COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

ELECTRONIC INVESTIGATION OF NUCLEAR ENERGY, GENERATION, STORAGE, AND RELATED MATTERS	)))	CASE NO. 2025-00186

A submission of public comments

Lessons Learned and A Discussion of Concerns

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Introduction

In an effort to best convey the lessons learned from the historical record, most of the citations here are not highly technical. Nearly all can be found on the web directly or with the Internet Archive Wayback

service[1], a few require a subscription to the Bulletin of the Atomic Scientists. The early 2000's local newspaper citations not on the web are available from me upon request.

The referenced publications and reports are meant as empirical examples, they are not a comprehensive review.

The order of presentation broadly follows the life cycle of a nuclear power plant from design, construction, operation, spent fuel management and decommissioning. The last third of the document pursues the long view. It looks at the 80 year history of civilian fission technologies, the limited success of prior federal efforts to promote NPPs and just how long choices made today by the PSC and Commonwealth will matter. The conclusion of the document attempts to place PSC Case 2025-00186 in the context of that history.

The Role of the Public Service Commission

The Kentucky Public Service Commission (PSC) opened Case # 2025-00186 to create an opportunity for stakeholders in the Commonwealth to discuss and investigate concerns and potential areas of opportunity involving nuclear energy. In its opening statements, the PSC acknowledged that the impact that nuclear generation and storage could have on any given community will be particularly significant.

As the PSC has been ordered by the Commonwealth's legislature to amend "the administrative regulations promulgated by the Commission pursuant to KRS Chapter 13A to require that electric utilities consider the costs and benefits of all generation resources, including but not limited to nuclear power generation resources, when determining how to meet future demand as part of the triennial integrated resource plans that they are required to file with the commission", the primary goal of this document is to traverse the spectrum of known costs affiliated with nuclear power.

Making a case for the benefits has been left to utilities seeking permits and to the Kentucky Nuclear Energy Development Authority (KNEDA), as KNEDA is tasked to support and facilitate the development of nuclear energy in the Commonwealth. Also absent from this work are records and citations about alternative carbon neutral energy production technologies. PSC Case 2025-00186 is primarily about nuclear installations.

The PSC has never before ventured into a permitting system for nuclear power plants (NPP). The boundaries of authority and responsibility abut other state agencies and the Department of Energy (DOE) Nuclear Regulatory Commission (NRC) in novel ways.

Unlike other power generating alternatives, should the PSC permit an NPP, its ability to later revoke that permit may be limited. The United States Court of Appeals for the Second Circuit ruled in 2013 that states cannot shut down nuclear plants over safety worries. The court found that states are "pre-empted" from regulating safety by the Atomic Energy Act of 1946, which made nuclear safety a federal responsibility.[2]

The NRC claims most authority once the the PSC approves the initial need, financing and sufficiency of a utility's NPP plan, but not all. The NRC grants the state "regulatory oversight of all Atomic

1 https://archive.org/

2 https://www.nytimes.com/2013/08/15/business/energy-environment/appeals-court-blocks-attempt-by-vermont-to-close-a-nuclear-plant.html?ref=business&_r=1&

Energy Act activities in Kentucky, except federal facilities and certain special nuclear material"[3], but the NRC still licenses the NPP and assumes responsibility for aspects of the public's safety and by so doing, subsumes the PSC's role in those aspects of public safety after licensing.

New ground to cover for the PSC includes how and what the NRC permits or licenses, where the "agreement" contracts between NRC and state government place nuclear authority and responsibility, and what role the Radiation Branch of the Cabinet for Health and Family Services (CHFS) or the Central Midwest Interstate Low-Level Radioactive Waste Compact will have in the siting, permitting, monitoring, decommissioning or waste management of a nuclear power plant in Kentucky. Resolving those roles, durations and boundaries with transparency is in the public interest and will help the PSC achieve the goals declared in Case 2025-00186.

The PSC's choices will matter for 40 to 80 years or more. Making prescient decisions that will last as long as it takes to initiate, operate and decommission a nuclear power plant is very different than the normal heuristic iterative course of work before the PSC, both the PSC and its utility clients are accustomed to reviews and adjustments after permitting. For a licensed nuclear power plant the NRC, not the PSC, has that authority.

Another purpose of this document is to help the PSC broadly scope what regulation of nuclear power plant systems has and will look like in the U.S. The Commonwealth's legislature has required that the PSC review and, if necessary, amend "all other administrative regulations promulgated by the PSC pursuant to KRS Chapter 13A to ensure that they do not contain any provisions that would impede the PSC from effectively regulating nuclear facilities or obstruct the development of the nuclear ecosystem in the Commonwealth." As the NRC largely assumes the regulatory domain of licensed NPPs, those legislatively mandated reviews and amendments will require dialog and attention to detail to determine the PSC's regulatory role at all stages of a NPP's lifespan. NB: the DOE has amended a Record of Decision more than 50 times.[4]

The concluding purpose of this submission is to encourage and validate the PSC's exploration of the costs, benefits, serviceability and trends around nuclear power plants to better compare them to other carbon neutral generating systems, both in the near term and on the temporal scales of an NPP license. The lessons documented here may help to inform the PSC proper as they rework their regulations to consider the costs and benefits of all generation resources and help the PSC to regulate and advise their electrical generator clients on the gamut of power generation technologies.

Nuclear Resources in the Commonwealth

The Commonwealth's nuclear work force was singularly proficient at ^{235}U fuel production. That workforce was effectively lost when Paducah stopped production and the United States Enrichment Corporation (USEC) Portsmouth centrifuge site in Piketon, Ohio opened in the early 2000s. The Commonwealth shed the last of their resident pool of working nuclear engineers when the Paducah Gaseous Diffusion Plant (PGDP) finally shut down in 2013 (as an aside, it is worth noting that USEC

3 https://www.chfs.ky.gov/agencies/dph/dphps/rhb/Pages/default.aspx
4 https://www.energy.gov/search?keywords=amended+record+of+decision&page=0

cited the proximity to the New Madrid fault and a 1980's demonstration facility already in Piketon as the basis for preferring Piketon[5] [6]).

Outside of small medical reactors that produce therapeutic isotopes, Kentucky has no current workforce expertise in nuclear reactor design, construction, operation, maintenance, management, spent nuclear fuel (SNF) waste, first response, or facility retirement. Paducah may offer some skilled decommissioning workforce, but by the time any nuclear power plant in the Commonwealth is installed and operated to retirement age, those workers will be gone.

Construction

Expensive Delays, Failures and Cancellations

Construction cost escalation and time frame delays in U.S. NPPs have few exceptions. Initial cost estimates are typically one quarter to one half of the final price. Prolonged delays are also the norm. License extensions and NPP upgrades share these trends.[7]

Expensive failures have occurred, below is a limited sample of examples.

South Carolina spent $9 billion on two reactors like those at Vogtle Units Three and Four before abandoning the effort.[8]

The Marble Hill NPP near Hanover, Indiana was abandoned before permitting in 1984. The Public Service Company of Indiana lost $2.5 billion.[9]

In January 1982 the Washington Public Power Supply System defaulted on $2.25 billion in bonds for 3 unfinished nuclear power plants- this amounted to more than $12,000 per customer in the towns with low populations.[10] [11]

The New Hampshire Public Service Commission went bankrupt in 1988 due to their $2.1 billion investment in the Seabrook NPP.[12] [13]

In 2013 Duke Energy canceled their proposed Levy Nuclear Power Plant[14] at a cost of $360 million.

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5 http://www.courier-journal.com/localnews/2002/10/20/ke102002s298168.htm (no longer on line, I have the original text)

6 http://www.courier-journal.com/localnews/2002/12/05/ke120502s325965.htm (no longer on line, I have the original text)

7 https://spectrum.ieee.org/minnesota-nuclear-plant-upgrade-is-267-million-over-budget

8 Von Hippel, https://fissilematerials.org/blog/2025/03/us_promotion_of_nuclear_p.html

9 https://en.wikipedia.org/wiki/Marble_Hill_Nuclear_Power_Plant

10 http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=5482

11 Daniel Pope. Nuclear Implosions: The Rise and Fall of the Washington Public Power Supply System. Cambridge: Cambridge University Press

12 https://www.nytimes.com/1988/01/29/business/bankruptcy-filed-by-leading-utility-in-seabrook-plant.html

13 https://gc.nh.gov/rsa/html/XXXIV/362-C/362-C-mrg.htm

14 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/08/01/duke-energy-cancels-proposed-levy-nuclear-power-plant-in-fpsc-agreement-080103

Paducah's operator, USEC, went bankrupt in 2013. The company ran the DOE's Paducah Gaseous Diffusion Plant which had stopped operations earlier that year.[15]

These trends are not confined to the United States. In 2015 French nuclear power and technology giant Areva (then largely owned by the government of France) said that it could post a net loss of $5.6 billion in 2014, up from $566 million in 2013.[16] Also in 2015, the CEO of French energy giant EDF (also owned by the French government), Jean-Bernard Levy, said the first French third-generation European Pressurized Water reactor (EPR) with a capacity of 1650 MW will cost in the region of U.S. $12 billion - more than three times the original projected cost of U.S. $3.37 billion and fuel loading will not even start until late 2018, six years behind schedule.[17]

Stanford University professor M. Z. Jacobson offers more examples of construction delays in Europe and China.[18]

The Waynesboro, Georgia Vogtle units Three and Four are the only new NPPs to come online in the U.S. in recent decades. That model suggests that more than 15 years are needed for the actual construction of a large scale NPP. The Vogtle units went online 7 years later than scheduled. The planning, siting and design stages would add to that. As well, the Vogtle units original cost estimate bore little resemblance to the final expense, some 14 billion dollars became more than 34 billion.

While Small Modular Reactors claim to have much shorter construction time frames, none have yet actually been built for commercial energy production. The evidence so far is that they will experience the same escalation of costs from the initial predictions.[19] As detailed below, the only scheduled NuScale SMR construction was canceled due to its cost more than doubling in five years. History suggests the fast neutron SMRs may encounter the same reliability and repair issues observed in the small fast neutron reactors from 1945-1975, where repairs that took the reactors offline for long periods were needed relatively soon after going online.

