



Commonwealth Edison  
1400 Opus Place  
Downers Grove, Illinois 60515

April 26, 1990

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555

Subject: Dresden Station Units 2 and 3  
Quad Cities Station Units 1 and 2  
LaSalle County Station Units 1 and 2  
Response to NRC Bulletin 90-02  
NRC Docket Nos. 50-237/249  
50-254/265 and 50-373/374

Reference: NRC Bulletin 90-02, dated March 20, 1990.

Dear Sir:

NRC Bulletin 90-02 (Bulletin) addresses potential problems at Boiling Water Reactors (BWR) associated with excessive channel box bow that could result in a loss of thermal margin. The main concern is that the channel box bow effect has not been taken into account in the critical power ratio (CPR) calculation for channel boxes in their second bundle lifetime operation. The Bulletin requests BWR licensees to determine whether any channel boxes are being reused after their first bundle lifetime and, if so, ensure that the effects of channel box bow on the CPR calculation are properly taken into account. Additionally, all BWR licensees are expected to assure that the effects of channel box bow on CPR limits are taken into account for all future reloads.

Attachment A to this letter presents Commonwealth Edison Company's (CECo) response to the Bulletin for Dresden, Quad Cities, and LaSalle County Stations.

Edison's current channel management strategy does not include the reuse of channels on new fuel assemblies at any of the BWR Stations; however, previous channel management practices included the reuse of channels. Consequently, five of the six CECO BWR Units (Dresden Unit 3 excluded) presently contain some channels which were previously assigned to another fuel bundle. Some of these reused channels have accumulated exposures which exceed that of a single bundle lifetime. With the exception of Dresden Unit 2, it was determined that there is no impact on CPR limits due to channel bow from those reused channels which are in a second bundle lifetime.

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For Dresden Unit 2, which is currently operating in Cycle 12, it was determined that the application of a critical power ratio (CPR) adjustment to the minimum critical power ratio (MCPR) operating limit was required to account for the effects of channel bow. Dresden Station has administratively incorporated a CPR adjustment (0.06) to the MCPR operating limit. A revision to the Dresden Unit 2 Cycle 12 Core Operating Limits Report, which will reflect this new MCPR operating limit, will be submitted by May 31, 1990.

The methodology utilized to determine the channel bow CPR adjustment for Dresden 2 Cycle 12 is presented in Attachments A and B. This methodology will also be used to determine any necessary CPR adjustment for the next cycle (Dresden 2 Cycle 13) which is scheduled for startup in November 1990. The approach utilized to determine the Dresden Unit 2 CPR adjustment is similar to the channel bow methodology currently being reviewed by the NRC as indicated in the Bulletin. Upon review of this response, CECO requests NRC concurrence for use of this approach on Dresden 2 Cycle 13 by May 31, 1990.

Quad Cities Unit 2, which will begin Cycle 11 operation in early May 1990, has two reused channels in the core. Although the exposure on these channels exceed that of a single bundle lifetime, it was determined that there is no MCPR impact due to the location of the channels in the core (low power, peripheral locations). For the upcoming cycle, the effects of channel bow have been taken into account utilizing methodology currently being reviewed by the NRC.

Similarly, for LaSalle County Unit 2 Cycle 4 operation, which will begin in June 1990, the effects of channel bow have been taken into account utilizing methodology currently being reviewed by the NRC.

It should be noted that the information in Attachment B is considered to be proprietary information to Advance Nuclear Fuels Corporation, and is supported by an affidavit signed by Advance Nuclear Fuels Corporation, the owner of the information. Attachment C contains the affidavit that sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses the considerations listed in paragraph (b) (4) of 10 CFR 2.790 of the NRC's regulations. Accordingly, CECO requests that the information contained in Attachment B be withheld from public disclosure in accordance with 10 CFR 2.790.

Please direct any questions that you have on this response to this office.

