[DNFSB LETTERHEAD]

September 1, 1992

Mr. Victor Stello, Jr.
Deputy Assistant Secretary for Facilities
Office of Defense Programs
U.S. Department of Energy
Washington, DC 20585

Dear Mr. Stello:

A team of three Board staff members recently reviewed the Moderator Chemistry Improvement Plan at the K-reactor in Savannah River. The review focused on the status of upgrades identified in a previous Board staff review and new items developed for future implementation. This report is a compilation of observations made during the review.

The report identifies several substantial improvements attributed to the proactive improvement process implemented by the Systems Chemistry Group at Savannah River. In addition, the report cites concerns of the Board staff, specifically in the areas of secondary side monitoring and reactor lay-up consideration which we understand are currently being evaluated by DOE and WSRC.

If you need further information, please let me know.

Sincerely,

John T. Conway
Chairman

Enclosure:
Savannah River Moderator Chemistry Review

Mr. Tom Henderson, NP-1
Honorable William H. Young, NE-1
Dr. Mario Fiori, DR-1

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

August 27, 1992

MEMORANDUM FOR: G. W. Cunningham, Technical Director

COPIES: Board Members

FROM: R. Arcaro
W. Moore

THROUGH: Andrew G. Stadnik, SRS Team Leader

SUBJECT: SRS Moderator Chemistry Review Trip

1. Purpose: This memorandum documents the technical staff report of a trip to the Savannah River Site to review the moderator chemistry program.

2. Summary: The moderator chemistry program at SRS is conducted by the Systems Chemistry Group to provide technical support in the realm of water chemistry control for the K-Reactor. From a self-assessment conducted in 1989, 69 areas of needed improvement were cited. A proactive method of analyzing data, detecting potential problems, and implementing corrections was developed to improve the system. As a result of this program, assisted by adding standards from INPO, EPRI, and commercial industry, an upgraded chemistry control program for the moderator is in place.

   The DNFSB staff expressed concern in two areas. First, it was noted that efforts in developing a secondary chemistry control program are not up to the same level of sophistication as that of the moderator chemistry control program. This is of particular concern considering the upcoming tie-in of the K-Reactor cooling tower will make the secondary system a partially closed loop system, for which a database and experience are non-existent at SRS. The other concern centers on the lack of a developed lay-up chemistry program for the K and L Reactors. This issue is of importance as the missions of each reactor, especially K, call for various states of stand-by/shutdown.

3. Background: The moderator chemistry program is designed to provide an acceptable level of moderator quality for reactor operation. Areas of focus include corrosion mitigation, suspended solids reduction, and impurity monitoring. Both oxygen and nitric acid are added to keep a slightly acidic pD (for heavy water) in order to reduce corrosion of the aluminum cladding on fuel elements. The moderator is purified through a filter and deionizer system to remove dissolved ionic impurities and light water is removed by distillation. A monitoring system consisting of pD and conductivity probes and dissolved oxygen sensors provides the information necessary for accurate chemistry control.

   As mentioned above, a 1989 self-assessment noted the deficiencies of the moderator

chemistry program in effect at that time. Input from the Vogtle commercial plant, EPRI and INPO standards, and the Westinghouse Nuclear Services Division provided the impetus necessary to develop an improvement plan for this program. The improvement plan was developed to address the 69 issues produced by the self-assessment. Specific areas of the improvement plan include the development of a dedicated chemistry group, increased instrumentation (on- and off-line), increased analytical lab involvement, procedure modifications, and more effective system monitoring. The moderator chemistry improvement plan has been previously reviewed by the DNFSB Technical Staff. The status of this improvement plan was the focus of this review.

4. Discussion/Observations: The status review of the improvement program showed that management of the process water system has adopted a broad-base upgrade program designed to bring the program up to the current standards of commercial and naval reactor plants.

A. Moderator Chemistry Program

The moderator chemistry improvement plan has resulted in the following significant accomplishments:

1. Establishment of a dedicated chemistry group in the Reactor Operations organization to support and implement technical specification requirements.

