GE Energy

Kathy K. Sedney
Principal Engineer, Regulatory Services

175 Curtner Ave. M/C 747
San Jose, CA 95125-1014
USA

T 408 925 5232
F 408 925 5004
Kathy.Sedney@ge.com

MFN 04-137

Project 717

December 14, 2004

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20852-2738

Attention: Chief, Information Management Branch
Program Management
Policy Development and Analysis Staff

Subject: **GENE Presentation Regarding TRACG Application for ESBWR Stability, December 14, 2004**

Enclosed is General Electric's presentation material for the December 14, 2004 kickoff meeting regarding NEDE-33083P, "TRACG Application for ESBWR Stability Analysis," Supplement 1, December 2004. The non-proprietary and proprietary versions of the presentation materials are contained in Enclosures 1 and 2, respectively.

GE considers Enclosure 2 to be proprietary in accordance with 10 CFR 2.390. The proprietary pages are indicated by the words "GE Proprietary Information."

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 2 has been handled and classified as proprietary to GE. GE hereby requests that the information in Enclosure 2 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

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If you have any questions about the information provided here, please contact either myself or Bharat Shiralkar at (408) 925-6889.

Sincerely,

Kathy K. Sedney

Kathy K. Sedney
Principal Engineer, Regulatory Services

Enclosures

1. MFN 04-137 – *TRACG Application for ESBWR Stability – Open Session, December 14, 2004* – Non Proprietary Information
2. MFN 04-137 – *TRACG Application for ESBWR Stability, December 14, 2004* – GE Proprietary Information
3. Affidavit, George B. Stramback, dated December 14, 2004

cc:	WD Beckner	USNRC (w/o enclosures)
	AE Cubbage	USNRC (with enclosures)
	MB Fields	USNRC (with enclosures)
	RE Gamble	GE (with enclosures)
	BS Shiralkar	GE (with enclosures)
	GB Stramback	GE (with enclosures)

ENCLOSURE 1

MFN 04-137

TRACG Application for ESBWR Stability – Open Session, December 14, 2004

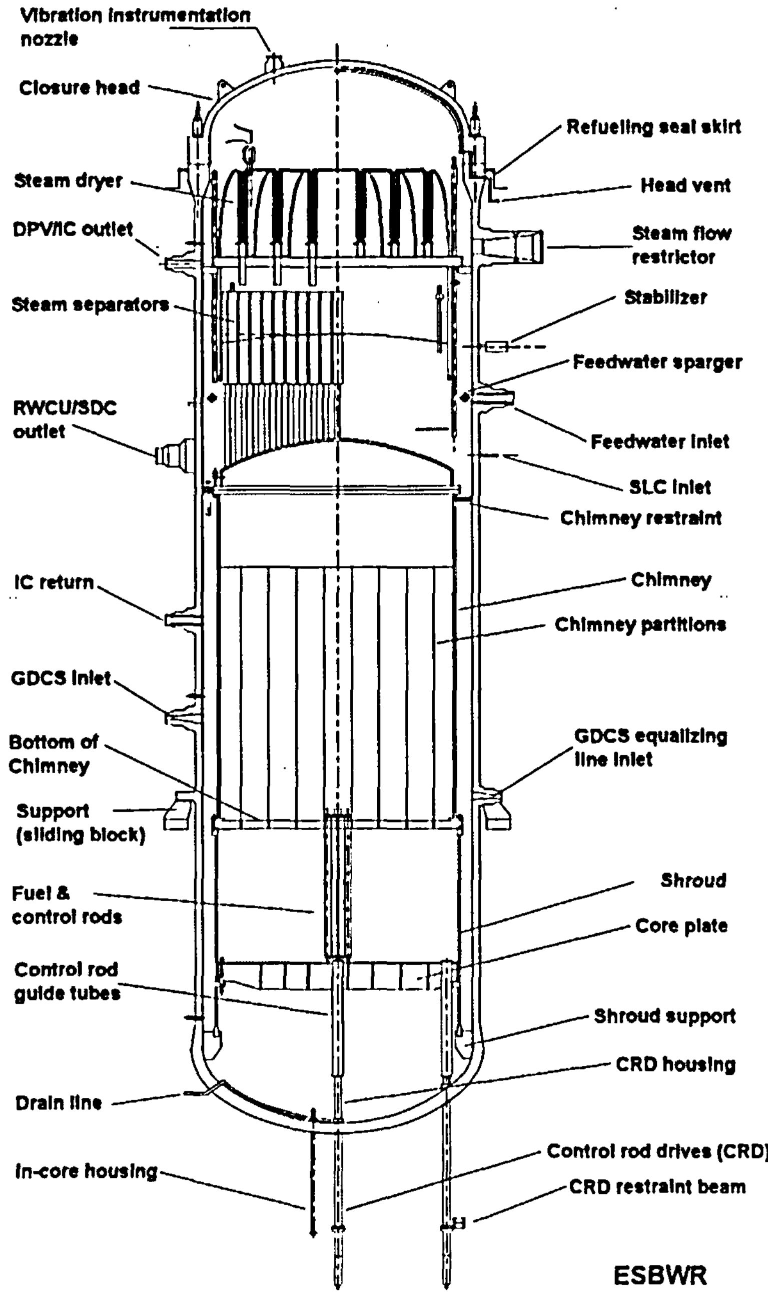
TRACG Application for ESBWR Stability -

LTR Review Kickoff Meeting

Open Session

Bharat Shiralkar

December 14, 2004



imagination at work

Outline

- Purpose and Scope
- Licensing Requirements and Scope of Application
  - Proposed design bases
- TRACG Application Methodology
  - Compliance with CSAU
- Phenomena Identification and Ranking
- Model Applicability
  - Additional model qualification
- Model biases and uncertainties

Outline (continued)

- Plant parameters and initial conditions
- Combination of uncertainties
- Demonstration results
  - Nominal
  - Sensitivity studies
  - Monte Carlo calculations
- Discussion of plant startup

Purpose and Scope

TRACG04 is used for licensing analysis of ESBWR stability

- Demonstrate stability margins during normal operation and anticipated transients

TRACG04 is also used to analyze plant startup trajectories, to assure a smooth ascension in pressure and power with a minimum of flow oscillation. Large MCPR margins are demonstrated for the startup scenario.

