DEFENSE NUCLEAR FACILITIES SAFETY BOARD

August 9, 1996

MEMORANDUM FOR:	G. W. Cunningham, Technical Director
COPIES:	Board Members
FROM:	William Yeniscavich
SUBJECT:	Review of Ongoing Work at the Savannah River Tritium Facility

1. **Purpose:** To review ongoing and planned work at the Savannah River Site (SRS) tritium facility with regard to safety of workers and the public. The review was conducted by Defense Nuclear Facility Safety Board (Board) staff members K. Fortenberry, T. M. Huntley, C. R. Martin and W. Yeniscavich at the SRS, July 29-30, 1996.

2. **Summary:**
   a. Conceptual design work is in progress on a new tritium extraction facility at SRS. The facility is being designed with a dual capability to process targets from a linear accelerator and targets irradiated in a commercial reactor. Its conceptual design is scheduled to be completed in February 1997, and construction initiated in FY 1999. The estimated operational date for the new facility is 2005. The linear accelerator is being designed by Los Alamos National Laboratory (LANL), and the conceptual design is scheduled to be completed by October 1997. If the acceleration were selected to proceed, it would be built at SRS, and construction initiated in FY 1999. A plan is being developed for the Board staff to conduct appropriate safety reviews of the new tritium extraction facility design and the linear accelerator design as they are developed.
   b. The reservoir surveillance testing program that had previously been conducted at Mound was transferred to SRS where testing is being conducted in a temporary facility. A new, permanent surveillance testing facility is being built within the Replacement Tritium Facility (RTF), and is scheduled to be operational by July 1998. No significant safety issues were identified during this review of the temporary or new facilities.
   c. In March of this year, SRS shipped a container of low level waste to the Scientific Ecology Group (SEG) in Oak Ridge, Tennessee for compaction into a smaller volume. The radioactive content of the shipment was incorrectly identified by SRS, and resulted in an excessive release of tritium to the environment during the compaction operation. As a result of this incident, SRS conducted an indepth review of waste handling practices at SRS and has proposed a number of actions which should significantly improve safe handling of radioactive waste.
   d. The unloading of expired reservoirs is continuing without incident, but is about 6 months behind schedule. Unloading of expired reservoirs should now be completed by March 1999. Completion of this work will eliminate the increased potential for a tritium leak inherent with expired reservoirs.

e. The Hydride Storage Vessels (HSVs) are available and are being used to safely store excess tritium being unloaded from expired reservoirs.
f. The first Highly Invulnerable Encased Safe (HIVES) was delivered to the tritium facility in July 1996. The remaining HIVES are scheduled to be delivered, installed, and in full use by October 31, 1996. A visual examination of the first HIVES revealed two last minute design changes and an installation change that was not conveyed to the Department of Energy (DOE) or the Board staff. These are currently being evaluated. In addition, the plan to replace file cabinets with HIVES for storing reservoirs in work areas was abandoned. The release of tritium due to fire was the limiting condition in the safety analysis of these work areas, and the HIVES had no mitigating effect on the fire scenario. The Board staff does not agree with this plan because the HIVES will provide protection from mechanical damage such as roof collapse.

3. **Background:**

A large number of reservoirs were shipped to SRS between 1991 and 1994 because of a reduction in the stockpile weapons inventory. DOE assumed that a reservoir storage life that is much longer than the design agency service life for reservoirs could be established and that the reservoirs could be used as storage containers for the tritium. Hence, reservoirs accumulated at SRS and were stored in office type file cabinets within a vault. Structural analysis indicated that the vault would collapse during a design basis earthquake or tornado and that the file cabinets offered very little protection to the reservoirs. Consequently, design of a new storage container resistant to vault collapse was initiated to replace the file cabinets. The new storage container was called the HIVES. It consisted of a commercial safe reinforced on the sides with welded steel plates and cushioned on the top with steel plates and crushable energy absorbent material. The Board staff reviewed the design and judged it acceptable

In December 1994, the reservoir design agencies rejected the idea of an extended storage life for reservoirs because of the potential for a reservoir to leak when design life is exceeded. By this time many reservoirs had already exceeded their design lives, and SRS began to unload these expired reservoirs. Because of the large backlog of expired reservoirs, those with the greatest potential to leak were identified and given priority in the unloading schedule.

