DS09
M Chatterton
J. Shapaker
W. Burton

62 FR 26729
May 20, 1997
(31)

Westinghouse Electric Corporation
Energy Systems
Nuclear Services Division
Box 355
Pittsburgh Pennsylvania 15230-0355

NSD-NRC-97-5197

June 19, 1997

Mr. David L. Meyer, Chief
Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop T-6D-69
Washington, D.C. 20555-0001

Subject: NRC Proposed Generic Communication: Control Rod Insertion Problems - Notice of Opportunity for Public Comment (NRC Bulletin 96-01, Proposed Supplement 1) (62 Fed. Reg. 27629)

Dear Mr. Meyer:

Westinghouse Electric Corporation ("Westinghouse") submits this letter in response to proposed U.S. Nuclear Regulatory Commission ("NRC" or Commission') Bulletin 96-01, Supplement 1: Control Rod Insertion Problems (62 Fed. Reg. 27629, May 20, 1997). The following sets forth the Westinghouse position and conclusion regarding the proposed Supplement. Further detailed comments are attached to this letter.

The NRC is proposing to issue a bulletin Supplement to NRC Bulletin 96-01 which would require extensive action by licensees involving testing, analyses and possible operating restrictions relating to control rod insertion. Westinghouse believes that the actions proposed by the NRC are unnecessary and would increase risk as defined by core damage frequency. Thus Westinghouse believes that the proposed Supplement should not be issued. Westinghouse participated in preparing the comments submitted by the Westinghouse Owners Group (WOG) on this matter, and fully endorses those comments.

Westinghouse has conducted a major program of testing and analyses for the last year and a half and has gained a thorough understanding of the phenomena of incomplete rod insertion (IRI). Westinghouse has provided information resulting from this program to the NRC in connection with numerous meetings held on the subject of IRI. This information confirms that IRI has not caused plant operating conditions to even approach the limits of the licensing bases of the plants

270016

ID+R-11A

which have experienced IRI. Included in this information is material demonstrating why the conservatism in the design basis shutdown margin for Westinghouse plants is sufficient to bound the events cited by the NRC as the basis for the proposed Supplement. The standard shutdown margin analysis performed for the Reload Safety Evaluation will bound the scenarios which reasonably could be postulated to occur based on incomplete insertion experiences. Consequently, the current safety analysis remains valid and there is negligible safety significance for IRIs that have occurred. Thus, the testing and other requirements proposed in the Supplement are not necessary to ensure adequate protection of the public health and safety, are not necessary to ensure continued operability of the control rods, are not necessary to ensure that adequate shutdown margins will be maintained and are not necessary to ensure that the control rods will satisfactorily perform their intended function of effectively terminating the fission process during all operating conditions in accordance with the current licensing basis for each facility.

The changed requirements which would be imposed under the Supplement would constitute a backfit under the NRC backfit rule, 10 CFR 50.109, and do not meet any of the exceptions under which the rule would not be applicable. The NRC has not complied with the backfit rule, including the preparation of the appropriate cost/benefit analysis, in considering the requirements which would be imposed by the Supplement. Based on the extensive work performed by Westinghouse, we believe that the required backfit analysis would not support the proposed changes.

Westinghouse appreciates the opportunity to submit this letter in response to the NRC's request for comments on the proposed Supplement. We would be pleased to continue discussions on our comments with the Commission and members of the NRC staff.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

cc: S. Collins
H. Thompson
M. Chatterton
G. Holahan
C. Craig

LD321

WESTINGHOUSE ELECTRIC CORPORATION
ATTACHMENT TO COMMENT LETTER
DATED JUNE 19, 1997
ON PROPOSED
NRC BULLETIN 96-01 SUPPLEMENT