Respectfully,

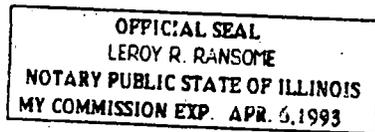
*Milton H Richter*

M. H. Richter  
Generic Issues Administrator

- Attachments: A - Commonwealth Edison Response to NRC Bulletin 90-02  
 for Quad Cities, LaSalle County, and Dresden Stations  
 B - Channel Bow Analysis for Dresden 2 Cycle 12  
 C - Advanced Nuclear Fuels Corporation Affidavit

- cc: A.B. Davis - Regional Administrator, Region III  
 Senior Resident Inspector - D/QC/LSCS  
 P. Eng - NRR Project Manager, Dresden  
 L. Olshan - NRR Project Manager, Quad Cities  
 R. Pulsifer - NRR Project Manager, LaSalle

/lmw:0925T



SUBSCRIBED AND SWORN to  
 before me this 26th day  
 of APRIL, 1990

*Leroy R. Ransome*  
 Notary Public

ATTACHMENT A

Commonwealth Edison Response to NRC Bulletin 90-02  
for  
Quad Cities, LaSalle County, and Dresden Stations

NRC Bulletin 90-02 (Bulletin) requests that all Boiling Water Reactor (BWR) licensees address the effect of channel bow on thermal margin, particularly the bow of channels that are being reused for a second bundle lifetime. Such reuse may result in high channel exposures, leading to excessive channel bow and an increase in the assembly wide-wide water gap. This additional thermalization increases the peaking of the fuel pins near the control blade, thereby potentially decreasing thermal margin. This effect is seen to a lesser extent for channels used for a single bundle lifetime. Fuel vendor methodology to account for this phenomena is currently under NRC review (References 1 and 2).

Channel bow is caused under irradiation by the differential flux profile across the channel and aggravated by the acceleration of zircaloy growth at high channel exposures, approximately 50 to 60 GWd/MTU. The effect of channel bow is greater for D-lattice plants (Quad Cities and Dresden Stations), due to the non-uniform water gap between fuel assemblies. Water gaps in C-lattice plants (LaSalle County Station) are uniform, thereby decreasing the driving force of the flux differential and the magnitude of the resulting channel bow.

The Bulletin does not require immediate action for plants currently operating with single bundle lifetime channels; however, channel bow must be accounted for in all future reload analyses. Licensees with reused channels must demonstrate the adequacy of current thermal margin methodology since channels with multiple bundle lifetimes may exceed the exposure threshold at which accelerated zircaloy growth occurs. It is Commonwealth Edison's (Edison) understanding that reused channels may be considered to be on a single bundle lifetime provided the channel exposure remains significantly below the critical exposure for accelerated growth.

Edison's current channel management strategy does not include the reuse of channels on new fuel assemblies at any of the BWR Stations - Dresden Units 2 and 3, Quad Cities Units 1 and 2, and LaSalle County Units 1 and 2. Edison's current channel supplier, Carpenter Technology Corporation, provides channels with stringent as-fabricated bow tolerances and uses manufacturing techniques which have been shown to minimize growth under irradiation. However, previous Edison channel management strategy in the early to mid-1980s included the reuse of channels. Although this practice has since been discontinued, some reused channels remain in Edison's BWRs.

A summary of the effect of channel bow on thermal margin at each Edison BWR Station follows.

## Quad Cities Station

Unit 1 - currently operating in Cycle 11.

Unit 2 - currently in a refueling outage prior to Cycle 11 operation.

Quad Cities Unit 1, which is currently operating in Cycle 11, has two reused channels in the core. These channels are both located on the periphery of the core. Quad Cities Unit 2, currently in a refueling outage, is scheduled to begin Cycle 11 operation in May 1990 with two reused channels, one on the periphery and the other one row in from the periphery. These four channels (two for each unit) are in a second bundle lifetime, with projected end of cycle (Cycle 11) exposures which will range between 50 to 60 GWd/MTU. The reused channels do not cause a degradation in the minimum critical power ratio for either unit due to their non-limiting location in a low power region. Such peripheral locations/cells typically exhibit significantly greater than 30% critical power ratio (CPR) margin (currently the Unit 1 cells which contain the reused channels are exhibiting in excess of 50% CPR margin at full power conditions). Based on General Electric (GE) evaluations on the effects of channel bow, cells with greater than 15% CPR margin are of no concern. For these reasons, there is no action required for the reused channels in either unit.

