119709 2288

BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To Senator John Glenn

RES... released outside the General ... approval

RELEASED

Actions Being Taken To Help Reduce Occupational Radiation Exposure At Commercial Nuclear Powerplants

Workers who operate and maintain commercial nuclear powerplants are exposed to low doses of radiation. Although exposures to individual workers have remained relatively constant, the total dose received by all nuclear powerplant workers has increased dramatically during the history of nuclear powerplant operations.

This report identifies the extent of the occupational exposure increase and examines (1) the causes for the increase, (2) the potential impacts of this increase, and (3) Federal and industry efforts to reduce occupational exposures. Because many of these efforts have only been recently implemented or are still in the developmental stage, it is too early to determine how effective these actions will be. Nevertheless, GAO believes that the actions taken or planned to date are a step in the right direction.

UNITED STATES GENERAL ACCOUNTING OFFICE

119709

GAO/EMD-82-91
AUGUST 24, 1982

523203

Request for copies of GAO reports should be sent to:

U.S. General Accounting Office
Document Handling and Information
Services Facility
P.O. Box 6015
Gaithersburg, Md. 20760

Telephone (202) 275-6241

The first five copies of individual reports are free of charge. Additional copies of bound audit reports are $3.25 each. Additional copies of unbound report (i.e., letter reports) and most other publications are $1.00 each. There will be a 25% discount on all orders for 100 or more copies mailed to a single address. Sales orders must be prepaid on a cash, check, or money order basis. Check should be made out to the "Superintendent of Documents".

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

ENERGY AND MINERALS DIVISION

B-208425

The Honorable John Glenn
Unites States Senate

Dear Senator Glenn:

This report is in response to your request that we provide you with information on increases in occupational radiation exposures that are occurring at commercial nuclear powerplants. This report focuses on the extent of the occupational exposure increase, its causes, and what is being done to reduce these exposures. In addition, we also discuss the potential future impact as a result.

As arranged with your office, no further distribution of this report will be made until 7 days from the date of the report. At that time, we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

GENERAL ACCOUNTING OFFICE REPORT
TO THE HONORABLE JOHN GLENN
UNITED STATES SENATE

ACTIONS BEING TAKEN TO HELP REDUCE OCCUPATIONAL RADIATION EXPOSURE AT COMMERCIAL NUCLEAR POWERPLANTS

D I G E S T

Workers who operate and maintain commercial nuclear powerplants are exposed to low doses of radiation. However, the health effects are not clear because the scientific community has not been able to show a clear cause-effect relationship. Because the health effects are not known, coupled with the knowledge that certain radiation effects are irreversible and cumulative, the scientific community assumes there is no threshold below which there is no risk and urges that any exposure to radiation be kept to the lowest possible level.

Concerned over the effect increasing exposures could have on the future availability of reactor technicians and the possibility of rising risks for some nuclear workers, Senator John Glenn requested that GAO examine the problem and provide answers to the following questions:

--To what extent have radiation exposures increased for reactor employees? Although exposures to individual workers have remained relatively constant, the collective dose--the total dose received by all nuclear powerplant workers--has increased dramatically. Individual exposures have not increased because operators of nuclear powerplants have, as a standard practice, restricted doses to individual workers by adding more workers, and exposing each worker for only a short period of time. From 1969 to 1980, the number of workers exposed per reactor has increased approximately eightfold. Thus, individual exposures have been maintained well below the regulatory limit. The collective dose, on the other hand, has increased substantially rising from 1,247

GAO/EMD-82-91
AUGUST 24, 1982

man-rems 1/ in 1969 to 53,796 man-rems in 1980. While some of this increase is due, in part, to an increase in the number of reactors, the average collective dose per reactor rose from 178 man-rems in 1969 to 791 man-rems in 1980--a fourfold increase. (See pp. 5 and 6.)

--What are the causes for this increase? Based on discussions with agency and industry officials, GAO identified a number of factors affecting occupational exposures, three of which have clearly contributed to the increase. These are (1) increased radiation levels and maintenance due to plant age, (2) modifications required by the Nuclear Regulatory Commission (NRC) to correct identified safety problems, and (3) unanticipated premature failure of major plant components. Other, less tangible factors that also appear to have contributed to the increase are (1) the use of less experienced workers and (2) nuclear plant management's attitude toward radiological safety. (See pp. 6 to 10.)

--What are the potential impacts? GAO believes the most likely impact would be increased exposures for highly skilled technical workers who are hired on a temporary basis to perform major maintenance and modifications when the plant is shut down. Because the practice of adding more workers to keep individual exposures down relies on an adequate supply of workers being available to replace those already exposed, individual exposures could increase should worker supply fall short of demand. Temporary workers in highly skilled technical positions require a great deal of training and will be the hardest to replace and the most likely affected should shortages occur. However, because licensees have restricted exposures to levels well below the regulatory limit,

---

1/A rem is a unit of dose of radiation which produces the same biological effect as a unit of absorbed dose of ordinary x-rays. The term man-rem is used by NRC to show the sum of doses to a group of people rather than the dose to one person.

individual exposures would have to increase about 7 times before contributing to any worker supply shortages. (See pp. 10 to 12.)

--What is the Federal role in dealing with the problem? GAO found that many of the efforts to reduce the collective dose began after the 1979 accident at the Three Mile Island Nuclear powerplant. Prior to that, NRC and the nuclear industry paid little attention to the collective dose and its increases. However, NRC, utilities, and industry groups have recently initiated a number of actions to improve control over and reduce occupational radiation exposures, including the collective dose. The Department of Energy (DOE), which is responsible for dose reduction research and development, is currently undergoing a reassessment of what its role should be. (See pp. 13 to 19.)

Because many actions to better control, or reduce, exposures have only been implemented in recent years, and because some efforts are still in the developmental stage and have not yet been fully implemented, it is too early to determine how effective these actions will be. Due to the number of factors affecting occupational exposures, it is also difficult to say whether any one action will reduce exposures. Nevertheless, GAO believes the actions taken or planned to date are a step in the right direction.

AGENCY COMMENTS AND GAO'S EVALUATION

Both NRC and DOE generally agreed with this report. DOE's comments were primarily focused around two points. First, DOE believed GAO's discussion of steam generator problems in pressurized water reactors should be balanced against other major component failures contributing to high exposures in boiling water reactors. Where appropriate, changes were made to reflect this concern. Second, DOE officials commenting on this report disagreed that DOE's dose reduction program was being phased out solely due to cuts in DOE's fiscal year 1982 budget. According to these officials, DOE also decided not to start any new dose reduction projects until completion of its efforts to develop a coordinated program that would satisfy the requirements of the Nuclear Safety Research, Development, and Demonstration

Act. DOE considered it inappropriate to begin any new projects until the safety issues were identified and prioritized.

In all but two instances, NRC's suggested changes were made to improve the technical accuracy of the report. However, GAO disagreed with two of NRC's comments. According to NRC, GAO's statement that little attention has been paid to the collective dose until recently, gives a false impression. While GAO recognizes certain past actions have been directed at collective dose control, past practice has been primarily aimed at controlling individual doses.