INTRODUCTION

As noted in our Comment Letter dated June 19, 1997, Westinghouse participated in the preparation of and fully endorses the comments, exceptions and recommendations submitted by the Westinghouse Owners Group (WOG) regarding the Draft NRC Bulletin 96-01, Supplement 1: Control Rod Insertion Problems. Like the WOG, Westinghouse believes there is sufficient data and evaluations available to conclude that the issuance of the Supplement is not warranted. Although we will not repeat in detail the bases for this conclusion here, Westinghouse strongly agrees with the statements in the WOG comments that: (1) the current safety analysis remains valid and the incomplete rod insertions that have occurred are of negligible safety significance; (2) there will be an increase in risk, as measured by core damage frequency risk, associated with bringing plants to the required operating state to perform the testing and other requirements proposed in the supplement; (3) the proposed requirements will impose considerable costs on the industry and individual licensees with no commensurate improvement in overall plant safety; and (4) the NRC has not justified the proposed requirements under the backfit rule, 10 CFR 50.109, and imposition of the requirements without the backfit analysis required by the rule cannot be justified under any of the exceptions to the rule.

Westinghouse has conducted a major program of testing and analyses for the last year and a half and has gained a thorough understanding of the phenomena of incomplete rod insertion. Our initial focus was on the root cause analysis for Wolf Creek and South Texas. Detailed in field drag testing, growth measurements, guide thimble single tube drag and borescope examinations along with assembly bow measurements were performed in 1996. Fuel rods were removed from two Wolf Creek fuel assemblies and the skeletons sent to the Westinghouse Science and Technology hot cells where various destructive examinations were performed which provided key information for our root cause investigation. The results and conclusions reached by this work were provided to the NRC in WCAP-14782, "Incomplete RCCA Insertion". These actions resulted in the most comprehensive investigation of guide tube behavior and understanding in the industry. The root cause was identified as distortion of the guide tube thimble due to compressive loads. These compressive loads were a result of a combination of hydraulic forces, weight of fuel, holddown spring forces and, for Wolf Creek, increased loading due to unusual fuel assembly growth. Models were developed which simultaneously calculate mechanical and hydraulic loads in addition to growth, corrosion, and creep of guide thimble material. This integration of the various

models is needed for a realistic understanding of how the various parameters, from design features to operational aspects, affect the overall guide tube performance. The foregoing actions resulted in the most comprehensive investigation of guide tube behavior and understanding in the industry and form the basis of both the WOG comments, as supported by Westinghouse, and our additional detailed technical comments which follow.

DETAILED TECHNICAL COMMENTS

1. <u>Fuel Features that Enhance Margin to Incomplete Rod Insertion</u>

From the basic understanding gained from the analytical models and field data, specific Westinghouse fuel features can be shown to provide margin and therefore less susceptibility to incomplete rod insertion. The increased margin from these specific fuel design features indicates that not all fuel designs should be categorized together in terms of burnup level limits. Fuel with 14 foot active length has shown clear susceptibility with repeated incidents of incomplete insertion. An important difference between 12 foot and 14 foot fuel designs is the double dashpot in the 14 foot design. Fuel with 12 foot active length has shown much lower susceptibility with the only domestic instance occurring in Wolf Creek fuel assemblies that experienced unusual growth. In addition to the clear differences between 12 and 14 foot fuel, the following fuel features - Intermediate Flow Mixing grids, ZIRLO™ material and Protective bottom grids (P-grids) - have characteristics which enhance margin such that the burnup limits proposed in the Supplement are inappropriate. The bases for these conclusions are described below:

a. <u>Intermediate Flow Mixing Grids (IFMs)</u>

The experience with IFMs has been excellent. No rodded fuel assembly with IFMs has had an insertion problem even when operated under aggressive conditions up to burnups of 54,900 MWD/MTU. The fuel assembly growth of these fuel assemblies has been well within our design basis such that no unusual or accelerated growth has been experienced. The ability of the IFMs to increase the stiffness and therefore the resistance to distortion has been well established given the reduction in span length and additional lateral resistance. In addition, there is a more favorable balance between axial loads due to holddown forces and hydraulic forces. This is due to the increased hydraulic forces from the pressure drop which more completely balances the holddown forces from the fuel assembly holddown spring. The non-IFM fuel assemblies such as the Wolf Creek assemblies that had insertion problems have a less favorable balance of forces which contributes to additional distortion of the fuel assembly. These design features enhance the performance of IFMs with respect to incomplete rod insertion.