Design Flaws

General Electric had not fully tested its then brand-new nuclear reactor technology when it introduced the reactor in Eureka, California in 1958. GE engineers soon figured out that the company's reactors had a number of defects, but it would be 16 years before GE informed the public.[20]

According to the 1985 lawsuits filed by the Washington Public Power Supply System and three operators in Ohio: Cincinnati Gas and Electric Company, the Columbus Southern Ohio Electric Company, and the Dayton Power and Light Company, GE's engineers and top management knew that its GE Mark II model boiling water reactor design was flawed.[21]

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15 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/12/17/usec-will-file-for-bankruptcy-121702

16 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2015/02/23/areve-says-losses-in-2014-could-hit-_2400_5.6-billion-022301

17 https://www.nuclearpowerdaily.com/reports/French_Nuclear_Nightmare_Sends_Shockwaves_Through_Europe_999.html

18 https://web.stanford.edu/group/efmh/jacobson/WWSStillNMN/SNMN-WhyNotNuclear.pdf pp.5-6

19 https://en.wikipedia.org/wiki/NuScale

20 https://times.org/the-long-tragic-trail-of-defective-general-electric-nuclear-reactors-from-hanford-to-fukushima/

21 https://web.archive.org/web/20131114002618/http://times.org/2013/04/03/from-the-pacific-northwest-to-fukushima-the-long-tragic-trail-of-failed-general-electric-nuclear-plants/

The NuScale SMR has reported design issues.[22] All other "Gen 4" SMRs are still under development.

Many of the 1945-1970 era fast neutron small research reactors proved to have significant design flaws that took them out of service for repairs or led to decommissioning.

This generation of SMRs have a dubious ancestry that invites consideration of the chances they too will encounter design flaws. As noted in the Shutdowns section below, the NRC records suggest that it took more than 30 years to debug and stabilize the less finicky NRC approved water moderated LEU powered NPP designs and their management. SMRs may take a similar path and take decades before they run reliably. Described below, the Russian and Chinese SMRs currently in service are not performing well.

Construction and Operating Cost Trends

A 2009 Vermont Law School report by Mark Cooper introduced arguments and trends that have largely held.[23] The report documents a comparison of original estimated costs for NPPs versus the observed final costs, typically with between 1:2 and 1:4 ratios. Price trends documented in the report for carbon neutral alternatives have also played largely as described, with costs dropping steadily with returns to scale and technology advances. NPPs have shown little progress in cost reduction, design safety, fuel safety, risk of SNF diversion or SNF waste management.

Lazard's June 2025 report, "Lazard's Levelized Cost of Energy"[24] documents the current price of energy production alternatives. The 2025 report validates Cooper's 2009 predictions and finds that NPPs are and will be the most expensive per GW energy source.

LG&E/KU President John Crockett wrote in November 2023 that it's cheaper and more reliable to invest in natural gas and solar resources than "aging coal units that emit far more pollutants."[25] When costs are the basis for choosing among reliable energy producing technologies in the Commonwealth, NPPs can't win.

Recently, the notion of powering AI computing centers with SMRs has gotten attention. However, the energy needs for AI are immediate and competitive, in the time frame of one to four years. No NPP of any scale can be licensed, built and brought on line within that time.

In spite of bringing two NPPs online in Georgia recently, two coal fired power plants slated to retire in the next decade will be kept running to meet an anticipated need for data centers that may come to the state.[26] This suggests that not only is the long delay from initiation to going on line prohibitive for NPP powered data centers, the cost of electricity from an operating NPP is already too high.

On July 25, 2025, DOE nominated Paducah as one of four federal sites as "potential development of artificial intelligence (AI) data centers and the energy infrastructure required to support them." Under

22 https://www.science.org/content/article/smaller-cheaper-reactor-aims-revive-nuclear-industry-design-problems-raise-safety
23 http://large.stanford.edu/publications/power/references/nirs/docs/cooperreport_neconomics062009.pdf pp1-7
24 https://www.lazard.com/media/uounhon4/lazards-lcoeplus-june-2025.pdf
25 https://www.kentucky.com/opinion/op-ed/article281388533.html
26 https://www.utilitydive.com/news/georgia-power-irp-coal-gas-plants-data-centers/753170/

the extant NRC agreement[27] Kentucky has no direct authority. Will DOE power those data centers with PSC permitted and regulated power plants, or add new carbon neutral energy production, or try to site an NPP, or just do like Georgia and re-enfranchise old coal power plants?

A July 18, 2025 article in the Kentucky Lantern[28] reports that states that have hosted AI, cloud and Bitcoin data centers did not see many jobs created in exchange for siting those data centers and that new significant additional base load costs were being passed on to utility customers. The article also reported that many states are now considering adding the requirement that data centers provide their own carbon neutral electrical generation systems rather than putting those costs on their regular customers.

NPP Operation

Reliability, Risks and Failures

Past experience has shown that unlike all other means of producing electricity, nuclear power plants suffer a knock-on effect where a single NPP failure anywhere in the world can take other NPPs offline. Three Mile Island[29], Chernobyl[30], Fukushima and others have led to other NPPs going offline for extended periods. Some of those NPPs were never restarted. As more plants around the world operate and age, such incidents have more opportunity to happen.[31] This stochastic external event driven base load failure aspect deserves consideration.

While typically referred as a single entity of uniform design, many very different reactor designs qualify as SMRs[32]. Small scale and modular reactors[33] (SMRs) have been unsuccessfully promoted for decades.[34] [35] To date the the U.S. market has found them unattractive to finance or operate. Seeking to find a lower cost of entry, SMRs may attract under-capitalized and inexperienced clients who neither understand what they've committed to nor have the skill set, longevity, user base or finances to properly afford, operate, retire and decommission an SMR. But for NuScale, NRC licenses for the entire array of SMR designs are in the future and uncertain.

Small reactors have a storied history, starting with the North American Aviation's 20 megawatt sodium cooled reactor core meltdown near Los Angeles in 1959.[36] Recent designs have a new mix of strengths and flaws. Here in the U.S. they are mostly still at the stage of research reactors and simulations.[37] The operational SMRs, both Russian and Chinese, have performed poorly.[38]

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27 https://www.chfs.ky.gov/agencies/dph/dphps/rhb/Pages/default.aspx
28 https://kentuckylantern.com/2025/07/18/repub/ai-data-centers-are-using-more-power-regular-customers-are-footing-the-bill/
29 https://thebulletin.org/2009/03/behind-the-scenes-of-three-mile-island-2/
30 http://news.bbc.co.uk/onthisday/hi/dates/stories/april/28/newsid_2500000/2500975.stm
31 https://www.nytimes.com/2013/08/04/world/asia/scandal-in-south-korea-over-nuclear-revelations.html?hp&_r=1&
32 https://www.ucs.org/resources/advanced-isnt-always-better
33 https://en.wikipedia.org/wiki/Small_modular_reactor
34 https://web.archive.org/web/20150501123303/http://spectrum.ieee.org/energy/nuclear/the-forgotten-history-of-small-nuclear-reactors
35 https://www.ucs.org/about/news/nuclear-powers-safety-security-and-cost-problems
36 https://www.latimes.com/archives/la-xpm-2009-jul-13-me-meltdown13-story.html
37 https://www.world-nuclear-news.org/search?search=SMR
38 https://www.powermag.com/a-closer-look-at-two-operational-small-modular-reactor-designs/

Small nuclear reactors have been designed since the 1940s using liquid water reactors, boiling water reactors, gas cooled reactors and liquid metal reactors. Some are moderated neutron reactors, others are fast neutron designs. Most newer design proposals are fast neutron reactors. SMRs may be fueled with rods or pebbles containing ^{235}U from 5% to 19.75%, or thorium. Manifestly, while there is a lot of publicity and attention to SMRs, the range of designs and fuels make any broad assertions of cost or safety superficial.

A 2021 report[39] by the Union of Concerned Scientists is a good primer on the science behind reactor designs. It examines the current SMR technologies and details the DOE NRC research and development timelines for SMRs. In 2017, under generous estimates of success, the DOE estimated it would cost approximately $4 billion and take 13 to 15 years to complete the first commercial demonstration unit of a sodium cooled fast reactor and that NPP units might follow in the mid-2030s. Commercial demonstration of molten salt reactors and other lower-maturity designs would not begin demonstration until 2040 and commercial NPP reactors would not be available until the mid-2040s or even the 2050s.

In 1956 Admiral Hyman Rickover summarized his experience with a sodium cooled reactor developed to power an early U.S. nuclear submarine by saying that such reactors are "expensive to build, complex to operate, susceptible to prolonged shutdown as a result of even minor malfunctions, and difficult and time-consuming to repair."[40]

The NRC is researching new fuel mixtures and cladding that may be more resilient and able to retain their shape under "meltdown" temperatures. None are licensed or tested at scale. As some measure of progress, the NRC "accident tolerant fuels" webpage hasn't been updated since January of 2020.[41]

Running on LEU, the NuScale integral pressurized light water SMR received NRC approval on May 29, 2025[42], some 18 months after its only planned construction was canceled due to spiraling costs ($4.2 billion went to $9.3 in five years).[43] "After losing their customer, NuScale's stock plunged, it laid off nearly a third of its workforce, and it was sued by its investors and investigated for investor fraud. Its CEO sold off most of his stock shares."[44] Nuclear Regulatory Commission licensing for all other SMRs is both well in the future and uncertain.[45]

From 1974 to 2007, the combined research and development costs for fast neutron reactors in the US, Europe, Japan, India and Russia exceeded $100 billion in 2007 dollars.[46] These efforts established that fast neutron reactors were economically uncompetitive with light-water reactors and until recently, research monies for them largely dried up worldwide after 1997.

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39 https://www.ucs.org/sites/default/files/2021-05/ucs-rpt-AR-3.21-web_Mayrev.pdf

40 Richard G. Hewlett and Francis Duncan, Nuclear Navy: 1946–1962 (Chicago: University of Chicago Press, 1974): 274, https://fissilematerials.org/library/rr08.pdf

41 https://www.energy.gov/ne/articles/these-accident-tolerant-fuels-could-boost-performance-todays-reactors

42 https://www.energy.gov/ne/articles/nrc-approves-nuscale-powers-uprated-small-modular-reactor-design

43 https://www.utilitydive.com/news/nuscale-uamps-project-small-modular-reactor-ramanasmr-/705717/

44 https://oregoncapitalchronicle.com/2024/10/29/the-rise-and-fall-of-nuscale-a-nuclear-cautionary-tale/

45 https://en.wikipedia.org/wiki/List_of_small_modular_reactor_designs

46 https://fissilematerials.org/library/rr08.pdf :7

Without proper containment structures, Chernobyl is an example[47], after an accident fugitive core particles are more likely.[48] Most SMRs don't have conventional massive concrete containment vessels. The recently licensed NuScale SMR is submerged below ground within a fairly typical building. It isn't contained in the same massive concrete enclosure typical of NPPs in the U.S.[49] The NuScale SMR is submerged in a cooling pool that will begin to fail after 72 hours without refreshment.[50] The container's concrete walls are thinner and published schematics show no significant cap.[51]

After decades of research starting in the mid 1940s, small reactors with fuel enriched beyond LEU were found to be more expensive and difficult to operate. This was especially true of the fast neutron reactors with designs like the Gen 4 SMRs now being widely promoted.[52] In order to sustain a chain-reaction with fast neutrons, the fissile material in a small geometry reactor core must have a higher neutron flux, usually they use a fuel more concentrated with ^{235}U.

