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Attachment

SUMMARY

This report documents our review of Yankee Atomic Electric Company report number YAEC-1926,[1] a licensing topical report that describes a number of plant-specific analysis and a methodology for Long Term Solution Option I-D exclusion region calculations using the LAPUR5 code.[2] In Appendix A, we include the report of an audit that reviewed the implementation of Option I-D in Vermont Yankee and Yankee Atomic's validation of the LAPUR5 code.

Our review is based on data presented in the submitted topical report[1] and during a number of meetings with the Boiling Water Reactor Owners' Group (BWROG) and Yankee Atomic Electric Company, including an audit conducted on May 30 and 31st, 1996. Based on our evaluation of these data, we find that the implementation of Option I-D in Vermont Yankee, including the use of the LAPUR5 code for exclusion region calculations and the proposed reload confirmation procedures, is adequate

Based on this review, we conclude that the implementation of Option I-D in Vermont Yankee satisfies all the requirements of a Long Term Solution to the stability issue.

BACKGROUND

A long term solution to the stability problem is required to prevent the violation of specified acceptable fuel design limits (SAFDL) in the event of out-of-phase instabilities or core-wide instabilities with large local power peaking. Under these events, the reactor protection system (specifically the high APRM scram, or the flow-biased thermal-power scram) may not provide sufficient margin to prevent SAFDL violations under all postulated operating conditions in all reactors.

A number of long term solutions have been proposed[3,4] and accepted.[5,6] The licensing basis for Option I-D is an administratively controlled Exclusion Region, supported by calculations showing low likelihood for out-of-phase oscillations and protection against core-wide mode oscillations by the unfiltered flow-biased scram. Vermont Yankee performed these calculations and documented them in reference 7, which was reviewed[8] and approved[9] with conditions. Vermont Yankee also submitted modifications to their technical specifications[10] to implement Option I-D, which were reviewed[11] and approved in August 1995. The report subject of this review (YAEC-1926[1]) satisfies one of the above conditions by providing a methodology to recompute the exclusion region for every new fuel cycle reload . The audit report enclosed as appendix A contains a review of the implementation of Option I-D in Vermont Yankee and the implementation of the SOLOMON stability monitor, which satisfies the second condition: the implementation of power distribution controls to guarantee that the operating conditions are within the assumptions used for the exclusion region calculations.

EVALUATION

The LAPUR code was developed by the U.S. NRC in the late 1970's and has been widely used both nationally and internationally over the years. Version 5 of LAPUR was benchmarked against both core-wide and out-of-phase instabilities in a published report ORNL/NRC/LTR-90/6,[12] where it was concluded that the error in decay ratios calculated by LAPUR is less than ± 0.2. Yankee Atomic's

topical report YAEC-1926[1] contains a number of benchmarks against the Vermont Yankee 1981 stability tests, and comparisons against other calculations using a vendor code. We have summarized these calculations in Figure 1, which compares the decay ratios calculated by Yankee Atomic versus the 1981 stability tests, and the vendor-calculated values for both core and hot channel. The results in this figure indicate that Yankee Atomic understands the LAPUR-5 input preparation process and can reproduce the results from tests and vendor calculations.

A standard procedure to verify the proper implementation of any computer code and its expected accuracy is to perform a number of sensitivity calculations and to determine: (a) whether trends in the results are as should be expected form first principles, and (b) whether the input-preparation assumptions result in unacceptable errors. Yankee Atomic has followed this process to validate their LAPUR-5 implementation and the results are documented in YAEC-1926.[1] The parameters used for the sensitivity study are: reactor kinetics data, recirculation loop gain and time constant, core pressure drop, gap conductance, and feedwater enthalpy. Based on their analysis, Yankee Atomic concluded that the sensitivity to input assumptions results in errors well within the ± 0.2 band that is observed for the benchmarks; thus, validating their input-generation procedure. We concur with this conclusion.

The details of the application of LAPUR-5 to the exclusion region methodology are summarized in Table 3.1 of YAEC-1926.[1] When compared with a standard application by General Electric, we find the following deviations from the standard vendor procedure:

(1) Yankee Atomic proposes to use the LAPUR-5 code, as opposed to FABLE/BYPSS. Based on the above evaluation of Yankee Atomic's LAPUR-5 implementation, we conclude that this deviation is technically acceptable. Indeed, the approved BWROG procedures specify that those procedures are applicable to any qualified code.

