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REBUTTAL TESTIMONY OF CRAIG J. NICHOLS AND JOSE L. CASILLAS ON NEC CONTENTION 3 – LARGE TRANSIENT TESTING – EXHIBIT 1

ODYN Model Reports

NEDO-24154 Vol 1 'Qualification of the One Dimensional Core Transient Model for BWRs' (Non- Proprietary):
This report provides the technical detail of the ODYN model. The report includes question and answer information during the approval process in Appendices and the NRC approval. With respect to the application to BWR transients, Section 2 of the report documents the major simplifications of the model and the fact that the model includes essential phenomena to simulate transient events, though qualification is limited to pressurization events as given in Volume 2. The ODYN model review by the NRC includes an assessment of the effect of the various correlations' uncertainties used by the model on the predictions as shown below (NRC review page xlviii). These uncertainties are based on the application of the correlation capability over the range of parameters to be used, and includes operating conditions of EPU by VY. The review by the NRC also includes comparison against separate effects tests, comparison against plant tests and comparison against other independent models (NRC evaluation page xv). Therefore, it is concluded that the ODYN model has been reviewed and approved for predicting pressurization events without limitation including EPU conditions, because its individual correlations remain applicable.

TABLE-I

COMPARISON OF CODE UNCERTAINTIES AND CORRESPONDING BOUNDING VALUES AS ESTIMATED BY GENERAL ELECTRIC AND THE STAFF

	GE		STAFF	
	Bounding Values of Parameters	$\pm\Delta CPR / ICPR$	Bounding Values of Parameters	$\pm\Delta CPR / ICPR$
I. Reactor Core Model				
(1) Nuclear Model				
(a) Void Coefficient	α_v ± 13%	0.020	α_v ± 11%	0.018
(b) Doppler Coefficient	α_d ± 6%	0.002	α_d ± 10%	0.002
(c) Scram Reactivity	α_s ± 4%	0.010	α_s ± 10%	0.020
(d) Prompt Neutron Heating		0.006		0.006
(2) Thermal Hydraulic Model				
(a) Drift Flux Parameters	C_o ± 3%		C_o = 1.00	
	V_{gj} ± 20%	0.008	V_{gj} = ± 30%	0.011
(b) Subcooled Void Model	n = 1.25	0.009	n = 0.5 2.0	0.023
(3) Fuel Heat Transfer Model				
(a) Pellet Heat Distribution	(Conservative)		-	-
(b) Pellet Heat Transfer Parameters	(Conservative)		-	-
II. Recirculation System Model				
(1) System Inertia	(L/A) + 200%	0.002	L/A + 200%	0.002
(2) Jet Pump losses	K - 20%	0.010	K - 20%	0.010
(3) Core Pressure Drop	Δ + 1.5 psi	0.005	Δp + 1.5 psi	0.005
(4) Separator (L/A)	-30%	0.002	-200%	0.015
(5) Separator ΔP	(Conservative)		-	-
III. Steam Line Model				
(1) Pressure Loss Coefficients	K - 20%	0.010	K - 20%	0.010
(2) Specific Heat Ratio	γ + .10	0.010	γ + .10	0.010
Total:		0.031		0.044

Template=SECY-028

SECY-02

U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of *Entergy Nuclear Vermont Yankee L.L.C.*

Docket No. *50-271* Official Exhibit No. *Entergy 23*

OFFERED by: (Applicant/Licensee) Intervenor ________

NRC Staff Other ________

IDENTIFIED on *9/13/06* Witness/Panel *Nichols/Casillas*

Action Taken: (ADMITTED) REJECTED WITHDRAWN

Reporter/Clerk *MAC*

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ADJUDICATIONS STAFF

NEDO-24154 Vol 2 'Qualification of the One Dimensional Core Transient Model for BWRs' (Non- Proprietary):

