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RE: Public Comment Submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS) (DOE/EIS-0542)

Sent by Chuck Broscious on or before March 1, 2021 by email to VTR.EIS@Nuclear.Energy.gov

EDI comments submittal on the Department of Energy Scope of an Environmental Impact Statement for a Versatile Test Reactor, ID: DOE-HQ-2019-0029-0001 is included herein by reference. [1]

In the interest of avoiding repetition for the public seeking independent information, EDI references critical contributors to the VTR EIS Scoping discussion by David McCoy. [2] Tami Thatcher offers essential comments on VTR's impact at INL.[3] [4] [5] [6] [7] Also, Ed Lyman, Union of Concerned Scientists, Acting Director, Nuclear Safety Project submits crucial review of the VTR. [8] EDI encourages the

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[1] Chuck Broscious, *Comments on scoping warfighter mobile nuclear reactor power generation environmental impact statement*, March 31, 2020, filed on behalf of Environmental Defense Institute. http://environmental-defense-institute.org/publications/EDIMicroreactor.pdf

[2] Dave McCoy, J.D., *Citizen Action New Mexico's EIS Scoping Comments for Plutonium Down-blending Dilution and Disposal at WIPP, Department of Energy/NNSA*, February 1, 2021, Dave McCoy, J.D., Executive Director Citizen Action New Mexico, dave@radfreenm.org http://environmental-defense-institute.org/publications/CommentNRCdEISHoltecM.pdf

[3] Tami Thatcher, *Public Comment Submittal on the U.S. Department of Energy's Versatile Test Reactor Draft Environmental Impact Statement (VTR EIS)* (DOE/EIS-0542); Comment submittal by Tami Thatcher, February 5, 2021. Comments Due: February 16, 2021. Sent by email to VTR.EIS@Nuclear.Energy.gov http://environmental-defense-institute.org/publications/CommentVTRdEIS.pdf http://environmental-defense-institute.org/publications/CommentVTRdEIS2.pdf

[4] Tami Thatcher, Public Comment Submittal on the Department of Energy Scope of an Environmental Impact Statement for a Versatile Test Reactor, ID: DOE-HQ-2019-0029-0001 http://environmental-defense-institute.org/publications/ScopeEISVTR.pdf

[5] Tami Thatcher, Public Comment Submittal on the U.S. Department of Energy Draft Environmental Assessment for Microreactor Applications Research, Validation and Evaluation (MARVEL) Project at Idaho National Laboratory(DOE/EA-2146) http://environmental-defense-institute.org/publications/CommentDOEMARVELdea.pdf

[6] Tami Thatcher, Public Comment Regarding Application to the U.S. Nuclear Regulatory Commission on the "Holtec International HI-STORE Consolidated Interim Storage Facility Project," Docket NRC-2018-0052regarding NRC's draft environmental impact statement. http://environmental-defense-institute.org/publications/CommentNRCdEISHoltecT.pdf

[7] Tami Thatcher, Public Comment Submittal on the Department of Defense "Prototype Microreactor EIS Comments" on the scope of an Environmental Impact Statement for Construction and Demonstration of a Prototype Advanced Mobile Nuclear Microreactor, Docket Number DOD-2020-OS-0002 http://environmental-defense-institute.org/publications/PublicCommentMicroRx.pdf

[8] Ed Lyman, *There are Faster, Cheaper, Safer and More Reliable Alternatives to the Energy Department's Proposed Multibillion Dollar Test Reactor*, April 5, 2019, Union of Concerned Scientists (UCS) questions the need for a dedicated fast neutron test reactor and, more generally, has serious concerns about fast reactor safety and security, detailed in a critique it released last year. https://allthingsnuclear.org/

interested public to access these resource links that cover most of the salient issues related to the VTR project and related issues in preparing their own comments.
EDI's comments will primarily cover the prolifery of new reactors and waste projects planned for the US, the Idaho National Laboratory (INL) and/or in the first stages of deployment by DOD, DOE, National Nuclear Security Administration, National Academies and NASA and the applicability for the need for the NEPA's Programmatic provisions. The common issues requirement of a PEIS are:

1. Cumulative environmental emissions impact of all new reactors in the nation;
2. Cumulative nuclear waste disposal impact of all new reactors;
3. Cumulative financial drain away from renewable energy development;
4. As the NEPA regulations cited below demonstrate, a Programmatic Environmental Impact Statement (PEIS) is required for the segmented and expansive program of these agencies. *Definition: Programmatic NEPA* document means a broad-scope EIS or EA that identifies and assesses the environmental impacts of a DOE program; it may also refer to an associated NEPA document, such as an NOI, ROD, or FONSI.

Nuclear Waste Generated by All Reactors Must be Included in a VTR PEIS

"By taking these positions on promoting nuclear reactors, the Nuclear Regulatory Commission (NRC) is ignoring some of the most important issues in the public mind as to whether New Mexico becomes an unwilling recipient for a permanent repository for existing wastes, more future generated nuclear reactor wastes and the adequacy of storage prior to transport for wastes from other sites. NRC thus limits any discussion of the elephant in the room." [9]

"[WASHINGTON, DC – February 10, 2021] -- The non-profit organization Beyond Nuclear filed suit in federal court today to prevent the U.S. Nuclear Regulatory Commission (NRC) from licensing a massive "consolidated interim storage facility" (CISF) for highly radioactive waste in Andrews County, west Texas.

"In its Petition for Review filed in the U.S. Court of Appeals for the District of Columbia Circuit, Beyond Nuclear asked the Court to dismiss the NRC licensing proceeding for a permit to build and operate a CISF proposed by Interim Storage Partners (ISP), a business consortium. It plans to use the facility to store 40,000 metric tons of highly radioactive irradiated fuel generated by nuclear reactors across the U.S. (also euphemistically known as "used" or "spent" fuel), amounting to nearly half of the nation's current inventory.

"The irradiated fuel would be housed on the surface of the land, on the site of an existing facility for storage and disposal of so-called "low-level radioactive waste" (LLRW). The LLRW facility is owned and operated by Waste Control Specialists (WCS). WCS and Orano (formerly Areva) comprise ISP. ISP's CISF is located about 0.37 miles from the New Mexico border, and very near the Ogallala Aquifer, an essential source of irrigation and drinking water across eight High Plains states.

"The Beyond Nuclear petition charges that orders issued by the NRC in 2018 and 2020 violate federal law by contemplating that the U.S. government will become the owner of the irradiated fuel during transportation to and storage at the ISP facility. Under the Nuclear Waste Policy Act, the government is precluded from taking title to irradiated fuel unless and until a repository is licensed and

[9] Ibid. Foot Note #2

operating. No such repository has been licensed in the U.S. The U.S. Department of Energy's (DOE) most recent estimate for the opening of a geologic repository is the year 2048 at the earliest.

"In its 2020 decision, in which the NRC rejected challenges to the license application, the NRC Commissioners admitted that the Nuclear Waste Policy Act would indeed be violated if title to irradiated fuel were transferred to the federal government so it could be stored at the ISP facility. But they refused to remove the proposed license provision which contemplates federal ownership of the irradiated fuel. "Instead, they ruled that approving ISP's application would not directly involve NRC in a violation of federal law – according to the NRC, that violation would occur only if DOE acted on the approved license – and therefore they could approve it, despite the fact the provision is illegal. The NRC Commissioners also noted with approval that "ISP acknowledges that it hopes Congress will change the law to allow DOE to enter storage contracts prior to the availability of a repository" (December 17, 2020 order, page 5).

"But the petition contends that the NRC may not approve license provisions that violate federal law in the hope the law will change. "This NRC decision flagrantly violates the federal Administrative Procedure Act (APA), which prohibits an agency from acting contrary to the law as issued by Congress and signed by the President," said Mindy Goldstein, an attorney for Beyond Nuclear. "The Commission lacks a legal or logical basis for its rationale that it may issue a license with an illegal provision, in the hopes that ISP or the Department of Energy won't complete the illegal activity it authorized. The buck must stop with the NRC." Co-counsel Diane Curran stated, "Our claim is simple. The NRC is not above the law, nor does it stand apart from it."

"In a separate case, filed in June 2020, Beyond Nuclear challenged a similar application, by Holtec International, to store up to 173,600 metric tons of irradiated fuel on another CISF site in southeastern New Mexico. The Holtec site lies just over 40 miles west from the ISP facility in Texas. Like ISP's license application, Holtec's application illegally assumes that the federal government will take title to the irradiated fuel during transportation and storage.

"*Background on the Nuclear Waste Policy Act.* According to a 1996 D.C. Circuit Court ruling, the NWPA is Congress' "comprehensive scheme for the interim storage and permanent disposal of high-level radioactive waste generated by civilian nuclear power plants" [*Ind. Mich. Power Co. v. DOE*, 88 F.3d 1272, 1273 (D.C. Cir. 1996)]. The law establishes distinct roles for the federal government, versus the owners of facilities that generate irradiated fuel, with respect to storage and disposal of the highly radioactive wastes. The "Federal Government has the responsibility to provide for the permanent disposal of…spent nuclear fuel" but "the generators and owners of…spent nuclear fuel have the primary responsibility to provide for, and the responsibility to pay the costs of, the interim storage of…spent fuel until such…spent fuel is accepted by the Secretary of Energy" [42 U.S.C. § 10131]. Section 111 of the NWPA specifically provides that the federal government will not take title to spent fuel until it has opened a permanent geologic repository [42 U.S.C. § 10131(a)(5)].

"'Congress acted wisely when it passed the Nuclear Waste Policy Act and refused to allow nuclear reactor licensees to transfer ownership of their irradiated reactor fuel to the DOE until a permanent repository was up and running,' said Kevin Kamps, radioactive waste specialist for Beyond Nuclear. "It understood that irradiated fuel remains hazardous forevermore, and that the only safe long-term strategy for safeguarding irradiated reactor fuel is to place it in a permanent repository for deep geologic isolation from the living environment." Certain radioactive isotopes in irradiated fuel remain dangerous for more than a million years, Kamps pointed out.

"'Today, the NWPA remains the public's best protection against a so-called consolidated 'interim' storage facility becoming a de facto permanent, national, surface 'parking lot dump' for radioactive waste,' Kamps said. "But if we ignore it or jettison the law, communities like west Texas and

southeastern New Mexico can be railroaded by the nuclear industry and its friends in government, and forced to accept mountains of forever deadly high-level radioactive waste other states are eager to offload."

"In addition to impacting Texas and New Mexico, shipping the waste to the ISP facility would also endanger 43 other states plus the District of Columbia, because it would entail hauling several thousands of high-risk, high-level radioactive waste shipments on their roads, rails, and/or waterways, posing risks of release of hazardous radioactivity all along the way.