(2) LAPUR-5 and Yankee Atomic's implementation of the exclusion region methodology use a maximum of 7 channels to represent the radial power and flow distributions. Although a larger number of radial nodes would be desirable, benchmarking data indicates that 6 to 7 are adequate.

(3) Yankee Atomic's implementation specifies that the exclusion region calculation must use most limiting axial power shape of: (a) the shape prescribed in the BWROG procedures or (b) the actual shape for the end-of-cycle Haling calculation. Since this is a conservative assumption, this deviation is technically acceptable.

(4) Yankee Atomic adjusts the pressure loss coefficients and two-phase multipliers to match the more accurate pressure drop distribution estimated using the FIBWR code. The standard BWROG methodology used design values for loss coefficients. This approach results in a more accurate pressure drop calculation in LAPUR-5 and is supported by the good results exhibited in the benchmarking cases.

(5) Yankee Atomic applies a conservative multiplier of 1.25 to the density reactivity calculated by CASMO3/SIMULATE3 at the most negative point in the fuel cycle, while the standard vendor calculation uses the nominal void reactivity coefficient estimated using licensing models.

(6) To estimate the recirculation loop parameters, Yankee Atomic uses a specific power-flow calculation and correlations based on first principles. The standard vendor calculation uses correlations that were developed generically for each product line. Yankee Atomic's approach is more accurate and is validated by the benchmark data.

(7) The largest difference between the standard vendor calculation and Yankee Atomic's procedure is in the estimation of the fuel gap heat transfer coefficient. The standard BWROG procedure applies a conservative 1.6 factor to the gap conductance calculated by vendor licensing models. Yankee Atomic applies the actual gap conductance estimated using the FROSSTEY2 code. The difference in estimated gap conductance values between the vendor licensing models and FROSSTEY2 is very large. For example, typical vendor calculations show gap conductance values at 50% power of 800 to 1200 BTU/hr/ft^2/°F, while FROSSTEY2 values for pressurized fuel are of the order of 2400 BTU/hr/ft^2/°F (and values as high as 4000 BTU/hr/ft^2/°F are sometimes used by Yankee Atomic - see appendix A). The discrepancies on calculated fuel gap conductance is a open issue that shows up during stability code reviews, and that remains unresolved (see, for example ORNL/NRC/LTR-94/41,[13] the review of the ODYSY code). We judge that the gap conductance values used by Yankee Atomic are likely to be conservative; thus, any error introduced would result in a larger (i.e. conservative) exclusion region. With this basis, we conclude that the gap conductance LAPUR-5 input methodology proposed by Yankee Atomic is technically acceptable.

CONCLUSIONS AND TECHNICAL RECOMMENDATIONS

The main conclusion from the present review is that the methodology proposed by Yankee Atomic in YAEC-1926[1] to calculate exclusion regions for application to Long Term Solution Option I-D is technically acceptable.

(1) Yankee Atomic's implementation of LAPUR-5 as described in YAEC-1926[1] is technically adequate. This implementation is defined as the LAPUR-5 code itself (which is under Yankee Atomic's configuration control) and the associated codes, procedures, and guidelines used to generate the LAPUR-5 input for an exclusion region calculation.

(2) Based on the benchmark data presented in YAEC-1926,[1] we conclude that the accuracy of Yankee Atomic's implementation of the LAPUR-5 code results in a decay ratio error of ± 0.2. With this accuracy, decay ratios estimated using Yankee Atomic's LAPUR-5 implementation can use the standard BWROG acceptance region in the core versus hot-channel decay ratio map[3,4] where the core and hot-channel decay ratio boundaries are set at 0.8.

(3) The deviations from the standard vendor methodology that are documented in Table 3.1 of YAEC-1926[1] from the standard BWROG methodology[3,4] are technically acceptable

REFERENCES

1. YAEC-1926, *Method for Power/Flow Exclusion Region Calculation Using the LAPUR5 Computer Code*. Yankee Atomic Electric Company, September 22, 1995.