GE requests NRC approval of TRACG for analyzing and demonstrating compliance with licensing limits for stability analysis for the ESBWR

Licensing Requirements

General Design Criterion 10 (Reactor Design) requires that:

"..specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences."

Criterion 12 (Suppression of Reactor Power Oscillations) requires that:

"power oscillations which can result in conditions exceeding specified acceptable fuel design limits are not possible or can be reliably and readily detected and suppressed."

ESBWR Stability Licensing Basis

A high degree of confidence is established that oscillations will not occur by imposing conservative design criteria on the channel, core wide (and regional) decay ratios under all conditions of normal operation and anticipated transients.

- As a backup, the ESBWR will implement a Detect-and-Suppress solution as a defense-in-depth system.

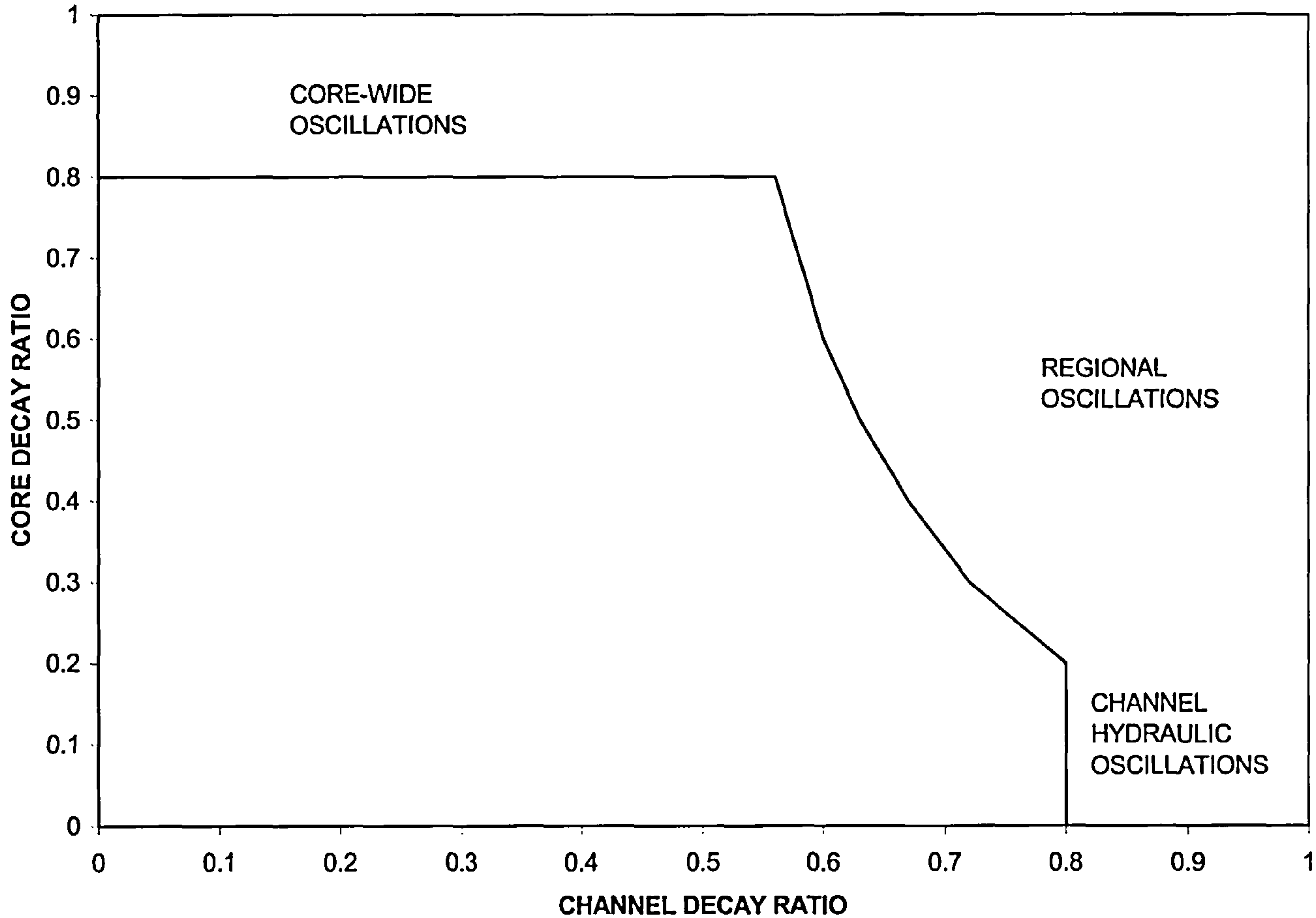
ESBWR Stability Design Criteria

Conventional stability map of core decay ratio vs. channel decay ratio is used

- Uncertainties and statistical limits are calculated for these parameters

Regional decay ratios are calculated for "nominal conditions" to demonstrate reasonableness of stability map

BWR Stability Design Criteria



ESBWR Stability Criteria

BWR design criteria evaluated and modified for ESBWR

TRACG Application Methodology

Calculate figures of merit (core and channel decay ratios) at limiting operating conditions

Statistically account for the uncertainties and biases in the models and plant parameters using a Monte Carlo method

- Normal Distribution One-Sided Upper Tolerance Limit (ND-OSUTL) if the output distribution is normal, or the Order Statistics method if it is not
- Demonstrate that decay ratios meet design criteria with sufficient margin for uncertainties (95/95 level)

Application Methodology (continued)

Uncertainties and biases considered include

- Model uncertainties
- Experimental uncertainties (inherent in data comparisons)
- Uncertainties related to test scale-up
- Plant uncertainties
- Process measurement errors
- Manufacturing tolerances

