

March 10, 2006

MEMORANDUM TO: Jennifer L. Uhle, Deputy Director
for Materials Engineering
Division of Fuel, Engineering and Radiological Research
Office of Nuclear Regulatory Research

FROM: Simon Sheng and Carolyn Fairbanks */RA/* Jennifer Uhle for
Division of Fuel, Engineering and Radiological Research
Office of Nuclear Regulatory Research

SUBJECT: TRIP REPORT - MEETING AT ASTM E10.02 SUBCOMMITTEE

Simon Sheng and Carolyn Fairbanks (RES staff), and Professor Robert Odette (University of California at Santa Barbara), the NRC contractor for Job Code Y6969, "Radiation Embrittlement Analysis," attended a meeting at the ASTM E10.02 Subcommittee from February 6, 2006, to February 7, 2007, at Phoenix, Arizona.

The purpose of the trip was to present to the Subcommittee the proposed reactor pressure vessel (RPV) embrittlement trend curve to be used in the revision of Regulatory Guide 1.99, Revision 2 (May 1988), "Radiation Embrittlement of Reactor Vessel Materials." The slides presented by NRC and its contractors are provided for public information in enclosures 1, 2, and 3 of this trip report. Further, the surveillance database used to develop the proposed RPV embrittlement trend curve is contained in Enclosure 4.

The staff welcome comments from public on these enclosures.

Enclosures:

- (1) Staff Analysis Results Supporting R. 1.99, Rev. 3
- (2) Revised 1/06 Embrittlement Shift Correlation
- (3) Review of IVAR Results
- (4) Surveillance Database

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Distribution w/ Enclosures: DFERR r/f ME r/f M. Cunningham M. Kirk
R. Hardies B. Elliot C. Fairbanks M. Mitchell

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NRC PRESENTATION REGARDING THE NEW EMBRITTLEMENT CORRELATION

- C Component 1 (50 min): "Revised 1/06 Embrittlement Correlation," by Dr. Ernie Eason of MCS.**
- C Component 2 (25 min): "Review of IVAR Results," by Professor Bob Odette of UCSB.**
- C Component 3 (15 min): "Staff Analysis Results Supporting RG 1.99, Revision 3," by Dr. Simon Sheng of NRC.**

**DISCLAIMER: INFORMATION FROM THIS NRC PRESENTATION IS
FOR PUBLIC INFORMATION ONLY AND SHALL NOT BE
CONSIDERED AS FINAL**

Enclosure 1

STAFF ANALYSIS RESULTS SUPPORTING RG 1.99, REVISION 3

Simon Sheng, NRR/DCI (Rotation in RES/DET)