GE has included the effect of single bundle lifetime channel bow as part of the reload analysis (in the process computer update for the reload) for Quad Cities 2 Cycle 11, which is scheduled for start up in May 1990. The methodology utilized is detailed in Reference 1 which is currently under NRC review. The Bulletin indicates that the staff will consider use of this methodology if it can be demonstrated that the methodology is conservative with respect to currently approved methods. Figures 1 and 2 of this response show the impact of the channel bow methodology on the bundle R-factors of the limiting fuel types in the Quad Cities 2 Cycle 11 core. Bundle R-factors are weighted peaking factors used in the GEXL correlation for CPR determination. Figures 1 and 2 illustrate the increase in R-factors when the effects of channel bow are included, which yields a conservative critical power calculation relative to currently approved methods.

There are no other reused channels in the Quad Cities units, and the previously discussed reused channels will be discharged at the end of Quad Cities 1 Cycle 11 and Quad Cities 2 Cycle 11, respectively.

Future reloads for Quad Cities Station will incorporate the GE channel bow methodology described in Reference 1. It is anticipated that this methodology will be approved prior to the Quad Cities 1 Cycle 12 startup, which is scheduled for January 1991.

## LaSalle County Station

Unit 1 - currently operating in Cycle 4.

Unit 2 - currently in a refueling outage prior to Cycle 4 operation.

LaSalle County Station reused channels from assemblies which were discharged at the end of Cycle 1 from both Units 1 and 2, therefore, the channels had accumulated only one cycle of exposure. These channels were installed on Unit 1 Cycle 3 and Unit 2 Cycles 2 and 3 fresh reload assemblies. The exposure of these channels is projected to be significantly below the threshold at which accelerated zircaloy growth occurs during the current Unit 1 cycle and upcoming Unit 2 cycle because of the low exposure (single cycle) these channels received prior to reuse.

LaSalle County Unit 1, which is currently operating in Cycle 4, has 224 channels which were reused from the initial cycle discharge batch. The batch average exposure of these channels is projected to be less than 31 GWd/MTU at the end of the current cycle. These channels are within one bundle lifetime and therefore no immediate action is required for LaSalle Unit 1.

LaSalle County Unit 2, which is currently in a refueling outage prior to Cycle 4 operation, will have a total of 217 channels which were reused from the initial cycle discharge batch. The maximum batch average exposure of these reused channels is projected to be approximately 40 GWd/MTU at the end of the upcoming cycle (Cycle 4). Again, these exposures are lower than the threshold at which accelerated zircaloy growth occurs, approximately 50 to 60 GWd/MTU, and hence these reused channels will not cause significant degradation in the minimum critical power ratio. GE has evaluated the effect of channel bow for all resident channels in LaSalle 2 Cycle 4 as part of the reload analysis (in the process computer update for the reload) in accordance with the methodology in Reference 1. This methodology accounts for channel bow by adjusting the R-factors by an amount determined by the core average channel bow. Variations about the average channel bow are statistically included in the MCPDR Safety Limit. Although the channels from the cycle 1 discharge fuel have been reused, GE has determined that bow in this exposure range is relatively insensitive to channel exposure and therefore the methodology described in Reference 1 is applicable to LaSalle 2 Cycle 4. It is anticipated that this methodology will be approved by startup of LaSalle 2 Cycle 4, which is scheduled for June 1990.

Future LaSalle County Station reload analyses will incorporate the channel bow methodology detailed in Reference 1 and will continue to explicitly account for the effect of the reused initial cycle discharge batch channels.

#### Dresden Station

Unit 2 - currently operating in Cycle 12.

Unit 3 - currently operating in Cycle 12.

Dresden Unit 3 is currently operating in Cycle 12 and has no reused channels; therefore, no immediate action is required. Dresden 3 Cycle 13 is scheduled for startup in June 1991 and will be analyzed with Advanced Nuclear Fuels' (ANF) advanced methodology. Channel bow effects will be modeled in accordance with the Reference 2 methodology currently under NRC review. It is anticipated that this methodology will be approved prior to Dresden 3 Cycle 13 operation.

