ABOUT BOSTON PACIFIC COMPANY, INC.

Boston Pacific is a consulting and investment services firm, located in Washington, D.C., specializing in the electricity and natural gas industries. For 23 years we have provided information and insight to our clients who span the full range of stakeholders: state regulatory commissions, regional transmission organizations, energy consumers, competitive power producers, electric utilities, gas pipeline companies, and electric transmission companies. We are nationally recognized experts on the electricity business as documented by our service as expert witnesses throughout North America. Boston Pacific also is an industry leader in monitoring major power procurements for State Commissions across the country. And for six years we have advised the Board of Directors of the Southwest Power Pool RTO on its full range of issues.

As to the specific issues addressed herein, Boston Pacific has substantial experience with and expertise in Integrated Gasification Combined Cycle (IGCC) projects. Most recently, we served as an independent advisor to the Mississippi Public Service Commission on the proposed Kemper County IGCC Project; the Mississippi Commission just set the ground rules for moving forward with Kemper. We are also currently serving as market or financial advisors to the Department of Energy's Loan Guarantee Program on a range of technologies including gasification projects. Additionally, we have previously evaluated an IGCC project in the Northwest for the Oregon Public Utility Commission.

For more information on Boston Pacific please visit us at www.bostonpacific.com

ABOUT MPR ASSOCIATES, INC.

MPR Associates is an employee-owned engineering services firm founded in 1964 and has provided engineering services relating to the design and operation of electric generating stations since its inception. MPR has a staff of over 200 persons located at our headquarters office in Alexandria, Virginia and other offices in Houston, TX, East Lyme, CT and Albany, NY.

MPR clients include the world's leading energy companies and financial institutions as well as various U.S. government agencies. MPR has a long history supporting the development, construction and operation of large power projects and has also supported the evaluation and development of gasification technologies and projects. We have an extensive background in commercial due diligence for project, project portfolio and corporate acquisitions. MPR has performed technical and commercial reviews for literally hundreds of energy and process facilities for commercial and government clients and have advised clients on purchase or financing of assets valued at well over $30 billion.

More information about MPR Associates can be found at our website: www.mpr.com

CRAIG R. ROACH

Craig Roach has more than thirty years of experience working on investments in, policies for, and litigation concerning the electricity, natural gas, and other energy businesses. Craig founded and incorporated Boston Pacific in Washington, DC in 1987.

Craig leads the Boston Pacific Team which has served for four years as the Independent Market Monitor/External Market Advisor (EMA) for the Southwest Power Pool Regional Transmission Organization (SPP RTO). As the IMM/EMA, the Boston Pacific Team is responsible for developing the Market Monitoring Plan and Market Power Mitigation Measures for the SPP RTO and has won Federal Energy Regulatory Commission (FERC) approval in this regard. The EMA also plays a significant role in market design for SPP's new real-time market which successfully started operations on February 1, 2007.

Craig oversees the Boston Pacific Teams which manage and monitor major power auctions such as those in Illinois, New Jersey, Maryland, Delaware, and the District of Columbia. Boston Pacific also manages and monitors unit contingent solicitations such as those in Oregon, Oklahoma, and the U.S. Virgin Islands.

Craig has extensive experience as an expert witness on the electricity and natural gas businesses. He has provided testimony, affidavits or comments on thirty occasions before FERC, to twenty-two state commissions (some on multiple occasions) plus three Canadian Provincial Boards, and a City Council. He also has served as an expert in arbitrations, in Federal Court, in State Court, and before a Congressional Subcommittee.

The great variety of topics in Craig's testimonies documents the breadth and depth of his experience in the electricity and natural gas businesses. He has served as an expert witness on issues such as market power (antitrust), market design, competitive bidding, transmission tariffs, ratemaking by both electric and gas utilities, finance for both competitive power suppliers and utilities, system reliability, prudence of power purchases, and contract abrogation. His expertise also is reflected in the fact that he is a widely sought-after speaker.

In previous years, Boston Pacific also had extensive, hands-on experience supplementing the in-house asset transaction teams of our clients for power project development and acquisition. We have done so throughout the U.S. and in two dozen countries around the world. Prior to founding Boston Pacific, Craig was a Project Manager with ICF Incorporated. While at ICF, Craig developed an engineering-economic model to forecast industrial fuel choice, assessed the impact of air pollution regulations on coal markets, and identified opportunities for coal exports to Asia and Europe. From 1975 to 1979, Craig was a Principal Analyst for the U.S. Congressional Budget Office. He provided analyses on energy and environmental legislation through written reports and testimony to Congressional committees.

Craig holds a Ph.D. in Economics from the University of Wisconsin. Craig earned his B.S. in Economics, *cum laude*, from John Carroll University. He now currently serves on an Advisory Board to the Department of Economics at the University of Wisconsin.

Frank currently serves in a leading role in our monitoring engagements for procurements of unit-contingent base load, intermediate load and renewable resources in Oregon. He is also the day-to-day lead on our work with Standard Offer Service procurements in New Jersey, Delaware, Pennsylvania, Ohio and the District of Columbia. He is responsible for leading the day-to-day operations of these engagements. His work also includes developing the technical analyses that we employ, such as our benchmark models, and leading analyses of utility-produced models and data, including reviewing utility and bidder cost buildups of projects. These projects have included both traditional technologies, such as combined-cycle and simple-cycle facilities, and new technologies, such as wind turbines and IGCC projects.

For all of the above engagements that we monitor, Frank is responsible for and has input in all phases of the procurement. This includes; reviewing and suggesting changes to the RFP design in order to attract more bidders and fairly analyze each bid, overseeing the receipt and qualification of bids, reviewing detailed proposals, creating models to score both price and non-price aspects of the bid, and making recommendations on which bids to select to initial and final shortlists. He has appeared formally and informally before Commissions and Commission Staff to present and explain his recommendations concerning procurement design and procurement outcomes. Recently, he testified before the Minnesota Public Utilities Commission regarding costs of new generation and potential futures emission compliance cost

In his initial tenure at Boston Pacific, prior to earning his MBA, Frank specialized in creating complicated valuation models from extremely large sets of data and then summarizing his findings in clear and concise language. He worked with clients and law firms to develop and defend detailed analyses that could withstand the rigors of contentious litigation.

Frank has worked at IBM in their Business Consulting Services division. While there he helped manage the updating of a Navy cost database system while conducting process improvement actions to ensure a better and faster flow of information to military cost estimators. He also worked with personnel to answer questions and create custom data queries. Frank also had the opportunity to work at a boutique investment banking division which specialized in mergers and acquisitions in the electric and gas space.

Frank has also been a Director at Analysis Research Planning Corporation (ARPC). There he engaged in a variety of sophisticated analytical projects. In one instance he combined extensive historical data with a Monte Carlo simulation to forecast defense costs for a major pharmaceuticals manufacturer. He designed claims valuation models for Asbestos and Silica claimants using complicated regressions and coefficient balancing formulas to generate fair outcomes for thousands of claimants.

Frank graduated *cum laude* from the Wharton Undergraduate School of the University of Pennsylvania with a BS in Economics and a concentration in Finance. He received his MBA from the University of Virginia's Darden Graduate School of Business Administration.

SAM CHOI

Sam is a Project Manager at Boston Pacific. He has technical knowledge of power generation and distribution and has cost modeling experience with renewable energy projects. His professional and academic experience brings versatility to the team with his background in engineering, finance, and policy.

Since joining Boston Pacific, Sam has provided his expertise on financial and technical issues on several significant projects, especially for renewable energy of various technologies. Sam is currently involved in PacifiCorp's 2008R-1 RFP for the procurement of up to 500 MW of renewable energy resources. He is the technical and financial consultant for a geothermal feasibility project sponsored by the USTDA. This feasibility project will assist a Colombian power company in developing Colombia's first geothermal power plant. During the course of this project, Sam has been assisting in the interpretation of geological data to relevant inputs to determine power plant specifications and thereby develop deterministic and stochastic cost models. Sam was also involved with developing an RFP for the U.S. Virgin Islands Water and Power Authority (WAPA) for the procurement of renewable energy for the next 20 years and played a crucial role in determining which renewable energy projects would have the greatest potential based upon cost modeling with projected oil costs.

Sam's other notable projects include serving as a lead consultant for Boston Pacific's procurement monitoring team for Ameren Illinois Utilities' 2008-2009 procurement of energy, capacity, and renewable energy credits in the State of Illinois. Sam has provided insight and analysis in the development of benchmarks and evaluation methodologies that was used to determine winning bids in the procurement. Sam has also been involved with analyzing the transaction debt of the widely publicized $45 billion leveraged buyout of TXU by private equity firms, in which Boston Pacific was advising the Public Utility Commission of Texas. His efforts on the project included determining the effects of credit rating actions on the solvency of TXU's transmission and distribution subsidiary. He also has participated in the evaluation of bids for PacifiCorp's 2012 RFP for unit contingent or firm base load service. This project included the evaluation of bids for the full range of technology types, including renewables.

Sam also has expertise in the biofuels industry through his graduate research. He has conducted several projects on the feasibility of ethanol plants using corn and sugarcane feedstocks. He has also researched the feasibility of cellulosic ethanol plants. His research involved a detailed technical assessment which consists of individual analyses of feedstock, crop yield, production process, and equipment specification. Sam also developed many project financing DCF models to determine the economics of power projects and infrastructure. Sam's other research areas included energy storage systems and power electronics.

Prior to coming to Boston Pacific, he worked for the United States Patent and Trademark Office. During his time there, Sam examined patents in the semiconductors, electrical and optical systems technology area. He was involved in the prosecution of patent applications and has successfully issued several patents. His experience there has allowed him to develop a strong foundation in intellectual property law.

Sam received a MS in Engineering Management with a concentration in Economics, Finance, and Cost Engineering from George Washington University and holds a BS in Electrical Engineering with a minor in business from Virginia Tech.

STUART REIN

Stuart is a Project Manager who has been heavily involved in Boston Pacific's External Market Advisor work for the Southwest Power Pool (SPP) Regional Transmission Organization (RTO) as well as its Auction and RFP monitoring for the New Jersey Board of Public Utilities, the District of Columbia Public Service Commission, the Oregon Public Utility Commission, and the Public Utilities Commission of Ohio.

Stuart led the effort to produce the *2008 State of the Market Report* for SPP. He played an integral role in all aspects of developing the report, from the design of the report to executing statistical analysis to writing the report. In the three years prior, Stuart was also involved with the production of the 2005, 2006, and 2007 State of the Market Reports. In addition, he has been instrumental in the production of numerous other reports for SPP's new Energy Imbalance Service (EIS) Market, including: the first three Monthly Reports, the first Quarterly Report, an assessment of price volatility experienced in the deployment tests leading up to market start, and an assessment of SPP's Market Monitoring Plan and Market Power Mitigation Measures. Through this work, Stuart has gained extensive knowledge of the SPP RTO in general and its data warehouse of market information in particular.

Stuart assisted in our role as the Auction Monitor for the New Jersey Board of Public Utilities' 2007, 2008, and 2009 Basic Generation Service (BGS) Auctions. Specifically, Stuart has helped to (a) monitor the application process, (b) analyze the auction rules, (c) develop stress tests to verify that the software used in the bidding process actually abides by the auction rules, (d) participate in dry run simulations as a mock bidder, and (e) actively monitor the actual Auctions in real-time. He also assisted in our work as the Ohio Commission's Consultant for FirstEnergy's 2009 Auction for full requirements service.

