



Higher Burnup Workshop Will Begin Shortly...

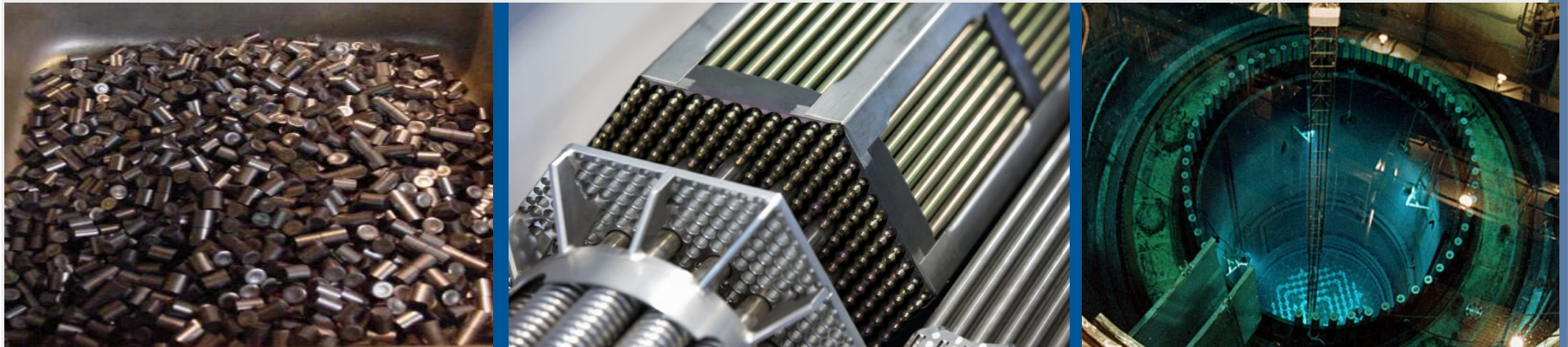
- Public Meeting Slides:
 - NRC Presentations
 - 1st: ML20211L082
 - 2nd: ML20211L086
 - NEI: ML20211L080
 - EPRI: ML20211L077
 - Westinghouse: ML20211L091
 - International Perspective: ML20211089
 - Please log into both webinar and bridgeline. Visuals will be through WebEx and audio will be through the bridgeline
 - [Webinar Link](#)
 - Bridgeline:
 - US: 888-378-9869
 - Int'l: +1 210-234-9856
- Passcode: 9654996



Higher Burnup Workshop

*Overview of Higher Burnup
and Increased Enrichment*

July 30, 2020





- 10:00am – 10:05am: Welcome/Introductions
- 10:05am – 10:50am: Overview of Higher Burnup and Increased Enrichment
- 10:50am – 11:30am: Presentations by NEI, EPRI, and Westinghouse
- 11:30am – 11:45am: International Perspective and FIDES Program
- 11:45am – 12:30pm: Public Question and Answer
- 12:30pm – 1:30pm: Lunch Break
- 1:30pm – 2:00pm: Schedules and Quality Submittals
- 2:00pm – 2:30pm: Open Discussion
- 2:30pm – 3:00pm: Public Comment Period



Welcome

- Joe Donoghue – Director, Division of Safety Systems

Introductions

- Joan Olmstead, NMSS – Meeting Facilitator
- Mike Orenak, NRR – ATF Lead Project Manager
- Kevin Heller, NRR – Higher Burnup and Increased Enrichment Technical Lead
- Marilyn Diaz, NMSS – Chemical Engineer
- Ricardo Torres, NMSS – Materials Engineer

Meeting Logistics



- Meeting visuals are through WebEx
- Meeting audio is through the bridgeline.
- Participants are in listen-only mode until the question and answer periods. The operator will open phone lines during the public discussion period.
- Today's meeting is a Category 2 meeting. Public participation and comments are sought during specific points during the meeting.
- No regulatory decisions will be made at today's meeting.

Purpose of Today's Meeting

1. Provide the general public with information about higher burnup and increased enrichment
2. Provide an open question and answer period on accident tolerant fuel subjects for the public.
3. Exchange of information with industry on higher burnup and increased enrichment, focusing on the components of a quality submittal.

