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ADVANCED LIGHT WATER REACTOR PLANTS

SYSTEM 80+™ DESIGN CERTIFICATION PROGRAM

FY-96 ANNUAL REPORT

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ADVANCED LIGHT WATER REACTOR PLANTS

SYSTEM 80+™ DESIGN CERTIFICATION PROGRAM

ANNUAL PROGRESS REPORT
for period October 1, 1995
through September 30, 1996

Prepared for:

UNITED STATES DEPARTMENT OF ENERGY
OFFICE OF NUCLEAR ENERGY
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A. Purpose

The purpose of this report is to provide a status of the progress that was made towards Design Certification of System 80+™ during the U.S. government's 1996 fiscal year. The System 80+ Advanced Light Water Reactor (ALWR) is a 3931 MW (1350 MWe) Pressurized Water Reactor (PWR). The design covers an essentially complete plant. It is based on EPRI ALWR Utility Requirements Document (URD) improvements to the Standardized System 80 Nuclear Steam Supply System (NSSS) in operation at Palo Verde Units 1, 2 and 3. The NSSS is a traditional two-loop arrangement with two steam generators, two hot legs and four cold legs, each with a reactor coolant pump. The System 80+ standard design houses the NSSS in a spherical steel containment vessel which is enclosed in a concrete shield building, thus providing the safety advantages of a dual barrier to radioactivity release. Other major features include an all-digital, human-factors-engineered control room, an alternate electrical AC power source, an In-Containment Refueling Water Storage Tank (IRWST), and plant arrangements providing complete separation of redundant trains in safety systems.

Some design enhancements incorporated in the System 80+ design are included in the four units currently under construction in the Republic of Korea. These units and the System 80+ design form the basis of the Korean standardization program.

The ABB-CE Standard Safety Analysis Report (CESSAR-DC) was docketed by the Nuclear Regulatory Commission (NRC) in May 1991 and a Draft Safety Evaluation Report (DSER) was issued in October 1992. The advance Final Safety Evaluation Report (FSER) was issued in February 1994, with no open issues. The NRC's Advisory Committee on Reactor Safeguards (ACRS) completed its review in only five meetings and issued a strong positive letter in May 1994. The FSER was formally released and the Final Design Approval (FDA) was issued in July 1994. A

revision to the FSER was issued in November 1994 to extend the expiration date for the FDA from 5 years to 15 years.

Major licensing achievements include 1) the resolution of all severe accident issues, including both deterministic and probabilistic analyses showing improved safety by a factor of more than 120, 2) implementation of the new radiological source term, 3) resolution of shutdown risk concerns, 4) approval of an all-digital instrumentation and controls design, 5) approval of major control room features using state-of-the-art human factors engineering principles, and 6) development of a seismic envelope (i.e., standard seismic design). CESSAR-DC also contains the technical basis for compliance with the EPRI URD for reduced emergency planning. The improved safety of the System 80+ design and its implications for revised emergency planning were documented in a letter from the ACRS to the Commission in July 1994.

B. History and Status of Project

Since 1985, ABB-CE and Duke Engineering & Services, Inc. (DESI) have been developing the next generation of the pressurized water reactor plant for worldwide deployment. In 1990, Stone & Webster Engineering Corporation (SWEC) joined this team, thereby adding the expertise of an Architect Engineer to the development of System 80+. The result is an NRC-approved, standard plant design that can satisfy the need for a reliable and economic supply of electricity for residential, commercial, and industrial use. To ensure that such a design is available to meet utility needs, it has been based on proven technology and the most current NRC licensing criteria. These requirements dictate the application of nuclear technology that is advanced, yet evolutionary in nature. This has been achieved with the System 80+ Standard Plant Design.

In 1985, ABB-CE and DESI joined forces under the aegis of the EPRI ALWR Program to develop, with utility oversights, the design requirements for the next generation of nuclear power plants. The final version of the EPRI ALWR URD was submitted to the NRC in September 1990, and in May 1991 CESSAR-DC was docketed by NRC. CESSAR-DC, initially consisting of 18 volumes, expanded to 26 volumes after responses to NRC questions and a Probabilistic Risk Assessment were incorporated. A DSER was issued by NRC on October 1, 1992. In 1993, after working on several commercial projects related to System 80+ development, SWEC became an approved subcontractor for Design Certification, taking on selected aspects of BOP design and licensing for the System 80+ Standard Plant Design. Other organizations involved in the technical development of System 80+ include Bechtel Power Corporation, Impell Corporation, RPK Structural Mechanics Consulting, United Engineers and Constructors, and ABB-Atom. To resolve issues raised by NRC in the DSER, responses to 3361 questions were provided. All technical issues were resolved and the FSER and FDA were issued on schedule in July 1994.

