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2011-046 BWR Vessel & Internals Project (BWRVIP)

March 03, 2011

Document Control Desk
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Attention: Jonathan Rowley

Subject: Project No. 704 – BWRVIP Response to NRC Request for Additional Information on BWRVIP-183

Reference: Letter from Tanya M. Mensah (NRC) to Rick Libra (BWRVIP Chairman), "Request for Additional Information Re: Boiling Water Reactor Vessel and Internals Project (BWRVIP)-183, "BWR Vessel and Internals Project, Top Guide Grid Beam Inspection and Flaw Evaluation Guidelines" (TAC NO. ME2178)," dated April 29, 2010.

Enclosed are five (5) copies of the BWRVIP response to the NRC Request for Additional Information (RAI) on the BWRVIP report entitled "BWRVIP-183: BWR Vessel and Internals Project, Top Guide Grid Beam Inspection and Flaw Evaluation Guidelines. The RAI was transmitted to the BWRVIP by the NRC letter referenced above.

Please note that the enclosed response contains proprietary information. The response includes margin bars and yellow shading to indicate the proprietary information. The proprietary information is also marked with the letters "TS" in the margin indicating the information is considered trade secrets in accordance with 10CFR2.390A.

Two (2) copies of a non-proprietary version of the BWRVIP response to the RAI are also enclosed. This non-proprietary response is identical to the enclosed proprietary response except that the proprietary information has been deleted and the words "EPRI Proprietary Licensed Material" have been deleted from the top of each page.

If you have any questions on this subject please call Randy Schmidt (PSEG Nuclear, BWRVIP Assessment Committee Technical Chairman) at 856.339.3740.

Sincerely,

Dave Czufin
Exelon
Chairman, BWR Vessel and Internals Project
Together . . . Shaping the Future of Electricity

G004
NRR

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Additional copies were sent to the PM

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NEIL WILMSHURST
Vice President and
Chief Nuclear Officer

For Use With Licensed Reports

February 28, 2011

Document Control Desk
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Request for Withholding of the following Proprietary Document:

BWRVIP Response to NRC Request for Additional Information on "BWRVIP-183, BWR Vessel and Internals Project: Top Guide Grid Beam and Flaw Evaluation Guidelines"

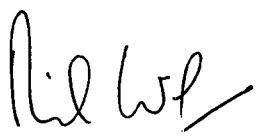
To Whom It May Concern:

This is a request under 10 C.F.R. §2.390(a)(4) that the U.S. Nuclear Regulatory Commission ("NRC") withhold from public disclosure the information identified in the enclosed Affidavit consisting of the proprietary information owned by Electric Power Research Institute, Inc. ("EPRI") identified above (the "Report"). Proprietary and non-proprietary versions of the Correspondence and the Affidavit in support of this request are enclosed.

EPRI desires to disclose the Report in confidence to assist the NRC. The Report is not to be divulged to anyone outside of the NRC or to any of its contractors, nor shall any copies be made of the Report provided herein. EPRI welcomes any discussions and/or questions relating to the information enclosed.

If you have any questions about the legal aspects of this request for withholding, please do not hesitate to contact me at (704) 704-595-2732. Questions on the content of the Report should be directed to ***Randy Stark*** of EPRI at (650) 855-2122.

Sincerely,



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AFFIDAVIT

RE: Request for Withholding of the Following Proprietary Document:

BWRVIP Response to NRC Request for Additional Information on "BWRVIP-183, BWR Vessel and Internals Project: Top Guide Grid Beam and Flaw Evaluation Guidelines"

I, Neil Wilmshurst, being duly sworn, depose and state as follows:

I am the Vice President and Chief Nuclear Officer at Electric Power Research Institute, Inc. whose principal office is located at 1300 W WT Harris Blvd, Charlotte North Carolina ("EPRI") and I have been specifically delegated responsibility for the above-listed Report that is sought under this Affidavit to be withheld (the "Report"). I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Report on behalf of EPRI.

