

February 10, 2021

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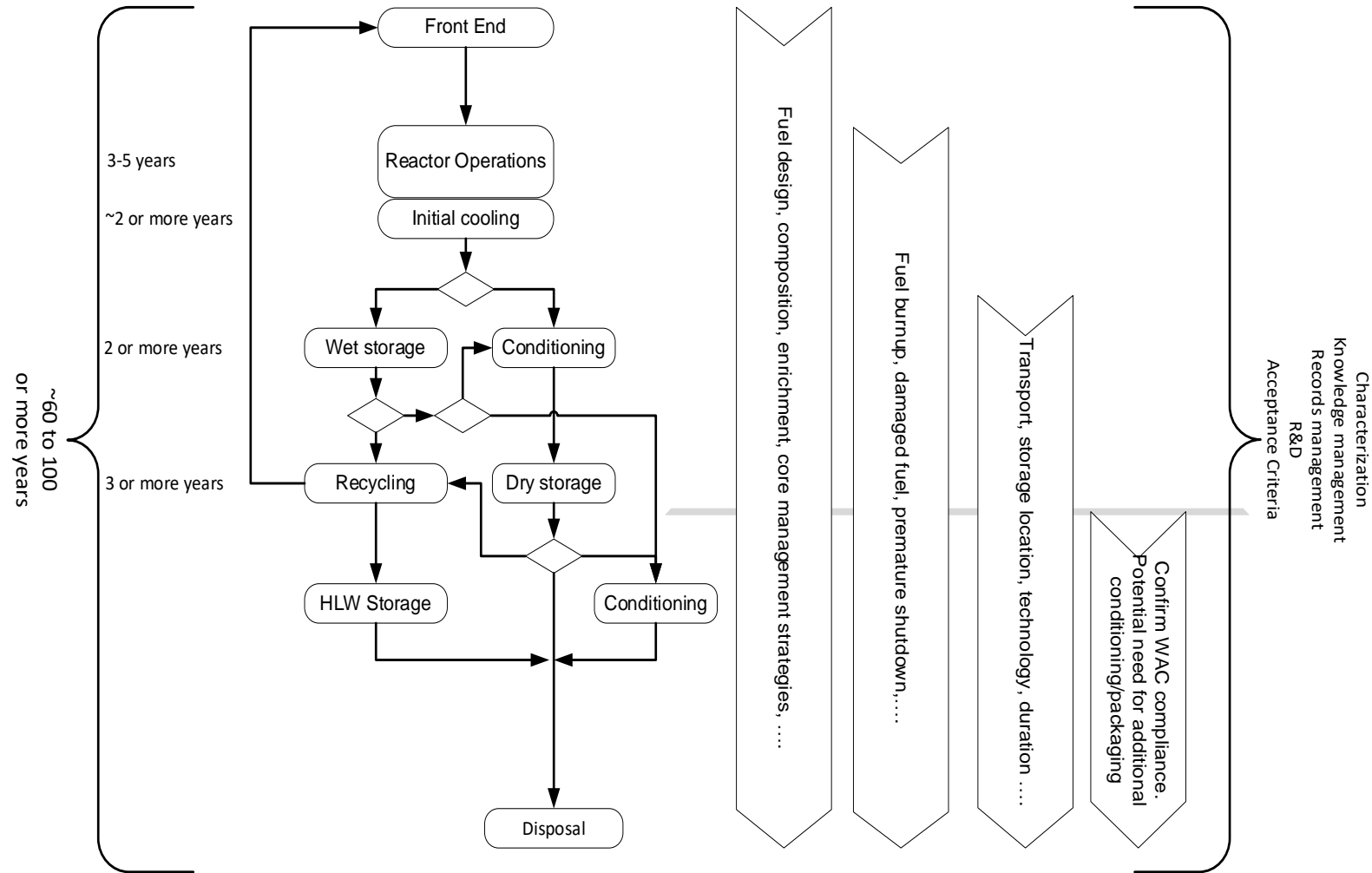
Used Fuel Management



# An Integrated Approach to the Backend of the Nuclear Fuel Cycle

Confidently addressing present and future challenges

# Many Pathways. Many Decades. Many Unknowns.



# Many Unknowns

- Storage – technologies, location, duration
- Endpoint – direct disposal vs recycling
- Trajectory of nuclear energy demand and technologies and the resulting spent fuel needs
- **These uncertainties should be acknowledged, accepted, and directly addressed.**

# U.S. History illustrates the challenge .....Other countries have similar stories

50s.... unbridled enthusiasm

60s.... reprocess

70s.... societal/political pushback

80s.... direct disposal

90s.... societal/political pushback

2000s.... delays

2010s.... defunded YMP

2020s.... CISF

.....??