DOE recognized that when all the tritium is unloaded from the expired reservoirs, the total amount of tritium at SRS would exceed the existing storage capacity. Therefore, a new tritium storage vessel was designed using a titanium bed in a stainless steel vessel. The new design was called the HSV. Titanium was selected as the bed material because it bonds chemically with tritium and permits the storage of a large quantity of tritium in a small volume at a low pressure. Although an inherently safe design, there was a concern that the titanium bed could prematurely release helium and over-pressurize the vessel. A general concern also existed because the use of a titanium bed for storage of tritium is a new technology in DOE.

By about the year 2005, the excess tritium stored in HSVs will have been unloaded and cycled back into the weapons program, and a shortage of tritium will be imminent. Development of new tritium production capabilities using both a linear accelerator and

a commercial light water reactor is in progress. A conceptual design for a new tritium extraction facility at SRS that will process targets from the linear accelerator and targets irradiated in a commercial reactor is also being developed.

4. **Discussion/Observations:**
   a. ***New Tritium Production Facilities***

      DOE now estimates that new tritium production must be available by the year 2007 to meet projected weapon stockpile demands. To meet this requirement, a decision was made in October 1995 to pursue a dual track tritium production program. One track consists of modifying an existing commercial nuclear reactor. The second track is to build a linear accelerator. In October 1998, a decision is scheduled to select one of the tracks as the primary tritium production method. In addition, a new tritium extraction facility would be built at SRS, capable of processing the targets from both of the dual track options.

      For the commercial reactor track, no technical difficulties are anticipated and negotiations have begun to buy irradiation services. The Nuclear Regulatory Commission is also involved at this early stage. The targets are Li-Al in a stainless steel tube, and prototypical targets have already been successfully irradiated in the Advanced Test Reactor.

      The linear accelerator track still requires significant development work which is being carried out by LANL. A conceptual design is scheduled to be completed by October 1997, and a plant design, with LANL as the design agency, is scheduled to be initiated in October 1998.

      Should this track be selected, construction of the linear accelerator would be under the cognizance of Westinghouse Savannah River Company (WSRC) and construction would start in FY 1999 at the SRS. The linear accelerator targets being considered are He-3 and Li-Al.

      A conceptual design for a new tritium extraction facility at SRS that is capable of processing targets from the linear accelerator and targets irradiated in a commercial reactor is being developed. The new facility will be located adjacent to the RTF. The intent is to keep all radioactive contamination within the new extraction facility, and still have the ability to transfer tritium to RTF by pipes through the adjoining wall. The conceptual design and a preliminary safety analysis report (SAR) are scheduled to be completed in February 1997. The detailed design is scheduled to begin in October 1998, and construction is scheduled to start in FY 1999.

   b. ***Reservoir Surveillance Program***

      Reservoir surveillance testing had previously been performed at Mound. However, because of the planned shutdown of the Mound facility, reservoir surveillance testing was transferred to SRS and a temporary testing facility began operation in January 1996. A permanent reservoir surveillance testing

facility is being built within the RTF. Construction is scheduled to be completed in July 1997 and the facility will be operational by July 1998.

A review of the temporary and new reservoir surveillance testing facilities was conducted during this trip. There were no safety issues identified with the facilities. The facilities are typical glove box facilities for processing tritium, and the new surveillance testing facility is very similar to Mound's facility. Some of the surveillance testing equipment being installed in the new facility were obtained from Mound. WSRC has not decided whether a Readiness Self Assessment or an Operational Readiness Review will be conducted prior to startup of the new facility. The review type selected will be approved by DOE. The Board staff will continue to follow this program and will overview the readiness review conducted prior to startup.

c. ***Release of Tritium at Scientific Ecology Group (SEG)***

SEG in Oak Ridge, Tennessee performs compaction of low level radioactive waste. On March 1, 1996, a release of 4.5 curies of tritium, 24 times the permitted daily limit, occurred while compacting a shipment from SRS. The shipping paperwork from SRS indicated only millicurie quantities of tritium when, in fact, there were hundreds of curies of tritium in the shipment. An investigation of the cause and corrective actions to be taken at SRS was conducted. In addition, an independent review of radioactive waste handling at SRS was conducted by an off-site team. The result was the identification of a number of deficiencies in the handling of radioactive waste at SRS and proposed actions to resolve these deficiencies.