2. Upgraded analytical laboratory support.

3. Quantitative chemistry performance indices patterned after commercial practice to enhance moderator chemistry control. This index assigns weighted scores to different chemistry parameters including impurity concentrations, pD level, and purification performance to provide a quantitative measure of system performance.

4. Expanded on-line monitoring including redundant pD monitoring and dissolved oxygen sensors.

5. Upgraded computerized monitoring system to provide chemistry parameter trending allowing for improved control of moderator chemistry.

6. Procedure modifications to clarify operating parameters and prevent precipitation of gadolinium on the fuel elements following a Supplementary Safety System injection.

7. Implementation of a total organic carbon (TOC) analyzer to control the level of carbonates in the system. This improves pD and scale formation control.

8. Future installation of on-line Ion-Selective-Electrode (ISE) monitoring for chlorine and other ions.

An example of the proactive approach to the water chemistry problem developed during the recently-concluded Power Ascension Program. During this program, the Systems Chemistry Group encountered a problem with the control of oxygen levels and nitrate/nitrite concentrations in the moderator. Due to the rapid oxidation of the aluminum fuel cladding during initial startup, the oxygen level must be closely monitored to prevent the onset of a reducing system which promotes the formation of ammonia and loss of moderator pD and conductivity control. An indication of this reducing system is the formation of nitrite from the reduction of nitrate. The group analyzed the chemistry sample data early in the Power Ascension Program and developed temporary procedures to ensure adequate control of the moderator chemistry. These procedure modifications included control of the additive nitrate/nitrite level as well as the ratio of nitrite to nitrate. This deliberate analytical investigation led to positive control of moderator pD and conductivity throughout the reactor test. The DNFSB staff believes that this is a very positive improvement in the program since our initial review in October, 1990.

The Systems Chemistry Group expressed the desire to have a moderator test loop for pilot-application and qualification of new technology, e.g. instrumentation, before use in the reactor system. Such a facility would require heavy water and a heat source for accurate moderator simulation. The group noted that a one-sixth scale loop from INEL currently proposed for storage at SRS may be adaptable to this need. The DNFSB Staff believes the possibility of adapting this loop as a test device for the process water system and associated chemistry development merits consideration by DOE, especially as it may also be useful to assess the effects of the planned lay-up conditions.

B. Secondary Chemistry Program

In contrast to the moderator chemistry control program, the Systems Chemistry Group has no plans for an active secondary chemistry control program with the exception the addition of chemicals for biological fouling. The cooling tower implementation effectively closes the secondary loop and causes an increase in impurity concentration due to evaporation. However, there is no plan for chemical addition for corrosion and scale formation control of the secondary system. It was stated in the briefings that chloride concentration will be monitored and secondary blowdown adjusted to control impurity levels. However, the presence of chlorides in the secondary system provides the environment for heat exchanger corrosion.

The basis for the decision not to develop an active secondary chemistry control

program is the result of the Systems Chemistry Group's dialogue with representatives from Vogtle commercial nuclear power plant. Vogtle has experienced minimal scale and corrosion problems and the representatives feel that only a minimal secondary chemistry program is required. Only a limited heat exchanger inspection program exists at K-Reactor, consisting primarily of an internal inspection of one heat exchanger every five years. This limited inspection program places responsibility on the secondary chemistry program for heat exchanger reliability and corrosion control. Thus, the DNFSB Staff believes a further review by DOE and WSRC concerning secondary chemistry control is required to ensure the integrity of the secondary system.

The DNFSB Staff noted that in a discussion among WSRC, DOE, and the Board on August 27, 1992, plans were revealed to implement a secondary side chemistry program to monitor total dissolved solids, chlorides, heavy metals, and impurities. WSRC committed to provide follow-up action based on the results of the secondary side monitoring.

C. Long Term Considerations

Another concern of the DNFSB staff is the lack of a moderator and secondary system lay-up plan. As part of the stand-by mission of K-Reactor, the integrity of the moderator and secondary system is essential to future startup. As noted by the Systems Chemistry Group, the development of a layup plan is conditional on the final decision on the future of K-Reactor. However, the DNFSB staff believes an active approach to moderator and secondary chemistry lay-up similar to that currently implemented in the moderator chemistry program would be effective in maintaining system integrity during long-term shutdown.