The SNF characteristics across the spectrum of SMR designs varies too widely to generalize in a single paragraph, but here are some considerations. The SNF and mid-level waste yields of SMRs seem likely to be relatively higher than the larger licensed NPPs as their cores are smaller which allows more fugitive neutrons to escape to impinge on and contaminate containment.[53] As well, they may have higher neutron flux from more highly enriched fuel or they may have reduced moderation that creates faster fugitive neutrons. They may make a more active transuranic (TRU) SNF. The small geometry of the reactor core requires a higher neutron count per square centimeter per second (neutron flux) to maintain the critical fission chain reaction to operate. That means that the fuel must be replaced while it is, relative to a large reactor core, still rich in fissionable isotopes, so in many designs the rate the small reactor makes SNF is higher. The small reactor spent fuel also has different characteristics. For example, it may take a longer time in pool storage to cool or occupy larger storage assemblies in the pool that ultimately become more mid-level waste. Further, a "fast burner" reactor (e.g. GE-Hitachi's 1000 MWe, PRISM metal-fueled fast reactor) requires first reprocessing SNF to extract plutonium (typically about 1 % of the SNF) to fuel the reactor at startup. Reprocessing SNF to isolate plutonium makes a lot of high and mid level waste, it is also very expensive. Given its roots in the production of nuclear weapons[54], the proliferation aspects of plutonium production cannot be discounted. There are instances where the entire reprocessing facility becomes contaminated. Kyshtym[55], Sellafield[56] and Hanford are examples of contamination from reprocessing to extract plutonium.

Fast-neutron reactor cores are smaller than those of light-water reactors with the same power. They require use of a coolant that can efficiently carry away the heat more effectively than water, often sodium is used. Sodium aggressively reacts with water or air.

47 https://www.bbc.co.uk/news/magazine-25086097
48 https://www.latimes.com/archives/la-xpm-2002-jun-30-adna-reactor30-story.html
49 https://www.nuscalepower.com/hubfs/Website/Files/Technical%20Publications/plant-safety-in-response-to-extreme-events.pdf
50 https://en.wikipedia.org/wiki/NuScale_Power
51 https://www.sciencedirect.com/science/article/pii/S2468605025000493#fig2
52 :8
53 https://news.stanford.edu/stories/2022/05/small-modular-reactors-produce-high-levels-nuclear-waste#:~:text=%E2%80%9CWe%20found%20that%20small%20modular,%2C%20which%20will%20be%20expensive.%E2%80%9D
54 https://www.hanford.gov/page.cfm/NReactor
55 https://en.wikipedia.org/wiki/Kyshtym_disaster
56 https://beyondnuclearinternational.org/2022/02/06/a-big-pile-of-pu/

Not all small or fast neutron reactors use molten sodium to transfer heat, NuScale , a small “Gen 3” SMR LEU reactor, uses water. Designs with molten lead or high temperature hydrogen gas cooling have proponents, Fermi’s “Clementine” fast neutron reactor used mercury as a coolant. Clementine reached full power in 1949, had some fuel rod problems and was shut down in 1950.

Japan’s 350-MWe Monju prototype fast-neutron reactor reached criticality in 1994 and was connected to the grid in August 1995, but was shut down four months later by a fire caused by leakage of its molten sodium coolant.[57] After repeated shutdowns, the reactor went offline permanently in 2010.

While modern Low Enriched Uranium (LEU, c. 5% ^{235}U) fueled reactors with water or other moderating fluids have little chance of neutron flux density and duration leading to a bomb like excursion of energy (they are not likely to just blow up in a nuclear detonation), High Assay Low Enriched Uranium (HALEU, c. 6-20% ^{235}U) reactors have a greater chance. SMRs with HALEU fuel at isotope concentrations below the classification of Highly Enriched Uranium (HEU, aka bomb grade, c. 20%-90% ^{235}U) have more paths to significant failure.

There are reported fatal flash criticality excursions of c. 19% ^{235}U fluids caused by simply changing the container geometry from rectangular to spherical, or from slight changes in the concentrations of uranium in the container.[58] [59]

The NRC recently reported that “HALEU is not currently available from domestic suppliers, and gaps in supply could delay the deployment of advanced reactors.”[60] However, as of June 27, 2025 the American Centrifuge Plant in Piketon, Ohio has produced nearly a tonne to support the fuel qualification and testing of advanced reactor designs.[61] On July24, 2025, the DOE revised it’s Record of Decision (ROD) at the Savannah River site to start downblending HEU to HALEU.[62] Manifestly, the HALEU powered SMRs developers are just now getting research reactors built to test their designs. The assurances of cost, performance and safety that are now common in the press are speculation, the empirical data measuring observed performance, costs, safety and waste production are years away. Given the array of designs being tested, general statements about SMRs deserve scrutiny.

In 2015 Reuters reported that the hacking of South Korea's nuclear operator means the country's second-oldest reactor may be shut permanently due to safety concerns.[63]

In 2016, David Sanger reported in the New York Times that twenty nations with significant atomic stockpiles or nuclear power plants have no government regulations requiring minimal protection of those facilities against cyberattacks.[64]

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57 https://fissilematerials.org/blog/2016/12/japan_decides_to_decommis.html
58 https://www.nrc.gov/docs/ml0037/ML003731912.pdf pp70-73
59 https://isis-online.org/isis-reports/chronology-and-press-reports-of-the-tokaimura-criticality/
60 https://www.energy.gov/ne/haleu-availability-program
61 https://www.world-nuclear-news.org/articles/centrus-reaches-haleu-production-milestone
62 https://www.ans.org/news/2025-07-24/article-7231/savannah-river-site-could-produce-31-mt-of-haleu-as-downblending-plan-okayed/
63 https://www.reuters.com/article/business/environment/hacking-of-koreas-nuclear-operator-raises-risk-of-aging-reactor-closures-idUSKBN0KL0F3/
64 https://www.nytimes.com/2016/01/15/world/nuclear-threat-initiative-cyberattack-study.html

Since 2004, the growth of NPPs has largely been in locations outside the U.S., India or China are examples. In 2022, across the world, seven out of ten NPPs were under 40 years old.[65] As juveniles they offer limited insight into failures due to aging.[66] As well, most nations have not yet had much experience in decommissioning old NPPs.[67] Re-licensing beyond design life has become common for NPPs, so choices the PSC makes now may well endure for 70 years or more. Permanent storage of spent fuel spans centuries.

The management of fresh spent nuclear fuel (SNF) poses extreme risks. Fresh SNF is both radiologically and physically hot. Without cooling, the rods can heat beyond their melting point and without barriers like water, lead, etc, or sufficient distance to insulate staff, radiation from fresh SNF is fatal. SNF is moved out of the major containment vessel into large pools of water maintained in more typical structures. Fukushima was at terrific risk should the many tons of fresh SNF in the disabled cooling pools run dry enough to expose the fresh rods[68]. The result would have been superheated steam that lofted fugitive particles of SNF. The hydrogen explosions at Fukushima ejected some reactor fuel, however the breached cores only penetrated 10% of the foundation's concrete floor and were mostly contained.[69] NPPs need containment structures. Inhaling or ingesting SNF particles is bad for your health.

Reactor pressure vessels themselves have had trouble. The Oak Harbor, Ohio Davis-Besse NPP primary reactor pressure vessel passed repeated inspections as early as 1998 before a mandated 2002 NRC review of the mechanism operating the control rods discovered that profound corrosion, starting in 1996, had cut through 6 inches of carbon steel leaving only 3/8" of stainless steel to withstand ambient primary coolant pressures as high as 2000 PSI. Breach of that last 3/8" would have ejected primary coolant from the reactor into a sump, overheated the reactor core, and likely degraded the emergency pumps that recycled the coolant back into the core.[70] [71] [72] NPPs don't survive such coolant losses (Three Mile Island is an example).

NPPs require a reliable coolant and that tends to site them near bodies of water.[73] [74] As most of the Commonwealth is south of the last ice age boundary and has no volcanic activity, the major interior rivers have no natural water impoundments and many have high impulse flows in their basins that lead to significant changes in water level and localized flooding. An NPP's need for coolant water sometimes puts them in competition with other public needs. In 2010, New York denied an NPP water use permit.[75] Droughts and heat waves in the U.S. like the one that throttled back the Tennessee Valley

65 IAEA Bulletin V46, No 1, June 2004

66 https://asmedigitalcollection.asme.org/ICONE/proceedings-abstract/ICONE29/86359/V001T01A082/1151088

67 https://web.archive.org/web/20131216104815/http://www.newsdaily.com/article/c1368d4036a915b909dbe388600dc32a/japan-lacks-decommissioning-experts-for-fukushima

68 https://apjjf.org/wp-content/uploads/2023/11/article-157.pdf p5

69 https://www.tepco.co.jp/en/hd/decommission/information/accident_unconfirmed/pdf/221110e0101.pdf

70 https://www.nrc.gov/reactors/operating/ops-experience/vessel-head-degradation/overview.html See esp, the 2nd to the last paragraph

71 https://www.nrc.gov/docs/ML0224/ML022400851.pdf

72 https://www.nytimes.com/2002/04/13/opinion/the-hole-in-the-reactor.html

73 https://docs.nrel.gov/docs/fy17osti/66714.pdf

74 https://www.ucs.org/sites/default/files/2019-09/Water-Smart-Power-Full-Report.pdf

75 https://web.archive.org/web/20210125090146/http://www.nytimes.com/2010/04/04/nyregion/04indian.html?ref=earth

Authority's (TVA) NPPs[76] and from around the world, have invited slowing or shutting down NPPs until water is again available.[77] [78]

Many municipalities in the interior of the Commonwealth depend of local watersheds and man made impoundments for their water. It is doubtful that those cities and towns will abide sharing or risking their water supply. Sites along the Ohio River seem the most likely in terms of physical requirements until proximity to the New Madrid fault line becomes a limit. However, placing them upstream on the Ohio River risks the water supply to many downstream communities and that may invite other states to take issue or invite the creation of opposition like the Paddlewheel Alliance that organized to successfully oppose the Marble Hill, Indiana nuclear power plants.