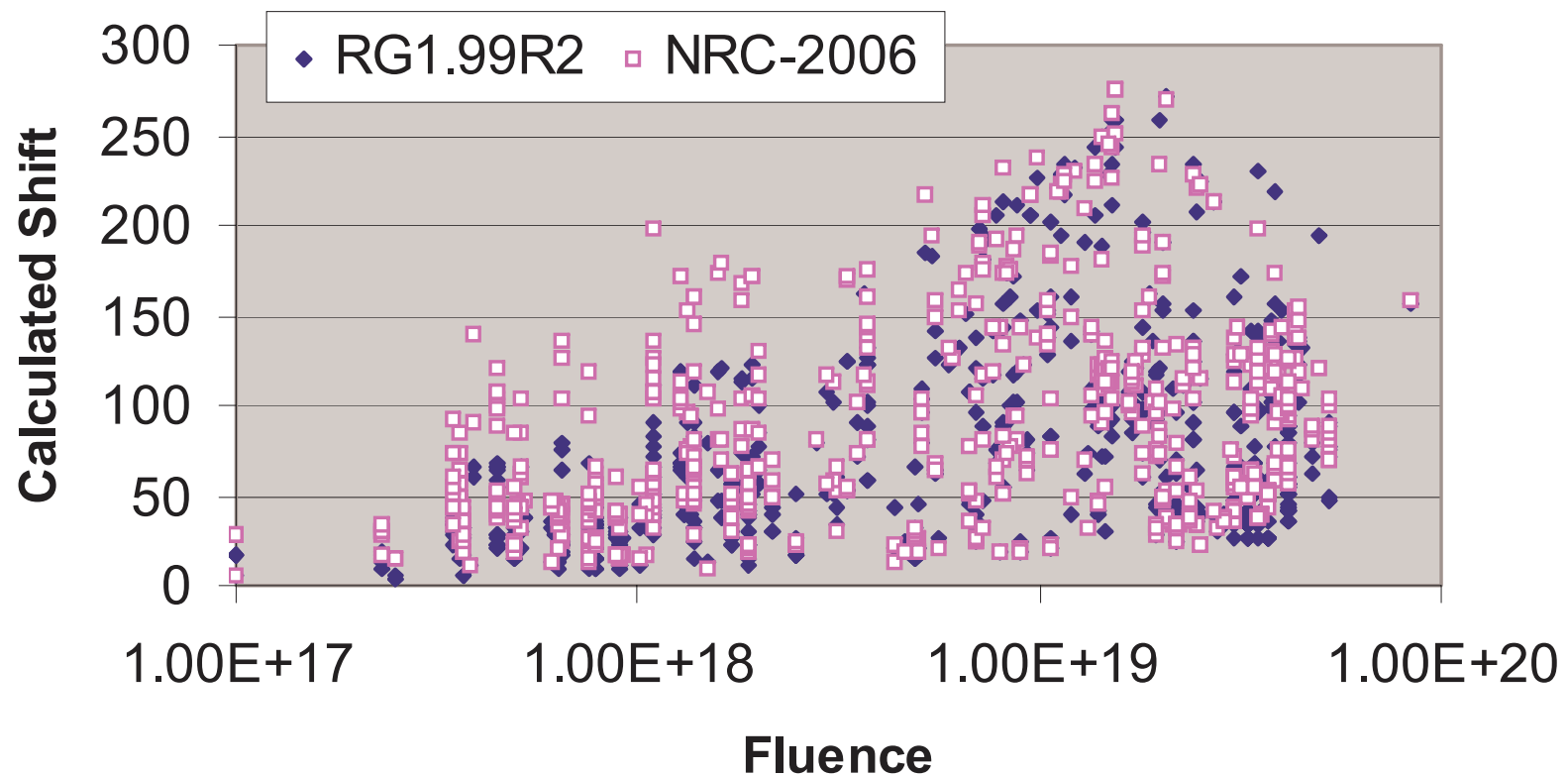
C The staff analyses have been performed to answer the following two questions:

(1) Is there a need for RG 1.99, Revision 3?

