

The Use of Nuclear Steam for Ethanol Production: The Regulatory Environment

By Samuel Rosenbloom

Ever since the beginning of the development of nuclear energy, numerous studies have been conducted and multiple reactors have been built to produce electricity and steam. The steam has been used for district heating, heavy water production and other limited uses. However, coproduced steam has never been a major product of nuclear reactors for two reasons: 1) there are few customers near rural nuclearplant sites, and 2) most of the markets for steam are so small that they aren't worth the complications of coproducing steam and electricity.

Today's production of fuel ethanol from corn and the future production of fuel ethanol from biomass creates the need for large quantities of steam in rural areas—the same areas in which nuclear power plants are built.

For ethanol production, steam would be provided by the reactor. The steam would be condensed in the ethanol plant, and warm water would be returned to the nuclear power plant.

Modern steam systems allow for more than a mile of separation between the reactor and the ethanol plant. The separation required to avoid security concerns would be more than necessary to ensure safety against fires and other accidents in the ethanol plant.

No fundamental technical or economic barriers stand in the way of cogeneration of electricity and steam for ethanol production. Sufficient experience exists from current and decommissioned

reactors that produced steam and electricity. The potential economic, national security (i.e., a reduced dependence on imported oil) and environmental benefits strongly support the commercialization of this use of nuclear energy for ethanol production.

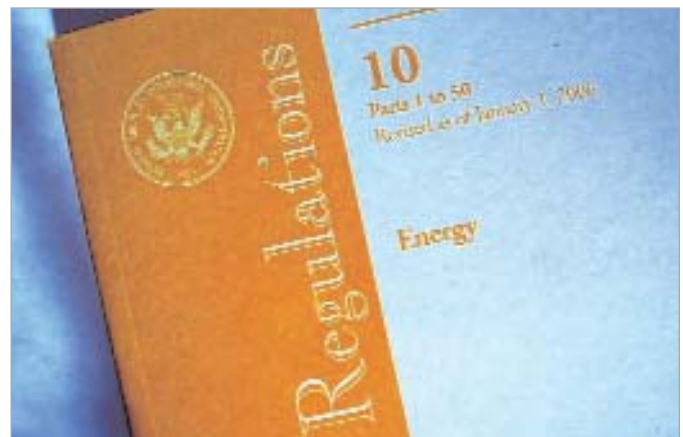
Nuclear Regulation Background

Any combination of an ethanol plant and nuclear facility requires extensive knowledge of the nuclear industry's regulatory background. It begins with the Atomic Energy Act of 1946 that established the Atomic Energy Commission (AEC). The AEC was charged with developing and regulating the safe applications of nuclear materials, including defense and peaceful applications. The Atomic Energy Act of 1954 legalized the development of commercial nuclear power by private industry and utilities.

In the early 1970s, concerns arose about the AEC's broad and conflicting powers for the development and regulation of governmental and civilian nuclear applications. The Energy Reorganization Act of 1974 abolished the AEC and created the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Agency (ERDA). The NRC had authority to license, inspect and regulate the civilian use of



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The NRC's regulations are documented in title 10 of the Code of Federal Regulations.

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nuclear facilities and materials. The ERDA was responsible for military applications of nuclear material, and the research and development function for new nuclear technologies. The U.S. DOE was created in 1978 to assume the functions of the ERDA.

The NRC is an independent federal agency directed by a five-member commission, which derives its authority solely from statutes enacted by Congress. The NRC and DOE interact on a number of nuclear issues, but the NRC doesn't regulate the DOE's production and use of nuclear materials at its national laboratories or sites unless specifically authorized by Congress.

The following provides an overview of the basic regulatory actions necessary for ethanol production by a new or existing commercial nuclear power plant. It is presumed that this ethanol production would be accomplished by the diversion of the power plant's steam, which is then piped from the plant to a nearby location that isn't within the fenced and secured perimeter of the plant.

