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The Nuclear Regulatory Commission (NRC) has a program for inspecting the construction of nuclear powerplants and a related program for inspecting firms that supply safety-related components for the powerplants. The vendor inspection program was started in 1974 when the NRC determined that 63% of nuclear powerplant construction and operation problems were traceable to vendor errors and that utility companies were not properly inspecting the vendors. Findings/Conclusions: NRC's bases for judging the quality of construction and its inspection practices need improvement. NRC's inspectors do little independent testing of construction work and rely heavily upon the utility company self-evaluation, spend little time observing ongoing construction work, and do not routinely communicate with people who do the construction work. Of 45 inspection report items reviewed, 34 were deficient either because of inadequate reporting, inadequate attention to details, acceptance of inadequate licensee action on deficient items, or inadequate investigation. Also, NRC did not require documentation for inspection reports. NRC is not making efficient use of its inspectors' time and talents. Too great a proportion of their time is spent on clerical duties, and their normal inspection work is disrupted by investigations of allegations of poor construction work. The vendor inspection program has had a positive effect on the safety of powerplants, but improvements are needed in inspectors' reporting practices, attention to details, documentation, and investigations. Recommendations: NRC should: increase independent measurements and direct observations and construction work, initiate formal interviews with craftsmen at construction sites, require licensees to train construction craftsmen in the principles of quality assurance, be more aggressive in its inspection activities, improve documentation and reporting practices, improve the productivity of its staff by increasing the time inspectors spend at construction sites and evaluating the potential for using clerks

or paraprofessionals, and review organizational elements and seek additional staff so that allegations can be investigated without disrupting routine efforts. It should improve its basis for vendor inspection by: developing a method to identify and select vendors for inspection, increasing inspections of vendors of items that control critical operations, seeking approval to hire more inspectors, being more aggressive in inspection activities, and improving documentation and reporting practices.
(HTW)

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

The Nuclear Regulatory Commission Needs To Aggressively Monitor And Independently Evaluate Nuclear Powerplant Construction

Although the Nuclear Regulatory Commission is responsible for assuring that nuclear powerplants are constructed safely, it has not been independently testing the quality of construction work. The Commission should do this plus

- improve its inspection and reporting practices,
- use the inspectors' time and talents more efficiently, and
- better document its inspection findings.

The Commission is aware of the need for improvements and has made some changes, one of which is the assignment of resident inspectors to selected reactors under construction.





COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-164105

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the Nuclear Regulatory Commission's procedures for inspecting nuclear power plants under construction.

This review was conducted as a part of our evaluation of the effectiveness of the Commission's regulatory activities as required by the Energy Reorganization Act of 1974 (42 U.S.C. 5876).

We are also sending this report today to the Chairman, Nuclear Regulatory Commission.

A handwritten signature in black ink, reading "James B. Steele".

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

THE NUCLEAR REGULATORY
COMMISSION NEEDS TO AG-
GRESSIVELY MONITOR AND
INDEPENDENTLY EVALUATE
NUCLEAR POWERPLANT CON-
STRUCTION

D I G E S T

Constructing a nuclear powerplant can employ several thousand construction workers 24 hours a day, 7 days a week. They will

--make about 25,000 welds,

--pour about 360,000 tons of concrete, and

--use 726 tons of copper and 34,662 tons of iron.

All this is required for each of the 78 nuclear powerplants now under construction in the United States.

To make sure they are built safely the Nuclear Regulatory Commission has a program for inspecting the construction of these nuclear powerplants. This report is an evaluation of that program and a closely-related program whereby the Commission inspects firms that supply safety-related components for nuclear powerplants.

At seven construction sites, GAO interviewed 484 workers, including 367 construction craftsmen, 68 quality assurance or control personnel, and 49 construction supervisors. All responses either orally or by questionnaire were confidential. With the aid of a professional engineer, GAO made independent observations of current construction and evaluated work previously performed by Commission inspectors at six of the powerplant sites to determine if their reports were complete, accurate, and based upon a thorough review of all available data.

GAO also visited six nuclear component manufacturing plants around the country

EMD-78-80

and evaluated work previously performed by Commission inspectors at those plants. (See p. 3.)

THE COMMISSION SHOULD
IMPROVE ITS BASIS FOR
JUDGING THE QUALITY OF
NUCLEAR POWERPLANT CON-
STRUCTION

Commission inspectors should know about the day-to-day activities at a construction site and determine for themselves the quality of construction work, but GAO's review revealed that the Commission inspectors

- do little independent testing of construction work, and rely heavily upon the utility company self-evaluation;
- spend little time observing ongoing construction work; and
- do not communicate routinely with people who do the actual construction work.

Inspectors do little
independent testing
of construction work

GAO found that each Commission inspector spends about 4 working days per year observing tests of components or systems by the utility or its contractors. Except for some simple measuring devices, the Commission does not have the equipment necessary to perform most types of testing.

Much of the Commission inspector's onsite time is used to review the mass of documentation that is maintained at a construction site as a basis for judging the adequacy of the utility's program for insuring quality construction. (See pp. 5 to 7.)

Inspectors do not routinely
communicate with the people
who perform construction work

GAO interviewed craftsmen at seven nuclear powerplant construction sites. The men

appeared to be mature, experienced, and interested in the quality of construction and the future safe operation of the nuclear powerplants they were building.

These workers told GAO of many irregularities related to safety questions, four of which were confirmed by the Commission. Commission inspectors are not required to talk with craftsmen and craftsmen are reluctant to initiate conversations with Commission inspectors for fear of reprisals from their employers.

GAO found that more than half of the craftsmen interviewed had never received any training on the importance of good quality assurance. This often leads craftsmen to misunderstand the quality of work that is required of them. (See pp. 7 to 9.)

Conclusion

The Commission's inspection practices need to be changed to provide a more thorough and independent evaluation of the quality of powerplant construction work. Without such an evaluation, the Commission has to rely excessively on the credibility and validity of evaluations made by utility companies and their contractors and cannot independently assure that powerplants are being constructed adequately.

Recommendations

GAO recommends that the Commission improve the independence and scope of its inspection by

- increasing independent measurements and direct observations of construction work;
- initiating formal, private interviews with craftsmen at construction sites, and
- requiring licensees to train construction craftsmen in the principles of quality assurance. (See p. 11.)

**IMPROVEMENTS NEEDED IN
THE INSPECTION PRACTICES
AND THE USE OF INSPECTORS**

With the aid of a professional engineer, GAO reviewed inspection reports at all the Commission regional offices and six of the seven nuclear powerplant construction sites visited. In total, GAO reviewed 45 inspection report items, and considered 31 deficient either because of inadequate reporting, inadequate attention to details, acceptance of inadequate licensee action on deficient items, or inadequate investigation. The Commission reexamined the deficient reports but did not identify major safety concerns in any of the 31.

In addition, GAO found that Commission inspectors are not required to maintain any type of documentation or support for their inspection reports. This means that the Commission has little evidence to support the extent and quality of the inspection effort. (See pp. 12 to 17.)

**Underuse of inspectors'
time and talent**

Commission inspectors spend about 22 percent of their official working time--about 50 days per year--performing work at construction sites.

While inspectors have educational credentials and are experienced, most of them believe their technical expertise and training are not being used to the fullest extent. GAO concurs. Many of the inspectors' administrative tasks could be performed by paraprofessionals or clerks, giving the professional inspector more time to do direct inspections. The Commission noted, however, that current budgeting practices, with manpower and dollar ceilings, discourage the increased use of paraprofessionals and clerks. (See pp. 17 to 20.)

The Commission's investigations
of allegations affect normal
inspection work

Commission inspectors are spending more of their time investigating allegations of improper construction activities, often at the expense of their normal inspection activities. A new regulation requires utility companies to post notices informing workers that they may report suspected defective work to the Commission. This new publicity will increase the number of allegations received by the Commission. However, the Commission should review organizational elements and seek additional staff to investigate these allegations without disrupting the normal inspection work.

The Commission has not developed a regulation to protect construction workers from reprisals when those workers bring construction problems to the attention of the Commission. Over a year ago, GAO recommended that such a regulation was needed. The Commission agreed, but the regulation has not been developed. An employee at a nuclear powerplant construction site has been fired recently, allegedly for notifying the Commission of defective construction work. (See pp. 20 to 22.)

Conclusion

The Commission can improve the quality of nuclear powerplant construction by adjusting its inspection and reporting practices. The Commission inspectors, in particular, need to be more aggressive in scrutinizing and following up on the items they select for review. Also, the Commission needs to increase the productivity of its inspectors by relieving them of many clerical duties. The Commission should seek additional staff and organizational units to investigate allegations of poor construction work without disrupting the routine inspection program.