C. Design Certification Overview

Licensing in the United States has been facilitated by a new process called Design Certification, described in Title 10, Part 52, of the Code of Federal Regulations (CFR). This part of the U.S. nuclear program is characterized by one-step licensing, where a single combined license is required to both build and operate the plant. Further, only complete, standardized plant designs can be licensed, and all safety issues must be resolved before construction begins, rather than after, as in the past. Opportunities for public participation are double, but are placed up front, where they are more effective, respecting both the public will and the public purse.

The first phase of Design Certification, technical review by NRC staff, was completed upon issuance of the FSER and FDA. As part of the Design Certification

process, ABB-CE has received 4,951 Requests for Additional Information (RAIs) and follow-on questions from the NRC during their review of System 80+. This includes 1,590 RAIs before the DSER, 939 DSER open items, and 802 questions on System 80+ Inspections, Tests, Analyses and Acceptance Criteria (ITAAC), and 1620 "follow-on" questions, including NRC independent review of the Technical Specifications and ITAAC.

Intensive interactions with the NRC were initiated in 1991 and continued until the System 80+ FDA was issued in July 1994. In the first quarter of FY 1995, the Design Control Document (DCD) was completed and submitted to the NRC. Staff review was completed and the DCD was revised in the second quarter of FY 1995. The NRC issued the System 80+ Notice of Proposed Rule (NOPR) and a nearly identical NOPR for General Electric's ABWR design in April 1995. ABB-CE provided extensive comments to the NRC on the proposed rule in addition to providing input to the Nuclear Energy Institute (NEI) and the U. S. Department of Energy for their comment packages. In December 1995, the NRC conducted a workshop on comments they received on the System 80+ and ABWR Notices of Proposed Rulemaking (NOPRs). ABB-CE, GE and NEI addressed the unresolved issues of scope of finality, Tier 2* expiration dates, post-certification design changes and applicable regulations to record on the rulemaking docket issues needing consideration by the Commission. During FY 1995 a great deal of effort was expended by ABB-CE and its subcontractors to complete the DCD and comment on NRC's NOPR. As a result, Certification of the System 80+ Standard Plant design in the United States represents a major technical and licensing advance.

The final phase of the Design Certification process involves resolution of comments and issuance of the final rule by the Commission. The final Design Certification rule, originally scheduled to be issued by the NRC in 1996, is now expected to be published in the Federal Register by mid-1997.

D. Progress in FY 1996

Design Certification Rule

Substantial discussions were held with the NRC during 1996 to review the NRC position and industry-proposed resolutions for Design Certification issues. Topics discussed included applicable regulations, finality for safeguards and proprietary information as well as requirements found in secondary references, 50.59 change finality, and an amended proposal for vendor-sponsored 50.59 changes after issuance of the design certification rule. In March, ABB-CE joined by GE and NEI in briefing the Commission on the industry position on the new "applicable regulations". The NRC indicated they were prepared to significantly reduce the number applicable regulations for System 80+.

The NRC staff provided a draft Design Certification rule, SECY-96-077, to the Commission on April 15th and released it to the public on April 19th. ABB-CE coordinated with NEI and GE to review and comment on the proposed final Design Certification rules and Statement of Considerations. Industry objected to the draft rules since they preserve the NRC ability to impose backfit requirements on the certified designs through operational avenues, thus circumventing the requirements of 10 CFR 52.63. A Senior Review Group composed of the NRR Director and other senior NRC managers was appointed to discuss design certification issues with the industry. Issues under discussion include applicable regulations, technical specifications, finality of operational requirements contained in the DCD, design certification renewal standards, and post-DC changes by the DC applicants.

In December 1996, the five NRC Commissoners affirmed their votes to approve the design certification rules for System 80+ and the ABWR (SECY-96-077) in accordance with the provisions of the NRC's August 13th and October 21st memoranda, subject to selected disapprovals. The most significant disapproval was the staff's provision for applicable regulations which will be removed and

replaced with alternative language in the rules and in the statements of consideration. The Commission also disapproved the application of the special backfit provisions of 52.63 to technical specifications; approved a staff proposal for limited finality to operational issues in the design certification rules, and deferred consideration of specific design certification renewal provisions until after the certification rulemaking has been issued.

