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Report to the Chairman, Committee on Science, Space, and Technology, House of Representatives

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Research Efforts Under Way to Support Nuclear Power Plant License Renewal

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Resources, Community, and
Economic Development Division

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September 25, 1991

The Honorable George E. Brown, Jr.
Chairman, Committee on Science,
Space, and Technology
House of Representatives

Dear Mr. Chairman:

Within the next 20 years, the licenses for 42 of the 113 nuclear power plants that the Nuclear Regulatory Commission (NRC) has licensed to operate will expire. NRC and industry have been developing information and analyses that would be needed as a basis for renewing the operating licenses of these plants, and NRC is developing guidance for industry on the information required for license renewal. At NRC's request, the National Research Council of the National Academy of Sciences examined the future role of NRC's regulatory research, including research on the aging of nuclear power reactors and the possibility of extending their operating licenses for 20 years beyond the normal 40-year license term. The Council issued a report in 1986 with many recommendations directed broadly toward revitalizing nuclear safety research; only four of these recommendations were directed at research related to license extension.

In regard to implementing recommendations in the 1986 study related to license extension, you asked that we provide information on

- the actions NRC has taken to implement the Council's recommendations concerning the need for NRC to conduct research on reactor aging to support its license renewal efforts,
- the research on reactor aging that the Department of Energy (DOE) and industry have initiated and completed as a result of the Council's recommendations that research be performed to prove that license conditions set by NRC can be met, and whether the results have been provided to NRC, and
- NRC's plan to refine the estimates of risks (or the probability of accidents) created by extending the life of the present generation of reactors.

Results in Brief

For years, NRC has been conducting various ongoing research projects at DOE national laboratories and private companies to determine whether safe conditions for license extension can be ensured and whether

existing safety margins under extended-life conditions are adequate. NRC did not initiate any specific research efforts in response to the recommendations contained in the National Research Council's 1986 report regarding reactor aging/license extension because it already had various research efforts under way. However, as a direct result of the Council's recommendations, NRC did establish a Nuclear Safety Research Review Committee to provide advice on NRC's nuclear safety research program. The Committee's chairman believes that NRC's research program is being well managed within available funding limits.

Like NRC, DOE and industry did not initiate any specific research on reactor aging as a result of recommendations contained in the National Research Council's 1986 report. Since 1986, however, DOE and industry have funded a number of research projects in preparation for license renewal reviews. These projects have focused on the critical safety systems and structures most likely to be affected by the aging process. In particular, industry, through its Nuclear Management and Resources Council,[1] in cooperation with the Electric Power Research Institute and DOE, has recently submitted to NRC a series of 10 generic technical reports, which it believes are the basic analyses needed to support the extension of a nuclear plant's license beyond the 40-year time frame. Each report deals with a different technical subject. NRC's review of these reports found that all 10 needed to be augmented or clarified, and the Nuclear Management and Resources Council is currently evaluating NRC's technical comments. Until these reports are acceptable to NRC, a utility requesting license extension may have to conduct its own research or provide information that NRC believes is not covered by the industry reports. Furthermore, since the reports are generic, utilities may need to conduct further research to support license renewal even after the reports are accepted by NRC.

NRC said that it has no plans to use the results of its research on reactor aging or of research obtained from other government and industry sources to establish estimates of the risk that may be created if NRC renews a plant's license. According to NRC officials, NRC does not base its regulatory decisions on the probability of accidents occurring, but rather uses engineering judgments to determine whether a plant can be operated safely. NRC pointed out, however, that it does employ selected probabilistic risk assessment techniques in the evaluation of individual systems, structures, and components.

[1] An industrial organization that provides a unified nuclear power industry approach on generic nuclear and technical issues and interacts with NRC, as appropriate, on such issues.

