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101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

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Licensee: Carolina Power and Light Company
P. O. Box 1551
Raleigh, NC 27602

Docket Nos. 50-325 and 50-324

License Nos. DPR-71 and DPR-62

Facility Name: Brunswick Steam Electric Plant, Units 1 and 2

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LIST OF ACRONYMS

ACR	Adverse condition report
BIP	Brunswick improvement plan
CAP	Corrective action program
CP&L	Carolina power and light
DBD	Design basis document
DET	Diagnostic evaluation team
EDG	Emergency diesel generator
EER	Engineering evaluation request
EWR	Engineering work request
FACTS	Facility adverse condition tracking system
HPCI	High pressure coolant injection
HPES	Human performance evaluation system
I&C	Instrumentation and controls
IAP	Integrated assessment plan
JO	Job order
LCO	Limiting condition for operation
NAD	Nuclear assessment department
NED	Nuclear engineering department
NRC	Nuclear regulatory commission
PID	Plant identification document
PLP-04	Corrective action program procedure
QC	Quality control
RBCCW	Reactor building closed cooling water
RHR	Residual heat removal
STSI	Short term structural integrity
TC	Temporary change
WR	Work request

EXECUTIVE SUMMARY

This special engineering inspection assessed the licensee's performance in the areas of engineering, technical support, and corrective actions and made comparisons with the performance that existed at the time of the Diagnostic Evaluation (DET) in 1989. The team reviewed organizational and personnel changes, material upgrades to the service water system, engineering backlogs, operating performance improvements, effectiveness of corrective actions, and effectiveness of support to maintenance and operations. Within these areas, the inspection consisted of interviews with personnel, observations of activities in progress, reviews of selected procedures and supporting documentation.

In 1989 the DET noted that many problems present at that time had been previously addressed in the 1982 Brunswick Improvement Program (BIP). Following the BIP, some improvement was observed but was not sustained. The DET concluded that the corrective action program lacked provisions for effective problem identification and root cause determination. Audits were ineffective in identifying engineering weaknesses and/or failed to receive adequate attention. The DET engineering team predicted that equipment problems would continue to be prevalent at Brunswick because of longstanding weaknesses in plant configuration control and engineering support activities. The chronic equipment problems fostered an attitude of living with or working around hardware problems. The maintenance department also stated that poor engineering support contributed to the delay in their activities.

In response to the DET, several engineering and plant improvements were implemented. Communication between Technical Support, Operations, and Maintenance organization improved. Additionally, communication and teamwork between Technical Support and corporate engineering to resolve concerns were enhanced. The educational level of the Technical Support organization was better, and the concept of board certification of system engineers, on their assigned systems, produced engineers having more design basis knowledge, understanding, accountability and ownership. Material improvements and replacements were made to several systems including the service water system. The ongoing Design Basis Document program was producing reliable design basis information that was accessed by both corporate and site engineering groups.

This inspection revealed that many performance weaknesses observed during the DET were still present in 1992. Timeliness and effectiveness of corrective actions, equipment failures, and personnel/maintenance errors have continued to occur. The Brunswick site was ranked at or near the bottom of their peer group of 23 Boiling Water Reactors in the areas of personnel and maintenance errors reported by LERs in 1990 and 1991.

Many inappropriately modified anchor and through-wall bolts were installed in the emergency diesel generator (EDG) building that resulted in a shutdown of both units following this inspection. This concern was first documented by site engineering in 1987 but was neither adequately examined nor corrected.

The licensee identified more than 200 safety-related components that did not meet FSAR or licensing design basis seismic requirements, and classified them as "short term" qualified (seismically degraded but operable). This list included inappropriately modified anchor bolts installed in the EDG building and also the nuclear service water pumps. These pumps had been "short term" qualified for more than 11 years.

Components in the service water building were degraded because of water in-leakage, other environmental conditions, and lack of repair. Many cable trays, supports, electrical junction boxes, and piping system components were severely corroded.

Problems existed with the corrective action program that prevented effective utilization of multiple tracking systems, trending of adverse conditions, provisions for timely corrective actions, and providing oversight for lower level corrective action subprograms.

Based on observations made during this engineering inspection, accomplishments made since the DET, and an examination of findings and observations in the DET report, the following root causes were developed: 1) The fundamental root cause for the licensee's continued weak performance has been a lack of management vision of where they wanted the plant to be in the future (including achievable lower level milestones that could be embraced and implemented by Brunswick personnel); 2) The licensee's problem resolution philosophy has been to treat the individual symptom, rather than the root cause. This philosophy resulted in vague site goals, priorities, and expectations, as well as ineffective and untimely corrective actions; 3) Insufficient capital expenditures in the past, as evidenced by major project deferrals, have contributed to the current marginal material condition of Brunswick; and 4) Chronic instability of the Technical Support organization. Thirty-six Technical Support supervisors have left the Technical Support organization since 1987.

1.0 INTRODUCTION

1.1 Background

A Diagnostic Evaluation (DET) was performed in 1989 and noted that many problems present were previously addressed in the 1982 BIP. Following the BIP, some improvement was observed but was not sustained. The DET concluded that the corrective action program lacked provisions for effective problem identification and root cause determination. Audits were ineffective in identifying engineering weaknesses and/or failed to receive adequate attention. The DET engineering team predicted that equipment problems would continue to be prevalent at Brunswick because of longstanding weaknesses in plant configuration control and engineering support activities. The chronic equipment problems fostered an attitude of living with or working around hardware problems. The maintenance department also stated that poor engineering support contributed to the delay in their activities. Many qualified supervisors have worked in the on-site Technical Support organization without substantially improving the quality or timeliness of engineering support to the station. Since January 1987, thirty-six supervisors have left the Technical Support organization.

