DRAFT

QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

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QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

I. SUMMARY OF FINDINGS

A. Background

The licensee of Case B has one nuclear station in operation and a second one under construction, both consisting of two large units (approximately 1,000 megawatts each). The former station has been in operation since the mid-1970s. The latter station is approximately half completed. The construction permits (CP) were issued in the mid-1970s. Licensee fiscal problems required an approximate 18-month slowdown in the construction of the station. Construction is presently proceeding on a round-the-clock, 7-day per week basis.

The licensee is the construction manager for the project. The major construction contractors -- civil, mechanical, and electrical -- all have had significant nuclear plant construction experience, as have many of the smaller contractors.

The architect-engineer for the Case B nuclear station has had extensive experience in the design and construction of nuclear power plants. Some of the non-safety-related design is being done by the engineering staff of the licensee's holding company. (Neither the AE home office staff nor the holding company's engineering staff was visited).

The licensee has experienced no major quality problems to date in the construction of this nuclear station (none occurred in the construction of the first station, either). There have been recognized engineering and construction deficiencies, but the licensee has taken positive action to correct them. There has not been significant intervention in the licensing and construction phases of the Case B nuclear station. No significant fines have been levied against the licensee for nonconformance violations or quality deficiencies.

The assessment team for the Case B study[1] was comprised of three teams of two personnel each; one concentrating on the project engineering/design aspects, one on construction, and one on quality assurance programs. The team spent five days at the plant site. Prior to the plant visit, two of the personnel spent one day at the licensee's headquarters reviewing the project with the licensee's upper management, and one day with the NRC regional staff. There were several group interviews and discussions with the licensee's senior project management. Altogether, about 50 interviews were held at the plant site, with individuals intimately involved with the project. In addition to the interviews and discussions, the entire assessment team spent one-half day touring the construction site. The site assessment culminated in a briefing for company officers and project staff members, in which the findings of the team were reviewed and the licensee staff had an opportunity to comment on the team findings.

B. Summary

The objective of this case study was to determine what were the significant factors in contributing to the assurance of quality at the licensee's construction project. The team identified the following factors:

1. <u>The licensee has an orientation toward, and an attitude supportive of, quality in their nuclear project</u>. At higher levels in the management structure, the conviction appeared to prevail that public safety and company profitability demand quality in the construction (and operation) of nuclear plants, and that it is less expensive in the long run to "do the job right the first time." At lower levels, there was an expressed feeling that the company wants to do the job right. Employees at all levels appeared to have a constructive attitude toward the need for quality in general, and quality assurance, in specific. A pro-company attitude and good morale on the part of the employees appears to exist.

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[1] The methodology for the Case Studies is described in Long-Term Quality Assurance Review: Site Assessment Methodology, November 8, 1982 (Draft).

The stated management philosophy of insisting on quality was not simply to satisfy the Nuclear Regulatory Commission (NRC) but to go beyond those requirements to have a reliable and safe operating plant. From the interviews conducted, both at the corporate offices and the site, it was evident that a sense of commitment to quality pervades the licensee's organization at all levels. The licensee volunteered for the first INPO design audit and has expanded on it with their own self-initiated evaluation. The quality assurance quality control (QA/QC) staff has direct access to an executive vice president. There was no indication from the interviews of cost/schedule overriding QA/QC.

2. The licensee has an experienced design, construction, and construction management team. The licensee has had prior experience with a previous nuclear station, and many of the personnel who worked on it are now actively involved in the present project. This experience has given them an understanding and appreciation of the complexity of large nuclear station construction activities. Many of the staff have 5-10 years experience in nuclear work. The persons contacted, in general, had good qualifications for their assignments. There is a substantial training program and an overall impression of a high level of deducation and enthusiasm to the job. Many of the key personnel had previous in-depth nuclear experience from other projects, and this has been further enhanced by in-house training. Early in the construction process, it was recognized that craft personnel needed further training on the special requirements of nuclear work, and this resulted in a comprehensive blue-collar training program. The QA/QC staff is broad and deep in experience and qualifications.

The architect-engineer has designed (and constructed) many nuclear power stations.

The major construction contractors (especially the mechanical and electrical contractors) and the smaller contractors have had previous experience in the construction of nuclear projects.

3. The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces. This is manifest most clearly in day-to-day activities at the site. The licensee is running the job. The licensee does not rely on the major subcontractors to perform the overall management functions. It is manifest by the direction for the overall quality assurance program that comes from the licensee and not from its subcontractors. There are limited points of contact by the licensee to direct work of its subcontractors. Licensee construction coordinators, many of whom are past inspectors, do a preinspection of craft work prior to formal inspection by QC. There seems to be a feedback of lessons learned from earlier construction experience and from other projects. Personnel within the licensee's and the major subcontractors' staffs were knowledgeable of their own, as well as others' responsibilities and authorities. (This, despite the fact that the organizational structure is quite complicated and not easily understood at first review. However, within the plant project team, the organizational structure was straightforward). Geographical separation of some of the major organizations (e.g., the AE and mechanical/NSSS contractor home offices) from the site was seen to hamper construction efficiencies.

4. The licensee supports Its assurance-of-quality program with adequate resources and backing. This is manifest at the top of the licensee's organization by a project management board comprised of senior utility management, senior project management, and senior AE and NSSS representatives reviewing the project, examining problems, and maintaining cognizance of nuclear matters. Quality does not seem to be sacrificed for schedule and cost considerations. The licensee and contractors have good training programs for crafts and quality control personnel. The planning, scheduling, and budgeting activities appear to allow for adequate resources to do the job correctly. Work was observed to be on schedule and chronic delays were not evident. Procedure compliances were stressed at all levels and daily work schedules appear realistic enough to allow work to be completed in accordance with those procedures.

   The licensee is pro-active in looking for improvement in its assurance-of-quality practices. Key managers were on a retreat to consider new approaches to the assurance-of-quality problem. This licensee was the first to be evaluated under 10CFR50, Appendix B. Their own QA organization was asked to study other QA programs as early as 1978. They have been involved in one of the pilot studies for the INPO audits. They have also aprticipated in self-initiated evaluations. There were numerous comments and indications in the interviews that problems, deficiencies, and areas of improvement can be surfaced without pumitive actions.

5. The licensee's QA/QC function is active in reviewing, witnessing, and verifying contractors' work. A well-staffed program with good procedures exists to insure that construction conforms to the design. The licensee and its contractors have an effective corrective action program which seems to bring about needed change. Design reviews for constructability and operability were thorough.

   The project engineering staff reviews the design for constructability. This appears to be the major design review (no data were obtained on the independent design reviews within the AE organization).

The case study team's evaluation of 20 generic indicators of quality is in Appendix A.

The foregoing factors are discussed in greater detail in the following section.

There were several observations which the assessment team made which could improve the licensee's assurance of quality. These included:

1. Document control: destruction of obsolete specifications and drawings is not tightly controlled. In some cases, there could be use of uncontrolled drawings.

2. Procurement procedures: the receipt inspection, source inspection, and communication to vendor of speficication requirements should be strengthened.

3. Construction process control: while the hold-card approach for civil-structural work and the application of process data sheets for the mechanical contractor are good, some of the other contractors, including the electrical contractor, lack procedures which could cause them to miss hold points because inspectors are not immediately available.

4. Field change requests and nonconformance requests: during the period of October 1 to November 17, 1982, there wre 1389 field change requests and 463 nonconformance requests processed. This continues at the rate of about 30-50 per day. This could be the result of some deficiency in the design process. (The AE design function is being audited on this item).

5. Senior management involvement at the site: licensee senior management should take a more proactive role in communicating the importance of quality to the staff.

6. Formalized quality engineering capability: at the present time, there is no separate quality engineering organization in the licensee's project staff. This function would help ensure that the process of translating the design into construction was carried out efficiently and optimized for quality.

7. Trending of QA/QC findings: a better presentation of the results of QA/QC activities to management would enhance the assurance-of-quality program. (It was noted that the licensee had initiated work on improved procedures).

This case study was the first one in which the licensee's project had not experienced major quality problems. Thus, there could be no comparison with other plants without major quality problems. The observations included here are in considerable contracts to the Case A study (a plant which had been shut down by NRC for quality problems). The case study team did not find any practices that would indicate an impending major quality problem. This does not guarantee that a major quality problem will not occur, but the key factors for not having one occur appear to be in place. The licensee's continued activities in looking for ways to improve the assurance of quality may reflect its own uncertainty in the matter, as well as providing a basis for the observation that no quality problems are likely to occur.

II. ROOT CAUSES OF THE LICENSEE'S SUCCESS WITH QUALITY IN CONSTRUCTION

Based on the case study team's review with the Nuclear Regulatory Commission Regional Office, documentation pertaining to the licensee's project and discussions and/or interviews with about 50 licensee and contractor staff personnel, the team believes that the root[1] causes of the licensee's success with the quality of construction reside in the following factors:

1. The licensee has an orientation toward, and an attitude supportive of, quality. The executive levels of the licensee evidenced a very good understanding of the significance and ramifications of uilding and operating nuclear power plants. This is probably due, in large part, to their experience with a previous plant, which came on line in the mid-1970s. There was no indication of a "fossil mentality" at the executive level. (This term refers to a utility's attitude that, since it was successful in building fossil fuel plants, it could be successful in building nuclear plants using the same techniques, personnel, and effort. This has been shown to be untrue). While the licensee's management seems very much aware of the importance of complying with NRC requirements, the comment was made, "satisfy the NRC and everything is okay, is not true; you have to satisfy yourself." There was recognition that a utility can be at considerable financial risk with a nuclear plant.

   There was considerable evidence of a top management commitment to quality. Further, there were indications of activities to directly address bringing about improvement. Some of the comments that indicate this were:

   - "There is a lot of talk about quality in nuclear construction. Some think there is a need for more of the same thing that isn't working."

   - "Maybe the industry and NRC need to back off and look. Maybe QA wasn't put in place right the first time."

   - "We don't want just more of the same -- what can we do that is innovative."

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[1]See Appendix B for definition of root causes.

- "Are we looking to see if we are doing what we said we would do, or what is right."

- "We are going to look at how we look at the QA organization and the growth potential for the people in it, also QC."[1]

An example of one need for improvement is that QA/QC findings are not presented to upper level management in a readily digestible format. The system in use now only identifies problems generally, and not specifically enough to identify to management what kinds of actions need to be taken. The licensee is presently strengthening the quality trend identification program via a computerized system, however.

An example of management's concern with quality, and its attempt to be aware of imending problems is the creation of a project management board. This project management board meets monthly and it consists of the chairman of the board (of the licensee), the presidents of two of its operating components, the executive vice presidents of finance and construction, the vice president of the architect-engineer firm, and a member of the NSSS firm. This board gives the project general manager direct access to top level management of engineering, construction, and startup. The board deals with costs, schedules, and quality assurance. A typical meeting includes mostly input from the project staff, but there is also some direction given to the project staff. Two examples of items recently discussed related to secondary water chemistry and seismic problems. The project general manager said this high level management involvement in significant problems was very helpful.

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[1] Quotations may not be direct, but they are believed to convey the meaning intended.

The project general manager acknowledged that it is very difficult to get quality assurance attitudes from upper management to craft levels. If, for no other reason it is important to do so, because approximately $2 million per day is being spent on the project, and any rework due to inadequate quality only escalates the costs and delays completion of the project.

The project general manager had been involved in the licensee's earlier nuclear plant. He commented on changes which have occurred between the earlier nuclear plant and the present plant: the power generating division (i.e., the operations staff) has been integrated into the construction effort; a simulator has been built adjacent to the site; the project has been organized to do as much work at the site as possible; superior facilities (e.g., warehouses and offices) have been built at the site; all engineering capability needed for the project, including subcontractors, report within the engineering organization; the quality assurance organization structure has been put in a stronger position; personnel with greater experience in quality assurance have been hired; there have been significant management changes for the better; and (though he acknowledged that there was a negative attitude to the processes required to support quality; i.e., paperwork and form filling out), he expressed concern about the communications problems which continue to arise because of the widespread locations of the AE and NSSS home offices and the construction site. This may be related to the large number of design change notices which have occurred.

The project general manager noted in his closing remarks that the licensee does not penalize employees when problems arise. This policy encourages the surfacing of problems at an early time.

The licensee's attitude toward quality was also expressed by the assistant construction project manager. When asked what he perceives as management's commitment to quality assurance, he enumerated several things:

First, personnel with greater quality assurance experience have been hired. Second, management keeps abreast of the work in the quality assurance department. Third, management has endorsed the INPO self-initiated evaluations. Fourth, management reviews quality assurance findings. He said that an executive vice president periodically checks on his work, and he perceives, as does his staff, that the chief executive officer is interested in quality assurance. He said that when there are accountability reviews at the top of the organization, they are interested first in safety, second in quality, and then in cost and schedule.

In response to a question concerning what quality assurance changes he has seen in the last three years, the assistant construction project manager said that there is an increased awareness of quality assurance and that the training programs (especially in the civil area) were prominent among the changes. He perceived that there is a more knowledgeable understanding by the craft personnel of quality assurance, and this has helped in communication with the crafts, and has increased productivity. The independence of the quality assurance organization is another major change. The attitude on quality assurance is one on increased openness. A vice president directly responsible for project QA now has direct access to the chief executive officer. He said the construction forces and the project management are now working together better.

The manager of quality assurance and the quality assurance field supervisor said that they do not win all their battles when they approach senior management and try to bring about change. They feel, in some cases, they have not done the best salesmanship job they could have. In other cases, though, where it really counted, they made their case heard and got appropriate action. They stated that the door has never closed in the face of the quality assurance organization. It is readily accepted and backed by other management.

The licensee has used stop work order authority approximately six times to shut down a contractor's operation completely. Individual jobs are stopped routinely. The situation now exists where most construction will stop their own work at the first level of quality control when problems arise. When a whole contractor's operation is stopped, the order originates about half the time with the quality control groups and half the time with engineering. Contractor's operations have been shut down because of coating problems, cadwelding, concrete work, and for housekeeping.

The same general attitude toward quality was forthcoming from the construction concrete superintendent. He said, "I don't have to go upstairs to get backing when I call the question on something. We (QC) can pretty much handle day-to-day problems without having to resort to escalation; however, when something is escalated, it is usually something beyond my jurisdiction or authority." In the same interview, the statement was made that the licensee was not afraid to fire people for poor performance.

Management's interest in the QA program is also demonstrated in the orientation and training program for crafts. Craft indoctrination includes a videotape entitled, "QA Is Everybody's Business." The videotape includes a message from the chief executive officer of the licensee's holding company and other licensee management stressing the importance of QA and the results of poor workmanship. Additionally, training including specification and workmanship requirements and rules of conduct specific to each craft is accomplished. For example, welders receive approximately 15 hours training, and electricians 10 hours.

Overall, the assessment team concluded that the licensee's general management is committed to quality assurance. Since a poorly constructed plant can bankrupt the licensee, management sees QA as insurance against producing a plant which will not perate successfully. As a result, management does not limit the implementation of QA to meet NRC requirements, but rather to do what is necessary to provide confidence that the plant will operate successfully.

2. The licensee has an experienced design, construction, and construction management team. As previously stated, the licensee has constructed a previous two-unit nuclear power station that went into commercial operation in the mid-1970s. The AE has been involved in nuclear power plant design and construction for over 20 years, and has been the AE and/or construction manager on many nuclear plants. The electrical and mechanical contractors participated in the construction of the licensee's previous plant, as well as other nuclear plants. The experience levels of the licensee's staff and contractor managers varied considerably. Many of those in key positions with the licensee have less experience than one might expect to find in similar projects; however, many of them have been with the licensee for 8-10 years and have worked at the licensee's previous nuclear plant before going to the Case B nuclear plant. It is apparent that the previous nuclear plant provided both the licensee and many of its personnel with valuable nuclear plant experience. This experience has resulted in, or permitted, a matrix organization which includes personnel in key positions from the licensee's holding company enginering function, the AE, and the NSSS vendor.

The extent of control exercised by the licensee at the construction site was impressive. The major construction contractors, except for one responsible for the containment vessel liner and another for the cooling towers, are all on a cost reimbursable basis. This permits the licensee to exercise control over the construction processes and their quality implications. All materials and equipment used at the site are provided by the licensee and the licensee controls the staffing levels of all except the fixed-price contractors.

One result of the experience by the licensee is the creation of the project management board. As previously stated, it is comprised of corporate level executives from several companies which play an active role in the project and which is chaired by the licensee chief executive officer. The project management board is veiwed essentially as a separate board of directors relative to the Case B project. The board is obviously composed of those who can make major decisions and commitments of their respective organizations. Further, it provides a forum for executive level communications between key organizations.

As previously stated, the major work force of the AE is located off site, and the problems related to this situation are being reviewed. The on-site engineering function is comprised of about 35 AE employees and about 10 licensee employees. In the past, original drawings were not made at the site. This may change, however, because of the need for closer coordination between construction and engineering. To improve engineering response time, one action being taken is to move an NSSS team on site in early 1983. This will result in 21 additional people being added to site engineering to respond to and correspond with the installation of small bore piping.

Lessons learned from the licensee's previous plant construction activity have resulted in improved advanced planning and scheduling and have been reflected in how they manage the work at the site. Standard lead times are set at 11 months for material, 7 months for pipe, and 90 days for having everything ready for construction. At the present time, design completion was estimated at: civil, 70%; mechanical, 60%; plant, 70%; and electrical, 60%.

Since the licensee and many of its construction contractors have had prior nuclear power plant experience, the effect of applying lessons learned is very beneficial to the successful QA program. For example, operations involvement in construction activities is more detailed and earlier than for the licensee's previous plant. Also, some operations engineers have been assigned to construction engineering to enable them to better understand the plant. Quality program items are included on the agenda of major management meetings. Management encourages getting problems put on the table so they can be dealt with. Employees seemed to recognize that management appreciates that problems will occur and that the important thing is to prevent recurrence. One case that was occurring at the time of the interviews related to protection of erected equipment. It was refreshing to hear a supervisor take the responsibility for the deficiency without inculcating others. This attitude exists not only within the licensee's structure, but also in the interface with the NRC inspection personnel. This openness without fear of recrimination tends to get problems solved before they become unmanageable.

Another experience factor is that all field coordinators are trained in the inspection techniques and approximately half of the coordinators are ex-inspectors. The crafts are therefore provided with an interface which emphasizes quality requirements consistent with that of the licensee's inspectors.

The QA/QC staff was noted to be broad and deep in its qualifications. When hired, these qualifications are further developed through formal classroom and on-the-job training. The recruitment for QA people stresses degreed personnel with experience in the practical side of the nuclear industry. Experience for QA management personnel ranged from 20-30 years; the average QA staff had approximately 10 years experience. The QC inspection supervisors have typically 2 and 4-year technical degrees and the section supervisors have a bachelor's degree as minimum education. Their experience ranges from 12-30 years.

There is active company involvement in looking for ways to do things better. The licensee sends their employees to other utilities to gether different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the licensee's holding company's engineering staff. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the PACE program, giving QA more authority than it had in early days, and adoption of innovative concrete processes (computerized batch plant use of Creter cranes, and plexiglass forms) are examples of such progressiveness.

The licensee uses an unusual construction shift work arrangement. The project is manned nearly 24 hours a day, 7 days a week, with four non-rotating shifts. There are problems with conflicts between shifts, but the licensee considers the benefits worth the additional problems. For instance, more workers can be utilized to improve the schedule. The current total job site work force is about 7700 employees. Somewhat better ambient temperature conditions for concrete placement exist. In cooler weather, most of the concrete is in place on day shift. A larger pool of skilled crafts is available. This is true in part because two of the shifts work only 3-day weeks and thus can use the other four days for commuting longer distances.

The union contracts also manifest experience of the licensee; e.g., each shift is paid straight hourly time for a specific number of hours in lieu of conventional overtime; there are no formal scheduled coffee breaks; in the event of a walk-out by one craft, there is no picketing, hence, other crafts continue to work. The licensee uses selective bid lists for on-site contractors; however, open shop contractors are permissible providing they abide by the special licensee-union agreements. The licensee takes an active part in negotiations between the union and the construction contractors.

3. The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces. The clearly defined responsibilities and authorities, together with appropriate procedures, stems from the licensee's active management of the project. The extent of control exercised at the construction site is impressive. The cost-reimbursable contracts which the licensee has with most of its contractors permit a large degree of control over day-to-day activities. All materials and equipment used at the site are provided by the licensee. The licensee controls the staffing levels of all except two fixed-price contractors (whose work does not significantly interface with other contractors). As previously stated, the project organization is a matrix-type organization and includes personnel in key positions from the licensee's holding company engineering function, the AE, and the NSSS supplier. While the licensee has not been as intimately involved in the AE's activities, it does review all drawings for constructability and operation. The licensee is becoming involved in AE design audit through the INPO process and the self-initiated evaluation.

   Advanced planning and scheduling, combined with management involvement, has resulted in the work being on schedule. Near-term work schedules are developed in concert with the construction contractors, but are controlled by the licensee. These include daily, weekly, 6-week and 3-month plans. Longer term scheduling and budgeting is done by the licensee. Standard leadtimes are 11 months for materials, 7 months for pipe, and 90 days for having all other materials, including consumables, ready for construction. The project general manager reported that the project is on budget for the year and about two months ahead of schedule (rebaselined in September 1981); however, the progress curve has flattened somewhat in the last two months. He said that contributing factors to maintaining schedule have been lessons learned from their previous nuclear plant, better training of personnel, and better support facilities on the site.

Among the lessons learned include the previously mentioned project management board, which provides a mechanism to promote timely resolution of problems, and to integrate senior management experience and expertise into the management process and provide clear direction to project groups. The board is composed of those who can make major decisions and commitments of their respective organizations. It meets monthly, and several of the licensee's management cadre emphasized good attendance of board members at these meetings and their active participation in them. (It must be observed, however, than in a meeting attended by a portion of the case study team, which included five licensee vice presidents and the company president, the latter did all of the talking).

The organizational structure in effect at the licensee's plant is best described as complex. The interplay of different lines of direction reporting, administration, and communications between the three major organizations involved; namely, the licensee, the licensee's holding company's engineering function, and the architect-engineer, as well as the entwined project relationships, make it difficult for one to understand the organization and its functions without considerable study. Nonetheless, the organization seems to work fairly effectively.

The project general manager, the highest ranking individual totally dedicated to the project, is a licensee vice president, but is at the fifth level below the president. Reporting to the project general manager is the on-site manager, called the construction project manager. He is considered by the corporate office to be responsible for everything at the site. The on-site field or project engineering functions report to him as does the superintendent of field coordination. The latter views his function as the intermediary between engineering and field construction; however, at least one construction contractor views his official contact with the licensee as the project engineering section supervisor, and the field coordinators as expediters for materials and tools, plus an arbitrator in relations with other contractors. The construction contractor's view was felt to be more accurate.

The QA and QC components are totally separated from each other and, for the licensee, this seems to work well. The QC function reports to the construction project manager.

The contracting and procurement function is managed from the licensee's home office. In addition to the minimal use of firm fixed price construction contracts, another significant practice is that the licensee provides all materials and equipment at the site. As a couple of interviewees expressed it, "All the construction contractors bring to the site is their bodies and their expertise."

Source inspection in vendors' plants is provided through project engineering by the architect-engineer and/or the licensee's holding company engineering function. Receiving inspection at the site is provided by the licensee's QC organization.

The licensee's quality assurance department is organized into a general office staff and a plant site staff. There are approximately 30 people who are directly involved with the programmatic side of quality assurance at the plant site. This is exclusive of the quality control personnel which, as previously stated, report separately from the quality assurance organization through the project side. Other quality control groups exist in the major subcontractor organizations. The mechanical contractor has about 70 inspectors. The NSSS supplier is staffing its inspection forces. The general office staff of the licensee's quality assurance is headed by project coordinating engineers and project quality assurance managers who report to the manager of quality assurance and to the applicable project general manager for project direction. The manager of quality assurance staff assists in establishing quality assurance policy, interpreting NRC and government regulations, and in personnel and organizational planning. The project quality assurance managers are assigned to specific nuclear construction projects and are responsible for carrying out quality assurance department directives as they apply to all aspects of design, construction, and operational testing.