2. NUREG/CR-5421, ORNL/TM-11285. *LAPUR User's Guide*. P. J. Otaduy and J. March-Leuba. June 1989.

3. NEDO-31960, *BWR Owners' Group Long-Term Stability Solutions Licensing Methodology*, General Electric Company, May 1991.

4. NEDO-31960 Supplement 1, *BWR Owners' Group Long-Term Stability Solutions Licensing Methodology*, General Electric Company, March 1992.

5. Letter, USNRC to L.A. England (BWROG), Acceptance for Referencing of Topical Reports NEDO-31960 and NEDO-31960 Supplement 1. "BWR Owners' Group Long Term Stability Solutions Licensing Methodology" (TAC No. M75928), July 12, 1993.

6. ORNL/NRC/LTR-92/15 *Licensing Basis for Long-Term Solutions to BWR Stability Proposed by the BWR Owners' Group*, José March-Leuba, ORNL letter report. August 1992

7. GENE-637-018-0793, DRF A00-04021, *Application of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution (Option I-D) to the Vermont Yankee Nuclear Power Plant*, General Electric Company, July 1993.

8. ORNL/NRC/LTR-93/23. *Review of Technical Issues Related to Long Term Solution I-D Regional Exclusion with Flow-Biased APRM Scram*, José March-Leuba, ORNL letter report. September 1994

9. Letter, USNRC to D.A. Reid (VYNPC), *Thermal Hydraulic Stability - Vermont Yankee Nuclear Power Station (TAC No. M87091)*, March 30, 1995.

10. Letter, Vermont Yankee Nuclear Power Corporation to U.S. NRC, *Proposed Change No. 173, BWR Thermal Hydraulic Stability and Plant-Information Requirements for BWROG Option 1-D Long Term Stability Solution*. BVY 94-36, March 31, 1994.

11. ORNL/NRC/LTR-95/08. *Review of Proposed Technical Specification Changes for Interim Implementation of Solution I-D in Vermont Yankee* , José March-Leuba, ORNL Technical Evaluation Report. March 1995.

12. ORNL/NRC/LTR-90/6. *LAPUR Benchmark Against In-Phase and Out-of-Phase Stability Tests*, José March-Leuba, ORNL Technical Evaluation Report. January 1990.

13. ORNL/NRC/LTR-94/41 "Review of the ODYSY Code For Use With Long Term Solution Enhanced Option I-A" Jose March-Leuba, ORNL letter report. July 1995.