What is ATF?

- After the Fukushima accident, Congress directed the US Department of Energy to fund research into fuels with enhanced accident tolerance, specifically:
 - improve performance during normal operation, anticipated operational occurrences, and loss of active cooling and other accidents
 - reducing fuel cost
 - reducing nuclear waste
- Accident tolerant fuel (ATF) is exclusively for the existing reactor fleet

ATF Technologies

- Near-term
 - Coated cladding
 - Doped pellets
 - FeCrAl cladding
- Longer term
 - Uranium nitride pellets
 - Silicon carbide cladding
 - Extruded metallic fuel
- Higher burnup (HBU) and increased enrichment (IE) are not ATF technologies, but are considered components of the ATF program

What is Increased Enrichment?

Increased Enrichment (IE) means increasing the amount of U-235 present in nuclear fuel to between 5% and 10% by weight.

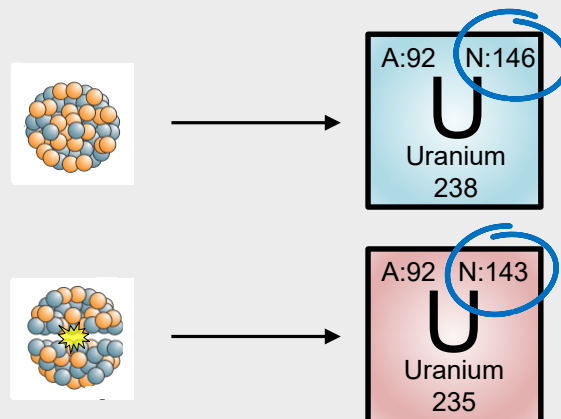
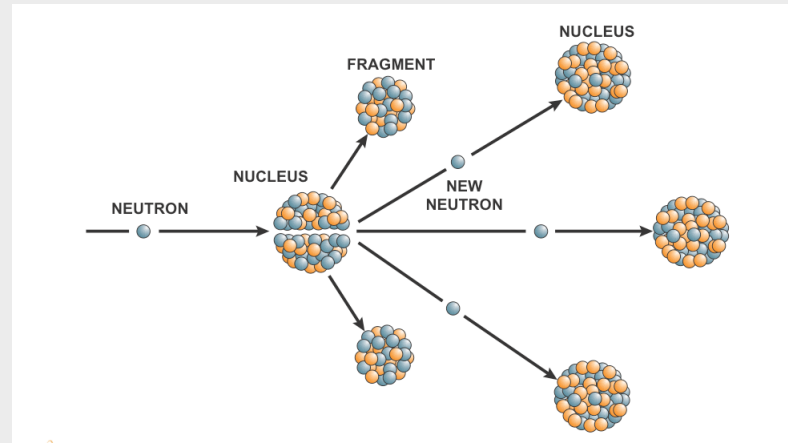
OK...



But what does *that* mean?