This report provides the qualification of the ODYN model. The report repeats the NRC approval statement found in Volume 1. With respect to the application to BWR transients, Section 2 includes qualification of the simplified single channel representation in ODYN by comparison against detail 3 dimensional nuclear and thermal hydraulic core properties, such as axial reactivity and void distributions, and Section 3 includes qualification of the transient predictions by ODYN against the Peach Bottom and KKM Turbine Trip tests. It is important to note that the comparison of ODYN against the tests is limited to both the core over-power and the vessel over-pressure, as these are the safety limits that apply to pressurization events. With respect to peak pressure, the ODYN model predictions are sufficiently conservative that safety analyses would be bounding to actual plant behavior (NRC conclusion in page cxix). With respect to peak power, the ODYN predictions are also conservative, but not to a sufficiently large degree that no additional margin for uncertainties would be applied (NRC conclusion in page xc). Shown below are the pressure and power comparison tables from the report (page 3-17, Tables 3-3 and 3-4) illustrating the higher pressure predicted by ODYN, and the larger change in CPR (indicative of the over-power) predicted by ODYN compared against the data. It is important to note that the PB tests included a delay of the time to scram and shut down the reactor (NRC conclusion in page lvi) such that a severe test was obtained, the resulting tests were such that they exceed the severity of actual plant events and are comparable to those in safety analyses (NRC introduction in page xi). Therefore, from a model qualification point of view, the ODYN model is qualified to as severe an over-power event as possible in a BWR.

NEDO-24154-A

Table 3-3

PEAK VESSEL PRESSURE

	Data*	Model Calculation
Turbine Trip 1	1042	1070
Turbine Trip 2	1052	1072
Turbine Trip 3	1069	1100

*Data value is biased to the same initial value as calculation.

Table 3-4

MAXIMUM ΔCPR VALUES FOR PEACH BOTTOM TURBINE TRIP TESTS

	Initial CPR	ΔCPR/ICPR (Data)	ΔCPR/ICPR (Model)
Turbine Trip 1	2.536	0.170	0.173
Turbine Trip 2	2.115	0.136	0.129
Turbine Trip 3	2.048	0.132	0.141

NEDO-24154P Vol 3 'Qualification of the One Dimensional Core Transient Model for BWRs' (Proprietary):
This report provides the procedure for performing safety analyses with the ODYN model. While no model qualification information is included in this report, GE demonstrates the conservative nature of the application safety analyses through several calculation sensitivities. Thus, in addition to accounting for the model uncertainties in the ODYN over-power analyses required by the NRC approval (NRC summary of code qualification page xc), the analysis also includes the plant equipment performance representing the most limiting conditions as noted in the NRC approval (NRC review page cvii Table IV) and copied below. Therefore, the application of ODYN to safety analyses at EPU includes accounting for both model uncertainties and worst equipment performance guaranteeing a conservative analysis.

TABLE IV

INPUT PARAMETERS SENSITIVE FOR THE ANALYSES

1. CRD scram speed - at tehcnical specification limit.
2. Scram setpoints - at technical specification limits.
3. Protection system logic delays - at equipment specification limits.
4. Relief valve capacities - minimum specified.
5. Relief valve setpoints and response - all valves at specified upper limits of setpoints and slowest specified response.
6. Pressure drop from vessel to relief valves - maximum value.
7. Steamline and vessel geometry - plant-unique values.
8. Initial power and steam flow - maximum plant capability.
9. Initial pressure and core flow - design values at maximum plant capability.
10. Core exposure/power distribution - consistent with Haling mode of operation.
11. Feedwater conditions - maximum temperature (maximum core average void content).

NEDE-24154P Vol 4 'Qualification of the One Dimensional Core Transient Model for BWRs' (Proprietary):
This report provides the qualification and procedure for the ODYN model for non-pressurization events. The purpose of this application extension of the ODYN model is to eliminate the older REDY model used for these non-limiting event applications. The report includes additional technical detail pertaining to core flow and feedwater flow transient disturbances to complete the approval application of the ODYN model to all BWR transients. The qualification includes comparisons to additional plant parameters, such as water level and core flow, which are key aspects of these events. This application extension of the ODYN model demonstrates the wide best estimate nature of the model to simulate BWRs. Therefore, with respect to the question of ODYN application to EPU conditions, the review by the NRC establishing ODYN as a best estimate code for transient application (NRC conclusion in page xc) as noted below applies also to EPU.

