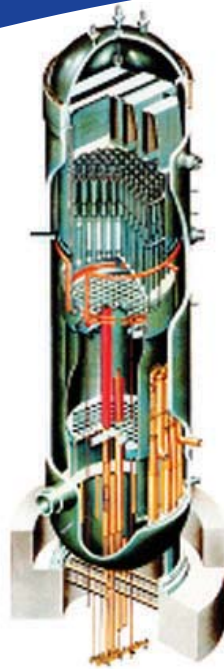


TR-105696-R17 (BWRVIP-03NP) Revision 17: BWR Vessel and Internals Project

Reactor Pressure Vessel and Internals Examination Guidelines



NON-PROPRIETARY INFORMATION

NOTICE: This report contains the non-proprietary information that is included in the proprietary version of this report. The proprietary version of this report contains proprietary information that is the intellectual property of EPRI. Accordingly, the proprietary report is available only under license from EPRI and may not be reproduced or disclosed, wholly or in part, by any licensee to any other person or organization.

TR-105696-R17 (BWRVIP-03NP) Revision 17: BWR Vessel and Internals Project

Reactor Pressure Vessel and Internals
Examination Guidelines

3002003091NP

Final Report, May 2015

EPRI Project Manager
J. Landrum

All or a portion of the requirements of the EPRI Nuclear
Quality Assurance Program apply to this product.

YES



DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

THIS DOCUMENT WAS PREPARED BY THE ORGANIZATION(S) NAMED BELOW AS AN ACCOUNT OF WORK SPONSORED OR COSPONSORED BY THE ELECTRIC POWER RESEARCH INSTITUTE, INC. (EPRI). NEITHER EPRI, ANY MEMBER OF EPRI, ANY COSPONSOR, THE ORGANIZATION(S) BELOW, NOR ANY PERSON ACTING ON BEHALF OF ANY OF THEM:

(A) MAKES ANY WARRANTY OR REPRESENTATION WHATSOEVER, EXPRESS OR IMPLIED, (I) WITH RESPECT TO THE USE OF ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR (II) THAT SUCH USE DOES NOT INFRINGE ON OR INTERFERE WITH PRIVATELY OWNED RIGHTS, INCLUDING ANY PARTY'S INTELLECTUAL PROPERTY, OR (III) THAT THIS DOCUMENT IS SUITABLE TO ANY PARTICULAR USER'S CIRCUMSTANCE; OR

(B) ASSUMES RESPONSIBILITY FOR ANY DAMAGES OR OTHER LIABILITY WHATSOEVER (INCLUDING ANY CONSEQUENTIAL DAMAGES, EVEN IF EPRI OR ANY EPRI REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) RESULTING FROM YOUR SELECTION OR USE OF THIS DOCUMENT OR ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT.

REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY ITS TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE, DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY EPRI.

THE ELECTRIC POWER RESEARCH INSTITUTE (EPRI) PREPARED THIS REPORT.

NON-PROPRIETARY INFORMATION

NOTICE: This report contains the non-proprietary information that is included in the proprietary version of this report. The proprietary version of this report contains proprietary information that is the intellectual property of EPRI. Accordingly, the proprietary report is available only under license from EPRI and may not be reproduced or disclosed, wholly or in part, by any licensee to any other person or organization.

THE TECHNICAL CONTENTS OF THIS PRODUCT WERE **NOT** PREPARED IN ACCORDANCE WITH THE EPRI QUALITY PROGRAM MANUAL THAT FULFILLS THE REQUIREMENTS OF 10 CFR 50, APPENDIX B. THIS PRODUCT IS **NOT** SUBJECT TO THE REQUIREMENTS OF 10 CFR PART 21.

NOTE

For further information about EPRI, call the EPRI Customer Assistance Center at 800.313.3774 or e-mail askepri@epri.com.

Electric Power Research Institute, EPRI, and TOGETHER...SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.

Copyright © 2015 Electric Power Research Institute, Inc. All rights reserved.

ACKNOWLEDGMENTS

The Electric Power Research Institute (EPRI) prepared this report.

Principal Investigator
BWRVIP Inspection Focus Group

This report describes research sponsored by EPRI and its Boiling Water Reactor Vessel and Internals Project (BWRVIP) participating members.

The BWRVIP Inspection Focus Group acknowledges the support of General Electric, Visual Inspection Technologies, Imaging and Sensing Technologies, RJ Electronics, and Framatome Technologies in providing personnel and equipment for demonstration of visual examination techniques.

The following staff of the EPRI NDE Program are acknowledged for contributing to the completion of this document:

Mark Dennis
Brett Flesner
Jeff Landrum
Greg Selby
Paul Zayicek

This publication is a corporate document that should be cited in the literature in the following manner:

TR-105696-R17 (BWRVIP-03NP) Revision 17: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines. EPRI, Palo Alto, CA: 2015.
3002003091NP.

PRODUCT DESCRIPTION

This report provides the boiling water reactor (BWR) fleet with inspection options for all of the safety-related vessel internal components, and provides a stable mechanism for documenting the capability of the evolving inspection technology. It is the sole resource for internals inspection information for BWR owners.

Background

In 1990, a visual examination of the core shroud of a Swiss BWR revealed the presence of intergranular stress corrosion cracking. Since that event, examinations of other BWR vessel internal components have revealed an industry-wide cracking problem. In 1994, domestic BWR-owning utilities formed the Boiling Water Reactor Vessel and Internals Project (BWRVIP), which is chartered to support a program addressing the problems of reactor internals, internal attachments, vessel welds, and vessel nozzles. Most international BWR owners have become members. This annual report defines inspection standards and documented inspection techniques for BWR vessel internal components.

Objectives

In-service inspection program managers and BWR vessel internals program managers use this document to ensure that their components are inspected in compliance with BWRVIP guidance.

Approach

The BWRVIP strives to make effective inspection techniques available by developing inspection standards that can ensure the structural integrity of the components and providing demonstrated, documented techniques for effectively examining the susceptible components.

Results

Procedure standards have been developed for ultrasonic, visual, and eddy current inspection. Many inspection techniques have been demonstrated and documented. In support of these demonstrations, realistic mockups of reactor internal components have been manufactured with controlled flaws. BWR owners can use these documented techniques to inspect their vessel internal components in compliance with BWRVIP guidance.

Applications, Value, and Use

The information contained in this report is applied by all BWR owners in the preparation for and during refueling outages. It is updated annually.

Keywords

BWRVIP

NDE

Internals

Inspection

Ultrasound

Vessel

EXECUTIVE SUMMARY

This document presents findings and products of the Inspection Focus Group of the Boiling Water Reactor Vessel and Internals Project (BWRVIP). An overview of the structure of the BWRVIP is presented, with an outline of the goals and approach of the Focus Group.

The Inspection Focus Group has developed guideline documents which establish protocols for utilities and nondestructive evaluation (NDE) vendor companies to follow in order to gain access to BWRVIP-owned mockups; to perform formal demonstrations of NDE techniques using BWRVIP mockups; and to perform their own demonstrations of NDE techniques or inspection tooling in a manner acceptable to the Focus Group. These documents are included in their entirety.

The Focus Group has conducted extensive investigations and demonstrations of NDE techniques appropriate for inspection of BWR internals. These efforts have included the design, fabrication, and inspection of a series of realistic mockups containing realistic simulations of the degradation mechanisms of concern. These investigations result in the development of evaluation factors, which are numerical values, related to the uncertainties inherent in delivering and executing an NDE technique in a BWR. These evaluation factors are combined with the actual results of an inspection to form input into a fracture-mechanics assessment of the component's serviceability.

The Focus Group's activities are ongoing. The various components of BWR vessels and internals are being addressed in concert with other technical Committee efforts. For components addressed to date, this report includes data on mockup fabrication, NDE uncertainty measurements and evaluation factors, and procedure standards for ultrasonic examination, eddy current examination, and visual examination.

This is a living document. Updates to the included data on components that have already been addressed, and new report sections on components that have not yet been addressed, will be supplied as they are developed. A history of changes is included within the document.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 17

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R16 (BWRVIP-03) Revision 16: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 3002000664, December 2013).

Affected Section(s)	Description of Change
4.3.1.7	Revised to show modifications to an existing shroud weld H1 mockup (BWRVIP-H1) that included adding core spray sparger brackets and associated flaws.
Table 4.4.2-1	Updated to include new NDE demonstrations.
4.4.75–4.4.78	New sections: new NDE technique demonstrations.
Table 5.4-1	Updated to include a new NDE demonstration.
5.4.59	New section: new NDE technique demonstration.
Table 6.4.2-1	Updated to include new NDE demonstrations.
6.4.37	Revised demonstration to clarify access.
6.4.65–6.4.67	New sections: new NDE technique demonstrations.
7.4.3	New section: new NDE technique demonstration.

Table 10.4-1	Updated to include new NDE demonstrations.
10.4.25–10.4.27	New sections: new NDE technique demonstrations.
14	Revised section to include discussion related to the inspection of instrument penetrations and to add new NDE mockups.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 16

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R15 (BWRVIP-03) Revision 15: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1025142, December 2012).

Affected Section(s)	Description of Change
Section 3.1	Revised to clarify guidance for flaw measurement accuracy of visual indications including treatment of NDE uncertainty as described in BWRVIP letter 2004-426, which was approved by the NRC on December 23, 2011 (reference: ADAMS accession numbers ML113550419 and ML113110505)
Table 4.4.2-1	Updated to reflect archival of NDE demonstrations.
4.4.23, 4.4.24, 4.4.33	Revised to reflect UT demonstrations that have been archived.
Table 5.4-1	Updated to reflect archival of NDE demonstrations.
5.4.12, 5.4.26	Revised to reflect UT demonstrations that have been archived.
Table 6.4.2-1	Updated to reflect archival of NDE demonstrations.
6.4.15, 6.4.16, 6.4.17, 6.4.23, 6.4.24	Revised to reflect UT demonstrations that have been archived.
8.4	Revised to add UT demonstration summary table.
8.4.5	New section: new NDE technique demonstration.
Table 10.4-1	Updated to reflect archival of NDE demonstrations.

10.4.4, 10.4.5, 10.4.6, 10.4.7	Revised to reflect UT demonstrations that have been archived.
12.4.1	New section for UT demonstration summary table.
12.4.2	New section: new NDE technique demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 15

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R14 (BWRVIP-03) Revision 14: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1022848, December 2011).

Affected Section(s)	Description of Change
1.4	Add nine-month implementation requirement.
4.3.1.12	New section documenting new NDE mockup.
Table 4.4.2-1	Updated to document new demonstrations.
4.4.69–4.4.74	New sections: new NDE technique demonstrations.
Table 5.4-1	Updated to document new demonstration.
5.4.58	New section: new NDE technique demonstration.
Table 6.4.2-1	Updated to document new demonstrations.
6.4.53–6.4.64	New sections: new NDE technique demonstrations.
12.3	New section documenting new NDE mockup.
Table 15.4.1-1	Updated to document new demonstrations.
15.4.4–15.4.7	New sections: new NDE technique demonstrations.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 14

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R13 (BWRVIP-03) Revision 13: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1021007, December 2010).

Affected Section(s)	Description of Change
Table 4.4.2-1	Updated to document new demonstrations.
4.4.67–4.4.68	New sections: new NDE technique demonstrations.
Table 5.4-1	Added table for UT demonstration summary.
5.4.53–5.4.57	New sections: new NDE technique demonstrations.
6.3.1.6	New section documenting new NDE mockups.
10.3.6	New section documenting new NDE mockups.
Table 10.4-1	Added table for UT demonstration summary.
10.4.24	New section: new NDE technique demonstration.
13.3.2	New section documenting new NDE mockup.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 13

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R12 (BWRVIP-03) Revision 12: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1019075, December 2009).

Affected Section(s)	Description of Change
	Deleted the Inspection Focus Group roster.
2.5, Para. 6.0	Clarified intent of performing cleaning assessments.
Table 4.4.2-1	Updated to document new demonstrations.
4.4.62–4.4.66	New sections: new NDE technique demonstrations.
5.4.50–5.4.52	New sections: new NDE technique demonstrations.
Table 6.4.2-1	Updated to document new demonstrations.
6.4.44–6.4.52	New sections: new NDE technique demonstrations.
7	Revised section to incorporate new inspection guidance for grid beams and to include new NDE mockups.
10.4.23	New section: new NDE technique demonstration.
10.6.5	New section: new delivery tool demonstration.
Table 15.4.1-1	Updated to document new demonstrations.
15.4.3	New section: new NDE technique demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 12

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R11 (BWRVIP-03) Revision 11: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1016584, December 2008).

Affected Section(s)	Description of Change
xxxiii	Updated the Inspection Focus Group roster.
4.3.1.10	Added new radial ring segment mockup.
4.3.1.11	Added new top guide support ring-to-cylinder mockup.
Table 4.4.2-1	Updated to reflect archival of NDE demonstrations and to document new demonstrations.
4.4.10, 4.4.11, 4.4.12, 4.4.13, 4.4.14, 4.4.15, 4.4.19, 4.4.20, 4.4.25, 4.4.26, 4.4.28, 4.4.29, 4.4.30, 4.4.34, 4.4.39	Revised to reflect UT demonstrations that have been archived.
4.4.59–4.4.61	New sections: new NDE technique demonstrations.
4.7.8	New section: new delivery tool demonstration.
5.3.1	Revised section to incorporate new NDE mockup for weld H7.
5.4.7, 5.4.8, 5.4.9, 5.4.10, 5.4.13, 5.4.15, 5.4.16, 5.4.20, 5.4.21, 5.4.22, 5.4.33, 5.4.34, 5.4.35	Revised to reflect UT demonstrations that have been archived.

5.4.47–5.4.49	New sections: new NDE technique demonstrations.
Table 6.4.2.-1	Updated to reflect archival of NDE demonstrations.
6.4.3–6.4.4	Revised to reflect UT demonstrations that have been archived.
7.4.2	Revised to reflect UT demonstration that has been archived.
8.4.3	Revised to reflect UT demonstration that has been archived.
10.3.5	Updated to include new description and drawings of jet pump beam mockups.
10.4.8, 10.4.13, 10.4.14, 10.4.17, 10.4.18	Revised to reflect UT demonstrations that have been archived.
10.4.22	New section: new NDE technique demonstration.
13.3	Added new control rod drive housing NDE mockup.
13.4.1	New section: new NDE technique demonstration.
15	New section: added new section addressing access hole covers.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 11

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R10 (BWRVIP-03) Revision 10: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1014993, December 2007).

Affected Section(s)	Description of Change
xxxi	Updated the Inspection Focus Group roster.
2.6, Para. 3.3	Clarified requirement for qualifications of UT analysis personnel with regard to automated versus manual IGSCC qualifications.
2.6, Para. 4.2	Updated UT technique parameters to include key elements associated with application of phased array techniques.
2.6, Para. 4.3	Added guidance to assist with updates of UT hardware and software for evaluating impact on published BWRVIP demonstrations.
2.6, Para. 9.1	Clarified requirement for UT data analyst to review examination data quality.
Table 4.4.2-1	Updated to reflect new NDE technique demonstration.
4.4.58	New section: new NDE technique demonstration.
6.3.1.6	New section: new NDE mockups for core spray.
10.3.3	Updated to reflect the addition of an NDE mockup for the jet pump downcomer mixer weld.
10.4.19–10.4.21	New sections: new NDE technique demonstrations.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 10

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R9 (BWRVIP-03) Revision 9: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1013394, December 2006).

Affected Section(s)	Description of Change
xxvii	Updated the Inspection Focus Group roster.
2.5, Para. 2.3	Clarified requirement for performing a VT-1 or VT-3 in accordance with a BWRVIP document versus in accordance with the utility's ASME Section XI requirements.
2.5, Para. 3.6	Changed the definition of Enhanced VT-1 (EVT-1) from requiring ½ mil resolution to requiring the capability of resolving the ASME Code Section XI VT-1 0.044 inch characters.
2.5, Para. 5.1	Deleted the requirement for the ½ mil SRCS and added the requirement for ASME Code Section XI VT-1 0.044 inch characters as a required SRCS.
2.5, Para. 6.3.2	Updated to reflect requirement for resolving the ASME Code Section XI VT-1 0.044 inch characters.
2.5, Para. 6.5.5	Added requirement for camera motion (speed) during examination to not exceed 0.5 inch/sec.
2.5, Para. 6.5.6	Changed requirement for camera angle to not exceed 30 degrees from perpendicular to the surface.
Table 4.4.2-1	Updated to reflect new NDE technique demonstrations and included reference to vertical welds in the applicable weld(s) column.

4.4.47–4.4.57	New sections: new NDE technique demonstrations.
5.4.40–5.4.46	New sections: new NDE technique demonstrations.
Table 6.4.2-1	Updated to reflect new NDE technique demonstrations.
6.4.40–6.4.43	New sections: new NDE technique demonstrations.
10.4.18	New section: new NDE technique demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 9

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected paragraphs of *TR-105696-R8 (BWRVIP-03) Revision 8: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1011689, December 2005).

Affected Section(s)	Description of Change
xxvii	Updated the Inspection Focus Group roster.
Chapter 1	Updated to include NEI 03-08 Implementation Requirements.
Table 4.4.2-1	Updated to reflect new NDE technique demonstrations.
4.4.42–4.4.46	New sections: new NDE technique demonstrations.
5.3.2	Added two new shroud support mockups.
Table 6.4.2-1	Updated to reflect new NDE technique demonstrations.
6.4.36–6.4.39	New sections: new NDE technique demonstrations.
10.4.14	Corrected errata.
10.4.15–10.4.17	New sections: new NDE technique demonstrations.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 8

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994, Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected Paragraphs of *TR-105696-R7 (BWRVIP-03) Revision 7: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI Report 1009910, December 2004).

Affected Section(s)	Description of Change
xxv	Updated the Inspection Focus Group roster.
2.5, Para. 4.3	Added guidance for visual examination training, regarding detection and reporting of unusual crud deposits on the vessel interior or internals.
2.5, Para. 6.3.2	Clarified EVT-1 guidance to require that the resolution targets must be seen as a dark object; detection only of the bright, glinting reflection of the lights is not adequate.
2.6, Para. 3.1	Clarified UT personnel requirements to include CP-189 in addition to ASNT-TC-1A.
2.6, Para. 3.3	Corrected errata.
2.6, Para. 7.3	Clarified discussion of one-sided UT access. This change was also made in many report sections documenting individual technique demonstrations.
2.6, Para. 7.5	Clarified requirement for adequate recording of transducer position data in ultrasonic examination.
2.6, Para. 11.0	New paragraph, providing background information on UT with one-sided access.