1.2 Scope and Objectives

This special engineering inspection assessed the licensee's performance in the areas of engineering, technical support, and corrective actions and made comparisons with the performance that existed at the time of the DET in 1989. The team reviewed organizational and personnel changes, material upgrades to the service water system, engineering backlogs, operating performance improvements, effectiveness of corrective actions, and effectiveness of support to maintenance and operations. Within these areas, the inspection consisted of interviews with personnel, observations of activities in progress, reviews of selected procedures and supporting documentation.

2.0 EVALUATION RESULTS

In response to the DET several engineering and plant improvements were implemented. Communication between site and corporate groups was improved. The educational level and system knowledge of system engineers had increased. Material improvements and replacements were made to several systems including the service water system. The ongoing Design Basis Document program was producing reliable design basis information that was accessed by both corporate and site engineering groups. However, this inspection also revealed that many performance weaknesses observed during the DET were still present in 1992. The licensee was still not learning from experiences. As a result, timeliness and effectiveness of corrective actions, equipment failures, and personnel/maintenance errors have continued to occur. The following is a listing of detailed inspection observations.

2.1 Improvements since the Diagnostic Evaluation.

Improvements were noted in four different areas that were identified as weaknesses during the Diagnostic Evaluation in May 1989: 1) the service water system material condition, 2) design basis availability and understanding, 3) communication and teamwork, and 4) site engineering education and experience.

For example:

1) Many plant modifications have been installed including pipe replacements, cross-tie valve replacements, upgraded service water pump motor cooling and insulation, Loss of Off-site Power logic added to the reactor building closed cooling water (RBCCW) isolation valves, service water single failure and minimum flow corrections, and others. Other modifications in progress included service water pump replacement, replacement of service water supply piping to the EDGs, replacement of inlet piping to RBCCW system, and miscellaneous replacement of electrical and piping supports. A service water system 5-year plan was also developed in 1990 to upgrade the material condition and design to be in full compliance with design requirements.

2) The design basis document (DBD) program was ongoing. As the service water system DBD is completed, along with others, additional areas will be identified in need of improvement. The DBD effort was viewed by the team and the licensee as a long needed project. The DBD project was well received by site personnel and information gathered in the DBD process made the responsible system engineers more aware of the capabilities, shortcomings, and design requirements of their assigned systems.

3) Communications and teamwork had improved between Technical Support, operations, and maintenance. Site engineering-corporate engineering communication was also improved.

4) Numerous organizational changes had taken place since the diagnostic that were outcomes of Brunswick's "organizational analysis," the "CRESAP" study, and the DET observations. These personnel changes have helped to increase the percentage of degreed engineers, and consolidated expertise and function.

2.2 Weak problem identification, root cause determination, and implementation of corrective action.

2.2.1 LER analysis results.

Brunswick has not been learning from experiences. A review of performance indicator cause codes for Brunswick was conducted for the years 1990 and 1991. The review consisted of a licensee evaluation report (LER) analysis to identify any performance indicator programmatic problem areas. As a result of the analysis, Brunswick was identified as an outlier in the maintenance and personnel errors performance indicator cause codes. Most of the maintenance errors reported were primarily due to inadequate procedures or inadequate clearance preparation. With regard to the personnel errors cause code, errors of omission or commission were included.

Compared to its peer group of 23 Boiling Water Reactor units, the Brunswick units ranked as follows:

Unit #	Maintenance Errors	Personnel Errors
1	23	23 (tie)
2	15 (tie)	21

2.2.2 Brunswick's performance had not significantly improved as a result of improvement programs.

Since 1982, Brunswick has initiated many improvement programs and initiatives. These included the BIP, the integrated action plan (IAP), the Corrective Action Program (CAP) and the self assessment plan. Many fundamental problems addressed in the 1982 BIP plan were present in 1989, and currently exist. Since the 1989 DET, repetitive equipment failures, and maintenance and personnel error-related events continued to occur. The typical problem resolution philosophy has been to treat the symptom, rather than the root cause.

Recent nuclear assessment department (NAD) evaluations of the effectiveness of the CAP program, an important part of the IAP, identified many areas in need of improvement. The team found that many NAD-identified issues over the past 12 months were generally consistent with the team's observations. The team determined that program integration, staffing levels, lack of experience, and training were factors that contributed to the ineffectiveness of the CAP.

There was a shortage of staff and experience necessary to perform the scope of work that senior management expected of the CAP staff and technical support organizations. For example, none of the CAP staff had engineering degrees or other engineering experience. The licensee's entire CAP staff consisted of two technical reviewers, a manager, and an office assistant. The technical reviewers were responsible for reviewing all adverse condition reports (ACRs) to ensure procedural compliance and to provide assistance to the technical groups in root cause analysis and problem resolution during the ACR report process. It should be noted that the two technical reviewers had received only introductory root cause and human performance evaluation system (HPES) training.

