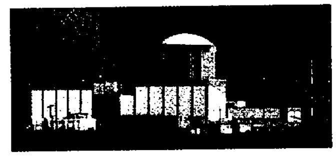
NRC-01-010

NMC
Committed to Nuclear Excellence

Kewaunee Nuclear Power Plant
N490, State Highway 42
Kewaunee, WI 54216-9511
920-388-2560

Operated by
Nuclear Management Company, LLC



February 7, 2001

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Ladies and Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Nuclear Management Company, LLC. Response to NRC 's Request for Additional Information on Wisconsin Public Service Corporation Reload Safety Evaluation Methods Topical Report, WPSRSEM-NP, Revision 3

References: 1) Letter from Kenneth H. Weinhauer (NMC) to Document Control Desk (NRC), dated October 12, 2000, Wisconsin Public Service Corporation Reload Safety Evaluation Methods Topical Report, WPSRSEM-NP, Revision 3

2) Letter from John G. Lamb (NRC) to Mark Reddemann (NMC) dated January 23, 2001, Kewaunee Nuclear Power Plant - Request For Additional Information Related To Reload Safety Evaluation Methods Topical Report, WPSRSEM-NP, Revision 3 (TAC NO. MB0306)

3) Letter from John G. Lamb (NRC) to Mark Reddemann (NMC) dated February 1, 2001, Kewaunee Nuclear Power Plant - Request For Additional Information Related To Reload Safety Evaluation Methods Topical Report, WPSRSEM-NP, Revision 3 (TAC NO. MB0306)

In reference 1, Nuclear Management Company, LLC. (NMC) submitted a request for approval of the Kewaunee Nuclear Power Plant (KNPP) Reload Safety Evaluations Methods Topical Report, WPSRSEM-NP, Revision 3. In reference 2 and 3, the NRC staff requested additional information concerning this topical report. This letter is NMC's response to the NRC's request for additional information.

Attachment 1 and 2 to this letter contains NMC's response. In attachment 1 some portions of the NRC Staff's request for additional information are excluded. The information excluded was considered background information and therefore unnecessary to be repeated in our response. The information from the NRC's RAI is in bold print to differentiate it from NMC's response.

In enclosure 1 of reference letter 3 some typographical errors were made which are corrected in this submittal. Comment 2 references DYNODE-Y, this should reference DYNODE-P. In comment 4 a reference is made to RETRAN-2D in the 2D mode, this should be RETRAN-3D in the 2D mode.

A001

In enclosure 2 the lettering of the comments should start with an "A" versus an "E". These corrections have been made in our submittal.

If you should have any questions concerning this matter, please contact John Holly (920) 388-8296 or Jerry Riste (920) 388-8424 of my staff.

In accordance with the requirements of 10 CFR 50.30(b), this submittal has been signed and notarized. A complete copy of this submittal has been transmitted to the State of Wisconsin as required by 10 CFR 50.91(b)(1).

Sincerely,

Mark E. Reddemann
Site Vice President

GOR

Attach.

cc - US NRC, Region III
US NRC Senior Resident Inspector
Electric Division, PSCW

Subscribed and Sworn to
Before Me This 7th Day
of February, 2001

Notary Public, State of Wisconsin

My Commission Expires:
October 24, 2004

ATTACHMENT 1

Letter from M. E. Reddemann (NMC)

To

Document Control Desk (NRC)

Dated

February 7, 2001

KNPP WPSRSEM-NP, Revision 3

NMC Response

To

NRC Request for Additional Information
Dated January 23, 2001

A. As a result of generic review of the RETRAN-3D code, the NRC staff limits the use of the code to certain conditions. Address your compliance with each item of the following conditions identified for use of RETRAN-3D computer code:

NMC NOTE: The staff positions provided in Enclosure 2 of the Request for Additional Information (RAI) are taken into account in assessing the compliance of the Kewaunee Nuclear Power Plant (KNPP) RETRAN-3D models with the conditions identified for use of the RETRAN-3D computer code.

1. Multidimensional neutronic space-time effects cannot be simulated as the maximum number of dimensions is one. Conservative usage has to be demonstrated.

NMC Response: The KNPP RETRAN-3D (R3D) models do not employ the 3-D nodal kinetics model and therefore are subject to the same condition of use as RETRAN-02 (R02) with respect to neutronic space-time effects, i.e., that conservative usage be demonstrated. The conservative input analysis assumptions in the deterministic methodology used for the Replacement Steam Generator Plant Safety Analysis (RSG PSA) along with the KNPP DYNODE-P RETRAN-3D benchmark ("R3D benchmark", Reference A-1) demonstrate conservative use of R3D. Since the 3-D kinetics model is not used and DYNODE-P , not R3D, is used for the Main Steam Line Break (MSLB) accident, the additional conditions concerning void generation, primary side nodalization and uncertainty evaluation do not apply as conditions over and above the justification of a R02 model. If the 3-D kinetics model is used or R3D is used for MSLB in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

2. There is no source term in the neutronics and the maximum number of energy groups is two. The space-time options assume an initially critical system. Initial conditions with zero fission power cannot be simulated by the kinetics. The neutronic models should not be started from subcritical or with zero fission power without further justification.

NMC Response: The KNPP R3D models are not started from sub-critical or zero fission power conditions. The Rod Withdrawal From A Sub-Critical Condition accident model employs the DYNODE-P code as the Nuclear Steam Supply System (NSSS) simulator. If R3D is used to model accidents starting from sub-critical or zero fission power conditions in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

3. A boron transport model is unavailable. User input models will have to be reviewed on an individual basis.

NMC Response: The Chemical Volume and Control (CVCS) Malfunction accident model is the only KNPP R3D model that explicitly treats boron transport and/or dilution. All KNPP R3D models employ the automatic time-step selection model. This model limits time step size to a small multiple of the Courant limit. A careful review of the CVCS Malfunction accident indicates an acceptable boron transport model. If the boron transport model is used for other applications in the future, such as steam line break, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

4. **Moving control rod banks are assumed to travel together. The boiling-water reactor (BWR) plant qualification work shows that this is an acceptable approximation.**

NMC Response: The KNPP R3D models employ only point-kinetics. If the 1-D kinetics model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

5. **The metal-water heat generation model is for slab geometry. The reaction rate is therefore underpredicted for cylindrical cladding. Justification will have to be provided for specific analyses.**

NMC Response: The KNPP R3D models only simulate Non-Loss of Coolant Accidents (Non-LOCA) where core uncovery and heatup are not significant. If R3D is used for LOCA analyses in the future, a separate submittal will be made to the NRC unless R3D is generically approved for LOCA analyses. Therefore, this condition is satisfied.

6. **Equilibrium thermodynamics is assumed for the thermal-hydraulics field equations although there are non-equilibrium models for the pressurizer and the sub-cooled boiling region.**

NMC Response: The KNPP R3D models only simulate Non-LOCA accidents where the conditions of sub-cooled liquid and superheated steam in contact do not arise. If R3D is used for LOCA analyses in the future, a separate submittal will be made to the NRC unless R3D is generically approved for LOCA analyses. Therefore, this condition is satisfied.