2.7, Para. 3.1	Clarified ET personnel requirements to include CP-189 in addition to ASNT-TC-1A.
4.4.36, 5.4.21	Corrected errata.
4.4.37–4.4.41	New sections: New NDE technique demonstrations.
4.7.6–4.4.7	New sections: New delivery system demonstrations.
5.4.37–5.4.39	New sections: New NDE technique demonstrations.
5.6.4	New section: New delivery system demonstration.
10.3.5	Added documentation of new jet pump beam mockups.
10.4.1	Modified discussion of single-side access, for consistency with similar discussions elsewhere in the document.
10.4.11–10.4.14, 10.5.2	New sections: New NDE technique demonstrations.
10.6.4	New section: New delivery system demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 7

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)* (EPRI Report TR-105696, October 1995). The changes listed below supersede the affected Paragraphs of *TR-105696-R6 (BWRVIP-03) Revision 6: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines*, (EPRI Report 1008061, December 2003).

Affected Section(s)	Description of Change
xxxiii	Updated the Inspection Focus Group roster.
Chapter 1	Replaced all references to Inspection Committee with Focus Group.
2.5, Para. 3.5	Removed recording medium, water clarity, and lighting from list of key elements.
2.5, Para. 6.2	Changed title from Minimum Water Clarity to Environmental Conditions.
2.5, Para. 6.2.2	Added lighting conditions as an environmental condition, along with water clarity.
2.6, Para. 3.3, 4.1	Clarified UT qualifications that are required for standby liquid control welds and recognizes the recent availability of qualified manual examiners.
2.6, Para. 5.2	Clarified acceptability of normal variation in transducer frequency.
4.3.1.8, 4.3.1.9	New sections: Added documentation of new mockups BWRVIP-SSC-1 and BWRVIP-H6OH.
4.4.2	Added new Demonstration References for UT Demonstrations 33 and 34.

4.4.35, 4.4.36	New sections: New NDE technique demonstrations.
5.3.2	Changed the word six to seven in the first line of the third paragraph.
5.4.21	Corrected an erratum and clarified the description of a technique's performance.
5.4.29–36	New sections: New NDE technique demonstrations.
10.2	Added a paragraph providing VT-1 guidance for viewing jet pump wedges.
11.1	Updated BWRVIP-27 to BWRVIP-27A where necessary.
11.2.3, 11.2.4	Updated guidance for SLC examination to include all allowable inspection alternatives: volumetric every ten years, surface examination every other outage, or enhanced leakage inspection every outage. Enhanced leakage inspection is to be performed with the insulation removed.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 6

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. The changes listed below supersede the affected paragraphs of *TR-105696R5 (BWRVIP-03) Revision 5: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines, December 2002*.

Affected Section(s)	Description of Change
xix	Updated the Inspection Focus Group roster.
5.4.27 – 5.4.28	New sections: New NDE technique demonstrations.
5.6.3	New section: New NDE delivery system demonstration.
6.4.32 - 6.4.35	New sections: New NDE technique demonstrations.
All NDE technique and delivery system demonstrations	Added the publication date of each demonstration.
Many UT demonstrations	Where appropriate, added a note stating the need to ultrasonically examine stainless steel and nickel-alloy welds from both directions if possible. (The same note was already present in generic form in Section 2.6, the UT Standard. This action identifies more clearly which UT technique demonstrations it applies to.)

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 5

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. The changes listed below supersede the affected paragraphs of *TR-105696R4 (BWRVIP-03) Revision 4: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines*.

Affected Section(s)	Description of Change
xvii	Updated the Inspection Focus Group roster.
2.5, Para. 8.1.2	Clarifies documentation of EVT-1 examination coverage to recognize access limitations. Documentation must include an estimate of the percentage of the examination area that was covered with EVT-1 quality.
2.6 and 2.7, Para. 2.4	New paragraphs. References ASNT CP-189 in addition to SNT-TC-1A for qualification and certification of examination personnel.
2.6, Para. 3.3	Clarifies qualification requirements for personnel performing UT. Provides personnel qualification requirements for examining standby liquid control welds, and for determining whether flaws have propagated into the pressure vessel. Deleted Paragraph 3.3.3.2, which was made redundant by this change.
2.6, Para. 7.3	New paragraph. States the need to ultrasonically examine stainless steel and nickel-alloy welds from both directions.
4.4.2, 6.4.2	Updated demonstration tables.
4.4.33–4.4.34	New sections: New NDE technique demonstrations.
4.7.5	New section: New NDE delivery system demonstration.
6.3.1.4	Added documentation of core spray tee box mockup BWRVIP-N.
6.4.18, 6.4.19 and 6.4.24	Withdrew UT demonstrations for core spray hidden weld P9 because of recent findings from a new, more comprehensive set of mockups.
6.4.26–6.4.31	New sections: New NDE technique demonstrations.
10.4.10	New section: New NDE technique demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 4

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. The changes listed below supersede the affected paragraphs of *TR-105696R3 (BWRVIP-03) Revision 3 December 2000: Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines*.

Affected Section(s)	Description of Change
xvii	Updated the Committee roster.
2.6, Para. 3.3	Clarifies prerequisite for UT data analysis personnel: their IGSCC qualification must be on non-overlaid components.
4.1, 5.1, 6.1, 7.1, 8.2, 9.2, 10.2, 11.2, 12.2, 13.2	Clarifies that examination procedures must be appropriate to the specific configuration of the plant. Previously “utility-specific” procedures were called for. This change of wording is intended to remove any suggestion that the procedures must be tied administratively to the specific utility.
4.4.2, 6.4.2	Updated demonstration tables.
4.4.29–4.4.32	New sections: New NDE technique demonstrations.
5.3.5	New section: Description of BWR/2 H8/H9 mockups.
5.4.23–5.4.26	New sections: New NDE technique demonstrations.
5.6.2	New section: New NDE delivery system demonstration.
6.4.21–6.4.25	New sections: New NDE technique demonstrations.
8.4.4	New section: New NDE technique demonstration.
TOC, Figure 6.3.1.5-1, 11.2.3	Correction of errata.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 3

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee *document BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 *document Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. The changes listed below supersede the affected paragraphs of the December 1999 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03) Revision 2*.

Affected Section(s)	Description of Change
1	Updated the Committee roster.
2.5, Para. 8.1.3	For EVT-1, recommends that the method of measuring flaw length (estimation or ruler) be recorded.
5.3.4	Updated the description of shroud support mockups.
5.4.21, 5.4.22	New sections: New NDE technique demonstrations.
6.2.2, 9.2, 10.2	Updates status of hidden welds.
6.3.1.5	New section: description of BWR/6 core spray mockup.
6.4.20	New section: New NDE technique demonstration.
10.4.9, 10.5.1	New sections: New NDE technique demonstrations.
13.3	Updated the status of control rod guide tube mockup.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 2

This is a living document. Updates to the included data will be added as they are developed. Minor or editorial changes may not appear in this summary listing of significant changes. This document supersedes the November 21, 1994 Inspection Committee document *BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*. The changes listed below supersede the affected paragraphs of the March 1999 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03) Revision 1*.

Affected Section(s)	Description of Change
1	Updated the Committee roster.
2.6, Paragraph 3.3	Modified the personnel qualification requirements for selected examinations.
3.0	Correction: Changed heading numbers to correspond with rest of the document.
4.3.1.7	New section: Description of new mockup BWRVIP-H1.
4.4.28	New section: New NDE technique demonstration.
5.4.20	New section: New NDE technique demonstration.
6.3.1.2	Correction: Figure 6.3.1.2-4 correct image inserted.
6.4.18-19	New sections: New NDE technique demonstrations.
8.4.3	New section: New NDE technique demonstration.

HISTORY OF CHANGES TO THIS DOCUMENT

REVISION 1

This is a living document. Updates to the included data on components that had already been addressed, and new report sections on components that had not yet been addressed, will be added as they are developed. Minor or editorial changes may not appear in this listing. This document supersedes the November 21, 1994 Inspection *Committee document BWR-VIP Core Shroud NDE Uncertainty & Procedure Standard* and the October 1995 document *Boiling Water Reactor Pressure Vessel and Internals Examination Guidelines (BWRVIP-03)*.

Affected Section(s)	Description of Change
1	Updated the Committee roster and Acknowledgments.
2.1 - 2.4	Changes to administrative procedures, made necessary by discontinuation of referenced Inspection Committee working groups. Revised key elements for visual inspection.
2.5	New section: “Generic Standards for Visual Examination of Reactor Pressure Vessel Internals, Components, and Associated Repairs.”
2.6	New section: “Generic Standards for Ultrasonic Examination of BWR Vessel Internal Components.”
2.7	New section: “Generic Standards for Eddy Current Examination of BWR Vessel Internal Components.”
3.0	New section: “Demonstration of Accuracy of Flaw Length Measurement by Visual Examination.” This section replaces the existing Section 3.
3.0	Correction: Changed heading numbers to correspond with rest of the document.
4	Added reference to generic NDE standards, Sections 2.5 – 2.7.
4.3	Added documentation of new mockups.

4.4.19 – 4.4.26, 4.6.5 – 4.6.6, 4.7.3	New sections: Documentation of NDE demonstrations conducted since issuance of prior documents.
4A, 4B, 4C	Deleted. Shroud-specific NDE standards deleted, references to generic standards in Sections 2.5 – 2.7 added.
5	Added reference to generic NDE standards, Sections 2.5 – 2.7.
5.3	Added documentation of new mockups.
5.4.10 – 5.4.18	New sections: Documentation of NDE demonstrations conducted since issuance of prior documents.
6	New section: Core Spray Piping and Sparger. These components had not been addressed in prior documents, except for Section 6A, “Standards for Visual Inspection of Core Spray Piping, Spargers, and Associated Components.”
6A	Section 6A, “Standards for Visual Inspection of Core Spray Piping, Spargers, and Associated Components,” is now deleted and Section 2.5 is referenced instead. New Section 6A: “Investigation of Core Spray Internal Piping Overlay Inspection.”
7	New section: Top Guide.
8	New section: Core Plate.
9	New section: LPCI Coupling.
10	New section: Jet Pump Assembly.
11	New section: Standby Liquid Control.
12	New section: Vessel Attachments.
13	New section: Lower Plenum.
14	New section: Vessel Penetrations.

CONTENTS

1 BWRVIP OVERVIEW AND BACKGROUND	1-1
1.1 BWRVIP.....	1-1
1.2 BWRVIP Inspection Focus Group	1-1
1.3 General Approach to Inspection Support.....	1-2
1.4 Implementation Requirements.....	1-3
2 GENERAL PROCEDURES	2-1
2.1 Guidelines for Use of BWRVIP Mockups.....	2-2
1.0 Purpose.....	2-2
2.0 Reference.....	2-2
3.0 Guidelines for Usage	2-2
4.0 Guidelines for Use Prioritization.....	2-4
2.2 Protocol for NDE Technique Demonstrations on BWRVIP Mockups	2-5
1.0 Purpose.....	2-5
2.0 Responsibilities	2-5
3.0 Prerequisites	2-5
4.0 Demonstration Plan.....	2-6
5.0 Demonstration Process	2-6
6.0 Results Reporting and Documentation	2-7
2.3 Guidelines for Determining NDE Technique Uncertainty	2-8
1.0 Purpose.....	2-8
2.0 References.....	2-8
3.0 Responsibilities	2-8

4.0	Demonstration Process	2-9
5.0	Documentation	2-11
2.4	Guidelines for Determining Inspection Tool Positioning Uncertainty	2-13
1.0	Purpose	2-13
2.0	References	2-13
3.0	Responsibilities	2-13
4.0	Guidelines for Uncertainty Measurements	2-14
5.0	Demonstration Plan	2-14
6.0	Demonstration Process	2-14
7.0	Documentation	2-15
2.5	Generic Standards for Visual Inspection of Reactor Pressure Vessel Internals, Components, and Associated Repairs	2-16
1.0	Purpose	2-16
2.0	Scope	2-16
3.0	Definitions.....	2-16
4.0	Personnel Training/Experience.....	2-17
5.0	Equipment Requirements	2-19
6.0	Inspection Requirements.....	2-22
7.0	Evaluation of Indications.....	2-26
8.0	Documentation of Results.....	2-27
2.6	Generic Standards for Ultrasonic Examination of BWR Vessel Internal Components.....	2-28
1.0	Scope	2-28
2.0	References	2-28
3.0	Personnel	2-28
4.0	Technique Demonstrations.....	2-31
5.0	Equipment	2-31
6.0	Calibration	2-32
7.0	Examination.....	2-33

8.0	Recording.....	2-34
9.0	Evaluation.....	2-35
10.0	Reporting.....	2-35
11.0	Examination of Stainless Steel and Nickel-Alloy Welds with Single-Sided Access.....	2-36
2.7	Generic Standards for Eddy Current Examination of BWR Vessel Internal Components.....	2-40
1.0	Scope.....	2-40
2.0	References.....	2-40
3.0	Personnel.....	2-40
4.0	Technique Demonstration.....	2-41
5.0	Equipment.....	2-41
6.0	Calibration.....	2-42
7.0	Examination.....	2-42
8.0	Recording.....	2-44
9.0	Evaluation.....	2-44
10.0	Reporting.....	2-44

3	DEMONSTRATION OF ACCURACY OF FLAW LENGTH MEASUREMENT BY VISUAL EXAMINATION.....	3-1
3.1	Summary.....	3-1
3.2	Demonstration.....	3-2
3.2.1	Vendors.....	3-2
3.2.2	Mockups.....	3-2
3.2.3	Flaws.....	3-3
3.2.4	Cameras.....	3-3
3.2.5	Measurement Techniques.....	3-3
3.3	Sizing Performance.....	3-3
3.3.1	Estimation.....	3-4
3.3.2	Measurement by Ruler.....	3-5

4 SHROUD	4-1
4.1 Summary.....	4-1
4.2 Inspection Considerations	4-2
4.3 Applicable Mockups	4-3
4.3.1 Shroud Weld Mockups.....	4-3
4.3.1.1 NDE Center’s Original H3 Mockup.....	4-4
4.3.1.2 Utility H3 and H4 Mockups.....	4-4
4.3.1.3 Shroud Block BWRVIP-A: Ring-to-Cylinder	4-4
4.3.1.4 Shroud Block BWRVIP-B: Ring-to-Cylinder	4-6
4.3.1.5 Shroud Block BWRVIP-C: Cylinder-to-Cylinder.....	4-8
4.3.1.6 Shroud Mockup BWRVIP-G and H: Ring Segment Welds	4-10
4.3.1.7 Shroud Mockup BWRVIP-H1: Shroud Weld H1	4-13
4.3.1.8 Shroud Mockup BWRVIP-SSC1: Shroud Scallops.....	4-15
4.3.1.9 Shroud Mockup BWRVIP-H6OH: Overhanging Core Plate Support Ring.....	4-17
4.3.1.10 Shroud Mockup BWRVIP-TGSR: Radial Ring Segment Mockup	4-17
4.3.1.11 BWRVIP-H2/H3: Top Guide Support Ring-to-Cylinder Mockup.....	4-18
4.3.1.12 BWR/6 H3 Core Shroud Weld Mockups (BWRVIP-BWR6-H3-A and BWRVIP-BWR6-H3-B).....	4-21
4.3.2 Special Purpose Mockups	4-24
4.3.2.1 Surface Roughness	4-24
4.3.2.2 Multiple Parallel Cracks	4-25
4.3.2.3 EDM Notches in Weld Toe.....	4-26
4.4 UT Technique Demonstrations for Core Shroud Welds	4-27
*4.4.1 General Findings for UT	4-27
*4.4.1.1 Detection of Shallow Reflectors	4-27
*4.4.1.2 Detection of Skewed Reflectors	4-27
*4.4.1.3 Effect of Multiple Parallel Defects.....	4-28
*4.4.1.4 Effect of Roughness of Scanning Surface.....	4-28

4.4.2	UT Demonstration Summary	4-29
4.4.3	UT Demonstration 1	4-34
4.4.4	UT Demonstration 2	4-35
4.4.5	UT Demonstration 3	4-36
4.4.6	UT Demonstration 4	4-38
4.4.7	UT Demonstration 5	4-39
4.4.8	UT Demonstration 6	4-40
4.4.9	UT Demonstration 7	4-41
4.4.10	UT Demonstration 8	4-42
4.4.11	UT Demonstration 9	4-43
4.4.12	UT Demonstration 10	4-44
4.4.13	UT Demonstration 11	4-45
4.4.14	UT Demonstration 12	4-46
4.4.15	UT Demonstration 13	4-47
4.4.16	UT Demonstration 14	4-48
4.4.17	UT Demonstration 15	4-49
4.4.18	UT Demonstration 16	4-50
4.4.19	UT Demonstration 17	4-53
4.4.20	UT Demonstration 18	4-54
4.4.21	UT Demonstration 19	4-55
4.4.22	UT Demonstration 20	4-56
4.4.23	UT Demonstration 21	4-58
4.4.24	UT Demonstration 22	4-59
4.4.25	UT Demonstration 23	4-60
4.4.26	UT Demonstration 24	4-61
4.4.27	UT Demonstration 25	4-62
4.4.28	UT Demonstration 26	4-65
4.4.29	UT Demonstration 27	4-66

4.4.30	UT Demonstration 28	4-67
4.4.31	UT Demonstration 29	4-68
4.4.32	UT Demonstration 30	4-70
4.4.33	UT Demonstration 31	4-72
4.4.34	UT Demonstration 32	4-73
4.4.35	UT Demonstration 33	4-74
4.4.36	UT Demonstration 34	4-76
4.4.37	UT Demonstration 35	4-78
4.4.38	UT Demonstration 36	4-80
4.4.39	UT Demonstration 37	4-82
4.4.40	UT Demonstration 38	4-83
4.4.41	UT Demonstration 39	4-86
4.4.42	UT Demonstration 40	4-88
4.4.43	UT Demonstration 41	4-91
4.4.44	UT Demonstration 42	4-93
4.4.45	UT Demonstration 43	4-95
4.4.46	UT Demonstration 44	4-97
4.4.47	UT Demonstration 45	4-100
4.4.48	UT Demonstration 46	4-102
4.4.49	UT Demonstration 47	4-105
4.4.50	UT Demonstration 48	4-107
4.4.51	UT Demonstration 49	4-109
4.4.52	UT Demonstration 50	4-112
4.4.53	UT Demonstration 51	4-114
4.4.54	UT Demonstration 52	4-116
4.4.55	UT Demonstration 53	4-118
4.4.56	UT Demonstration 54	4-120
4.4.57	UT Demonstration 55	4-123

4.4.58	UT Demonstration 56	4-125
4.4.59	UT Demonstration 57	4-129
4.4.60	UT Demonstration 58	4-132
4.4.61	UT Demonstration 59	4-134
4.4.62	UT Demonstration 60	4-137
4.4.63	UT Demonstration 61	4-140
4.4.64	UT Demonstration 62	4-144
4.4.65	UT Demonstration 63	4-147
4.4.66	UT Demonstration 64	4-151
4.4.67	UT Demonstration 65	4-155
4.4.68	UT Demonstration 66	4-158
4.4.69	UT Demonstration 67	4-162
4.4.70	UT Demonstration 68	4-165
4.4.71	UT Demonstration 69	4-170
4.4.72	UT Demonstration 70	4-173
4.4.73	UT Demonstration 71	4-177
4.4.74	UT Demonstration 72	4-181
4.4.75	UT Demonstration 73	4-186
4.4.76	UT Demonstration 74	4-191
4.4.77	UT Demonstration 75	4-196
4.4.78	UT Demonstration 76	4-208
4.5	VT Technique Demonstrations for Core Shroud Welds	4-219
*4.5.1	VT General Findings.....	4-219
4.5.1.1	Training.....	4-219
*4.5.2	VT Demonstration 1.....	4-219
4.6	ET Technique Demonstrations for Core Shroud Welds	4-222
4.6.1	ET General Findings.....	4-222
4.6.1.1	Detection of Skewed Reflectors	4-223