"'The communities near the nuclear plants that generated this dangerous high-level radioactive waste do not want it, and neither do we,' said Rose Gardner of Eunice, New Mexico, whose home and business are just several miles from the ISP CISF site. She is a co-founder of the grassroots environmental justice organization Alliance for Environmental Strategies, and a member of Beyond Nuclear. "Every single one of the thousands of high-risk shipments of irradiated nuclear fuel would pass through my community, which is unacceptable,' Gardner said.

"Besides threatening public health, safety, and the environment, evading federal law to license the ISP facility would also impact the public financially. Transferring title and liability for irradiated fuel from the nuclear utilities that generated it to DOE would mean that federal taxpayers would have to pay many billions of dollars for so-called "interim" storage of the waste. That's on top of the many tens of billions of dollars that ratepayers and taxpayers have already paid to fund a permanent geologic repository that hasn't yet materialized.

"While emphasizing the essential role of a repository to isolate irradiated fuel from the environment over the long term, Kamps said that the government should cancel the Yucca Mountain Project once and for all. 'A deep geologic repository for permanent disposal should meet a long list of stringent criteria: scientific suitability, legality, environmental justice, consent-based siting, mitigation of transport risks, regional equity, intergenerational equity, and safeguards against nuclear weapons proliferation, including a ban on irradiated fuel reprocessing,' Kamps said. "But the proposed Yucca Mountain dump, sited on land owned by the Western Shoshone in Nevada without their consent, fails to meet any of those standards. That's why a coalition of more than a thousand environmental, environmental justice, and public interest organizations, representing all 50 states, has opposed it for 34 years." [10]

Waste Isolation Pilot Plant

"Citizen Action New Mexico comments are submitted in opposition to the Department of Energy/ National Nuclear Security Administration plans to "dilute and dispose" and bring up to 42 metric tons of downblended Plutonium waste to the Waste Isolation Pilot Plant (WIPP) in southern New Mexico.

"WIPP may not be suitable for expanded disposal of downblended Plutonium for technical and regulatory reasons including prior accidents and that the waste planned for disposal at WIPP that is identified in DOE's 2016 inventory report exceeds the facility's disposal space. Even if the method

[10] Keven Kamps, *Beyond Nuclear Files Federal Lawsuit Challenging High-Level Radioactive Waste Dump Targeted at Texas/New Mexico Border, and* Stephen Kent, skent@kentcom.com, 914-589-5988 February 10, 2021.

Petition charges the Nuclear Regulatory Commission knowingly violated the U.S. Nuclear Waste Policy Act and up-ended settled law which prohibits transfer of ownership of commercial irradiated fuel to the federal government unless and until a permanent geologic repository is ready to receive it.

were changed for counting the amount of waste in storage, unidentified future waste and that proposed for disposition, WIPP" [11]

New Reactors Planned at the Idaho National Laboratory

Prototype Advanced Mobile Nuclear Microreactors

Project Pele – encompasses multiple prototype mobile nuclear reactors (2-10 MWe range). The Department of Defense funded mobile reactors can be fairly large. On Pele (2-10 MWe range) mobile reactor. [12]

"The U.S. Department of Defense (DOD), acting through the Strategic Capabilities Office (SCO) and in close collaboration with the U.S. Department of Energy, Nuclear Regulatory Commission, U.S. Army Corps of Engineers, as well as industry partners, is exploring modern design concepts and cutting-edge technology developed by industry to meet warfighter mobile power-generation needs. The DOD is considering the development of a prototype advanced mobile nuclear microreactor to support DOD domestic energy demands, DOD operational and mission energy demands, and Defense Support to Civil Authorities mission capabilities. SCO invites public comment on the scope of the Environmental Impact Statement (EIS) during a 30-day comment period from March 2, 2020 to April 1, 2020. The Notice of Intent is available for viewing online at https://www.federalregister.gov/ and https://www.cto.mil/pele_eis/.

"SCO will host a virtual presentation to provide information about the proposed project and the National Environmental Policy Act (NEPA) process, and to invite public comments on the scope of the EIS. Comments on the scope of the EIS may be submitted by email or in written form. Comments will be accepted via email to: PELE_NEPA@sco.mil

"Mailed comments regarding the proposed plan must be postmarked by April 1, 2020, and sent to: OSD Strategic Capabilities Office, ATTN: Prototype Microreactor EIS Comments, 675 N. Randolph Street, Arlington, VA 22203-2114. https://www.cto.mil/pele_eis/." [13]

Announcement of the Pentagon Contract Awards on M**obile, Small Nuclear Reactors**

WASHINGTON — The Pentagon on Monday issued three contracts to start design work on **mobile, small nuclear reactors**, as part of a two-step plan towards achieving nuclear power for American forces at home and abroad. *Updated 3/9/20*

https://www.csis.org/events/online-event-project-convergence-and-army-modernization-conversation-general-john-m-murray

"The department awarded contracts to BWX Technologies, Inc. of Virginia, for $13.5 million; Westinghouse Government Services of Washington, D.C. for $11.9 million; and X-energy, LLC of Maryland, for $14.3 million, to begin a two-year engineering design competition for a small nuclear microreactor designed to potentially be forward deployed with forces outside the continental United

[11] IBID., Footnote #2. Also see https://fas.org/sgp/othergov/doe/lanl/pubs/00818031.pdf

[12] Article from https://www.defensenews.com/smr/nuclear-arsenal/2020/03/09/pentagon-to-award-mobile-nuclear-reactor-contracts-this-week/

[13] Comments will be accepted via email to: PELE_NEPA@sco.mil
Mailed comments regarding the proposed plan must be postmarked by April 1, 2020, and sent to: OSD Strategic Capabilities Office, ATTN: Prototype Microreactor EIS Comments, 675 N. Randolph Street, Arlington, VA 22203-2114

States.

"The combined $39.7 million in contracts are from "Project Pele," a project run through the Strategic Capabilities Office (SCO), located within the department's research and engineering side. The prototype is looking at a 1-5 megawatt (MWe) power range. The Department of Energy has been supporting the project at its Idaho National Laboratory

TerraPower; DOE has awarded money to TerraPower and GE Hitachi for their sodium-cooled fast reactor research based on EBR-II (in the family are Hanford's Fast Flux Test Reactor, now dismantled and other fast reactors)

Xenergy; DOE has awarded money to Xenergy for their high-temperature gas-cooled (helium) reactors with TRISO fuel (something akin to Peach Bottom HTGR and Fort St. Vrain)

MARVEL; Microreactor Applications Research Validation and Evaluation Project (MARVEL) power level of less than 100 kilowatts of electricity using High-Assay, Low-Enriched Uranium (HALEU). DOE/ID announced comment opportunities January 11, 2021 on a draft environmental assessment for a proposal to construct the Microreactor Applications Research Validation & EvaLuation (MARVEL) project microreactor inside Idaho National Laboratory's (INL's) Transient Reactor Test Facility. The MARVEL design is a sodium-potassium-cooled, thermal microreactor with a power level of less than 100 kilowatts of electricity using High-Assay, Low-Enriched Uranium (HALEU). [14]

NuScale; NRC licensing is proceeding for NuScale (a so-called small modular reactor) slated for construction on INL site as a commercial nuclear power station. [15]

Versatile Test Reactor Draft Environmental Impact Statement (VTR DEIS)

S.8 VTR DEIS Preferred Alternative

"DOE's Preferred Alternative is the INL VTR Alternative. DOE would build and operate the VTR at the INL Site adjacent to the existing MFC. Existing facilities within the MFC would be modified and used for post-irradiation examination of test assemblies. Post-irradiation examination would be performed in HFEF, IMCL, and other MFC facilities. Spent VTR driver fuel would be treated to remove the sodium-bonded material at FCF. Modifications to FCF may be required to carry out this process. The intent of this treatment is to condition and transform the spent nuclear fuel into a form that would meet the acceptance criteria for a future permanent repository. This treated fuel would be temporarily stored at a new VTR spent fuel pad at MFC. DOE has no preferred options at this time for where it would perform reactor fuel production (feedstock preparation or driver fuel fabrication)for the VTR. This EIS evaluates options for both processes at the INL Site and at SRS. DOE could choose to use either site or a combination of both sites to implement either option. DOE will state its preferred options for feedstock

[14] DOE/ID, Press Release, Media Contacts**:** Tim Jackson, 208-526-8484, January 11, 2021

[15] Tami Thatcher, *U.S. Nuclear Regulatory Commission cautions that its recent NuScale approval does not mean NRC will approve a NuScale construction permitter an operating license*, http://www.environmental-defense-institute.org/publications/News.20.Nov.pdf

preparation and fuel fabrication in the Final VTR EIS, if preferred options are identified before issuance." [Draft Versatile Test Reactor Environmental Impact Statement Pg.S-20]

S.9 Summary of Environmental Consequences
S.9.1Comparison of Alternatives and Options

"Table S–1summarizes and allows side-by-side comparison of the potential environmental impacts of the INL VTR Alternative and the ORNL VTR Alternative. Impacts are presented for the construction of the VTR at the INL Site and the VTR and a hot cell facility at ORNL. The impacts, as presented, include the operation of the VTR, post-irradiation examination activities, and spent driver fuel management. Table S–2summarizes and allows comparison of the impacts from establishing the capabilities for and performing feedstock preparation and fuel fabrication at the INL Site or SRS. Under the No Action Alternative, DOE would make use of the limited capabilities available at existing facilities, both domestic and foreign, for testing in the fast-neutron-flux spectrum. DOE would not construct or modify any facilities or effect any substantial change in the level of operations for post-irradiation examination. There would be no need for new VTR driver fuel production and no VTR spent nuclear fuel would be generated. Whereas the impacts presented in Tables S–1 and S–2 represent potential incremental increases, under the No Action Alternative there would be no increase in environmental impacts at the INL Site, ORNL, and SRS above those described in Chapter 3, Affected Environment." [Page S.9 Summary]

S.9.2 Summary of Combined Idaho National Laboratory Impacts

"Potential Affected Environment environmental impacts were evaluated for three possible actions at the INL Site: 1) construction and operation of the VTR along with modification and operation of associated facilities needed for post-irradiation examination of test articles and management of spent fuel; 2) facility modifications and operation to prepare fuel feedstock material for use in VTR driver fuel; and 3) facility modifications and operation for fabrication of VTR driver fuel. Impacts were evaluated separately for each of these actions. Table S–3 summarizes the potential environmental consequences that could occur if DOE were to decide to perform all three actions at the INL Site" [Page DEIS S.9.2]

DOE fails to adequately analyze in the VTR DEIS in the following areas:

* Analysis of waste disposal for used spent nuclear fuel when none currently exists for high-level waste that VTR will generate;
* Analysis of storing/reprocessing sodium cooled nuclear fuel as opposed to water cooled reactors and difficulty of disposal of sodium fuel and coolant post closure;
* Does this relatively small (300 MW) VTR represent what the proponents call only the first step in expanding the modular design into a larger facility?
* Analysis of VTR emissions contribution to DOE/INL total emissions factoring in expansion of waste treatment operations at INTEC/IWTU, AMWTP, ATRC, NRC and MFC;
* Analysis of VTR emissions reliance on HEPA filters proven inadequacy;
* Analysis of VTR emissions radioactive gas emissions and tritium;
* Analysis of VTR defenses against cyber-attacks;
* Analysis of VTR emissions impact on health effects including cancers, autoimmune diseases, birth defects pulmonary diseases, cardiovascular diseases;
* Analysis of VTR construction emissions in contaminated soils resulting from 60+ years of INL operations deposition on the stie.

