

Developing the Puzzle Pieces for a Risk-Informed and Performance-based Radiological Consequence Analyses Future

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Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission

Consequence Analysis Related Topics

- Acts and Executive Orders
 - Rulemakings
 - NUREGs and Regulatory Guides
 - Staff Memorandums and Branch Technical Positions.
 - Technical Bases Documents
 - Code Updates

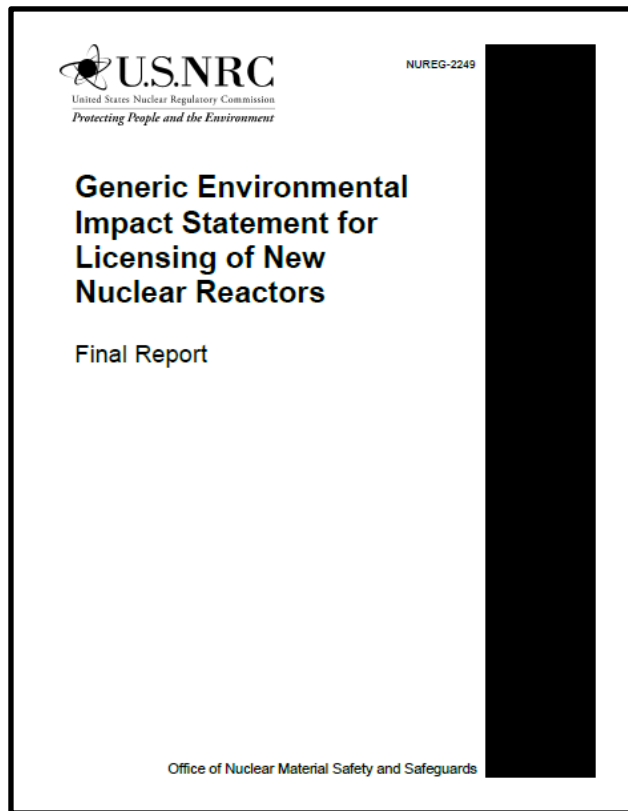
Acts and Executive Orders

- Nuclear Energy Innovation and Modernization Act (Pub. L. 115-439, 132 Stat. 5572) (NEIMA).
- Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (Pub. L. 118-67, 138 Stat. 1448) (ADVANCE Act).
- Executive Order (E.O.) 14300, “Ordering the Reform of the Nuclear Regulatory Commission” (90 FR 22587; May 29, 2025).
- E.O. 14156, “Declaring a National Energy Emergency” (90 FR 8433; January 29, 2025),
- E.O. 14154, “Unleashing American Energy,” (90 FR 8353; January 29, 2025),

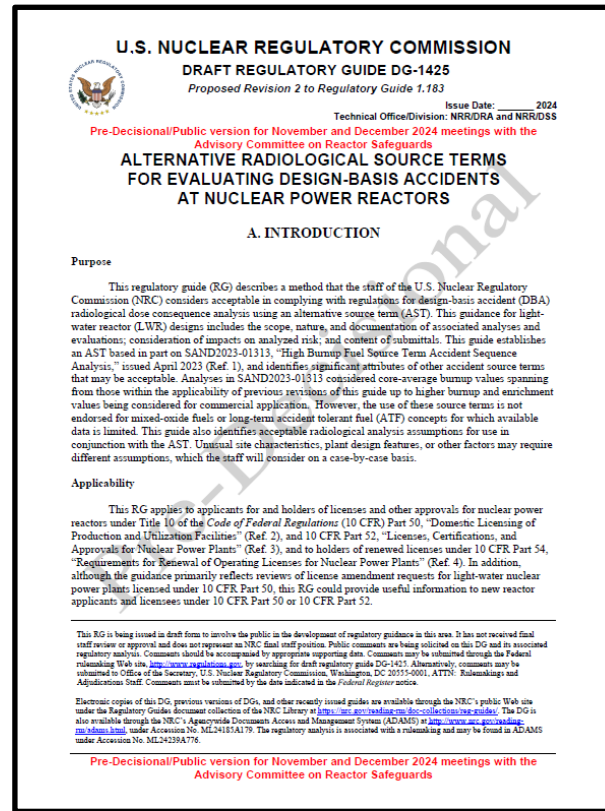
Rulemaking

- **NRC link to [Planned Rulemaking Activities – Rules](#).**
- **Some Notable efforts:**
 - Part 53, “[Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors](#)”
 - Part 51 codifying the “[New Nuclear Reactor Generic Environmental Impact Statement \(NR GEIS\)](#)”
 - Part 57, “[Licensing Requirements for Microreactors and Other Reactors with Comparable Risk Profiles](#)”
 - “[Modernizing Reactor Licensing, Safety Oversight, and Siting Practices](#)”

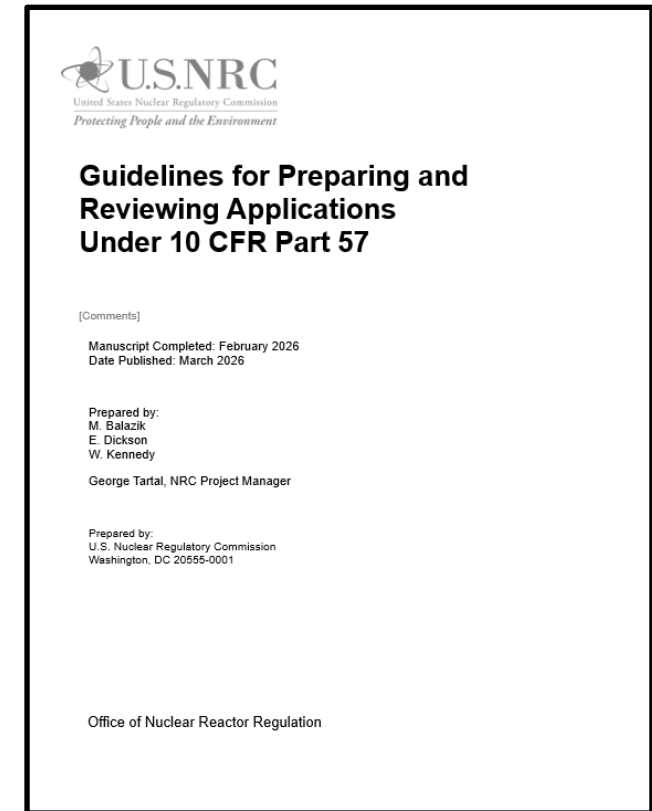
NUREGs and Regulatory Guides Concerning Radiological Consequence Analyses



