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MFN 05-109

Project 717

October 20, 2005

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **GE Response to Results of NRC Acceptance Review for ESBWR Design Certification Application – Item 2 (TAC # MC8168)**

In the Reference 1 letter, the NRC indicated that additional information was required in certain areas of the ESBWR design certification application before the NRC could begin its review in those areas. Enclosure 1 contains additional information regarding the TRACG Thermal Hydraulic Code (Item 2 in the Reference 1 letter). Enclosure 1 contains:

- Response to NRC question regarding TRACG applicability for the feedwater line break.
- Design information (feedwater line model), which documents that the largest possible feedwater line break location and area that was considered.
- Summary of ESBWR TRACG nodalization changes (from preapplication design to DCD design).
- Response to informal NRC questions regarding SCRAM water volume injected by HCUs, spillover hole locations/drywell annulus and suppression pool water level increase.

Enclosure 1 contains GE proprietary information as defined by 10 CFR 2.390. GE customarily maintains this information in confidence and withholds it from public disclosure. A non-proprietary version is contained in Enclosure 2

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GE. GE hereby requests

D068

the information of Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you have any questions about the information provided here, please let me know.

Sincerely,

David H. Hinds
Manager, ESBWR

Reference:

1. MFN 05-103, Letter from U. S. Nuclear Regulatory Commission, to Steven A. Hucik, *Results of Acceptance Review for ESBWR Design Certification Application (TAC NO. MC8168),* September 23, 2005

Enclosures:

1. MFN 05-109 – DCD Acceptance Review Item 2: TRACG Applicability for the Feedwater Line Break, Feedwater Line Model, Summary of ESBWR TRACG Nodalization Changes, Response to Informal NRC Questions – GE Proprietary Information
2. MFN 05-109 – DCD Acceptance Review Item 2: TRACG Applicability for the Feedwater Line Break, Feedwater Line Model, Summary of ESBWR TRACG Nodalization Changes, Response to Informal NRC Questions – Non Proprietary Version
3. Affidavit – George B. Stramback – dated October 20, 2005

cc: WD Beckner USNRC (w/o enclosures)
AE Cubbage USNRC (with enclosures)
LA Dudes USNRC (w/o enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0037-3348

ENCLOSURE 2

MFN 05-109

DCD Acceptance Review Item 2:

TRACG Applicability for the Feedwater Line Break

Feedwater Line Model

Summary of ESBWR TRACG Nodalization Changes

Response to Informal NRC Questions

NRC Request

Justify the applicability of the TRACG code and the associated PIRT and test programs to the FWLB. (The staff's approval of the TRACG thermal-hydraulic computer code for applicability to ESBWR LOCA analyses was based on the gravity driven cooling system line break, the bottom drain line break, and the main steam line break as the limiting break locations. The FW LB was not considered.) Provide justification of TRACG code applicability and associated PIRT and test programs.

GE Response - TRACG Applicability for Feedwater Line Break

Reference 1 provides a summary of the changes between the ESBWR design evaluated by the NRC staff during the pre-application review and the current design in the DCD, as well as the rationale for the applicability of TRACG and the SER to the new design. The purpose of this document is to amplify on the item related to the feedwater line break becoming the limiting break in the LOCA analysis.

A break in the feedwater line represents a liquid line break from the downcomer region at an elevation above the top of the core. This is similar to the GDCS line break. The differences are that a feedwater line break would be at a higher elevation and has a larger maximum break area. It will be shown that the nature of the transient is similar for both breaks; the important phenomena are the same; and there is test coverage of these phenomena. Thus, TRACG should be applicable to the analysis of the feedwater line break, as well as the other breaks previously analyzed.

Tables 6.3-7 and 6.3-9 in the DCD show the operational sequences of ECCS for the feedwater and GDCS line breaks. The sequences are similar, with the feedwater break transient showing a faster progression. The transient scenarios are similar for the two transients. There is a large initial drop in the downcomer level as the static heads equalize inside and outside the shroud following scram and loss of feedwater flow. The break flow from the feedwater break is approximately three times as much as that from the GDCS line break (DCD Figures 6.3-11 and 6.3-35). This results in a faster downcomer level decrease (DCD Figures 6.3-9 and 6.3-33) and a more rapid depressurization (DCD Figures 6.3-10 and 6.3-34). The falling downcomer level triggers reactor isolation, IC initiation and ADS/GDCS timers for both transients. When DPV actuation begins, the SLCS system is signaled to start. The minimum chimney level is reached prior to GDCS injection. When the vessel pressure drops below the maximum injection pressure of the GDCS, GDCS flow into the vessel begins. The water level in the shroud is restored shortly thereafter.

