UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

Report Nos. 50-324/81-18 and 50-325/81-18

Licensee: Carolina Power and Light Company
411 Fayetteville Street
Raleigh, NC 27602

Facility Name: Brunswick

Docket Nos. 50-324 and 50-325

License Nos. DPR-71 and DPR-62

Inspection at Brunswick site near Southport, North Carolina, Rockwell International Plant in Raleigh, North Carolina, and Carolina Power and Light Company Laboratory in Raleigh, North Carolina.

Inspectors: Frank Jape for H. L. Whitener, Region II — 10/5/81 Date Signed

Frank Jape for W. D. Kelley, Vendor Inspection Branch, Region IV — 10/5/81 Date Signed

Approved by: Frank Jape for F. Jape, Section Chief — 10/5/81 Date Signed
Engineering Inspection Branch
Engineering and Technical Inspection Division

SUMMARY

Inspection on July 21-25, 1981, at the Brunswick Plant; August 3-8, 1981, at the Rockwell International Plant; and August 12, 1981, at the Carolina Power and Light Company Laboratory.

Areas Inspected

This special, announced inspection involved 66 inspector-hours on site in the investigation of main steam isolation valve failures.

Results

Of the area inspected, no violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

C. Dietz, Plant Manager
*R. Morgan, Plant Operations Manager
*W. Tucker, Technical Supervisor
*M. Hill, Maintenance Superintendent
*E. Bishop, Engineering Supervisor
S. Grant, Principal Engineer, CP&L Harris Center Lab
*J. Boone, Project Engineer
E. Cathey, Engineer
G. Locklear, Senior Generation Specialist
S. Bohanon, Regulatory Compliance
*R. Poulk, Regulatory Compliance

Other Organizations

Rockwell International
**J. V. Grasso, General Plant Manager
B. Milleville, Senior Technical Advisor
**R. A. Bandukwala, Manager, Quality Assurance
J. P. Tucker, Product Specialist
**S. L. Adams, Supervisor, Project Engineering
N. West, Field Service Representative

NRC Resident Inspector

*D. Johnson, Senior Resident Inspector

*Attended exit interview July 25, 1981
**Attended exit interview August 13, 1981

2. Exit Interview

The inspection scope and findings were summarized on July 25, 1981 at the Brunswick Plant and on August 13, 1981 at the Rockwell International Plant with those persons indicated in paragraph 1 above.

3. Licensee Action on Previous Inspection Findings

Not inspected.

4. Unresolved Items

Unresolved items were not identified during this inspection.

5. Main Steam Isolation Valve Failure

a. History

Since Brunswick Unit 2 was licensed in December 1974, there have been six main steam isolation valve (MSIV) disc separations. Separation has occurred at the pressure balancing valve between the stem and stem disc on three occasions and between the piston and main valve disc on three occasions. Of these MSIV disc separations, four have occurred in 1981. A Region II inspector and a Region IV vendor inspector visited the Brunswick facility on July 21-25 and later the Rockwell International plant in Raleigh, North Carolina, on August 11-13, 1981 to review the cause of repeated valve failures and the corrective action to prevent future failure. At this time the only known Rockwell MSIV disc separation other than at Brunswick occurred at Hatch 2. The failure experienced at Hatch 2 was due to improper seating of the stem to stem disc pin. A brief summary of MSIV problems at Brunswick is listed below:

(1) July 30, 1976: Unit 2 steamline "D" inside isolation valve (F022D) main disc separated from the piston. The main disc unscrewed from the piston due to improper pin installation. The hole for the lock pin in the piston and disc had not been drilled deep enough.

(2) January 29, 1979: Unit 2 steamline "A" inside isolation valve (F022A) stem disc separated from the stem. The stem disc unscrewed from the stem after the locking pin had failed due to fatigue cracking. It was noted during inspection of this valve that the main disc to piston connection was loose but not separated. A number of observations indicate that torque is occurring in the valve which tends to unscrew the threaded connections as follows:

- Circumferential gall marks on top surface of the stem disc,
- elongated locking pin hole in the stem and stem disc,
- wear rings on valve body bore,
- main disc to piston locking pin deformed in a manner indicating attempted rotation in a direction which would unscrew the connection.

(3) January 1979 refueling outage: Unit 2 steamline "D" isolation valves F022D and F028D were disassembled due to failing the local leak rate test.

In valve F022D the threaded correction between the stem and stem disc was loose indicating a loss of torque preloading. The cross sectional area of the locking pin had been reduced in the range of 30 to 50 percent at the stem/stem disc interface. In valve F028D a similar condition was found to that in F022D. The stem to stem disc locking pin was deformed. The main disc to piston assembly connection was tight in both valves.