EPRI requests that the Report be withheld from the public on the following bases:

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information:

a. The Report is owned by EPRI and has been held in confidence by EPRI. All entities accepting copies of the Report do so subject to written agreements imposing an obligation upon the recipient to maintain the confidentiality of the Report. The Report is disclosed only to parties who agree, in writing, to preserve the confidentiality thereof.

b. EPRI considers the Report and the proprietary information contained therein (the "Proprietary Information") to constitute trade secrets of EPRI. As such, EPRI holds the Report in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Report. EPRI made a substantial economic investment to develop the Report, and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Report. If the Report and the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Report for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Report.

c. EPRI's classification of the Report and the Proprietary Information as trade secrets is justified by the Uniform Trade Secrets Act which California adopted in 1984 and a version of which has been adopted by over forty states. The California Uniform Trade Secrets Act, California Civil Code §§3426 – 3426.11, defines a "trade secret" as follows:

> "'Trade secret' means information, including a formula, pattern, compilation, program device, method, technique, or process, that:

(1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and

(2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

d. The Report and the Proprietary Information contained therein are not generally known or available to the public. EPRI developed the Report only after making a determination that the Proprietary Information was not available from public sources. EPRI made a substantial investment of both money and employee hours in the development of the Report. EPRI was required to devote these resources and effort to derive the Proprietary Information and the Report. As a result of such effort and cost, both in terms of dollars spent and dedicated employee time, the Report is highly valuable to EPRI.

e. A public disclosure of the Proprietary Information would be highly likely to cause substantial harm to EPRI's competitive position and the ability of EPRI to license the Proprietary Information both domestically and internationally. The Proprietary Information and Report can only be acquired and/or duplicated by others using an equivalent investment of time and effort.

I have read the foregoing and the matters stated herein are true and correct to the best of my knowledge, information and belief. I make this affidavit under penalty of perjury under the laws of the United States of America and under the laws of the State of California.

Executed at 3420 Hillview Avenue being the premises and place of business of Electric Power Research Institute, Inc.

Date: 3 - 2 - 2011

Neil Wilmshurst

(State of California)
(County of Santa Clara)

Subscribed and sworn to (or affirmed) before me on this 2nd day of March, 2011, by Neil Wilmshurst, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Signature _____ (Seal)

My Commission Expires 31st day of July, 2013

YORK HUANG
COMM. # 1856665
NOTARY PUBLIC-CALIFORNIA
SANTA CLARA COUNTY
MY COMM. EXP. JULY 31, 2013

Non-Proprietary BWRVIP Response to NRC Request for Additional Information on BWRVIP-183

Response to RAIs (Request for Additional Information)
"BWRVIP-183, "BWR Vessel and Internals Project:
Top Guide Grid Beam and Flaw Evaluation Guidelines"

Introduction to RAI Responses

The top guide inspection and flaw evaluation guidelines (BWRVIP-183) provide an inspection strategy for top guide grid beams. The body of the document discusses design configurations and susceptibility factors, historical information on observed indications, a brief discussion on the loads to be considered and a fracture mechanics evaluation approach, a loose parts evaluation, interaction of multiple indications in one grid beam, and finally the inspection strategy. Also included in the body of the document is an example analysis for a fully severed grid beam.

BWRVIP-183 also contains two appendices. Appendix A is an example analysis, documenting the approach for evaluation of any flaws found during an inspection that require plant specific analysis. Since it is an example, variables such as geometry, loads, and materials do not have to be specifically addressed. Appendix B again contains an example analysis for fit-up stresses. This analysis was included to investigate the effect of postulated fit-up stresses on growth of cracks. The analysis demonstrated that fit-up stresses cause negligible growth. Thus, fit-up stresses are not expected to contribute to crack growth.

Each item from the NRC Request for Information (RAI) is repeated below verbatim followed by the BWRVIP response to that item.