Conformance with CSAU Process

CSAU Step	Description	Addressed In
1	Scenario Specification	Normal operation, AOOs, plant startup
2	Nuclear Power Plant Selection	ESBWR 4500 MWt
3	Phenomena Identification and Ranking	**Error! Reference source not found.**
4	Frozen Code Version Selection	TRACG04
5	Code Documentation	References [1,2,6,7,11]
6	Determination of Code Applicability	**Error! Reference source not found.**
7	Establishment of Assessment Matrix	**Error! Reference source not found.**
8	Nuclear Power Plant Nodalization Definition	Section 5
9	Definition of Code and Experimental Accuracy	Section 5
10	Determination of Effect of Scale	Section 5
11	Determination of the Effect of Reactor Input Parameters and State	Section 6
12	Performance of Nuclear Power Plant Sensitivity Calculations	Section 8
13	Determination of Combined Bias and Uncertainty	Section 8
14	Determination of Total Uncertainty	Section 8

Sections & Table nos. refer to LTR

PIRT

- ESBWR stability PIRT builds on stability PIRT for operating plants in TRACG LTR supporting DSS-CD
- Differences highlighted in next chart

PIRT – Differences from Operating BWRs

LOWER PLENUM						
LOWER PLENUM RADIAL RESISTANCE	M	M	M	M	1	Affects natural circulation flow
BYPASS						
AXIAL AND RADIAL RESISTANCES	M	M	M	M	1	Affects bypass and chimney flow distribution
CORE / BUNDLE						
DOPPLER COEFFICIENT	NA	L	L	L		No fuel temperature changes in the absence of oscillations.
MARGIN TO DRYOUT/BT (steady-state and transient effects)	L	L	L	L		Criteria based on margin to stability; margin to dryout not impacted.
CHIMNEY & UPPER PLENUM						
VOID DISTRIBUTION	H	H	H	H	1	Affects natural circulation flow
FLOW OSCILLATION DURING STARTUP	NA	NA	NA	NA		See Section 9 for discussion of plant startup.
INTERACTIONS BETWEEN CHIMNEY CELLS	H	H	H	H	1	Affects stability of 16 bundles together with a chimney cell
SEPARATOR						
SEPARATOR L/A	L	L	L	L		Not important for small perturbations at low frequency.

Applicability of TRACG for ESBWR Stability Analysis

TRACG models adequate – Model LTR, Section 4

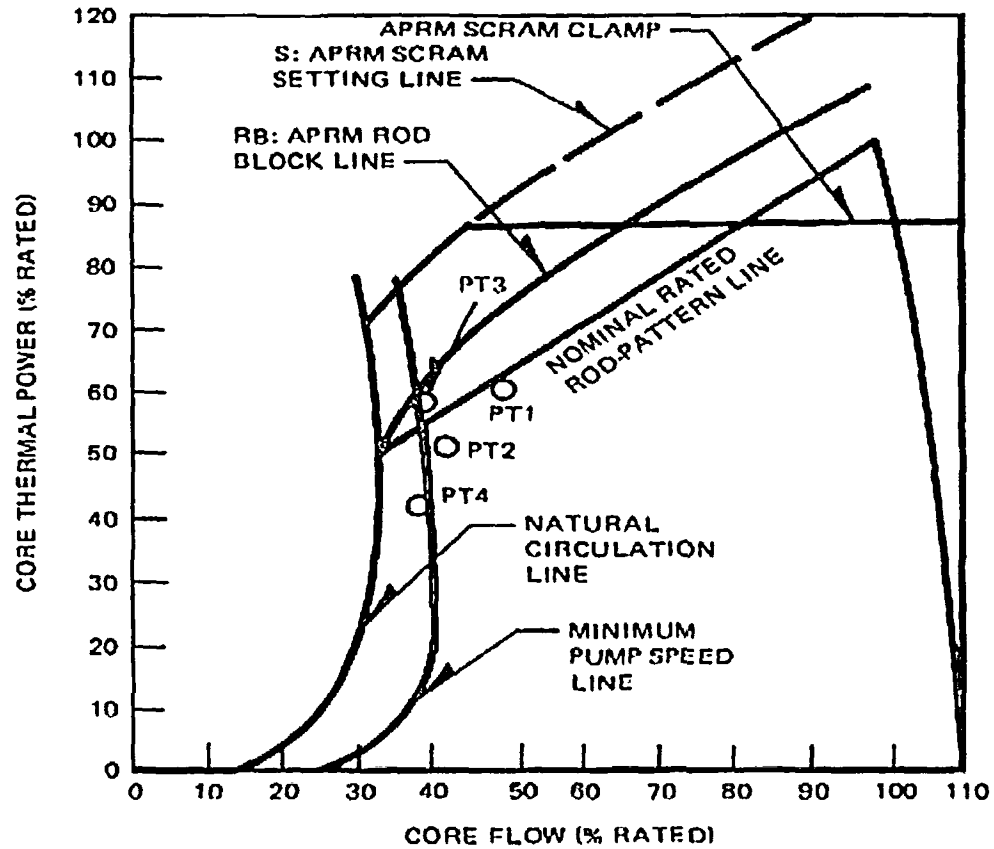
TRACG qualified vs extensive data base

- Separate effects, component, integral tests, BWR transient and stability data
- Additional qualification performed vs. low decay ratio plant tests

TRACG Qualification (Sample)