Stuart has worked as an on-site consultant for the District of Columbia's Public Service Commission as a monitor for Pepco's request for proposals for Standard Offer Service (SOS). For this client, he validated utility-provided data used by bidders in the formulation of their bids and assisted with monitoring and reviewing bids to ensure the integrity of the solicitation process. He performed a similar role in our work monitoring one of the four electric distribution companies' request for proposals for SOS in Maryland.

For the Oregon Public Utility Commission, Stuart assisted in an analysis of a utility's proposed acquisition of a natural gas-fired generating facility. This work included assessments of the plant's capital costs as well as costs associated with transmission, fuel, heat rates, operating and maintenance costs, and different operating lives.

Stuart has performed research and analysis on market power mitigation issues for the purposes of preparing testimony for FERC. His research assessed (a) over- and under-scheduling issues and (b) portfolio bidding (both tactics used by generating facilities to accumulate unwarranted profits).

Stuart received a BS, with a double major in Engineering Science and Economics and a minor in Management of Technology, *magna cum laude*, from Vanderbilt University.

KATHERINE GOTTSHALL

Katherine Gottshall is a Project Manager at Boston Pacific. She has both lead and played key roles in RFPs for both short- and long-term power supplies, specializing in creating and running models to analyze bids. She has worked on RFPs in Illinois, the District of Columbia, Delaware, Oklahoma, and Oregon, and has helped lead our External Market Advisory role with the Southwest Power Pool.

In Illinois, Katherine has been involved in our work monitoring RFPs for short-term energy, capacity, and renewable energy credits (RECs) for the last two years. She has specialized in evaluating bids and analyzing results for each of the five auctions that occur each year. Katherine created our in-house models, allowing us to efficiently and accurately evaluate bids. She has also overseen the testing and operation of this model, monitored several of the auctions in person, and analyzed auction results.

For over two years, Katherine has worked on all parts of the annual District of Columbia and Delaware RFPs. Her involvement each year begins with the initial review of the utility's data provided to bidders and review of initial comments on the RFP, and continues through building, testing and running Boston Pacific's model to validate and evaluate bids. She also provides valuable insight on RFP results, specifically rate impacts, by working with the utility to determine the change in rates for residential and commercial customers. For DC, in particular, she has reviewed the extensive rate filings that the utility files, providing feedback to the utility and the DC Commission Staff regarding any errors that affect rates.

In this last year, Katherine has also been a leading member of our Independent Evaluator team for Public Service of Oklahoma's (PSO's) 2008 RFP for base load energy and capacity. For this project, she participated in the stakeholder Collaborative that developed key RFP structures, helped determine what should be included in Boston Pacific testimony, analyzed other participants' responses to that testimony, and worked with PSO to determine which bidders should pre-qualify for the RFP. After bids were received, she used an annuity model she created to lead our team in bid evaluation and in the analysis of PSO's results. She also revised the model and participated in the evaluation of bids for a unit contingent RFP for traditional generation facilities in Oregon.

For the third straight year, Katherine also helped lead the Southwest Power Pool (SPP) team. The most recent project was the *2008 State of the Market (SOM) Report* for SPP, which Boston Pacific presents to the SPP Board and to the FERC. Katherine's involvement in the SPP SOM report included everything from analyzing raw data and developing statistics to writing sections of the final report. She focused on areas such as market prices, transmission expansion, and revenue adequacy. In addition to the SOM Reports, Katherine has worked on the first few monthly reports of the Energy Imbalance Service (EIS) Market, which started in February of 2007, the Monitoring and Mitigation Plan (MMP) Report, and she was also a key participant in the cost benefit analysis of the EIS Market done with SPP staff.

Katherine joined Boston Pacific after working in the Quantitative Research Group at Cambridge Associates. She brings extensive experience building quantitative models such as a sophisticated version of Markowitz's Efficient Frontier to assess and measure returns and risk of investment portfolios. She was also responsible for conducting research and building models that used historical data and futures projections (e.g. Monte Carlo simulations) to enable investment consultants to effectively make recommendations on investment strategies to clients.

Katherine received a BA, with a double major in Economics and Mathematics, from Wellesley College.

ANDREW SOUTHERLAND

Andrew is a Senior Consultant at Boston Pacific. He has substantial experience providing project and infrastructure financial advisory services for large scale infrastructure projects within the US and Mexico.

Andrew has recently completed several market and financial evaluations of electricity projects on behalf of the US Department of Energy's Loan Guarantee Program. For these, Boston Pacific evaluated the viability of the proposed energy projects' business plans, performed a thorough review of the financial model and projections, analyzed regulatory and other normative issues that could have an impact on the project, and analyzed power markets into which the projects' energy would be sold. In addition, Andrew performed a number of sensitivities to the financial model on key project assumptions to assess the project's ability to repay DOE's loan.

Prior to joining Boston Pacific, Andrew worked in the Infrastructure Group of Macquarie Capital Advisors, a division of the Macquarie Group, the world's largest private owner of infrastructure assets. While with Macquarie, Andrew worked to advise various Macquarie infrastructure funds on numerous road and rail transactions. His work included a substantial amount of financial modeling, network and econometric modeling, economic research, feasibility studies, liaising with market and economic consultants, and presentation to management, clients, and credit teams. Transactions included the bid for the $12.8 billion Pennsylvania Turnpike lease; the Mid-Town Tunnel PPP in Norfolk, Virginia; the PR-22 project in Puerto Rico; a bid to acquire a large, publicly traded US freight rail company; and several transactions on privately held toll roads in Mexico.

On the Pennsylvania Turnpike transaction, Andrew assembled Macquarie's RFQ response for the initial bid solicitation and conducted traffic and revenue due diligence for the 500-mile road system. This included extensive research of the local and regional economic dynamics, mapping of freight flows through the state, and sourcing of other major commercial and passenger traffic drivers, including sensitivity to fuel price, toll levels, and other factors. Andrew helped develop a traffic model derived from macroeconomic regressions and traffic data, and created other network models derived from O-D traffic data to test the effect of implementing unconventional zonal tolling methods on the primarily ticket-system road.

Roles on other notable projects include creating presentations on US rail industry dynamics and meeting with potential debt providers, working on responses to numerous RFP/RFQ requests on road projects in the US, and building financial models for three toll road transactions in Mexico.

Previous to his role with Macquarie, Andrew worked with Skanska Infrastructure Development – the project finance division of Skanska, a large multinational construction firm. Andrew participated in industry competitor research and marketing efforts to aid Skanska ID's entrance into the US PPP market.

Andrew graduated *magna cum laude* from Brown University with a Bachelor of Arts degree with concentrations in Economics and Philosophy.

James V. Bubb, P.E.

PROFESSIONAL HISTORY

1999 - Present	MPR Associates, Inc.
1997 - 1999	Virginia Polytechnic Institute and State University

MPR EXPERIENCE

Since joining MPR Associates, Mr. Bubb has performed various assignments evaluating both gasification technologies and power plant designs. Examples of Mr. Bubb's assignments for MPR are detailed below.

ACCOMPLISHMENTS SUMMARY

Technical Market Assessment of Small-to-Medium Scale Gasification Technologies

Performed a technical market assessment of small-to-medium scale gasification technologies for the US Department of Energy. For ~100 technology vendors the study summarized: technical characteristics, commercial characteristics, identified challenges to further deployment, and made recommendations to the DOE to foster additional growth in the sector.

IGCC Air Permit Development

Provided engineering inputs for an air permit for a brown-field development of and IGCC facility in Texas. Work products included: site layout material balances, emissions estimates, performance estimates, process flow diagrams / descriptions, and the material handling/storage conceptual design.

Clean Coal Technology Due Diligence

Performed a due diligence review of a clean coal technology for a potential investor. The technology upgraded Power River Basin coals by increasing heating value and removing sulfur. Provided a risk management plan for plant development from pilot stage, to commercialization phase, and through large scale manufacturing.

Bio Gasification Technical Review

Performed a technical review of a biogasification technology. The review considered mechanical and thermal design, potential operational challenges, the potential to increase the scale of the equipment, and likely marketability of the technology.

Plasma Gasification Project Plan

Authored a project plan to take an emerging plasma gasification technology from a concept demonstration to a commercial product.

IGCC Development Support

Reviewed vendor design documentation for a large scale IGCC facility. Evaluated the feasibility of CO2 capture from an air-blown gasifier.

IGCC White Paper

Authored a white-paper summarizing the status of Integrated Gasification Combined Cycle (IGCC) and gasification technologies. The white paper provided a historical perspective of gasification use, discussed the motivations for the technology, gave a technical summary of the processes, and compared the features of the most widely used gasification technologies.

Due Diligence

Over the course of numerous assignments, provided due diligence evaluation for over 20 power facilities. Technologies included: simple cycle, combined cycle, wind, coal, and gasification facilities. Provided summaries of risk and opportunities, and technical inputs to pro forma evaluations.

Combined Cycle Plant Design

On several occasions performed the conceptual design of combined cycle power plants. Developed detailed thermal heat balances; Determined required equipment capacities; evaluated design tradeoffs and sizing alternatives.

LNG Lifecycle Greenhouse Gas Estimate

Authored a study that quantified the Lifecycle Greenhouse Gas (GHG) footprints of power generation for a proposed LNG receiving terminal. Compared the facilities GHG emissions to alternative power production lifecycles based on domestic coal and natural gas generation.

EDUCATION

Virginia Polytechnic Institute and State University, M.S., Mechanical Engineering 1999
Virginia Polytechnic Institute and State University, B.S., Mechanical Engineering 1998 (Magna Cum Laude)

REGISTRATION

Registered Professional Engineer, State of Virginia

PUBLICATIONS

Steady and Unsteady Heat Transfer in a Transonic Film Cooled Turbine Cascade, ASME / IGTI Conference on Gas Turbines, 1999.

A Comparison of Radiation Versus Convection Calibration of Thin Film Heat Flux Gauges, ASME Ad-Hoc Committee on Heat Flux Measurement, 1999.

A Refined Model for Prediction of Balanced Disk Globe Valve Thrust Requirements, EPRI Report TR-113558, 1999.

William M. Dykema

EXPERIENCE SUMMARY

Since joining MPR in 1998, William Dykema has been responsible for project management. William Dykema has thirty-three years of experience on various industrial process facilities. His experience ranges from project development through startup and commercial operation. General areas of strength include cost estimating major projects, project control, project management, engineering management and construction management

ACCOMPLISHMENTS SUMMARY

Project Control
Provided overall project schedule review. Prepared integrated schedule containing Owner deliverables for FPL Energy. Provided specification and execution plan for the implementation of project control system for the MOX Project. Provided project cost and schedule support during development phase of combined cycle facility.

Project Management
Mentored new Project Manager and developed detailed start-up schedule for FPL Energy. Initiated detailed implementation schedule and provided project management services during implementation for First Energy. Provided claim settlement strategies which resulted in significant project savings for Constellation Power. Also, provided claim mitigation plans and support during negotiations and cost mitigation plans during construction.

Owners Representative
Responsibilities included managing the EPC contractor and providing owner's deliverables on time and within budget for Gregory Power Partners. Developed project execution plan. Scheduled review for monthly critical path analysis.

Engineering Manager
Responsible for plant engineering, capital projects, and special projects at the Doswell Combined Facility. Established a proactive environmental program. Specified, procured, installed and tested a continuous emissions monitoring system. Managed approximately $7 million of capital improvements. Managed the recovery of a failed gas turbine, total project value approximately $50 million in 120 days.

Environmental Programming
Established a proactive environmental program for the utility industry which specified, procured, installed and tested a continuous emissions monitoring system. Ensured compliance with project specific air and water permits.

32 MW Gas Turbine Cogeneration
Ensured compliance with state and local agency regulations such as the Air Pollution Control District, Division of Oil and Gas and Hazardous Materials Division of the Fire Department. Performed turnkey contract administration, performance test evaluation and plant acceptance. Developed 54 producing oil wells in preparation for enhanced recovery by cyclic steam injection.