NUREG-2249, NRGEIS

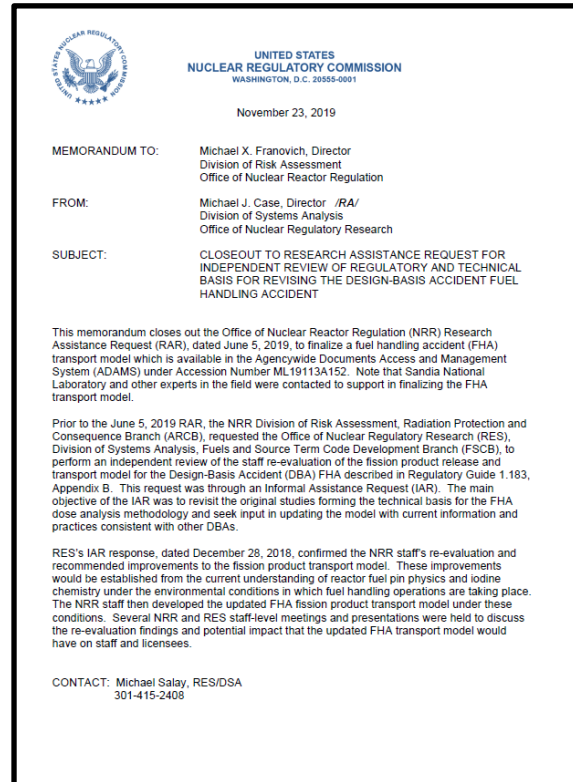


**DG-1425, (RG 1.183 Rev. 2,
2024 ACRS Version)**

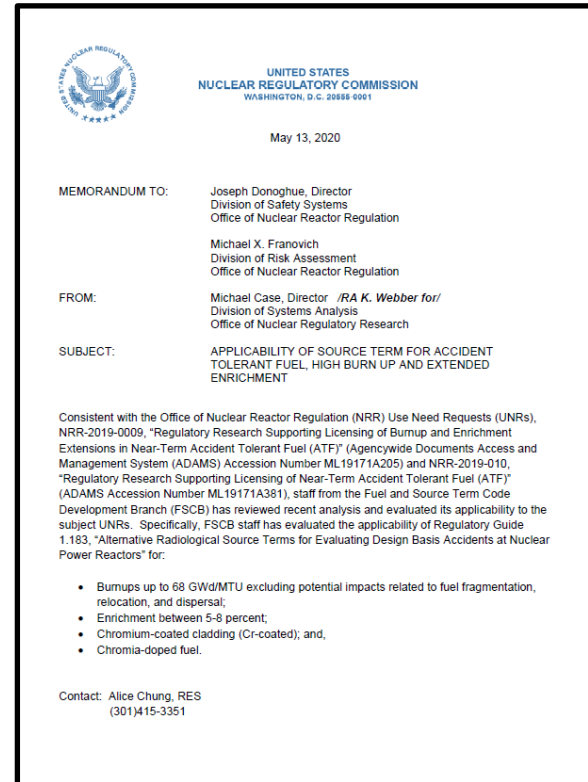


**NUREG-2271, Part 57
Implementation Guidance**

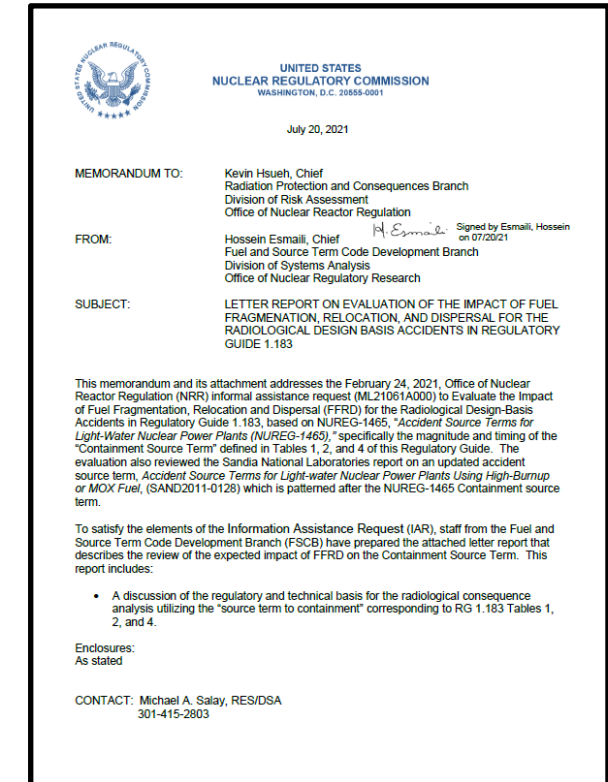
Staff Memos to Risk-Inform Radiological Consequence Analyses



Dickson and Salay, (NRC, 2019)
[Revised FHA](#)

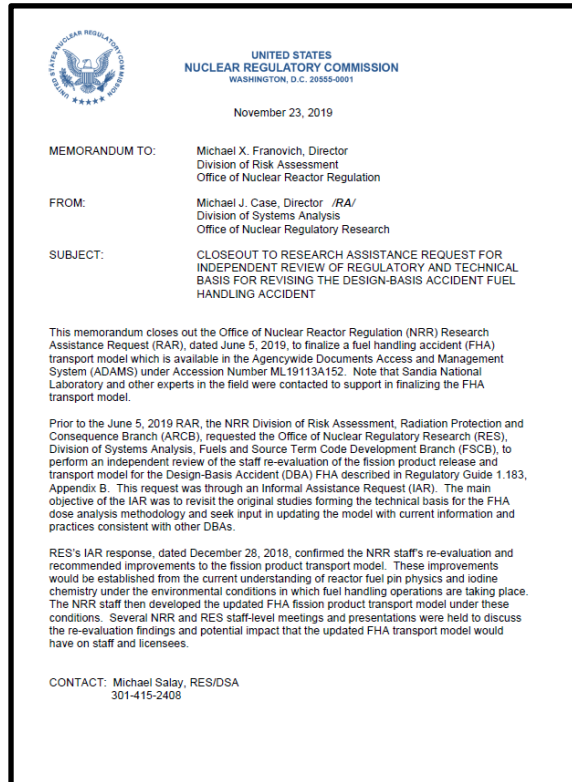


Case, (NRC, 2021)
[Applicability of ATF,
High Burnup, and Extended Enrichment](#)

