Consumers Power
POWERING MICHIGAN'S PROGRESS
Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT - CORRECTION FACTOR FOR IRRADIATION TEMPERATURE BELOW 525°F - PRESSURIZED THERMAL SHOCK - 10CFR50.61 - REVISION 1

Consumers Power Company's March 11, 1992 letter addressed the propriety of not using an irradiation temperature correction factor when applying Regulatory Guide (RG) 1.99, Revision 2, approved methodology to determine RT_{PTS} for the Palisades reactor vessel beltline material. Although, early in life, that beltline material was irradiated at temperatures below the RG 1.99, Revision 2, applicable temperature range (525°F - 575°F), four reasons for not applying an irradiation temperature correction factor were provided.

This revision to our March 11, 1992 letter provides supplemental information which: (1) includes the girth weld when computing a weighted average irradiation temperature (Reason 2 below); (2) explains why we estimated 234°F as T-Cold from the present to the time when the screening criterion limit will be exceeded; and (3) identifies the data plotted in Figure 1. Additionally, this revision corrects minor errors in the original letter including the number of CE and Westinghouse plants used in RG 1.99, Revision 2, Reference 2 (should be 42 rather than 44) and the reactor vessel plate fluence value and resulting computed chemistry factor stated in Reason 4 below. Vertical lines in the right margin indicate where changes are made to include the supplemental information and corrections.

Section C.1.3 of Regulatory Guide (RG) 1.99, Revision 2, states that calculation procedures utilizing the equations in the Guide are valid for a nominal irradiation temperature of 550°F; and, that irradiation below 525°F should be considered to produce greater embrittlement and a correction factor justified by reference to actual data should be used.

A preliminary search of Palisades records indicated that, during Cycle 1 and the first half of Cycle 2, the plant operated with a T-average program which

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ranged linearly from 532°F at zero power to 544°F at full power. At that time, core Delta-T was 43°F at full power. The program resulted in a full power T-Cold of 522.5°F and T-Cold being below 525°F when the power level was above approximately 70%.

Conservatively assuming all operation in the first cycle and half of the second cycle was at 100% power would result in the following fluence being delivered to the vessel inner wall at 522.5°F:

1. At 0 degrees vessel radial angle, f = 2.51E18 n/sq cm;
2. At 16 degrees vessel radial angle, f = 3.31E18 n/sq cm; and
3. At 30 degrees vessel radial angle, f = 2.57E18 n/sq cm.

Near the end of Cycle 2, the Palisades full power rating was increased from 2200 MWT to 2530 MWT and the T-Average program was increased at the same time. For the next 6 cycles of approximately 12 effective full power months each, T-Cold ranged from 536°F to 539°F. In Cycle 9, which was the first cycle after the steam generators were replaced, the T-average program was again changed so that it produced a T-Cold of 534°F at full power.

We believe no correction factor should be applied to the embrittlement calculated for the fluence increment below 525°F for the following reasons:

1. T-Cold was only 2.5°F below the 525°F lower irradiation temperature guideline. Fluence of 2.57E18 n/sq cm at the limiting weld represents about 22% of the fluence accumulated to date and about 15% of the estimated fluence at the 270°F screening limit for this weld. Since the welds have had at least 7 effective full power years at temperatures above 525°F, it is expected that any extra damage caused by the 2.5°F difference early in life would be minimized by annealing which took place during the operation at higher temperatures later in life.

2. Another approach which could be taken is to conservatively ignore the timing of the lower temperature irradiation and compute a fluence weighted average irradiation temperature.

   Assuming the longitudinal welds are limiting, the fluence would then be 2.07E19 n/sq cm when the screening criterion is exceeded. The present fluence is 1.18E19 n/sq cm. The calculation is accomplished as follows:

   Average T-Cold = [0.257E19(522.5)+0.923E19(536)] / 1.18E19
   Average T-Cold = 533.0 at the present time; or

   Average T-Cold = [0.257E19(522.5)+0.923E19(536)+0.890E19(534)] / 2.07E19
   Average T-Cold = 533.5 at the screening criteria limit.