The NRC states on page 10 of the Proposed Supplement (62 Fed. Reg. at p. 27631, Col. 2) "...the top and bottom spans might be the most susceptible portions of the fuel assembly and distortion of the top span could lead to control rod sticking very high in the core". Actual drag data, as shown in Figure 3 of the WOG response, shows no such tendency since the guide tube drag data is both low and well behaved with burnup. The striking characteristic of the data is the low drag above the dashpot, often consistent with drag measurements for fresh fuel.

Calculations with the Westinghouse Mechanical Model which used the data from the hot cell examination compared fuel assemblies with and without IFMs using the Wolf Creek H-50 fuel assembly as the reference case. The results showed almost a factor of 2 reduction in the worst span bow with the introduction of IFMs into the fuel assembly. It would take an assembly average burnup around 58,000 MWD/MTU to match the H-50 worst span bow, indicating the enhanced margin IFMs add to the fuel assembly.

Based on the design features, drag data and comparative calculation results, fuel assemblies with IFM grids do not need any fuel assembly burnup limit since compliance with current lead rod burnup limits will preclude distortion that could result in incomplete rod insertion. In the event that a fuel assembly burnup limit is used, Westinghouse suggests an assembly average burnup of at least 58,000 MWD/MTU.

b. ZIRLO Material for Guide Tubes

Another design feature which provides margin to incomplete rod insertion is the application of ZIRLO material for guide tubes. From the root cause analysis, it was determined that the Wolf Creek fuel assemblies experienced unusual growth and guide tube corrosion which added to the growth. From both in-reactor lead test assemblies and autoclave tests on ZIRLO, it has been well established that ZIRLO is a significantly more resistant material to corrosion than Zr-4 or low tin Zr-4. Other properties of ZIRLO also provide for a better material from a stability aspect. For example the creep behavior of ZIRLO is superior to that of Zr-4 and low tin Zr-4 which provides for more stability to resist change due to applied loads such as the compressive forces within a fuel assembly.

All ZIRLO fuel assembly growth measurements are well behaved and within our design allowances. Lead test ZIRLO assemblies have operated beyond 55,000 MWD/MTU with excellent performance, as designed.

The Mechanical Model was used to compare the Wolf Creek H-50 fuel assembly using its actual operating condition but replacing the guide tube material with ZIRLO instead of the improved Zr-4 material actually in the fuel assembly. The results from this analysis confirm the expected performance, namely, the span bow was reduced by 63% and the fuel assembly growth was reduced by 37% with the ZIRLO material. This

is a meaningful comparison since the only difference between the two cases is the use of ZIRLO properties instead of the low tin Zr-4 properties. To achieve a similar span bow as measured from H-50 would require a burnup well in excess of the current licensed lead rod burnup limit using ZIRLO.

The designs with ZIRLO address the root cause by resulting in lower fuel assembly growth, better corrosion resistance, more stable mechar ·cal properties. Additionally, the designs have a shorter fuel assembly length despite the lower growth rate, which essentially eliminates the possibility of growth above the growth allowance and therefore reduces compressive loads during operation.

Recent field data on ZIRLO fuel clearly illustrates the effect of this material change on guide tube drag. Figure 1 shows drag vs burnup for ZIRLO skeletons. The drag is ~10lbs in the upper guide tube region and ~20lbs in the dashpot for a burnup as high as 47,000 MWD/MTU. These drags are representative of fresh fuel. This data confirms the positive impact ZIRLO has on the incomplete rod insertion concern, especially as burnup increases.

Based on all the design aspects, field data, autoclave tests and analytical results, fuel assemblies with ZIRLO should be allowed to achieve assembly average burnups consistent with the current licensed lead rod burnup limit.

c. Protective Bottom Grid (P-grid)

The P-grid is a feature which places a grid on top of the bottom nozzle to capture debris before it enters the active portion of the fuel assembly. The P-grid is assembled with Inconel grid straps and positioned below the core effective height which reduces the impact of irradiation induced spring force relaxation. Fuel rods are placed as close as practical to the bottom nozzle so that their elongated bottom end plugs are within the protective grid. Placing the fuel rods on the bottom nozzle early in life removes the fuel rod weight off the guide tubes. In addition since the fuel rods grow up a tension load is added to the guide tube through the grids. Both of these differences reduce the compressive loads in the guide tube thereby reducing guide tube distortion.