Bid and Proposal Evaluation
Evaluated bid and proposals regarding schedule, cash flow and cost comparison. Established a system for tracking project status relating to schedule and contractor progress payments. Developed estimates and negotiating strategies for change orders.

Construction Engineering
Supervised and coordinated the activities of the installation and erection contractors for the steam generators, condensers, pressure piping, large bore hangers, and other related equipment. Duties included surveillance of contractors for compliance to contract specifications, standards, codes and required tests.

EDUCATION

Morrison Institute of Technology, Mechanical Engineering, Associates in Science, 1971.

Seminar Courses: Managing for Motivation, Technical Writing, Commercial Aspects of Contracting, LM 2500 Gas Turbine Operation, Team Building Works, Public Speaking

Virgil P. Sabin

EXPERIENCE SUMMARY

Mr. Sabin has significant operations, maintenance, and P&L experience in managing electrical power and chemical facilities. He has successfully managed commissioning and operations of numerous coal, IGCC, and NGCC electric power plants, petrochemical, refinery and first-of-a-kind commercial coal-to-synthetic natural gas facility. Experience includes setting strategic business plan followed by tactical responsibilities as third party contractor, contractor owner and owner in both union and non-union operations with proven history of outstanding safety and environmental success. Mr. Sabin is a creative problem solver and experienced negotiator able to deal positively with difficult situations and communicate effectively with diverse groups based on broad technical, financial and personnel management skills. He is experienced in clean coal burning, coal to SNG and chemical conversion. He has performed O&M assessment on GE / Texaco gasification unit in Delaware City and is familiar with Shell technology.

ACCOMPLISHMENTS SUMMARY

2002 – Present
Consultant/MPR Associates

Provided operation, technical and business services to East coast and Midwest utilities. Assumed Director responsibilities in day to day management of operating company while supporting its sale. Performed operation assessments of Texaco gasification complex. On two separate assignments, served in Owner's Engineer role for IGCC development. Served as general manager of new 1,100 MW combined cycle power plant while in bankruptcy proceedings.

1997 – 2002
General Manager – PG&E National Energy Group

Reported to East Coast Regional Director. Responsible for the daily operation, maintenance, engineering, employee relations, contract administration, safety, environmental performance and P&L of a 285 MW clean coal technology cogeneration plant. Structured and negotiated annual market-based excess power sales agreements increasing plant's revenues by over $5 million annually. Managed arbitration process to successfully resolve multi-million dollar dispute seeking termination of power sales agreement. Defeated NLRB organization attempt and initiated the development of self-directed work teams. Negotiated price reductions in long term fuel supply agreements saving plant income of $1.5 million annually. Safety record with no LTAs and nationally recognized as among the cleanest coal burning plants in USA. Achieved Silver Track Award from state of New Jersey recognizing emission and pollution program/awareness.

1997
Plant Manager – Enviroplast LLC

Reported to President. Served as plant manager of a prototype manufacturing facility recycling post consumer plastic. Was responsible for the activities of the day-to-day operations and working with investors in developing the business into a national small business franchise. Developed business relationships/contacts to begin plastic recycling in metro area where there was no program. Formed operations group to recycle 15 tons per day of recycled plastic. Designed and installed unique processing equipment to meet FDA standards for plastic recycle market. Recycling post consumer plastic back into virgin plastic worked, but economics did not support small franchise concept.

1991 – 1996
East Coast Division Director – LG&E Power Operating Services (Previously in partnership with Constellation – jointly known as UCOS)

Reported to Vice President. Started up operation, maintenance, and management services organization to serve electric power industry. Managed home office staff and eight plant managers in providing plant administration as well as operational and technical management of coal fired and NGCC power generation facilities. Accountable for the coordination of all plants and for matters of contractual obligation, personnel administration, safety and environmental success, business development and establishment and control of division business plan. Directed division administration and in turn the O&M of ten power plants representing $1.2 billion in assets by employing high performance matrix based work systems. Increased revenue from $1.86 million in 1991 to $18.1 million in 1995. Increased profits from $ 0.25 million in 1991 to $3.9 million in 1995. Successfully commissioned seven new power plants

with no serious personnel injuries, environmental mishaps or machinery loss.

1990 – 1991
Vice President of Operations – Oxford Energy
Reported to CEO. Responsible for asset management of two independent power plants (fueled by agricultural waste and tires), while commissioning and start-up of a third. Direct reports included three plant managers, personnel director, and project manager. Served as Oxford's negotiating representative to defeat IBEW's effort to unionize work force. Developed new method to burn agricultural waste as fuel, resulting in the reclassification of ash from hazardous to non-hazardous waste. Performed technical design reviews of new tire-derived fuels power plant followed by staging and commissioning.

1989 – 1990
Vice President of – Coastal Technology
Reported to President of Coastal Coal Division. Started new line of business designed to provide operations and maintenance services to cogeneration facilities, coal-to-chemical conversion plants and third party independent power producers. Started up and commissioned Cedeca, a 56 MW IPP. Established O&M contacts for Eagle Point Refinery.

1981 – 1989
Production Manager – Coastal – ANR
Reported to Plant Manager of Dakota Gasification Company DGC. Joined the Great Plains Project ($2.2 billion coal to SNG processing plant) and was responsible for all process operations of synfuels plant. Operation, maintenance and engineering personnel totaled more than 700 employees. Successfully commissioned in 1984. Optimized operations to produce 140 MM cubic feet per day of SNG and various other chemical byproducts. Hired, trained and developed O&M workforce utilizing North Dakota personnel. Was first commercial coal synthetic natural gas synfuels plant in USA. Successfully dealt with foreclosure of original partnership and reorganization with Basin Electric Cooperative.

1968 – 1981
Dow Chemical Company
Assigned to various engineering, chemical operating and business positions in the Colorado, Michigan, Texas and Oklahoma Division. Responsibilities included operations of large petrochemical and refinery complexes.

EDUCATION

Michigan Technological University, BSME, 1968

MPR ASSOCIATES INC. ENGINEERS

R. Jason Gwaltney

EXPERIENCE SUMMARY

Mr. Gwaltney joined MPR in February 2003 and has since been involved in a number of projects for fossil fuel power plants, the nuclear industry and the U.S. Navy. He has significant experience with the development of project schedules and cost estimates for major power plant and energy construction projects.

ACCOMPLISHMENTS SUMMARY

New Nuclear Plant Engineering, Procurement and Construction (EPC) Schedule

Assisted in the development of a logic driven, critical path, resource loaded schedule for the engineering and construction of a new U.S. nuclear plant. Acted as the Primavera Database Administrator for group of over 30 schedulers who were working simultaneously across multiple companies and geographic locations.

DOE Independent Cost Estimate

Performed an independent cost estimate of a $5 billion Department of Energy (DOE) cleanup program. Conducted on-site evaluations of facilities to be demolished; reviewed plot plans and inventories of hazardous substances; and evaluated cost estimates, schedules and Monte Carlo analyses.

Plasma Gasification Modeling

Assisted in the development and analysis of a process model for a plasma gasification reactor. Evaluated mass and energy balances, gas velocities and bed heights. Results of analyses used as design inputs for a reactor vessel.

Commercial Power Plant

Provided project planning and management support for a major commercial steam plant retrofit project. Developed and maintained the project cost and project schedule baseline and evaluated trends. The $50-60M project was for a major steam turbine retrofit. The scheduling work included development of the work breakdown structure and integration of the cost estimate; and coordination of efforts of owner, contractor and site forces.

Modular Nuclear Reactor DCD Schedule

Developed a logic driven, critical path, resource loaded schedule for the development of a Design Control Document (DCD) of a small modular nuclear reactor.

Commercial Liquid Natural Gas (LNG) Import and Evaporation Facility

Developed a cost basis and performed high level cost estimating and scheduling for a new LNG terminal. The work included development of the work breakdown structure using an EPC contracting strategy.

SO2 Scrubber System Analysis

Performed a review of a fossil plant's flue gas desulphurization (FGD) system to identify problem areas impacting the system and unit operation. Problem areas were identified based on discussions with plant personnel, review of operating and design data, and a walk down inspection of the FGD systems. The scope of the equipment included in the evaluation included the material handling systems, flue gas treatment systems (particulate removal and scrubbers), and centrifuge and dryer system.

SCR System Analysis

Conducted a review of a fossil plant's Selective Catalytic Reactor (SCR) to help determine the root cause of increasing gas-side differential pressure across the plant's air preheaters. The purpose of the review was to: identify corrective measures to mitigate problems with air preheater plugging and develop a long term corrective action plan to address the problems.

Software Development for Fluid System Model

Developed software to enable the land-based demonstrator testing of the DDG-51 Chilled Water Automation System Upgrade Project. The Land-Based Demonstrator is composed of real and simulated Programmable Automated Valves. A National Instruments processor was programmed to stimulate the circuit card of a Programmable Automated Valve using data input from a flow modeler.

EDUCATION

Virginia Tech, B.S. Chemical Engineering, 2001 (with Honors)

MPR ASSOCIATES INC. ENGINEERS

Robert M. Carritte

EXPERIENCE SUMMARY

Mr. Carritte joined MPR in 1986. He has worked essentially full-time in the power generation industry performing various engineering tasks including system analysis, equipment specification and test, design modifications, troubleshooting, and problem resolution. He has participated in numerous design, procurement, and construction projects involving various systems and components, including entire power plants. Mr. Carritte also has supervised and managed a wide variety of major projects involving different types of facilities, including nuclear, coal, and gas fired power plants, LNG facilities, petrochemical and steel facilities, and naval vessels. Specific examples of Mr. Carritte's experience are summarized below.

ACCOMPLISHMENTS SUMMARY

Owner's Engineer and IPP Project Development, Engineering, and Construction

Performed a technical assessments of several merchant and cogeneration power plant projects, including SkyGen Energy's 440 MW, 2x2x1 combined-cycle co-generation facility in Corpus Christi, TX and Aquila's 320 MW simple cycle Crossroads Energy Center in Clarksdale, MS. Served as Owner's Engineer for six unit, 480 MW simple cycle gas turbine facility in Ceredo, WV. Project was completed on budget and schedule. Worked on the development of EPC contracts and work scopes, site arrangements, electrical interconnections, and integrated project schedules for a number of other independent power projects. Performed design reviews of high voltage switchyard and auxiliary power distribution system for the 500 MW, 2x2x1 combined cycle Gregory Power project. Investigated the cause of impulse test failures on the main generator step-up transformers. Resolved raw and potable water balance issues between the IPP, the steam host, and the municipal water district. Participated in a number of due diligence and material condition reviews of various energy facility assets, including the LNG storage facility located in Milford, Conn.

Design and Licensing Bases Reviews

Performed and directed a number of design and licensing bases reviews of AC and DC electrical and I&C systems. Performed electrical system design reviews for the US-DOE's Mixed Oxide Fuel Fabrication Facility. Directed a five-man team in a several month effort to reconstitute, verify and validate the design and licensing bases for the Millstone Unit 2 Engineered Safeguards Actuation System (ESAS). As part of the project, reviews were performed to verify that the plant was operated, tested, and maintained in accordance with the system's design and licensing basis. The scope of these reviews included system design and qualification, design calculations, instrument loop uncertainty and setpoint calculations, as-built configuration, surveillance testing and maintenance, and operating procedures. Also, performed a number of design and licensing reviews and latent issues reviews at several different BWRs and PWRs.

