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MEMORANDUM TO: ACRS Members and Staff

MEMORANDUM #: AWC-102.2002

FROM: A. W. Cronenberg

SUBJECT: Observations Noted from Examination of the Farley-PWR 4.6-% Power Uprate:
Staff *Template* for Review of PWR Uprates

NOTE: This memo briefly summarizes observations noted from examination of the 1997 Farley-PWR power uprate of 4.6-%. The investigation stems from ACRS concerns regarding the adequacy of methods to support significant PWR uprates and the staff review process. An investigation was initiated in response to that concern, which centers on an assessment of the Farley uprate, which the staff has indicated will serve as a *template* for reviews of anticipated requests for uprating PWR plants, exemplified by the current 7.5-% uprate application for ANO-2 PWR plant. A complete report on the subject will be forthcoming in early March 2002. The purpose of this abbreviated memo is to provide ACRS with an advance indication of principal observations in support of its current review of the ANO-2 uprate.

Observations Noted from Examination of Farley-PWR Uprate *Template*:

Recent BWR uprate submittals have largely been performed under detailed guidance and updated analytical methodologies developed in the 90's by the General Electric Nuclear Energy (GE) corporation, pursuant to its Extended Power Uprate Program. The significant contributions by GE with regards to the development of methodologies and code improvements to support such uprates has been noted by the ACRS in its recommendation for approval of the BWR uprates for the Duane Arnold, Dresden, and Quad Cities plants. The ACRS however has expressed concerns regarding the less ambitious uprate support provided by vendors of PWR plants and indicated its concerns regarding the staff review process for PWR uprates. In response to that concern, the staff reassured the ACRS that its review of PWR uprates would be thorough and on par with the scope/depth of reviews for BWR plants; and that the staff review process for the 1997 Farley 4.6-% uprate provides an adequate *template* for review of future PWR uprate applications. This reviewer was therefore tasked by the ACRS to examine the scope and depth of the Farley uprate submittal and review process. Observations from that effort can be summarized as follows.

The Farley uprate application largely adheres to guidance outlined in the 1983 Westinghouse topical report WCAP-10263 (A Review Plan for Uprating the Licensed Power of a Pressurized Water Reactor Power Plant, January 1983). This guidance is simply that, and has never been formally reviewed or approved by the NRC staff, although it has served for the past two decades as a general guidepost for PWR uprate requests in the range of 1 to 5 % power increase. This reviewer could not find significant new information or methodologies employed in the Farley 4.6-% uprate submittal that are substantially different than used in prior limited PWR uprate submittals.

Although examination of the 1997 Farley-PWR uprate submittal (LAR) did not reveal information or methodologies that are substantially different than used in prior PWR uprates, a more comprehensive staff review process (SER) is indicated for the Farley uprate than for other PWR uprates. Not only does the Farley-SER present a more detailed discussion of staff review considerations of licensee submittal analysis, but several notable bench-marking assessments were undertaken by the staff to confirm the accurateness of licensee calculations. These include independent staff assessments of reactor vessel integrity and the radiological impact for the Farley plant at uprated conditions. Specifically the staff benchmarked licensee estimates of EOL-USE (end-of-life/upper shelf energy) for the reactor vessel toughness at the belt-line region, based on irradiated "sample capsules" at that region, with its own estimates of EOL-USE for the same samples. It is also noteworthy that the SER presents staff and licensee estimates of EOL-USE in a single comparative table in the SER; whereby the reader can readily compare staff and licensee predictions.

Additionally the staff performed confirmatory thyroid and whole-body dose estimates for individuals located at the Farley plant exclusion area boundary (EAB) and the low population zone (LPZ) at uprated conditions for a number of transients, namely: (a) loss-of-AC power event, (b) a large-break LOCA, (c) steam generator tube rupture, (d) locked rotor event, (e) control rod ejection accident, and (f) fuel handling accident. Although a discussion is presented in the Farley-SER, comparing NRC-staff dose predictions with estimates provided by the licensee, a direct comparative table is lacking in the SER. In this case the reader must page back and forth, between the LAR and SER, to compare staff with licensee predictions. When staff confirmatory predictions are made, this reviewer would encourage staff and licensee predictions be presented in the SER within comparative tables, as was the case for staff estimates of vessel toughness (EOL-USE estimates).