RAI 1

Section 2.2.1, "Environment," states that the top guide projected neutron fluence at the end of 32 EFPY can reach a value of approximately "Content Deleted – EPRI Proprietary Information". In Section 4.2.2, "Fluence Dependent Fracture Toughness," the BWRVIP recommends using a fracture toughness value of "Content Deleted – EPRI Proprietary Info" for the flaw evaluation methodology for top guide components that are exposed to a neutron fluence value greater than "Content Deleted – EPRI Proprietary Info" "Content Deleted – EPRI Proprietary Info". It is likely that the projected neutron fluence value at the end of 54 EFPY will be greater than the neutron fluence value at the end of 32 EFPY. Section 2.3.3 of the BWRVIP-100-A, "BWRVIP Vessel and Internals Project: Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds," report indicates that the fracture toughness values may drop below "Content Deleted – EPRI Proprietary Info" at neutron fluence levels above "Content Deleted – EPRI Proprietary Information". Provide and justify the use of a fracture toughness value which would be consistent with the bounding neutron fluence levels expected for the top guide components through 54 EFPY.

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BWRVIP Response to RAI 1

BWRVIP-100-A concludes that the minimum fracture toughness for fluence values greater than "Content Deleted – EPRI Proprietary Information". This value is well supported by the data and evaluations contained in BWRVIP-100-A. Additional fracture toughness tests conducted by the BWRVIP confirm that "Content Deleted – EPRI Proprietary Info" is an appropriate value for fluences less than "Content Deleted – EPRI Proprietary Info". This additional data will be documented in a revision to BWRVIP-100-A and submitted to the NRC. | TS | TS | TS

For fluence values greater than or equal to "Content Deleted – EPRI Proprietary Info", the fracture toughness value used in a flaw evaluation must be justified. This will be clarified in a revision to the report. | TS

RAI 2

Section 4.2.3, "Fluence Dependent Crack Growth Rate," states that, "A detailed evaluation of the Nine Mile Point, Unit 1 [NMP-1] top guide grid beam flaws is presented in Appendix A, as an example analysis." Section 5.2, "Seismic Analysis," states that, "[a] finite element analysis [FEA] was performed on the Oyster Creek top guide." Evidently, the results and conclusions of the BWRVIP-183 report are based on two different FEA models. Please address the variability of the top guide structures in terms of their geometry, materials, and loading among all Boiling Water Reactor (BWR)/2-5 plants to demonstrate that the NMP-1 and Oyster Creek results contain sufficient margin to account for this variability, so that the results and conclusions of the BWRVIP-183 report can be applied to any BWR/2-5 plant.

BWRVIP Response to RAI 2

The purpose of the top guide inspection and flaw evaluation guidelines (BWRVIP-183) is to provide an inspection strategy, based upon conservative fracture mechanics analyses. The analysis presented in Appendices A and B were not used to define the inspection strategy, but rather provided insight that additional inspections of the top guide grid beams were prudent. The inspection strategy is based upon maximum ASME Code allowable stresses, actual grid beam heights (see additional information in table following RAI 9 below), and material toughness with high fluence. Therefore, variability in geometry, materials, and loading have been addressed.

RAI 3

Section 5.3, "Results and Conclusion," states that, "Figure 5-1 shows a maximum deflection of "Content Deleted – EPRI Proprietary Info" at indication 5 of the Oyster Creek top guide." Confirm that the deflection is in the X-Z plane (i.e., the plane of the paper) with respect to the bottom support of the lower shroud cylinder. Provide the relative deflection between the two severed points at indication 5. If the maximum deflection of "Content Deleted – EPRI Proprietary Info" mentioned in the previous question is an absolute deflection, then it is inadequate to assume "arbitrary axial lengths of "Content Deleted – EPRI Proprietary Info" for the upper and lower shroud cylinders" as described in | TS | TS | TS

Section A.2.3, "Shroud," because a lower shroud cylinder with an axial length much greater than "Content Deleted - EPRI Proprietary" will provide a significantly larger deflection at indication 5. Provide the revised maximum deflection considering a realistic flexibility of the lower shroud cylinder and address the control rod blade insertion issue. | TS

BWRVIP Response to RAI 3

Section 5 is included in the body of BWRVIP-183 only for the purpose of illustrating an example of what could be expected if a grid beam severance occurred. It is certainly not expected that this situation would ever occur.