Recommendations

GAO recommends that the Commission

- be more aggressive in its inspection activities and pay more attention to inspection and reporting details;
- improve its documentation and reporting practices;
- improve the productivity of its staff by increasing the time inspectors spend performing work at construction sites and by evaluating the potential for using clerks or paraprofessionals to aid the inspectors; and
- review organizational elements and seek additional staff so it can continue to investigate allegations of irregularities at nuclear powerplants without disrupting its routine inspection efforts. (See p. 23.)

THE COMMISSION'S VENDOR INSPECTION PROGRAM NEEDS TO BE IMPROVED

The Commission began a program in 1974 to review the vendors who supply safety-related components for nuclear powerplants. This was after the Commission realized

- about 63 percent of all nuclear powerplant construction and operation problems were traceable to vendor errors; and
- utility companies were not properly inspecting these vendors to make sure that they were producing quality components.

The Commission's Vendor Inspection Program has had a positive effect on the safety of nuclear powerplants but before its full potential can be realized the program needs to be improved.

Specifically, improvements need to be made in the vendor inspectors'

- reporting practices,
- attention to inspection details,
- documentation of inspection work, and
- investigations.

The Commission has not identified all vendors of safety-related equipment and does not have a systematic method of selecting these vendors for inspection. In fact, it is largely neglecting one group of vendors that manufactures electrical components and other instruments that control critical operations in the plant. The Commission, in particular, needs to assign more inspectors to its vendor inspection activity --currently there are only 11 vendor inspectors who must review over 200 suppliers of safety-related equipment. (See pp. 24 to 29.)

Recommendations

GAO recommends that the Commission improve its basis for vendor inspection by

- developing a method to identify and statistically select vendors for inspection;
- increasing the inspections of vendors that manufacture electrical components and instruments that control critical operations in the plant;
- seeking approval to hire more inspectors for the vendor inspection program;
- being more aggressive in its inspection activities and paying more attention to inspection and reporting details; and
- improving its documentation and reporting practices. (See pp. 29 and 30.)

THE COMMISSION'S RESPONSE
TO GAO'S REPORT

In its formal reply to this report, the Commission generally agreed with the thrust of GAO's conclusions and recommendations. The Commission noted that its own evaluation of the inspection program "resulted in attention toward essentially the same areas where new or improved methods should be considered for incorporation."

The Commission did not fully agree with GAO conclusions and recommendations as to:

- use of manpower utilization data,
- use of construction craftsmen interviews as an inspection technique, and
- need to improve inspection documentation and reporting practices.

GAO considered the Commission's views in each of these areas and still believes the conclusions and recommendations are valid. Each area is dealt with, as applicable, in the body of the report. (See pp. 31 to 34.)

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ABBREVIATIONS

ASME	American Society of Mechanical Engineers
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
VEPCO	Virginia Electric and Power Company

CHAPTER 1

INTRODUCTION AND PERSPECTIVE

The Nuclear Regulatory Commission (NRC) is responsible for regulating the commercial nuclear industry. This industry consists of many different activities, ranging from the production and use of nuclear medicines to the production of electrical power in nuclear powerplants. NRC insures that an organization has the necessary plans, designs, and expertise --in a word, the capability--to carry out the nuclear activity safely. It then inspects the activity to assure that all rules, regulations, plans, and designs are being followed.

This report is an evaluation of NRC's program for inspecting nuclear powerplants under construction and of a closely related program whereby NRC inspects the firms that supply safety-related components for nuclear powerplants.

NUCLEAR POWERPLANTS --GROWTH AND PROBLEMS

In 1957 the first commercial nuclear powerplant became operational at Shippingport, Pennsylvania. Today, throughout the United States, 65 nuclear powerplants have been constructed and are licensed to operate, 78 are under construction, and 58 construction permits are under review by NRC. Utility companies have publicly announced their intentions to construct 22 additional plants. The safety report for commercial nuclear powerplants has been good. No reports have ever been made of deaths or injuries resulting from exposure to radiation.

But nuclear power is not without problems. Nuclear powerplants are susceptible to the inherent fallibilities of all machines--equipment failure and human error--and, although designed to cope with even the most remote possible failures and errors, they are not failsafe. Events have occurred which reveal unsafe practices in construction management, in onsite construction work, and in manufactured components. Following are some examples.

A highly publicized fire at the Tennessee Valley Authority's Browns Ferry plant in March 1975 was started when a craftsman testing for air leaks with an open flame ignited some polyurethane foam which was being used to seal the air leaks.

In April 1977 a 420-ton nuclear reactor vessel was installed in Southern California Edison's San Onofre plant. It

was not until the following November that construction workers discovered the vessel had been installed backwards.

Allegations from craftsmen at the Virginia Electric and Power Company's North Anna plant led to the discovery of significant problems in construction management and in defective construction work which had gone undetected and unreported. 1/

NRC'S INSPECTION PROGRAM FOR POWERPLANT CONSTRUCTION

NRC's Office of Inspection and Enforcement is responsible for inspecting and investigating utilities to determine whether they are safely complying with all applicable license provisions, rules, and regulations. NRC inspects safety-related items by direct observation, personnel interviews, and review of records to ascertain whether construction of plants meet applicable requirements. NRC has five regional inspection offices which carry out these inspection tasks.

NRC's inspection program, however, relies heavily on the utility companies licensed to construct the plants. For instance, the utility companies have the responsibility to establish and execute a quality assurance program for safety-related structures, systems, and components. The programs are supposed to control such activities as designing, purchasing, fabricating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, refueling, and modifying. NRC inspects some of the activities at the construction site to determine if the utility companies' quality assurance program is adequate to insure proper construction.

NRC'S INSPECTION PROGRAM FOR SUPPLIERS OF SAFETY-RELATED COMPONENTS

In many documented cases, safety-related components (valves, pumps, piping, and seismic restrainers) which had been certified as having met rigid design and manufacturing quality control standards have been found defective or under-designed when received at construction sites. In fact, NRC has estimated that about 63 percent of construction and operation problems could be traced to the vendors (i.e., the suppliers of the reactor components).

1/"Allegations of Poor Construction Practices on the North Anna Nuclear Powerplants" (EMD-77-30, June 2, 1977).

To enhance the safety of nuclear powerplants, the Energy Reorganization Act of 1974 authorized direct inspections of vendor plants by NRC, and as a result, a pilot program which NRC calls the Licensee Contractor and Vendor Inspection Program was established. Before this time, NRC inspections at vendor plants had to be arranged through a utility company. Responsibility for inspecting vendors lies with the Vendor Inspection Branch located in NRC's Region IV office near Dallas, Texas.

OUR REVIEW OBJECTIVES AND SCOPE

Our review was aimed at determining

- how NRC conducts inspections at nuclear powerplants under construction and of firms that manufacture the safety-related components that go into those plants and
- whether NRC inspections provide an adequate basis to insure that those nuclear powerplants will not pose an undue risk to the public health and safety or to the environment when they become operational.

We made our review at the NRC Office of Inspection and Enforcement headquarters, at each of the five NRC regional offices, and at seven nuclear powerplants under construction throughout the United States. We also used a questionnaire to elicit the views of NRC's construction inspectors about NRC's inspection program. The following powerplant construction sites were visited:

- William H. Zimmer Nuclear Power Station; Moscow, Ohio
- Diablo Canyon Power Plant; San Luis Obispo County, California
- Salem Nuclear Generating Station; Hancocks Bridge, New Jersey
- Shoreham Nuclear Power Station; Shoreham, New York
- Arkansas Nuclear One; Russellville, Arkansas
- Sequoyah Nuclear Plant; Daisy, Tennessee
- LaSalle County Nuclear Station; Seneca, Illinois

At these sites we held confidential interviews with 484 workers, including 367 construction craftsmen, 68 quality assurance and quality control personnel, and 49 construction supervisors.

With the aid of a professional engineer, we made independent observations of construction work and evaluated work previously performed by NRC inspectors to determine if their reports were complete, accurate, and based upon a thorough review of all available data.

We also visited six nuclear component manufacturing plants and evaluated work previously performed by inspectors from NRC's Vendor Inspection Branch.

The professional engineer who assisted us during this work has over 20 years of diversified quality assurance experience in industry and Government.

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The following chapters of this report discuss

- whether NRC's inspection program has the depth, scope, and aggressiveness for accurately judging the quality of nuclear powerplant construction;
- how NRC's inspection and reporting practices can be improved, and the time and talents of its inspectors can be better used; and
- the effectiveness of NRC's vendor inspection program.

