Name: Mark A. Gray
Title: Principal Engineer, Primary Systems Design and Repair

EXPERIENCE

Mark A. Gray has over 34 years of experience with Westinghouse. His principal activities involve the evaluation of structural integrity issues for nuclear power plant primary system piping and components. These activities range from ASME Code stress and fatigue analysis to the development of plant life extension and monitoring programs. He has led Westinghouse and industry efforts in evaluating environmentally assisted fatigue effects in ASME component evaluations. He has participated in the development and application of monitoring algorithms and software for the WESTEMS™ Transient and Fatigue Monitoring System. He has also participated in cooperative efforts outside Westinghouse in the development of transient and fatigue monitoring systems.

Mr. Gray has been involved in life extension and license renewal activities at Westinghouse since participating in the first Plant Life Extension pilot study for the Surry Unit 1 nuclear power plant. He co-authored the Westinghouse Owners Group Generic Technical Report on Aging Management for Pressurizers. He also contributed to a similar report covering Reactor Coolant System Piping, and represented Westinghouse before the NRC in their review of the generic reports. He has contributed to development of transient and fatigue monitoring programs for a number of plants, including Comanche Peak, V. C. Summer, Vogtle, Callaway, Wolf Creek, South Texas, Indian Point, Beaver Valley, Beznau, Salem, Harris, D. C. Cook, H. B. Robinson, and Fort Calhoun. These activities have included overall program development, as well as reduction and interpretation of plant historical records and monitoring data for the establishment of baseline fatigue estimates, justification of 40 year transients for 60 years, and identification of improvements to fatigue management programs. He has also performed and directed evaluations of the effects of reactor water environment on fatigue of reactor components for a number of plants, including Harris, H. B. Robinson, D. C. Cook, Beaver Valley, Beznau, Indian Point, Salem, Byron, and Braidwood.

Mr. Gray has extensive experience performing ASME Code stress and fatigue evaluations, and in evaluating actual plant transients, including surge line stratification (NRC Bulletin 88-11), pressurizer insurge/outsurge transients, and thermal stratification and cycling (NRC Bulletin 88-08). With respect to operating plant transient issues, Mr. Gray participated in Westinghouse and industry teams dedicated to evaluating the impact of these issues on stress and fatigue qualifications. He was a member of the team formed by the Westinghouse Owners Group (WOG) program to evaluate surge line stratification for all WOG plants in response to NRC Bulletin 88-11. This team performed numerous evaluations of actual plant surge line stratification data, including reduction of data and characterization of stratification transients, correlation of monitoring data to loadings for heat transfer and stress analysis of stratification in surge lines, and ASME Code stress and fatigue qualifications. He successfully led the Westinghouse Owners Group program on Mitigation and Evaluation of Pressurizer Insurge and Outsurge Transients, to evaluate pressurizer insurge/outsurge transients for Westinghouse plants. This team also evaluated actual plant monitoring data, developed transients to reflect the monitoring data for application in component heat transfer and stress evaluations, and performed ASME Code stress and fatigue qualifications of pressurizer components. He has also led and/or contributed to plant specific activities for evaluation of pressurizer insurge/outsurge transients for Beaver Valley, V. C. Summer, Salem, Comanche Peak, Surry, North Anna, Byron, Braidwood, Harris, H. B. Robinson, D. C. Cook, South Texas Project, and Prairie Island. He also participated on the Westinghouse team contracted by the Electric Power Research Institute (EPRI) to develop tools needed by utility operators to evaluate the thermal-hydraulic mechanisms of stratification, cycling, and striping (TASCS), consistent with the requirements of NRC Bulletin 88-08.

His experience also includes directing and performing analyses of plant systems and components subjected to various loading conditions, to satisfy ANSI and ASME Code requirements. For a number of years, he was lead engineer for fatigue analysis and fatigue related issues affecting class 1 piping and related systems in Westinghouse plants. He was responsible for all design fatigue evaluations of class 1 piping systems and components, as well as evaluation of reported non-design transients for their effects on design requirements. Mr. Gray has had extensive experience in application of finite element analysis, transfer function, and other techniques to evaluate heat transfer, stress and fatigue of components and structures subjected to complex thermal and mechanical loading conditions. He has also developed a working knowledge of power plant fluid systems design bases and operational conformance. He is currently involved in fatigue analysis applications in new plant design.

At Westinghouse, Mr. Gray has developed a substantial understanding of ASME Code requirements, background, and interpretation. He has participated in Pressure Vessel Research Council activities addressing Cyclic Life and Environmental Effects in nuclear plant applications, industry activities of the Materials Reliability Program Issues Task Group on Fatigue, and similar activities as part of the ASME Boiler & Pressure Vessel Code committees. He is a co-instructor for the Westinghouse internal training course on Application of Codes and Standards to Nuclear Components. He has performed and directed numerous evaluations of the impact of reactor water environment on fatigue of piping and components in license renewal applications.