# We know how to safely and effectively manage amidst uncertainty – with flexibility

- **Uncertainty ≠ “We don’t know how to safely manage Spent fuel”**
  - Uncertainties exist because we cannot predict the future.
  - Future conditions that impact strategies for management of our spent fuel include:
    - energy needs and the role of nuclear,
    - potential future uses of radioactive materials,
    - future technologies for storage, recycling, and disposal;
    - implementation of advanced fuel cycles, etc.
    - .....??
- **Flexibility ≠ “Wait and See”**
  - Preserving flexibility is not a ‘do nothing’ or ‘wait and see’ approach.
  - Flexibility is being prepared to adapt to a range of possible scenarios and to capitalize on available opportunities.



# 10 Tips for Driving Safely in the Fog\*

1. Leave plenty of distance between your car and the one in front of you. Decreased visibility means longer braking times. *When the future is not clear, planning and designs should include additional margin for the unforeseen.*
2. Take advantage of your windshield wipers and defrosters. *Use available tools – modeling, scenario analysis, international experiences, etc.* Give yourself the best view possible by clearing off your windshield completely. *Ensure an adequate understanding of potential future scenarios and their impact.*
3. Speaking of visibility: ditch your car's high beams. Low beams are actually better for driving in fog! *The further you try to see, the foggier it gets.* While your high beams are not useful in the fog, remember to turn on your low-beam headlights to help other drivers see you. *Communicate with others in same circumstances, and share operational experiences and lessons learned. Interact and communicate.*

\* <https://blog.firestonecompleteautocare.com/driving/driving-in-fog-safe-driving-tips-to-know/>



# 10 Tips for Driving Safely in the Fog

4. Resist the common urge to use the lights of any vehicles in front of you as a guide. **We could all end up at the wrong place ..... and with a false sense of security.** This can actually cause you to focus too much on the narrow patch of landscape in front of you – causing you to miss other things! **Improper focus can result in missing potential hazards .... and opportunities.**
5. Skip cruise control. Foggy roads can have surprises waiting, and it's best to maintain complete control of your car. Avoid complacency. **Frequently (constantly) assess conditions, re-evaluate, and adjust.**
6. “Follow the right-side line of the road to guide you,” The idea is to follow a guide that ensures you stay on the road.... **But choose the line (right or left) that gives the most margin for error.** Don't be afraid to slow down and drive cautiously. **.....Its not about optimization or getting there quickly. We have time. Its about avoiding costly, and perhaps irrecoverable, mistakes.**



# Tips for Driving Safely in the Fog

7. Don't accelerate if a car behind you is too close. **Refuse to be 'rushed'**. Stick to a safe, reasonable speed limit in the fog, even if other drivers don't. **And insist on doing things the right way.**
8. Stay home when the fog is bad (if possible!). Fog can make driving scary and dangerous, so stay off the roads altogether if you're able. **This may sound like a 'wait and see' approach. In our context, this is not a responsible option for those of us who have embarked on nuclear programs, we have crossed the Rubicon and must provide safe and effective solutions.**
9. Check your mirrors before slowing down, and gently apply your brakes. **Don't solve your problem and create a problem for someone else. Understand the interfaces within the fuel cycle and don't endanger your objectives or those of others by a lack of awareness.** The earlier you can start to tap the brakes, the better! Your brake lights will alert drivers behind you that you are slowing down, and you won't catch them by surprise with a sudden stop. ....  
**communicate/coordinate with other steps in the BEFC.**

# 10 Tips for Driving Safely in the Fog

10. If you choose to pull over and wait out the fog, pull as far to the side of the road as possible. Once you're stopped, turn on your hazard lights. If you are uncomfortable or unwilling to proceed, don't become an obstacle for others who are willing and able to responsibly move forward. The key to driving in the fog is to remember that everyone is having trouble seeing, **Lights on..... share info. the fog will begin to clear as we, and others, begin reaching their destinations.**

## Takeaways

- **Uncertainty can be navigated** – in the fog.... and in spent fuel management.
- Uncertainty can and should be addressed '**by design**' rather than '**by default**'

# Uncertainties have a strong impact on interfaces

- Optimization vs robustness
  - Optimization requires precise knowledge of conditions and interfaces to maximize performance.
  - Robustness trades some performance for stability and adaptability, to thrive in a broad range of possible future conditions.
- Given the long time horizons and the uncertainties relative to future needs, technologies, policies, etc., spent fuel management strategies should retain flexibility and apply principles of robust design.
- Think Differently – Less Optimization. More flexibility.

# A few things to contemplate as you listen to the presentations from Cecile and Bengt ....

- How would our spent fuel storage systems (i.e. equipment, facilities, and regulatory infrastructure) be different if we had known 50 years ago that in 2021 we would still be storing spent fuel and working to implement a strategy for the BEFC?
- How different is the current recycling situation in 2021 compared with the plans during 60s and 70s when it was predicted to have fleets of fast reactors with multirecycling within a few decades?
- Looking forward, how can we better design our operational and regulatory infrastructure to ensure the needed flexibility and integration across the BEFC?

# Near-term solutions have long-term consequences!

