From:	Michael Lorton
To:	Bladey, Cindy; Chang, Helen; Michael Lorton
Subject:	[External_Sender] Section 2.802 Rulemaking Petition
Date:	Thursday, February 20, 2020 1:12:40 PM
Attachments:	NRC2.802RuleMakingPetitionLtr19Feb20.docx

Dear Dr. Chang and Ms. Bladey:

Attached please find a brief memorandum in support of our rulemaking petition. We appreciate your recent letter. You provided us with very useful feedback. We realize that the NRC may choose not to initiate the requested rulemaking at this time, but we also understand that we may revisit this in the future if social, political, and technical developments make this issue more pressing.

We know you are very busy, and we have tried to technically knowledgeable out of respect for your time and attention. For the reasons set out in the memo, we believe Standard Design Certification rules would significantly assist the NRC's own efforts to advance Generation IV nuclear reactor technology and implementation.

Again, we thank you for your kind attention to this issue. You have been very gracious as have the people at USEPA.

Sincerely,
Michael D. Lorton, M.D., J.D., MBA
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To: Dr. Helen Chang, Nuclear Regulatory Commission

From: Algignis, Inc.

Date: 19 February 2020

Re: Sec. 2.802 Rulemaking Petition: Nuclear Heat Exchanger Standard Design Certifications

Dear Dr. Chang:

Thank you for your letter responding to our Petition for Section 2.802 Rulemaking. We are aware that rulemaking is subject to public notice and comment, but we filed the initial petition in the confidential portion of NRC portal out of respect for the NRC Commissioners and staff. We wanted to give you private notice of our intentions rather than blindside you with a public filing. We understand you may not choose to initial a rulemaking procedure, but we still wanted to consult with you and your staff to get your advice and opinions on our proposal. We respect and value your expertise.

We are also aware that we can seek a case-by-case modification of an existing nuclear operating license if we and our owner-operator partners wish to install heat exchangers on existing U.S. nuclear power plants. We broach the idea of Standard Design Certification rules for nuclear heat exchanger installation for the same reasons the NRC promulgated Standard Design Certification rules for current light water reactor designs: 1) SDCs provide technical, financial, and regulatory certainty that if an applicant complies with the nuclear heat exchanger installations SDCs, he/she is likely to receive NRC regulatory approval in a predictable manner.

For the reasons stated below, we believe nuclear heat exchanger Standard Design Certification rules substantially advance the objectives of the NRC. The NRC has done an excellent job in fostering the development of the next generation of advanced nuclear reactors. We can see that the NRC has focused on the technical and safety issues of the next generation nuclear reactors. Unfortunately, the NRC could do extraordinary work on next generation advanced reactors and still see few if any of them constructed due to economic issues. We respectfully submit the advanced next generation nuclear reactors will be built on or near the sites of current U.S. nuclear reactors because the next generation reactors will benefit immensely from technical and economic advantages of the current sites. The economic, social, and technical obstacles to building next generation advance reactors at new sites may be barriers too great to overcome.

Installing heat exchangers on current nuclear power plants will have immediate benefits, but, more importantly, it will also keep current nuclear power plants economically viable, operational, and available to transition to advance next generation nuclear reactors in 10-15 years. If most of the current nuclear power plants have been retired in 10-15 years, it will be much more difficult to build out the new advance reactors that will then be technically possible.

To that end, we propose installing nuclear heat exchangers on as many current nuclear power plants as economically and technically feasible.