The long term RPV transient scenarios for both break locations are discussed in Reference 1. For the feedwater line break, the long term level settles out close to the feedwater line elevation, substantially higher than the minimum short term level position.

The containment response to the feedwater line break is closer to that for the main steam line break, primarily because of the large break flow to the upper portion of the drywell. The break flow from the RPV is supplemented by the flow from the upstream portion of the feedwater piping. The analysis assumes that the inventory in the feedwater line to the direct contact feedwater heater is available to discharge into the drywell. The large initial break flow from both sides of the break results in a more pronounced drywell pressure peak due to vent clearing at about 6 seconds (DCD Table 6.2-7). Following vent clearing, the drywell pressure continues to increase due to an initial purge of the noncondensibles to the wetwell gas space, and a short term peak pressure is reached. This early peak pressure has a large margin to the design pressure of 4.137 bar, but is slightly higher than the long term pressure at 72 hours for the feedwater line break. For the steam line break, the break flow from the upstream side is terminated by the rapid closure of the isolation valves. The vent clearing transient pressure rise is milder and the peak pressure is reached in the long term following the eventual transfer of the noncondensibles from the drywell to the wetwell. Apart from differences in the magnitudes of the early and late pressure peaks, the transient responses for the two break locations are similar.

Important Phenomena for the Feedwater Line Break

The ESBWR TRACG LTR (Reference 2) shows PIRTs for the LOCA scenario for the RPV and containment. Tables 1 and 2 were extracted from Reference 2.

Table 1 shows the PIRT for the GDCS line break for the RPV from Reference 2, to which columns have been added for the feedwater line break. The important phenomena are virtually identical for the two break locations. For the blowdown phase the important parameters are the break flow (from the break and the DPVs), flashing, level swell and redistribution of inventory in various regions of the RPV. For the GDCS injection phase, additional phenomena related to decay heat, mixing of the colder GDCS water and condensation of voids become important. The PIRT for the long term phase for the feedwater line break was provided in Reference 1. The important phenomena that govern the long term response are decay heat, PCC capacity (medium), and GDCS pool and RPV volumes vs. elevation.

Table 2 shows the PIRT from the containment perspective. This PIRT is taken from Reference 2 and covers the blowdown, GDCS injection and long term phases of the LOCA transient. For each of the three phases, a separate column provides the ranking of the phenomena. The PIRT was developed without consideration of a specific break location and is valid for feedwater line breaks as well as steam line, GDCS line and bottom drain line breaks.

The short-term drywell pressure response is governed by energy deposition by break flow and DPV discharge flow and energy removal from the drywell through main vent and PCCS flow, and condensation on walls and internal structures. The pressure difference required for clearing of the main vents controls the initial pressure increase in the drywell. Thermal stratification of the suppression pool is a key factor in determining how this energy is distributed within the pool; it sets the pool surface temperature and, therefore, the temperature and steam partial pressure in the wetwell gas space. Another key parameter controlling the short-term wetwell pressure is the extent to which the noncondensibles (nitrogen) initially in the drywell are purged to the wetwell in the initial blowdown.

In the GDCS injection phase, PCC performance and condensation by reactor inventory spilling from the break are important phenomena. Vacuum breaker openings are expected in this phase, returning noncondensibles from the wetwell to the drywell. The long-term containment response is controlled primarily by the heat removal by the PCCS relative to the decay heat. The energy deposition in the wetwell is due to the PCC vent flow and any steam leakage from the drywell that bypasses the PCCS.

These phenomena are relevant for all break locations that discharge into the drywell.

In summary, no new phenomena are introduced by consideration of the feedwater line break.

TRACG Model Applicability for analysis of the Feedwater Line Break

Tables 2.3-1 and 3.3-1 of Reference 2 show TRACG model capability matrices for the RPV and containment respectively. These tables show that TRACG models have the capability to model the high ranked phenomena that determine the ESBWR LOCA response. As concluded above, the analysis of the feedwater line break introduces no new phenomena. Hence, these tables are also applicable to the feedwater line break and show that TRACG has the necessary models for the analysis.