In another comment, NRC stated that it does not consider permanent employees of companies such as General Electric and Westinghouse to be transient workers who are hired on a temporary basis to perform major maintenance and modifications at reactor facilities. However in GAO's view, although these workers are permanent employees of a specific company, when they perform work under contract at more than one reactor facility within one calendar year, they meet NRC's definition of a transient worker. Further, it is the licensee, not the employer, who is responsible for assuring these workers' exposures stay within the regulatory limit.

Contents

ABBREVIATIONS

AIF	Atomic Industrial Forum
DOE	Department of Energy
EPRI	Electric Power Research Institute
GAO	General Accounting Office
INPO	Institute of Nuclear Power Operations
NRC	Nuclear Regulatory Commission

CHAPTER 1

INTRODUCTION

The Nuclear Regulatory Commission (NRC) is responsible for licensing and regulating commercial nuclear powerplants and for assuring that nuclear powerplant operators protect workers from radiological hazards. Many workers who operate and maintain nuclear powerplants are exposed to low doses of radiation. However, the health effects of exposure to low doses are not clear because the scientific community has been unable to show a clear cause-effect relationship. Because the health effects of low doses are not known, coupled with the knowledge that certain radiation effects are irreversible and cumulative, the scientific community assumes that there is no threshold below which there is no risk and, therefore, strongly recommends that every effort be made to reduce exposures to the lowest possible level. 1/

Occupational radiation exposure to powerplant workers is defined in terms of individual dose and collective dose. The individual dose is the amount of radiation received by each worker. The collective dose is the total amount of radiation received by all workers at a particular powerplant and/or for the industry as a whole. Information on the average individual dose and the collective dose is determined by using annual exposure data provided to NRC by powerplant licensees.

NRC requires its licensees--nuclear powerplant operators--to monitor occupational radiation exposures and ensure individual exposures remain within established limits. Current radiation exposure standards for workers over the age of 18 limit exposure to 1.25 rems 2/ per quarter, resulting in an annual limit of 5 rems. Under certain conditions, however, a worker may receive higher exposures as long as the worker's average exposure does not exceed 5 rem per year. 3/

NRC requirements also state that licensees should abide by an operating philosophy that maintains occupational exposures to levels that are as low as reasonably achievable. However, since what constitutes reasonably achievable is subject to individual judgment, NRC in 1973 issued a regulatory guide to help licensees meet this requirement.

1/"Implications of Commission Recommendations that Doses Be Kept as Low as Readily Achievable," International Council on Radiation Protection, Publication 22, 1973.

2/A rem is a unit of dose of radiation which produces the same biological effect as a unit of absorbed dose of ordinary x-rays.

3/Licensees are not permitted to allow persons under 18 years of age to receive a dose in excess of 10 percent of the quarterly limits. Further, in determining a worker's average annual dose, only the exposures received over the age of 18 are averaged.

While the individual dose has remained relatively constant and generally well below regulatory limits, the collective dose has steadily increased during the history of nuclear powerplant operations and has increased at a rate four times faster than the number of operating reactors. The continual rise in the collective dose and the March 1979 accident at the Three Mile Island nuclear powerplant raised serious questions over the adequacy of radiation protection programs at nuclear power facilities. As a result, Federal agencies and the nuclear industry have become increasingly concerned about this trend and have begun to take actions and plan to take other actions to upgrade licensee radiation protection programs and to strengthen efforts to keep exposures as low as reasonably achievable.

OBJECTIVES, SCOPE, AND METHODOLOGY

In an October 7, 1981, letter, Senator John Glenn expressed concern over indications that occupational exposures were increasing and the effect this trend could have on the future availability of nuclear reactor technicians and the possibility of rising risks for some nuclear workers. Specifically, we were requested to

--document the increase in radiation exposures for reactor employees,

--ascertain the cause and extent of the increase,

--comment on potential impacts of the increase, and

--comment on the Federal role in dealing with this problem.

Because the nuclear industry is also taking actions to reduce radiation exposures, an additional objective was to identify and comment on industry efforts in this area.

Our review was performed in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions." In performing our review, we talked to officials responsible for collecting exposure data, evaluating radiation protection programs, establishing radiation protection standards and criteria, and managing dose reduction research and development at the following organizations:

--NRC Headquarters, Bethesda, Maryland.

--NRC Region II, Atlanta, Georgia.

--Environmental Protection Agency, Crystal City, Virginia.

--Department of Energy (DOE), Germantown, Maryland.

We also visited 6 utilities operating 20 of the Nation's 73 nuclear powerplants to obtain their views on the causes and impacts of increasing exposures as well as the Federal role in dealing with the problem. These were

--Georgia Power, Atlanta, Georgia;

--Florida Power and Light Company, Miami, Florida;

--Baltimore Gas and Electric, Calvert County, Maryland;

--Virginia Electric and Power Company, Richmond, Virginia;

--Tennessee Valley Authority, Chattanooga, Tennessee; and

--Carolina Power and Light Company, Raleigh, North Carolina.

We selected these utilities because they had powerplants reporting both low as well as relatively high collective doses and because they were representative of both pressurized water reactors and boiling water reactors--the two reactor types in use by the commercial nuclear industry.

Finally, we obtained studies from and interviewed officials of the following industry groups involved in activities dealing with occupational radiation exposure:

--Atomic Industrial Forum, Washington, D.C.

--Institute of Nuclear Power Operations, Atlanta, Georgia.

--Electric Power Research Institute, Palo Alto, California.

To determine the extent of occupational exposure increases, we examined NRC's compilation and analysis of licensee-reported exposure data. We found it to be a useful indicator of general industry trends concerning occupational exposures and used it as the basis for much of our analysis. To determine the accuracy of the NRC data, we examined NRC reporting requirements and discussed reporting practices with several officials at the six utilities we visited. We also examined studies on occupational radiation exposure at nuclear power facilities performed by NRC, DOE, the Atomic Industrial Forum, and the Electric Power Research Institute.

Through discussions with Federal and industry officials, we identified recent actions to better control or reduce occupational exposures as well as those that were underway or planned. In most cases, we obtained planning documents, internal papers on proposed actions, and reports that provided detailed discussions on actions planned and the results of actions already completed.

Finally, in evaluating the potential for adverse impacts due to rising exposures, we also examined (1) current NRC and industry requirements and practices for controlling exposures to all nuclear powerplant workers and (2) staffing studies performed by DOE and the Institute of Nuclear Power Operations to identify any future worker supply problems. In addition, we identified Federal and industry efforts to evaluate and prevent worker shortages in the future to determine what, if anything, was being done to address this problem.

