I. INTRODUCTION

The Systematic Assessment of Licensee Performance (SALP) program is an integrated NRC staff effort to collect available observations and data on a periodic basis and to evaluate licensee performance based upon this information. The SALP program is supplemental to normal regulatory processes used to determine compliance with NRC rules and regulations. The SALP program is intended to be sufficiently diagnostic to provide a rational basis for allocating NRC resources and to provide meaningful guidance to licensee management to promote quality and safety of plant construction and operation.

An NRC SALP Board, composed of the staff members listed below, met on December 15, 1987, to review the collection of performance observations and data to assess licensee performance in accordance with the guidance in NRC Manual Chapter 0516, "Systematic Assessment of Licensee Performance" A summary of the guidance and evaluation criteria is provided in Section II of this report.

This report is the NRC staff's assessment of licensee's safety performance at St. Lucie facility for the period May 1, 1986, through October 31, 1987.

SALP Board for St. Lucie Units 1 and 2

L. A. Reyes, (Chairman) Director, Division of Reactor Projects (DRP), RII

E. W. Merschoff, Deputy Director, Division of Reactor Safety (DRS), RII

W. E. Cline, Chief, Nuclear Materials Safety and Safeguards Branch, Division of Radiation Safety and Safeguards (DRSS), RII

B. A. Wilson, Chief, Reactor Projects Branch 2, DRP, RII

H. N. Berkow, Director, Project Directorate II-2, Division of Reactor Projects, NRR

E. Tourigny, Project Manager, Project Directorate II-2, NRR

R. Crlenjak, Senior Resident Inspector, St. Lucie, DRP, RII

Attendees at SALP Board Meeting:

H. O. Christensen, Project Engineer, Reactor Projects Section, 2B (RP2B), DRP, RII

M. A. Scott, Project Engineer, RP2B, DRP, RII

H. Bibb, Resident Inspector, St. Lucie, DRP, RII

T. C. MacArthur, Radiation Specialist, Technical Support Staff (TSS), DRP, RII

P. M. Madden, Reactor Engineer, TSS, DRP, RII

II. CRITERIA

Licensee performance is assessed in selected functional areas depending on whether the facility has been in the construction, preoperational, or operating phase during the SLAP review period. Each functional area normally represents an area which is significant to nuclear safety and the environment and which is a normal programmatic area. Some functional areas may not be assessed because of little or no licensee activity or lack of meaningful NRC observations. Special areas may be added to highlight significant observations.

One or more of the following evaluation criteria was used to assess each functional areas; however, the NRC Staff is not limited to these criteria and others may have been used where appropriate.

A. Management involvement in assuring quality
B. Approach to the resolution of technical issues from a safety standpoint
C. Responsiveness to NRC initiatives
D. Enforcement history
E. Operational and construction events (including response to, analysis of, and corrective actions for)
F. Staffing (including management)
G. Training and qualification effectiveness

Based upon the SALP Board assessment, each functional area evaluated is classified into one of three performance categories. The definitions of these performance categories are:

Category 1: Reduced NRC attention may be appropriate. Licensee management attention and involvement are aggressive and oriented toward nuclear safety; licensee resources are ample and effectively used such that a high level of performance with respect to operational safety or construction quality is being achieved.

Category 2: NRC attention should be maintained at normal levels. Licensee management attention and involvement are evident and are concerned with nuclear safety; licensee resources are adequate and are reasonably effective such that satisfactory performance with respect to operational safety or construction quality is being achieved.

Category 3: Both NRC and licensee attention should be increased. Licensee management attention or involvement is acceptable and considers nuclear safety, but weaknesses are evident; licensee resources appear to be strained or not effectively used such that minimally satisfactory performance with respect to operational safety or construction quality is being achieved.

The functional area being evaluated may have some attributes that would place the evaluation in Category 1, and others that would place it in wither Category 2 or 3. The final rating for each functional area is a composite of the attributes tempered with the judgement of NRC management as to the significance of individual items.

The SALP may also include an appraisal of the performance trend of a functional area. This performance trend will only be used when both a definite trend of performance within the evaluation period is discernable and the staff believes that continuation of the trend may result in a change of performance level. The trend, if used, is defined as:

Improving: Licensee performance was determined to be improving near the close of the assessment period.

Declining: Licensee performance was determined to be declining near the close of the assessment period.

III. SUMMARY OF RESULTS

A. St. Lucie continues to perform as one of the top sites in the region. This is evident by the consistent FPL staff enthusiasm and effort shown at St. Lucie. Program development, such as the Quality Improvement Program, contributions in Operations, Maintenance and Training have demonstrated continued plant staff and management involvement in safety issues. No major weaknesses were identified.

A procedure upgrade program which is a carry-over from the previous SALP period and which is discussed in the operations section of this report has yet to be fully implemented and should warrent a hard look by the licensee. On the opposite side of the coin, radiological control efforts discussed in the outage section of this report show consistent initiative on the part of the licensee even though these efforts were tinged by a inadequate procedure problem with the upper guide structure.

The Staff expressed concern over the number of reactor trips caused by personnel error, approximately half. It is encouraging that the licensee is taking positive steps to solve this problem by establishing a QIP team and by stressing attention to details with the plant staff.

B. The performance categories for the current and previous SALP periods in each functional area are as follows:

Functional Area	November 1, 1984 - April 30, 1986	May 1, 1986 - October 31, 1987
Plant Operations	1	1
Radiological Controls	2	2
Maintenance	1	1
Surveillance	1	1
Fire Protection	2	Not-Rated
Emergency Preparedness	2	1
Security and Safeguards	2	2
Outages	2	1
Quality Programs and Administrative Controls Affecting Quality	2	1
Licensing Activities	1	1
Training and Qualification Effectiveness	1	1

IV. Performance Analysis

A. Plant Operations

1. Analysis

During the evaluation period, inspections were performed by the resident and regional inspection staffs.

Management involvement in daily activities continues at the high levels indicated in the previous evaluation period. The position of Site Vice President (VP), established in the previous evaluation period, has evolved into the pivot point for coordinating site needs. The Plant Manager has been relieved of some of the burdens, such as budget considerations and purchasing, so that he may devote more attention to plant operational priorities, both from a safety and production standpoint. Additionally, the Site VP position has strengthened the communications link between the NRC resident staff and the

licensee. This has resulted, from a resident inspector perspective, in the licensee's heightened responsiveness to NRC initiatives and timely resolution of safety issues.

Overall, the licensee's management involvement has consistently produced evidence of prior planning and assignment of priorities. Although decision making is consistently at levels that ensure adequate management review, the licensee has excelled in encouraging involvement and input from all individuals within the plant organization. This has resulted in an organization which has achieved a cohesiveness and team spirit capable of identifying problems and producing effective corrective actions. A corporate program which has nurtured the concept of teamwork and effectively solved several plant problems is the Quality Improvement Program (QIP). Significant examples of QIP team solutions which have resulted in improved plant safety are; (1) identifying the root cause of failure of several safety related breakers, (2) proposing and implementing a solution to the problem of excessive plant trips (discussed later), and (3) identifying and implementing repairs of several reactor coolant system (RCS) combined leaks which resulted in unidentified leakage >1.0 gallon per minute (gpm). Corporate management has been involved in site activities, when required. The plant, however, has had the necessary expertise on-site and been very good at independently solving most problems.

Plant generation performance has continued at the high levels established previously. According to recent industry publications, as of June 30, 1987, St. Lucie unit 1 ranked number 11, highest ranked United States (US) plant in the world and unit 2 ranked number 83. For 1986, St. Lucie unit 1 capacity factor, at 99.42 percent, was ranked as the number 1 Combustion Engineering Corporation (CE) plant and the number 4 plant in the world overall. Unit 2 was ranked number 3 for CE plants with a capacity factor of 86.82 percent.

The plant has defined procedures for control of activities and procedures and policies are rarely violated. Generally, the licensee's performance in the areas of procedural adequacy and compliance for most of this period has been very good. However, on occasion there have been problems in the adequacy of some plant procedures and/or failure to follow procedures. Of the seven examples, (two minor) cited in this area, two examples (item nos. a.1. and d.2) of inadequate procedures, four examples (item nos. a.2, c., d.1 and e.) of failure to follow procedures and one example of a TS violation (item b.), most involve procedural problems. Of the two examples of inadequate procedures, both had a combination of elements involving failure to have adequate procedures and failure to follow the available procedures. Two examples (items a.2 and c.) of failure to

follow procedures could fit in the maintenance area. However, since these examples are connected to overall violations in the operations area, they have been listed in this area. In general, major violations are rare, minor violations are not indicative of a programmatic breakdown.

The licensee has recognized that certain procedural areas require upgrading. As described in the previous SALP evaluation, licensee management attention has been directed toward improving procedures by establishing a site Procedures Department. This has been considered a positive initiative on the part of the licensee. Emergency procedures were rewritten during the previous evaluation. Although off-normal and annunciator response procedures were being upgraded at the end of the last SALP period, they have not yet been completed. Due to a shifting of procedure review priorities and the licensee not yet fully staffing the procedures department, reviews of operating procedures have not yet started. Because of identified problems with health physics (HP) procedures, the licensee placed a priority on reviewing/improving HP procedures, causing the slippage of other procedure reviews. Additionally, the site Quality Assurance organization has become more directly involved in day to day plant operations, another positive initiative, and has spotlighted the need for improved plant procedures, particularly with the balance-of-plant (BOP). Several examples (items a.1 and d.2) of violations deal with BOP systems. In summary, the licensee has targeted procedures for review and improvement. However, they have shifted their priorities of procedure improvement to other areas. Because of this, they have not moved aggressively in improving procedures in some of the identified weak areas such as BOP. The licensee should reevaluate their schedule and the allocation of resources for completing the needed reviews.