7. **While the vector momentum model allows the simulation of some vector momentum flux effects in complex geometry, the thermal-hydraulics are basically one-dimensional.**

NMC Response: The KNPP R3D models do not rely on a detailed accounting of vector momentum flux for validity. The basic 1-dimensional nature of the momentum equation and the limited accounting of 2-dimension momentum effects in R3D are recognized. Therefore, this condition is satisfied.

8. **Further justification is required for the use of the homogeneous slip options with BWRs.**

NMC Response: The KNPP R3D models do not employ a slip model of any kind. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

9. **The drift flux correlation used was originally calibrated to BWR situations, and the qualification work for both this option and for the dynamic slip option only cover BWRs. The drift flux option can be approved for BWR bundle geometry if the conditions of (16) are met.**

NMC Response: The KNPP R3D models do not employ a slip model of any kind. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

10. The profile effect on the interphase drag (among all the profile effects) is neglected in the dynamic slip option. Form loss is also neglected for the slip velocity. For the acceptability of these approximations refer to (17).

NMC Response: The KNPP R3D models do not employ a slip model of any kind. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

11. Only one-dimensional heat conduction is modeled. The use of the optional gap linear thermal expansion model requires further justification.

NMC Response: The KNPP R3D models do not employ a gap expansion model. If the R3D gap linear thermal expansion model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

12. Air is assumed to be an ideal gas with a constant specific heat representative of that at containment conditions. It is restricted to separated and single-phase vapor volumes. There are no other noncondensables.

NMC Response: The KNPP R3D models do not employ a non-condensable gas model of any kind. If any R3D non-condensable gas models are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

13. The use of the water properties polynomials should be restricted to the subcritical region. Further justification is required for other regions.

NMC Response: The KNPP R3D models do not model ATWS events. If R3D is used to model PWR ATWS events in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

14. A number of regime-dependent minimum and maximum heat fluxes are hardwired. The use of the heat transfer correlations should be restricted to situations where the pre-CHF heat transfer or single-phase heat transfer dominates.

NMC Response: The KNPP R3D models employ the forced convection option heat transfer model. Only pre-CHF, single phase heat transfer regimes are analyzed with the R3D models. If the forced convection option is used again in the future, the applicable conditions pertaining to R3D will again be satisfied. Therefore, this condition is satisfied.

15. The Bennet flow map should only be used for vertical flow within the conditions of the data base and the Beattie two-phase multiplier option requires qualification work.

NMC Response: The flow regime maps in R3D are used to select the wall-to-phase and interphase friction models for certain flow structures in the dynamic slip model. The KNPP R3D models do not use a slip model of any kind. If future KNPP R3D models employ the dynamic slip option that utilizes flow regime maps, Bennet flow regime maps will be applied to vertical flows and Govier flow regime maps will be applied to horizontal flows. Therefore, this condition is satisfied.

16. **No separate effects comparison have been presented for the algebraic slip option and it would be prudent to request comparisons with the FRIGG tests before the approval of the algebraic slip option.**

NMC Response: The KNPP R3D models do not employ a slip model of any kind. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

17. **While FRIGG tests comparisons have been presented for the dynamic slip option, the issues concerning the Schrock-Grossman round tube data comparisons should be resolved before the dynamic slip option is approved. Plant comparisons using the option should also be required.**

NMC Response: This R02 condition of use is not a R3D condition of use.

18. **The nonequilibrium pressurizer model has no fluid boundary heat losses, cannot treat thermal stratification in the liquid region and assumes instantaneous spray effectiveness and a constant rainout velocity. A constant L/A is used and flow detail within the component cannot be simulated. There will be a numerical drift in energy due to the inconsistency between the two-region and the mixture energy equations but it should be small. No comparisons were presented involving a full or empty pressurizer. Specific application of this model should justify the lack of fluid boundary heat transfer on a conservative basis.**

NMC Response: The KNPP R3D pressurizer model is justified on the basis that the steady-state initialization process results in reasonable code-calculated pressurizer model parameters, that the pressurizer model exhibits reasonable transient behavior and that the model compares well to the DYNODE-P model (Reference A-1). No numerical discontinuity exists in the KNPP R3D models during a pressurizer filling or draining event and there are no other indications of pressurizer model instability or inadequacy. Therefore, this condition is satisfied.

19. **The nonmechanistic separator model assumes quasistatics (time constant approximately few tenths of seconds) and uses General Electric (GE) BWR6 carryover/carryunder curves for default values. Use of default curves has to be justified for specific applications. As with the pressurizer, a constant L/A is used. The treatment in the off normal flow quadrant is limited and those quadrants should be avoided. Attenuation of pressure waves at low flow/low quality conditions are not simulated well. Specific applications to BWR pressurization transients under those conditions should be justified.**

NMC Response: The KNPP R3D models do not employ the non-mechanistic separator model. If the non-mechanistic separator model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

20. **The centrifugal pump head is divided equally between the two junctions of the pump volume. Bingham pump and Westinghouse pump data are used for the default single-phase homologous curves. The SEMISCALE MOD-1 pump and Westinghouse Canada data are for the degradation multiplier approach in the two-phase regime. Use of the default curves has to be justified for specific applications. Pump simulation should be restricted to single-phase conditions.**

NMC Response: The KNPP R3D models employ the same R02 default Westinghouse pump model. Justification for the R02 model is through plant startup test and load rejection data comparisons. The KNPP R3D models employ pump simulations that remain in single phase conditions. Therefore, this condition is satisfied.

21. **The jet pump model should be restricted to the forward flow quadrant as the treatment in the other quadrants is conceptually not well founded. Specific modeling of the pump in terms of volumes and junctions is at the user's discretion and should therefore be reviewed with the specific application.**

NMC Response: This R02 condition of use is not a R3D condition of use.

22. **The nonmechanistic turbine model assumes symmetrical reaction staging, maximum stage efficiency at design conditions, a constant L/A and a pressure behavior dictated by a constant loss coefficient. It should only be used for quasistatic conditions and in the normal operating quadrant.**

NMC Response: The KNPP R3D models do not employ a turbine model of any kind. If the non-mechanistic turbine model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

23. **The subcooled void model is a nonmechanistic profile fit using a modification of Electric Power Research Institute (EPRI) recommendations for the bubble departure point. It is used only for the void reactivity computation and has no direct effect on the thermal-hydraulics. Comparisons have only been presented for BWR situations. The model should be restricted to the conditions of the qualification data base. Sensitivity studies should be requested for specific applications. The profile blending algorithm used will be reviewed when submitted as part of the new manual (MOD003) modifications.**

NMC Response: This R02 condition of use is not a R3D condition of use.

24. **The bubble rise model assumes a linear void profile, a constant rise velocity (but adjustable through the control system), a constant L/A, thermodynamic equilibrium, and makes no attempt to mitigate layering effects. The bubble mass equation assumes zero junction slip**

which is contrary to the dynamic and algebraic slip model. The model has limited application and each application must be separately justified.

NMC Response: The KNPP R3D bubble rise models are justified implicitly in the R3D to DYNODE-P benchmark (Reference A-1). No slip models are used in the KNPP R3D models so there is no inconsistency with other junctions. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

25. The transport delay model should restricted to situations with a dominant flow direction.

NMC Response: The KNPP R3D models do not employ an enthalpy transport delay model. If the transport delay model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

26. The stand-alone auxiliary departure from nucleate boiling ratio (DNBR) model is very approximate and is limited to solving a one-dimensional steady-state simplified homogeneous equilibrium model (HEM) energy equation. It should be restricted to indicating trends.