CHAPTER 2

OCCUPATIONAL EXPOSURES--

CAUSES AND POTENTIAL IMPACT

OF INCREASES

Although exposures to individual workers have remained well below the regulatory limit, the collective dose for all nuclear powerplant workers has increased over the years of commercial nuclear powerplant operation. However, because exposures are affected by many different factors and vary widely from plant to plant, there is no simple answer to why the collective dose is increasing. Nevertheless, we identified a number of factors affecting occupational exposures, some of which have clearly contributed to the collective dose increase.

Utilities, on the other hand, have avoided increasing individual exposures by adding more workers and exposing each worker for a shorter period of time. This practice, however, relies on an adequate supply of workers being available when needed. As new plants are licensed to operate, the nuclear power industry is going to need additional workers to safely operate and maintain these plants. At this time, it is uncertain whether enough workers can be hired and trained, particularly in certain highly skilled professions, to safely operate and maintain future plants. If worker supply should fall short of demand, utilities may not be able to maintain low individual exposures by adding more workers. As a result, exposures to individual workers--particularly those in highly skilled technical positions--could increase.

INDIVIDUAL EXPOSURES HAVE NOT INCREASED ALONG WITH THE COLLECTIVE DOSE

Exposure data, reported to NRC by powerplant licensees, reveals that since 1969, individual exposures have remained relatively constant, with the average annual dose per worker ranging between .60 and 1.02 rems or well below the average annual exposure of 5 rem permitted by NRC regulation. For example, in 1980, 99.5 percent of the workers exposed received annual doses of less than 5 rems, with 76 percent receiving less than 1 rem. Utilities have maintained individual exposures to such low levels by substantially increasing the number of workers exposed to radiation. Since 1969, the number of workers exposed per reactor increased approximately eightfold--rising from an estimated 149 in 1969 to 1,128 in 1980--with the total number of workers exposed to radiation increasing from an estimated 744 to 76,706 during the same period.

The collective dose, on the other hand, has increased substantially, from 1,247 man-rems 1/ reported for all nuclear powerplants licensed to operate in 1969 to 53,796 man-rems in 1980. Some of this increase is due to an increase in the number of operating reactors with 7 commercial reactors licensed to operate in 1969 as compared to 68 in 1980. However, the increase in the collective dose cannot be attributed solely to this as the average collective dose per reactor rose from 178 man-rems in 1969 to 791 man-rems in 1980--a fourfold increase.

FACTORS CONTRIBUTING TO OCCUPATIONAL EXPOSURE INCREASES

Because most occupational radiation exposure data management systems have been directed at recording and tracking doses received by individuals, only a limited amount of data is available that relates exposures to specific activities. As a result, the task of identifying causes for the collective dose increase for the nuclear industry as a whole is very difficult because it has not been fully documented. Further complicating the situation is the fact that occupational radiation exposures vary widely not only from plant to plant but also from year to year at individual plants.

Nevertheless, based on discussions with agency and industry officials, as well as a review of available studies, we were able to identify many of the factors affecting occupational exposures, three of which have clearly contributed to the increase. These are

--increased radiation levels and maintenance due to plant age,

--modifications required by NRC after the plant is operating to correct identified safety problems, and

--unanticipated premature failure of major plant components.

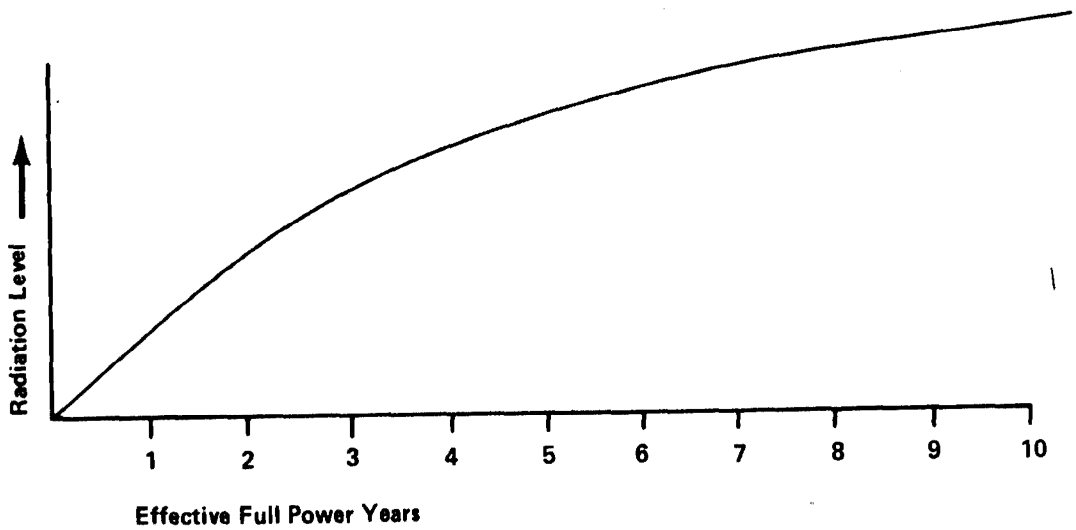
Other, less tangible factors that also appear to have contributed to the increase are (1) the necessity to use less experienced workers who, because they cannot complete the work as quickly as more experienced workers, receive higher exposures for a given task and (2) nuclear plant management's attitude toward radiological safety.

1/The term man-rem is used by NRC to show the sum of doses to a group of people rather than the dose to one person.

Radiation levels and maintenance increase with plant age

As a nuclear powerplant gets older, radiation levels at the plant increase. This occurs because radioactive corrosion products accumulate within the reactor system in pipes, pumps, valves, and heat exchangers. As shown below, radiation levels grow rapidly during the first few years of operation. After 4 to 6 years, this rate of growth declines. Shown below is a simplified radiation growth curve demonstrating how radiation levels increase in a typical commercial nuclear powerplant over the years.

Growth in Radiation Levels



Source: Management Study of Light Water Reactor Radiation Exposure, prepared for DOE by Catalytic, Inc., Sept. 1980.

Growth of occupational exposures at a nuclear powerplant follows the same curve. As corrosion products accumulate and radiation levels increase, exposures for many jobs also increase. Although studies have shown that after the first few years of operation corrosion buildup increases at a slower rate, more maintenance work is typically required as plants increase in age. Thus, exposures tend to continue to increase as the plant ages.

NRC-required modifications often cause exposures to increase

NRC often requires licensees of operating nuclear powerplants to backfit design changes based on advances learned through research efforts and plant operating experience. When workers perform these modifications in high radiation areas of the plant, a signficant increase in the overall collective dose can result. For example, NRC required licensees to perform modifications to improve fire protection at each nuclear facility because of a fire at the Browns Ferry nuclear plant. Such modifications expose workers to radiation that they would not have received otherwise. For example, at the Robinson nuclear plant in South Carolina a specific fire protection modification added over 600 man-rems of exposure to the collective dose in 1980.

In another example, potential problems with the containment design of existing boiling water reactors were identified during safety reviews. Subsequent testing indicated that the safety margins at existing reactor units were not as great as originally anticipated. As a result, NRC required licensees to perform modifications to restore the containment structure to originally envisioned safety margins. This work has to be performed in a radiation area and has caused increases in occupational exposures. For example, at Georgia Power's Hatch nuclear facility, workers received approximately 400 man-rems of additonal exposure in 1981 from such modifications.