4.6.1.2	Effect of Scanning on a Rough Surface	4-223
4.6.1.3	Scan Pattern	4-224
*4.6.2	ET Demonstration 1	4-225
4.6.2.1	Crack Length Measurement.....	4-225
4.6.2.2	Optimum Parameters for ET Imaging.....	4-225
*4.6.3	ET Demonstration 2.....	4-228
4.6.4	ET Demonstration 3.....	4-229
4.6.4.1	Data Acquisition.....	4-229
4.6.4.2	Data Evaluation	4-229
4.6.5	ET Demonstration 4.....	4-230
4.6.6	ET Demonstration 5.....	4-231
4.7	Delivery System Demonstrations for Core Shroud Welds.....	4-235
*4.7.1	Delivery System Demonstration 1	4-236
*4.7.2	Delivery System Demonstration 2.....	4-237
4.7.3	Delivery System Demonstration 3.....	4-238
4.7.4	Delivery System Demonstration 4.....	4-239
4.7.5	Delivery System Demonstration 5.....	4-241
4.7.6	Delivery System Demonstration 6.....	4-243
4.7.7	Delivery System Demonstration 7.....	4-245
4.7.7.1	Flaw Length Measurement Within a Single Scan.....	4-245
4.7.7.2	Flaw Length Measurement Using More Than One Scan	4-245
4.7.8	Delivery System Demonstration 8.....	4-247
4.7.8.1	Horizontal Welds.....	4-248
4.7.8.2	Vertical Welds.....	4-248
4.7.8.3	H2/H3 Welds (Scanned from the Ledge).....	4-249
*4.8	References.....	4-251
5	SHROUD SUPPORT	5-1
5.1	Summary.....	5-1

5.2	Inspection Considerations	5-2
5.2.1	Chicago Bridge & Iron/CBI Nuclear Shroud Supports	5-2
5.2.2	Babcock & Wilcox Shroud Supports	5-3
5.2.3	Combustion Engineering Shroud Supports	5-4
5.2.3.1	Gusset Supports	5-4
5.2.3.2	Cone Skirt Support.....	5-5
5.2.3.3	Heavy Steel Baffle Plate	5-6
5.2.4	Inspection Access.....	5-7
5.3	Applicable Mockups	5-7
5.3.1	Shroud Support Mockup BWRVIP-D: Weld H7	5-7
5.3.2	Shroud Support Mockups BWRVIP-E, BWRVIP-E1, and BWRVIP-E2: Weld H9.....	5-12
5.3.3	Shroud Support Mockup BWRVIP-F: Weld H8	5-33
5.3.4	Shroud Support Mockups BWRVIP-P, BWRVIP-Q1, BWRVIP-Q2	5-39
5.3.5	Shroud Support Mockups BWRVIP-B2SS1 and BWRVIP-B2SS2	5-41
5.4	UT Technique Demonstrations for Core Shroud Support Welds.....	5-42
5.4.1	General Findings for UT	5-48
5.4.1.1	Effect of Alloy 82/182 Weld Material	5-48
5.4.1.2	Effect of Mismatch in the Fit-up of Weld H7	5-48
5.4.2	UT Demonstration 1	5-49
5.4.3	UT Demonstration 2	5-50
5.4.4	UT Demonstration 3	5-51
5.4.5	UT Demonstration 4	5-52
5.4.6	UT Demonstration 5	5-53
5.4.7	UT Demonstration 6	5-56
5.4.8	UT Demonstration 7	5-57
5.4.9	UT Demonstration 8	5-58
5.4.10	UT Demonstration 9	5-59
5.4.11	UT Demonstration 10	5-60

5.4.12	UT Demonstration 11	5-61
5.4.13	UT Demonstration 12	5-62
5.4.14	UT Demonstration 13	5-63
5.4.15	UT Demonstration 14	5-64
5.4.16	UT Demonstration 15	5-65
5.4.17	UT Demonstration 16	5-66
5.4.18	UT Demonstration 17	5-67
5.4.19	UT Demonstration 18	5-70
5.4.20	UT Demonstration 19	5-72
5.4.21	UT Demonstration 20	5-73
5.4.22	UT Demonstration 21	5-74
5.4.23	UT Demonstration 22	5-75
5.4.24	UT Demonstration 23	5-77
5.4.25	UT Demonstration 24	5-79
5.4.26	UT Demonstration 25	5-81
5.4.27	UT Demonstration 26	5-82
5.4.28	UT Demonstration 27	5-84
5.4.29	UT Demonstration 28	5-88
5.4.30	UT Demonstration 29	5-90
5.4.31	UT Demonstration 30	5-94
5.4.32	UT Demonstration 31	5-97
5.4.33	UT Demonstration 32	5-99
5.4.34	UT Demonstration 33	5-100
5.4.35	UT Demonstration 34	5-101
5.4.36	UT Demonstration 35	5-102
5.4.37	UT Demonstration 36	5-105
5.4.38	UT Demonstration 37	5-106
5.4.39	UT Demonstration 38	5-107

5.4.40	UT Demonstration 39	5-109
5.4.41	UT Demonstration 40	5-111
5.4.42	UT Demonstration 41	5-113
5.4.43	UT Demonstration 42	5-115
5.4.44	UT Demonstration 43	5-117
5.4.45	UT Demonstration 44	5-119
5.4.46	UT Demonstration 45	5-121
5.4.47	UT Demonstration 46	5-123
5.4.48	UT Demonstration 47	5-127
5.4.49	UT Demonstration 48	5-131
5.4.50	UT Demonstration 49	5-134
5.4.51	UT Demonstration 50	5-140
5.4.52	UT Demonstration 51	5-142
5.4.53	UT Demonstration 52	5-145
5.4.54	UT Demonstration 53	5-149
5.4.55	UT Demonstration 54	5-154
5.4.56	UT Demonstration 55	5-156
5.4.57	UT Demonstration 56	5-161
5.4.58	UT Demonstration 57	5-164
5.4.59	UT Demonstration 58	5-168
5.5	ET Technique Demonstrations for Core Shroud Support Welds.....	5-176
5.5.1	General Findings for ET.....	5-176
5.5.2	ET Demonstration 1.....	5-176
5.6	Delivery System Demonstrations for Core Shroud Support Welds	5-177
5.6.1	Delivery System Demonstration 1	5-177
5.6.2	Delivery System Demonstration 2.....	5-178
5.6.3	Delivery System Demonstration 3.....	5-179
5.6.4	Delivery System Demonstration 4.....	5-181

6 CORE SPRAY PIPING AND SPARGER	6-1
6.1 Summary.....	6-1
6.2 Inspection Considerations	6-2
6.2.1 Downcomer Sleeve	6-7
6.2.2 Tee Box Assembly.....	6-8
6.2.3 Shroud Connection Region.....	6-9
6.3 Applicable Mockups	6-9
6.3.1 Core Spray Mockups	6-9
6.3.1.1 Downcomer Sleeve Joint Mockup (BWRVIP-J).....	6-9
6.3.1.2 BWR/2 Shroud Penetration Mockup (BWRVIP-K).....	6-15
6.3.1.3 BWR/3-5 Shroud Penetration Mockup (BWRVIP-L).....	6-20
6.3.1.4 BWR/3-5 Core Spray Header Tee Box Mockups (BWRVIP-M and -N)	6-24
6.3.1.5 BWR/6 Core Spray Pipe Coupling Assembly Mockup (BWRVIP-CS6).....	6-24
6.3.1.6 BWR/3-6 P4a, P4b, and P4c Pipe-to-Elbow Mockups (BWRVIP-P4-1r, BWRVIP-P4-2r, and BWRVIP-P4-3).....	6-30
6.4 UT Technique Demonstrations for Core Spray Welds	6-34
6.4.1 General Findings for UT	6-34
6.4.1.1 Detection and Sizing of Flaws Parallel to the Weld	6-34
6.4.1.2 Detection of Flaws Transverse to the Weld.....	6-34
6.4.1.3 Effect of Roughness of Scanning Surface.....	6-34
6.4.2 UT Demonstration Summary	6-35
6.4.3 UT Demonstration 1	6-38
6.4.4 UT Demonstration 2	6-39
6.4.5 UT Demonstration 3	6-40
6.4.6 UT Demonstration 4	6-41
6.4.7 UT Demonstration 5	6-42
6.4.8 UT Demonstration 6	6-43
6.4.9 UT Demonstration 7	6-44
6.4.10 UT Demonstration 8	6-45

6.4.11	UT Demonstration 9	6-47
6.4.12	UT Demonstration 10	6-49
6.4.13	UT Demonstration 11	6-51
6.4.14	UT Demonstration 12	6-52
6.4.15	UT Demonstration 13	6-54
6.4.16	UT Demonstration 14	6-55
6.4.17	UT Demonstration 15	6-56
6.4.18	UT Demonstration 16	6-57
6.4.19	UT Demonstration 17	6-58
6.4.20	UT Demonstration 18	6-59
6.4.21	UT Demonstration 19	6-60
6.4.22	UT Demonstration 20	6-62
6.4.23	UT Demonstration 21	6-63
6.4.24	UT Demonstration 22	6-64
6.4.25	UT Demonstration 23	6-65
6.4.26	UT Demonstration 24	6-66
6.4.27	UT Demonstration 25	6-68
6.4.28	UT Demonstration 26	6-69
6.4.29	UT Demonstration 27	6-71
6.4.30	UT Demonstration 28	6-72
6.4.31	UT Demonstration 29	6-74
6.4.32	UT Demonstration 30	6-75
6.4.33	UT Demonstration 31	6-78
6.4.34	UT Demonstration 32	6-79
6.4.35	UT Demonstration 33	6-80
6.4.36	UT Demonstration 34	6-82
6.4.37	UT Demonstration 35	6-83
6.4.38	UT Demonstration 36	6-84

6.4.39	UT Demonstration 37	6-85
6.4.40	UT Demonstration 38	6-86
6.4.41	UT Demonstration 39	6-88
6.4.42	UT Demonstration 40	6-90
6.4.43	UT Demonstration 41	6-91
6.4.44	UT Demonstration 42	6-93
6.4.45	UT Demonstration 43	6-96
6.4.46	UT Demonstration 44	6-99
6.4.47	UT Demonstration 45	6-103
6.4.48	UT Demonstration 46	6-106
6.4.49	UT Demonstration 47	6-109
6.4.50	UT Demonstration 48	6-111
6.4.51	UT Demonstration 49	6-113
6.4.52	UT Demonstration 50	6-117
6.4.53	UT Demonstration 51	6-119
6.4.54	UT Demonstration 52	6-122
6.4.55	UT Demonstration 53	6-125
6.4.56	UT Demonstration 54	6-127
6.4.57	UT Demonstration 55	6-129
6.4.58	UT Demonstration 56	6-131
6.4.59	UT Demonstration 57	6-134
6.4.60	UT Demonstration 58	6-136
6.4.61	UT Demonstration 59	6-138
6.4.62	UT Demonstration 60	6-140
6.4.63	UT Demonstration 61	6-143
6.4.64	UT Demonstration 62	6-145
6.4.65	UT Demonstration 63	6-147
6.4.66	UT Demonstration 64	6-150

6.4.67	UT Demonstration 65	6-153
6 A INVESTIGATION OF CORE SPRAY INTERNAL PIPING OVERLAY INSPECTION		6A-1
6A.1	Materials.....	6A-1
6A.1.1	Probes.....	6A-1
6A.1.2	Ultrasonic Instrument	6A-1
6A.1.3	Mockups.....	6A-2
6A.2	Surface Condition	6A-5
6A.3	Examination Results.....	6A-5
6A.4	Conclusions.....	6A-6
6A.5	References.....	6A-6
7 TOP GUIDE		7-1
7.1	Summary.....	7-1
7.2	Inspection Considerations	7-2
7.2.1	Aligner Pin Assemblies	7-3
7.2.2	Hold-Down Assemblies.....	7-6
7.2.3	Wedges	7-8
7.2.4	BWR/6 Hold-Down Studs	7-10
7.2.5	Rim-to-Bottom Plate Weld	7-10
7.2.6	Grid Beams	7-11
7.3	Applicable Mockups	7-20
7.3.1	Top Guide Grid Mockup BWRVIP-I.....	7-20
7.3.2	Top Guide Grid Mockups BWRVIP-TG1-x Through BWRVIP-TG13-x Series	7-24
7.4	UT Technique Demonstrations for Top Guide Components	7-25
7.4.1	General Findings for UT	7-25
7.4.1.1	Grid Beams.....	7-26
7.4.2	UT Demonstration 1	7-27
7.4.3	UT Demonstration 2	7-28

8 CORE PLATE	8-1
8.1 Summary.....	8-1
8.2 Inspection Considerations	8-2
8.2.1 Rim Hold-Down Bolt Locations	8-2
8.3 Applicable Mockups	8-3
8.4 UT Technique Demonstrations for Core Plate Rim Hold-Down Bolts.....	8-5
8.4.1 UT Demonstration 1	8-6
8.4.2 UT Demonstration 2	8-7
8.4.3 UT Demonstration 3	8-8
8.4.4 UT Demonstration 4	8-9
8.4.5 UT Demonstration 5	8-11
9 LPCI COUPLING	9-1
9.1 Summary.....	9-1
9.2 Inspection Considerations	9-1
9.3 Applicable Mockups	9-3
9.4 UT Technique Demonstrations for LPCI Coupling Welds	9-3
10 JET PUMP ASSEMBLY	10-1
10.1 Summary.....	10-1
10.2 Inspection Considerations	10-2
10.3 Applicable Mockups.....	10-3
10.3.1 Mockup BWRVIP-U.....	10-3
10.3.2 Mockup BWRVIP-V	10-3
10.3.3 Mockups BWRVIP-Z3 and BWRVIP-Z3R.....	10-3
10.3.4 Mockup BWRVIP-Z4	10-3
10.3.5 Jet Pump Beam Mockups.....	10-4
10.3.6 Riser Brace Mockups BWRVIP-RB-1 and BWRVIP-RB-2	10-12
10.4 UT Technique Demonstrations	10-14

10.4.1	General Findings for UT	10-17
10.4.2	UT Demonstration 1	10-18
10.4.3	UT Demonstration 2	10-19
10.4.4	UT Demonstration 3	10-20
10.4.5	UT Demonstration 4	10-21
10.4.6	UT Demonstration 5	10-22
10.4.7	UT Demonstration 6	10-23
10.4.8	UT Demonstration 7	10-24
10.4.9	UT Demonstration 8	10-25
10.4.10	UT Demonstration 9	10-26
10.4.11	UT Demonstration 10	10-28
10.4.12	UT Demonstration 11	10-31
10.4.13	UT Demonstration 12	10-32
10.4.14	UT Demonstration 13	10-33
10.4.15	UT Demonstration 14	10-34
10.4.16	UT Demonstration 15	10-37
10.4.17	UT Demonstration 16	10-40
10.4.18	UT Demonstration 17	10-41
10.4.19	UT Demonstration 18	10-42
10.4.20	UT Demonstration 19	10-46
10.4.21	UT Demonstration 20	10-48
10.4.22	UT Demonstration 21	10-50
10.4.23	UT Demonstration 22	10-54
10.4.24	UT Demonstration 23	10-58
10.4.25	UT Demonstration 24	10-62
10.4.26	UT Demonstration 25	10-67
10.4.27	UT Demonstration 26	10-72
10.5	ET Technique Demonstrations	10-75

10.5.1	ET Demonstration 1	10-75
10.5.2	ET Demonstration 2	10-76
10.6	Delivery System Demonstrations.....	10-77
10.6.1	Delivery System Demonstration 1	10-77
10.6.2	Delivery System Demonstration 2	10-78
10.6.3	Delivery System Demonstration 3	10-79
10.6.4	Delivery System Demonstration 4	10-80
10.6.5	Delivery System Demonstration 5	10-81
11	STANDBY LIQUID CONTROL	11-1
11.1	Summary.....	11-1
11.2	Inspection Considerations	11-2
11.2.1	Nozzle-to-Vessel Weld	11-2
11.2.2	Penetration-to-Vessel Weld.....	11-2
11.2.3	Nozzle-to-Safe-End Weld	11-2
11.2.4	Penetration-to-Safe-End Extension Weld	11-3
11.3	Applicable Mockups.....	11-3
11.3.1	Mockup BWRVIP-X1	11-4
11.3.2	Mockup BWRVIP-X2	11-4
11.3.3	Mockup BWRVIP-Y3	11-4
11.3.4	Mockup BWRVIP-Y4	11-4
11.3.5	Mockup BWRVIP-Y5	11-4
11.4	UT Technique Demonstrations for SLC Components	11-4
11.4.1	General Findings for UT	11-4
11.4.2	UT Demonstration 1	11-5
11.4.3	UT Demonstration 2	11-6
12	VESSEL ATTACHMENTS.....	12-1
12.1	Summary.....	12-1

12.2	Inspection Considerations	12-2
12.3	Applicable Mockups.....	12-2
12.3.1	Steam Dryer Support Lug Attachment Weld	12-2
12.3.1.1	BWRVIP-SDL1 (Steam Dryer Support Lug Mockup).....	12-2
12.4	UT Technique Demonstrations for Vessel Attachment Welds	12-8
12.4.1	UT Demonstration Summary	12-9
12.4.2	UT Demonstration 1	12-10
13	LOWER PLENUM.....	13-1
13.1	Summary	13-1
13.2	Inspection Considerations	13-2
13.3	Applicable Mockups.....	13-2
13.3.1	BWRVIP-CRDH1.....	13-2
13.3.2	BWRVIP-CRDH2.....	13-4
13.4	UT Technique Demonstrations for Lower Plenum Welds.....	13-7
13.4.1	UT Demonstration 1	13-7
14	INSTRUMENT PENETRATIONS.....	14-1
14.1	Summary	14-1
14.2	Configurations	14-1
14.3	Inspection Considerations	14-3
14.3.1	Inspection Considerations for Partial Penetration J-Groove Welds	14-4
14.3.2	Inspection Considerations for the Penetration Tube Material.....	14-5
14.4	Applicable Mockups.....	14-6
14.4.1	Mockup BWRVIP-IP-1	14-7
14.4.1.1	BWRVIP-IP-1 Configuration.....	14-7
14.4.1.2	Penetration Tube Flaws	14-10
14.4.1.3	J-Groove Weld Flaws.....	14-14
14.4.1.4	Simulated Erosion.....	14-19

15 ACCESS HOLE COVERS	15-1
15.1 Summary	15-1
15.2 Inspection Considerations	15-2
15.2.1 Thin Access Hole Covers	15-4
15.2.2 Intermediate Thickness Access Hole Covers.....	15-5
15.2.3 Thick Access Hole Covers.....	15-6
15.2.4 Non-Creveded Retrofit Design for Some BWR/4 and BWR/5 Plants.....	15-6
15.2.5 Non-Creveded Single Access Hole Cover Design.....	15-7
15.3 Applicable Mockups.....	15-8
15.3.1 Access Hole Cover Mockups.....	15-8
15.3.1.1 BWRVIP-AHC1	15-9
15.3.1.2 BWRVIP-AHC2.....	15-10
15.3.1.3 BWRVIP-AHC3 and BWRVIP-AHC4.....	15-11
15.3.1.4 BWRVIP-AHC5.....	15-12
15.3.1.5 BWRVIP-AHC6.....	15-13
15.4 UT Technique Demonstrations for Access Hole Covers	15-14
15.4.1 UT Demonstration Summary	15-14
15.4.2 UT Demonstration 1	15-15
15.4.3 UT Demonstration 2	15-19
15.4.4 UT Demonstration 3	15-22
15.4.5 UT Demonstration 4	15-27
15.4.6 UT Demonstration 5	15-32
15.4.7 UT Demonstration 6	15-37
15.5 References.....	15-41

* This section, its subsections, and all associated figures and tables are not proprietary. All sections that are NOT marked with an asterisk, their subsections, and associated figures and tables, are proprietary.