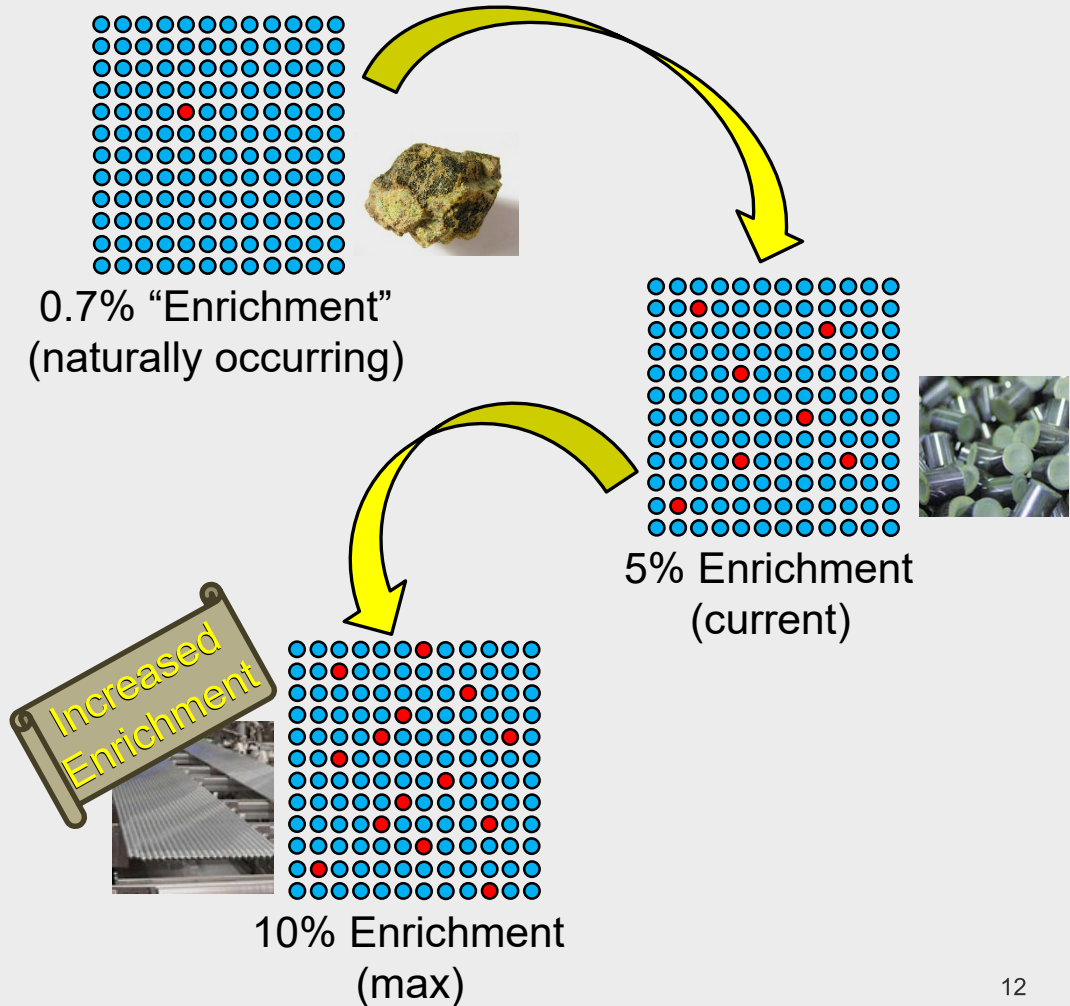
What Does It Mean to Increase the Amount of Uranium-235?

- Nuclear fuel, fission, and uranium isotopes



What Does It Mean to Increase the Amount of Uranium-235? (cont'd)

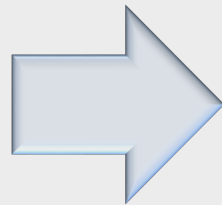
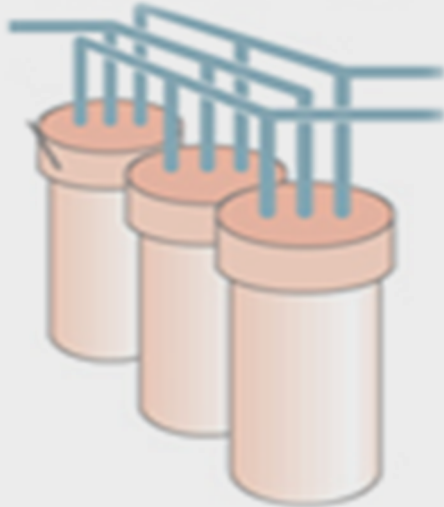
- Enrichment



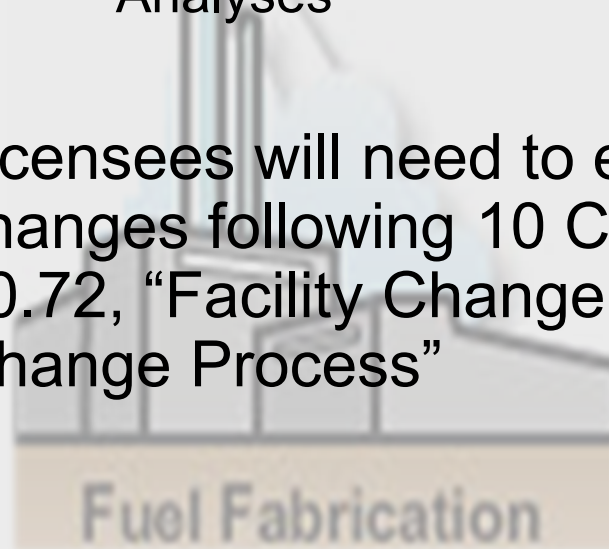
What Does It Mean to Increase the Amount of Uranium-235? (cont'd)

