UNITED STATES
NUCLEAR REGULATORY COMMISSION
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Public Service of Indiana
Attn: Mr. S. W. Shields
Senior Vice President
Nuclear Division
P.O. Box 190
Washington, Indiana 47162

Dear Mr. Shields:

Please accept our thanks for your cooperation with our activities to comply with Congressional direction to the NRC to perform certain quality assurance studies and pilot programs. As you know, several months ago, my staff conducted a review of the quality assurance program for design and construction of the Marble Hill power plant. A copy of the staff's working papers for the case study for your site is enclosed for your information. The working papers contain some preliminary conclusions which were developed by the working level staff and which were discussed with you at the exit meeting.

This case study, and others like it, will be used in preparing the final Congressional Report. The Congressional Report will contain a consolidated summary of the conclusions drawn from the individual case studies. It will not contain the individual case studies. NRC management will review and approve the summary conclusions contained in the Congressional Report.

We very much appreciate your openness in allowing us to perform the case study of your utility's program for the assurance of quality. It will be very useful to our analysis.

Sincerely,

James M. Taylor, Director
Division of Quality Assurance,
Safeguards, and Inspection Programs
Office of Inspection and Enforcement

Enclosure:
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QUALITY ASSURANCE CASE STUDY
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CASE A

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QUALITY ASSURANCE CASE STUDY WORKING PAPER

CASE A

I. SUMMARY OF FINDINGS

A. Introduction

The Nuclear Regulatory Commission (NRC) has undertaken a study of selected nuclear reactor construction projects to determine the important factors or root causes that support effective or cause ineffective nuclear construction projects and assurance-of-quality programs. Several nuclear projects which have experienced major quality problems in construction (or design) and several which have not will comprise the study population. This collection of site-specific studies and lessons learned will be used by the NRC in the formulation of generic policies and programs for the assurance of quality and in responding to the congress (Ford Amendment to 1982-83 NRC Authorization Act). These working papers summarize the findings from the first case study.

B. Background

The licensee of Case A is constructing its first nuclear station and is presently nearing the half way point in construction of

Unit 1. Unit 2 construction is about 15% behind Unit 1 construction. The construction permits (CPs) were issued in the late 1970's. Initial planning and site selection work commenced in the mid 1970's.

The licensee is the construction manager for the project. Several of the major construction contractors - civil, mechanical and electrical - as well as several of the smaller contractors, have limited nuclear power plant construction experience. The architect-engineer (AE) has had substantial experience in the design of nuclear power plants. This AE firm generally confines its work to the design area only and does not act as construction manager or constructor for nuclear (or other) projects. The AE frequently works as an extension of the customer's engineering department.

Shortly into the construction of this nuclear station, the licensee experienced major problems in the placement of concrete in safety-related structures and to a lesser degree, in safety-related piping work. Some of the construction quality problems were brought to light through allegations of a former construction worker, which were investigated and confirmed by the NRC. An intensive NRC team investigation found that the quality problems in concrete and piping were not isolated events, but were symptomatic of deep underlying, programmatic deficiencies in the management of the project and in the program for assurance of quality in the project. As a result of this investigation, all safety-related work at the site was halted and the licensee was required to substantially revise its management approach, organization, and staffing for the project. The stop work action was gradually rescinded in stages over the next 2-1/2 years, as the licensee demonstrated, to NRC's satisfaction, its ability to effectively manage additional functional project activities.

At the time of the Case Study A site review, the licensee had effectively implemented substantial modifications and improvements to the management of the project, and the project was regarded by cognizant regional NRC officials as having been turned around and as being something of a model project. The Case Study team findings support this regional assessment.

C. Summary of Root Causes

The primary objective of this case study was to determine the significant factors, or root causes, that contributed to the major construction quality problems at the Case A project. Other objectives were: (1) to evaluate the effectiveness of the current project management, construction management and quality assurance program; (2) determine the actions or changes that resulted in the project evolving from a quality failure to an apparent success; (3) determine generic implications arising from this case that may pertain to other nuclear construction projects, including future plants; and (4) determine the implications of this case for NRC's QA initiatives (described in papers SECY 82-352, 83-26, 83-32 and 83-32A) and for the five specific alternative approaches to the assurance of quality contained in Section 13b of NRC's FY82-83 Authorization Act (Ford Amendment). The root causes for the earlier quality problems at the Case A project are summarized below. Discussion of these root causes as well as information pertaining to the other four objectives of this case study comprise the content of these working papers.

1. The primary root cause of the construction quality problems was the licensee's inexperience in nuclear power plant construction projects, and its failure to appreciate and understand the difference in difficulty between fossil and nuclear construction projects.

   The utility had managed or overseen the construction of a number of successful fossil projects and it approached the nuclear project as an extension of the earlier fossil construction activity: to be managed, staffed, and contracted out in much the same way as fossil projects. The utility did not appreciate or understand the difference in complexity and regulation between fossil and nuclear projects and treated the nuclear project largely as just another construction project. The utility's lack of experience in and understanding of nuclear construction manifested itself in the following: lack of adequate staffing for the project, both in numbers, qualifications, and applicable nuclear experience; selection of contractors the utility had used in building fossil plants but which had very limited applicable nuclear construction experience; over reliance on their same contractors in the management of the project and evaluation of its status and progress; use of fixed price contracts only; oversight of the project from corporate headquarters with only a minimal utility presence at the site; a lack of appreciation for the importance of ASME codes and other nuclear related standards; a misunderstanding of the NRC, its practices, its authority, and its role in nuclear safety; and an inability to recognize that the piping and recurring concrete quality problems were merely manifestations or symptoms of much deeper underlying programmatic deficiencies in the management of the project.

2. Secondary root causes include the following:

   a. <u>Failure to understand and appreciate the potential merit of a formal institutionalized quality program</u>.

   The licen' e had built the successful fossil units of the past without having a formal program for the assurance of quality. For the nuclear project, NRC regulations require the establishment of a formal quality assurance (QA) program. The licensee viewed this requirement as just another government agency-imposed requirement necessary to obtain a license and treated it accordingly. The licensee inadequately staffed the QA/QC function both in numbers, qualifications, and nuclear experience. The licensee failed to listen to the QA/QC organization when it reported quality problems or asked for additional resources. Senior licensee management was skeptical about formal QA programs: earlier, successful fossil projects had been completed without a QA program, and they had been worried about the dangers of the QA organization trying to build an "empire." Quality, they felt, was something that came naturally.

b. <u>Development of a false sense of security</u>.

The licensee was unaware of the extent or the seriousness of the quality problem up to the issuance of the stop work order. The licensee had developed a false sense of security about this project resulting in part from the following: past fossil success; use of many of the same contractors who had worked on the fossil units; believing the contractors when they indicated that the project had no major problems, that similiar concrete placement problems were common in nuclear construction; the fact that the project's nuclear units were replicates of other plants being constructed by a more experienced utility and designed by the same AE; and a view that since NRC inspection findings (until the inspection resulting in the stop work action) focused on details and minor problems, these must not be any major problems with the project.

c. <u>Failure to manage the project from the outset.</u>

This secondary root cause is related to the primary root cause, inexperience. In retrospect, the project was not being managed by anyone. In the project structure, the role of project manager belongs to the licensee. The licensee acted as general contractor and construction manager but tried to run the project more as if it were only in an oversight role. The licensee ran the project from corporate headquarters with minimal site presence and without effective control over its contractors. Accountability for the project was deleted among several organizations in the utility. The false sense of security resulting from the replication phenomenon contributed in some degree to the failure to manage; the utility felt that any major problems would develop first at the project being replicated, and they would have time to make adjustments on this project.

d. <u>NRC licensing and inspection.</u>

For construction permits, NRC licensing review is limited largely to technical and engineering issues. NRC does not and did not in the case of the licensee, evaluate whether the applicant and his contractors had the experience, knowledge, staffing, or ability to effectively manage and consumate a project as complex as the construction of a nuclear reactor. Moreover, NRC's inspection activity at the site was irregular and non-constant, with several inspectors in different disciplines visiting individually for a week at a time, and with no one (until just before the team inspection) recognizing that the reported deficiencies were only symptoms of deep programmatic quality problems. The first resident inspector was not assigned to the site until four months after the stop work order. Just as the NRC, through its routine region based inspection program, was slow to put together the bits and pieces coming from individual inspectors, so too was the licensee slow to recognize the extent of the programmatic quality problem. Indeed, the licensee interpreted NRC's early narrow inspection findings as an indication that there were no major problems, and the licensee had some difficulty acclimating itself to the stronger, more pervasive findings of the team inspection.

QUALITY ASSURANCE CASE STUDY WORKING PAPER

CASE A

II. BRIEF HISTORY OF THE PROJECT

A. In the late 1970's, NRC issued construction permits (CPs) to the utility for the construction of two nuclear reactors at the same site. The utility had announced construction of the units in the early 1970's and applied for construction permits in the mid 1970's. Limited work authorizations (LWAs) were granted, permitting non-safety related work to be conducted prior to CP issuance. The first placement of safety relatod concrete occurred in 1978. The utility acted as general contractor for the project, which was the first nuclear project it had undertaken. A firm experienced in the design and engineering of nuclear projects was retained as architect/engineer (A-E). A construction company, which had previously participated in the construction of a number of fossil-fired plants for the utility, was retained as the civil engineering contractor for the project. The civil contractor's nuclear experience was limited to providing workers for projects managed by other firms. This company had not been the prime civil contractor for a nuclear project before. The utility contracted with other firms for the mechanical, electrical, and other construction activities. In the early phases of the project, the civil work fell behind schedule and considerable pressure was applied by the utility to regain lost time.

About one year after CP issuance, NRC identified deficiencies in the quality of the concrete work; e.g., severe cases of segregation and/or honeycombing. There had been a large number of nonconformance reports (NCRs) regarding the concrete work from the outset of the project. The utility agreed to upgrade its quality assurance program for the concrete work and to determine through testing if previously poured concrete was adequate.