NMC Response: The KNPP R3D models do not employ the DNBR models in R3D. If the stand-alone DNBR model is used in the future, it will be restricted to only indicating trends. Therefore, this condition is satisfied.

27. Phase separation and heat addition cannot be treated simultaneously in the enthalpy transport model. For heat addition with multidirectional, multfunction volumes the enthalpy transport model should not be used without further justification. Approval of this model will require submittal of the new manual (MOD003) modifications.

NMC Response: This R02 condition of use is not a R3D condition of use.

28. The local conditions heat transfer model assumes saturated fluid conditions, one-dimensional heat conduction and a linear void profile. If the heat transfer is from a local condition volume to another fluid volume, that fluid volume should be restricted to a nonseparated volume. There is no qualification work for this model and its use will therefore require further justification.

NMC Response: The KNPP R3D models do not employ the local conditions heat transfer model. If the local conditions heat transfer model is used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore this condition is satisfied.

29. The initializer does not absolutely eliminate all ill-posed data and could have differences with the algorithm used for transient calculations. A null transient computation is recommended. A heat transfer surface area adjustment is made and biases are added to feedwater inlet enthalpies in order to justify steady-state heat balances. These adjustments should be reviewed on a specific application basis.

NMC Response: All KNPP R3D base models undergo null-transient analysis. In the KNPP R3D models, the steam generator heat transfer area and the feedwater inlet enthalpy are adjusted by the steady-state initialization process. The adjustments are within acceptable ranges based on RETRAN-3D training session guidance and engineering judgement. Therefore this condition is satisfied.

30. Justification of the extrapolation of FRIGG data or other data to secondary-side conditions for pressurized water reactors (PWRs) should be provided. Transient analysis of the secondary side must be substantiated. For any transients in which two-phase flow is encountered in the primary, all the two-phase flow models must be justified.

NMC Response: The KNPP R3D models do not employ a slip model of any kind. If non-HEM two-phase flow models are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

31. The pressurizer model requires model qualification work for the situations where the pressurizer either goes solid or completely empties.

NMC Response: This R02 condition of use is not a R3D condition of use.

32. Transients which involve three-dimensional space-time effects such as rod ejection, transients would have to be justified on a conservative basis.

NMC Response: This is not a separate condition for R3D (see condition (1)).

33. Transients from sub-critical, such as those associated with reactivity anomalies should not be run.

NMC Response: The KNPP R3D models do not start from sub-critical conditions. If R3D is used to model transients from sub-critical in the future, the applicable conditions pertaining to R3D will be satisfied (see condition (2)). Therefore, this condition is satisfied.

34. Transients where boron injection is important, such as steamline break will require separate justification for the user-specified boron transport model.

NMC Response: This is not a separate condition for R3D (see condition (3)).

35. For transients where mixing and cross flow are important, the use of various cross flow loss coefficients has to be justified on a conservative basis.

NMC Response: The KNPP R3D models do not employ cross flow or mixing models. If cross-flow and mixing models are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied.

36. Anticipated transients without scram (ATWS) events will require additional submittals.

NMC Response: This is not a separate condition for R3D (see condition (13)).

37. For PWR transients where the pressurizer goes solid or completely drains, the pressurizer behavior will require comparison against real plant or appropriate experimental data.

NMC Response: This is not a separate condition for R3D (see conditions (18) and (31)).

38. PWR transients, such as steam generator tube rupture, should not be analyzed for two-phase conditions beyond the point where significant voiding occurs on the primary side.

NMC Response: This is not a separate condition for R3D (see conditions (16) and (30)).

39. BWR transients where asymmetry leads to reverse jet pump flow, such as the one re-circulation pump trip, should be avoided.

NMC Response: This is not a separate condition for R3D (see condition (21)).

References:

Reference A-1: Coen, E. D., Holly, J. T., "Kewaunee Nuclear Power Plant DYNODE-P RETRAN-3D Benchmark," Prepared 06-12-2000, Reviewed 06-14-2000.

B. RETRAN-3D USE IN A RETRAN-02 MODE

In the letter dated October 12, 2000, the NMC staff stated that you intend to adopt use of RETRAN-3D in the 2D mode for system analysis. The NRC staff has determined that it is not possible to use RETRAN-3D in a pure RETRAN-02 mode. The code's numerical solution scheme and various models have been changed so that there is no exact RETRAN-02 substitution that can be performed. However, the code can be used in a near RETRAN-02 mode provided that the user carefully selects models and options that reduce the divergence from those not available to the RETRAN-02 user.

While functionally equivalent to RETRAN-02, RETRAN-3D is more robust. The following models are always active when using RETRAN-3D:

- **Improved transient numerical solution (fully implicit solution of the balance equations, component models and source terms are linearized)**
- **Improvements to the time-step selection logic**
- **Improved water property curve fits**

Other model options have been improved with the improvements being active when the particular option is selected in an input model. For these options, the RETRAN-02 model was replaced by the improved model and there is no backward compatibility option. Consequently, the following improvements, if selected by the user, may be used for RETRAN-02 mode analyses:

- **Fully implicit steady-state solution**
- **Implicit pressurizer solution**
- **Wall friction model revised to use the Colebrook equation, allowing consideration of wall roughness rather than assuming smooth pipe**
- **Control system solution revised to solve a coupled system of equations using a Gauss-Seidel method rather than the single pass marching scheme**
- **Enthalpy transport model revised by eliminating several simplifying assumptions**
- **Improved dynamic slip formulation adding form losses**
- **Improved countercurrent flow junction properties**
- **Implicit solution of the heat conduction equation**

- **Combined heat transfer map updated with an improved set of heat transfer correlations and smoothed transitions**

- **Wall friction and hydrostatic head losses included in critical flow pressure**

The new steady-state option available for initializing models with steam generators makes some problems easier to initialize. The low power steam generator steady-state option can be used with RETRAN-02 mode analyses.

A RETRAN-02 mode model must not use any of the new RETRAN-3D features such as:

- **Generalized laminar friction model**

NMC Response: The KNPP R3D models do not employ the generalized laminar friction model (card 050000 absent).

- **Dynamic gap conductance model**

NMC Response: The KNPP R3D models do not employ the dynamic gap conductance model (card 01000Y, NGAP = 0).

- **Accumulator model**

NMC Response: The KNPP R3D models do not employ the accumulator model (card 01000Y, NACC = 0).

- **Dynamic flow regime model**

NMC Response: The KNPP R3D models do not employ the dynamic flow regime model (card 01000Y, ISFLAG ≠ 6).

- **New control blocks added to improve functionality**

NMC Response: The KNPP R3D models do not employ the new control blocks (card 702XXX, CSYM ≠ ABS, F2D, RAT, STF).

- **Govier horizontal flow regime map and stratified flow friction model**

NMC Response: The KNPP R3D models do not employ the Govier horizontal flow regime map and stratified flow friction model (card 01000Y, ISFLAG = 0; card 08XXXY, IFRJ < 100).