Few self-initiated corrective actions involving plant material condition have been taken by the licensee. If appropriate outside attention was focused on a problem (NRC initiated), the licensee generally obtained adequate human and financial resources necessary to make needed changes. The team requested Brunswick to provide copies of plant aging studies for review. The purpose of this request was to determine what plans were being considered to cope with degraded or outdated plant material, and what would be required to return the plant to design basis conditions. The information request was submitted, in part, because of numerous EWRs documenting the existence of obsolete equipment. The response received was that Brunswick had not performed plant material aging studies other than those identified in NRC generic communication such as bulletins, notices, or generic letters.

2.2.3 Nuclear service water pump seismic qualification.

In 1981, the licensee had initiated modifications (modification packages 81-207 and 208) to the nuclear service water pumps to upgrade the seismic qualification criteria and the design basis as described in the FSAR. These modifications were initiated because the licensee discovered that inappropriate seismic spectra curves had been used during the original design qualification of the nuclear service water pumps. The modifications were never completed. In 1989, an EER was written to validate the seismic design adequacy of the nuclear service water pumps and found them to be STSI-qualified but not meeting the long-term structural integrity criteria. The licensee issued another modification in 1982 to qualify these pumps to the FSAR seismic criteria, but no apparent action was taken. Since 1981 (some 11 years later), the nuclear service water pumps still have not been long term seismically qualified and have remained short-term qualified and seismically degraded.

2.2.4 Poor root cause analysis and untimely corrective action associated with inappropriately modified EDG bay wall anchors and through-wall bolting.

During construction of the masonry block and poured concrete interior walls within the EDG building, many inappropriately modified anchor and through-wall bolts were used. Examples of inappropriately modified bolts included: (1) bolts which had been cut off with only the head welded to the structure to give the appearance of bolts where none was actually installed; (2) bolts that were cut short eliminating or reducing the thread engagement; (3) bolts installed in concrete without required threaded steel anchor sleeves; and (4) combinations of the above. This condition was believed to have existed since the early 1970s and was first documented by the licensee in 1987. Since 1987, a period of two years el psed without action due to the loss of records detailing this concern. In 1990, a calculation was performed to short term structural integrity (STSI) qualify the walls. A component that was classified as short term qualified did not meet FSAR requirements (seismically degraded) but was considered operable. However, the team determined that this calculation was in error because the methodology used to obtain input data for the calculation was flawed. Once reliable data was obtained (i.e. accurate assessment of the number of good anchor bolts) the walls were determined to be inoperable.

During and subsequent to the inspection by the licensee, at least two of the interior walls separating the EDG bays were found not to meet the STSI requirements and were declared inoperable, resulting in the commencement of shutdown for both units on April 21, 1992.

There appeared to be widespread deficiencies with the missile shield protection and other steel reinforcements within the EDG building. Many bolts used for support of the missile shields were inappropriately modified. Other bolts used for seismic qualification of concrete and masonry walls within the EDG building were also found to be inappropriately modified.

The licensee had not identified the contractor for the missile shield and masonry walls within the EDG building or the extent of the bolting deficiencies. Work performed by the contractor(s) who constructed the missile shield plates and other modifications within the EDG building may not be limited to Brunswick. The licensee believe that the missile shield plates were installed as part of original construction, but this could not be confirmed.

An NRC staff letter dated April 9, 1992, requested the licensee to (1) describe corrective actions and evaluation criteria used in determining the acceptability of EDG walls; (2) describe the plan and schedule for evaluating other walls and equipment; (3) describe justification for continued operation; and (4) describe root causes for identified deficiencies. The licensee addressed these issues in a letter to the NRC staff dated April 15, 1992, and agreed to meet with the staff to discuss the issues prior to restart of either unit.

Deficient anchor bolting included loose horizontal anchor bolting of the battery trolley support structures located above the vital battery cells. These bolts were Hilti redhead gun-driven anchors. Anchor bolts securing the bullet proof steel plates located in the stairwell outside and inside the control room were also loose.

The licensee had not previously performed verification installation of anchor bolts in masonry block walls because Bulletin 80-11, "Design of Masonry Walls," required verification of design adequacy, not installation adequacy or testing. The licensee stated that approximately 80 walls exist at Brunswick that were screened under the guidelines for Bulletin 80-11. Approximately 20 of the 80 walls were identified by the licensee as having needed some modification to restore the seismic qualification. None of these walls had been examined for signs of inappropriately modified bolt installation.

Problems with anchor bolts have not been limited to installation problems. Anchor bolt corrosion was also observed to be a problem where water leakage had occurred. Anchor bolts located in the service water building and in some areas in the reactor building (-17 foot elevation in the core spray rooms and some Hydraulic Control Unit support anchor bolts) showed signs of severe degradation. The licensee attempted to verify operability on some nuclear service water system support bolts by backing off some of the more severely corroded nuts. At least 2 of these bolts sheared when torque was applied to them.

Appendix A contains an event chronology leading to the discovery of inappropriately modified anchor and through-wall bolts installed in the EDG building.

2.2.5 Several examples of poor root cause analysis were identified.

The team reviewed ACRs and found examples of poor root cause evaluations. The reasons for the inadequate root cause evaluations varied, but lack of initial or refresher training was the major contributor. Many Brunswick staff had trouble understanding how to interpret procedure PLP-04 (Corrective Action Program) which explained how to prepare ACRs and perform root cause evaluations. Infrequent use or misapplication of these procedures may have contributed to the poor quality of ACRs that the team reviewed.

The above observations are supported by the following examples.