- Historical enrichment levels
- Increased enrichment will have implications throughout the fuel cycle (enrichment facilities, transportation, use in-core, spent fuel storage).

Anticipated Impacts to Enrichment and Fabrication Facilities



- Facilities will require a license amendment.
 - Physical modifications to the facilities would likely be needed.
 - Focus areas:
 - Criticality Safety
 - Changes to Integrated Safety Analyses
- Licensees will need to evaluate changes following 10 CFR 70.72, “Facility Change and Change Process”



Anticipated Impacts to Transportation of Increased Enrichment Materials

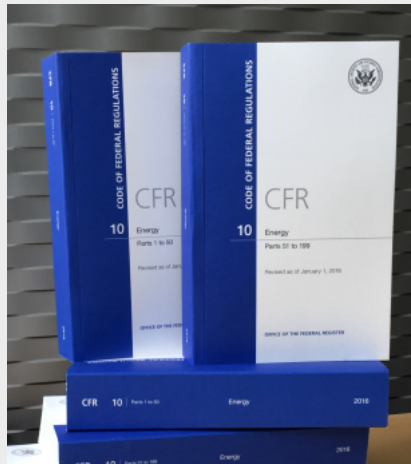


- Feed material (uranium hexafluoride, UF_6)
 - Criticality safety
- Fresh fuel transport (assemblies)
 - Criticality safety
 - Configuration control
 - Normal conditions of transport
 - Hypothetical accident conditions

Anticipated Impacts to Increased Enrichment In-core

- Potential for higher power peaking
 - Additional burnable absorbers to suppress
- Increased enrichment safety when at reactor site
 - Criticality Safety
 - Decay heat

Increased Enrichment and Current Regulations



- Some regulations specify limits for material enrichments to less than 5 weight percent
 - 10 CFR 50.68(b)(7) – Spent Fuel Pool
 - 10 CFR 71.55(g) – UF_6

What is Higher Burnup?

Higher burnup (HBU) means increasing the amount of energy extracted from nuclear fuel to between 75 gigawatt-days per metric ton of uranium (GWd/MTU) and 80 GWd/MTU

OK...



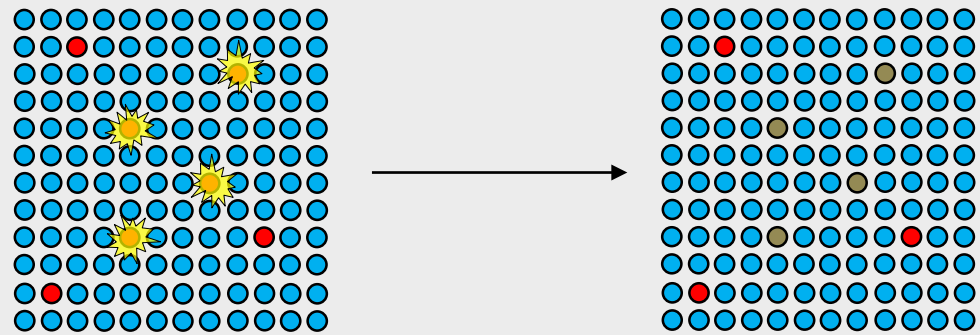
But what does *that* mean?