The LG&E/KU's Ghent power plant lies on the Ohio River upstream from Louisville. The sponsors of the Ghent Generating Station Nuclear Feasibility Study[79], the Gateway for Accelerated Innovation in Nuclear (GAIN) group at DOE's Idaho National Lab have spent most of the last decade supporting developers and suppliers of nuclear technology. Only about 5% of their work involved providing research vouchers to utilities for access to DOE national labs.[80] Each voucher project has a one year term. The contractors that wrote the Ghent study, MPR Associates, appear to have had the same one year term as GAIN. The feasibility study is an orphan, GAIN and MPR Associates interest ended when their one year grant expired. The Ghent proposal may have excited KNEDA, but it didn't make a strong case or offer specifics for an NPP at Ghent. Instead it offered a laundry list of most all known NPP designs and scales.

LG&E/KU President John Crockett wrote an article in 2023 about the future generating technologies available for LG&E/KU's consideration. He never mentioned nuclear at Ghent or anywhere else in his service purview, and stated plainly that measures of cost and reliability will govern their choices.[81]

Shutdowns

To get a feel for how often emergencies or unscheduled events makes NPP reactors shutdown, an advanced search of the NRC public and archived document database (https://adams.nrc.gov/wba/) for titles that contain "PNO" (Preliminary Notification Of event) and "Shutdown" yields 151 events in the 70's, 539 events in the 80's decade (covering 112 NPPs), 370 events in the 90's (104 NPPs), 169 events in 00's (104 NPPs), and 145 in the 10's (94 NPPs), a total of more than 1300 unscheduled shutdown events in the NRC record since 1970. That list doesn't contain any records of base load reduction like those due to water issues.

NPPs require shutdown to refuel, an event that occurs at some one to ten year intervals. Refueling, mechanical failures, flooding, fires and safety inspections have taken individual NPPs offline. As already noted, external events may also force NPPs to shut down.

76 https://enewscourier.com/2010/08/24/hot-river-costs-tva-millions-of-dollars/
77 https://www.reuters.com/article/france-power-idUSL8N34W3BT/
78 https://www.nbcnews.com/id/wbna22804065
79 https://gain.inl.gov/content/uploads/4/2024/06/Ghent-Generating-Station-Nuclear-Feasibility-Study-Summary-Report_INLRPT-23-72902.pdf
80 https://inl.gov/feature-story/celebrating-a-decade-of-innovation-the-gateway-for-accelerated-innovation-in-nuclear/
81 https://www.kentucky.com/opinion/op-ed/article281388533.html

Insurance

The recent estimate of Japan's liability from Fukushima is about $750 billion.[82]

As some measure of the intrinsic risks of NPPs, the PSC should note that while some underwriters offer private insurance, the federal cap on their liability brings the federal insurance pool mandated by the 1957 (and since renewed) Price-Anderson act in to play. It too has a cap, and should the roughly 16 billion now available be insufficient coverage, the federal treasury and U.S. taxpayers will foot the bill.[83]

The federal "Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act" (ADVANCE) of 2024 renews the liability caps extant in the Price-Anderson act through 2045. Many of the recently license extended NPPs in the nation will be more than 60 years old when the ADVANCE caps expire.

The Federal Register of July 27, 2010 contains a discussion of the national and international requirements for compensation for nuclear damage.[84]

Health Risks and Environmental Costs

Nuclear Fuel Production Workers

The occupational health risks to nuclear workers in the U.S. has long been minimized.[85]

A few examples:
On July 26, 2002, the Herald Leader published an AP report: "Bill aims to benefit energy workers.[86] A spending bill approved by a U.S. Senate committee would pay for an early cancer screening program for workers at three U.S. Department of Energy sites, including the Paducah Gaseous Diffusion Plant. The Bush administration has attempted to cut funding for the program. "

On Sunday, October 20, 2002 the Herald Leader published Kimberly Hefling's : "Paducah plant celebrates 50 years. Sick Workers, prosperity make for mixed legacy.[87]

The 2003 "Needs Assessment for Medical Screening of Construction Worker at the Portsmouth and Paducah Gaseous Diffusion Plants"[88] observes that before 1993 longitudinal health studies of plant operations and construction staff were were not federally required and that epidemiological studies of workers at DOE sites have rarely included construction workers. Because many construction workers were never located, the population of exposed workers at Paducah could only be estimated. Neutron exposure was not monitored at all. The assessments in that report describes 'areas with "moderate" to

82 https://thebulletin.org/2020/02/the-us-government-insurance-scheme-for-nuclear-power-plant-accidents-no-longer-makes-sense/

83 https://theinsuranceuniverse.com/insurance-for-nuclear-power-plant-accidents/
84 http://cryptome.org/0002/doe072710.htm
85 Len Ackland (1992) Bulletin of the Atomic Scientists, 48:9, 22-27, DOI: 10.1080/00963402.1992.11460124
86 http://www.kentucky.com/mld/heraldleader/news/state/3738058.htm
87 http://www.kentucky.com/mld/heraldleader/news/state/4325899.htm (not online, I have the original text)
88 https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/advboard/colley_email11_04242019.pdf

"high" potential for increased internal and external radiation exposure' dating back to major upgrades made in 1954 and 1973. It was estimated that 250 to 400 workers could have had internal radiation exposures that may have exceeded regulatory limits from those upgrades. Once in the body, uranium may concentrate in the kidneys, bones, or lungs depending on its solubility. The Needs Assessment report also determined that workers had been exposed to beryllium.

On February 8, 2004, the Courier-Journal's Malia Rulon published: "Uranium workers seek additional health tests", "Plants in Paducah, Ohio are concerned about beryllium". Eight people at Piketon were the first to test positive for chronic beryllium lung disease. Additional testing was scheduled at Paducah. Beryllium was first detected in the mid 1990s.

On August 18, 2004, the Courier-Journal's Nancy Zuckerbrod published "Contractor hired to aid ill nuclear workers assailed." The report detailed Senate Finance Committee chair Senator Charles Grassley's (R-Iowa) dismay with the DOE contractor responsible for handling 25,000 radiation exposure compensation claims. By 2004, 31 claims were paid. The program cost $95 million. In December 2004, 20 years after he died, Paducah worker James Cloyes' widow received $125,000.[89]

In Urey's 1942 ^{235}U isolation labs at Columbia University, none of the staff wore radiological protection gear as they pretended to be graduate students engaged in thesis studies.

Similar examples can be found in other countries too: Tokyo Electric Power (TEPCO) reported in December 2012 that 178 workers at Fukushima were believed to have received radiation doses to their thyroid glands above 100 millisieverts, some six months later they revised the 178 to 1,973.[90]

Paducah

On May 29, 2001 James Bruggers reported in the Courier-Journal [91] that "The uranium enrichment plant in Paducah, Ky., and its sister facility in [Portsmouth] Ohio have been by far the country's largest industrial emitters of a chemical [CFC-114] that eats the Earth's protective ozone layer. " … "The CFC emission numbers are found within the EPA's toxic release inventory, a giant public database of self-reported pollution totals. In all, the Paducah and Ohio plants released 818,000 pounds of CFC-114 in 1999. That amounted to 88 percent of the national total of industrial sources, and 14 percent of an international industry estimate of all CFC-114 emissions worldwide. " The 2025 DOE Environmental Management budget[92] on page four reports that in 2023 a million pounds of CFC-114 was removed from Paducah.

Paducah was designed for and dedicated to processing uranium ore, but as early as 1953 feedstock made from recycled reactor fuel from Hanford processed through the Paducah enrichment cascade contained plutonium.[93] The Paducah Health and Hygiene Department discovered that neptunium-137 and plutonium had entered the process stream from the reactor return feedstock materials. That resulted in a systematic distribution of plutonium in the equipment only designed for UF6. Neptunium was identified at Paducah in 1957. In June 2000, Kentucky Senator Bunning (R-KY), with explicit concern for plutonium contamination at Paducah, called for the Senate Committee on Energy and Natural

89 http://www.courier-journal.com/localnews/2004/12/19ky/B2-nuke12190-3626.html
90 https://medicalxpress.com/news/2013-07-thyroid-cancer-fukushima-workers-tepco.html
91 http://www.courier-journal.com/localnews/2001/05/29/ke052901s30057.htm (no longer on line I have the text)
92 https://www.energy.gov/sites/default/files/2024-03/doe-fy-2025-budget-vol-6-v2.pdf
93 https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/advboard/colley_email11_04242019.pdf

Resources Subcommittee on Energy Research Development, Production, and Regulation to hold a hearing to receive testimony regarding the GAO's report[94] “DOE's Paducah Plan Faces Uncertainties and Excludes Costly Cleanup Activities” on cleanup of nuclear and hazardous wastes at DOE's Paducah Gaseous Diffusion Plant .

Sen. Jim Bunning heard testimony from members of the three DOE offices involved in the cleanup, as well as a representative from the GAO. There was general agreement that several large areas of the Paducah site were not included in the DOE's current remediation plan and that there were concerns about the availability and effectiveness of various cleanup technologies that could seriously affect the agency's ability to estimate the cost and schedule of the cleanup.

Paducah became uneconomic and transitioned from a productive national asset to a national scale decommissioning effort.

Maxie Flats

Maxie Flats was a poorly designed landfill that took both low level radioactive waste and about ½ ton of plutonium and uranium high level waste from 1963 to 1977. The site became a Superfund cleanup in 1986. The closure, capping, and remediation of the site cost the Superfund some 100 million dollars and the Commonwealth some 35 million dollars.[95]

TENORM at Blue Sky Landfill

Like the more serious plutonium contamination at WIPP and the uranium enrichment plant at Paducah, a local relatively small scale improper TENORM waste disposal occurred in 2016-7 in Estill county at the Blue Ridge municipal solid waste landfill. Blue Ridge was built to the standards that became the effective design in the Wilkinson administration (SB2, 1991 Special Session) and was never designed or permitted to receive low level radionuclides. Omissions by the state and landfill operator compounded the error.

Uranium Mining

Kentucky has coal mines and miners, states with uranium mines and miners have similar risks.