So if the VTR reactor is built at the Idaho National Laboratory producing 34 MT of plutonium, the waste might not be considered military and therefore ineligible for WIPP. DOE is really screwed up about what to do with all the Pu these reactors will produce. New Mexico doesn't want it.

Nuclear Regulatory Commission Promotion of New Reactors

Flexible Licensing Processes for Advanced Reactors

"The NRC's review and licensing processes are flexible and allow interactions related to a wide variation in design development and deployment strategies. Based on interactions with stakeholders, the NRC determined that guidance would be beneficial to assist non-LWR developers in planning regulatory interactions. To address this need, the NRC developed guidance for its flexible regulatory review processes within the bounds of existing regulations, including the use of conceptual design reviews and staged-review processes in the document, "A Regulatory Review Roadmap for Non-Light Water Reactors." The "roadmap" is also intended to help designers prepare technology- or design-specific regulatory engagement plans. Regulatory engagement plans define desired outcomes from various interactions between the designer and the NRC, considering factors such as the resources available to the designer and the NRC and the coordination of regulatory issues with other aspects of the overall program for developing and deploying non-LWR designs. Regulatory engagement plans also define the timing and scope of regulatory interactions in order to align with stakeholders activities related to plant design, research and development, finance, public policy, and the fuel cycle. The NRC released a draft roadmap document in October of 2016 to support discussions with stakeholders during several public meetings. The staff incorporated stakeholder feedback, and guidance related to standard design approvals and prototype reactors into the final roadmap, which was issued on December 26, 2017."

NRC Industry-Led Licensing Modernization Project

"The NRC engaged with the Licensing Modernization Project (LMP) led by Southern Company, coordinated by the NEI, and cost-shared by DOE. The interactions between the NRC staff and LMP resulted in the submittal of NEI–18–04, Revision 1, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," on August 26, 2019. The guidance focuses on identifying licensing basis events; categorizing and establishing performance criteria for structures, systems, and components; and evaluating defense in depth for advanced reactor designs. The staff issued SECY-19-0117, "Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," on December 2, 2019. In this notation vote paper, the staff discussed potential policy issues associated with the LMP methodology and recommended that the Commission find that the use of the methodology described in NEI 18-04 is a reasonable approach for establishing key parts of the licensing basis for non-LWRs. The Commission's Staff Requirements Memorandum dated May 26, 2020, found that using the methodology is a reasonable approach to support the licensing of non-light water reactors. The NRC published Regulatory Guide 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors," in the Federal Register on June 9, 2020.

“The following table provides reports related to the LMP demonstration and pilot activities that have been submitted to date.

Date	Design
September 2019	Fluoride-Cooled High Temperature Reactor Licensing Modernization Project Demonstration
September 2019	Molten Salt Reactor Experiment (MSRE) Case Study Using Risk-Informed, Performance-Based Technical Guidance to Inform Future Licensing for Advanced Non-Light Water Reactors
August 2019	Westinghouse eVinci Micro Reactor Licensing Modernization Project Demonstration
December 2018	PRISM Sodium Fast Reactor Licensing Modernization Project Demonstration
September 2018	OKLO's DG-1353 Pilot
August 2018	High Temperature, Gas-Cooled Pebble Bed Reactor licensing Modernization Project Demonstration

NRC Advanced Reactor Content of Application Project

“The purpose of the advanced reactor content of application project (ARCAP) is to develop technology-inclusive, risk-informed and performance-based application guidance. The ARCAP is broader and encompasses the industry-led technology-inclusive content of application project (TI-CAP). These projects build on the outcome of the Licensing Modernization Project.

“The ARCAP guidance is intended to be used for an advanced reactor application for a combined license, construction permit, operating license, design certification, standard design approval, or manufacturing license. The industry-led TI-CAP's purpose is to develop the content for specific portions of the safety analysis report (SAR) that would be used to support an advanced reactor application. The TI-CAP portion of the SAR will be informed by the guidance found in in NEI 18-04, Revision 1, "Risk-Informed Performance-Based Technology-Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development.

“ARCAP is a longer-term effort that will support the 10 CFR Part 53 rulemaking effort. NRC staff has developed the "Non-Light Water Reactor Review Strategy Staff White Paper," dated September 2019, to provide internal guidance for the review of non-LWR applications in the near-term.”

NRC Advanced Nuclear Reactor Generic Environmental Impact Statement (GEIS)

“The NRC intends to develop a GEIS for advanced nuclear reactors with a small generating output and correspondingly small environmental footprint in order to streamline the environmental review process for future small-scale advanced nuclear reactor (ANR) environmental reviews. The purpose of an ANR GEIS is to determine which environmental impacts could result in essentially the same (generic) impact for different ANR designs that fit within the parameters set in the GEIS, and which environmental

impacts could result in different levels of impacts requiring a plant-specific analysis. Environmental reviews for small-scale advanced nuclear reactor license applications could incorporate the ANR GEIS by reference and provide site-specific information and analyses in a Supplemental Environmental Impact Statement (SEIS), thereby streamlining the environmental review process.

"In SECY-20-0020, the staff informed the Commission that it plans to use a technology-neutral plant parameter envelope (or PPE) approach to bound small-scale ANR projects. For the purposes of the ANR GEIS, the staff considers a "small-scale" ANR as having the potential to generate up to approximately 30 megawatts thermal per reactor with a correspondingly small environmental footprint. The actual bounding thermal power level of the ANR and the environmental footprint used in the ANR GEIS are topics to be determined during the scoping process for the GEIS.

"Because small-scale advanced reactors are not specific to only one reactor design and could be sited anywhere in the United States that meets NRC siting requirements, the NRC decided to pursue a technology neutral approach using a PPE. The PPE will consist of a table of bounding values or parameters for different reactor designs located on a site. In addition, a table of values representing the site parameter envelope (e.g., size of site, quantity of water used, demographics) will be developed to describe the affected environment. The ANR GEIS will evaluate the impacts of a reactor that fits within the bounds of the PPE on a site that fits within the bounds of the site parameter envelope to determine the environmental impact.

"A future application that references the ANR GEIS will need to demonstrate that its project is bounded by the analysis in the ANR GEIS and that there is no significant new information affecting the evaluation. If the project is bounded by the ANR GEIS and there is no significant new information, the NRC will incorporate by reference the ANR GEIS and no further analysis would be needed. The application will also need to analyze the site-specific resources not resolved generically in the ANR GEIS. If impacts to a resource have not been resolved generically by the ANR GEIS, the site-specific SEIS will evaluate the impacts to the resource."

NRC-DOE Joint Initiative - Non-LWR Design Criteria

"In July 2013, the US Department of Energy (DOE) and the NRC established a joint initiative to address a key portion of the licensing framework essential to advanced reactor technologies. The initiative addresses the "General Design Criteria for Nuclear Power Plants," Appendix A to 10 Code of Federal Regulations (CFR) 50, which were developed primarily for LWRs, by adapting them to the needs of advanced reactor design and licensing. The initiative is being accomplished in two phases. Phase 1, completed by DOE, consisted of reviews, analyses and evaluations resulting in a report issued by the DOE in December 2014 titled, "Guidance for Developing Principal Design Criteria for Advanced (Non-Light Water) Reactors." Phase 2 of the initiative, managed by the NRC, involved review of the Phase 1 DOE work products issuance of regulatory guidance resulting from the review.

"On April 7, 2016, the NRC issued the, "Draft - Advanced Non-LWR Design Criteria - April 2016," for informal public comment. The informal public comment period closed on June 8, 2016. After consideration of stakeholder input, the NRC issued draft regulatory guide DG-1330, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors" for formal public comment. DG-1330 was published in the *Federal Register* on February 3, 2017, for a 60 day public comment period.

"The issuance of this new NRC regulatory guidance is expected to provide the following benefits:

- reduced regulatory uncertainty for advanced reactor developers,
- improved guidance for NRC staff reviewing advanced reactor license applications, and
- improved timeliness and efficiency of licensing activities for both applicants and NRC staff."

NRC Advanced Reactor Training Materials

"The NRC contracted with the Oak Ridge National Laboratory (ORNL) to develop a 12-module training course on molten-salt reactors (MSRs). The course provides background on various MSR concepts presently under development, including a history of earlier MSR projects, descriptions of conceptual designs, and expected technical and regulatory challenges. The NRC also contracted with Argonne National Laboratory and Idaho National Laboratory to develop training courses for fast reactors and high-temperature gas-cooled reactors. The training materials for molten salt reactors, fast reactors, and high-temperature gas-cooled reactors are publicly available.

"The NRC contracted with Brookhaven National Laboratory (BNL) to prepare a Regulatory History of Non-Light Water Reactors. This report describes the history of licensing non-LWRs with a focus on regulatory policy and licensing beginning with the Atomic Energy Commission and transitioning to the NRC's past and current activities. This background information is a valuable knowledge management tool for NRC staff and member of the public."

NRC Testing Needs and Prototype Plants

"On June 16, 2017, the NRC issued a preliminary draft document, "Nuclear Power Reactor Testing Needs and Prototype Plants for Advanced Reactor Designs." This document described the relevant regulations governing the testing requirements for advanced reactors, described the process for determining testing needs to meet the NRC's regulatory requirements, clarified when a prototype plant might be needed and how it might differ from the proposed standard plant design, and described licensing strategies and options that include the use of a prototype plant to meet the NRC's testing requirements. The document was discussed during periodic public meetings on advanced reactor topics. The staff considered stakeholder feedback and issued the final paper as part of the regulatory review roadmap in December 2017."

