

## RESUME

### DOUGLAS C. CRAWFORD

April 2016

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#### Experience:

1/16 to present            Reactor Technology R&D Leader  
Deputy Director, GAIN  
Oak Ridge National Laboratory, Oak Ridge, TN

Coordination and strategic leadership of reactor technology programs and projects, with internal programmatic lead for some projects. Role includes representing ORNL with current and potential sponsors and collaborating with counterparts in other national laboratories.

2/15 to 1/16            Senior Engineering Manager, Plant Analysis  
GE-Hitachi Nuclear Energy, Wilmington, NC

Team performs stress, structural and vibrational analysis and hydraulic analysis and computational fluid dynamics for application to GEH BWR/2-6 plants, ABWR, and ESBWR. Components receiving focus include steam dryers, jet pumps, reactor pressure vessels, and piping. Projects supported include reactor modifications as well as addressing emergent questions from customer plants and utilities and from regulators.

6/12 to 2/15            Senior Engineering Manager, Systems Engineering  
GE-Hitachi Nuclear Energy, Wilmington, NC

Team is responsible for design and evaluation of key systems on GEH BWRs, including main steam, control rod drives, reactor water recirculation, residual heat removal, and the emergency core cooling subsystems. The team is also responsible for the specification and evaluation of key components including motors, pumps, valves, and electrical switchgear and relays, including Safety-Related classification and commercial-grade dedication. Position has required industry and regulator communications on main steam line choked flow calculations and performance of control rod drives. U.S. NRC "Q" Clearance.

10/08 to 6/12            Manager, Fuel Performance and Design  
Global Nuclear Fuel (GE-Hitachi Nuclear Energy), Wilmington, NC

Team includes scope described in previous position (below) plus mechanical design for all fuel bundle components, thermo-mechanical analysis of fuel performance, formal transmittal of fuel and reload design specifications to the GNF factory, Safety-Related classification, and other details related to licensing of GNF fuel and methods. Position required industry updates on GNF fuel reliability technology and industry and regulator communications on performance of control rod drives in the presence of channel bow. U.S. NRC "Q" Clearance.

6/07 to 9/08                      Manager, Materials Technology & Fuel Reliability  
Global Nuclear Fuel (GE-Hitachi Nuclear Energy), Wilmington, NC

Team evaluates in-service performance and reliability of GNF fuel products, including fuel utilization and fuel failures. This requires detailed knowledge of fuel performance phenomena such as cladding corrosion and hydrogen uptake, crud deposition, pellet-cladding interactions, and channel deformation as well as fuel and cladding fabrication processes and characteristics. Team members provide fabrication process technical support to the fuel production operation and are responsible for making and/or approving any updates to fuel and cladding specifications and to provide key technical analysis to motivate or support fuel design changes. The team interacts extensively with reactor engineers and fuel engineers at customer utilities and with many internal organizations, including fuel design and core design personnel, safety analysis, quality assurance, sales and commercial personnel, production operations, and sourcing. Finally, the team also has responsibility to help push GNF fuel technology forward by identifying new fuel design features or materials to enable better utilization or enhance reliability.

2/05 to 6/07                      Department Manager, Nuclear Fuels and Materials  
Deputy Director, Center for Nuclear Fuels and Materials Research  
Idaho National Laboratory

Department of more than 40 (later, 20) people performed reactor fuels and materials R&D including fuels for transmutation systems, low-enrichment fuel for research reactors, coated-particle fuels for high-temperature gas reactors, and some work with fuels and materials for light water reactors. Department work addressed fuel fabrication and process development, properties and microstructure characterization, irradiation testing, and evaluation and modeling of fuel performance and safety. Department also operated the Fuels and Applied Science Building and the Electron Microscopy Laboratory, both radiological laboratories. Personal activities included fuels program management and development (including long-term R&D planning), establishment and enhancement of capabilities, and management responsibilities. Personal technical emphasis was on fast reactor fuel technology and light water reactor fuel performance. Assigned to the Directorate's Employee Safety Team. U.S. DOE "Q" Clearance.