About one month later, a former employee of the civil construction contractor alleged that surface defects in the concrete had been improperly patched. Concurrently, but independently, the National Board of Boiler and Pressure Vessel Inspectors confirmed code-compliance problems with piping installation previously identified by a mechanical subcontractor.

The concrete deficiencies and the National Board findings led to an intensive NRC team inspection which resulted in a shutdown of all safety-related construction activities. NRC determined there were programmatic questions concerning the utility's project management, construction management and quality assurance programs significant enough to warrant full stoppage of safetyrelated construction work until these programmatic questions were satisfactorily resolved.

To evaluate its project management, construction management and quality assurance programs, the utility hired a management consulting firm to perform an in-depth analysis of the project. The consulting firm confirmed the existence of, and helped identify, underlying programmatic deficiencies in the project. Their report outlined a twenty point plan to restructure and improve the project. Subsequent to the report of the management firm, the utility submitted its formal reply to the order, detailing its effort to upgrade and implement its revised program for project and construction management and the assurance of quality.

To assure that the utility's corrective actions were properly and effectively implemented, the Commission approved a five-step plan for gradual recision of the shutdown order. The five stages would be subject to intensive reviews by NRC inspectors with an NRC "hold point" at each stage before the next could be undertaken. The plan covered revised quality assurance program, receipt inspections, material verification program, construction verification program, and resumption of construction.

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The utility was permitted to resume receipt inspections of materials at the construction site about one year after the stop work order following restructuring of its project and construction management and quality assurance programs. Limited electrical and pipe installation work resumed six months later followed by all remaining safety-related work, including concrete placement, in another four months. Unrestricted authority to continue the work would not be granted until the utility successfully demonstrated to NRC that its revised project and construction management and quality assurance programs were implemented properly. The total time period from work stoppage to full resumption of all construction activity was nearly two and one half years. It should be noted that substantial non-safety related civil work was completed during the period the stop work order was in effect.

During the period of the stop work order, the utility substantially restructured its project management, construction management, records management and quality assurance programs. The utility, which had been very shallow in applicable nuclear experience prior to the project, hired substantial numbers of well qualified people to work on the project. They also established a nuclear division, whose sole responsibility is the nuclear construction project. This division, including the senior vice president who heads it, is now located at the plant site. Morale has improved considerably and a team spirit and project determination, pervade the project.

NRC believes the project has made substantial progress and improvements as may be seen by the following: Three years after the quality problems became so pervasive that all safety-related construction work was halted, the cognizant NRC regional office rated the utility's QA program "outstanding" (the highest rating) on the annual NRC SALP (systematic assessment of licensee performance) review. The utility received the rating of "outstanding" the subsequent year also.

The reasons underlying why significant programmatic construction quality problems developed at this project, how they were addressed, and their generic implications will be the subject of the rest of this working paper.

III. THE UTILITY'S APPROACH TO NUCLEAR POWER

The quality problems described above were manifested in substandard concrete and piping work which resulted from programmatic deficiencies in the management of the project. In order to understand how and why the construction quality problems described above arose, and to draw reasonable generic inferences from this experience, we need to examine the utility's approach to nuclear power in general and their program for managing their project in particular.

A. Utility Character and Background

Like many utilities, this utility had and has a conservative management philosophy and is adverse to taking unnecessary risks. As with many utilities, this one is quasic monopolistic, being protected from competition by public utility commission policies and practices. With this protection from competition, however, comes close scrutiny from the public utility commission regarding how the utility spends money and handles their finances. These factors contribute, in part, to a cost and schedule consciousness on the part of the utility. For many years the utility's hiring procedures provided for review and approval by several levels of management, including the chief executive officer for all new hires. All their contracts, including those for construction of generating plants, were fixed price contracts.

The utility's prior construction experience consisted of about twenty fossil-fired plants. In some cases the utility had served as construction manager. The utility had a construction department headed by a vice president, which was responsible for all construction utility wide. Over the years the utility developed a close working relationship with, and confidence in, several of the major construction contractors that worked on their fossil projects. The utility's fossil construction success was a source of pride: each plant had come on line on or before schedule and at or within budget. Each plant was of acceptable quality; after a few early bugs were worked out, each plant operated safely and reliably. This quality, incidentally, was something put into the plant by the builders - there was no formal program for quality or the assurance of quality. To the utility, quality was something that happened if you put good people on the project.

Reflecting the generally conservative management philosophy of the company was an adherence to tradition: if something seems to work, stick with it. The traditional way of building fossil plants seemed to be successful, and the company carried over many of its fossil construction practices to its nuclear project; e.g., the utility served as construction manager, and several of their key contractors on fossil plants were retained (although the utility had no nuclear experience and their contractors had limited nuclear experience); only fixed price contracts were let; the construction department was responsible for construction management except for a few people permanently assigned to the project; personnel from existing departments in the utility were matrixed in to work on the project as needed they reported administratively and to some degree functionally to their department head, not to the project manager; the project was managed from corporate headquarters with a minimal utility presence at the site; and hiring and recruitment actions continued to be reviewed at the highest levels of the company.

B. Decision to Become a Nuclear Utility

Why, given the inherent conservatism of the utility and the risks and uncertainties associated with nuclear power, did the utility elect to build a nuclear plant? Many factors were involved including the following: projections for future energy demands were high; the price of oil had risen dramatically and its future availability in sufficient quantities was uncertain; and a number of other nuclear utilities, including first timers had built nuclear with apparent success. Indeed, careful calculations using the best estimates of cost, schedule, interest rates, plant life, final costs, licensing considerations, etc. coupled with the excellent safety record of nuclear power to date, showed nuclear power to be not only cost effective but reasonably risk free. Going nuclear was a break with tradition, perhaps, but still a conservative decision. The utility had no prior nuclear experience, but they felt they could compensate for this by hiring a few key people with prior nuclear experience. Moreover, their plants would be replicates of a plant already being built in a nearby state by a large utility with extensive nuclear experience. The utility felt that being able to draw from the lessons learned from the design, engineering, and construction of the neighbor's plant (they were using the same Architect/Engineer) would help compensate for the utility's lack of nuclear experience, as well as reduce the cost of the plant and shorten the licensing cycle.

C. Utility Attitude Regarding the Project, NRC, and Quality

After careful evaluation of the information available to them at the time, the utility decided to go ahead with a large commitment to nuclear power. Original plans called for a total of four units at a common site. The initial CP application was for two units. A subsequent CP application was prepared but became a casualty to the accident at Three Mile Island and was never formally submitted to the NRC. The attitude of the utility from the outset was one of confidence and adherence to practices that had worked on fossil projects in the past. There was a recognition that the project would be different from fossil projects, but the governing feeling was that the differences were not too great and cou'd be overcome through the hiring of some managers and staff members with prior nuclear experience and through the replication situation. Of greater concern was the desire to complete the project on time and within budget.

The utility had not dealt with the NRC before and saw the agency as the regulator that comes with nuclear energy, just as OSHA comes with occupational safety and EPA with fossil plant emission. The utility saw regulatory agencies as bodies that set rules and requirements which utilities must meet in order to obtain permits and licenses, and their view of NRC was no different. Submittal of the Preliminary Safety Analysis Report (PSAR) was viewed as a requirement, which was met through submitting a slight modification of the PSAR of the plant they were replicating. Establishment of a formal quality assurance program was a requirement that was met through Chapter 17 of the PSAR, appointment of a QA manager, and the establishment of a small QA/QC organization. The utility saw the formal QA program as a requirement to be met, not as a management tool to help with the project. The utility had been successful before without a formal quality program, and it saw the NRC-required program as being neither necessary nor sufficient to assure quality in the construction of the reactor. Quality was to the utility something that just happened, not something that had to be planned for. Accordingly, the NRC-required QA organization was given limited resources, personnel lacking minimal qualifications for the jobs they were doing, and limited authority (e.g., no stop work authority). Moreover, utility management had been warned of the development of QA "empires" elsewhere, and they were suspicious of the new QA manager, his organization, and the messages coming from it. In particular, requests for additional QA personnel (which like all recruitment/hiring actions had to be approved by the chief executive officer) were rejected.

IV. ROOT CAUSES OF THE UTILITY'S PROBLEMS WITH QUALITY IN CONSTRUCTION

Based on a review of NRC inspection reports, investigations, and other documentation, discussions with and interviews of cognizant NRC, utility and contractors' management and staff, the following appear to be the primary and secondary root causes of the quality problems that manifested themselves in the late 1970's and led to the cessation of safety-related work at the project.

A. Primary Root Cause

The primary root cause of the construction quality problems experienced by this project was the utility's lack of experience in building a nuclear project.

The utility did not understand or fully appreciate the several quantum jumps of complexity and quality requirement differences between building fossil plants and building nuclear plants. Their experience in building fossil plants had been quite positive: as previously mentioned, they had built nearly a score of successful fossil plants in the past thirty years, generally completing the projects on schedule (or before) and within budget. This led to the development of a mind set sometimes referred to as a "fossil mentality" the feeling that building a nuclear plant could not be much more difficult than building a fossil plant, the main difference being in how the steam was generated.

Their inexperience with nuclear projects, their failure to appreciate the legal and engineering complexities of a nuclear construction project, and their overall fossil-oriented outlook all contributed to the manner in which they addressed the project. As a result, several managerial errors occurred which ultimately led to the stoppage of safety-related work. Primary among these errors was a failure to staff the nuclear project adequately with sufficient personnel having applicable nuclearrelated experience. A few key positions were staffed with personnel with appropriate nuclear credentials, but overall there was neither sufficient breadth nor depth to provide reasonable assurance of success.

Another error lay in their understanding, or perhaps misunderstanding, of NRC and its role in the licensing and oversight of nuclear construction projects. With their strictly fossil background, they tended to view NRC as another government agency with another set of regulatory hurdles to engage and complete, much like had occurred in the construction of their fossil plants. This lack of understanding of the NRC role in reactor construction contributed in part to their failure to recognize the extent of their problems earlier than they did - "hearing" what NRC said, but not really "listening." NRC also was slow to recognize the extent and depth of the problems, as will be discussed later.