NRC Advanced Reactor Workshops

"In 2015, the NRC and the U.S. Department of Energy (DOE) began co-hosting a series of Advanced Reactor Workshops. The first workshop was held on September 1-2, 2015, 2015 and included presentations and discussions on roles and responsibilities of the NRC and DOE, previous experience licensing non-LWR designs, critical gaps and needs in research and development that need to be addressed, and suggestions for improvements in the licensing of non-LWR designs. The second workshop was held on June 7-8, 2016 and focused on exchanging information from NRC, DOE, industry and included presentations and discussions on strategies for advanced reactor development and deployment, recent initiatives; and advanced reactor fuel development, qualification, and challenges. The Third workshop in this series was held on April 25 and 26, 2017. The NRC has now transitioned from this workshop format to more frequent periodic stakeholder meetings to focus on specific topics of interest as discussed below."

Given that at least seven government nuclear labs are involved, a Programmatic EIS is clearly

indicated to show the cumulative emission impacts on the nation.

NRC Advanced Reactor Reference Materials

Date Issued	Topic	Author Affiliation
07/01/20	Molten Salt Reactor Fuel Salt Qualification Methodology	Oak Ridge National Laboratory
06/30/20	Technology-Inclusive Determination of Mechanistic Source Terms for Offsite Dose-Related Assessments for Advanced Nuclear Reactor Facilities	Idaho National Laboratory
06/30/20	Human Factors Considerations for Automating Microreactors	Sandia National Laboratories
05/31/20	Technical Letter Report on The Assessment of Tritium Detection and Control in Molten Salt Reactors: Final Report	Argonne National Laboratory
04/01/20	Technical and Licensing Considerations for Micro-Reactors	Sandia National Laboratories
03/31/20	Model Materials Controls and Accounting Plan for Pebble Bed Reactors	Oak Ridge National Laboratory
02/05/20	Regulatory Review of Micro-Reactors – Initial Considerations	Brookhaven National Laboratory
01/30/20	Simplified Approach for Scoping Assessment of Non-LWR Source Terms	Sandia National Laboratories
08/09/19	Hazards Associated with Molten Salt Reactor Fuel Processing Operations Presentation	Oak Ridge National Laboratory
08/07/19	Metal Fuel Fabrication Safety and Hazards Presentation	Pacific Northwest National Laboratory
06/30/19	Review of Hazards for Molten Salt Reactor Fuel Processing Operations	Oak Ridge National Laboratory
06/28/19	Metal Fuel Fabrication Safety and Hazards Final Report	Pacific Northwest National Laboratory
06/19/19	Advanced Reactor Siting Policy Considerations	Oak Ridge National Laboratory
06/10/19	NRC Regulatory History of Non-Light Water Reactors (1950-2019)	Brookhaven National Laboratory
03/31/19	Advanced Non-Light-Water Reactors Materials and Operational Experience	NUMARK Associates

03/31/19	Technical Gap Assessment for Materials and Component Integrity Issues for Molten Salt Reactors	Oak Ridge National Laboratory
11/30/18	Molten Salt Reactor Fuel Qualification Considerations and Challenges	Oak Ridge National Laboratory
08/21/18	Phenomena Important in Liquid Metal Reactor Simulations	Brookhaven National Laboratory
05/09/18	Phenomena Important in Modeling and Simulation of Molten Salt Reactors	Brookhaven National Laboratory

NRC Non-LWR Analytical Code Development

"In support of IAP Strategy 2, the staff prepared a three-volume report to describe computer code needs, current capabilities, and gaps relevant to non-LWR confirmatory and future (beyond initial licensing) safety analysis. The reports identify candidate computer codes, the decision criteria and technical rationale applied to the selection process, and specific development activities needed to address known gaps. On May 1, 2019 and September 17, 2019, the staff briefed the Advisory Committee on Reactor Safeguards (ACRS) Future Plant Design Subcommittee on its plans for development of codes for non-LWR analysis. On October 3, 2019, the staff briefed the ACRS full committee on the role of computer codes in regulatory activities and needs for advanced reactor reviews and codes the staff intends to develop. On November 4, 2019, the ACRS transmitted a letter containing its conclusions, recommendations and constructive feedback on the staff's code development strategies. On January 30, 2020 the NRC published the final version of these reports taking into account ACRS and stakeholder feedback."

The cumulative impact of NRC's testing/waste disposal of nuclear operation on radiation emissions must be considered in a comprehensive Programmatic EIS.

Space Council Stressing Cross-government Approach

Space Reactors must be considered in a comprehensive PEIS

Nuclear rockets to Mars are dangerous and unnecessary

https://independentaustralia.net/environment/environment-display/nuclear-rockets-to-mars-are-dangerous-and-unnecessary,14812

"Nuclear-powered space technology risks causing further damage to our planet and is an unnecessary expense when we have higher priorities, writes Karl Grossman.

"A REPORT ADVOCATING rocket propulsion by nuclear power for U.S. missions to Mars, written by a committee packed with individuals deeply involved in nuclear power, was issued last week by the National Academies of Sciences, Engineering and Medicine (NAS).

"The 104-page report also lays out "synergies" in space nuclear activities between the National Aeronautics and Space Administration (NASA) and the U.S. military, something not advanced explicitly since the founding of NASA as supposedly a civilian agency in 1958.

The report states: "*'Space nuclear propulsion and power systems have the potential to provide the United States with military advantages... NASA could benefit programmatically by working with a DoD* [Department of Defense] *program having national security objectives.'*

"The report was produced "by contract" with NASA, it states.

"NAS describe themselves as having been *'created to advise the nation'* with *'independent, objective advice to inform policy'*. [16]

HELEN CALDICOTT: Time to learn lessons of the past on nuclear

The threat of nuclear warfare is ever-present despite the horrors of the past, writes Dr Helen Caldicott.

Space Nuclear Technology

Kilopower project

"US Ramps Up Planning for Space Nuclear Technology: NASA and the Department of Energy are expanding their collaboration as part of a broader White House push to develop nuclear power systems for space applications. The initiative comes as NASA faces key decisions on what fuel sources and technology development paths to pursue.

"Among the Department of Energy officials to attend the Perseverance Rover launch were Office of Science Director Chris Fall, center, National Nuclear Security Administration head Lisa Gordon-Hagerty, far right, and Office of Nuclear Energy head Rita Baranwal, second from right.

"As NASA launched its Perseverance rover to Mars yesterday, senior officials from the Department of Energy were at Cape Canaveral to see it off. Perseverance is the first mission to launch since the Curiosity rover in 2011 that is powered by the radioactive isotope plutonium-238, which is manufactured in DOE facilities.

"Now, NASA, DOE, and the White House want nuclear power to play a much larger role in space exploration as plans take shape for a sustained human presence on the Moon and subsequent crewed journeys to Mars. During their trip, the DOE officials met with representatives from NASA at Kennedy Space Center to launch a new working group that aims to facilitate R&D on new space technologies, including ones powered by nuclear fission rather than radioactive decay.

"NASA is currently debating tradeoffs between different surface power and propulsion methods and is looking for commonalities with reactor designs under development by DOE and the Department of Defense. NASA must also decide whether it will use highly enriched uranium (HEU) or a less-enriched variant as a fuel. Although HEU has certain advantages, such as its high-power density, non-proliferation advocates argue its use would undermine longstanding U.S. efforts to limit applications of the material, which can be adapted for use in nuclear weapons." [17]

"The White House National Space Council released a strategy for deep space exploration on July 23 that identifies DOE as "critical" to the development of nuclear power and propulsion technologies. It notes that NASA plans on developing a power reactor that could provide electricity for a surface Moon base and is exploring nuclear propulsion methods that would significantly cut down travel time to deep-

[16] https://independentaustralia.net/environment/environment-display/nuclear-rockets-to-mars-are-dangerous-and-unnecessary,14812

[17] On Space reactors, see https://www.aip.org/fyi/2020/us-ramps-planning-space-nuclear-technology
Also see: DOE-officials-at-Cape-Canaveral-740x450.jpg

space destinations.

"The director of civil space policy at the National Space Council, Ryan Whitley, elaborated on the administration's work to promote nuclear technology development across agencies at a symposium convened this month by the American Astronautical Society.

"Whitley said NASA's "immediate need" is for a surface fission reactor that enables long-duration lunar exploration, since current systems based on radioisotope decay cannot provide enough power for larger missions that must operate through the lunar night or within shadowed craters. He added that nuclear propulsion is a longer-term priority, given its ability to enable eventual missions to Mars and beyond.

"NASA and the National Nuclear Security Administration have already tested a surface reactor through their joint Kilopower project, which is developing a system to provide up to ten kilowatts of electric power for crewed planetary bases. For propulsion technologies, NASA initiated a Mars Transportation Assessment Study in October through which it is evaluating the merits of nuclear thermal propulsion (NTP) versus nuclear electric propulsion (NEP). Both use a nuclear reactor to generate heat, which NTP systems use to expel gas, while NEP systems convert the heat into electricity then thrust.

"Whitley said one of the administration's near-term goals is to establish a capacity for producing high-assay low-enriched uranium (HALEU) that could be used as fuel for a range of agency missions. HALEU is enriched to contain between 5% and 20% of the isotope uranium-235 by weight, and last year DOE announced plans to establish a domestic supply line for the fuel, citing demand from designers of next-generation commercial power reactors. NASA is now exploring HALEU as an alternative to HEU, which it used in the Kilopower test.

"Whitley said the administration is likewise looking to leverage commonalities between reactor designs under consideration by NASA and the Department of Defense. The council's report highlights Project Pele, which is designing mobile reactors to power military bases, and DARPA's DRACO program, which aims to develop spacecraft that can maneuver quickly in the region between the Earth and the Moon.

"While DARPA is pursuing an NTP design through the DRACO program, NASA has not settled on a particular propulsion technology. Asked at the symposium about the choice between NTP and NEP, Whitley declined to weigh in directly given NASA's ongoing deliberations on the subject.