- **Chexal-Lellouche drift flux model**

NMC Response: The KNPP R3D models do not employ the Chexal-Lellouche drift flux model (card 01000Y, ISFLAG = 0).

- **Method of characteristics enthalpy option**

NMC Response: The KNPP R3D models do not employ the method of characteristics enthalpy option (cards 6300XX absent).

- **Noncondensable gas flow model**

NMC Response: The KNPP R3D models do not employ the non-condensable gas flow model (card 01000Y, NCFLOW = 0).

- **3D kinetics**

NMC Response: The KNPP R3D models do not employ the 3D kinetics model (card 01000Y, NODEL = 1).

- **5-equation nonequilibrium model**

NMC Response: The KNPP R3D models do not employ the 5-equation non-equilibrium model (card 01000Y, NEWEQS = 0).

Explain how you comply with the following conditions:

Organizations with NRC-approved RETRAN-02 methodologies can use the RETRAN-3D code in the RETRAN-02 mode without additional NRC approval, provided that none of the new RETRAN-3D models listed in the definition are used. Organizations with NRC-approved RETRAN-02 methodologies must obtain NRC approval prior to applying any of the new RETRAN-3D models listed above for updated final safety analysis report (UFSAR) Chapter 15 licensing basis applications. Organizations without NRC-approved RETRAN-02 methodologies must obtain NRC approval for such methodologies or a specific application before applying the RETRAN-02 code or the RETRAN-3D code for UFSAR Chapter 15 licensing basis applications. Generic Letter 83-11 provides additional guidance in this area. Licensees who specifically reference RETRAN-02 in their Technical Specifications will have to request a Technical Specification change to use RETRAN-3D.

NMC Response: The NMC (formerly WPSC) has NRC-approved RETRAN-02 methodologies for KNPP (Reference B-1) and is not using any of the restricted new R3D models listed in the definition. See the NMC responses above following each of the restricted new R3D models for demonstration of the compliance. The NMC must obtain NRC approval prior to applying any of the restricted new RETRAN-3D models listed in the definition for UFSAR Chapter 14 licensing basis applications. Also, RETRAN-02 is not specifically referenced in KNPP Technical Specifications. Therefore this condition is satisfied.

The RETRAN-3D five-equation, or nonequilibrium, model uses flow regime maps and flow pattern dependent heat transfer and interfacial area models to simulate the heat and mass transfer processes between phases. A licensee wishing to apply the five-equation model will have to justify its use outside areas of operation where assessment has been documented. This may include either separate effects or integral systems assessment that cover the range of conditions encountered by the application of interest. An assessment of the uncertainties must also be provided. The model is approved subject to these conditions.

NMC Response: The KNPP R3D models do not employ the 5-equation or non-equilibrium models (apart from the pressurizer model, which is previously addressed in question part A). If the 5-equation or non-equilibrium models are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore this condition is satisfied.

Assessment performed in support of use of RETRAN-3D must also address consistency between the RETRAN-3D calculations and any auxiliary calculations that are a part of the overall methodology, such as, Departure from Nucleate Boiling or Critical Power Ratio. The NRC staff concludes that the lack of a detailed RETRAN-3D specific user guideline document mandates a statement on the user's experience and qualification with the code when analyses are submitted in support of licensing actions. This statement is expected to be consistent with the guidance of Generic Letter 83-11.

NMC Response: The KNPP R3D model transient results are utilized by the VIPRE, TOODEE and CONTEMPT codes for some transients. The basis for the consistency remains the same as it is for the existing consistency between DYNODE-P and RETRAN-02 and these other codes. If other auxiliary calculations are performed in the future, the consistency between R3D and the auxiliary calculation will be assessed.

The NMC has a training program established and implemented to ensure that each qualified user of R3D in a R02 mode has a good working knowledge of the code and methods and is able to set up the input, to understand and interpret the output results, and understands the application and limits of the code. The program ensures that analyses are performed in compliance with the applicable procedures. Training has been provided to the qualified users by the code developer and from other qualified code users.

The KNPP R3D models were developed by qualified NMC (formerly WPSC) staff who have appropriate experience and training consistent with Generic Letter 83-11. R02 has been used extensively for best estimate calculations:

- KNPP simulator verification of selected operational transients
- KNPP Load Rejection Test simulation and comparisons
- Main Feedwater System leak analysis
- Containment Fan Coil Unit downstream piping orifice sizing

and licensing analyses:

- Chapter 14 Design Basis Non LOCA transients for topical report (Rev 2)
- Rod Drop in auto control accident
- High Energy Line Break outside containment

Therefore this condition is satisfied.

Application of the RETRAN-02 or RETRAN-3D codes for best estimate analysis of UFSAR Chapter 15 licensing basis events may require additional code and model assessment, and an evaluation of uncertainties to assure accurate prediction of best estimate response. This condition is based on the absence, in the best estimate analysis approach, of the conservative assumptions in traditional UFSAR Chapter 15 licensing basis analyses. For each use of RETRAN-3D in a licensing calculation, it will be necessary for a valid approach to assessment to be submitted, which is expected to include a phenomena identification and ranking table (PIRT) for each use of the code and the appropriate assessment cases and their results. The scope of the PIRT and validation/assessment will be commensurate with the complexity of the application.

NMC Response: The KNPP R3D models utilize only explicitly approved R3D models and are not used in a best estimate UFSAR Chapter 14 analysis methodology. Conservative assumptions are used in the UFSAR Chapter 14 licensing basis analyses. Therefore this condition is satisfied.

References:

Reference B-1: "Wisconsin Public Service Corporation "Reload Safety Evaluation Methods for Application to Kewaunee" (TAC No. 65155), NRC letter from Joseph G. Giitter to D.C. Hintz, dated April 11, 1988. (Docket No. 50-305)

C. Page 2 of Attachment 3 in the letter dated October 12, 2000 specifies two different sets of acceptance criteria for the DYNODE and RETRAN-3D comparison. One is for parameter trend and one is for key parameters comparisons. It is not clear how the two different sets of acceptance criteria are applied to the code comparisons. You are requested to provide a description of the applications of acceptance criteria in the code comparisons and justify its adequacy for the NRC staff approval. Also, key parameters acceptance criteria allow the differences in parameters calculated by DYNODE and RETRAN-3D to be within the following ranges: 30 psi for steam generator or pressurizer pressure, 0.14 for minimum departure from nucleate boiling ratio (MDNBR), 4^0F for peak clad temperature. Explain how the ranges of the parameters (especially, 0.14 for MDNBR with consideration of use of the HTP critical heat flux correlation) are determined and how these uncertainties are considered in establishing the limiting peak pressurizer pressure, minimum DNBR and peak clad temperature for the USAR accident analyses. Also, you are requested to identify any results of the DYNODE and RETRAN-3D code comparisons that do not meet the key parameters acceptance criteria and provide reasons in terms of code modeling assumptions for the NRC staff to review.

