ACRSR-1995

May 8, 2002

The Honorable Richard A. Meserve
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: PHEBUS-FP PROGRAM

Dear Chairman Meserve:

During the 492nd meeting of the Advisory Committee on Reactor Safeguards, May 2-3, 2002, we met with representatives of the Institut de Radioprotection et de Sûreté Nucleaire (IRSN) to discuss the PHEBUS-FP experimental program and plans for the PHEBUS-2K and PHEBUS-LOCA programs.

Observations

1. The PHEBUS-FP program is an outstanding example of an international cooperative research program that is yielding valuable data for validating severe accident analysis computer codes.

2. The proposed follow-on programs, PHEBUS-2K and PHEBUS-LOCA, promise to provide data pertinent to issues being, and will be, confronted by the NRC. High burnup fuel behavior under design basis accident conditions, fission product release and degradation of high burnup and MOX fuel, and effects of air ingression on core degradation and fission product release will be addressed in these programs.

3. Participation in these follow-on programs will yield important data not otherwise obtainable, but will require a commitment to long-term research efforts.

Discussion

The PHEBUS-FP program is an international cooperative research program to develop experimental data for validating computer codes used for severe reactor accident analysis. The experimental work is done at the Cadarache Centre in France. Partners in this program include the European Union, Canada, Japan, South Korea, Switzerland, and the United States.

The PHEBUS-FP experiments simulate the major aspects of a severe accident, beginning with the degradation of irradiated reactor fuel, release of fission products, transport of fission

products through a simulated reactor coolant system, and injection of these fission products into a model of a reactor containment. Fission product behavior within the containment is examined over a period of about five days. This examination includes study of both aerosol behavior and the chemistry of radioactive iodine.

The experiments in the PHEBUS-FP program are providing data that are valuable for validating and refining computer codes used for reactor accident analysis. Data from the tests have been used to refine models of core degradation and fuel relocation, hydrogen production, and fission product speciation. The data indicate needs for refining models of aerosol deposition within the reactor coolant system and models of the aqueous and gaseous chemistry of iodine within the reactor containment.

The five large-scale tests of the PHEBUS-FP program are supported by numerous separate effects tests and extensive test analyses from a number of perspectives by the international community participating in this program. One of the tests has been designated as an International Standard Problem for benchmarking computer codes used for severe accident analyses, including the MELCOR code developed by the NRC's Office of Nuclear Regulatory Research .

The PHEBUS-FP program is an example of effective international cooperation. Partners contribute both separate effects test results and analyses to aid in the interpretation of the integrated test results. These contributions have been organized into Interpretation Circles that intensively examine individual aspects of the integral phenomenological tests. Results of these examinations are reported to a Scientific Analysis Working Group that makes recommendations to a Steering Committee concerning work needed and plans for tests.

The investigators are now considering follow-ons to the PHEBUS-FP experiments. As in the United States, European operators are under pressure to improve the efficiency of nuclear power plants. They are trying to exploit margins that have existed in the past. Best-estimate, rather than conservative, safety models are becoming more widely used. These models were developed based on data obtained with fuel at modest levels of burnup. A program of in-pile tests of design basis accident phenomena with higher burnup fuel, PHEBUS-LOCA, is now being developed as a follow-on to the PHEBUS-FP program.

A follow-on program, PHEBUS-2K, to examine severe accident phenomena and accident mitigation phenomena is also being developed. This program will examine the degradation of high burnup fuel, degradation of and fission product release from MOX fuel, and the effects of air ingression on core degradation and fission product release. These test results would be pertinent to many issues the NRC is and will be confronting. Experimental investigations of air ingression, for example, will be pertinent to issues of fuel transportation safety, spent fuel pool safety, as well as reactor accident analyses.

There is now an experienced team of researchers at the Cadarache Centre. It is likely that this team could carry out any follow-on cooperative research programs at the PHEBUS facility successfully.

Sincerely,

/RA/

George E. Apostolakis
Chairman