Responsible for preparing and reviewing 10 CFR 50.59 reviews of various design changes, operating procedure changes, and engineering analyses, including I&C modifications, electrical system analyses, load sequencer modifications, station backfeed via generator step-up transformer, EDG generator replacements, and EDG voltage regulator replacements.

Engineering Quality Review Board

Member of a multi-disciplined, engineering quality review board that was chartered to review the engineering products (e.g., design packages, calculations, procedures, and safety evaluations) and assess the product completeness, soundness of concept, consistency with design requirements, and quality level at Millstone Unit 2. In 2003, served on an Oversight Panel as lead technical reviewer for the Davis-Besse Safety Function Validation Project (SFVP).

Power Plant Reactivation Project - Plant Electrical Systems

Served as lead electrical engineer for the FY1991 project to reactivate the deferred Bellefonte Nuclear Plant. Responsibilities included the technical direction of a team of 40 engineers, designers, and craftsmen from several companies. The scope of this effort included the assessment of the plant electrical systems and components in 2 PWR units to determine the completeness and adequacy of the design, the construction status and adequacy of the as-built installation. The scope of this effort also included making presentation for the resolution of licensing issues to the staff of the Nuclear Regulatory Commission.

Electrical System Analysis
Directed several major projects involving the re-analysis of on-site power distribution systems at both PWR and BWR nuclear power plants and combined cycle gas turbine power plants. One of these projects involved the conversion and validation of the electrical system data from ELMS to ETAP PowerStation. The scope of analysis performed during these projects comprises various plant operating modes as well as design basis accident conditions. Scope of analysis included load flow, voltage drop, short circuit, motor starting, transient loading, and fast bus transfer analyses. Established bases for plant Technical Specification loss of voltage and degraded voltage relay setpoints and time delays. Developed acceptance criteria for the analysis, prepared several GL 91-18 Operability Evaluations, and performed alternatives analyses and developed solutions for problems identified.

Electrical and I&C System Trouble-Shooting
Performed several root cause and troubleshooting investigations of I&C system failures and design issues. These investigations included the development of test plans for in-situ testing and the development and test of modifications to restore operability. The types of failures investigated have included electronic circuit failures in voltage regulating systems, electromagnetic interference (EMI) with plant protection systems, software bugs in digital systems, and power supply and fuse sizing issues.

Digital I&C Systems
Prepared software requirements specifications and V&V plans. Developed software and software test plans for programmable logic controller (PLC) applications. Provided plant personnel with training in the area of man-machine interface display designs. Conducted validation testing for new digital systems and performed troubleshooting on installed digital systems. Planned and directed the electromagnetic compatibility testing for the generic qualification of various digital equipment, including single loop controllers and the Triconex TMR platform. Directed an independent review of FMEA, digital design, and application software development project for a RPS/ESFAS plant protection system based on Siemens Teleperm XS modular platform.

Equipment Testing
Responsible for testing a various systems and components both in-situ and an test laboratories. Responsibilities have included the develop of detailed test plans and procedures, selection and setup of MT&E, conducting and directing tests, analysis of test data, and preparing and reviewing test reports. Systems and components tested included shipboard chilled water plants, submarine ship surface turbine generator (SSTG) governor response, emergency diesel generators (EDGs), electromagnetic compatibility (EMC) tests of digital equipment, motor starters and relays, calibration tests of ultrasonic flow meters.

Cable Installation
Performed technical evaluations of the adequacy of power plant cable installation. These evaluations addressed the potential for damage due to cable pullbys, excessive sidewall bearing pressure, and jamming in conduit installations. Defined the technical requirements and prepared a software requirements specification for a cable and raceway data system for automatic cable routing, performing cable separation and associated circuits analyses, and tracking the design and installation status of power plant cables.

Emergency Diesel Generators
Performed EDG steady-state and transient loading analyses. Performed a number of root cause investigations of emergency diesel generator voltage regulator systems. These investigations included working with plant personnel to develop root cause troubleshooting and test plans, evaluate of test data, and identify the root cause. Also prepared a 10 day training course on emergency diesel generator operation and maintenance requirements for standby AC power sources in nuclear power plant applications. Delivered classroom lectures for the course to members of the staff at the Atomic Energy Council, Republic of China and the Taiwan Power Company.

High Voltage Engineering
Performed design and reliability assessments of several 345 kV air insulated switchyards and an SF6 gas insulated switchyard. Performed design, feasibility, and cost analyses for the transmission line interconnects (new construction and required system upgrades) for several new combined cycle and simple cycle gas turbine power plants in various states including West Virginia, Florida, and Louisiana. Conducted reviews of the interface agreements and protocols between nuclear power plants and transmission system control centers. Performed an overvoltage analysis for 500 kV substation breakers. Project manager for Redbud Energy, LLC. responsible for overseeing and coordinating the upgrade of Oklahoma Gas and Electric Company's 345 kV Arcadia Substation Upgrade. Performed the root cause investigation of transmission line switching accident in Vermont.

Major Equipment Procurement
Developed detailed specifications, evaluated bids, performed design reviews, and witnessed factory acceptance testing for procurement of major plant equipment, including rewinds of large generators (>900 MVA), new combustion turbines, generators,

and excitation systems, large power transformers, and lower pressure steam turbine rotors. Prepared detailed technical specifications for replacement of existing nuclear power plant I&C systems with digital systems, including a radiation monitoring system, reactor protection system (RPS), wide range and power range nuclear instrumentation (NI) system, and the engineered safeguards actuation system (ESAS). Evaluated vendor proposals and developed installation and project plans.

Relay Protection System Design Reviews

Reviewed proposed designs for protective relaying schemes for combined cycle combustion turbine power plants. Evaluated relay protection and monitoring system designs for the protection of the TPC Maanshan Station turbine-generators from excitation of torsional natural frequencies due to sub-synchronous and super-synchronous resonance. Developed generic procedures for assessing the seismic vulnerability of relay circuits in nuclear power plants for use by the industry as part of the resolution of US NRC Unresolved Safety Issue A-46, "Seismic Qualification of Equipment in Operating Nuclear Power Plants." Reviewed the control and protective relaying schematics for the safe-shutdown equipment in a Boiling Water Reactor and a Pressurized Water Reactor.

Fault Tree, Reliability Analysis and FMEA

Performed a systematic safety evaluation of shipboard cargo/weapons elevators using a computerized fault tree analysis tool (IRAS) and participated in a design review of a digital control room alarm system to assess failure modes and effects. Prepared failure modes and effects analyses for various electrical and control system designs.

EDUCATION

Rensselaer Polytechnic Institute, M.S. Electric Power Engineering, 1986

Northeastern University, B.S. Electrical Engineering (with Honors), 1985

Northeastern University, B.E.T. Electrical Engineering Technology (with Honors), 1984

MEMBERSHIPS

Institute of Electrical and Electronics Engineers, Senior Member

Engineer in Training status with the Massachusetts Board of Registration of Professional Engineers.

PUBLICATIONS

Procedure for Evaluating Nuclear Power Plant Relay Seismic Functionality, NP-7148-SL, Electric Power Research Institute, Final Report, December 1990, coauthor.

Regan, J., Haller, C., and Carritte, R., “Benefits of a Control System Design Process Which Involves Operators and Accounts for Installation Requirements,” 1993 International Conference on Simulators, Modeling, and Training: Conference Proceedings.

Claude, E. J. and Carritte, R. M., “Increasing Product Yields With Automated Vision Systems,” Medical Device & Diagnostic Industry, Volume 22 Number 5, May 2000, pp. 158-169

Guidelines for Electromagnetic Interference Testing of Power Plant Equipment, EPRI 1000603; Revision 2 to TR-102323, Electric Power Research Institute, Final Report, November 2000, contributing author.

Generic Qualification of the Rosemount 3051N Pressure Transmitter: Summary of Activities and Results, EPRI 1001468, Electric Power Research Institute, Palo Alto, CA: Final Report, June 2001, contributing author.

Electrical Connector Application Guidelines, EPRI 1003471, EPRI Nuclear Maintenance Applications Center (NMAC), Final Report, December 2002, coauthor.

Cunningham, J., Carritte. R, and Shank. J., “Updating Electromagnetic Compatibility Testing Standards,” Fourth American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Controls and Human-Machine Interface Technologies (NPIC&HMIT 2004): Conference Proceedings, September 2004

Guidelines for Electromagnetic Interference Testing of Power Plant Equipment, EPRI 1003697; Revision 3 to TR-102323, Electric Power Research Institute, Final Report, November 2004, contributing author.

MPR ASSOCIATES INC ENGINEERS

Jeffery M. Russell

EXPERIENCE SUMMARY

Mr. Russell joined MPR in 1981. Mr. Russell has been involved in analysis, evaluation, and problem solving in connection with fossil-fueled power plants. Areas of expertise include steam cycle evaluations, inspection and diagnosis of fossil-fueled boiler problems, combustion and fuel evaluations, emissions compliance reviews and control system implementation, and plant condition assessment

ACCOMPLISHMENTS SUMMARY

Plasma Gasifier Design

Performed conceptual and detailed design engineering to support development of gasifiers for municipal waste. Design was based on proprietary plasma gasification process. Efforts included development of process model, design of gasification vessel and waste vitrification system, structural design for plasma gasifier island, evaluation of alternative refractories and feeder designs, and definition of interface requirements. Worked with development of operating approach including definition of instrumentation and controls. Solicited and reviewed proposals from vendors for the components of plasma gasifier island.

Coal Gasifier Improvements

Reviewed operation of full-scale test, coal gasifier to identify issues impacting reliability of operation. Developed changes to gasifier components to improve unit safety and operability. Identified maintenance requirements to support reliable operation. Specified changes to components and process to improve coal gasifier operation.

Fuel Evaluations

Conducted reviews of the impact of alternative fuels on coal fired generating stations designed for eastern bituminous coal firing. Alternative fuels evaluated have included:

- western and foreign bituminous coals,
- sub-bituminous coal, including PRB coal,
- orremulsion,
- petroleum coke,
- wood chips,
- bagasse,
- tire derived fuel,
- refuse derived fuel, and
- poultry derived fuel.

Evaluations included review of impact on unit ignition and firing stability, effect on unit capacity, potential for material degradation of coal handling and firing components, effect on unit slagging and ash (bottom, economizer and precipitator), and impact on unit emissions (air, water, and solid waste). For a number of the alternative fuels, test programs have been developed and implemented to quantify the impact of the fuel change on the unit operation. Negotiations with regulatory agencies concerning the findings from the fuel change have been performed. Where required, modifications to existing plant equipment to accommodate the effects of the changes in the fuel have also been developed. The impact of changes in bituminous coal sources on existing generating stations have also been evaluated.

Generating Station Component Evaluations

Investigated specific component problems for generating stations to improve reliability, availability and safety. Evaluations addressed component design, specific failure analyses, operating and maintenance procedures and practices, and nuclear and environmental regulatory issues. Issues evaluated involved feedwater system, main steam system, auxiliary steam system, subcritical and supercritical boiler components, condensate and service water systems, and steam process control systems. Performed extensive component inspections in support of these evaluations. Developed detailed inspection checklists and procedures for boiler and boiler related components.

Steam Cycle Design

Conducted a site studies for combined cycle, low pressure and auxiliary steam cycle systems for generating units. Preliminary evaluations were performed to size and locate components on site. Evaluated cycle thermal efficiency and developed construction cost comparisons. Conceptual design information developed used as basis for redesigning steam cycle.

Boiler Component Design

Designed, procured and installed fossil boiler tube assemblies and regenerative air heaters during retrofit upgrades of existing boilers. Reviewed vendor designs, prepared specifications, inspected fabrication shop, and performed installation review and follow. Evaluated and resolved specific boiler component design, fabrication, and installation problems. Efforts included both heat transfer design

evaluations and detailed mechanical design of boiler components.

