



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

ATTACHMENT 1

SAFETY EVALUATION REPORT BY THE OFFICE OF NUCLEAR REACTOR
REGULATION RELATING TO AMENDMENT NO. 183 TO LICENSE NO. DPR-49
IES UTILITIES - DUANE ARNOLD ENERGY CENTER
DOCKET NO. 50-331

1.0 INTRODUCTION

By letter dated November 30, 1995, IES Utilities submitted information supporting the application of Long Term Stability Solution Option 1-D (1-D) to the Duane Arnold Energy Center (a GE BWR/4). The package consisted of a plant specific licensing topical report (LTR)¹ supporting application of the previously approved Long Term Stability solution Option 1-D² to the Duane Arnold Energy Center and several attachments. The attachments describe the ODYSY code³, and the changes to the plant technical specifications necessary to implement 1-D.

Generic Option 1-D consists of two parts. First, an exclusion region in the power to flow map is established within which power oscillations are credible. Should the unit enter this region, operators are instructed to immediately exit the region and to scram the plant should power oscillations be detected. Second, a statistical method is employed to show that the existing flow biased APRM scram is sufficient to shutdown the plant in the event of oscillations before the Safety Limit Minimum Critical Power Ratio (SLMCPR) is violated. This method is described in NEDO-32465⁴ which has been approved by the staff.

2.0 EVALUATION

In reference 2, it was concluded that before 1-D can be applied to a plant the unit must satisfy several criteria. First, the core must be small and, therefore, tightly coupled. Duane Arnold is a low power BWR/4 with 368 fuel bundles. Additionally, it was demonstrated in the supporting analysis that the core wide decay ratio far exceeds the channel decay ratio over a wide range of operating conditions. This means that Duane Arnold is most likely to

experience core wide (fundamental mode) as opposed to out-of-phase (higher mode) oscillations. Second, the core must have relatively tight inlet orificing. This has been demonstrated to favor the core wide mode over the out-of-phase mode. Duane Arnold has an inlet orifice size 14% smaller than a typical BWR/4. Duane Arnold, therefore, meets the criteria necessary to use 1-D.

In addition to meeting the acceptance criteria stated above for a 1-D plant, licensees have a choice of either using power distribution controls while operating or using an on-line stability monitor. IES has opted to use an on-line stability monitor to provide operators with a means of detecting when the stability margin is degrading. IES proposes to use a system called SOLOMON at Duane Arnold. SOLOMON incorporates the General Electric (GE) proprietary frequency domain code ODYSY into an on-line software package which runs on the plant process computer to provide an evaluation of the reactor decay ratio. SOLOMON can also be used in a predictive mode to evaluate the stability affect of proposed reactor maneuvers. IES proposes to use SOLOMON at all times when the reactor is at power and to control certain types of operation if SOLOMON is inoperable. In order to do this, a "buffer zone" (figure 12 of reference 5) is established; inside of which operation is not allowed if SOLOMON is inoperable.

The detect and suppress methodology as approved in NEDO-32465⁴ was used to calculate the minimum MCPR during a postulated power oscillation event. This method allows demonstration, with a high statistical certainty, that the MCPR SL will not be violated before the Flow-Biased APRM system trips the plant. The procedure outlined in NEDO-32465 was properly applied to Duane Arnold and the final MCPR was calculated to be 1.16. Since this is still above the SL MCPR, the calculation demonstrates that, with a 95 percent probability and a 95 percent confidence (the 95/95 value), power oscillations will be successfully terminated.

In order for the analysis presented in reference 1 to be applicable to cycles other than cycle 14, specific reload confirmation criteria have been developed. These criteria establish deviations in core design within which

the FMCPR (Final Minimum Critical Power Ratio) calculation does not have to be redone and the calculations in reference 1 are assumed to be applicable to the operating cycle under consideration. This approach has also been proposed for the Monticello unit and GE has performed confirmatory calculations to demonstrate that the approach is valid⁶. These calculations show that there is very little difference between two subsequent applications of the Option 1-D methodology to a BWR similar to DAEC.

Review of individual Technical Specification Changes necessary to implement Option 1-D follows:

Change to Page vii

This change deletes a reference to Figure 3.3-1, "Thermal Power vs. Core Flow Limits for Thermal Hydraulic Stability Surveillance." This figure is no longer needed as it was used to implement the Interim Corrective Actions (ICA) which are superseded by Option 1-D. This change is acceptable.

Change to Pages 1.1-11,12

This change updates the APRM High Flux Scram bases to reflect that this scram also protects the plant from stability transients. This change is acceptable.

Change to Page 3.3-6

This change states that operation in natural circulation is not permitted. The change also states that should reactor operation in natural circulation occur, the reactor should be scrammed. This change is acceptable.

Change to Page 3.3-6

This change clarifies 3.3.F.2 to state that no recirculation pumps shall be placed in operation while the reactor is in natural circulation. This change is acceptable.

Change to Pages 3.3-6,7

This change replaces 3.3.F.3 with the requirement that operation inside the exclusion region is not acceptable. It also states either power should be decreased or flow should be increased to immediately exit the region upon entry. Surveillance requirements 4.3.F.3 are also deleted. This change is acceptable.

Change to Page 3.3-7a

This change deletes stability related requirements for single loop recirculation operation and requirements related to core differential pressure noise. This change is acceptable because the old TS applied to operation under the ICAs.

Change to Page 3.3-7b

This change deletes additional core differential pressure measurement requirements. This change is acceptable because these measurements were used while operating with the restrictions of Figure 3.3-1 (ICA).

Change to Pages 3.3-13,14

This change clarifies the bases of the TS regarding recirculation pump operation. The bases adds a discussion about thermal hydraulic instability. This change is acceptable.

Change to Page 3.3-15

This change adds a reference to GENE-A0000-04021-01, "Application of the Regional Exclusion with Flow-Biased APRM Neutron Flux Scram Stability Solution (Option 1-D) to the Duane Arnold Energy Center." This change is acceptable as this is the report providing the calculations supporting the application of 1-D to DAEC.

Change to Page 6.11-4

Adds the exclusion region in the power-flow map into the COLR. This change is acceptable because the exclusion region may need to be modified from cycle to cycle.

3.0 CONCLUSIONS

The staff has reviewed the changes proposed by IES Utilities to implement stability long term solution Option 1-D. The changes consist of modifying TS to make them consistent with Option 1-D and moving the power-to-flow map exclusion region to the COLR. The staff concludes the following:

The methodology used and the movement of the exclusion region to the COLR are acceptable. The design record files for all calculations supporting the implementation of Option 1-D at DAEC should remain available for staff audit.

4.0 REFERENCES

- 1.0 Application of the "Regional Exclusion with Flow Biased APRM Neutron Flux Scram" Stability Solution (Option 1-D) to the Duane Arnold Energy Center, GENE-A00-04021-01, September 1995.
- 2.0 BWR Owners' Group Long-Term Stability Solutions Licensing Methodology, NEDO-31960A, November 1995.
- 3.0 ODYSY Description and Qualification (Proprietary), GENE-A038-0495, August 1995.
- 4.0 BWR Owners' Group Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology and Reload Applications, NEDO-32465, May 1995.

- 5.0 Cycle 14 Core Operating Limits Report, Rev. 1, IES Utilities, October 1995.

- 6.0 Application of the "Regional Exclusion with Flow Biased APRM Neutron Flux Scram" Stability Solution (Option 1-D) to the Monticello Nuclear Generating Plant, GENE-A00-04021-02, February 1996.