9/00 to 1/05                      Associate Director, Nuclear Technology Division, Argonne National Laboratory  
8/97 to 9/00                      Department Manager, Engineering Division, Argonne National Laboratory

Department performed R&D for fuels programs at ANL-W including development of fuels for transmutation systems and low-enrichment fuel for research reactors and international programs for spent fuel storage and management programs. Worked as System Integration Manager for DOE's Generation IV Lead Cooled Fast Reactor (LFR) and as lead for Advanced Accelerator Applications fuel development. Personal activities included fuels program management and development (including long-term R&D planning), program development for the Transient Reactor Test Facility (TREAT) and Department/Division management responsibilities. Was assigned to Laboratory Nuclear Safety Review Committee. For a time, Department personnel also performed many nuclear materials processing and handling operations.

2/94 to 8/97                      Section Manager, Engineering Division, Argonne National Laboratory

Section performed materials-related R&D in support of spent fuel treatment process development and for waste form characterization activities. Also was responsible for many nuclear materials handling operations (unirradiated) at ANL-W, including storage issues for both U and Pu alloys. Also involved with DOE-Office of Environmental Management's Plutonium Focus Area as Chair of the Technical Advisory Panel.

4/95 to 9/95                      Temporary Assignment to Department of Energy's Nuclear Materials Stabilization Task Group, Washington, D.C.

Provided technical support to DOE program managers regarding plutonium technology issues, including scoping a common procurement of standardized Pu packaging equipment.

12/90 to 2/94                      Nuclear Engineer, Fuels and Engineering Division, Argonne National Laboratory

Responsibilities included planning, conducting, and analyzing experiments for assessing performance of nuclear reactor fuels and materials under irradiation as part of the Integral Fast Reactor Program. Developed irradiation plans for qualification of Mark-V EBR-II driver fuel (recycled U-Pu-Zr) and incorporation of weapons-return plutonium into an Integral Fast Reactor fuel cycle. Also help to set exposure limits for EBR-II core components based on irradiation performance. Assigned to the EBR-II Experiment Safety Review Group until EBR-II shutdown in late 1994.

1/87 to 12/90                      Research Assistant, Department of Nuclear Engineering, University of Michigan

Responsibilities included designing and maintaining laboratory equipment used for constant extension rate tests in high temperature autoclaves and in inert atmosphere.

4/86 to 12/86                      Laboratory Graduate Resident, EBR-II Division, Argonne National Laboratory  
6/85 to 9/85                      Summer Employee, Fuels and Materials Department, EBR-II Division, Argonne National Laboratory

Conducted research addressing the reliability of untempered end plug welds on HT9-clad fuel elements in an IFR; also did some work on other materials-related projects.

9/85 to 3/86                      Teaching Assistant and Research Assistant, Department of  
1/85 to 6/85                      Nuclear Engineering, University of Washington

Assisted with the laboratory class in radiation detection, graded assignments; did some work with the Department's computer account.

5/84 to 7/84                      Summer Student, Hot Fuels Examination Facility, Argonne National  
5/83 to 7/83                      Laboratory

Researched methods for de-cladding metallic fuel elements; did some work with a computerized quantitative metallography system. Investigated methods for removing surface oxides from dysprosium neutron radiography foils; wrote computer program for design of eddy current coils for NDE of irradiated fuels.

6/82 to 7/82                      NORCUS Student, Westinghouse Hanford

Performed high temperature hardness tests of materials for hard-facing LMFBR components; did some metallography and sample preparation.

**Education:**

Ph.D., Nuclear Engineering, University of Michigan, 1991

Ph.D. Dissertation: "The Effect of Grain Boundary Misorientation on the Intergranular Stress Corrosion Cracking Behavior of Ni-16Cr-9Fe in 360°C Argon and High Purity Water," Major Prof. Gary S. Was.

