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March 31, 2008

BVY 08-013

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

References: (a) BWRVIP-94, Revision 1, "BWR Vessel and Internals Project Program Implementation Guide"
(b) BWRVIP-130, "BWR Vessel and Internals Project BWR Water Chemistry Guidelines - 2004 Revision"

Subject: Vermont Yankee Nuclear Power Station
License No. DPR-28 (Docket No. 50-271)
Deviation from BWRVIP-130

Dear Sir or Madam:

In accordance with BWRVIP-94, Entergy hereby informs the NRC of a specific deviation from the BWRVIP-130 Action Level 1 for total Feedwater System copper. The attachment to this letter provides the history and technical basis for the deviation.

This notification is for information only and no action on the part of the NRC is requested.

There are no new regulatory commitments being made in this submittal.

If you have any questions concerning this submittal, please contact Mr. David J. Mannai at (802) 451-3304.

Sincerely,

Ted A. Sullivan
Site Vice President
Vermont Yankee Nuclear Power Station

Attachment: Vermont Yankee Nuclear Power Station, Technical Justification for Deviation from BWRVIP-130

cc: (next page)

A001
NRR

cc: Mr. Samuel J. Collins, Region 1 Administrator
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Mr. David O'Brien, Commissioner (w/o attachment)
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Docket No. 50-271
BVY 08-013

Attachment 1

Vermont Yankee Nuclear Power Station

Technical Justification for Deviation from BWRVIP-130

Vermont Yankee Nuclear Power Station
Technical Justification for Deviation from BWRVIP-130

Introduction

In accordance with BWRVIP-94 "BWRVIP Program Implementation Guide", Revision 1, a Deviation Disposition is required when utility procedures, inspections, methodology, or guidelines are inconsistent with the intent of the supporting BWRVIP guidelines. BWRVIP-94 Appendix A provides guidance on the document structure for a technical justification for a deviation.

BWRVIP Requirement

BWRVIP-130, "BWR Water Chemistry Guidelines", 2004 Revision, Section 6-14 in Table 6-6 identified that the Action Level 1 value for feedwater copper is 0.2 ppb. In Section 6-5 the following statement is made concerning an Action Level 1 condition for feedwater copper: "if not restored within 96 hours, perform a review to assess the impact of long-term system reliability. Identify and evaluate corrective actions. Develop and obtain management approval of a written plan and schedule to implement appropriate corrective actions."

The basis for the BWRVIP documents is that the presence of copper in the reactor coolant "can cause delamination of nodular oxide on zircaloy cladding or deposit in a tenacious crud, potentially leading to cladding damage". Crud Induced Localized Corrosion (CILC) type failures have been associated with elevated levels of copper in BWR feedwater. Plants with copper alloy condensers such as Vermont Yankee (VY) should carefully evaluate fuel concerns and take preventative measures, which should include the following:

- Use only fuel cladding with high resistance to nodular corrosion.
- Consult with the fuel vendor if planning to add zinc in the feedwater.
- Perform an engineering risk assessment including the potential effect on fuel integrity due to redistribution and deposition on the fuel of Fe, Cu, and Zn prior to making significant chemistry changes.

The justification below addresses these recommendations and risk assessment.

VY Deviation

Feedwater copper is not controlled to <0.2 ppb, BWRVIP-130 Action Level 1, under all operating conditions. The Cycle 25 average feedwater copper concentration was 0.47 ppb.

Background

Elevated feedwater copper levels for plants with admiralty brass condensers and filter demineralizers have been a noted industry problem for several years. The admiralty brass condenser tubes contain approximately 78% copper and approximately 20% zinc. Filter demineralizers are approximately 90% efficient for removal of soluble species due to the very short residence time on the thin ion exchange resin layer on the precoat.

The basis for this deviation is as follows:

1. VY cannot meet the 0.2 ppb feedwater copper limit under all operating conditions.

2. There have been no fuel failures at VY within the past 15 years where the root cause was copper when the cycle average copper concentration was ~ 0.5 ppb or greater. Actual fuel failures were attributed to fretting, manufacturing defects, FME, and accelerated corrosion.

3. Currently, all the fuel cladding in VY's core is process 8, which is more resistant to accelerated corrosion.

4. Feedwater copper concentrations > 0.2 ppb do not impact the effectiveness of hydrogen water chemistry in a plant (VY) that has injected noble metals.

5. VY procedures contain Fuel Warranty Limits and has a Continuous Limit of 1.0 ppb for feedwater copper. The Fuel Contract has a continuous limit of 1.0 ppb for feedwater copper.

6. Fuel inspections performed during RFO-26 showed no fuel failures after one year operation under Extended Power Uprate (EPU) conditions and testing zinc addition at the end of the cycle. However, higher than expected "lift off", within the GE experience base, was observed on second cycle fuel. This could mean more tenacious crud. Fuel inspections will be performed again in RFO-27 and the thrice burned fuel will not be put back in the core.