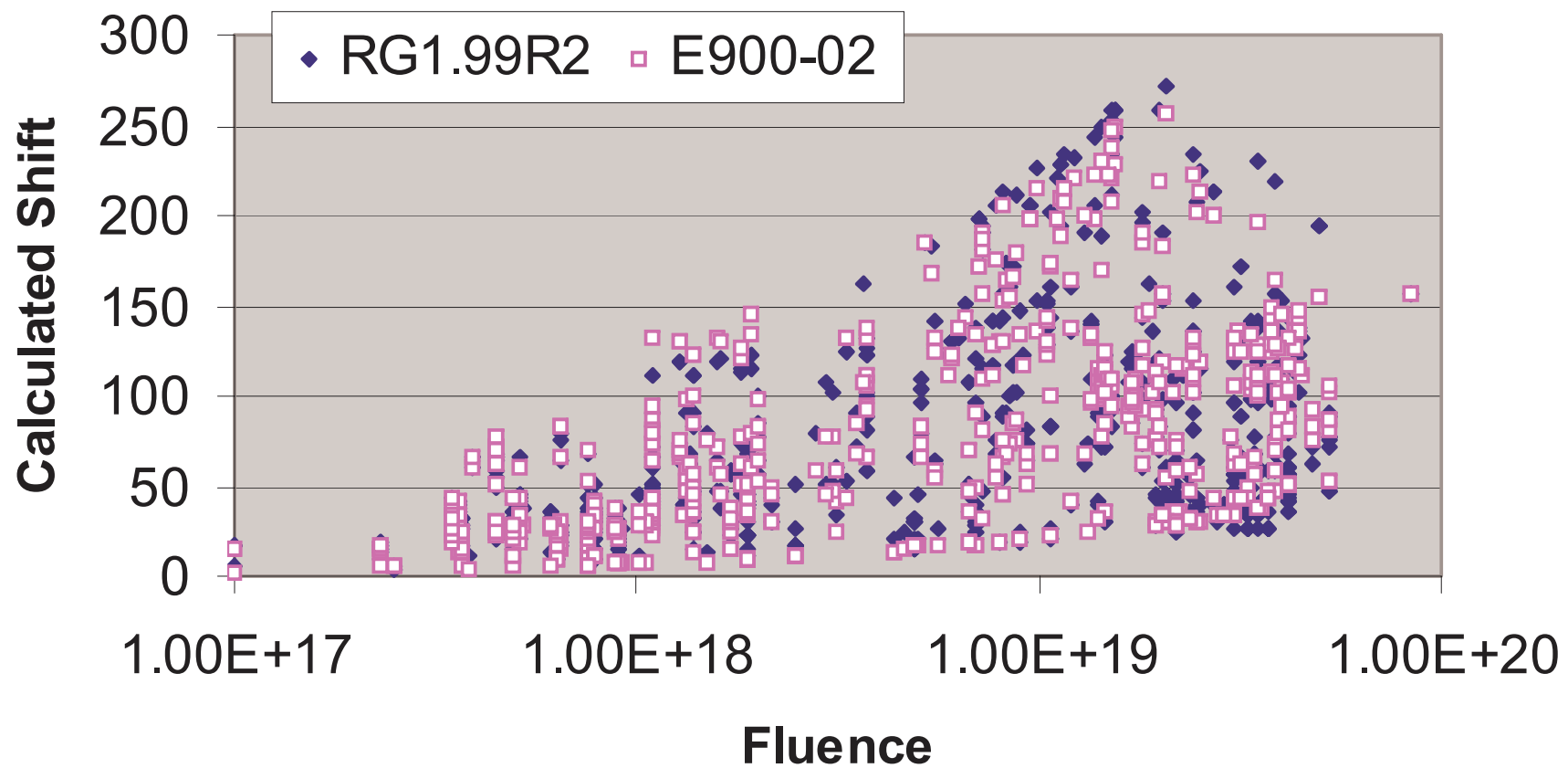
(2) How does the NRC 2006 model compare with the ASTM 900-02 (the ASTM) model?

IS THERE A NEED FOR RG 1.99, REVISION 3?

Figure 1 Calculated shifts for operating RPV materials using RG1.99, Rev. 2 and the NRC-2006 model



**Figure 2 Calculated shifts for operating RPV materials
using RG1.99, Rev. 2 and the ASTM E900-02 model**



HOW DOES THE NRC 2006 MODEL COMPARE WITH THE ASTM MODEL?

C Standard error - a quantitative measure:

$$\text{Define } S_e = \sqrt{\frac{\sum_{i=1}^{936} (\text{shift}_{\text{predicted}} - \text{shift}_{\text{actual}})^2}{936 - \text{No. of fitting parameters}}}$$