M.B.A., with honors, Executive Program, University of Chicago, 2005

M.A., Bible and Theology, Tyndale Theological Seminary and Biblical Institute, 2013

M.S., Nuclear Engineering, University of Washington, 1986

M.S. Thesis: "An Investigation into the Use of Untempered End Plug Welds on HT9-clad Fuel Elements in the Integral Fast Reactor," Major Prof. Kermit S. Garlid (UW) and Dr. Douglas L. Porter (ANL).

B.S., Metallurgical Engineering, University of Idaho, 1984

Courses taken include: physical metallurgy, pyrometallurgy, hydrometallurgy, corrosion, heat transfer, fluid dynamics.

**Honors and Awards:**

April 2008 GE Hitachi Nuclear Quality Cup Team Member,  
ANS Materials Science and Technology Division 2006 Significant Contribution Award,  
ANS 1996 Young Member Engineering Achievement Award,  
ANL Exceptional Performance Awards,  
ANS Materials Science and Technology Division Scholarship,  
Tau Beta Pi, Phi Gamma Delta chapter Outstanding Senior,  
Ziegler Foundation Scholarship at University of Idaho,

**Professional Activities:**

Participant, Fuels and Materials Subgroup of the OECD/NEA Working Party on Partitioning and Transmutation, 2002-2003.

U.S. DOE National Laboratory Review Committees

Idaho National Laboratory Institute for Nuclear Energy Science and Technology – Nuclear Fuels and Materials Steering Committee, 2010-2012

Idaho National Laboratory High Performance Research Reactor Fuel Development Technical Review Committee, 2013-present

Lawrence Livermore National Laboratory LDRD Proposal Review, 2009

Los Alamos National Laboratory Nuclear Engineering and Technology Capability Review, 2011

Co-chair, Fuels and Materials Crosscut Group, US DOE Generation IV Roadmap, also participant on Fuel Cycle Crosscut Group and Evaluation and Methodology Group, 2001-2002.

Co-chair, Target and Blanket Technical Working Group, US DOE Roadmap of Accelerator Transmutation of Waste, 1999.

Participant, US DOE Office of Nuclear Energy, Science, and Technology Roadmap, 1998.

University of Idaho: Affiliate Faculty; College of Mines and Earth Resources Advisory Board, 1996 to 2002; Dept. of Materials Science and Engineering Advisory Board, 2004 to 2007.

Chair, Technical Advisory Panel of the US DOE Plutonium Focus Area, Oct. 1995 to Sept. 1996.

Site Assessment Team Leader, US DOE ES&H Plutonium Vulnerability Assessment, 1994.

American Nuclear Society

Chair, Vice Chair, National Program Committee

Chair, Vice Chair, Idaho Section

Chair, Vice Chair, Program Chair, Mats. Sci. and Tech. Division

Technical Program Chair, 2001 ANS Winter Meeting

Technical Program Committee, 2000 International Meeting on Light Water Reactor Fuel  
Performance

Assistant Technical Program Chair, 1996 ANS Annual Meeting

Assistant Chair and Proceedings Editor, "International Symposium on Fuels for Liquid Metal  
Reactors"

Track Leader for Track 9: Fuel Cycle and Waste Management, Eighth International Conference on  
Nuclear Engineering (ICONE-8), April 2-6, 2000

## LIST OF PUBLICATIONS

**DOUGLAS C. CRAWFORD**

April 2016

### Journal Publications

Y. J. Kim, R. Rebak, Y-P Lin, D. Lutz, D. Crawford, A. Kucuk, and B. Cheng, "Photoelectrochemical Investigation of Radiation-Enhanced Shadow Corrosion Phenomenon," Journal of ASTM International, Vol. 7, No. 7 (2010) Paper ID JAI102592.