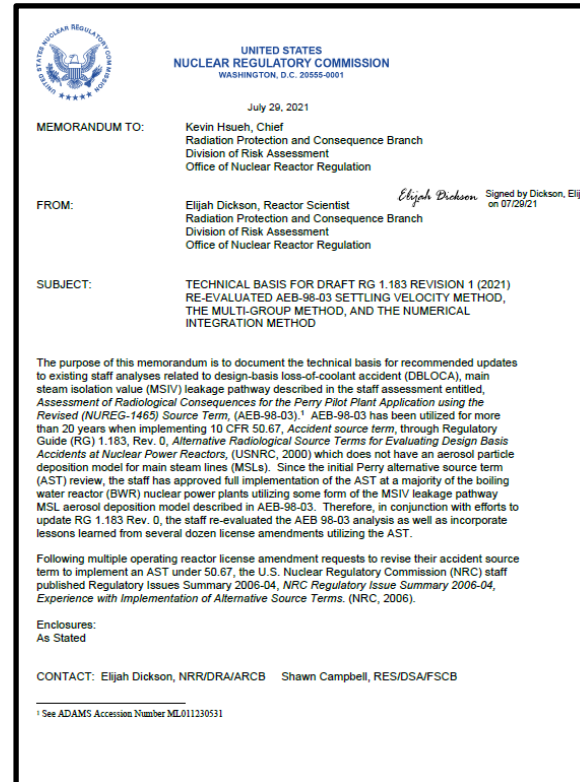


Salay, (NRC, 2021)
[Impact of FFRD on RG 1.183](#)

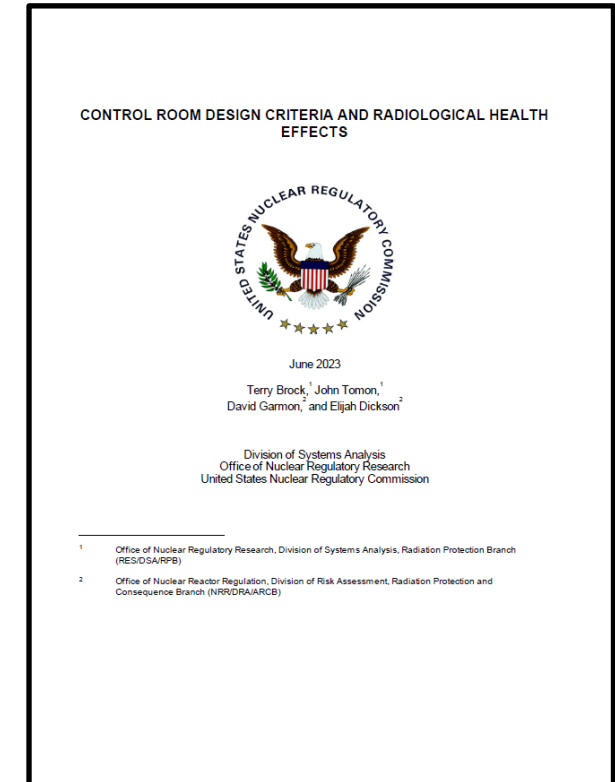
Staff Memos to Risk-Inform Radiological Consequence Analyses (Cont.)



Clifford, (NRC, 2021)
[Non-LOCA Release Fractions](#)




Dickson and Campbell, (NRC, 2021)
[Re-Evaluated AEB-98-03](#)



Brock, Tomon, Gamon,
Dickson (NRC, 2023)
[Health Effects and CR Design Criteria](#)

Staff Memos to Risk-Inform Radiological Consequence Analyses (Cont.)



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 25, 2024

MEMORANDUM TO: Kevin Hsueh, Chief
Radiation Protection and Consequence Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

MEMORANDUM FROM: Elijah Dickson, Senior Reliability and Risk Analyst
Radiation Protection and Consequence Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation *Elijah Dickson* Signed by Dick on 09/15/24

SUBJECT: INCREASED ENRICHMENT RULEMAKING TECHNICAL BASIS FOR DRAFT REGULATORY GUIDE 1.183 REVISION 2 (2024) GRADED RISK-INFORMED PERFORMANCE-BASE CONTROL ROOM DESIGN CRITERIA FRAMEWORK


The purpose of this memorandum is to document the technical basis for the Increased Enrichment Rulemaking technical basis for draft Regulatory Guide 1425 (DG-1425), *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors*. DG-1425 is the proposed revision 2 of Regulatory Guide 1.183 Rev. 1 which does not have a graded risk-informed performance-based control room design criteria framework.

The U.S. Nuclear Regulatory Commission (NRC) is proposing to amend its regulations to facilitate the use of light-water reactor (LWR) fuel containing uranium enriched to greater than 5.0 weight percent uranium-235 (U-235) in title 10 of the Code of Federal Regulations (10 CFR) part 50, "Domestic Licensing of Production and Utilization Facilities"; 10 CFR part 51, "Environmental Protection Regulations for Domestic Licensing and Related Nuclear Power Plants"; 10 CFR part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants"; and 10 CFR part 71, "Packaging and Transportation of Radioactive Material."

This proposed rule would increase the numerical value of the control room design criteria in 10 CFR part 50, appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 19, "Control Room" (GDC-19), and 10 CFR 50.67(b)(2)(iii) from 5 rem to 10 rem (0.05 Sievert (Sv) to 0.10 Sv) total effective dose equivalent (TEDE) but range up to 25 rem (0.25 Sv) TEDE with a consideration of the plant-specific risk profile or risk information. If additional operational flexibilities are needed beyond 10 rem (0.10 Sv) TEDE, facility-specific risk profile or information could be leveraged to justify a higher numerical value up to 25 rem (0.25 Sv) TEDE. To justify a higher value, the NRC proposes a risk-informed, performance-based framework in DG-1425 to balance engineering analysis and judgment, including the principle of defense-in-depth and the incorporation of safety margins, with performance history.