Quality assurance staffs at the site are headed by a quality assurance field supervisor who reports to the manager of quality assurance and who is responsible for all quality assurance activities at the construction site and the operating units. The staffs are composed of quality assurance engineers or quality assurance field representatives for each engineering discipline involved in the construction activity, plus two or more qualified quality assurance engineers or field representatives for each operating unit. The prime job of the staff is that of audit. The personnel are responsible for assuring that plant site activities are accomplished in full compliance with the quality assurance manual, technical specifications, and procedural requirements.

The quality assurance program for the AE was not evaluated, as their work is primarily conducted at their home office.

With respect to the design process, the licensee receives all drawings from the architect-engineer and, for non-safety related matters, from the licensee's holding company engineering function. The project section supervisors review the activity packages and initiate field change requests and field change notices as they review the design for constructability. The licensee does not do any design on safety-related systems or equipment. The on-site design functions of the architect-engineer are limited to nine items as far as design changes are concerned, such as cable tray supports and reinforcing rod matters. Construction will only work to AE-approved drawings. Each construction group within the licensee's project controls its own drawings and each is audited every three months for properly approved drawings. The mechanical contractor does the drafting work at the project site.

The architect-engineer's field office approves field change requests, nonconformance requests, and handles all drawings to the job site. Revisions to drawings are returned to the home office when there is not adequate expertise at the job site. The design work is completed within the requirements of the project reference manual and appropriate regulatory guides. One of the architect-engineer's responsibilities at the job site includes monitoring the N stamp. The AE has the authority to apply N stamp to the design and also to systems within

the project.

In summary of the foregoing, the licensee has overall responsibility for the project. Its AE has overall plant architect-engineer responsibilities. Its NSSS supplier is responsible for NSSS design, and the holding company's engineering function has design of certain ancillary facilities.

4. The licensee supports its assurance-of-quality program with adequate resources and backing. A number of items that lend credibility to this root cause for the success of quality in construction have already been discussed, including previous experience with nuclear plant construction and use of experienced personnel.

The licensee's management recognizes that QA boils down to an economic issue -- and a long-term one at that. They are not focused exclusively on the short-term goal of getting the plant licensed, but on building a plant that will operate safely for its expected life. This is not to say that licensing for operation is not a very important milestone, because failure to license could spell economic disaster, but rather to say that the job needs to be done correctly now to minimize costs over the entire life of the plant.

The AE on-site manager's comments on the licensee's consideration of quality are interesting. He received strong signals from both the licensee as well as his own management with respect to quality. He said that the licensee's management is very supportive of their quality assurance staff. He mentioned a problem with welds on piping spools fabricated at the mechanical contractor's home plant. There were only slight defects in the welds, some minor weld slag and pinholes. These were all repaired even though they were detrimental to the progress of construction. The AE's on-site manager was impressed.

The comment was made by the AE manager that whereas on other projects redlining drawings (to denote field changes) is accepted practice, for the licensee's plant it is necessary to revise drawings.

The AE resident manager, in responding to the question why no quality problems of a major nature have been experienced at the licensee site, said that the licensee's management concerns about quality assurance and safety have been very high. They have spent much money and they want to license the plant as efficiently as possible and create a positive climate with respect to quality. He said the message is nothing is to be sacrificed for schedule.

The manager of scheduling and budget, an AE employee, said he was impressed with the licensee's interest in quality as manifest by the project management review board feedback. He said the executive vice president reviews his program area about six times a year, devoting one day each time. He said the performance review for licensee employees is now tied to budget and schedule. (Interestingly, most licensee employees said that safety and/or quality were the first items in their performance reviews). Another quality input from management relates to the project general manager's review.

The importance and the extent of training programs has already been discussed to some extent. The various programs include the licensee's QC training, construction craft training, and plant operations training. All of the QC inspectors of the licensee have received at least one week of formal training conducted on site and off site. The superintendent of field coordination has also required his entire staff to attend QC training programs.

Craft training programs are conducted by the construction contractor. In addition to a half-day orientation, the training programs have included specific classes in concrete placement and vibration pipe weld preparation, grinding, cadwelding, electrical specification requirements, and storage and handling of materials.

The plant operations staff training program was impressive. The licensee has installed a complete control simulator at the site and trains station engineering staff as well as the control room operators on this simulator. Also, the licensee has established agreements with other utilities so that some licensee staff are assigned to operating nuclear power plants for a period of 12-18 months.

Attitudes are also important to the assurance of quality. There is active company involvement in looking for ways to do things better. Licensee sends their employees to other utilities as previously stated, to gather different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the holding company engineering function. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the people achieving excellence program, giving QA more authority than it had in previous times, and adoption of the innovative concrete processes are examples of such progressiveness.

Sufficient resources as far as manpower, funds, and time have been allotted to provide adequate confidence that a quality performance will result. For instance, in interviewing the assistant manager for quality control, the question was asked how he knows whether he knows he has sufficient manpower to do the work required. He described how he determined his manpower needs (they relate to construction team size) and he said that sometimes double shifts are required; however, he lets management know of his needs and they are usually filled.

The QA manager has organizational independence and reports to an executive vice president. There is also a senior management quality assurance committee made up of vice presidents from organizations such as engineering, construction, power generation, licensing design, and quality assurance, and these represent both the licensee and the licensee holding company's engineering function. It is headed by an executive vice president and provides a forum where large time, money, and organizational quality assurance issues are settled.

The pro-quality attitude of senior management prevails throughout the licensee's organization, and carries over into the subcontractor's operations. All individuals surveyed were able to talk intelligently on QA/QC as related to their sphere of work, although at some of the lowest levels (craft level) personnel had difficulty explaining why it was important. They just know it was because of the observed actions and the emphasis by management.

This same attitude was reflected in discussions with the supervisor of the civil projects section, where he said that the message from management is stay on schedule but hold quality. (But then in a subsequent statement, changed and said that if something has to suffer, it should be schedule, not quality). The licensee only wants to do the job once. Effort then would be applied to improve the schedule later. When asked the question why no major QA deficiencies had occurred at the licensee's site, he said that the project is a whole team effort. They have a feeling that this job has to be done right and that the engineers, coordinators, QA/QC people, and constructors work together. They have the attitude that this job will be Number One.

In summary, every project experiences the conflicting demands of quality, cost, and schedule. This one is no different, and the occasional ambivalence expressed by those interviewed shows the struggle. Overall, a good balance appears to be maintained.

5. The licensee is taking a pro-active role in looking for improvements in its assurance of quality program. A number of examples have been cited already, including the project management board, the staff retreat to consider new approaches to quality. The project general manager and vice president's response to the question about what changes have occurred between the licensee's first plant and the present one illustrate substantive improvements:

   1) The Power Generating Division (Operations Division) has been integrated into the construction effort. The Operations Division now sits in on design reviews and other project activities to help avoid the need to make numerous changes when the construction is completed.

   2) A simulator for the licensee's most recent plant has been built near the site.

   3) The project organization has been organized in an attempt to do as much of the work at the site as possible. They now have the ability to manage and support the job at the site.

   4) Superior facilities for equipment storage and project personnel have been built at the site.

   5) The licensee now has the engineering management needed for the project and the subcontractors now report to engineering.

   6) The quality assurance organization for the constructor has been put in a stronger position and is headed up by personnel who have extensive nuclear experience.

   7) There has been a significant changeover in management, with a net result that there is now a more positive attitude toward quality.

In the day-to-day construction activities, the planning and coordination of project QA/QC interfaces is well done and conducive to good quality. The QC shifts overlap at shift change and interface with the construction coordination group in work planning and scheduling for the following shift. QC/contractor differences of opinion are resolved readily. The organizational structure for the project has the site QA overviewing the site QC, who overview the contractors. Corporate QA overviews site QA and the licensee's holding company's engineering function overviews all of its utilities' subsidiaries.

The quality assurance program is actively managed by the licensee. The licensee is supported by its holding company's engineering function and has taken firm control and has not relied upon contractors to provide program direction. The requirements are spelled out in a well-documented program and enforced through stop work orders that are both job specific and generic to a contractor. There has been early recognition of situations which may have developed into severe problems, such as the erosion problem. Cost-plus contracts are used nearly exclusively because of recognition that fixed-fee type will eventually force poor quality. A shortage of trained work force both in the professional and crafts area is met by active recruiting and through implementation of an effective training program. Preparations for the operating phase are currently underway in addressing and resolving technical programmatic issues. A nuclear training center for technical and maintenance activities is being built and future plant operators are now being trained in plant and on the reactor simulator.

The licensee was recently "written up" for the third time in a year for improper protection of stored-in-place equipment, and the corporate management was reacting very forcefully. This factor causes one to ask whether the dominating factor in the quality emphasis at the licensee's plant is because of a need to satisfy the Nuclear Regulatory Commission. The following observations were made by NRC inspectors as this question was discussed:

- They consider the licensee's plant average, except above average in doing their own quality control.

- They feel that quality assurance and quality control are both good and adequately staffed and trained.

- They are impressed with the construction craft training programs at the site.

- They feel that upper level management should be at the site more often.

III. REMEDIAL ACTIONS TAKEN TO CORRECT QUALITY PROBLEMS

As previously stated, there have been no major construction-related quality problems at the licensee's site. There have been, however, a number of typical problems that arise in the course of construction. Some of these are described to illustrate the type of problems encountered, how the licensee has responded to deficiencies in quality, and for background to the licensee's responses in the interviews. Most of these problems have been alluded to earlier in the report. The following list is comprised of those problems that the case study team became aware of during the site visit:

1) Early in construction, an NRC inspector idnetified an erosion problem due to rainwater during excavation for the plant. The licensee initially disagreed that this was a problem, but subsequently agreed that it was a potentially very serious one and, as a result, took corrective action. This particular quality problem was felt to be significant for two reasons: (a) it established early on that the NRC would be insistent about correcting potential problems, and (b) it was a real physical problem identified by on-site NRC inspection, rather than a procedural or records problem detected in a paper audit.

2) The licensee has been concerned over the number of field change requests and nonconformance requests that have been required in the design. While the volume of field change requests and nonconformance requests is greater than other projects out of the AE's home office, there may be good reason why it may be greater at the licensee's site. As a result of monitoring the number of changes, the licensee has insisted that the AE's design

procedures be audited. The changes are being categorized by discipline (mechanical, electrical, or civil) to determine which groups need attention. This activity has resulted in the home office checking to make sure the remaining drawings are more closely reviewed. It appeared likely that the AE would assign a quality assurance person from the home office to the licensee's site.

3) The licensee at one time had a problem with rock pockets in the surface of thin concrete walls (12" thick). This problem was resolved by reducing the pour lifts 12' to 6' and increasing the attention given to vibrator technique. An innovative practice subsequently put in place for thin wall high lift pours is forming one side with plexiglass. This permits QC and construction forces to observe directly the placement and vibration of the concrete. In addition, through-the-form vibration with inspection ports are now used quite extensively.

4) During the plant walk-through, it was noted that a hold tag had been placed on a spray ring pipe spool because center punch marks near each end of the spool were considered too deep. The QC inspector had to have examined the approximately 30' long spool piece very closely to have found these small marks. This is an excellent example of thorough QC inspection.

5) The licensee had been notified of inadequate storage requirements for installed electrical equipment. While the supervisor in charge had given instructions to his field coordinators to correct the deterioration of the storage process, it was not done. The supervisor acknowledged this problem as his responsibility. As the team probed for root causes in this situation, it was noted that there was no finger-pointing. The supervisor felt that the cause was inadequate procedures and followup.

The information flow from engineering to coordination was verbal. The procedures for conveying the information were weak; i.e., there was no form nor paperwork. The supervisor said he thought the system was working and that the periodic inspection checklist covered this item. As a result, the licensee was considering establishing a contractor crew to ensure that storage measures are sustained.

6) There has been difficulty with respect to the quality assurance on piping spools. It was noted that the licensee examined all of the prefabricated piping spools and did, while finding no significant quality defects, spend considerable time in correcting well spatter and surface defects.

IV. GENERIC APPLICATIONS

Based on the information reviewed and analyzed by the Case B study team, several possible generic implications, or lessons, emerge. These are highlighted for each case study to provide input and to help form generic conclusions concerning factors which constitute important elements in nuclear plant construction quality.

1) The importance of the licensee managing the project. The licensee has clearly accepted responsibility for the completion of the project and the quality of the overall work. As a result, they have instituted practices that permit them to dictate the scope and degree of quality. They actively manage the day-to-day activities of each contractor. Their field forces review the design for constructability. They have instituted audits where appropriate for their subcontractors.

2) The importance of experienced personnel. The licensee has staffed the project rather broadly and deeply with personnel with substantial experience, both in general construction, as well as in nuclear construction. Many of the staff have 5-10 years with the licensee, have worked on the previous nuclear plant constructed by the licensee, or on other nuclear plants.

3) The importance of good training programs. Many of the licensee's staff, as well as the construction contactors' staffs, undergo training programs. Some of the training has been instituted because there is limited availability of skilled labor in the area. The licensee and its contractors train crafts and staff in quality control. In many cases, they have found that in training new personnel, there are fewer bad habits to overcome.

4) The importance of planning. Nuclear projects are complex projects and require extensive planning and coordination. The licensee's projects seem to be well coordinated with interfaces generally well handled. The construction staff does not appear to be standing around; that is, productivity appears good. Evidence of the planning is also manifest in preparation of the operations staff with 80 engineers already on the staff. The licensee has a training center and sent staff to other reactors for training. Lessons learned from their previous nuclear project, as well as other projects with the holding company's purview, have been fed back into the licensee's construction project.

5) The importance of a pro-company attitude among the employees. The licensee's staff appears to enjoy working for the licensee. Comments were made about fairness, opportunity for advancement, and rewards for hard work. The licensee appears to be a people-oriented company, in that layoffs are relatively rare, and the company provides a good pay scale with good fringe benefits.

6) The importance of an orientation toward quality. There seems to be a perception at all levels within the licensee's staff that quality is highly important. At the higher levels of management, there is a conviction that public safety and company profitability demand quality and that it is less expensive to do the job right the first time. At lower levels, there is a feeling that upper management wants to do the job right. Many of the staff were able to identify the signals that tell them that; and that quality is at least as important as schedule and cost.

7) The importance of support to quality. This is evident in the qualifications of the personnel that have been hired in both the quality assurance and quality control functions. It is also evident in the programs for these types of personnel as well as crafts. It was apparent from interviews that quality assurance/quality control personnel were respected by management, and the management supported them when it was necessary to stop a job when adequate quality was not manifest.

8) The importance of the seeking ways to improve quality. There is an attitude within the licensee that it has no monopoly on good ideas and looks far and wide for ways to improve its program. The licensee was first to be evaluated under 10CFR50, Appendix B. It has been proactive in looking at others' quality programs. It was one of the pilot studies for the INPO audit and it has also embraced the idea of self-initiated evaluation. They were open to participation in the NRC case studies. A number of their senior staff were on retreat at the time of the case study to consider ways to improve the quality program at the site. The licensee expressed considerable interest in good practices that the team had noted at other sites, and at least one contact was made at the Case A visit. They appeared to be more interested in finding out where they could improve than in knowing what they were doing right.

9) The importance of openness. The licensee exhibited an openness in encouraging its employees to identify quality problems without fear of punitive action. In addition, they are open to the NRC in its activities at the site. There appeared to be no attempt to hide marginal practices from the NRC inspection staff.

10) The importance of experience in the construction of nuclear plants. The licensee learned a great deal from the construction of its initial nuclear plant, including an understanding of the magnitude and complexity of a nuclear project.

11) The importance of top management involvement in nuclear projects. The licensee has seen fit to establish a project management board for its nuclear project comprised of senior utility management personnel involved in the project. This type of activity enhances resolutions on problems and helps keep management informed. Top management appears to have made a resolution to spend more time at the construction site.

V. IMPLICATIONS OF THE CASE STUDY 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 of nuclear facilities, to improve the management control of quality and/or to improve the NRC capability to evaluate the implementation of licensee assurance of quality programs. These initiatives are described in the NRC staff paper SECY 82-352 titled, "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 licensee's nuclear construction project. Subsequent paragraphs take each initiative in turn and discuss whether the initiative, had it been an ongoing activity at the time of the licensee's construction program (or quality problems, if such occurred) would have made a difference. That is, would the initiative have helped prevent or at least mitigate construction quality problems that may have occurred or, in the case of this licensee, would it have improved the quality of the plant.

A more complete discussion of the scope and details of the various NRC QA initiatives may be found in SECY 82-352 and SECY 83-32 titled, "First Quarterly Report on Implementation of the Quality Assurance Initiative."

It should be noted that each of the initiatives were discussed with senior management of the licensee and they agreed (or did not take exception to) the study team's evaluation of the applicability of the initiatives to their prior construction experience.

A. Measures for Near-Term Operating Licensees (NTOL)

1. Licensee Self-Evaluation - not applicable
The licensee self-evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the licensee self-evaluation would not have taken place up to the present phase of construction of the plant, which is about half completed and, thus, its effect on the project is not applicable.

2. Regional Evaluation - not applicable
The licensee regional evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the regional evaluation would not have taken place up to the present phase of construction of the plant and, thus, its effect on the project is not applicable.

3. Independent Design Verification Program (IDVP) - not applicable
The licensee IDVP is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the IDVP would not have taken place up to the present phase of design of the plant, which is about 70% complete and, thus, its effect on the project is not applicable. Design verifications can be performed at any stage of design, of course, but are most productive when the design is completed. Should the time come when nuclear plant design is completed substantially in advance of construction, then an independent design verification program could be an effective guard against allowing quality deficiencies in design from creeping into construction. However, the present NRC practice of requesting some licensees to submit to an IDVP prior to receiving an operating license would not be applicable in this case.

B. Industry Initiatives

1. INPO Construction Audits - yes

While no major construction quality deficiencies have been found in the licensee's plant to date, the licensee implied that the INPO pilot audit had been helpful in identifying areas that should be improved. This measure looks at both management and programmatic considerations as well as the quality of the product. Licensees tend to listen to INPO findings because they come from people who should be experts and they come from a group comprised of their peers, supported by their industry.

2. Utility Evaluation Using INPO Method - yes

This measure is basically a self-evaluation using the INPO methodology devised above. As a result of the design audit done by INPO in early 1982, self evaluation design review teams were established to conduct a more extensive review. This review is estimated to require more than 15,000 manhours of effort. The review teams are led by representatives from the architect-engineer who were not involved in the original design. The team includes licensee personnel; licensee holding company engineering function staff are representatives also.

C. NRC Construction Inspection Program

1. Revised Procedures and Increased Resources - yes

The resident inspector program at the licensee's site is well thought of and its recommendations have been well received. This initiative would be particularly helpful if: (a) the inspection procedures were streamlined to eliminate redundancy and given priority according to safety significance; (b) its focus was more on observations of actual construction work and less on paper and reports, and (c) a focus on the quality of management of the project and less on the formal QA manual, organization chart, and written procedures. Further, the increased inspection resources should be applied from the outset of the construction project.

2. Construction Appraisal Team (CAT) Inspections - yes

   While the licensee's project has not been subjected to significant quality problems, the licensee has benefited from audits of various types, as well as NRC inspections. The licensee appears open to the benefits that come from these inspections; however, several comments were made concerning the large number of audits being made, including those by the licensee itself, the NSSS vendor, the architect-engineer, ASME, NRC, and INPO, among others. The proper timing and spacing for audits appears to be an important consideration in their effectiveness, otherwise, they could become counter-productive.

3. Integrated Design Inspection - not applicable

   The integrated design inspection is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the integrated design inspection would not have taken place up to the present phase of design of the plant; thus, its effect on the project would not be applicable.

4. Evaluation of Reported Information - yes

   This initiative would computerize 10CFR50.55E and Part 21 reports, facilitating trend and other analyses of these event reports. This analysis would simply provide an additional cross check on the quality operations at the licensee's site. At the present time, there is no reason to believe that there would be any observed trends from the reports, but they could be useful to the NRC staff in directing their inspections at the site.

D. Designated Representatives - no

At the time this case study was conducted, it was unclear how a designated representatives 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 designated representative program would make any difference. The assistant construction project manager said with respect to quality assurance holds, it would be relieving the licensee of responsibility. Inspectors must be in the process, or they would not be helpful in solving emerging problems, he said. At the present time, there are holds for quality assurance and he saw no reason why additional ones would be beneficial. The civil project construction supervisor concurred in this. He thought they would create no more quality than they have now.

E. Management Initiatives

1. Seminars - yes

The seminars similar to those that the NRC commissioners have conducted in years past, as well as seminars by trusted utility executives, would probably have been helpful in bringing the licensee's management to their present state of awareness of the importance of quality at an earlier date.

2. Qualifications/Certifications of Quality Assurance/Quality Control Personnel - no

The licensee already has a very strong training program for its quality control personnel, as well as its quality assurance personnel. The Quality Assurance/Quality Control staff was noted to be deep and broad in its qualifications. When hired, these qualifications are then further developed through formal classroom and on-the-job training. The recruitment for quality assurance people stresses degreed persons with experience in the practical side of the nuclear industry. Many of the QA/QC staff brought strong nuclear experience to the licensee when they hired on.

3. Craftsmanship - yes

While there is a very good training program for craftsmen at the licensee's site, management interactions with the craftsmen would reinforce their understanding of why quality workmanship is of prime importance in the construction of nuclear plants.

F. Certification of QA/QC Programs (SECY 83-26) - no

The licensee has hired QA/QC personnel with good qualifications and experience. Special certifications would have added to the quality or know-how of the staff only marginally. Certification is not seen as addressing the types of problems that the licensee has experienced to date. The licensee management has treated QA/QC as something more substantive then other regulatory requirements. They look upon it as an integral part of assuring that the project is completed without significant rework and with the potential for satisfactory operation over its lifetime.

G. Management Audits - maybe

At the present time, the licensee is examining its management structure and general approach to quality, looking for new and innovative methods of attaining this goal in the construction of their nuclear project. The fact that inquiries are presently going on suggests that the management audit might be a helpful input to their decision-making process. The licensee did not express itself on this particular issue, however.

VI. IMPLICATIONS OF THIS CASE STUDY FOR THE FORD AMENDMENT ALTERNATIVES

Section 13 to NRC's FY 1983 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 efficiency of five specific alternative program concepts. As a part of this analysis, each alternative concept was evaluated with respect to whether it would make a difference in the licensee's construction program had it been in place at the time of the licensee's construction permit. As was the case with the quality assurance initiatives, each of the Ford alternatives was discussed with senior utility management, as well as with their staffs.

A. More Prescriptive Architectural and Engineering Criteria - no

The Authorization Act requires NRC to evaluate the following alternatives: 13(b)1 - adopting a more prescriptive approach to defining principle architectural and engineering criteria for the construction of commerical nuclear power plants would serve as a basis for quality assurance and quality control inspection and enforcement actions. Generally speaking, the licensee believed that NRC is sufficiently prescriptive in defining principal architectural and engineering criteria for construction of nulcear plants and that it is not necessary to be more so. The problems the nuclear plants have in quality would not be significantly changed if there were more prescriptive criteria.

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 plants that the licensee demonstrate the capability of independently managing the effective performance of all quality assurance and quality control responsibilities for the plant. The licensee senior management was in agreement that prospective licensees should be required to demonstrate to a panel of peers the capability to manage a nuclear project. The licensee is a great advocate of peer review. Their viewpoint is that the NRC does not have the necessary resources to police the industry and should not have to do so. This responsibility should be with the licensees themselves, or the utility industry in general. Several suggestions were offered regarding how a licensee with no previous nuclear plant experience might accomplish this. The most feasible was similar to what the ASME does for new N stamp applicants; i.e., the applicable procedures involved need to be exercised on a demonstration project or task.

C. Audits, Inspections, or Evaluations by Associations of Professionals Having Expertise in Appropriate Areas - Management Audits - yes

Regarding audits by independent organizations, the statement was made that the system should not be made any more complicated than it currently is. It is important to keep the responsibility for implementing an adequate quality assurance program with the licensees, with the Nuclear Regulatory Commission in a verification role. The NRC CAT team audits were felt to be a worthwhile approach to verify adequacy of work at a construction site. Most every employee interviewed said that a large number of audits were conducted by many organizations. The audits are becoming a problem as they impact the time that personnel have to do their job, thereby reducing both quality and productivity. The audits can highlight problem areas to the overall benefit of the project. The licensee commented that audits have become a way of life and that the licensee just lives with it.