Because of the higher than average number of reactor trips on unit 2 during the last SALP evaluation period and the SALP board comments of concern in this area, the licensee implemented programs to reduce the number of reactor trips during the current period. For unit 1, there were eight reactor trips and five actuations of the engineered safety features (ESF); three of the trips were at power levels greater than 85 percent, For unit 2, there were six reactor trips and two ESF actuations; four of the trips were at power levels greater than 85 percent. Overall, of the trips greater than 85 percent, for both units, approximately half were due to personnel error and half to equipment failure. Of the six trips below 85 percent power, two were due to equipment failure and four due to personnel error. Two of the personnel error trips were directly related to the difficulties associated with manual feedwater control at power levels below 20 percent power. The previous SALP period trip

data indicated a larger percentage of the total trips attributed to low power feedwater control problems. The total number of trips (both units) was reduced from 19 to 14 overall, with a significant improvement achieved in reducing the low power trips. Management attention has been directed to eliminating the low power trips due to feedwater control. By placing additional emphasis on attention to detail during plant startup and establishing a QIP team to analyze and recommend solutions to the low power trip problem, the licensee has made a significant improvement in this area. Due to the QIP team efforts, an automatic low power feedwater control system was proposed and installed on unit 1 during the Spring 87 outage. No low power feedwater trips have been experienced on unit 1 since the modification. The same modification was installed on unit 2 during the Fall 1987 refueling outage and the unit returned to power successfully with no low power trips.

Most unit trips are now attributable to about half personnel error and half equipment failure. In order to reduce the total number of trips, the licensee has shifted the focus to these weaknesses. To limit trips caused by personnel error, licensee management has increased the administrative controls associated with performing surveillance and maintenance activities during unit operation. These controls include restrictions on when certain tasks are scheduled and performed, with further consideration on whether certain evolutions can be performed during times when the plant is at less or no risk of a trip. Additionally, the administrative requirements for review and approval of jumpers/lifted leads installation and verification have been expanded and improved.

Overall, the licensee has performed well during this SALP period. This is not to imply that the facility has not experienced problems. However, the licensee has performed in an above average manner when dealing with various non-routine plant problems. Management usually provides the appropriate levels of experience and competence to assure viable solutions, with proper safety emphasis, to these problems. The techniques utilized in approaching these problems can be attributed, at least in part, to the licensee's Quality Improvement Program (QIP). Several problems in which the QIP concept was utilized in finding solutions have been discussed previously in this section, They are examples of where teamwork, a major licensee attribute, was utilized to set and achieve their own realistic goals and reach the goals set by others. Additionally, because of the licensee's aggressiveness in identifying, proposing and implementing prompt and effective corrective actions, and achieving technically sound results without repeat nonconformances, several violations were not cited (in accordance with 10 CFR 2, Appendix C, V.A) against the

facility during this SALP period. One example of a violation not cited was a failure to maintain two operable redundent loops for component cooling water (CCW). Because of the potential for escalated enforcement an enforcement conference was held at the St. Lucie site. As a result of the licensee's self identification of the problem, their prompt and effective corrective actions, their engineering review of safety significance, and their candid and open review in "facing the facts" and presenting those facts to the NRC this violation was not cited. These aggressive licensee actions, along with prompt reporting, resulted in the licensee achieving enhanced safety while being recognized by NRC for performing as expected in identifying and correcting problems and nonconformances. Other positive initiatives and accomplishments made through QIP have been a reduction in lost time accidents from seven in 1986 to three as of October 31, 1987, and an effective plant material condition and cleanliness improvement program which includes weekly tours by the Plant Manager and representatives from all plant departments. This has contributed to a noticeable improvement in plant material condition and cleanliness.

Conduct of operations in the control room continued to be excellent. Any identified minor lapses in control room demeanor were quickly corrected by licensee management. Observations by the resident inspectors have shown shift turnovers to be adequate. Questions by inspectors were, with few exceptions, satisfactorily addressed on subjects such as; alarm conditions, plant and system status, technical specification (TS) and limiting conditions for operations (LCO). Procedures for annunciator responses and TS requirements for LCO's were consistently followed. The control rooms were always adequately staffed with an appropriate combination of knowledge and experience. To the credit of plant management, the licensee has continued to delegate responsibilities, to lower levels within the plant's management structure. This has resulted in certain operational issues and management decisions being made at the Nuclear Plant Supervisor (NPS) and assistant (ANPS) levels. Additionally, management efficiency and operator morale has been enhanced. The continued use of the plant morning meeting, which is chaired by the NPS, has proven to be a major positive contributor to overall management effectiveness. Plant status of both units, planned evolutions and problems are discussed. This meeting is one easily identified element, within the plant management structure, which has been successful in bringing all departments within the plant to support each other and, more importantly, the operations department and plant operations.

In summary, senior plant management has promoted throughout the plant organization, including the lower level supervisory positions, well defined authorities and responsibilities. This

has resulted in an organization, with few exceptions, made up of responsible individuals who are held accountable by management.

Five violations were identified:

a. Severity Level IV violation for failure to establish/implement procedures:

1. Resulting in incorrect valve descriptions and positions in the procedure and misalignment of three valves in the unit 1 condensate and feedwater system. (335/86-18)

2. On July 11, 1986, the resident inspector noted that a Plant Work Order (PWO) had not been issued for a deficiency on a plant system (190 foot wind direction remote instrument) which had been identified in the plant "out-of-service" log on July 9.

b. Severity Level IV violation for failure to take grab samples required by TS when the fuel handling building exhaust ventilation radiation monitor was rendered inoperable. (335/87-10)

c. Severity Level IV violation for failure to implement a procedure requiring a PWO, use of the "Jumper/Lifted Lead Request Log" and "Out of Service Log." (335/87-10)

d. Severity Level IV violation (PROPOSED) for failure to establish/implement procedures:

1. While performing a lift of the unit 2 in-core instrumentation plate while reassembling the reactor vessel internals. (389/87-20)

2. While electrically realigning the unit 1 condensate pumps. (335/87-21)

e. Severity Level V violation for failure to implement procedures requiring unit 2 containment elevator fan power supply to be de-energized during power operations. (389/86-19)

2. Conclusion

Category: 1

3. Recommendations

NONE

B. Radiological Controls

1. Analysis

During the assessment period, inspections were performed by the resident and regional inspection staffs in the areas of occupational exposure control, control of radioactive materials and wastes, shipment of radioactive materials, and liquid and gaseous effluent releases.

The licensee's health physics, chemistry, and radioactive waste staffing levels were adequate and compared favorably with other utilities having a facility of similar design, rating and age. A sufficient number of ANSI qualified licensee health physics and chemistry technicians were available to support routine operations. During outage operations, additional contract health physics technicians were employed to supplement the permanent plant staff. The performance of the health physics staff in support of routine and outage operations was satisfactory. A low turnover rate in the staff has resulted in a more experienced group of individuals. The overall quality and experience level of the health physics staff is a program strength.

The licensee's health physics technician and general employee radiation protection training programs were adequate. The technician training program was accredited by the Institute for Nuclear Power Operations (INPO) during the assessment period.

Due to problems noted during two previous SALP assessment periods, the NRC determined that the site health physics procedures were inadequate. The licensee therefore initiated efforts to improve the facility's radiation protection program with emphasis on revising the health physics procedures currently being used and developing a hot particle reduction and control program at the plant. The procedure revision program is scheduled to be completed by the end of 1987. The hot particle reduction and control program has led to the elimination of the onsite dry cleaning process for laundering used protective clothing and additional emphasis on and training of personnel concerning the hot particle problem. This program has not yet produced an appreciable reduction in the number of personnel contaminations resulting from hot particles.

During the assessment period, licensee management support of and involvement in the radiation protection program was good. This is evidenced by the support received for the procedure revision program and the support received by Health Physics from other groups to reduce the total area in both units that is maintained under contamination controls. Also, members of management have

been involved sufficiently early in outage preparation to permit adequate planning of the work and allow more consideration of ALARA-related issues.

Subsequent to the identification of problems in the transportation area during the previous SALP period, the licensee initiated improvements in the facility's transportation program. Previous deficiencies were remedied but during this assessment period the licensee was again cited for problems dealing with transportation. A violation, (a) below was issued for failure to perform radiation level surveys on the bottoms of transport vehicles. In a related area, preparation of waste for shipment, another violation, (b) was also issued to the licensee for failure to meet the structural stability and minimum volume of liquid in waste requirements and failure to implement an adequate Quality Control (QC) program for waste characterization. This event occurred due to the licensee's failure to perform an evaluation or verify vendor actions to ensure that the sludge contained in a metal liner was adequately mixed and solidified with cement. The licensee is continuing efforts to improve the transportation and waste preparation programs.

Management attention in the area of keeping exposures as low as reasonably achievable (ALARA) was increased and the total accumulated exposure per unit for 1986 was 234 person-rem compared to the goal of 270. This figure is well below the pressurized water reactor (PWR) national average of 397 person-rem. However, two outages have been scheduled for 1987 with an annual goal set at 442 person-rem per unit. As a result of outage related work, through October 30, 1987, 318 person-rem has been expended per unit. Based on the projected workload through the end of the year, the licensee will likely exceed the PWR national average, but not the established goal.