Dresden Unit 2 is currently operating in Cycle 12 and has a significant number of reused channels as a result of Edison's previous channel management strategy. During the Cycle 9 and Cycle 10 refueling outages, fresh reload fuel assemblies received channels with one or two prior cycles of irradiation. A total of 303 reused channels remain in Dresden 2 Cycle 12. The remaining 421 assemblies do not have reused channels.

Channel exposures were compiled and projected to the end of Cycle 12. Of the 303 reused channels, 194 will exceed 40 GWd/MTU exposure and 28 will surpass 50 GWd/MTU prior to shutdown for refueling scheduled for September 1990. Essentially all of the reused channels, 297 out of 303, were manufactured by Carpenter Technology. These channels have matched halves and consequently exhibit less irradiation induced growth than similar channels with mismatched halves of the same vintage.

In light of the relatively high channel exposures, ANF has performed a cycle specific analysis for Dresden Unit 2 to assess the impact of channel bow on the MCPR Operating Limit for the current operating cycle. The analysis took into account the actual Dresden 2 Cycle 12 loading pattern and projected end of cycle exposure conditions. Using the end of cycle exposure projections, the CASMO-3G lattice physics code, and the ANFB critical power correlation, ANF has determined the impact on CPR using a procedure similar to that outlined in Reference 2. ANF's generic channel bow methodology statistically accounts for the effects of channel bow by an adjustment to the MCPR Safety Limit; however, an equivalent adjustment to the MCPR operating limit provides the same level of thermal margin protection. For the analysis performed, the calculated CPR adjustment for channel bow is partially offset by the inherent conservatism of the XN-3 CPR correlation, the current thermal margin licensing basis for Dresden, relative to the ANFB correlation. ANF has discussed this inherent XN-3 conservatism with the NRC and transmitted the supporting documentation via Reference 3. The results of the Dresden Unit 2 channel bow analysis, which is included as Attachment B, are summarized below.

$$\begin{array}{cccccc}
 (\text{MCPR OL}) & + & (\text{CPR Bow Penalty}) & - & (\text{XN-3 Conservatism}) & = & (\text{New MCPR OL}) \\
 1.39 & & 0.15 & & 0.09 & & 1.45
 \end{array}$$

Dresden Station has administratively incorporated the net CPR adjustment (0.06) into the MCPR Operating Limit for Dresden Unit 2 Cycle 12. A revision to the Dresden Unit 2 Cycle 12 Core Operating Limits Report, which will reflect this new MCPR Operating Limit, will be submitted by May 31, 1990.

Approximately 50 percent of the reused channels will be discharged from Dresden Unit 2 during the upcoming refueling outage (scheduled for September 1990). The impact of the remaining channels will be explicitly analyzed for Dresden Unit 2 Cycle 13 using the approach outlined above. It is expected the Cycle 13 channel bow CPR adjustment will be within the XN-3 conservatism since the majority of the reused channels will reside in peripheral core locations. For all future Dresden Unit 2 cycles starting with Cycle 14, the ANF generic channel bow methodology described in Reference 2 will be used to account for channel bow.

### Conclusions

Edison has evaluated the impact on thermal margin resulting from channel bow at its BWR Stations and has formulated the following conclusions.

- For current cycles operating with reused channels, Edison has determined that the CPR margin impact is negligible or has applied an appropriate delta-CPR adjustment to the MCPR Operating Limit. Edison's fuel vendors have evaluated the impact of channel bow on the remaining thermal limits and have determined sufficient conservatism exists.

- Edison will implement methodology to account for the effects of channel bow in future reload analyses as described previously.
- The effects of channel bow are expected to decrease because Edison's current channel management strategy prohibits the reuse of channels on new fuel assemblies. Additionally, stringent as-built bow criteria have been established to maintain bow levels at a minimum.

The steps taken to account for the effects of channel bow are adequate and conservative; therefore, there is no impact on safe plant operation.