CONTACTS: Elijah Dickson, NRR/DRA 301-415-7647 Sunil Weerakody, NRR/DRA 301-415-2870

Dickson, (NRC, 2024)
Graded Risk-Informed and Performance-Based Control Room Design Criteria



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 5, 2026

MEMORANDUM TO: Hossein Esmaili, Chief
Fuel and Source Term Code Development Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research

FROM: Sean Meighan, Acting Chief
Radiation Protection and Consequence Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation


Elijah Dickson, Senior Reliability and Risk Analyst
Radiation Protection and Consequence Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation *Elijah Dickson*

SUBJECT: TECHNICAL BASIS FOR CONTINUED APPLICABILITY OF GSI-187 CONCLUSIONS FOR CONTINUED USE OF TID-14844 TO DEMONSTRATE COMPLIANCE WITH 10 CFR 50.49 WITH UPDATED ACCIDENT SOURCE TERMS ENDORSED IN LATER VERSIONS OF REGULATORY GUIDE 1.183

The purpose of this memorandum is to document the technical basis for the continued applicability concluded by the U.S. Nuclear Regulatory Commission staff to resolve Generic Safety Issue (GSI)-187, "Potential Impact of Postulated Cesium Concentrations on Equipment Qualification." The staff reached this conclusion in the context of updated accident source terms endorsed in Regulatory Guide (RG) 1.183, Revisions 1 and 2, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," for environmental qualification (EQ) programs governed by Title 10 of the Code of Federal Regulations (10 CFR) 50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants."

The updated accident source terms have continued to demonstrate higher cesium release fractions, along with additional radionuclides not previously emphasized. The new source terms indicate that certain severe accident release characteristics may be more significant than earlier predictions suggested. The evaluation documented by this memorandum follows Commission regulation, policy, and guidance on backfitting and forward fitting pursuant to 10 CFR 50.109, "Backfitting," for assessing previous staff regulatory positions. The evaluation assesses analytical margin within the current licensing-basis EQ programs, using best estimate values with contemporary safety analysis tools. Results demonstrate substantial analytical margin in

Dickson, (NRC, 2026)
GSI-187, EQ, and ASTs



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 6, 2026

MEMORANDUM TO: Tony Nakanishi, Acting Director
Division of Risk Assessment
Office of Nuclear Reactor Regulation

FROM: Victor Hall, Acting Director
Division of Systems Analysis
Office and Nuclear Regulatory Research *Victor E. Hall* Signed by Hall, Victor on 02/06/26

SUBJECT: PUBLICATION OF SAND2026-15948 FOR UPDATING REMOVAL RATES FOR PWR CONTAINMENTS IN RG 1.183 REV. 2

The purpose of this memorandum is to notify NRR of the recent publication of SAND2026-15948, "Pressurized Water Reactor Containment Aerosol Settling Rate for Accident Source Terms" (SNL, 2026) - ML260214079. This report provides updated recommendations for containment aerosol settling rates for Pressurized Water Reactors (PWRs) that are consistent with the revised source term in SAND2023-01313 (SNL, 2023) for integration into DG1425 (RG 1.183 Rev. 2) (NRC, 2026).

Background

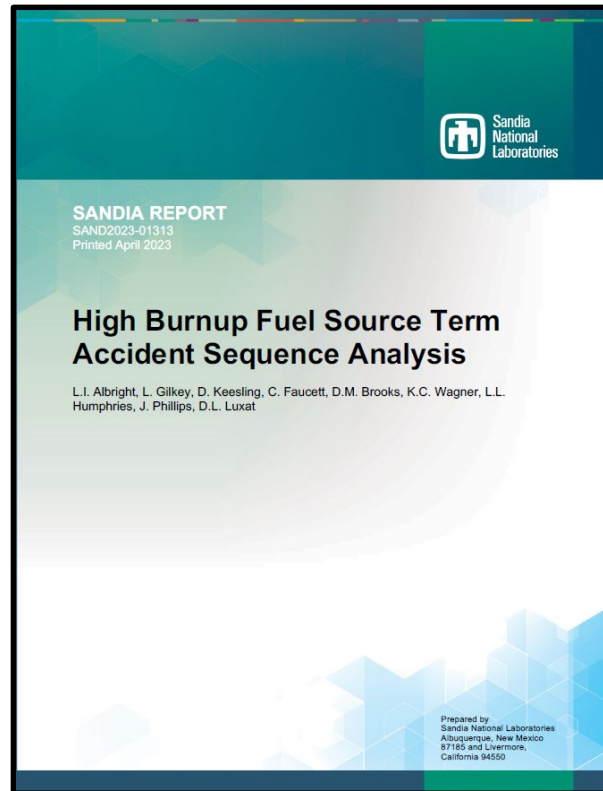
The NRC, with technical support from Sandia National Laboratories, recently developed an updated Alternative Source Term (AST) to facilitate the licensing of Accident Tolerant Fuels (ATFs), increased enrichments, and higher fuel burnups. These updated ASTs have been documented in SNL reports such as SAND2023-01313 (SNL, 2023), SAND2024-10670 (SNL, 2024), and SAND2024-10673 (SNL, 2024). These ASTs have been adopted by DG1425 (RG 1.183 Rev. 2) (NRC, 2026) to demonstrate compliance with 10 CFR 50.67, "Accident Source Term." (64 FN 71990, Dec. 23, 1999).

Reduction in airborne radioactivity in the containment by natural deposition within the containment can be credited to demonstrate compliance with 10 CFR 50.67. Acceptable models for removal of iodine and aerosols are described in Chapter 6.5.2, "Containment Spray as a Fission Product Cleanup System," of the Standard Review Plan (NRC, 2007) and in NUREG/CR-6189, "A Simplified Model of Aerosol Removal by Natural Processes in Reactor Containments" (NRC, 1996). These models are incorporated into the analysis code RADTRAD (NRC, 2016) which performs dose calculations for releases to the environment. In the past, staff have found acceptable the use of NUREG/CR-6189 at the 10th-percentile values. However, the NUREG/CR-6189 models are not recommended in DG1425. SAND2026-15948 provides PWR source term characteristics (removal rates and timings) based on best estimate MELCOR calculations that are applicable to the PWR source term in DG1425.

CONTACT: Shawn Campbell, RES/DSA/FSCB

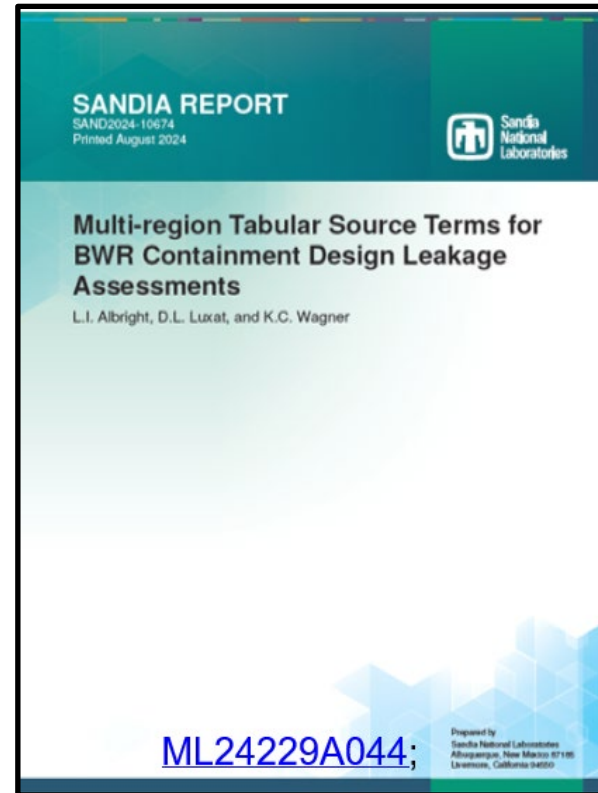
Campbell, (NRC, 2026)
PWR Aerosol Settling