During 1986, 227 personnel contamination events were recorded including 176 skin and 83 clothing contaminations. The number of personnel contamination events increased sharply in 1987 and through October 30, a total of 477 events had been reported including 277 skin and 200 clothing contaminations. The increase was due to the two outages which occurred in 1987, with 306 contaminations attributed to the unit 1 outage and 106 contaminations to the unit 2 outage through October 30, 1987. During periods of non-outage activity, the licensee averaged approximately 10 contamination events per month as compared with approximately 100 contamination events per month during outage periods.

The licensee submitted the required radiological effluent and environmental reports. There were no unplanned radioactive liquid or gaseous releases during 1986 or from January - June 1987. Although radioactive gaseous releases of fission and activation products were higher than any other Region II PWR facility during 1986, it was observed that the gaseous releases during 1986 (4.33 E+4 curies) were 28% lower than in 1985 (6.03 E+4 curies). Approximately 4.96 curies of mixed fission and activation products were released via the liquid effluent pathway during 1986. Although this value was slightly higher than the Region II average for PWRs, it represented an 11% decrease from the previous year. Annual effluent release summaries for 1984-1986 can be found in Section V.K. of this report. The licensee has had in place a liquid waste reduction program. Calculated offsite dose estimates for liquid and gaseous effluents were within the limits prescribed by 10 CFR Part 50, Appendix I and 40 CFR 190. During 1986, the whole-body dose estimate due to liquid releases was approximately one millirem, while the whole body dose estimate due to gaseous releases was less than one millirem. The thyroid dose estimate during 1986 was approximately seven millirem.

The consistently high gaseous effluent releases over a period of several years were caused by a higher than expected rate of fuel cladding perforation in both units. During 1986, most of the gaseous radioactivity had been from unit 1. The licensee has had a program in place to improve the integrity of the fuel by new fuel design and "reconstitution" of fuel assemblies. During the liquid and gaseous radwaste inspection, it was noted that the licensee had discontinued use of the gaseous waste decay tanks. In the FSAR, the licensee calculated average fill and holdup times for the waste gas decay tanks to be on the order of 30 days. In recent practice, the licensee found the fill and holdup times to be on the order of two to four days, primarily as a result of higher than anticipated generation of dissociated gases (hydrogen and oxygen) and system air and gas inleakage. The design volume capacity of the three installed waste gas decay tanks was inadequate to accommodate the volume of waste gas actually generated. Each tank was 144 ft^3 in volume and had a design operating pressure of about 150 psig. The licensee evaluated this situation, determined that the occupational dose would be reduced if the tanks were bypassed, that the dose to the public would not increase significantly if the tanks were bypassed, and therefore chose to operate with the tanks bypassed in most circumstances. A violation was identified during this inspection in that the radwaste operating procedures for unit 1 did not reflect the direct discharge mode of operation.

During this period, the two St. Lucie units had experienced hydriding of the titanium condenser tubes that had resulted in tube plugging and heightened awareness of damage to the steam generators that could occur through inleakage of sea water. Additional steam generator tubes had been plugged as the result of non-chemically related stress and wear problems. During the most recent outages, 100% eddy current testing had been performed. Chemistry control continued to be better than the criteria recommended by the Steam Generator Owners Group. The licensee had actively addressed NRC Notices and Bulletins related to pipe thinning. The licensee also had an active program designed to reduce wastage of carbon steel pipe and transport of corrosion products to the steam generators, but large amounts of sludge are still being removed during outages.

In December 1986, 42,053 square feet of the radiation control area (RCA), or 31.5% of the total RCA of the plant excluding the reactor buildings, were maintained as contaminated. By dedicating plant resources to this problem, the licensee had reduced the contaminated area to 16,550 square feet or 14.7% of the RCA. During the outage in October, that figure increased to approximately 25,000 square feet but the licensee indicated that efforts would be made to reduce that area to at least the pre-outage total.

The licensee disposed of approximately 8,110 cubic feet of solid radioactive waste per unit during 1986 containing a total for both units of 2,135 curies of activity. This was somewhat above the PWR national average of 7,450 cubic feet per unit. The large total disposal volume was due to the licensee's efforts to dispose of accumulated waste from previous outages including the 1983-84 refueling, thermal shield removal and core support barrel repair outage. Through October 1987, the licensee had disposed of 7,166 cubic feet of solid radioactive waste per unit containing a total for both units of 1,090 curies of activity.

Five violations were identified:

a. Severity Level IV violation for failure to perform surveys on the bottom of transport vehicles as required by the Department of Transportation (335/87-04).

b. Severity Level IV violation for failure to implement an adequate QC program for waste characterization and to properly solidify waste (335/87-04).

c. Severity Level V violation for failure to label containers of radioactive material (335/87-04).

d. Severity Level V violation for an inadequate procedure for controlled gaseous release. (335/87-11)

An additional proposed violation was identified during the SALP period. The violation, however, was not issued until after the end of the SALP period and the licensee has not yet responded to the citation.

e. Proposed Severity Level IV violation for failure to adhere to radiological control procedures for personnel contamination monitoring and for failure to properly wear protective clothing as required (335/87-27).

2. Conclusion

Category: 2

3. Recommendations

NONE

C. Maintenance

1. Analysis

During the evaluation period, inspections were performed by the resident and regional inspection staffs.

Licensee management have continued to pursue and achieve above average performance in the plant's maintenance activities. The licensee has taken several paths to meet these goals. During this evaluation period, a new department, Reliability and Maintenance Support, was formed and the QIP approach further developed to become an important element when addressing and solving problems. As in the previous SALP period, no violations were directly attributable to maintenance. However, several plant trips and/or engineered safety feature (ESF) actuations, discussed later, could be traced to either failure to follow procedures or personnel error on the part of maintenance personnel. Additionally, equipment failure has resulted in several plant trips. However, overall performance in the maintenance area has been well above average.

The licensee has continued to focus attention on maintaining the plant work order (PWO) backlog at acceptable levels. The licensee is committed to the INPO guideline that no more than 50 percent of the outstanding PWO's be greater than three months old. The licensee has effectively met this guideline throughout the evaluation period. At the end of the SALP period, for the combined departments of I&C, electrical and mechanical, for trouble and breakdown work, there were 653 outstanding PWO's with 247 being greater than 90 days old. Additionally, to further monitor their overall management of PWO's, the licensee tracks the total number and the age of the PWO's. For the same group of PWOs, the oldest was 17 months old (in the mechanical department).

As mentioned previously in this section and discussed in the operations section, for trips above 85 percent (both units, 7 total), approximately half were due to equipment failure and half to personnel error. In recognition of the equipment failure problems which have resulted in plant trips and other equipment reliability shortcomings, the licensee established a new maintenance group at the beginning of 1987. The new group, Reliability and Maintenance Support, has been tasked with formulating and implementing programs directed toward improved equipment reliability. Previously, the licensee had been tracking systems performance, such as, emergency diesel and auxiliary feedwater, by monitoring unavailable hours and had pursued solutions to specific equipment problems through QIP. However, the licensee felt that a more aggressive and dedicated

role in addressing potential equipment failures, both safety related and non-saftey related, was in order, hence the formation of the new group.

The feed/condensate system, a balance of plant (BOP) system, has been chosen by the group as the initial system for evaluation, because it has historically resulted in plant trips leading to considerable unplanned hours off-line. This is another example of management attention being directed to secondary, BOP, systems. Additionally, the group has assumed the role of investigating major plant problems associated with specific equipment for root cause and recurrence prevention.

As an example, the reliability group combined with a QIP team to analyze the recent problems associated with primary system leakage >1.0 gpm and the apparent failure of two LPSI breakers to close on demand. The formation and active involvement of these teams contributed to timely resolutions, with appropriate emphasis on conservatism, of the problems associated with these examples.

The licensee's commitment to QIP has had, during this period, a positive effect on plant safety. From an NRC perspective, the addition of the reliability group is a positive initiative, taken by the licensee, toward mitigating equipment failures which can have significant negative effects on overall plant performance and safety. The group's priorities are directed toward improved equipment reliability for both safety-related and BOP equipment. The licensee's emphasis on BOP equipment is significant because it is a non-safety-related area. However, this equipment has been involved in a large percentage of the site's total plant trips.

One example, identified previously, which is an indicator of the effectiveness of a dedicated QIP team in solving a plant problem, was the apparent failure of both LPSI pump power supply breakers to close on demand while the unit was preparing to enter mode 4. This failure of both breakers on the described system can, under certain plant conditions, have a major impact on plant safety. Because of these concerns, the licensee quickly formed a QIP team dedicated exclusively to investigating the failures. Over a period of several months, data was accumulated and reviewed by the team and additional testing conducted. Eventually, the team determined the root cause as a faulty resistor connection in one of the breaker's control circuits. All of the most likely failure mechanisms considered initially were, one by one, discarded as invalid. It had been determined earlier that the other LPSI pump's breaker would have functioned had it been challenged. Both the team concept and the tenacity of this particular team deserve credit for

eventually determining the root cause of this example. Additionally, because of the trouble shooting procedure implemented for this problem, a root cause was identified for another related breaker problem associated with the control circuit fuse holders.

To limit the number of trips caused by personnel error, licensee management has increased the administrative controls associated with performing maintenance activities during unit operation. These controls include restrictions on when certain tasks are scheduled and performed. If a maintenance item can be deleted or a preventative maintenance (PM) rescheduled, without having a negative effect on plant safety or performance, to a period when the plant is in a less vulnerable condition, the item is scheduled accordingly. Additionally, the administrative requirements for review and approval of maintenance jumpers/lifted leads installation verification have been expanded and improved.