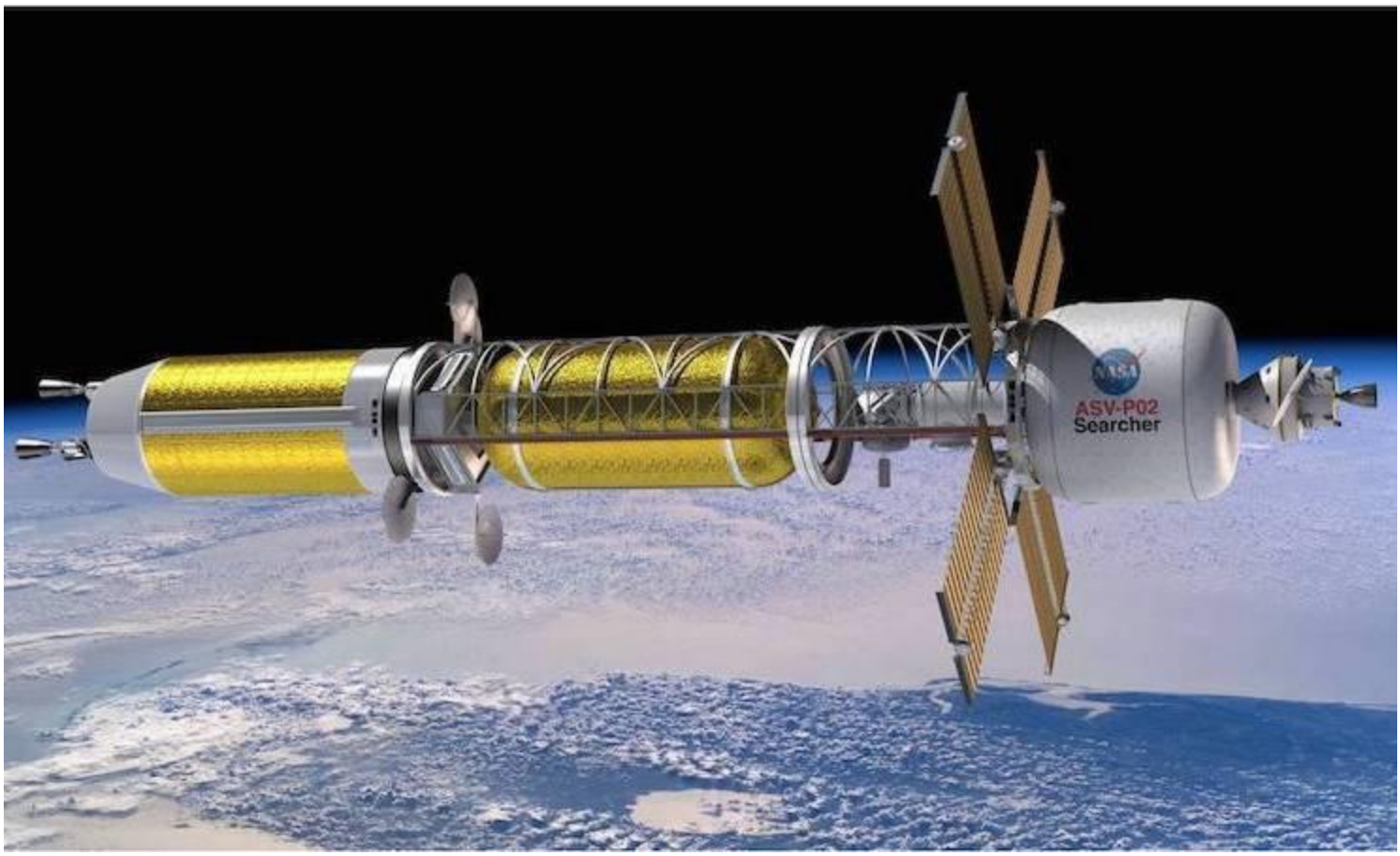
"There's pluses and minuses to both, and so it's not easy necessarily to make a clean decision there," he said.

Congress pushing thermal nuclear propulsion

NTP-rocket-design-740x450.jpg

SpaceX launches 60 Starlink satellites but booster landing fails

https://www.yahoo.com/news/spacex-launches-60-starlink-satellites-062316233.html



A design concept for a spacecraft using nuclear thermal propulsion.

NTP-rocket-design-740x450.jpg

"To aid its decision-making, NASA has commissioned a National Academies study committee to assess the tradeoffs associated with NEP and NTP, as well as considerations arising from the use of HEU versus HALEU. Jim Reuter, head of NASA's Space Technology Mission Directorate, told the committee at its kickoff meeting in June that the study is not meant to focus on policy matters, except when it comes to considerations associated with the fuel choice.

"In recent years, Congress has prioritized NTP development, which is led by Marshal Space Flight Center in Alabama. In fiscal year 2020, it provided $110 million specifically for NTP, of which at least $80 million was to prepare for performing a flight demonstration by 2024.

"Reuter said NASA has requested that in future appropriations Congress instead target a demonstration in the late 2020s and not specify that all the funding must go toward NTP. He explained that recent studies are leading the agency to consider "looking much more strongly" at NEP and that it wishes to focus on surface power in the near term.

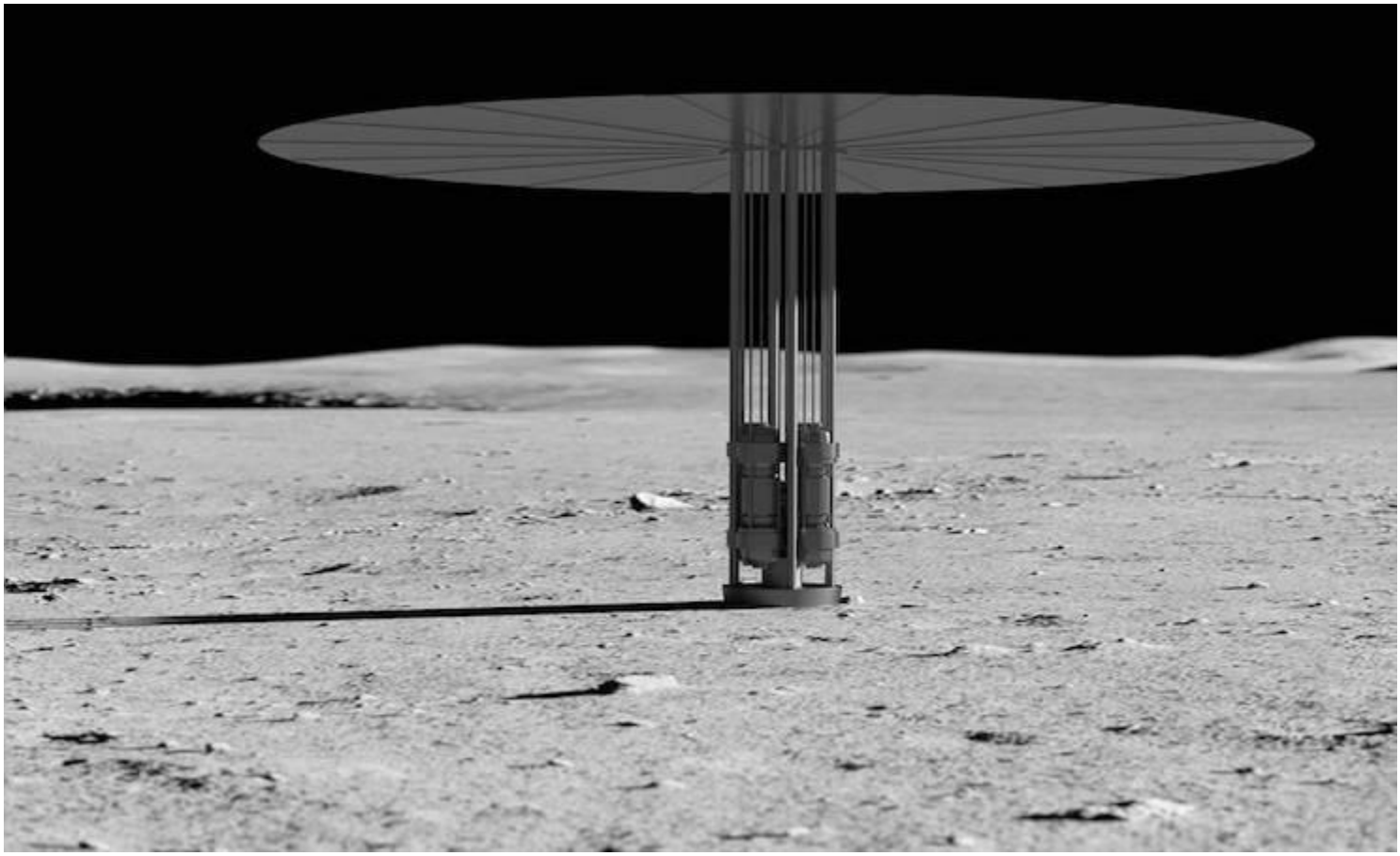
"Reuter noted that NASA's budget request for fiscal year 2021 includes $100 million for the space nuclear technology portfolio within a new line item, of which $62 million is for surface power and the remainder is for propulsion, not limited to NTP. The agency projects its request for the portfolio will grow to $250 million in fiscal year 2025.

"However, the House has proposed that NASA instead press ahead with NTP, again including $110

million for its continued development in pending appropriations legislation for fiscal year 2021. In their report accompanying the legislation, House appropriators note they have not yet received a plan they mandated from NASA on a path toward performing an NTP flight demonstration by 2024. The Senate has not yet released its NASA spending legislation for the year.

HEU debate heating up

kilopower-moon-740x450.jpg



An artist's rendering of a Kilopower fission reactor on the Moon.

"As NASA has moved forward with its propulsion and Kilopower projects, non-proliferation advocates have taken issue with NASA's continued interest in using HEU.

"The American Nuclear Society hosted a debate on the topic at its annual meeting in June. While the society has generally supported the use of space nuclear power and propulsion in the past, it has decided to develop a position statement by spring 2021 on whether to favor the use of LEU.

"Among the participants was Rep. Bill Foster (D-IL), a former Fermilab physicist, who argued that proceeding with HEU would set a dangerous precedent. "If all of the spacefaring nations start using HEU reactors in space, then this would involve utilization of a significant amount of weapons grade material," he remarked. Conversely, he continued, if the U.S. develops an LEU-based design, it could

become a "de facto standard." Foster also suggested the high costs of security measures associated with handling HEU could outweigh the advantages of using the material.

"Alan Kuperman, a policy scholar affiliated with the Nuclear Proliferation Prevention Project, pointed to U.S. efforts since the 1970s to minimize the use of HEU in civilian applications, arguing they are "based on the logic of no exceptions."

"If we say, 'well, we're going to have exceptions,' then other countries are going to say, 'well, we want exceptions too,' and then the whole thing falls apart," he remarked.

"Among those advocating in favor of HEU, Kilopower chief reactor designer David Poston said that in his experience regulators were most concerned with a criticality accident resulting in a high-yield event, which he said HEU systems tend to mitigate. Len Dudzinski, NASA's program executive for radioisotope power systems, also said that LEU reactors are not powerful enough for certain potential missions, such as burrowing through thick ice sheets on the moons of Europa or Enceladus.

"Bhavya Lal, another panelist at the event and a member of the National Academies study committee, contended that choosing between HEU and LEU is ultimately a political decision rather than a technical one, and noted other countries may pursue HEU systems regardless of how the U.S. proceeds. She advocated for not adopting a blanket ban on the material.

"In my view, it would be prudent that we retain flexibility and allow the use of HEU in space systems only where the mission is not possible without HEU or where HEU is a significant enabler of mission scope or objective," she said [18]

The US military is getting serious about nuclear thermal propulsion

"Activity in cislunar space is expected to increase considerably in the coming years."