S. T. Mahmood, P. E. Cantonwine, Y-P Lin, D. C. Crawford, E. V. Mader, K. Edsinger, "Shadow Corrosion-Induced Bow of Zircaloy-2 Channels," Journal of ASTM International, Vol. 7, No. 9 (2010) Paper ID JAI103036.

Douglas E. Burkes, Randall S. Fielding, Douglas L. Porter, Douglas C. Crawford, Mitchell K. Meyer, "A US Perspective on fast reactor fuel fabrication technology and experience part I: metal fuels and assembly design," Journal of Nuclear Materials 389 (2009) 458-469.

D. Petti, D. Crawford, N. Chauvin, "Fuels for Advanced Nuclear Energy Systems", MRS Bull., Vol. 34, No. 1 (January 2009) 40-45.

T. R. Allen, K. Sridharan, L. Tan, W. E. Windes, J. I. Cole, D. C. Crawford, Gary S. Was, "Materials Challenges for Generation IV Nuclear Energy Systems," Nuclear Technology, Volume 162, No 3 (June 2008) 342-357.

T. R. Allen and D. C. Crawford, "Lead-Cooled Fast Reactor Systems and the Fuels and Materials Challenges," Science and Technology of Nuclear Installations, vol. 2007, Article ID 97486, 11 pages (2007). doi:10.1155/2007/97486

Douglas C. Crawford, Douglas L. Porter, Steven L. Hayes, "Fuels for sodium-cooled fast reactors: US perspective," Journal of Nuclear Materials 371 (2007) 202–231.

Douglas C. Crawford, Douglas L. Porter, Steven L. Hayes, Mitchell K. Meyer, David A. Petti, Kemal Pasamehmetoglu, "An approach to fuel development and qualification," Journal of Nuclear Materials 371 (2007) 232–242.

L. C. Walters, D. L. Porter, and D. C. Crawford, "Nuclear Fuel Considerations for the 21<sup>st</sup> Century," International Seminar on Advanced Nuclear Energy Systems Toward Zero Release of Radioactive Wastes, in Progress in Nuclear Energy, Vol. 40, No. 3-4 (2002), pp. 513-521.

G. S. Was, V. Thaveprungsriporn, D. C. Crawford, "Grain Boundary Misorientation on Creep and Cracking of Nickel-base Alloys," JOM, 50 (1998) 44-49.

Editor, "Proceedings of the International Symposium on Fuels for Liquid Metal Reactors," Chicago, IL, November 15-20, 1992, published in Journal of Nuclear Materials 204 (1993) 1-270.

D. C. Crawford, C. E. Lahm, H. Tsai, and R. G. Pahl, "Performance of U-Pu-Zr Fuel Cast into Zr Molds," Journal of Nuclear Materials 204 (1993) 157-164.

C. E. Lahm, J. F. Koenig, R. G. Pahl, D. L. Porter, and D. C. Crawford, "Experience with Advanced Driver Fuels in EBR-II," Journal of Nuclear Materials 204 (1993) 119-123.

R.G. Pahl, D.L. Porter, D.C. Crawford, and L.C. Walters, "Irradiation Behavior of Metallic Fast Reactor Fuels," Journal of Nuclear Materials 188 (1992) 3-9.

D.C. Crawford and G.S. Was, "The Role of Grain Boundary Misorientation in Intergranular Cracking of Ni-16Cr-9Fe in 360°C Argon and High Purity Water," Metallurgical Transactions A, 23A (1992), 1195-1206.

D.C. Crawford and G.S. Was, "Grain Boundary Character Distributions in Ni-16Cr-9Fe Using Selected Area Channeling Patterns," Journal of Electron Microscopy Technique, 19 (1991) 345-360.

### **Proceedings and/or Presentations**

K. L. Ledford, A. A. Lingenfelter, R. J. Schneider, P. E. Cantonwine, M. N. Jahingir, K. Hida and D. C. Crawford, "GNF Defense in Depth 2010 Update," Proceedings of 2010 LWR Fuel Performance/Top Fuel/WRFPM, September 26-29, 2010, Orlando, Florida, USA, Paper 106.