NMC Response:

Background:

The attachment referred to in the question is the DYNODE to RETRAN-3D benchmark report (Reference C-1). DYNODE has been used extensively by NMC staff (formerly WPSC staff) for analyzing Kewaunee non-LOCA USAR Chapter 14 events since 1979. RETRAN-02 has been used by NMC staff (formerly WPSC staff) for Kewaunee safety analysis since 1988, but has been used less extensively than DYNODE for analyzing Kewaunee non-LOCA USAR Chapter 14 events. Comparisons of both DYNODE and RETRAN-02 to Kewaunee plant and simulator data were included in the October 1988 revision to the Kewaunee reload safety evaluation methods topical report (approved by Reference C-2). These comparisons demonstrated the competency of NMC staff (formerly WPSC staff) to build and use both DYNODE and RETRAN-02 models. These competencies have been maintained by continued use of both models.

The purpose of the benchmark report is to compare RETRAN-3D in RETRAN-02 mode results to existing DYNODE results for Kewaunee non-LOCA USAR Chapter 14 transients. The comparison will verify the ability of NMC staff (formerly WPSC staff) to model the non-LOCA events with RETRAN-3D used in RETRAN-02 mode. The RETRAN-3D in RETRAN-02 mode model created for this comparison was made as similar as possible to the existing DYNODE model in terms of basic inputs (geometry, power level, fluid conditions, et cetera) and sub-system models (charging/letdown, steam generators, et cetera) in order to facilitate a meaningful comparison.

Note that for the remainder of this response, the word "RETRAN" will refer to RETRAN-3D used in RETRAN-02 mode.

As previously stated, the comparison of RETRAN to DYNODE in the benchmark report is intended to verify the ability of the NMC staff (formerly WPSC staff) to build and use a RETRAN model for Kewaunee safety analysis, particularly the Chapter 14 events that have historically been primarily

analyzed in DYNODE. To that end, the benchmark report documents the comparisons and explains any significant, unexpected, or unusual deviations in the calculation of safety related parameters. In order to identify significant, unexpected, or unusual deviations, acceptance criteria were developed. These criteria are only intended to aid in the comparison of results between the two models and are independent of the overall Kewaunee safety analysis methodology. The Kewaunee safety analysis methodology ensures conservative output results by utilizing conservative input values for parameters such as pressure, temperature, power, flow, reactor trip setpoints, safety system setpoints, circuit delays, system configuration, single active failure, et cetera. Use of approved codes such as DYNODE and RETRAN-02 with conservative inputs has ensured conservative output results for use in safety analysis. RETRAN-3D in RETRAN-02 mode will use this same analysis approach.

Acceptance Criteria Used In Benchmark Comparisons:

The acceptance criteria described in the benchmark report are more accurately viewed as review criteria. Based on engineering judgement, differences between DYNODE and RETRAN results that meet the review criteria are considered to be acceptable without further explanation. Differences between DYNODE and RETRAN results that do not meet the review criteria must be explained prior to acceptance. The review criteria are intended to identify areas where parameter differences should be investigated to ensure that the differences are due to the inherent differences between the DYNODE and RETRAN-3D codes, and not due to a modeling error or code misuse.

There are one qualitative review criterion and two sets of quantitative review criteria. The qualitative review criterion states that general trends in parameters plotted in the USAR shall be consistent. All of the plots shown in the USAR for a particular transient were included in the benchmark report, as these are important parameters for the transient. The qualitative trend review criterion, for example, was used to verify that reactor power is rising in both DYNODE and RETRAN at the beginning of the uncontrolled RCCA withdrawal cases. Or that pressurizer water level is rising in both DYNODE and RETRAN soon after the beginning of the automatic control loss of external electric load event. The qualitative review criterion was also used to identify parameter oscillations that warranted further investigation. The few significant trend differences between DYNODE and RETRAN results are explained in the benchmark report discussion of each figure. For example, the last paragraph on Page III.3-1 of the benchmark report explains a trend difference between DYNODE and RETRAN calculated T_{ave} results toward the end of the transient. Another example is on Page III.7-1, which explains the calculated steam generator wide range level oscillations seen on Figure 7-3.

The first set of quantitative review criteria is applied to parameters that are plotted in the USAR, but are not accident acceptance criteria parameters. The list of parameters reviewed under this set of criteria varies from accident to accident. For example, the USAR plots for the Condition II boron dilution (also called CVCS malfunction) at full power transient consist of plots of MDNBR, RCS (pressurizer) pressure, reactor power, T_{ave}, and heat flux as a function of transient time. Of these parameters, MDNBR and RCS pressure are Condition II event acceptance criteria. The remaining parameters (reactor power, T_{ave}, and heat flux) are not event acceptance criteria and are therefore reviewed under the first set of quantitative review criteria. As a result, for this transient, reactor

power would be expected to compare within 5% between DYNODE and RETRAN at all transient times, T_{ave} would be expected to compare within 5°F at all transient times, and heat flux would be expected to compare within 5% at all transient times. Any differences between the DYNODE and RETRAN results at any time that exceed these review criteria would have to be explained prior to acceptance. Since these parameters are not USAR acceptance criteria parameters, the benchmark report does not summarize in detail the instances where pertinent parameters exceed the review criteria. However, significant differences between the DYNODE and RETRAN results for these parameters are explained in the benchmark report discussion of each figure. For example, the first paragraph on Page III.2-1 of the benchmark report explains why the RETRAN case trips earlier than the DYNODE case for the CVCS malfunction dilution at power. The explanation provides the reason why the Figure 2-1 fraction of reactor power in DYNODE at 80 seconds is still greater than 1.0, while the RETRAN fraction of reactor power has already decreased to less than 0.25.

The second set of quantitative review criteria is applied to parameters that are USAR acceptance criteria. These are the "key parameters" referred to in the question. All parameters that are USAR acceptance criteria parameters are considered under this set of review criteria, regardless of whether or not they are plotted in the USAR. USAR acceptance criteria that are known not to be challenged by a particular event, that are known to be bounded by another event, or that are bounded by other USAR acceptance criteria are not formally summarized for that particular event. For example, as stated earlier, boron dilution (also called CVCS malfunction) at full power is a Condition II event. Condition II events have acceptance criteria related to RCS pressure, MDNBR, fuel centerline temperature, dose consequences, main steam system pressure, and containment pressure/temperature. By meeting the MDNBR acceptance criteria, the fuel centerline temperature and dose acceptance criteria are met. For a Condition II event such as boron dilution there is no challenge to the containment acceptance criteria. Therefore, the USAR acceptance criteria remaining to be considered under the second set of quantitative review criteria are MDNBR, RCS pressure, and main steam system pressure. Any differences between the DYNODE and RETRAN results for these parameters that exceed the second set of quantitative review criteria would have to be explained prior to acceptance. Note that some of the USAR acceptance criteria are not calculated by DYNODE or by RETRAN. For example, MDNBR is not calculated directly by DYNODE or RETRAN. Statepoint output from DYNODE or RETRAN is passed to VIPRE for the MDNBR calculation. Therefore, the DYNODE to RETRAN MDNBR differences are based on the differences in the values of heat flux, RCS pressure, core inlet temperature, and RCS flow passed to VIPRE from DYNODE or RETRAN. The beginning of Section 8 (Page III.8-1) of the benchmark report provides explanations for differences that exceed this set of review criteria for the key parameters for all of the events in the benchmark report.

Note that the second set of quantitative review criteria is slightly more restrictive than the first set of quantitative review criteria. This is not to imply that RETRAN or DYNODE are better able to predict parameters reviewed under the second set of review criteria. It simply means that a smaller difference will require an explanation for the DYNODE to RETRAN differences for these parameters prior to the acceptance of the benchmark results.