Test Data Coverage for Feedwater Line Break

Tables 2.3-2, 2.3-3 and 2.3-4 in Reference 2 show that the highly ranked phenomena for LOCA for the RPV are covered by a combination of separate effect, component and integral tests. As the highly ranked phenomena for the feedwater line break are the same as for the GDCS line break, test coverage for the feedwater line break is also is also demonstrated by Tables 2.3-2 through 2.3-4. For example, break flow is covered by the PSTF and Marviken tests, level swell in the PSTF tests, and flashing and inventory redistribution in the GIRAFFE/SIT and GIST tests. Effects of GDCS injection were covered by the GIRAFFE/SIT and GIST tests and PCC performance by the prototypical PANTHERS tests. Thus, even though specific tests simulating a feedwater line break have not been performed in the GIST or GIRAFFE/SIT test facilities, the highly ranked phenomena have been covered by these tests.

Containment test coverage is indicated in Tables 3.3-2, 3.3-3 and 3.3-4 for separate effect, component and integral tests. For example, critical flow is covered by the PSTF and Marviken tests, the early blowdown period, pool stratification and vent clearing phenomena are covered by the PSTF tests; transport of noncondensibles to the wetwell is part of the GIRAFFE/SIT and PANDA tests. PCCS performance was tested in the prototypical PANTHERS tests and the long term phase is simulated in the PANDA tests.

Summary

Based on the above, it can be concluded that:

- The highly ranked phenomena for the feedwater line break are the same as for the GDCS line break for the RPV
- The highly ranked phenomena for the feedwater line break are covered by the PIRT in Reference 2 (Table 3.2-1) for the containment
- TRACG models are applicable to analyze these highly ranked phenomena
- There is adequate test coverage and TRACG qualification for these phenomena.

Therefore, TRACG is applicable for feedwater line break analysis.

References:

1. MFN 05-105, Letter from David H. Hinds to U.S. Nuclear Regulatory Commission, *TRACG LOCA SER Confirmatory Items (TAC # MC 1868)*, Enclosure 2, *Reactor Pressure Vessel (RPV) Level Response for the Long Term PCCS Period, Phenomena Identification and Ranking Table, and Major Design Changes from Pre-Application Review Design to DCD Design*, October 6, 2005.
2. 'TRACG Application for ESBWR", NEDC-33083P-A, March 2005.

Table 1: LOCA/RPV PIRT (based on Table 2.2-3 of NEDC-33083P-A)

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Table 2: LOCA/RPV PIRT (from Table 3.2-1 of NEDC-33083P-A)

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NRC Request

Provide design information to document that the largest possible feedwater line break location and area was considered. State the break area on both sides of the break. 10 CFR 50.46 requires that a spectrum of break sizes and locations be analyzed to demonstrate that the limiting break has been identified.

GE Response - Feedwater Line Model

Figure 3-1 shows the schematic of the entire feedwater line model. The model encompasses the feedwater lines from the FW heaters to the RPV. Figure 3-2 depicts a single flow path that represents parallel trains of FW heaters and FW pumps in the Turbine Building. Elevations are conservatively assumed so that the inventory can be flashed into the containment through the postulated break location. Feedwater lines in the Steam Tunnel and in the containment are modeled with two loops: Intact Loop and Broken Loop, one for each 550 mm (22") main feedwater line in the steam tunnel and associated piping. Figure 3-3 shows a TEE component that represents the FW header in the Turbine Building and main feedwater lines in the Steam Tunnel. Two branches of TEE components end at the Isolation Valves near the containment boundary. Inside the containment, each 550 mm main feedwater line is physically connected to an arc-shaped header that also has three 300 mm (12") risers connected to the feedwater nozzles at the RPV. The flow area of the ring header is doubled to represent the branched flow and the three risers are combined in the TRACG model. Figure 3-4 shows the Intact Loop inside the containment. Figure 3-5 shows the Broken Loop inside the containment. A break is postulated at the connection of main feedwater line to the arc-shaped header in the broken loop. The break flow area is 0.1977 m^2 at each end. The break flow from the reactor is flashed through one of these areas and the break flow from FW heater, pumps and the Intact Loop is flashed through the other area. The break flow from the reactor is limited by the feedwater spargers inside the RPV. The total flow area of spargers associated with three feedwater risers is 0.08387 m^2. The location of modeled spargers is indicated in Figure 3-5. Figure 3-6 shows the calculation for the assumed FW Line break area.

The break flow from the FW heaters is limited by a venturi in the feedwater system. The effect of the venturi is accounted for with a reduced area of 0.1 m^2 in the TRACG model. The location of the modeled venturi is indicated in Figures 3-3 and 3-5.