1) Examples of significant ACRs (i.e., requiring a root cause analysis) performed by individuals who were not trained in root cause or HPES evaluations: ACR #s 91-191, 91-107, 91-600, 91-329, and 91-324.

2) Examples of ACRs with poor root cause analyses: ACR # 91-243, and 91-324.

2.2.6 The number and duration of temporary modifications due to lifted leads and jumpers was not effectively controlled.

A review of temporary modifications of plant equipment, in the form of lifted leads and jumpers, revealed that there was not an impetus to limit either the number of temporary modifications or the length of time they could left in place.

The team reviewed the jumper and lifted leads logs for both units in an effort to evaluate licensee corrective actions pertaining to temporary modifications of plant equipment. The team noted that between the two units there were approximately 55 jumpers installed, some dating back to 1984. Some of the jumpers were installed to disable control room annunciators to eliminate nuisance alarms to achieve a "black board." While the short term goal of a black board was met, a lack of technical and management support to permanently resolve temporary modifications of plant equipment was evident. The team noted that there were 32 disabled control room annunciators between the two units. Discussions with the licensee revealed that they did not consider this a problem and they had no immediate plans to permanently resolve the issue other than to maintain the number of disabled annunciators below 20 per unit. The team also noted that Procedure AI-58, (the governing procedure for jumpers) did not impose a time limit for permanently dispositioning jumpers which implied that there was no real impetus to permanently resolve temporary conditions.

2.2.7 Many problem identification systems were not integrated with the CAP, resulting in a loss of valuable data needed to detect adverse trends.

Problem identification systems and the CAP "subprograms" were not originally designed or intended to be integrated into a centralized tracking system such as the CAP. Most of these subprograms were in existence prior to formation of the CAP program in January 1991, and continued to function as originally designed.

There were sixteen subprograms referred to in the CAP. Since the beginning of the CAP program in January 1991, the licensee had intended the subprograms be used to detect adverse trends in a timely manner and used as input to the CAP program. The subprograms, according to site procedure PLP-04, were to contribute to identifying adverse conditions, and enhance the ACR identification process. The team performed a review of selected subprograms and concluded that: (1) the subprograms performed their function independently from CAP, (2) adverse conditions or deficiencies tracked within these subprograms rarely resulted in an ACR, (3) until recently, corrective actions associated with the subprograms were not tracked by the CAP, and (4) the licensee's failure to integrate subprogram data into the CAP hampered the program's effectiveness.

In the most recent NAD assessment of CAP (dated March 27, 1992), it was stated that "most subprogram procedures do not provide guidance for escalating a problem into the ACR process when adverse trends are detected, when corrective action is not timely, or when the problem becomes repetitive." An example the team found of this was the repetitive failure database within Technical Support. This database tracked component repetitive failures within the jurisdiction of Technical Support. At least two of these entries contained items with 21 repetitive component failures within a period of two years and still had not resulted in an ACR. Unless a specific determination was made by Technical Support that the item was considered a "significant" adverse trend or that reached ACR-trigger levels, the item(s) were not flagged for entry into the ACR process. Most ACRs did not precipitate from the subprograms.

The EDG Building anchor bolt deficiencies were not identified or tracked by the ACR process. The licensee wrote an ACR on the issue when questioned by the team. Additionally, the CAP program had not been tracking the more than 200 safety-related STSI items (including more than 1000 individual action items). The EDG masonry block missile shield walls and seismic qualification concerns for the service water pumps were two items included on the STSI list.

2.2.8 ACR classification was inconsistent.

Many examples of inconsistencies were noted in the classification of ACRs. It appeared that ACRs classified as non-significant should have been classified as significant. Unless an ACR was classified as "significant," a root cause analysis would not be performed, and the generic concern of "why did this happen?" may not be answered until repeated failures or similar events had occurred. Examples included: (1) ACR # 92-0026, "tag on fire extinguisher did not reflect that inspections had been performed," was classified as significant, (2) ACR # 91-0281, "Containment Air Dilution system did not meet single failure criteria" was classified as non-significant, and (3) ACR # 92-0082, "reactor core isolation cooling system inoperable due to particulate matter in oil" was classified as non-significant.

2.2.9 Establishment of corporate and site work priorities.

The nuclear prioritization process as described in the Nuclear Generation Manual procedure 305-05 and Brunswick site procedure BSP-36 was complex and not well understood by the Technical Support engineers. The relative priorities determined by this process were frequently artificially escalated by management to coincide with a particular manager's desire. The process was further circumvented by the system engineer's influence over maintenance or operations using an informal process that got the work completed that was high on the system engineers informal priority list. Work accomplished seemed directly related to the tenacity of the work proponent and did not necessarily reflect the priority assigned by the nuclear prioritization process. The priority system was so complex that work request T 91-1421, "Evaluate Microwave Outlet in Lunchroom," was given that same priority as work request T 92-0020, "Salt Water Leakage in the Service Water Building Has Corroded Various Cable Trays, Conduits and Supports to the Point That Their Reliability & Design Safety Margins Have Been Reduced, Jeopardizing The SW System Equipment" (This was identified in plant MOD 87-140).

There had been training in prioritization of work, however, this training was insufficient to ensure consistent priority classification. To assess the adequacy of the prioritization process, some Technical Support engineers were asked by the team to prioritize selected work packages. No two Technical Support engineers set priorities the same and none of the priorities matched the actual assigned priorities.

