Ronald D. Willoughby, PE

Position:	**Executive Consultant**
Years' Experience:	45+
Education:	Honorary Professional Degree of EE – University of Missouri-Rolla (MO Univ. of Science & Tech)(MS&T) Post Graduate Studies – Carnegie-Mellon Univ (CMU) MSEE Power Engineering – Carnegie-Mellon Univ. BSEE – University of Missouri-Rolla (UMR) Professional Engineer (PE) License – Pennsylvania

Key Qualifications:

Distribution Grid Modernization Planning: Systematic/incremental addition of smart grid devices; with technology, performance, and cost central to the planning process.

Renewables Integration and Impact on Utility Grid: Power system analysis/operation, architecture, configurations, distributed generation strategies, market analysis, portfolio analysis, wind power and PV integration.

Conservation Voltage Reduction (CVR): Using smart grid data points and controllable VAR sources to regulate distribution voltages in near real time to reduce demand, lower peaks (kW), and save energy (kWh).

Transmission & Distribution Planning: Power flows; reliability analysis; transient & long-term stability; load shedding; reconfiguration schemes; contingency analysis; root cause analysis; distributed generation; energy storage strategies; protection/coordination; systematic replacement/upgrade strategies; and special protection systems (SPS).

Advanced Protection, Automation & Control: Sensor, communication, sectionalizing, controllable VAR sources, voltage control, expert systems, demand, and energy reduction application strategies.

Distribution Substation Design and Specifications Review: Modular Integrated Transportable Substation (MITS) application, design, specification, and implementation; renewables integration; volt/VAR control; substation upgrades; and distribution automation/protection strategies.

Patents & Publications

Earned U.S. Software Patent 6549880 for *Improving Reliability of Electrical Distribution Networks* (2003).

More than 60 publications relating to electric power systems analysis and operation.

Project Types

Distribution Grid Modernization Planning: Systematic/incremental addition of smart grid devices; with technology, performance, and cost central to the planning process.

Conservation Voltage Reduction (CVR): Using smart grid data points and controllable VAR sources to regulate distribution voltages in near real time to reduce demand, lower peaks (kW), and save energy (kWh).

Renewables Integration: Main substation, collector systems, protection and control.

Power System Energy Use: Technical and non-technical loss evaluation and improvement measures; with specific expertise in island power systems.

Power System Automation: Application of sensor/communication packages, sectionalizing equipment, and SCADA systems to achieve performance targets.

Power System Reliability: Preventive actions and sectionalizing strategies to achieve reliability performance targets.

Power System Protection: Protection/coordination; systematic replacement/upgrade strategies.

Root Cause Analysis (RCA): For unexplained electric power system events.

Knowledge Management: Use cases for technical procedures associated with power system analysis/operation, expert systems, architecture, and configurations.

Project Management: Transmission analysis, distribution analysis, system protection, and reliability improvement.

Training: Power system design, reliability, protection, stability, and operation.

Representative Project Experience

Conservation Voltage Reduction (CVR)

- Project Manager and Technical Lead for Commonwealth Edison Company (ComEd) feasibility study to quantify energy and demand savings using distribution Voltage Optimization techniques. Objectives: 1) Minimize cost by initiating feeder upgrades to achieve minimum performance thresholds. 2) Maximize energy savings by optimizing performance while staying within Total Resource Cost (TRC) constraints.
- Co-Instructor of CVR workshop customized to meet specific ComEd engineering and energy efficiency department needs.
- Co-founder of a CVR Industry Consortium to guide CVR research, work with industry groups, develop policy recommendations, promote implementation strategies, and document the results.
- Technical lead for project commissioned by DOE to conduct a comprehensive study across the USA on CVR, including deployment strategies, costs, benefits, barriers, and potential solutions, through a broad market outreach effort.

Advanced Protection, Automation, & Control for Transmission & Distribution

- Co-Chaired (with the Director of R&D at We-Energies) Distribution Vision 2010 LLC (DV2010), a consortium of Investor Owned Utility (IOU) companies. Mission: To create and execute a roadmap of equipment and service requirements important to cost-effectively operating a reliable electric distribution system; 2002-2006. DV2010 was accountable to CEOs and CFOs of member utilities.
- Led EPC and turnkey solutions in support of electric utility companies for electrical distribution automation, medium voltage modular substations (distribution centers), and wind farm electrical distribution systems (from the base of the turbine towers through interconnection to the utility grid); 1985-1988.
- Invited by the Director of Power & Energy Initiative at the University of Pittsburgh to be an Instructor for a graduate course on Smart Grid Technologies & Applications. Subject: Substation Automation and Protective Relaying; on-going.
- Participated in U.S./Canada Power Outage Task Force led by the Department of Energy (DOE), Natural Resources Canada, and the North American Electric Reliability Council (NERC) created to study the blackout of August 14, 2003, the largest electrical outage event in U.S. history.
- Led comprehensive Root Cause Analysis (RCA) for PJM executive management in response to a July 1999 low voltage condition stemming from record peak loading conditions on the bulk transmission system. Proactive corrective measures prevented future occurrences.