Negative reaction was obtained to the policy of NRC and INPO publishing the audit findings to the public. The nuclear industry has all its problems aired to the public, causing loss of confidence by the public, because they continually hear of the nuclear problems.

The licensee also felt that the Nuclear Regulatory Commission should be audited by an independent organization, but could not identify the appropriate organization to conduct such audits.

D. Improvement of NRC's QA Program

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

Several suggestions arose from this case study: (1) assignment of a resident inspector at start of construction would not have been of much benefit to the licensee. The licensee knew from previous experience how to manage and got started off correctly. For less experienced utilities, though, the licensee felt it would be necessary to assign an inspector very early; such as when basemats are poured and cadweld work is beginning. This should be the first day of the project. This is important, because it is there that relationships and procedures begin to develop. (2) the licensee felt more and better help from the NRC is requied. NRC Headquarters needs to become more active in and share in meaningful decisions that affect the industry and then stand by their commitments; (3) inspectors should not be so paperbound. There is too much emphasis on the size of reports flowing to Headquarters. The 15 volumes of field procedures that exist now is overkill. In fact, the old manual was sufficient. Inspectors should be free to be in the plant and not excessively deskbound by bureaucratic work; (4) some inspectors are not systems or management oriented; i.e., they are too concerned with specific nuts and bolts-type problems to look further and see systemic problems; (5) too many construction permits were issued in the same time period, causing NRC inspection to be stretched too thin; (6) the NRC CAT team inspections seem valuable. Standard review plans are good. The NRC major effort should be to ensure that quality assurance is finding problems (not generating paperwork); (7) NRC tends to monitor what the licensee says, rather than what the licensee does. It was noted that if there is too much direction from NRC, it stifles initiative; (8) the biggest argument with quality assurance is over the applicability of codes; not so much the ASME code, but the ANSI daughter standards, especially in the areas of training and housekeeping. Persons tend to interpret these standards either as guidelines or an engraved in stone. What is needed is a more definite interpretation of standard requirements by NRC.

E. Conditioning the CP on the Applicant's Commitments to Submit to Third-Party Audits of His QA Program

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 or make other arrangements with an independent inspector for auditing quality assurance responsibilities for the purposes of verifying quality assurance performance. An independent inspector 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 Formd Amendment alternative 3 above. Basically, the licensee was already committed to a quality program based on its experience with a previous nuclear plant. Over the time period since construction has continued, the licensee has become all the more positive in developing a quality QA/QC program.

APPENDIX A

EVALUATION OF GENERIC KEY INDICATORS FOR CASE B STUDY

KEY TO EVALUATIONS:

C - CONSTRUCTION SUBTEAM
Q - QUALITY ASSURANCE SUBTEAM
E - ENGINEERING SUBTEAM

CASE B
EVALUATION OF GENERIC KEY INDICATORS

1.0 Licensee fully committed to a program for assurance of quality

a. From the interviews conducted both at the corporate offices and the site, it was evident that a sense of commitment to quality pervades the licensee organization at all levels. There were repeated remarks that indicated an understanding that the licensee wants the plant "built right the first time."

The licensee volunteered for the first INPO Design Audit and has expanded on it with their own extensive design audit.

QA/QC has access to the Executive Vice-President directly and there was no indication of cost/schedule overriding QA/QC.

Rated 5 (C)

b. Senior management was deemed to be actively involved and knowledgeable in all areas of activity of the site with emphasis on quality about on par with schedule and cost. Staffing and material resources provided for control of the quality function appeared adequate; however, staffing of a quality engineering activity to perform specific task planning, especially for the receiving inspection cycle, seemed to be advisable. High emphasis on the Quality Control function was apparent. Positive messages about the licensee's commitment to quality came from personnel at all levels of the licensee's organization as well as from the contractors. The commitment to quality was seen as being long term (i.e., for the life of the plant) rather than meeting a short-term goal such as obtaining an operating license.

Rated 4 (Q)

c. The upper and lower echelons of management say they are fully committed to a program for assurance of quality and, as far as was determined, they are. The motivation, however, seems to stem less from a burning desire for quality per se than from a concern of not having adequate quality and the consequences which could emanate from that. To elucidate on the preceding observation, it is necessary to compare Case B with something, and the only other site visited to this point is the Case A site. The Case B site does not exhibit the same intensity and enthusiasm for quality that one senses at the Case A site. The difference is manifest in (a) the regular involvement of upper management in the activities of lower echelons as they relate to actual construction of the plant, and (b) the lower management and their staff insistence that quality is first (or possibly safety, then quality) without a clear and consistent understanding about where the driving force for quality originates (sometimes expressed as NRC requirements). This apparent inconsistency may arise from the appraisals which list quality first (or sometimes safety, then quality) before other measures of employee performance. It was difficult to determine whether interviewees were responding to questions about the importance of quality from the standpoint of their appraisals or from a clear signal from management concerning quality.

Rated 4 (E)

2.0 Responsibility and authority are clearly defined and properly implemented

a. The overall responsibilities and authorities appear to be clearly specified and well understood by the project participating organizations. It is clear that the licensee has structured these in such a way that it is completely in control of all activities and is, in fact, "running the job."

There appears to be some overlapping of responsibilities between the licensee's Construction Coordination Group and their project sections; however, their authorities seem clear and both components report to a single manager. Therefore, this is not considered to be a problem.

Rated 5 (C)

b. Overall, the responsibilities and authorities for each organization were adequately documented and apparently implemented. Personnel within the project and with the major subcontractors were always knowledgeable of their own as well as others' responsibilities and authorities; however, the organizational structure is quite complicated and not easily understood by an outsider. Geographical separation of some of the major organizations from the construction site were seen to somewhat hamper organizational efficiency (e.g., AE's home office performs the design and procurement activities which then must be coordinated with the licensee at the construction site).

Rated 3 (Q)

c. Responsibility and authority appeared to be clearly defined and, for the most part, properly implemented. The "Project Triangle" (the communication problem arising from having the AE's home office in one location, the NSSS vendor and mechanical contractor's home offices at another location, and the project site at a third location) and the division of responsibilities between the AE and the engineering services function tend to complicate responsibilities and authorities -- if not on paper -- then in practice. The potential vulnerability in the triangle may reside in design-related quality matters, which were not assessed. In the one example of a deficiency in quality (failure to maintain appropriate temporary protection for electrical switchgear) there was no evidence of finger pointing, suggesting that responsibility was properly understood. The fact that no construction is done, except from the AE approved drawings, and that "redlining field changes would get you fired," also supports the acceptance of responsibility/authority.

Rated 5 (E)

3.0 Personnel are adequately qualified for assigned work

a. Records relative to this factor were not reviewed; however, the persons contacted, in general, had good qualifications for their assignments.

There is a good base of nuclear experience at the site. Some people in key management positions and in QC have less experience than one would expect. This is not considered to be serious, but is felt to be marginal.

In part, the lack of experience is offset by a substantial training program and an overall impression of a high level of dedication and enthusiasm.

Rated 4 (C)

b. The licensee and its major contractors have a good program for obtaining qualified personnel and furthering their training. Key personnel have previous in-depth nuclear experience from either the licensee's earlier plant for from other nuclear projects, which has been further enhanced by in-house training. Early in construction, crafts people were recognized to need further training on how to do nuclear work, which has resulted in a comprehensive blue collar training program.

Rated 4 (C)

c. Personnel are generally qualified for assigned work. A number of the first and second line project engineering/design supervision have had about 5-6 years of nuclear experience. Often a year or two of that was on later phases of Plant Hatch prior to moving to Plant Vogtle. This amount of experience is probably not enough to have seen all the things that can go wrong in nuclear plant construction activities.

Rated 3.5 (E)

4.0 Instructions, procedures, and drawings are clear and adequate

a. It was found that specific insturctions to the crafts in the form of Process Data Sheets (PDS) are used only on the ASME Code covered work. Further, an unusually large number of Field Change Requests (FCRs) have been generated in the past few months. Although it has not been confirmed, it is suspected that many of these FCRs are resulting from dimensional conflicts between different items in the installations.

An expanded use of PDSs and a more thorough checking of design dimensions could improve this situation.

Rated 3 (C)

b. This area was not evaluated to any great extent by the subteam.

No rating (Q)

c. Overall instructions, procedures, and drawings appear adequate, though some are only manually logged (as for Field Change Requests) and listings are not routinely sent to all interested parties (e.g., one must go to the log to review entries). Procedures are not up to date. In the case of the failure to maintain protection on electrical switchgear (Item 2), the comment was made that verbal instructions had been given to the construction coordinators to correct the condition, but there were no procedures or paperwork, and it fell through the cracks. The periodic inspection check list was thought to cover this item, but it didn't.

In another case, desktop instructions which can govern some of the more significant details of drawing/specification control, are not monitored for consistency among the project specifications.

Rated 3.5 (E)

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

a. There were numerous comments and indications that management has a strong desire for problems, deficiencies, and areas of improvement be identified whenever possible. Statistical reports on deficiencies, nonconformances, etc., are routinely provided by QA to Project management. It was felt that the usefulness of these reports, in terms of trend analyses, could be improved.

One such improvement being considered is to categorize the deviations and nonconformances in a way to improve trend analyses. Such categorization may be according to the judged seriousness of such occurrences.

Rated 4 (C)

b. Policies and directives about reporting QA/QC deficiencies exist and are being implemented. Increasing the visibility of these policies would seem to be of further benefit. Quality Control is very strong in the civil/structural area wherein a hold point system works in a very effective fashion; however, some work is inspected on a catch-as-catch can basis (e.g., electrical installations). Quality performance data and trends are reported and acted upon by management in a timely manner.

Rated 3 (Q)

c. The large number of Field Change Requests and nonconformance requests (1389 FCRs and 463 NCRs during the period October-November 17, 1982) may suggest some type of deficiency in the design process. The fact that the licensee does not permit redlining to facilitate field changes accounts for part of the number. Also, the project engineering sections review drawings for constructability, and these reviews turn up a number of required design changes. Nonetheless, the number is large and AE home office design function is being audited on this item.

The licensee's project team has been audited by NRC, INPO, and a host of others to the point where one member of the project staff commented that there are too many audits and that they can become demotivators.

Conformance to design appears to be tightly controlled by field QC inspectors.

Rated 4 (E)

6.0 Corrective action program is effective

a. Not investigated by "Construction" subteam.

No rating (C)

b. The licensee and its contractors have a quite good corrective action program which seems to be effective in bringing about needed change. The QC people seem to have higher favor with upper management when it comes to bringing about rapid change. The QA people are also listened to, but management seemed more cautious about accepting their proposals and recommendations.

Rated 4 (Q)

c. The corrective action program was noted only peripherally with regard to the electrical switchgear protection problem and the design audit problem. In one case, the problem escalated prior to corrective action; in the other, corrective action was self-initiated or recommended by the INPO audit.

No rating (E)

7.0 Design reviews, including independent reviews, detect and clearly resolve design deficiencies

a. The INPO audit and subsequent internal, independent Design Reviews appear to have been effective in identifying and resolving problems or deficiencies in the areas of engineering analysis and content of the design. However, a very large rate at which FCRs are being generated may indicate a weakness in the design review for dimensional problems and constructability. There is an element of risk that these more pragmatic design issues may impact the quality.

It is significant that the plant operations staff has reviewed both the design criteria and the completed designs for operability and maintenance needs.

Rated 4 (C)

b. This area was not evaluated by the subteam.

No rating (Q)

c. As previously stated, there has been a large and, apparently, continuing number of FCRs and DCNs at the licensee's project. Design reviews by the AE have not detected and clearly resolved design deficiencies as evidenced by the number of Field Change Requests; however, this problem has been recognized, and increased design review activity is in process. Various reasons were given for constructability. This appears to be the major design review. No data were obtaoned on the independent design reviews within the AE's organization.

Rated 4.5 (E)

8.0 Design input data are adequately controlled

a. The utility, through its Engineering, Operations, and QA organizations, has participated in the reivew of the design criteria and has made significant inputs to some design features; i.e., the Control Room. The degree of formalization of this process was not investigated.

Rated 5 (C)

b. This area was not evaluated by the subteam.

No rating (Q)

c. Limited information was obtained on control of design input data. Design drawings appear to be adequately controlled in the field, and design changes arising in the field appear to be adequately controlled. Design conformance to NRC and code requirements is managed in the AE's home office.

No rating (E)

9.0 Complex organizational structure and arrangements do not contribute to poor assurance of quality

a. The organizational structure, once it could be understood, is considered appropriate and adequate. However, it was difficult to understand functionally, because unusual titles and component names are used. In the interviewing process, it was found that this practice is resulting in potential communications problems, because components were referred to by different functional titles by different people. The use of more functionally descriptive titles could reduce the confusion potential.

Rated 4 (C)

b. The structure is well documented and was judged to work fairly effectively, even though it is quite complicated. Organizational independence is provided for those groups responsible for performing verification and audit activities, both within the utility's and the subcontractor's organizations.

Rated 3 (O)

c. Within the licensee's project team, the organizational structure was straightforward. The divisions of responsibilities and authorities did not have apparent overlaps.

It was commented on that there had been better communication between project engineering and quality assurance when the latter was housed in the same building. As the staffs increased in size and the building became overcrowded, the QA staff was moved to another building outside the construction area. One wonders whether upper management considered this effect in making the move, and what measures were taken to compensate for it.

Rated 4 (E)

10. Planning, scheduling, and budgeting activities allow for adequate resources to do the job correctly

    a. The "Construction" subteam probed this factor to only a very limited extent. The efforts on providing short-term construction schedules appeared good. These include daily, weekly, 6-week, and 3-month plans. Although these schedules are provided to QC, there were indications that assuring QC inspectors are at the right place at the right time is handled rather informally in practice.

    Rated 4 (C)

    b. Work was observed to be on schedule and chronic delays were not evident. Subtle messages to cut corners and get the job done were not evident, either. Procedure compliance is stressed at all levels and daily work schedules appear realistic enough to allow work to be completed in accordance with those procedures.

    Rated 4(Q)

    c. The overall cost/schedule activity appears quite adequate, although there seemed to be some problem in projecting the actual productivity of the mechanical contractor. Budgeting was not assessed in detail. The leadtime that is built into the schedule is as follows: all equipment is to be onsite within 11 months of the time it is needed; all design 7 months; and 90 days before an operation is to proceed, all other supporting facilities and expendable materials are to be on the site. Even with the large distance between the designer and the plant site, the time difference, and the large number of FCRs and DCNs, the design process seemed to be going smoothly.

    Rated 4.5 (E)

11.0 Design control process

a. The design review and audit activities were discussed in Indicator 7. These audits have been documented.

Field Change Requests require formal approval by appropriate design agency representatives and are well controlled.

As discussed in Indicator 7, there is some concern as to the adequacy of design review for application and constructability.

Rated 4 (C)

b. This area was not evaluated by the subteam, but it was noted that a large number of Field Change Requests are being processed.

No rating (Q)

c. The design control process, apart from that performed at the construction site, was not reviewed. The design control process at the site, as far as procedures were concerned, appears quite adequate.

No rating (E)

12.0 Work package development and control

a. As discussed in Indicator 4, this area could be strengthened by more extensive use of Process Data Sheets.

A "Work Package" system is used for procurement, but the extension of this to construction was identified only through the concrete pour cards and the travellers used on ASME code work.

Rated 3 (C)

b. The civil area was seen to be very strong. Control over other contractor operations was judged also to be good, with the exception of the electrical contractor. Also, receiving inspection relies on generic inspection requirements, rather than specific planning.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

13.0 Procurement control

a. The procurement process was not investigated in depth by the "Construction" subteam.

It was identified that source inspection is performed on specified items by the engineering groups, including both the AE and the engineering services function. There is documented evidence of receipt inspections; however, it was determined that the inspection instructions should be strengthened.

Rated 4 (C)

b. The AE handles all front-end activities related to procurement and no evaluation was made in this area. On the receiving end of procurement, acceptance is pretty much limited to an accountability and paper review exercise. Little or no overcheck activity occurs; thus, deficient materials or items may not be discovered until point of installation.

Rated 2 (Q)

c. Not reviewed.

No rating (E)

14.0 Nonconformance control

a. Not investigated by "Construction" subteam.

No rating (C)

b. The licensee's quality program is oriented heavily towards detecting discrepancies (receiving inspection excepted) and a good program for controlling nonconforming items exists once they are identified.

Rated 4 (Q)

c. Not reviewed.

No rating (E)

15.0 Special process controls

a. Such controls are being applied where required by codes, but could be extended in greater depth to other areas as discussed in Indicator 4.

Rated 4 (C)

b. A comprehensive program exists for qualifying special process operators. The program even has requirements for qualifying fitters.

Rated 5 (Q)

c. Not reviewed.

No rating (E)

16.0 Examination, test, and inspection control

a. All indications were that the licensee is doing a well above average performance in this area. It is considered significant that the utility efforts on QC are very extensive -- a staff of about 250.

Rated 5 (C)

b. For the most part, these processes looked well controlled. The electrical contractor was seen to be an exception. Hold points here were not really hold points. If an inspector was not available when needed, work would still proceed.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

17.0 Calibration control

a. Not investigated.

No rating (C)

b. The calibration program is managed by GPC at the site and was judged adequate. Evaluation was limited to discussions with the supervisor, observance of processes within the test laboratory, and checking numerous calibration status labels in the field.

Rated 4 (Q)

c. Not reviewed.

No rating (E)

18.0 Records

a. Not investigated.

No rating (C)

b. Overall, the records program was deemed adequate. The records storage facility was found acceptable and the personnel well informed and directed. The menu for retrieval of information was not extensive, which would mean that data retrieval may be slow.

Rated 3 (Q)

c. Records were not reviewed in sufficient detail to make an adequate evaluation.

No rating (E)

19.0 Audits

a. There were numerous indications that audits have been both frequent and numerous.

RAted 5 (C)

b. The audit program was judged quite strong. Numerous audits are performed by qualified people by various organizations (e.g., the licensee, the engineering services function, and the AE). The audits are frequent, comprehensive, and detailed.

Rated 4 (Q)

c. With respect to audits, the comment was made that there were training programs for a variety of job assignments, but more frequently than not, the supervisor or manager had not audited the program that his subordinates were required to attend. In another case, the discipline project supervisors require their engineers to audit parts of the construction twice a year. In some cases, the engineers need to come in on their days off to do the audit, because of the press of work. There was no evidence of this practice being carried out in a routine and orderly manner.

There was not sufficient evidence that the middle and upper management get to the construction workplace with any degree of regularity. On the other hand, several of those interviewed mentioned day-long sessions with corporate officers inquiring in detail into those persons' activities.

Rated 4 (E)

20.0 Corrective action

a. The subteam was impressed by the corrective actions which ave been applied, particularly relative to concrete placement. These have included:

- Reducing the height of pour lifts in thin walls to reduce the air pockets
- Forming one side with plexiglass so that vibration can be directly observed during placement
- Training vibrator operators

Rated 5 (C)

b. Good responses to quality problems were evident in review of the audit reports sampled. Corrective actions are implemented in a timely manner by responsible management.

Rated 4 (Q)

c. Corrective action was not reviewed in detail.

No rating (E)

21.0 Identification and control of materials and items

a. This was not investigated in depth; however, since all procurement, storage, and site disbursement of materials is done by the utility, it is suspected that the control is very good.

No rating (C)

b. The subteam saw no evidence that this was any large problem, either in the storage areas or on installed piping and equipment in the plant. Nuisance-type vandalism was reported to occur with fair frequency. Many areas that contained installed euqipment were locked and entrance administratively controlled to minimize these occurrences.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

APPENDIX B

DEFINITION OF LEVELS OF QUALITY FAILURE CAUSES

1. The Deepest Sense of Quality Failure

There are basic underlying causes of quality failure, which clearly transcend QA and QA programs. They can be characterized as broadly philosophical. They are at the extremity of the chain of causes (e.g., building a nuclear power plant without knowing how -- which has as necessary conditions (1) the licensee does not know how, and (2) NRF permits them to build, even though they don't know how). It is usually very difficult, if not impractical, to develop recommendations that address such philosophical issues. They are, of course, the root causes. For our purposes, we are defining root causes at at a more operative level.

2. The Operative Sense of Quality Failure

There are basic underlying causes of quality failure, which frequently transcend QA and QA programs, but not necessarily. They can be characterized as general. They are near the end of the chain of causes, but are limited to where it is practical to bring about corrective action (e.g., lack of management commitment). It is at this level that corrective actions often treat many symptoms of poor quality. It is in this sense that the term "root causes" applies in this report. There is a third level which we have defined as symptomatic/procedural.

3. The Symptomatic/Procedural Sense of Quality Failure

These are the causes of quality assurance failures. These can transcend QA and QA program, but it is unlikely. They are characterized as detailed and specific. They are intermediate in the chain of causes and, as such, are subcauses of (2) above. Recommendations for corrective actions at this level are relatively easy, but are likely to treat individual symptoms without curing the disease.

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QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

~~APRIL 28, 1983~~

NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC. 20555

DRAFT

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QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

I. SUMMARY OF FINDINGS

A. Background

The licensee of Case B has one nuclear station in operation and a second one under construction, both consisting of two large units (approximately 1,000 megawatts each). The former station has been in operation since the mid-1970s. The latter station is approximately half completed. The construction permits (CP) were issued in the mid-1970s. Licensee fiscal problems required an approximate 18-month slowdown in the construction of the station. Construction is presently proceeding on a round-the-clock, 7-day per week basis.

The licensee is the construction manager for the project. The major construction contractors -- civil, mechanical, and electrical -- all have had significant nuclear plant construction experience, as have many of the smaller contractors.

The architect-engineer for the Case B nuclear station has had extensive experience in the design and construction of nuclear power plants. Some of the non-safety-related design is being done by the engineering staff of the licensee's holding company. (Neither the AE home office staff nor the holding company's engineering staff was visited).

The licensee has experienced no major quality problems to date in the construction of this nuclear station (none occurred in the construction of the first station, either). There have been recognized engineering and construction deficiencies, but the licensee has taken positive action to correct them. There has not been significant intervention in the licensing and construction phases of the Case B nuclear station. No significant fines have been levied against the licensee for nonconformance violations or quality deficiencies.

The assessment team for the Case B study[1] was comprised of three teams of two personnel each; one concentrating on the project engineering/ design aspects, one on construction, and one on quality assurance programs. The team spent five days at the plant site. Prior to the plant visit, two of the personnel spent ~~one~~ two days at the licensee's headquarters reviewing the project with the licensee's upper management, and one day ~~with~~ the NRC regional ~~staff~~. There were several group interviews and discussions with the licensee's senior project management. Altogether, about 50 interviews were held at the plant site, with individuals intimately involved with the project. In addition to the interviews and discussions, the entire assessment team spent one-half day touring the construction site. The site assessment culminated in a briefing for company officers and project staff members, in which the findings of the team were reviewed and the licensee staff had an opportunity to comment on the team findings.

B. Summary

The objective of this case study was to determine what were the significant factors in contributing to the assurance of quality at the licensee's construction project. The team identified the following factors:

1. <u>The licensee has an orientation toward, and an attitude supportive of, quality in their nuclear project</u>. At higher levels in the management structure, the conviction appeared to prevail that public safety and company profitability demand quality in the construction (and operation) of nuclear plants, and that it is less expensive in the long run to "do the job right the first time." At lower levels, there was an expressed feeling that the company wants to do the job right. Employees at all levels appeared to have a constructive attitude toward the need for quality in general, and quality assurance, in specific. A pro-company attitude and good morale on the part of the employees appears to exist.

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[1] The methodology for the Case Studies is described in Long-Term Quality Assurance Review: Site Assessment Methodology, November 8, 1982 (Draft).

The stated management philosophy of insisting on quality was not simply to satisfy the Nuclear Regulatory Commission (NRC) but to go beyond those requirements to have a reliable and safe operating plant. From the interviews conducted, both at the corporate offices and the site, it was evident that a sense of commitment to quality pervades the licensee's organization at all levels. The licensee volunteered ~~for~~ the first INPO ~~design~~ construction pilot audit and has expanded on it with their own self-initiated evaluation. The quality assurance ~~quality control~~ (QA/~~QC~~) staff has direct access to an executive vice president. There was no indication from the interviews of cost/schedule overriding QA/QC.