CHAPTER 2

NRC NEEDS TO IMPROVE ITS BASIS FOR JUDGING

THE QUALITY OF NUCLEAR POWERPLANT CONSTRUCTION

NRC inspectors should be knowledgeable about the day-to-day activities at construction sites and determine for themselves the quality of construction work, but our review disclosed that NRC

- does little independent testing of construction work, relying heavily upon the utility company's self-evaluation;
- spends little time observing construction work; and
- does not routinely communicate with the people who perform the construction work.

NRC'S RELIANCE UPON UTILITY SELF-EVALUATION

Utility companies are responsible for establishing an effective quality assurance system for the continuous monitoring of construction work. We noted, however, that the utility companies rely very heavily upon their construction contractor to evaluate its own work and identify poor construction practices, defects, or other irregularities. For instance, many tests of construction work are performed by the construction contractor or by other testing specialists to determine if construction items meet specified standards. When construction problems are identified, the contractor normally decides what corrective action, if any, is required; performs the corrective action; reinspects the rework; and accepts the rework. The utility has only a small quality assurance staff to (1) insure that its contractors completely document all safety-related construction work, inspection results, defects, and corrective actions and (2) audit the contractor's activities to determine if they are meeting construction requirements.

NRC inspectors spend much of their onsite time reviewing the mass of documentation that is maintained at the construction site and assessing the utility company's audit reports to test the quality assurance program and to determine if it is working well enough to insure proper construction. NRC inspectors do little actual observation or independent testing of the work performed at the site. This necessitates almost complete reliance on the utility and its contractor to monitor themselves and report on deviations from acceptable standards. In response to our questionnaire, NRC inspectors indicated that they spend only about 7 percent of their onsite inspection

time, or about 4 working days per year each, observing tests being done. Also, except for some simple measuring devices, NRC does not have the equipment necessary to perform most types of testing.

As a part of a self-evaluation, NRC contracted with Sandia Laboratories for an independent review of its total quality assurance program, including inspection activities. Sandia Laboratories' report pointed out that a good quality assurance organization involves two essential elements: (1) verification that a control system is being implemented and (2) verification that the output of the controlled operation meets accepted criteria. The study concluded that NRC should be doing both and that an increase in direct independent testing or inspection of the product would increase confidence in the total evaluation. Sandia recommended that independent NRC inspection and testing of hardware be increased.

NRC has been considering the increased use of direct inspection techniques for some time but nothing has begun. It is still trying to decide whether to select a sample of work and independently retest it or require the utility to retest it under NRC's observation. The latter, NRC believes, could make better use of the inspector's time and would not require large capital investments for testing and calibration equipment.

NRC SPENDS LITTLE TIME OBSERVING CONSTRUCTION WORK

NRC inspectors spend little time observing construction work, thereby limiting the benefits of first-hand knowledge of the general quality. The inspectors indicated that they spend about 20 percent of their total onsite inspection time, or about 10 working days per year each, observing construction work as it is being performed. We asked 324 construction craftsmen if an NRC inspector had ever observed them doing their work. Although 86 said they did not know, 150 said they had never been observed by NRC. The remaining 88 told us that an NRC inspector had observed them performing their work on at least one occasion.

We recognize that visual observations of specific work or random surveillance of the construction site usually cannot provide conclusive evidence of the quality, but often it does provide the inspector with indications of shortcomings in construction practices.

We noted that, during surveillance trips, NRC inspectors often make observations of poor construction practices which lead to corrective action and, in our opinion, NRC should

spend more time in this activity. The following two examples demonstrate the benefits of observing ongoing construction work.

Example 1

During an investigation of allegations at the North Anna plant of the Virginia Electric and Power Company (VEPCO), an NRC inspector alertly noted that reinforcing steel (rebar) was being joined without being properly cleaned. He made that observation while walking by, enroute to another area of the construction site. Although this was not the subject of an allegation, the inspector pursued the issue to determine if proper procedures were being followed. NRC concluded that the improperly welded rebar was unsafe and violated VEPCO's commitments because the improper welds could weaken the structural integrity of the building. NRC reported the problem to the contractor and the welds were rejected.

Example 2

During a surveillance trip through the Tennessee Valley Authority's Sequoyah plant, an NRC inspector observed electrical craftsmen positioning wiring in cable trays. He noted that no scaffolding had been provided for the craftsmen, requiring them to walk on the cable trays, which already contained some wiring. Fearing that the insulation on the wiring would be damaged by the weight of the craftsmen, NRC required corrective action.

NRC DOES NOT ROUTINELY COMMUNICATE WITH THE PEOPLE WHO PERFORM CONSTRUCTION WORK

NRC inspectors generally do not discuss construction work privately with craftsmen, although the craftsmen who build the nuclear powerplants often have information which would be valuable to NRC in evaluating the quality of construction work. Also, the craftsmen often have questions which could be answered by NRC inspectors.

We independently selected 367 craftsmen at seven nuclear powerplant construction sites located throughout the country and interviewed them privately to get their view of NRC, obtain their candid opinions relative to the quality of construction at the plants, and to learn more about the craftsmen who build nuclear powerplants.

We selected craftsmen who were at the journeyman or foreman level, who had worked at the site for 6 months or more (with a few exceptions), and who had performed safety-related

construction work. These craftsmen are the ones who build the structures, systems, or components that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public.

In our view, the craftsmen appeared to be mature, experienced, and genuinely interested in the quality of construction and the future safe operation of the nuclear powerplants they were building. Most of the craftsmen indicated that they had never been interviewed at the site privately by NRC, and many were of the opinion that they could provide NRC inspectors with some insight as to the quality of plant construction and day-to-day problems which otherwise may never be brought to the attention of NRC.

During our interviews with the craftsmen, many of them expressed dissatisfaction and concerns about the quality of the construction work. Most of the dissatisfaction involved management-labor differences and many of the concerns about the quality of the work involved items which were obviously not related to safety. However, 43 craftsmen made 57 allegations of irregularities which appeared to us to involve safety considerations. With the prior knowledge and approval of those craftsmen, we conveyed the allegations to NRC. NRC reacted by contacting the craftsmen and performing review work at the subject construction sites to determine the validity of the allegations.

NRC reported that four of the allegations were substantiated and three utility companies were cited for being in noncompliance with regulatory requirements. For example, at one plant NRC verified allegations relating to poor workmanship and inspection practices in the fabrication of pipe welds and pipe rupture restraints. A notice of violation was issued and corrective action required.

In five other cases, NRC confirmed, or partially confirmed, that irregularities had occurred but that they did not constitute a citable offense. In addition, NRC reported that some indications of irregularities were noted on four of the items but that further review work would be necessary before a final determination could be made.

NRC reported that the remainder of the allegations could not be substantiated, were problems which had already been detected and properly dealt with by the utility company, were substantiated but were not related to safety, or were apparently based upon the craftsman's misunderstanding of the applicable construction practice. NRC officials told us that their investigation of these allegations required about one-half staffyear of effort.

Need for increased accessibility

Eighty-seven percent of the craftsmen we interviewed said they had never talked to an NRC inspector at the site. NRC inspectors are not required to initiate private conversations with craftsmen and craftsmen are reluctant to initiate conversations with NRC inspectors at the construction sites for fear of being fired or criticized for loafing or causing trouble.

We noted that NRC inspectors recently began wearing identifying markings on their hard hats and do occasionally chat with craftsmen during inspection trips, but they do not normally initiate private interviews with craftsmen. NRC's contact with craftsmen is usually not private, is informal, and is most often related to a specific construction item. In addition, we found that NRC's contact with craftsmen, even on an informal basis, is limited.

Need for better quality assurance training

We found that craftsmen are generally well-trained and have many years of experience in their respective crafts, but many of them do not know the basic elements of the quality assurance program and do not understand how the program works.

More than half the craftsmen we interviewed indicated they had received no training on the quality assurance program or the importance of good quality assurance. This led to considerable misunderstanding at construction sites about the quality of work required.

Training craftsmen in quality assurance has been found to be valuable by at least one utility. The Virginia Electric and Power Company initiated such training at its North Anna construction site after NRC identified serious management weaknesses and substantiated allegations of work knowingly performed contrary to established procedures. Both findings demonstrated deficiencies in the training, motivation, and discipline of the workforce. Although NRC had not required the training as a routine part of the quality assurance program, NRC inspectors noted that utility management personnel involved in the training were impressed with the craftsmen's interest and concern for work quality following the training.

We believe that every craftsman performing safety-related work should be knowledgeable of the basic elements of the quality assurance program and understand why it is important.

CONCLUSIONS

We believe that NRC's inspection process needs to provide a more thorough and independent evaluation of the quality of powerplant construction work. Without such an evaluation, NRC has to rely to an undue extent on the credibility or validity of evaluations made by utility companies. Thus NRC's inspection program cannot independently assure that nuclear powerplants are constructed adequately. The following simple description of the enormity of nuclear powerplant construction activities and the current NRC inspection level underscores our position.

