PLANT-LIFE EXTENSION PLANNING FOR AN OPERATING LMFBR*

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PLANT LIFE EXTENSION PLANNING FOR AN OPERATING LMFBR*

A study was completed in September 1984, to determine the feasibility of extending the operating lifetime of Experimental Breeder Reactor II (EBR-II) to 30 years or more, to identify potential problem areas that could prevent or hinder an extended-life program, identify those features that have contributed to the first 20 years of successful operation, and formulate specific recommendations to help ensure the long-term operability of EBR-II.

Since EBR-II was first brought to power in 1964, it has accomplished many important milestones in the development, application, and demonstration of LMFBR technology. Perhaps the most significant achievement of EBR-II has been the demonstration of the safety, operability, reliability, and maintainability of a complete LMFBR power plant, specifically a pool-type LMFBR plant, over the past 20 years. This has been accomplished through a combination of "routine" reactor operation and plant tests to address both normal and off-normal operation, while maintaining respectable plant factors (routinely greater than 70%), and supporting ambitious irradiation and experimental programs.

Continued reliable operation is increasingly important to the development of LMFBR technology in the U.S., especially with the cancellation of the CRBR. Sound plant operating experience to demonstrate that liquid-metal-cooled reactors are easily operated and maintained,

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that they are reliable, that there is considerable margin to accommodate off-normal events, and that they can achieve high plant factor at low operating cost, is the key to acceptance of liquid-metal-cooled reactors. This information is being developed through a combination of U.S. and foreign experience. Especially important, however, are those aspects which are currently unique to EBR-II. These include run beyond cladding breach, response of fuel to operational transients, shutdown-heat-removal testing, balance-of-plant transient testing, metal-fuel development, and the demonstration of a reasonable plant lifetime of 30 years or more. To be successful in this approach, EBR-II must continue to operate reliably.

To determine the feasibility of continuing to operate EBR-II for at least 10 more years, the EBR-II Division initiated a study to identify potential causes of significant disruptions in the useful operability of the facility, and identify features that have contributed to EBR-II's successful operating history. Other important goals were to identify any feature of the plant that would inherently limit its lifetime, and recommend ways to reduce the chances that identified potential problems would have a significant detrimental effect on the operation of EBR-II.

The study included an engineering and operational assessment of each major system and component of EBR-II. The approach used in assessing the various systems and components was to review the design features, review operating and maintenance histories with particular attention to significant operating events, determine current status, and identify potential significant problems. Based on the assessment, recommendations were made that included procurement of spare parts, changes in in-service inspections, changes in surveillance strategies, and system modifications to enhance reliability.

The balance of the effort covered other areas, such as the availability of adequate supplies of fuel and subassembly hardware, availability of qualified personnel and critical support organizations, and the adequacy of work and configuration control practices.

The most significant conclusion reached during the study was that there is nothing inherent in the design or construction of EBR-II that would prevent it from operating well beyond 30 years, assuming that it will continue to be adequately controlled and protected. Certain aspects of EBR-II were identified that have contributed greatly to the 20 years of safe, reliable operation, and that make an extended operating lifetime feasible. These aspects are based primarily on the use of a liquid metal coolant (sodium) in a pool-type configuration wherein the reactor and entire primary cooling system are submerged in the coolant. The benefits from these features that contribute to plant safety and longevity include: 1) a low-pressure primary cooling system, 2) a coolant which is noncorrosive to its containment boundaries, 3) the ability to maintain a constant temperature in the pool and avoid temperature cycling of primary-system boundaries, 4) the availability of a very large built-in heat sink surrounding the reactor, and 5) lack of primary system pipes and valves outside the primary tank. These features make the plant reliable and easy to operate because of the reduced need for active, redundant plant safety systems, because of minimum requirements for primary system maintenance, and because of very low stresses imposed on the primary system.

Also identified in the study were certain design-related problem areas that affect reliability and could impact plant longevity. These problems, however, can easily be avoided in the design of future liquid-metal-cooled reactors. They are: 1) nonreplaceable, nonrepairable primary-system instrumentation, and 2) rotating-plug sticking due to contamination of the eutectic seal alloy and the inaccessibility of the seal trough for cleaning. A third potential problem area relates to the use of graphite canisters for reactor neutron shielding in the primary tank. Although not expected to cause problems in the long-term operation of EBR-II, the use of graphite in sodium should be avoided because of the potential sodium/graphite interaction resulting in significant swelling of the graphite. This was amply demonstrated in EBR-II subassembly surveillance samples. It is important to note here that maintenance on the pool-type configuration has been relatively easy and no significant problems have been encountered. The 20-year EBR-II operating record attests to this.

The study did identify areas of vulnerability in the plant where problems could develop due to equipment or instrument malfunction or failure, and cause a disruption in plant operability. Specific recommendations to reduce vulnerability in these areas were made which included completing fabrication of a spare intermediate heat exchanger; improving force-monitoring and protection systems for the in-tank, remotely operated, motor-driven fuel-handling-system components; and upgrading in-service monitoring for potential radiation-induced misalignment of the reactor grid plate. Other recommendations included continuing development of alternative techniques for measuring primary-system parameters; and providing scoping plans for recovery from certain identified off-normal situations that could occur in the plant. A total of 45 recommendations were identified in the study as being important for consideration by the Division, some on a near-term basis and some for long-range implementation.

One significant recommendation to come from the study was based on the observation that extended-life planning must be based on an effective plant surveillance program. While our preventive maintenance and plant surveillance activities have been successful in the past, methods must be actively pursued for making these activities even more effective and efficient as the plant grows older and resources become more limited. Greater use and further development of computer-based systems for diagnostics and prognostics, and the development of well-defined surveillance plans for critical areas including development of more in-service inspection techniques will help ensure early detection and even prediction of impending problems. Increased open communications between the operating personnel and technical support staff is very important to this approach and can be further developed through the implementation of a "Quality Circle" approach to surveillance.

Recognized in the study was that the original design and inherent safety features of EBR-II and the continuing evolution of the plant through the ongoing experience-based simplifications have been the major contributing factors to the success of EBR-II, and help make feasible the continued operation of the plant.

The study concluded that continued EBR-II operation is certainly feasible for well beyond 10 more years, and that continued demonstration of the unique inherent safety and operability features of a pool-type liquid-metal-cooled reactor and the demonstration of a reasonable operating lifetime are very important and will provide invaluable information for the design and development of the next generation nuclear power plants.