ID	REGION or PHENOMENA DESCRIPTION	Channel Thermal Hydraulic Stability	Core wide Stability	Regional Stability	Highest Ranking	Critical Safety Parameter	1. Decay Ratio - controls stability margin/growth rate of perturbations COMMENTS	Qualification Basis Reference to Section Number in the *TRACG Qualification*, LTR NEDE-32177, (Reference 3)			
								Separate Effects Qualification	Component Performance Qualification	Integral System Qualification	Plant Data Qualification
A	LOWER PLENUM										
A11	LOWER PLENUM RADIAL RESISTANCE	M	M	M	M		Affects natural circulation flow				
B	BYPASS										
B2	VOID FRACTION	L	M	M	M		Bypass voiding affects overall void coefficient	3.1.5, 3.4.2		5.1.2, 5.1.3, 5.1.4, 5.2.2	
B13	DIRECT MODERATOR HEATING	NA	M	M	M		Affects bypass void and core void coefficient.				7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7
B14	AXIAL AND RADIAL RESISTANCES	L	M	M	M		Determine chimney and bypass flow distributions				
C	CORE / BUNDLE										
C1AX	VOID COEFFICIENT	NA	H	H	H	1	Determines reactivity and power due to void fraction change. Determines forward loop "gain" for void perturbations.				7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7,7.8, 7.9
C1BX	DOPPLER COEFFICIENT	NA	M	M	M		Determines reactivity and power due to fuel temperature change.	3.8			7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9
C1DX	3-D KINETICS	NA	M	H	H	1	Power distribution from 3D reactivity distribution affects total power, hot region power, axial power shape and CPR. 3D effects primarily important for regional evaluations.				7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9
C1EX	DELAYED NEUTRON FRACTION	NA	H	H	H	1	Improves stability by reducing prompt gain	3.8			7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7,7.8, 7.9
C1FX	SUB-CRITICALITY OF FIRST HARMONIC MODE	NA	L	H	H	1	Neutronics "damping" offsets thermal hydraulic gain for regional mode.				7.5, 7.7

TRACG Qualification vs. PB2 Stability Tests



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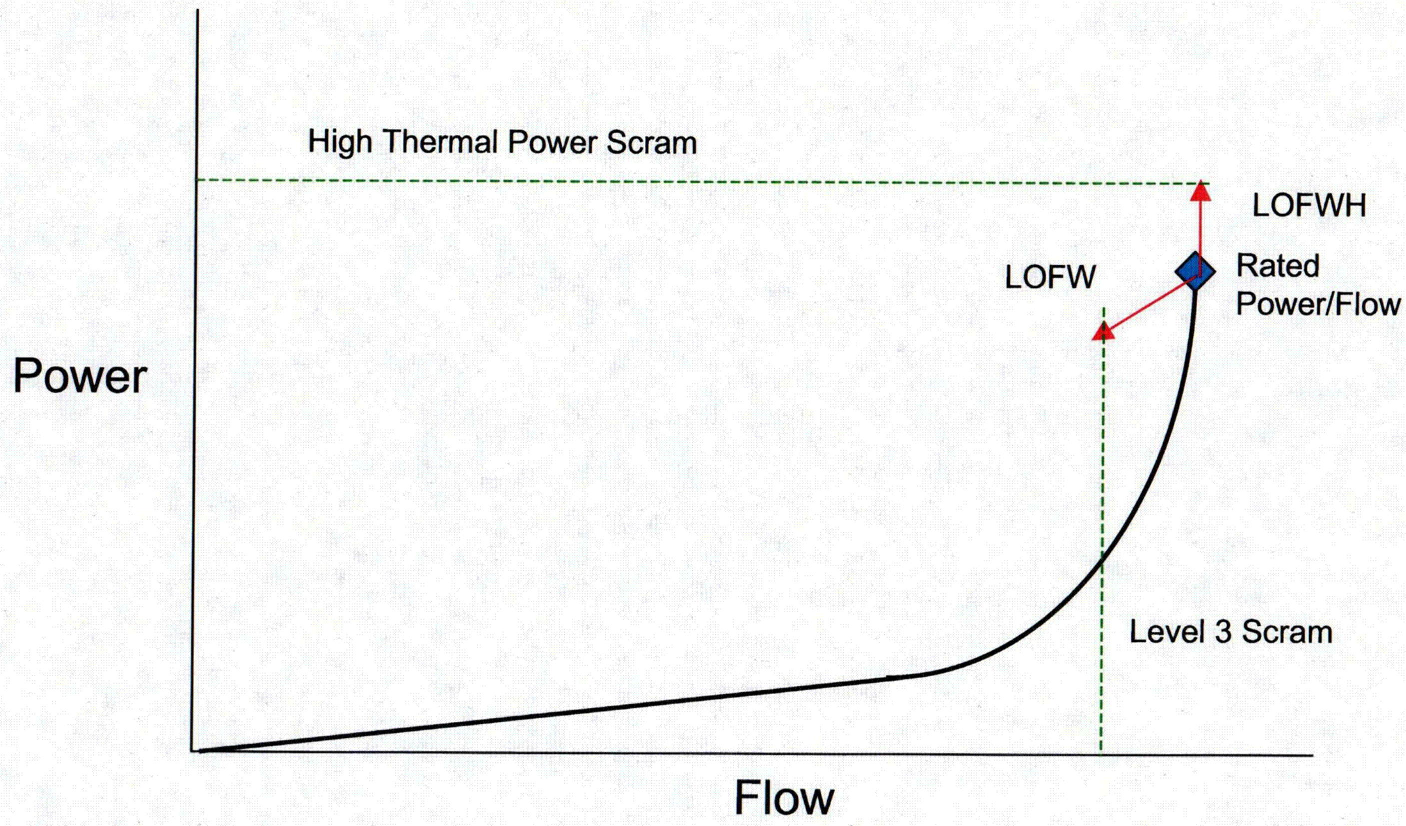
Results of Peach Bottom Qualification

TRACG calculated Beach Bottom results with acceptable accuracy

Limiting Conditions for Stability



C01

Types of Stability Analyses

Single channel hydrodynamic analysis

- Flow response to inlet flow perturbation to single channel in core

"Super Bundle" hydrodynamic analysis

- Flow response to inlet flow perturbation to group of 16 bundles under common chimney partition cell