System 80+ Design Changes

A number of changes to the System 80+ Standard Plant design were reviewed and approved by the staff during 1996. The changes involved addition of hot-leg tanks for mid-loop level measurement, provisions for additional CEAs, a revised damping factor for response spectrum piping analyses, application of alternative leak-before-break evaluation methods, updated materials specified for NSSS components, and allowance for either hydraulic or explosive expansion of tubes into the steam generator tube sheets. These changes plus editorial corrections in the System 80+ Design Control Document that have been made subsequent to issuance of the Final Design Approval were approved by the ACRS in August 1996.

Standard Safety Analysis Report - Design Certification

In November 1996, ABB-CE requested that the NRC confirm the status of CESSAR-DC relative to the FDA for the System 80+ design. The NRC advised that the revised FDA could reference CESSAR-DC, but this document must be updated to conform with the current version of the System 80+ design, including the probabilistic risk assessment, verified by the NRC staff, and maintained for the duration of the FDA.

Amendments to the Design Control Document and to CESSAR-DC are being prepared to incorporate all approved technical changes, to provide consistency

between the ITAAC and the Tier 2 information, and to remove minor typographical and editorial errors. Except for the PRA (Chapter 19), these amendments will ensure that both CESSAR-DC and Tier 2 of the DCD contain identical information.

E. Summary

The U.S. NRC has completed its review of the System 80+ Standard Plant Design, approving advanced design features and closing severe accident licensing issues, and has issued the proposed Design Certification rule for the System 80+ design. The System 80+ design is an evolutionary ALWR plant, producing 3931 MWt, or 1350 MWe, whose development was sponsored by the U.S. DOE. The NRC released the System 80+ advance FSER in February, 1994 with no open technical issues. It was then approved by the NRC Commissioners and the System 80+ FDA was issued in July 1994. The NRC review required written responses to 4951 questions. Not only were all regulatory concerns resolved, but the review process was flexible and efficient. This was due to NRC and ABB-CE management commitments to schedule and technical correctness. The task was formidable for both ABB-CE and the NRC. Design features to address improved plant safety had to be incorporated, evaluated and approved by the NRC.

The System 80+ design was developed and supported during NRC review by a single, closely-coordinated design team. This ensures that structures and systems which interface with each other and licensing issues which cross boundaries of multiple structures and systems were addressed in an integrated manner. ABB-CE assigned a "Chapter Champion" to each of the chapters in CESSAR-DC. These Chapter Champions were authorized to resolve all outstanding questions with their counterpart reviewers at the NRC.

Plant safety was evaluated using a "defense-in-depth" analytical approach. Design basis accidents were analyzed with the historic conservative methods. Severe

accidents were analyzed deterministically using best-estimate methods, as well as probabilistically using a detailed three-level PSA. These analyses demonstrated the importance of consistently analyzing design features, since changing a characteristic or component in one structure or system was found to impact design features or safety analyses in other structures or systems. Examples of such integrated structures, systems and analyses are: 1) structural design, soil properties analysis, and seismic margins assessment; 2) equipment qualification, radiological source term dose analysis, ventilation system design, water chemistry control, and plant emergency evacuation; 3) reactor cavity floor design, wall design, and containment ultimate strength; and 4) electrical distribution system, emergency and standby power sources, and hydrogen control systems.

An integrated approach to the design and analysis of the System 80+ advanced design features has resulted in not only a safer plant design, but also a balanced allocation of safety functions. A comprehensive PSA was used to select the most effective design features and allocate risk among plant structures, systems, and components. The PSA was also used to demonstrate that plant safety has been improved by more than two orders of magnitude relative to the current generation of nuclear power plants.

The Design Control Document which is required as the main reference for the Design Certification rule was submitted to and approved by NRC in FY 1995. ABB-CE and other industry participants provided substantial comments on NRC's proposed DC rules. Revisions to the System 80+ design were submitted and approved by the ACRS and the NRC during 1996.

F. Complete Bibliography of System 80+ and Related Publications

For information purposes, a bibliography of System 80+ publications is provided below. This list covers all public information provided on System 80+ since February 1985, when development began, through December 1996 including papers to be presented. Together, papers marked with an asterisk (*) give a fairly comprehensive and up-to-date picture of the System 80+ design, including the status of licensing and commercial efforts. These are recommended for anyone wishing to obtain a basic understanding, without having to digest the entire collection of publications.

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