During the evaluation period, two inspections in the areas of maintenance were performed by the regional inspection staff. Licensee management involvement in maintenance activities appeared to be adequate and decision making was at a level that assured management review. Records were complete, well maintained and available. Key positions were identified, and authorities and responsibilities were defined. A number of weaknesses were identified in the maintenance welding program. Since no code violations were identified and the licensee had identified similar weaknesses and was in the process of improving the program, a violation was not issued.

During the evaluation period two inspections were performed in the electrical area by regional personnel and one inspection was peformed during the previous evaluation period, but was not evaluated until this period, by headquarters based personnel. These inspections were: a team inspection on Environmental Qualification (EQ) of electrical equipment; a special inspection on the Low Pressure Safety Injection (LPSI) pump's failure to start; and a routine inspection to close open items and review the licensee's program with regard to heat shrinkable tubing and limitorque internal wiring. The last two inspections indicated no major problems.

Weaknesses were noted in the EQ program in that concerns identified in the NRC team report and during the inspection period should have been resolved prior to the inspection. The licensee had no documented corporate policy on EQ until just prior to the inspection. In the week prior to the inspection, the licensee issued, for a 90-day trial use, an EQ manual which defined corporate EQ policies. The issuance of these documents

was considered untimely relative to the 10 CFR 50.49 deadline of November 30, 1985.

The license's actions with regard to NRC initiatives, especially during all of the above three inspections, was generally good and timely. The resolution of technical issues from a safety standpoint was generally sound; however, in the EQ area specific examples identified during the EQ inspection indicated a lack of thoroughness or in-depth analysis in establishing the qualification documentation. This includes EQ procurement and maintenance practices and activities. Seven unresolved items in the EQ area are being considered for escalated enforcement. These deficiencies were in the area of unqualified Limitorque wiring, inadequate documentation, and the failure to establish EQ requirements for various equipment.

The staffing of key positions was identified and authority and responsibilities were defined. The staffing in the EQ area was considered adequate.

In summary, the licensee has established a maintenance organization which continues to seek improvements as demonstrated by programs described above and management's attention to detail. The licensee has demonstrated evidence of prior planning and assignment of priorities through programs, such as Short Notice Outage Work (SNOW), which ensures that any backlog of work which requires other than operating plant conditions is scheduled and staged in the event of an unplanned outage. Further, the licensee has demonstrated the ability to manage and assign priorities by establishing and utilizing programs, such as QIP, to ensure management goals of safety and performance are achieved. The managements initial involvement in the EQ area was one noted weakness, which was adequately addressed by the end of the SALP period.

No violations were identified during the evaluation period.

2. Conclusion

Category: 1

3. Recommendations

NONE

D. Surveillance

1. Analysis

During the evaluation period, inspections were performed by the resident and regional inspection staffs. The regional staff

performed inspections of the surveillance testing, calibration control, snubber surveillance and integrated leak rate testing programs which were conducted by Region I inspectors.

Surveillance testing programs appeared effective. Technical Specification (TS) required surveillances were, with few exceptions, completed in a timely manner. No instances of the licensee using out-of-date surveillance procedures were identified. Management involvement in staffing and training for operational surveillances was adequate.

Surveillance scheduling and implementing of procedures can be considered effective. There were four missed surveillances identified during the reporting period. These failures were equally spaced throughout the period and were reported and corrected by the licensee. Although no violations were issued, several could be considered non-conformances, however, they were not cited in accordance with 10 CFR 50, Appendix C., V.A., giving credit to the licensee for self-identification and appropriate corrective actions. Considering the limited number of surveillances missed and the minor safety significance of the items, the NRC considers the findings to be typical in comparison to other Region II facilities. The licensee had, at the beginning of this evaluation period, instituted an upgrading of their surveillance scheduling procedures to correct problems, few in number, experienced in the previous SALP period. It appears that the program was effective in limiting and reducing the number of surveillances missed during this evaluation period.

Inspection of surveillance for reactor coolant system leakage and thermal power was performed in part by comparison of results with those obtained from microcomputer programs provided by the NRC Independent Measurements Program. The results compared favorably and are acceptable. In the leak rate procedure, the licensee has specified a sufficient test period, two hours, to assure reproducible results. The frequency of the licensee's surveillances in these areas was satisfactory.

A Regional based inspection of the activities associated with the Integrated Leak Rate Testing (ILRT) was conducted during this SALP period. Appropriate management involvement in assuring quality of the ILRT was demonstrated. The Quality Assurance Department provided extensive coverage of the containment ILRT including coverage of pretest preparations such as system alignment and installation of test data acquisition hardware. QA findings were verbally transmitted to the appropriate test personnel in a timely manner. QA auditors are hired as experienced individuals with appropriate technical backgrounds. The plant manager and technical staff supervisor were both involved in monitoring the progress of test activities

and were helpful in providing information to the inspectors. The licensee contracted an engineering consultant who was experienced in containment integrated leak rate testing to conduct data taking and provide technical assistance. Management involvement in assuring quality was further demonstrated in the area of administrative control of the ILRT and its related activities. Containment isolation valves (CIVs) were properly tagged out for the test, containment and penetration room access was adequately limited, an ILRT briefing session was held, and procedural sign-offs and ILRT log book were properly maintained for the test.

Technical staffing, and training and qualification effectiveness appeared adequate for the ILRT. The test director was knowledgeable of test methodology and requirements, and of overall plant systems operability and conditions as related to the test. Other members of the plant technical staff (assistant test directors and technical staff engineers) were knowledgeable of test requirements and plant systems. Several technical staff engineers were qualified to serve as test director in his absence.

Snubber surveillance program demonstrated consistent evidence of prior planning and use of well-defined procedures. Records of snubber inspection results were complete, well-maintained, legible and retrievable. The licensee's approach to resolution of problems encountered during snubber surveillance inspections was conservative, timely, and technically sound and thorough. When problems are encountered, studies are conducted to evaluate the cause and properly correct the deficiency. Staffing and training and qualification of personnel is adequate.

No violations were identified during the evaluation period.

2. Conclusion

   Category: 1

3. Recommendations

   NONE

E. Fire Protection

1. Analysis

During the evaluation period, one inspection was performed by the regional inspection staff to close out previous open inspection items.

The resident inspectors performed routine weekly tours of all plant areas, paying particular attention to fire hazards, fire alarms, fire-fighting equipment, fire barriers, emergency lighting and permanently installed and portable extinguishing equipment. Several fire drills were observed during the SALP period. All fire brigade responses were timely and brigade teams appeared to be well - trained. Additionally, the inspectors have observed the condition and restoration of Appendix R fire barriers and equipment after refueling outages and major maintenance activities. In general this equipment has been found to be in excellent condition and fully restored to the original as-built conditions. However, since no formal inspections were conducted in the fire protection area during this evaluation period, the area was not rated.

No violation or deviations were identified during the evaluation period.

2. Conclusion

Category: Not-rated

3. Recommendations

NONE

F. Emergency Preparedness

1. Analysis

During the assessment period, a full scale radiological emergency preparedness exercise was observed by regional and resident staffs. No routine emergency preparedness inspections were conducted during the subject assessment period.

An adequately staffed corporate emergency response and planning organization routinely provided support to the plant. Key positions in the corporate and plant emergency response organizations were filled. Corporate management continued a strong commitment to maintenance of an effective emergency response program, as demonstrated by their direct involvement in the 1987 annual emergency preparedness exercise and followup critiques. The licensee continues to promptly and effectively respond to the NRC initiatives regarding emergency preparedness issues, as demonstrated by prompt implementation of required corrective actions in response to identified inspection findings.

During the annual exercise, the licensee demonstrated significant improvement in command and control of the emergency response organization required to effectively implement the Radiological Emergency Plan (REP) and respective procedures. In the previous two annual exercises (1985 and 1986), there were conflicts between the REP and implementing procedures regarding delegation of Emergency Coordinator responsibilities (e.g., emergency declaration, offsite notifications, protective action recommendations) resulting in poor communications and lack of full command and control. The 1987 exercise disclosed that the corporate emergency planning staff implemented appropriate corrective actions, including: procedural revisions; improved communications training; provision of timely information, emergency status, and updates as a prerequisite to delegation of Emergency Coordinator responsibilities to an assigned recipient.

The annual emergency preparedness exercise showed that the emergency plan and procedures could be implemented. The following essential elements of emergency response, demonstrated during the referenced exercise, were determined to be acceptable: emergency detection and classification; protective action decision making; notification and communications, except as noted below; dose assessment and projection; training; public information, except as discussed below; and coordination with offsite support agencies. The exercise disclosed that several findings were observed by the licensee and the NRC, which required correction. These findings were formally documented, and the licensee committed to correction consistent with regulatory requirements and guidance. The principal items

involved the following: (1) a weakness concerning consistent failure to notify the State and counties within 15 minutes following declaration of the Unusual Event, Site Area Emergency, and General Emergency classifications; (2) a weakness addressing failure of the EOF Emergency Control Officer to approve all news releases prior to issuance of same to the public. In reference to prompt notification, it was noted that consistent with the applicable procedure, the State implements notification of the counties. It was determined that delay in notification of the counties was attributable to the State notification procedures. It should also be noted, however, that the licensee bears responsibility for all notifications, including Federal, State, and counties.

One violation was identified.