What is Higher Burnup? (cont'd)

- Burnup is a measure of how much thermal energy is produced by the nuclear fuel over a given time frame divided by the initial mass of uranium
- It is also thought of as a measure of fuel depletion

What is Higher Burnup? (cont'd)

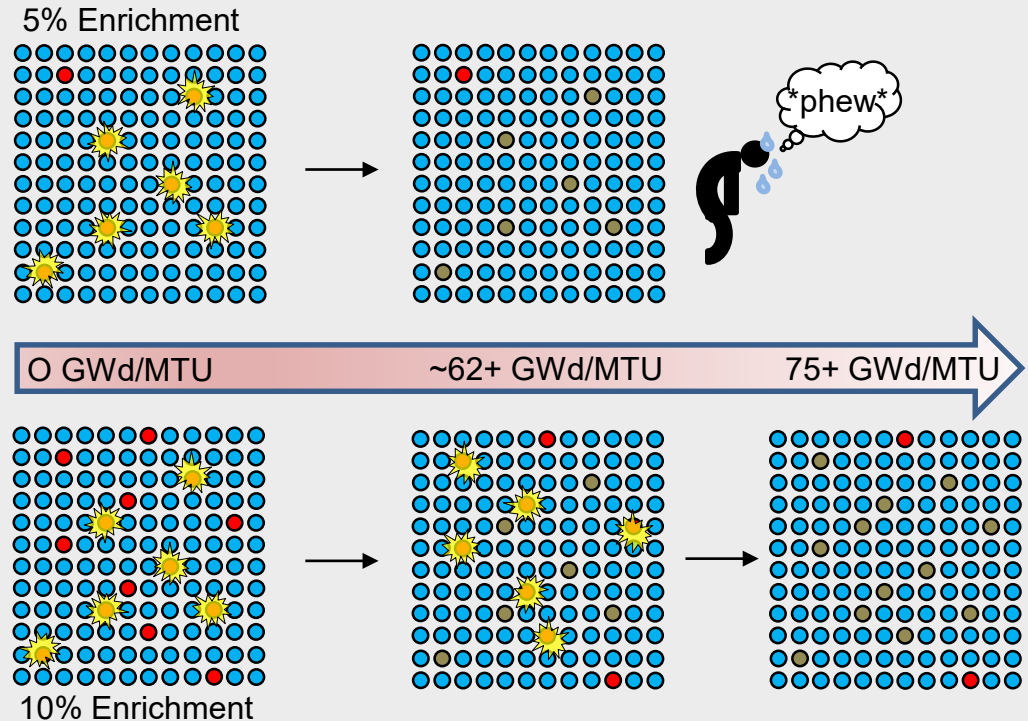
- As uranium-235 fissions, energy is generated



- The total amount of uranium-235 present decreases, and the fuel begins to deplete
- Currently limited to 62 GWd/MTU

What is Higher Burnup? (cont'd)

- Not enough uranium-235 present in current fuel to reach burnups much greater than ~62 GWd/MTU



- To reach higher burnups, fuel would need to start with more uranium-235

What is Higher Burnup?

(cont'd)

- Higher burnups would allow the fuel to be irradiated for longer periods in the reactor
- The amount of burnup affects the temperature, radioactivity and physical makeup of the irradiated fuel

Anticipated Impacts to In- Reactor Performance

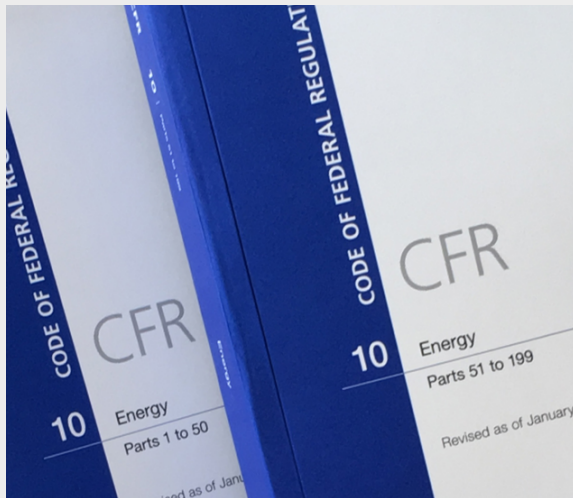
- Radioactivity of the irradiated fuel
- Heat generated by the irradiated fuel
- Characteristics of the irradiated fuel cladding and fuel pellet material
 - Fuel pellet fragmentation
 - Potential fuel relocation and dispersal in reactor
 - Fuel cladding mechanical performance and stresses

Anticipated Impacts to Spent Fuel Storage and Transportation



- Wet Storage (spent fuel pool)
 - Criticality safety
- Dry Storage
 - Criticality safety / Radiation shielding
 - Higher fuel temperatures and stresses
 - Age-related phenomena
- Transportation
 - Normal conditions of transport
 - Hypothetical accident condition

Higher Burnup and Current Regulations



- No explicit limits on burnups defined in current regulations
- Limitations placed on applicability of analysis methods
 - 10 CFR 50.34
 - Primary basis for applicability limits is range of experimental data

What is the NRC Doing?