Quantitative Review Criteria Values:

Values for both sets of quantitative review criteria were determined using engineering judgement. For the second set of review criteria, the current USAR Section 14.0 steady state errors were used to guide the selection of some of the review criteria. USAR Section 14.0 gives the steady state primary pressure error as ±30 psi. It was therefore decided that DYNODE to RETRAN differences greater than 30 psi for this parameter would have to be explained before acceptance. It is important to note that the 30 psi is just a criteria to initiate a review of the differences in the benchmark analysis. It does not imply that 30 psi must be added to or subtracted from either the DYNODE or RETRAN result to account for uncertainties. As discussed previously, the overall conservatism of a DYNODE or RETRAN transient case when used in safety analysis is based on the use of conservative input throughout, not on applying conservatism to the output value.

The 30 psi RCS pressure review criterion was also used for the secondary side pressure review criterion. Once again, this does not imply that 30 psi must be added to or subtracted from either the DYNODE or RETRAN result to account for uncertainties. The overall conservatism of a DYNODE or RETRAN transient case when used in safety analysis is based on the use of conservative input throughout, not on applying conservatism to the output value.

The peak clad temperature review criterion was established somewhat differently. The only event in the DYNODE to RETRAN benchmark that requires an explicit assessment of the peak clad temperature is the locked rotor accident. Neither DYNODE nor RETRAN are used to directly calculate peak clad temperature. Instead, power as a function of time is passed from DYNODE or RETRAN to TOODEE. The values passed to TOODEE are conservative based on the conservative input used to generate them. USAR Section 14.0 gives the steady state core inlet temperature error as ±4°. Although the core inlet temperature is not the same parameter as the peak clad temperature, it was decided that DYNODE to RETRAN differences greater than 4°F in peak clad temperature would have to be explained before acceptance. Analogous to the case for the RCS pressure parameter, this does not imply that 4°F must be added to or subtracted from TOODEE results based either on DYNODE or RETRAN to account for uncertainties. The overall conservatism in the TOODEE peak clad temperature results based on DYNODE or RETRAN is based on the use of conservative input throughout when performing safety analysis, not on applying conservatism to the output value.

The MDNBR review criterion was also established somewhat differently. As discussed earlier, neither DYNODE nor RETRAN are used to directly calculate MDNBR. Instead, values of heat flux, RCS pressure, core inlet temperature, and RCS flow are passed from DYNODE or RETRAN to VIPRE. The values passed to VIPRE are conservative based on the conservative input used to generate them. The MDNBR review criterion was set at 0.14 guided by the fact that the Kewaunee HTP correlation DNBR limit is 1.14. Once again, this does not imply that 0.14 must be added to or subtracted from a VIPRE MDNBR calculated using either DYNODE or RETRAN results to account for uncertainties when performing safety analysis. The overall conservatism of the VIPRE MDNBR calculation when performing safety analysis is based on the conservative DYNODE or RETRAN transient case output passed to VIPRE. The VIPRE HTP correlation DNBR limit is based on a qualification of VIPRE to experimental data and is independent of whether DYNODE or RETRAN is being used to provide safety analysis statepoint information to VIPRE. The

Uncontrolled Rod Withdrawal, Fast Rate, Intermediate Power is the only benchmark report event for which the MDNBR review criterion is exceeded. An explanation for the review criterion being exceeded is provided in Section 8 (Page III.8-1) of the benchmark report. All other benchmark report events are well within the NDNBR review criterion of 0.14, and would have met an MDNBR review criterion as low as 0.06.

The first set of quantitative review criteria also depended on engineering judgement to establish their values. The values are somewhat less restrictive than the review criteria applied to transient USAR acceptance criteria parameters. Once again these review criteria are not meant to determine a number that must be added to or subtracted from a DYNODE or RETRAN result to account for uncertainties. They are meant to establish criteria to identify areas where parameter differences observed in the benchmark should be investigated to ensure that the differences are due to the inherent differences between the DYNODE and RETRAN-3D codes, instead of to a modeling error or code misuse.

Explanation of Key Parameter Differences Exceeding Acceptance (Review) Criteria:

As was mentioned earlier, the beginning of Section 8 (Page III.8-1) of the benchmark report provides explanations for differences that exceed the second set of quantitative review criteria for the key parameters (USAR event acceptance criteria parameters) for all of the events in the benchmark report.

References:

Reference C-1: "DYNODE-P RETRAN-3D Benchmark," report prepared by E.D. Coen, dated June 12, 2000 (prepared) and June 14, 2000 (reviewed).

Reference C-2: Wisconsin Public Service Corporation "Reload Safety Evaluation Methods for Application to Kewaunee (TAC No. 65155), NRC Letter from Joseph G. Giitter to D.C. Hintz, dated April 11, 1988. (Docket No. 50-305)

D. Describe which accidents are intended to be analyzed in the future using DYNODE and RETRAN-3D in the 2D mode. Justify the adequacy of the application of these codes regarding accident conditions analyzed.

NMC Response:

DYNODE and RETRAN-3D are used for the NSSS simulation of various events. Section 3.0 of the submitted topical report contains seventeen sections, sixteen of which describe accidents or transients. The seventeenth section describes power distribution control. The current use of DYNODE and RETRAN-3D and the planned future use of RETRAN-3D for each of these topical report sections are discussed below. Note that current use refers to the analysis of record for the currently operating Kewaunee Cycle 24. Future use refers to the analysis to be used starting with Cycle 25, which is scheduled to start up in Fall 2001.

It should also be noted that in the following discussion, for Cycle 25, "RETRAN" means the use of RETRAN-3D in the 2D mode, with all applicable conditions met. For cycles beyond Cycle 25, "RETRAN" means either of the following:

- The use of RETRAN-3D in 2D mode with all applicable conditions met; or
- The use of RETRAN-3D in other than 2D mode supported by a submittal.

1. Uncontrolled RCCA Withdrawal from a Sub-Critical Condition: This event is currently analyzed using DYNODE for the NSSS simulation. For Cycle 25, it is intended to continue to use DYNODE. At some time after Cycle 25, the NMC may develop a RETRAN model for this event to replace DYNODE. If such a model is developed, the model will meet all applicable RETRAN conditions, notably the conditions related to initially sub-critical RETRAN models.

2. Uncontrolled RCCA Withdrawal At Power: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

3. Control Rod Misalignment: No NSSS simulation is performed for this event. Therefore, neither DYNODE nor RETRAN are currently used for this event or planned for future use for this event.

4. Control Rod Drop: No NSSS simulation is performed for this event. Therefore, neither DYNODE nor RETRAN are currently used for this event or planned for future use for this event.

5. Chemical and Volume Control System Malfunction: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

6. Startup of an Inactive Coolant Loop: This event is currently analyzed using DYNODE for the NSSS simulation. For Cycle 25, it is intended to continue to use DYNODE. At some time after Cycle 25, the NMC may develop a RETRAN model for this event to replace DYNODE. If such a model is developed, the model will meet all applicable RETRAN conditions, notably the conditions related to RETRAN models initially at part power.