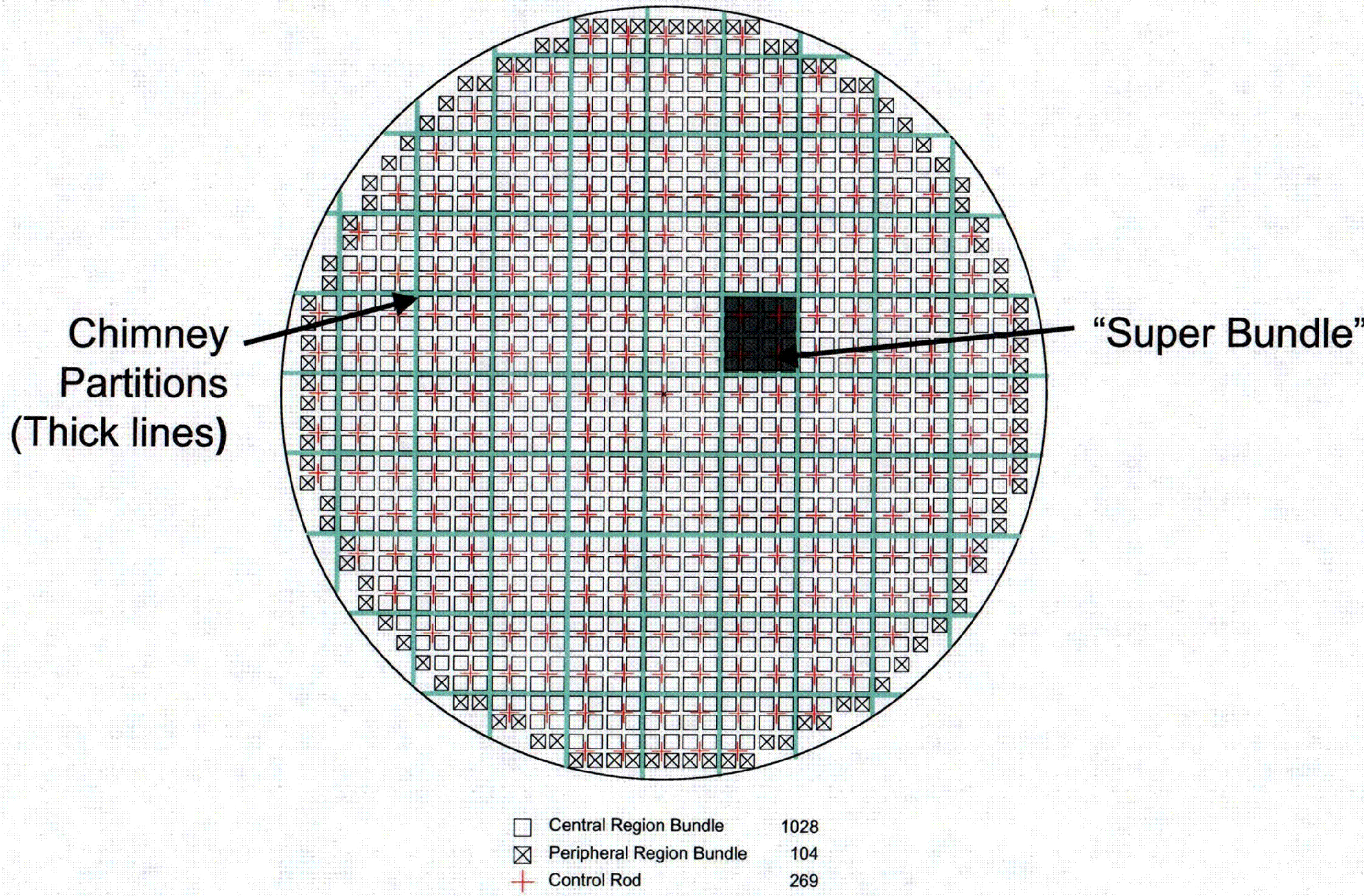
Core stability

- Power response to core wide pressure perturbation

Regional stability

- Power response to symmetric out-of-phase flow perturbations

Top View of Chimney and Core Region



C02

Design Criteria

$$OSUTL - DR_{CH\,95,95} =$$

$$DR_{CH} + z_{95,95} \cdot s_{DR-CH} < Design\ \ Limit$$

$$OSUTL - DR_{Core95,95} =$$

$$DR_{Core} + z_{95,95} \cdot s_{DR-Core} < Design\ Limit$$

Demonstration Calculations

Nodalization For Stability Analysis

Channel Grouping

Initial Conditions

Core-wide & Channel Stability

Sensitivity to Channel Grouping

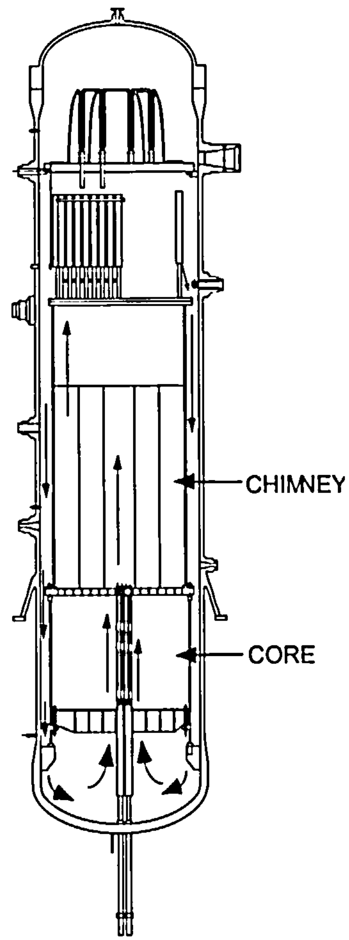