Seventy-eight nuclear powerplants are now in various stages of construction. A typical powerplant construction site may involve several thousand construction workers and supervisory personnel--in many cases, working 24 hours a day, 7 days a week. A single powerplant requires making about 25,000 welds, pouring about 360,000 tons of concrete, and using 726 tons of copper and 34,662 tons of iron. Many complex electrical and computerized systems are also involved.

In answer to our questionnaire to NRC inspectors, the 63 respondents indicated that collectively they each spend only about 22 percent of their official working time, or about 50 days per year, at construction sites. They further indicated that they used only about 34 percent of that time (about 16 days per year) to determine for themselves the quality of construction by performing or observing tests of completed construction work, observing construction work in progress, and talking with construction workers. Therefore, in 1 year, all 76 NRC construction inspectors and supervisors spent about 1,216 staffdays--or about 5-1/2 staffyears effort--in direct inspection work. At each of the 78 powerplants then, NRC's annual direct inspection is about 16 days.

For most of the past 2 years, however, NRC has been re-evaluating its inspection philosophy and approaches. It recognizes many of the shortcomings of the present system, such as the limited amount of direct inspections and verification and the limited time its inspectors spend onsite observing construction work and talking with construction workers. NRC is evaluating the need to perform some type of independent verification of the quality of construction work and is instituting a program to assign resident inspectors to powerplant sites--both under construction and in operation. This, NRC anticipates, will increase an inspector's onsite inspection time from about 22 percent to 75 percent, will permit greater observation and surveillance of construction activities, and will make its inspectors more accessible to construction craftsmen.

NRC plans to have 20 such inspectors at plant sites by October 1978. Five of these will be assigned to powerplants under construction. Depending on congressional approval, NRC plans to expand the program and provide a resident inspector at every powerplant in operation or under construction by 1981. 1/ Currently, a request is before Congress for a supplemental appropriation in fiscal year 1978 to provide 61 people and \$2.65 million to get the program started. These people have to be hired now, according to NRC, because it will take a minimum of 2 years of training and experience before they are qualified to take over a resident site. In the meantime, existing NRC inspectors will fill the resident positions.

We believe that these programs are a step in the right direction and should, if fully implemented, give NRC greater confidence that powerplants are being constructed in accordance with approved criteria. To supplement these inspection initiatives, however, NRC needs to (1) insure that construction workers are given adequate training by their employers on the value of quality construction and (2) make its inspectors more accessible to construction workers.

RECOMMENDATIONS

We recommend that the Chairman, NRC, continue to expand the scope of NRC's inspection effort and supplement its current practices by

- increasing the number of representative tests of safety-related equipment and systems to evaluate their quality;
- performing a greater number of evaluations of tests, engineering analyses, and other analytical work now performed by the utilities or contractors;
- increasing surveillance effort at construction sites;
- initiating formal, private interviews with craftsmen at construction sites; and
- promoting quality assurance at construction sites by requiring training in quality assurance for construction craftsmen and observing and evaluating the training given.

1/Due to budgetary restrictions, current plans do not envision putting a resident inspector at a construction site until the later stages of construction, when the critical safety-related construction work is being done.

CHAPTER 3

IMPROVEMENTS NEEDED IN THE INSPECTION

PRACTICES AND IN THE USE OF INSPECTORS

NRC's inspection and reporting practices need to be improved. In a number of cases, we found that inspectors did their work without proper attention to detail and accepted inadequate corrective actions from utilities. The inspection reports contained errors, lacked details about the scope of work performed, and did not have adequate supporting documentation.

Also, the NRC Inspection and Enforcement Division's most valuable resource, the professional inspector, is being underused. As a result, the quality of construction inspection suffers. Further, much inspection effort and time is being spent on investigating allegations made to NRC. While we agree that investigating allegations is necessary, they are very time consuming and divert inspectors from regularly programmed inspection work.

NRC'S INSPECTION AND REPORTING PRACTICES NEED TO BE IMPROVED

To evaluate the manner in which NRC inspectors did their work, we reviewed inspection reports at all five NRC regional offices and selected individual report items for detailed review. During visits to 6 of the 7 powerplant construction sites, we reviewed 45 of the NRC inspection report items to determine if we could retrace the steps of the NRC inspectors, identify and review the documents they reviewed, and interview the site personnel they contacted.

In some cases, we could not determine which records the inspector had reviewed because that information was not shown in the reports. In other cases, we found errors in the reports which made it difficult for us to follow the work performed by NRC. In addition, we identified instances where NRC inspectors overlooked or did not report certain weaknesses which we believe they should have found and reported.

We discussed these deficiencies with NRC regional personnel. Based upon our findings and NRC's responses, we concluded that 31 of the 45 inspection report items, about 69 percent, were deficient in some manner. We note, however, that some of these items are insignificant and others reflect our judgment as opposed to NRC's. Also, while we did not attempt to determine the safety significance of these inspection deficiencies, NRC does not consider any of them major safety concerns or items of noncompliance with regulatory requirements.

Deficient inspection reports

The following chart summarizes the results of our detailed review of selected NRC report items.

<u>NRC region</u>	<u>Powerplant</u>	<u>No. items reviewed</u>	<u>Items deficient</u>	
			<u>Number</u>	<u>Percent</u>
I	Salem	5	5	
	Shoreham	<u>10</u>	<u>8</u>	
	Subtotal Region 1	15	13	87
II	Sequoyah	6	6	100
III	La Salle	8	6	75
IV	Arkansas			
	Number One	9	1	11
V	Diablo Canyon	<u>7</u>	<u>5</u>	<u>71</u>
	TOTAL	<u>45</u>	<u>31</u>	<u>69</u>

The nature and number of each type of deficiency noted for each NRC region are shown below.

<u>Nature of deficiency</u>	<u>Regions</u>					<u>Total</u>
	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>	
Inadequate reporting	7	3	1	0	1	12
Inadequate attention to details	1	3	2	1	3	10
Acceptance of inadequate licensee action	3	0	1	0	0	4
Inadequate investigation	<u>2</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>1</u>	<u>5</u>
TOTAL	<u>13</u>	<u>6</u>	<u>6</u>	<u>1</u>	<u>5</u>	<u>31</u>

Following are examples of each type of deficient item noted by GAO.

Inadequate reporting

Of the 31 deficient items we found, we considered 12, or 39 percent, deficient because of misstatements or lack of sufficient detail to provide an audit trail. These items range

in significance from relatively minor typographical transpositions to more significant misstatements which changed the meaning of the report item. For example, during an inspection at the Sequoyah plant site, an NRC inspector reviewed the reactor coolant pressure boundary piping weld records and reported that no irregularities were identified. He selected one pipe piece containing three welds for detailed review. Of these three welds, records were complete and traceable for only one weld. We were informed by the responsible plant engineer that records for the remaining two welds were not available for our review and had not been available for NRC's review because at the time of the inspection one weld was incomplete and the records were misplaced and the third weld had not yet been made.

NRC's response to this finding confirmed that the inspector had improperly reported this item. According to NRC, the inspector misinterpreted his field notes causing the reporting error. NRC also determined that records for two of the three welds were now complete and retrievable, but the third weld has not yet been made. No items of noncompliance or deviations were identified by NRC as a result of its reinspection.

Inadequate attention to detail

Ten of the 31 items we identified as deficient, or 32 percent, exhibited inattention to detail. The deficiencies included incomplete and missing data, conflicting procedures, and quality assurance documentation NRC overlooked or did not report.

In one NRC report of a LaSalle plant site inspection which concerned, in part, observance of two concrete pours and review of related documentation, the inspector stated that the pours were made in accordance with job specifications and good concrete handling practices. No irregularities were noted. We reviewed records of one of the pours and noted numerous omissions and deficiencies. The pour checkout card, for example, contained (1) no record of either unit number or area, weather conditions, pour start or stop time, (2) no acceptance of site clean-up before the pour, and (3) a signature block with initials only. The construction procedure used for the concrete pour referenced an American Concrete Institute Standard not valid since March 1972. The revised standard, which the construction company quality assurance supervisor agreed was the proper standard, requires an inspector to record, at frequent intervals, air and concrete temperature, wind velocity, relative humidity, and other general weather conditions. No recording, or requirement for the recording of this information was found.

Also, contrary to established quality control procedures, many of the concrete plant batch tickets for this pour contained penciled changes without any authorization and one batch of concrete exceeded the maximum 2-hour limit within which it must be poured.