Renewables Integration and Impact on Transmission & Distribution Systems

- Invited by Prime Minister of Curacao to represent USA in 1st Annual Durable Energy Conference in Curacao to address renewables integration issues for the transmission and distribution system; March 2012.
- Invited by CEOs of Wind-2-Power-Systems (W2PS) and Hudson Energy to represent USA for conference in Madrid to cover PV integration, grid integration, energy storage, and DC infrastructure issues; February 2012.
- Invited by CARILEC to chair two sessions on Transforming the Electricity Grid at the Renewable Energy Forum, St Thomas, U.S. Virgin Islands; September 2011. CARILEC represents CEOs, COOs, and CFOs for 33 island utilities in the Caribbean.

Transmission & Distribution Planning

- Led distribution grid modernization planning efforts, focused on systematic and incremental addition of smart grid devices, with technology, performance, and cost central to the planning process
- Led EPC and turnkey solutions for electric distribution automation, medium voltage modular substations (distribution centers), and wind farm distribution systems (from base of turbine towers through interconnection to utility grid). Accountable for success of these focused areas when measured against sales and margin goals, internal and

external budget constraints, and overall customer satisfaction. Routinely augmented internal direct staff with external resources according to project needs. Matrix managed project teams to effectively utilize project resources.

- Co-founder of industry-wide consortium focused on strategic, business, regulatory, and technical issues associated with Conservation Voltage Reduction/Regulation (CVR) at investor-owned utilities, electric cooperatives, and municipals.
- Managed commissioning and public relations for comprehensive distribution line installation in the city of Smolensk, Russia. Project was collaborative effort between U.S. Trade & Development Agency (TDA) and Cooper Power Systems (CPS); 2002-2004.
- Developed distributed CVR measures to conserve energy and reduce overall losses without compromising end-user reliability or power quality.
- Developed emergency generation integration strategies for major industrial complexes in the USA.
- Conducted comprehensive seminar on electric power systems for the Ministry of Water and Power in Peking, China; 1984.
- Performed international power systems studies on power flow, transient stability, shunt compensation, load shedding, motor starting, loss formula development, short circuit, and protective device coordination; 1974-2000. Interfaced with Engineering Planning Managers.
- Led projects sponsored by the Pacific Power Association (PPA) for power system energy analysis and loss reduction on 20 islands in the South Pacific, 10 with U.S.-style power systems, and 10 with European-style power systems. Interfaced directly with CEOs and PPA throughout study.
- Taught Westinghouse Advanced School on Power System Stability; 1980-1988.

Professional Development Activities

NERC Compliance; IEC 61850; DMVP (DMEDI) Process Improvement; Professional Development Seminars on Management (Management Grid, Management Techniques, Team Building); Interpersonal Skills; Time Management; Managing the Software Project; Sales Techniques; SPIN Sales Training; Pricing Strategies; Finances; Technical Writing; Safety; Problem Solving & Decision Making; IEEE Seminars on Relay Coordination and Reactive Power Control; Root Cause Analysis; Reliability Analysis; Intellectual Property; Environmental Compliance; Corporate Ethics; Toastmasters International.

Company Affiliations

Willoughby Consulting, Raleigh, NC (2012 to Present)

Executive Consultant, Electric Power Systems Planning & Operation - Owner

Modular distribution substation application, specification, and implementation. Quantifiable Conservation Voltage Reduction (CVR) assessments for energy efficiency energy savings (kWh) and peak power reduction (kW); CVR application strategies. Emergency backup

power supply needs assessment and solution strategies for large industrial/commercial facilities. Portfolio analysis, go-to-market strategies, and operations support related to electric power systems. Specific service areas include transmission and distribution planning, renewables integration strategies, energy efficiency measures, system protection strategies, distribution automation schemes, data management, and business plan development.

River Consulting Group (RCG), Clayton, GA (2018 to Present)
Executive Consultant - Contract

Advisory services related to distribution grid modernization planning efforts involving systematic and incremental addition of smart grid devices, with technology, performance, and cost central to process.