LIST OF FIGURES

Figure 2.5.8.1-1. System Setup.....	2-27
Figure 4.3.1.3-1. Design of Shroud Mockup BWRVIP-A.....	4-5
Figure 4.3.1.3-2. Cross Section of Weld in Mockup BWRVIP-A	4-6
Figure 4.3.1.4-1. Design of Shroud Mockup BWRVIP-B.....	4-7
Figure 4.3.1.4-2. Cross Section of Weld in Mockup BWRVIP-B.	4-8
Figure 4.3.1.5-1. Design of Shroud Mockup BWRVIP-C	4-9
Figure 4.3.1.5-2. Cross Section of Weld in Mockup BWRVIP-C	4-10
Figure 4.3.1.6-1. Mockup BWRVIP-G and BWRVIP-H, Representing the Ring Segment Weld.....	4-11
Figure 4.3.1.6-2. Cross Section of Mockup BWRVIP-G and BWRVIP-H	4-12
Figure 4.3.1.6-3. Shroud Ring Segment Weld	4-12
Figure 4.3.1.7-1. Mockup BWRVIP-H1: Shroud Weld H1	4-252
Figure 4.3.1.7-2. Configuration of BWRVIP-H1-R1 Mockup (New Sparger Brackets Shown in Blue)	4-13
Figure 4.3.1.7-3. Details for BWRVIP-H1-R1 Sparger Bracket Flaws.....	4-14
Figure 4.3.1.8-1. Mockup BWRVIP-SSC1	4-15
Figure 4.3.1.8-2. Mockup BWRVIP-SSC1; Detail of Notches 1-4	4-16
Figure 4.3.1.8-3. Mockup BWRVIP-SSC1; Detail of Notches 5-8	4-16
Figure 4.3.1.9-1. Illustration of the Overhanging Configuration of Weld H6b	4-17
Figure 4.3.1.9-2. BWRVIP-H6OH, Representing the Overhanging Core Plate Support Ring Weld Configuration.....	4-253
Figure 4.3.1.10-1. BWRVIP-TGSR Mockup (Photograph).....	4-18
Figure 4.3.1.10-2. Configuration Drawing of Mockup BWRVIP-TGSR.....	4-254
Figure 4.3.1.10-3. Flaw Details for Mockup BWRVIP-TGSR	4-255
Figure 4.3.1.11-1. Typical Phased Array Technique for Examination of Core Shroud H2 Welds	4-19

Figure 4.3.1.11-2. Typical Phased Array Technique for Examination of Core Shroud H3 Welds	4-19
Figure 4.3.1.11-3. Photograph of BWRVIP-H2/H3 Mockup	4-20
Figure 4.3.1.11-4. Configuration of BWRVIP-H2/H3 (Side View).....	4-20
Figure 4.3.1.11-5. Configuration of BWRVIP-H2/H3 (End View)	4-256
Figure 4.3.1.11-6. BWRVIP-H2/H3 Ring Segment Weld Flaws	4-257
Figure 4.3.1.11-7. BWRVIP-H2/H3 Ring-to-Cylinder Weld Flaws (Flaws 1 Through 4)	4-258
Figure 4.3.1.11-8. BWRVIP-H2/H3 Ring-to-Cylinder Weld Flaws (Flaws 5 Through 8)	4-259
Figure 4.3.1.11-9. BWRVIP-H2/H3 Flaw Details	4-260
Figure 4.3.1.12-1. Roll-Out View of Shroud Flange, Showing Bolt Hole and Alignment Pinhole Locations	4-21
Figure 4.3.1.12-2. BWR/6 H3 Weld Configurations (Bolt Hole Cross Section Shown).....	4-22
Figure 4.3.1.12-3. BWR/6 H3 Core Shroud Mockups (Photograph)	4-23
Figure 4.3.1.12-4. BWR/6 H3 Core Shroud Mockups (Photograph of Bolt Holes)	4-23
Figure 4.3.1.12-5. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 1 Through 4)	4-261
Figure 4.3.1.12-6. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 5 Through 11)	4-262
Figure 4.3.1.12-7. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 12 Through 16)	4-263
Figure 4.3.1.12-8. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 1 Through 5)	4-264
Figure 4.3.1.12-9. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 6 Through 11)	4-265
Figure 4.3.1.12-10. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 12 Through 16)	4-266
Figure 4.3.2.1-1. Surface Roughness Mockup	4-25
Figure 4.3.2.2-1. Mockup With Multiple, Parallel EDM Notches.....	4-26
Figure 4.4.5-1. Principle of Operation of Creeping-Wave Probes	4-37
Figure 4.4.5-2. Principle of Operation of LLT Technique	4-37
Figure 4.4.40-1. Illustration of Sector-Scan Examination of Weld H2 and Full-Vee Linear-Scan Examination of Weld H3	4-85
Figure 4.4.46-1. GE Immersion UT Technique for Weld H1	4-98
Figure 4.4.51-1. Configuration of H1 Inspection Using Array Probe at the Top of the Shroud Flange.....	4-110
Figure 4.4.57-1. Probe Scan Line Locations for Mockup BWRVIP-A.....	4-124
Figure 4.4.57-2. Probe Scan Line Locations for Mockup BWRVIP-B.....	4-124
Figure 4.4.58-1. BWRVIP-A and BWRVIP-B Scan Surface.....	4-126
Figure 4.4.58-2. BWRVIP-A and BWRVIP-B (H3 and H6/H6B) Scan Surface.....	4-127

Figure 4.4.58-3. BWRVIP-C (H4/H5) Flaws Connected to the Scan Surface	4-127
Figure 4.4.58-4. BWRVIP-C (H4/H5) Flaws Connected Opposite to the Scan Surface	4-127
Figure 4.4.59-1. Surface Distance of First and Fourth Scan Lines.....	4-130
Figure 4.4.60-1. Vertical Ring Segment Weld Orientation	4-132
Figure 4.4.62-1. Scanning the H1 Weld from the Core Shroud Flange.....	4-138
Figure 4.4.63-1. H5/H6A Looking Up and Looking Down Scan Configurations.....	4-141
Figure 4.4.63-2. H4/H5 and Vertical Weld Scan Configuration	4-142
Figure 4.4.64-1. H2 Examination Technique	4-145
Figure 4.4.65-1. H3 Full-Vee Technique at Rear Scan Line Position.....	4-148
Figure 4.4.65-2. H3 Full-Vee (Red) and High-Angle (Pink) Technique at Forward Scan Line Position.....	4-148
Figure 4.4.66-1. H6OH Examination Technique	4-152
Figure 4.4.68-1. Top View of Data Collected with the UltraVision 3.2/Dynaray System.....	4-160
Figure 4.4.68-2. Top View of 2006 Data Collected with the TomoView/TomoScan-III System	4-161
Figure 4.4.69-1. Probe Position on BWRVIP Mockup.....	4-163
Figure 4.4.70-1. Mockups BWRVIP-A and BWRVIP-B (H1, H2, and H5/H6A Scan Surface).....	4-166
Figure 4.4.70-2. Mockups BWRVIP-A and BWRVIP-B (H3 and H6/H6B Scan Surface).....	4-166
Figure 4.4.70-3. Mockup BWRVIP-C (H4/H5 Flaws Connected to the Scan Surface)	4-166
Figure 4.4.70-4. Mockup BWRVIP-C (H4/H5 Flaws Connected Opposite to the Scan Surface).....	4-167
Figure 4.4.71-1. Probe Positions on BWRVIP Mockup.....	4-171
Figure 4.4.72-1. 25° to 55° Sector Scan Technique for H3 Weld Examination	4-174
Figure 4.4.72-2. Creeping Wave (ODCR) Technique for H3 Weld Examination	4-174
Figure 4.4.73-1. Core Plate Support Ring and Top Guide Support Ring Scan Locations	4-178
Figure 4.4.74-1. H6OH Line Scan Examination Technique	4-183
Figure 4.4.75-1. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected to the Scan Surface)	4-187
Figure 4.4.75-2. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected Opposite to the Scan Surface).....	4-187
Figure 4.4.76-1. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected to the Scan Surface)	4-192

Figure 4.4.76-2. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected Opposite to the Scan Surface).....	4-192
Figure 4.4.77-1. BWR/6 H3 Configuration Without Flange Extension Above the H3 Weld ...	4-197
Figure 4.4.77-2. Demonstrated Scan Line Positions	4-198
Figure 4.4.77-3. OD Looking Down D-Scan Images Showing Unflawed Region (Left) and Outside Surface Flaw A8 (Right)	4-203
Figure 4.4.77-4. OD Looking Down D-Scan Images Showing Unflawed Region (Left) and Inside Surface Flaw A6 (Right).....	4-204
Figure 4.4.77-5. OD Looking Down B- and C-Scan Images Showing Shadowing of Geometric Response (Top) and Low-Amplitude Flaw Responses (Bottom).....	4-205
Figure 4.4.77-6. ID Looking Down B- and Sector-Scan Images Showing Shadowing of Geometric Response (Left) and A14 Flaw Response (Right).....	4-205
Figure 4.4.77-7. ID Looking Down Examination Data Showing Near-Side and Far-Side OD Flaw Responses	4-206
Figure 4.4.78-1. BWR/6 H3 Configuration with Flange Extension Above the H3 Weld	4-209
Figure 4.4.78-2. Inside Surface (Left) and Outside Surface (Right) Scan Line Positions	4-211
Figure 4.4.78-3. Looking Down Ultrasonic Data Display from Unflawed Region of BWRVIP-B Mockup (Probe Located on Outside Surface).....	4-215
Figure 4.4.78-4. Looking Down Ultrasonic Data Display from Flaw B7 in Mockup BWRVIP-B (Probe Located on Outside Surface).....	4-215
Figure 4.4.78-5. Looking Down Ultrasonic Data Display from Unflawed Region of BWRVIP-B Mockup (Probe Located on Inside Surface)	4-216
Figure 4.4.78-6. Looking Down Ultrasonic Data Display from Flaw B5 in Mockup BWRVIP-B (Probe Located on Inside Surface).....	4-216
Figure 4.5.2-1. VT Length Measurement Performance on Simulated Cracks (Pieces of Tape) in NDE Center’s 20-foot-deep Water Tank	4-222
Figure 4.6.1-1. Cross-Wound ET Probe	4-223
Figure 4.6.1.2-1. Eddy Current Image of Surface Roughness Mockup.....	4-224
Figure 4.6.2.2-1. Amplitude and Phase Eddy Current Images of Mockup BWRVIP-A. (a) Amplitude, raw. (b) Amplitude, thresholded	4-226
Figure 4.6.2.2-1 (continued). Amplitude and Phase Eddy Current Images of Mockup BWRVIP-A. (c) Phase, raw. (d) Phase, thresholded	4-227
Figure 4.6.6-1. Eddy Current Surface Probe	4-231
Figure 4.6.6-2. Eddy Current Responses from Ring Segment Weld Mockup	4-232
Figure 4.6.6-3. Eddy Current Responses Obtained from Surface Flaws of Various Depths.....	4-233
Figure 4.6.6-4. Shroud Mockup Containing Rough Weld Surface	4-233

Figure 4.6.6-5. Eddy Current Response from Shroud Mockup with Rough Weld Surface	4-234
Figure 4.7.8-1. Illustration of Potential Location Error for BWR Vertical Weld UT Inspections	4-249
Figure 4.7.8-2. Illustration of Potential Location Error for Depth Sizing When Scanning on the H2/H3 Ledge	4-250
Figure 5.2.1-1. CB&I/CBIN, B&W Shroud Support Configuration	5-3
Figure 5.2.3.1-1. CE Shroud Support Configuration	5-4
Figure 5.2.3.2-1. BWR/2 Cone Skirt Shroud Support Configuration	5-5
Figure 5.2.3.3-1. Hatch Unit 2 Shroud Support Configuration.....	5-6
Figure 5.3.1-1. Configuration of Mockup BWRVIP-D, Representing Weld H7	5-8
Figure 5.3.1-2. Cross Section of Mockup BWRVIP-D.....	5-9
Figure 5.3.1-3. Distribution of Flaws in Mockup BWRVIP-D	5-9
Figure 5.3.1-4. BWRVIP-D2 Flaws 5J Through 5Q	5-11
Figure 5.3.1-5. BWRVIP-D2 Flaws 5R Through 5U.....	5-12
Figure 5.3.2-1. Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details	5-14
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-15
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-16
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-17
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-18
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-19
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-20
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-21
Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.....	5-22
Figure 5.3.2-2. Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details	5-23
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-24

Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-24
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-25
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-25
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-26
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-26
Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-27
Figure 5.3.2-3. Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details	5-28
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-29
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-29
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-30
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-30
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-31
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-31
Figure 5.3.2-3 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details.....	5-32
Figure 5.3.3-1. Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details	5-33
Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-34
Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-35
Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-36
Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-37

Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-38
Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details.....	5-39
Figure 5.3.4-1. Shroud Support Mockup BWRVIP-P	5-40
Figure 5.3.5-1. Mockup BWRVIP-B2SS1.	5-41
Figure 5.3.5-2. Mockup BWRVIP-B2SS2.	5-42
Figure 5.4.18-1. Configuration for Inspecting Weld H10 from the Outside of the Bottom Head of the Pressure Vessel.....	5-69
Figure 5.4.28-1. Setting the Sensitivity for Inspection of Weld H9	5-85
Figure 5.4.28-2. Geometry for Inspection of Weld H8.....	5-86
Figure 5.4.28-3. Coverage for Inspection of Weld H8.....	5-86
Figure 5.4.28-4. Some Potential Flaw Locations and Orientations in Weld H8	5-87
Figure 5.4.30-1. Setting the Sensitivity for Inspection of Weld H9	5-89
Figure 5.4.30-2. Geometry for Inspection of Weld H8.....	5-92
Figure 5.4.30-3. Coverage for Inspection of Weld H8.....	5-92
Figure 5.4.30-4. Some Potential Flaw Locations and Orientations in Weld H8	5-93
Figure 5.4.31-1. Example Display Showing Responses of Weld Crown Geometry in Mockup BWRVIP-E	5-95
Figure 5.4.31-2. Response from Flaw 6b in Mockup BWRVIP-E.....	5-96
Figure 5.4.36-1. Geometry for Inspection of Weld H8.....	5-103
Figure 5.4.36-2. Coverage for Inspection of Weld H8.....	5-103
Figure 5.4.36-3. Some Potential Flaw Locations and Orientations in Weld H8	5-104
Figure 5.4.47-1. Scan Line Positions.....	5-124
Figure 5.4.47-2. Inside Surface Flaw Depth Sizing Error If Correction Is Not Used	5-125
Figure 5.4.47-3. Outside Surface Flaw Depth Sizing Error If Correction Is Not Used.....	5-125
Figure 5.4.47-4. Geometric Reflector Used to Measure the Amount of Weld Mismatch	5-126
Figure 5.4.48-1. Geometry and Ultrasonic Beam Simulation for Inspection of Weld H8	5-128
Figure 5.4.48-2. Coverage for Inspection of Weld H8.....	5-129
Figure 5.4.48-3. Some Potential Flaw Locations and Orientations in Weld H8	5-129
Figure 5.4.48-4. Setting the Sensitivity for Inspection of Weld H8	5-130
Figure 5.4.50-1. Reported Flaw Depth for Circumferential Flaws Oriented Perpendicular to the Scan Surface (Measurements Made Along the Ultrasound Axis)	5-136

Figure 5.4.50-2. Reported Flaw Depth for Circumferential Flaws Oriented Parallel to the Scan Surface (Measurements Made Along the Ultrasound Axis).....	5-137
Figure 5.4.50-3. Reported Flaw Depth for Circumferential Flaws Oriented Parallel to the Scan Surface (Measurements Made Along the Scan Axis).....	5-137
Figure 5.4.50-4. Reported Flaw Depth for Axial Flaws (Measurements Made Along the Ultrasound Axis)	5-138
Figure 5.4.50-5. Reported Flaw Depth for Axial Flaws (Measurements Made Along the Scan Axis)	5-138
Figure 5.4.51-1. BWRVIP-P NDE Mockup (Scan and Index Orientations).....	5-141
Figure 5.4.52-1. H7 Scan Configuration	5-143
Figure 5.4.53-1. Axial Beam Direction Scan for H8 Weld	5-147
Figure 5.4.53-2. Circumferential Beam Direction Scan for H8 Weld	5-147
Figure 5.4.54-1. Axial Beam Direction Scan for H9 Weld (Side View)	5-151
Figure 5.4.54-2. Circumferential Beam Direction Scan for H9 Weld (Top View)	5-151
Figure 5.4.56-1. Axial Flaw Located in the H9 Weld and Attachment Pad. (Axial flaw detection in this area was possible.)	5-157
Figure 5.4.56-2. Axial Flaw Located in H9 Weld and Shroud Support Plate. (Axial flaw detection in this area was unreliable.).....	5-158
Figure 5.4.56-3. Reported RPV Extent (Flaw Depth Reported Along the Ultrasound Depth Axis).....	5-159
Figure 5.4.56-4. Reported Shroud Support Plate Extent (Flaw Depth Based on Axial Distance Measurements).....	5-160
Figure 5.4.57-1. H12 Flaw Depth Measurements	5-163
Figure 5.4.59-1. Probe Positions for Axial Scan Lines.....	5-169
Figure 5.4.59-2. Probe Positions for Circumferential Scan Lines.....	5-169
Figure 5.4.59-3. Reported Circumferential Flaw Depth (Flaw Depth Reported Along the Ultrasound Axis Using Data Acquired During the Axial Scan Examination Shown in Figure 5.4.59-1).....	5-174
Figure 5.4.59-4. Reported Circumferential Flaw Depth (Flaw Depth Measured From the Electronic Sector Scan Sweep During the Axial Scans Shown in Figure 5.4.59-1)	5-174
Figure 5.4.59-5. Reported Axial Flaw Horizontal Depth (Flaw Depth Reported Along the Ultrasound Axis Using Data Acquired During the Circumferential Scan Shown in Figure 5.4.59-2).....	5-175
Figure 5.4.59-6. Estimated Axial Flaw Vertical Depth (Flaw Depth Estimated Using the 0.5-inch Incremental Scan Line Positions in Scans Performed Between the Two Elevations Shown in Figure 5.4.59-2)	5-175
Figure 6.2-1. Typical BWR/2 Core Spray Piping Configuration.....	6-4

