CSC7575 Reivew - Resilient Nuclear Power Plants

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Main Contribution

This paper is a bit different in that it is more of a review of a dissertation defense by Sherrell Greene. Dr. Greene worked at the laboratory for many years and retired in 2011. After retiring, Sherrell persued his PhD and recently (July 2, 2018) successfully defended his work. While the dissertation is still embargoed and would have been too long to digest anyway, Dr. Greene was kind enough to share his slides with me for use in this class.

The primary contribution for this work is his assessment of the state of resiliency of Nuclear Power Plants and his proposed design for what he referrs to as *rNPPs*: Resilient Nuclear Power Plants. Dr. Green lays out a series of requirements that would need to be met for a NPP to be considered resilient and then discusses, theoretically, how these requirements could be met.

Related Problems Yet Unresolved

This paper made some of the unresolved issues quite easy to identify as they were highlighted by the presenter as being both important yet out of scope of his work. These issues included:

1. The value (or not) of modifying existing nuclear power plants to achieve rNPP functionality
2. The development of a conceptual design for an rNPP (remains very theoretical)
3. Addressing regulatory issues
4. Proper evaluation of the costs/economics of rNPPs

Strengths/Weaknesses

This paper/presentation was quite strong and rather interesting to listen to. It is obvious that Dr. Green has an entire career behind him in this field and this was simply a capstone project on top of work he has previously done.

I found the definition (by Sansavini) on System Resilience to be quite helpful in my thinking of this topic. Similarly, the Generic System Resilience Curve (also by Sansavini) was beneficial. Dr. Greene's adaptation of both of these to his specific research domain was also worthwhile.

A weakness (which I addressed with the author directly) is the lack of discussion of the LERs (their equivalent) in the traditional fuel space. The comment was that they do not have to report LERs and his intuition was that they were less. This was an important point as he used these numbers to establish the need for some of his proposed changes. Being able to compare the downtime (or lack thereof) of NPPs to those of other fuel sources would be critical. I am certain that this information exists - it simply wasn't included in this paper/presentation.

Another minor weakness is that the items listed on slides 31 and 32 could broadly apply to any power generation plant regardless of the fuel source. It took quite some time to be convinced that some of what was being discussed was, in fact, unique to Nuclear-based generation sources.

Additional Publications by the Same Author(s)

This slide deck was delivered on July 2, 2018 and there have been no official publications since this point. That said, the dissertaion itself centers around four journal publications, one of which has yet to be published (it has, however, been accepted for publication). The three articles that are currently available are as follows:

- Sherrell R. Greene, "Are Current U.S. Nuclear Power Plants Grid Resilience Assets?" Nucl. Technol., 202, 1 (2018); https://doi.org/10.1080/00295450.2018.1432966
- Sherrell R. Greene, "Nuclear Power: Black Sky Liability or Black Sky Asset?" Int. J. Nucl. Security, 2, 3 (2016), http://dx.doi.org/10.7290/V78913SR
- Sherrell R. Greene, "The Key Attributes, Functional Requirements, and Design Features of Resilient Nuclear Power Plants (rNPPs)," Nucl. Technol. (accepted for publication); https://doi.org/10.1080/00295450.2018.1480213

Review Questions

- According to Dr. Greene, what is the primary reason that Nuclear Power Plants are strong candidates as anchors in the US grid resiliency program?

  Fuel Security (at any given point in time, a Nuclear Plant has an average of 1 year's worth of fuel in reserves compared to 2-3 days for fossil-fuel based generation facilities.)

- What is one of the challenges that prevents Nuclear Power Plants from being used as *"Islands"* in the recovery process?

  They have an inability to cold start (black start)

- What is Dr. Greene's design recommendation (technical, not policy) for soliving the Black Start problem?

  To design future nuclear power plants as a series of smaller modules such that each module was easy to run and one module could cold start another and the two could support the starting of successfully larger modules until the normal power output was once again achieved.