Background

The Generation IV advanced nuclear reactors will be built on or near the sites of current light water reactors because the current sites have all the technical and economic advantages needed for the next generation reactors. It is therefore necessary to prevent premature closure of the current reactors to preserve those technical and economic advantages needed to economically transition to the next generation reactors. Allowing current nuclear reactors to remain operational by monetizing their waste heat with the installation of heat exchangers provides the following advantages:

- *Cooling water:* All of the Generation IV reactors (e.g. molten salt, liquid metal, helium-cooled) will need an ultimate heat sink. The current sites have the required water and pumping infrastructure.
- *Location:* All of the current sites are located far enough away from major population center to reduce the risks of any accidents, while at the same time being close enough to avoid major line-loss of electricity.
- *Transmission lines and infrastructure:* Current sites have the high voltage transmission lines, inverters, transformers, etc. needed for the next generation reactors. Building and permitting that infrastructure at a new site will add immensely to the cost of building the next generation reactors.
- *Human capital:* Nuclear engineers and technicians working at the current nuclear power plants will be able to transition to the next generation technologies. If the current nuclear power plants close, the human capital will retire or move away. It will be more difficult and costly to recruit new human capital to new sites.
- *Regulatory permits:* All of the current nuclear power plants have the required environmental and nuclear regulatory licenses and permits. It will be much easier, faster, and less costly to merely update those licenses and permits than to secure new permits at a new site.
- *Community and social acceptance:* The only places in the United States that openly welcome nuclear power plants are those communities that already have them. The people appreciate the jobs, taxes, and economic input of the nuclear power plants and want them to remain operational. Attempting to build nuclear power plants at new site will be met with protests and lawsuits.
- *Availability of spent fuel repositories on*-site: Overwhelmingly, the greatest objection to nuclear power is centered on the production of nuclear waste. Spent fuel rods are currently stored on-site at the nuclear reactors that generated them. Those “spent” fuel rods contain a massive amount of nuclear energy (approximately 4% fission products, 95% Uranium-238, and 1% Plutonium). The scientists at the Argonne National Laboratory have invented Pyroprocessing technology that can reprocess spent fuel on-site (thereby removing nuclear transportation risk) in molten salt fast reactors with a closed fuel cycle. This has the astonishing benefits of:
    - *Breeding and burning the plutonium and transuranic elements in “spent” fuel provides massive amounts of nuclear energy:* The 95% Uranium-238 can be converted by fast neutrons to burnable Plutonium thereby using all of the energy contained therein. It is estimated that “spent” fuel rods contain enough nuclear energy to supply all of the electricity for the United States for several hundred years without having to mine additional Uranium;
    - *Shrinks the volume of nuclear waste immensely:* The highly radioactive fission products can be separated out of the liquid nuclear fuel stream by Zeolite exchange columns and vitrified in tiny final volumes compared to the current stored spent fuel.
    - *Reduces the time the nuclear waste must be stored from approximately one million years to 300-500 years:* Radionuclides with long half-lives (heavy transuranic elements with half-lives in ranges of tens to hundreds of thousands of years) must be stored up to one million years before their radiation levels drop to that of the background. Fission products from Uranium and Plutonium, while more intensely radioactive in the short-term, must only be stored for 300-500 years.