Tech Bases Documents to Risk-Inform Radiological Consequence Analyses



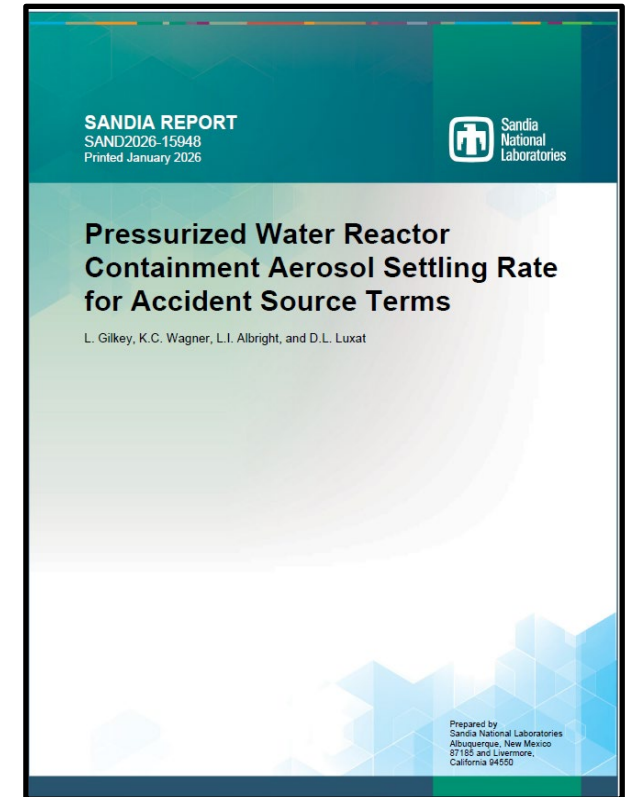
Albright, et. al. (SNL,
2023)

[High Burnup AST](#)



Albright, et. al. (SNL,
2024)

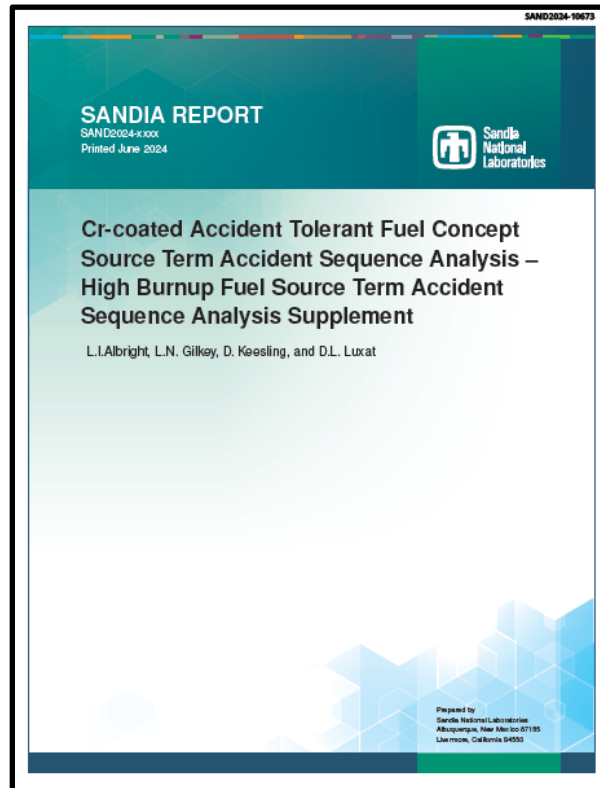
[BWR Multi-Region AST](#)



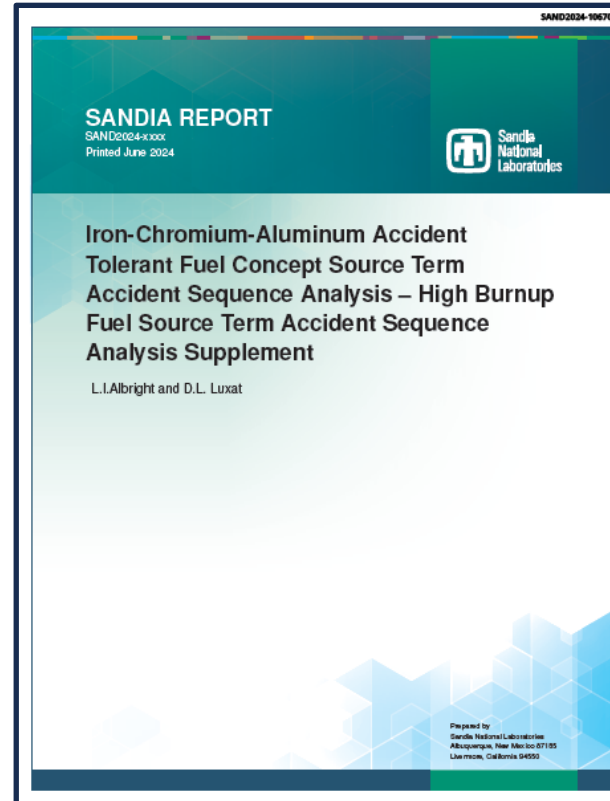
Gilkey, et. al. (SNL,
2026)

[PWR Containment AST](#)

Tech Bases Documents to Risk-Inform Radiological Consequence Analyses

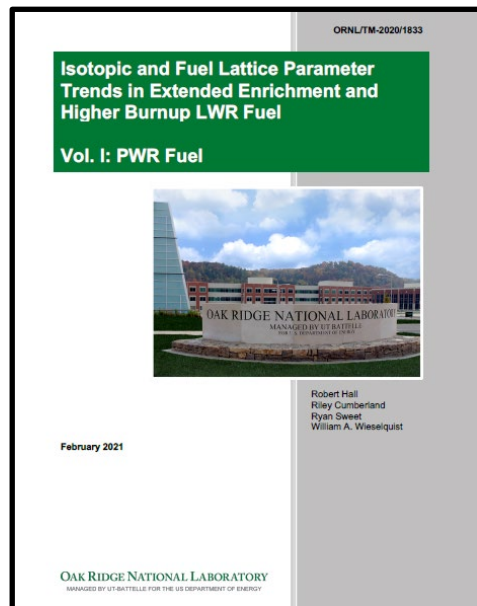


Albright, et. al. (SNL,
2024)
[Cr-coated ATF AST](#)