Background

Because of the safety concerns associated with commercial nuclear power plants, the Atomic Energy Act of 1954, as amended, empowers NRC to issue operating licenses to commercial nuclear power plants. NRC oversees the safe construction and operation of these facilities by, among other things, developing regulatory standards, inspecting plants to ensure that utilities comply with the standards, and issuing notices of violation and levying civil penalties when companies violate the standards. Because each utility is ultimately responsible for the safe operation of its nuclear power plants, NRC requires each company to have programs and systems in place to ensure that public health and safety are protected from radiological danger.

By 2012, the licenses of 42 of the 113 nuclear power plants that NRC has licensed to operate for up to 40 years will expire. Instead of decommissioning the plants and constructing new plants to provide replacement power, the nuclear industry would like to extend the life of existing reactors beyond their original license term of 40 years. The first 2 licenses will expire in the year 2000, and 40 more licenses will expire by the end of 2012. (See app. II.)

Proposed License Renewal Rule

NRC has developed a proposed license renewal rule that a nuclear power plant licensee is to follow to have NRC review its license. The process is explained in NRC's proposed addition of part 54 to title 10 of the Code of Federal Regulations entitled "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Under NRC's proposed process (see app. III), each applicant is responsible for showing that it has addressed age-related degradation of selected systems, structures, and components that NRC considers important to license renewal. In NRC's view, this requirement will provide assurance that the plant can continue to operate as currently licensed without endangering public safety for the additional term. The proposed rule defines the current licensing basis as the requirements and licensee commitments imposed by NRC at the time of initial license, as modified or supplemented by the many requirements that have been added subsequent to the initial license.

NRC's commissioners (the Commission) considered the proposed addition to NRC's regulations at a meeting on June 28, 1991, and directed NRC's staff to revise the license renewal rule in keeping with their instructions. The final regulations are to specify the technical information to be included as part of an application for license renewal. In addition, NRC is developing a "Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants." This plan will provide guidance

to NRC staff reviewers evaluating the programs and processes that the license renewal applicant utilizes or will utilize in managing the age-related degradation of plant systems, structures, and components important to license renewal.

Once the renewal application has undergone NRC's staff review, it must be referred to NRC's Advisory Committee on Reactor Safeguards, which will then prepare a report to the Commission on the proposed license renewal. After considering staff recommendations and the Advisory Committee on Reactor Safeguard's report, the Commission may renew the license for an additional term of up to 20 years. Members of the affected public may request a public hearing to consider the Commission's decision.

The nuclear industry has developed a "lead plant" program to demonstrate the viability of the license renewal process. At present, two lead plants are preparing applications for license renewal: Yankee Rowe in Massachusetts, which has a 175-megawatt (electric) reactor that started operating in 1960, and Monticello in Minnesota, which has a 525-megawatt (electric) reactor that started operating in 1971. Industry and NRC plan to use the experience gained from processing these two applications to develop guidance to assist future applicants. Initially, Yankee Rowe planned to submit its application for renewal in the fall of 1991. However, the utility's Board of Directors, after reviewing significant issues concerning the reactor's pressure vessel, decided in July 1991 not to submit an application until all questions about the pressure vessel's embrittlement had been resolved. Currently, the licensee and the NRC staff do not expect the questions to be resolved until late 1992.

NRC's Implementation of National Research Council's Recommendations on Plant Aging

The National Research Council established an ad hoc Committee on Nuclear Safety Research, composed of members from industrial, academic, and nuclear safety organizations, to examine the future role of NRC's regulatory research. The Council's report, while recognizing that NRC had work on plant aging in progress, stated that the Committee had not seen any evidence that NRC's results were being used in a systematic way to develop an integrated approach toward life-extension research and regulation. Therefore, the Council made two recommendations to NRC regarding plant aging and the extension of plant licenses:

- NRC needs research to enable it to define whether safe conditions for license extension can be found.

- NRC needs and should fund research that will allow it to set new design margins[2] and to evaluate the adequacy of existing ones under extended-life conditions.