2. The licensee has an experienced design, construction, and construction management team. The licensee has had prior experience with a previous nuclear station, and many of the personnel who worked on it are now actively involved in the present project. This experience has given them an understanding and appreciation of the complexity of large nuclear station construction activities. Many of the staff have 5-~~10~~ 15 years experience in nuclear work. The persons contacted, in general, had good qualifications for their assignments. There is a substantial training program and an overall impression of a high level of dedication and enthusiasm to the job. Many of the key personnel had previous in-depth nuclear experience from other projects, and this has been further enhanced by in-house training. Early in the construction process, it was recognized that craft ~~personnel~~ available in the area needed further training on the special requirements of nuclear work, and this resulted in a comprehensive blue-collar training program. The QA/QC staff is broad and deep in experience and qualifications.

The architect-engineer has designed (and constructed) many nuclear power stations.

The major construction contractors (especially the mechanical and electrical contractors) and the smaller contractors have had previous experience in the construction of nuclear projects.

3. The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces. This is manifest most clearly in day-to-day activities at the site. The licensee is running the job. The licensee does not rely on the major subcontractors to perform the overall management functions. It is manifest by the direction for the overall quality assurance program that comes from the licensee and not from its subcontractors. There are limited points of contact by the licensee to direct work of its subcontractors. Licensee construction coordinators, many of whom are past inspectors, do a preinspection of craft work prior to formal inspection by QC. There seems to be a feedback of lessons learned from earlier construction experience and from other projects. Personnel within the licensee's and the major subcontractors' staffs were knowledgeable of their own, as well as others' responsibilities and authorities. (This, despite the fact that the organizational structure is quite complicated and not easily understood at first review. However, within the plant project team, the organizational structure was straightforward). Geographical separation of some of the major organizations (e.g., the AE and mechanical/NSSS contractor home offices) from the site was seen to hamper construction efficiencies.

4. The licensee supports its assurance-of-quality program with adequate resources and backing. This is manifest at the top of the licensee's organization by a project management board comprised of senior utility management, senior project management, and senior AE and NSSS representatives reviewing the project, examining problems, and maintaining cognizance of nuclear matters. Quality does not seem to be sacrificed for schedule and cost considerations. The licensee and contractors have good training programs for crafts and quality control personnel. The planning, scheduling, and budgeting activities appear to allow for adequate resources to do the job correctly. Work was observed to be on schedule and chronic delays were not evident. Procedure compliances were stressed at all levels and daily work schedules appear realistic enough to allow work to be completed in accordance with those procedures.

   The licensee is pro-active in looking for improvement in its assurance-of-quality practices. Key managers were on a retreat to consider new approaches to the assurance-of-quality problem. This licensee was the first to be evaluated under 10CFR50, Appendix B. Their own QA organization was asked to study other QA programs as early as 1978. They have been involved in one of the pilot studies for the INPO audits. They have also participated in self-initiated evaluations. There were numerous comments and indications in the interviews that problems, deficiencies, and areas of improvement can be surfaced without punitive actions.

5. The licensee's QA/QC function is active in reviewing, witnessing, and verifying contractors' work. A well-staffed program with good procedures exists to insure that construction conforms to the design. The licensee and its contractors have an effective corrective action program which seems to bring about needed change. Design reviews for constructability and operability were thorough.

   The project engineering staff reviews the design for constructability. This appears to be the major design review (no data were obtained on the independent design reviews within the AE organization).

The case study team's evaluation of 20 generic indicators of quality is in Appendix A.

The foregoing factors are discussed in greater detail in the following section.

There were several observations which the assessment team made which could improve the licensee's assurance of quality. These included:

1. Document control: destruction of obsolete specifications and drawings is not tightly controlled. In some cases, there could be use of uncontrolled drawings.

2. Procurement procedures: the receipt inspection, source inspection, and communication to vendor of specification requirements should be strengthened.

3. Construction process control: while the hold-card approach for civil-structural work and the application of process data sheets for the mechanical contractor are good, some of the other contractors, including the electrical contractor, lack procedures which could cause them to miss hold points because inspectors are not immediately available.

4. Field change requests and nonconformance requests: during the period of October 1 to November 17, 1982, there were 1389 field change requests and 463 nonconformance requests processed. This continues at the rate of about 30-50 per day. This could be the result of some deficiency in the design process. (The AE design function is being audited on this item).

5. Senior management involvement at the site: licensee senior management should take a more proactive role in communicating the importance of quality to the staff, and be more visible at the job site.

6. Formalized quality engineering capability: at the present time, there is no ~~separate~~ formal quality engineering ~~organization~~ function in the licensee's project staff. This function would help ensure that the process of translating the design into construction was carried out efficiently and ~~optimized for quality~~. constructability enhanced.

7. Trending of QA/QC findings: a better presentation of the results of QA/QC activities to management would enhance the assurance-of-quality program. (It was noted that the licensee had initiated work on improved procedures).

This case study was the first one in which the licensee's project had not experienced major quality problems. Thus, there could be no comparison with other plants without major quality problems. The observations included here are in considerable contrasts to the early history of the Case A study (a plant which had been shut down by NRC for quality problems). The case study team did not find any practices that would indicate an impending major quality problem. This does not guarantee that a major quality problem will not occur, but the key factors for not having one occur appear to be in place. The licensee's continued activities in looking for ways to improve the assurance of quality may reflect a healthy skepticism ~~its own uncertainty~~ in the matter. ~~as well as providing a basis for the observation that no quality problems are likely to occur.~~

II. ROOT CAUSES OF THE LICENSEE'S SUCCESS WITH QUALITY IN CONSTRUCTION

Based on the case study team's review with the Nuclear Regulatory Commission Regional Office, documentation pertaining to the licensee's project and discussions and/or interviews with about 50 licensee and contractor staff personnel, the team believes that the root[1] causes of the licensee's success with the quality of construction reside in the following factors:

1. The licensee has an orientation toward, and an attitude supportive of, quality. The executive levels of the licensee evidenced a very good understanding of the significance and ramifications of building and operating nuclear power plants. This is probably due, in large part, to their experience with a previous plant, which came on line in the mid-1970s. There was no indication of a "fossil mentality" at the executive level. (This term refers to a utility's attitude that, since it was successful in building fossil fuel plants, it could be successful in building nuclear plants using the same techniques, personnel, and effort. This has been ~~shown to be untrue~~). While the licensee's management seems very much aware of the importance of complying with NRC requirements, the comment was made, "satisfy the NRC and everything is okay, is not true; you have to satisfy yourself." There was recognition that a utility can be at considerable financial risk with a nuclear plant.

   There was considerable evidence of a top management commitment to quality. Further, there were indications of activities to directly address bringing about improvement. Some of the comments that indicate this were:

   - "There is a lot of talk about quality in nuclear construction. Some think there is a need for more of the same thing that isn't working."
   - "Maybe the industry and NRC need to back off and look. Maybe QA wasn't put in place right the first time."
   - "We don't want just more of the same -- what can we do that is innovative."

[1]See Appendix B for definition of root causes.

- "Are we looking to see if we are doing what we said we would do, or what is right."

- "We are going to look at how we look at the QA organization and the growth potential for the people in it, also QC."[1]

An example of one need for improvement is that QA/QC findings are not presented to upper level management in a readily digestible format. The system in use now only identifies problems generally, and not specifically enough to identify to management what kinds of actions need to be taken. The licensee is presently strengthening the quality trend identification program via a computerized system, ~~however~~.

An example of management's concern with quality, and its attempt to be aware of imending problems is the creation of a project management board. This project management board meets monthly and it consists of the chairman of the board (of the licensee), the presidents of two of its operating components, the executive vice presidents of finance and construction, the vice president of the architect-engineer firm, ~~and a member~~ of the NSSS firm. This board gives the project general manager direct access to top level management of engineering, construction, and startup. The board deals with costs, schedules, and quality assurance. A typical meeting includes mostly input from the project staff, but there is also some direction given to the project staff. Two examples of items recently discussed related to secondary water chemistry and seismic problems. The project general manager said this high level management involvement in significant problems was very helpful.

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[1] Quotations may not be direct, but they are believed to convey the meaning intended.

The project general manager acknowledged that it is very difficult to get quality assurance attitudes from upper management to craft levels. If, for no other reason it is important to do so, because approximately $2 million per day is being spent on the project, and any rework due to inadequate quality only escalates the costs and delays completion of the project.

The project general manager had been involved in the licensee's earlier nuclear plant. He commented on changes which have occurred between the earlier nuclear plant and the present plant: the power generating division (i.e., the operations staff) has been integrated into the construction effort; a simulator has been built adjacent to the site; the project has been organized to do as much work at the site as possible; superior facilities (e.g., warehouses and offices) have been built at the site; all engineering capability needed for the project, including subcontractors, report within the engineering organization; the quality assurance organization structure has been put in a stronger position; personnel with greater experience in quality assurance have been hired; there have been significant management changes for the better; and (though he acknowledged that there was a negative attitude to the processes required to support quality; i.e., paperwork and form filling out), he expressed concern about the communications problems which continue to arise because of the widespread locations of the AE and NSSS home offices and the construction site. This may be related to the large number of design change notices which have occurred.

The project general manager noted in his closing remarks that the licensee does not penalize employees when problems arise. This policy encourages the surfacing of problems at an early time.

The licensee's attitude toward quality was also expressed by the assistant construction project manager. When asked what he perceives as management's commitment to quality assurance, he enumerated several things:

First, personnel with greater quality assurance experience have been hired. Second, management keeps abreast of the work in the quality assurance department. Third, management has endorsed the INPO self-initiated evaluations. Fourth, management reviews quality assurance findings. He said that an executive vice president periodically checks on his work, and he perceives, as does his staff, that the chief executive officer is interested in quality assurance. He said that when there are accountability reviews at the top of the organization, they are interested first in safety, second in quality, and then in cost and schedule.

In response to a question concerning what quality assurance changes he has seen in the last three years, the assistant construction project manager said that there is an increased awareness of quality assurance and that the training programs (especially in the civil area) were prominent among the changes. He perceived that there is a more knowledgeable understanding by the craft personnel of quality assurance, and this has helped in communication with the crafts, and has increased productivity. The independence of the quality assurance organization is another major change. The attitude on quality assurance is one of increased openness. A vice president directly responsible for project QA now has direct access to the chief executive officer. He said the construction forces and the project management are now working together better.

The manager of quality assurance and the quality assurance field supervisor said that they do not win all their battles when they approach senior management and try to bring about change. They feel, in some cases, they have not done the best salesmanship job they could have. In other cases, though, where it really counted, they made their case heard and got appropriate action. They stated that the door has never closed in the face of the quality assurance organization. It is readily accepted and backed by other management.

The licensee has used stop work order authority approximately six times to shut down a contractor's operation completely. Individual jobs are stopped routinely. The situation now exists where most construction will stop their own work at the first level of quality control when problems arise. When a whole contractor's operation is stopped, the order originates about half the time with the quality control groups and half the time with engineering. Contractor's operations have been shut down because of coating problems, cadwelding, concrete work, and for housekeeping.

The same general attitude toward quality was forthcoming from the construction concrete superintendent. He said, "I don't have to go upstairs to get backing when I call the question on something. We (QC) can pretty much handle day-to-day problems without having to resort to escalation; however, when something is escalated, it is usually something beyond my jurisdiction or authority." In the same interview, the statement was made that the licensee was not afraid to fire people for poor performance. The major civil contractor has terminated several welders including their foreman foreman ~~receiving~~ for work of poor quality.

Management's interest in the QA program is also demonstrated in the orientation and training program for crafts. Craft indoctrination includes a videotape entitled, "QA Is Everybody's Business." The videotape includes a message from the chief executive officer of the licensee's holding company and other licensee management stressing the importance of QA and the results of poor workmanship. Additionally, training including specification and workmanship requirements and rules of conduct specific to each craft is accomplished. For example, welders receive approximately 15 hours training, and electricians 10 hours.

Overall, the assessment team concluded that the licensee's general management is committed to quality assurance. Since a poorly constructed plant can bankrupt the licensee, management sees QA as insurance against producing a plant which will not operate successfully. As a result, management does not limit the implementation of QA to meet NRC requirements, but rather to do what is necessary to provide confidence that the plant will operate successfully.

2. The licensee has an experienced design, construction, and construction management team. As previously stated, the licensee has constructed a previous two-unit nuclear power station that went into commercial operation in the mid-1970s. The AE has been involved in nuclear power plant design and construction for over 20 years, and has been the AE and/or construction manager on many nuclear plants. The electrical and mechanical contractors participated in the construction of the licensee's previous plant, as well as other nuclear plants. The experience levels of the licensee's staff and contractor managers varied considerably. Many of those in key positions with the licensee have less experience than one might expect to find in similar projects; however, many of them have been with the licensee for 8-10 years and have worked at the licensee's previous nuclear plant before going to the Case B nuclear plant. It is apparent that the previous nuclear plant provided both the licensee and many of its personnel with valuable nuclear plant experience. This experience has resulted in, or permitted, a matrix organization which includes personnel in key positions from the licensee's holding company enginering function, the AE, and the NSSS vendor.

The extent of control exercised by the licensee at the construction site was impressive. The major construction contractors, except for one responsible for the containment vessel liner and another for the cooling towers, are all on a cost reimbursable basis. This permits the licensee to exercise control over the construction processes and their quality implications. All materials and equipment used at the site are provided by the licensee and the licensee controls the staffing levels of all except the fixed-price contractors.

One result of the experience by the licensee is the creation of the project management board. As previously stated, it is comprised of corporate level executives from several companies ~~which play an active role~~ involved in the project and which is chaired by the licensee chief executive officer. The project management board is viewed essentially as a separate board of directors relative to the Case B project. The board is ~~obviously~~ composed of those who can make major decisions and commitments for ~~of~~ their respective organizations. Further, it provides a forum for executive level communications between key organizations.

As previously stated, the major work force of the AE is located off site, and the problems related to this situation are being reviewed. The on-site engineering function is comprised of about 35 AE employees and about 10 licensee employees. In the past, original drawings were not made at the site. This may change, however, because of the need for closer coordination between construction and engineering. To improve engineering response time, one action being taken is to move an NSSS team on site in early 1983. This will result in 21 additional people being added to site engineering ~~to respond to and correspond with~~ primarily in connection with the installation of small bore piping.

Lessons learned from the licensee's previous plant construction activity have resulted in improved advanced planning and scheduling and have been reflected in how they manage the work at the site. Standard lead times are set at 11 months for material, 7 months for pipe, and 90 days for having everything ready for construction. At the present time, design completion was estimated at: civil, 70%; mechanical, 60%; plant, 70%; and electrical, 60%.

Since the licensee and many of its construction contractors have had prior nuclear power plant experience, the effect of applying lessons learned is very beneficial to the ~~successful QA program~~ construction program. For example, operations involvement in construction activities is more detailed and earlier than for the licensee's previous plant. Also, some operations engineers have been assigned to construction engineering to enable them to better understand the plant. Quality program items are included on the agenda of major management meetings. Management encourages getting problems put on the table so they can be dealt with. Employees seemed to recognize that management appreciates that problems will occur and that the important thing is to prevent recurrence. One case that was occurring at the time of the interviews related to protection of erected equipment. It was refreshing to hear a supervisor take the responsibility for the deficiency without ~~inculcating~~ implicating others. This attitude exists not only within the licensee's structure, but also in the interface with the NRC inspection personnel. This openness without fear of recrimination tends to get problems solved before they become unmanageable.

Another experience factor is that all field coordinators are trained in the inspection techniques and approximately half of the coordinators are ex-inspectors. The crafts are therefore provided with an interface which emphasizes quality requirements consistent with that of the licensee's inspectors.

The QA/QC staff was noted to be broad and deep in its qualifications. When hired, these qualifications are further developed through formal classroom and on-the-job training. The recruitment for QA people stresses degreed personnel with experience in the practical side of the nuclear industry. Experience for QA management personnel ranged from 20-30 years; the average QA staff had approximately 10 years experience. The QC inspection supervisors have typically 2 and 4-year technical degrees and the section supervisors have a bachelor's degree as minimum education. Their experience ranges from 12-30 years.

There is active company involvement in looking for ways to do things better. The licensee sends their employees to other utilities to gather different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the licensee's holding company's engineering staff. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the PACE program, giving QA more authority than it had in ~~early days~~, and adoption of innovative concrete processes (computerized batch plant use of Creter cranes, and plexiglass forms) are examples of such progressiveness.

The licensee uses an unusual construction shift work arrangement. The project is manned nearly 24 hours a day, 7 days a week, with four non-rotating shifts. There are problems with conflicts between shifts, but the licensee considers the benefits worth the additional problems. For instance, more workers can be utilized to improve the schedule. The current total job site work force is about 7700 employees. Somewhat better ambient temperature conditions for concrete placement exist. In cooler weather, most of the concrete is in place on day shift. A larger pool of skilled crafts is available. This is true in part because two of the shifts work only 3-day weeks and thus can use the other four days for commuting longer distances.

The union contracts also manifest experience of the licensee; e.g., each shift is paid straight hourly time for a specific number of hours in lieu of conventional overtime; there are no formal scheduled coffee breaks; in the event of a walk-out by one craft, there is no picketing, hence, other crafts continue to work. The licensee uses selective bid lists for on-site contractors; however, open shop contractors are permissible providing they abide by the special licensee-union agreements. The licensee takes an active part in negotiations between the union and the construction contractors.

3. The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces.

The clearly defined responsibilities and authorities, together with appropriate procedures, stems from the licensee's active management of the project. The extent of control exercised at the construction site is impressive. The cost-reimbursable contracts which the licensee has with most of its contractors permit a large degree of control over day-to-day activities. All materials and equipment used at the site are provided by the licensee. The licensee controls the staffing levels of all except two fixed-price contractors (whose work does not significantly interface with other contractors). As previously stated, the project organization is a matrix-type organization and includes personnel in key positions from the licensee's holding company engineering function, the AE, and the NSSS supplier. While the licensee has not been as intimately involved in the AE's activities, it does review all drawings for constructability and operation. The licensee is becoming involved in AE design audits through the INPO process and the self-initiated evaluation.

Advanced planning and scheduling, combined with management involvement, has resulted in the work being on schedule. Near-term work schedules are developed in concert with the construction contractors, but are controlled by the licensee. These include daily, weekly, 6-week and 3-month plans. Longer term scheduling and budgeting is done by the licensee. Standard leadtimes are 11 months for materials, 7 months for pipe, and 90 days for having all other materials, including consumables, ready for construction. The project general manager reported that the project is on budget for the year and about two months ahead of schedule (rebaselined in September 1981); however, the progress curve has flattened somewhat in the last two months. He said that contributing factors to maintaining schedule have been lessons learned from their previous nuclear plant, better training of personnel, and better support facilities on the site.

Among the lessons learned include the previously mentioned project management board, which provides a mechanism to promote timely resolution of problems, and to integrate senior management experience and expertise into the management process and provide clear direction to project groups. The board is composed of those who can make major decisions and commitments of their respective organizations. It meets monthly, and several of the licensee's management cadre emphasized good attendance of board members at these meetings and their active participation in them. (It must be observed, however, that in a meeting attended by a portion of the case study team, which included five licensee vice presidents and the company president, the latter did all of the talking).

The organizational structure in effect at the licensee's plant is best described as complex. The interplay of different lines of direction reporting, administration, and communications between the three major organizations involved; namely, the licensee, the licensee's holding company's engineering function, and the architect-engineer, as well as the entwined project relationships, make it difficult for one to understand the organization and its functions without considerable study. Nonetheless, the organization seems to work fairly effectively.

The project general manager, the highest ranking individual totally dedicated to the project, is a licensee vice president, but is at the fifth level below the president. Reporting to the project general manager is the on-site manager, called the construction project manager. He is considered by the corporate office to be responsible for everything at the site. The on-site field or project engineering functions report to him as does the superintendent of field coordination. The latter views his function as the intermediary between engineering and field construction; however, at least one construction contractor views his official contact with the licensee as the project engineering section supervisor, and the field coordinators as expediters for materials and tools, plus an arbitrator in relations with other contractors. The construction contractor's view was felt to be more accurate.

The QA and QC components are totally separated from each other and, for the licensee, this seems to work well. The QC function reports to the construction project manager.

The contracting and procurement function is managed from the licensee's home office. In addition to the minimal use of firm fixed price construction contracts, another significant practice is that the licensee provides all materials and equipment at the site. As a couple of interviewees expressed it, "All the construction contractors bring to the site is their bodies and their expertise."

Source inspection in vendors' plants is provided through project engineering by the architect-engineer and/or the licensee's holding company engineering function. Receiving inspection at the site is provided by the licensee's QC organization.

The licensee's quality assurance department is organized into a general office staff and a plant site staff. There are approximately 30 people who are directly involved with the programmatic side of quality assurance at the plant site. This is exclusive of the quality control personnel which, as previously stated, report separately from the quality assurance organization through the project side. Other quality control groups exist in the major subcontractor organizations. The mechanical contractor has about 70 inspectors. The NSSS supplier is staffing its inspection forces. The general office staff of the licensee's quality assurance is headed by project coordinating engineers and project quality assurance managers who report to the manager of quality assurance and to the applicable project general manager for project direction. The manager of quality assurance staff assists in establishing quality assurance policy, interpreting NRC and government regulations, and in personnel and organizational planning. The project quality assurance managers are assigned to specific nuclear construction projects and are responsible for carrying out quality assurance department directives as they apply to all aspects of design, construction, and operational testing.

Quality assurance staffs at the site ~~are headed by~~ a quality assurance field supervisor who reports to the manager of quality assurance and who is responsible for all quality assurance activities at the construction site and the operating units. The staffs are composed of quality assurance engineers or quality assurance field representatives for each engineering discipline involved in the construction activity, plus two or more qualified quality assurance engineers or field representatives for each operating unit. The prime job of the staff is that of audit. The personnel are responsible for assuring that plant site activities are accomplished in full compliance with the quality assurance manual, technical specifications, and procedural requirements.

The quality assurance program for the AE was not evaluated, as their work is primarily conducted at their home office.

With respect to the design process, the licensee receives all drawings from the architect-engineer and, for non-safety related matters, from the licensee's holding company engineering function. The project section supervisors review the activity packages and initiate field change requests and field change notices as they review the design for constructability. The licensee does not do any design on safety-related systems or equipment. The on-site design functions of the architect-engineer are limited to nine items as far as design changes are concerned, such as cable tray supports and reinforcing rod matters. Construction will only work to AE-approved drawings. Each construction group within the licensee's project controls its own drawings and each is audited every three months for properly approved drawings. The mechanical contractor does the drafting work at the project site.

The architect-engineer's field office approves field change requests, nonconformance requests, and handles all drawings to the job site. Revisions to drawings are returned to the home office when there is not adequate expertise at the job site. The design work is completed within the requirements of the project reference manual and appropriate regulatory guides. One of the architect-engineer's responsibilities at the job site includes monitoring the N stamp. The AE has the authority to apply N stamp to the design and also to systems within

the project.

In summary of the foregoing, the licensee has overall responsibility for the project. Its AE has overall plant architect-engineer responsibilities. Its NSSS supplier is responsible for NSSS design, and the holding company's engineering function has design of certain ancillary facilities.

4. The licensee supports its assurance-of-quality program with adequate resources and backing. A number of items that lend credibility to this root cause for the success of quality in construction have already been discussed, including previous experience with nuclear plant construction and use of experienced personnel.

The licensee's management recognizes that QA boils down to an economic issue -- and a long-term one at that. They are not focused exclusively on the short-term goal of getting the plant ~~licensed~~, but on building a plant that will operate safely for its expected life. This is not to say that licensing for operation is not a very important milestone, because failure to license could spell economic disaster, but rather to say that the job needs to be done correctly now to minimize costs over the entire life of the plant.

The AE on-site manager's comments on the licensee's consideration of quality are interesting. He received strong signals from both the licensee as well as his own management with respect to quality. He said that the licensee's management is very supportive of their quality assurance staff. He mentioned a problem with welds on piping spools fabricated at the mechanical contractor's home plant. There were only slight defects in the welds, some minor weld slag and pinholes. These were all repaired even though they were detrimental to the progress of construction. The AE's on-site manager was impressed.