7. Excessive Heat Removal Due to Feedwater System Malfunction: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

8. Excessive Load Increase: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

9. Loss of External Load: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

10. Loss of Normal Feedwater Flow: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

11. Loss of Reactor Coolant Flow – Pump Trip: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

12. Loss of Reactor Coolant Flow – Locked Rotor: This event is currently analyzed using DYNODE for the NSSS simulation. Starting with Cycle 25, it is intended to use RETRAN for the NSSS simulation.

13. Fuel Handling Accident: No NSSS simulation is performed for this event. An outside vendor performs a fuel handling accident analysis using its approved methods. The NMC then verifies that the vendor analysis applies to each reload. This is currently the case for Cycle 24 and is expected to continue to be the case in the future.

14. Main Steam Line Break: This event is currently analyzed using DYNODE for the NSSS simulation. For Cycle 25, it is intended to continue to use DYNODE. At some time after Cycle 25, the NMC may develop a RETRAN model for this event to replace DYNODE. If such a model is developed, the model will meet all applicable RETRAN conditions, notably the conditions related to RETRAN models initially at zero power.

15. Control Rod Ejection: This event is currently analyzed using DYNODE for the NSSS simulation. For Cycle 25, it is intended to continue to use DYNODE. At some time after Cycle 25, the NMC may develop a RETRAN model for this event to replace DYNODE. If such a model is developed, the model will meet all applicable RETRAN conditions, notably the conditions related to RETRAN models initially at less than full power.

16. Loss of Coolant Accident: An outside vendor performs the loss of coolant accident analyses using its approved methods. The NMC then verifies that the vendor analysis applies to each reload. This is currently the case for Cycle 24 and is expected to continue to be the case in the future.

17. Power Distribution Control Verification: This verification does not involve an NSSS simulation. Therefore, neither DYNODE nor RETRAN are currently used for this event or planned for future use for this event.

The adequacy of DYNODE and RETRAN-02 for the uses described above was confirmed in the April 11, 1988 safety evaluation (Reference D-1) for Revision 2 to the Kewaunee reload safety evaluation methods topical report. The NRC safety evaluation included the performance of the DYNODE-P and RETRAN-02 codes, stating, "DYNODE-P and TOODEE2 have been approved (Ref. 1) for the reload safety evaluation of the Prairie Island Units 1 and 2, plants similar to Kewaunee. RETRAN-02 is a derivative of RELAP, and both codes have been extensively used to provide best estimate as well as conservative analyses of the transients under consideration. The staff utilized RETRAN-02 to qualify DYNODE-P for the reload safety evaluation of the Prairie Island Units (Ref. 1)."

The transients under consideration in the current submittal are the same as those considered in Revision 2 to the Kewaunee RSE methods topical report. Therefore, both DYNODE and RETRAN-02 continue to be adequate for the uses described above. Meeting the conditions required to use RETRAN-3D in 2D mode ensures that RETRAN-3D used in 2D mode is adequate for the transients under consideration.

References:

Reference D-1: "Wisconsin Public Service Corporation "Reload Safety Evaluation Methods for Application to Kewaunee" (TAC No. 65155), NRC letter from Joseph G. Giitter to D.C. Hintz, dated April 11, 1988. (Docket No. 50-305)

ATTACHMENT 2

Letter from M. E. Reddemann (NMC)

To

Document Control Desk (NRC)

Dated

February 7, 2001

KNPP WPSRSEM-NP, Revision 3

NMC Response

To

NRC Request for Additional Information
Dated February 1, 2001

1. **The response to RAI A.3 states that "This model limits time step size to a small multiple of the Courant limit. A careful review of the CVCS malfunction accident indicates an acceptable boron transport model....". Clarify whether the Courant limit is exceeded or not in selecting the time step size for the CVCS malfunction analysis. Expand the discussion to include acceptance criteria and rationale for drawing the conclusion claiming that the boron transport model is acceptable.**

NMC Response

The text of the response to RAI A.3 is as follows: "NMC Response: NMC Response: The Chemical Volume and Control (CVCS) Malfunction accident model is the only KNPP R3D model that explicitly treats boron transport and/or dilution. All KNPP R3D models employ the automatic time-step selection model. This model limits time step size to a small multiple of the Courant limit. A careful review of the CVCS Malfunction accident indicates an acceptable boron transport model. If the boron transport model is used for other applications in the future, such as steam line break, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied."

In the KNPP R3D CVCS Malfunction accident model the "small multiple" factor used is the recommended (R3D code default) value of 5. The R3D iterative numerics Courant time-step limit (i.e., $C_2 * M_j/|W_j|$, $C_2 = 5$) will never be exceeded for any time step due to R3D code logic. Additionally, based on a review of the KNPP R3D CVCS Malfunction analysis output, the Courant limit proper (i.e., $C_2 * M_j/|W_j|$, $C_2 = 1$) is not exceeded for any time-step of the CVCS Malfunction accident analyses.

Ensuring that the Courant limit is not exceeded for any time ensures that numerical instabilities are not introduced. However, if the time step size is significantly smaller than the Courant limit, significant artificial damping and significant increased downstream propagation can result, yielding inaccurate boron transport model behavior. A comparison of the RETRAN-3D in a RETRAN-02 mode CVCS Malfunction accident results to the DYNODE-P CVCS Malfunction accident results shows that this is not the case.

The acceptability of the boron transport model is demonstrated by a comparison of the transient results of the CVCS Malfunction accident analyzed with RETRAN-3D in a RETRAN-02 mode to the results obtained with DYNODE-P as documented in the DYNODE-P to R3D benchmark report (Ref. C1-1). The benchmark report shows that the important transient parameters, reactor power, reactor coolant system (RCS) average temperature, and core average heat flux that are not USAR acceptance criteria parameters are within the applicable review criteria for the benchmark. In addition, the USAR acceptance criteria parameters all meet the applicable benchmark review criteria, with the exception of the main steam system pressure. The main steam system pressure result is explained in section 8 of the benchmark report.

Furthermore, the core average boron concentration and reactivity insertion due to boron dilution calculated by R3D trend similarly to the values calculated by DYNODE-P. Up to the time of the reactor trip, the R3D to DYNODE-P difference in core boron concentration is less than 3 ppm. The reactivity insertion due to the boron dilution calculated by R3D also trends similarly to DYNODE-P up until the time of the reactor trip, at which point the differences are due to the non-coincident trip times. The R3D to DYNODE-P reactivity insertion differences are consistent with the observed core average boron concentration differences. Therefore, the R3D and DYNODE-P models both alter the core average boron concentration in a similar manner, with respect to magnitude and rate of change, and the respective core average boron concentration changes result in a similar reactivity change for the two models.

In conclusion, the generally well-behaved character of the R3D numerical results, the physical reasonableness of the R3D transient results and the acceptable comparisons to DYNODE-P results indicate that the KNPP R3D CVCS Malfunction accident model including the boron transport model is acceptable.

References:

Reference C1-1: Coen, E.D., Holly, J.T., "Kewaunee Nuclear Power Plant DYNODE-P RETRAN-3D Benchmark," Prepared 06-12-2000, Reviewed 06-14-2000.