Analyses ("Final Test Report, CRD Performance Evaluation Testing with Drive Line Misalignment," NEDC-32406, September 1994) have shown that control rod insertion is not affected unless the extent of cracking is sufficient to result in a sustained movement of the top guide by more than "Content Deleted - EPRI Proprietary Info", which is approximately comparable to a dynamic movement of "Content Deleted - EPRI Proprietary Info" The "egg crate" design of the top guide and the close packing of the fuel assemblies provide substantial redundancy to resist local movement, even if a grid beam is fully severed. Therefore, potential movement would occur only if the entire core were repositioned or a grid beam were plastically deformed. | TS | TS

Even if the core were to shift, and control rod insertion were prevented, the consequences could be mitigated because reactivity control would be achieved by operator initiation of the standby liquid control (SLC) system.

Since the BWRVIP did not determine the maximum total deflection of the top guide with a severed beam, Section 5.3 of BWRVIP-183 will be revised as follows to clarify that a plant specific analysis is required to address the issue of control rod insertion for design basis transients:

5.3 Results and Conclusion

Figure 5-1 shows a maximum deflection of "Content Deleted - EPRI Proprietary Info" at indication 5 of the "Content Deleted - EPRI Proprietary Info" top guide; the deflection at indication "Content Deleted - EPRI Proprietary Info" is insignificant. The analytical results demonstrate that the increase in the overall stress level is insignificant. | TS | TS

In order to address the ability to insert control rods during a dynamic event, a plant specific analysis must be performed for any severed grid beam found during an inservice inspection or if severance is predicted to occur. This analysis must take into account the lateral displacement of the core shroud due to all dynamic loads, such as seismic, safety-relief valve blowdown, loss of coolant accident, etc., as well as all plant service conditions. The lateral displacement of the core shroud determined above must be added to that resulting from a severed grid beam subject to similar loading conditions.

RAI 4

Section A.4, "Load Combination Stress Analyses," states that, "Appropriate scale factors are applied to these load cases to reflect the actual loads on the NMP-1 top guide." Discuss how much the actual loads for other plants could vary from the loads associated with the NMP-1 top guide, especially for those plants located at the active seismic region.

BWRVIP Response to RAI 4

As discussed previously, the inspection strategy is based upon the grid beams being stressed to their ASME Code allowable values. Therefore, plant specific loadings do not have to be evaluated. Table 8-2 is used to determine when scope expansion is required. As stated in Section 8.4, should indications be detected in any grid beam, a plant specific analysis will have to be performed. Again to reiterate, Appendix A is provided in BWRVIP-183 only as an example approach for evaluating any identified indications.

RAI 5

Appendix A.2.2, "Grid Beam Intersections," states that, "while the ends of the beams are directly attached to the top guide rim." Figure A-3 indicates that the bottom of the beam end plate elements contact the flat ring connecting the upper and lower shroud cylinders. Please confirm that the beam end plate elements are not attached to the flat ring in your FEA model per the original design.

BWRVIP Response to RAI 5

The top guide is supported vertically from the shroud ring between welds H2 and H3. Vertical up and down support is provided by four hold-down bolt clamping devices. In addition, vertical downward support is provided by four aligner pin assemblies, which also provide tangential support. The beam end plates are not attached to the flat ring in the FEA model. The beams are connected to the side cylinder of the rim, but not connected to the top and bottom flat rings of the rim. Therefore, the four hold down bolt clamping devices and four aligner pin assemblies are the only "connection" points in the FEA model. Refer to Figure A-4 of BWRVIP-183 and Figure 1 of this RAI response. This will be clarified in a revision to the report.

RAI 6

Appendix A.2.2 further states that, "[t]he top and bottom of each interlocking notch are coupled to the perpendicular beam's matching node (along the axial direction of the notched beam). This produces a three-node couple in the axial direction of the beam." For each pair of interlocking notches, there is only one contact point (i.e., the notch end of the lower beam contacts the matching notch end of the upper beam). At the contact point, these two notch ends have the same axial displacement, but are free in the remaining two translational and two rotational degrees of freedom. With this understanding, what does the "three-node couple" mean? Separately, confirm whether

the upper beams are firmly locked to the lower beams through interference fit along the entire length of the notches. How does the FEA model reflect this?