Flame Stability and Impingement
Evaluated problems with operation of oil and gas ignitors for several boilers. Field testing and computer modeling of flame combustion and heat absorption were used to diagnose problems. Changes in burner tip design, burner alignment procedures and water wall materials were developed to correct problems.

Clean Air Compliance
Evaluated electrostatic precipitator operational deficiencies including investigations of electrical performance, rapping strategy, temperature and flow maldistribution, and flue gas SO_3 concentration. Evaluations involved extensive field testing and modeling of precipitator behavior. Fuel switching and blending and monitoring modifications as compliance strategies were evaluated. Investigated applicability of flue gas conditioning systems to improve electrostatic precipitator operation. Several flue gas conditioning chemicals and commercial systems evaluated by physical testing, literature review and technical evaluation. Emissions monitoring equipment problems also evaluated and resolved.

NO_X Control Technology Assessment
Designed and tested alternative methods of NO_X control for ozone transport zone emissions compliance. Alternatives evaluated by testing included water injection, over-fire air, biasing, combustion management, and selective non-catalytic reduction (SNCR) systems. Systems were evaluated on both stand alone and combination basis. Utility compliance strategy developed based on comparing test results with potential controls from selective catalytic reduction (SCR) system designed for site. Economic evaluation of the alternative compliance approaches was performed to justify the recommended compliance strategy expenditures.

Selective Catalytic Reduction System Improvement and Stack Plume Control
Evaluated modifications to the ammonia injection grid designs and tuning to improve performance of NO_X reduction and minimize SO_3 impact on air preheater. Developed use of NH_3 injection system to minimize the stack plume by collecting excess flue gas SO_3 in ESP. Evaluated cause of SCR catalyst plugging problems and identified changes to the furnace operation, and design of SCR catalyst protective screens to minimize future impact.

Selective Non-Catalytic Reduction System Improvement
Evaluated modifications to the control and arrangement of selective non-catalytic reduction (SNCR) systems to accommodate changes in fuel characteristics and plant operating patterns. Evaluations included testing to optimize SNCR control configuration. Impact of alternative injector arrangements evaluated both by modeling and field testing. Prepared report for licensing the use of SNCR as continuous control technology.

Steel Structure Analysis and Design
Inspected and evaluated structural adequacy of generating station structures including boiler support systems, casing and buckstay systems, piping, cranes and buildings.

Efficiency Improvements Flue Gas Scrubber Systems
Reviewed operating history of limestone and MgO wet flue gas desulfurization (WFGD) systems to identify improvements in the operation of the chemical process. Evaluated cause of deposits on the absorber liner and recommended corrective action. Modified settings used on hydrocone separators to improve quality of gypsum and waste water contaminants. Identified process improvements in the slaking, spray nozzle design, and dryer operation to improve quality of $MgSO_3$ produces and minimize operating problems Evaluated the impact of WFGD operation on particulate and mercury discharges. Evaluated cause of high particulate loadings and developed corrective actions to improve collection systems.

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Turbine Generator Failure Reviews
Investigated major turbine-generation failures in nuclear generating stations. Water induction potential, turbine pedestal growth, rotor alignment procedures, turbine-generator control system and distribution system instabilities were evaluated. Response of feedwater level control system was determined analytically and through testing. Growth of turbine pedestal due to alkali-aggregate reaction and thermal expansion measured to specify requirements for replacement rotors. Operating procedures revised to accommodate reduced clearances in higher efficiency turbine designs.

EDUCATION

Cornell University, M.E. Structural Engineering, 1981
Cornell University, B.S. Civil and Environmental Engineering, 1980

MEMBERSHIPS

Tau Beta Pi Association
Chi Epsilon Honorary Fraternity
American Society of Civil Engineers

PAPERS

Russell, J. M., N. J. Marrone, S. E. Smith, and K. P. Panzino (Reliant Energy - Cheswick Station), "Operational Changes to Compensate for Excess Flue Gas SO_3 by an SCR Addition," COAL-GEN '05, San Antonio, TX, August 17–19, 2005.

Russell, J. M., J. S. Gratz, S. E. Smith, and K. P. Panzino (Reliant Energy - Cheswick Station), "Use of Ammonia Flue Gas Conditioning to Control SO_3 Emissions and Stack Plume," 8th Annual Electric Utilities Environmental Conference, Tucson, AZ, January 24-26, 2005.

Russell, J. M., W. C. Gibson, and V. N. Bhamidipati (Conectiv), and C. D. Rose (SGS Mineral Services), "Compliance Blending of PRB Coal at B. L. England Station Using Cross-Belt Analyzer," International On-line Analyzer Technical Conference, St. Louis, MO, November 8-10, 2004.

Russell, J. M., M. B. Gillespie, W. C. Gibson and V. N. Bhamidipati (Conectiv), and D. Mahr (Energy Associates, P.C.), "Considerations For Low Sulfur Coal Blending At B. L. England Station," POWER-GEN '03 International Conference, December 9-11, 2003.

Russell, J. M., M. B. Gillespie, and V. N. Bhamidipati, "Dispersion of Ammonia in Flue Gas and Ash," POWER-GEN '99 International Conference Papers, November 29-December 2, 1999.

Russell, J. M., T. J. Zygmunt, and V. N. Bhamidipati, "Implementation and Control of an Over-fire Air System," POWER-GEN '99 International Conference Papers, November 29-December 2, 1999.

Russell, J. M., V. N. Bhamidipati, W. C. Gibson, R. G. Broderick, and D. C. O'Connor, "NO_X Reduction Utilizing Targeted Cyclone Water Injection, Over-fire Air, and SNCR on a Coal-Fire Cyclone Boiler," POWER-GEN '98 International Conference Papers, December 8-11, 1998.

Russell, J. M., V. N. Bhamidipati and D. M. Skedzielewski (Conectiv), R. E. Himes, D. O'Connor, and C. Cataldini (EPRI), "An Assessment of Combined NO_X Control Technologies Versus SCR in Achieving a 0.15 lb/MMBtu NO_X Limit on a Coal-Fired Cyclone Boiler," NO_X Controls for Utility Boilers, 1998 Workshop, August 25-27, 1998.

Russell, J. M., and V. N. Bhamidipati, "Bio-mass for Power Generation," NJ/DEL Biomass Supplier Conference, Sponsored by Delaware Department of Environmental Affairs, June 4, 1998.

Russell, J. M., and V. N. Bhamidipati, "Characterization of Performance and Unit Impact of NO_XOUT® SNCR," Pennsylvania Electric Association Fall 1997 Meeting, September 16-17, 1997.

Russell, J. M., V. N. Bhamidipati, and D. Y. Fong, "Implementation of Tire Derived Fuel Co-firing at B. L. England Station," POWER-GEN '96 International, December 4-6, 1996.

Russell, J. M., "Tire Derived Fuel Co-firing Impact on Unit Performance and Condition," Pennsylvania Electric Association Fall 1995 Meeting, September 19-20, 1995.

Russell, J. M., and V. N. Bhamidipati, "Impact of Tire Derived Fuel Co-firing on Operation of B. L. England Station Unit 1," Pennsylvania Electric Association Fall 1994 Meeting, October 14-16, 1994.

Fred P. Buckingham, Ph.D., P.E.

EXPERIENCE SUMMARY

2001 – Present	MPR Associates, Inc.
1999 – 2001	Electric Power Technologies, Inc. & Clean Fuels Technology, Inc.
1996 – 1998	Triconex Corporation
1977 – 1995	Forney Engineering Company
1975 – 1976	Southwestern Public Service Company

Dr. Buckingham has concentrated his efforts on combustion systems for gas, oil and coal fired boilers, safety systems, process control, project management and business development.

ACCOMPLISHMENTS SUMMARY

Project Management
Dr. Buckingham has been certified as a Project Management Professional (PMP) and has successfully executed numerous projects for electric utility, petro-chemical, and marine clients. Dr. Buckingham executed the first project to implement distributed controls using fiber optic communication for a marine application. He developed processes and procedures for implementation of retrofit projects for electric utility boilers. Dr. Buckingham was executive sponsor for the distributed control system project for Santee Cooper, Cross Station, Unit 1, a fourteen thousand I/O point system that at the time was the largest plant wide DCS implemented.

Burner Equipment
Dr. Buckingham designed numerous burners for oil and gas fired boilers, worldwide. He designed and commissioned the first commercial burner for firing Coal-Water-Mixture fuel in electric utility boilers in North America. Dr. Buckingham designed and applied many igniters, warm-up burners and flame detectors for pulverized coal fired boilers and fluidized bed boilers. Dr. Buckingham has extensive experience in commissioning and troubleshooting combustion equipment in steam boilers.

Fuel Systems
Dr. Buckingham designed fuel handling, blending and delivery systems for many applications. He designed and commissioned pilot scale fuel preparation plants for Coal-Oil Mixture (COM) fuel and Coal–Water Mixture (CWM) fuel. Dr. Buckingham has designed numerous fuel distribution systems for oil, gas, and coal fired multiple burner boilers. Dr. Buckingham has designed and specified coal-handling equipment such as coal feeders and pulverizers.

Safety Systems
Dr. Buckingham has managed and been in responsible charge of many burner management systems for oil, gas, and coal fired boilers. He has designed final control elements (valve assemblies) for large boiler burner management systems. Dr. Buckingham chaired and was an active member of a design review committee for the Interposing Logic System (ILS) for Korea Electric Power Company's Yong Wang Station, Units 3 & 4. Dr. Buckingham has authored and presented two technical papers and presentations on burner management system design.

Control Systems
Dr. Buckingham has managed and supervised many boiler control projects for military and civilian marine applications including boiler controls for the LHD and CVN class ships for the U.S. Navy. Dr. Buckingham designed numerous final control element and transducer applications for coal fired power plants.

Power Plant Systems
Dr. Buckingham designed and specified many power plant systems including hot and cold reheat steam piping design, heater drains piping, for Harrington Station, Unit 2. Steam turbine, boiler feedwater steam turbine and coal feeders for Harrington Station, Unit 3.

Research and Development
Dr. Buckingham performed research and development on many fuel firing concepts and systems. He developed a second generation High Energy Spark Ignition (HESI) product line. Dr. Buckingham developed many specialty fuel atomizer designs for liquid fuels including COM and CWM.

EDUCATION

BSME (1975), The University of Texas at Austin
MSME (1980), The University of Texas at Arlington
Ph.D. (1993), The University of Texas at Arlington

LICENSES

Professional Engineer, State of Texas, License 47271
Professional Engineer, Commonwealth of Massachusetts, License 30718-M
Professional Engineer, State of New York, License 063082

SELECT PUBLICATIONS

Buckingham, F.P. and Lin, D.J.L., “Alternative Burner Designs for Industrial Boilers", *National Engineer*, December 1980.

Buckingham, F.P. and Hickman, R.H., “Combustion of COM" , *Substitutions of Liquid Fuels by Fluid Mixtures of Coal*, Technical Meeting conducted February 17, 1982, Compania de Sevillana de Electridad, Almeria, Spain.

Hickman, R.H. and Buckingham, F.P., “Burner Development for Coal and Water Slurry Fuel", *Fifth Annual Coal Slurry Combustion Symposium*, Tampa, Florida, US. Department of Energy, May 1983.

Haji-Sheikh, A and Buckingham, F.P., “Multidimensional Inverse Heat Conduction Using the Monte Carlo Method", *ASME Journal of Heat Transfer*, 1993, Vol. 115, No. 1, pp 26-33

Buckingham, F.P. and Haji-Sheikh, A., “Heat Transfer in Spray Cooling Using a Binary Flow With Change of Phase", *Transport Phenomena in Nonconventional Manufacturing and Materials Processing,* HTD-Vol. 259, *ASME Winter Annual Meeting*, November 28-December 3, 1993 New Orleans, Louisiana.