A. A. Lingenfelter, R. J. Schneider, P. E. Cantonwine, B. Moore, J. Rea, M. N. Jahingir, and D. C. Crawford, "GNF Defense in Depth 2009 Update," Proceedings of Top Fuel 2009, September 6-10, 2009, Paris, France, Paper 2124.

P. Cantonwine, D. Crawford, M. Downs, B. Joe, T. Bahensky, J. Reimer, C. del laHoz, K. Petersen, M. Reitmeyer, J. Morris, A. Zbib, "Channel - Control Blade Interference Management at LaSalle 1 and 2 during 2007 and 2008," Proceedings of Top Fuel 2009, September 6-10, 2009, Paris, France, Paper 2154.

D. C. Crawford, R. J. Schneider, and A. A. Lingenfelter, "GNF Fuel Performance Update," American Nuclear Society 2008 Winter Meeting, Reno, NV, November 9-13, 2008, Trans. Am. Nucl. Soc., 99 (2008).

P. E. Cantonwine, A. A. Karve, Y. P. Lin, S. T. Mahmood, D. W. White, and D. C. Crawford, "GNF Channel Performance and Success in Mitigating Channel Distortion and Cell Friction," 2008 Water Reactor Fuel Performance Meeting, October 19-23, 2008, Seoul, Korea, Paper No. 8078

B. A. Hilton, S. L. Hayes, M. K. Meyer, J. R. Kennedy, D. C. Crawford, G. S. Chang, R. G. Ambrosek, "Irradiation Tests and Post-irradiation Examination of Metallic Alloy and Nitride Based Transmutation fuels," Proceedings of ICONE 12: 12<sup>th</sup> International Conference on Nuclear Engineering, April 25-29, 2004, Arlington, Virginia, paper no. 49597.

T. R. Allen and D. C. Crawford, Fuel And Materials Needs For Generation IV Nuclear Energy Systems, Proceedings of ICAPP '03, Cordoba, Spain, 2003, American Nuclear Society, paper 3237.

D. C. Crawford, M. K. Meyer, S. L. Hayes, and J. J. Laidler, "Requirements and Long-term Development Plan for Fast-Spectrum Transmutation Fuels in the U.S.," Seventh Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation, Jeju, Korea, October 14 – 16, 2002, OECD-NEA, pp 465 - 476.

J. R. Kennedy, M. K. Meyer, S. L. Hayes, D. C. Crawford and G. C. Knighton, "Fabrication and Characterization of TRU Alloys as Actinide Transmutation Fuels," Proceedings of the 2002 International Conference on Nuclear Engineering (2002 ICONE), Las Vegas, NV, 1-5 April 2002.

S. L. Hayes, M. K. Meyer, D. C. Crawford, G. S. Chang and F. W. Ingram, "Irradiation Testing of Actinide Transmutation Fuels in the Advanced Test Reactor," Proceedings of the Conference on Accelerator Applications/Accelerator Driven Transmutation Technology and Applications '01 (AccApp/ADTTA-01), Reno, NV, 12-15 November 2001.

M. K. Meyer, S. L. Hayes, D. C. Crawford, R. G. Pahl and H. Tsai, "Fuel Design for the U.S. Accelerator Driven Transmutation System," Proceedings of the Conference on Accelerator Applications/Accelerator Driven Transmutation Technology and Applications '01 (AccApp/ADTTA-01), Reno, NV, 12-15 November 2001.

T. R. Allen, D. C. Crawford, and S. L. Hayes, "Materials for Advanced Reactors," Proceedings of the 23rd National Society of Black Physicists Annual Conference," March 15-18, 2000, pp. 41-54.

