GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

April 20, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Review Schedule - **DFSER Confirmatory Item 15.1-1**

Dear Chet:

Enclosed are the Level 2 Design Review reports from the Independent Design Verification Packet(s) for the ODYNA and REDYA computer codes you requested in our telecon on 4/19/93 supporting closure of DFSER Confirmatory Item 15.1-1. These reports are annotated to show the information required by EOP 40-7.00, Section 4.3.4.

Please provide copies of this transmittal to George Thomas and Bob Gramm.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Phil Novak (GE)
Rich Schrum (GE)

See attached dist

300026

JF93-96

2222

1/1

DESIGN REVIEW NOTIFICATION AND FINAL REPORT DISTRIBUTION

Design Review Title ØDYNA01C Level 2 Design Review

Date of Review September 4, 1985 Date of Report November 5, 1985

Mandatory Distribution

W. M. Barrentine	M/C 025	H. H. Klepfer (Final Report Only)	M/C 159
L. S. Bohl	862	G. G. Sherwood/R. Artigas	683
R. J. Brandon	779	M. A. Smith	435
R. Ehrlich	862	G. T. Stiles (Final Report Only)	778
G. L. Gyorey	828	J. P. Stapleton	784
L. K. Holland	862	R. C. Stirn	740

Other Distribution

Include Lead System Engineer(s) for affected system(s), Program Manager(s) for affected program(s).

GE Dix	M/C 151	J. A. McGrady	M/C 765	C. D. Sawyer	M/C 754
JE Wood	M/C 148	B. S. Shirolker	M/C 186	J. K. Garrett	M/C 754
BP Grim	M/C 746	J. G. M. Anderson	M/C 186	L. E. Fennern	M/C 765
~~PW Tennis~~	~~M/C 755~~	R. W. Shrum	M/C 186		
SA Hucik	M/C 780	J. C. Shang	M/C 186		
MA Ross	M/C 765	R. L. Huang	M/C 754		
		F. M. Paradiso	M/C 754		

INSTRUCTIONS TO REVIEW CHAIRMAN

If the document being transmitted by this distribution sheet is the final report, check where appropriate to indicate that the report contains the following required by EOP 40-7.00:

1. Acton Item Commitments: ⟶ Completed - No Open Items
   - a. Description of commitment —
   - b. Person responsible —
   - c. Completon date —
   - d. Statement that action item schedule submitted to Engineering Services 1 —

   OR Statement that action items included in Engineering Work Authorization (EWA) —

   - e. Signature of Responsible Manager —
2. Description of material reviewed (design or problem) ✓
3. Conclusions about adequacy of the design ✓
4. If review for design verification, a verification statement per EOP 42-6.00 ✓
5. Statement that Review Team's concerns are resolved ✓
6. Identification of DRF in which report will be filed ✓
7. Signatures of Review Chairman and Design Representative ✓

Rev. 8/85

ADVANCED BOILING WATER REACTOR PROGRAM
SAN JOSE, CALIFORNIA

TO: J. C. Shaug January 8, 1986

FROM: L. E. Fennern

SUBJECT: Design Review of ODYNA01C BWR (b)
Transient Simulator Computer Code

(c)
REFERENCE: ODYNA01C Design Review conducted on 9/4/85 and Design Review Report dated 11/5/85

This letter shall be filed in DRF A00-022552. (a)

(f) It should be understood that the subject Design Review found the encoded technology for the ODYNA01C ECP performs acceptable calculations for the intended applications, and fully meets the requirements of the Hardware/Software System Specification, ID No. 23A8016, Rev 0. The intended applications were found to be appropriately detailed in both the User's Manual and the Program Abstract dated 10/17/85, Rev. 1.

L. E. Fennern

L. E. Fennern, Chairman

ADVANCED BOILING WATER REACTOR PROGRAM
SAN JOSE, CALIFORNIA

TO: Design Review Distribution

November 5, 1985
ESED-85-142

FROM: L. E. Fennern

SUBJECT: Design Review of ODYNAO1C BWR
Transient Simulator Computer Code

Date of Review: 9/4/85
Date of Report: 11/5/85

This Design Review Report shall be filed in DRF AOO-02252. (j)

1. Purpose and Scope of Review (d)

In conformance with EOP Guidelines, this ECP Design Review constitutes a final independent review and verification of the ODYNAO1C encoded technology to contribute to the assurance that ODYNAO1C will permit acceptably accurate calculations when used in accordance with its intended application, as stated in the Program Abstract dated 10/17/85, Rev. 1.

