High Burnup Nuclear Fuel

No short-term storage or transport solutions

Docket ID No. NRC-2012-0246

The Nuclear Regulatory Commission (NRC) states they have no safe short-term storage or transportation solutions for high burnup[1,2] spent nuclear fuel:

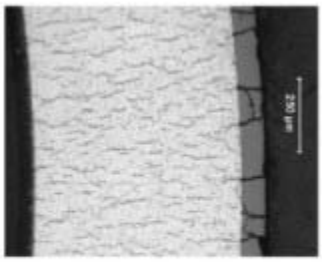
- Insufficient data to approve high burnup dry cask storage for over 20 years,[3] and
- No approved transportation casks to safely move high burnup spent nuclear fuel offsite. *Exceptions approved on a case-by-case basis.*[4]

San Onofre[5] and Diablo Canyon[6] nuclear power plants both use high burnup fuel as do other U.S. nuclear power plants.[7] The NRC approved high burnup fuel about 15 years ago.[8]

High burnup fuel stays in the reactor longer, thus increasing industry profits, but makes us less safe. The NRC defines "high burnup" as fuel that has burned over 45 gigawatt-days per metric ton of uranium (>45 GWd/MTU). However, according to a June 15th, 2013 Department of Energy (DOE) report, experimental data suggests fuel with burnup as low as 30 GWd/MTU shows signs of premature failure.[9]

The NRC has not approved short-term storage and transportation because numerous scientific reports have shown these high burnup fuel problems:

- **Unstable and unpredictable in storage**
  - The protective Zirconium metal cladding around the low enriched (up to 5% U-235) uranium fuel is becoming brittle, making it fragile and subject to shattering. If the radiation breaches the cladding, it can also breach the steel canister and cement cask, release radiation into the environment.
  - High burnup fuel reacts with the Zirconium cladding resulting in hydrides, adding the risk of a hydrogen explosion.



Microscopic View of Fuel Clad Hydrides

- **Hotter and over twice as radioactive**
  - Requires up to a minimum cooling of 20 years in spent fuel pools (instead of 5 years for lower burnup fuel).[10] Fuel cladding temperature must be 400° C (752° F) or less before moving fuel assemblies to dry storage.[11]
  - Requires over double the storage space (of lower burnup fuel) in a permanent geological repository and there are no geological repository designs for high burnup fuel. [12]

The NRC has known for decades of high burnup fuel problems,[13] yet continues to approve use of this fuel. In some cases, it has approved burnup levels up to 62 GWd/MTU.[14]

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The independent U.S. Nuclear Waste Technical Review Board December 2010 report, "*Evaluation of Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel,*"[15] states ***"Argonne scientists reported high burn-up fuels may result in fuel rods becoming more brittle over time.***" And ***"...insufficient information is available on high burnup fuels to allow reliable predictions of degradation processes during extended dry storage.***" It also states

> *Only limited references were found on the inspection and characterization of fuel in dry storage, and they all were performed on low-burnup fuel after only 15 years or less of dry storage. Insufficient information is available on high-burnup fuels to allow reliable predictions of degradation processes during extended dry storage, and no information was found on inspections conducted on high-burnup fuels to confirm the predictions that have been made. The introduction of new cladding materials for use with high-burnup fuels has been studied primarily with respect to their reactor performance, and little information is available on the degradation of these materials that will occur during extended dry storage.*

There is no technology to monitor conditions inside dry casks.[16] According to Argonne scientists, this requires sensors with (1) the ability to endure temperatures above 200 degrees C, (2) the ability to endure radiation levels higher than 1000 rads per hour, (3) a means of "harvesting" the energy inside the container, and (4) batteries that will power the sensors for more than 10 years, and (5), a way to wirelessly transmit the sensor data out of the cask.

Statistics from the Nuclear Energy Institute (NEI):

- High burnup fuel has been stored in dry casks in the U.S. since 2003
- Approximately 200 loaded-casks contain high burn-up fuel
- Most fuel in pools for future loading is high burn-up.[17]

RECOMMENDATIONS

The NRC should stop approving high burnup fuel. The NRC should not approve the Waste Confidence Generic Environmental Impact Statement, since they do not have sufficient data on extended storage of high burnup to have confidence this waste can be safely stored or transported.

The DOE and NRC should take a leadership role in finding both short and long term storage and transport solution for high burnup spent fuel, and not depend on the nuclear industry to put safety over profits. This should take priority over research for new reactors and nuclear waste reprocessing. Congress should provide adequate funding to find a solution that puts safety above industry profits.