Following the accident at the Three Mile Island nuclear facility in March 1979, NRC required licensees to immediately perform a number of actions to improve the safety of nuclear powerplants. Many of these actions have caused occupational exposures to increase. In addition, a number of actions were recommended for either near- or long-term implementation. NRC expects these modifications to also result in increased exposures during the next few years.

Major component failures have contributed to occupational exposure increases

Unanticipated premature failure of major components is another major contributor to occupational exposure increases.

These include steam generator failures in pressurized water reactors as well as cracking of major components in the reactor coolant system in boiling water reactors.

The largest single contributor to exposure in pressurized water reactors is steam generator maintenance and repair. In a pressurized water reactor, the primary coolant water is heated by circulating through the reactor core and is kept under sufficient pressure to prevent boiling. The water then passes through tubes to heat the secondary coolant water circulating around the tubes. The water in the secondary system is allowed to boil and produce steam to drive the turbine generators. The assembly in which the transfer takes place is the steam generator. The tubes within the steam generator are an integral part of the reactor coolant system, keeping the radioactive primary coolant in a closed system sealed off from the environment. When these tubes develop leaks, radioactivity enters the secondary system where it could escape to the environment. Thus, damaged tubes must be repaired.

Due to an unanticipated number of leaks in steam generator tubing, licensees have had to perform extensive repair and maintenance at a number of facilities. At some facilities, entire steam generators have had to be replaced. Steam generator repair and replacement results in high occupational exposures because of the high radiation levels associated with this type of work.

Problems with steam generators are the result of a combination of improper design and poor operating practices. Although the industry has identified some of the design and operational practices that led to steam generator failures, NRC expects these failures to continue, but perhaps at a slower rate due to operational improvements. However, all plants with pressurized water reactors scheduled to receive an operating license before 1984 will have steam generators similar to those currently in service.

In boiling water reactors, a number of major components in the reactor coolant system have developed cracks resulting from stress and corrosion. Because crack growth in these components could lead to reduction in design safety margins, licensees with boiling water reactors inspect and repair affected components when the reactor is shut down for refueling. Repair of these components can result in major increases in occupational exposures because of the high radiation levels in the work areas and the length of time required to perform the necessary work. Despite industry efforts to solve this problem, cracking incidents continue to occur.

Intangible factors

Other factors which are difficult to define and even harder to quantify deal with people. For example, a worker who knows his job well is generally more proficient and can do it faster than one who does not. Because the less experienced worker generally takes longer to perform the same task than the more experienced, proficient worker, the exposure for that worker is higher--the longer the exposure time, the higher the exposure. Thus, the practice of adding more workers to perform tasks in high radiation areas in order to keep individual exposures down often results in using workers that are qualified but have less experience. In addition, as more workers are added to a task, the collective dose increases simply because more people are exposed during nonproductive periods as they approach the job, as they become oriented, and as they withdraw from the work site. Not only does this practice serve to increase the collective dose, it also conflicts with an operating philosophy of maintaining the collective dose as low as reasonably achievable. According to NRC's regulatory guide, restricting individual doses to a fraction of the limit is inappropriate if more people are exposed and the collective dose at a powerplant increases.

Attitudes can also affect exposures. For example, an NRC evaluation of licensee radiation protection programs (discussed more fully on p. 14) showed that when management failed to demonstrate a continuing concern for proper radiological work practices, workers often adopted similar attitudes. In the past, such experiences have resulted in several individual overexposures. Further, weaknesses in the area of radiation protection organization and management were identified at approximately one-third of the facilities appraised. NRC believes that the single greatest cause for these weaknesses was generally poor attitude toward radiological safety. According to NRC, nuclear plant management often considered the radiation protection group more of a routine service organization rather than a radiation support function integrated into the fabric of overall plant operations. As a result, funding, staffing, and management backing were frequently provided at the minimum level.

EXPOSURES COULD INCREASE FOR HIGHLY SKILLED TEMPORARY WORKERS SHOULD WORKER SUPPLY FALL SHORT OF DEMAND

The nuclear industry is going to face a difficult challenge in the future obtaining an adequate number of workers to safely operate and maintain present and future powerplants. A survey conducted by the Institute of Nuclear Power Operations projects that approximately 41,000 additional permanent employees will be needed to operate the Nation's nuclear power facilities through 1991. Both DOE and the nuclear industry believe that attainment of this personnel level will only be achieved through a concerted effort on the part of the nuclear industry. These projections, however, only consider the number of employees needed for normal operations and do not include the vast number of employees hired on a temporary basis to perform major maintenance and modifications when the plant is shut down. In 1980 temporary workers 1/ received almost two-thirds of the collective dose from all nuclear powerplant operations.

The typical nuclear powerplant operates with a core of permanent employees retained directly by the utility. In a large plant with a capacity of over 1,000 megawatts, for example, the core of workers could consist of about 250 permanent employees, such as managers, operators, quality assurance personnel, welders, and electricians. Periodically, powerplants must be shut down for refueling. At this time, utilities perform major maintenance work, special repairs, and modify systems and equipment. To perform these tasks, several hundred to a thousand temporary workers are brought in to ensure individual exposures are kept well below regulatory limits.

The most mobile of the temporary workers are referred to as transient workers. A transient worker is one who begins and terminates two or more periods of employment with at least two different reactor facilities within one calendar year. Many transient workers are in highly skilled professions which are of limited supply and frequent demand by a number of employers. In addition, many of these workers fall into technical employee categories which require the greatest amount of training and represent the group most difficult to recruit, such as master welders and electronics technicians. According to NRC exposure data, transient workers already receive higher exposures than that received by the average worker. For example, NRC's evaluation of 1980 exposure data for transient workers shows that:

--The average annual dose per transient worker is about 1.0 rem, while for nuclear workers in general it is only 0.67 rem.

--The average annual dose per transient worker tends to increase as the number of facilities where the worker was employed increases. For example, the average dose per worker employed by two licensees in 1980 was 0.89 rem while the average dose for workers employed by 4 or more licensees was 1.69 rems.

Although exposures to transient workers are higher than for other nuclear workers, exposures have remained well within the average annual exposure of 5 rems permitted by NRC regulation. Thus, experience to date does not indicate a cause for alarm. However, the practice of controlling individual doses by adding more people and exposing each worker for a short period of time

---

1/Temporary workers are all workers other than those hired directly by nuclear powerplants on a conventional, long-term basis.

relies on an adequate supply of workers being available to replace those already exposed. Because many transient workers are difficult to recruit and are already of limited supply and in frequent demand by a number of utilities, these workers could be faced with an even greater demand for their skills as the number of nuclear powerplants increases, and thus even greater exposures should future shortages occur.