The licensee used a system that ranked the priority of an item from 1 to 51 with category 99 used to store items until they are evaluated. Approximately 46 percent of closed temporary changes (TCs) and 48 percent of open TCs were category 4. Approximately 20 percent of the closed TCs were closed as priority 99. The overloading of corporate priority category 4 made the relative priority system less meaningful.

Finally, to further complicate the prioritization process, there was a Scheduling Index that was applied to PIDs. None of the Technical Support engineers interviewed clearly understood this system, or could reproduce the results of others. After discussions with management in this area the team was informed that management recognized that there was a problem with the scheduling index calculation training. The definitions of some factors, such as the meaning of the Nuclear Safety factor, was not uniformly used or clearly understood. This skewed the schedule index data base. The team was informed that experienced personnel could reproduce the results on the Scheduling Index Worksheet, however, the team found no evidence of this ability during the discussions with the Technical Support engineers.

In conclusion, the team attributed the recurrent ambiguous assignment of relative work priorities to a lack of definitive management direction. More specifically, there was not sufficient management involvement or followup to assure implementation of an effective prioritization process. The program may have appeared appropriate for the task as written, however the implementation of the program led to inconsistent and conflicting conclusions. The results of this inconsistency were the establishment of informal programs to work around this poorly implemented program.

The examples listed in section 2.2 are identified as potential violation 50-325 and 50-324/92-10-01, Inadequate Corrective Actions.

2.3 Corporate and industry experience not effectively utilized by Technical Support engineers

The technical support engineers at Brunswick had very few technical contacts outside their own organization. Based on interviews with Technical Support engineers the team concluded that they were generally unaware of industry problems with their components or systems. Most did not have a single technical contact outside CP&L and some did not know their corporate or other CP&L site counterparts. The sharing of system engineering failures and successes rarely occurred. Without this contact the Technical Support engineers did not always recognize the bigger picture implication of identified problems or that they could learn from the mistakes of others without having to make the mistakes themselves.

Brunswick had several systems for the distribution of technical information to employees. These were generally big picture items and not the system or component specific items that would have assisted the Technical Support engineers in the evaluation of their assigned systems.

From discussions with management one manager did not think they had a problem with contact with industry counterparts. One manager stated there might be a problem and that he would investigate. At the Technical Support engineer level the engineers generally agreed that they would benefit from more contact with industry or corporate counterparts.

2.4 Staff engineering experience and background

Very few of the staff within the Technical Support organization had experience outside of Brunswick or CP&L. The number of degreed engineers was also low (approximately 50 percent) although improvements in this area had been made since the DET. The lack of outside nuclear experience, and a decreased standard of excellence in combination with the reactive nature of work (supporting a plant needing much attention) appeared to limit the effectiveness of the organization.

There were 28 certified engineers in Technical Support that appeared to have an extensive understanding of their assigned system. The certification process involved first qualifying as an engineer and then certifying on a particular system. The process produced well qualified engineers, however, the engineers were certified on only one system or group of closely related systems.

Given the heavy work load, it was difficult to qualify on another system due to time constraints. None of the certified Technical Support engineers had certified backups. System engineers received little if any formal training for their assigned systems. The lack of certified backup engineers tended to overload certain Technical Support engineers. The effectiveness of the Technical Support group was limited in that without qualified backups an overloaded engineer could not productively share the workload with another qualified individual to provide more timely resolution for emergent system specific issues.

2.4.1 Effectiveness of Technical Support - Maintenance interface

Based on a review of the background of the 9 personnel in the Maintenance section within Technical Support, it was determined that there were no certified personnel and no degreed engineers. Additionally, none of the personnel had any previous commercial nuclear experience outside Brunswick. However, the group functioned well within their limitations. This primarily resulted from the continuation of close maintenance contacts after the entire group was transferred from maintenance to Technical Support.

2.4.2 Effectiveness of Technical Support - Operations interface

The interface between the operations group and the on-site engineering groups was found have improved since the DET, although quite informal and reactive as opposed to proactive in nature.

The evaluation of the interface between the operations group and the on-site engineering groups was performed by interviewing personnel in both the operations and engineering groups. It was determined that the interface/communication between the groups was quite informal; a "we call them if we have a problem" approach, a statement in and of itself indicative of a reactive program. It should be noted, however, that operations personnel indicated that the engineering staff was competent, and helpful when called upon. The number of issues requiring engineering attention, and the limited number of available engineers, have precluded the Technical Support staff from operating more proactively. Thus, the staff has generally not been able to identify and correct minor deficiencies before they became problems requiring reaction. Additionally, the informality of the interface between the groups could lead to the loss of valuable data pertaining to system/equipment performance that could be useful in a proactive program aimed at improved availability/operability.

2.5 Plant Performance Indicator Review

The team reviewed the licensee's practice for reporting safety system availability as a performance indicator. The licensee's practice was found to be in accordance with established criteria for this indicator. The team noted that reported availability was different from operability and thus systems may not be able to perform intended safety functions when they are reported as available.

2.6 Surveillance Tests

Technical Specification required surveillances that are initiated but aborted prior to completion (or not successfully completed for reasons such as support equipment failures), may not undergo a rigorous analysis relative to the declaration of a failed surveillance.