Consistent with Council practice, the Committee ceased to exist after the report was issued.

In response to the Council's report, NRC established the Nuclear Safety Research Review Committee on February 8, 1988. The Committee is responsible for providing advice to the Director, Office of Nuclear Regulatory Research, and, through him, to the Commission on NRC's nuclear safety research programs, including its Nuclear Plant Aging Research Program. The Committee is composed of nongovernment individuals skilled in the range of technology and science important to NRC. According to the Committee's chairman, NRC's research program is being well managed, given existing limitations on funding.

NRC formally responded to the National Research Council on April 6, 1988. According to NRC officials, NRC did not initiate any specific research efforts to implement the Council's first recommendation because it already had under way various research efforts that it considered adequate to determine whether safe conditions for license extension can be found. Before 1982, NRC was focusing its aging research on primary reactor components, such as pressure vessels, piping, and steam generators. But in 1982 NRC started to develop its Nuclear Plant Aging Research Program to study the effects of aging on all types of systems, structures, and components found in licensed commercial nuclear power plants.

NRC's Nuclear Plant Aging Research Program's goals are to

- identify and characterize aging effects that, if unchecked, could cause the degradation of systems, structures, and components and thereby impair plant safety;
- identify methods of inspection, surveillance, and monitoring, and evaluate the residual life of systems, structures, and components, in order to ensure the timely detection of significant aging effects before the loss of safety function; and

[2]The excess capability designed into a structure or component in any system to ensure that the structure or component will perform the desired service under all operating conditions throughout its expected service life.

- evaluate the effectiveness of storage, maintenance, repair, and replacement practices in mitigating the rate and extent of degradation caused by aging.

The research conducted under NRC's Nuclear Plant Aging Research Program is done at a number of national and private laboratories. According to NRC officials, this research represents approximately 25 percent of the major systems, structures, and components potentially important to plant safety and license renewal. NRC estimates that about 5 to 10 percent of its research budget of $110 million estimated for fiscal year 1991 is related to aging power plants, and NRC expects to complete its aging research by 1997. DOE and industry expect to spend about $3 million each for license extension research during fiscal year 1991. Through May 31, 1991, 101 reports related to NRC's research program on plant aging had been issued. (See app. V for examples.)

NRC has performed research for various components and systems. For example, NRC has completed its research on electric motors and batteries. In fiscal year 1986, NRC also started a study, which it expects to complete in 1995, of the residual life of major light water reactor[3] plant components and structures. The components and structures have a significant impact on safety and are the large, relatively expensive parts of a nuclear power plant that are not routinely or frequently replaced. In addition, NRC started a program in 1988 to look at the aging of structures and plans to complete this work in 1997.

Over the years, NRC has had various ongoing reactor aging research projects at DOE's national laboratories, the National Institute for Science and Technology, and commercial contractors to determine whether safe conditions for license extension can be ensured and whether existing safety margins under extended-life conditions are adequate. (See app. IV.)

NRC did not formally respond to the Council's recommendation that NRC should conduct research to allow it to set new design margins and evaluate the adequacy of existing ones. NRC advised us that it considers existing design margins to be adequate. According to NRC officials, the safety-related systems, structures, and components, for the initial 40-year license term, are designed to comply with the national consensus

[3]A type of reactor that uses ordinary water to remove the heat generated by fission and includes pressurized water reactors and boiling water reactors, which are the types of power reactors being used in the United States today.

codes and standards of organizations such as the American Society of Mechanical Engineers. The codes and standards normally provide for design margins against failures. According to NRC's proposed license renewal rule, applicants will be required to maintain the current licensing basis by adhering to the existing safety margins for their facility during the license renewal period.

DOE and Industry Research Programs on Aging Plants

In its 1986 report, the National Research Council made two recommendations to industry on funding research on aging plants:

- Utilities need and should fund research to prove that license conditions set by NRC can be met.
- Industry should play a major role in funding research on plant aging.