2. **The response to RAI A.24 states that "The KNPP R3D bubble rise models are justified implicitly in the R3D to DYNODE-P benchmark...." You are requested to identify the applicable examples included in Reference A.1 and discuss the R3D and DYNODE-P comparisons to address the acceptability of the bubble rise model used in the KNPP R3D code.**

NMC Response

The text of the response to RAI A.24 is as follows: "NMC Response: The KNPP R3D bubble rise models are justified implicitly in the R3D to DYNODE-P benchmark (Reference A-1). No slip models are used in the KNPP R3D models so there is no inconsistency with other junctions. If any R3D slip options are used in the future, the applicable conditions pertaining to R3D will be satisfied. Therefore, this condition is satisfied."

All of the R3D Benchmark report (Ref. C2-1) events are examples that demonstrate the validity of the R3D bubble rise model since all of the events analyzed in the benchmark report include a bubble rise model in both R3D and DYNODE-P. Phenomena affected by the bubble rise model include the

steam generator level and steam dome pressure response, the main steam line flow and pressure response, the steam generator mass and energy throughout the event, and the primary to secondary heat transfer throughout the event. The benchmark report parameters that can be compared to ensure that these phenomena are being modeled acceptably are the steam generator level, the main steam line pressure, the main steam flow, the reactor coolant system temperature and pressure, core delta-T, and the power. As shown in the benchmark report there is acceptable agreement between R3D and DYNODE-P for these parameters.

The R3D and DYNODE-P bubble rise model input parameters can be summarized as follows. The bubble gradient parameter, alpha, (which determines the slope of the vapor density gradient in the liquid region) can range from 0.0 to 1.0. An alpha value of 0.0 implies a homogeneous bubble density; an alpha of 1.0 implies a maximum bubble density gradient from the bottom of the control volume to the mixture level. A typical value is 0.8. The bubble rise velocity parameter, Vbub (which determines the rate of separation of the vapor phase from the liquid phase at the liquid-vapor interface) can range from 0 ft/s to +infinity ft/s. A Vbub value of 0 ft/s implies no vapor separation, Vbub values greater than 0 ft/s and less than 3 ft/s imply a separation rate due to bubble buoyancy, and Vbub values greater than about 15 ft/s imply more or less complete separation.

A value for alpha is input to both DYNODE-P and R3D. DYNODE-P uses the user specified input value of alpha directly, which for the KNPP DYNODE-P models is 0.8. R3D will use the user specified input value of alpha unless the steady-state initialization requires an adjustment. For the KNPP R3D models, the user specified input alpha value of 0.8 is adjusted by the R3D code during the steady-state initialization to values falling in the range of 0.5 to 1.0. However, as mentioned above, the parameters affected by the bubble rise model continue to show acceptable agreement between DYNODE-P and R3D.

Both R3D and DYNODE-P calculate the Vbub parameter. Vbub values calculated by the KNPP DYNODE-P models range from 0 to 14 ft/s. The Vbub parameters calculated by R3D for the KNPP models range from 3 ft/s to 21 ft/s. Once again, as mentioned above, the parameters affected by the bubble rise model continue to show acceptable agreement between DYNODE-P and R3D.

Since the R3D and DYNODE-P bubble rise parameters used in the KNPP models fall within similar ranges and since the results influenced by the bubble rise model show acceptable agreement between R3D and DYNODE-P for the events in the benchmark report, the R3D bubble rise model is acceptable.

References:

Reference C2-1: Coen, E.D., Holly, J.T., "Kewaunee Nuclear Power Plant DYNODE-P RETRAN-3D Benchmark," Prepared 06-12-2000, Reviewed 06-14-2000.

3. The response to RAI A.29 states that "All KNPP R3D base models undergo null-transient analysis..... The adjustments are within acceptable ranges...." Discuss the acceptable ranges and address the acceptability of the acceptable ranges for the null-transient analysis using KNPP R3D.

NMC Response

The text of the response to RAI A.29 is as follows: "NMC Response: All KNPP R3D base models undergo null-transient analysis. In the KNPP R3D models, the steam generator heat transfer area and the feedwater inlet enthalpy are adjusted by the steady-state initialization process. The adjustments are within acceptable ranges based on RETRAN-3D training session guidance and engineering judgement. Therefore this condition is satisfied."

The steady-state initialization process utilized by the KNPP R3D models performs an adjustment to the input steam generator feedwater inlet enthalpy and the input heat transfer areas of the steam generator conductors in order to obtain an overall primary-to-secondary energy balance.

Since the steam dome enthalpy is established by the steam dome pressure, R3D adjusts the user input steam generator feedwater enthalpy as part of the overall primary-to-secondary energy balance. Regardless of the size of the adjustment, the final adjusted steam generator feedwater enthalpy should compare reasonably to plant data. The adjustment to the input steam generator feedwater inlet enthalpies for the full power KNPP R3D models intended for use in KNPP licensing analyses range from +0.5% to +0.9%. The adjustments for the part power R3D models intended for use in KNPP licensing analysis are larger, since the full power input steam generator feedwater enthalpy was retained in the R3D input. However, in all cases, the adjusted steam generator feedwater inlet enthalpies for the KNPP R3D models are within ±2% of plant data, which is judged to be acceptable based on engineering judgement.

The adjustment to the steam generator heat transfer areas for the models intended for use in KNPP licensing analyses range from -0.9% to +5.5%. These adjustments are within the recommended acceptable range of ±10% (Ref. C3-1, Page IX-69), and are therefore judged to be acceptable.

References:

Reference C3-1: "RETRAN-3D – A Program for Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems," NP-7450, Research Project 889-10 Computer Code Manuals, December 1997 (Volume 1: Theory and Numerics Manual, Revision 2).

4. **The response to last item in the RAI states that "...for cycles beyond Cycle 25, "RETRAN" means either of the following:**

   - **The use of RETRAN-3D in 2D mode...; or**
   - **The use of RETRAN-3D in other than 2D mode...."**

   The staff notes that in a letter dated October 12, 2000, the licensee originally requested for the staff to review and approve only the use of RETRAN-3D in 2D mode for licensing applications. The staff also finds that all the licensee's submittals are intended to use in support of the original request. Accordingly, the staff will limit its review to evaluate the acceptability of the use of RETRAN-3D in 2D mode as the licensee originally requested. If the licensee is requesting for review of the use of RETRAN-3D in other than 2D mode, the licensee should state its request in a written letter and provide a submittal addressing the restrictions and limitations for the use of RETRAN-3D as specified in all the items of RAI A.

NMC Response

The entire RAI text of the second bullet item shown in the comment reads:

- The use of RETRAN-3D in other than 2D mode supported by a submittal.

The words "supported by a submittal" refer to a future submittal other than that of the October 12, 2000 letter. The licensee agrees that, with respect to RETRAN, the letter dated October 12, 2000, requested the staff to review and approve only the use of RETRAN-3D in 2D mode (RETRAN-02 mode) for licensing applications. The licensee is not requesting review for the use of RETRAN-3D in other than 2D mode in the letter dated October 12, 2000.

Any use of RETRAN-3D in other than 2D mode for licensing applications for any Kewaunee cycle, including those beyond Cycle 25, will be supported by separate future licensee interaction with the NRC. This interaction could be a separate licensee submittal, a separate licensee notification based on a future approved RETRAN-3D in other than 2D mode submittal in accordance with Supplement 1 to Generic Letter 83-11, or other means acceptable to the NRC at the time.