Similiar to their lack of understanding of the importance of the NRC role and its rules was the utility's lack of understanding of the importance of various nuclear codes and standards. This misunderstanding caused them to be slow to recognize the significance of the findings of the National Board of Boiler and Pressure Vessel Inspectors referred to earlier.

Another management error on the utility's part was their over-reliance on contractors. They regarded their contractors, despite their inexperience, as being competent in nuclear construction work. The utility tended to view their contractors as the experts in the areas in which they were working and generally did not question their activities. Moreover, they turned over de facto management of the project to their contractors. (More about this later.) Finally, their inexperience, lack of qualified staff and over-reliance on contractors resulted in not recognizing or being able to recognize that the construction quality problems they saw (e.g.,

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the honeycombing of the concrete and improper patching) were but symptoms of a much deeper underlying malaise in their entire program of project, construction, and quality management. In short, they saw the symptoms but did not understand how much deeper the underlying causes ran.

B. Secondary Root Causes

We have identified four secondary root causes of the construction quality problems at the reactor project. They are:

1. Lack of understanding of the potential merit of a formal program for the assurance of quality.

2. Development of a false sense of security by the utility.

3. Failure of the utility to manage the reactor project from the outset, and

4. Deficiencies in NRC licensing, inspection and enforcement practices.

We will explain each of these in more detail.

1. Lack of understanding of the potential merit of a formal program for the assurance of quality.

As indicated above, the utility has a history of completing successful fossil projects on time and within budget. They viewed quality in such a project as something that just gets built in it comes naturally as the result of good management and an able, knowledgeable and dedicated staff. From years of experience, everyone from the top down seemed to know what it took to build a successful fossil plant, and they all worked together to ensure that the overall project and final product works and is safe. The utility viewed their success record as the result of teamwork and dedicated personnel. It was a record established without the help of, or need for, a formal quality program or organization. The same attitude carried over to the construction of nuclear plants. Because NRC's 10 CFR 50 Appendix B required a formalized QA program and organization, they created one without an adequate understanding of its role, importance or potential as a management tool. Since NRC requires that the head of the QA organization report to the highest levels of utility management, coupled with the fact that the QA organization also has the authority to audit the activities of others (including those at high levels) the predictable result was a lack of enthusiasm, a lack of management support, and even a mistrust of the QA program and staff. The NRC Region's investigation in the late 1970's produced internal utility documentation which showed that company executives were cold to the idea of hiring very many people for the quality assurance organization, fearing the development of a quality assurance "empire."

Such mistrust of and lack of enthusiasm for the mandated quality assurance program resulted in a lack of adequate authority or staff (either in size or qualifications) for the quality assurance organization (NRC inspection reports contain a more complete discussion of this point).

2. <u>Development of a false sense of security by the utility</u>.

This secondary root cause is somewhat related to the primary root cause, inexperience. NRC's region based inspectors found numerous problems at the reactor site between CP issuance and the stop work order about a year and a half later, but until just before the stoppage of work, the utility (and NRC) did not recognize the full extent of the problems. One utility staff member (quality assurance) who was there at the time of the problems explained it this way (paraphrased): "NRC came in and they found a few things wrongs, but that's their job. They didn't communicate to us that we had any really serious problems. Since we viewed them as the experts, we felt that we probably didn't have any major problems." This opinion was corroborated by others involved at the time, including very senior utility management.

Heavy reliance on contractors also caused the utility to develop a false sense of security. Here, too, they felt that the contractors were the experts and that if anything went wrong, the contractors would address it.

Another contributor to the utility's false sense of security is the fact that the reactor is a replicate of another plant which is being built for a neighboring utility with several operating nuclear plants. The utility made extensive use of design and licensing documents prepared for the other plant and felt that most major problems in construction would surface there first and the utility's project could be reprogrammed to take advantage of the neighbor's experience.

3. Failure of the utility (or its designated representative) to manage the reactor construction project from the outset.

This secondary root cause overlaps the primary root cause, inexperience, but it is of such fundamental importance that it is highlighted as a root cause in its own right.

Perhaps the utility did not effectively take control of the reactor project from the outset because they knew they had no prior nuclear project experience, and so they would rely more heavily on contractors than was their normal mode of operation. In any event, the utility, acting as the project's general contractor, relinquished too much of the day-to-day management of the project to surrogates, they failed to establish an effective project management presence at the construction site (they tried to manage in a matrix arrangement from corporate headquarters), and they diluted accountability within the corporation for project responsibility. All of these failure-to-manage factors (plus over reliance on replication) contributed to the construction problems that led to the stop work shutdown.

4. <u>Deficiencies in NRC licensing, inspection and enforcement practices</u>.

NRC's licensing review for a construction permit is largely limited to technical issues and conformance with 10 CFR 50. Although NRC does review an applicant's financial position, NRC does not (and did not in the case of this utility) perform a formal review of the applicant's ability to manage, and carry through to completion, the construction of a nuclear reactor. The issues in this case are management capabilities and lack of experience, and NRC's formal licensing process failed to adequately address either.

NRC's inspection program for the reactor project consisted of a series of visits by regional based inspectors. A resident inspector was not assigned to the site until several months after the stop work order. Occasional visits by a series of regional inspectors does not provide any of them individually or NRC with the comprehensive feel for or command of a project that a resident inspector obtains. Given the extreme contrast between the utility's performance before and after the stop work order, there are generic implications for licensing to be derived from the NRC's high standards for construction resumption, including the use of hold points.

Finally, the enforcement signals sent to the utility by NRC were confusing to the utility. On the one hand, NRC was late to recognize the extent of the problem. This helped reinforce the utility's false sense of security. On the other hand, when NRC did recognize or suspect the extent of the problems, the utility was late to understand the significance of NRC's new stronger message. They did not fully appreciate NRC's role in the construction of nuclear reactors.

V. REMEDIAL ACTIONS TAKEN TO CORRECT (TURN AROUND) QUALITY PROBLEMS

As a result of the site assessment of the utility's QA program, it is the opinion of the study team that a dramatic improvement has occurred in the effectiveness of the utility's project management, construction management and QA program. This opinion is consistent with the NRC Region's rating of the licensee's QA program as "outstanding" in the last two SALP reports. Remedial actions taken by the utility of significance for inclusion in this report follow.

A. Recognition of Problem

A manifestation of the inexperience factor (in nuclear construction) was that corporate management was unable to recognize legitimate nuclear construction problems or their severity. While they assumed the role of general contractor and construction manager for the project in name, they didn't accept the responsibility. Indeed, they did not fully appreciate what that responsibility entails. When problems arose, they failed to evaluate them correctly (as minor or significant) and pushed them back on their contractors for action. Subsequent to the stop work order, the utility contracted to have a management analysis performed of the construction project. The findings of this study corroborated and went beyond the NRC and National Board findings, and were instrumental in convincing utility management that they had a serious quality problem and that its roots went much deeper than the QA program and organization, into the very management approach, structure, organization, and staffing of the entire project. Faced with the preponderance of evidence resulting from the NRC order and findings, confirmation of the allegations, congressional hearings. the management analysis, and their own cost analysis which showed the future of the company at risk, top corporate management recognized they had made serious managerial miscalculations in the project.

Based on our observations, discussions, and interviews with numerous people cognizant of the situation before and after the stop work order, this drawing of understanding was not unlike a religious experience. Once this recognition and understanding was grasped, the company decided to do whatever it took to manage the project successfully and to complete safely built, quality nuclear reactors. Subsequently, they embarked on a conscientious program not only to do better, but to "be the best," despite the added costs. This commitment manifested itself in reorganization and staffing of key management positions with personnel having extensive backgrounds in nuclear reactor projects.

B. Decision to Address the Problem Substantively

Having recognized the problem with their project, its seriousness, its depth, and its pervasiveness, utility management decided they would do whatever it took and pay whatever it cost to correct the situation and prevent its recurrence. They recognized that recognizing the problem was only a first step - they had to put in place, in a substantive manner, the management system to correct past problems and successfully complete the project. While recognition was a difficult step, the next steps of planning and implementing a meaningful fix would be just as difficult. Certain aspects of these next steps are particularly noteworthy and will be discussed below.

It is important to note that both recognition of the problem and the decision to face it substantively began with and emanated from the highest levels of utility management.

The key factors were as follows:

1. Why

Why did they decide to address the problem substantively? The utility recognized their corporate future hung in the balance. Their very survival as a corporation depended on the success of this project. (The current estimated cost of the two unit reactor project is about twice the net worth of the utility.)

The licensee performed a cost analysis and determined it was in the best interest of the company to continue with their project and to complete it. They recognized, however, that they could not affort further substantive delays on rework resulting from inadequate quality of construction. Hence they decided that in order to successfully complete the project (and save their company), they had to pay extremely close attention to all the members of the cost, schedule and quality triad. A failure in any one area could result in a failure of the project and possible bankruptcy.

2. Humility

Humility is another important aspect of the turn around. People who reach the tops of their professions, including high utility executives, are normally high achievers accustomed to success and uncomfortable with failure. It is difficult, and perhaps even rare, for such people to recognize and admit failure or mistakes. The top management of the utility swallowed their pride, admitted they were failing in their goal to build a quality facility, and decided to aggressively pursue meaningful remedies.

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3. Be the Best

They decided they were not only going to be better, but to be the best. They determined this approach was necessary to regain public confidence and NRC approval for licensing. Moreover, they felt a need to repair a tarnished corporate image. The utility that had built nearly a score of successful fossil plants in the past was neither happy nor comfortable being labeled a failure in the nuclear arena. They consciously set out to erase that image.

4. Staffing, Attitude, Morale, Etc.

Consistent with this desire to be the best, they recruited for the best people available with applicable, nuclear experience to fill their key project management, construction management and quality assurance positions. They recruited on a nationwide basis, paid the salaries necessary to attract qualified personnel away from their earlier jobs and performed selective screening (including using the services of industrial psychologists) to assemble a management team that was talented and could work well together as a team. The utility has developed a team spirit and an orientation to this project which appears to permeate the entire project from the president and chairman down to laborers and quality control workers. Workers are proud to say they work on this particular utility's project.