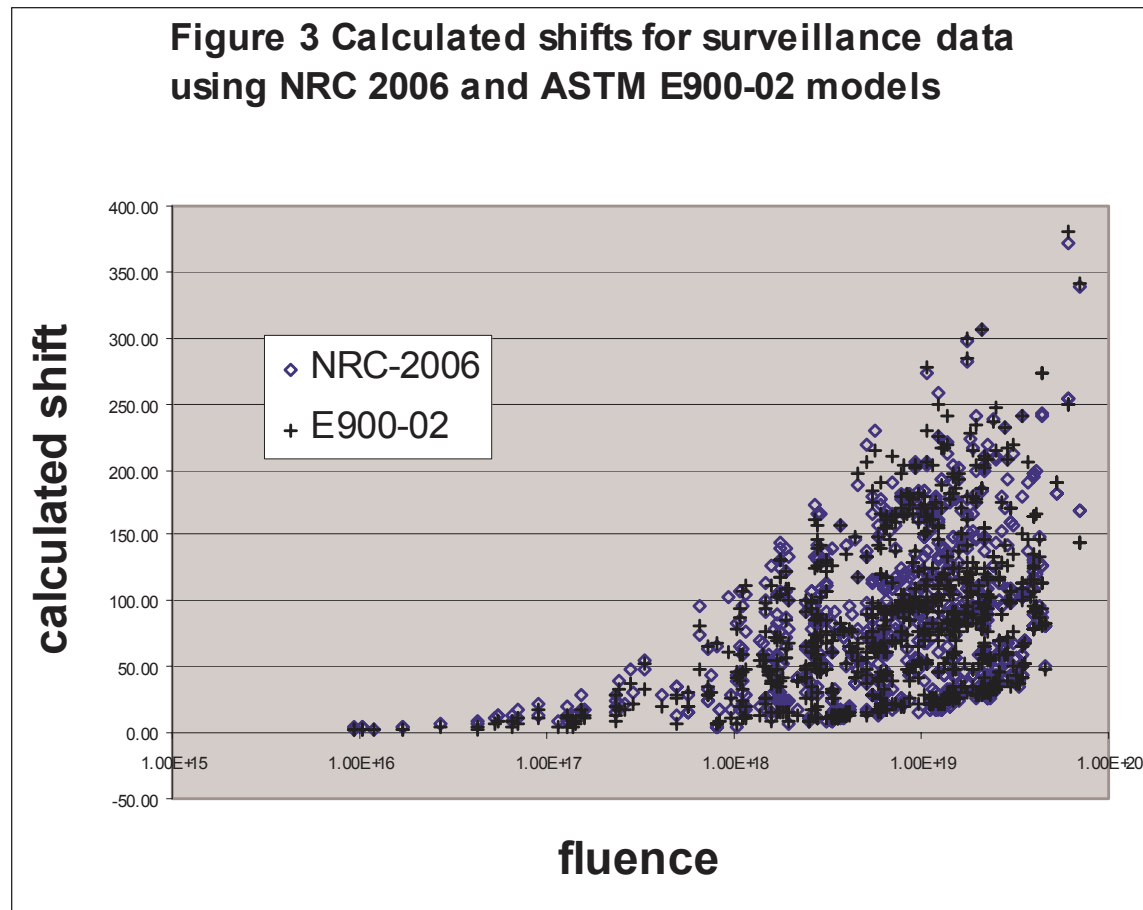
Where 936 represents the surveillance database size

Calculated results:

$S_e = 21.39\text{EF}$ for the NRC 2006 model
(25 fitting parameters)