Although staff confirmatory vessel toughness and dose predictions provided in the Farley-SER are noteworthy and in keeping with ACRS encouragement of such confirmatory/audit staff analysis, it is unclear whether or not similar confirmatory estimates are likewise to be made in the review of other PWR uprates. Thus ambiguity remains as to whether similar staff confirmatory analysis is to be performed for all subsequent PWR uprate reviews and thus the Farley predictions can truly be viewed as a "template".

The Farley uprate was also compared to those for BWRs, most notably the recent 15-% uprate for the Duane Arnold BWR plant. An examination was made of the primary GE topical reports used in support of the Duane Arnold uprate application compared to the Westinghouse WCAP reports referenced in the Farley uprate submittal. Several salient observations are noted from comparison of these supporting documents. The majority of the GE topical reports cited in the Duane Arnold submittal indicate publication dates after 1995 and reflect dedicated GE efforts in the 1990s to update codes and analysis methods to support a significant number anticipated BWR uprate applications. The first of these applications were the 1998 6.3-% uprate for Monticello and the 8-% uprates for Hatch Units 1 & 2. The majority of supporting GE topical reports and methodologies have likewise been individually reviewed by the NRC staff and found acceptable for BWR extended power uprate applications. This is in stark contrast to the WCAP reports cited in the Farley submittal, the vast majority of which are vintage 1980's reports stemming from original uprate guidance provided in the 1983 WCAP-10263 report. Exceptions to this observation are: (a) the 1994 reports related to use of VANTAGE-5 fuel, (b) the proprietary 1997 reports on large-break LOCA analysis performed by Westinghouse to support the Farley

uprate, and (c) the Farley Uprate NSSS Licensing Report. Nevertheless, nothing comparable to scope and depth of the generic uprate methodologies developed by GE as part of its extended power uprate program is evident from examination of the Farley uprate application.

The staff review process, as reflected in the SERs for the Farley-PWR and Duane Arnold-BWR uprates, was also examined. In a general sense, the principal subject matter reviewed and documented in the Farley-SER mirrors, to some degree, the subjects covered in the Duane Arnold SER, taking into account obvious differences in plant characteristics. Both SERs pay particular attention to staff evaluations of licensee submittal analysis of design basis accidents (DBA) re-evaluated at uprated power conditions, i.e. LOCA and reactivity transients. Likewise, both SERs examine fuel design changes accompanying the respective uprates, that is conversion to VANTAGE-5 fuel for the Farley uprate and conversion to GE-14 fuel for the Duane Arnold uprate. Additionally, the impact of the uprate on balance-of-plant (BOP) characteristics, changes in facility operating license (FOL), and changes to plant technical specifications (TS) are covered in both SERs. However, significant differences are also noted, particularly with respect to SER format and depth of review.

SER format differences are clearly evident by a comparison of the principle section headings for each SER. The SER for Duane Arnold basically follows a "systems performance evaluation" structure, while the SER for Farley is structured more on an "accident evaluation" basis, with follow-on evaluations of NSSS (nuclear steam supply system) and balance-of-plant (BOP) performance. An examination of the SER content for these two uprates also indicates to this observer that the staff review process, as documented in the SER, appears to be reflective of vendor uprate guidance, rather than a review process that is dictated by a prescribed regulatory framework or considerations. This observation stems from significant variations not only in SER format, but also the depth of the subject matter reviewed and the presence or absence of confirmatory staff analysis. As mentioned, the staff performed independent confirmatory dose and vessel toughness estimates in its Farley review. Such independent estimates provided a sound technical bases for staff conclusions regarding the acceptability of licensee submittal analysis. Independent staff dose estimates however were not evident from review of the Duane Arnold-SER.. Likewise, although the Duane Arnold-SER provides a detailed discussion of the staff's review of licensee estimates of P-T limits to assure reactor vessel ductility at uprated conditions, the SER does not indicate independent staff estimation of such P-T limits. Although the staff may have felt confident that confirmatory dose and vessel integrity estimates were not needed to judge the accurateness of Duane Arnold licensee estimates, this reviewer is hard pressed to find clearly defined criteria for when staff audit/confirmatory estimates are warranted and when they are not. That lack of reasoning or criteria in SERs for confirmatory staff analysis has also been noted by the ACRS, per the following comments made in its letter to the Commission on the Duane Arnold uprate.....

