Duke Power Company
McGuire Nuclear Station
12700 Hagers Ferry Road
Huntersville, NC 28078-8985

(704)875-4000

DUKE POWER

November 9, 1990

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station Unit 2
Docket No. 50-370
Voluntary Special Report

Gentlemen:

Attached is a Voluntary Special Report concerning a Control Rod being inadvertently pulled from a fuel assembly during removal of the upper internals. This report is being submitted as a Voluntary Special Report. This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Tony McConnell

T.L. McConnell

DVE/ADJ/cbl

Attachment

xc: Mr. S.D. Ebneter
Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta St., NW, Suite 2900
Atlanta, GA 30323

INPO Records Center
Suite 1500
1100 Circle 75 Parkway
Atlanta, GA 30339

M&M Nuclear Consultants
1221 Avenue of the Americas
New York, NY 10020

Mr. Darl Hood
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Mr. P.K. Van Doorn
NRC Resident Inspector
McGuire Nuclear Station

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DUKE POWER COMPANY
McGUIRE NUCLEAR STATION
Special Report No. 2-M90-0245
A Control Rod Was Inadvertently Pulled From A Fuel Assembly
During Removal Of The Upper Internals Caused By
Reasons Unknown, Possible Procedure Deficiency

ABSTRACT:

On September 17, 1990, at 0645, Unit 2 was in Mode 6 (Refueling) in preparation for unloading the fuel from the core. The Operations Refueling Senior Reactor Operator discovered a Control Rod laying on top of the Core. The Control Rod had been inadvertently pulled from the Fuel Assembly when the Reactor Vessel Upper Internals were removed by Maintenance personnel. The Upper Internals had been removed at 0200 on September 17, 1990. This incident is assigned a root cause of Unknown, Possible Procedure Deficiency. A contributing cause of Defective Procedure, Lack of Procedural Precautions is also assigned. Corrective actions include procedure enhancements, lighting improvements, and equipment improvements.

EVALUATION:

Background

The Reactor Vessel Upper Internals section is comprised of the Top Support Plate, the Upper Core Plate, Support Columns, and Guide Tube Assemblies. These Internals are designed to be removed as one unit during Refueling operations. The Upper Internals, including the lifting device, weighs approximately 167,000 pounds when submerged in water.

Control Rods are used to help in controlling the power level of the Reactor. Each Control Rod has rodlets which enter the top of the Fuel Assembly. The weight of a Control Rod is approximately 74 pounds. The tops of the rodlets are connected to a Spider Assembly. The center of the Spider Assembly has a hub which latches to a Control Rod Drive Rod. The Drive Rod passes up through Guide Tube Assemblies which protect and guide the Control Rod Drive Rods. The top of the Drive Rod is raised or lowered by the Control Rod Drive Mechanism.

Technical Specifications defines Shutdown Margin as "the instantaneous amount of reactivity by which the Reactor is, or would be subcritical from its present condition assuming all Control Rods are fully inserted except for the single Control Rod of highest reactivity worth, which is assumed to be fully withdrawn."

Description of Event

On September 14, 1990, refueling activities began in the Unit 2 refueling outage. At 1434, the Reactor Vessel Head was removed from the Reactor Vessel and placed on the Head Stand by Maintenance (MNT) personnel. Operations personnel began filling the Refueling Cavity with borated water at 1753 in preparation for unloading the fuel from the Reactor to the Spent Fuel Pool.

On September 16, at 1236, after the Refueling Cavity had been filled, MNT personnel began unlatching the Control Rods from the Drive Assemblies as directed in procedure MP/2/A/7150/73, Rod Cluster Control Assembly Drive Rod Unlatching And Latching. The MNT personnel stated that three of the four underwater lights were burning when they began the unlatching procedure. The day shift MNT crew had completed unlatching 37 of the 53 Control Rods at 1830 when the night shift MNT crew reported for work. The day shift MNT supervisor stated that a second underwater light had burned out just prior to the night shift crew coming in to work. This MNT supervisor stated that adequate lighting was available to proceed with unlatching the Control Rods with the remaining two underwater lights in service. The day shift MNT supervisor noted in the turnover log that the lights in the Reactor Cavity needed to be checked.

The night shift MNT crew completed unlatching the remaining 16 Control Rods at approximately 2300 on September 16, 1990. The night shift MNT crew next began removing the Reactor Vessel Upper Internals as directed by procedure MP/0/A/7150/43, Reactor Vessel Upper Internals Removal and Replacement. This procedure, in part, directs MNT personnel to utilize the Polar Crane with a load cell and lifting device connected to the Reactor Vessel Upper Internals. These Internals are lifted up high enough to clear the Reactor Vessel Flange and then placed on the Upper Internals Storage Stand. During the lift of the Upper Internals, and subsequent moving to the Storage Stand, the crane

operator monitors the load cell indications to ensure the Internals are not binding. Also, an observer is positioned at the Refueling Canal deep end to ensure that components are not attached to the Upper Internals Core Plate. The Upper Internals were placed on the Storage Stand at approximately 0200 on September 17, 1990.