The Council did not make a specific recommendation to DOE, but rather pointed out that DOE (1) needs the research to ensure the continued safety of DOE's production reactors, (2) can provide industry with useful spin-offs from development work in other areas, such as nondestructive testing and examination, and (3) can provide industry with insights from efforts to design advanced reactors intended to operate for a long time.

DOE and industry officials informed us that, like NRC, they have not initiated any specific research program solely focused on reactor aging as a result of recommendations contained in the National Research Council's 1986 report. Although DOE does not have a program with primary emphasis on plant aging, it does have a program promoting the extension of nuclear power plant life through license renewal, which includes aging studies related to some specific technical issues. The objectives of the program are to establish and demonstrate the viability of renewing nuclear power plant operating licenses by 1995.

The U.S. nuclear industry, through the Nuclear Management and Resources Council, in cooperation with DOE and the Electric Power Research Institute, submitted 10 technical reports to NRC between October 1989 and October 1990. The reports focus on potential age-related degradation processes associated with a given system, structure, or component that industry considers important to license renewal, and identifies preventive, corrective, and mitigative actions specific to that system, structure, or component that must be performed before NRC renews a plant's license. According to the Nuclear Management and

Resources Council, individual applicants will be able to refer to the technical information in these documents once the documents have been reviewed and approved by NRC, so that the applicants will not have to duplicate analyses already done. According to the Nuclear Management and Resources Council, the 10 technical reports form the cornerstone of industry's technical research and are designed to provide a scientific basis for renewing nuclear power plant licenses.

NRC has reviewed each of the 10 reports and has found that each report contains information that needs to be augmented or clarified before NRC gives its approval for a utility to use the report in the license renewal process. For example, NRC's review of one report showed, in part, that it

- lacked sufficient justification for the conclusions reached and lacked sufficient guidance for the licensees,
- dismissed a large number of components from consideration for license renewal because the components did not perform any safety functions, and
- did not clearly specify assumptions made in performing the degradation analysis.

According to NRC, all of the reports contained unresolved issues and lacked either sufficient detail and/or justification for the conclusion reached, or specific guidance for licensee implementation. According to a Nuclear Management and Resources Council official, the Council will make many of the changes suggested by NRC, but any remaining differences should be addressed by NRC when it prepares a safety evaluation report on each report. The safety evaluation reports are NRC's summary of its reviews to determine the effect that the 10 technical reports will have on public health and safety. In the event that NRC's review of industry's reports shows that information needed for NRC to review a license is missing, the utility itself will have to perform its own research, extending the time and cost to the utility for renewal.

In addition to NRC, DOE, and the nuclear industry, other organizations are involved in aging research and related studies. These include the Electric Power Research Institute (sponsoring research on reactor pressure vessel embrittlement and co-funding lead plants with DOE) and various international organizations, such as the International Atomic Energy Agency and the Organization for Economic Cooperation and Development. The French Commissariat a l'Energie Atomique, for example, has a 6-year agreement with NRC for researching long-term electrical cable aging degradation in nuclear power plants. Under the agreement, the

French are to irradiate and thermally age both French and U.S. cables at a test reactor at 10 times the normal rate.

NRC's Use of Probabilistic Risk Assessments

NRC says that it has no plans to use the results of its research on reactor aging or research from other government and industry sources to establish estimates of the risk that may be created by NRC's renewing a plant's license.

Furthermore, NRC does not plan to require that a probabilistic risk assessment be performed to support an application for renewing a nuclear power plant's license. Probabilistic risk assessment is a methodology that produces quantitative estimates of the risks associated with complex engineering systems. According to NRC, it does not base initial plant licensing decisions on probability, nor will it base license renewal decisions on the probability of accidents occurring as the plant's life increases. NRC advised us, however, that it does employ selected probabilistic risk assessment techniques in evaluating individual systems, structures, and components.