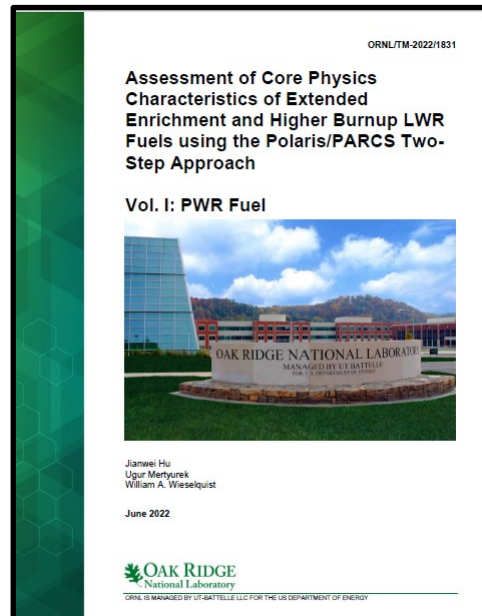


Albright, et. al. (SNL,
2024)
[Iron-Cr-Al ATF AST](#)

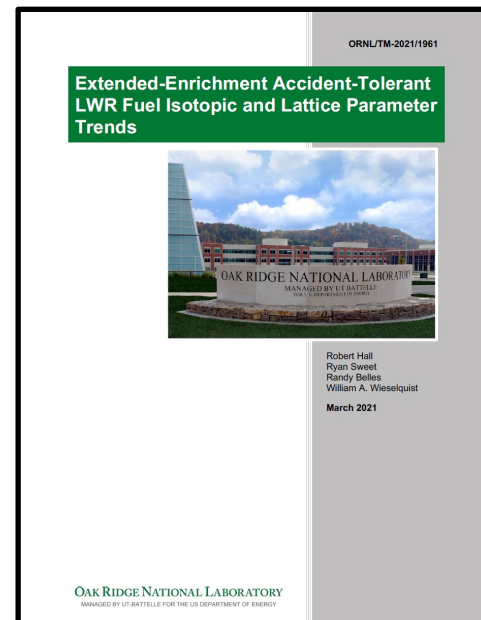
Tech Bases Documents to Risk-Inform Radiological Consequence Analyses (Cont.)



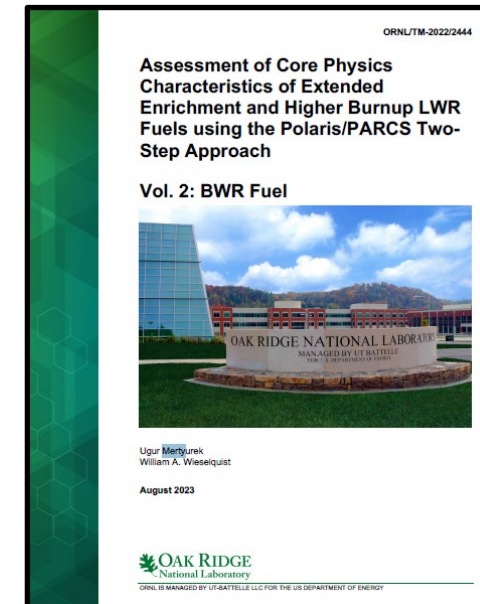
Hall, et. al. (ORNL, 2021)
[PWR: Higher Burnup
Parameter Trends](#)



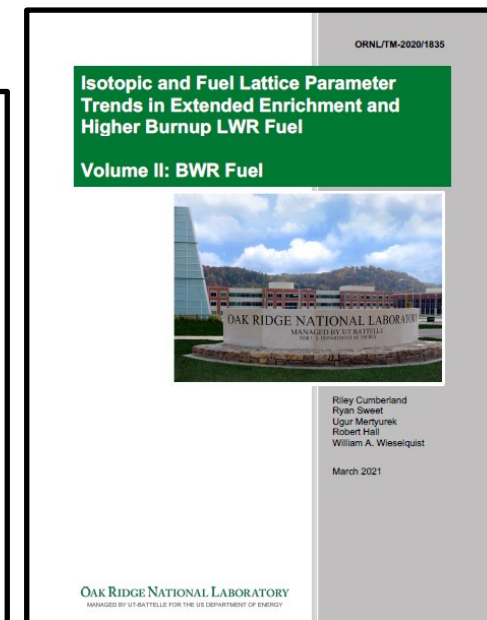
Hu, et. al. (ORNL, 2022)
[PWR: Higher Burnup Core
Physics](#)



Hall, et. al. (ORNL, 2021)
[Extended-Enrichment ATF
Isotopic and Lattice
Parameter Trends](#)