ODYNAO1C simulates the transient behavior of a BWR with an internal pump recirculation system. Both operational transients and anticipated transients without scram (ATWS) may be simulated.

2. ODYNAO1C Level 2 Design Review Attendees (e)

Name	Organization	Extension	M/C
J. A. McGrady*	ABWR Program	54763	765
B. S. Shiralkar	NFED	6889	186
R. L. Huang*	ABWR Program	55399	754
J. K. Garrett*	NSPD	58084	755
J. G. M. Andersen	NFED	56904	186
R. W. Schrum	NFED	56968	186
J. C. Shaug**	NFED	56696	186
F. M. Paradiso**	ABWR Program	56953	754
L. E. Fennern*	ABWR Program	54167	765

* Review Team Member
**Design Team Member

3. Design Review Presentations

Attachment 1 ODYNAO1C Level 2 Design Review (J. C. Shaug)
September 4, 1985

Attachment 2 Independent user Testing (F. M. Paradiso)

Other Materials/Documents/Letters Reviewed (Pre-design review material):

1. Program Abstract, 10/26/84, Rev. 0
2. ODYNA01C Level 1 Design Review Report, 11/6/84
3. (9) ODYNA01C Hardware/Software System Specification, Control Number 23A8016, Rev. 0
4. ODYNA01C Software Requirements Description, 8/85, DRF A00-02252
5. ODYNA01C Software Design Description, 8/85, DRF A00-02252
6. ODYNA01C User's Manual (w/o Appendices), 8/85
7. ODYNA01C Software Test Plan, 7/85, DRF A00-02252
8. ODYNA01C Software Test Report, 8/85 DRF A00-02252 (Summarized in Attachment 1 during the design review presentation)

4. Conduct of the Review

(9)

The basic methodology used to accomplish independent verification of the ODYNA01C Code was comparison to alternate methods, primarily the ODYNM08 code, which has been qualified against plant transient data, and the REDYA01 code.

The recirculation model and control system models were tested using a modified Peach Bottom input deck for the following transients:

(a) Steady State
(b) Turbine Trip with simulated external recirculation loop
(c) All pump trip with simulated external recirculation loop
(d) All pump trip with internal recirculation loop

Attachment 1 provides the turbine trip comparisons between ODYNM08 and ODYNA01C using the new physics option.

The ECCS capabilities were exercised by starting with a steady state transient simulation and activating and deactivating all ECCS systems. A tabular summary of the results was provided (Attachment 1)

The upper plenum modeling was tested by devising a test case that subcooled the upper plenum. Pressure rate model comparison calculations were presented for the turbine trip case (Attachment 1).

Independent user testing verified the reasonableness of ODYNA01C trends relative to REDYA01 cases (Attachment 2). ABWR based decks and the old physics option were used for these test runs. It is noted that the development of the ODYNA01C model was intended to provide subsequent confirmation of previous Phase III REDYA01 evaluations for ABWR pressurization transient events and to provide a basis for further review and evaluation of design procedures which use the REDYA01 ECP (Reference: REDYA01 Transient Simulator Design Review Report, 7/11/84), DRF A00-01382).

(g) 5. Verification Statement

See Attachment 3.

(h) 6. Open Items

Item #1: It was noted that there have been some run aborts with REDYA01 when one half of the reactor internal pumps (RIPs) are tripped, followed by a later trip of the remaining RIPs, which happens for loss of feedwater and certain ATWS transients. Reverse flow may occur in the pumps which are initially tripped. During the transient period when the remaining pumps are tripped, reverse core inlet flow may momentarily occur, which have caused REDYA01 calculation problems. The review team is concerned that ODYNA01C may abort under these circumstances.

Resolution:

The users have conducted additional test cases to check ODYNA01C capabilities in regard to the above concern. ODYNA01C did not abort and the users are satisfied (see Attachment 3). This item is closed.

Item #2: The application statement indicates that ODYNA01C can be used for non-ATWS and ATWS transients. However, user testing of the (lengthy) ATWS cases is not yet complete.

Resolution:

User testing of the following ATWS cases has been completed and is documented in a letter to the review team (see Attachment 3):

(1) MSIV Closure with FMCRD run-in to check over-pressure protection and shutdown.