Some of the key findings from this review were the insufficient enforcement of program requirements, unclear waste acceptance criteria, and incorrect assumptions that treatment (processing) criteria for radioactive waste were the same as disposal criteria. As a result, actions are being taken to clarify and simplify waste acceptance criteria, standardize waste characterization and handling, perform restart assessments of all waste generators, and create an independent enforcement group of inspectors. These actions when implemented should provide a significant improvement in the safe handling of radioactive waste at SRS.

d. ***Status of Unloading Expired Reservoirs***

After an unsuccessful attempt to extend the storage lives of reservoirs, SRS began in December 1994, to unload the large backlog of expired reservoirs that had accumulated at the SRS site. Because of the large backlog, each type of reservoir was evaluated and put into a category based on its potential to develop a leak. By September 1995, expired reservoirs with the greatest potential to leak had been unloaded, and unloading was in progress on the remaining expired reservoirs that have a lower potential to leak.

Although unloading of the remaining expired reservoirs has proceeded without

incident, it is about 6 months behind schedule. This slippage was caused by slowing down the unloading of expired reservoirs to avoid gas logging in the RTF, which in turn was due to the late delivery of HSVs to hold the excess tritium removed from the expired reservoirs. The entire backlog of expired reservoirs is now scheduled to be unloaded by March 1999, after which, reservoirs will be unloaded before they expire.

e. ***Hydride Storage Vessels***

Although the HSV is an inherently safe design, there is a concern that the titanium bed could prematurely release helium and over-pressurize the vessel, and also that surprises may occur because the use of a titanium bed to store tritium is a new technology for DOE. The first HSV was successfully loaded in April 1996. This unit is being monitored for pressure and is wrapped in insulation to simulate the highest temperature that will be experienced in storage. In addition, a series of 1 gram titanium samples loaded with various amounts of tritium are being aged and monitored under a variety of conditions to study the helium release mechanism.

The results from the lead unit and the sample studies to date indicate no unexpected behavior or surprises. A total of 6 HSVs have been loaded thus far with no incidents. It is expected that an additional 24 HSVs will be loaded during the next 2 years to store excess tritium recovered from expired reservoirs. There are no outstanding safety concerns with the HSVs, however, as an additional protection against over-pressurization it was suggested by the Board staff that the vessel diameter be monitored on each HSV in storage during the planned routine surveillances.

f. ***Highly Invulnerable Encased Safes***

The first HIVES was delivered to SRS in July 1996, and was examined during this trip. Two last minute changes made to the HIVES design were observed. Instead of a commercial safe with reinforcing steel plates, the HIVES was constructed from a single, thick steel plate. The second change was the addition of support plates inside the HIVES that blocked inlet air circulation holes along the bottom of the HIVES. These holes are used for providing air to cool the contents. In addition, an installation change was made. The plan to bolt the HIVES to the vault floor to prevent tipping during an earthquake was abandoned. The HIVES main protection from roof collapse is a crushable energy absorbing cap on the top of the HIVES. If the HIVES were to tip over before roof collapse, the benefit of the energy absorbing cap would be lost. These design and installation changes are being evaluated by DOE and the Board staff.

Another change was in the preplanned locations for the HIVES. The original plan was to have the majority of HIVES in the storage vault and have a few HIVES located in work areas to replace the file cabinets being used to store reservoirs. The plan to locate HIVES in the work areas has been canceled. The most recent safety analysis indicates that the worst case scenario for tritium

release from the work areas to the site boundary is caused by a fire. Since HIVES do not provide additional protection against the fire scenario in the safety analysis, they were deemed to be of insufficient benefit to warrant replacing the file cabinets used for storing reservoirs in the work areas. The Board staff does not agree with this evaluation. Although of little benefit in a fire, the HIVES is designed to protect against mechanical damage to reservoirs in the work areas, such as during a roof collapse.

5. **Future Staff Actions:**
    a. Develop a plan to conduct appropriate safety reviews of the new tritium extraction facility design at SRS and the accelerator design at LANL. (W. Yeniscavich)
    b. Overview the readiness review performed on the permanent reservoir surveillance testing facility at SRS. (W. Yeniscavich)
    c. Overview resolution of the design, installation, and location issues related to HIVES at SRS. (W. Yeniscavich)