The team evaluated the licensee's failed surveillance analyses regarding technical specification-required surveillance tests that were aborted prior to successful completion. The team was concerned with this type of analysis after a test of EDG #1 had to be aborted prior to the completion of the scheduled 2-hour run. An evaluation of that particular event detected no deficiencies, but identified some philosophical divergences that could lead to non-conservative decisions.

The team reviewed hypothetical scenarios with the licensee. One such hypothetical scenario involved an aborted surveillance of the high pressure coolant injection (HPCI) system. In this scenario, the HPCI system had been successfully started for a test, but test acceptance criteria had not been achieved/recorded when the HPCI auxiliary oil pump motor overheated. The licensee decided, based on the failure of the motor, to terminate the test. The HPCI system was declared inoperable until the auxiliary oil pump motor could be replaced and tested. For the purposes of this example, the post maintenance test of the auxiliary oil pump was not a repeat of the aborted surveillance test but an auxiliary oil pump start. Operations management staff stated that the HPCI system could be returned to operable status without having performed the aborted surveillance test provided the surveillance frequency interval had not been exceeded.

Absent from the above analysis was the evaluation of the HPCI system's ability to perform its intended safety function, given the auxiliary oil pump motor overheating. Assuming certain accident scenarios (small break Loss of Coolant Accident), the HPCI system would start on low reactor vessel level, trip when a pre-determined reactor vessel level was attained, and then restart when the reactor vessel level decreased to the low level setpoint. Given the overheating of the auxiliary oil pump motor, the HPCI system might have been incapable of performing it's intended safety function. An aborted surveillance test should be considered a failure if the test was aborted for reasons which would have precluded the supported equipment from performing its intended safety function.

2.7 Plant material condition and engineering work backlog

2.7.1 As stated by the licensee, to reduce the existing backlog of work in a timely manner would require more human and financial resources than are currently allotted.

Some open engineering work items were not evaluated to determine the man-hours and financial resources needed to close out the items, individually or collectively. It would appear difficult to plan current or future work without having this information available during problem scoping, resolution, and implementation phases.

The team requested a list of corrective action systems used at the site or at corporate that document or resolve deficiencies, nonconformances, errors, adverse quality conditions, and failed components. The information that was supplied in response to the team's request was "subprogram" data relative to the CAP program. How much of this data constituted backlogged information that engineering was responsible for was not clear to the team. The team was able to determine that at least the following programs were related to engineering deficiency tracking systems.

Program Description	# of Open Items
deficiency resolution information program (DRIPs)	45
general engineering assist requests (GEARS)	<100
STSIs (part of TCs)	>1000
engineering modifications	unknown
engineering work requests	unknown

Note: The above list was not meant to serve as a complete list of tracking systems.

Human and financial resources needed to resolve and implement corrective actions associated with closed and open STSI concerns (in excess of 1000) was unknown. The team reviewed only two STSIs in detail; 1) the EDG building inappropriately modified anchor bolt issue, which resulted in a plant shutdown subsequent to the team's review, and 2) the work surrounding service water pump replacement; and did not evaluate the extent of concerns with the remaining STSI components.

2.7.2 Availability of funding to support plant material improvements

It was the perception of the Brunswick staff that budget restraint was a factor in Brunswick's weak performance, and that the plant material condition needed to be improved if a reduction in plant events was expected.

A reduction in capital spending was planned over the next five year period despite degraded material conditions. Using 1990 as a base the planned capital expenditures for the six subsequent years (either planned or actual) fell noticeablely shorter than the 1990 amount, in spite of a retrogressing physical condition. Planned expenditures were reduced because fewer major modifications were planned. The planned expenditures did not include the resources to cover new deficiencies that were considered likely to arise from new initiatives such as the system engineer reviews and eventual plant aging studies. The proposed expenditures for the next five years were not indicative of a concerted effort to improve material conditions.

There was an apparent budget shortfall which may impact the timely completion of service water repairs or other projects over the next 5 years. The team discussed the service water project with the service water modification group. The scope of their project was the completion of the piping modifications, reactor building closed cooling water heat exchanger replacement, valve repair, service water pump repair, GL-89-13, and design basis reconstitution. The team asked the group to estimate the number of man-years required to complete only the items that were currently identified as deficiencies in these areas. The group reached a consensus that the human resources needed was approximately 100 man-years per year for the next five years. The actual budgeted amount for this entire project was approximately $23 Million, which was not sufficient to cover the groups estimated man-power requirements for this project, material costs, and any emergent work that results from this project.

2.7.3 Operations "10 Most Wanted Lists" may not be effective in resolving significant deficiencies.

The team concluded that the Operations group "10 Most Wanted Lists" were no more effective in resolving plant deficiencies than the routine plant-wide deficiency identification process.

The team evaluated the effectiveness of the operation's group "10 Most Wanted Lists" to determine if the program was effective in resolving the deficiencies identified by the operating staff as the 10 most important or troublesome. The team performed this evaluation by interviewing operation personnel to determine their assessment of the program, analyzing the significance of the items placed on the list, reviewing the completion rate of the items and evaluating the analysis performed for those items that were on the lists but were removed for various reasons. The team reviewed two "10 Most Wanted" lists. One list delineated the 10 most wanted/needed equipment modifications and the other listed the 10 most wanted/troublesome equipment related work requests (WR/JOs).

Operations personnel said they were less than enthusiastic about the completion of the modifications on the list. The operators noted that only two of the ten most wanted modifications were implemented during the last refueling outage.