### References

1. GE Document, "Effect of Channel Bow on Margins to Core Thermal Limits in BWRs".
2. ANF-524(P), Revision 2, Supplement 1, "Advanced Nuclear Fuels Corporation Critical Power Methodology for Boiling Water Reactors - Methodology for Analysis of Assembly Channel Bowing Effects", November 1989.
3. Letter, R. A. Copeland (ANF) to R. C. Jones (USNRC), "Loss of Thermal Margin Caused by Channel Box Bow", April 9, 1990.

# Figure 1 - Effect of Bow on R-Factor GE9B Fuel - Q2C11

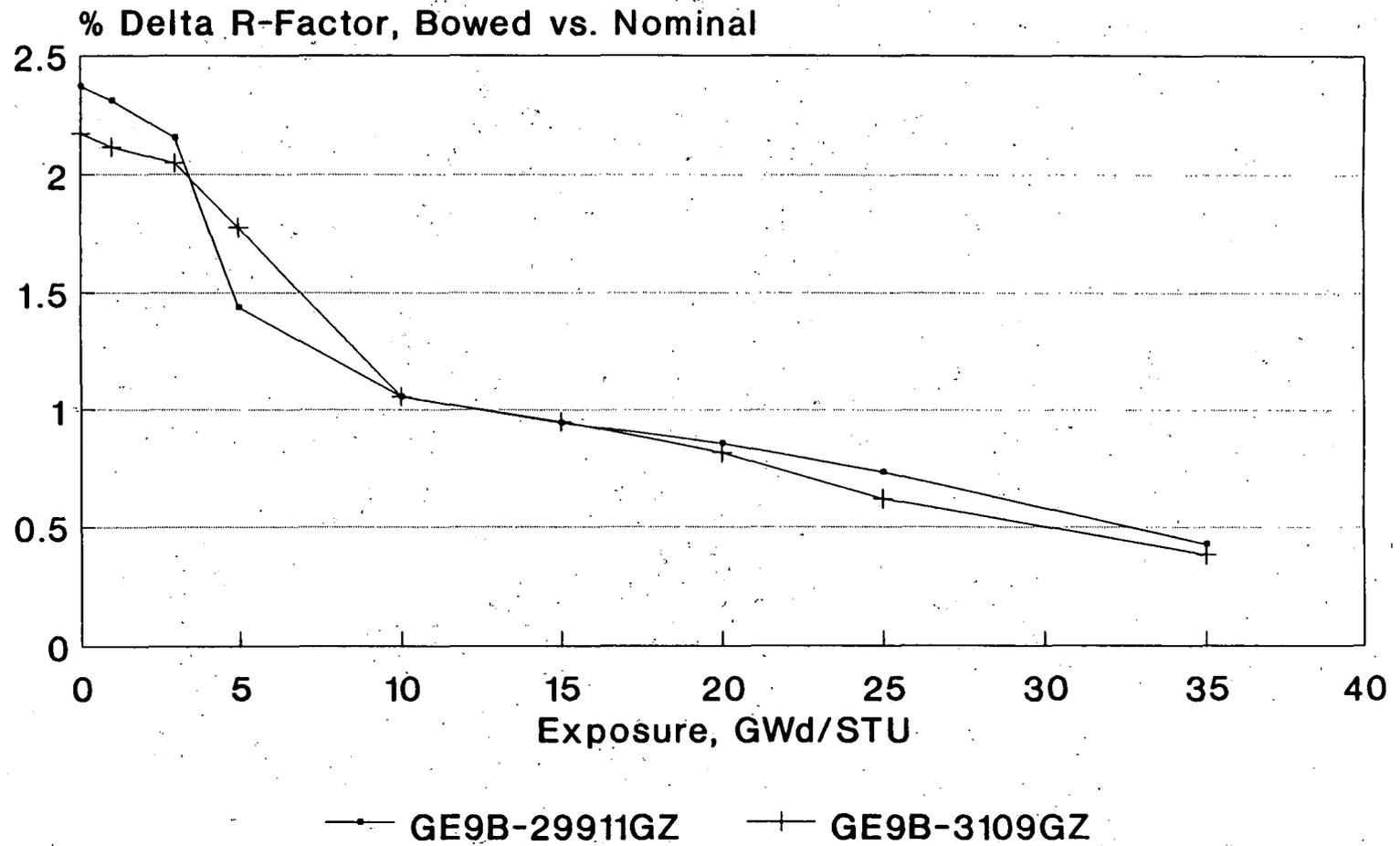
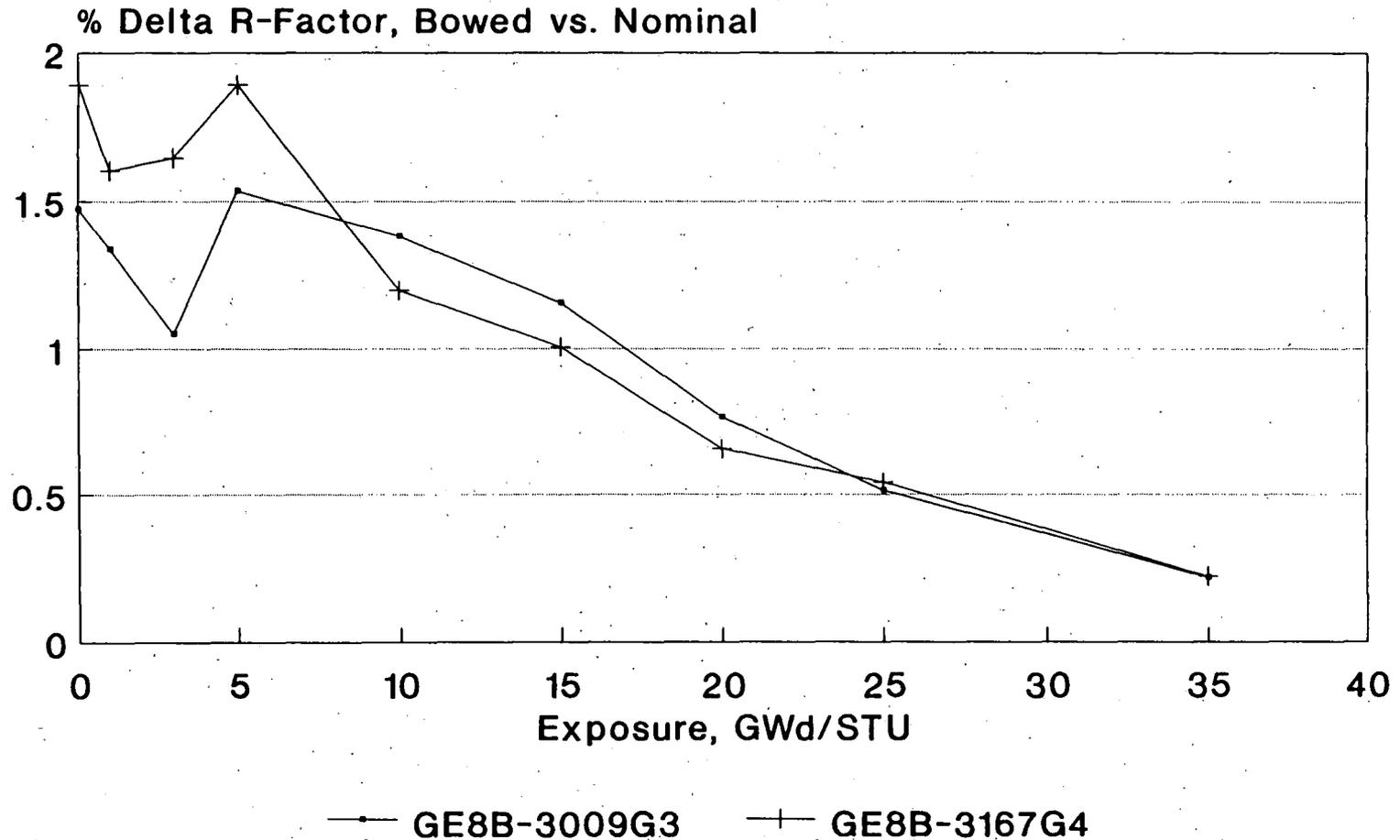


Figure 2 - Effect of Bow on R-Factor  
GE8B Fuel - Q2C11



ATTACHMENT B

Channel Bow Analysis For  
Dresden 2 Cycle 12