Therefore, the FW line break critical flow areas are 0.08387 m^2 from the RPV to the DW and 0.1 m^2 from the BOP to the DW.

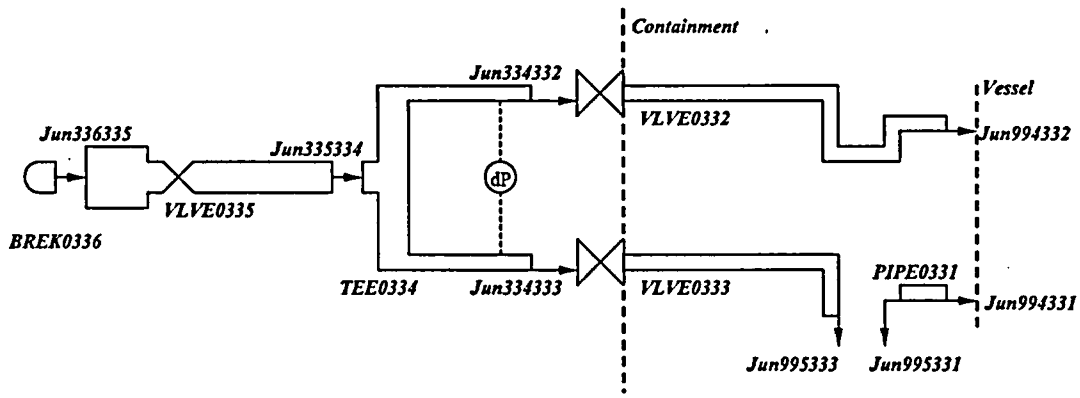

Figure 3-1. Feedwater Line Model for FWL Break Analysis

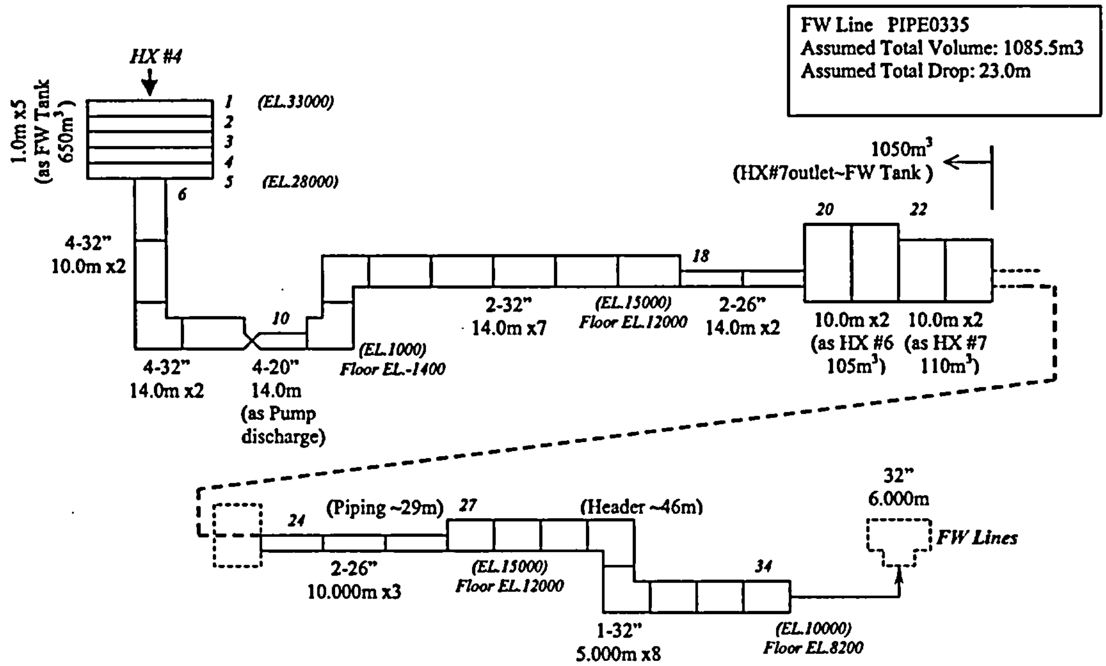

Figure 3-2. TRACG Model for Feedwater Lines in Turbine Building

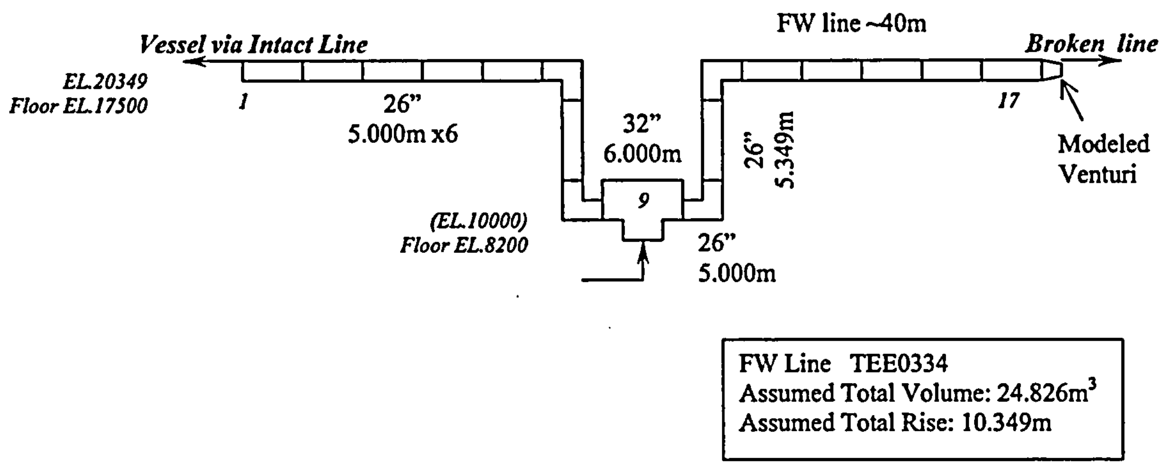

Figure 3-3. TRACG Model for Feedwater Header in Turbine Building Main Feedwater Lines in Steam Tunnel