NRC officials stated that although reexamination of the licensee's records confirmed documentation irregularities, no regulatory requirements were found to have been violated. The contractor had performed an engineering evaluation that eliminated the need to record general weather conditions as long as a specific concrete temperature was maintained. We note, however, that this engineering evaluation was found by NRC after we brought the item to its attention. It was not, to our knowledge, considered by the inspector during his initial review. Also, the current concrete control procedure at the plant does not reflect the engineering evaluation referred to by NRC.

Acceptance of inadequate licensee action

Four of the 31 items we considered deficient, or 13 percent, related to NRC's acceptance of inadequate action by utilities to correct deficiencies discovered either by the utility or NRC.

At the LaSalle plant site, NRC reviewed the corrective action reports which were prepared by the utility during its quality assurance inspection activities. The NRC inspector stated that these reports were legible, complete, retrievable, had been reviewed by quality control personnel, and that appropriate corrective action had been taken.

We selected 4 of the 10 corrective actions reports for review. We verified the inspector's findings on two reports but found the other two involved inadequate licensee action.

One report noted that equipment was not being properly protected during storage and suggested that the work crews be indoctrinated in the proper storage procedures. The only corrective action taken, however, was that the foreman was instructed on the proper storage procedures. Utility personnel told us--10 months after the corrective action report--that the crews still had not been instructed in the procedures.

The other report we reviewed contained seven pages of deficient items identified by a quality control inspector during his review of a cable tray installation. Despite this rather lengthy listing, the only suggested action to prevent recurrence was to require closer inspection by the responsible

foreman. We do not believe this is in keeping with the volume, type, and severity of the deficiencies found. In fact, it could be an indication that the construction workers or foreman need additional training or indoctrination in the proper construction procedures. NRC, however, found the corrective action acceptable.

Inadequate investigation

Of the 31 items, we found 5--or 16 percent--deficient because of NRC's inadequate investigation of items reported. One item involved an inspection at the Diablo Canyon plant site where NRC reviewed the utility's test program to evaluate concrete expansion anchors. The inspector, however, did not observe the test being performed and as of the date of our review he had not reviewed test data or examined the test site. Instead he reviewed only the test procedures the utility had used. Based on that evaluation the inspector reported that the utility had used both 3,000 and 5,000 psi 1/ concrete to test the expansion anchors. These actions, in our view, are not sufficient to determine whether the tests were adequately conducted.

We found that the site where all tests were made was an unused concrete floor composed of 3,400 psi concrete. Utility personnel told us that they had not done any tests in 5,000 psi concrete. NRC agreed that the inspector had made a mistake in noting that tests were made in 5,000 psi concrete and told us that a later inspection report had corrected the mistake.

Inadequate supporting documentation

NRC maintains practically no documentation to support its inspection reports. The inspectors' informal notes form the bases for most report preparation, and current NRC policy does not require the maintenance of additional support. As a result, tracing or evaluating NRC inspection performance is difficult and time consuming.

NRC officials told us that inspectors are not required to keep supporting documentation of their reports. They said it is not their practice to obtain and maintain copies of documents, pictures, or records of interviews with personnel at

1/Psi is a measure of the strength of concrete and refers to the pressure, expressed in pounds per square inch, which the concrete can withstand without failing.

the construction sites. NRC inspectors told us they usually destroy their informal notes after the inspection report is prepared.

Except for the inspector's memory or the few notes escaping destruction, NRC can provide little support to attest to the extent and quality of the inspection effort or evidence that reported findings are correct.

Since specific construction problems can take several months to resolve and certain inspection efforts can take a year or more to complete, an inspector leaving NRC employment can create doubt as to what was actually inspected and reinspection of some items may be required.

In addition, when inspection reports or conclusions are challenged by someone outside the agency, NRC can provide little tangible evidence with which to support its position.

INEFFICIENT USE OF INSPECTORS' TIME AND TALENT

NRC regional branch chiefs, section chiefs, and inspectors indicated that collectively they spend only about 22 percent of their official working time, or about 50 days per year, performing inspection work at construction sites.

The following chart shows how those NRC regional personnel responsible for construction inspection answered our request to account for 100 percent of their official working time. We converted the results to equivalent working days per year.

<u>Activity</u>	<u>Approximate percentage</u>	<u>Equivalent working days per year</u>
Preparing for inspections	9	20
Traveling to and from construction sites	8	18
Performing inspections at construction sites (note a)	22	50
Preparing inspection reports	16	36
Preparing computer inputs	3	7
Manually tracking data not available from computer	3	7
Receiving training	6	14
Providing training at powerplants	0	0
Other (note b)	<u>33</u>	<u>75</u>
TOTAL	<u>100</u>	<u>227</u>

a/NRC officials stated that the onsite inspection goal was an average of 30 percent of the inspectors' official working time or about 70 days per year. According to NRC officials, current statistics for the last quarter of calendar year 1977 show construction inspectors average 27.9 percent of their time onsite at construction sites.

b/The other category includes such items as time spent on offsite and in-office inspections, handling of special NRC headquarters requests, and other administrative tasks. It also includes time not accounted for by the respondents to the questionnaire.

In response to our request to indicate how their total onsite time was used, the regional branch chiefs, section chiefs, and inspectors responded as shown by the following chart.

<u>Inspection activity on site</u>	<u>Approximate percentage</u>	<u>Equivalent working days per year</u>
Reviewing licensee quality assurance procedures	14	7
Reviewing records	21	10
Entrance/exit conferences	4	2
Observing construction work being performed	20	10
Performing or observing tests of construction work	7	4
Talking with those who perform construction work	6	3
Other (note a)	<u>28</u>	<u>14</u>
TOTAL	<u>100</u>	<u>50</u>

a/The other category primarily includes time unaccounted for by the respondents. In commenting on our draft report, NRC felt this reflected time spent by inspectors to react and follow-up on matters identified during the regular inspection work.

The credentials of NRC inspectors are impressive. The results of our questionnaire showed that 83 percent of the NRC inspectors have degrees in engineering or other disciplines and many have advanced degrees. In addition, the average NRC inspector has about 14 years of nuclear-related work experience with NRC, the military, or with private industry. Further, NRC employs some qualified nondestructive test personnel.

Of 61 NRC inspectors responding to our questionnaire, 59 percent said they feel that their technical expertise and training are not being used to the fullest extent. We concur. These highly qualified professionals spend a great deal of their time on activities other than direct inspection.

NRC inspectors indicated to us that many of the functions they performed could be performed at least partially by clerks or paraprofessionals. More than 60 percent of the inspectors responding to our questionnaire said they could use their time more effectively if they had someone to aid them with preparing computer inputs, updating manuals, and performing other clerical duties.

In response to this action, NRC officials told us that the present budgeting process discourages the increased use of clerks and paraprofessionals. Each agency must operate within both a funding limitation and a manpower ceiling. As

a practical matter, the lowest paid clerks and the senior managers count equally against the manpower ceiling (i.e., adding a clerk or paraprofessional means removing an inspector). Thus, NRC said it attempts to minimize clerical and other overhead personnel in order to maximize productivity within the funding and ceiling limitations. As long as a clerk or paraprofessional counts the same as an inspector against the manpower ceiling, NRC believes it would not be prudent to replace the inspector. If, however, a system could be devised to replace one inspector position with more than one clerk or paraprofessional position (totaling, for example, the same salary and benefits), then NRC would consider this as a viable management alternative.

NRC'S INVESTIGATIONS OF ALLEGATIONS AFFECT NORMAL INSPECTION ACTIVITIES

NRC's policy is to investigate all allegations of defective construction work at nuclear powerplants. These investigations can be very time consuming and are often performed by NRC inspectors who have been diverted from their regularly programmed inspection work. We are concerned that inspectors will be unable to perform indepth evaluations of construction work during their regular inspections if they are diverted to investigate allegations.

In response to our questionnaire, about 90 percent of the NRC construction inspectors indicated that they are able to perform indepth investigations of all allegations, but about 80 percent indicated that when they do so, their regularly programmed inspection work stacks up and is not performed by other inspectors.

Volume of allegations may increase in the future

On July 6, 1977, NRC issued a new regulation which, among other things, requires utility companies to post notices at all nuclear powerplant construction sites informing all individuals that they may report to NRC any known or suspected defect or failure and that their identity will not be disclosed. Although NRC had requested utility companies to post similar notices at construction sites before July 1977, we noted that a majority of the utility companies which we contacted had not done so. Others had posted the notices in places where they were not easily seen.

More than half of the craftsmen we interviewed at construction sites were not aware that they had the right to

bring such matters to the attention of NRC. Of the 367 craftsmen we interviewed, about 59 percent indicated that they did not know they could contact NRC about construction deficiencies, and more than 80 percent told us they did not know how to contact NRC if they wanted to. Many of the craftsmen we interviewed thought they could provide NRC inspectors with information about the quality of construction which otherwise might never be brought to the inspectors' attention.