5. Summary of Code Qualification

In summary, we find that the ODYN is a best estimate code containing models developed from first principles and provides good predictions of existing experimental data. The experimental data were obtained from separate effects and integral plant tests. The separate effects tests include core power measurements from various plants and heated tube tests to verify the void fraction model. Integral plant tests were performed at Peach Bottom Unit 2 and KKM. Comparison of the test data and calculations indicates that the agreement is within the uncertainties calculated in Section A. We find that the ΔCPR predictions from the ODYN and SCAT codes are neither conservative nor nonconservative. They predict the available data well.

ODYN Benchmark at EPU

GE-NE-A13-00413-01-04, 'Engineering Evaluation of KKL Revision 99 Turbine Trip Test 109% Power of 11 September 1999', December 1999:
This report presents the evaluation of the turbine trip test results in KKL at 109% uprate power, corresponding to 102% over VY EPU power density, against the ODYN pre-test predictions. The purpose of the turbine trip test is to perform control system adjustments to mitigate the transient event. This plant is similar to VY in that it includes a large turbine steam bypass capacity, not typical of most BWRs. The result of the bypass capacity is that the transient becomes very mild, and in the case of KKL, the plant remains on-line with partial power reduction due to automatic core flow runback and partial control rod insertion actuations. A similarly mild transient is expected in VY at EPU conditions. With respect to the ODYN power and pressure predictions, the comparison against the KKL test data shows that ODYN power and pressure are conservatively predicted. This conclusion is consistent with other observations; this was particularly true in this KKL test because of the presence of partially inserted rods, which have a stronger effect on the single channel model used in ODYN. Therefore, the EPU high steam conditions do not impact the prediction capability of the ODYN model.

NEDE-30253 'Qualification of the ODYNM05 and ODYNV05 Computer Programs' (Proprietary), September 1983:
This report presents the predictions of a later version of ODYN against several plant test data, discussed in this summary is the MSIV closure test comparison. The MSIV test was conducted at plant Hatch Unit 2 during the initial plant startup program on June 27, 1979. The MSIV test conditions are 95% power and 96.5% flow, the power density of Hatch Unit 2 is the same design as for VY. The ODYN benchmark calculation applied the equipment response corresponding to the test and compared the dome pressure predicted by the ODYN model to the test data. The test recorded a lower peak pressure than the ODYN model prediction, consistent with previous observations. The MSIV test does not record a power increase because the automatic pre-emptive scram signal from the valve closure position inserts the control rods before the pressure increase takes effect in the vessel. A similarly mild MSIV closure test is expected in VY at EPU conditions. Therefore, the MSIV closure test does not challenge the ODYN model beyond its qualification basis corresponding to the Peach Bottom turbine trip tests.

GE-NE-0000-0041-1254, 'ODYN Benchmark of the Dresden 3 January 30, 2004 Turbine Trip Event', July 2005:
This report presents a comparison of ODYN model predictions of a Dresden 3 unplanned turbine trip event on January 30, 2004. The turbine trip event occurred at 95% of EPU power, which corresponds to an approximate power density of 75% of VY EPU power level. The event was evaluated using the ODYN model as committed by the utility to the NRC as part of their EPU requirements. The purpose of the evaluation is to confirm that the ODYN model predictions of significant transient events are consistent with past experience. This event represents a more severe pressurization than would be expected in VY at EPU conditions because the Dresden plant has a turbine steam bypass capacity of only a third compared against VY and thus a pressure transient bounds that expected for VY at EPU power. The comparison of the event data against the ODYN model prediction was consistent with past experience by over-predicting the peak vessel dome pressure and peak power. While this event was initiated at lower power than VY EPU, the results reflect a more severe condition than expected for VY EPU and therefore are

indicative of the ODYN capability for VY at EPU. Therefore, the ODYN model capability for predicting a turbine trip for VY at EPU is defensible.