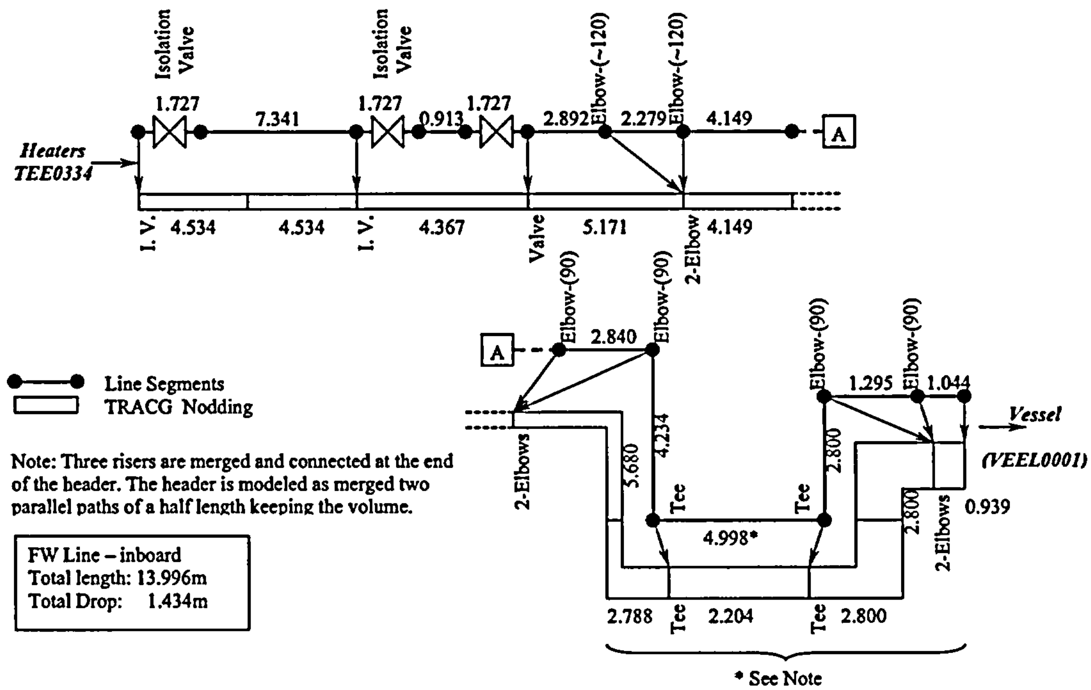

Figure 3-4 TRACG Feedwater Line Model for Intact Loop inside the Containment

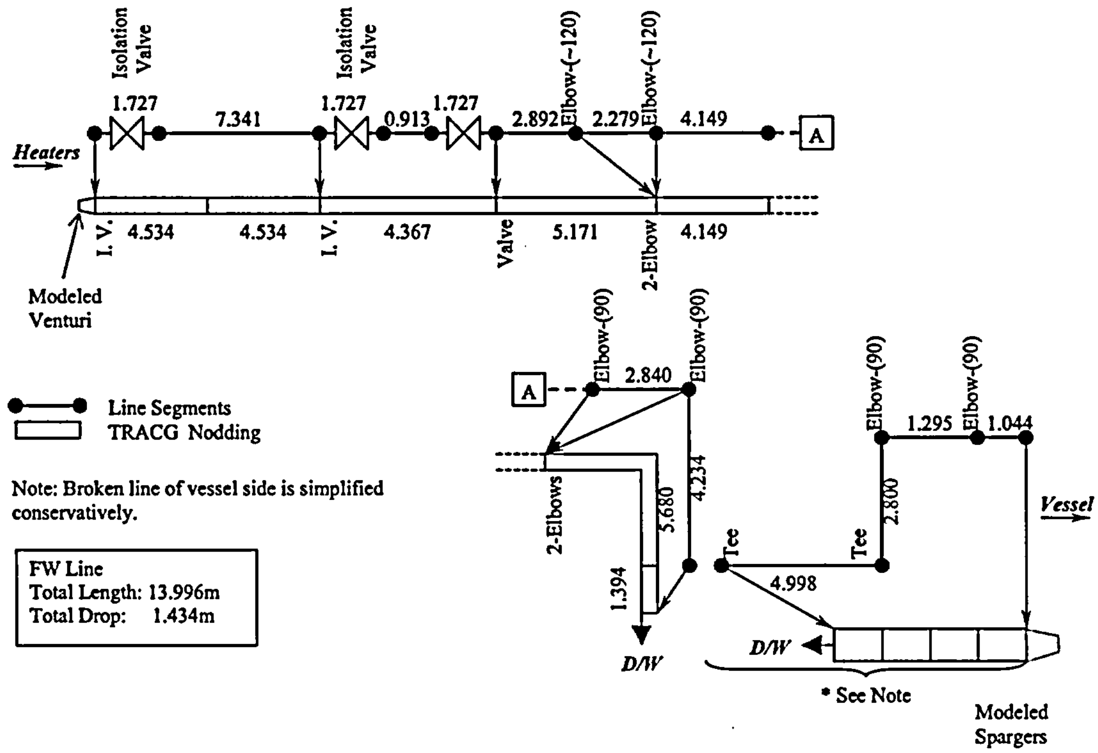

Figure 3-5 TRACG Feedwater Line Model