BWRVIP Response to RAI 6

The top and bottom of each inter-locking notch are coupled to the perpendicular beam's matching node (along the axial direction of the notched beam). This produces a couple in the axial direction of the beam. The inter-locking notches are also coupled at their contact point in the vertical direction, while the ends of the beams are directly attached to the top guide ring. See Figure 2 for a close up of a coupled intersection.

An interference fit at the intersection of the grid beams has not been assumed. The notches are specified as "Content Deleted – EPRI Proprietary Info", as is the thickness of the grid beams. | TS

RAI 7

Section A.2.3 states that, "the mid-radius for the upper shroud cylinder is "Content Deleted – EPRI Proprietary Info" | TS
"Content Deleted – EPRI Proprietary Info" for the lower shroud cylinder. This results in a "Content Deleted – EPRI Proprietary gap | TS
between the top guide rim and the lower shroud cylinder." This statement is misleading. It should be revised to, "the mid-radius for the top guide rim is "Content Deleted – EPRI Proprietary Info" | TS
"Content Deleted – EPRI Proprietary Info" for the lower shroud cylinder. This results in a "Content Deleted – EPRI Proprietary Info" gap | TS
between the top guide rim and the lower shroud cylinder." After the revision, another Section A.2.3 statement, "the mid-radius for the lower shroud cylinder is modeled the same as that for the top guide rim, "Content Deleted – EPRI Proprietary Info"," becomes clear to indicate that the 1" | TS
gap is not modeled in the FEM model.

BWRVIP Response to RAI 7

The BWRVIP agrees that the statement is misleading. This will be clarified in a revision to the report.

RAI 8

Section A.2.3 states that, "the top guide rim is seated on the lower shroud cylinder." However, Section A.2.4 states that, "the vertical separating between the top guide rim and the shroud is taken as "Content Deleted – EPRI Proprietary Info", instead of "Content Deleted – EPRI Proprietary Info"." Which one is | TS
true? If the latter one is, then do the spar elements provide the axial connection between the top guide rim and the lower shroud cylinder?

BWRVIP Response to RAI 8

The actual dimension in the finite element model is "Content Deleted – EPRI Proprietary Info" due to the fact that shell | TS
elements are used for modeling the shroud, and the hold-down bolt pads are not modeled. So, the top guide portion of the finite element model has been moved vertically downward about "Content Deleted – EPRI Proprietary Info". | TS

RIA 9

Sections A.3.2 to A.3.5 discuss seismic excitations in different directions. A typical statement in these sections describing the locations where pressure applies is, "a pressure "Content Deleted --EPRI Proprietary Info" is applied in the positive [or negative] X [or Z] direction, simulating a seismic motion in the negative [or positive] X [or Z] direction, to all cells having 4 fuel assemblies." Please use load case A.3.2 as an example to identify the surface(s) of a typical 4-fuel-assembly cell where the pressure is applied in the FEA model. TS

BWRVIP Response to RAI 9

Refer to Figure 3.

Additional Information Provided by the BWRVIP Regarding BWRVIP-183

Upon further review of the report, it was determined that the report did not address the various grid beam heights in the BWR fleet. Therefore, Table 8-2 of BWRVIP-183 will be revised to include grid beam heights that envelop the BWR fleet. In addition, it will be noted the flaw lengths are only applicable at grid beam locations away from "notches and slots". A plant-specific evaluation will be required for notches and slots.