At 0600, the Operations Refueling Senior Reactor Operator (SRO) entered the Reactor Building and began lowering lights around the Reactor Cavity in preparation for unloading fuel. During the process, the SRO discovered a Control Rod Assembly laying at an angle on top of the fuel assemblies. The Spider Hub end of the Control Rod was leaning against the Core Barrel and the rodlets were laying on top of the Fuel Assemblies. The Refueling SRO notified the Operations Control Room SRO of his discovery.

At 0630, Operations personnel verified adequate Shutdown Margin with one Control Rod withdrawn from the Reactor Core.

At 1145, on September 17, a camera was lowered down to inspect the Control Rod. Viewing of the tape from this inspection did not reveal any major damage to the Control Rod or to the tops of the Fuel Assemblies in the area of the Control Rod.

Procedure TO/2/A/9600/057, Retrieval of RCCA On Top Of Rx Core, was written and approved and the Control Rod was retrieved and placed on the floor of the Refueling Canal at 2030 on September 17, 1990. The Control Rod was moved to the Spent Fuel Pool for storage on October 16, 1990.

Conclusion

This incident is assigned a cause of Unknown, Possible Procedure Deficiency. The exact cause for the Control Rod coming out of the Core could not be determined. MNT personnel performing the procedure for removal of the Upper Internals stated they believed the Control Rod was properly unlatched. They also stated that had the Control Rod not been unlatched, it would not have dropped free when the Upper Internals were being moved. The Rodlets would probably have bent when they bumped into the Core Barrel, but the Drive Shaft should have remained latched to the Spider Assembly of the Control Rod.

A possible scenario for the Control Rod being lifted with the Upper Internals is associated with the Control Rod Unlatching procedure. This procedure requires the MNT personnel to position the Unlatching Tool over the Control Rod. The Unlatching Tool is latched to the Drive Rod and the entire Control Rod Assembly is lifted approximately 6 inches while monitoring a load cell. This ensures the Control Rod is properly attached to the Unlatching tool. The Control Rod is then lowered back and the Drive Rod is Unlatched from the Control Rod. The Drive Rod is raised approximately 12 inches while monitoring the load cell to ensure the Control Rod is unlatched. The Drive Rod is then set on top of the Hub of the Spider Assembly of the Control Rod and the Unlatching Tool is disconnected from the Drive Rod (see Enclosure 6). When all of the Control Rods have been unlatched, a check pass is performed. The check pass has the MNT personnel latch each Drive Rod and raise it approximately 6 inches while monitoring the load cell. This check pass again verifies the Control Rod is unlatched. The Drive Rods are removed with the Upper Internals.

Elevation marks are established on the Unlatching Tool lifting bail during the unlatching of the first Drive Rod. The Manipulator Crane handrail is the reference point for these elevation marks. The handrail is located approximately 6 inches away from the elevation marks on the Unlatching Tool. The lower elevation mark is the unlatched position and the upper elevation mark is the latched position. These reference points are used to help ensure each Control Rod is properly unlatched.

The Control Rod possibly remained partially attached to the Drive Rod following the check pass. This could occur if the Drive Rod did not sit down exactly on top of the Spider Assembly Hub. During the check pass, the Unlatching Tool is aligned over each Control Rod Drive Rod. The Unlatching Tool can be latched to the Drive Rod even if it is not exactly centered over the Drive Rod. A deviation of a fraction of an inch will still allow the Drive Rod to be latched. The Drive Rod is raised approximately 6 inches and then lowered back down on top of the Spider Assembly Hub. The small amount the Unlatching Tool was off center could cause the Drive Rod to miss sitting flush on the Spider Assembly Hub. This could allow the Drive Rod latching fingers to straddle the Hub of the Spider Assembly, partly in the Hub and partly outside of the Hub. If this occurred, the potential exists for the fingers to catch enough to raise the Control Rod when the Drive Rod was lifted with the Upper Internals. When the Upper Internals had been lifted sufficiently to clear the Reactor Vessel Flange, the Upper Internals were moved toward the Internals Stand. The Control Rod would have been hanging below the Upper Internals and would have contacted the Core Barrel. This would have jarred the Control Rod free.