for Broken Loop inside the Containment

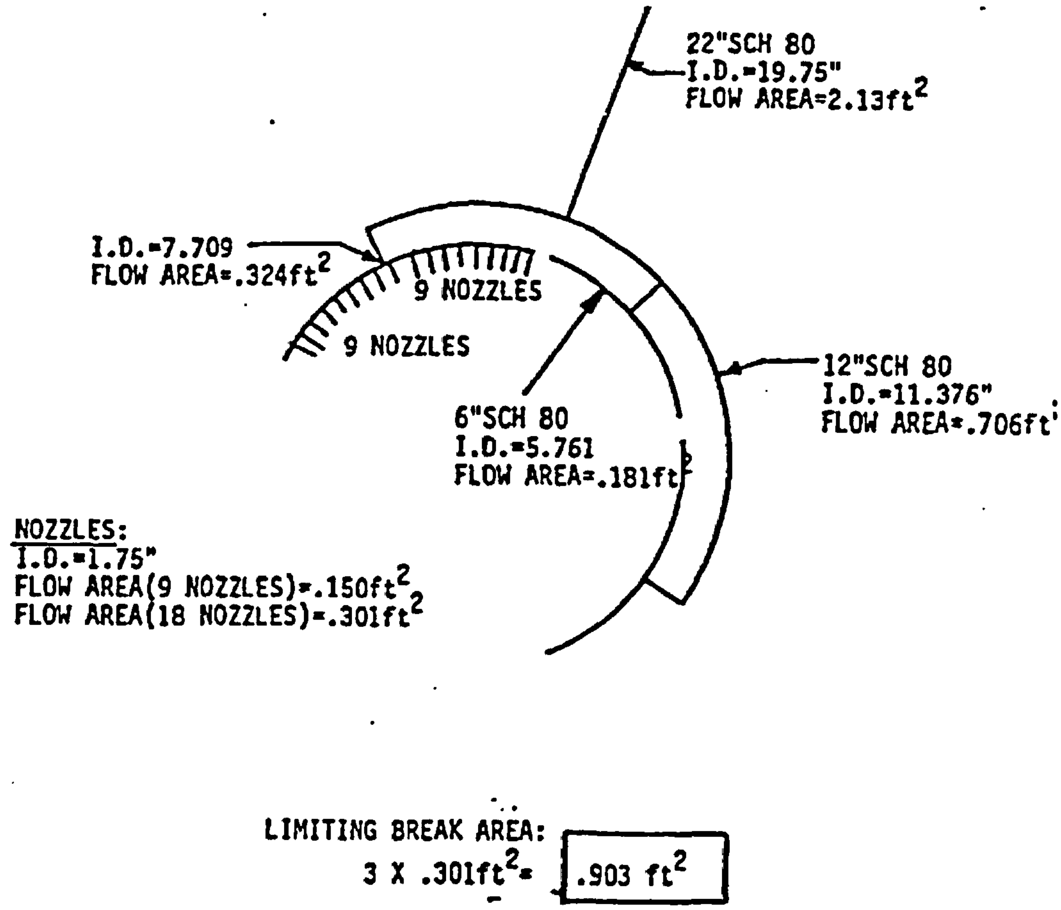

Figure 3-6 Feedwater Line Break Area Calculation

Summary of ESBWR TRACG Nodalization Changes from Preapplication