October 14, 2010

ATTACHED IS THE MAY 19, 2008 MEMORANDUM FROM WILLIAM RECKLEY, DNRL TO TIMOTHY FRYE, DCIP RE: ANTICIPATED REGULATORY ISSUES INVOLVING THE POTENTIAL FOR SMALL AMOUNTS OF TRITIUM TO ENTER INTO FLUID PRODUCTS MADE WITH NUCLEAR PROCESS HEAT.

THE MEMORANDUM WAS REVIEWED AND RELEASED AS PUBLICALLY AVAILABLE BY WILLIAM RECKLEY ON OCTOBER 12, 2010

May 19, 2008

MEMORANDUM TO: Timothy J. Frye, Chief
Health Physics Branch
Division of Construction Inspection and Operational Programs
Office of New Reactors

FROM: William D. Reckley, Chief ***/RA/***
Rulemaking, Guidance and Advanced Reactors Branch
Division of New Reactor Licensing
Office of New Reactors

SUBJECT: ANTICIPATED REGULATORY ISSUES INVOLVING THE POTENTIAL FOR SMALL AMOUNTS OF TRITIUM TO ENTER INTO FLUID PRODUCTS MADE WITH NUCLEAR PROCESS HEAT

This memorandum formalizes our recent discussions on anticipated technical and regulatory issues associated with the potential for small amounts of tritium to enter into fluid products, such as hydrogen, steam, various synthetic fuels and other chemicals, made using process heat from the operation of nuclear reactors designed for that purpose. The development of such new types of nuclear reactors is supported in the United States (US) through the Nuclear Hydrogen Initiative and its Next Generation Nuclear Plant (NGNP) project. As set forth in the Energy Policy Act of 2005 (EPAct), the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) are now engaged in interactions on strategies and supporting research and development toward:

(a) the NRC licensing of an NGNP prototype facility that, per EPAct, will be built at Idaho National Laboratory by 2021 for demonstrating the production of hydrogen from high-temperature nuclear process heat, and

(b) the future NRC design certification of similar commercial reactor systems for hydrogen production and other applications of high-temperature nuclear process heat.

The hydrogen gas and other valuable fluid products to be generated by such systems would not be derived directly from the nuclear fission or activation processes taking place in the reactor core but rather from dedicated and separate thermal process systems that would be isolated from the reactor's primary cooling system by at least one heat exchanger barrier. The concern is that a potential exists for radioactivity to migrate or permeate through the reactor plant systems and become entrained in the process heat systems and the fluid products they generate for commercial and industrial uses.

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The primary isotope of concern in this context is tritium, the radioactive isotope of hydrogen. Decaying with a 12-year half-life, tritium is barely distinguishable chemically from the stable hydrogen isotopes, protium and deuterium, and is known to permeate readily through metallic barriers. It is therefore important to control within regulated limits the leakage or permeation of tritium from reactor systems into the process heat facilities and their fluid products. In the types of high-temperature gas-cooled reactors (HTGRs) being considered in the NGNP project, tritium will be produced mainly from

- ternary fission,
- neutron absorption by lithium-6 impurities in nuclear grade graphite,
- neutron absorption in boron-containing reactor control elements, and
- neutron reactions with helium-3 in the reactor's helium coolant.

As a consequence, it is important to ensure that radioactivity from the nuclear plant and its process systems (cooling and waste processing) does not enter the fluid products in amounts that could exceed radiation protection standards for worker health, public health, or the environment.

The determination of allowable levels of tritium in the fluid products would consider the technical and regulatory bases for present limits on tritium in drinking water and in the air and liquid effluent releases from nuclear plants and would evaluate whether specific regulatory provisions would need to be enacted for the envisioned commercial distribution and use of fluid products containing byproduct materials. A brief overview of these issues is presented next.