Sensitivity to Initial Perturbation

Regional Stability

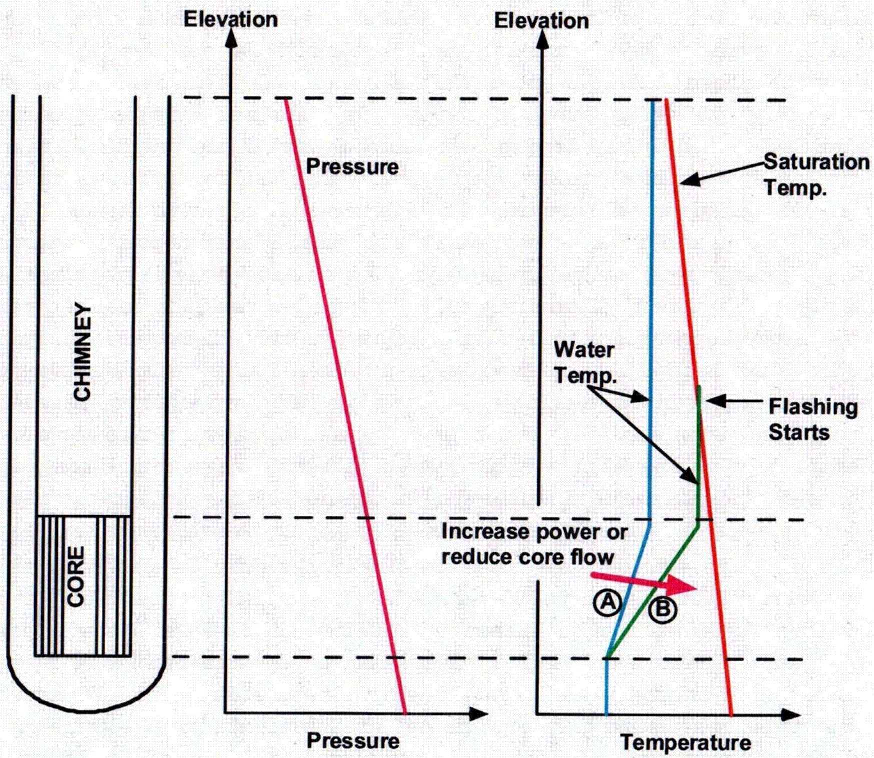
PIRT Analysis & Monte-Carlo Analysis

Startup - Background

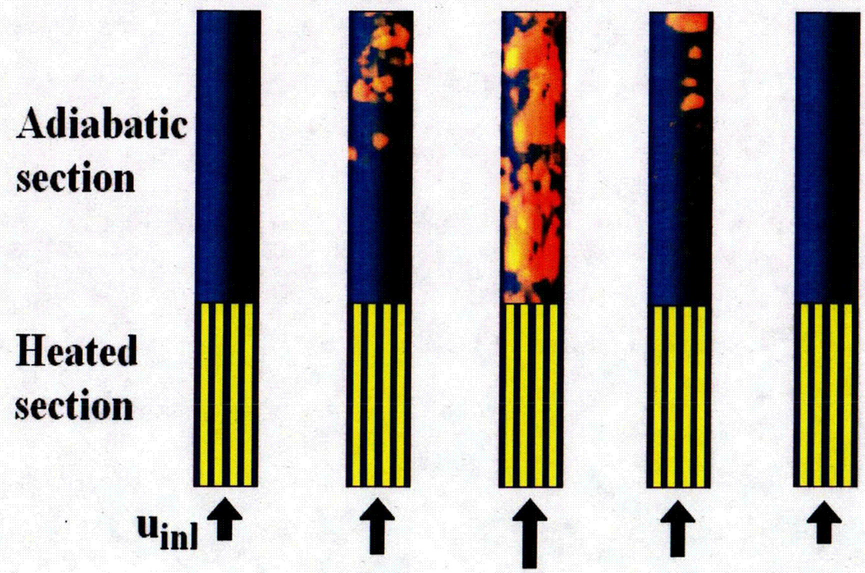
- **ESBWR natural circulation startup**
  - –Generally follow established procedure from Dodewaard plant
  - –Heat up reactor coolant to ~ 80 - 90 C with Shutdown Cooling System auxiliary heater and decay heat
  - –Deaerate reactor coolant by drawing vacuum on main condenser with steam drain line open
  - –Withdraw control rods to criticality
  - –Increase power at controlled heatup rate
  - –As pressure increases, open turbine bypass valve to control pressure