"Content Deleted --EPRI Proprietary Information" TS

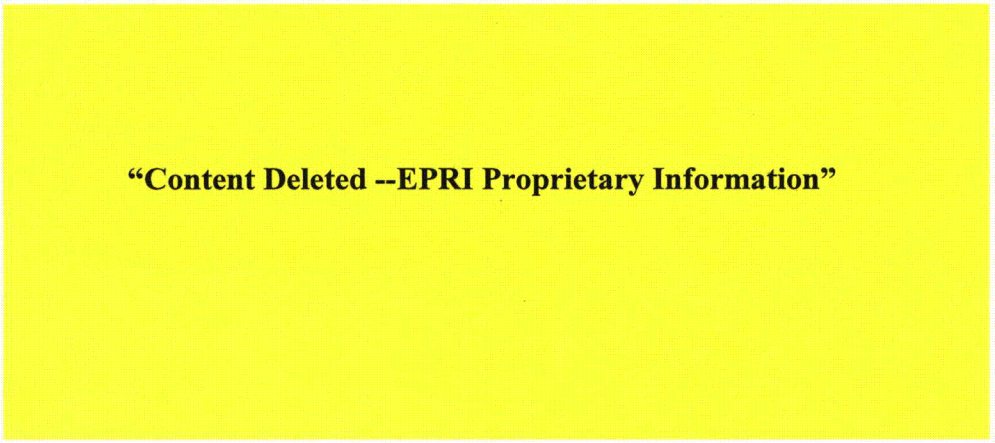

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Figure 1. Modeling of Grid Beam to Top Guide

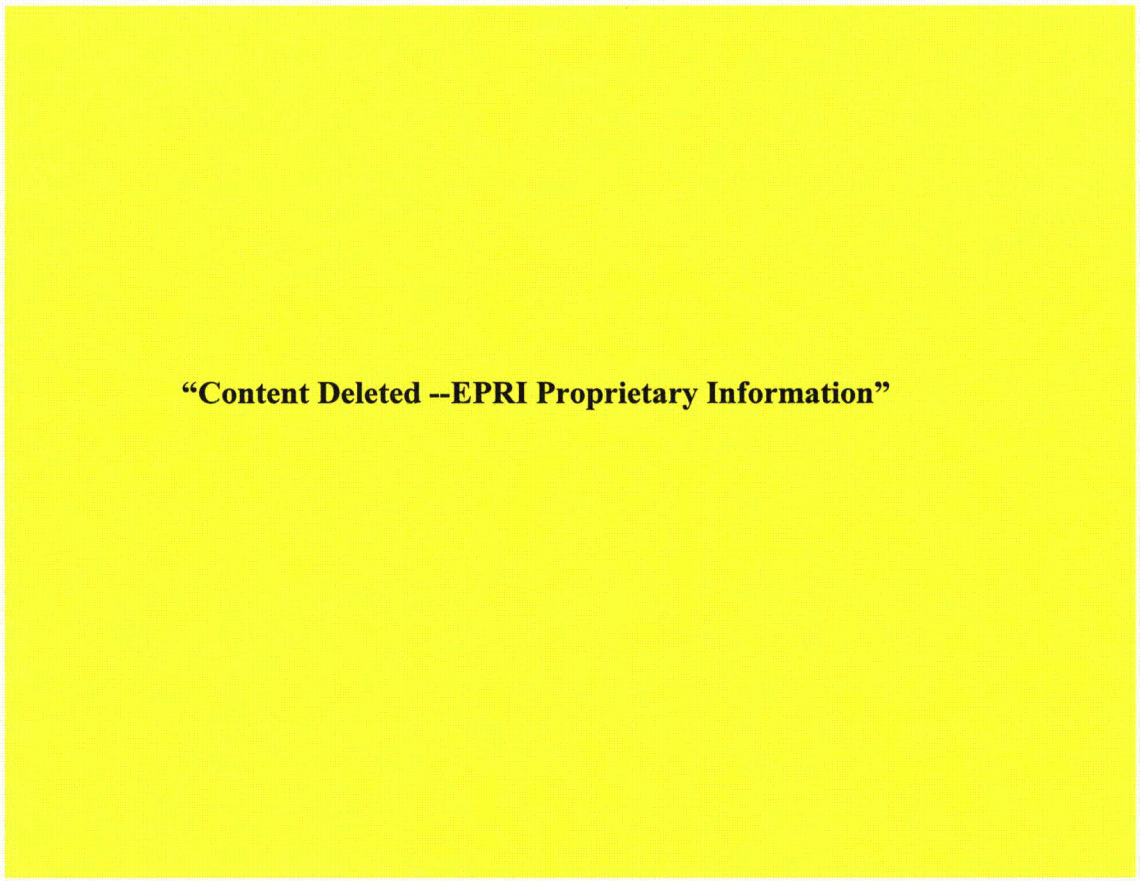

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Figure 2. Coupling at Intersections