The data shown in Figure 2 substantiates the performance impact the P-grid has on dashpot drag. The dashpot drag is reduced by almost a factor of 3 from measured data by the application of the P-grid from data up to burnups of ~50,000 MWD/MTU. Calculation results also confirm that the P-grid design feature substantially reduces fuel assembly distortion and provides a substantial increase in margin to incomplete rod insertion.

Field data clearly shows the benefits of various features, including those described above, for burnups well in excess of those proposed in the Supplement. Westinghouse recommends using a more fundamental approach than burnup limits to

determine susceptibility/acceptability to incomplete rod insertion which can take into account different fuel features and operating conditions. This methodology is presented below and has been discussed with the NRC technical staff.

2. Mechanical Model and Susceptibility Criteria

Westinghouse has developed a mechanical model based on the large amount of data accumulated from different plants with many different fuel designs and information learned from the hot cell examination. The model includes a representation of all the key features of a fuel assembly (including guide thimble, a fuel rod, the grids, holddown springs, thimble plugs, burnable absorbers) and accounts for the different phenomena which influences both guide thimble performance and fuel assembly growth. Phenomena such as oxide formation, irradiation effects, and stress induced irradiation creep are included to predict performance of the guide tube under mechanical and hydraulic loads. Ultimately, the model calculates drag as a function of fluence and "drag work", which represents the integral of drag.

This model has been described to the NRC at a number of meetings. A report on the model, WCAP-14802, "GROWBOW, a Fuel Assembly Growth and Guide Thimble Bow Model," will be provided to the NRC. The model is being used to determine the drag work for rodded fuel assemblies under plant specific operating conditions. This plant and fuel assembly design specific drag work then is compared to the limits on drag work from the extensive testing program. The specific process we suggest is given in the paragraph entitled "Predictive Methodology" on page 4 of the WOG response dated June 18,1997 and is repeated below for ease of reference.

The following process is proposed as a means to manage the operating fuel:

- For burnup less than proposed NRC guideline - no action required, no testing required
- For burnup in excess of proposed NRC guideline - use the Westinghouse model to determine susceptibility limit
- For burnup greater than proposed NRC guideline and less than Westinghouse model susceptibility limit - perform EOC testing
- For burnup greater than both guidelines - perform safety evaluation and testing, as appropriate.

This predictive methodology can be supplemented by the use of actual measured data as a function of burnup for different fuel designs to further determine acceptability of operating fuel and fuel for a new reload. By this means different fuel features and fuel operating environments, as described above, can be represented and their impact on rod insertion appropriately included. This process also is not solely dependent on prior performance to predict future performance but rather addresses

potentially significant differences in fuel design and/or other factors such as cycle length and fuel management in an integrated manner.

3. Proactive Actions to Address IRI

The substantial effort devoted by Westinghouse as described above has resulted in an understanding of the root cause for the events at Wolf Creek and South Texas. This effort has enabled Westinghouse to determine the parameters which contribute to incomplete rod insertion and understand, from design and operational aspects, their impact on incomplete rod insertion. From this knowledge and understanding, modifications and recommendations have been developed which enhance margin to incomplete rod insertion. In addition to developing these modifications and recommendations, Westinghouse has been proactive in putting them into operation to mitigate or eliminate incomplete rod insertion. For example, Westinghouse and South Texas agreed in March to modify the reload for the next cycle for Unit 1 this fall to include ZIRLO guide thimbles instead of Zr-4 and the use of the Protective grid. Both of these changes will enhance margin to incomplete insertion.

The Mechanical Model is being used by Westinghouse to review all current Westinghouse fuel in operation and assembly designs to identify opportunities for enhanced margin, as has been discussed with the NRC.

All of the above actions have been initiated following the understanding derived from the root cause investigation and from the application of our Mechanical Model to assist in determining the impact of various changes. The detailed understanding Westinghouse has gained through the development and application of this model will be key to avoiding future incidents of this type as fuel utilization and fuel designs evolve.