Analogous to Kentucky’s black lung and black water problems, uranium miners are exposed to heavy metals and radon.[96] A 2009 article in The Nation details the history of uranium mining and the related lung cancers in the Four Corners region of the U.S.[97] In 2010 Scientific American ran a similar article.[98] A 2012 New York Times article detailed the extent of soil and water contamination from abandoned uranium mines in that region.[99]

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94 https://www.gao.gov/products/rced-00-96

95 https://maysville-online.com/news/123856/beshear-proposes-35-million-for-maxey-flat-in-budget

96 https://www.tandfonline.com/doi/full/10.1093/ohr/ohp025

97 https://www.thenation.com/article/archive/radioactive-revival-new-mexico/

98 https://www.scientificamerican.com/article/abandoned-uranium-mines-a/

99 https://web.archive.org/web/20240613002313/https://www.nytimes.com/2012/04/01/us/uranium-mines-dot-navajo-land-neglected-and-still-perilous.html?_r=1

Mining waste along Utah's Dolores River, the uranium mill processing Superfund site (now erased) mining town of Uravan, Utah[100] [101], the cities of Moab[102], Rifle, Gunnison and others on the western slope of Colorado, and Utah's Arches National park (the only national competition to Kentucky's natural bridges and arches) have all been troubled[103] in ways much like Kentucky's mine waste problems.[104]

The DOE 2025 Environmental Management Budget

Nuclear power often claims to be a clean energy source. However, the DOE's 2025 federal budget for Environmental Management (EM) reports staggering and escalating costs.[105] The budget quantifies the waste to be managed: "The EM program is responsible for the cleanup of millions of gallons of radioactive waste; the safe management and disposition of thousands of tons of spent nuclear fuel and nuclear material; disposition of large volumes of transuranic waste and mixed low-level waste; remediation of huge quantities of contaminated soil and groundwater; and deactivation and decommissioning of thousands of excess facilities." The EM budget is an authoritative deep dive into the real costs of nuclear facilities. It belies the notion that nuclear power is clean energy.

DOE Waste Isolation Pilot Plant (WIPP) Organic Filler

On February 14, 2014, a radiation release occurred at the WIPP from a compromised drum of contact-handled transuranic waste. The drum contained nitrate salts. It was processed in late 2013. The Department of Energy Accident Investigation Board determined the cause of the radiation release was the use of incompatible organic sorbent material.[106] The sorbent, a commercial kitty litter, was likely chosen due to a single typo that left "in" off of "organic".[107] WIPP was closed for a clean-up that took 3 years and $500 million.

Hanford Cleanup

In July of 1990, 40 years after the fact, Energy Secretary James Watkins acknowledged that heavy emissions of ^{131}Iodine that bio accumulates with cancerous results in the human thyroid were released at Hanford in the late 1940s.[108]

2014: "The Hanford Site in southeastern Washington state is widely considered to be the most contaminated place in the Western Hemisphere... The Hanford cleanup is now expected to take at least 70 years to complete."[109] The 2025 Hanford site remaining cleanup cost estimates range from $364 billion to $589.[110]

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100 https://cdphe.colorado.gov/hm/uravan-uranium-project

101 https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0800076

102 https://www.energy.gov/sites/default/files/2024-03/doe-fy-2025-budget-vol-6-v2.pdf p419

103 https://denvergazette.com/news/environment/uranium-mining-waste-colorado-hazards-left-behind/article_81ebaed8-8265-11ef-aca8-a3c0d9efa7dc.html

104 https://www.hcn.org/issues/issue-20/parental-care-for-uranium-tailings-only-goes-so-far/

105 https://www.energy.gov/sites/default/files/2024-03/doe-fy-2025-budget-vol-6-v2.pdf
106 https://www.epa.gov/radiation/2014-radiological-event-wipp
107 https://gizmodo.com/how-a-simple-typo-may-have-turned-a-drum-of-radioactive-1662683094
108 K. Steele, Bulletin of the Atomic Scientists Volume 46, Issue 8, October 1990, pp 7-47
109 Ken Niles, Bulletin of the Atomic Scientists, Volume 70, 2014 - Issue 4
110 https://www.hanford.gov/files.cfm/2025_Lifecycle_Scope,_Schedyle_and_Cost_Report.pdf pp iv-v

Oak Ridge Cleanup

A keyword search for ‘"Oak Ridge" and “Remediation”’ yields more than 1000 citations.[111] Manifestly, cleaning up Oak Ridge is a protracted, expensive and difficult task.

Other Examples

The Savannah River site (SRS) has produced, housed, and reprocessed SNF. It has both military and civilian waste on site. The Defense Waste Processing Facilty (DWPF) processes and vitrifies high level waste at great expense[112].

The West Valley, New York commercial waste reprocessing facility was a commercial and environmental failure.[113]

USS Calhoun County sailors dumped thousands of tons of radioactive waste into ocean.[114]

Sellafield (Cumbria, Britain) may be more contaminated than Hanford.[115] [116]

Nuclear Waste Barrels Litter English Channel.[117]

2013 Bloomberg.com articles see decommissioning as a growth industry.[118] [119] Decommissioning NPPs offers some of the same risks as the Paducah 1954 and 1973 upgrades.

The uranium processing company Nuclear Metals (later renamed Starmet) of Concord Massachusetts operated from 1958 to 2000 just up the street where I lived. Safety management was lax, as detailed in an affidavit of working conditions.[120] Uranium waste was dumped in an unlined landfill on site. It became a Superfund site in 2000[121]

Spent Nuclear Fuel

In all reactor designs, nuclear fuel becomes depleted or poisoned over time and must be replaced. The removed reactor rods/pebbles/etc are a signature mix of transmuted fuel typically salted with high activity short and medium half life species that pose an immediate physical threat to living things. Fresh Spent Nuclear Fuel (SNF) itself is generally so radiologically emissive that it is self protecting from theft. However, fresh SNF must be immediately deported to a large water bath to both cool the SNF and absorb radiological emissions. Failing to cool fresh SNF is a short path to fugitive particle production and egress. Only after dwelling in pools for years can fresh SNF be moved to a dry cask.

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111 https://www.tandfonline.com/action/doSearch?AllField=”oak+ridge”+and+remediation

112 https://www.gao.gov/assets/rced-92-183.pdf p2, p8
113 https://www.nytimes.com/1977/04/10/archives/too-hot-to-handle-nuclear.html
114 https://www.tampabay.com/news/military/veterans/the-atomic-sailors/2157927/
115 https://www.independent.co.uk/news/uk/politics/sellafield-failed-by-private-cleanup-firms-series-of-expensive-mistakes-has-led-to-review-at-nuclear-plant-8735040.html
116 https://www.europarl.europa.eu/RegData/etudes/etudes/join/2001/303110/DG-4-JOIN_ET(2001)303110_EN.pdf
117 https://www.spiegel.de/international/europe/legacy-danger-old-nuclear-waste-found-in-english-channel-a-893991.html
118 http://www.bloomberg.com/news/2013-09-04/nuclear-trashmen-gain-from-record-u-s-reactor-shutdowns.html
119 http://www.bloomberg.com/news/2013-06-16/nuclear-decommissioning-surge-is-investor-guessing-game.html
120 https://www.cdc.gov/niosh/ocas/pdfs/sec/nucmetals/pet/p195appende.pdf
121 https://semspub.epa.gov/work/01/475319.pdf

Should SNF coolant water boil off or drain, fresh SNF rods can heat beyond their melting points then collapse into the remaining water creating a plume of superheated steam and fugitive SNF particles.[122] As described above, SNF in the breached pools at Fukushima, estimated at some 400 tons, was an immediate risk. Circulation pumps were inundated and failed at Fukushima. The pool at Reactor Four was reported to be leaking.[123] A molten rod/superheated steam event outside primary containment was likely to happen quickly with the fresh SNF in Fukushima's damaged cooling pools.[124] It was estimated that the intact pools would evaporate enough in a few days to expose the fresh SNF. Without recirculation, replenishment or sufficient water, fresh SNF rods would have then melted and fallen into the remaining water in the pools stationed in buildings already breached by the explosion of hydrogen gas released when the zirconium clad fuel rods in the molten reactor cores fell into the primary coolant water. The primary order of business after the tsunami was for the first responders to hose seawater into the cooling pools to keep the fresh SNF rod arrays submerged.

Cooling pools have failed under far more benign circumstances. In December 1986, at the Hatch nuclear power plant in Georgia, about half the water in the cooling pool leaked away. The NRC reported that if the water level had gotten low enough to expose the spent fuel, the high radiation level around the pool would have made it difficult for workers to fix the problem.[125]

Nuclear waste management is a long term problem. The Commonwealth's efforts to fully fund long term obligations like pensions and schools are models for how difficult it will be for the state to fully afford the complete life cycle of nuclear power generation. While the current Kentucky government is the "future generation" now for inbuilt pension and education costs from the past, the 2017 Kentucky legislature passed a bill to let nuclear power plants avoid the unsolved issues of SNF waste disposal and leave the problem to later generations and legislatures.

The Nuclear Waste Policy Act of 1982 required NPPs to pay into a waste management fund[126] [127], but that fee has long been contested.[128] SNF was the basis of lawsuits because there were no approved waste sites in the U.S.[129] [130] [131]

It is a kind of magical thinking on the 2017 legislature's part that by removing the permitting constraints requiring SNF disposal that SNF is not the same problem it always has been.

122 https://www.fairewinds.org/nuclear-energy-education/after-disaster-the-deadliest-part-of-japans-nuclear-clean-up
123 https://blog.ucs.org/dlochbaum/possible-source-of-leaks-at-spent-fuel-pools-at/
124 https://oecd-nea.org/jcms/pl_19596/status-report-on-spent-fuel-pools-under-loss-of-cooling-and-loss-of-coolant-accident-conditions-final-report
125 https://blog.ucs.org/dlochbaum/possible-source-of-leaks-at-spent-fuel-pools-at/
126 https://www.energy.gov/sites/default/files/2023-06/NWPA.pdf
127 https://www.gao.gov/assets/rced-87-17.pdf
128 https://www.powermag.com/federal-court-suspends-nuclear-waste-fee-payments/
129 https://www.energyca.org/eca-updates/2023/3/8/frustration-over-nuclear-waste-local-government-sues-doe-over-being-an-interim-storage-site
130 https://www.reviewjournal.com/news/doe-sued-over-nuclear-waste-fund/
131 https://www.hklaw.com/en/insights/publications/2024/10/us-supreme-court-takes-up-nuclear-waste-storage-cases

Current Spent Nuclear Fuel Management Options

In 2020 the Congressional Research Service published an overview of Nuclear Waste Disposal sites in the U.S.A. Nigh all are NPP on site pool and cask storage.[132] [133]

The DOE's Office of Spent Fuel and High-Level Waste Disposition web page, as of 7/14/2025, says: "This website is currently under development. You can find some current program information below; please check back for updates.".[134] The information offered below is: "Temporarily under construction".

In place storage

Prior to the June 18, 2025 Supreme Court decision to reverse lower court decisions and allow Interim Storage Partners (ISP) a 40 year license[135] from the NRC to store up to 5,000 tonnes of SNF[136], federally approved SNF waste depositories have never materialized. The Yucca Mountain SNF storage site had the NRC's blessing, but nonjudicial opposition led to de-funding the site, and that may happen to ISP. Regardless, ISP's five kilotonne license is a very small fraction of the extant national SNF inventory. The site will be full to capacity long before the Commonwealth makes any SNF.

A lingering question remains: ISP and the NRC have not detailed what will happen after the 40 year license expires. The ISP website says the storage site will be decommissioned. Will the SNF be returned to the state of origin after 40 years?