Severity Level V violation for failure to submit changes to the radiological emergency plan to the NRC within 30 days. (335/87-08, 389/87-07)

2. Conclusion

Category: 1

3. Recommendations

NONE

G. Security and Safeguards

1. Analysis

Inspections during this evaluation period were performed by the resident and Regional inspection staffs.

Based on minimal inspection effort, review of documentation onsite and lack of event reports, the security program appears effective. Management involvement and support for the security program is evident by the resources expended on maintenance of security equipment and security force training and facilities.

The licensee's security organization consists of a contract guard force with a proprietary management function. The training and qualification of the guard force is adequate and the force demonstrates an ability to implement the security program.

During the last rating period, there was one violation with two examples, (violation a) involving failure to control access to vital equipment as required by the Physical Security Plan. During the rating period, this violation was classified as one Severity Level III violation and a Twenty-five Thousand Dollar Civil Penalty was assessed. A Severity Level III violation (b) was identified during this SALP period, which involved a failure to adequately design safeguards for vital equipment. No Civil Penalty was issued for this violation.

As a response to the violations concerning securing vital equipment the licensee submitted a security plan change deleting the vital equipment from the security plan. This action was based on an engineering study that indicated the equipment was not needed to achieve hot standby conditions. Even though the study was licensee initiated and that it validated that the equipment was not required to achieve hot standby conditions, the plan change was disapproved since it was judged to decrease the overall effectiveness of the plan.

During the SALP period the licensee made significant improvements to security of the site perimeter, and at the end of the period those improvements were under evaluation by the NRC to determine their effectiveness.

The site security manager and Chief of Uniformed Security recently retired or resigned; their replacements appeared capable of managing the security program.

Three violations were identified.

a. Severity Level III violation for failure to protect vital equipment (inadequate barriers and security patrols), which was previously discussed in the last SALP Report. A civil penalty was assessed during this rating period. (335/86-11)

b. Severity Level III violation for failure to design adequate safeguards protection for vital equipment. (335/86-17 and 389/86-16)

c. Severity Level IV violation for failure to secure an unattended vehicle. (335/86-19 and 389/86-18)

2. Conclusion

Category: 2

3. Recommendations

NONE

H. Outage

1. Analysis

During this evaluation period, routine inspections were performed by the resident and regional inspection staffs. The seventh refueling outage for unit 1 was performed from February 7 through April 16, 1987, (68 days, 22 days over schedule because of work to upgrade and replace Raychem splices), and unit 2 was in the 30th day of a scheduled 40 day outage at the conclusion, October 31, 1987, of this SALP period.

Routine inspections were conducted by the resident inspectors covering planned work in the following areas:

a. Preparations for refueling,
b. Receipt/handling of new fuel,
c. Refueling operations/fuel reconstitution,
d. Retube moisture separator reheaters (MSR's) and component cooling water (CCW) heat exchangers (unit 1),
e. Replace 6 containment penetrations (unit 1),
f. Installation of low power steam generator level control system, and

In the following areas covering unplanned events:

a. Remove/replace unit 1 tilted fuel assembly,
b. Remove/replace damaged unit 1 reactor head "O" ring, and
c. Repair unit 2 in-core instrument (ICI) plate.

The licensee's program for short notice outage work (SNOW) continued to demonstrate consistent evidence of prior planning and assignment of responsibilities and priorities. Technically sound procedures for control of outage activities were evident. Corporate involvement in daily outage activities continued, as in the previous evaluation period, through daily conference calls between corporate headquarters and the plant staff, on-site residence of a corporate vice-president and a visit to the site by the group vice-president during the ICI plate problem on unit 2.

The refueling outages continue to be well planned and well managed. Upper management has continued to encourage and expect results from the middle-to-lower level supervisors. As a result, the strength of outage management resides in these levels. Each manager/supervisor is assigned an area of responsibility and given authority to function in a manner necessary to achieve his/her goals. The licensee has established several positions which have had significant impact in managing overall tracking and progress of scheduled work. Shift directors, who work a rotating shift, are the "can do"

individuals, who not only follow the outage schedule but also make the appropriate adjustments for unforeseen occurrences, thereby minimizing unreasonable schedule lapses. New for the Fall 87 unit 2 refueling, is the containment building coordinator. In addition to ensuring the flow of containment operations, the duties of this position include, establishing and scheduling crane priorities, monitoring housekeeping, material/equipment control (flow in and out of containment), etc. The establishment of this position is another example of a positive licensee initiative in overall outage management. Total team refueling meetings were held twice daily, planning was effective, authorities and personnel responsibilities were well defined and staffing met or exceeded technical specification requirements.

The licensee has instituted several other initiatives to improve the efficiency of and the time required to complete a refueling outage. The following are examples of two of these initiatives. During refueling outages, every fuel assembly is removed from the reactor vessel and each fuel pin tested to identify leakers. In the past both units have experienced higher than desired levels of iodine-131 and noble gases, due to leaking fuel pins. By identifying and replacing individually leaking pins, levels of iodine-131 in the reactor coolant of the operating plant are reduced (ref. HP section for details). The end product is that coolant leakage during normal plant operations and gas releases associated with opening up the reactor coolant system for refueling do not result in excessive airborne or surface contamination levels. These lower levels reduce the complexity of conducting the outage and maintenance in general, thereby allowing a shorter length outage. The I-131 levels for the first 7 months of unit 1 cycle 8 have been a factor of 10 lower than the previous cycle. Similar results are expected during the upcoming unit 2 restart. Another licensee initiative which has improved the working conditions in containment and the plant overall, has been in the efforts by the licensee to lower the total square footage of controlled contaminated area. Over the past year, plant contaminated areas have been reduced by more than 60 percent. Overall, these efforts have produced the benefits of easier access to plant systems for operation and maintenance tasks. Additionally, intangible benefits have resulted such as improved worker morale and efficiency because the need for anti-contamination clothing is reduced or eliminated. The licensee's ALARA (as low as reasonably achievable) program has had success in reducing personnel contaminations during outages.

Although management involvement has been demonstrated at all levels and management of the outage schedule has been excellent throughout the evaluation period, there have been several events which may indicate a need for additional management attention.

One area which requires additional attention is the performance of routine outage tasks, such as reactor internal disassembly and reassembly. Problems in performing some of these otherwise routine outage tasks first occurred during the Fall 85 (previous SALP period) unit 1 outage, when the upper guide structure (UGS) lifting rig was not properly attached, due to an inadequate procedure. During this evaluation period, additional incidents occurred, one resulting in a violation (d of section IV.A.1, Plant Operations), which added to the length of the outages.

During the Spring 87 unit 1 outage, while reloading the reactor core and placing the third fuel assembly, the assembly fell over after being set down in the vessel. The assembly came to rest against the opposite side of the core shroud. The licensee quickly formed a team to investigate the event and to establish procedures for recovery of the fuel assembly. The assembly was recovered without incident and conservatively replaced with a new assembly. At the time of plant heatup, while recovering from the outage, the control room received an alarm indicating reactor coolant leakage past the inner of two "O" ring seals on the reactor vessel head. A QIP team was formed to analyze the problem and propose a course of action. Although a reactor startup would have been permissible, and the leak was isolable, the licensee conservatively decided to cool down and repair the seal. The planning and care taken in removing the vessel head and inspecting prior to moving anything demonstrated a strong commitment by the licensee to maintain a conservative approach in determining root cause when the potential for safety-significant events exist. Because of the licensee's aggressive actions and the involvement of the QIP team, the outage was extended by only 10 days, with the end result of the plant being returned to service in a more reliable condition.

Similarly, during the Fall 87 unit 2 refueling outage, while reassembling the vessel internals, the in-core instrumentation (ICI) plate was bent or bowed slightly because a load cell was not utilized during lifting as required by plant procedures (violation d.1, section IV A, plant operations). The deformation of the plate resulted in a misalignment of the plate and the upper guide structure (UGS) guide tubes and thimbles. Subsequently, the plate did not seat properly on the UGS. Again, management involvement and a strong team effort led to a technically sound, but conservative resolution of the problem. At the time of this report, the plate had been repaired and was properly seated on the UGS. However, as in the previous examples, an extension to the length of the outage was experienced.

The above examples could be related to lack of attention to detail when conducting routine outage tasks, or inadequate procedures, or both. To the licensee's credit, when these

complicated events occurred plant management acted appropriately to ensure timely resolution, while exhibiting the necessary conservatisms, in achieving a viable solution with minimum impact on safety. However, greater licensee management attention is warranted to ensure that these lapses, in an otherwise above average outage record, do not recur. Overall, the licensee's response was timely and proper to these challenging events and demonstrates a unique ability, on the part of the licensee, to function appropriately under unusual and sometimes difficult circumstances. Overall, the licensee's ability to conduct an outage and manage unexpected problems has been above average.

During the evaluation period, three inspections in the area of inservice inspection (ISI) and two inspections in the area of inservice testing (IST) of pumps and valves were performed by the regional inspection staff.

Licensee management involvement in ISI and IST activities appeared to be adequate and decision making was at a level that assured adequate management review. As noted in the last reporting period, the IST coordinator now reports to the Technical Services Department. It is apparent during the current reporting period that this change in organization has strengthened the ISI organization. Key positions were identified and responsibilites were defined.

The ISI/IST program reviews were timely, thorough and technically sound. Records were complete, well maintained and available.

One minor IST procedural violation, as noted below, was identified. The violation was not repetitive and was not indicative of a programatic breakdown.

One violation was identified.

Severity Level V violation (proposed) for failure to follow document control procedure (335/87-23, 389/87-22).