To perform our work, we contacted NRC, DOE, the National Research Council, and industry officials and reviewed numerous articles and reports that had been prepared on the aging of nuclear power plants. Our objectives, scope, and methodology are discussed in detail in appendix I. Appendixes II through V contain technical information needed to understand NRC's proposed process for extending nuclear power plants' licenses.

We discussed the facts in the report with NRC and DOE officials, who generally agreed with the facts as presented, and we incorporated their views where appropriate. As requested, we did not obtain official agency comments on a draft of this report. Our work was conducted during April and May 1991 in accordance with generally accepted government auditing standards.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the appropriate Senate and House Committees; the Secretary of Energy; the Chairman of the Nuclear Regulatory Commission; and the Director, Office of Management and Budget. Copies will also be made available to other interested parties on request.

Should you have any questions or need additional information, please contact me on (202) 275-1441. Major contributors to this report are listed in appendix VI.

Sincerely yours,

Victor S. Rezendes
Director, Energy Issues

Contents

Abbreviations

DOE	Department of Energy
FSAR	final safety analysis report
GAO	General Accounting Office
MWe	megawatts electricity
NRC	Nuclear Regulatory Commission

Objectives, Scope, and Methodology

On March 29, 1991, the Chairman, House Committee on Science, Space, and Technology, asked us for information about research being done to support the extension of operating licenses for nuclear power plants in the United States. Specifically, we were asked to determine (1) the actions NRC has taken to conduct research on reactor aging to support its license extension efforts, (2) the research on reactor aging that DOE and industry have initiated and completed to prove that license conditions set by NRC can be met, and whether the results have been provided to NRC, and (3) NRC's plan to refine the estimates of risks (or the probability of accidents) created by extending the life of the present generation of reactors.

To obtain the information needed, we reviewed the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; and NRC regulations applicable to license renewal. We also reviewed numerous NRC reports relating to the aging of nuclear power plants, including NRC's Nuclear Plant Aging Research Program Plan for systems, structures, and components; its plan for the integration of aging and life extension; its annual reports; and its draft regulatory guide on "Standard Format and Content of Technical Information for Applications to Renew Nuclear Power Plant Operating Licenses." We also reviewed NRC's proposed rule on nuclear power plant license renewal, various articles and papers from technical publications on aging, and reports by NRC's Advisory Committee on Reactor Safeguards and the Nuclear Safety Research Review Committee.

In addition, we met or talked with NRC staff in the Office of Nuclear Regulatory Research and the Office of Nuclear Reactor Regulation; DOE officials from the Office of the Assistant Secretary for Nuclear Energy; industry officials from the Nuclear Management Resources Council and the Electric Power Research Institute; officials from public interest groups, such as the Union of Concerned Scientists, Nuclear Information Research Service, and Safe Energy Communication Council; and former officials from the Nuclear Safety Research Review Committee and the National Research Council.