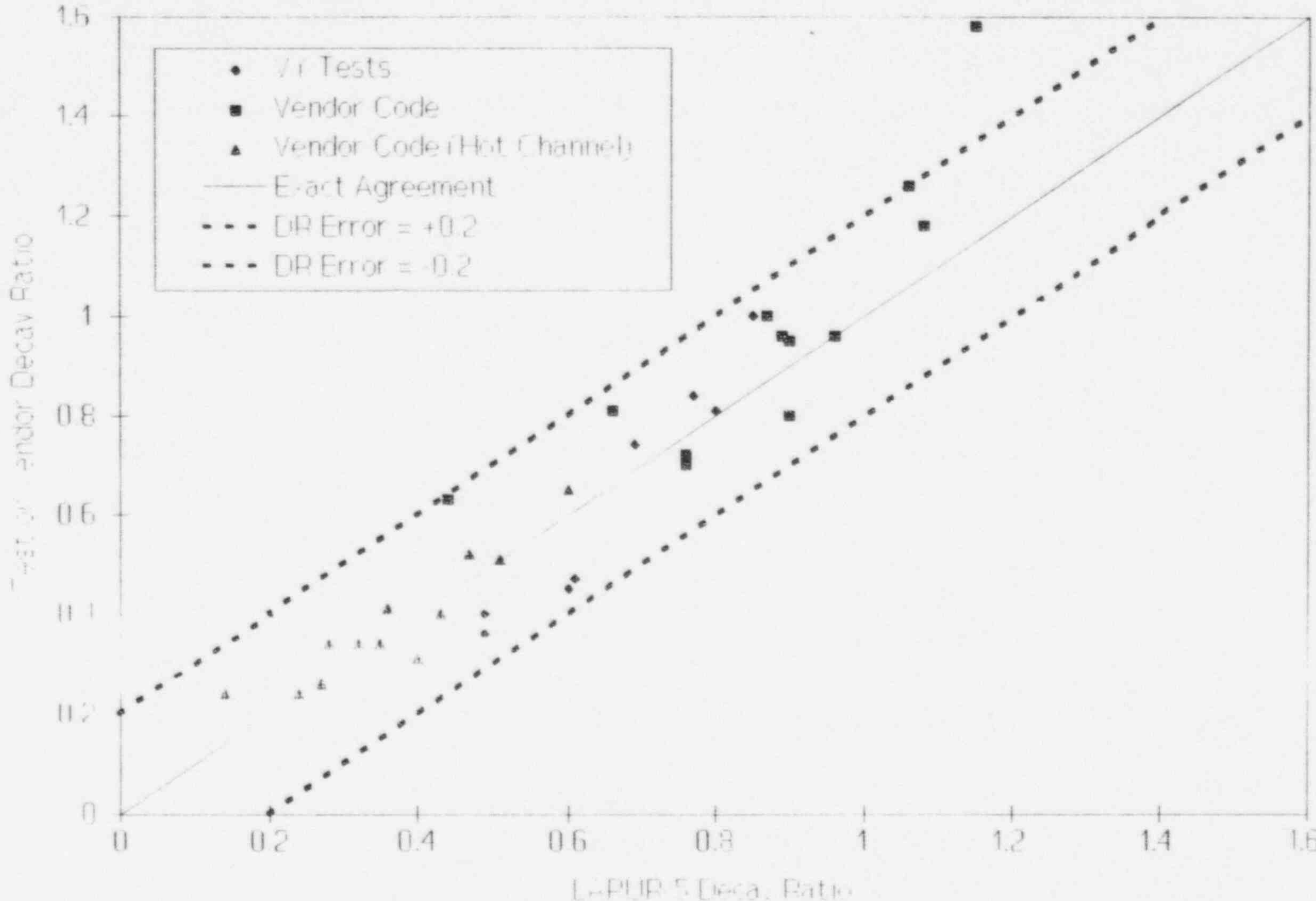

Figure 1. Summary of Yankee Atomic's LAPUR-5 calculations showing that the LAPUR-5 decay ratio error is within ±0.2

APPENDIX A

Audit Report: Vermont Yankee Solution I-D Implementation
May 30 and 31, 1996

INTRODUCTION

This report documents the conclusions of an audit conducted at the Vermont Yankee power plant and at the headquarters of the Yankee Atomic Electric Corporation on May 30 and 31st, 1996. The primary purpose of this audit was to review the implementation of Long Term Solution Option I-D in Vermont Yankee. To this end, the audit covered the following general areas:

(1) Yankee Atomic use of the LAPUR5 code for I-D exclusion region calculations, including design record files for benchmarking and for an example exclusion region calculation, and engineering procedures and guidelines for LAPUR5 input preparation.

(2) Vermont Yankee procedures and engineering guidelines related to stability, specifically: startup procedures to avoid instabilities and flow-reduction-events procedures to avoid and recognize instabilities.

(3) Stability related training records.

(4) Interviews with plant personnel.

(5) Documentation and an operational demonstration of the SOLOMON stability monitor/predictor.

The audit was conducted by two members of the NRC staff, Laurence E. Phillips and Tai. L. Huang, and an NRC contractor, José March-Leuba, from the Oak Ridge National Laboratory. A list of documents reviewed is contained in Table A.1, and a list of persons interviewed during the audit is shown in Table A.2.

The main conclusion of this audit is that the implementation of Option I-D in Vermont Yankee is acceptable, and it satisfies the requirements for a Long Term Solution to the stability issue.

AUDIT FINDINGS

USE OF THE LAPUR5 CODE FOR EXCLUSION REGION CALCULATIONS

The use of the LAPUR5 code for exclusion region calculations was one of the main items for this audit. The review concentrated in two major points: (1) the code validation and its documentation, and (2) Yankee Atomic procedures and guidelines for future exclusion region calculations.

