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SUBJECT: Informs NRC of 1995 refueling outage planned maint activities for Westinghouse Alloy 600 mechanical plugs installed in steam generator hot leg tubes at plant.

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ROBERT C. MECREDY
Vice President
Nuclear Operations

February 24, 1995

U.S. Nuclear Regulatory Commission
Document Control Desk
Attn: Allen R. Johnson
Project Directorate I-3
Washington, D.C..20555

Subject: "Failure of Westinghouse Alloy 600 Steam Generator Tube Mechanical Plugs"
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Ref. (a): Letter from R. C. Mecredy, (RG&E) to A. R. Johnson, (NRC) "Failure of Westinghouse Alloy 600 Steam Generator Tube Mechanical Plugs", date January 25, 1995

Dear Mr. Johnson:

In Reference (a) Rochester Gas & Electric committed to inform the NRC of the 1995 Refueling Outage planned maintenance activities for Westinghouse Alloy 600 mechanical plugs installed in steam generator hot leg tubes at Ginna Station. Due to the scheduled replacement of the existing steam generators in 1996, Rochester Gas & Electric plans to visually inspect all hot leg mechanical plugs during the 1995 Refueling Outage. Any hot leg plugs with leakage indications will be either repaired or replaced during the 1995 Refueling Outage. Replacement of all of the other plugs will be accomplished by virtue of the steam generator replacement.

Rochester Gas & Electric's technical basis for these planned activities is provided in Attachment 1.

Very truly yours,

Robert C. Mecredy

JFD\368

xc: Mr. Allen R. Johnson (Mail Stop 14D1)
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ATTACHMENT 1

ASSESSMENT OF CONTINUED OPERATION WITH MECHANICAL PLUGS

1.0 INTRODUCTION

In 1989 North Anna Unit 1 experienced a primary to secondary leakage event as a result of circumferential cracking in a Westinghouse Alloy 600 mechanical steam generator (SG) tube plug. The circumferential cracking resulted in a severance of the mechanical plug top. As a result of the large differential pressure acting across the plug top, the severed plug top was accelerated to a high velocity up the length of the SG tube and punctured a hole in the U-bend portion of the tube resulting in a SG tube leak of approximately 75 gpm. The North Anna Unit 1 SGs were Westinghouse Series 51 SGs with a fully expanded tubesheet region.

The root cause of the circumferential cracking in the Alloy 600 mechanical plug was determined by Westinghouse to be Primary Water Stress Corrosion Cracking (PWSCC). As a result of the North Anna event, Westinghouse performed evaluations and testing which determined that all Westinghouse Alloy 600 mechanical plugs were potentially susceptible to PWSCC. Consequently, Westinghouse developed an algorithm to determine the effective life of all installed Westinghouse Alloy 600 mechanical plugs. The primary factors used to determine effective plug life were the microstructure of the plug material and the operating temperature of the installed plugs. An effective plug life was calculated for all installed Westinghouse Alloy 600 mechanical plugs and the results were documented in WCAP-12244 (Reference 1).

As identified in Reference 2, Rochester Gas & Electric presently has 176 Westinghouse Alloy 600 mechanical plugs (89 hot leg and 87 cold plugs) installed at the Ginna Station. As a result of Supplement 2 to NRC IE Bulletin 89-01 (Reference 3), Rochester Gas & Electric committed (Reference 6) to perform repair or replacement of all installed Westinghouse Alloy 600 mechanical plugs prior to the end of the effective plug lifetime. The effective plug lifetime for Ginna Station hot leg plugs was 4734 EFPDs as documented in Addendum 2 to WCAP-12244 (Reference 4). Based upon this effective lifetime, RG&E planned to repair or replace installed hot leg mechanical plugs beginning with the 1996 Refueling Outage.

In November of 1994 St. Lucie Unit 1 discovered through wall cracking in a small population of their installed Westinghouse Alloy 600 mechanical plugs. Since the through wall cracking occurred after only 50 % of the effective plug lifetime had been expended, Westinghouse re-evaluated the effective plug

lifetime for all batches of installed plugs. This re-evaluation is documented in Addendum 3 to WCAP-12245 (Reference 5). As a result of this re-evaluation, the estimated effective lifetime for all the Ginna hot leg mechanical plugs has been reduced to 2354 EFPDs. Since the cumulative operating time for all of the installed Ginna plugs through the 1994 Refueling Outage exceeds 3400 EFPDs, it is necessary to evaluate the maintenance activities required for the 1995 Refueling Outage.