The following table shows cycle averages for total feedwater copper:

Cycle Average Total Feedwater Copper	
Cycle	Total Copper (ppb)
19	0.50
20	0.43
21	0.41
22	0.45
23	0.23
24	0.25
25	0.47

The data shows that VY feedwater total copper on a cycle average basis has been consistently greater than 0.2 ppb (Action Level 1 of BWRVIP-130). The cycle averages for cycles 23 and 24 show an improvement in total copper concentration. This is due to improvements in the resin mix of the condensate demineralizers. The optimized copper removal continued into cycle 25 until March 2006. For the EPU condensate flow was increased by 20% and a bypass line was added to the condensate demineralizers to balance flow at 100% power with a demineralizer out of service. These factors have resulted in an increase in feedwater copper concentration for the rest of cycle 25 and cycle 26. Since EPU, feedwater copper concentration has typically been 0.5-0.6 ppb. Higher copper concentrations are seen during the summer months and periods of operation with four condensate demineralizers and the bypass line.

VY is modifying the condensate demineralizer system to optimize copper removal. The modification of the system involves complete replacement of the internal components of the condensate demineralizer vessels and adding an integrated flow distributor to each vessel. This will present more filter area and resin to condensate flow and maximize copper removal.

The concern with copper is for copper oxide on the fuel surface. This caused the industry CILC fuel failures of the 1980s. Fuel vendors have developed corrosion resistant fuel cladding to prevent CILC failures, such as the P-8 cladding used at VY. The current fuel concern involves copper oxide precipitating onto a tenacious layer of zinc ferrite on the fuel cladding, causing an increased temperature gradient and affecting heat transfer, which could lead to fuel failures. A concentration of 0.2 ppb in the feedwater was chosen as Action Level 1 for BWRVIP-130 because there was copper with large concentrations of iron and zinc in the River Bend fuel failures.

Review of Operating Experience

The River Bend Station (RBS) fuel failure incident of 1999 was thoroughly evaluated and discussed at several EPRI meetings. RBS experienced fuel failures in 7 fuel assemblies that appeared to be related to fuel crud (copper + zinc + iron). Although there was an elevated amount of copper in the fuel crud, the failure mechanism was more a result of heavy deposition of iron oxide-based tenacious crud. Two conductivity excursions resulting from a chemical decontamination of an Residual Hear Removal (RHR) system heat exchanger during the October 1997 refueling outage and the subsequent startup are the suspected causes for a large influx of corrosion products early in the operating cycle. Their feedwater iron levels were around 3.7 ppb. This did not account for all iron deposits on the fuel inside the core and it was not clear where this extra iron came from. At VY, feedwater iron is maintained below the EPRI Guideline value of 5 ppb and is infrequently above 2 ppb. Therefore, the RBS event does not apply to VY because VY has much less iron and zinc, and iron and zinc were the major contributors to RBS's fuel failures. As a result, the type of fuel failures seen at RBS are not expected at VY, even with a feedwater copper concentration >0.2 ppb. Based on a review of the EPRI Guidelines, the RBS incident was used as the basis for the guideline value for feedwater copper being reduced from 0.5 ppb to 0.2 ppb.

The General Electric (GE) BF2/VY Root Cause Investigation Report dated 03/17/2003 did not determine a root cause for the 5 fuel failures identified during Cycle 22. The report indicated that the high levels of copper likely contributed to accelerating the corrosion process along with some unknown initiating event. However, high levels of copper crud did not affect the performance of the 3rd cycle fuel that was discharged during RFO-22 (these assemblies were exposed to less flux). Copper concentrations were very low on the GE BF2 failed fuel. Fuel examinations at VY indicated relatively high copper deposits on Cycle 19, 20 and 21 fuel. The 5 fuel rod failures were from the same tubing lot that failed in VY reload number 20. The data indicate that other reloads residing in the core are not exhibiting the accelerated corrosion. It was noted in later fuel inspections that Reload 22 had significant accelerated corrosion and probably could not be used for another cycle. The root cause evaluation did not provide any recommendations for copper control. Following the VY fuel failures, the Reactor Engineering department contacted Aquarius Services Corporation and requested an evaluation of the data associated with the fuel failures. This included GE evaluations and material, two cycles of Chemistry Data and plant operating history. Fuel manufacturing data was also reviewed. Some conclusions and notes from the report are as follows:

- Nodular corrosion should not occur on an in-process heat treated cladding. Of the two causes, corrosion by high copper chemistry water is unlikely, since GE work in the past showed that this does not occur either in or outside the reactor. High copper chemistry with noble metals might induce nodular corrosion by the change in redox conditions at the cladding surface. The previously proposed poor in-process heat treating control could be a second cause.

- The continued evaluation of the fuel examination tapes confirm previous conclusions that there is a correlation between the level of corrosion observed, some of the cladding lot numbers and some of the local peaking factor histories of the rods.

- The author concurs with GNF's conclusion that three cladding lot numbers behaved poorly.

- A cursory comparison of fuel rod local peaking factor histories of rods from the same cladding lot indicates a reasonable correlation of power with corrosion control.

- Based on GE information, there does not appear to be a correlation between copper content and liftoff measurements, and there does not appear to be a correlation between linear power generation and liftoff either. This indicates a lack of correlation between copper content and corrosion.

- The maximum concentration of copper at a discreet axial location was 1885 $\mu g/cm^2$ that occurred at the 31" elevation of Rod D* Bundle YJF493. This fuel rod was without a fuel defect.

Duration of Technical Justification

This deviation will remain in effect until such time that the admiralty brass condenser is replaced with one that does not contain copper alloys. This is currently scheduled for 2011. The current revision of the Deviation Disposition will be reviewed after the condensate demineralizer modifications are completed. This is currently scheduled for May 2009.