Even though the code validation is the focus of a separate technical evaluation report (to which this audit report is an appendix), during the audit we reviewed this validation and we examined some

additional data not reported in YAEC-1926 "*Method for Power/Flow Exclusion Region Calculation Using the LAPUR5 Computer Code.*" These data included some comparisons with SOLOMON calculations and additional calculations showing sensitivity to gap conductance. The audit team found the LAPUR5 validation documentation acceptable.

The primary focus of the LAPUR5 portion of the audit was directed towards guidelines and procedures in place to perform future exclusion region calculations. The steps required to generate a LAPUR5 input deck were described as follows:

(1) The calculation starts with a full run from the licensed steady state physics methods, which model an end of cycle Haling distribution.

(2) A FBWR steady state thermal-hydraulic calculation is performed with the specified power and flow to estimate the core bypass flow and pressure drops.

(3) A preliminary LAPUR5 calculation is performed at those conditions, and the LAPUR5 node-dependent friction multipliers are adjusted to match the axial pressure drop profile calculated by FBWR. With this procedure, the "effective" spacer friction factors and two-phase-flow friction multipliers are determined so that LAPUR5 matches the more accurate FBWR pressure drop model at every node. These adjustments are performed by validated software under configuration control.

(4) The LAPUR5 radial power distribution is matched by grouping channels into six regions: (1) the hot channel of the newest batch, (2) the hot channel of the previous batch, (3) an average channel for the new batch, (4) an average channel for the previous batch, (5) the periphery channels, and (6) and average of the remaining channels. The channel grouping is performed automatically by software under configuration control.

(5) Each of the LAPUR5 radial regions has its own axial power shape, which averaged by the YAEC software form the CASMO-SIMULATE 3-D power distributions for all the channels in a region.

(6) The void reactivity coefficient is computed using a small pressure perturbation in CASMO-SIMULATE and estimating the change in nodal reactivity at each node. A correlation for void reactivity as function of node void fraction is then adjusted by first plotting the nodal void coefficient versus the node void fraction and then performing a polynomial fit. This correlation is cycle-specific, and it is performed for every reload.

(7) The overall void reactivity coefficient is adjusted using a LAPUR5 multiplier to adjust the overall reactivity estimated from the CASMO-Simulate pressure perturbation and the one calculated by LAPUR5W.

(8) Recirculation loop dynamics are modeled in LAPUR5 using a first order gain and time constant. Yankee Atomic has develop software to perform this calculation and has placed it under configuration control.

As a result of this audit, we did not find any weaknesses in the LAPUR validation and input preparation procedures. We consider a strength the fact that most of the LAPUR input preparation is

automated, so that it is reproducible and there is a high likelihood that future exclusion region calculation will be adequate.

To complete the LAPUR5 audit and verify its proper implementation in the new platform, Yankee Atomic was asked to perform a LAPUR5 calculation using an input deck provided by the audit team. This calculation was performed successfully and yielded essentially the same results that in the original PC platform. The only small differences are attributable to different machine precision. We concluded that Yankee Atomics LAPUR5 implementation is adequate and free of obvious errors.

VERMONT YANKEE IMPLEMENTATION OF OPTION I-D

Vermont Yankee has implemented Long term Solution Option I-D by modifying their Technical Specifications according to document No. BVY 94-36, *Proposed Change No. 173, BWR Thermal Hydraulic Stability and Plant-Information Requirements for BWROG Option 1-D Long Term Stability Solution*, which was submitted to the U.S. NRC March 31, 1994. The proposed modifications were reviewed and approved in August 9, 1995.

Because Vermont Yankee chose to go ahead and implement Option I-D, they did not implement the BWR Owners' Group interim corrective actions (ICA's).

The basic Tech Spec modification requires that administrative controls be in place to avoid intentional entrance in an Exclusion Region that is defined in the core operating limits report (COLR) and calculated using approved procedures. In addition a larger Buffer Region is defined, where intentional entry is allowed is power distribution controls (based on a stability monitor implementation) are met. If the Exclusion Region (or the Buffer Region with the stability monitor not operational) is entered unintentionally, the operator is instructed to exit the region immediately. Thus, the licensing basis for Option I-D is an administratively controlled Exclusion Region, supported by calculations showing low likelihood for out-of-phase oscillations.