Design to DCD Design DCD Acceptance Review Item 2, Part C

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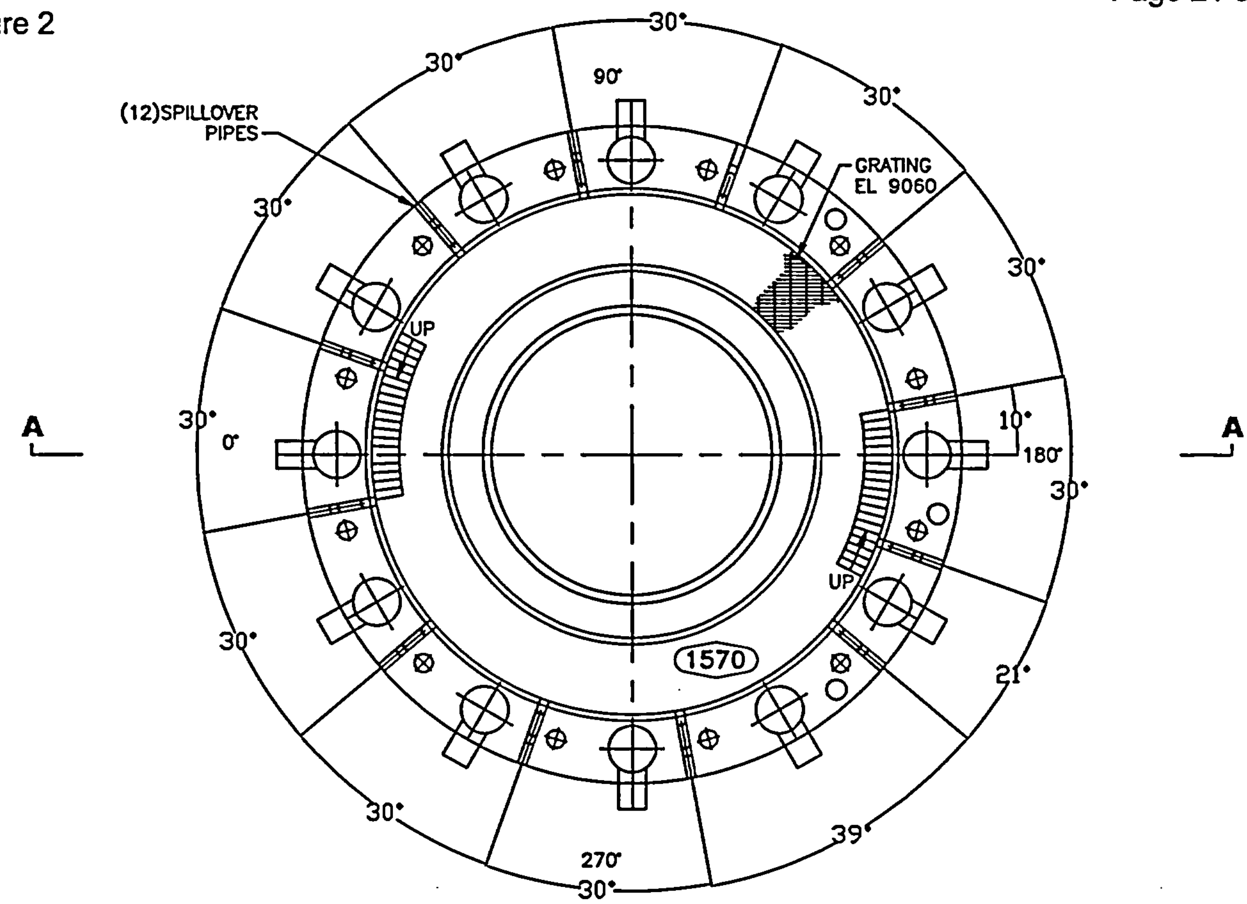
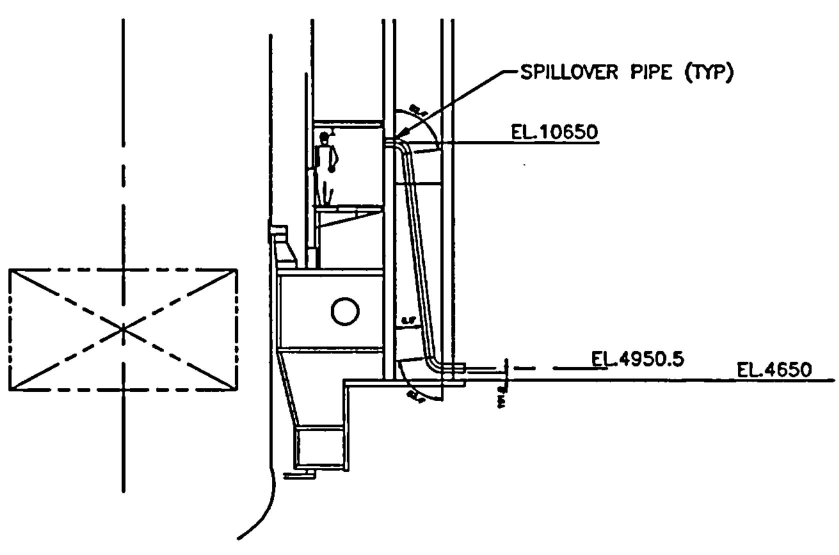