The NRC has long permitted NPPs on site storage. This has been the only available option for commercial SNF in the U.S.A.

The PSC and CHFS should consider the risks to, availability of, and quality of training of first responders to SNF related events should they permit NPPs of any scale. Many of the Chernobyl firemen died and others became the only known cases of genetic damage being passed to their offspring.[137] Interestingly, no such second generation impacts were observed in Hiroshima or Nagasaki. Japan has injured first responders cleaning up primary coolant water spills at Fukushima and at other NPPs.

As a siting criteria for NPPs, some catastrophes require prompt access to resources like huge volumes of pressurized water. Fukushima's SNF needed immediate access to very large quantities of water to prevent tons of fresh SNF from vaporizing.

The dirty bomb potential of SNF is essentially a permanent attribute.

Yucca Mountain

This proposed federal site was defunded in 2011. There are no current plans to open Yucca Mountain for SNF disposal.

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132 https://sgp.fas.org/crs/nuke/IF11201.pdf
133 https://en.wikipedia.org/wiki/File:Spent_nuclear_fuel_in_the_US.jpg
134 https://www.energy.gov/ne/office-spent-fuel-and-high-level-waste-disposition
135 https://www.federalregister.gov/documents/2021/09/17/2021-20092/interim-storage-partners-llc-wcs-consolidated-interim-storage-facility-issuance-of-materials-license
136 https://www.supremecourt.gov/opinions/24pdf/23-1300_b97c.pdf
137 http://news.bbc.co.uk/2/hi/science/nature/1319386.stm

WIPP

The DOE Waste Isolation Pilot Plant (WIPP) near Carlsbad, NM is limited to military transuranic waste (TRU) with small quantities of Plutonium. No commercial SNF is planned for disposal there.

Texas

The Waste Control and Storage company (WCS) of Andrews, TX operates a Federal Waste Disposal Facility (FWF) designed, permitted, and constructed for disposal of Class A, B and C Low-level Waste (LLW) and Mixed Low-level Waste (MLLW). SNF storage or disposal is not an option there.

As of June 2025 litigation continues regarding waste disposal in Texas and New Mexico.[138]

Decommissioning

While the NRC has jurisdiction over most of the NPP license and operation process, the PSC permit starts the ball rolling. As the initiating agent, understanding the whole picture of what happens once an NPP gets PSC permission is important.

The NRC offers three time frames to decommission an NPP: immediate, a 60 year timeout, or an entomb in place.[139] All NRC licensed reactors have a 5 year cooling off period before the NPP is dismantled. To date the "immediate" decommissioning of an NPP has taken at least 15 years.

The NRC may change the decommissioning schedules ad hoc. Accidents that have led to taking an NPP out of service before its planned retirement or led to more extensive contamination may prolong the decommissioning. NPPs or SMRs that add new reactors may defer the decommissioning of the old retired units until all the new licensed reactors age out.

The permits initiated by the PSC start the siting, licensing and construction, that takes some 10-15 years, then 40 to 80 years of licensed operation, then 15 to 60 more years after the NPP has closed before it is all done and fully decommissioned (assuming that new units are not later added at a licensed site that prolong the process). Vetting a utility seeking to install an NPP in the Commonwealth will be challenging. It is hard to be confident that the business or utility will be solvent in 65 to 155 years.

Just as Kentucky faced the belated cost of under funding the state pension system, so too will NPP operators and SNF producers that fail to provide for the total cost of decommissioning and waste disposal. The 1954 Atomic Energy Act 10 CFR Part 50 requires operators to maintain a sinking fund or pay up front. Most but not all NPP operators in the US appear to be on track.[140] The statutory formula for calculating the costs has largely been supplanted by a case by case valuation. Time will tell if the sinking fund accounts are sufficient.

Sinking funded decommissioning may fail if the NPP doesn't run for its projected lifetime due to accidents or insolvency. The NRC licensed NPP operators Energy Harbor, Pacific Gas and Electric Company, El Paso Electric Company, and the Public Service Company of New Hampshire have been bankrupt, and that complicated their NPPs decommissioning.

138 https://apnews.com/article/supreme-court-nuclear-waste-storage-c456419801ab93cb272e92937e2c76d5

139 https://www.reuters.com/article/business/environment/decommissioning-a-nuclear-plant-can-cost-1-billion-and-take-decades-idUS1788835968/

140 https://decommissioningcollaborative.org/wp-content/uploads/2020/07/Callan-2019-NDT-Study.pdf :p5

SMRs are promoted as requiring less capital. It seems likely that small capital agents may not have the deep pockets or lifespan that an NPP requires. Assuring that their operators have sufficient funds for the entire life cycle of the NPP may be so difficult as to be prohibitive.

Lessons From the Past as Guidance for the Future

Weaponization, Nuclear Fuel Diversions and Proliferation

The classing of nuclear fuel as low enriched versus highly enriched uranium dates back to the mid 1950s and was predicated on practical and theoretical estimates of neutron flux and the minimum fissile mass needed to initiate a chain reaction fission. HALEU with greater than 10% ^{235}U, even in the 1950s, would be considered a weapons grade material.[141]

Access to nuclear fuel and SNF is an established risk. In the Volume 17, 2009 issue of Science & Global Security, T. Cochran, H. Feiveson and F. von Hippel reported that: 'On March 24, 1977, President Jimmy Carter, building on an October 28, 1976 decision by President Ford directed the indefinite deferral of commercial reprocessing and plutonium recycling in the United States. In the same directive, President Carter suspended the licensing process geared toward obtaining a Limited Work Authorization for the Clinch River Breeder Reactor.

The decisions by Presidents Ford and Carter were primarily in response to India's use of plutonium separated with U.S. assistance in an "Atoms for Peace" program to make a nuclear explosion in 1974. At the time, Brazil, Pakistan and South Korea had all contracted to buy reprocessing plants from France and Germany. The U.S. Government suspected that all three countries were interested in separating plutonium for weapons purposes.'[142]

The June 2024 report by R. Scott Kemp, Edwin S. Lyman, Mark R. Deinert, Richard L. Garwin, and Frank N. von Hippel titled "The weapons potential of high-assay low-enriched uranium" explains these risks in detail.[143] They report that the 19.75% HALEU fuel assembly from a single reactor, less than a 1000kg mass, has the potential to be directly reshaped to a critical [nuclear explosive] geometry. They further report that 10 of the next generation HALEU designs funded for proof of concept by the U.S. Department of Energy (DOE) and Department of Defense (DOD) use more than a tonne of HALEU fuel.

Fast neutron SMRs may operate as plutonium breeder reactors. Cheap transportable SMRs sold to nations intent on weapons production will pose risks both from immediate HALEU diversion and from weapons grade plutonium production. It may not be in the best interest in the Commonwealth or the nation to lower the cost of entry to plutonium production or make it easy to relocate and hide a reactor.

It's likely that any HALEU fueled NPP or SMR will require extensive security to prevent or respond to a theft of fresh or spent fuel.[144]

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141 https://scienceandglobalsecurity.org/archive/sgs24brown.pdf
142 https://www.tandfonline.com/doi/full/10.1080/08929880903445514
143 Science,6 Jun 2024,Vol 384, Issue 6700, pp. 1071-1073, also available as https://rlg.fas.org/haleu-science.pdf
144 https://www.kentoncounty.org/DocumentCenter/View/2818/Appendix-1----Nuclear-Terrorism-Response-PDF

The National Nuclear Goals are Ambiguous

Nuclear fission is a dual use technology. Because of its military history and ongoing national security concerns, getting a complete picture of the past, the current and the future states of the technology is difficult. Many agents and agencies have both civilian and military roles: the DOE, the Atomic Energy Commission/Nuclear Regulatory Commission, the national labs, and the TVA are examples. Federal interests may be be more complicated than they appear.

In March 2013 former Nuclear Regulatory Commission Chairman Gregory Jaczko said "The biggest problem with the NRC continues to be the heavy influence that the industry has in selecting the members of the commission. It is a very political process. ... It would be virtually impossible for someone who is publicly skeptical of nuclear power to ever be confirmed as a commissioner on the NRC. That is fundamentally wrong."[145]

The argument that nuclear power is the solution to global warming has never held up. The June 1990 report by Alan Miller and Irving Mintzer in the Bulletin of the Atomic Scientists detailed that NPPs would need to be installed at a 16% growth rate to meet minimal impacts on global warming, but nations around the world would be bankrupted by that growth rate and that it wasn't possible to train and educate the needed staff to operate the reactors that quickly. They finally concluded that the initial global warming outcome was made worse by the mining and construction needed at growth rates above 7%.[146] Manifestly, the rate of adding NPPs around the world never approached such rates.

An analysis of the pathways to net-zero emissions was published in December 2021 by the Organization for Economic Co-operation and Development's (OECD) Nuclear Energy Agency (NEA). It found "that to limit global warming to no more than 1.5°C, installed nuclear energy capacity must triple to 1,160 gigawatts by 2050. The world is not on track to meet these targets. Even with the about 50 nuclear energy reactors now under construction around the world and the 100 planned, global nuclear energy capacity will remain roughly constant as older reactors are retired."[147] To replace all carbon sourced generation (coal, gas and oil) worldwide with nuclear power plants would require roughly 3500 GWe nuclear power, about ten times the installed capacity of today and require 3000 to 4000 new units [and require ignoring the capital, staffing, and carbon costs needed to accomplish this].[148]

In June 2025, Stanford University professor M.Z. Jacobson released a pre-print of a Cambridge University Press article where he asserts that small modular reactors will not be able to help address global warming or air pollution in a rapid or meaningful way. Instead, money spent on them will prevent faster and less expensive solutions from being implemented. Spending money on NPPs exacerbates the climate and air-pollution problems the world faces and is an opportunity cost.[149]

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145 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/03/15/fukushima-daiichi-nuclear-plant-weekly-review-031502

146 Alan Miller & Irving Mintzer (1990) Global Warming: No Nuclear Quick Fix,
Bulletin of the Atomic Scientists, 46:5, 31-34, DOI: 10.1080/00963402.1990.11459844

147 https://www.oecd-nea.org/jcms/pl_62806/the-role-of-nuclear-energy-in-mitigating-climate-change

148 https://www.sciencedirect.com/science/article/pii/S0301421521002330 Nuclear energy - The solution to climate change?