Such a practice could also serve to aggravate and contribute to a worker supply shortage should one occur. However, this is likely to happen only if individual exposures started approaching the 5 rem limit. Because licensees have restricted exposures to levels well below the limit, individual exposures would have to increase on the average about 7 times before this would occur. In addition, licensees could also limit exposures by implementing design and operational changes as discussed more fully in chapter 3.

CHAPTER 3

RECENT EFFORTS TO REDUCE OCCUPATIONAL RADIATION EXPOSURE

Since the 1979 accident at the Three Mile Island nuclear powerplant, NRC and the nuclear industry have paid greater attention to the increase in the collective dose. Both NRC and the nuclear industry have begun efforts to improve control and reduce occupational radiation exposure. Also, DOE is in the process of developing a program, mandated by law, to develop practical improvements in the generic safety of nuclear powerplants--including radiation dose reduction. Because most efforts have only recently been implemented or are still under development, it is too early to determine the impact of these actions on occupational radiation exposure.

NRC EFFORTS TO IMPROVE OCCUPATIONAL RADIATION PROTECTION

NRC has recently taken or plans to take several actions to address concerns over increases in occupational radiation exposure. Specifically, NRC has

--proposed procedures that would require that occupational exposures be considered whenever new generic safety requirements are under development,

--appraised the radiation protection programs of all facilities with operating reactors and recommended improvements, and

--plans to amend its regulations to require licensees to develop radiation protection plans which would include more effective measures for maintaining occupational radiation exposures as low as reasonably achievable.

NRC also has a number of research projects that it believes will lead to reductions in occupational exposures.

NRC proposes review of occupational exposure when issuing new requirements

In response to a growing concern throughout the nuclear industry over possible negative safety impacts caused by the number and scope of new NRC requirements being imposed, NRC established the Generic Requirements Review Committee to review generic safety requirements 1/ proposed by the NRC staff. This Committee was

---

1/A generic requirement applies to one or more classes of reactors.

established because (1) new requirements were being issued from different organizations within NRC, (2) these organizations were not coordinating among each other, and (3) no single organization within NRC had the authority to review and prioritize new requirements to ensure appropriate attention was given to those issues most important to safety.

One of the objectives in establishing the Committee was to reduce the exposure of workers to radiation when licensees implement new requirements. For each generic requirement under consideration, an assessment of any increases or decreases in occupational exposures must be included for the Committee's review. This requirement should better assure that NRC does not overlook occupational exposures when imposing new requirements on licensees.

<u>NRC has recommended specific improvements in licensee radiation protection programs</u>

In an effort to determine whether the radiation protection programs at nuclear power facilities needed to be upgraded, in 1980 NRC initiated an evaluation of the adequacy and effectiveness of licensee radiation protection programs at each facility. This effort was a major deviation from past NRC inspection efforts where it simply audited discrete subject areas of licensee radiation protection programs to determine whether they complied with specific regulatory requirements. Instead, NRC established teams to comprehensively evaluate the total radiation protection program, emphasizing capability and performance rather than compliance with regulations. NRC considered this approach necessary, since merely meeting the explicit regulatory requirements did not necessarily ensure an adequate and effective program.

NRC's major findings were that few licensee radiation protection programs met the high standards of excellence expected of nuclear power facilities, and that the single greatest cause for weaknesses was a lack of management support resulting in minimal funding and staffing for radiation protection at those facilities. NRC made a number of recommendations for correcting significant deficiencies identified as a result of the appraisal reviews at individual facilities. During regularly scheduled inspections, performed by the regional offices, NRC inspectors are to follow-up to assure these corrective actions are taken.

According to NRC officials at Region II, all licensees for that region had been reinspected and had either corrected the identified deficiencies or had taken initial steps to correct problems requiring longer term action. In addition, according to radiation protection officials at the Florida Power and Light Company, management attention and support for radiation protection had increased as a result of NRC's appraisal at that facility.

NRC plans to modify regulations to require radiation protection plans

To further reduce the risk to workers from radiation exposure, NRC plans to modify its regulations to require licensees to develop, document, and implement a radiation protection plan that would include effective measures for maintaining occupational exposures as low as reasonably achievable. The proposed rule change is not only intended to strengthen efforts performed by the licensee to maintain occupational exposures as low as reasonably achievable, but should also strengthen NRC's ability to enforce licensee implementation of the concept by requiring a documented plan that it can inspect against.

NRC research efforts to reduce occupational exposures

NRC also has a number of research projects for occupational radiation protection. NRC believes that these projects will lead to significant dose reductions. The projects include studies of: the formation, transport, and deposition of radioactive corrosion products in reactor systems; the effectiveness of decontamination for removal of such corrosion products; the radioactive waste treatment and disposal problems created by decontamination; handling techniques for packaged radioactive waste; the use of low-maintenance equipment in reactor systems; and incentives to reduce the collective dose.

INDUSTRY EFFORTS TO REDUCE OCCUPATIONAL RADIATION EXPOSURE

Individual utilities and industry groups have also taken steps to better control occupational radiation exposures. Although maintaining individual exposures as low as reasonably achievable has been a practice for many years, utilities have paid little attention to the collective dose. However, in recent years, utilities have become more concerned over collective dose increases and have recently taken or planned actions to better control and reduce collective doses.

All six of the utilities we visited had either taken or planned actions to formalize programs and improve their capability to maintain exposures as low as reasonably achievable. These actions included: setting up committees to review tasks and identify areas where exposures could be reduced, assigning specific people dedicated to maintaining doses as low as reasonably achievable, and, in one instance, a total revamping of a radiation protection program. At some facilities, licensees informed us that they were already experiencing reductions in exposures for some routine tasks.

These utilities also had efforts underway to track doses by individual tasks performed. For example, those that did not have the computer capability for tracking occupational exposures by individual tasks were in the process of developing that capability. Improved capability for recording exposures by system, job, and component is necessary to identify and track exposures of significant activities to determine specific causes for exposures and to ultimately reduce them. Most utilities have not done this in the past.

Utilities and reactor vendors are also continuing to evaluate areas where improvements can be made in the design and operation of steam generators. Although the industry has already identified and corrected some of the design deficiencies that led to tube failures and have made certain operational improvements, NRC expects tube failures to continue for the immediate future and expects them to continue to cause an increased total dose to workers because of increased inspection requirements and associated repair efforts.

In addition to actions taken by individual utilities, we also found that independent, non-profit industry groups are also taking steps to address the occupational exposure problem including the (1) Atomic Industrial Forum (AIF), (2) Electric Power Research Institute, (EPRI) and (3) Institute of Nuclear Power Operations (INPO).

AIF, a nonprofit organization that provides for cooperation in resolving problems relating to nuclear power, has performed a number of studies on occupational radiation exposures to identify ways, from an engineering standpoint, to reduce exposures. Specifically, they have evaluated and published reports on

--occupational exposure experience at commercial nuclear powerplants.

--economic effects of reducing individual exposures, and

--engineering design modifications for reducing exposures.

AIF currently has a study underway to provide better information on the exposure experience of temporary workers, and it is also looking at the feasibility of a computerized recordkeeping system that would enhance the nuclear power industry's ability to exchange exposure information on transient employees.