Eric Berger - 6/15/2020, 5:18 AM

"There are many ways to get around space, but most of them are pretty slow. This is why, even when launching at an optimal time, a spacecraft leaving Earth requires about six months to reach orbit around Mars.

"For decades, many rocket scientists have looked to a propulsion system powered by a nuclear reactor as the fastest practical means of getting to Mars and other places in the Solar System more quickly.

"Wernher von Braun, the German engineer who defected to the United States after World War II, recognized the potential of nuclear thermal propulsion even before his Saturn V rocket landed humans on the Moon with chemical propulsion. Eventually, this led to a project called NERVA, which stood for Nuclear Engine for Rocket Vehicle Application. It was eventually canceled to help pay for the space shuttle.

"NASA has supported efforts to develop a nuclear thermal engine in fits and starts since. The basic idea is pretty simple—a nuclear reactor heats a propellant such as liquid hydrogen, and it expands through a rocket nozzle and provides thrust. No such rocket engine has ever flown, however, and at

[18] Hale Stolberg, American Institute of Physics, fyi@aip.org, 301-209-3095

present, NASA is more interested in developing nuclear energy for surface power on other worlds than working on propulsion."

Enter DARPA

"But now, the US Department of Defense is getting interested in space-based propulsion. Last month, through a presolicitation, the US Defense Advanced Research Projects Agency announced its intent to have a flyable nuclear thermal propulsion system ready for a demonstration in 2025.

"Through this Demonstration Rocket for Agile Cislunar Operations, or DRACO program, the defense agency seeks technology that will allow for more responsive control of spacecraft in Earth orbit, lunar orbit, and everywhere in between, giving the military greater operational freedom in these domains.

""Activity in cislunar space is expected to increase considerably in the coming years," Maj Nathan Greiner, manager of the DRACO Program, told Ars. "An agile nuclear thermal propulsion vehicle enables the DOD to maintain Space Domain Awareness of the burgeoning activity within this vast volume."

Further Reading

Astra came close to achieving what DARPA has sought for two decades

"In 'Phase 1' of its solicitation, DARPA has asked industry for the designs of both a nuclear thermal reactor and an operational spacecraft upon which to demonstrate it. This initial phase of the program will last 18 months. Subsequent phases will lead to detailed design, fabrication, ground tests, and an in-space demonstration. No contracts have yet been awarded, and award values will be determined by industry submissions.

"With the DRACO program, the US Defense Department could potentially move large satellites quickly around cislunar space. For example, moving a 4-ton satellite from point A to point B might take about six months with solar electric propulsion, whereas it could be done in a few hours with nuclear thermal propulsion.

"To use this technology for Mars missions, NASA would probably want a system with higher thrust. But having DARPA show the way in terms of developing this technology, proving out a lot of overlapping technologies, and demonstrating operation of a nuclear engine in space, would have benefits for NASA down the road. So while the defense department is interested in cislunar space, a successful DRACO test would be good news for human exploration as well.

Converging technologies

"DARPA's decision to push forward with development of nuclear thermal propulsion comes as critical enabling technologies are maturing, said Jonathan Cirtain, president of advanced programs at BWX Technologies. Cirtain's company, which makes most of the nuclear reactors found on US Navy submarines and aircraft carriers, is working with NASA on the design of a reactor to enable Mars missions.

"One advancement has come in the ability to manufacture refractory metals, which are extraordinarily resistant to heating. To operate efficiently, Cirtain said, an engine must be able to withstand huge temperature and pressure changes across just two meters in length. Hydrogen fuel is stored at just 19 Kelvin and heated to 2,500 Kelvin or higher.

"At the same time, engineers designing nuclear reactor cores have access to computational power that allows them to iterate new designs—calculating such variables as neutron flux and fluid dynamics—quickly. "Now, with supercomputers on your desk, you can go from years' worth of calculation time to

days, and iterate to a design solution much faster than you could previously," he said.

"DARPA has decided that now is the time to capitalize on these maturing technologies."

NASA's plasma rocket making progress toward a 100-hour firing

https://arstechnica.com/science/2017/08/nasas-plasma-rocket-making-progress-toward-a-100-hour-firing/?itm_source=parsely-api

Now, the company is firing VASIMR for about five minutes at a time.

Eric Berger - 8/10/2017, 6:56 AM

"Almost everyone recognizes that if humans are truly to go deeper into the Solar System, we need faster and more efficient propulsion systems than conventional chemical rockets. Rocket engines powered by chemical propellants are great for breaking the chains of Earth's gravity, but they consume way too much fuel when used in space and don't offer optimal control of a spacecraft's thrust.

"NASA recognizes this, too. So in 2015, the space agency awarded three different contracts for development of advanced propulsion systems. Of these, perhaps the most intriguing is a plasma-based rocket—which runs on Argon fuel, generates a plasma, excites it, and then pushes it out a nozzle at high speed. This solution has the potential to shorten the travel time between Earth and Mars to weeks, rather than months."

Further Reading

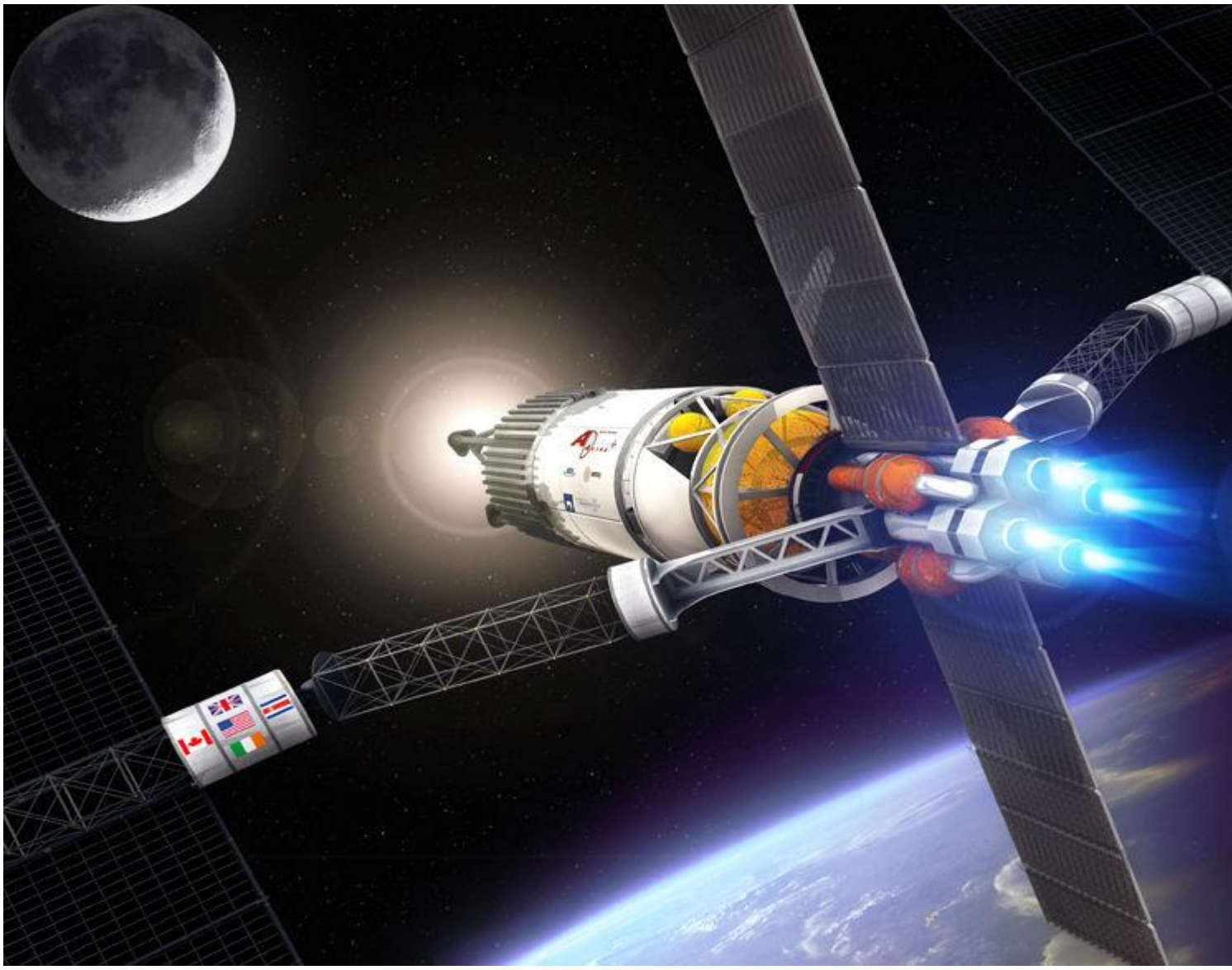
NASA's longshot bet on a revolutionary rocket may be about to pay off

"But to realize that potential, Houston-based Ad Astra Rocket Company must first demonstrate that its plasma rocket, VASIMR, can fire continuously for a long period of time. The three-year, $9 million contract from NASA required the company to fire its plasma rocket for 100 hours at a power level of 100 kilowatts by 2018.

"This week, Ad Astra reported that it remains on target toward that goal. The company completed a successful performance review with NASA after its second year of the contract, and it has now fired the engine for a total of 10 hours while making significant modifications to its large vacuum chamber to handle the thermal load produced by the rocket engine.

"As the company continues to test the new hardware, it is gradually building up to longer and longer pulses, with inspections in between. Ad Astra remains on target to perform the 100-hour test in late summer or early fall of 2018, Chang-Diaz said.

"Initially, the company foresees the plasma rocket as a means for pushing cargo between Earth and the Moon—or on to Mars. With solar powered panels, the rocket would have a relatively low thrust and therefore would move loads slowly but efficiently. But with more power, such as from a space-based nuclear reactor, it could one day reach much higher velocities that would allow humans to travel rapidly through the Solar System."



NASA's plasma rocket making progress toward a 100-hour firing

Now, the company is firing VASIMR for about five minutes at a time.

Eric Berger - 8/10/2017, 6:56 AM

"With 200 kW of solar power, the VASIMR engine could be used as a lunar tug.

"Almost everyone recognizes that if humans are truly to go deeper into the Solar System, we need faster and more efficient propulsion systems than conventional chemical rockets. Rocket engines

powered by chemical propellants are great for breaking the chains of Earth's gravity, but they consume way too much fuel when used in space and don't offer optimal control of a spacecraft's thrust.

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"When Ars visited Ad Astra early in 2017, it was pulsing its rocket for about 30 seconds at a time. Now, the company is firing VASIMR for about five minutes at a time, founder Franklin Chang-Diaz told Ars. "The limitation right now is moisture outgassing from all the new hardware in both the rocket and the vacuum chamber," he said. "This overwhelms the pumps, so there is a lot of conditioning that has to be done little by little."