Forty-Two Nuclear Power Plant License Expirations Through 2012

Year of license expiration	Reactor plant/location	Capacity (Net MWe)	Licensing utility
2000	Big Rock Point/Michigan	64	Consumers Power
2000	Yankee-Rowe/Massachusetts	175	Yankee Atomic Electric
2005	Nine Mile Point-1/New York	610	Niagara Mohawk Power
2006	Dresden 2/Illinois	772	Commonwealth Edison
2006	Ginna/New York	470	Rochester Gas & Electric
2007	Haddam Neck/Connecticut	555	Northeast Utilities
2007	H.B. Robinson-2/South Carolina	665	Carolina Power & Light
2007	Palisades/Michigan	635	Consumers Power
2007	Quad Cities-1/Illinois	769	Commonwealth Edison
2007	Quad Cities-2/Illinois	769	Commonwealth Edison
2007	San Onofre-1/California	436	So. Calif. Edison & San Diego Gas & Electric
2007	Turkey Point-3/Florida	646	Florida Power & Light Co.
2007	Turkey Point-4/Florida	646	Florida Power & Light Co.
2008	Cooper/Nebraska	764	Nebraska Public Power District
2008	Diablo Canyon-1/California	1,084	Pacific Gas & Electric
2008	Fort Calhoun/Nebraska	478	Omaha Public Power District
2008	Maine Yankee/Maine	810	Main Yankee Atomic Power Co.
2008	Peach Bottom-2/Pennsylvania	1,051	Philadelphia Electric Co.
2008	Peach Bottom-3/Pennsylvania	1,035	Philadelphia Electric Co.
2008	Rancho Seco/California	873	Sacramento Municipal Utility District
2008	Salem-1/New Jersey	1,079	Public Service Electric & Gas Co.
2008	Salem-2/New Jersey	1,106	Public Service Electric & Gas Co.
2008	Zion-1/Illinois	1,040	Commonwealth Edison Co.
2008	Zion-2/Illinois	1,040	Commonwealth Edison Co.
2009	D.C. Cook-1/Michigan	1,044	Indiana & Michigan Electric Co.
2009	D.C. Cook-2/Michigan	1,082	Indiana & Michigan Electric Co.
2009	Indian Point-3/New York	891	Power Authority of the State of New York
2009	Oyster Creek/New Jersey	620	GPU Nuclear Corp.
2010	Brunswick-1/North Carolina	790	Carolina Power & Light Co.
2010	Brunswick-2/North Carolina	790	Carolina Power & Light Co.
2010	Diablo Canyon-2/California	1,106	Pacific Gas & Electric Co.
2010	Duane Arnold/Iowa	515	Iowa Elec. Power & Light Co.
2010	Millstone-1/Connecticut	654	Northeast Nuclear Energy Co.
2010	Monticello/Minnesota	525	Northern States Power Co.
2010	Point Beach-1/Wisconsin	495	Wisconsin Electric Power Co.
2011	Davis-Besse/Ohio	874	Toledo Edison-Cleveland Electric
2011	Dresden-3/Illinois	773	Commonwealth Edison Co.
2011	Trojan/Oregon	1,080	Portland General Electric Co.

(continued)

Year of license expiration	Reactor plant/location	Capacity (Net MWe)	Licensing utility
2012	Arkansas Nuclear-2/Arkansas	858	Arkansas Power & Light Co.
2012	Pilgrim-1/Massachusetts	670	Boston Edison Co.
2012	Surry-1/Virginia	775	Virginia Electric & Power Co.
2012	Vermont Yankee/Vermont	504	Vermont Yankee Nuclear Power Corp.

Source: NRC's 1989 Annual Report and Information Digest, 1991 edition.

NRC's Process for Licensing Nuclear Power Plants and Proposed Process for Renewal

The initial licensing procedure for a nuclear power plant is a two-step process. The first step consists of selecting and approving the plant site and its general design before NRC issues a construction permit. The second step consists of refining design specifications and resolving environmental concerns before NRC issues an operating license. Both phases entail close consultation between the utility and NRC staff, and both provide for public participation at hearings.

The license renewal process will, as currently proposed, add a possible third step to the licensing procedure. The proposed regulations allow a licensee to apply for a renewed license before its existing license expires. The application must include an environmental report and a supplement to the plant's current updated final safety analysis report (FSAR). The FSAR, which demonstrates that the plant's design is safe and consistent with NRC's rules and regulations, was first submitted and approved when NRC issued the original operating license. Technical information to be provided with the FSAR supplement will include an evaluation of the aging processes, such as corrosion or thermal embrittlement, that degrade systems, structures, and components of the plant that are important to license renewal. Also, information will be provided showing that any degradation, such as physical or chemical changes, will be effectively managed so that the current licensing basis for the plant can be maintained throughout the renewal term. If adequate, this information will enable NRC to find that the facility can continue to operate as currently licensed without endangering public health and safety.