2.0 Safety Concerns

The safety concerns associated with plant operation with suspect mechanical plugs was evaluated by Westinghouse in Reference 1 following the initial failure at North Anna. Reference 1 performed a safety evaluation and provided all utilities with a justification for continued operation. The safety evaluation concluded that there were no safety concerns associated with continued plant operation. This conclusion was based upon evaluating the consequences of a plug top release event.

The Westinghouse evaluation determined that for plants with a fully expanded tubesheet design, the failure of a plug top would result in the plug top being shot up the tube. The acceleration of the plug top in the tubesheet region would impart sufficient energy to the plug top such that it would travel the full length of the straight portion of the hot leg tube. Although frictional interaction of the plug top with the roll transition region of the tube at the top of the tubesheet decelerates the plug top, complete deceleration of the plug top would not occur. For all the tubes except the shortest radius U-bend tubes, the Westinghouse testing and analysis determined that the plug top would travel the length of the tube, traverse the U-bend region and travel down into the cold leg region of the tube without causing a tube puncture. However, for tubes in Rows 1-4 for Westinghouse Series 51 SGs, the sharp curvature of the U-bend would prevent the plug top from making the turn. The plug top would impact the tube in the U-bend region and could cause a puncture of a tube as was experienced by North Anna Unit 1.

The design of the Westinghouse mechanical plug includes an expander in the plug base which provides a restriction for RCS leakage from a punctured tube. The maximum flow through the expander would limit tube primary to secondary leakage to

approximately 75 gpm consistent with the North Anna event. Since the probability of simultaneous multiple plug top releases and punctures was evaluated by Westinghouse in Reference 1 to be small, the consequences of a plug top release with resulting puncture was determined to be well within the bounds of existing design basis analyses. Additionally, plant procedures for responding to a tube leak of this magnitude existed for all of the affected plants.

Additionally, Westinghouse performed analyses (Reference 1) to assess the consequences of a plug top release for a partial depth tubesheet design which is applicable for the Series 44 steam generators installed at Ginna Station. Since the expanded tube length for partial depth steam generators is approximately 2"-3" in comparison to the 20"-22" for full depth steam generators, the initial acceleration of the plug top prior to reaching the tube roll transition region is significantly reduced from that calculated for a full depth plant. This results in a significant reduction in the plug top kinetic energy as the plug top reaches the roll transition region. The plug top kinetic energy at the roll transition region for a partial depth tubesheet plant is approximately an order of magnitude less than the kinetic energy for a fully expanded tubesheet design.

This reduced plug top kinetic energy at the roll transition region is insufficient to force the plug top past the roll transition region. Therefore, for a steam generator with a partial depth tubesheet design the severed plug top would become lodged approximately 1" into the unexpanded portion of the tube near the bottom of the tubesheet. As stated in Reference 1, laboratory testing and analysis has demonstrated that the partial depth tubesheet design precludes the occurrence of a North Anna Unit 1 type of steam generator tube puncture incident. Consequently, since the Ginna steam generators have a partial depth tubesheet, there are no safety concerns associated with operation of Ginna Station with installed hot leg Westinghouse Alloy 600 mechanical plugs.

3.0 RCS Leakage Concerns

If a plug top release did occur in a partial depth tubesheet steam generator, it is expected that the lodged plug top would prevent significant leakage past the plug top. However, plug top and tube interaction would cause some deformation of both the plug top and the tube so as to allow some leakage past the

lodged plug. This leakage would equalize the differential pressure across the severed plug top. If through wall defects are present in the plugged tube, an increase in primary to secondary steam generator leakage could occur as a result of this failure. The amount of steam generator leakage allowed by Plant Technical Specifications specifies that, if measured primary to secondary leakage during plant operation exceeds 0.1 gpm per steam generator, a plant shutdown would be required per Section 3.1.5.2.2.c of the Ginna Station Technical Specifications.

In the past as part of normal Refueling Outage (RFO) SG maintenance activities, Rochester Gas & Electric has included a visual examination of the steam generator tubesheet to identify any leaking tubes. Typically, this examination is performed at the beginning of the RFO after installation of SG nozzle dams. The visual examination requires that a static head of water be established on the secondary side of the SG to assist in the identification of any leaking tubes. After the static head of water has been established a video camera inspection of the SG tubesheets is performed to identify any leaking tubes. Any leaking tubes identified are noted and added to the RFO repair list for disposition.

