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# Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants

A Report to Congress

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**U.S. Nuclear Regulatory  
Commission**

Office of Inspection and Enforcement

W. Altman, T. Ankrum, W. Brach



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W. Altman, T. Ankrum, W. Brach

**Division of Quality Assurance, Safeguards, and Inspection Programs**

**Office of Inspection and Enforcement**

**U.S. Nuclear Regulatory Commission**

**Washington, D.C. 20555**





## ABSTRACT

At the request of Congress, NRC conducted a study of existing and alternative programs for improving quality and the assurance of quality in the design and construction of commercial nuclear power plants. A primary focus of the study was to determine the underlying causes of major quality-related problems in the construction of some nuclear power plants and the untimely detection and correction of these problems. The study concluded that the root cause for major quality-related problems was the failure or inability of some utility managements to effectively implement a management system that ensured adequate control over all aspects of the project. These management shortcomings arose in part from inexperience on the part of some project teams in the construction of nuclear power plants. NRC's past licensing and inspection practices did not adequately screen construction permit applicants for overall capability to manage or provide effective management oversight over the construction project.

The study recommends a number of improvements in industry and NRC programs. For industry, the study recommends self-imposed rising standards of excellence, treatment of quality assurance as a management tool, not a substitute for management, improved trend analysis and identification of root causes of quality problems, and a program of comprehensive third party audits of present and future construction projects. To improve NRC programs, the study recommends a heavier emphasis on team inspections and resident inspectors, an enhanced review of new applicant's capabilities to construct commercial nuclear power plants, more attention to management issues, improved diagnostic and trending capabilities, improved quality and quality assurance for operating reactors, and development of guidance to facilitate the prioritization of quality assurance measures commensurate with the importance of plant structures, systems, and components to the achievement of safety.





UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

April 20, 1984

The Honorable George Bush  
President of the United  
States Senate  
Washington, DC 20515

Dear Mr. Speaker:

The NRC Authorization Act for fiscal years 1982-83 (P. L. 97-415) directed that the NRC "shall conduct a study of existing and alternative programs for improving quality assurance and quality control in the construction of commercial nuclear power plants." Section 13 of that Act contained specific study requirements, including requirements to analyze five alternative approaches to improving the assurance of quality in the nuclear industry and to describe any administrative actions or legislative proposals that the Commission has taken or plans to undertake for improving quality assurance in construction.

In response, the NRC staff recently completed its report of the required study. The Commissioners received a briefing concerning that report on April 4, 1984. A brief overview of the staff's report is attached (Enclosure 1) along with a copy of the report itself (Enclosure 2).

The staff's report is complex and contains a large number of interrelated actions recommended to be undertaken by the NRC. Due to the complexity of the report and the need for the Commission to fully understand the plans, schedules, and resource implications if the recommendations are implemented, we believe it necessary to take considerably more time to study the matter before informing the Congress of our final recommendations. While we are considering the details of the report, we also believe it desirable to request comments from the public on the staff's report.

The above deliberations by the Commission will likely take several months. At the end of that time, we will forward the Commission's final recommendations to the Congress.

Sincerely,

Nunzio J. Palladino

Enclosures: As stated





Brief Overview of NRC Staff Report on Improving  
Quality and the Assurance of Quality in the  
Design and Construction of Commercial Nuclear  
Power Plants

The staff's report focuses heavily on improvements to the NRC program. Improvements to NRC's programs are necessary, but not sufficient, to achieve significant improvements in quality in the nuclear industry. Significant improvements can come only from the industry. We view the industry's Institute of Nuclear Power Operations as a positive step in that direction. The staff expresses the hope that NRC's initiatives regarding the importance of excellence in management to the achievement and assurance of quality will act as a catalyst for such change.

A primary focus of the required study was to determine the underlying causes, of (1) the occurrence of major quality-related problems in the construction of some nuclear power plants, and (2) the untimely detection and correction of these problems. The answers to these questions provided the staff with a foundation for evaluating the specific alternatives proposed by Congress in the Act and for recommending improvements to NRC's and the nuclear industry's approach to and programs for both achieving quality and assuring quality.