ABB, Inc. (ABB), Raleigh, NC (2016 to 2017)
Executive Consultant - Contract

Advisory services related to distribution grid modernization planning efforts involving systematic and incremental addition of smart grid devices, with technology, performance, and cost central to process.

Advanced Microgrid Solutions (AMS), San Francisco, CA (2015 to 2017)
Executive Consultant - Contract

Advisory services regarding business strategy, competitive intelligence, and energy services pricing strategies related to the company's business development efforts.

Applied Energy Group (AEG), New Brunswick, NJ (2012 to 2015)
Principal, Executive Consultant - Contract

Energy efficiency (savings) analysis methods, project procurement, and project execution. Innovative applications of existing technologies to advance the art. Industry-wide investigations. Direct responsibility for project teams, including subcontractors.

Dell Innovation Services, Peoria, IL (2012 to 2014)
Vice President, Electricity Transmission & Distribution - Contract

Design and apply substations (including modular) for emergency power supply. Develop electrical site one-line diagrams and associated loading profiles. Conduct power demand audits.

KEMA, Raleigh, NC (2006 to 2012)
Vice President, Electricity Transmission & Distribution

Strategic leadership of the U.S. technical T&D practice in North America, focusing on client issues related to electric power system T&D planning, asset management, protection and reliability, advanced technology applications, and future power systems. Direct responsibility for team of 30 professionals.

Cooper Power Systems, Franksville, WI (1989 to 2006)
Director, Industrial Development & Technical Services Marketing; Manager, Systems Integration Solutions; Director, Thomas A. Edison Technical Center; Manager, Systems Engineering Group

Technical solution development for electrical distribution automation, substations, distribution operating centers, and wind farm integration. Accountable for sales, margins, budget, and customer objectives. Directed project teams to matrix manage overall resources (which included marketing, sales, and engineering staffs) to promote services, identify

opportunities, and secure business. Participated in strategic alliances and acquisitions. Managed high power laboratory (500 MVA short circuit generator), high voltage laboratory (2 million volts), and full materials laboratory, with direct responsibility for a team of 110 professionals. Managed group responsible for Modular Integrated Transportable Substation (MITS) application, design, specifications, implementation, and support (69 kV and below) (10 MVA and below).

Westinghouse Advanced Systems Technology, Pittsburgh, PA (1974 to 1988)
Manager, Transmission Planning Section; Manager, T&D Software Services

Responsible for a staff of 8 involved in the application of technical transmission and distribution software, including marketing and customer service.

Black & Veatch Consulting Engineers, Kansas City, MO (1971 to 1974)
Coop student while with the University of Missouri - Rolla

Professional Memberships

- IEEE – Life Senior Member
- IEEE Power Engineering Society – Senior Member
- IEEE Industrial Applications Society – Senior Member
- Phi Kappa Phi – Member
- Eta Kappa Nu – Member
- Tau Beta Pi – Member
- Kappa Kappa Psi – Member
- Wake County NC – Precinct Election Official (2017-2019)

Professional Recognition

2016 Achieved **Life Member** status for the Institute of Electrical and Electronics Engineers (**IEEE**).

2012-14 Invited **Instructor** for **University of Pittsburgh** graduate course on *Smart Grid Technologies & Applications*. Subject: *Substation Automation and Protective Relaying*.

2013 Co-Founder of an industry-wide ***CVR Consortium*** focused on increasing energy savings by resolving strategic, business, and technical issues preventing more wide-spread deployment by electric utility companies.

2012 Earned ***Order of the May*** honors recognition from Carnegie-Mellon University for more than 10 years of continous and consistent support. Citation includes these words: “This special order honors those who embody all the best characteristics for which the society was originally founded in 1947.”

2011 Invited **Chairman**, 2 Sessions, *Transforming the Electricity Grid*, **Carilec Renewable Energy Forum**, September 20-21, St. Thomas, U.S. Virgin Islands.