Buckingham, F.P., *Heat Transfer in Spray Cooling*, 1993, The University of Texas at Arlington, Arlington, Texas

Buckingham, F.P. and Haji-Sheikh, A., “Cooling of High-Temperature Cylindrical Surfaces Using a Water-Air Spray”, *ASME Journal of Heat Transfer*, Vol. 117, No 4, pp 1018-1027, Nov. 1995

Adamski, Robert S. and Buckingham, F.P., “What the ANSI/ISA S84.01 Standard Means to the Power Generation Business”, *Proceedings of the 1997 Joint power Generation Conference, Volume 1*, November 2-5, 1997, Denver, Colorado, ASME, pp 523-528

Buckingham, F.P., *“Modern Burner Management System Design and Application”*, 1997, Triconex Corporation, Dallas, Texas

McElroy, Michael W., Buckingham, Fred P., and Cox, David B., “Managing NOx for a Competitive Advantage”, Proceedings of Forum 2000 Cutting NOx”, March 2000, The Institute of Clean Air Companies, Washington, D.C.

PROFESSIONAL ORGANIZATIONS

Member, The American Society of Mechanical Engineer

Douglas E. Carroll

EXPERIENCE SUMMARY

2002 – Present MPR Associates, Inc.

Since joining MPR Associates, Mr. Carroll has been involved in a variety of projects relating to mechanical and thermal analysis of power plant components as well as working as the project engineer for a major project with BP Alternative Energy in the Houston area.

ACCOMPLISHMENTS SUMMARY

BP Alternative Energy STG805 Condensing Steam Turbine Addition (2/2006-to present)

Working for BPAE as the project engineer on the addition of a 250 MW condensing steam turbine to an existing cogeneration plant at BP's Texas City Refinery site. Work includes the following responsibilities:

- Review and comparison of EPC bids.
- Design development during a three month FEED process.
- Working onsite and at EPC's engineering offices since project groundbreaking to oversee detailed engineering design and construction, work with EPC and others in schedule and constructability reviews, provide technical interface between BPAE and BP subcontractors/refinery.
- Procurement of all engineered equipment including process design, equipment specification, bid meetings with vendors, detailed design after receipt of vendor information, and installation on site.
- Assurance of compliance with BP engineering standards.
- Development of steam transient analysis to determine impact of turbine and HRSG trips on the cogen and refinery steam systems.
- Development and review of all DCS control logic and HMI graphics with DCS vendor and EPC engineers.

Steam Line Damage Root Cause Evaluation

Performed walkdowns and interviewed plant personnel to determine the root cause of a transient that caused significant damage to the export steam line at a new 240 MW combined cycle cogeneration plant in Mexico supplying steam to a nearby chemical plant. Reviewed operating manuals and plant DCS data to determine the sequence of events before, during, and after the failure. Developed a thermal/hydraulic computer model of the piping system to determine the loads on the piping resulting from a water hammer event and developed recommendations to prevent future transients.

CFB Power Plant Performance Evaluation

Developed analysis to characterize the performance of a circulating fluidized bed power plant with external bed heat exchangers. Used heat and mass balance techniques to benchmark a spreadsheet model and then used the model to determine the change in plant performance with the addition of boiler surface area.

LNG Receiving Terminal Training Program

Developed training materials for operations personnel at a LNG receiving terminal. Materials included training on LNG vaporizers, LNG desuperheaters, LNG transfer operations, and terminal utilities.

CT Exhaust Duct Analysis and Design

Performed walkdowns and calculations to address design issues with ductwork connecting two 5 MW gas turbines with an existing boiler. Performed design calculations for a replacement duct including pressure loss, thermal expansion, insulation design, and flow induced loads. Developed design specification and detailed design package for replacement duct.

FW Pump Clutch Replacement Conceptual Design Package

Developed a conceptual design package to replace an existing feedwater pump clutch with a fluid drive unit. Contacted plants for operating experience with fluid drive, worked with vendors to determine required plant system interfaces, and performed plant cooling system calculations.

EDUCATION

Carnegie Mellon University, B.S. Mechanical Engineering with University Honors, 2002

MPR ASSOCIATES INC ENGINEERS

Robert D. D'Olier, P.E.

EXPERIENCE SUMMARY

Over thirty years of Project Management, Project Engineering, Owner's Engineer, Lender's Engineer, Mechanical Engineering, and Environmental Engineering experience.

ACCOMPLISHMENTS SUMMARY

Owner's Engineer

Mr. D'Olier has provided Owner's Engineer services for a wide range of power and process plant projects. Examples of specific projects assignments completed include:

- Project Manager/Engineer for providing the design, installation and start-up of Turbine Water Induction System additions for PEPCO's coal-fired Dickerson Station.
- Project Engineer for the conceptual design for four biomass power plants to support ethanol and power production. Prepared PFDs, P&IDs, specifications, and bid evaluations for European Bio Power LLC, Hungary.
- Project Engineer for providing start-up assistance, operating procedures, microprocessor control programming, and operator training sessions for a $4M pyrite removal and pollution control system for VEPCO's coal-fired Mount Storm Power Station.
- Project Manager for the addition of 152 nuclear level detectors to three electrostatic precipitators, installation of a CEMS, instrument air systems, and burner ignition systems at Mount Storm.
- Project Engineer/Lead Mechanical Engineer for the conceptual and final design and air permitting of a wood-fired central heating plant for Fort Drum, NY.
- Project Engineer for a 700 MW (16 – GE LM6000s) simple-cycle power plant in Brazil. Responsible for the procurement of $24 Million of Balance of Plant equipment.

Babcock & Wilcox

As Proposition Engineer in B&W's Industrial and Marine Department was responsible for developing designs and cost estimates for package boilers, combustion equipment, burner management systems, pollution control equipment, bio-fuel boilers, recovery boilers, waste heat boilers, heat exchangers, blast furnace hoods, pulverizers, and superheaters and for preparing cost proposals for engineering studies and boiler modification projects.

Due-Diligence and Lender's Engineer

Project Engineer for due-diligence assessments and providing Lender's Engineer services for over 10,000 MW of power plant projects. Mr. D'Olier has been responsible for performing plant inspections, reviewing design and O&M records, reviewing plant contracts, interviewing the owner and O&M staffs, performing environmental assessments and technical reviews, monitoring plant construction, and preparing due-diligence and technical assessment reports. Examples of specific projects completed by Mr. D'Olier include:

- Three coal-fired power plants in Maryland.
- A three-unit 2,460 MW supercritical pulverized coal plant in Pennsylvania.
- The assessment review and construction monitoring of three Shandong Power Project coal-fired plants in the Peoples Republic of China including a 4x300MW plant in Shiheng, a 2x300MW plant in Heze, and a 2x600MW plant in Liaocheng.
- 2x600 MW coal-fired Sual Power Project in the Philippines.
- 900 MW cogeneration plant in New Jersey.
- Three oil-fired power plants in Pakistan.
- 103 MW diesel power plant in the Philippines.
- Two combined-cycle plant in Massachusetts.
- Two coal-fired power plants in New York.
- 600 MW Shajiao "C" coal plant in the Peoples Republic of China.
- 543 MW CoGen Lyondell Project in Texas.
- 500 MW simple-cycle Riverside Generating Company Project in Kentucky.
- 500 MW simple-cycle Heard County Project in Georgia.
- 390 MW simple-cycle Richland Peaking Project.
- 240 MW combined-cycle Pecem Power Project in Brazil.

Environmental Engineering

Mr. D'Olier has provided plant owners and developers with a wide range of environmental engineering services. Specific environmental projects assignments completed include:

- A two-year assignment in England as part of the management team that started Brown & Root Environmental Limited. During this period Mr. D'Olier provided environmental input to Martin Engineering for a waste-to-energy power plant proposal, prepared environmental audits for a large cement works and a scrap recycling facility, and prepared an environmental assessment for a new ammunition incinerator facility.
- Project Manager/Engineer for environmental permitting for Tenneco Power's 75 MWe West Campus Cogeneration/Chilled Water Plant for Texas A & M University.
- Lead Environmental Engineer for a pulp and paper mill expansion project and a new TMP newspaper mill.
- Lead Environmental Engineer for a carbon graphite electrode manufacturing facility.
- Environmental Engineer for the assessment of the TGS Project to finance a gas pipeline expansion program in Argentina.

Expert Witness/Technical Expert

Expert Witness for evaluating technical issues associated with a 125 MW heavy-oil fired power plant in Pakistan. Expert Witness for evaluating technical issues associated with a 128 MW combined cycle power plant in Pakistan. Prepared Expert Reports and provided testimony for these two successful arbitration cases. Technical Expert for evaluating EPC contractor performance for a 620 MW cogeneration plant at a US refinery.

Lender's Engineer

Project Director for the 32,500 BPSD InterOil Refinery Project located in Napa Napa, Papua New Guinea. Project Manager for the Pine Needle LNG Project located in Stokesdale, NC with responsibility for preparing the Technical Review Report and monitoring the construction.

Ecotechniek Thermal Treatment System

Project Engineer for application of the Ecotechniek Thermal Treatment System for the remediation of solid wastes from hazardous waste sites and for the preparation of remediation system designs, air pollution system designs, project costs, air monitoring plans, remedial action plans, and trial burn plans. Prepared plans and cost estimates for the Love Canal, Times Beach, and the Smith Farm proposals.

EDUCATION

University of Connecticut, B.S. Mechanical Engineering, 1969

REGISTRATIONS

Registered Professional Engineer, State of Connecticut, 1976

PAPERS

"DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment", October 2005.

"Performance and Energy Conservation Features of the Ecotechniek Thermal Treatment System" presented at the AWMA 85th Annual Meeting, Kansas City, Missouri, June 1992.

"The Impact of California BACT Determinations on Top-Down BACT," presented at PowerGen '1989, New Orleans, Louisiana, December 1989.

EMPLOYMENT HISTORY

2000 - Present	MPR Associates, Inc.
1981 - 2000	Halliburton Company (NUS, Brown & Root Environmental Limited, Halliburton NUS Environmental Corporation, Brown & Root Engineering Consulting Services)
1977 - 1981	Preferred Utilities Manufacturing Corporation
1973 - 1977	Peabody Engineering Corporation
1969 - 1973	Babcock & Wilcox

Kristin Harper

EXPERIENCE SUMMARY

2008 – Present	MPR Associates, Inc.
2006 – 2007	Virginia Polytechnic Institute and State University – Chemistry Laboratory
2005 – 2006	M/A-Com, Tyco Electronics

Since arriving at MPR in 2008, Ms. Harper has worked on projects for fossil and nuclear power generation facilities. Her experience has included engineering calculations, software simulations, technical evaluations, and report writing.

ACCOMPLISHMENTS SUMMARY

Piping Inspection Program
Oversaw pipe inspections for flow accelerated corrosion (FAC) and degradation in high energy piping (HEP) at multiple sub-critical and super-critical coal plants. Performed hanger inspections to prevent damage to the main steam and reheat piping. Evaluated results to identify likely failure locations.

FAC Evaluation
Identified piping systems and components susceptible to flow accelerated corrosion (FAC) in a super-critical coal-fired generating station. Identified and prioritized locations at risk to FAC.

ISI Program Description
Wrote guidelines on inspecting for FAC in feedwater heater shells as part of an ISI program description that applies to an entire fleet of coal-fired generating stations.