(2) Reactor shutdown due to Boron injection only.

The applicability of ODYNA01C to analyze ATWS events has been demonstrated, and this item is closed.

Item #3: The Application Statement should indicate either old and new physics options can be used, and should be consistent with the program limitations on page 1-2 of the user's manual. However, item I of the program limitations, indicating a lower limit of 800 PSI(A) on steam properties, may be too conservative. The design team is requested to review this value and substitute a lower value if it can be justified.

Resolution:

A new revision (Rev. 1) of the Program Abstract, including an application statement incorporating the above changes, has been approved and issued (Attachment 4). The lower limit for the steam properties is 15.7 PSIA. This item is closed.

Conclusions:

h(1) In conformance with EOP guidelines for independent verification of EOP technology, this review team finds that the encoded technology for the ODYNA01C ECP performs acceptably accurate calculations when used with its intended application as specified in the Program Abstract dated 10/17/85, Rev. 1. and should be given Level 2 status.

For the Review Team

L. E. Fennern, Chairman

For the Design Team

J. C. Shaug, Representative

L. E. Fennern
Electric Systems & Equipment Design
M/C 765, Ext. 5-4167

LEF:pp

DESIGN REVIEW DISTRIBUTION

Design Review Title REDYA01 ABWR Transeint Simulator

Date of Review June 20, 1984 Date of Report 8/10/84

Mandatory Distribution

LS Bohl	M/C 310	GG Sherwood/R Artigas	M/C 682
LK Holland/DW Wilson	306	WH Reas/TM Snyder/JE Corr	120
R Ehrlich/AV Seshadri	306	MA Smith/RK Waldman	209
CD Sawyer	754	FD Judge (Final Report only)	017
RJ Brandon	889	DR Wilkins (Final Report only)	782
GL Gyorey	828	HH Klepfer (Final Report only)	159
		BL Smith (Final Report only)	786

Other Distribution
Include Lead System Engineer(s) for affected system(s), Program Manager(s) for affected programs(s).

	M/C
G. C. Dix	786
J. E. Wood	148
E. C. Eckert	763
B. P. Grim	746
R. C. Stirn	740
L. B. Claassen	763
S. A. Hucik	780
K. C. Huang	763
L. E. Fennerk	780

INSTRUCTIONS TO REVIEW CHAIRMAN

If the document being transmitted by this distribution sheet is the final report, check where appropriate to indicate that the report contains the following as required by EOP 40-7.00:

1. Action Item Commitments: ✓

   a. Description of commitment ____

   b. Person responsible ____

   c. Completion date ____

   d. Statement that action item schedule submitted to Engrng. Services 1 ____

   OR Statement that action items included in Engineering Work Authorization (EWA) ✓

   e. Signature of Responsible Manager ✓

2. Description of material reviewed (design or problem) ✓

3. Conclusions about adequacy of the design ✓

4. If review for design verification, a verification statement per EOP 42-6.00. ✓

5. Statement that Review Team's concerns are resolved ✓

6. Identification of DRF in which report will be filed ✓

7. Signatures of Review Chairman and Design Representative ✓

Rev. 3/84

NUCLEAR POWER SYSTEMS ENGINEERING DEPT.
San Jose, California

LEF/84-460

July 20, 1984

TO: DESIGN REVIEW DISTRIBUTION

FROM: L. E. FENNERN

(b) SUBJECT: DESIGN REVIEW OF REDYA01
TRANSIENT SIMULATOR

(c) REVIEW DATE: July 11, 1984

(d) PURPOSE AND SCOPE OF REVIEW:

In conformance with EOP Guidelines, this ECP Design Review constitutes a final independent review and verification of the REDYA01 encoded technology to contribute to the assurance that REDYA01 will permit acceptably accurate calculations when used in accordance with its intended application, as stated in the Program Abstract dated July 23 1984, Rev. 2.

REDYA01 simulates the transient behavior of a BWR with an internal pump recirculation system. Both operational transients and anticipated transients without scram (ATWS) may be simulated.