We believe that the implementation of this new regulation should result in growing awareness among craftsmen that they can report suspected construction defects to NRC, and will lead to an increase--perhaps a considerable increase--in the volume of allegations.

Need to protect workers who bring safety concerns to NRC's attention

On June 2, 1977, we issued a report which recommended that NRC develop a rule or regulation to protect individuals from reprisals by employers or others if those individuals tell NRC of poor construction activities at a nuclear powerplant construction site. ^{1/} We felt that the opportunity for individuals to notify NRC of poor construction practices was a very useful tool in NRC's overall cognizance of nuclear powerplant construction. NRC said, at that time, such a regulation was "under intensive review by the NRC staff, with a view to providing the Commission with recommendations for more effective means of assuring protection for such workers, including any necessary legislation."

As of the date of this report, however, such a regulation has not been developed by NRC. This has become important because a construction worker at the Callaway, Missouri, nuclear powerplant was recently fired by his employer, possibly for bringing allegations of poor construction practices to the attention of NRC and the public. The utility in this case--Union Electric Company--has refused to give NRC access to its plant and records to determine if the worker was fired with just cause or because of the allegations.

In response, NRC issued an order on Union Electric Company threatening suspension of its construction permit unless it gives NRC the necessary access or justifies its refusal for doing so. The utility subsequently requested a hearing on the

^{1/}"Allegations of Poor Construction Practices on the North Anna Nuclear Powerplants" (EMD-77-30, June 2, 1977).

matters identified in the order and on June 16, 1978, a three-member NRC hearing board met to define the issues and set a schedule for resolving the problem.

We believe that this incident--even though its nature and cause have not been determined--underscores the need for NRC to have specific authority to protect workers who conscientiously bring details of poor construction practices to the attention of NRC.

In this regard, the Subcommittee on Nuclear Regulation of the Senate Committee on Environment and Public Works has incorporated provisions in NRC's fiscal year 1979 authorization bill that would give such protection to construction workers. We believe this would aid NRC in its overall authority at nuclear powerplants.

CONCLUSION

We believe that NRC can improve its basis for determining the quality of nuclear powerplant construction by adjusting its inspection and reporting practices. Because NRC performs a rather limited audit of utility data and operations, we think it is very important that its inspectors more closely scrutinize and follow up on the sample of items it selects for review. We found problems with the scope of some examinations, with the attention that the inspectors gave to some of the items they reviewed, with the way they reported the items reviewed, and with the documentation of inspection activities.

Further, in our opinion the time spent by NRC inspectors on nontechnical work is excessive and should be reduced. This would enable the inspectors to perform more indepth evaluations of construction work. We believe that NRC should take steps to increase its inspection productivity by better using the time and talents of the professional inspectors.

However, it must also be recognized that NRC investigations of allegations divert inspectors from their regular work which could compromise the quality of the programmed inspection work. Furthermore, if the recently implemented regulations cause the volume of allegations to increase significantly, NRC will be unable to investigate all of the allegations while continuing to perform all of the inspection work that we believe is necessary.

For investigations of allegations to be effective, however, NRC must develop a rule or regulation to protect construction workers from reprisals by their employers when they bring construction problems to the attention of NRC.

RECOMMENDATIONS

To correct weaknesses in inspection performance and reporting practices, we recommend that the Chairman, NRC

- change reporting procedures to require a more extensive scope section and more detail on deficiencies noted;
- revise the internal review process to minimize report errors and to insure adequate investigation of report items;
- not close deficient items until licensees can demonstrate proper completion of approved corrective action; and
- obtain and maintain sufficient documentation to adequately support the inspectors' reports.

To increase its inspection productivity, we recommend that the Chairman, NRC

- increase the time the inspectors spend performing inspection work at construction sites; and
- evaluate its inspection practices to determine if clerks and paraprofessionals can be used effectively to aid the inspectors.

To exercise its policy of investigating all allegations of irregularities at nuclear powerplants, but to do so in a manner which is not disruptive to the programmed inspection effort, we recommend that the Chairman, NRC

- review organizational elements and seek additional staff to investigate allegations more efficiently; and
- expedite efforts to develop a rule or regulation to protect workers from being fired because they have brought safety concerns to NRC's attention.

CHAPTER 4

NRC'S VENDOR INSPECTION PROGRAM

NEEDS TO BE IMPROVED AND EXPANDED

NRC's Vendor Inspection Program began in 1974 after NRC found that utility companies were not properly reviewing vendors who supplied components for constructing nuclear powerplants. One NRC study concluded that about 63 percent of all nuclear powerplant construction and operation problems were traceable to vendor errors which had not been detected by the utility companies' reviews at vendor plants. Under NRC's Vendor Inspection Program, utility companies continue to be responsible for reviewing vendors, but NRC inspectors perform additional independent evaluations of selected vendors.

We believe that NRC's Vendor Inspection Program has had a positive effect on the safety of nuclear powerplants. Many vendor problems have been identified and corrected as a result of NRC action. However, the program needs to be improved and expanded before its full potential can be realized. Specifically, NRC should improve its inspection and reporting practices and also its method of identifying and selecting vendors to inspect.

IMPROVEMENTS NEEDED IN THE IDENTIFICATION AND SELECTION OF VENDORS TO INSPECT

NRC has not identified all vendors of safety-related components nor has it developed a systematic method for deciding which vendors to inspect. Quarterly, NRC publishes what it calls a "White Book" which lists the vendors it considers heavily involved in the nuclear industry. The December 31, 1977, version of this book lists 205 vendors, 143 of whom were inspected by NRC during 1977. NRC officials told us, however, that they have no way of knowing if the list is complete, because a detailed effort to identify the major vendors has never been made.

These officials also said that the selection of vendors from the list was somewhat arbitrary, was intuitive in nature, and was not based on any scientific or statistical method. We think this is important because with its limited resources

--there are only 11 vendor inspectors 1/--NRC cannot adequately inspect all vendors of safety-related equipment. NRC must set inspection priorities and be selective in the work it does. Therefore, we believe that the results of its vendor inspection efforts can be more meaningful if NRC (1) would identify all manufacturers of safety-related equipment and (2) develop a statistical method of selecting vendors for inspection that would enable it to evaluate, within certain established levels of confidence, whether the vendors are building quality nuclear components.

NRC is neglecting one group of vendors of safety-related equipment

The majority of vendor inspections have been of vendors who are subject to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. 2/ Other vendors of very important safety-related components have been relatively neglected--only two inspectors are available for 53 non-ASME vendors. For instance, there are thousands of instruments such as gauges, meters, indicators, arms, and monitors which are manufactured by non-ASME vendors and used in nuclear powerplants. Some of these instruments control the operation of vital valves, pumps, and switches, while others indicate the status of virtually every significant part of the plant. Critical radiation monitoring systems function with the aid of instrumentation gauges. In addition, electrical cables and a variety of electronic equipment are produced by non-ASME vendors.

Many non-ASME components are critical to the safe operation of nuclear powerplants. They are integral parts of back-up safety systems as well as primary operating systems. NRC spends little time inspecting the vendors of these components, even though numerous utilities have attributed many malfunctions in operating plants to components produced by non-ASME vendors.

1/The Office of Management and Budget has put a personnel ceiling on NRC's Vendor Inspection Program at least through fiscal year 1979.

2/Manufacturing codes, the requirements of which have been incorporated into NRC regulations (10 CFR 50, 50.55a) to guide the manufacture of safety-related components put into a nuclear powerplant.

In addition to the ceiling on personnel and the lack of inspectors, NRC's inspection capability suffers from the lack of strong industry standards that can be used to evaluate the quality of non-ASME components. Both NRC officials and representatives of the nuclear industry told us that existing standards, developed by industry, are too general to be adequate. In a report to the Chairman of NRC, dated May 19, 1976, the Advisory Committee on Reactor Safeguards 1/, said:

"An increased effort between the NRC and appropriate code or standards groups to develop better criteria and codes or standards comparable to the ASME Nuclear Codes for fire prevention, for electrical systems, and for other safety-related components, is desirable. Current requirements often are ill-defined and amorphous so the 'inspector' lacks adequate criteria to determine acceptability. Until these criteria are better defined, there will continue to be confusion concerning acceptable limits as evaluated by the NRC-IE organization."

This lack of industry standards has made it difficult for NRC to develop inspection procedures for non-ASME vendors. It was not until July 1977--almost 3 years after the Vendor Inspection Program began--that NRC issued procedures for inspecting electrical components. Similar procedures for instrumentation inspections still have not been issued.

