
- National Society of Professional Engineers

AWARDS

- National Science Foundation Faculty Fellowship
- Atomic Energy Commission Special Fellowship
- Annual Achievement Award, Analog Computer Users Group
- Faculty Advisor Award, Engineering Society of California State University
- Carr Award for Teaching Excellence, Wayne State University
- American Chemical Society, Student of the Year
- Tau Beta Pi National Essay Award
- R.C. Mahon Scholarship