"As the company continues to test the new hardware, it is gradually building up to longer and longer pulses, with inspections in between. Ad Astra remains on target to perform the 100-hour test in late summer or early fall of 2018, Chang-Diaz said.

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NASA wants to cut travel time to Mars "in half" with new propulsion tech

Ion thrusters, nuclear rockets, and other in-space propulsion tech being looked at.

Sebastian Anthony - 6/4/2015, 11:13 AM

NASA/JPL

"Speaking at an Aerojet Rocketdyne plant, NASA administrator Charles Bolden said the program is looking into advanced propulsion technologies that can cut the current eight-month journey to Mars "in half." Technologies such as solar-electric propulsion are definitely in the cards, but NASA may look towards more unconventional solutions such as nuclear rockets as well.

"Over the past few years, there's been a lot of attention on getting astronauts to Mars, mostly fuelled by crazy projects like Mars One, the success of the Curiosity rover, and heavyweights like Elon Musk saying he wants to colonise the planet.

"The main problem with getting humans to Mars is that, with our current liquid-fuelled rocket engines, it takes a very long time to get there; about eight months or so. If we can cut the journey in half, we significantly reduce the amount of food and water needed—which in turn cuts down the weight of the spacecraft, which in turn reduces the amount of fuel needed, which in turn feeds a very positive feedback loop. Less time in outer space means astronauts will be bombarded by less radiation too."

Further Reading

Round trip to Mars would push radiation safety limits

"Finding a propulsion technology that's better than liquid fuel, though, has proven difficult. NASA has been looking at a variety of different technologies for *decades*. An In-Space Propulsion roadmap (PDF) from 2010 lists no less than 41 different propulsion methods. One of the most promising propulsion techniques, at least in the short term, is solar-electric propulsion—gathering solar energy with photovoltaic cells, which then powers some kind of electric engine like a Hall effect ion thruster.

"Aerojet Rocketdyne recently won a NASA contract to develop Hall effect ion thrusters. The main benefit of solar-electric propulsion (SEP) technologies such as ion thrusters is that the energy source (the Sun) lasts for a very long time, while liquid-fuelled rockets have a very finite duration. SEPs aren't quite ready to send humans to Mars, though. "The limiting power of this type of propulsion has been the power to drive it," Bolden said, according to Space.com's account of Bolden's visit to the Aerojet facility. "Aerojet Rocketdyne has partnered with different entities around the country in looking [at] how to get more energy density onto a solar cell. The more power we can get, the larger we can make the engine and its capability."

"According to Space.com, Bolden also mentioned the possibility of using thermal nuclear rockets: rockets that use a nuclear reactor to heat gas, which then expands through the nozzle to create thrust. NASA did a lot of work on nuclear rockets with the NERVA program in the '50s and '60s, but it was eventually cancelled in 1972.

"Bolden wants NASA to put more money into in-space propulsion technologies, noting that they could be "game changers." Bolden also stressed that he doesn't want NASA's rocket partners to fixate on moving *cargo* more quickly through space. "I want industry to focus on getting people to move really fast. I think we can do far better than we are doing today, but we've got to show our commitment by putting some money into it."

Space X deployment of 5G system

80 to 100 thousand low-orbit satellites will require thousands of launches to deploy these 5G satellites thus resulting in significant emissions and o-zone depletion that must be included in a comprehensive PEIS. The debris when these satellites eventually fall back to earth must also be included in the PEIS.

Media hype over Mars rover ignores deadly truth

*"Media coverage of the Perseverance rover mission fails to report that NASA projected fair odds of lethal plutonium being released by accident, writes Professor **Karl Grossman**.* [19]

"WITH ALL the media hoopla last week about the Perseverance rover, frequently unreported was that its energy source is plutonium – considered the most lethal of all radioactive substances – and nowhere in media that National Aeronautics and Space Administration (NASA) projected one-in-960 odds of the plutonium being released in an accident on the mission.

"*'A "one-in-960 chance" of a deadly plutonium release is a real concern — gamblers in Las Vegas would be* Further, NASA's Supplementary Environmental Impact Statement (SEIS) for the U.S.$3.7 billion (AU$4.8 billion) mission acknowledges that an "alternative" power source for Perseverance could have been solar energy. Solar energy using photovoltaic panels has been the power source for a succession of Mars rovers.

"For an accident releasing plutonium on the Perseverance launch – and one in 100 rockets undergo major malfunctions upon launch, mostly by blowing up – NASA, in its SEIS, described these impacts for the area around Cape Canaveral under a heading *'Impacts of Radiological Releases on the Environment'*. NASA states:

"*In addition to the potential human health consequences of launch accidents that could result in a release of plutonium dioxide, environmental impacts could also include contamination of natural vegetation, wetlands, agricultural land, cultural, archaeological and historic sites, urban areas, inland water, and the ocean, as well as impacts on wildlife'.*

"In addition to the potential direct costs of radiological surveys, monitoring, and potential cleanup following an accident, there are potential secondary societal costs associated with the decontamination and mitigation activities due to launch area accidents. Those costs may include: temporary or longer-term relocation of residents; temporary or longer-term loss of employment; destruction or quarantine of agricultural products, including citrus crops; land-use restrictions; restrictions or bans on commercial fishing; and public health effects and medical care.

"NASA was compelled to make disclosures about the odds of an accident releasing plutonium, alternatives to using nuclear power on the Perseverance and consequences of a plutonium release, under the National Environmental Policy Act (NEPA).

"Meanwhile, the U.S. is now producing large amounts of plutonium-238, the plutonium isotope used for space missions. The U.S. stopped producing plutonium-238 in 1988 and began obtaining it from Russia, however that is no longer happening. A series of NASA space shots using plutonium-238 are planned for coming years.

"Plutonium-238 is 280 times more radioactive than plutonium-239, the plutonium isotope used in atomic bombs and as a "trigger" in hydrogen bombs.

"There are 10.6 pounds (4.8 kilograms) of plutonium-238 on Perseverance.

"We might have dodged a plutonium bullet on the Perseverance mission. The Atlas V rocket carrying it was launched without blowing up. And the rocket didn't fall back from orbit with Perseverance and its plutonium-238 disintegrating on re-entry into the Earth's atmosphere and plutonium dispersed.

[19] By Karl Grossman | 28 February 2021, 12:00pm

"But with NASA planning more space missions involving nuclear power, including developing nuclear-powered rockets for trips to Mars and launching rockets carrying nuclear reactors for placement on the Moon and Mars, space-based nuclear Russian roulette is at hand."

Dangers of launching nukes into space [20]

"The US began launching space probes with nuclear power in the early 1960's. One of these military satellites powered with a nuclear reactor fell back to Earth in April of 1964.

"It was called SNAP 9-A and was launched aboard a Department of Defense weather satellite that failed to reach orbit. The nuclear reactor, as designed, released radioactive debris in our upper atmosphere during reentry and then burned up. Remnants struck the Indian Ocean. A total of 2.1 pounds of plutonium-238 vaporized in the atmosphere and spread worldwide.

"Over the years there have been a host of space nuclear accidents by the US and former Soviet Union/Russia. See more **here**

"Dr. John Goffman studied the SNAP 9-A accident and concluded that the dispersed deadly plutonium-238 was a leading cause of the increase in cancers around the world today. During our 1997 Florida Coalition for Peace & Justice and Global Network campaign to stop the launch of the Cassini space probe, with 72 pounds of plutonium-238 onboard, Goffman was a huge help to us doing frequent media interviews where he warned of the dangers of global contamination if there was to be a launch accident.

"(Goffman's earliest research was in nuclear physics and chemistry, in close connection to the Manhattan Project. He co-discovered several radioisotopes, notably uranium-233; he was the third person ever to work with plutonium. Later in life, Gofman took on a role as an advocate warning of dangers involved with nuclear power.)

"The nuclear industry currently views space as a new (and wide open) market for their toxic product that has run its dirty course on Mother Earth.

"During our campaigns in 1989, 1990, and 1997 to stop NASA's Galileo, Ulysses and Cassini plutonium launches, we learned that the nuclear industry positioned their agents inside NASA committees that made the decisions on what kinds of power sources would be placed on those deep space missions. Similarly, it now appears that the nuclear industry has also infiltrated the National Academies of Sciences, Engineering, and Medicine that has been studying missions to Mars. The recommendation, not any surprise, is that nuclear reactors are the best way to power a Mars mission.

"But nukes are not the best for us Earthlings because the Department of Energy (DoE) has a bad track record of human and environmental contamination as they fabricate space nuclear devices. An accident at launch could have catastrophic consequences.

"In 1996, just prior to the launch of Cassini, it was reported that while fabricating the plutonium generators for the Cassini space probe, 244 cases of worker contamination occurred at DoE's Los Alamos lab in New Mexico. So it is not just a launch pad explosion that we worry about.

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[20] Bruce K. Gagnon, **http://space4peace.blogspot.com/2021/02/our-opposition-remains-dangers-of.html** February 15, 2021

"We fought the DoE and NASA on those previous nuclear launches and are entering the struggle again. The nuclear industry has its sights set on nuclear-powered mining colonies on an assortment of planetary bodies - all necessitating legions of nuclear devices being produced at DoE and then launched on rockets that blow up from time to time. They are also now promoting a nuclear rocket to Mars - with reactors for engines. The Pentagon has long claimed that they need nuclear reactors to power space-based weapons.

"We urge the public to help us pressure Congress, NASA and DoE to 'say no' to nukes in space. We've got to protect life here on this planet. The best way you can help is to share this information with others so that we can build an international base of awareness and action around this issue.

"We are in the middle of a pandemic and people have lost jobs, homes, health care and even food on their table. Trips to Mars (without nuclear devices) can wait."

The cumulative impact of space projects and NASA's testing/launch/waste disposal of nuclear space propulsion on radiation emissions must be considered in this VTR comprehensive Programmatic EIS.

Programmatic NEPA Applicability to Reactors and Reactor Waste Planned or Ready in Initial Operations Throughout the US by DOD, DOE, NASA and NRC.

Title 10: Energy
PART 1021—NATIONAL ENVIRONMENTAL POLICY ACT IMPLEMENTING PROCEDURES
Subpart C—Implementing Procedures

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10 §1021.330 Programmatic (including site-wide) NEPA documents.

"(a) When required to support a DOE programmatic decision (40 CFR 1508.18(b)(3)), DOE shall prepare a programmatic EIS or EA (40 CFR 1502.4). DOE may also prepare a programmatic EIS or EA at any time to further the purposes of NEPA.