Figure 6.2-2. Typical BWR/3-5 Core Spray Piping Configuration	6-5
Figure 6.2-3. Typical BWR/6 Core Spray Piping Configuration.....	6-6
Figure 6.2-4. Typical Core Spray Sparger	6-7
Figure 6.3.1.1-1. Mockup BWRVIP-J: Downcomer Slip Joint	6-11
Figure 6.3.1.1-2. Downcomer Sleeve Mockup (BWRVIP-J).....	6-12
Figure 6.3.1.1-3. Mockup BWRVIP-J: Downcomer Slip Joint: Configuration	6-13
Figure 6.3.1.1-4. Mockup BWRVIP-J: Downcomer Slip Joint: Flaw Details	6-14
Figure 6.3.1.2-1. BWRVIP-K Mockup: Shroud Penetration (BWR/2).....	6-16
Figure 6.3.1.2-2. BWR/2 Shroud Penetration Mockup (BWRVIP-K).....	6-17
Figure 6.3.1.2-3. Mockup BWRVIP-K: BWR/2 Shroud Penetration: Configuration	6-18
Figure 6.3.1.2-4. Mockup BWRVIP-K: BWR/2 Shroud Penetration: Flaw Details	6-19
Figure 6.3.1.3-1. BWRVIP-L Mockup: Shroud Penetration (BWR/3-5)	6-21
Figure 6.3.1.3-2. BWR/3-5 Shroud Penetration Mockup (BWRVIP-L)	6-22
Figure 6.3.1.3-3. Mockup BWRVIP-L: BWR/3-5 Shroud Penetration: Configuration.....	6-22
Figure 6.3.1.3-4. Mockup BWRVIP-L: BWR/3-5 Shroud Penetration: Flaw Details	6-23
Figure 6.3.1.4-1. BWRVIP-M Mockup: Header Tee Box.....	6-25
Figure 6.3.1.4-2. BWR/3-5 Core Spray Header Tee Box Mockup (BWRVIP-M)	6-26
Figure 6.3.1.4-3. Mockup BWRVIP-M: BWR/3-5 Header Tee Box: Configuration	6-27
Figure 6.3.1.4-4. Mockup BWRVIP-M: BWR/3-5 Header Tee Box: Flaw Details	6-28
Figure 6.3.1.5-1. BWRVIP/6 Core Spray Pipe Coupling Assembly Mockup BWRVIP- CS6: Weld Configuration and Flaw Details	6-29
Figure 6.3.1.6-1. Photograph of BWRVIP-P4-1r and BWRVIP-P4-2r	6-30
Figure 6.3.1.6-2. Flaw Details of BWRVIP-P4-1r.....	6-31
Figure 6.3.1.6-3. Flaw Details of BWRVIP-P4-2r.....	6-32
Figure 6.3.1.6-4. Flaw Details of BWRVIP-P4-3.....	6-33
Figure 6.4.32-1. Correspondence of Flaws in Mockup BWRVIP-J to the Inspection Configuration of BWR/2 Weld P8.....	6-76
Figure 6.4.32-2. Inability to Detect OD Pipe-Side Flaws Using the Single-Stroke Scan Technique	6-77
Figure 6.4.35-1. Detection Paths for Flaws in Mockup BWRVIP-K.....	6-81
Figure 6.4.44-1. Array Probe Positioning on T-Box	6-94
Figure 6.4.45-1. Array Probe Positioning for Scanning from the Cover Plate Side	6-97

Figure 6.4.53-1. Scan Surface for P1 Weld Examination.....	6-120
Figure 6.4.54-1. Scan Surface for P2 Weld Examination.....	6-120
Figure 6.4.46-1. 45° and 50° Examination Angles.....	6-100
Figure 6.4.46-2. 0° Skew Examination.....	6-100
Figure 6.4.46-3. Supplemental ±10° Skew Examination.....	6-100
Figure 6.4.46-4. Primary 360° Scan (Blue) and Supplemental Scan (Green).....	6-101
Figure 6.4.47-1. 1/2-Vee Technique for ID Flaws (Pipe Side).....	6-104
Figure 6.4.47-2. Full-Vee Technique for OD Flaws (Pipe Side).....	6-104
Figure 6.4.47-3. Probe Position for Elbow-Side Scanning (P4d Weld Shown).....	6-104
Figure 6.4.48-1. 45° and 50° Examination Angles from Riser Pipe Side (P5 Shown).....	6-107
Figure 6.4.48-2. 45° Examination Angles from Sliding Sleeve Side (P5 Shown).....	6-107
Figure 6.4.48-3. 45° Examination Angle from Outer Sleeve Side (P7 Shown).....	6-107
Figure 6.4.49-1. Direction of Sound Beams.....	6-110
Figure 6.4.50-1. Direction of Sound Beams.....	6-111
Figure 6.4.51-1. BWR/2 P8 Weld Examination.....	6-114
Figure 6.4.51-2. BWR/2 P9 Weld Examination.....	6-115
Figure 6.4.53-1. Scan Surface for P1 Weld Examination.....	6-120
Figure 6.4.54-1. Scan Surface for P2 Weld Examination.....	6-123
Figure 6.4.65-1. Example of the Original Demonstration Data (Zetec μTomoScan Instrument).....	6-148
Figure 6.4.65-2. Example of the Equivalency Demonstration Data (Zetec Z-Scan UT Instrument).....	6-148
Figure 6.4.67-1. C-Scan Display Showing the Four Different Engagement Responses in Mockup BWRVIP-J.....	6-153
Figure 6A.1.3-1. Mockup BWRVIP-CSRA: Weld Overlay Repair with Cracks Propagating from Existing Throughwall Defects: Configuration and Flaw Details.....	6A-3
Figure 6A.1.3-2. Mockup BWRVIP-CSRC: Weld Overlay Repair with Sidewall Lack of Fusion: Configuration and Flaw Details.....	6A-4
Figure 7.2-1. Grid Beam Regions to Be Inspected for BWR/2-5 Designs.....	7-3
Figure 7.2.1-1. Typical Vertical Aligner Pin Assembly.....	7-5
Figure 7.2.1-2. Aligner Pin Assembly Variations.....	7-6
Figure 7.2.2-1. Hold-Down Assembly.....	7-7
Figure 7.2.2-2. Hold-Down Assembly.....	7-8

Figure 7.2.3-1. Lateral Restraint Brackets and Wedges	7-9
Figure 7.2.4-1. Hold-Down Assembly.....	7-10
Figure 7.2.5-1. Rim-to-Bottom Plate Weld.....	7-11
Figure 7.2.6-1. Typical 0.36-Inch Wide Top Guide Grid Structure	7-12
Figure 7.2.6-2. Typical 0.55-Inch Wide Top Guide Grid Structure	7-13
Figure 7.2.6-3. Typical BWR/6 Top Guide Grid Structure.....	7-13
Figure 7.2.6-4. Photograph of BWR/2 Grid Beam Cracking Observed During Metallurgic Evaluation	7-14
Figure 7.2.6-5. Mid-Span Flaw in Upper Grid Beam.....	7-15
Figure 7.2.6-6. Intersecting Slot Flaw in Upper Grid Beam.....	7-15
Figure 7.2.6-7. Mid-Span Flaw in Lower Grid Beam.....	7-16
Figure 7.2.6-8. Flaw Located at Incore Instrumentation Notch Location of Lower Grid Beam.....	7-16
Figure 7.2.6-9. Intersecting Slot Flaw in Lower Grid Beam.....	7-17
Figure 7.2.6-10. Flaw Emanating from Poison Notch	7-17
Figure 7.2.6-11. Configuration of Top Guide Grid, Fuel Channels, and Control Blades.....	7-18
Figure 7.2.6-12. Phased Array Sector Scan Techniques for Top Guide Grid Beam Examinations.....	7-19
Figure 7.3.1-1. Configuration of Top Guide Grid Mockup BWRVIP-I	7-21
Figure 7.3.1-2. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-A: Configuration and Flaw Details.....	7-21
Figure 7.3.1-3. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-B: Configuration and Flaw Details.....	7-22
Figure 7.3.1-4. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-C: Configuration and Flaw Details.....	7-22
Figure 7.3.1-5. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-D: Configuration and Flaw Details.....	7-23
Figure 7.3.1-6. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-E: Configuration and Flaw Details.....	7-23
Figure 7.3.2-1. BWRVIP-TG1-x and BWRVIP-TG2-x Flaw Details.....	7-32
Figure 7.3.2-2. BWRVIP-TG3-x and BWRVIP-TG4-x Flaw Details.....	7-33
Figure 7.3.2-3. BWRVIP-TG5-x and BWRVIP-TG6-x Flaw Details.....	7-34
Figure 7.3.2-4. BWRVIP-TG7-x Flaw Details	7-35
Figure 7.3.2-5. BWRVIP-TG8-x and BWRVIP-TG9-x Flaw Details.....	7-36

Figure 7.3.2-6. BWRVIP-TG10-x and BWRVIP-TG11-x Flaw Details.....	7-37
Figure 7.3.2-7. BWRVIP-TG12-x and BWRVIP-TG13-x Flaw Details.....	7-38
Figure 7.4.3-1. Example of CAD-Generated Drawing Overlaid on Examination Data Display	7-30
Figure 7.4.3-2. Example of Flaws That Initiate from Geometric Reflectors	7-30
Figure 8.3-1. EDM Notches in Upper and Lower Threaded Regions of Core Plate Bolt Mockup	8-4
Figure 8.4.5-1. BWRVIP-B Mockup Configuration (with Bolt Installed)	8-12
Figure 8.4.5-2. BWRVIP-H6OH Mockup Configuration (with Bolt Installed).....	8-13
Figure 10.3.1-1. Jet Pump Riser Mockup BWRVIP-U: Configuration and Flaw Details.....	10-69
Figure 10.3.2-1. Jet Pump Riser Mockup BWRVIP-V: Configuration and Flaw Details.....	10-70
Figure 10.3.3-1. Jet Pump Mixer Mockup BWRVIP-Z3: Configuration and Flaw Details.....	10-71
Figure 10.3.4-1. Jet Pump Mixer Mockup BWRVIP-Z4: Configuration.....	10-72
Figure 10.3.4-2. Jet Pump Mixer Mockup BWRVIP-Z4: Flaw Details	10-73
Figure 10.3.5-1. EPRI Jet Pump Beam Mockup A.....	10-4
Figure 10.3.5-2. EPRI Jet Pump Beam Mockup B (No Flaws).....	10-5
Figure 10.3.5-3. EPRI Jet Pump Beam Mockup C	10-6
Figure 10.3.5-4. Jet Pump Beam Mockup BWRVIP-G2JPB1	10-7
Figure 10.3.5-5. Jet Pump Beam Mockup BWRVIP-G2JPB2	10-8
Figure 10.3.5-6. Jet Pump Beam Mockup BWRVIP-G2JPB3	10-9
Figure 10.3.5-7. Jet Pump Beam Mockup BWRVIP-G2JPB4	10-10
Figure 10.3.5-8. Jet Pump Beam Taper-to-Radius Transition Mockups (Perspective Drawing)	10-11
Figure 10.3.5-9. Jet Pump Beam Taper-to-Radius Transition Mockups (Photo)	10-11
Figure 10.3.5-10. Jet Pump Beam Taper-to-Radius Transition Mockups (Side View Drawing)	10-12
Figure 10.3.6-1. BWRVIP-RB-1 and BWRVIP-RB-2 Mockups (Photograph).....	10-13
Figure 10.3.6-2. Flaw Layout and Electrode Profiles	10-13
Figure 10.4.16-1. LaSalle 1, Fermi Jet Pump Adapter Configuration.....	10-37
Figure 10.4.16-2. Demonstration for Weld AD-1.....	10-38
Figure 10.4.16-3. Demonstration for Weld AD-2.....	10-39
Figure 10.4.16-4. Demonstration for Weld DF-3.....	10-39
Figure 10.4.19-1. Area BB-2 and BB-3 Examination Technique.....	10-43

Figure 10.4.19-2. Jet Pump Beam Taper-to-Radius Transition Mockups.....	10-45
Figure 10.4.22-1. Fermi-2 and LaSalle-1 (“U-Shaped”) Curved Adapter Configuration.....	10-51
Figure 10.4.22-2. Fermi-2 and LaSalle-1 DF-3 Weld Inspection Location.....	10-52
Figure 10.4.23-1. Azimuthal Focal Laws (Technique 2 Shown on AD-1 Weld Configuration).....	10-55
Figure 10.4.23-2. Linear Focal Laws (Shown on AD-1 Weld Configuration)	10-56
Figure 10.4.24-1. Area BB-2 and BB-3 Examination Technique	10-60
Figure 10.4.24-2. Jet Pump Beam Taper-to-Radius Transition Mockups.....	10-61
Figure 10.4.25-1. Lateral and Raster Scan Techniques (Including Focal Laws)	10-64
Figure 10.4.25-2. Reported Versus Actual Length Measurements	10-65
Figure 10.4.26-1. Actual Ultrasonic Beam Path for Flaw Depth Sizing (Outside Surface of Elbow Affects Refracted Angle, Inside Surface of Elbow Affects Reflected Angle) ...	10-70
Figure 10.4.26-2. Assumed Geometry for Reporting Flaw Depth (Does Not Account for Elbow Curvature / Assumes Flat and Parallel Surfaces).....	10-71
Figure 11.3.1-1. SLC Nozzle Mockup BWRVIP-X1: Configuration and Flaw Details	11-7
Figure 11.3.2-1. SLC Nozzle Mockup BWRVIP-X2: Configuration and Flaw Details	11-8
Figure 11.3.3-1. SLC Penetration Mockup BWRVIP-Y3: Configuration and Flaw Details	11-9
Figure 11.3.4-1. SLC Penetration Mockup BWRVIP-Y4: Configuration and Flaw Details	11-10
Figure 11.3.5-1. SLC Penetration Mockup BWRVIP-Y5: Configuration and Flaw Details	11-11
Figure 12.3.1.1-1. BWRVIP-SDL-1 Mockup (Photograph).....	12-3
Figure 12.3.1.1-2. "Set-in" Lug Configuration (Cross-Sectional View)	12-4
Figure 12.3.1.1-3. Flaws in Lugs A, B, and C	12-5
Figure 12.3.1.1-4. Flaws in Lugs D, E, and F	12-6
Figure 12.3.1.1-5. Typical Fabrication Flaws in Close Proximity to Flaw F1	12-7
Figure 12.3.1.1-6. Repaired Lack-of-Fusion Flaw	12-8
Figure 12.4.2-1. Probe Position and Scan Distance on the BWRVIP Mockup	12-11
Figure 12.4.2-2. Focal Law Calculator Image Showing All Three Sets of Sector Scans	12-12
Figure 12.4.2-3. Length Measurements for Flaws with Orientations Similar to the Orientations of A-1, B-1, B-2, D-1, and D-2	12-14
Figure 12.4.2-4. Depth Measurements for Flaws with Orientations Similar to the Orientations of A-1, B-1, B-2, D-1, and D-2	12-15
Figure 12.4.2-5. Length and Depth Measurements for Flaws with Orientations Similar to the Orientation of C-2	12-15

Figure 12.4.2-6. Length and Depth Measurements for Flaws with Orientations Similar to the Orientation of A-2 (Note That Flaw Extents Are Measured from the Edge of the Lug and Not from the Flaw Initiating Point in the Weld)	12-16
Figure 13.3.1-1. BWRVIP-CRDH1 Mockup (Photograph)	13-4
Figure 13.3.2-1. BWRVIP-CRDH2 Mockup (Photograph)	13-6
Figure 14.2-1. Example of Instrument Penetration (Partial Penetration J-Groove Weld Configuration).....	14-2
Figure 14.2-2. Example of Instrument Penetration (Full-Penetration Welded Low-Alloy Steel Nozzle Configuration).....	14-3
Figure 14.3.1-1. BWR/6-Style Instrument Penetration That Contains the Low-Alloy Weld Pad.....	14-4
Figure 14.4.1.1-1. BWRVIP-IP-1 Instrumentation Penetration Mockup (OD Surface).....	14-7
Figure 14.4.1.1-2. BWRVIP-IP-1 Instrumentation Penetration Mockup (ID Surface)	14-8
Figure 14.4.1.1-3. Penetration #1 Configuration (Nominal Dimensions)	14-9
Figure 14.4.1.1-4. Penetration #2 Configuration (Nominal Dimensions)	14-10
Figure 14.4.1.2-1. Penetration #1 Flaw Details (Nominal Design Intent).....	14-13
Figure 14.4.1.2-2. Penetration #2 Flaw Details (Nominal Design Intent).....	14-13
Figure 14.4.1.3-1. As-Built Details of J-Groove Weld Flaw 1a	14-16
Figure 14.4.1.3-2. As-Built Details of J-Groove Weld Flaw 1b	14-16
Figure 14.4.1.3-3. As-Built Details of J-Groove Weld Flaw 1c	14-17
Figure 14.4.1.3-4. As-Built Details of J-Groove Weld Flaw 2a	14-17
Figure 14.4.1.3-5. As-Built Details of J-Groove Weld Flaw 2b	14-18
Figure 14.4.1.3-6. As-Built Details of J-Groove Weld Flaw 2c	14-18
Figure 14.4.1.4-1. Simulated Erosion Path Ground into Penetration #1 Bore Hole (Photograph)	14-19
Figure 14.4.1.4-2. Simulated Erosion Path Ground into Penetration #1 Bore Hole (CAD Roll-Out Drawing).....	14-20
Figure 15.1-1. Access Hole Cover.....	15-1
Figure 15.2-1. Examples of Shroud Support Plate Side Ultrasonic Examination Techniques.....	15-3
Figure 15.2-2. Retrofit Top Hat Access Hole Cover Configuration.....	15-4
Figure 15.2.1-1. Thin AHC and Conventional Shroud Support Plate with Ledge	15-5
Figure 15.2.2-1. Intermediate Thickness Access Hole Cover and Conventional Shroud Support Plate Without Ledge.....	15-5