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REFERENCES

[1] Low enriched uranium (up to 5% U-235) fuel that has burned over 45 gigawatt-days per metric ton of uranium is high burnup (>45 GWd/MTU). Spent fuel assemblies with average burnups exceeding 45 GWd/MTU are only approved for transport on a case-by-case basis. NRC Spent Fuel Project Office Interim Staff Guidance - 11, Revision 3, Cladding Considerations for the Transportation and Storage of Spent Fuel, Nov 17, 2003 http://www.nrc.gov/reading-rm/doc-collections/isg/isg-11R3.pdf

[2] Division of Spent Fuel Storage and Transportation Interim Staff Guidance-24, Revision 0, *The Use of a Demonstration Program as Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years* http://pbadupws.nrc.gov/docs/ML1305/ML13056A516.pdf;
NRC Dr. Robert E. Einziger: *insufficient data to support licensing dry casks for >20 years*, (slide 7) *Status of NRC Research on High Burnup Fuel Issues*, March 13, 2013 Regulatory Information Conference session on *W24-Storage and Transportation of High Burnup Fuel*. Dr. Einziger is Senior Materials Scientist, NRC Division of Spent Fuel Storage & Transportation http://1.usa.gov/15E8gX5,
Audio of Dr. Einziger's presentation starts at minute 39:50: http://www.nrc.gov/public-involve/conference-symposia/ric/past/2013/docs/audio/w24.mp3

[3] Ibid

[4] NRC Spent Fuel Project Office Interim Staff Guidance - 11, Revision 3, Cladding Considerations for the Transportation and Storage of Spent Fuel, Nov 17, 2003 http://www.nrc.gov/reading-rm/doc-collections/isg/isg-11R3.pdf

[5] NRC Inspection Report: San Onofre Independent Spent Fuel Storage Installation (ISFSI), May 20, 2011. Attachment 2 LOADED CASKS AT THE SONGS ISFSI (last 3 pages of document). http://pbadupws.nrc.gov/docs/ML1114/ML111430612.pdf

[6] NRC Inspection Report: Diablo Canyon Independent Spent Fuel Storage Installation (ISFSI), May 20, 2013. Attachment 2 LOADED CASKS AT THE DIABLO CANYON POWER PLANT ISFSI (last 2 pages of document) http://pbadupws.nrc.gov/docs/ML1314/ML13140A430.pdf

[7] DOE Inventory and Description of Commercial Reactor Fuels within the United States, March 31, 2011 (Table 7) http://sti.srs.gov/fulltext/SRNL-STI-2011-00228.pdf

[8] GAO-12-797 SPENT NUCLEAR FUEL: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, August 2012 http://www.gao.gov/assets/600/593745.pdf

[9] DOE FCRD-NFST-2013-000132, Rev. 1; Fuel Cycle Research & Development-Nuclear Fuel Storage and Transportation-2013-000132, Rev. 1, June 15, 2013 http://www.hsdl.org/?abstract&did=739345

[10] No. 1029 Technical Specifications for Advanced NUHOMS® System Operating Controls and Limits, Appendix A Table 2-12 (page 2-16) http://pbadupws.nrc.gov/docs/ML0515/ML051520131.pdf

[11] NRC Spent Fuel Project Office Interim Staff Guidance - 11, Revision 3, Cladding Considerations for the Transportation and Storage of Spent Fuel, Nov 17, 2003 http://www.nrc.gov/reading-rm/doc-collections/isg/isg-11R3.pdf

[12] RWMA Marvin Resnikoff, PhD: *The Hazards of Generation III Reactor Fuel Wastes* May 2010 http://bit.ly/19dVRsY

[13] NRC Agency Program Plan for High-Burnup Fuel, To NRC Commissioners, July 6, 1998 http://bit.ly/19R1i2L

[14] Catawba Nuclear Station, Environmental Assessment & Finding of No Significant Impact, Federal Register Vol 75, No. 142, Docket 50-413 & 50-414; NRC-2010-0260, 7/26/10 http://www.gpo.gov/fdsys/pkg/FR-2010-07-26/html/2010-18241.htm

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[15] U.S. Nuclear Waste Technical Review Board (NWTRB) *Evaluation of Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*, December 2010 http://bit.ly/1jfI1Sn

[16] Fancy New Lids for Nuclear Waste Casks, As Contents Get Hotter, Jeff McMahon, May 2, 2013 http://www.forbes.com/sites/jeffmcmahon/2013/05/02/fancy-new-lids-for-nuclear-waste-casks-as-contents-get-hotter/?view=pc

Division of Spent Fuel Storage and Transportation Interim Staff Guidance-24, Revision 0, *The Use of a Demonstration Program as Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years* http://pbadupws.nrc.gov/docs/ML1305/ML13056A516.pdf;

Briefer on the DOE's High Burn-Up Used Fuel Demonstration Project,John Kessler EPRI, Power Engineering 10/11/2013 http://www.power-eng.com/articles/npi/print/volume-6/issue-5/departments/nuclear-world/briefer-on-the-doe-s-high-burn-up-used-fuel-demonstration-project.html

[17] *Cask Storage of High Burn-up Fuel*, NEI, Marc Nichol 7/25/2012 presentation Slide 3 http://sanonofresafety.files.wordpress.com/2013/06/nei-highburnupslide2012-07-25.pdf