D. C. Crawford, S. L. Hayes, and M. K. Meyer, "Current U.S. Plans for Development of Fuels for Accelerator Transmutation of Waste," presented at the International Atomic Energy Agency Technical Committee Meeting on Core Physics and Engineering Aspects of Emerging Nuclear Energy Systems for Energy Generation and Transmutation, Argonne, U.S.A, November 28 - December 1, 2000.

D. C. Crawford, A. E. Wright, R. W. Swanson, and R. E. Holtz, "RIA Testing Capability of the Transient Reactor Test Facility," Proceedings of the IAEA Technical Committee Meeting on Fuel Cycle Options for LWRs and HWRs, Victoria, Canada, May 1998, IAEA-TECDOC-1122, pp. 99-109.

P. E. MacDonald, D. C. Crawford, L. E. Neimark, and J. S. Herring, "Technical Basis for the Proposed High Efficiency Nuclear Fuel Program," Proceedings of the IAEA Technical Committee Meeting on Fuel Cycle Options for LWRs and HWRs, Victoria, Canada, May 1998, IAEA-TECDOC-1122, pp. 45-58.

P.E. MacDonald, D. C. Crawford, and J.S. Herring, "The DOE High Efficiency Nuclear Fuel Program," 6th International Conference on Nuclear Engineering (ICONE-6), May 10-15, 1998.

D.D. Keiser, D.C. Crawford, S. Bhaduri, O.N. Senkov, F.H. Froes, and C.F. Yolton, "A Powder Metallurgy Approach for Production of Innovative Radioactive Waste Forms," in Proceedings of the Fifth International Conference on Advanced Particulate Materials and Processes, W. Palm Beach, FL, April 7, 1997, Metal Powder Industries Federation, Princeton, NJ, 1997, pp. 112-119.

T.C. Totemeier, S.L. Hayes, R.G. Pahl, and D.C. Crawford, "Corrosion and Pyrophoricity of ZPPR Fuel Plates: Implications for Basin Storage," presented at the American Institute of Chemical Engineers Spring 1997 National Meeting, Houston, TX, March 10-13, 1997. (abstract only)

D. C. Crawford, S. L. Hayes and R. G. Pahl, "Large-Diameter, High-Plutonium Metallic Fuel Testing in EBR-II," Trans. Am. Nucl. Soc., 71 (1994), pp. 178-179.

D. C. Crawford, C. E. Lahm, and H. Tsai, "Performance of U-Pu-Zr Fuel Cast into Zr Molds," Trans. Am. Nucl. Soc., 66 (1992), pp. 219-220.

C. E. Lahm, J. F. Koenig, R. G. Pahl, D. L. Porter, and D. C. Crawford, "Experience with Advanced Driver Fuels in EBR-II," Trans. Am. Nucl. Soc., 66 (1992), p. 11.

D.C. Crawford and G.S. Was, "The Effect of Grain Boundary Misorientation on Intergranular Cracking of Ni-16Cr-9Fe in 360°C Argon and High Purity Water," in Proceedings of the Fifth International Symposium on Environmental Degradation of Materials in Nuclear Power Systems - Water Reactors, Monterey, CA, Aug. 25-29, 1991, American Nuclear Society, LaGrange Park, Illinois, 1992, pp. 488-494.

J.F. Mansfield and D.C. Crawford, "Thickness Measurement in the Analytical Electron Microscope by Macintosh-based Analysis of Two-beam Convergent Patterns," Proceedings of the XIIth International Congress for Electron Microscopy, San Francisco Press, Inc., San Francisco, 1990, pp. 504-505.