IMPROVEMENTS NEEDED IN NRC'S VENDOR INSPECTION AND REPORTING PRACTICES

NRC's Vendor Inspection Program has some of the same inspection and reporting problems as the construction inspection program. For instance, the current emphasis of NRC vendor inspections is toward an audit of the vendors' quality assurance organization and systems; that is, an audit of paperwork. Although some visual inspections of components are made, NRC does not independently test components on a sample basis. In a 1976 report on the program's first year of operation, the Chief of the Vendor and Advanced Reactor Programs Branch stated that NRC's inspection of products during its vendor inspections

1/A Committee established by law to review and advise NRC concerning license applications for nuclear powerplants and other major nuclear facilities. It is composed of individuals from industry, national laboratories, and universities who have considerable experience in various fields related to safety.

had been minimal. We found, during our review, that this is still true. In a number of cases NRC vendor inspections were performed without adequate investigation or attention to detail, and reports contained errors and lacked supporting documentation.

During our review we selected 24 items from NRC vendor inspection reports and found 9, or about 37 percent, to be defective because of poor inspection or reporting. The table below summarizes those deficiencies.

<u>Vendor</u>	<u>Component or product</u>	<u>Number of items reviewed by GAO</u>	<u>Items deficient</u>	
			<u>Number</u>	<u>Percent</u>
A	Piping	3	3	100
B	Valves	5	4	80
C	Pumps	3	0	0
D	Shock absorbers	4	0	0
E	Electrical components	5	0	0
F	Steam generators and pressurizers	<u>4</u>	<u>2</u>	<u>50</u>
	TOTAL	<u>24</u>	<u>9</u>	<u>37.5</u>

The deficiencies vary in significance and frequency, as noted below.

<u>Nature of deficiency</u>	<u>Number of items deficient per vendor</u>						<u>Total</u>
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	
Inadequate reporting	1	0	0	0	0	1	2
Inadequate attention to details	1	1	0	0	0	0	2
Inadequate investigation	<u>1</u>	<u>3</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>5</u>
	<u>3</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>9</u>

It should be noted that NRC did not have an opportunity to re-examine the tabulated deficiencies before this report was issued.

The following examples are characteristic of the deficiencies noted.

Inadequate reporting

One NRC inspection report concluded that no items of non-conformance or deviations were noted as a result of the inspector's review of a vendor's audit of its suppliers. However, NRC's report did not state which records were reviewed. We reviewed the type of records that should have been reviewed

and found errors in the vendor's audits: (1) three audit reports were not signed by the vendor's auditor; (2) three reports did not contain corrective action and anticipated date of corrective action for deficient items; and (3) one audit report noted a deficiency in the maintenance of nondestructive examination records, but did not classify this as inadequate.

Inadequate attention to detail

During an inspection, the NRC inspector reviewed action taken by a vendor on a previously reported failure to perform management audits. The vendor had subsequently performed an audit so the NRC inspector closed the item but apparently without evaluating the adequacy of the audit. We noted numerous irregularities in the vendor's audit and the related quality assurance standard. For example, (1) much of the audit report contained no supporting data, (2) the audit did not include management "audit discrepancy and corrective action reports" for two audit segments having deficiencies although such reports are required even if the segments contain no deficiencies; and (3) the related quality assurance standard did not have the required approval signature or initials, approval date or review date, and distribution list or category.

Inadequate investigation

An NRC inspector reported that he reviewed vendor corrective action on a failure to perform certain internal audits at the prescribed frequency. He stated that the required audit had been completed and the promised revisions to the internal audit program had been performed. However, we found no evidence that one of the four required audit areas had been performed. The remaining three audit areas had been completed but contained numerous irregularities, including improper distribution, no identification of corrective action, incomplete internal audit checklist, and the performance of an audit segment by a person whose routine work included the area covered by the audit. The vendor's promised expansion of the internal audit program had not yet been accomplished, and we found no indication of vendor intent to expand the program.

Lack of support for inspection reports

NRC maintains practically no documentation to support its inspection reports. The inspectors' informal notes form the basis for most report preparation, but current NRC policy does not require the retention of these notes or any additional support. As a result, in many cases when a question arises about the adequacy of an inspection of a vendor's product, NRC

cannot determine if an item has been inspected. In addition, NRC has no documentary support for its findings other than the report itself. NRC must rely on the inspector's memory or make a costly reinspection of the item.

CONCLUSIONS

NRC's Vendor Inspection Program has resulted in the identification and correction of many vendor problems but deficiencies remain. First, NRC has limited resources for vendor inspection--only 11 inspectors must cover at least 200 different vendors. Secondly, NRC has neither identified all vendors of safety-related components nor devised a systematic method of selecting the vendors for review. In fact, it is almost neglecting one group of vendors who produce electrical equipment and other instruments because of the lack of inspectors and of adequate industry standards by which to inspect.

Also, in our view NRC vendor inspectors do not (1) give sufficient attention to details in conducting and reporting inspections, (2) sufficiently examine followup actions, (3) maintain sufficient documentation to show the scope of inspections and the results of the review, and (4) perform sufficient testing of components as a basis for judging the adequacy of the vendors' ability to produce quality components.

RECOMMENDATIONS

We recommend that the Chairman, NRC, improve NRC's basis for vendor inspections by

- developing criteria and procedures to identify all vendors of safety-related components and include them in the list from which vendors are selected for inspection,
- initiating a statistical method for selecting vendors for inspection which will improve the basis for projecting inspection findings to the nuclear component supplier industry,
- working with the nuclear industry to promote the development and adoption of adequate standards for manufacturing all safety-related non-ASME components,
- inspecting non-ASME vendors in a manner that reflects their importance to the safe operation of nuclear powerplants, and
- seeking Office of Management and Budget approval to hire more inspectors for the vendor inspection program.

To improve its inspection performance and reporting practices we recommend that the Chairman, NRC

- expand NRC's reporting procedures to require a more extensive scope section and more elaboration on deficiencies noted,
- not close deficient items until vendors have demonstrated proper completion of approved corrective action,
- obtain and maintain sufficient documentation to adequately support the inspection reports, and
- instruct inspectors to expand their reviews to include sample examination of vendors' products.

CHAPTER 5

NRC COMMENTS AND GAO OBSERVATIONS

Following the completion of our review, we met several times with NRC officials to discuss the details of our findings and to obtain their verbal responses to our conclusions and recommendations. In addition, NRC provided written comments which further elaborated on its specific agreement and disagreement with our report (see Appendix II).

Generally, NRC agreed with the thrust of our conclusions and recommendations. NRC said that for the past 2 years it has been conducting an extensive examination of its inspection practices, focusing on many of the same issues as we did. NRC noted that our audit and its own examination have directed attention toward essentially the same areas where new or improved methods should be considered for adoption. Specifically, NRC says that it is initiating changes in its inspection practices aimed at

- increasing the time NRC inspectors are at licensees' sites,
- increasing direct verification of licensee activities by NRC inspectors,
- instituting a program to appraise licensee performance and the effectiveness of the NRC inspection program and inspector objectivity, and
- improving its manpower management.

We agree with all these measures and believe that they are steps in the right direction.

NRC, however, identified three specific areas where it did not agree with our conclusions and recommendations or our handling of data in the report:

- use of manpower utilization data,
- use of construction craftsmen interviews as an inspection technique, and
- need to improve inspection documentation and reporting practices.

USE OF MANPOWER UTILIZATION DATA

NRC expressed concern that we used data obtained from our questionnaire to show how inspectors utilize their time. Instead, NRC thought we should have used the more extensive and "accurate" computerized data base it maintains on manpower utilization. As told to NRC several times, however, we do not accept the idea that NRC's data is necessarily more accurate than that obtained in our questionnaire. Any routine collection of manpower data, we believe, puts the individual employee in a position of proving that he has used his time productively and, therefore, results in a built-in bias. Our questionnaire data did not have this bias because the identity of the individual respondents was not known.

USE OF CONSTRUCTION CRAFTSMEN INTERVIEWS AS AN INSPECTION TECHNIQUE

NRC disagrees with the importance we placed on interviewing craftsmen at powerplant construction sites. NRC said it estimated that we spent 33 manweeks of effort interviewing these craftsmen and reviewing work previously done by NRC inspectors. Also, according to NRC, it took 46 manweeks of effort for its inspectors to review potential problems that we identified during our powerplant site visits. NRC notes, however, that this 79 manweeks of effort resulted in the identification of only four items of noncompliance. It said that if its inspectors had used the equivalent time in normal inspections, statistics show that they would have identified 63 items of noncompliance.

First, we think it is extremely important that NRC believes that the number of noncompliances identified by its inspectors is directly related to the amount of time the inspectors spend at powerplant construction sites. This adds significantly more weight to our conclusion that NRC should not place so much faith in the desire and ability of utilities to find and correct their own mistakes and that there is a real need for greater NRC control at powerplant sites.