Figure 15.2.3-1. Thick Access Hole Cover and Conventional Shroud Support Plate with Ledge	15-6
Figure 15.2.4-1. Retrofit Design for Some BWR/4 and BWR/5 Plants	15-7
Figure 15.2.5-1. BWR/6 Single Oval Design	15-8
Figure 15.3.1.1-1. BWRVIP-AHC1 Mockup (Photograph)	15-9
Figure 15.3.1.1-2. Bottom Side of BWRVIP-AHC1 Mockup (Photograph)	15-10
Figure 15.3.1.1-3. Configuration Drawing of BWRVIP-AHC1	15-43
Figure 15.3.1.1-4. Partial Top View of BWRVIP-AHC1 (1 of 2)	15-44
Figure 15.3.1.1-5. Partial Top View of BWRVIP-AHC1 (2 of 2)	15-45
Figure 15.3.1.1-6. BWRVIP-AHC1 (Flaws 1a Through 1e).....	15-46
Figure 15.3.1.1-7. BWRVIP-AHC1 (Flaws 1f Through 1i).....	15-47
Figure 15.3.1.1-8. BWRVIP-AHC1 (Flaws 1j Through 1n).....	15-48
Figure 15.3.1.2-1. BWRVIP-AHC2 Mockup (Photograph)	15-11
Figure 15.3.1.2-2. Configuration Drawing for BWRVIP-AHC2	15-59
Figure 15.3.1.2-3. BWRVIP-AHC2 Flaw Drawings (Flaws 2a Through 2d).....	15-50
Figure 15.3.1.2-4. BWRVIP-AHC2 Flaw Drawings (Flaws 2e Through 2h).....	15-51
Figure 15.3.1.2-5. BWRVIP-AHC2 Flaw Drawings (Flaws 2i Through 2l).....	15-52
Figure 15.3.1.3-1. BWRVIP-AHC3 and BWRVIP-AHC4 (Photograph)	15-12
Figure 15.3.1.3-2. Configuration Drawing of BWRVIP-AHC3	15-53
Figure 15.3.1.3-3. Flaw Detail Drawing of BWRVIP-AHC3	15-54
Figure 15.3.1.3-4. Configuration Drawing of BWRVIP-AHC4	13-55
Figure 15.3.1.3-5. Flaw Detail Drawing of BWRVIP-AHC4	15-56
Figure 15.3.1.4-1. BWRVIP-AHC5 Mockup (Photograph)	15-13
Figure 15.3.1.4-2. BWRVIP-AHC5 (Flaw Table and Configuration Dimensions)	15-57
Figure 15.3.1.4-3. BWRVIP-AHC5 (Ring-to-Cover Weld Flaw Locations)	15-58
Figure 15.3.1.4-4. BWRVIP-AHC5 (Ring-to-Cover Weld Flaw Details).....	15-59
Figure 15.3.1.4-5. BWRVIP-AHC5 (Adapter Ring-to-Ring Weld Flaw Locations)	15-60
Figure 15.3.1.4-6. BWRVIP-AHC5 (Adapter Ring-to-Ring Weld Flaw Details)	15-61
Figure 15.3.1.5-1. BWRVIP-AHC6 Mockup (Photograph)	15-13
Figure 15.3.1.5-2. Configuration Drawing of BWRVIP-AHC6	15-62
Figure 15.3.1.5-3. Flaw Detail Drawing for BWRVIP-AHC6 (Flaws 6a Through 6d)	15-63
Figure 15.3.1.5-4. Flaw Detail Drawings for BWRVIP-AHC6 (Flaws 6e Through 6h)	15-64

Figure 15.4.2-1. Surface Distance Required for Azimuthal (Sector) Scan	15-16
Figure 15.4.2-2. Surface Distance Required for Linear Scans (Electronic Raster).....	15-16
Figure 15.4.5-1. Demonstrated Immersion Technique (1-inch Water Path)	15-28
Figure 15.4.7-1. Demonstrated Immersion Technique (1-inch Water Path)	15-38

LIST OF TABLES

Table 3.1-1. Flaw Evaluation Factors	3-1
Table 3.3.1-1. Sizing Performance of Length Estimation Techniques.....	3-4
Table 3.3.2-1. Sizing Performance of Length Measurement by Ruler.....	3-6
Table 4.1-1. Where to Find Evaluation Factors for the Shroud.	4-2
Table 4.3.1.8-1. Notches in Mockup BWRVIP-SSC-1	4-15
Table 4.4.2-1. UT Demonstration Summary	4-29
Table 4.4.18-1. Definition of Scan Patterns Used in UT Demonstration 16.....	4-51
Table 4.4.18-2. Results of UT Demonstration 16.....	4-52
Table 4.4.27-1. Sizing Performance and Evaluation Factors for UT Demonstration 25	4-62
Table 4.4.36-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH	4-77
Table 4.4.41-1. Linear Scans Performed in Various Shroud Inspection Situations	4-87
Table 4.4.42-1. Sizing Performance and Evaluation Factors for UT Demonstration 40	4-88
Table 4.4.55-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH	4-118
Table 4.4.56-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH	4-120
Table 4.4.61-1. Focal Law Groups for Demonstration 59	4-134
Table 4.4.66-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH	4-151
Table 4.4.68-1. UT System Essential Variables	4-160
Table 4.4.74-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH	4-182
Table 4.4.75-1. Focal Laws for Line Scan Technique.....	4-188
Table 4.4.75-2. Focal Laws for Raster Scan Technique	4-188
Table 4.4.76-1. Focal Laws for Line Scan Technique.....	4-193
Table 4.4.76-2. Focal Laws for Raster Scan Technique	4-193
Table 4.5.2-1. Data and Analysis from Shroud VT Demonstration 1.....	4-221
Table 4.7.4-1. Evaluation Factors for Carousel Scanner	4-239
Table 4.7.8-1. Evaluation Factors for TS ²	4-247

Table 5.3.4-1. Configuration of Cracks in Shroud Support Mockup BWRVIP-P	5-40
Table 5.3.4-2. Configuration of EDM Notches in Shroud Support Mockup BWRVIP-Q1	5-41
Table 5.4-1. UT Demonstration Summary	5-43
Table 5.4.6-1. Definition of Scan Patterns Used in UT Demonstration 5	5-54
Table 5.4.6-2. Results of UT Demonstration 5	5-55
Table 5.4.19-1. Sizing Performance and Evaluation Factors for UT Demonstration 18	5-70
Table 5.4.39-1. Linear Scans Performed in Various Shroud Inspection Situations	5-108
Table 5.4.49-1. Search Unit Angles and Beam Orientations for Demonstration 48	5-132
Table 5.4.49-2. Summary of Detection Results for Demonstration 48	5-132
Table 5.4.50-1. Demonstrated Search Unit Angles and Beam Orientations	5-135
Table 5.4.50-2. Reported Length Sizing Errors	5-139
Table 5.4.50-3. Reported Depth Sizing Errors	5-139
Table 5.4.53-1. Demonstrated Focal Law Parameters and Resolutions	5-146
Table 5.4.53-2. Demonstrated Parameters for Volumetric Merge	5-148
Table 5.4.54-1. Demonstrated Focal Law Parameters and Resolutions	5-150
Table 5.4.54-2. Demonstrated Parameters for Volumetric Merge	5-152
Table 6.4.2-1. UT Demonstration Summary.	6-35
Table 7.3.2-1. BWRVIP Top Guide Grid Beam Mockups	7-24
Table 8.4-1. UT Demonstration Summary	8-5
Table 10.3.6-1. Flaw Table for BWRVIP-RB-1 and BWRVIP-RB-2	10-14
Table 10.4-1. UT Demonstration Summary	10-15
Table 10.4.15-1. Examination Sequence	10-36
Table 10.4.23-1. Demonstrated Parameters for Technique 1	10-56
Table 10.4.23-2. Demonstrated Parameters for Technique 2	10-56
Table 10.4.26-1. Scan Surface and Probe Orientation for RS-1 Weld Locations	10-68
Table 10.4.26-2. Scan Surface and Probe Orientation for RS-2 Weld Locations	10-68
Table 10.4.26-3. Scan Surface and Probe Orientation for RS-3 Weld Locations	10-68
Table 12.4.1-1. UT Demonstration Summary	12-9
Table 13.3.1-1. Specifications of Applicable Flaws for BWRVIP-CRDH1	13-3
Table 13.3.2-1. Specifications of Applicable Flaws for BWRVIP-CRDH2	13-5
Table 14.4.1.2-1. 10 CFR 50.55a Requirements for PWR Reactor Vessel Head Specimens Versus BWRVIP Mockup Design Inputs	14-11

Table 14.4.1.2-2. As-Built Flaw Details (Penetration Tube Flaws)	14-14
Table 15.4.1-1. UT Demonstration Summary	15-14
Table 15.4.2-1. Demonstrated Examination Groups and Scan/Index Resolutions	15-17
Table 15.4.4-1. Demonstrated Scan and Index Variables	15-24
Table 15.4.5-1. Demonstrated Scan and Index Variables	15-29
Table 15.4.6-1. Demonstrated Scan and Index Variables	15-34
Table 15.4.7-1. Demonstrated Scan and Index Variables	15-39

1

BWRVIP OVERVIEW AND BACKGROUND

In 1990 a visual examination (VT) of the core shroud of a Swiss boiling water reactor (BWR) revealed the presence of cracking adjacent to one of the horizontal welds. A boat sample was taken, and its analysis identified the flaw mechanism as intergranular stress corrosion cracking (IGSCC). Since that event, examinations of other BWR shrouds have revealed an industry-wide problem with IGSCC and irradiation-assisted stress corrosion cracking (IASCC) associated with core shroud welds. As a result of this and degradation of other in-vessel components, domestic BWR-owning utilities have formed the Boiling Water Reactor Vessel and Internals Project (BWRVIP), which is chartered to support a program addressing the problems of reactor internals, internal attachments, vessel welds, and vessel nozzles. The inspection guidance provided herein supplements mandated examinations so that BWR owners can assure safety and assess component integrity in support of business decisions.

1.1 BWRVIP

BWRVIP was established by executive participants from each domestic BWR-owning utility. The BWRVIP's technical program is managed by the Electric Power Research Institute (EPRI). The Executive Operating Committee of BWRVIP oversees the activities of BWRVIP's five technical committees and focus groups:

- The Assessment Committee
- The Inspection Focus Group
- The Repair Focus Group
- The Mitigation Committee
- The Integration Committee

The Inspection Focus Group is tasked with producing nondestructive evaluation (NDE) techniques for assessing the integrity of the affected components. This document presents findings and products of the Inspection Focus Group.

1.2 BWRVIP Inspection Focus Group

The Focus Group comprises NDE and inservice inspection (ISI) representatives of BWR utilities, and is supported by EPRI task managers, the EPRI NDE Center, and NDE vendor company representatives. The Focus Group established the NDE Methods Working Group and the Qualification and Data Management Working Group to perform and direct activities in support of its goals.

The Focus Group is chartered to ensure the availability of effective, predictable, and cost-effective inspection techniques to determine the condition of BWR vessel welds, internals, vessel attachments, and penetrations which are potentially susceptible to degradation.

To satisfy this charter, the Focus Group has set the following goals:

- To provide demonstrated, documented NDE techniques for effectively examining the susceptible components.
- To develop inspection standards that can ensure the structural integrity of the components.
- To liaise with regulatory agencies on inspection issues.
- To develop and maintain an internal budget and financial controls.
- To develop short, medium, and long range plans based on utility inspection needs.
- To interface with the other Committees of BWRVIP.
- To provide training, when necessary, to support the industry's inspection needs.

This document presents the Focus Group's activities toward the first two goals. It provides measurements of the uncertainty of NDE techniques as applied to examinations of BWR internal components, to be included with flaw size measurements in calculations of the serviceability of components for subsequent operation; guidance for utilities or vendors to perform measurements of uncertainty that can be recognized by the Focus Group; standards for NDE procedures for examination of internal components; and a referenceable vehicle for regulatory review and approval.

1.3 General Approach to Inspection Support

The Assessment Committee and Repair Focus Group identify those structures that require inspection because of their safety function, susceptibility to degradation, or pre- and post-repair inspection needs. The degradation mechanism, likely flaw locations and orientations, and the degradation severity that must be detected are also identified. The Inspection Focus Group then develops, demonstrates, and documents NDE techniques capable of establishing component and component repair integrity. Alternatively, the Focus Group may witness and document such demonstrations by NDE vendor companies.

The design and fabrication of realistic component mockups are an important part of the Inspection Focus Group's program. The mockups are designed to represent the materials and welding techniques used in the original construction of the components. Intentional defects in the mockups are of the size, location, and orientation of concern, and are designed to resemble the suspect degradation mechanism in their response to NDE techniques.

The Inspection Focus Group also supports BWR internals inspections by providing specific training to spread the knowledge that has been gained through individual plant experiences. Training courses in visual and ultrasonic examination of core shroud welds, and in access and other inspection issues for internal components located below the core plate, have been offered or are planned.

The Focus Group has provided on-site advisory support to requesting member utilities during their internals inspection outages. EPRI and the EPRI NDE Center, directed by the Focus Group, have assisted in on-site advisory support and also have performed off-site data reviews and supporting laboratory work

1.4 Implementation Requirements

In accordance with the requirements of Nuclear Energy Institute (NEI) 03-08, Guideline for the Management of Materials Issues, this report is considered to be “needed.”

A nine-month implementation schedule is applicable starting from the date that the report is published.

2

GENERAL PROCEDURES

Demonstration of inspection tooling and NDE techniques on realistic mockups is a central premise of the Inspection Committee's approach to assurance of effective internal NDE. These demonstrations must be performed, documented, and reported in a consistent and formal manner.

The following guideline documents are intended to provide objective, uniform demonstrations.

2.1 Guidelines for Use of BWRVIP Mockups

1.0 Purpose

**Content Deleted -
EPRI Proprietary Information**

2.0 Reference

**Content Deleted -
EPRI Proprietary Information**

3.0 Guidelines for Usage

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 Guidelines for Use Prioritization



**Content Deleted -
EPRI Proprietary Information**

2.2 Protocol for NDE Technique Demonstrations on BWRVIP Mockups

1.0 Purpose

**Content Deleted -
EPRI Proprietary Information**

2.0 Responsibilities

**Content Deleted -
EPRI Proprietary Information**

3.0 Prerequisites

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 *Demonstration Plan*

**Content Deleted -
EPRI Proprietary Information**

5.0 *Demonstration Process*

**Content Deleted -
EPRI Proprietary Information**

6.0 Results Reporting and Documentation

**Content Deleted -
EPRI Proprietary Information**

2.3 Guidelines for Determining NDE Technique Uncertainty

1.0 Purpose

**Content Deleted -
EPRI Proprietary Information**

2.0 References

**Content Deleted -
EPRI Proprietary Information**

3.0 Responsibilities

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 Demonstration Process

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.0 Documentation

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

2.4 Guidelines for Determining Inspection Tool Positioning Uncertainty

1.0 Purpose

**Content Deleted -
EPRI Proprietary Information**

2.0 References

**Content Deleted -
EPRI Proprietary Information**

3.0 Responsibilities

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 Guidelines for Uncertainty Measurements

**Content Deleted -
EPRI Proprietary Information**

5.0 Demonstration Plan

**Content Deleted -
EPRI Proprietary Information**

6.0 Demonstration Process

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

7.0 Documentation

**Content Deleted -
EPRI Proprietary Information**

2.5 Generic Standards for Visual Inspection of Reactor Pressure Vessel Internals, Components, and Associated Repairs

1.0 Purpose

**Content Deleted -
EPRI Proprietary Information**

2.0 Scope

**Content Deleted -
EPRI Proprietary Information**

3.0 Definitions

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 Personnel Training/Experience

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.0 Equipment Requirements

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.0 Inspection Requirements

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

7.0 Evaluation of Indications

**Content Deleted -
EPRI Proprietary Information**

8.0 Documentation of Results

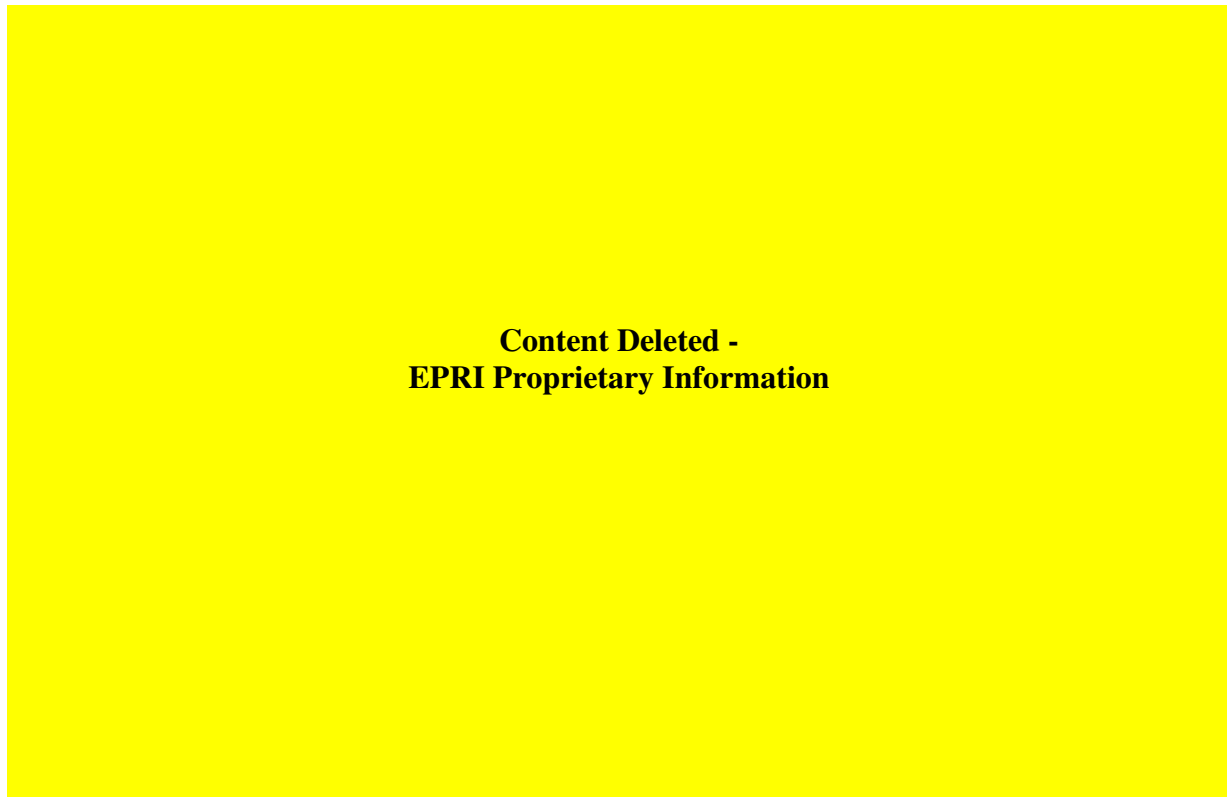
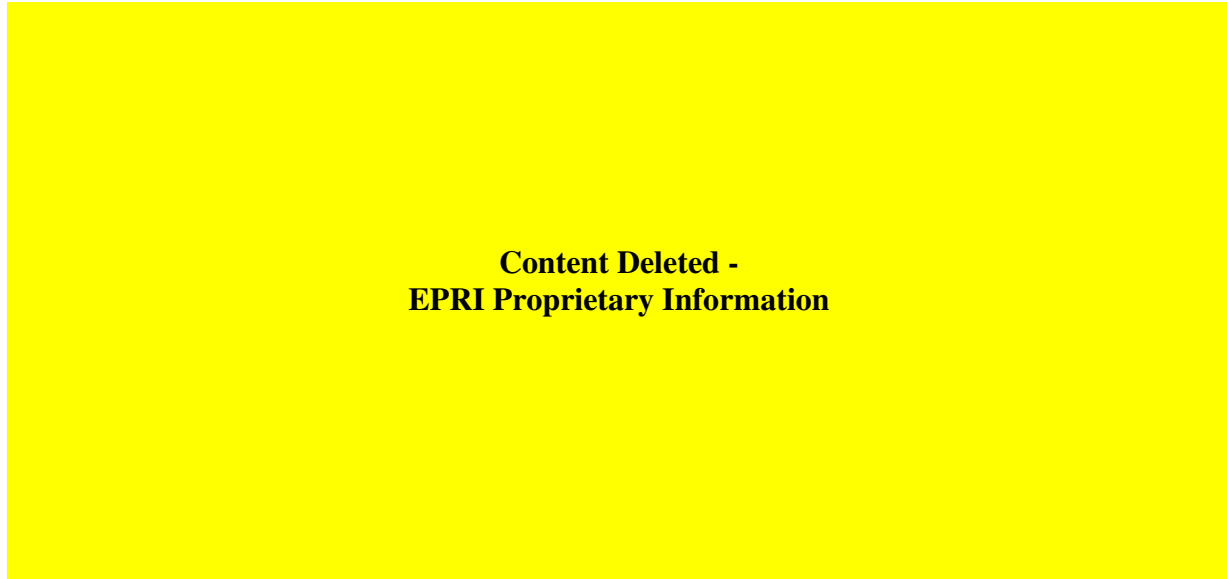