NRC Regulations

The Atomic Energy Act of 1954 gives the NRC broad statutory authority to license and regulate civilian uses of nuclear material and to promulgate all necessary regulations in order to do so. NRC regulations are documented in Title 10 (Energy) of the Code of Federal Regulations (CFR), Parts 0-199. NRC regulations contained in 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities are pertinent to the production of ethanol by use of steam from a nuclear reactor.

Before a company can operate a commercial nuclear power plant, it must receive a license from the NRC.

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The NRC licensing process for a nuclear power plant is comprehensive, detailed and lengthy. It includes a safety, environmental and antitrust review. The safety requirements for a license are principally set forth or referenced in 10 CFR Part 50. The environmental requirements are in Part 51, and the general design criteria and siting requirements are in Part 100. The licensing process established in 10 CFR Part 2 includes an opportunity for public involvement, a mandatory adjudicatory hearing, and a commission review and decision that might be subject to federal judicial review. If an applicant uses a standardized reactor design, it can go through a more streamlined licensing process set forth in 10 CFR Part 52 that relies on a previous NRC decision and certification that the standardized reactor is safe and meets applicable requirements. If granted, the NRC license will establish the terms and conditions for operation.

If an application for construction and operation of a new nuclear power plant includes the diversion of steam for ethanol production, the NRC will consider the safety, security and health impacts of that steam diversion, and the location of the ethanol plant nearby. These considerations include the following:

- ▶ Will diversion of steam off-site pose a radiological health or safety hazard to operations or personnel at the ethanol plant?

- ▶ Will operations at the ethanol plant pose a hazard to the safe operations at the nuclear plant?
- ▶ Will operations at the ethanol plant present an undue security risk to the nuclear plant?
- ▶ How will normal or abnormal conditions of the diversion, transport and return of steam by pipeline affect operations of the nuclear power plant?
- ▶ What are the safety systems that are needed for diversion of steam to assure safe operations?
- ▶ What are the emergency preparedness measures that are needed to assure the safety of personnel at the ethanol plant in the event of an accident at the nuclear power plant?

If an ethanol plant uses steam from a licensed nuclear power plant, the licensed operator must submit a license amendment to the NRC for review and approval in accordance with the provisions of 10 CFR 50.90-50.92. In determining whether an amendment will be issued, the commission is guided by the considerations that govern the issuance of the initial license to the extent applicable and appropriate (10 CFR 50.92(a)). In addition to the safety review, Part 51 prescribes the environmental review, if any, that must occur to support the NRC action under the National Environmental Policy Act. If the amendment involves a significant hazards consideration, the NRC must give public notice of the proposed



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action and provide an opportunity for a hearing. The significant hazards analysis will consider whether the proposed amendment:

- ▶ Involves a significant increase in the probability or consequences of an accident previously evaluated
- ▶ Creates the possibility of a new or different kind of accident from any accident previously evaluated
- ▶ Involves a significant reduction in a margin of safety

In determining whether an amendment involves a significant hazards consideration, the NRC is particularly sensitive to whether the amendment involves irreversible consequences such as one that permits a significant increase in the amount of effluents or radiation emitted by a nuclear power plant (10 CFR 50.92(b)). After publication of its preliminary determination and consideration of any comments received, the NRC staff may make a determination on the significant hazards consideration.

If the NRC determines that the amendment doesn't involve a significant hazards consideration, it may issue the amended license. If the NRC finds that the proposed amendment does involve a significant hazards consideration, and if there is a request for a public hearing, the hearing must occur before the NRC can issue the amendment. The NRC review of the proposed amendment will address the safety, health and security considerations noted above for initial licensing.

Conclusion

The U.S. government has a national goal to displace 30 percent of our gasoline by 2030. That is an extraordinary challenge that requires increasing ethanol production by more than an order of magnitude. Biomass processing requires massive quantities of low-temperature steam. For this scale of operation, the total steam demand at a few hundred plants would be tens of gigawatts.

Low-temperature steam is a product that existing and future light-water reactors are very good at producing in combination with electricity. Because of the potential for highly favorable economics and the potential to make a major contribution to reducing our national dependence on foreign oil, it is a nuclear future that the nation should explore today.

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