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CRUTCHFIELD,D. Operating Reactors Branch 5

SUBJECT: Forwards detailed description of lead test assemblies program & analyses performed.Assemblies designed by Exxon Nuclear Co & will be inserted starting in Cycle 15.Tech Specs will not affected by inclusion of four assemblies.

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ROGER W. KOBER
VICE PRESIDENT
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April 10, 1984

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Lead Test Assembly Program
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Crutchfield:

As part of an agreement with the Empire State Electric Energy Research Company (ESEERCO), Rochester Gas and Electric plans to insert four lead test assemblies at the R. E. Ginna Nuclear Plant, starting in Cycle 15. These assemblies are being designed by Exxon Nuclear Company using their standard PWR design techniques such as were used on the Exxon Nuclear designed reload fuel in R. E. Ginna.

Rochester Gas and Electric has reviewed the neutronic, mechanical, and safety analyses performed by Exxon Nuclear Company. Attached for your information is a more detailed description of the lead assemblies program and the analyses performed. The assumptions in the neutronic calculations were: 1) that the lead assembly fuel would be of a comparable enrichment to obtain the same energy as the standard reload fuel which is inserted in Cycle 15, 2) the annular lead assemblies would be loaded in symmetric locations, and 3) they would be irradiated for up to six cycles. These assumptions result in a peak assembly burnup for the lead assemblies of between 52 and 55 MWD/kgU. The neutronic calculations were performed using the Exxon Nuclear standard reload analytical techniques and the results satisfy the reload design criteria.

Similarly, the standard mechanical analyses of the lead assemblies verified that the mechanical design criteria applied for the resident Exxon Nuclear reload fuel are satisfied. The fuel rod length and the upper tie plate height will be reduced in the lead assemblies to preclude any irradiation growth concerns resulting from the planned high exposures.



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The calculated peak clad temperature of the lead assemblies predicted by the ECCS analyses is lower than for the standard fuel design, as previously used at Ginna, primarily due to the lower stored energy of the annular pellets. The fuel has been designed to be thermal hydraulically compatible to the resident Exxon and Westinghouse fuel.

Based on these analyses, it is not expected that the R. E. Ginna Technical Specifications will be affected by the inclusion of the ESEERCO lead assemblies, and there should be no unreviewed safety questions involved with the operation with these lead assemblies. The final review will be performed as part of our review, pursuant to 10 CFR 50.59 of the Cycle 15 reload.

The specific core design for Cycle 15 will be determined by our current fuel supplier, Westinghouse, who has explicitly modeled the LTAs based on information provided by Exxon. The LTAs will occupy a peripheral, low power position for the first cycle (Cycle 15) of irradiation where their performance will be monitored and compared to predicted values.

If you have any questions about this program, please contact us. It is our desire to have any issues which might be raised by the NRC resolved by October 1, 1984.

Very truly yours,

Roger W. Kober

Roger W. Kober

# DESCRIPTION OF THE R.E. GINNA LEAD ASSEMBLY DESIGN

## INTRODUCTION

In a joint agreement between the Empire State Electric Energy Research Company, the Rochester Gas and Electric Company, and the Exxon Nuclear Company, four lead assemblies have been designed for irradiation in the R.E. Ginna reactor. These assemblies contain fuel rods with annular pellets and with zirconium barrier cladding. Also, segmented fuel rods are included in the design to allow subsequent power ramp experiments in test reactors.

The program was developed as part of an advanced fuel design technology effort. The lead assembly design was selected because of the potential higher burnup capabilities of annular fuel when compared with solid fuel, and because of the potential of allowing reactor load following operation by reducing the risk of fuel failure from pellet-cladding interaction.

## SUMMARY

The four ESEERCO lead assemblies planned for irradiation in the R.E. Ginna reactor were designed by the Exxon Nuclear Company. The bundle and exterior rod configuration are similar to the Exxon Nuclear designed reload fuel that has been irradiated in this plant from 1978 to 1984 and which has exhibited excellent fuel performance. The fuel consists of annular pellets with the cladding having a zirconium barrier on the inner diameter. The cladding outer diameter will be reduced from 0.426 inch to 0.417 inch which increases the moderator to fuel ratio, thus enhancing the fuel utilization. Selected rods in the assemblies will be segmented for subsequent ramp testing.

Mechanical, safety and neutronic design analyses have been performed for the proposed fuel design. The results of these analyses indicated that the

lead assembly design has more margin to the design limits than the standard, solid pellet design with regard to LOCA/ECCS. In terms of thermal hydraulic compatibility and thermal margin performance, the lead assemblies are considered bracketed by the current Westinghouse design and prior ENC reload fuel for R.E. Ginna.

DESIGN

The four lead assemblies are designed for insertion into the R.E. Ginna reactor which is a two-loop Westinghouse PWR. The assembly design is a 14x14 array with 179 fuel rods, 16 guide tubes and one instrument tube. Two of the four assemblies will contain 179 full length annular pellet zirconium barrier clad fuel rods. The other two assemblies will contain the following types of fuel rods:

- 168 full length annular pellet zirconium barrier clad fuel rods.
- 6 segmented annular pellet zirconium barrier clad fuel rods with four segments per rod.
- 3 segmented annular pellet standard clad rod with four segments per rod.
- 2 segmented solid pellet standard clad rods with four segments per rod.

Fuel rods without the zirconium barrier were included in the assembly to provide a comparison with the performance of zirconium barrier clad rods and evaluate the effectiveness of the barrier in reducing pellet-to-clad interaction. The segmented rods were included to provide a source of fuel rods which may be used for possible power ramp tests in the future.

The design parameters for the proposed annular pellet fuel rods and the current solid pellet fuel rod design are given in Table 1. The initial nominal pellet-to-clad radial gap is 3.75 mils for both zirconium barrier and standard cladding.