The present audit concentrated on the implementation of these administrative controls, which are reflected on Vermont Yankee operating procedure OT 3117 "*Reactor Instability.*" This procedure has two entry conditions: (1) Operation inside the Exclusion Region, or (2) Operation inside the Buffer region with the stability monitor unavailable. The immediate operator actions are three:

(1) Monitor LPRM readings using the ERFIS system, which is an ampliation of the safety parameter display system (SPDS).

(2) If an instability is recognized, manually scram the reactor. Instability is defined as:
   - (a) Multiple periodic high or low LPRM alarms
   - (b) Multiple periodic LPRM oscillations > 20% peak-to-peak
   - (c) Multiple periodic APRM oscillations > 10% peak-to-peak

(3) Exit the Exclusion or Buffer Regions by: (a) inserting control rods, or (b) increasing recirculation pump speed.

Follow up actions are:

(1) Initiate SOLOMON stability monitoring. If the SOLOMON decay ratio is outside prescribed limits, insert control rods or increase recirculation pump speed until core decay ratio of hot channel decay ratio are both within their respective limits.

(2) Notify reactor engineering manager, operations manager, duty and call officer, and initiate an event report.

Other operating procedures take the stability Exclusion Regions into account. For example, OT 3118 *"Recirculation Pump Trip"* reminds the operator to maintain the operating pump at high enough speed to avoid entering the Restricted Region. Other related procedures, such as OP 0102 *"Maneuvering at Power"* require that SOLOMON stability monitor operability be demonstrated prior to significant power maneuvers. This step is necessary to identify whether the operation in the Buffer Region is allowed.

The teams review of the relevant operating procedures indicates that the Option I-D implementation is adequate. We found, however, some apparent inconsistencies between procedures OT 3117 and OT 3118 that are described in the weaknesses section.

TRAINING

The audit team reviewed training material and attendance records, including LOT-00-202 *"Reactor Recirculation System"*, LOR-18-701 *"Simulator Scenarios"*, and TTP-96-002 *"Thermal Stability Software, Activating SOLOMON Prior to Control Room use."*

The review of the training documents indicates that stability-related training is adequate, and the records review indicate that Vermont Yankee personnel had been properly trained. This fact was also confirmed by the audit interviews.

As a weakness, the audit team noticed that Vermont Yankee has experienced two instability events: one during the 1981 tests, and another unexpected one during plant maneuvers at low flow. A review of the training material indicated that operators were trained on the LaSalle, WNP-2, and Cofrentes events, but no mention was given to their own Vermont Yankee experiences. Lessons learned from specific Vermont Yankee experience should have been incorporated in the training.

INTERVIEWS WITH PLANT PERSONNEL

A number of interviews were performed by the audit team, covering a shift engineer, a supervisory control room operator, an Alternate Control Room Operator, and three reactor engineers. The staff provided a number of similar questions to each of the interviewees on stability procedures (specifically OT 3117 and OT 3118) to attempt to identify any weaknesses in the Option I-D implementation.

Overall the answers were quite satisfactory, and the audit team was positively impressed by the knowledge of the Vermont Yankee staff. The main conclusion obtained from these interviews was that the implementation of Option I-D was adequate and that the related training had been effective.

During the interview some weaknesses were identified in three areas: (1) Lack of effective communication between the corporate office and the plant about the status of the SOLOMON stability monitor, and (2) a general reluctance to use SOLOMON, and (3) Some level of confusion whether the Buffer Region was an allowed region of operation. When directly asked if they had ever used it, none of the operators had or had intentions to use it. Their operating strategy is to stay away from the Buffer Region and ignore SOLOMON. These identified weaknesses are described in more detail in the Audit Conclusions section of this report.

SOLOMON STABILITY MONITOR

The audit team reviewed SOLOMON validation documents and performed a demonstration run. The SOLOMON stability monitor is a component of the 3D MONICORE software package. SOLOMON receives input (e.g., current operating conditions) from 3D MONICORE and performs a calculation to estimate the current core and hot channel decay ratios. SOLOMON operation is mostly manual upon operator request, unless the operating condition is inside the Buffer Region, in which case it runs continuously in automatic mode. SOLOMON is a General Electric Company product and is based on the ODYSY stability code. General Electric is responsible for software support and configuration control. Yankee Atomic and Vermont Yankee verified the installation and helped validate the Vermont-Yankee specific parameters for the base input deck.