The comment was made by the AE manager that whereas on other projects redlining drawings (to denote field changes) is accepted practice, for the licensee's plant it is necessary to revise drawings.

The AE resident manager, in responding to the question why no quality problems of a major nature have been experienced at the licensee site, said that the licensee's management concerns about quality assurance and safety have been very high. They have spent much money and they want to license the plant as efficiently as possible and create a positive climate with respect to quality. He said the message is nothing is to be sacrificed for schedule.

The manager of scheduling and budget, an AE employee, said he was impressed with the licensee's interest in quality as manifest by the project management review board feedback. He said the executive vice president reviews his program area about six times a year, devoting one day each time. He said the performance review for licensee employees is now tied to budget and schedule. (Interestingly, most licensee employees said that safety and/or quality were the first items in their performance reviews). Another quality input from management relates to the project general manager's review.

The importance and the extent of training programs has already been discussed to some extent. The various programs include the licensee's QC training, construction craft training, and plant operations training. All of the QC inspectors of the licensee have received at least one week of formal training conducted on site and off site. The superintendent of field coordination has also required his entire staff to attend QC training programs.

Craft training programs are conducted by the construction contractor. In addition to a half-day orientation, the training programs have included specific classes in concrete placement and vibration pipe weld preparation, grinding, cadwelding, electrical specification requirements, and storage and handling of materials.

The plant operations staff training program was impressive. The licensee has installed a complete control simulator at the site and trains station engineering staff as well as the control room operators on this simulator. Also, the licensee has established agreements with other utilities so that some licensee staff are assigned to operating nuclear power plants for a period of 12-18 months.

Attitudes are also important to the assurance of quality. There is active company involvement in looking for ways to do things better. Licensee sends their employees to other utilities as previously stated, to gather different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the holding company engineering function. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the people achieving excellence program, giving QA more authority than it had in previcus times, and adoption of the innovative concrete processes are examples of such progressiveness.

Sufficient resources as far as manpower, funds, and time have been allotted to provide adequate confidence that a quality performance will result. For instance, in interviewing the assistant manager for quality control, the question was asked how he knows whether ~~he knows~~ he has sufficient manpower to do the work required. He described how he determined his manpower needs (they relate to construction team size) and he said that sometimes double shifts are required; however, he lets management know of his needs and they are usually filled.

The QA manager has organizational independence and reports to an executive vice president. There is also a senior management quality assurance committee made up of vice presidents from organizations such as engineering, construction, power generation, licensing design, and quality assurance, and these represent both the licensee and the licensee holding company's engineering function. It is headed by an executive vice president and provides a forum where large time, money, and organizational quality assurance issues are settled.

The pro-quality attitude of senior management prevails throughout the licensee's organization, and carries over into the subcontractor's operations. All individuals surveyed were able to talk intelligently on QA/QC as related to their sphere of work, although at some of the lowest levels (craft level) personnel had difficulty explaining why it was important. They just know it was because of the observed actions and the emphasis by management.

This same attitude was reflected in discussions with the supervisor of the civil projects section, where he saic that the message from management is stay on schedule but hold quality. (But then in a subsequent statement, changed and said that if something has to suffer, it should be schedule, not quality). The licensee only wants to do the job once. Effort then would be applied to improve the schedule later. When asked the question why no major QA deficiencies had occurred at the licensee's site, he said that the project is a whole team effort. They have a feeling that this job has to be done right and that the engineers, coordinators, QA/QC people, and constructors work together. They have the attitude that this job will be Number One.

In summary, every project experiences the conflicting demands of quality, cost, and schedule. This one is no different, and the occasional ambivalence expressed by those interviewed shows the struggle. Overall, a good balance appears to be maintained.

5. The licensee is taking a pro-active role in looking for improvements in its assurance of quality program. A number of examples have been cited already, including the project management board, the staff retreat to consider new approaches to quality. The project general manager and vice president's response to the question about what changes have occurred between the licensee's first plant and the present one illustrate substantive improvements:

   1) The Power Generating Division (Operations Division) has been integrated into the construction effort. The Operations Division now sits in on design reviews and other project activities to help avoid the need to make numerous changes when the construction is completed.

   2) A simulator for the licensee's most recent plant has been built near the site.

   3) The project organization has been organized in an attempt to do as much of the work at the site as possible. They now have the ability to manage and support the job at the site.

   4) Superior facilities for equipment storage and project personnel have been built at the site.

   5) The licensee now has the engineering management needed for the project and the subcontractors now report to engineering.

   6) The quality assurance organization for the constructor has been put in a stronger position and is headed up by personnel who have extensive nuclear experience.

   7) There has been a significant changeover in management, with a net result that there is now a more positive attitude toward quality.

In the day-to-day construction activities, the planning and coordination of project QA/QC interfaces is well done and conducive to good quality. The QC shifts overlap at shift change and interface with the construction coordination group in work planning and scheduling for the following shift. QC/contractor differences of opinion are resolved readily. The organizational structure for the project has the site QA overviewing the site QC, who overview the contractors. Corporate QA overviews site QA and the licensee's holding company's engineering function overviews all of its utilities' subsidiaries.

The quality assurance program is actively managed by the licensee. The licensee is supported by its holding company's engineering function and has taken firm control and has not relied upon contractors to provide program direction. The requirements are spelled out in a well-documented program and enforced through stop work orders that are both job specific and generic to a contractor. There has been early recognition of situations which may have developed into severe problems, such as the erosion problem. Cost-plus contracts are used nearly exclusively because of recognition that fixed-fee type will eventually force poor quality. A shortage of trained work force both in the professional and crafts area is met by active recruiting and through implementation of an effective training program. Preparations for the operating phase are currently underway in addressing and resolving technical programmatic issues. A nuclear training center for technical and maintenance activities is being built and future plant operators are now being trained in plant and on the reactor simulator.

The licensee was recently "written up" for the third time in a year for improper protection of stored-in-place equipment, and the corporate management was reacting very forcefully. This factor causes one to ask whether the dominating factor in the quality emphasis at the licensee's plant is because of a need to satisfy the Nuclear Regulatory Commission. The following observations were made by NRC inspectors as this question was discussed:

- They consider the licensee's plant average, except above average in doing their own quality control.

- They feel that quality assurance and quality control are both good and adequately staffed and trained.

- They are impressed with the construction craft training programs at the site.

- They feel that upper level management should be at the site more often.

III. REMEDIAL ACTIONS TAKEN TO CORRECT QUALITY PROBLEMS

As previously stated, there have been no major construction-related quality problems at the licensee's site. There have been, however, a number of typical problems that arise in the course of construction. Some of these are described to illustrate the type of problems encountered, how the licensee has responded to deficiencies in quality, and for background to the licensee's responses in the interviews. Most of these problems have been alluded to earlier in the report. The following list is comprised of those problems that the case study team became aware of during the site visit:

1) Early in construction, an NRC inspector identified an erosion problem due to rainwater during excavation for the plant. The licensee initially disagreed that this was a problem, but subsequently agreed that it was a potentially very serious one and, as a result, took corrective action. This particular quality problem was felt to be significant for two reasons: (a) it established early on that the NRC would be insistent about correcting potential problems, and (b) it was a real physical problem identified by on-site NRC inspection, rather than a procedural or records problem detected in a paper audit.

2) The licensee has been concerned over the number of field change requests and nonconformance requests that have been required in the design. While the volume of field change requests and nonconformance requests is greater than other projects out of the AE's home office, there may be good re[illegible] why it may be greater at the licensee's site. As a result of monitoring the number of changes, the licensee has insisted that the AE's design

procedures be audited. The changes are being categorized by discipline (mechanical, electrical, or civil) to determine which groups need attention. This activity has resulted in the home office checking to make sure the remaining drawings are more closely reviewed. It appeared likely that the AE would assign a quality assurance person from the home office to the licensee's site.

3) The licensee at one time had a problem with rock pockets in the surface of thin concrete walls (12" thick). This problem was resolved by reducing the pour lifts from 12' to 6' and increasing the attention given to vibrator technique. An inrovative practice subsequently put in place for thin wall high lift pours is forming one side with plexiglass. This permits QC and construction forces to observe directly the placement and vibration of the concrete. In addition, through-the-form vibration with inspection ports are now used quite extensively.

4) During the plant walk-through, it was noted that a hold tag had been placed on a spray ring pipe spool because center punch marks near each end of the spool were considered too deep. The QC inspector had to have examined the approximately 30' long spool piece very closely to have found these small marks. This is a good example of thorough QC inspection.

5) The licensee had been notified of inadequate storage requirements for installed electrical equipment. While the supervisor in charge had given instructions to his field coordinators to correct the deterioration of the storage process, it was not done. The supervisor acknowledged this problem as his responsibility. As the team probed for root causes in this situation, it was noted that there was no finger-pointing. The supervisor felt that the cause was inadequate procedures and followup.

The information flow from engineering to coordination was verbal. The procedures for conveying the information were weak; i.e., there was no form nor paperwork. The supervisor said he thought the system was working and that the periodic inspection checklist covered this item. As a result, the licensee was considering establishing a contractor crew to ensure that storage measures are sustained.

6) There has been difficulty with respect to the quality assurance on piping spools. It was noted that the licensee examined all of the prefabricated piping spools and did, while finding no significant quality defects, spend considerable time in correcting well spatter and surface defects.

IV. GENERIC IMPLICATIONS

Based on the information reviewed and analyzed by the Case B study team, several possible generic implications, or lessons, emerge. These are highlighted for each case study to provide input and to help form generic conclusions concerning factors which constitute important elements in nuclear plant construction quality.

1) The importance of the licensee managing the project. The licensee has clearly accepted responsibility for the completion of the project and the quality of the overall work. As a result, they have instituted practices that permit them to dictate the scope and degree of quality. They actively manage the day-to-day activities of each contractor. Their field forces review the design for constructability. They have instituted audits where appropriate for their subcontractors.

2) The importance of experienced personnel. The licensee has staffed the project rather broadly and deeply with personnel with substantial experience, both in general construction, as well as in nuclear construction. Many of the staff have 5-10 years with the licensee, have worked on the previous nuclear plant constructed by the licensee, or on other nuclear plants.

3) The importance of good training programs. Many of the licensee's staff, as well as the construction contactors' staffs, undergo training programs. Some of the training has been instituted because there is limited availability of skilled labor in the area. The licensee and its contractors train crafts and staff in quality control. In many cases, they have found that in training new personnel, there are fewer bad habits to overcome.

4) The importance of planning. Nuclear projects are complex projects and require extensive planning and coordination. The licensee's projects seem to be well coordinated with interfaces generally well handled. The construction staff does not appear to be standing around; ~~that is~~, productivity appears good. Evidence of the planning is also manifest in preparation of the operations staff with 80 engineers already on the staff. The licensee has a training center and sent staff to other reactors for training. Lessons learned from their previous nuclear project, as well as other projects with the holding company's purview, have been fed back into the licensee's construction project.

5) The importance of a pro-company attitude among the employees. The licensee's staff appears to enjoy working for the licensee. Comments were made about fairness, opportunity for advancement, and rewards for hard work. The licensee appears to be a people-oriented company, ~~in that~~ layoffs are relatively rare, and the company provides a good pay scale with good fringe benefits.

6) The importance of an orientation toward quality. There seems to be a perception at all levels within the licensee's staff that quality is highly important. At the higher levels of management, there is a conviction that public safety and company profitability demand quality and that it is less expensive to do the job right the first time. At lower levels, there is a feeling that upper management wants to do the job right. Many of the staff were able to identify the signals that tell them that; and that quality is at least as important as schedule and cost.

7) The importance of support to quality. This is evident in the qualifications of the personnel that have been hired in both the quality assurance and quality control functions. It is also evident in the programs for these types of personnel as well as crafts. It was apparent from interviews that quality assurance/quality control personnel were respected by management, and the management supported them when it was necessary to stop a job when adequate quality was not manifest.

8) The importance of the seeking ways to improve quality. There is an attitude within the licensee that it has no monopoly on good ideas and looks far and wide for ways to improve its program. The licensee was first to be evaluated under 10CFR50, Appendix B. It has been proactive in looking at others' quality programs. It was one of the pilot studies for the INPO construction audit and it has also embraced the idea of self-initiated evaluations. They were open to participation in the NRC case studies. A number of their senior staff were on retreat at the time of the case study to consider ways to improve the quality program at the site. The licensee expressed considerable interest in good practices that the team had noted at other sites, and at least one contact was made at the Case A utility visit. They appeared to be more interested in finding out where they could improve than in knowing what they were doing right.

9) The importance of openness. The licensee exhibited an openness in encouraging its employees to identify quality problems without fear of punitive action. In addition, they are open to the NRC in its activities at the site. There appeared to be no attempt to hide marginal practices from the NRC inspection staff.

10) The importance of experience in the construction of nuclear plants. The licensee learned a great deal from the construction of its initial nuclear plant, including an understanding of the magnitude and complexity of a nuclear project.

11) The importance of top management involvement in nuclear projects. The licensee has seen fit to establish a project management board for its nuclear project comprised of senior utility management personnel involved in the project. This type of activity enhances resolutions on problems and helps keep management informed. Top management appears to have made a resolution to spend more time at the construction site.

V. IMPLICATIONS OF THE CASE STUDY 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 of nuclear facilities, to improve the management control of quality and/or to improve the NRC capability to evaluate the implementation of licensee assurance of quality programs. These initiatives are described in the NRC staff paper SECY 82-352 titled, "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 licensee's nuclear construction project. Subsequent paragraphs take each initiative in turn and discuss whether the initiative, had it been an ongoing activity at the time of the licensee's construction program (or quality problems, if such occurred) would have made a difference. That is, would the initiative have helped prevent or at least mitigate construction quality problems that may have occurred or, in the case of this licensee, would it have improved the quality of the plant.

A more complete discussion of the scope and details of the various NRC QA initiatives may be found in SECY 82-352 and SECY 83-32 titled, "First Quarterly Report on Implementation of the Quality Assurance Initiative."

It should be noted that each of the initiatives were discussed with senior management of the licensee and they agreed (or did not take exception to) the study team's evaluation of the applicability of the initiatives to their prior construction experience.

A. Measures for Near-Term Operating Licensees (NTOL)

1. Licensee Self-Evaluation - not applicable for current stage of ...
The licensee self-evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the licensee self-evaluation would not have taken place up to the present phase of construction of the plant, which is about half completed and, thus, its effect on the project is not applicable.

2. Regional Evaluation - not applicable for current stage of ...
The licensee regional evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the regional evaluation would not have taken place up to the present phase of construction of the plant and, thus, its effect on the project is not applicable.

3. Independent Design Verification Program (IDVP) - not applicable, for current stage of ...
The licensee IDVP is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the IDVP would not have taken place up to the present phase of design of the plant, which is about 70% complete and, thus, its effect on the project is not applicable. Design verifications can be performed at any stage of design, of course, but are most productive when the design is completed. Should the time come when nuclear plant design is completed substantially in advance of construction, then an independent design verification program could be an effective guard against allowing quality deficiencies in design from creeping into construction. However, the present NRC practice of requesting some licensees to submit to an IDVP prior to receiving an operating license would not, ~~be applicable in~~ yet have effected this case.

B. Industry Initiatives

1. INPO Construction Audits - yes

While no major construction quality deficiencies have been found in the licensee's plant to date, the licensee implied that the INPO pilot audit had been helpful in identifying areas that should be improved. This measure looks at both management and programmatic considerations as well as the quality of the product. Licensees tend to listen to INPO findings because they come from people who should be experts and they come from a group comprised of their peers, supported by their industry.

2. Utility Evaluation Using INPO Method - yes

This measure is basically a self-evaluation using the INPO methodology devised above. As a result of the design audit done by INPO in early 1982, self evaluation design review teams were established to conduct a more extensive review. This review is estimated to require more than 15,000 manhours of effort. The review teams are led by representatives from the architect-engineer who were not involved in the original design. The team includes licensee personnel; licensee holding company engineering function staff are representatives also.

C. NRC Construction Inspection Program

1. Revised Procedures and Increased Resources - yes

The resident inspector program at the licensee's site is well thought of and its recommendations have been well received. This initiative would be particularly helpful if: (a) the inspection procedures were streamlined to eliminate redundancy and given priority according to safety significance; (b) its focus was more on observations of actual construction work and less on paper and reports, and (c) a focus on the quality of management of the project and less on the formal QA manual, organization chart, and written procedures. Further, the increased inspection resources should be applied from the outset of the construction project.

2. Construction Appraisal Team (CAT) Inspections - yes

While the licensee's project has not been subjected to significant quality problems, the licensee has benefited from audits of various types, as well as NRC inspections. The licensee appears open to the benefits that come from these inspections; however, several comments were made concerning the large number of audits being made, including those by the licensee itself, the NSSS vendor, the architect-engineer, ASME, NRC, and INPO, among others. The proper timing and spacing for audits appears to be an important consideration in their effectiveness, otherwise, they could become counter-productive.

3. Integrated Design Inspection - ~~not applicable~~ Yes

The integrated design inspection is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the integrated design inspection would not have taken place up to the present phase of design of the plant; thus, its effect on the project would not be applicable. ~~The same discussion of timing as in item A.3 above (IDVP) applies.~~

4. Evaluation of Reported Information - yes

This initiative would computerize 10CFR50.55E and Part 21 reports, facilitating trend and other analyses of these event reports. This analysis would simply provide an additional cross check on the quality operations at the licensee's site. At the present time, there is no reason to believe that there would be any observed trends from the reports, but they could be useful to the NRC staff in directing their inspections at the site.

As with the other types of audits, were not to take place at the present stage of construction, ... would continue to ... (An example of this is the licensee requiring the AE to visit site and independent task force (mandated by licensee management) to conduct and review portions of the AE's design work for the project.

D. Designated Representatives - no

At the time this case study was conducted, it was unclear how a designated representatives 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 designated representative program would make any difference. The assistant construction project manager said with respect to quality assurance holds, it would be relieving the licensee of responsibility. Inspectors must be in the process, or they would not be helpful in solving emerging problems, he said. At the present time, there are holds for quality assurance and he saw no reason why additional ones would be beneficial. The civil project construction supervisor concurred in this. He thought they would create no more quality than they have now.

E. Management Initiatives

1. Seminars - yes

The seminars similar to those that the NRC commissioners have conducted in years past, as well as seminars by trusted utility executives, would probably have been helpful in bringing the licensee's management to their present state of awareness of the importance of quality at an earlier date.

2. Qualifications/Certifications of Quality Assurance/Quality Control Personnel - no

The licensee already has a very strong training program for its quality control personnel, as well as its quality assurance personnel. The Quality Assurance/Quality Control staff was noted to be deep and broad in its qualifications. When hired, these qualifications are then further developed through formal classroom and on-the-job training. The recruitment for quality assurance people stresses degreed persons with experience in the practical side of the nuclear industry. Many of the QA/QC staff brought strong nuclear experience to the licensee when they hired on.

FAX TO HAROLD HARTY, DNL
ENERGY SYSTEMS DIVISION
FAX NO: 8-444-3[illegible]

FROM BILL ALTMAN, NRC
FTS 8-492-[illegible]

~~4~~ 5 PAGES TO FOLLOW

Karen:
Please refax. They did not get ~~this~~ part
Thanks
Bill

3. Craftsmanship - yes

While there is a very good training program for craftsmen at the licensee's site, management interactions with the craftsmen would reinforce their understanding of why quality workmanship is of prime importance in the construction of nuclear plants.

F. Certification of QA/QC Programs (SECY 83-26) - ~~no~~ yes

~~The licensee has hired QA/QC personnel with good qualifications and experience. Special certifications would have added to the quality or know-how of the staff only marginally.~~ Certification is not seen as addressing the types of problems that the licensee has experienced to date. The licensee management has treated QA/QC as something more substantive then other regulatory requirements. They look upon it as an integral part of assuring that the project is completed without significant rework and with the potential for satisfactory operation over its lifetime. Such a program might contribute to NRC and public confidence that an appropriate program is in place.

G. Management Audits - ~~maybe~~ yes

At the present time, the licensee is examining its management structure and general approach to quality, looking for new and innovative methods of attaining this goal in the construction of their nuclear project. The fact that inquiries are presently going on suggests that the management audit might be a helpful input to their decision-making process. The licensee did not express itself on this particular issue, however.

VI. IMPLICATIONS OF THIS CASE STUDY FOR THE FORD AMENDMENT ALTERNATIVES

Section 13 to NRC's FY 1983 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 efficiency of five specific alternative program concepts. As a part of this analysis, each alternative concept was evaluated with respect to whether it would make a difference in the licensee's construction program had it been in place at the time of the licensee's construction permit. As was the case with the quality assurance initiatives, each of the Ford alternatives was discussed with senior utility management, as well as with their staffs.

A. More Prescriptive Architectural and Engineering Criteria - no

The Authorization Act requires NRC to evaluate the following alternatives: 13(b)1 - adopting a more prescriptive approach to defining principle architectural and engineering criteria for the construction of commerical nuclear power plants ~~would~~ to serve as a basis for quality assurance and quality control inspection and enforcement actions. Generally speaking, the licensee believed that NRC is sufficiently prescriptive in defining principal architectural and engineering criteria for construction of nuclear plants and that it is not necessary to be more so. The problems ~~the nuclear plants have in quality~~ would not be significantly changed if there were more prescriptive criteria.

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 plants that the licensee demonstrate the capability of independently managing the effective performance of all quality assurance and quality control responsibilities for the plant. The licensee senior management was in agreement that prospective licensees should be required to demonstrate to a panel of peers the capability to manage a nuclear project. The licensee is a great advocate of peer review. Their viewpoint is that the NRC does not have the necessary resources to police the industry and should not have to do so. This responsibility should be with the licensees themselves, or the utility industry in general. Several suggestions were offered regarding how a licensee with no previous nuclear plant experience might accomplish this. The most feasible was similar to what the ASME does for new N stamp applicants; i.e., the applicable procedures involved need to be exercised on a demonstration project or task.

C. Audits, Inspections, or Evaluations by Associations of Professionals Having Expertise in Appropriate Areas - Management Audits - yes

Regarding audits by independent organizations, the statement was made that the system should not be made any more complicated than it currently is. It is important to keep the responsibility for implementing an adequate quality assurance program with the licensees, with the Nuclear Regulatory Commission in a verification role. The NRC CAT team audits were felt to be a worthwhile approach to verify adequacy of work at a construction site. Most every employee interviewed said that a large number of audits were conducted by many organizations. The audits are becoming a problem as they impact the time that personnel have to do their job, thereby reducing both quality and productivity. The audits can highlight problem areas to the overall benefit of the project. The licensee commented that audits have become a way of life and that the licensee just lives with it.

Negative reaction was obtained to the policy of NRC and INPO publishing the audit findings to the public. The nuclear industry has all its problems aired to the public, causing loss of confidence by the public, because they continually hear of the nuclear problems.

The licensee also felt that the Nuclear Regulatory Commission should be audited by an independent organization, but could not identify the appropriate organization to conduct such audits.

D. Improvement of NRC's QA Program

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

Several suggestions arose from this case study: (1) assignment of a resident inspector at start of construction would not have been of ~~much~~ benefit to the licensee. The licensee knew from previous experience how to manage, and got started off correctly. For less experienced utilities, though, the licensee felt it would be necessary to assign an inspector very early; such as when basemats are poured and cadweld work is beginning. This should be the first day of ~~the project~~. This is important, because it is there that relationships, ~~and~~ procedures begin to develop. (2) the licensee felt more and better help from the NRC is requied. NRC Headquarters needs to become more active in and share in meaningful decisions that affect the industry and then stand by their commitments; (3) inspectors should not be so paperbound. There is too much emphasis on the size of reports flowing to Headquarters. The 15 volumes of field procedures that exist now is overkill. In fact, the old manual was sufficient. Inspectors should be free to be in the plant and not excessively deskbound by bureaucratic work; (4) some inspectors are not systems or management oriented; i.e., they are too concerned with specific nuts and bolts-type problems to look further and see systemic problems; (5) too many construction permits were issued in the same time period, causing NRC inspection to be stretched too thin; (6) the NRC CAT team inspections seem valuable. Standard review plans are good. The NRC major effort should be to ensure that quality assurance is finding problems (not generating paperwork); (7) NRC tends to monitor what the licensee says, rather than what the licensee does. It was noted that if there is too much direction from NRC, it stifles initiative; (8) the biggest argument with quality assurance is over the applicability of codes; not so much the ASME code, but the ANSI daughter standards, especially in the areas of training and housekeeping. Persons tend to interpret these standards either as guidelines or an engraved in stone. What is needed is a more definite interpretation of standard requirements by NRC.