2. Conclusion

Category: 1

3. Recommendation

NONE

I. Quality Programs and Administrative Controls Affecting Quality

1. Analysis

During this evaluation period the licensee has taken steps to improve the effectiveness of the Quality Assurance (QA) organization. The licensee has shifted the focus of the QA group to be more involved in the day to day plant operations and problems. To support this shift a new QA manager was appointed during the evaluation period. The overall effectiveness of the organization has been improved which has lead to improved plant safety. This has come about mainly because the deficiencies now identified by QA are more significant and are reviewed and analyzed in greater depth. This provides better solutions to problems then just identifying or pointing out deficiencies.

The Quality Control group is another organization which has continued to identify problems before they become significant safety issues. This group is somewhat unique to FP&L in that they monitor plant operations on a daily basis. As an example they review all Technical Specification (TS) required surveillances and review plant and equipment status prior to changing plant modes. The group has been credited with identifying items which would have resulted in violations had they not been identified by the licensee. In summary, this group has added to overall plant safety and is considered to be a major plant asset in maintaining a high level of plant safety assurance.

For the purposes of this assessment, this functional area is defined as the ability of the licensee to identify and correct their own problems. It encompasses all plant activities, all plant personnel, as well as those corporate functions and personnel that provide services to the plant. The plant and corporate QA staff have responsibility for verifying quality. The rating in this area specifically denotes results for various groups in achieving quality as well as the QA staff in verifying that quality.

During the assessment period, one inspection was performed by regional inspection staff. This inspection was conducted in the area of licensee actions on previously identified enforcement matters and licensee actions on previously identified inspection findings.

Management involvement in assuring the responsiveness in dealing with NRC issues was demonstrated by successful closure of several previously identified NRC concerns.

A review was performed on all sections of the SALP report in an attempt to capture apparent strengths and weaknesses related to

management controls affecting quality. The following are some observed strengths in management controls affecting quality:

Management is actively involved in operational and maintenance activities as evidenced by coordinating site needs via the site Vice President, effective use of the Quality Improvement Program and continuing work for upgrading procedures.

Management attention related to ALARA exposures was successful for 1986 continued management commitment as evidenced by the 1987 emergency preparedness exercise and responses to NRC concerns during that exercise.

Outages were well planned and managed especially at the middle to lower level supervisory level.

The following are some observed weaknesses in management controls affecting quality:

There are continuing problems in the facilities transportation program for radioactive material.

EQ problems were not identified and resolved prior to an NRC inspection.

No violations were identified:

2. Conclusion

Category: 1

3. Recommendations

NONE

J. Licensing Activities

1. Analysis

In general, management involvement for assuring quality has been constant over the report period. Most licensing actions are handled by lower level management, with upper management participation only as needed. The channels of communication are always open with the licensee's management at the site and at the corporate locations. Management control for assuring quality has improved over the report period. A formal computerized system to track licensing commitments and a PC-based licensing action status log were instituted by the licensee during the rating period.

Good management involvement and control were noted when licensee technical resources were required. The technical resources were available in a timely manner at the site and at the corporate offices. The licensee is continuing the Quality Improvement Programs (QIP), and the staff was directly involved in some of them, e.g., increase diesel generator reliability, LPSI pump inoperability, scram reduction, mangrove restoration. Management involvement was also noted by the addition of a person on the licensing staff who worked at the plant and has direct knowledge of plant activities. Management involvement and control was also displayed in upgrading the technical specifications. Amendments were requested to delete requirements that are currently outdated, to editorially correct the technical specifications and to correct the containment valve tables. Amendments were also requested to delete the snubber tables for both units and to update the ISI Technical Specifications for unit 1 to make them more consistent with the CE STS and the unit 2 Technical Specifications.

There are a number of improvements that can be undertaken by the licensee's management. Although most submittals are timely, there are still some that are not. Examples of licensing actions not submitted in a timely manner include the emergency TS change on the operability of the unit 1 steam generators, the use of Code Case N-416 for both units, the updating of both units' RCS pressure -temperature limit figures/LTOP TS's and reload-related amendments for both units. In general, the licensee should assume a three month processing time for simple amendments and at least a six month processing time for more complicated issues.

The licensee continues to maintain a significant technical capability at the site and at the corporate headquarters, which is supplemented by the licensee's NSSS Vendor and Architect/Engineer. This capability generally leads to a good

approach to the resolution of technical issues from a safety standpoint.

Most of the technical evaluations performed by the licensee demonstrated a detailed understanding of the technical issues involved and acceptable approaches for resolution. In addition, the licensee's no significant hazards consideration determinations for amendment applications have been technically sound. Sixty-nine individual licensing reviews were completed. Examples of actions with good technical approach include the final core support barrel inspection (unit 1), inservice inspection program/reliefs (unit 2), changes to ODCM/PCP (both units), PTS Rule, Phase I (both units), deletion of flux peaking augmentation factors (unit 2), fire protection deviations/exemptions (both units), and remaining NUREG-0737 TS's (both units).

There were several examples of licensing actions for which a better technical approach could have been undertaken. Each steam generator on unit 1 was completely eddy-current tested during the winter 1985 outage. The licensee removed three steam generator tubes from the "A" generator because many of the eddy-current test signals could not be characterized. The tubes were sent to a consultant for further evaluation, and the steam generators were declared operable and unit 1 was returned to service. However, as a result of the consultant's investigation, the licensee determined that 13 tubes in the "A" generator and 4 tubes in the "B" generator exceeded the 40% plugging limit. The licensee advised the staff of the results of the post-refueling outage evaluation and proposed not to plug the affected tubes until the next refueling outage. The licensee believed that continued operation for the remainder of the cycle was acceptable because the steam generators' 1.0 gallon per minute primary-to-secondary leakage TS was the governing TS. The NRC staff's position was that the steam generator operability TS was also applicable and that a TS change was needed. An emergency TS change was issued and the unit was subsequently shut down for tube plugging.

A second example of a licensing action for which a better technical approach could have been undertaken was the licensee's request for the deletion of a license condition related to storing high burnup fuel in the spent fuel pool for unit 2. An error was discovered by the staff's consultant in the fission gas gap release data submitted by the licensee. The quality control of the licensee's fuel supplier's work product was not adequate, especially since the licensee is reported to have a fuels expert on staff. The error was corrected by the licensee and the license condition was subsequently deleted.

A third example relates to the adequacy of the unit 2 10 CFR 50 Appendix H surveillance capsule withdrawal schedule. The licensee did not present a conservative approach to the issue and uncertainty was not considered in the analysis as a basis for the withdrawal schedule. The issue was subsequently resolved, but significant staff effort was expended to resolve it.

The fourth and final example was the licensee's request that the OL term for Unit 1 be extended to 40 years from date of OL issuance, versus date of CP issuance. This is current practice for newer plants, and many of the older plants have requested similar extensions. The licensee's submittal did not consider several of the technical issues involved when comparing the initial FES impact assessments with the proposed extension of the operating life to 40 years, notably, population changes and population dose impacts, fuel usage changes, and spent fuel disposition. Resolution of most of the staff's concerns was accomplished by review of other licensee technical information, including unit 1 and 2 FSAR's, FES's, SER's, and Annual Radiological Environmental Impact Reports. The OL extension was subsequently issued.

The licensee was generally responsive to NRC initiatives. Most staff requests for additional information were answered in a timely manner. The licensee responded to Generic Letters and Bulletins, as required. The staff discussed various LER's and operational events with the licensee during the rating period and the licensee responded in a timely manner to the requests. The licensee also gave the staff a special presentation entitled, "FP&L Transmission System Reliability Review" in order to update the staff as to the present electrical grid stability for the FP&L service area. One instance in which the licensee could have been more responsive relates to Generic Letter 87-02 entitled, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors." The licensee did not believe that the generic letter is applicable to St. Lucie, unit 1 because St. Lucie is located in an area of low seismic hazard. Thus, the licensee believed that the concerns expressed in the generic letter do not apply to St. Lucie, unit 1.

The licensee continues to keep informed of industry approaches to plant safety issues and is aware of programs, problems, and resolutions at other plants. The licensee has accomplished this by membership in major industry groups and particularly by membership in owners groups.

The licensee continues to report and analyze operational events in a timely and adequate manner. This includes the reporting of operational events pursuant to 10 CFR 50.72 (telephone notification) and the reporting and analysis of operational

events pursuant to 10 CFR 50.73 (written Licensee Event Reports (LER's)).

A few of the LER's had high safety significance. For unit 1, there were 23 masonry walls reclassified as seismic (LER-87-01), loss of redundant LPSI pump due to breaker problem (LER-87-08) and loss of CCW redundancy (LER-87-12). For unit 2, there were no LER's that had high safety significance. The licensee took prompt action in correcting the problems found on the high safety significance LER's.

In its review of the number of plant trips reported in the LER's for both units, the staff noted the licensee's discussion of main steam safety valves (MSSV's) lifting. Some of the MSSV's open following a turbine trip/reactor trip. The problem appeared to begin after each unit went to its "stretch power level." The plant is designed such that the MSSV's are not supposed to open. It appears that there is an operational problem associated with the steam dump and bypass valves, thus causing the MSSV's to open, or the MSSV's settings may need adjustment. The safety significance is repeated challenges to the MSSV's, increasing the likelihood that a valve might stick open, producing an unisolable steam leak. This problem has been discussed with the licensee, and the licensee has implemented a program with the objective of correcting this problem.