Since installed in December 1995, SOLOMON has had two failures to operate. One of the instances was caused by a 3D MONICORE failure caused by a recirculation pump signal out of range (negative) following a single pump trip. The failure was reported to GE and a fix was installed. The second failure was a division by zero that aborted the execution. In this second instance, SOLOMON ran successfully when restarted a second time.

Vermont Yankee staff demonstrated the use of SOLOMON during a reduced flow transient (81% power, 70% flow) and SOLOMON ran successfully in approximately 2 minutes. The result of the calculation, however, indicated that the core decay ratio was 0.5, which the audit team considered extremely high for those conditions. Vermont Yankee and Yankee Atomic staff were aware of the problem and explained that they had set the fuel gap conductance to a conservatively high value (4000 $BTU/ft^2s^{\circ}F$) based on their own conservative FROSTTEY code calculations. When compared with more common values of 1000 to 1500, the decay ratio estimated is 0.15 to 0.2 higher, which would account for the high decay ratio estimated by SOLOMON for the audit conditions.

Yankee Atomic staff stated that they were considering reducing the value used for fuel gap conductance to a less conservative value by allowing for 50% power operation (rather than 100% power), where instabilities are more likley, and by using a cycle-average value as opposed to an end-of-cycle value.

As a consequence of the discussion about the conservative nature of the SOLOMON calculations, Yankee Atomic agreed to provide NRC and ORNL noise data to be used for a benchmark. The noise data will be used by ORNL to estimate the stability of some actual operating conditions using a standard analysis technique. These result will then be benchamrked against SOLOMON calculations to ascertain the adequacy of Yanke Atomic's gap conductance model.

AUDIT CONCLUSIONS

WEAKNESSES

The audit found the following weaknesses:

(1) Lapses in communication between the plant and corporate headquarters. The corporate office was convinced that the SOLOMON stability monitor was functional and fully implemented, but the operators at the plant thought the the monitor was still under testing and were not using it.

(2) Software configuration control in the ERFIS system allowed for the reloading of an obsolete version of the software. During installation of the SOLOMON stability monitor, plant engineers realized that the 15 seconds update in the ERFIS system was inadequate to perform the LPRM monitoring requirements in OT-3117. They inmediately corrected this defficinecy by updating the ERFIS "stability screen" once a second. During a demonstration for this audit, the NRC staff realized that the update interval was 15 seconds and informed plant personnel that the update inerval was inadequate. The explanation given was that they must have reloaded the old version of the software by mistake. The error was inmediately corrected.

(3) Vermont Yankee has experienced two instability events: one during the 1981 tests, and another unexpected one during plant maneuvers at low flow. A review of the training material indicated that operators were trained on the LaSalle, WNP-2, and Cofrentes events, but no mention was given to their own Vermont Yankee experiences. Lessons learned from specific Vermont Yankee experience should have been incorporated in the training.

(4) The licensing basis for Option I-D applicability to Vermont Yankee is the fact that out-of-phase instabilities are highly unlikely in this plant. A review of the training material indicates that this point is not emphasized, and specific out-of-phase avoidance methods (such as avoiding extremely bottom power peaks) are not described in the training material.

(5) The review of procedures OT-3117 "Reactor Instability" and OT-3118 "Recirculation Pump Trip" showed some apparent procedural inconsistencies in the event of a single recirculation pump trip:
   (a) Immediate operator action No. 1.e in procedure OT-3118 instructs the operator to maintain the operating condition outside the exclusion region by adjusting the pump speed between 50% and 70%. This operation cannot be performed without entering the Buffer Region because operation outside this region at the 100% rod line requires pump speeds greater than 70% (which are not allowed for vibration considerations).
   (b) Immediate operator action No. 3 in procedure OT-3117 instructs the operator to immediately exit both the Exclusion and Buffer Region, which is incosistent with the action required by OT-3118.