- *Carbon-free electricity available to build Generation IV nuclear reactors:* One criticism of current nuclear power plants is that they contribute significant CO2 over their life cycle in two ways: 1) Significant fossil fuel was used in their construction; and 2) significant CO2 is produced in the mining and refinement of Uranium. As we have seen, pyroprocessing and reusing spent fuel eliminates the need to mine and refine additional Uranium. Construction of Generation IV nuclear power plants on or near current nuclear power plants would use zero-carbon energy supplied by the current on-site nuclear power plant.
- *Nuclear waste heat recovery infrastructure available for the high-grade heat produced by Generation IV nuclear reactors:* The United States is the only country in the world that does not use nuclear energy cogeneration to produce both electricity and very useful recovered heat. Admittedly, the current U.S. nuclear reactors produce low-grade heat (i.e. less than 300C), but the Generation IV reactors will produce moderate- (300-650C) and high-grade heat (greater than 650C) that can be economically put to far more uses. The heat recovered from current reactors can be used for:
  - *Year-round cultivation of genetically-modified algae at commercial scale to*
    - *Substantially reduce toxic algae blooms in Lake Erie and other American waters by removing excess phosphorus, nitrogen, and carbon from eutrophic waters.*
    - *Economically producing biodegradable bioplastics.*
  - *Industrial composting, chemical degradation, and recycling of plastics:*
    - *Both petroleum-based plastics and bioplastics.*
  - *Local residential/office heating and cooling.*
  - *Industrial process heating:* This is limited to certain low-grade heat applications.
  - *Transient high temperature processes when combined with excess solar energy at times of the day when there is so much solar that the price of that solar energy is negative:* The infamous "Duck Curve" of solar energy economics shows that solar electricity is so plentiful for several hours at midday that its price is negative, i.e. solar energy producers have to pay customers to take the solar electricity off their hands. There are industrial and recycling processes that require high-grade heat that can still be economical if conducted a five to six hours per day. Midday diversion of the nuclear waste heat and excess solar energy would drive those applications profitably.
  - *Nuclear energy load following:* Current U.S. nuclear power plants cannot bid for energy supply that requires electrical grid load following. They can only bid in steady baseload supply and capacity auctions. Without external heat exchanger applications, current U.S. nuclear power plants can only vary their nuclear heat and electricity output by slowing lowering or raising the reactor control rods. That is not quick enough for minute to minute load following. Variable-speed electric turbines and generators are well-established technologies. The pressure and volume of steam can very quickly be adjusted to such variable-speed machines if there is a heat exchanger and outlet for waste heat diversion. Installation of external heat exchangers on current U.S. nuclear reactors would allow effective nuclear load-following.
- *High-grade nuclear waste heat from Generation IV nuclear reactors could be put to much more effective uses:*
  - *Hydrogen production:* The extensive research conducted by the International Atomic Energy Agency (IAEA) unequivocally demonstrates that hydrogen production can be economically produced by high-temperature steam reforming, but not by low-temperature steam reforming. The IAEA has developed an elegant computer programmable spread sheet (Hydrogen Economic Evaluation Program—HEEP) that

calculates the parameters under which hydrogen can be economically produced by nuclear cogeneration.

- *Per- and Polyfluoroalkyl substances (PFAS) degradation:* These fire-retardant “forever chemicals” are drawing increasing attention as ubiquitous cancer-causing drinking water contaminants. They are called “forever chemicals” because the fluorine-carbon bonds are among the strongest known and are very energy intensive to break. The electricity and high-grade heat from Generation IV nuclear reactors (with or without solar energy supplementation) could economically be used to degrade these PFAS chemicals and neutralize their harmful effects.
- *High-grade heat industrial processes:* Steel, concrete, and chemical production produce 20-30% of the worlds CO2. High-grade heat from Generation IV nuclear reactor cogeneration would supplant fossil fuel combustion for those processes.

Summary

Yes, applicants can seek modification of the NRC licenses of current U.S. nuclear power plants to install nuclear waste heat recovery exchangers on a case-by-case basis. The problems are 1) long review times 2) economic/financial uncertainty, and 3) regulatory uncertainty when approaching this problem on an *ad hoc* basis. That is why the NRC has issued Standard Design Certification (SDC) rules for several current U.S. nuclear reactor designs. Applicants wishing to build nuclear reactors know that if they follow the SDCs, they will receive NRC regulatory approval in a predictable manner. That allows financial and business risk management that would otherwise not exist. The same goes for a comprehensive effort to build a nuclear waste heat and cogeneration program in the United States. Nuclear heat exchanger engineering is well-established and used safely and economically in every other nuclear country in the world. SDC rules for nuclear heat exchangers would allow applicants wishing to install nuclear waste heat recovery exchangers to manage risk in a way that would otherwise not be possible.

A comprehensive nuclear waste heat recovery and cogeneration system in the United States would provide all of the benefits listed above and would keep current U.S. nuclear power plants economically viable until the Generation IV advanced nuclear reactors can be built on or near those sites in 10-15 years. We will submit technical and engineering addenda for proposed Standard Design Certification rules at a later date.

We would be happy to work with the NRC in any way you desire. Thank you for your assistance in these matters.

Respectfully submitted,

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