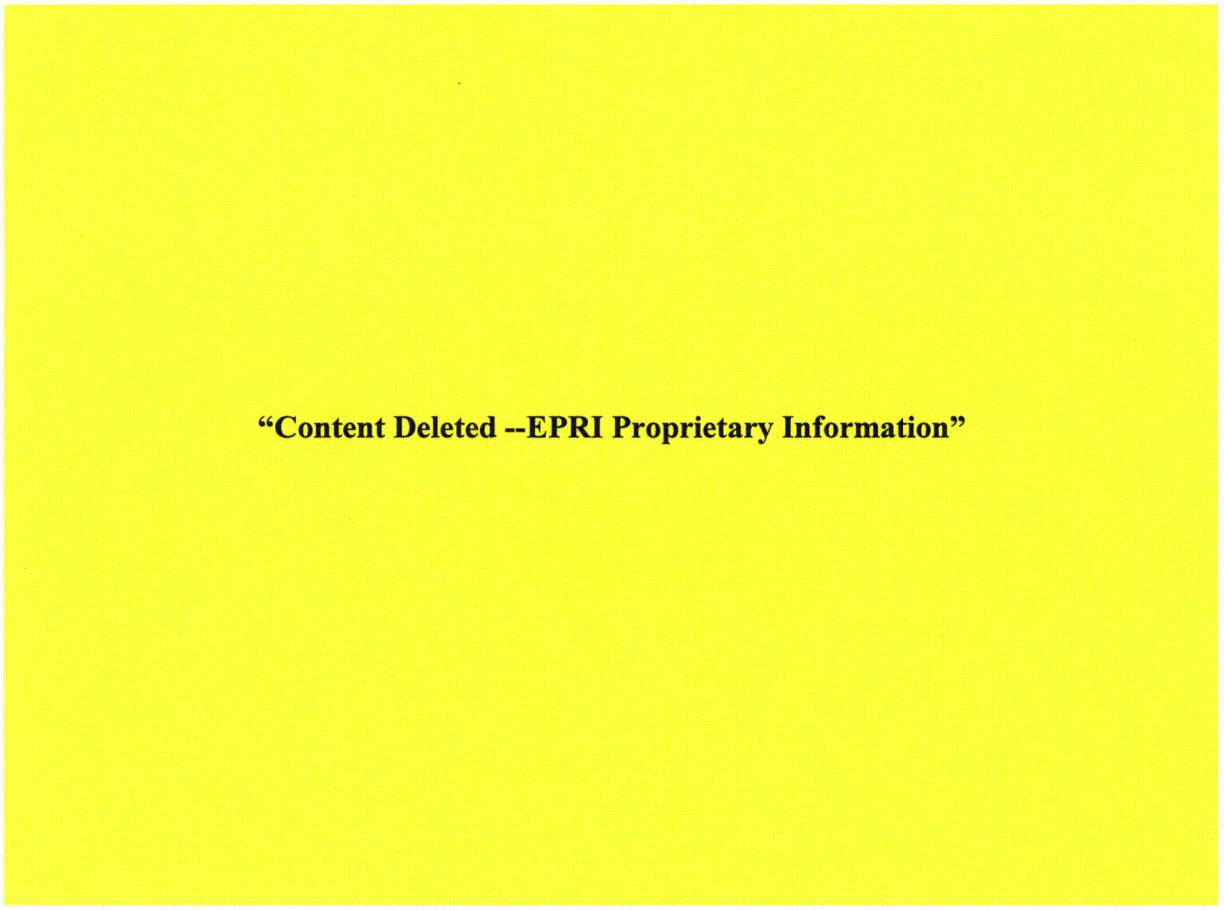

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Figure 3. Seismic Evaluation in the X-Direction