E. Conditioning the CP on the Applicant's Commitments to Submit to Third-Party Audits of His QA Program — Yes

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 or make other arrangements with an independent inspector for auditing quality assurance responsibilities for the purposes of verifying quality assurance performance. An independent inspector 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 Formal Amendment alternative 3 above. Basically, the licensee was already committed to a quality program based on its experience with a previous nuclear plant. Over the time period ~~since~~ as construction has continued, the licensee has become all the more positive in developing a quality QA/QC program. The licensee welcomed new ideas and independent evaluations, and they would use the results of ~~third~~ party audits of their Project management programs including the QA program, to improve the project

APPENDIX A

EVALUATION OF GENERIC KEY INDICATORS FOR CASE B STUDY

KEY TO EVALUATIONS:

C - CONSTRUCTION SUBTEAM
Q - QUALITY ASSURANCE SUBTEAM
E - ENGINEERING SUBTEAM

CASE B
EVALUATION OF GENERIC KEY INDICATORS

1.0 Licensee fully committed to a program for assurance of quality

a. From the interviews conducted both at the corporate offices and the site, it was evident that a sense of commitment to quality pervades the licensee organization at all levels. There were repeated remarks that indicated an understanding that the licensee wants the plant "built right the first time."

The licensee volunteered for the first INPO Design Audit and has expanded on it with their own extensive design audit.

QA/QC has access to the Executive Vice-President directly and there was no indication of cost/schedule overriding QA/QC.

Rated 5 (C)

b. Senior management was deemed to be actively involved and knowledgeable in all areas of activity of the site with emphasis on quality about on par with schedule and cost. Staffing and material resources provided for control of the quality function appeared adequate; however, staffing of a quality engineering activity to perform specific task planning, especially for the receiving inspection cycle, seemed to be advisable. High emphasis on the Quality Control function was apparent. Positive messages about the licensee's commitment to quality came from personnel at all levels of the licensee's organization as well as from the contractors. The commitment to quality was seen as being long term (i.e., for the life of the plant) rather than meeting a short-term goal such as obtaining an operating license.

Rated 4 (Q)

c. The upper and lower echelons of management say they are fully committed to a program for assurance of quality and, as far as was determined, they are. The motivation, however, seems to stem less from a burning desire for quality per se than from a concern of not having adequate quality and the consequences which could emanate from that. To elucidate on the preceding observation, it is necessary to compare Case B with something, and the only other site visited to this point is the Case A site. The Case B site does not exhibit the same intensity and enthusiasm for quality that one senses at the Case A site. The difference is manifest in (a) the regular involvement of upper management in the activities of lower echelons as they relate to actual construction of the plant, and (b) the lower management and their staff insistence that quality is first (or possibly safety, then quality) without a clear and consistent understanding about where the driving force for quality originates (sometimes expressed as NRC requirements). This apparent inconsistency may arise from the appraisals which list quality first (or sometimes safety, then quality) before other measures of employee performance. It was difficult to determine whether interviewees were responding to questions about the importance of quality from the standpoint of their appraisals or from a clear signal from management concerning quality.

Rated 4 (E)

2.0 Responsibility and authority are clearly defined and properly implemented

a. The overall responsibilities and authorities appear to be clearly specified and well understood by the project participating organizations. It is clear that the licensee has structured these in such a way that it is completely in control of all activities and is, in fact, "running the job."

There appears to be some overlapping of responsibilities between the licensee's Construction Coordination Group and their project sections; however, their authorities seem clear and both components report to a single manager. Therefore, this is not considered to be a problem.

Rated 5 (C)

b. Overall, the responsibilities and authorities for each organization were adequately documented and apparently implemented. Personnel within the project and with the major subcontractors were always knowledgeable of their own as well as others' responsibilities and authorities; however, the organizational structure is quite complicated and not easily understood by an outsider. Geographical separation of some of the major organizations from the construction site were seen to somewhat hamper organizational efficiency (e.g., AE's home office performs the design and procurement activities which then must be coordinated with the licensee at the construction site).

Rated 3 (Q)

c. Responsibility and authority appeared to be clearly defined and, for the most part, properly implemented. The "Project Triangle" (the communication problem arising from having the AE's home office in one location, the NSSS vendor and mechanical contractor's home offices at another location, and the project site at a third location) and the division of responsibilities between the AE and the engineering services function tend to complicate responsibilities and authorities -- if not on paper -- then in practice. The potential vulnerability in the triangle may reside in design-related quality matters, which were not assessed. In the one example of a deficiency in quality (failure to maintain appropriate temporary protection for electrical switchgear) there was no evidence of finger pointing, suggesting that responsibility was properly understood. The fact that no construction is done, except from the AE approved drawings, and that "redlining field changes would get you fired," also supports the acceptance of responsibility/authority.

Rated 5 (E)

ersonnel are adequately qualified for assigned work

a. Records relative to this factor were not reviewed; however, the persons contacted, in general, had good qualifications for their assignments.

There is a good base of nuclear experience at this site. Some people in key management positions and in QC have less experience than one would expect. This is not considered to be serious, but is felt to be marginal.

In part, the lack of experience is offset by a substantial training program and an overall impression of a high level of dedication and enthusiasm.

Rated 4 (C)

b. The licensee and its major contractors have a good program for obtaining qualified personnel and furthering their training. Key personnel have previous in-depth nuclear experience from either the licensee's earlier plant for from other nuclear projects, which has been further enhanced by in-house training. Early in construction, crafts people were recognized to need further training on how to do nuclear work, which has resulted in a comprehensive blue collar training program.

Rated 4 (Q)

c. Personnel are generally qualified for assigned work. A number of the first and second line project engineering/design supervision have had about 5-6 years of nuclear experience. Often a year or two of that was on later phases of ~~Plant Hatch~~ prior to moving ~~to Plant Vogtle~~. This amount of experience is probably not enough to have seen all the things that can go wrong in nuclear plant construction activities.

Rated 3.5 (E)

the earlier nuclear project

What happened to Case B designation

4.0 Instructions, procedures, and drawings are clear and adequate

a. It was found that specific insturctions to the crafts in the form of Process Data Sheets (PDS) are used only on the ASME Code covered work. Further, an unusually large number of Field Change Requests (FCRs) have been generated in the past few months. Although it has not been confirmed, it is suspected that many of these FCRs are resulting from dimensional conflicts between different items in the installations.

An expanded use of PDSs and a more thorough checking of design dimensions could improve this situation.

Rated 3 (C)

b. This area was not evaluated to any great extent by the subteam.

No rating (Q)

c. Overall instructions, procedures, and drawings appear adequate, though some are only manually logged (as for Field Change Requests) and listings are not routinely sent to all interested parties (e.g., one must go to the log to review entries). Procedures are not up to date. In the case of the failure to maintain protection on electrical switchgear (Item 2), the comment was made that verbal instructions had been given to the construction coordinators to correct the condition, but there were no procedures or paperwork, and it fell through the cracks. The periodic inspection check list was thought to cover this item, but it didn't.

In another case, desktop instructions which can govern some of the more significant details of drawing/specification control, are not monitored for consistency among the project specifications.

Rated 3.5 (E)

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

a. There were numerous comments and indications that management has a strong desire for problems, deficiencies, and areas of improvement be identified whenever possible. Statistical reports on deficiencies, nonconformances, etc., are routinely provided by QA to Project management. It was felt that the usefulness of these reports, in terms of trend analyses, could be improved.

One such improvement being considered is to categorize the deviations and nonconformances in a way to improve trend analyses. Such categorization may be according to the judged seriousness of such occurrences.

Rated 4 (C)

b. Policies and directives about reporting QA/QC deficiencies exist and are being implemented. Increasing the visibility of these policies would seem to be of further benefit. Quality Control is very strong in the civil/structural area wherein a hold point system works in a very effective fashion; however, some work is inspected on a catch-as-catch can basis (e.g., electrical installations). Quality performance data and trends are reported and acted upon by management in a timely manner.

Rated 3 (Q)

c. The large number of Field Change Requests and nonconformance requests (1389 FCRs and 463 NCRs during the period October-November 17, 1982) may suggest some type of deficiency in the design process. The fact that the licensee does not permit redlining to facilitate field changes accounts for part of the number. Also, the project engineering sections review drawings for constructability, and these reviews turn up a number of required design changes. Nonetheless, the number is large and AE home office design function is being audited on this item.

The licensee's project team has been audited by NRC, INPO, and a host of others to the point where one member of the project staff commented that there are too many audits and that they can become demotivators.

Conformance to design appears to be tightly controlled by field QC inspectors.

Rated 4 (E)

6.0 Corrective action program is effective

a. Not investigated by "Construction" subteam.

No rating (C)

b. The licensee and its contractors have a quite good corrective action program which seems to be effective in bringing about needed change. The QC people seem to have higher favor with upper management when it comes to bringing about rapid change. The QA people are also listened to, but management seemed more cautious about accepting their proposals and recommendations.

Rated 4 (Q)

c. The corrective action program was noted only peripherally with regard to the electrical switchgear protection problem and the design audit problem. In one case, the problem escalated prior to corrective action; in the other, corrective action was self-initiated or recommended by the INPO audit.

No rating (E)

7.0 Design reviews, including independent reviews, detect and clearly resolve design deficiencies

a. The INPO audit and subsequent internal, independent Design Reviews appear to have been effective in identifying and resolving problems or deficiencies in the areas of engineering analysis and content of the design. However, a very large rate at which FCRs are being generated may indicate a weakness in the design review for dimensional problems and constructability. There is an element of risk that these more pragmatic design issues may impact the quality.

It is significant that the plant operations staff has reviewed both the design criteria and the completed designs for operability and maintenance needs.

Rated 4 (C)

b. This area was not evaluated by the subteam.

No rating (Q)

c. As previously stated, there has been a large and, apparently, continuing number of FCRs and DCNs at the licensee's project. Design reviews by the AE have not detected and clearly resolved design deficiencies as evidenced by the number of Field Change Requests; however, this problem has been recognized, and increased design review activity is in process. Various reasons were given for constructability. This appears to be the major design review. No data were obtained on the independent design reviews within the AE's organization.

Rated ~~4.5~~ (E)

8.0 Design input data are adequately controlled

a. The utility, through its Engineering, Operations, and QA organizations, has participated in the review of the design criteria and has made significant inputs to some design features; i.e., the Control Room. The degree of formalization of this process was not investigated.

Rated 5 (C)

b. This area was not evaluated by the subteam.

No rating (Q)

c. Limited information was obtained on control of design input data. Design drawings appear to be adequately controlled in the field, and design changes arising in the field appear to be adequately controlled. Design conformance to NRC and code requirements is managed in the AE's home office.

No rating (E)

9.0 Complex organizational structure and arrangements do not contribute to poor assurance of quality

a. The organizational structure, once it could be understood, is considered appropriate and adequate. However, it was difficult to understand functionally, because unusual titles and component names are used. In the interviewing process, it was found that this practice is resulting in potential communications problems, because components were referred to by different functional titles by different people. The use of more functionally descriptive titles could reduce the confusion potential.

Rated 4 (C)

b. The structure is well documented and was judged to work fairly effectively, even though it is quite complicated. Organizational independence is provided for those groups responsible for performing verification and audit activities, both within the utility's and the subcontractor's organizations.

Rated 3 (Q)

c. Within the licersee's project team, the organizational structure was straightforward. The divisions of responsibilities and authorities did not have apparent overlaps.

It was commented on that there had been better communication between project engineering and quality assurance when the latter was housed in the same building. As the staffs increased in size and the building became overcrowded, the QA staff was moved to another building outside the construction area. One wonders whether upper management considered this effect in making the move, and what measures were taken to compensate for it.

Rated 4 (E)

10. Planning, scheduling, and budgeting activities allow for adequate resources to do the job correctly

    a. The "Construction" subteam probed this factor to only a very limited extent. The efforts on providing short-term construction schedules appeared good. These include daily, weekly, 6-week, and 3-month plans. Although these schedules are provided to QC, there were indications that assuring QC inspectors are at the right place at the right time is handled rather informally in practice.

    Rated 4 (C)

    b. Work was observed to be on schedule and chronic delays were not evident. Subtle messages to cut corners and get the job done were not evident, either. Procedure compliance is stressed at all levels and daily work schedules appear realistic enough to allow work to be completed in accordance with those procedures.

    Rated 4 (Q)

    c. The overall cost/schedule activity appears quite adequate, although there seemed to be some problem in projecting the actual productivity of the mechanical contractor. Budgeting was not assessed in detail. The leadtime that is built into the schedule is as follows: all equipment is to be onsite within 11 months of the time it is needed; all design 7 months; and 90 days before an operation is to proceed, all other supporting facilities and expendable materials are to be on the site. Even with the large distance between the designer and the plant site, the time difference, and the large number of FCRs and DCNs, the design process seemed to be going smoothly.

    Rated 4.5 (E)

11.0 Design control process

a. The design review and audit activities were discussed in Indicator 7. These audits have been documented.

Field Change Requests require formal approval by appropriate design agency representatives and are well controlled.

As discussed in Indicator 7, there is some concern as to the adequacy of design review for application and constructability.

Rated 4 (C)

b. This area was not evaluated by the subteam, but it was noted that a large number of Field Change Requests are being processed.

No rating (Q)

c. The design control process, apart from that performed at the construction site, was not reviewed. The design control process at the site, as far as procedures were concerned, appears quite adequate.

No rating (E)

12.0 Work package development and control

a. As discussed in Indicator 4, this area could be strengthened by more extensive use of Process Data Sheets.

A "Work Package" system is used for procurement, but the extension of this to construction was identified only through the concrete pour cards and the travellers used on ASME code work.

Rated 3 (C)

b. The civil area was seen to be very strong. Control over other contractor operations was judged also to be good, with the exception of the electrical contractor. Also, receiving inspection relies on generic inspection requirements, rather than specific planning.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

13.0 Procurement control

a. The procurement process was not investigated in depth by the "Construction" subteam.

It was identified that source inspection is performed on specified items by the engineering groups, including both the AE and the engineering services function. There is documented evidence of receipt inspections; however, it was determined that the inspection instructions should be strengthened.

Rated 4 (C)

b. The AE handles all front-end activities related to procurement and no evaluation was made in this area. On the receiving end of procurement, acceptance is pretty much limited to an accountability and paper review exercise. Little or no overcheck activity occurs; thus, deficient materials or items may not be discovered until point of installation.

Rated 2 (Q)

c. Not reviewed.

No rating (E)

14.0 Nonconformance control

a. Not investigated by "Construction" subteam.

No rating (C)

b. The licensee's quality program is oriented heavily towards detecting discrepancies (receiving inspection excepted) and a good program for controlling nonconforming items exists once they are identified.

Rated 4 (Q)

c. Not reviewed.

No rating (E)

15.0 Special process controls

a. Such controls are being applied where required by codes, but could be extended in greater depth to other areas as discussed in Indicator 4.

Rated 4 (C)

b. A comprehensive program exists for qualifying special process operators. The program even has requirements for qualifying fitters.

Rated 5 (Q)

c. Not reviewed.

No rating (E)

16.0 Examination, test, and inspection control

a. All indications were that the licensee is doing a well above average performance in this area. It is considered significant that the utility efforts on QC are very extensive -- a staff of about 250.

Rated 5 (C)

b. For the most part, these processes looked well controlled. The electrical contractor was seen to be an exception. Hold points here were not really hold points. If an inspector was not available when needed, work would still proceed.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

17.0 Calibration control

a. Not investigated.

No rating (C)

b. The calibration program is managed by ~~GPC~~ the site at the site and was judged adequate. Evaluation was limited to discussions with the supervisor, observance of processes within the test laboratory, and checking numerous calibration status labels in the field.

Rated 4 (Q)

c. Not reviewed.

No rating (E)

18.0 Records

a. Not investigated.

No rating (C)

b. Overall, the records program was deemed adequate. The records storage facility was found acceptable and the personnel well informed and directed. The menu for retrieval of information was not extensive, which would mean that data retrieval may be slow.

Rated 3 (Q)

c. Records were not reviewed in sufficient detail to make an adequate evaluation.

No rating (E)

19.0 Audits

a. There were numerous indications that audits have been both frequent and numerous.

RAted 5 (C)

b. The audit program was judged quite strong. Numerous audits are performed by qualified people by various organizations (e.g., the licensee, the engineering services function, and the AE). The audits are frequent, comprehensive, and detailed.

Rated 4 (Q)

c. With respect to audits, the comment was made that there were training programs for a variety of job assignments, but more frequently than not, the supervisor or manager had not audited the program that his subordinates were required to attend. In another case, the discipline project supervisors require their engineers to audit parts of the construction twice a year. In some cases, the engineers need to come in on their days off to do the audit, because of the press of work. There was no evidence of this practice being carried out in a routine and orderly manner.

There was not sufficient evidence that the middle and upper management get to the construction workplace with any degree of regularity. On the other hand, several of those interviewed mentioned day-long sessions with corporate officers inquiring in detail into those persons' activities.

Rated 4 (E)

20.0 Corrective action

a. The subteam was impressed by the corrective actions which ave been applied, particularly relative to concrete placement. These have included:

- Reducing the height of pour lifts in thin walls to reduce the air pockets
- Forming one side with plexiglass so that vibration can be directly observed during placement
- Training vibrator operators

Rated 5 (C)

b. Good responses to quality problems were evident in review of the audit reports sampled. Corrective actions are implemented in a timely manner by responsible management.

Rated 4 (Q)

c. Corrective action was not reviewed in detail.

No rating (E)

21.0 Identification and control of materials and items

a. This was not investigated in depth; however, since all procurement, storage, and site disbursement of materials is done by the utility, it is suspected that the control is very good.

No rating (C)

b. The subteam saw no evidence that this was any large problem, either in the storage areas or on installed piping and equipment in the plant. Nuisance-type vandalism was reported to occur with fair frequency. Many areas that contained installed equipment were locked and entrance administratively controlled to minimize these occurrences.

Rated 3 (Q)

c. Not reviewed.

No rating (E)

APPENDIX B

DEFINITION OF LEVELS OF QUALITY FAILURE CAUSES

1. The Deepest Sense of Quality Failure

There are basic underlying causes of quality failure, which clearly transcend QA and QA programs. They can be characterized as broadly philosophical. They are at the extremity of the chain of causes (e.g., building a nuclear power plant without knowing how -- which has as necessary conditions (1) the licensee does not know how, and (2) NRC permits them to build, even though they don't know how). It is usually very difficult, if not impractical, to develop recommendations that address such philosophical issues. They are, of course, the root causes. For our purposes, we are defining root causes at at a more operative level.

2. The Operative Sense of Quality Failure

There are basic underlying causes of quality failure, which frequently transcend QA and QA programs, but not necessarily. They can be characterized as general. They are near the end of the chain of causes, but are limited to where it is practical to bring about corrective action (e.g., lack of management commitment). It is at this level that corrective actions often treat many symptoms of poor quality. It is in this sense that the term "root causes" applies in this report. There is a third level which we have defined as symptomatic/procedural.

3. The Symptomatic/Procedural Sense of Quality Failure

These are the causes of quality assurance failures. These can transcend QA and QA program, but it is unlikely. They are characterized as detailed and specific. They are intermediate in the chain of causes and, as such, are subcauses of (2) above. Recommendations for corrective actions at this level are relatively easy, but are likely to treat individual symptoms without curing the disease.

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Review & Comment
NLetz
Bill

Battelle
Pacific Northwest Laboratories

Project Number [redacted]

Internal Distribution

WD Altman
J Heidenreich, NC Kist
H Kirschenman, EG&G
L Kubicek, EG&G
MG Patrick, BCL

Date April 29, 1983

To Distribution

From H. Harty HH

Subject REVIEW OF VOGTLE CASE STUDY REPORT

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Enclosed is a draft of the Vogtle Case Study report (Parts I and II) for your review and comment. I plan to have the report redrafted prior to the Review Panel Meeting on May 11-12, 1983, so I need your comments by the close of business on May 4. If your comments can be handled by telephone call, I will be pleased to receive them that way. If they are more extensive, please fax them.

NOTE: I wasn't able to work from your debriefing notes on a one-to-one basis, but I tried to be faithful to your intent. There were a couple of yesses that I changed to nos in the initiatives. Please check these also.

team spirit
people who to work for the company

Enclosure:
As stated

HH:jlc

cc: JA Christensen, PNL

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cc: JA Christensen, PNL

For A-84-293

K|54

54-1800-001 (3-71)

DRAFT

QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

APRIL 28, 1983

NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC. 20555

DRAFT

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QUALITY ASSURANCE CASE STUDY WORKING PAPER
CASE B

I. SUMMARY OF FINDINGS

A. Background

The licensee of Case B has one nuclear station in operation and a second one under construction, both consisting of two large units (approximately 1,000 megawatts each). The former station has been in operation since the mid-1970s. The latter station is approximately half completed. The construction permits (CP) were issued in the mid-1970s. Licensee fiscal problems required an approximate 18-month slowdown in the construction of the station. Construction is presently proceeding on a round-the-clock, 7-day per week basis.

The licensee is the construction manager for the project. The major construction contractors -- civil, mechanical, and electrical -- all have had significant nuclear plant construction experience, as have many of the smaller contractors.

The architect-engineer for the Case B nuclear station has had extensive experience in the design and construction of nuclear power plants. Some of the non-safety-related design is being done by the engineering staff of the licensee's holding company. (Neither the AE home office staff nor the holding company's engineering staff was visited).

The licensee has experienced no major quality problems to date in the construction of this nuclear station (none occurred in the construction of the first station, either). There have been recognized engineering and construction deficiencies, but the licensee has taken positive action to correct them. There has not been significant intervention in the licensing and construction phases of the Case B nuclear station. No significant fines have been levied against the licensee for nonconformance violations or quality deficiencies.

The assessment team for the Case B study[1] was comprised of three teams of two personnel each; one concentrating on the project engineering/ design aspects, one on construction, and one on quality assurance programs. The team spent five days at the plant site. Prior to the plant visit, two of the personnel spent one day at the licensee's headquarters reviewing the project with the licensee's upper management, and one day with the NRC regional staff. There were several group interviews and discussions with the licensee's senior project management. Altogether, about 50 interviews were held at the plant site, with individuals intimately involved with the project. In addition to the interviews and discussions, the entire assessment team spent one-half day touring the construction site. The site assessment culminated in a briefing for company officers and project staff members, in which the findings of the team were reviewed and the licensee staff had an opportunity to comment on the team findings.

B. Summary

The objective of this case study was to determine what were the significant factors in contributing to the assurance of quality at the licensee's construction project. The team identified the following factors:

1. <u>The licensee has an orientation toward, and an attitude supportive of, quality in their nuclear project</u>. At higher levels in the management structure, the conviction appeared to prevail that public safety and company profitability demand quality in the construction (and operation) of nuclear plants, and that it is less expensive in the long run to "do the job right the first time." At lower levels, there was an expressed feeling that the company wants to do the job right. Employees at all levels appeared to have a constructive attitude toward the need for quality in general, and quality assurance, in specific. A pro-company attitude and good morale on the part of the employees appears to exist.

---

[1] The methodology for the Case Studies is described in Long-Term Quality Assurance Review: Site Assessment Methodology, November 8, 1982 (Draft).

The stated management philosophy of insisting on quality was not simply to satisfy the Nuclear Regulatory Commission (NRC) but to go beyond those requirements to have a reliable and safe operating plant. From the interviews conducted, both at the corporate offices and the site, it was evident that a sense of commitment to quality pervades the licensee's organization at all levels. The licensee volunteered for the first INPO design audit and has expanded on it with their own self-initiated evaluation. The quality assurance quality control (QA/QC) staff has direct access to an executive vice president. There was no indication from the interviews of cost/schedule overriding QA/QC.