Piping Inspection Program – Database Tracking
Provided guidance on the creation of a Piping Inspection database. Organized all of the flow accelerated corrosion data for 14 coal-fired units, covering over 55 inspection reports that span 20 years of inspections.

Water Usage/Alternatives Analysis
Evaluated the current water usage of multiple coal-fired generating stations. Modeled the inlet water to determine the scale and corrosion properties and predict outlet water properties for once-through and cooling tower systems. Determined what pretreatment options were available in order to use water from a new source. Helped identify ways to reduce a plant's water usage and save over 12,400 gallons per minute.

Corrosion Mitigation
Provided guidance to multiple generating facilities about various material corrosion issues. Topics included sulfuric acid in flue gas ductwork, water corroding rebar with iron leeching through cement, and potential stress corrosion cracking from high cation conductivity levels.

Gland Sealing Steam – Root Cause Analysis
Performed a root cause analysis to determine why excessive leakage was occurring during start-up in an HP turbine of a supercritical, coal-fired generating station. Emphasis was given on investigation of the gland sealing system as a potential contributing factor.

Super-Critical Boiler Design Review
As part of a super-critical boiler design review for a major Indian Utility, conducted calculations to determine the pressure drop through steam piping to verify design calculations.

Support for Simulations to calculate NPSH
Supported multiple safety-significant flow modeling simulations used in calculating the Net Positive Suction Head (NPSH) of HPSI, LPSI, and CS pumps at nuclear power generating stations.

Mercury Reduction Technologies
Investigated multiple mercury reduction technologies and evaluated each of them for use in a sub-critical coal fired generating station.

Nuclear Hydrogen Initiative – SI System
As part of a DOE project to co-produce hydrogen and electricity with a fourth generation nuclear power plant design, evaluated multiple designs for a Sulfur-Iodine (SI) thermochemical cycle to determine its feasibility, technical readiness and technology alternatives for producing hydrogen.

Pressure Part Support Grid Evaluation
Performed an evaluation of the pressure part support grid of a super-critical utility boiler to determine which sections needed to be replaced immediately and which sections could wait until the next outage.

DCD Renewal Submission Scope
Determined the scope of updating the current Design Certification Document for renewal submission. Developed a methodology to collect and simplify over 2,400 figures required for the DCD.

NAC and SAC Simulation with AspenPlus
As part of an upgrade to the DOD Radford Army Ammunition Plant, modeled a nitric acid and sulfuric acid concentration system using AspenPlus software. This model was used to evaluate the feasibility of a vendor proposed design.

EDUCATION

Virginia Polytechnic Institute and State University, B.S. in Chemical Engineer, 2008 (Magna Cum Laude)

Technical University of Denmark, Unit Operations Lab, 2007 (Junior Year Abroad)

Completed the Fundamentals of Engineering (FE) exam in Virginia as first step to Professional Engineering Licensure

MEMBERSHIP

National Society of Collegiate Scholars (NSCS), Member since 2007

Thomas S. Lubnow

EXPERIENCE SUMMARY

1986 - Present MPR Associates, Inc.
1984 - 1986 Virginia Tech, Research Assistant

ACCOMPLISHMENTS SUMMARY

Group Leader – Energy Services

Technical, administrative and commercial manager for $10M+ plus business unit focused on power generation, petrochemicals, and fuels consulting. Group has approximately 50 members and has provided owners engineering and development engineering services for over 20,000 MWe of new generation projects and has performed technical due diligence for over 300 plants. The group is also responsible for MPR project controls (estimating and scheduling) services, design of plant modifications, projects related to operational improvements, root cause investigations and maintenance optimization programs. Mr. Lubnow was responsible for formation of new joint venture company focused on liquefied natural gas project consulting (CH•IV International) and serves as an officer of the company.

Project Management

Responsible for various MPR projects in the competitive power sector. Had lead responsibility for marketing, contract negotiation, project management, and completion of technical work activities. Specific projects for which Mr. Lubnow has had direct responsibility include:

- Acting Design Manager for >$1.2B greenfield uranium enrichment plant. Developed organization, methods and procedures for configuration control and design acceptance for all facility buildings and systems. Supported re-baseline of project cost estimates and helped identify cost savings measures valued at over $100M
- Reviews of the technical and financial viability of greenfield domestic and international independent power plant projects. Projects involving gas turbine, gas turbine-combined cycle, boiler (fluid bed and stoker), hydro turbine, and internal combustion engine technology have been evaluated.
- Conceptual design, development engineering, permitting support and EPC contractor selection for simple and combined cycle natural gas-fired power projects.
- Owner's engineer for 450MWe combustion turbine cogeneration plant in TX.
- EPC specification and contract negotiation for merchant combined cycle and simple cycle combustion turbine power projects.
- Technical and marketing support for developer of biomass-fired boiler and gas turbine cogeneration projects in Brazil.
- Technical due diligence for proposed acquisition of two large gas turbine combined cycle cogeneration facilities in the Southeastern United States.
- Review of operating data to determine potential contribution of prior operating practices to a major failure of a combustion turbine at a 600 MWe combined cycle plant.
- Design review of an advanced gas turbine cycle being considered for use by a utility in a base load generation application.
- Review of the design and manufacture of a heat exchanger design used for fuel pre-heating at a combustion turbine facility.
- Support of a bid evaluation for supply of electric power to a domestic utility.
- Reliability assessment and technical audit of a troubled 200 MWe combined cycle facility.
- Conceptual design and EPC cost estimates for modernization of compressors and gas turbine equipment for a LNG liquefaction and storage facility.
- Technical assistance to a major OEM to resolve potential design problems with advanced gas turbine auxiliary equipment.
- Independent Engineer's review for a gas-turbine combined cycle power plant for a major lender.

Assistant Project Coordinator - Japan

Primary technical responsibility for projects for Japanese nuclear utility clients. Tasks have included reviews of power plant maintenance and operations

practices and various technology studies. Responsible for day-to-day customer contact.

Project Engineer

Responsible for engineering, work planning, and cost estimating for all balance of plant systems during reactivation of the deferred Bellefonte nuclear power plant. Supervised over thirty engineers and technicians from MPR, TVA and other contractors assigned to the project. Accomplishments included identifying and estimating engineering and construction activities required to complete sixty-five balance of plant systems. In addition, initial engineering activities required for these systems were completed. These activities included preparation of system assessments and design basis documents, conceptual design of reactor building cooling and feedwater system improvements, inspection of service water system piping and heat exchangers to determine extent of corrosion and evaluation of the feasibility of reactor coolant temperature reduction.

Directed a project to evaluate the viability of a small, prototypical petrochemical facility consisting of a landfill gas collection and treatment system, a reformer, scrubber/absorber towers, process reactors, distillation columns, a steam boiler, an air-cooled condenser, a 3 MWe steam turbine generator, and several other auxiliary systems. The conclusion of the study was that the concept of the plant was viable. Major design changes, equipment upgrades and changes to operating practices were identified, however, which would be required to successfully operate the plant. Conceptual designs and heat and material balances for plant utility and steam systems were provided.

Responsible for engineering support to a manufacturer of ultrasonic flow measurement systems used in power plant and oil pipeline applications.

Senior Engineer – Materials Engineering and Failure Analysis

Performed material condition assessments to assist in the determination of future economic viability and capital investment strategies for aging fossil-fuel and nuclear power stations.

Prepared reports documenting causes of failures of nuclear and fossil-fired power plant components including a reactor coolant pump shaft, emergency condenser system piping, turbine blades, service water system piping, and heat exchangers. These evaluations required oversight and direction of metallurgical laboratory activities and the performance of stress and fracture mechanics analyses.

Prepared or reviewed procurement specifications for various nuclear and fossil-fired power plant components including a recirculation system pump heat exchanger, service water system piping, turbine rotors, boiler tubing, and steam generator tubing. Performed material condition assessments for systems in nuclear and fossil-fired power plants.

Performed ASME Code stress analyses and fracture mechanics analysis of power plant and process industry pressure vessels and piping.

Performed evaluations of the condition and performance of service water systems at several nuclear and fossil-fired plants. Follow-up activities included technical support and oversight of a large service water system pipe replacement and development of alternative heat exchanger test methods.

Supervised shift operations during successful removal of metallurgical samples from the lower head of the Three Mile Island Unit 2 reactor vessel. Responsible for planning sample removal operations, trouble shooting system operations, and training and supervising equipment operators.

EDUCATION

Virginia Tech, M.S. Materials Engineering, 1986
Virginia Tech, B.S. Engineering Science & Mechanics, 1985

MEMBERSHIPS

President and Co-Founder, Capital Area Energy Association
Member, ASM
Member, Gulf Coast Power Association

CLEARANCES

DOE “Q” Cleared

Nicholas J. Marrone, P.E.

EXPERIENCE SUMMARY

Since joining MPR Associates in 1983, Mr. Marrone has worked in the fossil power and nuclear generation industry in areas ranging from structural and performance analyses to system evaluations. This work has involved design reviews of existing systems and design, procurement, installation and testing of plant modifications. Mr. Marrone is currently the Group Manager for MPR's Energy Service business. Specific examples of Mr. Marrone's experience include.

ACCOMPLISHMENTS SUMMARY

Project Management

Project Engineer on a variety of power plant projects, including power plant siting and material condition assessments, boiler superheater and reheater replacements, and piping system replacements projects. The work included the planning, coordination and technical direction of the design, fabrication, testing, site preparation and thermal/stress analysis activities, development of all design outputs, including the design report, calculations, fabrication and installation drawings, and support of repair fabrication, and installation.

Lead owner's engineer during the detailed design of a fast track 700MW simple cycle power plant. The detailed design and procurement was performed in parallel with construction activities by an EPC vendor who did not have power plant experience. Successfully provided the detailed direction and follow required for the EPC contractor to develop the detailed design within ~4 months.

Performed site assessments of potential power plant locations and assisted merchant plant developer in the preparation of the EPC specification and EPC Contractor qualification. The work included review of the EPC specification and contract.

Project Engineer on the annealing demonstration of a U.S. reactor vessel using electric furnace technology developed in Russia. The project required the technical direction, planning, and coordination of the design, fabrication, testing, site preparation and thermal/stress analysis activities performed by several different organizations. The project also required the coordination of oversight activities provided by several industry and government organizations.

Project Engineer on the design of a repair addressing circumferential cracking of welds in several boiling water nuclear reactor core shrouds. The work included development of all design outputs, including the design report, calculations, fabrication and installation drawings, support of repair fabrication and installation, and support of licensing activities with the NRC. The repair permitted continued operation of the plant with a reduced shroud inspection frequency and scope.

Directed the quality assurance department of a manufacturer supplying radioactive sources and radiographic cameras during the resolution of issues previously identified by the NRC. The work included the analysis, testing and licensing radioisotope transport containers under 10CFR71. Responsibilities included serving as the Interim Quality Assurance Manager, implementation of practices to address the regulatory issues, development of a new quality assurance program to cover an expanded product line and working with the engineering, production, regulatory, marketing and procurement departments to resolve quality and production issues.

Project Manager for the development of the conceptual design for a new thermal energy storage system and wind turbine drive. Follow on work included support of the successful design and testing of a prototype drive train in a 63 KWe wind turbine

Power Plant Material Condition Assessments

Evaluated the physical condition of the balance-of-plant systems at several fossil fuel power plants. Plant designs, operating histories and maintenance histories were reviewed to identify potential problem areas. Non-destructive inspections were specified and the results evaluated. The resulting condition assessment included the identification and prioritization of the modifications required to extend the operating life of the plants.

Technical due diligence assessment of existing power generation facilities. This work included the identification of plant reliability risks and the development of budgetary estimates of the capital investment required to extend the operating life of the plant by 20 years.