In its review of the number of plant trips reported in the LER's for both units associated with low power operation, the staff noted that the licensed operators had difficulties in maintaining proper steam generator water level. The licensee evaluated this problem and implemented a relatively inexpensive plant change/modification to assist the operators. This was accomplished by installing a low power automatic feedwater control system during the rating period for unit 1 and at the end of the rating period for unit 2.

The size of the licensing staff is more than adequate to support licensing activities. There are three licensing engineers and one licensing supervisor dedicated to St. Lucie' activities. One licensing engineer has direct NRC experience and is intimately familiar with the NRC regulatory framework. One licensing engineer has direct St. Lucie plant experience and also has an intimate knowledge of the plant. The other licensing engineer specializes in fire protection, security, and NRC regional interface. All four personnel interface with NRC headquarters personnel. The St. Lucie Plant also has one person who interfaces with the above-described FP&L licensing staff and the NRC staff. This person also has an in-depth knowledge of the plant, and has been particularly helpful in assisting the PM in his visits to the site.

As evidenced by the knowledgeability of the FP&L licensing staff in day-to-day interactions with the NRR staff in licensing activities, the effectiveness of training and qualification of licensee personnel in this area appears to be more than adequate.

Management involvement for assuring quality has been constant during the rating period and management control for assuring quality has increased during the rating period. The licensee has been requested to ensure that all licensing submittals are made in a timely manner and was advised that the implementation of an Integrated Living Schedule would be beneficial. The licensee continues to maintain a significant technical capability, and has been requested to assure that all licensing submittals contain an adequate technical basis. The licensee was generally responsive to NRC initiatives. Operational events are reported and analyzed in a timely and adequate manner. Staffing and training and qualification effectiveness are more than adequate.

2. Conclusion

   Category: 1

3. Recommendations

   NONE

K. Training and Qualification Effectiveness

1. Analysis

No formal inspections of the St. Lucie training programs were conducted during this assessment period.

Three sets of replacement operator license examinations were administered during this SALP assessment period. The first set of written and oral examinations was administered in June 1986 to one reactor operator (RO) and five senior reactor operator (SRO) candidates, the sole RO candidate failed, and four SROs passed their examinations. The SRO and RO candidates who failed their June examinations were administered retakes in November 1986, with both passing. The two remaining sets of examinations were administered in November 1986 and April 1987, and resulted in a combined pass rate of 100 percent; five SRO and twelve RO candidates. The overall SRO and RO passing rates of 90 and 92 percent, respectively, were above the industry average. These passing rates indicate that management is effective in both the screening of prospective license examination candidates as well as the training process.

The new training facility was completed and placed in use in early 1987. The training simulator was delivered and installed in November 1987 with testing and certification to take place in 1988.

The licensee has made a commitment to develop a strong training program which will provide programs for operations, as well as other plant departments, such as maintenance. In fact, all 10 training programs have been reviewed and have received INPO accreditation during this SALP period. For the licensee administered requal exams, 117 have taken the written , with 112 passing on the first attempt, and 117 have taken the oral, with 110 passing on the first attempt. All of the failing candidates passed on a second attempt after a brief period of upgrade in their weak areas. In summary, the training program is well defined and implemented with dedicated resources. Inadequate training could rarely be traced as a root cause of major or minor events occurring during the rating period. There was one example (item no. d.2 of section IV.A.1., Plant Operations) which indicated a weakness in watchstanding philosophy as a root cause. However, this was not indicative of a programmatic problem.

No violations were identified.

2. Conclusion

Category: 1

3. Recommendations

NONE

V. SUPPORTING DATA AND SUMMARIES

A. Licensee Activities

During the assessment period, unit 1 was in routine commercial operations with a refueling outage from February 7, 1987 to April 16, 1987. Other outages included those discussed under Item J - Reactor Trips; and outage to perform steam generator tube plugging from June 6 to June 19, 1986; and a one day outage to repair an extraction steam line leak on September 6, 1987.

Unit 2 remained in a refueling outage at the beginning of the assessment period. Routine commercial operation was conducted from June 4, 1986 to October 3, 1987, at which time the unit entered another refueling outage which continued to the end of the SALP period. Other outages included those discussed under item J- Reactor Trips and a maintenance outage to repair condenser tube leaks from July 25, 1987 to July 28, 1987.

B. Inspection Activities

The routine inspection program was performed during the period, with special inspections conducted to augment the program as follows:

1. June 2-3, June 18 and June 25, 1986, in the area of physical security.

2. February 17-26, 1987, in the area of physical security; conducting tests on the newly installed intrusion detection system.

3. April 1-3, 1987, to examine the conditions surrounding the failure of Unit 1B Low Pressure Safety Injection Pump to start.

4. June 22-26, 1987, involved an examination in the area of gaseous and liquid radwaste management, and TMI/NUREG-0737 II.F.1. attachments 1 and 2 implementation.

C. Licensing Activities

The basis for this appraisal was the licensee's performance in support of licensing actions that were either completed or had a significant level of activity during the rating period. These actions consisted of amendment requests, exemption and relief requests, responses to generic letters, TMI items, and other actions. In addition to these specific issues, the licensee was evaluated for overall general performance on the many day-to-day and continuing matters which arise.

The actions completed during this SALP period can be divided into three major categories. The number of actions which were completed for each category are:

	Unit 1 only	Unit 2 only	Both Units
Plant-specific actions	28	24	11
Multi-plant actions	0	0	3
TMI actions	0	0	3

Below is a summary of licensing activities, including further descriptions of the completed actions.

1. NRR/Licensee Meetings

	Dates
SPDS	05/02/86
Steam Generator Operability	05/29/86
Steam Generator Tube Degradation Mechanism	08/27/86
Use of Gd in CE Manufactured FA's	12/02/86
IST Appeal (Flow Measurement Devices)	03/04/87
RETRAN	03/16/87
Steam Generator Tube Plugging Limit	06/04/87
Spent Fuel Re-Rack	09/02/87
FP&L Transmission System Reliability Review	09/02/87
Spent Fuel Re-Rack	10/02/87
Spent Fuel Re-Rack	10/29-30/87
Licensing Status	At least once per month, usually face-to-face

2. NRR Site Visits

Steam Generator On-Site Meeting	06/11-13/86
PM Site Tour/Visit with Plant Management, Review Unit 2 10 CFR 50.59's (1986 Reported PCM's)	06/24-27/86
PM Corporate Office Visit (Miami)	07/08-10/86
Diesel Generator On Site Meeting, review Unit 1 10 CFR 50.59's (1986 Reported PCM's)	09/15-19/86
PM Site Tour/Visit with Plant Management	12/08-12/86
Special Physical Security Test	02/17-27/87
PM, PD, and AD Site Tour/Visit with Plant Management	04/29-30/87
PM Site Tour/Visit with Plant Management, review Unit 2 10 CFR 50.59's (1987 Reported PCM's)	06/09-12/87

	PM Site Tour/Visit Plant with Management, review Unit 1 10 CFR 50.59's (1987 Reported PCM's)	09/15-18/87
3.	Commission Visits (Chairman)	
	Plant Tour and Training Center Dedication	03/03/87
4.	Schedular Extensions Granted	
	Unit 2 IST (Installation of Flow Measurement Devices)	05/13/86, 03/04/87
	Unit 2 Implementation of ATWS Rule to March 1989	07/01/87
	Unit 1 Implementation of ATWS Rule to February 1990	09/17/87
5.	Reliefs Granted	
	Unit 2 ISI Program/Reliefs	10/10/86
	Unit 1 ISI (One Relief, #8)	05/04/87
	Unit 2 Interim Relief Associated with IIT	10/09/87
6.	Exemptions/Deviations Granted	
	Unit 2 Fire Protection Deviations	12/05/86
	Unit 1 Fire Protection Exemptions	03/05/87
	Unit 1 Appendix J Exemption	08/19/87
7.	License Amendments Issued	
	Unit 1	
	Amendment 73 - Steam Generator Operability	05/30/86
	Amendment 74 - LHR	06/10/86
	Amendment 75 - Fuel Enrichment	12/01/86
	Amendment 76 - Active Fuel Length	12/22/86
	Amendment 77 - Power Level Versus ASI	02/19/87
	Amendment 78 - NAOH Flow/Pressure	03/30/87

Amendment 79 - ICCI	04/07/87
Amendment 80 - Core Barrel Movement	05/20/87
Amendment 81 - P-T Limits, LTOP	06/05/87
Amendment 82 - OL Extension Date	07/08/87
Amendment 83 - Snubber Tables	07/27/87
Amendment 84 - LHR	08/13/87
Amendment 85 - Containment PAL	09/15/87
Amendment 86 - Administrative Changes	10/23/87
Amendment 87 - Test Exceptions Shutdown Margin	10/28/87

Unit 2

Amendment 15 - Reload U-235 Enrichment	09/30/86
Amendment 16 - P-T Limits; LTOP	10/16/86
Amendment 17 - Nuclear Flux peaking Factor	03/05/87
Amendment 18 - Administrative Changes	03/11/87
Amendment 19 - ICCI	04/07/87
Amendment 20 - Containment Continuous Purge	05/20/87
Amendment 21 - High Burnup Fuel	05/29/87
Amendment 22 - Snubber Tables	07/29/87
Amendment 23 - Low Steam Generator Trip-Setpoints	09/24/87
Amendment 24 - Steam Generator Inspection	10/15/87
Amendment 25 - Administrative Changes	10/23/87
Amendment 26 - Test Exception on Shutdown margin	10/28/87

8. Emergency Technical Specifications Issued

Steam Generator Operability - Unit 1	05/30/87
Core Barrel Movement Surveillance Temporary Changes - Unit 1	Not needed