Similarly, a review of the 10 most wanted work requests revealed that selected safety significant work requests were removed from the list, having been deferred for reasons such as "waiting on an outage" or "waiting on an engineering evaluation." Some of these deferred work requests are listed below.

- WR/JO 90-AM2X1 dealt with a malfunctioning reactor building ventilation system.
- WR/JO 91-AIGG1 dealt with unit 2 alarms that annunciate on unit 1.
- WR/JO 91-AGNM1 dealt with a malfunctioning EDG building ventilation system.
- WR/JO 91-ANBU1 pertained to a malfunctioning HPCI flow controller.

Some of these items were dated 1990 and constituted safety-significant equipment deficiencies that the operators had to compensate for, or "work around." A review of the evaluations performed to justify deferring the above work revealed that the safety significance of operators having to compensate for these equipment deficiencies was not a prime consideration in the evaluation. Additionally, there were 28 items on Unit 1 and 5 items on Unit 2 that were placed on the 10 most wanted lists and removed without being worked.

3.0 ROOT CAUSES

Based on observations made during this engineering inspection, accomplishments made since the DET, and an examination of findings and observations in the DET report, the following root causes were developed:

1) The fundamental root cause for the licensee's continued weak performance has been a lack of management vision of where they wanted the plant to be in the future (including achievable lower level milestones that could be embraced and implemented by Brunswick personnel);

2) The licensee's problem resolution philosophy has been to treat the individual symptom, rather than the root cause. This philosophy resulted in vague site goals, priorities, and expectations, as well as ineffective and untimely corrective actions;

3) Insufficient capital expenditures in the past, as evidenced by major project deferrals, has contributed to the current marginal material condition of Brunswick. This condition is not expected to significantly improve in the future because of proposed reductions in capital spending over the next five years; and

4) Chronic instability of the Technical Support organization. Thirty-six Technical Support supervisors have left the Technical Support organization since 1987.

4.0 EXIT MEETING

The inspection scope and findings were summarized on April 10, 1992, with those persons indicated in Appendix B. The team described the areas inspected and discussed in detail the inspection findings. There was some clarifying discussion; however, there were no dissenting comments received from the licensee. Proprietary information is not contained in this report.

Item Number	Status	Description/Reference Paragraph
50-325, 324/92-10-01	OPEN	VIO Inadequate Corrective Actions. (par. 2.2)

SUMMARY OF EVENTS

Appendix A

Discovery of Inappropriately Modified Anchor and Through-wall Bolts Installed in the EDG Building

Below is a brief listing of events and corrective action taken by the licensee regarding inappropriately modified anchor bolts.

During the early 1970's: Masonry block walls were constructed within the EDG building in accordance with original design specifications. The licensee believed the masonry walls were seismically constructed but not safety-related. Sometime in 1973, missile protection plates with reinforcing angles were constructed over these masonry block walls which separate the EDG bays.

On May 8, 1980: IE Bulletin No. 80-11, "Masonry Wall Design" was issued by the NRC as a result of inspections conducted at the Trojan Nuclear Plant in response to non-conservative design criteria for the reactions from supports anchored into the face of concrete masonry walls. The licensee's response to this bulletin stated that approximately 80 walls met the criteria for examination and that 20 of the walls would require modification in accordance with the bulletin. The masonry block walls in the EDG building were included in the list that needed modification.

On Feb 13, 1987: The EDG system engineer wrote a site memorandum Brunswick Engineering Support Unit to senior site engineering supervisors which identified that some of the anchor bolts were inappropriately modified as a result of a recent inspection of the missile protection shield walls. The EDG system engineer became aware of this concern when an I&C technician told him of the problem. In remberance of the event, a recently signed statement (April 1992) by the supervisor at the same time, but stated the cost to perform a 100 percent sampling of the sheild wall bolts was estimated to have cost approximately $170,000. The anchor bolt sample size was reduced to include a partial sample at a cost of $60,000. Subsequent memoranda were produced concerning the inappropriately modified bolts, however, anchor bolts inspections were not accomplished until 1990.

In 1988: IE Bulletin 80-11 was closed out by the licensee without any action taken to resolve the inappropriately modified EDG wall anchor bolts.

On December 18, 1990: Calculation #0-1534A-270, Masonry Block Walls in the EDG Building, was performed to determine if the walls were operable given the "missing" anchor bolts. The calculation showed a mapping of the missile shield walls where the licensee thought the inappropriately modified bolts were located. The test used to determine the location of missing bolts utilized a feeler gauge test (physically placing a shim between the angle steel and the concrete wall to feel for the existence of a bolt shaft). On December 18, 1990, engineering evaluation report #90-0313, "Evaluation of masonry block wall el. 23'-0" diesel generator building," determined that the masonry block walls (with the as-found missile shield plates) were acceptable for short term structural integrity qualification, according to Engineering Procedure ENP-12, "Requirements for Performing Engineering Evaluations." The corrective actions identified from this EER were to perform repairs and/or modifications to the wall anchor bolts to restore the long-term structural integrity requirements. On December 18, 1990 EER # 90-031, "Evaluation of masonry block wall" determined that a change to the FSAR or the technical specification was not required, and that long term corrective actions were mandated by the action items in EER #90-0313.