1. Reactor radioactive effluent releases

Under Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR Part 50 or Part 50), radioactive releases via liquid and gaseous effluents are regulated under specific provisions. General Design Criteria 60, 61, 63, and 64 of Appendix A to Part 50 mandate that reactors include specific provisions for the purpose of processing, controlling, and monitoring the amounts of radioactivity released in the environment. 10 CFR 50.34a identifies design objectives to control releases of radioactivity, and 10 CFR 50.36a, with Appendix I to Part 50, defines technical specifications and numerical guides and objectives in maintaining effluent releases as low as reasonably achievable (ALARA). These provisions would appear to be adequate for the licensing of NGNP facilities, but it should be noted that current regulations and guidance to NRC staff and applicants are defined for light-water reactors and not for other reactor designs. It should nevertheless be further noted that in the 1960s and 1970s the US licensed three reactors of other designs - namely the Peach Bottom 1 and Fort St. Vrain HTGRs and the Fermi sodium cooled reactor - using earlier versions of essentially the same regulations. Accordingly, the NRC would need to determine how the current body of regulations and guidance can be adapted or extended for regulating radioactive effluent releases from NGNP and similar future reactor facilities.

2. Occupationally exposed radiation workers at NGNP facilities

With respect to occupational radiation protection, the current provisions of 10 CFR Part 20 should be adequate in licensing NGNP facilities, given that Part 20 is relatively insensitive to the NRC regulatory domain. For example, Part 20 applies to licensing and regulation for source materials, byproduct materials, special nuclear materials, power and research reactors, waste disposal facilities, industrial radiography, nuclear medical programs, spent fuel storage, etc. Accordingly, no new specific radiation protection provisions are anticipated.

3. Adequacy of current Federal limits for environmental radioactivity

Releases of radioactivity in the environment from licensed power reactors are covered in Part 20 (Appendix B, Table 2) and also in Sections II to IV of Appendix I to Part 50. Under Environmental Protection Agency (EPA) regulations, Title 40 CFR Part 190 defines acceptable doses and addresses releases of radioactivity from facilities within the fuel cycle. These regulations are implemented under 10 CFR 20.1301(e) for Part 50 licensed facilities, which include LWRs. In addition, the NRC has issued guidance to the staff and licensees on the implementation of these EPA requirements. In the context of licensing NGNP facilities, there would be a need to determine if these new facilities fall within the definition of "fuel cycle" facilities, and whether NRC regulations and guidance would need to be revised based on a regulatory analysis.

The presence of radioactivity in drinking water is addressed in EPA regulations under 40 CFR 141.66. The limits are 4 millirems per year (total body or any organ) for man-made radionuclides and 20,000 pico-Curies per liter for tritium. As before, the NRC has issued guidance to the staff and LWR licensees on the implementation of the EPA drinking water standards. In the context of licensing NGNP facilities, it is assumed, for now, that the EPA drinking water standards would apply.

4. Distribution of a commercial fluid product containing byproduct materials

The distribution and uses of hydrogen and other fluid products, assuming the potential presence of some residual levels of tritium, would need to be assessed against the provisions of 10 CFR Part 32 (Specific domestic licenses to manufacture or transfer certain items containing byproduct material), 10 CFR 30.14 (Exempt concentrations), and Schedule A to 10 CFR 30.70 (Exempt concentrations) regarding the distribution of a commercial product containing byproduct materials, such as tritium, from NGNP or similar facilities. The scope and applicability of the provisions of Part 30 and Part 32 would need to be evaluated for commercial and industrial uses of hydrogen and other fluid products from reactor process heat facilities in non-regulated facilities, including releases of tritium during the burning of hydrogen and other synthetic fuel products, exposure to workers covered under Occupational Safety and Health Administration (OSHA) regulations, exposure and doses to members of the public, and the fate and transport of tritium in combustion products in the environment. This evaluation would determine whether the current provisions of Part 20 (Appendix B, Table 2 concentration limits) and 10 CFR 30.70 (Exempt concentrations) are adequately protective of the public and environment and assess if NRC regulations, protection standards, and guidance would need to be revised.

It is expected that these and related issues will be discussed in various forums (internal, interagency, public, international) over the coming months and years as the NGNP project evolves in parallel with other domestic and international activities involving nuclear process heat, radiation protection, and environmental protection. For NGNP in particular, these discussions will likely include focused interactions between DOE, NRC, EPA, and possibly OSHA. It will therefore be important to maintain communication and coordination between our branches on any activities in this area. Initial discussions of these issues with you, Jean-Claude F. Dehmel of your staff, and Donald E. Carlson of my staff have been very helpful and much appreciated. Please continue to interact with me or Dr. Carlson at 301-415-0109 on this matter.

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