(b) A DOE programmatic NEPA document shall be prepared, issued, and circulated in accordance with the requirements for any other NEPA document, as established by the CEQ Regulations and this part.

(c) As a matter of policy when not otherwise required, DOE shall prepare site-wide EISs for certain large, multiple-facility DOE sites; DOE may prepare EISs or EAs for other sites to assess the impacts of all or selected functions at those sites.

(d) DOE shall evaluate site wide NEPA documents prepared under §1021.330(c) at least every five years. DOE shall evaluate site-wide EISs by means of a Supplement Analysis, as provided in §1021.314. Based on the Supplement Analysis, DOE shall determine whether the existing EIS remains adequate or

whether to prepare a new site-wide EIS or supplement the existing EIS, as appropriate. The determination and supporting analysis shall be made available in the appropriate DOE public reading room(s) or in other appropriate location(s) for a reasonable time.

(e) DOE shall evaluate site-wide EAs by means of an analysis similar to the Supplement Analysis to determine whether the existing site-wide EA remains adequate, whether to prepare a new site-wide EA, revise the FONSI, or prepare a site wide EIS, as appropriate. The determination and supporting analysis shall be made available in the appropriate DOE public reading room(s) or in other appropriate location(s) for a reasonable time."

§1021.341 Coordination with other environmental review requirements.

"(a) In accordance with 40 CFR 1500.4(k) and (o), 1502.25, and 1506.4, DOE shall integrate the NEPA process and coordinate NEPA compliance with other environmental review requirements to the fullest extent possible.

(b) To the extent possible, DOE shall determine the applicability of other environmental requirements early in the planning process, in consultation with other agencies when necessary or appropriate, to ensure compliance and to avoid delays, and shall incorporate any relevant requirements as early in the NEPA review process as possible."

§1021.102 Applicability.

(a) This part applies to all organizational elements of DOE except the Federal Energy Regulatory Commission.

(b) This part applies to any DOE action affecting the quality of the environment of the United States, its territories or possessions. DOE actions having environmental effects outside the United States, its territories or possessions are subject to the provisions of Executive Order 12114, "Environmental Effects Abroad of Major Federal Actions" (3 CFR, 1979 Comp., p. 356; 44 FR 1957, January 4, 1979), DOE guidelines implementing that Executive Order (46 FR 1007, January 5, 1981), and the Department of State's "Unified Procedures Applicable to Major Federal Actions Relating to Nuclear Activities Subject to Executive Order 12114" (44 FR 65560, November 13, 1979).

§1021.103 Adoption of CEQ NEPA regulations.

DOE adopts the regulations for implementing NEPA published by CEQ at 40 CFR parts 1500 through 1508.

Definition: Programmatic NEPA document means a broad-scope EIS or EA that identifies and assesses the environmental impacts of a DOE program; it may also refer to an associated NEPA document, such as an NOI, ROD, or FONSI.

§1021.341 Coordination with other environmental review requirements.

(a) In accordance with 40 CFR 1500.4(k) and (o), 1502.25, and 1506.4, DOE shall integrate the NEPA process and coordinate NEPA compliance with other environmental review requirements to the fullest extent possible.

(b) To the extent possible, DOE shall determine the applicability of other environmental requirements early in the planning process, in consultation with other agencies when necessary or appropriate, to ensure compliance and to avoid delays, and shall incorporate any relevant requirements as early in the NEPA review process as possible.

§1021.342 Interagency cooperation.

For DOE programs that involve another Federal agency or agencies in related decisions subject to NEPA, DOE will comply with the requirements of 40 CFR 1501.5 and 1501.6. As part of this process, DOE shall cooperate with the other agencies in developing environmental information and in determining whether a proposal requires preparation of an EIS or EA, or can be categorically excluded from preparation of either. Further, where appropriate and acceptable to the other agencies, DOE shall develop or cooperate in the development of interagency agreements to facilitate coordination and to reduce delay and duplication.

Title 40: Protection of Environment
PART 1502—ENVIRONMENTAL IMPACT STATEMENT

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40 §1502.4 Major Federal actions requiring the preparation of environmental impact statements.

"(a) Agencies shall define the proposal that is the subject of an environmental impact statement based on the statutory authorities for the proposed action. Agencies shall use the criteria for scope (§1501.9(e) of this chapter) to determine which proposal(s) shall be the subject of a particular statement. Agencies shall evaluate in a single environmental impact statement proposals or parts of proposals that are related to each other closely enough to be, in effect, a single course of action.

(b) Environmental impact statements may be prepared for programmatic Federal actions, such as the adoption of new agency programs. When agencies prepare such statements, they should be relevant to the program decision and timed to coincide with meaningful points in agency planning and decision making.

(1) When preparing statements on programmatic actions (including proposals by more than one agency), agencies may find it useful to evaluate the proposal(s) in one of the following ways:

(I) Geographically, including actions occurring in the same general location, such as body of water, region, or metropolitan area.

(ii) Generically, including actions that have relevant similarities, such as common timing, impacts, alternatives, methods of implementation, media, or subject matter.

(iii) By stage of technological development including Federal or federally assisted research, development or demonstration programs for new technologies that, if applied, could significantly affect the quality of the human environment. Statements on such programs should be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

(2) Agencies shall as appropriate employ scoping (§1501.9 of this chapter), tiering (§1501.11 of this chapter), and other methods listed in §§1500.4 and 1500.5 of this chapter to relate programmatic and narrow actions and to avoid duplication and delay. Agencies may tier their environmental analyses to defer detailed analysis of environmental impacts of specific program elements until such program elements are ripe for final agency action."

EXAMPLE OF Applicability of PEIS

"The Final Programmatic EIS incorporates by reference the Draft Programmatic EIS published in June 2003. After considering all the comments received on the Draft PEIS and developing responses, the agencies determined that changes required to the Draft Programmatic EIS were minor. Therefore, the agencies implemented the provision of the Council on Environmental Quality regulations for implementing the National Environmental Policy Act at Section 1503.4(c), which reads:

(c) If changes in response to comments are minor and are confined to the responses described in paragraphs (a)(4) and (5) of this section, agencies may write them on errata sheets and attach them to the statement instead of rewriting the draft statement. In such cases only the comments, the responses, and the changes and not the final statement need be circulated (Sec. 1502.19). The entire document with a new cover sheet shall be filed as the final statement (Sec. 1506.9).

"In accordance with this provision, the agencies placed a Final Programmatic EIS cover sheet on the Draft Programmatic EIS and, along with the errata sheet and comments/responses, filed it as the Final Programmatic EIS on mountaintop coal mining and associated valley fills in Appalachia.

"DEPARTMENT OF DEFENSE Department of the Army, Corps of Engineers ENVIRONMENTAL PROTECTION AGENCY DEPARTMENT OF THE INTERIOR Office of Surface Mining Fish and Wildlife Service Final Programmatic Environmental Impact Statement for Mountaintop Mining and Valley Fills

"SUMMARY: The above agencies announce the availability of the FPEIS that considers developing policies, guidance, and coordinated agency decision- making processes to minimize, to the maximum extent practicable, the adverse environmental effects to waters of the United States and to fish and wildlife resources affected by mountaintop mining operations, and to environmental resources that could be affected by the size and location of excess spoil-disposal sites in valley fills within the Appalachian

study area in West Virginia, Kentucky, Virginia, and Tennessee. This FPEIS was prepared as part of a settlement agreement that resolved the Federal claims brought in Bragg v. Robertson, Civ. No. 2:98–0636 (S.D.W.Va.). This FPEIS was prepared consistent with the provision set forth in 40 CFR 1503.4(c) of the Council on Environmental Quality regulations implementing NEPA, which allow the agencies to attach an errata sheet to the statement instead of rewriting the draft statement and to circulate the errata, comments, responses, and the changes, rather than the entire document. The agencies are filing the entire statement with a new cover sheet as the FPEIS. The FPEIS is being made available by mail and can be viewed on the Internet at http://www.epa.gov/region3/mtntop/ index.htm. The FPEIS can also be viewed at local offices of the above agencies and at selected local libraries. Copies of the FPEIS may be obtained by writing to the address listed below."

10 CFR 1021.315,

"Amended Record of Decision for the Department of Energy's Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility, DOE/EIS–0310AGENCY: Department of Energy. ACTION: Amended record of decision. SUMMARY: The Department of Energy (DOE), pursuant to 10 CFR 1021.315, its implementing regulations under the National Environmental Policy Act (NEPA), is amending its Record of Decision (ROD) (66 FR 7877, January 26, 2001) for its Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (Nuclear Infrastructure (NI) PEIS)."

EDI's VTR Comment Summary

In EDI's view, the prolifery of reactors, the nuclear fuel and radioactive waste generated by these reactors discussed above is clearly problematic deserving a full Programmatic Environmental Impact Statement (PEIS) to fully evaluate the cumulative impact. As the regulations cited above demonstrate, a Programmatic Environmental Impact Statement (PEIS) is required for the segmented and expansive program of these agencies (DOD, DOE, NRC, National Nuclear Security Administration, National Academies and NASA). In addition, the multiple US agencies involved, these reactors and their related nuclear wase operations are spread around multiple states. As the statute below outlines:

40 §1502.4 Major Federal actions requiring the preparation of environmental impact statements.

"(b) Environmental impact statements may be prepared for programmatic Federal actions, such as the adoption of new agency programs. When agencies prepare such statements, they should be relevant to the program decision and timed to coincide with meaningful points in agency planning and decision making.
(1) When preparing statements on programmatic actions (including proposals by more than one agency), agencies may find it useful to evaluate the proposal(s) in one of the following ways:
(i) Geographically, including actions occurring in the same general location, such as body of water, region, or metropolitan area.
(ii) Generically, including actions that have relevant similarities, such as common timing, impacts,

alternatives, methods of implementation, media, or subject matter.

(iii) By stage of technological development including Federal or federally assisted research, development or demonstration programs for new technologies that, if applied, could significantly affect the quality of the human environment. Statements on such programs should be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

(2) Agencies shall as appropriate employ scoping (§1501.9 of this chapter), tiering (§1501.11 of this chapter), and other methods listed in §§1500.4 and 1500.5 of this chapter to relate programmatic and narrow actions and to avoid duplication and delay. Agencies may tier their environmental analyses to defer detailed analysis of environmental impacts of specific program elements until such program elements are ripe for final agency action."

In EDI's view, the prolifery of reactors proposed by so many US agencies, the nuclear fuel produced at numerous DOE sites and radioactive waste generated by all these reactors discussed above is clearly problematic deserving a full Programmatic Environmental Impact Statement (PEIS) to fully evaluate the cumulative impact. It's imperative to show the American public the collective impact/scope of these projects via a PEIS.