   Therefore, since the fluence weighted average irradiation temperature is significantly greater than 525°F, no correction is necessary.

The same calculation, assuming that the girth weld is limiting, would proceed as follows:

Fluence at end of low T-Cold operation = 3.31E18 n/sq cm
Fluence in December 1991 (near EOC 9) = 1.61E19 n/sq cm
Fluence at screening criterion (300°F) = 2.78E19 n/sq cm

Average T-Cold=[0.331E19(522.5)+1.279E19)536)] ÷ 1.61E19
Average T-Cold=533.2 at the present time; or

Average T-Cold=[0.331E19(522.5)+1.279E19(536)+1.170E19(534)] ÷ 2.78E19
Average T-Cold=533.6 at the screening criterion limit.

This calculation produces essentially the same results and the same conclusion as the case with the longitudinal welds limiting.

3. Our understanding is that the correlations of 10CFR50.61 have been derived exclusively from data from power reactor surveillance specimens. RG 1.99, Revision 2, Reference 2, lists 51 weld metal points which are all from older PWR's (except for the two Dresden Unit 3 points and the two Quad Cities points). There are 5 Babcock & Wilcox plants. The remaining 42 plants are Westinghouse or Combustion Engineering. These plants typically run with T-Cold in the 525°F to 550°F range. Power Reactors typically irradiate their vessel at T-Cold. Although much research data is available at an irradiation temperature of 550°F, the center band of the power reactor surveillance data is likely to be in the 535°F to 540°F range. Section B.4 of RG 1.99 suggests a ±25°F band be applied to surveillance data. This would extend the operating power reactor range to 510°F or 515°F. Palisades is well within these limits.

4. To address the requirement of RG 1.99, Section C.1.3.2, to refer to actual data, consider the surveillance program results for the RACO 3 W5214 heat. There are 7 available points. Of these, 3 were irradiated at 539°F and 2 were irradiated at 522°F. All 7 points lie on a reasonably straight line and agree quite well with the 10CFR50.61 correlation if our proposed chemistry is assumed. Thus, it is shown by test that, for the W5214 heat, irradiation at 522°F did not produce results outside the certainty allowance typically used to judge a qualified surveillance program. Furthermore, Palisades irradiation temperatures are bounded on both the high and the low sides by the surveillance data points.

   If a chemistry factor is calculated for Heat W5214 from the measured shifts using the fitting procedure in Section C.2 of RG 1.99, a value of 217°F is determined. This agrees well with the value of 217°F calculated from our best estimate chemistry and the RG 1.99 tables. This is further evidence that in the range of temperatures we are considering, no correction is necessary. The attached plot (Figure 1) illustrates this agreement.

   The Palisades surveillance program contains specimens from plate D-3803-1. The plate chemistry is 0.24% Cu and 0.51% Ni. The chemistry among and

within the Palisades plates is very consistent. The chemistry factor calculated by RG 1.99, Revision 2, for this plate is 159°F. Irradiated Charpy specimens from the plate produced a shift of 155°F at a fluence of 1.09E19 n/sq cm and 205°F at a fluence of 4.40E19 n/sq cm. Applying the RG 1.99, Section C.2, procedure produces a chemistry factor of 150°F. This shows that samples exposed to the Palisades exact flux spectrum and T-Cold history conservatively agree with the RG correlation without correction.

In view of the above reasons, we believe Palisades has satisfied the conditions of RG 1.99, Revision 2, Section C.1.3, and, as stated earlier, no additional correction is required to compensate for operation during Cycle 1 and part of Cycle 2 with T-Cold at 522.5°F.