149 https://web.stanford.edu/group/efmh/jacobson/WWSStillNMN/SNMN-WhyNotNuclear.pdf

An MIT study completed in 2003[150] argued both for NPPs: "The nuclear option should be retained precisely because it is an important carbon-free source of power" and against them: "But the prospects for nuclear energy as an option are limited, the report finds, by four unresolved problems: high relative costs; perceived adverse safety, environmental, and health effects; potential security risks stemming from proliferation; and unresolved challenges in long-term management of nuclear wastes. "

The current DOE web page on the nuclear fuel cycle[151] needs work: the central entry in the graphic is "Recycling" but extracting fuel by reprocessing was defunded by Presidents Ford and Carter in the 1970s. Recycling is how plutonium contaminated the uranium isolation system at the Paducah Gaseous Diffusion Plant when they used tailings from Hanford's spent reprocessing waste. The "Fuel Fabrication" glyph doesn't include a link to "Waste Disposal". There are hundreds of tons of UF6 DU waste that have been gathering since the 1950s at Oak Ridge, Paducah and Piketon. A risk assessment published in the Federal Register in 2009 offered proposals on how to remove uranium waste from Paducah.[152]

Research is certainly warranted and welcomed, but sometimes federally or state funded demonstration projects make little economic sense. Paducah's 2014 proposed separation of isotopes by laser excitation (SILEX) effort[153] to research and demonstrate an already proven and patented Australian technology[154] to re-reprocess depleted UF6 tailings is an example. The theoretical basis had been established in the early 1940s by Urey's Columbia University ^{235}U enrichment research, but lasers did not then exist. The federal government and Global Laser Enrichment (GLE) first promoted the SILEX exercise at Paducah not as a means to make LEU, but as a means to isolate ^{235}U, and once enriched, to then dilute the isolated ^{235}U with more tailings to make a product with ^{235}U concentrations equivalent to native yellowcake that might be sold as ore-equivalent UF6.[155]

The payoff for making more uranium ore is unclear. The world's supply of uranium ore is relatively large. 'If plausible estimates of geological abundance are used, the amount of uranium still to be discovered at recovery costs up to $130/kg would be 50–126 million tons. This corresponds to 500 to 1000 times the projected demand in 2030'[156] Less generous estimates report reserves on the order of 100 times the 2030 demand.

The first demonstration SILEX project proposal failed when the anchor companies left.[157] [158] Under new ownership, the project has been restarted 10 years later as a production facility with the same goal and original NRC permits to re-reprocess depleted UF6 tailings and downblend the recovered ^{235}U with tailings to make ore-equivalent UF6.

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150 https://web.mit.edu/nuclearpower/
151 https://www.energy.gov/ne/nuclear-fuel-cycle
152 https://www.energy.gov/sites/default/files/nepapub/nepa_documents/RedDont/EA-1607-FONSI-2009.pdf
153 https://web.archive.org/web/20230518052615/https://www.world-nuclear-news.org/UF-US-DOE-sells-depleted-uranium-for-laser-enrichment-1111167.html
154 https://web.archive.org/web/20180901084634/http://www.silex.com.au/History
155 https://www.nrc.gov/docs/ML2433/ML24332A108.pdf
156 Erich Schneider and William Sailor, "Long-term Uranium Supply Estimates,"
Nuclear Technology 162 (2008): 379, from https://fissilematerials.org/library/rr08.pdf
157 https://optics.org/news/5/7/48
158 https://web.archive.org/web/20240621082515/https://www.world-nuclear-news.org/UF-GE-Hitachi-to-exit-laser-enrichment-JV-1904168.html

GLE's NRC filing says they expect to spend 30 years re-reprocessing the UF6 waste at Paducah. Paducah's UF6 tailings are already depleted uranium, there will be little change in their heavy metal toxicity. Depleted uranium already has relatively low radiological emissivity, re-reprocessing those tailings won't change much. In exchange for the cost of the 30 year demonstration, something like a third of the UF6 waste might be marketable as ore which will become DU waste again once it's processed to re-extract the SILEXed ^{235}U. The best outcome of this demonstration effort is to repeat proven research and eventually make an expensive but temporary reduction in depleted UF6 waste. It would not make LEU.

Last November, Greater Paducah Economic Development president and CEO Bruce Wilcox misrepresented and oversold the project as one that will produce LEU fuel. GLE's Nima Ashkeboussi recently said that it was still a [30 year] demonstration, not a production project.[159]
SILEX generated ore-equivalent UF6 would simply become depleted uranium waste again after the ore was processed by whomever might have bought it. Ultimately, using SILEX to make DU into ore is pointless and expensive.

Rarely mentioned, SILEX has serious proliferation issues.[160]

The Global Nuclear Energy Partnership (GNEP)

The current round of federal grants promoting the Commonwealth's interest in supporting NPP facilities looks a lot like the Bush-Cheney era GNEP initiatives.

Contrary to the GNEP goals, that initiative led to a federal constriction of plans and funding. A 2008 article in the Bulletin of the Atomic Scientists[161] on the future of GNEP states: "...last year, an increasingly skeptical Congress, following the lead of the House and Senate Energy and Water Appropriations Subcommittees, barred Energy from building a reprocessing facility or a fast neutron reactor. And recently, Energy announced that it would no longer consider "project-specific proposals for the siting, construction, and operation of a nuclear fuel recycling center, an advanced recycling reactor, and an advanced fuel cycle research facility." Instead, it said it would focus on the feasibility of the technologies. This decision may result in less active local support for GNEP, now that the near-term construction of reprocessing and fast reactor facilities seems less likely."

A 2008 Congressional Research Service (CRS) study[162] also points out that: " Congress has itself raised concerns about GNEP. In the Consolidated Appropriations Act FY2008 (P.L. 110-161), Congress provided $181 million out of $395 million requested by the administration. Of this amount, $151 million is for research, development, and design activities, with no funds for constructing facilities for technology demonstration or commercialization."

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159 https://www.wkms.org/business-economy/2024-11-27/laser-uranium-enrichment-company-acquires-land-in-paducah

160 https://www.laserfocusworld.com/lasers-sources/article/16558982/silex-laser-uranium-enrichment-technology-may-create-new-nuclear-proliferation-risks

161 Leonor Tomero , 8 August 2008, http://www.thebulletin.org/web-edition/reports/the-future-of-gnep/the-future-of-gnep-domestic-stakeholders

162 www.fas.org/sgp/crs/nuke/RL34234.pdf Congressional Research Service ,"Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power" March 7, 2008

A 2010 article in the Scientific American describes the nuclear industry in the U.S. as “in a coma”.[163]

The GNEP initiatives here in the Commonwealth only invited a failed ambition in 2008 to re-purpose the Paducah Gaseous Diffusion Plant[164] [165] to reprocess spent nuclear fuel.

Given how few megawatts evolved in the U.S.A. from the GNEP initiative, it is worthwhile for the PSC to consider what happens if the current effort yields the same results.

Operating License Extension and the Basis for Long Term Comparisons

By the end of 2016 about 50% of the 104 licensed U.S. NPP units were eligible to seek a second license renewal. The majority of U.S. NPPs are keeping the option open for long term operation beyond 60 years.[166] License extension is attractive to the NPP operators, it spreads the capital costs of the facility over a longer term and forestalls decommissioning costs.

Not all operators choose license extension. In 2013, Dominion announced the retirement of the Kewaunee NPP in Wisconsin. It was running well and its owner had secured permission to run it an additional 20 years, but it was losing money because of the low wholesale price of electricity.

By 2015 the U.S. Nuclear Regulatory Commission has granted license extensions for 81 nuclear reactors that allow them to operate for up to 60 years, 20 years past their original expiration dates. In December 2015, the NRC said it was preparing for the possibility of extending the commercial viability of commercial nuclear reactors to eight decades.[167] The Russian nuclear agency Rosatom has predicted that a plant built in Turkey in 2016 will operate for 100 years.[168] The Davis-Besse NPP that had the complete corrosion of the carbon-steel reactor vessel described above has had it’s license extended by 20 years.[169]

Considering that NRC operating license extension beyond design life is now typical in NPPs, long term time horizons deserve attention in the initial permitting and operation of NPPs, and in the comparisons to other means of making electricity. Questions like “will fusion reactors be available within 50 years” or “will solar panel and battery costs continue to drop with returns to scale and innovation in the next 20 years” become germane in the context of 60+ year NPP lifetimes.

NPP Operators’ Take on Alternatives and PSC Case 2025-00186

Currently about 20 NPPs in the U.S. are only operating because six states have used taxation to subsidize them.[170] Most dubiously, Ohio legislators took bribes to make that happen.[171] In Finland

163 https://www.scientificamerican.com/article/is-the-nuclear-renaissance-failing/

164 http://web.archive.org/web/20070922220512/http://www.paducahgnep.com/

165 https://web.archive.org/web/20081017091431/http://www.gnep.energy.gov/peis/peisprocess.html

166 https://asmedigitalcollection.asme.org/PVP/proceedings-abstract/PVP2013/55737/V007T07A028/282916

167 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2015/12/18/nrc-preparing-guidance-for-extending-plant-licenses-to-80-years-121801

168 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2014/12/01/rosatom-ceo-kiriyenko-expects-turkish-npp-to-operate-for-100_2d00_years-120102

169 https://www.nucnet.org/news/us-nrc-approves-vistra-s-application-to-operate-perry-1-nuclear-plant-for-60-years-7-3-2025

170 https://www.congress.gov/crs-product/R46820 Table 3: “U.S. Nuclear Reactors Supported by State Intervention”

171 https://en.wikipedia.org/wiki/Ohio_nuclear_bribery_scandal

subsidized nuclear power "dramatically slowed investment in renewable energy."[172] Stanford's M.Z. Jacobson, cited above, argues that spending money on NPPs does that here in the U.S.

In a complaint published in 2013[173] Exelon's CEO warned that continued subsidies for wind generation could affect power markets in ways that lead to the premature closure of nuclear plants. In that same year, Exelon asked for $300 million a year in taxpayer funded subsidies to keep its Quad Cities NPP running because it could not compete with lower priced gas powered plants.[174]

When Duke Energy responded to PSC Case 2025-00186[175] they listed reasons why NPPs are too risky to build. Duke then asked for new legislation in the Commonwealth that would shift those risks from the agency seeking the permit (Duke) to Kentucky utility consumers and taxpayers. Duke's filing invites questions. If NPPs are so financially risky to build, afford and operate, why would the taxpayer want to take that risk. Why would the PSC? Are there other ways to generate and dispatch carbon neutral electricity at scale that aren't so expensive or risky?

Duke Energy's filing in this PSC case (2025-00186) notes that legislative ambiguities need resolution to better define how the decommissioning costs for NPPs and for steam powered generators being replaced by NPPs are to be assigned and accrued. Duke also asks for legislation to permit Construction Work In-Progress (CWIP) fees an annual review to allow new increased rates be charged to customers before a NPP comes on line. Manifestly, Duke both wants to make rate payers involuntary investors, and anticipates the well established escalation of NPP costs above their primary estimates. Duke wants new legislation to put those additional costs on the utility's customers.