In addition, each renewal application must be referred to NRC's Advisory Committee on Reactor Safeguards for a report. Furthermore, while the type and nature of the NRC staff's internal reviews for renewal are not specified in the proposed rules, NRC officials said that the staff will prepare a safety evaluation report summarizing the results of its review of the FSAR, which, along with the Advisory Committee's report, will be used by the Commission to decide whether a license should be renewed. The proposed rules also provide for a public hearing on the renewal application and stipulate that renewals will not be approved for more than 20 years beyond the original license expiration date.

Example of How Aging Research for One Component May Provide Technical Basis Useful to License Renewal

Nuclear power plants presently in operation were designed and licensed with the expectation that they would operate for 40 years. As these plants approach the end of their initial license period, the nuclear power industry wants to extend their usefulness by having NRC renew their licenses for an extended period. If NRC extends a plant's lifetime, NRC must ensure that the plant continues to operate as safely as it did during its initial license period. Safe operation requires that all parts of the plant important to safety be in good operating condition so that they can do the job they were designed to do.

Some nuclear power plant systems and components are designed specifically to perform a safety function, such as the electric equipment and systems that are essential to emergency reactor shutdown, reactor core cooling, or containment and reactor heat removal to prevent significant releases of radioactive material into the environment.

Illustrative of components designed to perform a safety function are the electric components needed to pump emergency cooling water into a reactor to prevent a core melt in the event that normal cooling water is lost through a broken pipe. A typical emergency cooling system would consist of more than one cooling water path. Each path would include all of the pipes, valves, pumps, instruments, and other equipment required to provide the needed amount of cooling water. The system is designed so that if one of the paths fails to do its job, one of the remaining paths can provide sufficient cooling water to the reactor core. Then, if one component fails to operate, NRC believes, there is still reasonable assurance that the plant will be safe, although the design margin of safety will be reduced.

An example of a component used in the emergency cooling water path is the electric motor that drives the cooling water pump. These motors are expected to work whenever they may be needed, regardless of the age of the power plant, and they are expected to work in the possibly harsh environments of high radiation, high humidity, or high temperature, and in combinations of these harsh environments.

Before an electric motor can be used in a safety system, it must be qualified for normal service as well as for service under the conditions that might occur during or following an accident. Once an electric motor has been qualified for use in a safety system, it is expected that it will continuously remain qualified from the time it is first installed until it is called upon to perform its safety function. This period of time is called the motor's "qualified life." If a motor's qualified life is shorter than the

time the nuclear power plant is expected to operate, the motor would have to be refurbished or replaced and requalified before the power plant reached the end of its operating life. If a motor's qualified life is equal to or longer than the expected operating life of the power plant, e.g., 40 years, the motor would be expected to provide its required level of safety for 40 years or more.

Qualifying a motor for safety system service does not guarantee that the motor will work when it is needed; however, it does increase confidence in the motor's reliability. If the operating life of the power plant where the motor is used is to be extended, the confidence that the motor will work when needed during the extension period must be maintained. The qualification of the motor must be reestablished.

An electric motor's qualified status may be extended by any of several methods. The original qualification may be reevaluated to determine whether the motor's continued use is justified. If it is not, the motor must be replaced or refurbished to extend its capacity for service.

In either case, component aging research may be used to guide the decision and to provide a technical basis for the motor's future surveillance and maintenance that will give assurance that it will perform its safety function when needed. For example, aging research might show that the motor's insulation material may not last for as many years as the plant's life is being extended. If the insulation can be replaced, then the motor can be refurbished; if not, the entire motor can be replaced. In either case, the aging research would have shown that the motor could not be used as it was and, if the motor had not been replaced earlier, the research would flag the motor as needing intensive surveillance to determine when it could no longer perform its safety function and would have to be replaced or refurbished.