4. Summary

Westinghouse believes that the actions proposed by the NRC are unnecessary and would increase risk, as defined by core damage frequency. Westinghouse believes that the proposed Supplement should not be issued.

Figure 1: Drag vs. Burnup

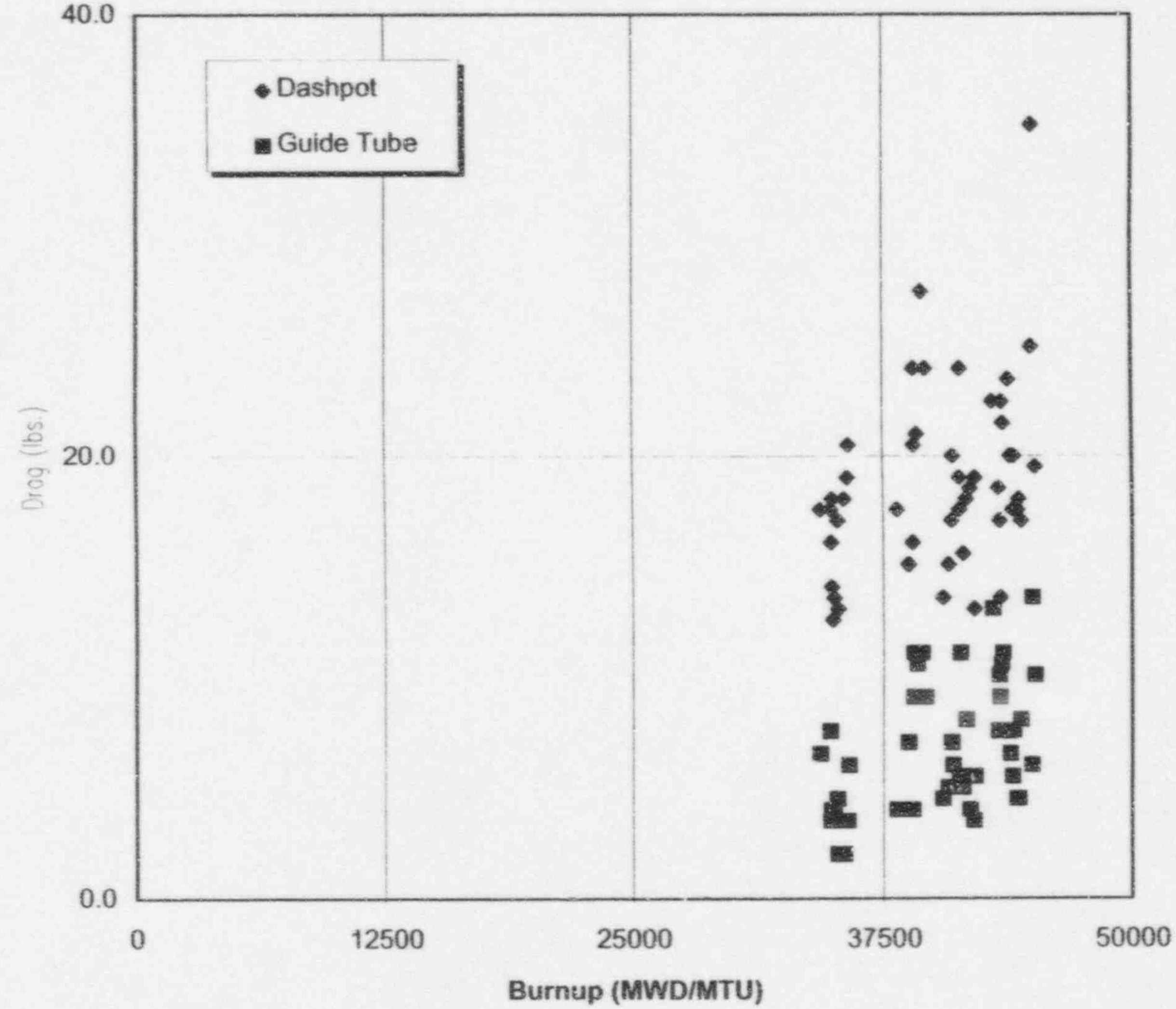

Figure 2: P-Grid Experience
Drag vs. Burnup