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| EDUCATION | B.S.M.E., University of Pittsburgh, 1981<br>M.S.M.E., Nuclear Certificate, University of Pittsburgh, 2012 |
| PROFESSIONAL AFFILIATIONS | Registered Professional Engineer, Commonwealth of Pennsylvania<br>Member, American Society of Mechanical Engineers<br>Member, ASME Boiler & Pressure Vessel Code Section III Working Group on Piping Design<br>Vice Chair, ASME Boiler & Pressure Vessel Code Section III Working Group on Environmental Fatigue Evaluation Methods<br>Member, EPRI Environmentally Assisted Fatigue Focus Group |
| PUBLICATIONS | "Finite Element Analysis of Piping Trunnions for Fatigue Loadings", M. A. Gray and D. H. Roarty, ASME Publication PVP-Vol. 120, June 1987.<br><br>“Evaluation of Thermal Stratification in PWR Pressurizers”, M. A. Gray and E. L. Cranford, ASME Publication PVP-Vol. 388, August, 1999.<br><br>“Fatigue Aging Management Reconciliation of 40-Year Transients for 60-Year Application”, E. L. Cranford, M. A. Gray, L. E. Sheffield, *Transactions*, SMiRT 16, Washington D. C., August 2001.<br><br>“Reduced Life Cycle Costs and Improved Analysis Accuracy Utilizing WESTEMS Integrated Modeling Methods”, E. L. Cranford, M. A. Gray, R. Kabir, PVP2002-1325, ASME PVP 2002.<br><br>“Advanced Methods for Monitoring Operating Transient and Fatigue Cycles”, M. A. Gray and E. L. Cranford, Second International Conference on Fatigue of Reactor Components, EPRI/OECD NEA/CSNI/USNRC, July 2002.<br><br>“Analysis Continuity Considerations and Methods Used in Fatigue Monitoring”, E. L. Cranford and M. A. Gray, PVP2003-1783, ASME 2003. |

“Life Cycle Management of PWR Pressurizer”, K. K. Dwivedy, N. J. Shah, M. A. Gray, Transactions, SMiRT 17, Prague, CR, August 2003.

“Predicting Steam Generator Auxiliary Feedwater Nozzle Thermal Stratification Transients and Fatigue Effects in Complex Systems,” E. L. Cranford, M. A. Gray, S. Sahgal, PVP2005-71403, ASME 2005.

“Application of Environmental Fatigue Penalty Factors and Implications for Design Analyses,” M. A. Gray, E. L. Cranford, P. R. Donavin, PVP2006-ICPT11-93982, ASME 2006.

“Simulation of a PWR Residual Heat Removal System for Component Fatigue Monitoring,” E. L. Cranford, M. A. Gray, Transactions, SMiRT 19, Toronto, Ontario, August 2007.

“Simulation of Reactor Pressure Vessel Internals Thermal Stress Due to Internal Heat Generation and Environmental Boundary Conditions Using Stress Transfer Functions,” M. A. Gray, E. L. Cranford, C. B. Gilmore, S. G. Guillot, C. Y. Yang, PVP2008-61394, ASME 2008.

“Evaluation of Improved Methods for Plant Data Validation in Automated Fatigue Monitoring,” E. L. Cranford, M. A. Gray, J. L. Shychuck, H. Haegeli, B. Blokker, PVP2009-77826, ASME 2009.

“Strain Rate Calculation Approach in Environmental Fatigue Evaluations,” M. A. Gray, M. C. Salac, D. H. Roarty, E. L. Cranford, PVP2010-25947, ASME 2010.

“Method for Selecting Stress States for Use in an NB-3200 Fatigue Analysis,” T. L. Meikle, E. L. Cranford, M. A. Gray, PVP2010-25891, ASME 2010.

“Simulation and Evaluation of Thermal Stratification in a Sloped Surge Nozzle Correlated with Plant Measurements,” T. L. Meikle, E. D. Johnson, M. A. Gray, N. L. Glunt, J. D. Burr, PVP2011-57700, ASME 2011.

“Observations from Environmental Fatigue Sample Problem Evaluations,” M. A. Gray, M. M. Verlinich, D. H. Roarty, International Boiling Water Reactor and Pressurized Water Reactor Materials Reliability Program Conference and Exhibition 2012.

Guidelines for Addressing Environmental Effects in Fatigue Usage Calculations. EPRI, Palo Alto, CA: 2012.1025823

“Transient and Fatigue Monitoring Operational Feedback Application and Evaluation,” T. L. Meikle V, W. R. Wetmore III, M. A. Gray, PVP2014-29102, ASME 2014.

“License Renewal Environmental Fatigue Screening Application,” C. T. Kupper, M. A. Gray, PVP2014-29093, ASME 2014.

“Fatigue Monitoring and Assessment: Different Approaches Combined for Lifetime Extension Challenges,” T. Gilman, M. Gray, J. Rudolph, B. Heinz, PVP2015-45659, ASME 2015.

In addition, Mr. Gray has authored or co-authored numerous Westinghouse "WCAP" reports.