ATTENDEES

(e)

Name	Organization	M/C
JK Garrett*	NPSED - Reactor System Design	740
JC Shaug*	NFED - Transient Methods	186
LB Claassen*	Plant Transient Performance Engrg.	763
SF Chen**	NPSED - Process Control & Elect. Sys. Des.	746
JG Andersen	NFED - Transient Methods	186
LE Lasher	NPSED - Reactor System Design	740
R Ehrlich	QA&RO - NJA	306
LK Holland	QA&RO - BWR Design Review	306
JV Hice**	NPSED - Transient Performance Engrg.	763
S Wolf	" " " "	763
L Braddi**	" " " "	763
D Cox	" " " "	763
W Marquino**	" " " "	763
E Mische	" " " "	763
RW Schrum**	NFED - Transient Methods	186
BS Shiralkar	NFED - Core Methods	186
JA McGrady*	NPSED - Process Control & Elect. Sys. Des.	746
LE Fennern*	NPSED - Advanced Engineering	780

* Review Team Member (Note: LB Claassen substituted for RL Huang)

** Design Team Member

DESIGN REVIEW PRESENTATIONS

(9)

Attachment 1 (RW Schrum)	Design Review Notice Purpose of Review REDYA01 - ECP Q/A Checklist REDYA01 - Functional Specifications Model Overview
Attachment 2 (LJ Braddi & W Marquino)	Methodology/Basedeck Preparation Steady State Verification Transient Event Verification
Attachment 3 (JV Hice)	REDYA01 - User Testing - ATWS
Attachment 4 (SF Chen)	User Testing of the REDYA01 Control System Models

(9) Other Materials/Documents/Letters Reviewed

1. REDYA01 Technical Basis Report (Pre-design review material).
2. REDYA01 User's Manual (Pre-design review material).
3. Letter, JV Hice to LE Fennern, "REDYA01 Design Review ATWS Issues" (Post-design review material - Attachment 5).

(9) **CONDUCT OF REVIEW**

The basic methodology used to accomplish independent verification of the REDYA01 code was comparison to alternate methods, primarily the REDYM04 code. Modeling improvements in REDYA01 resulted in some differences in peak dome pressure, heat flux and neutron flux for some pressurization transients. In order to formulate a criteria for determining the acceptability of these deviations, the review team requested an understanding of the comparison of REDYM versions to Peach Bottom-2 plant transient data. From an examination of earlier code/data comparison results, the deviations of REDYM versions from pressurization transient data is seen to be large, and has motivated the use of conservative multipliers of void, doppler and scram reactivity when using REDY for design evaluation of pressurization events, as well as the development of the ODYN code. An assessment of the validity of REDYA01 evaluations using the estabished design basis and procedures for performing analyses of pressurization transient events with the REDY code, therefore, is scheduled as part of the ABWR Phase III program, EWA's EAB 33-74 Supp. A, and EAB 33-95 Rev. 0.

These EWA's provide for the development of the ODYNA01 model and the subsequent confirmation of previous Phase III REDYA01 evaluations for ABWR pressurization transient events, respectively, and will provide a basis for further review and evaluation of design procedures which use the REDYA01 ECP.

Review team members questioned whether internal pump plant transient data exists for performing direct code to data comparisons. From the discussion it was noted that some TVO (ASEA-ATOM plant) recirculation pump trip data exists. However, large uncertainties regarding TVO separator and recirculation pump performance for this plant design, and uncertainties in core thermal-hydraulic and neutronic parameters, vitiate the code/data comparison for this event.

Questions were also raised during the Design Review regarding the ability of REDYA01 to model certain ATWS events resulting in subcooling of the upper plenum and core prior to full hot shutdown. These issues were further investigated and resolved following the review, and documented in a letter by JV Hice (Attachment 5).

(g) **VERIFICATION STATEMENT**

Attachment 6 is a verification statement for the REDYA01 computer code.

(h) **OPEN ITEM**

REDYA01 needs to be loaded into the program library and appropriate confirmation checks need to be completed. Resolution: This activity is required by the Q/A checklist and is scheduled as part of Item 9.0 of EWA EAB 33-07, Rev. 0. Item closed. (Responsible: RW Schrum Schedule: 8436 Mgr. Comp 578

(f) **CONCLUSIONS**

h(1) In conformance with EOP Guidelines for independent verification of EOP technology, this review team finds that the encoded technology for the REDYA01 ECP performs acceptably accurate calculations when used with its intended application as specified in the Program Abstract dated July 23 1984, Rev. 2, and should be given Level 2 status.

(a) This report is filed in DRF A00-01382.

(j) attachment 7

For the Review Team

h(1) L. E. Fennern, Chairman

For the Design Team

R. W. Schrum

8/10/84