"A Safety Evaluation Report (SER) should be revised to document adequately the technical resolution of the issues raised by the staff, and.....the staff should develop improved guidance on the detail to be provided in the SER and criteria for when independent assessments should be performed to complement its reviews of applicant submittals".

These observations lead this reviewer to note the following points with regards to the adequacy of the Farley uprate submittal/review process, as a *Template* for PWR uprates:

A) The Farley uprate application (LAR) is largely based on guidance provided in the 1983 Westinghouse topical report WCAP-10263, "A Review Plan for Upgrading the Licensed Power of a Pressurized Water Reactor Power Plant". This guidance is simply that and has not been formally approved by the NRC staff, although it has served for the past two decades as a general outline of scope of material to be included in PWR uprate requests. This reviewer could not find significant new

information or methodologies employed in the Farley submittal that are substantially different than used in prior PWR uprate submittals.

B) The WCAP-10263 guidance basis for the Farley uprate LAR is not comparable to the scope and depth of the generic uprate methodologies developed by GE as part of its extended power uprate program. No significant new analysis methods were evident from review of the Farley uprate.

C) Examination of staff Safety Evaluation Report (SER) for Farley reveals a more detailed discussion of staff review considerations of licensee uprate analysis than presented in prior PWR-SERs. Several notable bench-marking/confirmatory assessments were also provided in the Farley-SER to confirm the accurateness of licensee calculations. These include independent staff assessments of reactor vessel integrity (i.e. EOL-USE estimates) and confirmatory thyroid and whole-body dose estimates. Unfortunately, staff reasoning was not provided in the SER, why such confirmatory estimates were undertaken as part of the Farley review and not performed for PWR uprates of similar magnitude (e.g. the 4.25-% North Anna-PWR uprate). It is unclear to this reviewer if such predictions are to be viewed as a *standard review template*, to be followed in staff reviews of all future PWR uprate requests, or simply a one-of-a-kind confirmation for Farley.

D) Differences were also noted with respect to the Farley staff review process (SER) when compared with that for the recent Duane Arnold-BWR uprate. Although the subject matter reviewed and documented in the Farley-SER mirrors, to some degree, the subjects covered in the Duane Arnold-SER, significant differences were evident. Both SERs pay particular attention to staff consideration of licensee submittal analysis of design basis accidents (DBA), fuel design changes accompanying the uprates, balance-of-plant (BOP) considerations, and changes to plant technical specifications (TS). Nevertheless, significant differences are noted, particularly with respect to SER format and depth of review. The SER for Duane Arnold basically follows a "systems performance evaluation" structure, while the SER for Farley is structured more on an "accident evaluation" basis, with follow-on evaluations of NSSS (nuclear steam supply system) and balance-of-plant (BOP) performance. An examination of the SER content for these two uprates also indicates that the staff review process, as documented in the SER, appears to be reflective of vendor uprate guidance, rather than a review process that is dictated by a prescribed regulatory framework or considerations. This observation stems from significant variations not only in SER format but also subject matter reviewed.

Although notable improvements in the staff review process are evident from examination of the Farley-SER compared to prior PWR uprate-SERs, this reviewer is not drawn to the conclusion that the Farley-SER provides an adequate *template* for review of future significant PWR uprates. This observation particularly applies, if PWR uprates are to approach the magnitude of recent BWR extended power uprate applications, i.e. 10-20 % one-step power increases. Although some improvements are noted in the staff review for Farley, this reviewer could not find significant new information or methodologies employed in the Farley uprate submittal that are substantially different than used in prior limited PWR uprates. Such observations lead this reviewer to concur with ACRS recommendations for development of a Standard Review Plan for power uprates. This need appears particularly relevant for PWRs.