2. The licensee has an experienced design, construction, and construction management team. The licensee has had prior experience with a previous nuclear station, and many of the personnel who worked on it are now actively involved in the present project. This experience has given them an understanding and appreciation of the complexity of large nuclear station construction activities. Many of the staff have 5-10 years experience in nuclear work. The persons contacted, in general, had good qualifications for their assignments. There is a substantial training program and an overall impression of a high level of deducation and enthusiasm to the job. Many of the key personnel had previous in-depth nuclear experience from other projects, and this has been further enhanced by in-house training. Early in the construction process, it was recognized that craft personnel needed further training on the special requirements of nuclear work, and this resulted in a comprehensive blue-collar training program. The QA/QC staff is broad and deep in experience and qualifications.

The architect-engineer has designed (and constructed) many nuclear power stations.

The major construction contractors (especially the mechanical and electrical contractors) and the smaller contractors have had previous experience in the construction of nuclear projects.

3. <u>The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces</u>. This is manifest most clearly in day-to-day activities at the site. The licensee is running the job. The licensee does not rely on the major subcontractors to perform the overall management functions. It is manifest by the direction for the overall quality assurance program that comes from the licensee and not from its subcontractors. There are limited points of contact by the licensee to direct work of its subcontractors. Licensee construction coordinators, many of whom are past inspectors, do a preinspection of craft work prior to formal inspection by QC. There seems to be a feedback of lessons learned from earlier construction experience and from other projects. Personnel within the licensee's and the major subcontractors' staffs were knowledgeable of their own, as well as others' responsibilities and authorities. (This, despite the fact that the organizational structure is quite complicated and not easily understood at first review. However, within the plant project team, the organizational structure was straightforward). Geographical separation of some of the major organizations (e.g., the AE and mechanical/NSSS contractor home offices) from the site was seen to hamper construction efficiencies.

4. The licensee supports Its assurance-of-quality program with adequate resources and backing. This is manifest at the top of the licensee's organization by a project management board comprised of senior utility management, senior project management, and senior AE and NSSS representatives reviewing the project, examining problems, and maintaining cognizance of nuclear matters. Quality does not seem to be sacrificed for schedule and cost considerations. The licensee and contractors have good training programs for crafts and quality control personnel. The planning, scheduling, and budgeting activities appear to allow for adequate resources to do the job correctly. Work was observed to be on schedule and chronic delays were not evident. Procedure compliances were stressed at all levels and daily work schedules appear realistic enough to allow work to be completed in accordance with those procedures.

   The licensee is pro-active in looking for improvement in its assurance-of-quality practices. Key managers were on a retreat to consider new approaches to the assurance-of-quality problem. This licensee was the first to be evaluated under 10CFR50, Appendix B. Their own QA organization was asked to study other QA programs as early as 1978. They have been involved in one of the pilot studies for the INPO audits. They have also participated in self-initiated evaluations. There were numerous comments and indications in the interviews that problems, deficiencies, and areas of improvement can be surfaced without pumitive actions.

these two sentences appear to be completely off the wall !!! what is meant here

5. The licensee's QA/QC function is active in reviewing, witnessing, and verifying contractors' work. A well-staffed program with good procedures exists to insure that construction conforms to the design. The licensee and its contractors have an effective corrective action program which seems to bring about needed change. Design reviews for constructability and operability were thorough.

   The project engineering staff reviews the design for constructability. This appears to be the major design review (no data were obtained on the independent design reviews within the AE organization).

The case study team's evaluation of 20 generic indicators of quality is in Appendix A.

The foregoing factors are discussed in greater detail in the following section.

There were several observations which the assessment team made which could improve the licensee's assurance of quality. These included:

1. Document control: destruction of obsolete specifications and drawings is not tightly controlled. In some cases, there could be use of uncontrolled drawings.

2. Procurement procedures: the receipt inspection, source inspection, and communication to vendor of speficication requirements should be strengthened.

3. Construction process control: while the hold-card approach for civil-structural work and the application of process data sheets for the mechanical contractor are good, some of the other contractors, including the electrical contractor, lack procedures which could cause them to miss hold points because inspectors are not immediately available.

4. Field change requests and nonconformance requests: during the period of October 1 to November 17, 1982, there were 1389 field change requests and 463 nonconformance requests processed. This continues at the rate of about 30-50 per day. This could be the result of some deficiency in the design process. (The AE design function is being audited on this item).

5. Senior management involvement at the site: licensee senior management should take a more proactive role in communicating the importance of quality to the staff.

6. Formalized quality engineering capability: at the present time, there is no separate quality engineering organization in the licensee's project staff. This function would help ensure that the process of translating the design into construction was carried out efficiently and optimized for quality.

7. Trending of QA/QC findings: a better presentation of the results of QA/QC activities to management would enhance the assurance-of-quality program. (It was noted that the licensee had initiated work on improved procedures).

This case study was the first one in which the licensee's project had not experienced major quality problems. Thus, there could be no comparison with other plants without major quality problems. The observations included here are in considerable contracts to the Case A study (a plant which had been shut down by NRC for quality problems). The case study team did not find any practices that would indicate an impending major quality problem. This does not guarantee that a major quality problem will not occur, but the key factors for not having one occur appear to be in place. The licensee's continued activities in looking for ways to improve the assurance of quality may reflect its own uncertainty in the matter, as well as providing a basis for the observation that no quality problems are likely to occur.

II. ROOT CAUSES OF THE LICENSEE'S SUCCESS WITH QUALITY IN CONSTRUCTION

Based on the case study team's review with the Nuclear Regulatory Commission Regional Office, documentation pertaining to the licensee's project and discussions and/or interviews with about 50 licensee and contractor staff personnel, the team believes that the root[1] causes of the licensee's success with the quality of construction reside in the following factors:

1. The licensee has an orientation toward, and an attitude supportive of, quality. The executive levels of the licensee evidenced a very good understanding of the significance and ramifications of building and operating nuclear power plants. This is probably due, in large part, to their experience with a previous plant, which came on line in the mid-1970s. There was no indication of a "fossil mentality" at the executive level. (This term refers to a utility's attitude that, since it was successful in building fossil fuel plants, it could be successful in building nuclear plants using the same techniques, personnel, and effort. This has been shown to be untrue). While the licensee's management seems very much aware of the importance of complying with NRC requirements, the comment was made, "satisfy the NRC and everything is okay, is not true; you have to satisfy yourself." There was recognition that a utility can be at considerable financial risk with a nuclear plant.

   There was considerable evidence of a top management commitment to quality. Further, there were indications of activities to directly address bringing about improvement. Some of the comments that indicate this were:

   - "There is a lot of talk about quality in nuclear construction. Some think there is a need for more of the same thing that isn't working."
   - "Maybe the industry and NRC need to back off and look. Maybe QA wasn't put in place right the first time."
   - "We don't want just more of the same -- what can we do that is innovative."

[1]See Appendix B for definition of root causes.

- "Are we looking to see if we are doing what we said we would do, or what is right."

- "We are going to look at how we look at the QA organization and the growth potential for the people in it, also QC."[1]

An example of one need for improvement is that QA/QC findings are not presented to upper level management in a readily digestible format. The system in use now only identifies problems generally, and not specifically enough to identify to management what kinds of actions need to be taken. The licensee is presently strengthening the quality trend identification program via a computerized system, however.

An example of management's concern with quality, and its attempt to be aware of impending problems is the creation of a project management board. This project management board meets monthly and it consists of the chairman of the board (of the licensee), the presidents of two of its operating components, the executive vice presidents of finance and construction, the vice president of the architect-engineer firm, and a member of the NSSS firm. This board gives the project general manager direct access to top level management of engineering, construction, and startup. The board deals with costs, schedules, and quality assurance. A typical meeting includes mostly input from the project staff, but there is also some direction given to the project staff. Two examples of items recently discussed related to secondary water chemistry and seismic problems. The project general manager said this high level management involvement in significant problems was very helpful.

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[1] Quotations may not be direct, but they are believed to convey the meaning intended.

The project general manager acknowledged that it is very difficult to get quality assurance attitudes from upper management to craft levels. If, for no other reason it is important to do so, because approximately $2 million per day is being spent on the project, and any rework due to inadequate quality only escalates the costs and delays completion of the project.

The project general manager had been involved in the licensee's earlier nuclear plant. He commented on changes which have occurred between the earlier nuclear plant and the present plant: the power generating division (i.e., the operations staff) has been integrated into the construction effort; a simulator has been built adjacent to the site; the project has been organized to do as much work at the site as possible; superior to what? facilities (e.g., warehouses and offices) have been built at the site; all engineering capability needed for the project, including subcontractors, report within the engineering organization; the quality assurance organization structure has been put in a stronger position; personnel with greater experience in quality assurance have been hired; there have been significant management changes for the better; and (though he acknowledged that there was a negative attitude to the processes required to support quality; i.e., paperwork and form filling out), he expressed concern about the communications problems which continue to arise because of the widespread locations of the AE and NSSS home offices and the construction site. This may be related to the large number of design change notices which have occurred.

The project general manager noted in his closing remarks that the licensee does not penalize employees when problems arise. This policy encourages the surfacing of problems at an early time.

The licensee's attitude toward quality was also expressed by the assistant construction project manager. When asked what he perceives as management's commitment to quality assurance, he enumerated several things:

rsonnel with greater quality assurance experience have been hired. Second, management keeps abreast of the work in the quality assurance department. Third, management has endorsed the INPO self-initiated evaluations. Fourth, management reviews quality assurance findings. He said that an executive vice president periodically checks on his work, and he perceives, as does his staff, that the chief executive officer is interested in quality assurance. He said that when there are accountability reviews at the top of the organization, they are interested first in safety, second in quality, and then in cost and schedule.

In response to a question concerning what quality assurance changes he has seen in the last three years, the assistant construction project manager said that there is an increased awareness of quality assurance and that the training programs (especially in the civil area) were prominent among the changes. He perceived that there is a more knowledgeable understanding by the craft personnel of quality assurance, and this has helped in communication with the crafts, and has increased productivity. The independence of the quality assurance organization is another major change. The attitude on quality assurance is one on increased openness. A vice president directly responsible for project QA now has direct access to the chief executive officer. He said the construction forces and the project management are now working together better.

The manager of quality assurance and the quality assurance field supervisor said that they do not win all their battles when they approach senior management and try to bring about change. They feel, in some cases, they have not done the best salesmanship job they could have. In other cases, though, where it really counted, they made their case heard and got appropriate action. They stated that the door has never closed in the face of the quality assurance organization. It is readily accepted and backed by other management.

The licensee has used stop work order authority approximately six times to shut down a contractor's operation completely. Individual jobs are stopped routinely. The situation now exists where most construction will stop their own work at the first level of quality control when problems arise. When a whole contractor's operation is stopped, the order originates about half the time with the quality control groups and half the time with engineering. Contractor's operations have been shut down because of coating problems, cadwelding, concrete work, and for housekeeping.

The same general attitude toward quality was forthcoming from the construction concrete superintendent. He said, "I don't have to go upstairs to get backing when I call the question on something. We (QC) can pretty much handle day-to-day problems without having to resort to escalation; however, when something is escalated, it is usually something beyond my jurisdiction or authority." In the same interview, the statement was made that the licensee was not afraid to fire people for poor performance.

Management's interest in the QA program is also demonstrated in the orientation and training program for crafts. Craft indoctrination includes a videotape entitled, "QA Is Everybody's Business." The videotape includes a message from the chief executive officer of the licensee's holding company and other licensee management stressing the importance of QA and the results of poor workmanship. Additionally, training including specification and workmanship requirements and rules of conduct specific to each craft is accomplished. For example, welders receive approximately 15 hours training, and electricians 10 hours.

Overall, the assessment team concluded that the licensee's general management is committed to quality assurance. Since a poorly constructed plant can bankrupt the licensee, management sees QA as insurance against producing a plant which will not perate successfully. As a result, management does not limit the implementation of QA to meet NRC requirements, but rather to do what is necessary to provide confidence that the plant will operate successfully.

2. The licensee has an experienced design, construction, and construction management team. As previously stated, the licensee has constructed a previous two-unit nuclear power station that went into commercial operation in the mid-1970s. The AE has been involved in nuclear power plant design and construction for over 20 years, and has been the AE and/or construction manager on many nuclear plants. The electrical and mechanical contractors participated in the construction of the licensee's previous plant, as well as other nuclear plants. The experience levels of the licensee's staff and contractor managers varied considerably. Many of those in key positions with the licensee have less experience than one might expect to find in similar projects. However, many of them have been with the licensee for 5-10 years and worked at the licensee's previous nuclear plant before going to the Case B nuclear plant. It is apparent that the previous nuclear plant provided both the licensee and many of its personnel with valuable nuclear plant experience. This experience has resulted in, or permitted, a matrix organization which includes personnel in key positions from the licensee, holding company enginering function, the AE, and the NSSS vendor.

The extent of control exercised by the licensee at the construction site is impressive. The major construction contractors, except for one responsible for the containment vessel liner and another for the cooling towers, are all on a cost reimbursable basis. This permits the licensee to exercise control over the construction processes and their quality implications. All materials and equipment used at the site are provided by the licensee and the licensee controls the staffing levels of all except the fixed-price contractors.

One result of the experience by the licensee is the creation of the project management board. As previously stated, it is comprised of corporate level executives from several companies which play an active role in the project and which is chaired by the licensee chief executive officer. The project management board is veiwed essentially as a separate board of directors relative to the Case B project. The board is obviously composed of those who can make major decisions and commitments of their respective organizations. Further, it provides a forum for executive level communications between key organizations.

As previously stated, the major work force of the AE is located off site, and the problems related to this situation are being reviewed. The on-site engineering function is comprised of about 35 AE employees and about 10 licensee employees. In the past, original drawings were not made at the site. This may change, however, because of the need for closer coordination between construction and engineering. To improve engineering response time, one action being taken is to move an NSSS team on site in early 1983. This will result in 21 additional people being added to site engineering to respond to and correspond with the installation of small bore piping.

Lessons learned from the licensee's previous plant construction activity have resulted in improved advanced planning and scheduling and have been reflected in how they manage the work at the site. Standard lead times are set at 11 months for material, 7 months for pipe, and 90 days for having everything ready for construction. At the present time, design completion was estimated at: civil, 70%; mechanical, 60%; plant, 70%; and electrical, 60%.

Since the licensee and many of its construction contractors have had prior nuclear power plant experience, the effect of applying lessons learned is very beneficial to the successful QA program. For example, operations involvement in construction activities is more detailed and earlier than for the licensee's previous plant. Also, some operations engineers have been assigned to construction engineering to enable them to better understand the plant. Quality program items are included on the agenda of major management meetings. Management encourages getting problems put on the table so they can be dealt with. Employees seemed to recognize that management appreciates that problems will occur and that the important thing is to prevent recurrence. One case that was occurring at the time of the interviews related to protection of erected equipment. It was refreshing to hear a supervisor take the responsibility for the deficiency without inculcating others. This attitude exists not only within the licensee's structure, but also in the interface with the NRC inspection personnel. This openness without fear of recrimination tends to get problems solved before they become unmanageable.

Another experience factor is that all field coordinators are trained in the inspection techniques and approximately half of the coordinators are ex-inspectors. The crafts are therefore provided with an interface which emphasizes quality requirements consistent with that of the licensee's inspectors.

The QA/QC staff was noted to be broad and deep in its qualifications. When hired, these qualifications are further developed through formal classroom and on-the-job training. The recruitment for QA people stresses degreed personnel with experience in the practical side of the nuclear industry. Experience for QA management personnel ranged from 20-30 years; the average QA staff had approximately 10 years experience. The QC inspection supervisors have typically 2 and 4-year technical degrees and the section supervisors have a bachelor's degree as minimum education. Their experience ranges from 12-30 years.

There is active company involvement in looking for ways to do things better. The licensee sends their employees to other utilities to gather different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the licensee's holding company's engineering staff. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the PACE program, giving QA more authority than it had in early days, and adoption of innovative concrete processes (computerized batch plant use of Creter cranes, and plexiglass forms) are examples of such progressiveness.

The licensee uses an unusual construction shift work arrangement. The project is manned nearly 24 hours a day, 7 days a week, with four non-rotating shifts. There are problems with conflicts between shifts, but the licensee considers the benefits worth the additional problems. For instance, more workers can be utilized to improve the schedule. The current total job site work force is about 7700 employees. Somewhat better ambient temperature conditions for concrete placement exist. In cooler weather, most of the concrete is in place on day shift. A larger pool of skilled crafts is available. This is true in part because two of the shifts work only 3-day weeks and thus can use the other four days for commuting longer distances.

The union contracts also manifest experience of the licensee; e.g., each shift is paid straight hourly time for a specific number of hours in lieu of conventional overtime; there are no formal scheduled coffee breaks; in the event of a walk-out by one craft, there is no picketing, hence, other crafts continue to work. The licensee uses selective bid lists for on-site contractors; however, open shop contractors are permissible providing they abide by the special licensee-union agreements. The licensee takes an active part in negotiations between the union and the construction contractors.

3. The licensee manages the project, and it has clearly defined the responsibilities and authorities of the participants, and has provided adequate procedures to ensure compliance, especially at the interfaces. The clearly defined responsibilities and authorities, together with appropriate procedures, stems from the licensee's active management of the project. The extent of control exercised at the construction site is impressive. The cost-reimbursable contracts which the licensee has with most of its contractors permit a large degree of control over day-to-day activities. All materials and equipment used at the site are provided by the licensee. The licensee controls the staffing levels of all except two fixed-price contractors (whose work does not significantly interface with other contractors). As previously stated, the project organization is a matrix-type organization and includes personnel in key positions from the licensee's holding company engineering function, the AE, and the NSSS supplier. While the licensee has not been as intimately involved in the AE's activities, it does review all drawings for constructability and operation. The licensee is becoming involved in AE design audit through the INPO process and the self-initiated evaluation.

Advanced planning and scheduling, combined with management involvement, has resulted in the work being on schedule. Near-term work schedules are developed in concert with the construction contractors, but are controlled by the licensee. These include daily, weekly, 6-week and 3-month plans. Longer term scheduling and budgeting is done by the licensee. Standard leadtimes are 11 months for materials, 7 months for pipe, and 90 days for having all other materials, including consumables, ready for construction. The project general manager reported that the project is on budget for the year and about two months ahead of schedule (rebaselined in September 1981); however, the progress curve has flattened somewhat in the last two months. He said that contributing factors to maintaining schedule have been lessons learned from their previous nuclear plant, better training of personnel, and better support facilities on the site.

Among the lessons learned include the previously mentioned project management board, which provides a mechanism to promote timely resolution of problems, and to integrate senior management experience and expertise into the management process and provide clear direction to project groups. The board is composed of those who can make major decisions and commitments of their respective organizations. It meets monthly, and several of the licensee's management cadre emphasized good attendance of board members at these meetings and their active participation in them. (It must be observed, however, than in a meeting attended by a portion of the case study team, which included five licensee vice presidents and the company president, the latter did all of the talking).

The organizational structure in effect at the licensee's plant is best described as complex. The interplay of different lines of direction reporting, administration, and communications between the three major organizations involved; namely, the licensee, the licensee's holding company's engineering function, and the architect-engineer, as well as the entwined project relationships, make it difficult for one to understand the organization and its functions without considerable study. Nonetheless, the organization seems to work fairly effectively.

The project general manager, the highest ranking individual totally dedicated to the project, is a licensee vice president, but is at the fifth level below the president. Reporting to the project general manager is the on-site manager, called the construction project manager. He is considered by the corporate office to be responsible for everything at the site. The on-site field or project engineering functions report to him as does the superintendent of field coordination. The latter views his function as the intermediary between engineering and field construction; however, at least one construction contractor views his official contact with the licensee as the project engineering section supervisor, and the field coordinators as expediters for materials and tools, plus an arbitrator in relations with other contractors. The construction contractor's view was felt to be more accurate.

The QA and QC components are totally separated from each other and, for the licensee, this seems to work well. The QC function reports to the construction project manager.

The contracting and procurement function is managed from the licensee's home office. In addition to the minimal use of firm fixed price construction contracts, another significant practice is that the licensee provides all materials and equipment at the site. As a couple of interviewees expressed it, "All the construction contractors bring to the site is their bodies and their expertise."

Source inspection in vendors' plants is provided through project engineering by the architect-engineer and/or the licensee's holding company engineering function. Receiving inspection at the site is provided by the licensee's QC organization.

The licensee's quality assurance department is organized into a general office staff and a plant site staff. There are approximately 30 people who are directly involved with the programmatic side of quality assurance at the plant site. This is exclusive of the quality control personnel which, as previously stated, report separately from the quality assurance organization through the project side. Other quality control groups exist in the major subcontractor organizations. The mechanical contractor has about 70 inspectors. The NSSS supplier is staffing its inspection forces. The general office staff of the licensee's quality assurance is headed by project coordinating engineers and project quality assurance managers who report to the manager of quality assurance and to the applicable project general manager for project direction. The manager of quality assurance staff assists in establishing quality assurance policy, interpreting NRC and government regulations, and in personnel and organizational planning. The project quality assurance managers are assigned to specific nuclear construction projects and are responsible for carrying out quality assurance department directives as they apply to all aspects of design, construction, and operational testing.

Quality assurance staffs at the site are headed by a quality assurance field supervisor who reports to the manager of quality assurance and who is responsible for all quality assurance activities at the construction site and the operating units. The staffs are composed of quality assurance engineers or quality assurance field representatives for each engineering discipline involved in the construction activity, plus two or more qualified quality assurance engineers or field representatives for each operating unit. The prime job of the staff is that of audit. The personnel are responsible for assuring that plant site activities are accomplished in full compliance with the quality assurance manual, technical specifications, and procedural requirements.

The quality assurance program for the AE was not evaluated, as their work is primarily conducted at their home office.

With respect to the design process, the licensee receives all drawings from the architect-engineer and, for non-safety related matters, from the licensee's holding company engineering function. The project section supervisors review the activity packages and initiate field change requests and field change notices as they review the design for constructability. The licensee does not do any design on safety-related systems or equipment. The on-site design functions of the architect-engineer are limited to nine items as far as design changes are concerned, such as cable tray supports and reinforcing rod matters. Construction will only work to AE-approved drawings. Each construction group within the licensee's project controls its own drawings and each is audited every three months for properly approved drawings. The mechanical contractor does the drafting work at the project site.

The architect-engineer's field office approves field change requests, nonconformance requests, and handles all drawings to the job site. Revisions to drawings are returned to the home office when there is not adequate expertise at the job site. The design work is completed within the requirements of the project reference manual and appropriate regulatory guides. One of the architect-engineer's responsibilities at the job site includes monitoring the N stamp. The AE has the authority to apply N stamp to the design and also to systems within

the project.

In summary of the foregoing, the licensee has overall responsibility for the project. Its AE has overall plant architect-engineer responsibilities. Its NSSS supplier is responsible for NSSS design, and the holding company's engineering function has design of certain ancillary facilities.

4. The licensee supports its assurance-of-quality program with adequate resources and backing. A number of items that lend credibility to this root cause for the success of quality in construction have already been discussed, including previous experience with nuclear plant construction and use of experienced personnel.

The licensee's management recognizes that QA boils down to an economic issue -- and a long-term one at that. They are not focused exclusively on the short-term goal of getting the plant licensed, but on building a plant that will operate safely for its expected life. This is not to say that licensing for operation is not a very important milestone, because failure to license could spell economic disaster, but rather to say that the job needs to be done correctly now to minimize costs over the entire life of the plant.

The AE on-site manager's comments on the licensee's consideration of quality are interesting. He received strong signals from both the licensee as well as his own management with respect to quality. He said that the licensee's management is very supportive of their quality assurance staff. He mentioned a problem with welds on piping spools fabricated at the mechanical contractor's home plant. There were only slight defects in the welds, some minor weld slag and pinholes. These were all repaired even though they were detrimental to the progress of construction. The AE's on-site manager was impressed.

The comment was made by the AE manager that whereas on other projects redlining drawings (to denote field changes) is accepted practice, for the licensee's plant it is necessary to revise drawings.

The AE resident manager, in responding to the question why no quality problems of a major nature have been experienced at the licensee site, said that the licensee's management concerns about quality assurance and safety have been very high. They have spent much money and they want to license the plant as efficiently as possible and create a positive climate with respect to quality. He said the message is nothing is to be sacrificed for schedule.