REACTOR BUILDING
FLOOR EL 9060



SECTION "A-A"
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ENCLOSURE 3

MFN 05-109

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 1 of GE letter MFN 05-109, David H. Hinds to U.S. Nuclear Regulatory Commission, *GE Response to Results of NRC Acceptance Review for ESBWR Design Certification Application – Item 2 (TAC # MC8168)*, dated October 20, 2005. The proprietary information in Enclosure 1, *DCD Acceptance Review Item 2: TRACG Applicability for the Feedwater Line Break, Feedwater Line Model, Summary of ESBWR TRACG Nodalization Changes, Response to Informal NRC Questions*, is identified by a dark red font with double underlines inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object or contain the page header "GE Proprietary Information". In each case, the superscript notation{3} refers to Paragraph (3) of this affidavit, which 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 LOCA and transient evaluations using the TRACG code for the ESBWR. GE has developed this TRACG code for over fifteen years, at a total cost in excess of three million dollars.

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 20th day of October, 2005

George B. Stramback
General Electric Company

ENCLOSURE 1

MFN 05-109

DCD Acceptance Review Item 2:

TRACG Applicability for the Feedwater Line Break

Feedwater Line Model

Summary of ESBWR TRACG Nodalization Changes

Response to Informal NRC Questions

Contains GE Proprietary Information

PROPRIETARY INFORMATION NOTICE

This enclosure contains proprietary information of the General Electric Company (GE) and is furnished in confidence solely for the purpose(s) stated in the transmittal letter. No other use, direct or indirect, of the document or the information it contains is authorized. Furnishing this enclosure does not convey any license, express or implied, to use any patented invention or, except as specified above, any proprietary information of GE disclosed herein or any right to publish or make copies of the enclosure without prior written permission of GE. The proprietary information is identified by a dark red font with double underlines inside double square brackets. [[This sentence is an example {3}]]. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of the enclosed affidavit, which provides the basis for the proprietary determination.