- ATF Project Plan
- Following Technological Progress
- CRAFT and ESCP
- Interaction with U.S. Department of Energy and International Counterparts



Revised ATF Website

The screenshot displays the U.S. Nuclear Regulatory Commission (NRC) website. The header includes navigation links: HOME, FAQ, GLOSSARY, FACILITY LOCATOR, WHAT'S NEW, SITE HELP, INDEX A-Z, CONTACT US, EMAIL UPDATES, and LISTEN TO PAGE. The NRC logo and tagline "Protecting People and the Environment" are on the left. A search bar and a "REPORT A SAFETY CONCERN" button are on the right. A horizontal menu lists: NUCLEAR REACTORS, NUCLEAR MATERIALS, RADIOACTIVE WASTE, NUCLEAR SECURITY, PUBLIC MEETINGS & INVOLVEMENT, NRC LIBRARY, and ABOUT NRC. A breadcrumb trail reads: Home > Nuclear Reactors > Power Reactors > Accident Tolerant Fuel Regulatory Activities. The main heading is "Accident Tolerant Fuel Regulatory Activities". Below it are tabs: Stay Connected, FAQs, Additional Topics, and References. The "FAQs" tab is active, showing the question "What is Accident Tolerant Fuel?". The text explains that ATF are new technologies to enhance safety and mentions the NEIMA Act of 2019. Two numbered points define ATF: (1) makes an existing commercial nuclear reactor more resistant to a nuclear incident; and (2) lowers the cost of electricity over the licensed lifetime of an existing commercial nuclear reactor. Below this are two columns: "Why the Interest Now?" and "What is the NRC's Role?". The "Origins" section features a play button icon and text stating the NRC's role is to review new fuel technologies against applicable guidance, available data, and past precedent applications to determine if the new fuel design continues to meet NRC regulations.

U.S. NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Enter Search Term(s) Search

REPORT
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NUCLEAR REACTORS NUCLEAR MATERIALS RADIOACTIVE WASTE NUCLEAR SECURITY PUBLIC MEETINGS & INVOLVEMENT NRC LIBRARY ABOUT NRC

PRINT

Home > Nuclear Reactors > Power Reactors > Accident Tolerant Fuel Regulatory Activities

Accident Tolerant Fuel Regulatory Activities

Stay Connected ▾ FAQs Additional Topics ▾ References ▾

What is Accident Tolerant Fuel?

Accident tolerant fuels (ATF) are a set of new technologies that have the potential to enhance safety at U.S. nuclear power plants by offering better performance during normal operation, transient conditions, and accident scenarios.

On January 14, 2019, the president signed the Nuclear Energy Innovation and Modernization Act (NEIMA). NEIMA, Section 107, "Commission Report On Accident Tolerant Fuel," provides a definition of ATF as a new technology that:

- (1) makes an existing commercial nuclear reactor more resistant to a nuclear incident; and
- (2) lowers the cost of electricity over the licensed lifetime of an existing commercial nuclear reactor.

Why the Interest Now?

What is the NRC's Role?

The NRC's role with ATF is to review the new fuel technologies and their associated enrichment, fabrication, transportation, and storage aspects to ensure that they maintain public health and safety when implemented by NRC licensees.

The NRC ensures this by reviewing the technologies against the all applicable guidance, available data, and past precedent applications to determine if the new fuel design continues to meet the NRC's regulations.

Origins

Closing Remarks

If you have any remaining questions:

- Use the “Contact Us” on the ATF website
- Email:
accident_tolerant_fuel@nrc.gov