2003 Awarded ***Honorary Professional Degree of Electrical Engineering***, Univ of MO-Rolla (UMR), based on "outstanding professional and personal achievements"

2003 Elected **President**, *Academy of Electrical & Computer Engineers*, UMR

2001 Elected VP, *Academy of Electrical & Computer Engineers*, University of Missouri-Rolla

2001 Co-Chair, Steering Committee to develop **Distribution Vision 2010 LLC (DV2010)**, consortium of Investor Owned Utility (IOU) companies

2001 Appointed **Chairman**, Technical Paper Committee, USA National Committee, **CIRED**

2000 Appointed to ***Industry Advisory Council***, Rensselaer Polytechnic Institute (RPI), NY

1998 Appointed to ***Industrial Liason Council (ILC)*** for the College of Engineering and Applied Science, University of Wisconsin-Milwaukee

1997 Elected to ***Academy of Electrical & Computer Engineers***, University of Missouri-Rolla for "outstanding contributions to the profession of electrical engineering and for leadership in the community and profession." Requires minimum 20 years experience to qualify.

1991 Selected for **USA Trade Mission** on Electric Power to East Germany. Represented USA distribution equipment technologies. [E & W Berlin concrete wall fell Nov 1989]

1989 Appointed to ***Industry Advisory Council***, University of Missouri-Rolla (UMR).

1985 *Westinghouse* ***Engineering Achievement Award*** for "high level technical contribution to the development and implementation of profitable engineering courses in the Electric Utility and Industrial markets."

1985 ***Senior Member*** status for Institute of Electrical & Electronics Engineers (**IEEE**).

1984 Elected *Chairman* of the only **Quality Circle** in operation at Westinghouse Advanced Systems Technology (AST)

1982 Appointed to first ***Engineering Advisory Council*** for Westinghouse AST

1978 Earned ***PROFESSIONAL ENGINEER (PE) License*** from the Commonwealth of Pennsylvania

1972 Received *Outstanding Bandsman* award from Kappa Kappa Psi band fraternity

1969 **Valedictorian** and **Student Council President**, Grandview Senior High School

Publications

Ronald Dean Willoughby, PE

Willoughby, Ronald D, Bob Grant, and George Fandos. "Unbiased 360-Degree DER Evaluations and Assistance," EnergyCentral - Utility Professionals Group, April 20, 2020.

Willoughby, Ronald D. "Why Do It?," *EnergyPulse* from Energy Central – Intelligent Utility, March 21, 2018.

Willoughby, R., S. K. Gill, E, Zhang, J. Silvers. "Distributed Energy Resources Supporting Power Grid Reliability," CIGRE US National Committee, 2016 Grid of the Future Symposium, November 2016.

Willoughby, Ronald D. "Grid Modernization is Like Remodeling a House," Energy Central - Electric Power Systems Planning & Operation, July 20, 2016.

Willoughby, Ronald D. "The Power of Incrementalism," *EnergyPulse* from Energy Central - Communications & Security, February 10, 2016.

Willoughby, Ronald D. "Aging Workforce Presents Knowledge Management Opportunities," *EnergyPulse* from Energy Central - Human Resources, November 13, 2015.

Willoughby, Ronald D. "SEPB CVR Proposal Response Review," Report for AEG for TVA on behalf of SEPB, PO 916082, June 8, 2015.

Willoughby, Ronald D. "Distribution Automation and Conservation Voltage Reduction," *EnergyPulse* from Energy Central - Grid Operations; April 17, 2015.

Willoughby, Ronald D. "CVR Fundamentals," White Paper, January 5, 2015.

Willoughby, Ronald D., et al. "Final Report - Voltage Optimization (VO) Feasibility Study," AEG for ComEd VO Study, Contract No. 01146430, January 6, 2015.

Willoughby, Ronald D. "Order of the 9's," *EnergyPulse* from Energy Central - Grid Operations, June 2, 2014.

Willoughby, Ronald D. "Analysis Paralysis," *EnergyPulse* from Energy Central - Business Corporate, January 16, 2014.

Willoughby, Ronald D. "CVR and the Lost Revenue Conundrum," *EnergyPulse* from Energy Central, August 9, 2013.

Willoughby, Ronald D. "Time to Take a Second Look at Conservation Voltage Regulation?" *Intelligent Utility Update*, June 4, 2013.

Willoughby, Ron, Kellogg Warner. "Voltage Management: A Hidden Energy Efficiency Resource," GTM Research *Energy Efficiency Newsletter*, May 7, 2013.

Willoughby, Ron, Kellogg Warner. "Conservation Voltage Regulation: An Energy Efficiency Resource," IEEE *Smart Grid Newsletter*, April 10, 2013.

Willoughby, Ronald D. "Thinking Through Grid Modernization: It's a Chinese Puzzle – Moving Each Piece Moves Another," article written by Phil Carson of *Intelligent Utility Daily* after an exclusive interview with Mr. Willoughby, June 17, 2012.