The utility set up a very visible program to promote the project, pride in the project and the importance of quality. This program helped develop an awareness of quality requirements and a positive attitude towards quality that was detectable among all utility and most contractor personnel that were interviewed.

5. Decision to Manage the Project

A significant change in the project has been a dramatic increase in the level of management control exercised by the utility over the project. This program has increased utility control has been manifested in several visible changes including: establishment of a nuclear division whose sole responsibility is the project and which administratively controls personnel assigned to the project; moving all corporate personnel associated with the project to the site; substantively upgrading and increasing the utility staff assigned to the project; and changing fixed price contracts to cost reimbursable contracts.

6. Elevate Quality Organization and Function; Firmness

One aspect of the utility's implementation of their desire to turn the project around was to take the formal quality function seriously. They elevated the QA organization's de facto role in the management and conduct of the project. The QA manager is now a corporate officer (equivalent to vice president's rank). The utility also recognized that to make the formal QA program work, management had to visibly back it. Shortly after safety-related concrete work resumed, several employees who refused to comply with quality requirements were fired. This and other actions conveyed a clear message to utility staff and contractor management and staff that the utility was serious about quality and that what may have been acceptable before was no longer acceptable. Our study team noted a firmness towards quality by management that conveyed to the entire project staff that the utility wants the job done right.

In addition to backing the quality organization and function, utility management hired or transferred into the quality organization personnel of more ability and

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applicable experience. They significantly upgraded their training and qualification programs for QA and quality control (QC) personnel and instituted a formal quality engineering (QE) program. They also significantly increased the resources allocated to QA/QC. Before the shutdown, there were 29 utility QA/QC personnel, only 4 of which were found by NRC to be qualified for their jobs. Presently there are about 120 qualified QA/QC personnel at the site. Their efforts are supplemented by 210 QA/QC personnel working for the major civil, piping, electrical and HVAC contractors.

7. Quality is Cost Effective

The utility embraced the philosophy that quality is cost effective. Their post-shutdown cost analysis convinced them that it was less expensive to do the work right the first time. Their project resumption plan was predicated on the recognition that building the project correctly the first time (i.e., with adequate quality) was essential if they were to meet the other goals of cost and schedule.

Now, emphasis is placed on doing the job right the first time and making the necessary resources available to cause this to happen. This includes the QA function, which prior to the shutdown had neither the resources, talent, nor authority to do an effective job. Based on the study team's observations, the utility from the chairman down feels that quality is cost effective, and has made decisions and set in place actions that reflect this belief (including the hiring of highly qualified people in key positions, the setting up of a state-of-the-art records management system, the implementation of most of the recommendations of the management firm's diagnostic, and a continuing emphasis on quality).

Moreover, the utility changed fixed fee contracts to cost reimbursable contracts, thus enabling each contractor to give full support to the utility's high QA standards without experiencing financial loss.

8. Team Spirit

It is difficult to develop a sense of team spirit in a project that has been subject to a stop work order, and the subsequent laying off of hundreds of workers. In turning the project around, the utility has managed to attract quality people who believe in the project and their ability to help make it a success. An example: The supervisor of the QE function was recruited by the utility after the shutdown and hired away from another, apparently more successful, nuclear project several states distant. On the wall behind his desk hangs an embroidered plaque made for him by a friend shortly after he came to work for the utility (and long before the lifting of the stop work order). It reads, "Achieving starts with believing in (name of project)."

B. Help From NRC

NRC had been slow to recognize the extent or severity of the quality problems at the construction site. Through their regional-based inspection program, they were aware of some problems in the placement of concrete, but it wasn't until shortly before the shutdown order that NRC recognized and communicated to the utility that the concrete placement problems were symptomatic of a much deeper and more serious underlying malaise in the management of the project. The NRC's recognition of the seriousness of the problem was jelling just prior to the allegations of improper concrete placement and the confirmation of quality problems in piping systems by the National Board. When NRC went to the utility with their findings and the position that the utility indeed had a very serious problem, the utility was slow to totally understand or believe what the NRC was saying.

1. Strong NRC Action

NRC was instrumental in getting the utility to recognize they had a serious construction quality and, ultimately, project management, problem. The NRC's order had the effect of law and prevented the utility from resuming safety-related work until the NRC was satisfied that the utility had in place the management system, people, procedures, etc. to effectively manage the project. This strong action by the NRC served as a catalyst for the project analysis that led to the utility's recognition of the problem and their decision to address it substantively. That is, the NRC order led to the cost analysis, management diagnostic, and congressional hearings that finally brought recognition and reform. Moreover, during this process the utility came to recognize the enormous regulatory and safety responsibility and power of the NRC. NRC, for this project, was not another OSHA or EPA whose regulatory hurdles were to be engaged and cleared. NRC could determine whether this project would ever be completed or licensed or not; hence, NRC decisions could affect the solvency of the corporation. The utility recognized that while they were ultimately responsible for their own destiny, NRC essentially holds veto power. They decided that the earlier antagonistic attitude of some of their project staff toward the NRC was inappropriate and counterproductive. As one senior utility official told the team, "It doesn't pay to fight the NRC; the best you can get with the NRC is a tie."

2. High Standards

NRC contributed to the turn around, and its extent, in a significant way by setting high standards for the resumption of the project. NRC's requirements for total restart of the project

NRC's requirements for total restart of the project contained "hold points" corresponding to the different stages of recovery, each of which would be subject to intensive scrutiny by NRC inspectors. In addition, there were intermediate hold points within each stage. As indicated previously, the five stage were: revised QA program, receipt inspections, material verification programs, construction verification program, resumption of construction. NRC's requirements for for resumption of construction were more stringent than were NRC's initial requirements for CP issuance. For resumption of construction, NRC focused more on the issues of management and management capability, and required demonstrations of capability rather than statements of intent.

F. NRC Resident Inspector

Prior to the work stoppage, NRC had not assigned a resident inspector to the project. An experienced NRC inspector was assigned to the project as the resident inspector about 4 months after the stop work order was issued. Both NRC and utility staff credit the resident with being a key factor in the project's turn around. He was perceived to be firm but fair and results oriented - one who focuses on substantive issues. Senior utility management felt that had a capable resident inspector been assigned to the site coincident with or prior to the CP, the project's quality problems would not have proceeded to the extent they did. Based on their own difficult experience, senior utility management feels that NRC should have an experienced resident on site from the beginning that, in fact, the first 15% of the project may be the most crucial 15% because it is during this period that working practices, procedures, contractor-management interfaces, etc. are established for better or worse. If they are the latter, there is not much the NRC inspector who comes on at 15% can do to turn a bad project around - short of recommending strong enforcement action (such as work stoppage). By 15% completion bad habits are established, ingrained and hard to turn around.

VI. GENERIC IMPLICATIONS

Based on the information reviewed and analyzed by the study team, this case study suggests several possible generic implications or lessons with respect to insuring quality in nuclear projects. They are discussed below.

A. Management Commitment to Quality

Although it seems almost trite to say, management must be committed to quality. However, it takes more than a management attitude that knows it wants quality. It takes management understanding of what it takes to have a successful project, and it takes a workable system to implement their understanding. A workable system may be expensive and may be costly. Cost, as expressed by commitment of resources, is probably a good measure of management's commitment to quality. Commitment of resources includes management's own time devoted to involvement in the project and to assuring quality, and their willingness to invest in talent, experience, and workable systems to support the quality function in the project.

B. Understanding

The utility should understand what it is getting into in a nuclear project. The utility should understand that there is a significant difference in construction complexity and difficulty between a fossil or hydro project and a nuclear project. The utility should understand the difference in construction complexity caused by the addition of safety requirements of nuclear plants. The utility should understand that the greater safety requirements bring with them the NRC and a great deal more regulatory attention than would be the case in a fossil plant. The utility should understand that NRC can, and might, in its public safety role suspend construction on the plant, refuse to license it, or revoke its license. The utility should understand that it may well be mortgaging its corporate future to the nuclear plant and that as the nuclear project goes, so goes the company. The utility should understand that there is nothing more important to the utility than the successful completion and operation of the nuclear project, and the utility should provide the nuclear project attention and management commensurate with the project's importance.

Not only should the utility understand that these things are true, it should appreciate consciously how true they are and that shortcuts in any aspect of the nuclear project may lead to corporate disaster.

To some degree these understandings may be achieved through education, through looking at projects that have had problems and trying to learn from them.

The utility should educate its people, both management, labor crafts, QA/QC, etc. of the importance of quality in a nuclear project for both safety and economic reasons.

C. Effective Management of the Project. Responsibility for the Project

Given that the utility may be bankrupted if it has an unsuccessful nuclear project, it would seem logical to put its full attention on management of the project. Although the utility often hires contractors to do design, engineering, procurement, construction management and/or construction work, the utility is ultimately responsible for the safety of the product; hence, whatever the utility's arrangement with A/E's, contractors, etc., the utility must exercise effective stewardship over those contractors. That is, different responsibilities and amounts of responsibilities will be delegated in different projects (depending on how much the utility does itself, how much the A/E does, etc); however, the utility must exercise effective oversight over the whole project to be sure it is coming together properly. In this case, the

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utility's role was a central one as construction manager. In other cases, the A/E might also act as construction manager. Whatever the utility's role in construction management, it is responsible for overall project management, and it must set up systems and practices so that it can effectively discharge that responsibility.

D. Resources and Support for Quality Programs and Organization

The law (through NRC regulations) requires that nuclear projects have a formal quality program and organization. Given that this is a requirement and many people in the project know it, including laborers and QA/QC staff, the utility will make a costly mistake if it treats the requirement only as a requirement, not as a management tool that management believes in. Lack of management support for the required quality program is generally readily evident to those both in and out of the program, and it sets the tone for the success of failure of the program. To work, the mandated program needs the support, both on paper and in substance, of utility management. This support should be manifested in commitment of management's time to insuring quality, in delegation of sufficient authority to the quality organization, in backing up the quality organization where required, in assignment of high quality personnel with proper experience and training to the quality organization, and in assignment of sufficient resources to get the quality organization's job done.