Another purpose of aging research is to determine how frequently a safety system component, such as an electric motor, will fail, or, stated differently, how long the component can be expected to operate before it fails. This failure rate information is used in probabilistic risk assessments to predict the increase in risk over operating lifetime. The confidence that can be placed in the results of probabilistic risk assessments is determined by the accuracy of the failure rate information used in the model for making the prediction.

Examples of Research Reports Related to Plant Aging Issued Through May 1991

NRC's Nuclear Plant Aging Research Program has produced over 100 reports. The following examples illustrate the kind of research that is being done.

BNL Technical Report A-3270-11-26-84, Scoping Test on Containment Purge and Vent Valve Seal Material, Brookhaven National Laboratory, December 1984.

BNL Technical Report A-3270-11-85, Seismic Endurance Tests of Naturally Aged Small Electric Motors, Brookhaven National Laboratory, November 1985.

NUREG/CR-2641, The In-Plant Reliability Data Base for Nuclear Power Plant Components: Data Collection and Methodology Report, Oak Ridge National Laboratory, July 1982.

NUREG/CR-3819, Survey of Aged Power Plant Facilities, Idaho National Engineering Laboratory, June 1985.

NUREG/CR-3956, In Situ Testing of the Shippingport Atomic Power Station Electrical Circuits, Idaho National Engineering Laboratory, April 1987.

NUREG/CR-4234, Aging and Service Wear of Electric Motor-Operated Valves Used in Engineered Safety-Feature Systems of Nuclear Power Plants: Aging Assessments and Monitoring Method Evaluations, Oak Ridge National Laboratory, August 1989.

NUREG/CR-4457, Aging of Class 1E Batteries in Safety Systems of Nuclear Power Plants, Idaho National Engineering Laboratory, July 1987.

NUREG/CR-4590, Aging of Nuclear Station Diesel Generators: Evaluation of Operating and Expert Experience, Pacific Northwest Laboratory, August 1987.

NUREG/CR-4715, An Aging Assessment of Relay and Circuit Breakers and System Interactions, Brookhaven National Laboratory, June 1987.

NUREG/CR-4731, Residual Life Assessment of Major Light Water Reactor Components, Idaho National Engineering Laboratory, June 1987.

NUREG/CR-4928, Degradation of Nuclear Plant Temperature Sensors, Analysis and Measurement Services Corporation, June 1987.

NUREG/CR-5141, Aging and Qualification Research on Solenoid Operated Valves, Franklin Research Center, August 1988.

NUREG/CR-5192, Testing of a Naturally Aged Nuclear Power Plant Inverter and Battery Charger, Brookhaven National Laboratory, September 1988.

NUREG/CR-5280, Age-Related Degradation of Westinghouse 480-Volt Circuit Breakers and Aging Assessment and Recommendations for Improving Breaker Reliability, Brookhaven National Laboratory, July 1990.

NUREG/CR-5383, Effect of Aging on Response Time of Nuclear Plant Pressure Sensors, Analysis and Measurement Services Corporation, June 1989.

NUREG/CR-5406, BWR Reactor Water Cleanup System Flexible Wedge Gate Isolation Valve Qualification and High Energy Flow Interruption Test, Analysis and Conclusion, Idaho National Engineering Laboratory, October 1989.

NUREG/CR-5560, Aging of Nuclear Plant Resistance Temperature Detectors, Analysis and Measurement Services Corporation, March 1990.

NUREG/CR-5461, Aging of Cables, Connections, and Electrical Penetration Assemblies Used in Nuclear Power Plants, Sandia National Laboratories, July 1990.

SAND88-0754 UC-78, Time-Temperature-Dose Rate Superposition: A Methodology for Predicting Cable Degradation Under Ambient Nuclear Power Plant Aging Conditions, Sandia National Laboratories, August 1988.

WYLE 60103-X, Test Plan for the Comprehensive Aging Assessment of Circuit Breakers and Relays for Nuclear Plant Aging Research (NPAR) Program, Phase II, Wyle Laboratories, July 1989.

Major Contributors to This Report

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