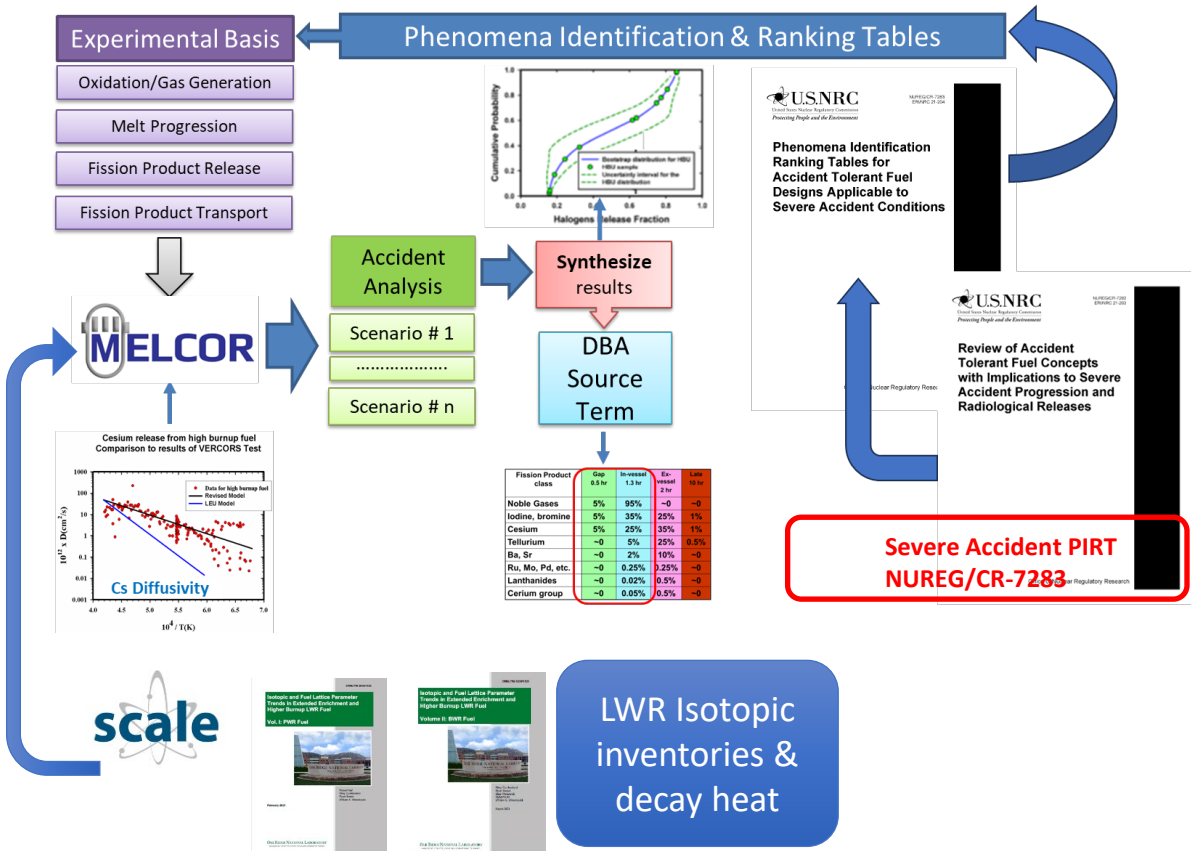
Mertuyrek, et. al. (ORNL,
2023)
[BWR: Higher Burnup Core
Physics](#)



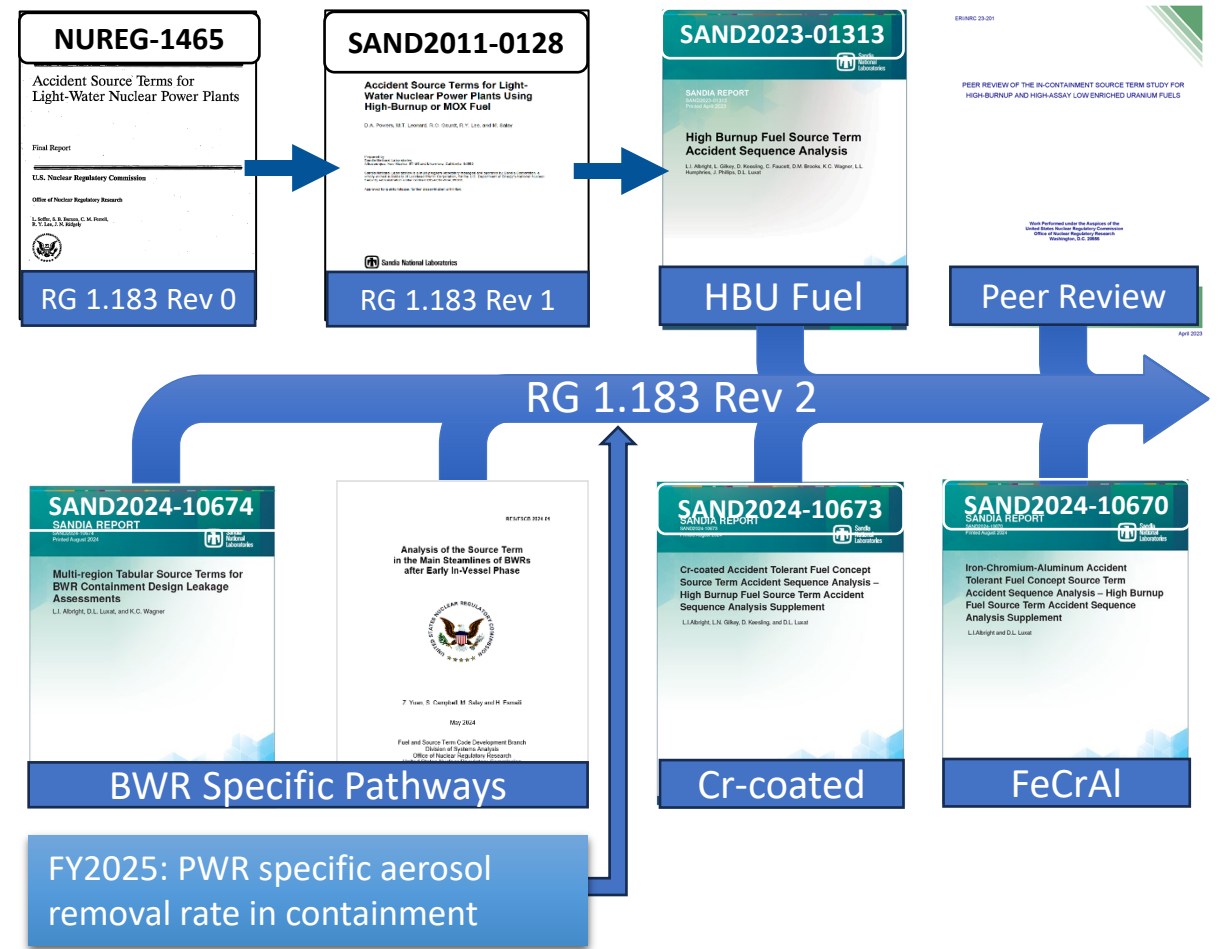
Cumberland, et. al. (ORNL,
2020)
[BWR: Higher Burnup
Parameter Trends](#)

Regulatory Source Term for Advanced Fuels

Process of Developing Regulatory Source Term



Evolution of Technical Basis for Regulatory Guide (RG) 1.183



Some Radiological Consequence Analyses Code Updates...

