Remarks by Dr. R. G. Bennett

Session 1: Advanced Fuel Cycles and Reactor Concepts

The main program responsible for research and development of advanced fuel cycle systems in the United States is our Advanced Fuel Cycle Initiative, or AFCI. The AFCI program addresses three needs associated with past and future use of nuclear energy in the U.S.: First, the AFCI provides alternatives to building multiple repositories for geological disposal of existing commercial spent nuclear fuel while supporting an expanding role for nuclear energy in the future. Second, the AFCI explores fuel cycles in conjunction with the complementary Generation IV program. Third, the AFCI seeks nuclear fuel cycles that improve proliferation resistance by using advanced separations and fuels technologies, and by reducing the inventory of weapons-usable material. While accomplishing these goals, both programs also work towards the goal of ensuring competitive economics and exceptional safety for the entire nuclear fuel cycle.

The range of our options in the U.S. follows the potential for growth: We examine the combinations of market factors that drive the amount of spent fuel produced, along with the options for managing that material. In short, alternative levels of nuclear energy generation result in different amounts of SNF. Alternative management approaches for the SNF result in different amounts of material that go to geologic disposal. Currently, the AFCI program follows four alternative strategies: (1) the once-through fuel cycle, (2) a closed fuel cycle with thermal recycle, (3) a combination of thermal and fast recycle, or (4) exclusively fast recycle. While the U.S. has adopted the once-through cycle, the other alternatives are being explored to address future needs arising from a continuing and expanding role for nuclear energy in the U.S. We are also considering the case where an international provider-user arrangement may be developed in which the U.S. and other existing nuclear weapons states lease fuel to non-weapons states.

With regard to ultimate disposal, the AFCI program anticipates the licensing and operation of the Yucca Mountain repository. The program looks broadly at technologies that may be able to optimize the capacity of the first repository, as well as to greatly reduce the technical need for the development of future repositories. Our work in separations technology is exploring a number of avenues. First, separation of the SNF to remove the uranium provides some benefits to repository operation, but no improvement in capacity, from the standpoint of long-term decay heat from americium and plutonium. To increase the capacity, these elements must be partitioned and recycled. In addition, the short-term heat load may need to be mitigated or reduced. Partitioning cesium and strontium from the fuel could accomplish this if they are stored separately until they decay and then disposed as low level waste. Other advanced technology needs arise, such as specialized waste forms for nuclides that pose challenges to their storage.

Some notable accomplishments in the AFCI program are already evident: In the area of separations, laboratory scale separation of very pure uranium (to nearly five 9's purity) from irradiated fuel was demonstrated with all associated partitioning steps, including U, Cs/Sr, Pu/Np, and Am/Cm separation. In the area of fuels, first irradiation of small samples of advanced metal, nitride and mixed oxide fuels has been completed. In the area of transmutation engineering, 1000-hour corrosion experiments on a wide variety of materials in Pb-Bi coolant have been completed. And finally, in the area of systems analysis, dynamic simulations have begun of fuel cycles, as well as a systematic study of thermal and fast transmutation concepts.

The AFCI is now focused on research and development supporting the advanced fuels and fuel cycles for Generation IV, and also on informing the Secretary of Energy's recommendation in the 2007-2010 timeframe on the technical need for a second repository in the U.S. The highest priority AFCI program objectives over the next ten years include:

- **2008** – Providing engineering data and analysis to support the Secretarial recommendation;
- **2010** – Quantitatively defining feasible nuclear fuel cycle options and technologies for implementation, and developing fuel cycle technologies that enable our transition to an advanced fuel cycle; and
- **2015** – Providing engineering data and analysis for a recommendation of the best option for an advanced nuclear fuel cycle incorporating Generation IV technology.

The complementary Generation IV program is exploring a range of nuclear energy system options for future production of electricity, hydrogen for transportation, and potable water. The program also includes research and development to support the relatively near-term option for a very-high-temperature reactor. As it is becoming known in the U.S., the Next Generation Nuclear Plant seeks to demonstrate the potential for higher thermal efficiency and hydrogen production. More broadly, AFCI supports Generation IV with R&D into fuel technology and waste form development under the once-through strategy, as well as technology that can bridge this new generation into an advanced fuel cycle for the U.S.