EPRI, as the research arm of the utility industry, looks at the whole question of power generation, including the question of health effects. Since its inception, in 1975, EPRI has supported research projects aimed at reducing occupational radiation exposure. These research projects emphasize methods for reducing the buildup of radiation levels within the plant itself.

INPO is dedicated to promoting safety in nuclear powerplants from an operational standpoint. In late 1980, it began focusing on radiation protection to bring all plant radiation protection practices up to the highest standards. Specifically, INPO

--evaluates and recommends improvements in utility radiological protection programs,

--develops job qualification and performance standards and evaluation methods,

--promotes an exchange of information between utilities on "best practices" in radiation protection, and

--assists utilities in maintaining the best radiological protection practices.

INPO's accomplishments to date include the development of

--radiation protection performance objectives and criteria,

--guidelines for general employee training and education,

--training qualification criteria for radiological protection technicians, and

--a Radiological Experience Notebook describing "good practices" being performed within the industry.

INPO has also reviewed the radiation protection programs at all nuclear facilities and recommended improvements. INPO plans to review utility programs about once every 15 months and has already begun its second round of evaluations. Its criteria for controlling radiation exposures includes controlling exposures associated with specific tasks through preplanning and scheduling of work to ensure the lowest possible radiation exposure and the assignment of job goals for exposures.

INPO is also establishing an accreditation program for industry training activities. This program will include training for radiological protection technicians and is intended to help assure other plant personnel are properly trained in radiological protection matters. And, finally, INPO is working closely with the utilities to help ensure that staffing requirements are met for each nuclear plant and for the industry as a whole.

DOE IS REEVALUATING ITS SUPPORT OF RADIATION DOSE REDUCTION RESEARCH AND DEVELOPMENT

Under the Nuclear Safety Research, Development, and Demonstration Act (P.L. 96-567), passed by the Congress in 1980, DOE must establish a research, development, and demonstration program for developing practical improvements in the generic safety of nuclear powerplants. Specifically, the act requires DOE to include in its program efforts directed at a number of specific objectives, including developing changes in the design and operation of nuclear powerplants to reduce radiation exposure to workers.

To carry out the objectives of the act, DOE is currently in the process of identifying and prioritizing the appropriate DOE research and development role for each of the specific safety areas identified in the act. To do this, DOE has established a working group for each area to

--define the issues,

--determine what is required to resolve the issues,

--identify and review accomplishments and any ongoing work in the area,

--determine what yet needs to be done, and

--develop a coordinated program.

DOE's goal is to identify and support those safety areas that have the highest potential payoff for improving light water reactor safety. DOE plans to complete its evaluation later this year.

In the past, DOE has funded a number of research projects to develop and demonstrate new technology and improved maintenance and operational practices that would reduce occupational radiation exposures. Until fiscal year 1982, DOE had a specific program supporting radiation dose reduction research and development with the objective of reducing occupational exposures by 50 percent by 1990. However, according to DOE officials, due to reductions in DOE's fiscal year 1982 budget, DOE began phasing out its dose reduction research and development program. At that time, DOE decided to attempt to complete existing projects and not start any new dose reduction research and development efforts. In commenting on our report, DOE officials also told us that DOE considers it inappropriate to start any new dose reduction projects until DOE completed its identification and prioritization of the safety issues involved and developed a coordinated program to meet the requirements of the Nuclear Safety Research, Development, and Demonstration Act. Thus, the extent to which DOE will support dose reduction research and development in the future will depend on its prioritization of the safety issues identified in the act and available funding.

In addition, DOE has assisted the nuclear power industry in tackling the staffing problem by funding and participating in a comprehensive, three-part staffing study to

--quantify current staffing and future needs for powerplant operations,

--investigate the sources of staff supplies, and

--identify competing areas of demand.

This project should be completed before the end of 1982.

CHAPTER 4

OBSERVATIONS, CONCLUSIONS,

AND AGENCY COMMENTS

OBSERVATIONS AND CONCLUSIONS

Protecting workers from radiological exposure is a vital national concern. Thus, NRC requires powerplant operators to monitor occupational radiation exposures and ensure that exposures are within regulatory limits. NRC regulations also state that licensees should maintain exposures as low as reasonably achievable. While individual exposures have, for the most part, been kept well below the regulatory limit, the collective dose has dramatically increased. The average collective dose per reactor rose from 178 man-rems in 1969 to 791 man-rems in 1980--a fourfold increase. Keeping individual exposures down, however, has been achieved by adding more workers and exposing each worker for only a short period of time, causing the average number of workers exposed per reactor to increase eightfold between 1969 and 1980.

There is no simple answer to why the collective dose is increasing because occupational radiation exposure data has not been recorded and tracked by specific tasks, and because exposures are affected by many factors. However, three factors have clearly contributed to increases in occupational exposures:

--Increased radiation levels and maintenance due to plant age.

--Modifications required by NRC to correct safety problems.

--Premature failure of major plant components.

In addition, the utility practice of spreading exposures over more workers results in a higher collective dose than would occur otherwise because the less experienced worker takes more time to do required operational and maintenance activities and as more workers are added to a task, more people are exposed during nonproductive periods. Finally, based on an NRC analysis, the single greatest cause for weaknesses identified in the area of radiation protection organization and management was generally poor attitude toward radiological safety which resulted in utilities providing inadequate staff resources and management support. Such resources and support are critical if occupational exposures are to be kept as low as reasonably achievable.

In the future, more workers will be needed to operate and maintain additional powerplants that will come on line. Many of these workers that will be needed are in highly skilled technical areas which are already in short supply. If a shortage occurs, utilities will no longer be able to follow the practice of adding more workers to keep individual exposures down. Thus, individual exposures could increase--particularly for workers in highly skilled technical positions--unless other actions are taken to reduce exposures.

Since individual exposures are currently well below regulatory limits, utilities could increase individual exposures on the average about 7 times before exceeding the limits. This, however, would be inconsistent with (1) the scientific community's assumption that there is no threshhold below which there is no risk and (2) NRC's requirement that licensees should maintain exposures as low as reasonably achievable. However, as individual exposures approach the 5 rem limit and if a worker shortage were to continue, the utilities' ability to adequately carry out operational and maintenance activities would be adversely affected.

The rising collective dose and the potential impact are not going unnoticed by the Federal Government and the nuclear industry. As the collective dose has continued to climb over the years, both the Federal Government and the nuclear industry have begun efforts to improve control of, and reduce, occupational radiation exposures. NRC actions are aimed at strengthening radiation protection at the facility level as well as providing a mechanism for assuring occupational exposures are evaluated when imposing new requirements on licensees. DOE, on the other hand, is in the process of developing a program, mandated by law, to develop practical improvements in the generic safety of nuclear powerplants--including reducing radiation exposure to workers. Because DOE's goal is to identify and support those safety areas that have the highest potential payoff, DOE's role is uncertain until this study is completed.