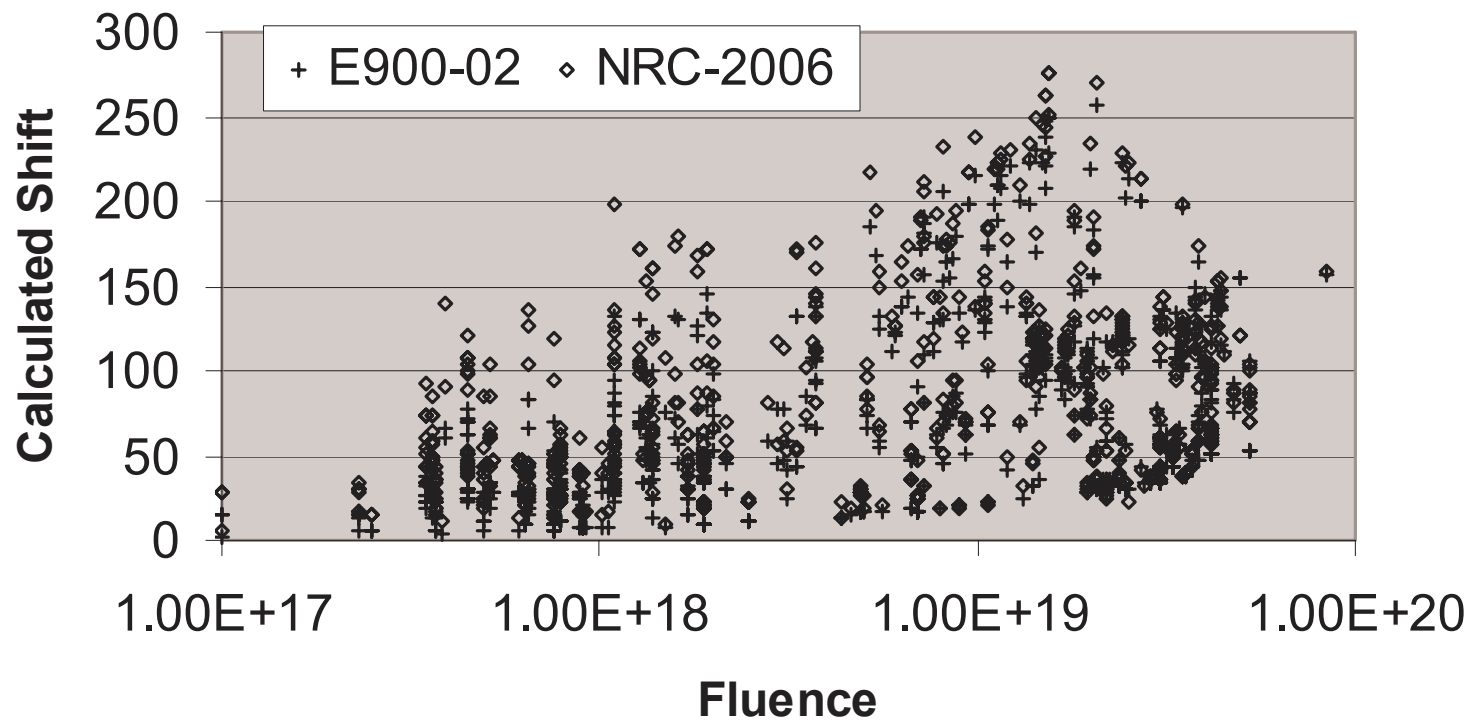
$= 22.26\text{EF}$ for the ASTM model
(15 fitting parameters)

C Calculated shift plot: a macroscopic view: For surveillance data



C Calculated shift plot: a macroscopic view:
For operating plant data

**Figure 4 Calculated shifts for operating RPV materials
using NRC 2006 and ASTM E900-02 models**



SURVEILLANCE DATABASE COMPOSITION

	Calibration set	Validation set	Remaining SRM data
PWR High Cu	440	45	
PWR Low Cu	219	23	
BWR High Cu	124	11	
BWR Low Cu	27	1	
Subtotal	775	80	81 (out of 107)
Total	936 (8 outliers and 4 data with unusual irradiations are excluded)		

CONCLUSIONS

- C Figure 1 shows that the NRC-2004 model gives significantly higher shifts for many RVID materials. Hence, revision of RG 1.99, Rev. 2 is justified**
- C Figure 3 and the calculated standard errors using all surveillance data indicate that, macroscopically, the NRC 2006 model and the ASTM model are comparable**

However, these two models give quite different shifts for RVID materials with fluence less than $1.1\text{E}+19 \text{ n/cm}^2$