- RadTrad

- RG 1.183 Rev. 1 and Rev. 2 model implementations:
 - Meteorology
 - Source terms, including MSIV leakage model
 - Revised FHA
 - Gamma Energy Output
 - DAKOTA Uncertainty

- SCALE

- fuel cycle estimator - generate HBU/EE core configurations & inventories for rapid generation of representative inventories for a high burnup core

References

- NUREG-2249, “Generic Environmental Impact Statement for Licensing of New Reactors NREGIS,” Washington, DC, April, 2026 (ML25324A130).
- DG-1425 2024 ACRS Version (RG 1.183, Revision 2), “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” Washington, DC, October 2023 (ML24304A864).
- NUREG-2271-Draft, “Guidelines for Preparing and Reviewing Applications Under 10 CFR Part 57,” Washington, DC, April, 2026 (MLXXXXXXXXXX).
- Dickson, E., NRC, internal memorandum to K. Hsueh, “Example Calculation of Re-evaluated Fuel Handling Accident Fission Product Transport Model for Draft RG 1.183 Revision 1 (2021),” Washington, DC, August 30, 2021 (ML21190A040).
- U.S. Nuclear Regulatory Commission (NRC), “Re-evaluation of the Fission Product Release and Transport for the Design-Basis Accident Fuel Handling Accident” (ML19248C647), Enclosure 4 to internal memorandum from M.J. Case to M.X. Franovich, “Closeout to Research Assistance Request for Independent Review of Regulatory and Technical Basis for Revising the Design-Basis Accident Fuel Handling Accident,” Washington, DC, November 23, 2019 (ML19114A117 (package)).
- Case, M., NRC, internal memorandum to J. Donoghue and M. Franovich, “Applicability of Source Term for Accident Tolerant Fuel, High Burn Up and Extended Enrichment,” Washington, DC, May 13, 2020 (ML20126G376).
- Esmaili, H., NRC, internal memorandum to K. Hsueh, “Letter Report on Evaluation of the Impact of Fuel Fragmentation, Relocation, and Dispersal for the Radiological Design Basis Accidents in Regulatory Guide 1.183,” Washington, DC, July 20, 2021 (ML21197A067).
- Clifford, P., NRC, internal memorandum to R. Lukes, “Technical Basis for Draft RG 1.183 Revision 1 (2021) Non-LOCA Fission Product Release Fractions,” Washington, DC, July 28, 2021 (ML21209A524).
- Dickson, E., NRC, internal memorandum to K. Hsueh, “Technical Basis for Draft RG 1.183 Revision 1 (2021) Re-evaluated AEB-98-03 Settling Velocity Method, the Multi-Group Method, and the Numerical Integration Method,” Washington, DC, July 29, 2021 (ML21141A006).
- Brock, T., Tomon, J., Garmon, D., Dickson, D., “Control Room Design Criteria and Radiological Health Effects,” Washington DC, June 2023 (ML23027A059)
- Dickson, E., NRC, internal memorandum to K. Hsueh, “Increased Enrichment Rulemaking Technical Basis for Draft Regulatory Guide 1.183 Revision 2 (2024) Graded Risk-Informed Performance-Based Control Room Design Criteria Framework,” Washington DC, September 2024 (ML24159A016)

References (Cont.)

- Dickson, E., NRC, internal memorandum to K. Hsueh, “Technical Basis for Continued Applicability of GSI-187 Conclusions for Continued use of TID-14844 to Demonstrate Compliance with 10 CFR 50.49 with Updated Accident Source Terms Endorsed in Later Versions of Regulatory Guide 1.183,” Washington DC, March 2025 (ML26057A158)
- Hall, V., NRC, internal memorandum to T. Nakanishi, “Publication of SAND2026-15948 for Updating Removal Rated for PWR Containments in RG 1.183 Rev. 2,” Washington DC, September 2024 (ML26021A079)
- Sandia National Laboratories, SAND2023-01313, “High Burnup Fuel Source Term Accident Sequence Analysis,” Albuquerque, New Mexico, April 2023 (ML23097A087).
- Sandia National Laboratories, SAND2024-10674, “Multi-region Tabular Source Terms for BWR Containment Design Leakage Assessments,” Albuquerque, New Mexico, June 2024 (ML24229A044).
- L.I. Albright, L.N. Gilkey, D. Keesling, and D.L. Luxat, Sandia National Laboratories, SAND2024-10673, “Cr-coated Accident Tolerant Fuel Concept Source Term Accident Sequence Analysis – High Burnup Fuel Source Term Accident Sequence Analysis Supplement,” Albuquerque, New Mexico, June 2024.
- L.I. Albright and D.L. Luxat, Sandia National Laboratories, SAND2024-10670, “Iron-Chromium-Aluminum Accident Tolerant Fuel Concept Source Term Accident Sequence Analysis – High Burnup Fuel Source Term Accident Sequence Analysis Supplement,” Albuquerque, New Mexico, June 2024.
- L. Gilkey, K.C. Wagner, L.I. Albright, and D.L. Luxat, “Containment Aerosol Settling Rate for Accident Source Terms,” January 2026 SAND2026-15948, (ML26021A079)
- R. Hall, R. Cumberland, R. Sweet, W. Wieselquist, ORNL/TM-2020/1833, “Isotopic and Fuel Lattice Parameter Trends in Extended Enrichment and Higher Burnup LWR Fuel Vol. I: PWR Fuel,” Oak Ridge, Tennessee, February 2021 (ML21088A336)
- J. Hu, U. Mertyurek, W. Wieselquist, ORNL/TM-2022/1831, “Assessment of Core Physics Characteristics of Extended Enrichment and Higher Burnup LWR Fuels using the Polaris/PARCS Two-Step Approach Vol. I: PWR Fuel,” Oak Ridge, Tennessee, June 2022 (ML23012A122)
- R. Cumberland, R. Sweet, U. Mertyurek, R. Hall, W. Wieselquist, ORNL/TM-2020/1835, “Isotopic and Fuel Lattice Parameter Trends in Extended Enrichment and Higher Burnup LWR Fuel Volume II: BWR Fuel,” Oak Ridge, Tennessee, March 2021 (ML21088A354)
- R. Hall, R. Sweet, R. Belles, W. Wieselquist, ORNL/TM-2021/1961, “Extended-Enrichment Accident-Tolerant LWR Fuel Isotopic and Lattice Parameter Trends” Oak Ridge, Tennessee, March 2021 (ML21088A254)
- U. Mertyurek, W. Wieselquist, ORNL/TM-2022/2444, “Assessment of Core Physics Characteristics of Extended Enrichment and Higher Burnup LWR Fuels using the Polaris/PARCS Two-Step Approach Vol. 2: BWR Fuel,” Oak Ridge, Tennessee, August 2023 (ML23279A041)
- Sandia National Laboratories, SAND2026-15948, “Pressurized Water Reactor Containment Aerosol Settling Rate for Accident Source Terms,” Albuquerque, New Mexico, (ML26021A079)