On March 23, 1992: The team discovered that the licensee's temporary change tracking system listed an item associated with EER #91-1200, Block walls with 1/4 inch steel cover plates at elevation 23'0" in EDG building, the drilled-in anchor bolts provide lateral support for wall do not penetrate the concrete. This item was listed as being "open" in December of 1990, but still had a priority classification of "99," which meant that it had not been prioritized yet. The team later performed a review of EER #91-1200 and visually confirmed that many anchor bolts were inappropriately modified.

On April 4, 1992: The team determined that the test methodology used by the licensee to locate inappropriately modified anchor bolts was in error. A feeler gauge was originally used to determine the presence or absence of inappropriately modified bolts which resulted in inaccurate information. Consequently, the basis for the finite element calculation was also inaccurate. The team also observed the licensee using a "Ping" test (ball-peen hammer test) to compliment the feeler gauge technique. While the licensee was performing the ping test, one anchor bolt fell off the wall. The anchor bolt was not only inappropriately modified, but a hole was never bored in the concrete in which to install a "real" anchor bolt. Examination of the inappropriately modified anchor bolt revealed that the bolt was cut short, (possibly by using an acetylene torch). The team observed that no procedure was used by the licensee during the examinations of the walls and the team questioned the choice of testing techniques employed by the licensee When the team questioned the assumption by the licensee that the missile shield through-wall bolts were not suspect, the licensee responded that they had no reason to suspect those bolts and that the STSI qualification of the wall did not rely on the through-wall bolts. The licensee informed the team that the QC records for both the anchor bolts and the through-wall bolts could not be located.

On April 6, 1992: The team informed the licensee that the feeler gauge or ping test methodology was unacceptable for locating inappropriately modified anchor bolts, so the licensee chose to remove several of the anchor bolts in the supposed worst case wall (wall #8, located between EDG #4 and the south switchgear room) for visual examination. Using this method, many anchor bolts were found to be inappropriately modified that were not previously suspected.

On April 7, 1992: An ultrasonic test engineer arrived at the site to test a sample of the through-wall bolts. Eight of fiftynine through-wall bolts (located within reach of the inspector standing on the floor) were confirmed by ultrasonic testing to be inappropriately modified. Based on the latest analysis, the licensee determined that wall #8 failed the STSI acceptance criteria by a factor of 2. Senior licensee management subsequently declared entry into the technical specification 7-day limiting condition for operation for EDG #4 inoperable.

On April 8, 1992: The licensee further investigated the impact of the inoperable wall (wall #8) and subsequently identified a core spray loop and one nonsafety-related service water pump that were also rendered inoperable by failure of wall # 8 (due to electrical conduits adjacent to the wall). This determination required the licensee to enter two additional limiting condition for operations action statements.

On April 21, 1992: The licensee had been performing ultrasonic tests and backing out anchor bolts on the angle iron plates that provide seismic lateral support for the poured concrete walls adjacent to the interior EDG masonry block walls. These walls did not have rebar that extended below floor elevation (not keyed walls) and were required to have additional lateral supports with bolted angle iron. The concrete interior wall having the most known inappropriately modified or missing bolts (wall #9D, located between EDG #1 and the north switchgear room) was inspected first. The design of the wall required a total of 20 bolts (10 on each side with 8 of the 10 located at the top horizontal run). The as-found condition of wall 9D had 11 bolts confirmed operable. The results of the subsequent STSI calculation resulted in the licensee declaring Wall 9D, EDG #1, and E6 and E5 switchgear inoperable. A waiver of compliance was granted by the staff to allow the licensee time to make the necessary modifications to restore STSI qualification. The licensee was continuing their efforts to STSI-qualify the remaining EDG interior walls. Further examinations of the remaining non-keyed poured cement walls in the EDG building revealed that all the poured walls were suspect. The licensee later declared the walls inoperable and took action to place both units in a shutdown condition.

Attended Exit Interview

Appendix B

Carolina Power and Light Company

K. Ahern	Manager - Operations
H. Beane	Manager - Quality Control
E. Bishop	Mechanical Engineering Supervisor - NED
M. Bradley	Manager - NAD
J. Brown	Manager - BNP NED
A. Burkhart	Manager - Operational Experience Program
S. Callis	Site Licensing Engineer
J. Casteen	BNP - Plant Services
L. Eury	Executive Vice President
K. Fennell	Manager - BOP Systems
S. Floyd	Manager - Regulatory Compliance
M. Foss	Manager - Regulatory Programs
R. Helme	Manager - Technical Support
J. Holder	Manager - OM/M
M. Kesmodel	BNP - IAP
R. Knight	Specialist - Regulatory Compliance
C. Lewis	BNP - Project Services
A. Lucas	Manager - NED
J. Martin	Site Assistant Team
D. McCarthy	Manager - Nuclear Licensing
G. Miller	Manager - Nuclear Systems Engineering
B. Monroe	Site Engineering
D. Quick	BNP - NAD
R. Richey	Vice President - BNP
S. Scharff	BNP - NAD
J. Spencer	Plant General Manager
J. Waldorf	NPSS - Manager Technical Support
G. Warriner	Manager - Administration
H. Williams	Manager - Civil Engineer -NED
S. Zimmerman	Site Assistance Team

USNRC

E. Adensam	NRR
P. Byron	Resident Inspector - Brunswick
A. Gibson	RII - Division of Reactor Safety - Division Chief
R. Lloyd	AEOD
L. Mellen	RII - Reactor Inspector
W. Orders	Senior Resident Inspector - Catawba
R. Prevatte	Senior Resident Inspector - Brunswick
J. Thompson IV	AEOD