The staff concluded that the root cause for the major quality-related problems in design and construction was the failure or inability of some utility management to effectively implement a management system that ensured adequate control over all aspects of the project. These management shortcomings arose in part from inadequate nuclear design and construction experience on the part of one or more of the key participants in the nuclear construction project: the owner utility, architect-engineer, nuclear steam supply system manufacturer, construction manager, or the constructor, and the assumption by some participants of a project role which was not commensurate with their level of experience. As a corollary, NRC's past licensing and inspection practices did not adequately screen construction permit applicants for overall capability to manage or provide effective management oversight over the construction project.

The staff found a number of reasons why the utilities and the NRC were slow to detect or recognize the extent of major problems in quality or quality assurance. The reasons include an inability on the part of either to recognize the underlying programmatic and managerial deficiencies that caused individual quality problems, an

attenuation in the flow of essential project information from the working level to top management, and a tendency on the part of NRC to set the threshold for taking action for construction problems higher than for operational problems because of the lack of an immediate threat to public health and safety.

The staff's conclusions with respect to the five specific alternative approaches to quality assurance described in the Act were as follows:

- (1) Making architectural and engineering criteria more prescriptive would not have a substantial impact on quality; however, reducing the number of design changes during construction would. More complete designs at initiation of construction would enhance quality.
- (2) Construction permits (CP) for future CP applicants should be conditioned on post-CP demonstration by the applicant of its capability and effectiveness in managing a nuclear construction project, including the quality assurance program. NRC's pre-CP screening should be modified to evaluate the management competence and prior nuclear experience of applicants, and a special advisory board should be established to provide further advice to the NRC on the qualifications of new applicants.
- (3) Audits by certain associations of professionals including the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel Inspectors, cover certain narrow technical areas in more depth than NRC's inspection program but are not sufficiently comprehensive in scope to substitute for NRC inspections. The new construction evaluation program of the Institute of Nuclear Power Operations (INPO) provides the most comprehensive construction audit of any professional association, and it represents a positive industry initiated step toward helping the nuclear industry raise its own standards of performance. This INPO program should not be construed as a substitute for NRC oversight of construction quality, however. The roles of the NRC and INPO are necessarily different, and INPO serves the government, the industry and the public best in its present role. Although the roles of the NRC and INPO must remain separate, they are not fixed, and NRC

needs to be alert to industry improvements resulting from INPO programs and adjust its programs accordingly.

- (4) There are a number of ways in which the NRC program has improved in the past several years and can be improved further. The resident inspector program has become the foundation of the NRC inspection program, and it may be expanded. Team inspections such as the new Construction Appraisal Team (CAT) inspections offer significant detection and diagnostic capability for quality problems, and their use should be expanded. NRC's past quality assurance efforts have focused on form and paper at the expense of implementation and evaluating quality of completed work, and they should be reoriented to emphasize performance and effectiveness. The inspection program should address the issue of management capability and effectiveness on a routine basis, not just when the need for remedial action has become apparent.
- (5) Comprehensive periodic audits by independent (third-party) inspectors should be required of plants currently under construction as well as future CP applicants. In the interim until such a program can be established by regulation, the CAT program should be expanded to cover more plants for an operating license for additional assurance that their plant's design complies with licensing commitments and NRC regulations.

Administrative actions underway and planned to address these conclusions and others are found in the report and are summarized in tables 2.1, 2.2, and 2.3 of Chapter 2. Chapter 2 provides a comprehensive summary of the study, its conclusions and its recommendations.

The staff's report concludes that at this time there are no legislative changes required. Each of the recommended staff actions could be implemented within NRC's current statutory authority. However, the staff identifies several issues that after subsequent analysis may result in legislative proposals.

The staff notes that the actions which have been identified and recommended by the study are extremely comprehensive and several of them could consume all of NRC's current budget and manpower allocated to development of the quality assurance program. It will be necessary to establish

priorities for the quality assurance issues within the other issues faced by the NRC and make resource allocations. As a result, some of the recommended actions may necessarily be deferred until the higher priority actions are completed.

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Mr. Brian Grimes, former Deputy Director for the Division of Quality Assurance, Safeguards, and Inspection Programs, IE, provided valuable advice on several complex issues and was largely responsible for establishment of the special review group and selection of its members. Mr. Tom Dorian of the Office of the Executive Legal Director provided continuing legal review and advice on the project as well as comprehensive editorial advice.

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- Florida Power and Light Company (Case Studies)
- Consumers Power Company (Pilot Program)

The authors of the report are solely responsible for any awkwardness of phrase, redundancy (of which there is much) and lack of logical thought.



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