9. Exigency Technical Specifications Issued

Steam Generator Inspection - Unit 2	10/15/87

10. Generic Reviews Completed - Non-Amendment Related

Salem ATWS Items 4.2.1/4.2.2, Generic Letter 83-28 (Both Units)	05/22/86
RG 1.97, Inst, to Follow the Course of an Accident, TMI, (Both Units)	07/29/86
Diesel Generator Reliability, Generic Letter 84-15 (Both Units)	09/03/86
Emergency Response Facilities, TMI (Both Units)	11/20/86
Procedure Generation Package, TMI (Both Units)	12/22/86
PTS Rule, Phase 1, MPA-A-21, (Both Units)	02/10/87

11. Plant-Specific Reviews Completed - Non-Amendment Related

Control Rod Swap Technique (Both Units)	05/06/86
EQ of Mechanical and Electrical Equipment (Unit 2)	05/08/86
Code Case N-416 (Both Units)	05/28/86
Final CSB Inspection Report (Unit 1)	08/08/86
On-Site Staff Review of ECT Data (Unit 2)	09/12/86
Evaluate Report on Cold Shutdown (Unit 2)	10/06/86
Code Case N-411 (Both Units)	10/31/86
Gd in CE Manufactures FA's (Unit 2)	12/02/86
Inspection interval of LP Turbine Disc's (Unit 2)	12/11/86
Special Review of Snubber Failures (Unit 1)	12/31/86
ODCM/PCP Changes (Both Units)	01/12/87
Periodic Update of Population Data (Both Units)	03/10/87
Special Review of PCM on RTD Changeout (Unit 1)	03/13/87

Reanalysis of Seized Rotor/Loss of Non-Emergency AC Power (Unit 1)	03/16/87
Special Review of PCM on Wave Run Up Stop Logs (Unit 1)	03/25/87
ISI - Component Supports (Unit 2)	06/04/87
Surveillance Capsule Withdrawal Schedule Reconsideration (Unit 2)	06/23/87
Station Blackout (Unit 1)	07/12/87
Evaluate FP&L Position on Missed Surveillances (Both Units)	07/15/87
Special Review of ILRT Report (Unit 2)	07/17/87
Confirmatory Analysis Associated with LTOP TS's (Unit 2)	07/17/87
Request for Exempt. on Criminal History - Not Needed	07/29/87
Steam Line Break Analysis (Unit 1)	08/05/87
Special Review of PCM on Instrument Inverters (Unit 1)	10/13/87

12. Assistance to Region Under TIA Program

TS Clarification on Shutdown Hx's (Unit 1)	06/04/86
Seismic Analysis of SI Piping (Unit 2)	04/06/87
RCP Anti-Reverse Rotational Devices (Both Units)	06/16/87
TS Additional Clarification on Shutdown HX's (Unit 1)	09/17/87

13. Orders Issued

None

D. Investigation and Allegation Review

No major investigations were conducted at St. Lucie during this appraisal period.

E. Escalated Enforcement Actions

1. Civil Penalties

   a. A Notice of Violation (Severity Level III, Supplement VI, with no civil penalty (EA 86-95) was issued June 30, 1986, for failure to maintain radwaste shipment external radiation levels within limits. This violation, although issued during the current SALP period, was addressed in the previous SALP analysis.

   b. A Notice of Violation (Severity Level III, Supplement III) and Proposed Imposition of Civil Penalty (EA 86-99) for $25,000 was issued August 7, 1986. The first violation with the Civil Penalty involved the failure to ensure vital area barriers were maintained and the failure of security personnel during vital area patrols to detect opening leading into vital area. The second violation with no Civil Penalty issued involved the failure to adequately design safeguards for vital equipment. The first violation although issued during the current SALP period, was addressed in the previous SALP analysis.

2. Orders.

   No orders were issued for St. Lucie during this appraisal period.

F. Licensee Conferences Held During Appraisal Period

1. May 9, 1986, Enforcement Conference to discuss vital area barrier controls and radioactive waste shipping issues.

2. June 25, 1986, Enforcement Conference to discuss security issues.

3. September 11, 1986, SALP board presentation on St. Lucie.

4. August 7, 1987, Enforcement Conference to discuss loss of component cooling water system redundancy.

G. Confirmation of Action Letter.

   None.

H. Licensee Event Report Analysis

During the assessment period, 20 LERs for Unit 1 and 12 LERs for Unit 2 were analyzed by the NRC staff to determine cause. The distribution of these events was as follows:

Cause	Number of LERs Unit 1	Unit 2	Total
Component Failure	3	5	8
Design	1	1	2
Construction, Fabrication, Installation	0	0	0
Personnel			
- Operating Activity	4	1	5
- Maintenance Activity	3	2	5
- Test/Calibration Activity	5	3	8
- Other Activity	1	0	1
Other	3	0	3
TOTAL	20	12	32

NOTE 1: The 'Other' category is comprised of events where there was a spurious signal or unknown cause.

I. Enforcement Activity

UNIT SUMMARY

FUNCTIONAL AREA / UNIT NO.	NO. OF DEVIATIONS AND VIOLATIONS IN EACH SEVERITY LEVEL					
	D	V	IV	III	II	I
	1/2	1/2	1/2	1/2	1/2	1/2
Plant Operations		0/1	4/2			
Radiological Controls		2/0	3/0			
Maintenance						
Surveillance						
Fire Protection						
Emergency Preparedness		1/1				
Security			1/1	2/1		
Refueling		1/1				
Training						
Quality Program and Administrative Controls Affecting Quality						
TOTAL		4/3	8/3	2/1		

FACILITY SUMMARY

FUNCTIONAL AREA	NO. OF DEVIATIONS AND VIOLATIONS IN EACH SEVERITY LEVEL					
	D	V	IV	III	II	I
Plant Operations		1	4			
Radiological Controls		2	3			
Maintenance						
Surveillance						
Fire Protection						
Emergency Preparedness		1				
Security			1	2		
Refueling		1				
Training						
Quality Program and Administrative Controls Affecting Quality						
TOTAL		5	8	2		

J. Reactor Trips

Eight unplanned reactor trips and one manual shutdown occurred during the evaluation period for Unit 1. Unit 2 sustained six unplanned trips and one manual shutdown. The unplanned trips and shutdowns are listed below.

1. Unit 1

   a. September 19, 1986, the reactor was manually tripped from 100 percent power due to smoking isophase bus cable jumpers.

   b. September 19, 1986, the reactor tripped while returning to full power due to low steam generator level caused by personnel error.

   c. February 7, 1987, the reactor tripped from less than 5 percent power due to low steam generator level caused by the tripping of the main feedwater pumps and discrepancies in steam generator level indications.

   d. April 14, 1987, the reactor tripped from mode 2, less than 5 percent power, due to loss of instrument buses caused by personnel error.

   e. May 21, 1987, the reactor tripped from 100 percent power due to a turbine generator lock out caused by a failed exciter field transducer.

   f. June 14, 1987, the reactor tripped from 100 percent power due to reactor high pressure caused by a turbine runback on loss of main feedwater pump.

   g. October 8, 1987, the reactor was shutdown due to a reactor coolant leak on a reactor coolant pump seal line.

   h. October 29, 1987, the reactor tripped from 20 percent power due to low steam generator level caused by the tripping of the only operating main feedwater pump.

   i. October 29, 1987, the reactor tripped from Mode 3 due to a spurious high startup rate trip during the start of the first shutdown bank withdrawal.

2. Unit 2

   a. June 4, 1986, the reactor tripped from 5 percent power due to low steam generator water level caused by personnel error.

b. September 15, 1986, the reactor tripped from 100 percent power due to a turbine generator trip.

c. March 3, 1987, the reactor tripped from 100 percent power due to loss of the auxiliary feedwater actuation system power supplies which caused a main feedwater isolation valve to close.

d. March 5, 1987, the reactor tripped from 40 percent power due to failure of a main feedwater regulating valve actuator.

e. April 9, 1987, the reactor tripped from 100 percent power due to inadvertent actuation of the main steam isolation signal caused by personnel error.

f. April 22, 1987, the reactor tripped from 100 percent power due to the loss of a non-safety-related load center, which caused a turbine trip. The loss of the load center was due to personnel error.

g. May 27, 1987, the reactor was manually shutdown due to two dropped control element assemblies.

K. Effluent Summary for St. Lucie

St. Lucie Nuclear Station
Annual Effluent Release Summary, 1984-1986

Year	1984	1985	1986
Activity Released (Curies)			
a. Liquid			
1. Fission and Activation Products	3.86×10^{0}	5.51×10^{0}	4.96×10^{0}
2. Tritium	4.42×10^{2}	6.50×10^{2}	5.56×10^{2}
3. Gross Alpha	0	0	0
b. Gaseous			
1. Noble Gas	4.32×10^{4}	6.03×10^{4}	4.33×10^{4}
2. Halogens	5.40×10^{-1}	9.80×10^{-1}	3.11×10^{-1}
3. Tritium	1.10×10^{3}	5.62×10^{2}	8.11×10^{1}
4. Gross Alpha	2.03×10^{-8}	1.55×10^{-7}	1.06×10^{-6}
Dose Estimate (mrem)			
a. Liquid			
Whole-body	3.12×10^{-1}	7.92×10^{-1}	1.11×10^{0}
b. Gaseous			
1. Whole-body	3.5×10^{-2}	1.87×10^{-2}	1.32×10^{-2}
2. Thyroid	1.14×10^{1}	6.60×10^{0}	6.67×10^{0}