MECHANICAL ANALYSES

The Exxon Nuclear PWR design methodologies were used to assess the adequacy of the lead assembly and rod designs. The calculations indicated that the standard design criteria[1] for cladding stresses and the 1% plastic strain criterion (steady-state and transient) are satisfied. The design criteria for stresses is presented in Section III of the ASME Boiler and Pressure Vessel Code. Because annular fuel provides more internal rod volume for fission gas and operates at a lower temperature, thus reducing fission gas release, the calculated end-of-life internal pressure in annular fuel rods was substantially less than the reactor primary system pressure. The collapse analysis was performed using the criterion presented in the Exxon Nuclear high burnup report (XN-NF-82-06, Rev. 1) which is currently under NRC review. This analysis verified that cladding collapse would not occur.

Transient stress/strain calculations were performed for power escalations using the Exxon Nuclear RAMPEX code. These calculations showed that no plastic strain resulted from these ramps. The stresses generated during these ramps were used to compute the cumulative usage factor for this fuel, described in reference 1. The result was below the Exxon Nuclear limit of 0.67, which satisfies the ENC potential fatigue criteria. To satisfy the test requirement for high exposure, a minor change in the tie plate height and the rod length from the standard reload fuel will be required. These changes

will preclude the possibility of unacceptable irradiation growth.

The other mechanical design concern was fuel assembly limitation resulting from using the lighter annular fuel. The analyses performed indicate that the fuel assembly holddown springs, assuming worst case tolerences and high flow, are adequate to prevent assembly lift-off.

Similar rod mechanical analyses were performed on the segments in the segmented rod designs. The results were similar to those obtained for the full length rods.

SAFETY ANALYSES

Because the spacer, tie plates, and rods have configurations similar to the Exxon Nuclear fuel previously inserted in the R.E. Ginna plant, there is a large degree of compatibility between the present lead assemblies and Exxon Nuclear fuel previously loaded. The 0.417 inch OD of the lead assembly fuel rods is 2.1% smaller than the 0.426 inch OD of previously loaded ENC reload fuel and is about 4% larger than the fuel rod diameter of Westinghouse assemblies now being loaded into R.E. Ginna. Thus thermal-hydraulic compatibility analyses between current Westinghouse reload fuel and previously loaded ENC fuel brackets the four lead assemblies.

Since the four lead assemblies will comprise only a small fraction of the R.E. Ginna core, the overall hydraulic resistance of the core will not be significantly effected. Similarly, since there are only four lead assemblies and these assemblies have the same general neutronic design as other fuel in the core, the moderator or Doppler feedback parameters for the core will not be significantly impacted. Thus, transient responses of the R.E. Ginna plant during anticipated operational occurrences will not be changed by the four lead assemblies.

LOCA/ECCS sensitivity studies have been performed assuming a full core of annular fuel. The results showed that the annular fuel had better performance than the solid fuel, primarily as a result of the lower initial stored energy of the annular fuel.

NEUTRONIC ANALYSES AND NUCLEAR DESIGN

The enrichment of the four lead assemblies has been determined to provide a similar $k_\infty$ versus exposure relationship to the co-resident reload batch of solid fuel loaded with the lead assemblies. This enrichment selection will minimize the impact on fuel management and avoid excessive peaking in the annular fuel or adjacent solid-pellet fuel assemblies. The enrichment for the annular fuel is 3.7 w/o U-235.

The suggested loading of the four assemblies is on the major axes, to preserve core symmetry. By using a loading pattern on the core axes, it is possible to attain up to six cycles of irradiation, corresponding to a peak assembly exposure between 52 and 55 MWD/kgU for the annular pellet fuel. The nuclear design analyses were also performed for the four annular pellet fuel assemblies. The results of these calculations demonstrated that there was no significant impact on the Technical Specification limits regarding the shutdown margin or thermal limits of the reactor.

CONCLUSIONS

Based on the mechanical, thermal-hydraulic, neutronic, and safety analyses results, it is concluded that there will be no adverse impact of the four lead assemblies containing annular pellet fuel and zirconium barrier cladding on the design limits and thermal margins of the R.E. Ginna reactor fuel.

Table 1 - Fuel Design Parameters

| | Annular Pellet Zirconium Barrier | Standard Ginna Reload Solid Pellet |
|---|---|---|
| Cladding OD (in) | .417 | .426 |
| Cladding ID (in) | .358 | .364 |
| Total Cladding Thickness (in) | .0295 | .031 |
| Zirconium Barrier Thickness (in) | .003 | -- |
| Pellet OD (in) | .3505 | .3565 |
| Pellet ID (in) | .1108 | .0000 |
| Diametral Gap (in) | .0075 | .0075 |
| Pellet Density (% TD) | 94.0 | 94.0 |
| Active Fuel Length (in) | 142.0 | 142.0 |
| Cell Water/Fuel Ratio | 1.99 | 1.68 |
| Fuel Assembly Weight (KgU) | 327 | 373 |
| Fuel Rod Pitch (in) | .556 | .556 |

## REFERENCES


1. XN-NF-78-34, "Generic Mechanical and Thermal Hydraulic Design for Exxon Nuclear 14 x 14 Reload Fuel Assemblies with Zircaloy Guide Tubes for Westinghouse Two-Loop pressurized Water Reactors", Exxon Nuclear Company, November 1978.

2. XN-NF-77-40, "Plant Transient Analysis for the R.E. Ginna Unit 1 Nuclear Power Plant", Exxon Nuclear Company, November 1979.

3. XN-NF-77-40, Supplement 1, "Plant Transient Analysis for the R.E. Ginna Unit 1 Nuclear Power Plant", Exxon Nuclear Company, March 1980.