Willoughby, Ronald D. "Power System Automation Drives Need for Data Acquisition," *Distributed Energy* Magazine, April 2012.

Willoughby, Ronald D. and Juan Gers. "IEC 61850 Primer," DNV KEMA *TECH Notes*, April 2012.

Willoughby, Ronald D. "Power System Automation Drives the Need for Smart Grid," DNV KEMA *Sherpa* Web Site, December 1, 2011.

Willoughby, Ronald D. "System Automation Drives Need for Data Acquisition," *Electric Light & Power* Magazine, November 2011.

Willoughby, Ronald D. "System Automation Drives Need for Data Acquisition," *PowerGrid International* Magazine, September 2011, pp 52-56.

Willoughby, Ronald D. "The 'Next Big Thing,'" article written by Phil Carson of *Intelligent Utility Daily* after an exclusive interview with Mr. Willoughby, April 21, 2010.

Willoughby, R. D., S. French Smith, S. Varadan. "A Knowledge Framework for Sustaining Business Growth and Success," Panel Session Submission 2010TD0574, IEEE T&D World Conference & Exposition, April 2010, New Orleans.

Willoughby, R. D. (Contributing Expert). *Utility of the Future*, Volume 2, *The Promise of Energy Storage*, KEMA, December 2009.

Willoughby, R. D. "The Evolving Convergence of Distribution Automation and Advanced Metering Infrastructure," KEMA Automation Insight, June 2007.

Willoughby, R. D. and L. A. Kojovic. "Integration of Distributed Generation In A Typical USA Distribution System," CIRED 2001, Amsterdam Netherlands, June 2001.

Willoughby, R. D. "Order of the 9's," Cooper Power Systems *SETUP* Newsletter, Summer 2000 Edition.

Willoughby, R. D., P. Avery, et al. "Economic Solutions To Power Quality and Reliability Problems," American Power Conference *Proceedings*, Chicago, IL, April 10-12, 2000.

Willoughby, R. D. and L. A. Kojovic. "Digital Models Simulate Physical Test Facilities," *IEEE Computer Applications in Power* Magazine, April 1995.

Willoughby, R. D., C. A. McCarthy, et al. "Power Quality and Reliability Services," Electric Power '99 Conference *Proceedings*, Baltimore MD, April 1999.

Willoughby, R. D., C. Gilker, and E. Strauss. "Education Highway for the Practicing Engineer: What Next in the Age of Deregulation?" Systems Engineering Group Bulletin SE9901, February 1999.

Willoughby, R. D. and S. R. Mendis. "Harmonic Filters Provide The Key To Plant Reliability," PPE Magazine, April 1996.

Willoughby, R. D. and L. A. Kojovic. "Computer Methods for Simulations of Power Lab Tests & Electrical Apparatus Operations in Power Systems," TESLA II Millennium, Belgrade, Yugoslavia, October 1996.

Willoughby, R. D., C. Gilker, et al. "Training for TODAY'S Practicing Electrical Distribution Engineer," Systems Engineering Group Bulletin SE9402, Cooper Power Systems, August 1994.

Willoughby, R. D. and K. Argiropoulos. "Hybrid Surge Arrester Technology," US Technology for the Production, Transmission, & Distribution of Electric Power Seminar, Berlin, Germany, October 1991.

Willoughby, R. D. and K. Argiropoulos. "Overcurrent Protection Devices for Overhead Distribution Systems," US Technology for the Production, Transmission, & Distribution of Electric Power Seminar, Berlin, Germany, October 1991.

Willoughby, R. D. and K. Argiropoulos. "Voltage Regulation Equipment for Overhead Distribution Systems," US Technology for the Production, Transmission, & Distribution of Electric Power Seminar, Berlin, Germany, October 1991.

Willoughby, R. D. and S. R. Mendis. "Power Quality Problems in Electric Power Systems," US Technology for the Production, Transmission, & Distribution of Electric Power Seminar, Berlin, Germany, October 1991.

Willoughby, R. D., et al. "Electrical Studies for an industrial Gas Turbine Co-Generation Facility," IEEE Industrial Applications Society (IAS) *Transactions*, July/August 1989.

Willoughby, R. D., R. W. Johnson, and R. A. Whiteside. "Computer-Aided Protective Device Coordination: Advantages," Congress on Protective Systsems for Electrical Installation, Puerto la Cruz, VZ, July 29-31, 1987.

Willoughby, R. D. , et al. "A Key to Plant Reliability: System Studies," Pakistan Electrical Conference, February 1987.