Figure 2.5.8.1-1. System Setup

2.6 Generic Standards for Ultrasonic Examination of BWR Vessel Internal Components

1.0 Scope

**Content Deleted -
EPRI Proprietary Information**

2.0 References

**Content Deleted -
EPRI Proprietary Information**

3.0 Personnel

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.0 Technique Demonstrations

**Content Deleted -
EPRI Proprietary Information**

5.0 Equipment

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.0 Calibration

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

7.0 Examination

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

8.0 Recording

**Content Deleted -
EPRI Proprietary Information**

9.0 Evaluation

**Content Deleted -
EPRI Proprietary Information**

10.0 Reporting

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

11.0 Examination of Stainless Steel and Nickel-Alloy Welds with Single-Sided Access

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

2.7 Generic Standards for Eddy Current Examination of BWR Vessel Internal Components

1.0 Scope

**Content Deleted -
EPRI Proprietary Information**

2.0 References

**Content Deleted -
EPRI Proprietary Information**

3.0 Personnel

**Content Deleted -
EPRI Proprietary Information**

4.0 Technique Demonstration

**Content Deleted -
EPRI Proprietary Information**

5.0 Equipment

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.0 Calibration

**Content Deleted -
EPRI Proprietary Information**

7.0 Examination

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

8.0 Recording

**Content Deleted -
EPRI Proprietary Information**

9.0 Evaluation

**Content Deleted -
EPRI Proprietary Information**

10.0 Reporting

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

3

DEMONSTRATION OF ACCURACY OF FLAW LENGTH MEASUREMENT BY VISUAL EXAMINATION

3.1 Summary

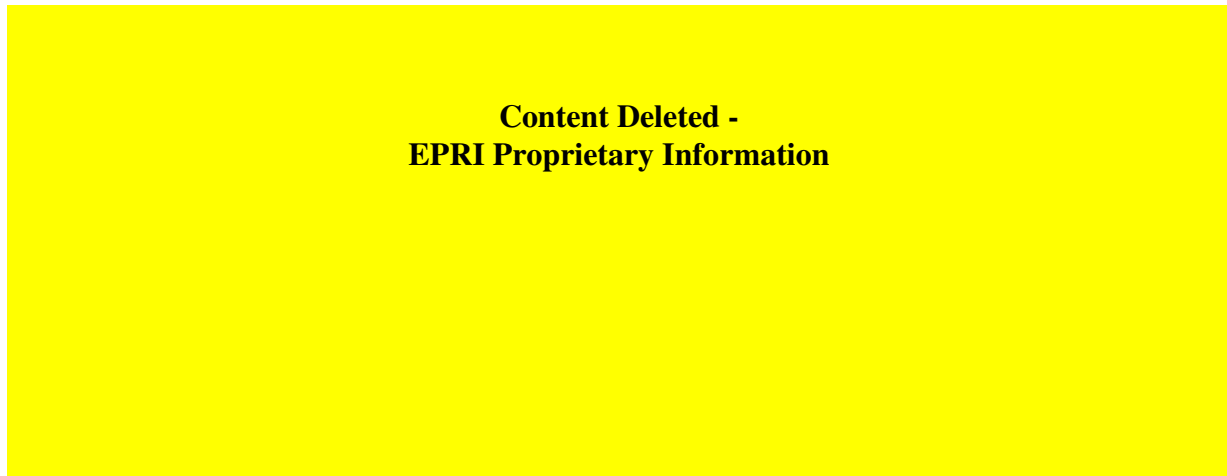
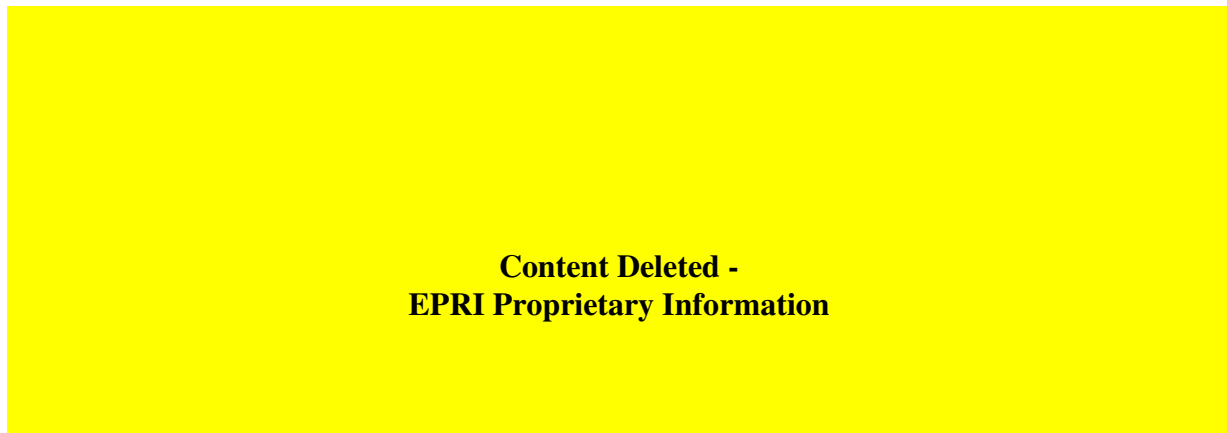
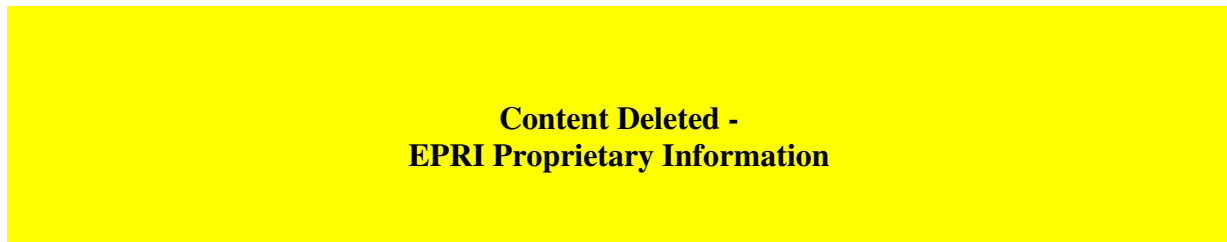


Table 3.1-1. Flaw Evaluation Factors



**Content Deleted -
EPRI Proprietary Information**

3.2 Demonstration

**Content Deleted -
EPRI Proprietary Information**

3.2.1 Vendors

**Content Deleted -
EPRI Proprietary Information**

3.2.2 Mockups

**Content Deleted -
EPRI Proprietary Information**

3.2.3 Flaws

**Content Deleted -
EPRI Proprietary Information**

3.2.4 Cameras

**Content Deleted -
EPRI Proprietary Information**

3.2.5 Measurement Techniques

**Content Deleted -
EPRI Proprietary Information**

3.3 Sizing Performance

Content Deleted - EPRI Proprietary Information

3.3.1 Estimation

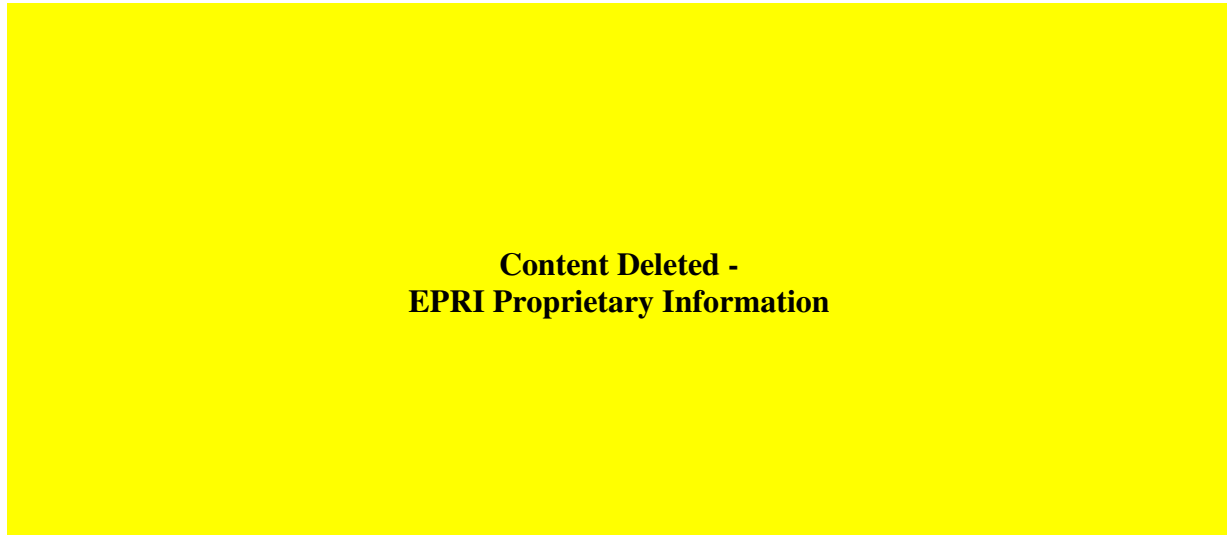


Table 3.3.1-1. Sizing Performance of Length Estimation Techniques



**Content Deleted -
EPRI Proprietary Information**

3.3.2 Measurement by Ruler

**Content Deleted -
EPRI Proprietary Information**

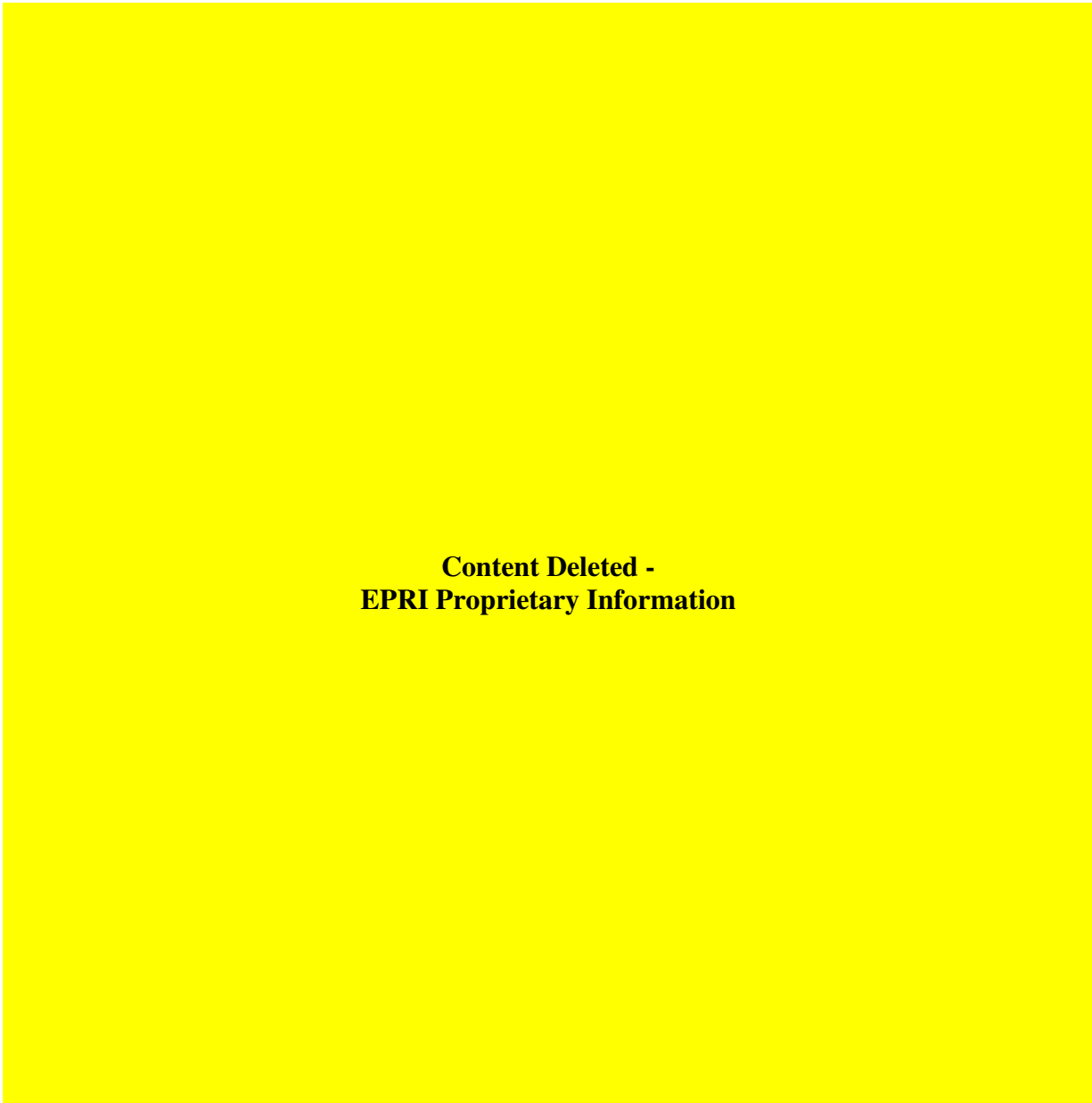
Table 3.3.2-1. Sizing Performance of Length Measurement by Ruler