E. Team Attitudes

Development of a healthy attitude toward quality and a project mindedness in a construction team is not something NRC can require in a regulation, but it is one of the important intangibles, like management commitment, that is associated with good projects. Development of such a team spirit and project orientation is very likely a product of good management. Both a team spirit and a project orientation seem important, perhaps necessary, for the successful completion of a nuclear construction project today.

F. Quality Personnel

Just as good management seems to be necessary, so does staffing the project broadly and deeply with capable, dedicated personnel. As with almost any other endeavor, the quality of the final product is a function of, and directly related to, the quality of the people working on the project. There is no substitute for good people. In short, utilities must have or obtain personnel with the education, qualifications and experience that are required to construct complex nuclear reactor facilities.

G. Effective Communication and Interaction Between Organizational Components (Project Management, Construction Management, QA)

There should be effective communication and involvement between the project management team, the construction manager, the designers, the engineers, the craftsmen, QA/QC, etc. Bridging these interfaces effectively is essential to the smooth progress and completion of the project, and to ensure that the ball is not dropped on some crucial aspect of the project. The more interfaces there are, the more difficult it is to control and monitor the project, and the more challenging it is for the utility and its project management team. Effective management of these interfaces is enhanced by team attitude and project mindedness and is a measure of good management. A team attitude should exist for the QA/QC program and organization to be effective. Project oriented (as opposed to "turf-oriented") interfaces should be established between engineering, project management, constructors, construction management and quality assurance.

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H. Nuclear Experience Necessary But Not Sufficient

Prior corporate nuclear experience would appear to be helpful. Lacking previous corporate nuclear experience, the new nuclear utility needs to hire people with applicable nuclear experience to staff key positions, both at management and lower levels. However, hiring experienced personnel is not enough to assure success. The personnel have to be put together right to make the project succeed. This requires an understanding of what is required by management and by the entire project team (which management must mold) to build a nuclear reactor in the U.S. today.

I. NRC Licensing and Inspection

NRC, in granting a CP, should look beyond the plant design, seismic criteria, and financial status to determine whether the utility is capable of managing a project having the scope and complexity of construction of a nuclear project.

NRC's presence in the early stages of construction is vital and should be constant, not sporadic. Qualified NRC personnel should monitor the project at the construction site from the very beginning of construction work. NRC should focus more on the substance of the project and the quality of the design and construction work, and less on paper requirements. Moreover, NRC should take action to increase inspection coverage of construction activities, even after the assignment of a resident inspector. Active construction problems at other sites seem to be contributing to a lessening of the inspector's presence at sites that are not thought to be in as much difficulty. Moreover, bad practices developed during the early stages of construction carry over into later work and the time to catch these practices and correct them is at the beginning. Waiting until the project is 15% complete can permit poor practices to become accepted and ingrained and much harder to turn around. In this case, licensee management said assignment of a resident to the reactor site from day one of construction would have been a great help in recognizing the utility's problems earlier and before they became as extensive as they were.

NRC Region personnel stated that when they started reviewing the QA program submittals (PSAR) prior to issuing a construction permit for this utility (mid 1970's) they were inexperienced and did not fully understand what was needed for a successful QA program. They said they were minimally qualified at that time and badly understaffed. The qualification problem appeared to have been rectified as far as qualification of NRC personnel at the utility site is concerned by assignment of an experienced resident inspector. However, the NRC Region Office staff is still stretched thin. The resident inspector performed over 90% of the on-site inspection in FY-82.

J. Other Generic Implications

The application of nuclear codes, standards and the regulatory requirements is confusing. Several contractor personnel interviewed who had worked at other reactor projects mentioned that in their view there was an inconsistency of application of requirements within the various NRC Regions.

The Architect-Engineer should prepare specifications that are unambiguous and interpretable with clearly defined tolerances to reduce conflict between QA/QC and construction personnel on how strictly the specification must be interpreted and enforced. This has implications for Ford Amendment Alternative 13(b)(1).

VII. IMPLICATION OF THIS CASE STUDY (CASE A) FOR NRC QA INITIATIVES

NRC has underway or under study a number of initiatives which are designed to establish additional confidence in the quality of design and construction activities, to improve the management control of quality, and/or to improve the NRC capability to evaluate the implementation of licensee programs. These initiatives are described in the NRC staff paper, Secy 82-352, entitled "Assurance of Quality" and subsequent correspondence between the Commission and the NRC staff. One of the purposes of this case study is to provide feedback regarding the relevance of the various initiatives to this utility's nuclear construction project. Subsequent paragraphs take each initiative in turn and answer whether the initiative, had it been an ongoing activity at the time of this utility's construction quality problems, would have made a difference. That is, would the initiative have helped prevent or at least mitigate the construction quality problem that has been discussed earlier.

A more complete discussion of the scope and details of the various NRC QA initiatives may be found in Secy 82-352, Secy 83-32, and Secy 83-32A. The latter two papers are quarterly status reports to the Commission on the implementation of NRC's quality assurance initiatives. It should be noted that each of these initiatives were discussed with those interviewed, especially senior management of the utility. They agreed with the study team's evaluation of the applicability of the initiatives to their prior construction quality problems.

Which initiatives might have made a difference in the case of this construction project's quality problems?

A. Measures for Near Term Operating Licensees (NTOL)

1. Licensee Self-Evaluation - Not applicable/No.

This licensee's construction problems occurred early in the construction process, and the licensee self-evaluation is an action that would take place when the licensee is in the process of receiving the operating license. Had this measure been in effect in the late 1970's when the licensee obtained his CP, its effect on the licensee's construction performance in the first 20% of the project would have been negligible.

2. Regional Evaluation - Not applicable/No.

Same reason as above in VII.A.1.

3. Independent Design Verification Program (IDVP) - No.

Same reason as above in VII.A.1. In addition, this measure is oriented toward design adequacy, and the licensee's quality problems examined in this case were in construction. This conclusion could not be interpreted as implying that an IDVP might not be beneficial at some point in the design/construction of the project either before or as the licensee nears the operating license stage, nor that the licensee many not have or develop design problems. Rather, this conclusion means that with regard to the construction quality problem examined in this case study, NRC's practice of requesting some licensees to submit to an IDVP prior to receiving an OL, would not have made any difference. Some utilities have extended this concept into construction verification. Such construction quality audits could be effective in a manner similiar to INPO construction audits (discussed below in B.1).

B. Industry Initiatives

1. INPO Construction Audits - Yes.

This measure, which looks at both management and programmatic considerations and the quality of the product (hardware) would have been beneficial had it been in place at the time of this utility's construction problems. The licensee might have listened to INPO findings because (1) they came from outside the utility from people who should be experts and (2) they came from a group comprised of their peers and supported by the industry. The utility, at the time of its trouble, did not quite know how to read NRC and tended to look at NRC findings as hurdles rather than indications of real problems. They might have listened to an INPO type group more than to NRC. These audits would have been particularly beneficial to the utility if they had a heavy focus on the quality of the project, on project construction management, and on obvious quality problems (e.g., poor concrete quality) as indicators of deeper programmatic problems.

3. Utility Evaluating Using INPO Method - Yes.

This measure, which is basically a self-evaluation using the INPO methodology described in VII.B.1 above, would not have helped if the utility used only their own people in the audit team. At the time utility management would not have listened (they did not, in fact, listen to their own QA department). However, these "self evaluations" could have been of some benefit if they included personnel from outside the utility. First, outsiders may well have had more experience and perspective than licensee staff and hence been better able to identify problems. Second, utility management would have been more receptive to outsiders' views than those of their staff. Although this kind of audit, with outsider participation, would have helped, it would not have been as effective as an INPO audit. It is easier for the utility to ignore or minimize the findings of their own audit or evaluation than to ignore INPO findings.

D. NRC Construction Inspection Program

1. Revise Procedures and Increase Resources - Yes.

This initiative gets a yes if by revising procedures it is meant: (1) streamline the inspection procedures to eliminate redundancy and prioritize according to safety significance, (2) focus more on observations of actual construction work and less on paper and reports, and (3) focus more on the quality of management of this project and less on the formal QA manual, organization chart and written procedures. A strong yes applies to increased inspection resources, especially at the outset of a construction project. NRC's irregular, nonconstant and limited presence at the site in the early part of this project was a contributing factor to not detecting the problem at an earlier stage. In the exit briefing licensee management went further, arguing that placement of a capable NRC resident inspector at the site, coincident with or prior to CP issuance, might indeed have prevented a good part of the quality problems they experienced. Based on their own difficult experience, senior utility management feels that NRC should have an experienced resident on site from the beginning - that, in fact, the first 15% of the project may be the most crucial 15% because it is during this period that working practices, procedures, contractormanagement interfaces, etc. are established for better or worse.

2. Construction Appraisal Team (CAT) Inspections - Yes.

This initiative gets a very definite yes (assuming the licensee had been subjected to this inspection procedure prior to the shutdown order). The depth and comprehensiveness of this inspection procedure would have enabled NRC to assess the extent and severity of the utility's quality problems more rapidly and completely than the routine inspection program and would have given form and substance to the Region's early indications that the project had quality problems. Indeed, the shutdown order was precipated in large part by a special regional team inspection, which may be thought of as a scaled down version of the present CAT inspection. Given NRC resource limitations and other priorities, only 4 CATS per year are planned. This means that the CAT program cannot cover all plants under construction each year. However, a combination of INPO Construction Audits (in sufficient number) overchecked by NRC CAT inspections is feasible and would have helped had it been in place at the time of this utility's problems.

3. Integrated Design Inspection - No.

Same reason as VII.A.3, Independent Design Verification Program.

4. Evaluation of Reported Information - Maybe.

This initiative would computerize 10 CFR 50.55(e) and Part 21 reports, facilitating trend and other analyses of the event reports. This licensee had submitted no such reports to NRC prior to the shutdown, so NRC analysis of their reports would have shown nothing (except that the utility did not think they had problems which in itself might be an indicator). However, had NRC had such a data analysis capability, they might have observed trends in other beginning construction projects which could have been useful as warnings for potential problems at their site. This is conjecture, and the intitiative gets a "maybe."