### **Selected Technical Reports**

D. C. Crawford, "Evaluation – Non-Conservative Calculations of MSL Choked Flow Rate," GE Hitachi Nuclear Energy, February, 2013. (GEH proprietary)

D. C. Crawford (lead author), "Error in Main Steam Line High Flow Computational Methodology," GE Hitachi Nuclear Energy 10 CFR Part 21 Safety Information Communication SC 12-18, R2, February, 2013. (GEH proprietary)

D. C. Crawford (lead author), "Critical Characteristics of GNF Safety-Related Fuel Assembly Components," Global Nuclear Fuel, January, 2010, (with revisions in February, 2010 and June 2012). (GNF proprietary)

D. C. Crawford (lead author), "Description of Evaluation and Surveillance Recommendations for BWR/2-5 Plants," GE Hitachi Nuclear Energy 10 CFR Part 21 Safety Information Communication SC 11-05, R0, September, 2011. (GEH proprietary)

D. C. Crawford, "GNF2 Spacer Deformation Performance and Reliability Assessment," Global Nuclear Fuel, June, 2010. (GNF proprietary)

D. C. Crawford and R. Fawcett, "Impact of GNF2 Bent Flow Wing Condition on GESTAR Analyses," Global Nuclear Fuel, May, 2010. (GNF proprietary)

D. C. Crawford, "Cracked Channel 10 CFR part 21 Evaluation," Global Nuclear Fuel, October, 2009. (GNF proprietary)

D. C. Crawford (lead author), "Updated Surveillance Program for Channel-Control Blade Interference Monitoring," GE Hitachi Nuclear Energy 10 CFR Part 21 Safety Information Communication SC 08-05, R0, May, 2008. (GNF proprietary)

D. C. Crawford, M. K. Meyer, and S. L. Hayes, "Requirements for GNEP Transmutation Fuels," INL report no. INL/EXT-07-12468, March 2007.

D. C. Crawford, "Transmutation Fuel Qualification: General Approach," ANL document control no. W7520-0517-00-ES, September, 2002.

F. Venneri, D. C. Crawford, et al., "A Roadmap for the Developing ATW Technology: Target - Blanket Technology," Los Alamos National Laboratory report no. LA-UR-99-3022, September, 1999.

D. C. Crawford, K. A. Bunde, R. W. Swanson, D. Pan, R. L. Burnham, R. D. Haga, T. L. Wright, A. E. Wright, and S. L. Hayes, "Defense Programs Testing in TREAT," Argonne National Laboratory, December, 1998.

D. C. Crawford, S. A. Brown-VanHoozer, E. A. Howden, M. K. Meyer, J. R. Krsul, R. D. Haga, C. C. Dwight, G. C. McClellan, D. G. Abbott, and J. E. Werner, "INEEL Candidate Option for Fabrication of Mixed-Oxide Lead Assemblies," U.S. Dept. of Energy Idaho Operations Office, October 1997.

S. L. Hayes, D. C. Crawford and R. G. Pahl, "Test Design Description and Post-irradiation Examination of the HT9 Advanced Driver Fuel Test (X430)," Argonne National Laboratory Report, ANL-IFR-225 (March 1994).

D.C. Crawford, E.J. Hughes, C.D. Griffin, R.D. Haga, D.N. Olsen, and T.P. Zahn, "Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage," Vol. II Appendix B, Part 5: Argonne National Laboratory-West Site Team Assessment Report, DOE/EH-0415, U.S. Department of Energy, September, 1994.

D.C. Crawford, "Background Radiation and Shielding Requirements for FCF Element Inspection Station," September 1993.

D.C. Crawford, "Mark-V/VA Fuel Qualification, Experiment, and Surveillance Plan," April 1993.

D.C. Crawford, "Prediction of Relative Duct Dilation in EBR-II," Fuels and Engineering Division Progress Report, Jan. - Feb., 1993, Argonne National Laboratory Report, ANL-FED-1, pp. 36 - 38.

D.C. Crawford and D.L. Porter, "The Reliability of Untempered End Plug Welds on HT9-Clad IFR Fuel Elements," Argonne National Laboratory Report, ANL-IFR-65, February 1987.

## Patents

D. C. Crawford, D. L. Porter, S. L. Hayes, and R. N. Hill, "Fuel Element Design for the Enhanced Destruction of Plutonium in a Nuclear Reactor," U. S. Patent No. 5,887,044, Issued March 23, 1999.