Power Plant Performance Assessments

Evaluation of fossil-fired power plant performance, including:

- Combustion and boiler heat transfer analyses
- Boiler performance analyses
- Steam Cycle performance analyses
- Combined Cycle/Cogeneration cycle performance analyses

These analyses resulted in plant modifications and in some cases were used by the utility to evaluate generation alternatives.

Boiler Failure Evaluation and Modification

Participated in the root cause assessment of a number of operation and equipment reliability issues on a CFB boiler. As part this effort, lead a design review of the key boiler systems at the boiler OEM. The work supported the owner's decision to implement a number of hardware and operating modifications.

Modification of the secondary superheater and reheater in several utility boilers. The work included performance testing, independent verification of vendor performance predictions, material selection, the preparation of design, procurement, and installation documents, and the engineering follow of all phases of work. The modifications improved the energy absorption distribution within the boiler and plant reliability and efficiency.

Root cause evaluations of a range of power plant issues including, HRSG and boiler tube failures, plant vibration issue and piping system water hammer events.

Root cause evaluation of boiler vibration when firing high percentage of blast furnace gas. Worked with burner vendor and owner to develop burner modification, which allowed co-firing of up to ~90% BFG with natural gas.

Root cause evaluation of a stacker/reclaimer structural failure at a large coal fired power plant. In addition to supporting the utilities root cause team in determining the likely contributors to the failure, the effort included the development of actions to be taken to reduce the potential for future failures, including the development of conceptual design changes.

Component Design

Design of a modified nuclear plant containment penetration to ASME Code Section III criteria. The work included finite element computer analyses, hand stress calculations, and the development of the design and installation drawings. The modification eliminated uninspectable pressure boundary welds in the penetration and resolved an open licensing issue.

Design of check valve component modifications for oscillating pressure loads. The work included dynamic structural analysis of the valve internals and resulted in the design and installation of several valve modifications.

Pressure vessel design specification certification.

Structural redesign and refurbishment of a rotary air preheater.

Piping System Design

Design of a modified reactor coolant pressure boundary piping and piping support system. The work included finite element computer analyses, hand stress calculations, and the development of the design and installation drawings. The modification resulted in a piping system which is not susceptible to stress corrosion cracking, with larger containment isolation valves and with no increase in the number of seismic restraints which must be maintained by the plant.

Structural evaluation of as-built discrepancies in nuclear power plant piping and support systems. The evaluations demonstrated that sufficient design margin remained to allow the systems to perform their design functions. This permitted the utility to efficiently plan and implement required modifications. Guidelines for use by the utility in performing future "functionality" evaluations were also provided.

Structural evaluation of containment pressure boundary piping and design of a modified support system, including preparation of design and installation drawings. The modification resulted in a piping system capable of surviving transient hydraulic loads

Design of a modified hot reheat piping and pipe support system, including preparation of design and installation drawings and installation specifications. The modification eliminated seam welded pipe which was susceptible to creep failures.

Root cause assessment of cracked piping supports on a main steam line.

System Design Basis Development

Development of a program to create System Design Basis Documents (SDBDs) for a nuclear power plant. This effort was acknowledged by the NRC as an integral part of the utility's design basis reconstitution program. The effort included preparation of procedures and guidelines for writing and controlling the documents, a pilot program to prepare prototype SDBDs, and training of utility personnel. The full-scale program was successfully implemented by the utility with support from MPR.

ASME Section XI – In-service Inspection

Part of a team which developed and presented an ASME Section XI training course for the engineering staff at a nuclear power plant.

Plant Licensing and Design Basis

Vertical slice reviews of nuclear power plant systems. The vertical slice reviews used the methodology of the safety system function inspection (SSFI). The reviews were used by the utility as part of its System Readiness Review Program and resulting justification for restart.

Participated in the preliminary design review of the MOX fuel preparation plant, with responsibility for the review of balance of plant systems.

Station Blackout Assessment

Development of an approach for a nuclear power plant to cope with a station blackout event. The approach considered the ability of the plant to remain subcritical, remove decay heat, maintain adequate reactor coolant inventory, monitor plant conditions, and return AC power to required systems. The approach has been accepted by the NRC and has been implemented by the utility.

Technical Due Diligence of Emerging Technologies

Technical due diligence evaluation of high temperature gas reactor technology and its application to industrial process heat applications, including coal-to-liquids and oil sands production facilities. The assessments included detailed reviews of the technical development and implementation and implementation challenges and the vendor plans to bring the prototype HTGR to commercial operation.

Technical due diligence evaluations of a Stirling Engine based solar power plant technology moving from prototype to commercial scale applications

Miscellaneous Root Cause Evaluations

Numerous Root Cause and Failure Evaluations including, process steam line water hammer do to combination of turbine controls and leaking desuperheating spray valve, LNG unloading line cracking due to water hammer event, switch yard switching failure.

EDUCATION

Princeton University, M.S. Mechanical Engineering, 1983

University of Notre Dame, B.S. Mechanical Engineering, 1981

PUBLICATIONS

"Boiling Water Reactor Core Shroud Repair," Proceedings of the ASME-JSME 4th International Conference on Nuclear Engineering, Book No. 10389E - 1996.

"Boiling Water Reactor Core Shroud Repair," Nuclear Plant Journal, Vol. 13, No. 3, 1995.

"Operability Approach for Piping System Design Basis Reconstitution," ASME PVP, Vol. 285, Book No. 600853, 1994.

"Coke Formation in the Combustion of Isolated Heavy Oil Droplets," Combustion Science and Technology, Vol. 36, Nos. 3 and 4, 1984.

"Droplet Combustion of Residual Oil-Water Emulsions," Combustion Science and Technology, 1983.

MPR ASSOCIATES INC. ENGINEERS

Alan Russell, P.E.

EXPERIENCE SUMMARY

Over 20 years of diverse engineering expertise primarily related to power generation that includes: system and equipment design and performance, design reviews, power plant asset valuation, owner's engineering, project oversight, and environmental and safety protection. This experience encompasses most power generation technologies including fossil-fired steam generation, nuclear power, combustion turbine-based, and geothermal.

ACCOMPLISHMENTS SUMMARY

Cost Estimating

Performed cost estimates of various nuclear power plant construction projects related to control room HVAC, spent fuel storage facilities, power uprate related projects, and others. Supported the project managers in defining the scope of the work and startup activities.

Owner's/Lender's Engineering

Acted as the owner's engineer for the construction of four natural gas-fired combustion turbine power facilities, including review of the design, following the contractor's progress, assessing issues for schedule and cost impact, following startup testing, and ensuring turnover to the plant operators. Also specified and followed construction of a lube oil skid fire suppression system after plant completion. This covered all aspects of the plant design, including the design of the fire protection and detection systems.

Acted as Lender's Engineer for a waste energy project that is applying for a DOE loan guarantee. Activities included review of the technical basis, status of design, cost and schedule reviews, and evaluation of the adequacy of contingency levels.

DOE External Independent Review Support

Participated on several DOE project external independent review (EIRs) teams for Office of Engineering and Construction Management to assess the project's baseline. Reviews assess the technical and management readiness of the projects to support critical funding decisions. Focus was primarily on technical baseline but included cost and schedule baselines. Identified concerns and corrective actions for the project.

Oil Production Facility Safety Assessment

Performed reviews of technical issues identified at an oil production facility to assess potential impact on safety, efforts to address the issue, and design activities. Issues that were reviewed included those associated with fire and gas systems, flare systems, emergency shutdown systems, hydrogen sulfide detection, and communications systems. Developed recommendations to address safety issues and improve management of the issues.

Due Diligence Review

Participated in technical due diligence processes for major energy corporations for the purchase of over 80 power facilities. Tasks included identifying risks and potential value enhancements by performing reviews of EPC contracts and ability of plant to meet obligations, assessing plant technology and design, evaluating outage rates and plant reliability, and evaluating qualifying facility status. Other tasks included evaluating operating and maintenance costs, estimating capital expenditures, evaluating plant feasibility (for a development project), and reviewing pro forma data. This effort has covered combined cycle cogeneration facilities, simple cycle units, geothermal, fossil fuel-fired boilers, and chilled water systems.

In addition, coordinated the activities of one client divesting about 20 assets by preparing the data room, coordinating technical data collection and distribution, identifying potential issues and their impact on valuation, preparing sites for site visits, and coordinating site visits.

Performed reliability reviews of combined cycle and coal fired power facilities to assess their capabilities to meet contractual requirements. This effort included review of operating and maintenance experience, major maintenance plans, and capital expenditure plans to determine long term viability of the facilities.

Performed a technical assessment of a sludge oxidation process to support potential commercialization of the process. Review identified technical needs to address for commercialization, evaluated construction costs, assessed O&M costs of the process, and compared to other sludge handling processes to determine strengths and weaknesses.

Liquefied Natural Gas Facility Fire Protection

Led Front End Engineering and Design of fire protection systems for LNG import terminal development projects for submittal to the Federal

Energy Regulatory Commission. Activities include performing fire and hazards safety evaluations, designing methane vapor generation control features and fire protection systems, and verifying compliance with NFPA codes. Provided owner's oversight of the development of fire hazards analyses and fire protection system design for other LNG terminals under development. Oversight role included verifying the design basis of the features and systems and ensuring owner's risks were considered in the design.

DOE Technical Oversight Activities

Acted as one of DOE's Subject Matter Experts on fire protection and fire safety for oversight of the Mixed Oxide Fuel Fabrication Facility (MFFF). Led DOE's team reviewing the contractor's fire hazards analyses, fire suppression and detection system design, and fire barrier design. Oversight role included verifying the design basis for features and systems, ensure analyses are comprehensive, identifying key project risks, and following contractor progress.

Participated in DOE's licensability review of MFFF with focus on the fire protection sections of the license amendment, ISA summary, and Nuclear Safety Evaluation.

Leading DOE's team reviewing MFFF construction Environmental, Safety & Health program. This includes assessing adequacy of program elements and the implementation of the elements covering environmental protection, safety and health, emergency response, waste management, and radiation protection.

Participated in DOE design review of the Waste Solidification Building in preparation of CD-2 with focus on fire protection systems and the Preliminary Documented Safety Analysis.

Performed technical reviews of the fire hazards analysis for the Los Alamos CMRR project to assess the technical adequacy of the safety basis.

Power Plant Support

Was Acting Technical Support Superintendent for the powerhouse of a bauxite processing facility. Responsibilities included management of projects to improve powerhouse performance and availability, reviewing design modifications, following construction effort for engineering projects, and assessing root causes of equipment failures. Key contributions included improved turbine availability with installation of lube oil purifying equipment, and boiler combustion with improved fuel control system.

Boiler Performance Analysis

Developed models of supercritical fossil-fired boilers and analyzed their thermal-hydraulic response to various transients to identify control system improvements. The task included preparing a transient thermal hydraulic computer model of the boiler, including the gas side and water side flow paths and the control system, identifying transients to model, assessing the results of the model, and identifying control system modification to improve the overall response.

Emissions Controls Assessment

Supported an assessment of mercury emissions controls technologies for a coal-fired boiler to identify effective technologies to meet the plant’s performance, cost, and schedule requirements. The assessment also considered different coals. The assessment helped the client define test requirements and focus engineering design effort.

EDUCATION

Virginia Polytechnic Institute and State University, B.S. Engineering Science and Mechanics, 1985 (Magna Cum Laude)

MEMBERSHIPS/AWARDS

Registered Professional Engineer, Commonwealth of Virginia

Society of Fire Protection Engineers - Professional Member Number 104476

CLEARANCES

U. S. Department of Defense, Secret

U. S. Department of Energy, Q Clearance