   After review of the apparent incosistency, it was noted that procedure OT-3117 is not applicable (entry conditions are not met) if the Buffer Region is entered when the SOLOMON stability monitor is available. Thus, the procedures are (at least technically) not incosistent. The audit found, however, that the wording and training for this procedures should make this point more clear.

(6) The audit team found a reluctance from the part of the operators to use the SOLOMON stability monitor. The general attitude that transpired during the interviews seems to indicate that operators plan to ignore the stability monitor and simply operate outside the Buffer Region. Although highly unlkikely, instabilities outside the Buffer Region are possible during startup if very skewed power distributions are achieved by the selected rod sequence. The use and reliance on the stability monitor during startup should be encouraged.

(7) A spot check of SOLOMON stability monitor results during the audit indicated that the input parameters for SOLOMON may have been selected too conservatively. The concern of the audit team was that by excessive conservatism, the stability monitor may provide unnecessary false alarms, which would decrease operator confidence in its use. Yankee Atomic is aware of this problem and they have traced it to a conservatively high fuel gap conductance. To resolve this issue, Vermont Yankee and NRC will perform a noise-based stability test in the near future to benchmark SOLOMON.

STRENGTHS

The audit found the following strengths:

(1) The review of the adminstrative procedures in place to implement Option I-D in Vermont Yanke found that these procedures are adequate and they satisfy the requirements for a Long Term Solution to the stability issue in Vermont Yankee.

(2) The review of the validation and input-preparation documentation for the LAPUR5 exclusion calcuations found that both, the validation efforts and the LAPUR5 input-preparation guidelines for future reloads are adequate to estimate the Option I-D exclusion regions in Vermont Yankee.

(3) The startup control rod pull sequence is preprogrammed by reactor engineering and followed without deviations by the control room operators. This is a good practice that avoids last minute decissions by operators, which may affect the power distributions during startup; thus, the likelihood of instabilities is minimized.

(4) The Vermont Yankee and Yankee Atomic staff was knowledgeable and very cooperative in preparing all necessary information available for staff use. The staff was impressed by the fact that the best explanation for policy and the basis for this policy was provided not by the reactor engineers in headqaurters but by the operator responsible for control room actions.

CONCLUSIONS

The main conclusion of this audit is that the implementation of Option I-D in Vermont Yankee is acceptable, and it satisfies the requirements for a Long Term Solution to the stability issue.

Table A.1 List of Documents Reviewed

Vermont Yankee Procedures:

OT 3117 Reactor Instability
OT 3118 Recirculation Pump Trip
OP 0100 Reactor Startup to Criticality
OP 0102 Maneuvering at Power
OP 2110 Reactor Recirc System
OP 4401 Core Thermal-Hydraulics Limits Evaluation

Vermont Yankee Trainig Documents and Records:

LOT-00-202 Reactor Recirculation System
LOR-18-701 Simulator Scenarios
Training Records for LOR-18-701
TTP-96-002 Thermal Stability Software, Activating SOLOMON Prior to Control Room use

SOLOMON Related Documents:

VYC-1449 Review of GE Solomon Data for VY Stability Analysis
VYC96-002 YAEC Memo from M.P. LeFrancois to M.J. Marian
Disposition of Use of SOLOMON Stability Monitor, Jan 30, 1996

LAPUR Related Documents:

VYC-1371 LAPUR Comparison to GE Cycle 15 Stability Calculations
VYC-1337 LAPUR Benchmark to VY Stability Tests
VYC-1448 Cycle 18 Stability Exclusion Region Calculation
VYC-336 LAPUR Code Validation
YAEC-1926 Method for Power/FLow Exclusion Region Calculation Using the LAPUR5 Code

Table A.2 List of Vermont Yankee and Yankee Atomic Personnel Interviewed

Paul A. Bergeron, Manager for Transient Analysis
Mark Le Francois, Lead Engineer for Transient Analysis
R.J. Weader, Transient Analysis Engineer
James Duffy, Licensing Engineer
Francis J. Helin, Reactor Engineer
Dennys May, Shift Engineer
Stephen P. Aprea, Supervisory Control Room Operator
Richard F. Shuman, Alternate Control Room Operator
Robert C. Potter, Reactor Engineer
John Cihak, Computer Engineering Supervisor