Individual utilities and private industry groups have also started to take a number of steps to address the exposure problem. All six of the utilities we visited were beginning to improve their ability to track exposures related to specific tasks as well as evaluate these tasks to determine ways exposures could be reduced. In addition, a number of independent, industry groups are looking into the causes of, and methods to reduce, occupational exposures. Improvements are being examined from an operational, as well as an engineering standpoint. Industry efforts are also underway to evaluate and recommend improvements in individual utility radiation protection programs and to promote a free exchange of information on good practices being used within the industry.

Because increases in the collective dose have received little attention in the past, actions to better control, or reduce, exposures have only been implemented in recent years. Many of these efforts are still in the developmental stage and have not yet been implemented. As a result, it is too early to determine how effective these actions will be. Further, due to the number of factors affecting occupational exposures, it is difficult to say whether any one action will reduce exposures. Nevertheless, we believe the actions taken or planned to date are a step in the right direction.

AGENCY COMMENTS AND OUR EVALUATION

Both NRC and DOE commented on our report. DOE provided verbal comments and NRC provided formal written comments which are included in appendix I of this report. In general, NRC's and DOE's comments were of a technical nature and, where appropriate, we made changes to improve the technical quality of this report.

DOE's comments reflected concerns in two specific areas. One of these dealt with our discussion of steam generators as being the single largest contributor to exposures at pressurized water reactors. DOE officials felt that this section gave the impression that exposures are higher at plants with pressurized water reactors when in fact they are not. These officials pointed out that there are also failures in major components in boiling water reactors that are contributing to increases in occupational radiation exposure. As a result, we changed our report, accordingly, to recognize DOE's comments concerning boiling water reactors.

DOE officials commenting on our report also did not agree with our observation that the dose reduction research and development program was phased out solely as a result of cuts in DOE's fiscal year 1982 budget. At this time, we were told that DOE decided not to start any new dose reduction projects until they finished developing a coordinated program that would meet the requirements of the Nuclear Safety Research, Development, and Demonstration Act. In the absence of issue identification and prioritization, DOE considered it inappropriate to begin any new projects. These commments are reflected in the body of the report.

In all instances but two, we made NRC's suggested changes to improve the technical accuracy of our report. However, we disagreed with NRC on two points.

According to NRC, our comment that, until recently, little attention has been paid to the collective dose at nuclear powerplants gives a false impression. In support of this belief, NRC provides information on earlier regulatory guides and actions recognizing the importance of collective doses. While we recognize that certain past actions have been directed at collective dose control, in our discussions with agency and industry officials, we found that, until recently, attention has been primarily focused on controlling individual doses. In addition, the limited data relating exposures to specific tasks is further evidence of the lack of attention to collective dose control in day-to-day operations at nuclear power facilities.

In another comment, NRC stated that,

> "The highly-skilled workers that go from plant to plant during outages and who receive the larger doses, are not hired on a temporary basis. They are permanent employees of companies like General Electric and Westinghouse, among others. The transient workers, hired on a temporary basis, usually are not highly-skilled and normally are limited to 1.25 rems per quarter."

However, according to NRC's own definition, a transient worker is one who begins and terminates two or more periods of employment with at least two different reactor facilities within one calendar year. Employees of companies, such as General Electric and Westinghouse, working at two or more reactor facilities in one calendar year fall under this definition. Further, it is the licensee not the employer, who is responsible for assuring these worker's exposures stay within the regulatory limit. During our review, we found that these workers, along with other highly skilled technical workers, are included in NRC's analysis of transient workers discussed in its annual report on "Occupational Radiation Exposure at Commercial Nuclear Reactors." In addition, according to NRC and industry officials, these employee's skills are in demand by a number of utilities, and as a result, they are among those receiving some of the highest exposures.

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

JUL 16 1982

Mr. J. Dexter Peach, Director
Energy and Minerals Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Peach:

We have reviewed the General Accounting Office draft report, "Will Federal and Industry Efforts Help Reduce Occupational Radiation Exposure at Commercial Nuclear Power Plants?", as requested in your letter to Chairman Palladino dated June 18, 1982. We have identified a few statements in the report that should be corrected, and in an attachment to this letter we have provided our comments for your consideration.

Sincerely,

William J. Dircks
Executive Director
for Operations

Enclosure:
NRC Staff Comments

Nuclear Regulatory Commission Staff Comments on the General Accounting Office Draft Report, "Will Federal and Industry Efforts Help Reduce Occupational Radiation Exposures at Commercial Nuclear Power Plants?":

1. On page 1, the report states that the NRC is responsible for assuring that power plant workers are protected from radiological hazards. It would be more accurate to state that the NRC is "responsible for ...providing regulations and controls which, when properly implemented by licensees, will assure that power plant workers are protected from radiological hazards.

2. On pages 1 and 24, the report states that "...the scientific community takes the conservative approach of assuming that there is no threshold below which the risk is acceptable..." This statement is not correct. The approach taken by the scientific community, as represented by the International Commission on Radiological Protection (ICRP), is concerned with a threshold for radiation effects rather than a threshold for acceptable risks. A basic assumption of the ICRP regarding radiation doses in the occupational range is the existence of "a linear relationship without threshold between dose and the probability of effect" (ICRP-26, paragraph 27). It does not follow that there is no threshold below which the risk is acceptable. The risks associated with doses below regulatory limits are considered acceptable even though the probability of effect is not zero.

3. On page 6, the report indicates that NRC regulations contain an annual whole-body dose limit for workers and that this limit is 5 rems. (Previously, on page 1, the report states that the standard is 1.25 rems per quarter, which results in an annual limit of 5 rems.) This is an incomplete account of NRC requirements which, we believe, could lead to a false impression. NRC quarterly dose limits appear in 10 CFR Part 20, Section 20.101. No annual limits are given. Workers are allowed to receive up to 1.25 rems per calendar quarter, with no restrictions on the lifetime accumulated dose. However, workers are allowed to receive up to 3 rems per calendar quarter, provided that the lifetime accumulated dose is controlled; specifically, the average annual dose cannot exceed 5 rems. The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5(N-18) rems where "N" equals the individual's age in years at his last birthday. Section 20.104 of 10 CFR Part 20 limits the quarterly exposure of minors, individuals under 18 years of age, to 10 percent of the limits specified in Section 20.101 of 10 CFR Part 20.

4. On pages i, 1, and 2, references are made to keeping radiation exposures to the lowest possible level. Terminology of this nature is usually avoided because it is possible to reduce occupational exposures by unacceptably large expenditure of funds. The terminology normally employed is "as low as is reasonably achievable," which takes costs into consideration.