The manager of scheduling and budget, an AE employee, said he was impressed with the licensee's interest in quality as manifest by the project management review board feedback. He said the executive vice president reviews his program area about six times a year, devoting one day each time. He said the performance review for licensee employees is now tied to budget and schedule. (Interestingly, most licensee employees said that safety and/or quality were the first items in their performance reviews). Another quality input from management relates to the project general manager's review.

The importance and the extent of training programs has already been discussed to some extent. The various programs include the licensee's QC training, construction craft training, and plant operations training. All of the QC inspectors of the licensee have received at least one week of formal training conducted on site and off site. The superintendent of field coordination has also required his entire staff to attend QC training programs.

Craft training programs are conducted by the construction contractor. In addition to a half-day orientation, the training programs have included specific classes in concrete placement and vibration pipe weld preparation, grinding, cadwelding, electrical specification requirements, and storage and handling of materials.

The plant operations staff training program was impressive. The licensee has installed a complete control simulator at the site and trains station engineering staff as well as the control room operators on this simulator. Also, the licensee has established agreements with other utilities so that some licensee staff are assigned to operating nuclear power plants for a period of 12-18 months.

Attitudes are also important to the assurance of quality. There is active company involvement in looking for ways to do things better. Licensee sends their employees to other utilities as previously stated, to gather different experiences and ideas, as well as studying comments and criticisms from others such as NRC, INPO, and the holding company engineering function. The study on adopting an expanded role for quality engineering, establishment of senior management quality committee, organization of the people achieving excellence program, giving QA more authority than it had in previous times, and adoption of the innovative concrete processes are examples of such progressiveness.

Sufficient resources as far as manpower, funds, and time have been allotted to provide adequate confidence that a quality performance will result. For instance, in interviewing the assistant manager for quality control, the question was asked how he knows whether he knows he has sufficient manpower to do the work required. He described how he determined his manpower needs (they relate to construction team size) and he said that sometimes double shifts are required; however, he lets management know of his needs and they are usually filled.

The QA manager has organizational independence and reports to an executive vice president. There is also a senior management quality assurance committee made up of vice presidents from organizations such as engineering, construction, power generation, licensing design, and quality assurance, and these represent both the licensee and the licensee holding company's engineering function. It is headed by an executive vice president and provides a forum where large time, money, and organizational quality assurance issues are settled.

The pro-quality attitude of senior management prevails throughout the licensee's organization, and carries over into the subcontractor's operations. All individuals surveyed were able to talk intelligently on QA/QC as related to their sphere of work, although at some of the lowest levels (craft level) personnel had difficulty explaining why it was important. They just know it was because of the observed actions and the emphasis by management.

This same attitude was reflected in discussions with the supervisor of the civil projects section, where he said that the message from management is stay on schedule but hold quality. (But then in a subsequent statement, changed and said that if something has to suffer, it should be schedule, not quality). The licensee only wants to do the job once. Effort then would be applied to improve the schedule later. When asked the question why no major QA deficiencies had occurred at the licensee's site, he said that the project is a whole team effort. They have a feeling that this job has to be done right and that the engineers, coordinators, QA/QC people, and constructors work together. They have the attitude that this job will be Number One.

In summary, every project experiences the conflicting demands of quality, cost, and schedule. This one is no different, and the occasional ambivalence expressed by those interviewed shows the struggle. Overall, a good balance appears to be maintained.

5. The licensee is taking a pro-active role in looking for improvements in its assurance of quality program. A number of examples have been cited already, including the project management board, the staff retreat to consider new approaches to quality. The project general manager and vice president's response to the question about what changes have occurred between the licensee's first plant and the present one illustrate substantive improvements:

   1) The Power Generating Division (Operations Division) has been integrated into the construction effort. The Operations Division now sits in on design reviews and other project activities to help avoid the need to make numerous changes when the construction is completed.

   2) A simulator for the licensee's most recent plant has been built near the site.

   3) The project organization has been organized in an attempt to do as much of the work at the site as possible. They now have the ability to manage and support the job at the site.

   4) Superior facilities for equipment storage and project personnel have been built at the site.

   5) The licensee now has the engineering management needed for the project and the subcontractors now report to engineering.

   6) The quality assurance organization for the constructor has been put in a stronger position and is headed up by personnel who have extensive nuclear experience.

   7) There has been a significant changeover in management, with a net result that there is now a more positive attitude toward quality.

In the day-to-day construction activities, the planning and coordination of project QA/QC interfaces is well done and conducive to good quality. The QC shifts overlap at shift change and interface with the construction coordination group in work planning and scheduling for the following shift. QC/contractor differences of opinion are resolved readily. The organizational structure for the project has the site QA overviewing the site QC, who overview the contractors. Corporate QA overviews site QA and the licensee's holding company's engineering function overviews all of its utilities' subsidiaries.

The quality assurance program is actively managed by the licensee. The licensee is supported by its holding company's engineering function and has taken firm control and has not relied upon contractors to provide program direction. The requirements are spelled out in a well-documented program and enforced through stop work orders that are both job specific and generic to a contractor. There has been early recognition of situations which may have developed into severe problems, such as the erosion problem. Cost-plus contracts are used nearly exclusively because of recognition that fixed-fee type will eventually force poor quality. A shortage of trained work force both in the professional and crafts area is met by active recruiting and through implementation of an effective training program. Preparations for the operating phase are currently underway in addressing and resolving technical programmatic issues. A nuclear training center for technical and maintenance activities is being built and future plant operators are now being trained in plant and on the reactor simulator.

— by whom, what does this mean?

The licensee was recently "written up" for the third time in a year for improper protection of stored-in-place equipment, and the corporate management was reacting very forcefully. This factor causes one to ask whether the dominating factor in the quality emphasis at the licensee's plant is because of a need to satisfy the Nuclear Regulatory Commission. The following observations were made by NRC inspectors as this question was discussed:

- They consider the licensee's plant average, except above average in doing their own quality control.

- They feel that quality assurance and quality control are both good and adequately staffed and trained.

- They are impressed with the construction craft training programs at the site.

- They feel that upper level management should be at the site more often.

III. REMEDIAL ACTIONS TAKEN TO CORRECT QUALITY PROBLEMS

As previously stated, there have been no major construction-related quality problems at the licensee's site. There have been, however, a number of typical problems that arise in the course of construction. Some of these are described to illustrate the type of problems encountered, how the licensee has responded to deficiencies in quality, and for background to the licensee's responses in the interviews. Most of these problems have been alluded to earlier in the report. The following list is comprised of those problems that the case study team became aware of during the site visit:

1) Early in construction, an NRC inspector identified an erosion problem due to rainwater during excavation for the plant. The licensee initially disagreed that this was a problem, but subsequently agreed that it was a potentially very serious one and, as a result, took corrective action. This particular quality problem was felt to be significant for two reasons: (a) it established early on that the NRC would be insistent about correcting potential problems, and (b) it was a real physical problem identified by on-site NRC inspection, rather than a procedural or records problem detected in a paper audit.

2) The licensee has been concerned over the number of field change requests and nonconformance requests that have been required in the design. While the volume of field change requests and nonconformance requests is greater than other projects out of the AE's home office, there may be good reason why it may be greater at the licensee's site. As a result of monitoring the number of changes, the licensee has insisted that the AE's design

procedures be audited. The changes are being categorized by discipline (mechanical, electrical, or civil) to determine which groups need attention. This activity has resulted in the home office checking to make sure the remaining drawings are more closely reviewed. It appeared likely that the AE would assign a quality assurance person from the home office to the licensee's site.

3) The licensee at one time had a problem with rock pockets in the surface of thin concrete walls (12" thick). This problem was resolved by reducing the pour lifts 12' to 6' and increasing the attention given to vibrator technique. An innovative practice subsequently put in place for thin wall high lift pours is forming one side with plexiglass. This permits QC and construction forces to observe directly the placement and vibration of the concrete. In addition, through-the-form vibration with inspection ports are now used quite extensively.

4) During the plant walk-through, it was noted that a hold tag had been placed on a spray ring pipe spool because center punch marks near each end of the spool were considered too deep. The QC inspector had to have examined the approximately 30' long spool piece very closely to have found these small marks. This is an excellent example of thorough QC inspection.

5) The licensee had been notified of inadequate storage requirements for installed electrical equipment. While the supervisor in charge had given instructions to his field coordinators to correct the deterioration of the storage process, it was not done. The supervisor acknowledged this problem as his responsibility. As the team probed for root causes in this situation, it was noted that there was no finger-pointing. The supervisor felt that the cause was inadequate procedures and followup.

The information flow from engineering to coordination was verbal. The procedures for conveying the information were weak; i.e., there was no form nor paperwork. The supervisor said he thought the system was working and that the periodic inspection checklist covered this item. As a result, the licensee was considering establishing a contractor crew to ensure that storage measures are sustained.

6) There has been difficulty with respect to the quality assurance on piping spools. It was noted that the licensee examined all of the prefabricated piping spools and did, while finding no significant quality defects, spend considerable time in correcting well spatter and surface defects.

IV. GENERIC APPLICATIONS

Based on the information reviewed and analyzed by the Case B study team, several possible generic implications, or lessons, emerge. These are highlighted for each case study to provide input and to help form generic conclusions concerning factors which constitute important elements in nuclear plant construction quality.

1) The importance of the licensee managing the project. The licensee has clearly accepted responsibility for the completion of the project and the quality of the overall work. As a result, they have instituted practices that permit them to dictate the scope and degree of quality. They actively manage the day-to-day activities of each contractor. Their field forces review the design for constructability. They have instituted audits where appropriate for their subcontractors.

2) The importance of experienced personnel. The licensee has staffed the project rather broadly and deeply with personnel with substantial experience, both in general construction, as well as in nuclear construction. Many of the staff have 5-10 years with the licensee, have worked on the previous nuclear plant constructed by the licensee, or on other nuclear plants.

3) The importance of good training programs. Many of the licensee's staff, as well as the construction contactors' staffs, undergo training programs. Some of the training has been instituted because there is limited availability of skilled labor in the area. The licensee and its contractors train crafts and staff in quality control. In many cases, they have found that in training new personnel, there are fewer bad habits to overcome.

4) The importance of planning. Nuclear projects are complex projects and require extensive planning and coordination. The licensee's projects seem to be well coordinated with interfaces generally well handled. The construction staff does not appear to be standing around; that is, productivity appears good. Evidence of the planning is also manifest in preparation of the operations staff with 80 engineers already on the staff. The licensee has a training center and sent staff to other reactors for training. Lessons learned from their previous nuclear project, as well as other projects with the holding company's purview, have been fed back into the licensee's construction project.

5) The importance of a pro-company attitude among the employees. The licensee's staff appears to enjoy working for the licensee. Comments were made about fairness, opportunity for advancement, and rewards for hard work. The licensee appears to be a people-oriented company, in that layoffs are relatively rare, and the company provides a good pay scale with good fringe benefits.

6) The importance of an orientation toward quality. There seems to be a perception at all levels within the licensee's staff that quality is highly important. At the higher levels of management, there is a conviction that public safety and company profitability demand quality and that it is less expensive to do the job right the first time. At lower levels, there is a feeling that upper management wants to do the job right. Many of the staff were able to identify the signals that tell them that; and that quality is at least as important as schedule and cost.

7) The importance of support to quality. This is evident in the qualifications of the personnel that have been hired in both the quality assurance and quality control functions. It is also evident in the programs for these types of personnel as well as crafts. It was apparent from interviews that quality assurance/quality control personnel were respected by management, and the management supported them when it was necessary to stop a job when adequate quality was not manifest.

8) The importance of the seeking ways to improve quality. There is an attitude within the licensee that it has no monopoly on good ideas and looks far and wide for ways to improve its program. The licensee was first to be evaluated under 10CFR50, Appendix B. It has been proactive in looking at others' quality programs. It was one of the pilot studies for the INPO audit and it has also embraced the idea of self-initiated evaluation. They were open to participation in the NRC case studies. A number of their senior staff were on retreat at the time of the case study to consider ways to improve the quality program at the site. The licensee expressed considerable interest in good practices that the team had noted at other sites, and at least one contact was made at the Case A visit. They appeared to be more interested in finding out where they could improve than in knowing what they were doing right.

this could be expanded upon to include a review of the other site?

?

9) The importance of openness. The licensee exhibited an openness in encouraging its employees to identify quality problems without fear of punitive action. In addition, they are open to the NRC in its activities at the site. There appeared to be no attempt to hide marginal practices from the NRC inspection staff.

10) The importance of experience in the construction of nuclear plants. The licensee learned a great deal from the construction of its initial nuclear plant, including an understanding of the magnitude and complexity of a nuclear project.

11) The importance of top management involvement in nuclear projects. The licensee has seen fit to establish a project management board for its nuclear project comprised of senior utility management personnel involved in the project. This type of activity enhances resolutions on problems and helps keep management informed. Top management appears to have made a resolution to spend more time at the construction site.

V. IMPLICATIONS OF THE CASE STUDY 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 of nuclear facilities, to improve the management control of quality and/or to improve the NRC capability to evaluate the implementation of licensee assurance of quality programs. These initiatives are described in the NRC staff paper SECY 82-352 titled, "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 licensee's nuclear construction project. Subsequent paragraphs take each initiative in turn and discuss whether the initiative, had it been an ongoing activity at the time of the licensee's construction program (or quality problems, if such occurred) would have made a difference. That is, would the initiative have helped prevent or at least mitigate construction quality problems that may have occurred or, in the case of this licensee, would it have improved the quality of the plant.

A more complete discussion of the scope and details of the various NRC QA initiatives may be found in SECY 82-352 and SECY 83-32 titled, "First Quarterly Report on Implementation of the Quality Assurance Initiative."

It should be noted that each of the initiatives were discussed with senior management of the licensee and they agreed (or did not take exception to) the study team's evaluation of the applicability of the initiatives to their prior construction experience.

I am not sure not applicable as explained paragraphs A1, A2, A3, & C3 are correct. The applicability would be determined at time of OL review - suggest terminology be revised to state "not applicable for current stage of construction"

A. Measures for Near-Term Operating Licensees (NTOL)

1. Licensee Self-Evaluation - not applicable

The licensee self-evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the licensee self-evaluation would not have taken place up to the present phase of construction of the plant, which is about half completed and, thus, its effect on the project is not applicable.

2. Regional Evaluation - not applicable

The licensee regional evaluation is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the regional evaluation would not have taken place up to the present phase of construction of the plant and, thus, its effect on the project is not applicable.

3. Independent Design Verification Program (IDVP) - not applicable

The licensee IDVP is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the IDVP would not have taken place up to the present phase of design of the plant, which is about 70% complete and, thus, its effect on the project is not applicable. Design verifications can be performed at any stage of design, of course, but are most productive when the design is completed. Should the time come when nuclear plant design is completed substantially in advance of construction, then an independent design verification program could be an effective guard against allowing quality deficiencies in design from creeping into construction. However, the present NRC practice of requesting some licensees to submit to an IDVP prior to receiving an operating license would not be applicable in this case.

B. Industry Initiatives

1. INPO Construction Audits - yes

While no major construction quality deficiencies have been found in the licensee's plant to date, the licensee implied that the INPO pilot audit had been helpful in identifying areas that should be improved. This measure looks at both management and programmatic considerations as well as the quality of the product. Licensees tend to listen to INPO findings because they come from people who should be experts and they come from a group comprised of their peers, supported by their industry.

2. Utility Evaluation Using INPO Method - yes

This measure is basically a self-evaluation using the INPO methodology devised above. As a result of the design audit done by INPO in early 1982, self evaluation design review teams were established to conduct a more extensive review. This review is estimated to require more than 15,000 manhours of effort. The review teams are led by representatives from the architect-engineer who were not involved in the original design. The team includes licensee personnel; licensee holding company engineering function staff are representatives also.

C. NRC Construction Inspection Program

1. Revised Procedures and Increased Resources - yes

The resident inspector program at the licensee's site is well thought of and its recommendations have been well received. This initiative would be particularly helpful if: (a) the inspection procedures were streamlined to eliminate redundancy and given priority according to safety significance; (b) its focus was more on observations of actual construction work and less on paper and reports, and (c) a focus on the quality of management of the project and less on the formal QA manual, organization chart, and written procedures. Further, the increased inspection resources should be applied from the outset of the construction project.

2. Construction Appraisal Team (CAT) Inspections - yes

While the licensee's project has not been subjected to significant quality problems, the licensee has benefited from audits of various types, as well as NRC inspections. The licensee appears open to the benefits that come from these inspections; however, several comments were made concerning the large number of audits being made, including those by the licensee itself, the NSSS vendor, the architect-engineer, ASME, NRC, and INPO, among others. The proper timing and spacing for audits appears to be an important consideration in their effectiveness, otherwise, they could become counter-productive.

3. Integrated Design Inspection - not applicable

The integrated design inspection is an action that would take place when the licensee is in the process of receiving its operating license. The effect of the integrated design inspection would not have taken place up to the present phase of design of the plant; thus, its effect on the project would not be applicable.

4. Evaluation of Reported Information - yes

This initiative would computerize 10CFR50.55E and Part 21 reports, facilitating trend and other analyses of these event reports. This analysis would simply provide an additional cross check on the quality operations at the licensee's site. At the present time, there is no reason to believe that there would be any observed trends from the reports, but they could be useful to the NRC staff in directing their inspections at the site.

D. Designated Representatives - no

At the time this case study was conducted, it was unclear how a designated representatives 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 designated representative program would make any difference. The assistant construction project manager said with respect to quality assurance holds, it would be relieving the licensee of responsibility. Inspectors must be in the process, or they would not be helpful in solving emerging problems, he said. At the present time, there are holds for quality assurance and he saw no reason why additional ones would be beneficial. The civil project construction supervisor concurred in this. He thought they would create no more quality than they have now.

E. Management Initiatives

1. Seminars - yes

The seminars similar to those that the NRC commissioners have conducted in years past, as well as seminars by trusted utility executives, would probably have been helpful in bringing the licensee's management to their present state of awareness of the importance of quality at an earlier date.

2. Qualifications/Certifications of Quality Assurance/Quality Control Personnel - no

The licensee already has a very strong training program for its quality control personnel, as well as its quality assurance personnel. The Quality Assurance/Quality Control staff was noted to be deep and broad in its qualifications. When hired, these qualifications are then further developed through formal classroom and on-the-job training. The recruitment for quality assurance people stresses degreed persons with experience in the practical side of the nuclear industry. Many of the QA/QC staff brought strong nuclear experience to the licensee when they hired on.

3. Craftsmanship - yes

While there is a very good training program for craftsmen at the licensee's site, management interactions with the craftsmen would reinforce their understanding of why quality workmanship is of prime importance in the construction of nuclear plants.

F. Certification of QA/QC Programs (SECY 83-26) - no

The licensee has hired QA/QC personnel with good qualifications and experience. Special certifications would have added to the quality or know-how of the staff only marginally. Certification is not seen as addressing the types of problems that the licensee has experienced to date. The licensee management has treated QA/QC as something more substantive then other regulatory requirements. They look upon it as an integral part of assuring that the project is completed without significant rework and with the potential for satisfactory operation over its lifetime.

how does this comment relate to the subject identified in F ?

also stmt contradicts B on p37

G. Management Audits - maybe

At the present time, the licensee is examining its management structure and general approach to quality, looking for new and innovative methods of attaining this goal in the construction of their nuclear project. The fact that inquiries are presently going on suggests that the management audit might be a helpful input to their decision-making process. The licensee did not express itself on this particular issue, however.

VI. IMPLICATIONS OF THIS CASE STUDY FOR THE FORD AMENDMENT ALTERNATIVES

Section 13 to NRC's FY 1983 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 efficiency of five specific alternative program concepts. As a part of this analysis, each alternative concept was evaluated with respect to whether it would make a difference in the licensee's construction program had it been in place at the time of the licensee's construction permit. As was the case with the quality assurance initiatives, each of the Ford alternatives was discussed with senior utility management, as well as with their staffs.

A. More Prescriptive Architectural and Engineering Criteria - no

The Authorization Act requires NRC to evaluate the following alternatives: 13(b)1 - adopting a more prescriptive approach to defining principle architectural and engineering criteria for the construction of commerical nuclear power plants would serve as a basis for quality assurance and quality control inspection and enforcement actions. Generally speaking, the licensee believed that NRC is sufficiently prescriptive in defining principal architectural and engineering criteria for construction of nulcear plants and that it is not necessary to be more so. The problems the nuclear plants have in quality would not be significantly changed if there were more prescriptive criteria.

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 plants that the licensee demonstrate the capability of independently managing the effective performance of all quality assurance and quality control responsibilities for the plant. The licensee senior management was in agreement that prospective licensees should be required to demonstrate to a panel of peers the capability to manage a nuclear project. The licensee is a great advocate of peer review. Their viewpoint is that the NRC does not have the necessary resources to police the industry and should not have to do so. This responsibility should be with the licensees themselves, or the utility industry in general. Several suggestions were offered regarding how a licensee with no previous nuclear plant experience might accomplish this. The most feasible was similar to what the ASME does for new N stamp applicants; i.e., the applicable procedures involved need to be exercised on a demonstration project or task.

C. Audits, Inspections, or Evaluations by Associations of Professionals Having Expertise in Appropriate Areas - Management Audits - yes

Regarding audits by independent organizations, the statement was made that the system should not be made any more complicated than it currently is. It is important to keep the responsibility for implementing an adequate quality assurance program with the licensees, with the Nuclear Regulatory Commission in a verification role. The NRC CAT team audits were felt to be a worthwhile approach to verify adequacy of work at a construction site. Most every employee interviewed said that a large number of audits were conducted by many organizations. The audits are becoming a problem as they impact the time that personnel have to do their job, thereby reducing both quality and productivity. The audits can highlight problem areas to the overall benefit of the project. The licensee commented that audits have become a way of life and that the licensee just lives with it.

Negative reaction was obtained to the policy of NRC and INPO publishing the audit findings to the public. The nuclear industry has all its problems aired to the public, causing loss of confidence by the public, because they continually hear of the nuclear problems.

The licensee also felt that the Nuclear Regulatory Commission should be audited by an independent organization, but could not identify the appropriate organization to conduct such audits.

D. Improvement of NRC's QA Program -- Yes or No ?

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

Several suggestions arose from this case study: (1) assignment of a resident inspector at start of construction would not have been of much benefit to the licensee. The licensee knew from previous experience how to manage and got started off correctly. For less experienced utilities, though, the licensee felt it would be necessary to assign an inspector very early; such as when basemats are poured and cadweld work is beginning. This should be the first day of the project. This is important, because it is there that relationships and procedures begin to develop. (2) the licensee felt more and better help from the NRC is requied. NRC Headquarters needs to become more active in and share in meaningful decisions that affect the industry and then stand by their commitments; (3) inspectors should not be so paperbound. There is too much emphasis on the size of reports flowing to Headquarters. The 15 volumes of field procedures that exist now is overkill. In fact, the old manual was sufficient. Inspectors should be free to be in the plant and not excessively deskbound by bureaucratic work; (4) some inspectors are not systems or management oriented; i.e., they are too concerned with specific nuts and bolts-type problems to look further and see systemic problems; (5) too many construction permits were issued in the same time period, causing NRC inspection to be stretched too thin; (6) the NRC CAT team inspections seem valuable. Standard review plans are good. The NRC major effort should be to ensure that quality assurance is finding problems (not generating paperwork); (7) NRC tends to monitor what the licensee says, rather than what the licensee does. It was noted that if there is too much direction from NRC, it stifles initiative; (8) the biggest argument with quality assurance is over the applicability of codes; not so much the ASME code, but the ANSI daughter standards, especially in the areas of training and housekeeping. Persons tend to interpret these standards either as guidelines or an engraved in stone. What is needed is a more definite interpretation of standard requirements by NRC.

E. Conditioning the CP on the Applicant's Commitments to Submit to Third-Party Audits of His QA Program Yes or 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 or make other arrangements with an independent inspector for auditing quality assurance responsibilities for the purposes of verifying quality assurance performance. An independent inspector 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 Formd Amendment alternative 3 above. Basically, the licensee was already committed to a quality program based on its experience with a previous nuclear plant. Over the time period since construction has continued, the licensee has become all the more positive in developing a quality QA/QC program.