Willoughby, R. D., and S. Rubino. "Power Systems Studies can P4redict and Resolve Harmonic Resonance Problems in Industrial Planrs," IEEE Petroleum and Chemical (PCIC) *Conference Record*, September 1985.

Willoughby, R. D., J. A. Juves, and A. Batenburg. "Utility Survey of Methods for Minimizing the Number and Severity of System Separations," *Final Report*, Electric Power Research Institute, EPRI EL-3437, Project 1952-1, March 1984.

Willoughby, R. D. "Limitations on Local Shunt Compensation Studied with WESTCAT™," the Westinghouse *AST/Group News*, Pittsburgh, Pennsylvania, Winter 1983/84.

Willoughby, R. D. "New Program for Modelling Induction Motors," the Westinghouse *AST/Group News*, Pittsburgh, Pennsylvania, Summer 1983.

Willoughby, R. D. and J. A. Juves. "Computer Software for the Analysis of Industrial Power Systems," Westinghouse Industrial Applications *Workshop Proceedings*, Philadelphia, Pennsylvania, April 19-20, 1983.

Willoughby, R. D., J. A. Juves and S. S. Waters. "A Streamlined Procedure fro Obtaining Regulatory Approval for New Transmission Lines," *Final Report*, Electric Power Research Institute, EPRI EL-1404, Contract TPS-733, December 1982.

Willoughby, R. D., R. W. Powell, and T. E. Szabo. "The Effects of Shunt Compensation on Local Generation Requirements," Fourth (4^{th}) Conference on Electric Power Supply Industry *Proceedings*, Bangkok, Thailand, 1982.

Willoughby, R. D. and S. S. Waters. "Modeling Induction Motors for System Studies," IEEE Industrial Applications Society (IAS) *Transactions*, San Francisco, California, 1982.

Willoughby, R. D. and P. M. Myers. "Special Industrial System Studies to Insure Plant Reliability," IEEE Petroleum and Chemical (PCIC) *Conference Record*, St. Louis, Missouri, 1982.

Willoughby, R. D. and J. A. Juves. "Justification and Approval of New Electric Transmission Lines: A Procedure," *Workshop Proceedings*, Electric Power Research Institute, EPRI EL-2190, Contract WS 79-230, December 1981, Section 1.

Willoughby, R. D. and S. S. Waters. "Procedure for Conducting a Transient Stability Study," IEEE Midwest Power Symposium *Conference Record*, University of Illinois, October 1981.

Willoughby, R. D. and E. R. Taylor, Jr.. "Practical Application Limit for Shunt Compensation Before Generation Addition," Pennsylvania Electric Association (PEA) Biannual System Planning Committee Meeting *Record*, Hershey, Pennsylvania, September 1981.

Willoughby, R. D., R. S. Hahn, S. Dasgupta, and E. M. Baytch. "Maximum Frequency Decay Rate for Reactor Coolant Pump Motors," IEEE *Transactions* on Nuclear Science, Vol NS-26, No. 1, February 1979, pp. 863-870.

Willoughby, R. D. and R. W. Johnson. "Stability Study Commentary and Interpretation of Computer Printout for Sonatrach LNG Plant Electrical Power System," *Final Report*, Report No. AST-75-1000-08, Westinghouse Advanced Systems Technology, Pittsburgh, Pennsylvania, June 1975.

Willoughby, R. D. and J. W. Skooglund. "Transient Stability Study for Central Nuclear de Almaraz," *Final Report*, Report No. AST-75-1023, Westinghouse Advanced Systems Technology, Pittsburgh, Pennsylvania, May 1975.

Willoughby, R. D. and R. W. Johnson. "Load Flow Study Commentary and Interpretation of Computer Printout for Sonotrach LNG Plant Electrical Power System," *Final Report*, Report No. AST-75-1000-06, Westinghouse Advanced Systems Technology, Pittsburgh, Pennsylvania, April 1975.

Willoughby, R. D. and R. W. Johnson. "Protective Device Coordination Study Commentary and Interpretation of Computer Printout for Sonotrach LNG Plant Electrical Power System," *Final Report*, Report No. AST-75-1000-04, Westinghouse Advanced Systems Technology, Pittsburgh, Pennsylvania, March 1975.

Willoughby, R. D. and R. W. Johnson. "Short Circuit Study Commentary and Interpretation of Computer Printout for Sonotrach LNG Plant Electrical Power System," *Final Report*, Report No. AST-75-1000-02, Westinghouse Advanced Systems Technology, Pittsburgh, Pennsylvania, February 1975.