D. Designated Representative (DR) - Unclear.

At the time this case study was conducted, it was unclear how a DR system would be implemented by the NRC. Without a constant NRC presence at the site (to oversee the work of the designated representative), it is not clear that a DR program would have made any difference. The DRs very likely would have been selected from the licensee QA/QC staff and the licensee was not listening to his QA/QC people at the time of the problem. On the other hand, a constant NRC presence at the site, early on, probably would have helped mitigate the licensee's problems (quicker discovery, possibly some prevention). Expansion of this NRC presence via a DR program should have been even more effective. If the DR program involved a rigorous qualification check of those selected fo participation, the QA/QC work would have been performed by more qualified individuals. However, the problems of the utility not listening to its QA/QC staff might still have existed.

E. Management Initiatives

1. Seminars - Yes.

Part of the utility's problem was that utility management did not fully appreciate what they were getting into with the construction of a nuclear plant, nor what construction problems they might encounter. Industry or NRC sponsored seminars aimed at CEOs and other senior management, which went into some depth and used real examples in explaining what could go wrong in a nuclear construction project if a utility were not careful, might well have been useful. This is especially true if senior executives of other utilities who could speak from experience were involved in the presentations.

It can be argued that executives of this utility might have listened to such a presentation and come away with the feeling that "it can't happen to us." However, senior utility management indicated that their prior obliviousness was caused by the fact that they simply didn't understand what they were getting into and that any information from peers who had been there before would have been listened to and perhaps heeded.

2. Qualification/Certification of QA/QC Personnel - No.

At the time of the utility's construction quality problem, utility management was not listening to warnings coming from the QA organization (nor were they acting favorably on requests for additional QA/QC personnel). The utility had established a formal QA program and organization because NRC required it, but they did not view the QA program as a management tool that could contribute to the success of the project. QA was not perceived to be part of the project team. An NRC requirement that personnel holding certain QA/QC positions hold special certifications might have improved the quality of the QA/QC staff, but it would not have made management listen to them any more than they did.

3. Craftsman Ship - No.

Although the utility's quality problems manifested themselves in substandard concrete and piping work, the cause of the problems was not poor craftsmanship, it was poor management. Indeed, the discovery of the extent and seriousness of the problem was speeded by allegations of poor concrete work made by a laborer. More awareness training of craftsmen stressing their responsibilities for quality might have caused the extent to the problem to be recognized sooner.

F. Certification of QA/QC Programs (Secy 83-26) - Yes.

Had this proposal been in effect at the time, particularly as a condition for issuance of the CP (see VIII.B in the discussion of the Ford Amendment), the licensee would have had to pay more attention to, and put more into, his QA program. As a result, utility management would have had to treat QA as something more substantive than just another regulatory requirement, resulting in some improvement in their annual audit program. It is more likely that this initiative by itself would not have prevented their problems, but it would have helped mitigate them.

1. Management Audits - Yes.

This intitiative was suggested by senior licensee management during the case study team's exit briefing. Utility management felt that the one thing that would have helped more than anything else was being subjected to good, substantive management audits. No one told them they were not managing the project properly (until the shutdown) and they were too inexperienced in nuclear construction to discover this fact on their own. Utility management felt that an in-depth look at their project/construction management by an INPO-like group or by a management analysis group such as the one which performed the diagnostic subsequent to the shutdown would have been extremely helpful.

IMPLICATIONS OF THIS CASE STUDY FOR THE FORD AMENDMENT ALTERNATIVES

Section 13 to NRC's FY-83 Authorization Bill requires NRC to conduct a study of existing and alternative programs for improving quality assurance and quality control at nuclear power plants under construction. This section, called the Ford Amendment, requires NRC to look in particular at the feasibility and efficacy of five specific alternative program concepts. As part of this case study analysis, each alternative concept was evaluated with respect to whether it would have made a difference in this utility's case, had it been in place at the time of the utility's CP issuance and subsequent construction problems. As was the case with the QA initiatives, each of the Ford Alternatives was discussed with the project team, including senior utility management, and they agreed with the study team's evaluation of the applicability of the initiative to their prior construction problems.

Which Ford Amendment concepts or alternatives might have made a difference in the case of their construction project's quality problems?

A. More prescriptive architectural and engineering criteria - No.

The Authorization Act requires NRC to evaluate the following alternative: 13(b)(1) - adopting a more prescriptive approach to defining principal architectural and engineering criteria for the construction of commercial nuclear power plants that would serve as a basis for quality assurance and quality control, inspection, and enforcement actions.

Same reason as above in VII.A.3. The quality problems that are the subject of this case study were in construction, not design or engineering. It does not appear that a more prescriptive approach for defining principal architectural and engineering criteria would have made any difference in how the licensee managed (or failed to manage) the construction project.

B. Conditioning the construction permit on the applicant's demonstration of his ability to manage an effective quality assurance program - Yes.

The Authorization Act requires NRC to evaluate the following alternative 13 (b)(2) - requiring, as a condition of the issuance of construction permits for commercial nuclear power plants, that the licensee demonstrate the capability of independently managing the effective performance of all quality assurance and quality control responsibilities for the plant.

It does appear that this measure, had it been in place at the time of the issuance of a construction permit to the utility, would have had a positive effect on the project nor would have lessened the postconstruction permit construction problems. The reasoning behind this judgment is as follows: The licensee had not had a QA program prior to its embarking on a nuclear project, and it set up a QA program for this nuclear project because it was an NRC requirement. The utility viewed the QA program as just another requirement and supported it accordingly. Had NRC required a demonstration of the utility's ability to manage an effective QA program prior to construction permit issuance, both the licensee and NRC would have had to take implementation of the QA program more seriously. However, it would have had to be viewed in a different light: The licensee could no longer pass the NRC test for QA (i.e., approval of a chapter in the PSAR) through a written description of a program that existed more on paper than in fact; the utility would have had to have in place, not only a program, but one that was demonstratably effective (for example, in the contracting, procurement and limited work activities conducted prior to the CP issuance). In short the utility would have been forced to (1) recognize that NRC weas indeed serious anout QA, (2) recognize that NRC would not let it go forward into its construction activities until an actual (not a hypothetical program described in the PSAR) effective program was in place, and (3) think through more clearly how to manage the project and how QA fit into it. This concept, had it been a requirment at the time, would, in addition to making utility management think that NRC really through QA was important (indeed more of a management tool or system than a requirement), would have potentially put in place an effective, qualified, staffed QA program and organization fromthe outset of the project.

Hence, at least three factors that contributed to the utility's constructions problems would have been somewhat mitigated: (1) utility management would have had to pay more attention to QA, both in a broad sense and in a programmatic sense, (2) the utility would have had to think through and plan the project better, and (3) the utility would have had a strong QA program in place from the outset. Given: (1) some change in management attitude toward quality, (2) better management practives and (3) a viable QA program from the beginneing, all of which could have resulted from this Ford Alternative, the licensee could have been in a far superior position to deal effectively with, and perhaps avoid, construction quality problems of the type that 16 months after construction permit issuance resulted in cessation of all safety-related construction activities.

C. Audits, inspections, or evaluations by associations of professionals having expertise in appropriate areas - Management audits, yes.

The Authorization Act requires NRC to evaluate the following alternative 13(b)(3) - encouraging and obtaining more effective evaluations, inspections or audits of commercial nuclear power plant construction by independent industry or institutional organizations, based upon best experience and practices.

The licensee was subject to audits, inspections, and/or evaluations by associations of professionals during the period between construction permit issuance and the shutdown. Audit findings by the National Board of Boiler and Pressure Vessel Inspectors regarding substandard piping work coincided with NRC recognition of substandard concrete work and helped speed realization on the part of NRC and alert the utility that the utility had a severe and pervasive quality problem, the roots of which lay in poor project management. However, until the shutdown and subsequent independent third party diagnostic and introspection on the part of the utility, the utility had little appreciation for and paid little attention to inspection results by the National Board, ASME, or other similiar groups. The utility did not understand the code system that applies to nuclear projects and viewed National Board-like inspection findings as irritations more than as something of substance that needed to be dealt with. A change in this attitude did not come until after, and as a result of, the shutdown action.

Hence, audits, inspections, or evaluations were conducted by associations of professionals during the period between construction permit and shutdown, and contributed ultimately to the shutdown decision. However, these reviews did not help to prevent the problem from happening, mitigate it, or cause earlier detection or program turn around. The licensee did not take the findings of these groups seriously. This lack of attentiveness was due partly to ignorance and inexperience but also to the fact that it is quite difficult to recognize that substandard piping work is only a symptom and that

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poor project management is the disease. Senior licensee management indicated that what they needed at the time to recognize their problem was not code surveys aimed at a narrow construction activity, but rather management audits aimed broadly at the quality and effectiveness of their planning, organization, project management, and QA program (such as the one performed later by a third party after the shutdown). They argued that their problem was poor management, that they dinn't recognize it and that no one pointed it out to them (until the shutdown). During the period of their construction quality problems no one, NRC or anyone else, pointed out their management problems. They argued that it is much easier to recognize that the problem may be bad management when someone outside the utility, particularly a group of recognized experts, conducts an audits and finds that bad management is the problem than when someone conducts an audits and says that the problem is bad welds. Moreover, a management audit which makes use of actual defects in design or construction to bolster its conclusions will be stronger than one which does not.

Although the utility might have been reluctant to accept findings pointing to project management problems, they at least would have had that information available to them rather than proceeding forward oblivious in their ignorance of management problems. Senior utility management strongly endorsed the idea of outside management audits, including INPO-type reviews, as in improvement to the overall system that would have been of benefit to them during the period they were getting into trouble. This is particularly true if the organization doing the management audit also had the power to bring some pressure on the licensee, be it peer pressure or stronger. If the auditing organization were subservient to the utility and had no power, even indirectly over the subject utility, the utility would not have paid much attention to the audit findings during the problem period. Hence, an INPO-type audit or NRC required third party audit would have had an effect; however, a self-initiated audit whose results went no futher than the utility would not have.

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D. Improvement of NRC's QA Program - Yes

The Authorization Act requires NRC to evaluate the following alternative: 13(b)(4) - reexamining the Commission's organization and method for quality assurance development, review and inspection with the objective of deriving improvements in the agency's program.