5. On pages iii and 25 of the report, a statement is made which indicates that "little" attention has been paid to the collective dose at nuclear power plants until recently. While it is true that the collective dose problem is now receiving more attention than in the past when the problem was less evident, considerable attention has been paid to the collective dose problem for some time. For example, Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achieveable," was first issued in July 1973; and Regulatory Guide 8.19, "Occupational Radiation Dose Assessment in LWR Power Plants, Design Stage

Man-rem Estimates," was first issued in May 1978. Both of these guides are concerned with collective dose control. These guides and subsequent revisions have been used in the evaluation of construction permit and operating license applications since their inception. Implementation of the guidance in newly designed plants has involved a considerable effort by both industry and the NRC. Since new plants have been designed and built using the guidance in Regulatory Guides 8.8 and 8.19, we expect that the collective doses will be lower than earlier plants of similar size, which were built without the benefit of such guidance.

Also, in recognition of the importance of collective doses, the NRC, in 1969, amended 10 CFR Part 20 to require reactor licensees to provide annual reports of collective dose. In 1974, Regulatory Guide 1.16, "Reporting of Operating Information-Appendix A Technical Specifications," was issued to establish a standard format for reporting collective dose by job function and work classification. These annual reports have been analyzed by the staff for use in focusing regulatory attention on work areas where collective doses are higher.

In recognition of the effect that in-service-inspection (ISI) had on increasing collective doses, we established, in early 1978, a system for use by NRC staff in balancing ISI safety improvements against collective worker dose. In addition during the 1970's, NRC staff interacted with industrial representatives, particularly representatives of the Atomic Industrial Forum (AIF) and the Electric Power Research Institute (EPRI), to encourage efforts to reduce radioactive corrosion product buildups and thus reduce the major sources of worker doses.

Thus, we believe that the adjective "little" as used in this connection leaves a false impression. We suggest that the sentence, on both pages, be revised as follows: Recently, greater attention has been paid to reducing the collective dose.

6. On page 1, the report indicates that new employees are allowed to receive only approximately 0.3 rem per quarter until the licensee receives their occupational dose histories. This practice is not required by the NRC, nor is it recommended in any NRC regulatory guide. NRC regulations permit a quarterly dose of 1.25 rems even though the worker's exposure history is unknown. After the history is obtained, the worker may receive up to 3 rems per quarter provided that the acccumulated lifetime occupational dose does not exceed an average of 5 rems per year. Some licensees voluntarily impose more restrictive dose limits. If administrative limits of this nature are referenced in the report, they should be identified as such.

7. On page 10, a statement is made that "... work has to be performed in a "high radiation area...". The term "high radiation area" is specifically defined in 10 CFR Part 20.202 as any area having radiation levels high enough that a worker could receive in any one hour, a dose in excess of 100 mrem. Only a fraction of the required containment structure modification work is performed in high radiation areas. We suggest deleting the word "high".

8. On pages 11, 23, and 24, there are references to an NRC "requirement" that occupational exposures be maintained as low as is reasonable achievable (ALARA). In 10 CFR Part 20, Section 20.1.c, it is stated that licensees should maintain exposures ALARA. This statement is considered to be hortatory rather than prescriptive. It is not referred to by the NRC staff as a requirement.

9. On page 12, there is an indication that "transient workers hired on a temporary basis" are among the highly-skilled workers in limited supply who may be called upon to accept higher individual doses. It appears that there may be a misconception here. The highly-skilled workers that go from plant to plant during outages and who receive the larger doses, are not hired on a temporary basis. They are permanent employees of companies like General Electric and Westinghouse, among others. The transient workers, hired on a temporary basis, usually are not highly-skilled and normally are limited to 1.25 rems per quarter.

10. On page 13, there is a statement that utilities redesign systems and equipment while the plants are shut down for refueling. In general, the designs are performed well before shutdown. We suggest "modify" rather than "redesign".

11. On page 15, the section entitled "NRC Efforts to Improve Occupational Radiation Protection" does not mention the NRC research projects for occupational radiation protection. We believe these projects will lead to significant dose reductions. The projects include studies of: the formation, transport, and deposition of radioactive corrosion products in reactor systems; the effectiveness of decontamination for removal of such corrosion products; the radioactive waste treatment and disposal problems created by decontamination; handling techniques for packaged radioactive waste; the use of low-maintenance equipment in reactor systems; and incentives to reduce the collective dose.

12. On page 16, the following sentence appears:

"In an effort to upgrade radiation protection at all nuclear power facilities, in 1980 NRC evaluated the adequacy and effectiveness of licensee radiation protection programs at each facility."

The actual purpose of this appraisal program was to determine whether upgrading was needed.

13. On page 23, the words identified by underlining below should be added to the third sentence:

"While individual exposures have, <u>for the most part</u>, been kept well below the regulatory limit..."

14. On page 23, after the first sentence in the final paragraph additional statements should be added which explain that higher collective doses associated with the use of extra workers are not always the result of higher individual doses to inexperienced personnel. When crew changes are required because of radiation, the workers are exposed as they approach the job, as they become oriented, and as they withdraw from the work site. This extra dose is called, "nonproductive" because no progress is made on the task while dose is being received by workers. While it is obviously true that inexperienced workers would also increase the

collective dose, in general, it is not true that they are allowed to receive higher doses.

15. On page 23, in reference to the NRC health physics appraisal of the nuclear power plants, the final paragraph mentions adequate staff resources and support for radiation safety as critical to maintaining occupational exposures ALARA. The paragraph fails to mention the very important finding that the responsibility for radiation protection at these plants often is not clearly assigned to line management. We believe this problem to be as critical as staff resources, if not more so; and we suggest that it be included.

APPENDIX II

United States Senate

COMMITTEE ON
GOVERNMENTAL AFFAIRS
SUBCOMMITTEE ON ENERGY, NUCLEAR
PROLIFERATION AND GOVERNMENT PROCESSES
WASHINGTON, D.C. 20510

October 7, 1981

Mr. J. Dexter Peach
Director, Energy and
Minerals Division
U.S. General Accounting Office
441 G Street
Washington, D.C. 20548

Dear Mr. Peach:

As a result of information I have received concerning both the United States and foreign countries, I have become concerned about the levels of radiation received by workers at commercial nuclear power plants.

I am specifically concerned because of indications that occupation exposures have increased 20 to 40 percent over each of the past several years. During that period, only one commercial nuclear power plant was brought on line. Thus, this obviously does not provide an explanation. Several discussions have led me to believe that such increases may have resulted from unanticipated maintenance due to the premature aging of the power plants. The effect of this trend may be devastating on the future availability of reactor technicians with possibly rising risks for temporary workers whose previous radiation exposure histories may not be well documented.

Consequently, I would like you to provide me with information related to this matter. Specifically, I am requesting that you document this increase in radiation exposures for reactor employees and ascertain the cause of the increase and the extent of the problem. I am also requesting your comments concerning the potential impacts and implications of this increase, as well as the federal role in dealing with this problem.

I would greatly appreciate receiving a report on this matter in early 1982. If you or your staff have any questions or need any clarification, please contact Dr. Leonard Weiss at 224-4508.

Sincerely,

John Glenn

JG/lwp
(301576)

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE,$300

POSTAGE AND FEES PAID
U. S. GENERAL ACCOUNTING OFFICE

U.S.MAIL

THIRD CLASS