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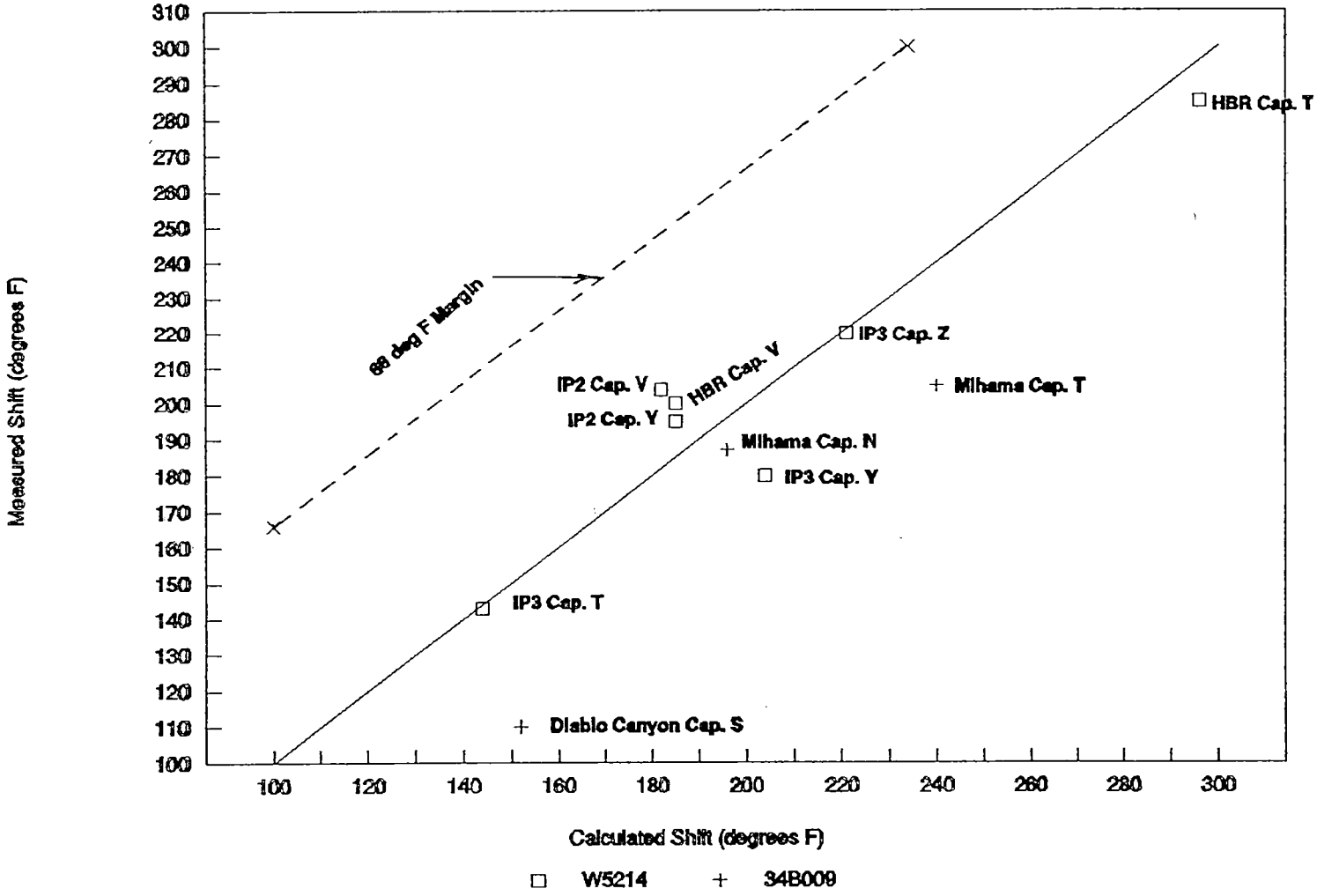
Attachment


Measured Shift (degrees F)
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300
290
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250
240
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210
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170
160
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220
240
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280
300
Calculated Shift (degrees F)
68 deg F Margin
HBR Cap. T
IP3 Cap. Z
Mihama Cap. T
IP2 Cap. V
HBR Cap. V
IP2 Cap. Y
Mihama Cap. N
IP3 Cap. Y
IP3 Cap. T
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W5214
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Figure 1