Duke also wanted legislation to indemnify them for canceling due to costs: "In the event of cancellation, any costs that were deemed prudent in the annual review should be recoverable in order for the utility to manage its risk". This penalizes the utility's consumers for getting out of a deal where costs they had little control over became large enough that either the PSC or the utility chose to quit.

Duke's legislative wish list continues with: "Under Kentucky's well-established process for obtaining Certificates of Public Convenience and Necessity (CPCN), the utility must demonstrate that its proposed construction represents the least-cost, most reasonable solution for customers." and "As much as 50 percent of a nuclear project's cost must be spent before a CPCN is granted." Duke concludes those observations with a pitch for new legislation to shed some of that risk by asking for the "Commonwealth to adopt some portion of the risk of deployment to allow a project to move forward".

After asking for legislation to put all those risks on utility customers and taxpayers, Duke's filing encourages the PSC to embrace and invest in unproven and unspecified SMR systems.

To accommodate Duke's legislative wish list will add years to siting NPPs while the legislature passes the desired statutes. It will also require the PSC to make the utility customers and taxpayers assume the

172 https://spectrum.ieee.org/uk-builds-nuclear-plants-while-france-scales-back

173 https://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2013/02/11/exelon-ceo_3a00_-wind-subsidies-could-threaten-nuclear-plants-021102

174 https://web.archive.org/web/20250422134313/https://www.chicagobusiness.com/article/20150729/NEWS11/150729783/exelon-likely-closing-quad-cities-nuclear-plant

175 https://psc.ky.gov/pscecf/2025-00186/e.rolfes-adkins%40duke-energy.com/07112025034926/DEK_Comments_071125.pdf

front end construction costs, the annually reviewed escalated costs, the risk of those costs rising beyond expectation and leading to a commercial failure or PSC permit disqualification, and will require the PSC to make and present a comparison of those same costs for the carbon neutral alternatives.

Duke's filing indicates that they will only be interested in Case 2025-00186 if it leads to significant new legislation that put most risks on others who have little control over costs.

Observations on Recent Legislation

The legislature's tasking of the PSC staff to become competent in Nuclear Power Plant (NPP) siting and construction is not a sufficient scope of review for a permitting agency. To comply with their statutory requirement to advise on costs and benefits of all base load energy alternatives, the PSC's competencies should also include assessing NPP risk management, operation, maintenance, spent fuel management and closure. Those skill sets are needed to establish NPP costs relative to the alternatives.

In 2017, the Kentucky Senate passed Bill 11, which amended both KRS 278.600 and KRS 278.610 and repealed KRS 278.605 that limited NPP construction permits to those showing a means for disposal of high-level nuclear waste approved by United States government.

In the regular session of 2023, Senate Joint Resolution 79 directed the formation of a working group of state officials and industry representatives to advise the General Assembly regarding a permanent nuclear energy commission with the mission of "education, coordination of resources, and professional expertise necessary to foster the development of the nuclear industry in the Commonwealth"

Senate Joint Resolution 140 passed in the 2024 Regular Session formed the Kentucky Nuclear Energy Development Authority (KNEDA) to serve as the "nonregulatory, trusted state government agency on nuclear energy issues and to support and facilitate the development of the nuclear energy ecosystem across the Commonwealth."

The Kentucky Nuclear Energy Development Authority (KNEDA) appears biased by fiat. The fundamental construction by the 2024 Senate Joint Resolution 140 requires it to support and facilitate the development of the nuclear energy ecosystem across the Commonwealth, it makes no mention of the costs or benefits of that support.

The recently enacted legislation (SB84, Regular Session 2025) requiring courts to defer to it's own interpretation of statue, not the regulating agencies interpretation used to construct administrative regulation, invites a transfer of executive branch power to the judicial branch. While state agencies are far better staffed and experienced than the Administrative Office of the Courts or Judicial staff in matters germane to their agency that lie outside the four corners of legal interpretation, under this new statute, the PSC will have to anticipate judicial intervention as it pursues the legislature's requirement to amend "all other administrative regulations promulgated by the PSC pursuant to KRS Chapter 13A to ensure that they do not contain any provisions that would impede the PSC from effectively regulating nuclear facilities or obstruct the development of the nuclear ecosystem in the Commonwealth."

In particular concern to me is the phrase "obstruct the development of the nuclear ecosystem in the Commonwealth" as it may well come to pass that the PSC's research leads them to conclude that nuclear power plant generated electrical service is in fact more expensive, or some proposals may

prove too immature, untenable, ill-financed or unreliable. Such determinations might be misinterpreted as “obstruction”.

A Broad Concern: Maxie Flats Redux

This is not strictly a PSC problem, but it’s a headache the PSC might want to help the Commonwealth avoid.

While Kentucky has no inventory of SNF, some 88 kilotons of SNF are awaiting long term disposal from across the nation.

If the NRC starts permitting commercial SNF interim storage sites in the nation like they have in Texas[176], will some enterprising company seek a permit here in Kentucky to host a commercial SNF interim disposal site even if there are no NPPs operating here? Will the state have any local control over a commercial SNF storage site since the NRC has regulatory control of SNF? The NRC appears to have some say over the source of SNF at the Texas interim repository, but would Kentucky have an inalienable right to govern that decision here? Will those NRC source location limits survive a court challenge based on the Commerce Clause? Given the national backlog, is it possible that any repository opened here could soon fill up with SNF, and little to none of it might originate from within the Commonwealth?

As the Commonwealth learned with solid waste in the 1990s, the Interstate Commerce Clause of the Constitution required Kentucky to accept waste from anywhere in the nation once we permitted a landfill.

Kentucky was once one of the cheapest places in the nation to dump solid waste. That led to a massive influx of waste from other states. The legal means to limit those imports was for Kentucky to raise its municipal solid waste landfill design standards.

It may be that the best way for Kentucky to not become a nationally attractive SNF interim dumping ground is to set local SNF repository standards high enough to make us an uneconomic place to dump. As the state has no SNF inventory of it’s own, if it’s possible there is no downside to making very strong local standards.

Conclusion

The intent of this submission is to offer the PSC accessible facts to help inform them about the last 80 years of civilian nuclear policies and technology in the United States. I have written about that history in the hope that the PSC might then be better prepared for making the choices now facing them that will carry the Commonwealth into the next 80 years. Kentucky is a nuclear neophyte and states have gotten it wrong before. Getting it wrong has cost them many billions of dollars while failing to meet the needs of their constituents. Our only nuclear workforce is now atrophied and had only ever made fuel. Manifestly, the Commonwealth has a lot to learn.

If there is an actual NPP project seeking licensing and permitting, the PSC, the Cabinet for Health and Family Services and the NRC will be the involved agents. The time it will take to site, permit, license and operate an NPP of any scale means that the consequences of this PSC’s choices, good or bad, will

176 https://www.supremecourt.gov/opinions/24pdf/23-1300_b97c.pdf

likely belong to your successors. I'd like to encourage the current PSC to think long and hard about permitting utilities to commit to the new technologies. SMR and HALEU technologies did not prove economic in the past. The new designs are in their technical and licensing infancy.[177] [178]

I hope is it now clear beyond doubt that no megawatts going on the grid in the next decade from here in the Commonwealth will be generated by nuclear fission. The immediate proven non-carbon generating solutions are in the solar, wind and battery sectors. By choosing them, the sitting PSC staff as well as the state's residents can witness and enjoy immediate rewards of safe affordable dispatchable electrical service.

The coming decades will give Kentucky a chance to mature its nuclear competencies. The relative virtues among power generating technologies should gain evidence in that interval as well.

The Author

My name is William S. Herrick.

My parents met working as Nobel Laureate Harold Urey's Manhattan Project research assistants in 1942. Urey (along with many others) developed the large scale gaseous diffusion isotope isolation of ^{235}uranium, the fissile fuel used in atomic bombs and nuclear power plants. Oak Ridge and Paducah implemented gaseous diffusion isolation from the 1940s through 1985 (Oak Ridge K-25), and 2013 (Paducah). On August 6, 1945 Secretary of War Stimson commended my civilian parents for helping end WW2.[179]

In 1962 I lived on the same street as Nuclear Metals (later renamed Starmet), Main Street, Concord Massachusetts. Nuclear Metals was a commercial uranium foundry and unlined landfill that became a Superfund site in 2001.

In 1968 an illegal strip mine damaged the public road a mile and a half from my home. The mine was on the Umber Fork of the Upper Devil's Creek, a tributary of the North Fork of the Kentucky River. I own the north bank of the Upper Devil's Creek where it meets the Kentucky River. The mine has never been reclaimed. I pass that highwall and spoil dump every time I leave home.

In 1971 I lived, hiked and boated in the coal, radium and uranium mining regions of Colorado and Utah. I was a 15 year old high school senior that ran out of science curricula so I spent my final semester under the tutelage of Dr. Martin E. Fuller (PhD Chemistry MIT, PhD Physics MIT) studying nuclear physics and the skill sets, social responsibility and motivations of the Manhattan Project scientists. I am familiar with the history and lessons offered by a long study the U.S. nuclear fuel cycle.[180] [181]

In the mid 1990s, I became one of Dr. Ron Eller's UK Commonwealth Fellows.

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177 https://www.sciencedirect.com/science/article/abs/pii/S0029549322000024
178 https://www-pub.iaea.org/MTCD/Publications/PDF/PUB2002_web.pdf
179 https://www.appal.org/pix/ceh.aug6.1945.JPG

180 https://appal.org/padgnep/Paducah_GNEP_PEIS_wsh1.pdf
181 https://appal.org/why/why.ky.leg.addendum.2017.pdf

My intent for this document is to help the PSC lay a more complete foundation for their mandated assessment of nuclear power plant costs relative to other carbon-neutral alternatives. In particular, I hope to convey the extended time frames of consequence. The half lives of SNF constituents are complex and hard to grasp. NPP licenses now trend to 60 or 80 years and decommissioning will add another 15 to 60 years to that. Federal design certifications and permitting for new technologies will also take more than a decade, further extending the impact of the choices the PSC makes now.

I have shown here that, different from any other permits ever issued by the PSC, the term of consequence and the scale of liability for NPPs are measured in decades and centuries and in costs that may encumber unhealthy fractions of the state's economy. I've also shown that recent state and federal statutory changes appear to superficially skew favorably towards more liberally permitting NPPs, but as in the past, when devilish details are uncovered, the opposite may happen.

The Commonwealth's legislature may wish to externalize costs or embrace wishful hopes about new technologies and licensing, but public agents and utilities responsible for issuing permits or effecting their implementations from cradle to grave to provide least cost electricity for decades and centuries don't have such luxuries.

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