Since the occurrence of the North Anna Unit 1 tube puncture in 1988, Rochester Gas & Electric has used this video inspection to verify that no hot leg mechanical plugs exhibit visual indications of leakage. During every RFO at Ginna Station since 1991, RG&E has included plans to repair/replace any hot leg mechanical plug that has been identified to exhibit any signs of leakage. Through the 1994 RFO, none of the 89 installed hot leg Westinghouse mechanical plugs have exhibited any visual signs of leakage. This visual examination provides assurance that the RCS pressure boundary is being maintained for those tubes which have been plugged with Westinghouse Alloy 600 mechanical plugs.

An enhanced primary-to-secondary leakage monitoring program was implemented at Ginna Station as discussed in Rochester Gas & Electric's response to Bulletin 88-02 dated March 25, 1988. In Reference 7 Rochester Gas & Electric recommitted to the enhanced monitoring program in response to an NRC request dated July 10, 1990. Resolution of the issues identified in Bulletin 88-02 was completed and relaxation of the leakage monitoring program was documented in NRC letter dated Dec. 22, 1992 (TAC No. M67308). However, Rochester Gas & Electric has chosen to continue to perform the enhanced leakage monitoring.

4.0 1995 Refueling Outage Maintenance Plans

Addendum 3 to WCAP-12245 (Reference 5) reduced the effective lifetime of the hot leg plugs installed at Ginna. The new effective lifetime for the Ginna plugs would have required action prior to the 1994 RFO Outage. Consequently, it is necessary to re-evaluate planned maintenance activities for the hot leg mechanical plugs. Prior to the Reference 5 revision, Rochester Gas & Electric planned to remove from service all installed Westinghouse mechanical plugs in 1996 as part of the planned replacement of the existing SGs.

The Section 2.0 discussion demonstrates that the Ginna SG design precludes the possibility of a SG tube puncture incident resulting from a mechanical plug top release event. Additionally, as discussed in Section 3.0, no problems with leaking mechanical plugs have been identified to date. Therefore, due to the planned replacement of the existing SGs in 1996 and to the increased personnel radiation exposure that would result from replacing all installed hot leg plugs in 1995, Rochester Gas & Electric plans to defer replacement of all plugs by one year until 1996, at which time they would be removed by virtue of the steam generator replacement.

To verify that no leakage presently exists with the installed hot leg mechanical plugs, Rochester Gas & Electric plans to continue the visual examination of all installed hot leg mechanical plugs during the 1995 RFO. Consistent with previous RFOs, Rochester Gas & Electric will perform a tubesheet video camera inspection of all hot leg plugs to identify any indication of large boron patches or leakage. Any hot leg mechanical plugs identified to be leaking will be repaired or replaced during the 1995 RFO.

Additionally, Rochester Gas & Electric plans to continue with the enhanced primary-to-secondary leakage monitoring until completion of the steam generator replacement in 1996. This will ensure that if increased SG leakage occurs subsequent to start-up from the 1995 RFO it will be readily identified and that plant operation in conformance with the SG leakage requirements of the Plant Technical Specifications is maintained.

ASSESSMENT OF CONTINUED OPERATION WITH MECHANICAL PLUGS

5.0 References

1. Westinghouse WCAP-12244, "Steam Generator Tube Plug Integrity Summary Report", Revision 3, November 1989

2. RG&E Letter to NRC, R. C. Mecredy to A. J. Johnson, "Failure of Westinghouse Alloy 600 Steam Generator Tube Mechanical Plugs - R. E. Ginna Nuclear Power Plant - Docket No. 50-244", dated Jan. 25, 1995

3. Supplement 2 to NRC Bulletin 89-01, "Failure of Westinghouse Steam Generator Tube Mechanical Plugs", dated June 28, 1991

4. Addendum 2 to Westinghouse WCAP-12244, "Steam Generator Tube Plug Integrity Summary Report", Revision 3, June 1991

5. Addendum 3 to Westinghouse WCAP-12245, "Steam Generator Tube Plug Integrity Summary Report", Revision 3, January 1995

6. Letter from R. C. Mecredy, (RG&E) to A. R. Johnson, (NRC), "Response to Bulletin 89-02, Supplement 2, Failure of Westinghouse Steam Generator Tube Mechanical Plugs," dated July 29, 1991.

7. RG&E Letter to NRC, R. C. Mecredy to A. J. Johnson, "NRC Bulletin 88-02, TAC No. 67308 - R. E. Ginna Nuclear Power Plant - Docket No. 50-244", August 13, 1990