It is clear from previous sections of this document that NRC was part of the problem also. The following changes to NRC's program would have mitigated and possibly prevented the development of the construction quality problems discussed earlier.

1. Modify the licensing review process for a construction permit (CP) to examine the utility's ability to effectively manage a project as complex and technologically demanding as the construction of a nuclear reactor in accordance with NRC requirements. The CP review for this licensee focused on technical issues and financial capability, but it did not assess the capability of the applicant to manage the project or oversee the work of the contractors. A paper review would not be sufficient; just as ineffective QA programs are approved based on a paper review, ineffective project management programs could be approved based only on a paper review. What seems needed is some demonstration of the applicant's awareness of the complexity and seriousness of the project being undertaken and a test of his understanding through some tangible, measurable demonstration of his management acumen for a nuclear project. This recommendation is not unlike Ford Amendment Alternative 13(b)(3), but would be broader and require the applicant to demonstrate his capability to effectively manage the project before CP issuance.

2. As part of 1 above, the applicant would have to demonstrate his capability to effectively manage a QA program. This is Ford Alternative 13(b)(2).

project. Bad habits are very hard to break once a project is 15% complete. To improve effectiveness, residents should be assigned at the Limited Work Authorization (LWA) stage because substantial activity, including development of a QA program and organization take place prior to CP issuance.

4. Expand the scope and depth of the licensing review for QA. This licensee's PSAR QA chapter (and most of its PSAR) was copied from another licensee's previously approved PSAR (this was a duplicate plant). The NRC QA licensing review focuses on a general description of the QA program and commitments by the licensee to comply with 10 CFR 50, Appendix B. It has not looked into the substance of the licensee's QA program, its understanding of what it is committed to, or its ability to manage such a program. This improvement would be coordinated with improvements 1 and 2.

5. Conditioning the CP on the applicant's commitments to submit to third party audits of the QA program - No.

The Authorization Act requires NRC to evaluate the following alternative: 13(b)(5) - requiring, as a condition of the issuance of construction permits for commercial nuclear power plants, that the licensee contract o make other arrangements with an independent inspector for auditing quality assurance responsibilities for the purpose of verifying quality assurance performance. An independentinspector is a third party who has no responsibilities for the design or construction of the plant.

This alternative, as it applies to this case study, has been discussed under Ford Amendment Alternative (3) above. Essentially, the result is as follows: Third party audits of the licensee's management program would have helped had the results been available to outside groups holding substantial direct or indirect authority over the licensee (e.g., NRC or INPO). Third party audits of the licensee's QA program only at the time would have had much less effect (even with outside pressure) because the licensee had little use for the QA organization and program, did not listen to what the QA group was reporting and probably would not have listened to what a third party said about any area the utility did not consider important, including QA. (The licensee was not against quality. The licensee was strongly in favor of quality, but did not see QA as a management tool to help achieve it.)

The essential difference between the licensee's response under this alternative and alternative 13(b)(3) hinges on the lack of confidence in a formal QA program. However, this alternative coupled with alternative 13(b)(2), which would have forced the utility to take QA more seriously, could have been effective and could have helped mitigate or prevent the construction problems.

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APPENDIX A

EVALUATION OF GENERIC KEY INDICATORS FOR CASE A STUDY

KEY TO EVALUATIONS:

C - CONSTRUCTION SUBTEAM

Q - QUALITY ASSURANCE SUBTEAM

E - ENGINEERING SUBTEAM

CASE A

EVALUATION OF GENERIC KEY INDICATORS

1.0 Licensee fully committed to a program for assurance of quality.

a. From the interviews conducted and the observations made, it is evident that this utility is committed to a program for assurance of quality. This commitment carries over from the licensee to its contractors. To assure the contractor's commitment, the licensee was willing to convert contracts from fixed fee to cost plus incentive fee contracts.

Cost and schedule constraints do not cause quality to be overridden. Instead additional engineers were assigned to coordinate and resolve problems, in advance of scheduled work so that schedules could be maintained. It was evident that this licensee has committed resources, set up organziational structures and involved senior management in the QA program to assure success. Senior management, who are located at the construction site, involve themselves in the corrective action process and have set up a management review board responsible to review the status of the QA program. Personnel have been terminated for failure to comply with QA requirements.

b. Participation of senior management was found to be very strong at this utility. Management does participate fully in the QA program and are very visible to all levels in their commitment. QA problems are escalated to the level necessary to get appropriate resolution. What's more, top management is very interested in what the QA/QC have to say. The nuclear program management for this utility is located at the site and corporate management visits the site frequently.

Cost and schedule are maintained in good balance with quality performance. If any mismatch occurs, it is probably in favor of quality.

Stop work authority exists at many levels in the organizational structure both within the licensee and the major subcontractors, is widely and readily used, and recognized as an effective management tool. Authority is excercised to stop a specific portion of a job, the whole job, a contractor's operation, or all contractors' operations.

In the area of QA/QC staffing, the licensee currently has 114 people. The major subcontractors also appear to be adequately staffed. Training and qualification of personnel appears first rate. Q

c. The organization is fully committed to a program for assurance of quality. Senior management are actively engaged in assuring that adequate quality is built into the plant. They have backed up their intent with time (in site visits and meetings on quality) and funds (by providing adequate levels of staffing). Management works with QA/QC staff to improve their approach to decision making. E

2.0 Responsibility and authority are clearly defined and properly implemented.

a. The licensee's QA Manual clearly establishes the responsibility and authority of the QA organization. Contractor's responsibility and authority and interfaces between organizations were reviewed and personnel interviewed clearly understood their responsibilities, authority and interfaces. Specific contracts were not reviewed; however, organizational charts were reviewed. The licensee and and its contractors were set up in similar organizational structure for various buildings to coordinate interfaces and establish schedules for work activities. A smooth working relationship between all contractors was evident with minimal finger pointing. C

b. Clear definition of responsibilities and authorities were evident at all areas sampled and personnel were quite knowledgeable of their own as well as other's responsibilities and authorities. Defined responsibilities and authorities appeared to be properly implemented. Q

c. Responsibility and authority appear to be clearly defined and properly implemented. Procedures are in place governing responsibilities and authorities, and personnel are required to acknowledge in writing changes which pertain to them. There is an acceptance at the working level (nonsupervisory professionals) of the procedures. There is a significant involvement of QA personnel in the planning of the construction work. "Whistle blowing" is actively encouraged. E

3.0 Personnel are adequately qualified for assigned work.

a. This licensee is doing some unique things to train and maintain a qualified work force as follows:

1) One contractor utilizes video cassette training films to train craftsmen on how to perform certain tasks. Professionals from television were utilized to prepare these video films.

2) Personnel applying for key company positions are required to be examined by industrial psychologists to determine their suitability for handling a key management position.

Personnel interviewed were found to be highly qualified for their positions both from the standpoint of nuclear experience and technical education. Training manuals were very impressive and established appropriate experience levels and formal training requirements before an individual could be certified as being qualified to perform a task. C

b. A very comprehensive training program is in existence at this utility both within the utility and the major subcontractors. The licensee has gone to great lengths to obtain highly qualified managerial and technical people and to further train them. Key people go through a fairly extensive screening process that includes an evaluation of a candidate's ability to be a team worker. The assessment team did not have access to personnel records but action is taken for poor performance or violations of company policy or rules of conduct. D

Training programs include schedules, required courses, course outlines, required attendance, attendance records and meaningful examinations when qualification examinations are required; however, there was some indication that further improvements in the program could be made in the area of verifying the training really took place.

c. A well-qualified professional engineering staff was assigned to the utility. Most have significant experience appropriate to their present positions. Some are on the cutting edge of their technology (e.g., on cost and schedule monitoring). Not all personnel in key positions were utility employees, however, so some projects' strengths may be lost to the company as the plant becomes operational. E

4.0 Instructions, procedures and drawings are clear and adequate.

a. This area appeared to be adequately addressed. The contractor responsible for civil/structural work had an excellent system for detailing welding and inspection requirements for structural welds. The mechanical contractor utilizes an effective fabrication inspection traveler to control welding and inspection. An excellent change control program was in place. Some dispute was noted between QC and engineering over the adequacy of some tolerances established in drawings and specifications. C

b. Overall, the system for use of instructions, procedures and drawings was quite comprehensive and well controlled. Utility personnel and contractor personnel recognized and generally accepted the need for clear instructions and procedures. There is some feeling both within the utility and the major subcontractors that there has been overkill - maybe too much detail. Q

c. Instructions, procedures, and drawings were well controlled and appeared current. There was an effort to ensure a consistent approach to quality down to the craft/laborer level. E

5.0 Quality and/or QA program deficiencies are identified and reported promptly and clearly.

a. Strong evidence existed that program deficiencies are promptly reported. Signs were very prominent assuring personnel that there wouldn't be recriminations for reporting problems. The NRC Resident Inspector indicated that utility and contractor personnel were willing to report problems to him. The corrective action system was fully implemented and senior management promptly reviews corrective action requests. The utility has imposed a very strong overview program including required QC holdpoint sign-off before work could proceed. This could be an area of overkill by the utility but is consistent with their desire to be the best. C

b. A very visible program exists at the utility encouraging reporting and correcting of discrepancies or quality problems; e.g., the "HiQ" program and posting of hot line phone numbers and contracts for reporting problems. Source inspections, surveillances and audits are regularly performed and results promptly reported to management both by the utility and its contractors. A strong program of over-checking was utilized by the utility.

Trend analysis reporting is done on a quarterly basis by utility and contractors. The reports flow to the utility and contractor management and concentrate on system breakdowns and causes plus the corrective actions to be taken. Q

c. Having been burned badly in the matter of assurance of quality early-on in the project, evidences that might suggest a compromise of quality appear to be closely monitored. There is a management information system on quality of construction-related activities, but its usefulness to upper management was not determined. There is an attitude within the utility project staff toward quality that is very positive, and which suggests that quality deficiencies are promptly identified and corrected promptly. E

6.0 Corrective action program is effective.

a. The construction assessment team did not look at this area extensively. Interviews indicated that corrective action was taken promptly. Dismissal of personnel for violation of quality requirements has been carried out which is a good indicator of whether management is sincere in backing QA. C

b. A computerized trend program exists which feeds data into the trend report. Trends are available on nonconformance reports, corrective action reports, audit results, construction reports and surveillance reports. No one indicator is used to determine effectiveness of program but data from many sources is evaluated to determine system type problems.

