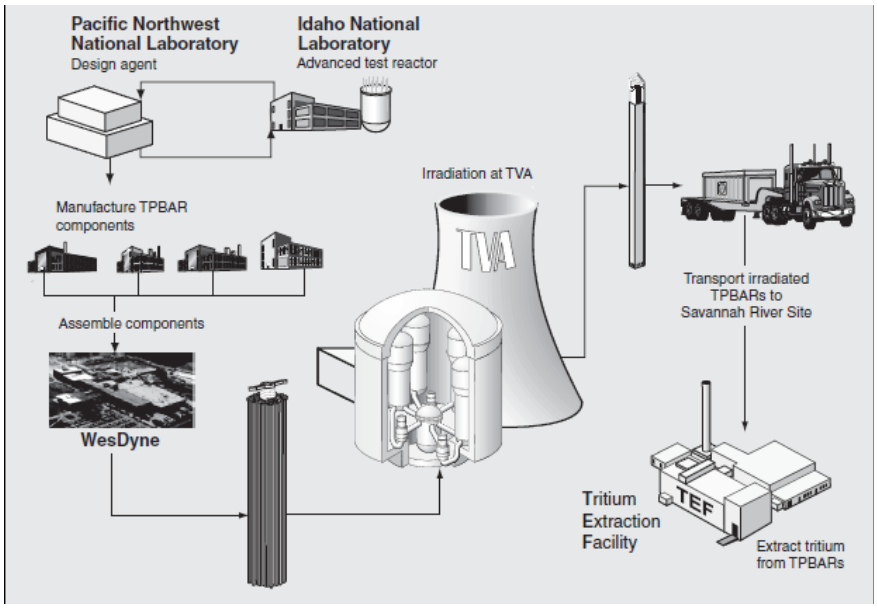
Tritium Production and Environmental Impacts

The production of tritium in a commercial light water reactor (CLWR) is technically straightforward. Most existing CLWRs utilize 12-foot-long rods containing an isotope of boron (boron-10) in ceramic form. These rods are generally referred to as burnable absorber rods. The rods are inserted in the reactor fuel assemblies to absorb excess neutrons produced by the uranium fuel in the fission process for the purpose of controlling power at the beginning of an operating cycle. DOE/NNSA's tritium program has developed another type of burnable absorber rod in which neutrons are absorbed by a lithium aluminate ceramic rather than boron ceramic. These tritium-producing burnable absorber rods (TPBARs) would be placed in the same locations in the reactor core as the standard burnable absorber rods. There is no fissile material (uranium or plutonium) in TPBARs.



While the two types of rods function in a very similar manner to absorb excess neutrons in the reactor core, there is one notable difference: when neutrons strike the lithium aluminate ceramic material in a TPBAR, tritium is produced. This tritium is captured almost instantaneously in a solid zirconium material in the rod, called a "getter." The solid material that captures the tritium as it is produced in the rod is so effective that the rod will have to be heated in a vacuum at much higher temperatures than normally occur in the operation of a reactor to extract the tritium for eventual use in the nuclear weapons stockpile.

HOW MUCH TRITIUM NEEDS TO BE PRODUCED?

Steady-state tritium requirements are classified and vary depending upon the specific requirements set forth by Presidential directives to support the requirements of the post-Nuclear Posture Review stockpile. Considering the design of the TPBARs and the efficiency of the tritium extraction process, NNSA has determined that tritium demand to supply the nuclear weapons stockpile could be satisfied with a maximum of approximately 2,500 TPBARs per fuel cycle, with a projected steady state number of approximately 1,700 TPBARs per fuel cycle.

WHAT ARE THE ENVIRONMENTAL IMPACTS OF TRITIUM PRODUCTION?

The replacement of burnable absorber rods with TPBARs has few impacts on the normal operation of the reactor. The normal power distribution within the core and reactor coolant flow and its distribution within the core remain within existing technical specification limits. Some tritium permeates through the TPBARs during normal operation, which increases the quantity of tritium in the reactor's coolant water system. Since tritium is an isotope of the hydrogen atom, once the tritium is in the reactor's coolant water system, it can combine with oxygen to become part of a water molecule and could eventually be released to the environment. The operational differences between a tritium production reactor and a nuclear power plant without tritium production are as follows:

• Tritium Releases—The amount of tritium in liquid effluents and gaseous emissions increases as a result of the presence of TPBARs in the reactor.

• Public and worker exposure—The increased levels of tritium released to the environment and the additional activities required in the handling and processing of TPBARs results in slightly increased radiation exposure for the public and workers.

• Accident conditions—The physical changes to the reactor core involve replacing some burnable absorber rods with TPBARs. This change slightly increases the estimated quantity of radionuclides assumed to be released in certain accidents.

• Wastes—Additional activities associated with handling, processing, and shipping TPBAR assemblies slightly increases low-level radioactive waste generation rates.

• Spent fuel—Additional spent fuel is generated when a reactor operates in a tritium-producing mode.

• Transportation and handling—Irradiated TPBAR assemblies are packaged and transported from the CLWR site to the Savannah River Site for tritium extraction and purification. In addition, the low-level radioactive waste associated with the TPBARs is packaged and transported for disposal at a low-level waste disposal facility. Some small additional radiological exposures and accident risks en route would be expected.

• Personnel—Additional TPBAR handling and shipping activities create a small number of new jobs.

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