Secondly, we still feel that routine interviews of construction craftsmen can be effectively used as an inspection technique. While we probably spent more time at powerplant construction sites than the 33 manweeks estimated by NRC, only a small fraction of that time was devoted to asking craftsmen if any construction work was defective. Also our work was not of the nature of an NRC inspection. We were auditing NRC and evaluating its inspection techniques, not looking for items of noncompliance.

Also, we consider it misleading for NRC to say it took 46 manweeks to follow-up on the potential problems we identified. NRC felt it had to be as thorough as possible in investigating these potential problems and spent more time on each item than it normally would. Further, we understand that NRC spent some of this time reviewing items that we, at one time, had planned to review but, did not include in our work.

We think it inaccurate, therefore, for NRC to use the manweeks expended during our review to question the importance of interviewing craftsmen as an inspection technique. These craftsmen, we feel, are in an excellent position to know the quality of construction, and could provide a valuable link in NRC's overall cognizance of construction site activities.

NEED TO IMPROVE INSPECTION DOCUMENTATION AND REPORTING PRACTICES

NRC, because of manpower limitations, said it disagreed with our comments on documentation and reporting but would examine ways to improve the quality of its documentation. It felt, however, that its professional inspectors could make better use of their time by inspecting rather than constructing a detailed "audit trail" or writing an extensive inspection report.

We tend to agree with this assessment but believe that NRC can increase the effectiveness of its inspectors and still improve its documentation and reporting practices.

As our report indicates, NRC inspectors spend only about one-fifth of their time at construction sites and only a small portion of that in direct testing or observation of construction activities. By increasing inspectors' onsite time and requiring direct testing of components or systems, NRC can greatly increase the effectiveness of its inspections. This, NRC is proposing to do.

At the same time, however, we believe that NRC must require its inspectors to adequately document their inspection activities and insure their reports are both accurate and understandable. Such documentation would only have to be as extensive as NRC determines is consistent with its manpower limitations.

As it now stands, however, NRC does not have any documentation behind its inspection reports and findings other than some informal notes. Consequently, NRC management cannot effectively evaluate the quality of the inspection or determine

if it was performed according to NRC's inspection criteria. This more or less lets the inspector perform the inspection as he sees fit without having to demonstrate, for his supervisors or the public, the basis behind his inspection findings and conclusions. It also results, as we occasionally found, in inadequate reporting of inspection details.



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

JUL 17 1978

Mr. Monte Canfield, Jr.
Director
Energy and Materials Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Canfield:

We appreciate the opportunity to comment on the draft GAO report entitled, "The Nuclear Regulatory Commission Needs to More Aggressively Monitor and Independently Evaluate the Construction of Nuclear Powerplants." GAO has already considered many of our comments separately through meetings between our respective staffs.

As an overall assessment of your report, we note that GAO does not disagree with our philosophy of requiring the NRC licensees to discharge their basic responsibility for quality of the plant, and that you agree that the role of NRC inspection is one of audit. We believe, therefore, that your summary statement that "...the Commission does not independently assure that nuclear powerplants are constructed adequately" could be misleading. As you are aware, NRC does not see totally independent assurance as a role of NRC inspection. Rather, NRC inspection and enforcement independently assures that the licensee is discharging this responsibility for quality. We interpret the thrust of your report as not that we should abandon our current philosophy of audit but that we audit more effectively and efficiently -- we agree.

Your audit utilized two GAO auditors and a consultant for a period of about twelve months. From the report of this effort, we have characterized your recommendations to include the following:

- . NRC should lessen its dependence on licensees by:
 - More direct NRC independent measurements
 - More direct observation of activities by NRC
 - More direct communication by NRC with licensee and contractor workers
 - More vendor inspectors

*GAO note--Our assignment included five GAO auditors and a consultant for a period of about 12 months.

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- . NRC should modify the use of inspector's time and skills by:
 - Changes in documentation and reporting
 - Organizational separation of routine inspection work from investigations ("reactive" work)
 - More attention to details

For at least the last two years, NRC has had underway a comprehensive examination of its inspection practices which has focused on many of the elements of our work upon which you have commented and made recommendations. The studies of our efforts are largely completed and we are initiating changes in our inspection practices resulting from our studies. Basically, our revised inspection program has been aimed at:

- . Increasing the time NRC inspectors are at the licensees' sites
- . Increasing direct verification of licensee activities by NRC inspectors. This includes both independent measurement by NRC and direct observation by NRC
- . Institution of a performance appraisal program on a national level by NRC. This program will appraise licensee performance, the effectiveness of the NRC inspection program and inspector objectivity. This effort also would include the capability for managing the performance of certain of the more important investigations
- . Improved manpower management

Hence, your audit and our examination of the NRC inspection program -- although approached from different perspectives -- have resulted in attention toward essentially the same areas where new or improved methods should be considered for incorporation.

Although we may basically agree on the needed improvements there are areas where the NRC does not agree with the conclusions and recommendations in your report. We particularly have concern with your expression and handling of data related to our manpower utilization. We routinely collect and have stored in a computer an extensive data base which

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reflects, on a dynamic basis, our manpower utilization. Rather than relying on this data, your auditors chose to use a questionnaire which relies on memory for completion. We believe our data is more accurate and expressed in a form more easily understood. We have included pertinent information from our data in the enclosure to this letter.

A second area of disagreement is the importance of information supplied by licensee and contractor workmen. We were interested in your technique of questioning workers but the significance of its outcome was small as a function of the effort needed to collect the information. The GAO on site audit consisting of interviews with construction craftsmen and review of areas previously inspected by NRC inspectors was estimated by the NRC to have required 33 man weeks of effort. (NRC followup of concerns raised by GAO required an estimated additional 46 man weeks of on site effort.) A total of 4 items of noncompliance were identified related to the GAO audit. The average rate of identification of noncompliance by inspectors in the routine IE construction program is 0.8 items per man week on site which means that the effort applied to the GAO audit would have resulted in identification of approximately 63 items of noncompliance if applied under the existing program. Although we do not see value in extensive use of the technique used by your auditors, we acknowledge its value in certain situations. We will assess incorporation of the technique when appropriate. As you know, the NRC has been concerned about increasing its accessibility to workers. Responding to this concern, we have identified our inspectors by distinctive apparel, requested licensees to post at construction sites instructions on how the NRC can be contacted, and listed our telephone numbers in local directories. We continue to see ways to open channels of communication from concerned workers and citizens.

A third area of some disagreement are your comments on documentation and reporting. Because of manpower limitations, we do not believe the most effective use of our manpower is to construct a detailed, "audit trail" as a part of our documentation. The backup documentation maintained by your auditors was impressive and we are reviewing our position on maintenance of field notes by inspectors and on reporting. However, we have responded to a 1972 GAO Audit criticism to reduce our reporting efforts in order to conserve inspector resources and we intend to move more carefully into any changes which will shift more inspector time to documentation. We share with you the belief that

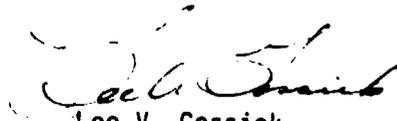
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the inspector is most effective when on site inspecting and we exert considerable discipline to limit the time devoted to documentation. We are concerned with what you have characterized as errors and inattention to detail in our documentation. Although we disagree with the significance of these, we will examine ways to improve the quality of our documentation.

As an enclosure to this letter, we are providing detailed comments explaining our areas of disagreement and clarifying several points raised in your report. Again, we are gratified by your endorsement of our basic approach to inspection. Notwithstanding some specific disagreements, we are pleased that both your efforts and ours have identified many of the same areas for improvement.

Sincerely,



Lee V. Gossick
Executive Director
for Operations

Enclosure:
Comments on Draft Report*

*GAO note--We have deleted NRC's enclosure because, in our view, it provided only further elaboration of the points raised in its letter.

PRINCIPAL OFFICIALS
RESPONSIBLE FOR ADMINISTERING ACTIVITIES
DISCUSSED IN THIS REPORT

Tenure of office
From To

NUCLEAR REGULATORY COMMISSION

CHAIRMAN:

Joseph M. Hendrie	Aug. 1977	Present
Marcus A. Rowden	Apr. 1976	June 1977
William A. Anders	Jan. 1975	Apr. 1976

EXECUTIVE DIRECTOR FOR OPERATIONS:

Lee V. Gossick	Jan. 1975	Present
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DIRECTOR OF INSPECTION AND ENFORCEMENT:

John Davis (Acting)	July 1978	Present
Ernst Volgenau	Apr. 1976	July 1978
John G. Davis (Acting)	Jan. 1976	Apr. 1976
Donald F. Knuth	Jan. 1975	Jan. 1976