Pressure and Temperature at Startup Pressures

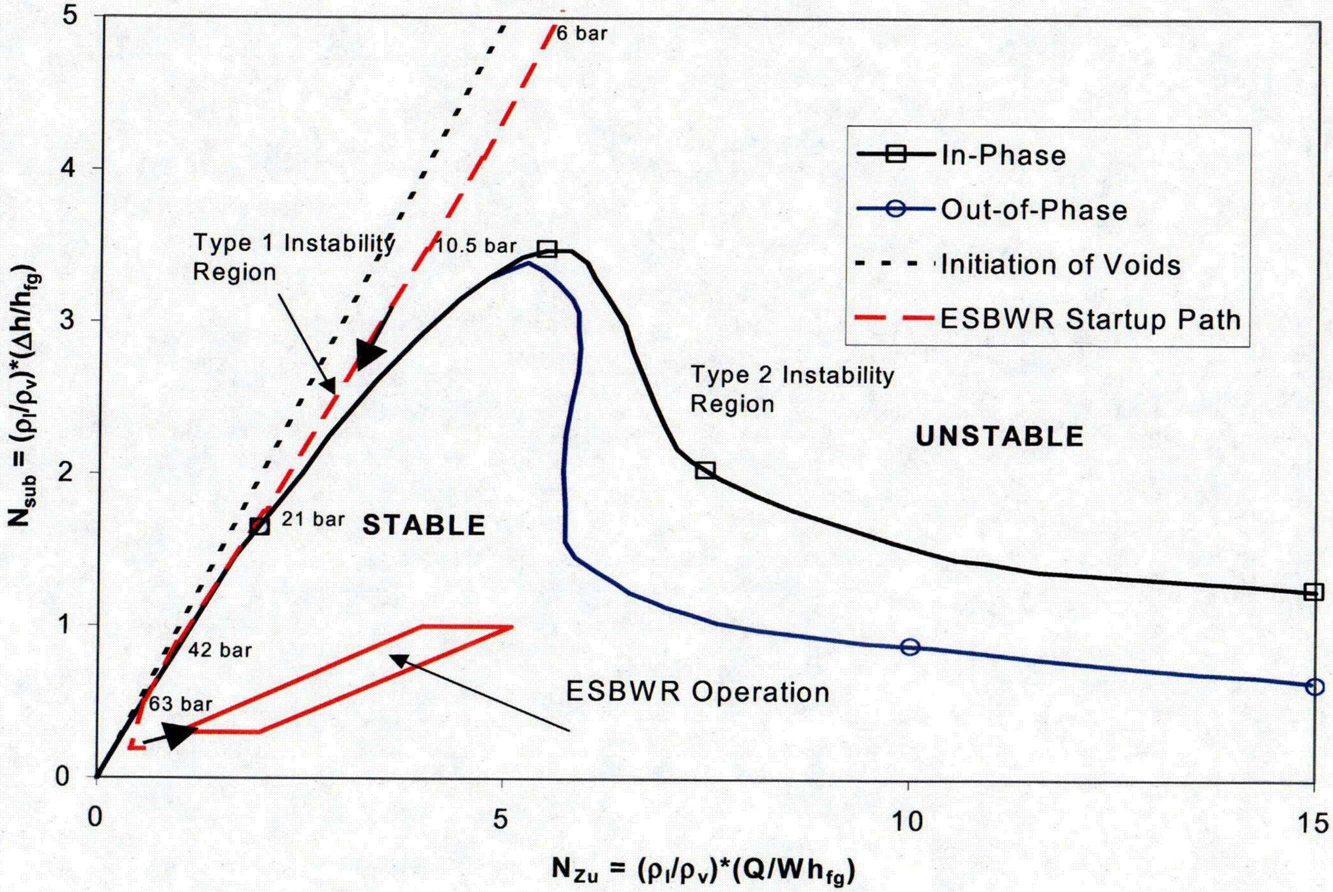


Dynamic conditions



C03

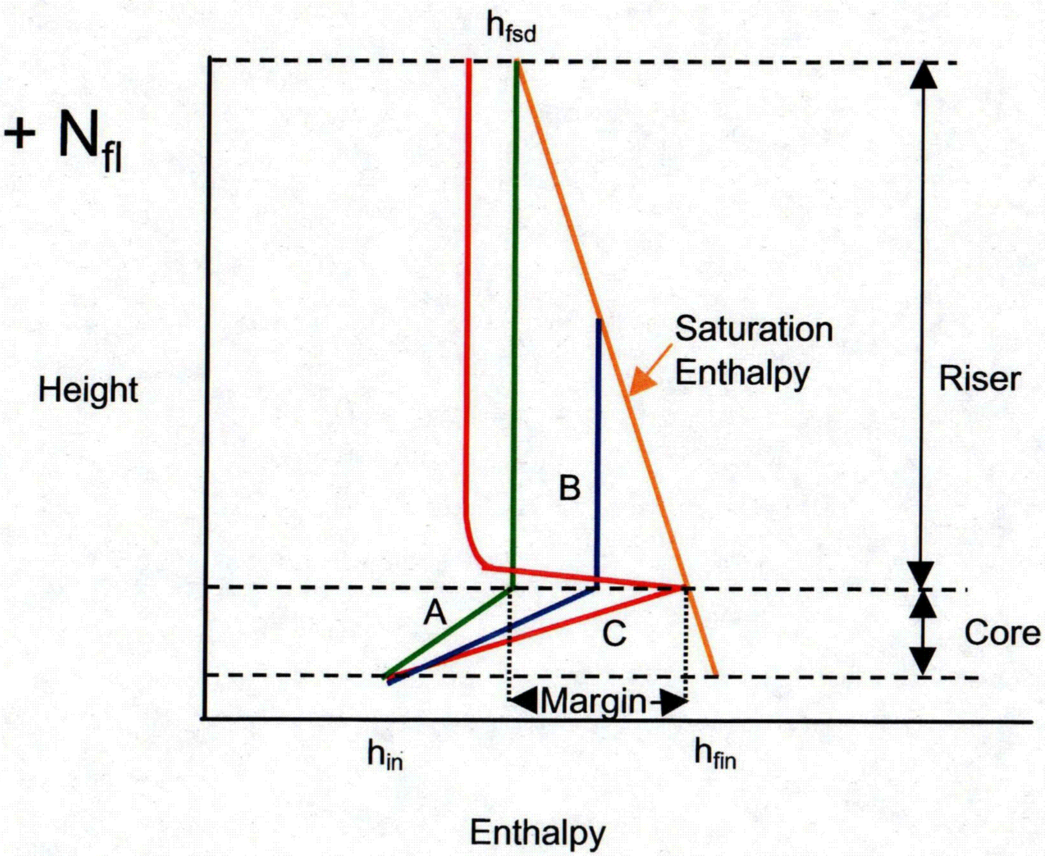
Generalized Stability Map and Plant Startup



C04

Enthalpy Profiles for Different Heatup Rates

Path A : $N_{Zu} = N_{sub}$
Path B: $N_{sub} < N_{Zu} < N_{sub} + N_{fl}$
Path C: $N_{Zu} = N_{sub} + N_{fl}$