The corrective action program is very thorough and readily used. Corrective action requests are written frequently. The willingness to identify and attack problems in the open as a team effort was seen to be a real strong point in the utility's QA program. Personnel readily recognized their responsibilities and acted accordingly. Q

c. The corrective action program, to the extent observed, appeared effective. The management, in particular, seemed tuned to root cause detection and/or eradication. Staff training in assurance of quality was an emphasis. E

[illegible stamp]

.0 Design reviews, including independent reviews, detect and clearly resolve design deficiencies.

a. The construction assessment team didn't review this area extensively. This plant is a replication of one being built by another utility. Full advantage of design errors made at the other plant were not being taken by this utility. An excellent field change control system was in place for controlling changes to drawings. C

b. This area was not evaluated by the subteam. Q

c. Information on independent design reviews per se was not obtained. The utility project engineering staff reviews all the "top level" drawings issued by the Architect-Engineer (A-E), but not "all 60,000 drawings and 210 (?) specifications." Project engineering does review all design changes. Some type of design review may occur within the A-E as a matter of course as the Byron design is replicated at this plant. Design changes resulting from field changes are all reviewed by the A-E prior to release to the field for construction. The A-E is increasing their staff at the construction site from about 20 to over 100 in early 1983 in recognition of the importance of processing change orders expeditiously without compromising design quality. E

2.0 Design input data are adequately controlled.

a. This area was not evaluated by the subteam. C

b. Not evaluated in detail. What was observed did appear adequate or maybe above industry average. B

c. Information on control of design input data, per se, was not obtained in detail. The design control process appeared to be adequate. However, there was concern that the "replication engineers" at the A-E were not as knowledgeable of the background of the design as were the Byron engineers at the A-E who did the original design. E

10.0 Planning, scheduling and budgeting provide the resources to do the job.

a. The construction management team concept being used by this utility enhances their ability to meet schedule. Contracts with major contractors were changed from fixed fee to cost plus incentive contracts which have allowed sufficient staffing to plan work and resolve problems in advance so that schedules are met. Personnel fully understand that they must follow procedures and adequate time is allotted to clear QC holdpoints before work is allowed to progress. This utility fully committed itself and its contractors to the resources necessary to attract good people. Salaries were not disclosed, but when key people were asked why they came to this project, they said the salary offer was too good to refuse. C

b. A very strong planning and scheduling activity was found to be in place and effectively functioning. The planning and scheduling function included day to day type activities, those to take place within the year and those which will be taking place years in the future.

Procedural compliance is continually stressed. The general philosophy is to do it by the procedure. If the procedure is wrong, change the procedure but don't deviate.

Pay was evaluated to be very competitive to attract and hold very highly qualified people. Q

c. The planning, scheduling, and budgeting activities are excellent. Good coordination exists among construction, engineering, procurement, inspection, etc. The utility's cost-schedule integration system is a cut above anything else that exists in the industry. Not only does it provide an estimate of job completion and cost to complete, but it also shows where there is a breakdown in productivity and changes in critical path scheduling. E

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11.0 Design Control Process

a. The subteam only evaluated the field design change control process and considered it to be very good. All contractor personnel interviewed reported they could not proceed on a safety-related item until the design change was approved. All field changes required review and approval by the A-E. C

b. This area was not evaluated by the subteam. Q

c. This area was not evaluated in depth by the subteam. Key Indicators 7 and 8 provide detail on what was observed. E

2.C Work package development and control.

a. The civil/structural contractor utilized effective instructions, procedures and drawings. A very impressive system was used to detail structural welding for safety-related structures. Each weld and its inspection requirements were detailed on isometric drawings that were incorporated into an inspection traveler to document essential data associated with each weld joint.

Appropriate codes and standards are referenced in work package documents; however, tolerancing of specifications and drawings was considered too vague in some areas leading to interpretation conflicts.

Change control and document control practices were computerized and very effective. This utility is considered leading industry technology in this area. Only one contractor was checked in the field to see if correct drawings were at the work location, and their program was rated excellent. When it is necessary for the inspector to witness QC holdpoints, he checks the applicable drawing out of a document control room each shift as needed. This assures he has the latest revision of the drawing to perform inspections. This also precludes having to rely on field stick files of drawings which are very difficult to keep up from a document control standpoint. C

b. This area was not evaluated by the subteam. Q

c. This area was not evaluated by the subteam. E

13.0 Procurement Control

a. This area was not directly reviewed but all observations led the subteam to believe that procurement control met the appropriate requirements. Contractors interviewed were adament that they could only buy safety-related items from approved suppliers. The utility retains the responsibility for approving suppliers. Supplier performance is verified through source inspection. The utility has computerized their procurement system and the program appeared to be excellent, but no in-depth review was performed.

The warehousing and receiving inspection functions were observed and found to be excellent. Warehouse stock awaiting installation was reviewed for appropriate quality status tags with a very good system being evident. C

b. From the review made by the subteam, their program appears very adequate and in compliance with requirements. Supplier selection, evaluation of bids for compliance with quality provisions and evaluation of the performance of suppliers was properly included in their program. Difficulties were still being experienced on old subcontracts. Suppliers have difficulty understanding why hardware and documentation which is acceptable to the nuclear industry at large is not acceptable to this utility.

Computerized tracking of all nonconformances on procured items assures that material is adequately controlled. The system also insures that appropriate maintenance is done on equipment awaiting installation. Q

c. All contracts are processed through a single organization at this utility. The A-E reviews technical specifications and quality aspects. The purchasing organization monitors the contract, change orders, and delivery. All information pertaining to the purchasing process is forwarded to the records management function for filing and storage. The purchasing function is audited twice a year by consultants. E.

14.0 Nonconformance Control

a. Nonconforming materials and workmanship were observed and were appropriately tagged and controlled. Further processing of a nonconforming item was controlled, and all nonconformances are subject to review by appropriate engineers for the utility, contractors and the A-E. C

b. A very strong program was found to exist. Q

c. This area was not evaluated by the subteam. E

15.C Special Process Controls

a. This area was not reviewed extensively. The welding procedures for one contractor were reviewed and found in full compliance with the code. The piping contractor was utilizing an excellent form for documenting the results of nondestructive examinations (NDE). C-

b. Special process control was not evaluated to any great depth. On the strength of the other training programs in place at this utility and its contractors and indirect feedback from those interviewed, the special process qualification program would be rated above average. O

c. This area was not evaluated by the subteam. E

15.0 Examinations, Test and Inspection Control

a. All observations convinced the subteam that personnel were qualified for their positions. A very effective training and certification program was in place not only for inspectors but craftsmen as well. Inspection was well controlled through work packages and is subject to overcheck by the utility. The program utilized by the utility and its contractors to coordinate field work, prior to scheduled start, to assure all procedure and equipment problems have been identified and solved indicates conditions necessary to satisfy the quality requirements (especially objectives and prerequisites) for a scheduled segment of work are well controlled. C

b. The subteam referred back to Item 15.0 and made no further observations. Q

c. This area was not evaluated by the subteam. E

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17.0 Calibration

a. This area was not evaluated by the subteam. C

b. This area was not evaluated sufficiently to allow rating. Calibration control is handled by an off-site contractor. The utility test laboratory only performs a few aspects of calibration. D

c. This area was not evaluated by the subteam. E

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18.0 Records

a. The utility is an industry leader in records management systems. Control of incoming records, filing, storage and retention practices are excellent. An IBM prepared computer system called STAIRS is used. They demonstrated the ability to search and locate records even when minimum descriptions of the record desired were given. Ten thousand records of eight pages each are processed each month. The records facility fully meets the requirements of ANSI N45.2.9 and duplicate records are provided through the microfilm process. C

b. A very good program for records management was in effect at this utility. Equipment and facilities are first rate and include a computerized microfilm retrieval system. Very little documentation is outside the scope of the document control/records management system. Some problems still exist in the system as far as retrievability of early records but these problems are actively being worked and should not have a significant impact on the records control program. D

c. The records control for this utility is excellent with respect to control and distribution of design drawings, specifications, and related project materials. All materials are logged in, photographed, distributed, and controlled from a control organization. Outdated material is retrieved and the process is documented. Records are stored in a fireproof vault. E

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19.0 Audits

a. The utility has an effective audit program in place and audits internally and all contractors for compliance with the QA program. The audit section was utilizing appropriate audit checklists and had organizational independence. C-

b. Planned and scheduled audits are performed to verify compliance with all aspects of the QA program and to determine its effectiveness both within the utility and its contractors. Review of audit schedules revealed audit frequency to be commensurate with the importance of the work. Audit results were documented and reported to responsible management and form the basis for an effective corrective action system. Q

c. Audits appear to be made for many of the functions at this utility including purchasing (by outside consultants) and project engineering (internal, management QA, and NRC audits). Audits seemed to be quite common at this project. E

D.0 Corrective Action

a. The corrective action system is functioning and given good management attention and response. Personnel interviewed reported that when senior management of the utility came down firmly on corrective action responses (CARs), people knew they meant business and became responsive to CARs. C-

b. Refer to key indicators numbers 5 and 6. O

c. Corrective action seems to be adequate. Cost and schedule are acknowledged as important considerations, but not as important as quality, at least at this time in the project history. There is not reluctance to inform management of needed changes and there appear to be ample opportunities to do so. E

21.0 Identification and Control of Material and Items

a. The subteam observed tagging of nonconforming workmanship and material in the field and found it very adequate. The warehouse materials awaiting installation were appropriately marked as to their quality status. C

b. The program for identifying, tracking protecting and maintaining procured equipment and materials appeared in general to be very good. Q

c. This area was not evaluated by the subteam. E