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Flow Assisted Corrosion (FAC) and Flow Induced Localized Corrosion: Comparison and Discussion

Summary

- The computer model Checworks, used to manage aging of hot high pressure water and steam carbon steel lines was designed for Flow Assisted Corrosion (FAC) phenomena. Erosion Corrosion, Impingement and Cavitation are expressly excluded as unrelated to FAC. It is shown that the latter three corrosion phenomena are extensions of FAC as the local flow intensity due to turbulence increases. The transition from one to the others is continuous and difficult to identify. FAC therefore is only one manifestation of Flow Induced Localized Corrosion (FILC).
- The localized corrosion rate under the umbrella of FAC varies, per definition, almost linearly with fluid velocity; however, this linear relationship transitions into an exponential one as the local turbulence becomes such that erosional features become manifest. Whether such transition actually occurs following a power upgrade (PU) must be determined experimentally. It cannot be estimated from within Checworks.
- It has been stated that "the algorithms used to predict the FAC wear rate are based on extensive laboratory and plant data. This assures that the FAC wear rates predicted by Checworks are accurate." This accuracy is said to be within +/- 50%. However, this statement is based on an erroneous interpretation of the graphic representation of predicted vs. measured wear. Actually, the accuracy is within a factor 2. The measured wear ranges from twice the predicted to half the prediction.
- Partial review of the result from the pipe inspections using Checworks in 2003 and 2006 shows significant unexplained discrepancies.

I. Introduction

The direct testimony by Dr. Jeffrey S. Horowitz and Dr. James C. Fitzpatrick¹⁾ with regards to NEC Contention 4 – Flow Accelerated Corrosion has raised a number of questions, which are being discussed below:

¹⁾ Joint Declaration of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4 – Flow-Accelerated Corrosion, May 12, 2008.

measured ones is derived from a representation of the data as shown in Figure 3 below. It is true that when the measured wear data are plotted against the predicted ones most of the data points lie between two lines that are plotted +/- 50% off the 45 degree equivalency lines. This interpretation is totally misleading and scientifically dishonest.

First, one sees that there is no correlation between the predictions and the actual measurements. Second, one also sees that measurements which we are made to believe are within 50% of the predicted value are really twice as large or larger; similarly, on the other side one sees that measured values are half or less of the predicted ones, again a factor of 2 different.

Conclusion: The accuracy of Checworks is such that the measured values are within a factor of +/- two [+/- 2] of the predicted values rather than +/- 50% as claimed.

A factor-of-two difference between measured and predicted corrosion [or corrosion rate] can be quite significant with respect to selecting a particular item (line) for inspection during a given refueling outage. Indeed the report of the "EPRI Checworks Wear Rate Analysis Results for Cycle 22B"¹⁵⁾ shows that the time predicted to reach the critical minimum wall thickness in a majority of cases is many years *negative*. This means that the item should have failed a long time ago. Similarly, the remaining time to failure may be grossly overestimated. But one will never know unless the proper inspections are performed and the computer model recalibrated, a process Dr. Horowitz and Entergy seem to find irrelevant.¹⁶⁾

Examination of the data from March 2003 (RFO 23) showed average and measured corrosion rates of the order of 28 and 21 mpy, respectively, for the outlet "P-1-1A" on line 001-16-FDW-01. In May of 2006 these same rates have come down to 7.524 and 5.712 mpy, respectively.¹⁷⁾ It is hard to see how this could have happened. There is in the program something called "Line Correction Factor." This factor has been defined by Dr. Horowitz as the relationship between predicted and measured corrosion rate (see below¹⁸⁾). However in 2003 this factor was 0.649 and by 2006 it had become 0.175. It is amazing to observe that fudge factors are built into the program which

¹⁵⁾ Exhibit E-4-29.

¹⁶⁾ Joint Declaration of Jeffrey S. Horowitz and James C. Fitzpatrick on NEC Contention 4-Flow-Accelerated Corrosion: A 34.

¹⁷⁾ Exhibit E-4-30.

¹⁸⁾ HOROWITZ'S TESTIMONY STATES THE FOLLOWING ABOUT THE ABOVE-MENTIONED "CORRECTION FACTOR" AT A28: "A Pass 2 Analysis compares the measured inspection results to the calculated wear rates and adjusts the FAC rate calculations to account for the inspection results. The program does this by comparing the predicted amount of degradation with the measured degradation for each of the inspected components. Using statistical methods, a correction factor is determined which is applied to all components in a given pipe line - whether or not they were inspected."