C05

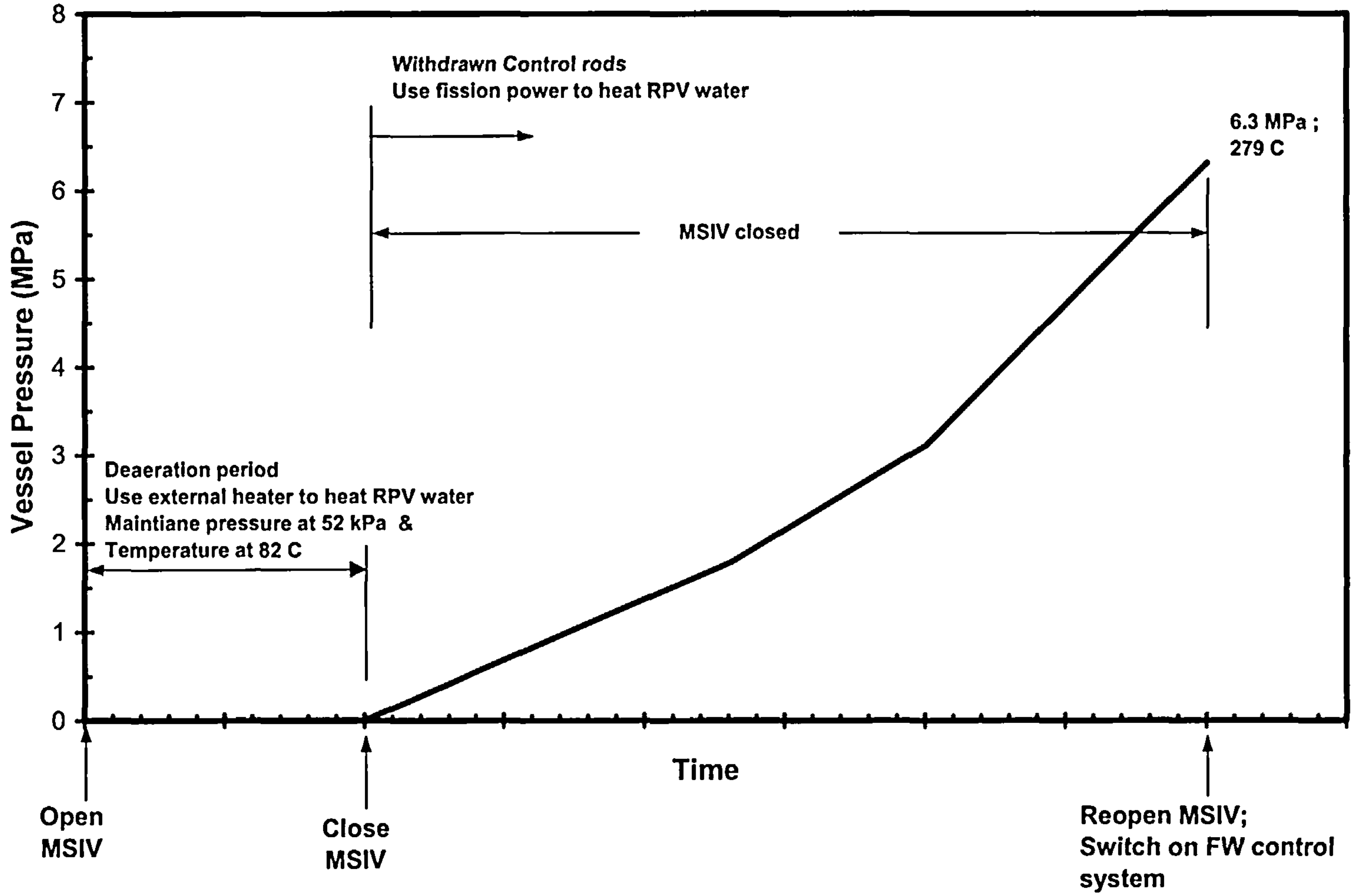
Startup Procedure

- **Deaeration period**
  - Use mechanical pump to pull vacuum
  - Use external heater and decay heat to maintain water temperature at 80 C (180 F) and pressure at 52 kPa (7.5 psia)
- **Startup period**
  - Close MSIV
  - Withdraw control rods to criticality
  - Use fission power to heat the RPV water
  - Maintain water level below the main steam line elevation
  - RPV is pressurized due to steaming at the free surface (at top of separators)
  - Core region remains subcooled due to large static head at low pressures

Startup Procedure

- Use RWCU (Reactor Water Cleanup/Shutdown Cooling System) to enhance coolant flow and reduce thermal stratification
- Reopen MSIV at the end of startup period (~ 6.3 MPa, 279 C),
  - open bypass valves to maintain RPV pressure
  - increase RPV power and prepare to roll turbine

ESBWR Startup Procedure



Startup.xls

Results of TRACG Calculations

TRACG calculates small flow oscillations when voiding begins in the separators

- During this phase,
  - Core flow is single phase
  - No oscillations in neutron flux
  - Large thermal margins (CPR >30)
- Large power level (2.5 times expected) can lead to early core voids and larger condensation-induced oscillations
  - Beyond design heatup rates

Stable void fraction established in separators and chimney

Smooth ascension to rated pressure and power

Startup flow oscillations pose no threat to any thermal limits

Conclusion

Application Methodology for stability analysis consistent with CSAU approach for realistic analysis

- Accounts for model and plant parameter uncertainties

Results demonstrate ESBWR meets design criteria

ENCLOSURE 3

MFN 04-137

Affidavit

General Electric Company

AFFIDAVIT

I, **George B. Stramback**, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 2 of GE letter MFN 04-137, Kathy K. Sedney to NRC, *GENE Presentation Regarding TRACG Application for ESBWR Stability, December 14, 2004,* dated December 14, 2004. The proprietary information is in Enclosure 2, *TRACG Application for ESBWR Stability, December 14, 2004.* The proprietary pages are identified by the marking "GE Proprietary Information." Paragraph (3) of this affidavit provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.790(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

(5) To address 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains the results of analytical models, methods and processes, including computer codes, which GE has developed, and applied to perform stability evaluations using the detection and suppression capability of the confirmation density algorithm for the BWR. GE has developed this TRACG code for over fifteen years, at a total cost in excess of three million dollars. The reporting, evaluation and interpretations of the results, as they relate to the detection and suppression capability of the confirmation density algorithm for the BWR was achieved at a significant cost, in excess of one quarter million dollars, to GE.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 14th day of December 2004

George B. Stramback
General Electric Company

ENCLOSURE 2

MFN 04-137

TRACG Application for ESBWR Stability
December 14, 2004

GE Company Proprietary

PROPRIETARY INFORMATION NOTICE