(4) January 15, 1981: Unit 2 steamline "C" outside isolation valve (F028C) main disc separated from the piston. The main disc unscrewed from the piston. In this case it appeared that the disc to piston locking pin had not been installed.

(5) March 30, 1981: Unit 1 steamline "C" inside isolation valve (F022C) stem disc separated from the stem. The locking pin was not recovered but damage to the pin hole indicates that the pin had been installed.

(6) July 2, 1981: Unit 2 steamline "C" inside isolation valve (F022C) stem disc separated from stem. The locking pin was present but was rounded on the end rather than bevelled as a new pin would be. Also the locking pin hole in the stem which should be ¼-inch deep was only about 1/8-inch deep.

(7) July 17, 1981: Unit 2 steamline "D" inside isolation valve (F022D) main disc separated from the piston. The locking pin broke out a section of the main disc hub. Inadequate thread engagement appears to be the failure mechanism.

(8) July 21, 1981: Spare parts manufactured by Rockwell and stored on site were inspected on site. The threads on three of four stems and two of two stem disc were found to be out of drawing specification limits in a nonconservative direction. This matter was reviewed at the Rockwell plant and the results are reported in IE Report No. 99900058/81-02.

A Rockwell International Technical Report dated August 7, 1981, indicates that for items (5) and (7) above, the separation of the threaded joints occurred without unscrewing. In item (6) it is not clear whether separation occurred from unscrewing or pulling straight out.

b. Failure Mechanisms

Rockwell engineers stated that the threaded connections in the valve are designed to be self-locking connections under the applied torque preloading. Pinning is an anti-rotational device only. The pin is not intended to sustain valve operational forces. Examination of valve components and review of maintenance records indicates that several factors may contribute to eventual failure such as: (1) loss of preloading, (2) lack of thread engagement, (3) inadequate pinning, and (4) flow induced vibration.

The engineering evaluation of the cause of failure based on available data postulates that a loss of preloading on the threaded connections is occurring. The preloading is obtained by applying torque to the threaded connection in order to pull the stem disc tightly against a full shoulder on the stem. This preloading may be lost momentarily during valve operation or as a result of flow induced vibration. Loss of the preload will result in movement between the threaded pieces and eventual looseness of the threaded joint due to thread wear. Thread wear will ultimately lead to axial disc separation due to loss of thread engagement Also, if the pin engagement is inadequate or if pin failure occurs, vibration induceds rotation of the threaded parts will cause disc separation .As indicated in paragraph 5.a., these conditions and failure modes have been observed. Conditions which support this failure analysis are as follows:

(1) The presence of vibrational forces from turbulent steam flow is postulated due to the close connection of pipe elbows to the inside isolation valves. Five of the six disc separations have occurred on inside isolation valves. In the one disc separation on an outside isolation valve failure was due to unthreading. It appears that a pin was never installed to prevent rotation.

(2) Pin Engagement:

As indicated in paragraph 5.a., poor pin engagement such as misalighment of pin and hole, lack of depth in hole, and failure to install a pin has been identified with valve failures. Although the pin is not intended to be a force sustaining device, it is clear from pin wear and deformation that it does retard rotation of valve parts.

(3) Thread Engagement:

Lack of thread engagement due to undersized threads would accelerate failure from thread wear because of the presence of less thread material. Undersized threads on installed valve components have not been confirmed.

Based on the above analysis the licensee, in conjunction with vendor engineers, has developed an immediate corrective action plan for repair of the failed valves. The plan includes verification of proper thread engagement by dimensional checks of threaded parts, and improvement of pin engagement by increasing the number, length and diameter of pins and increasing the depth of pin holes.

- Ensure proper thread engagement by dimensional checks of threaded parts.

- Ensure proper pin engagement by increasing the number, length and diameter of pins and increasing the depth of pin holes.

Permanent corrective action to prevent recurrence of the failures is being pursued with the valve manufacturer.

c. Safety Evaluation

Prior to returning the plant (Unit 2) to operation, the Plant Nuclear Safety Committee performed a safety review and concluded that the plant could be safely returned to operation. This review included consideration of the following:

(1) The transient resulting from the rapid closure of one MSIV is bounded by the FSAR analysis.

(2) CP&L and Rockwell engineers conclude that for either stem disc or main disc separation the main disc will seat.

(3) Seating of the main disc causes a loss of steam flow which will be evident to the reactor operator who will take action to close the second isolation valve and isolate the affected steamline.

(4) Although increased leakage may occur through the stem-disc seat of the failed valve, closure of the second valve will isolate the affected line.

The NRC concluded that the licensee's evaluation was adequate to permit continued plant operation for an interim time until the permanent corrective action can be determined and implemented. However, should an additional MSIV failure occur, the NRC will re-evaluate the corrective action and continued reactor operation based on the conditions at that time.