The Control Rod was discovered laying on the opposite side of the Core from the Core location that it came from. The procedure for unlatching the Control Rods did not instruct the MNT personnel to ensure the unlatching tool was aligned for plumbness over the Control Rod Drive Rod.

MNT personnel use a load cell when lifting the Upper Internals. The weight of the Upper Internals and the lifting device is approximately 167,000 pounds. The Control Rod weight of 74 pounds would not be noticeable to the MNT personnel performing this procedure.

The elevation marks used to ensure that a Control Rod is unlatched could have given an indication of a Drive Rod not sitting properly on top of the Spider Assembly Hub. If the Drive Rod was straddling the Hub, the elevation mark would be slightly higher than normal. The MNT personnel are required to sight from the handrail to the elevation marks on the Unlatching Tool lifting bail, a distance of approximately 6 inches. This small amount of difference would be very difficult to notice.

A contributing cause of Defective Procedure, Lack of Procedural Precautions, is being assigned to this event. The procedure for removing the Upper Internals requires an observer to stand at the Refueling Canal deep end to ensure that Core components are not attached to the Upper Internals Core Plate. The MNT person performing this task is approximately 40 feet away and attempting to look down through the water. The procedure did not have any lighting requirments for the Reactor Cavity Area. The underwater lights used for unlatching the Control Rods are not sufficient to enable this observer to see that a Control Rod was being lifted with the Upper Internals. The positioning of the lights and the amount of light were both inadequate.

A review of the Operating Experience Program data base for the past twenty four months prior to this incident revealed no incidents involving Control Rods or Fuel assemblies being inadvertently removed from the Core. Therefore, this incident is not considered recurring.

This event is not Nuclear Plant Reliability Data System (NPRDS) reportable.

There were no personnel injuries, radiation overexposures or uncontrolled releases of radioactive material as a result of this incident.

CORRECTIVE ACTIONS:

Immediate:

1) Operations personnel verified adequate Shutdown Margin with one Control Rod out of the core.

Subsequent:

1) Operations and MNT personnel inspected the dropped Control Rod with a submersible video camera.

2) The Operations Fuel Handling supervisor wrote procedure TO/2/A/9600/057, Retrieval Of RCCA On Top Of Rx Core.

3) Operations and MNT personnel retrieved the Control Rod from the top of the core and placed it on the floor of the Refueling Canal.

4) Operations and MNT personnel inspected the Fuel Assemblies in the area where the Control Rod dropped with a video camera.

5) MNT personnel designed and fabricated a pointer to be attached to the handrail, during Control Rod Unlatching, to improve the accuracy of the elevation marks on the Unlatching Tool.

6) Lights were installed by MNT personnel on the Unlatching Tool to better illuminate the area where the Unlatching Tool connects to the Drive Rod.

7) A video camera inspection was performed by MNT personnel of the bottom of the Upper Internals and of the Spider Assembly Hub on the Control Rod that was dropped searching for the cause of the Control Rod being lifted. No conclusive evidence was found.

8) The Drive Rod for the affected Control Rod was inspected by MNT personnel. No damage was found.

Planned:

1) MNT personnel will revise the Control Rod Unlatching procedure (MP/2/A/7150/73) to require verification of plumbness of the Unlatching Tool over the Drive Rods when latching or unlatching.

2) MNT personnel will revise the procedure for removing the Upper Internals (MP/0/A/7150/43) to require a back light to help in determining that Control Rods or Fuel Assemblies are not being inadvertently lifted.

3) MNT personnel will investigate the feasibility of using a submersible camera in conjunction with a back light to ensure that no Control Rods or Fuel Assemblies are inadvertently being lifted with the Upper Internals.

SAFETY ANALYSIS:

Technical Specifications requires that the boron concentration of the Reactor Coolant System and the Refueling Canal be the more restrictive of either a Shutdown Margin of 5 percent or a minimum boron concentration of 2000 parts per million (ppm) while in Mode 6. This requirement ensures that the Reactor will remain subcritical during Core Alterations.

During the time of this incident, the Reactor Coolant System and Refueling Canal Boron concentration was 2049 ppm. This concentration was more than adequate to ensure the Reactor remained subcritical. Calculations show that even with the most reactive Control Rod out of the Core, the required Boron Concentration to ensure a Shutdown Margin of 5 percent is 1659 ppm.

The Fuel Assemblies were not damaged in this incident. In a worst case scenario, the dropping of a Control Rod could have caused a breach in the fuel clad. The dose consequences for such an event would be bounded by the analysis for Fuel Handling Accidents performed in Chapter 15.7.4 of the Final Safety Analysis Report which states that the doses from this accident are within 10CFR100 limits.

The health and safety of the public were not affected by this incident.