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4 SHROUD

4.1 Summary



Content Deleted - EPRI Proprietary Information

Table 4.1-1. Where to Find Evaluation Factors for the Shroud

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

4.3.1 Shroud Weld Mockups

**Content Deleted -
EPRI Proprietary Information**

Content Deleted - EPRI Proprietary Information

4.3.1.1 NDE Center's Original H3 Mockup

**Content Deleted -
EPRI Proprietary Information**

4.3.1.2 Utility H3 and H4 Mockups

Content Deleted - EPRI Proprietary Information

4.3.1.3 Shroud Block BWRVIP-A: Ring-to-Cylinder

**Content Deleted -
EPRI Proprietary Information**

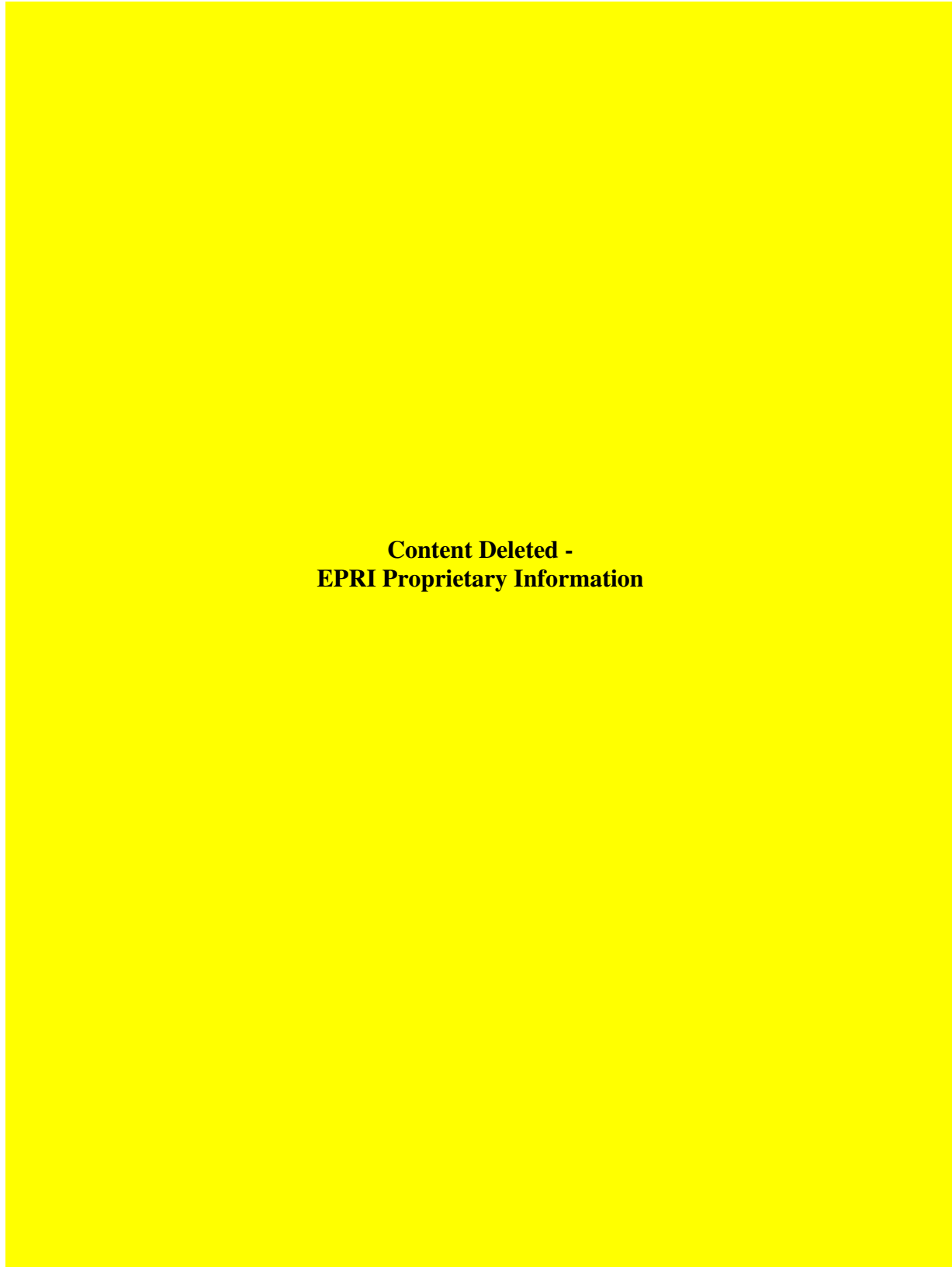


Figure 4.3.1.3-1. Design of Shroud Mockup BWRVIP-A



**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.3-2. Cross Section of Weld in Mockup BWRVIP-A

4.3.1.4 Shroud Block BWRVIP-B: Ring-to-Cylinder



**Content Deleted -
EPRI Proprietary Information**

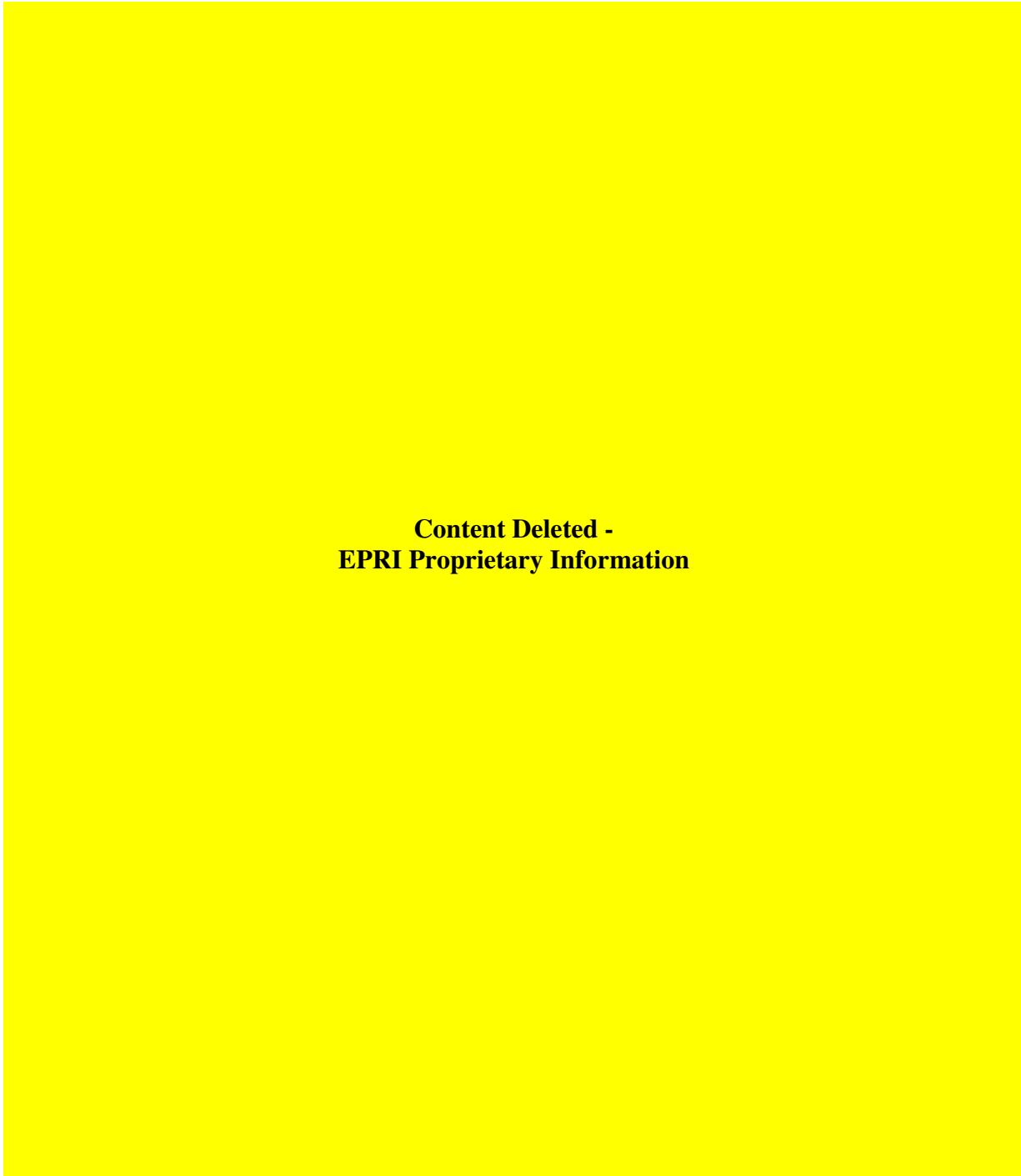


Figure 4.3.1.4-1. Design of Shroud Mockup BWRVIP-B

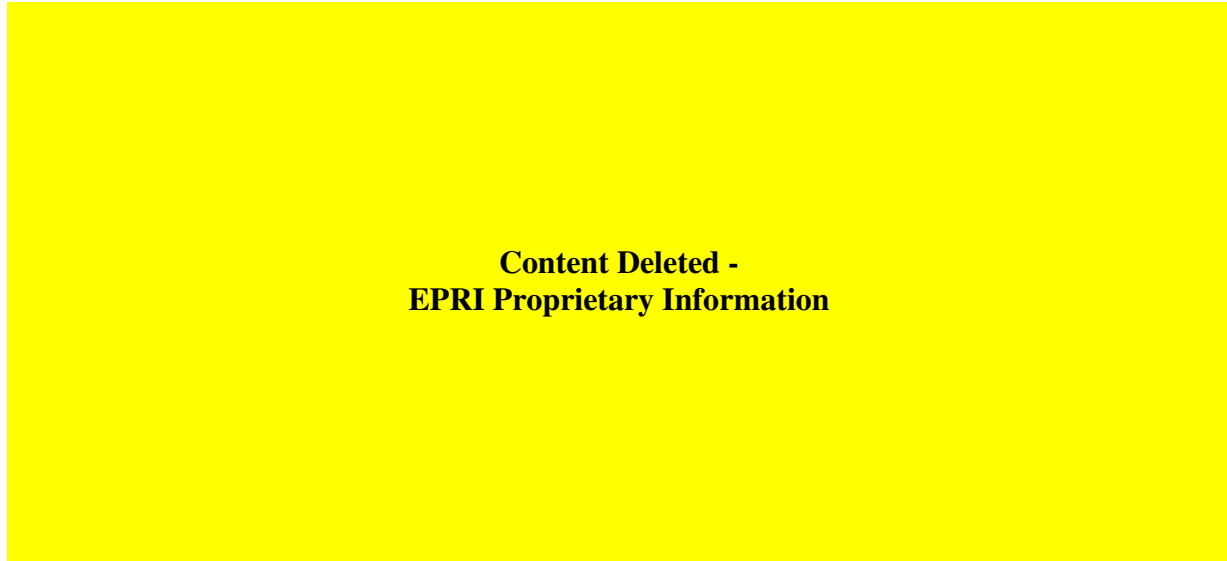
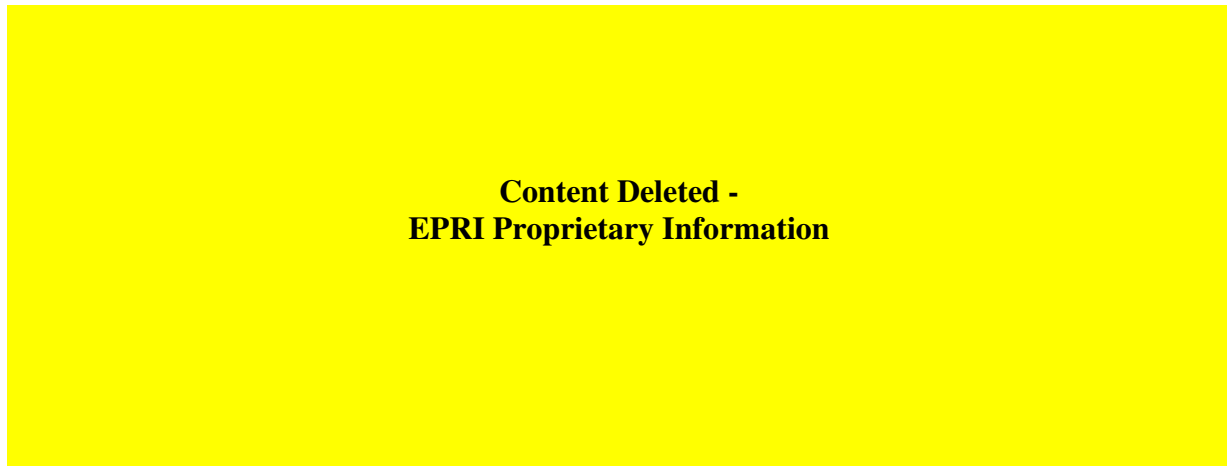


Figure 4.3.1.4-2. Cross section of Weld in Mockup BWRVIP-B

4.3.1.5 Shroud Block BWRVIP-C: Cylinder-to-Cylinder



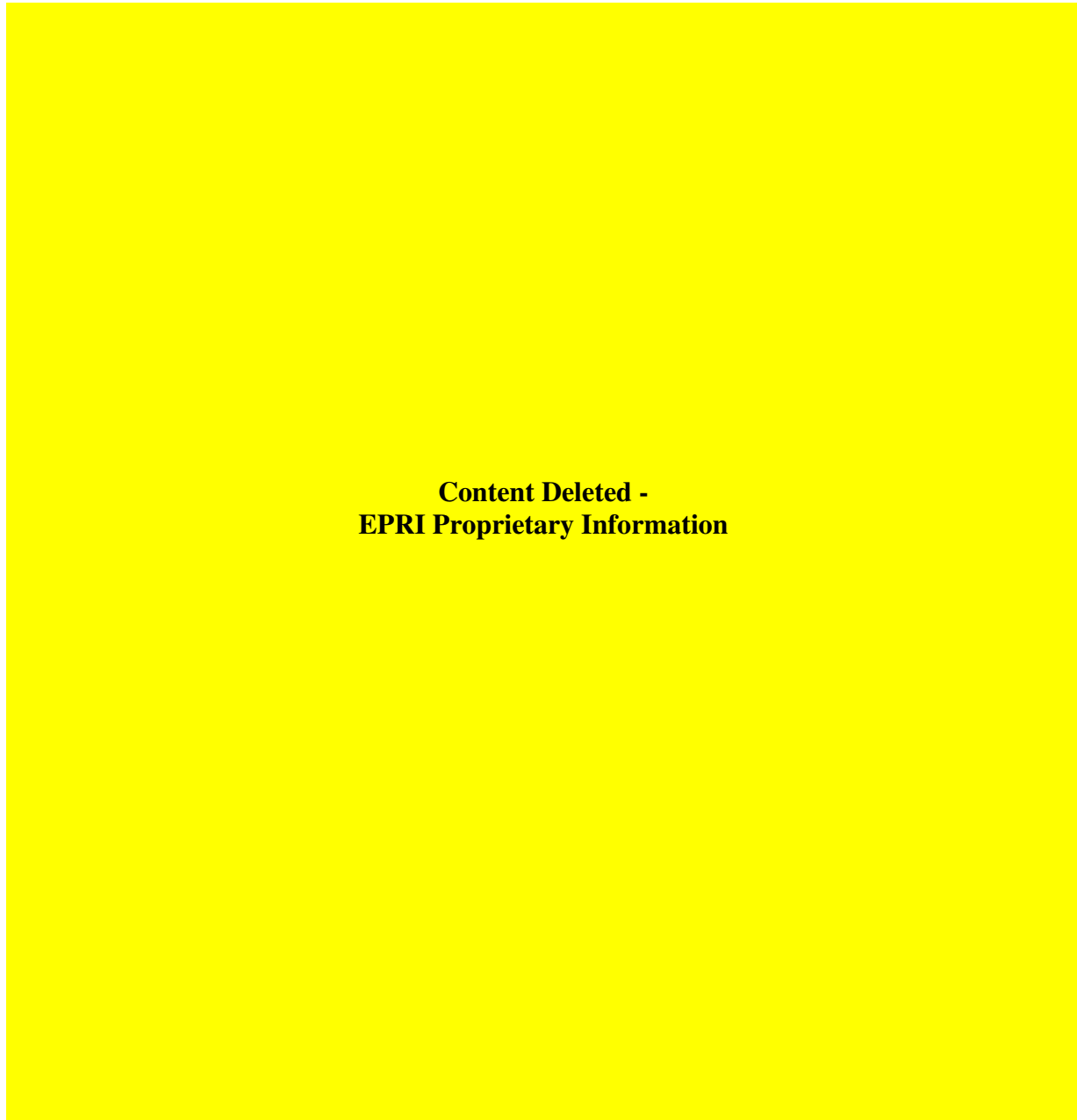


Figure 4.3.1.5-1. Design of Shroud Mockup BWRVIP-C

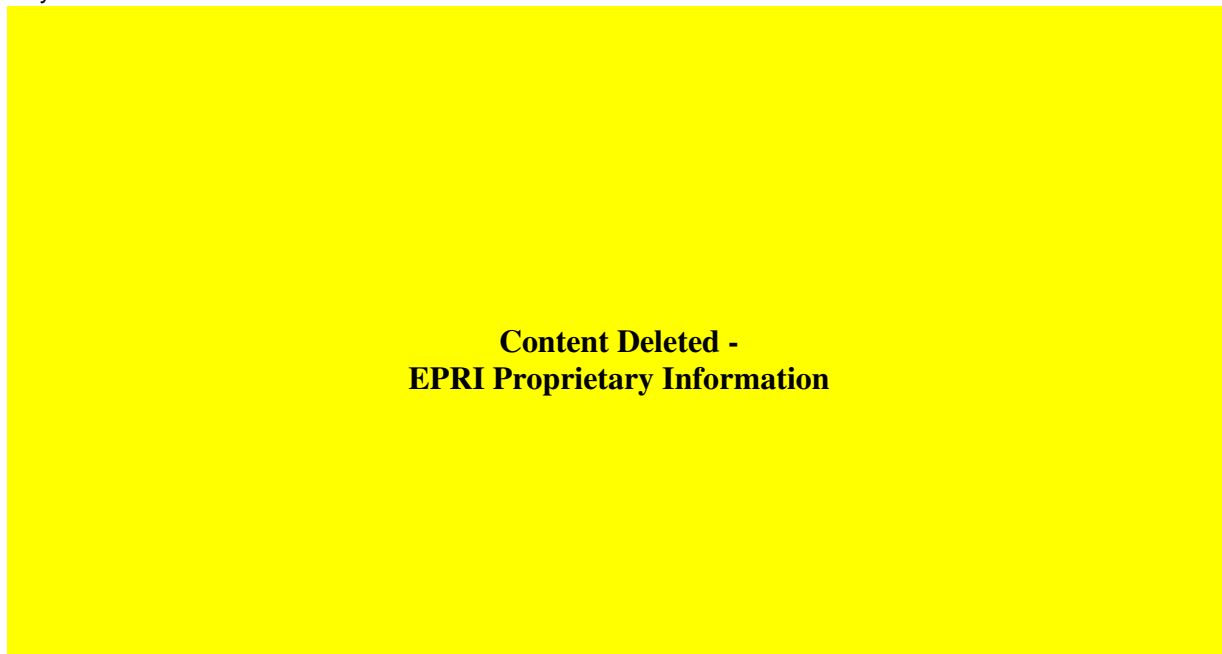
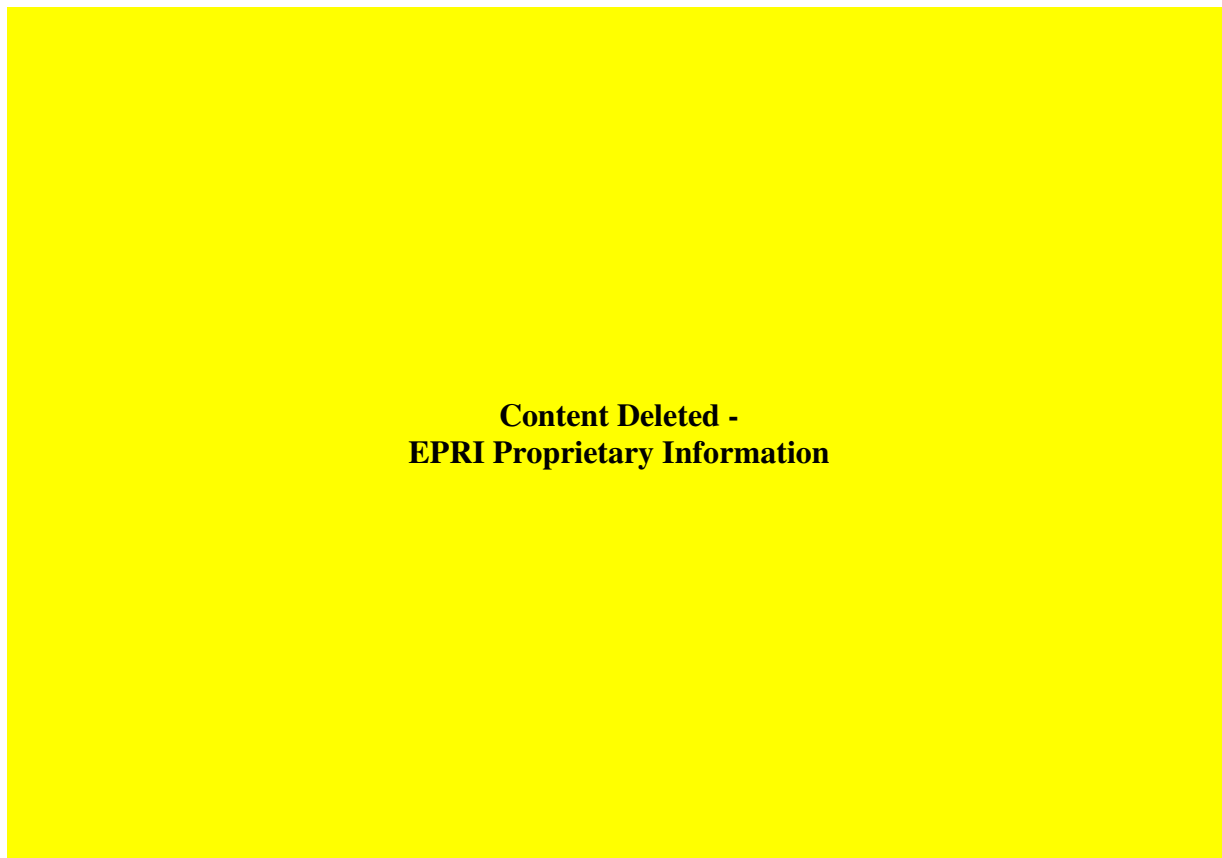


Figure 4.3.1.5-2. Cross Section of Weld in Mockup BWRVIP-C

4.3.1.6 Shroud Mockup BWRVIP-G and H: Ring Segment Welds



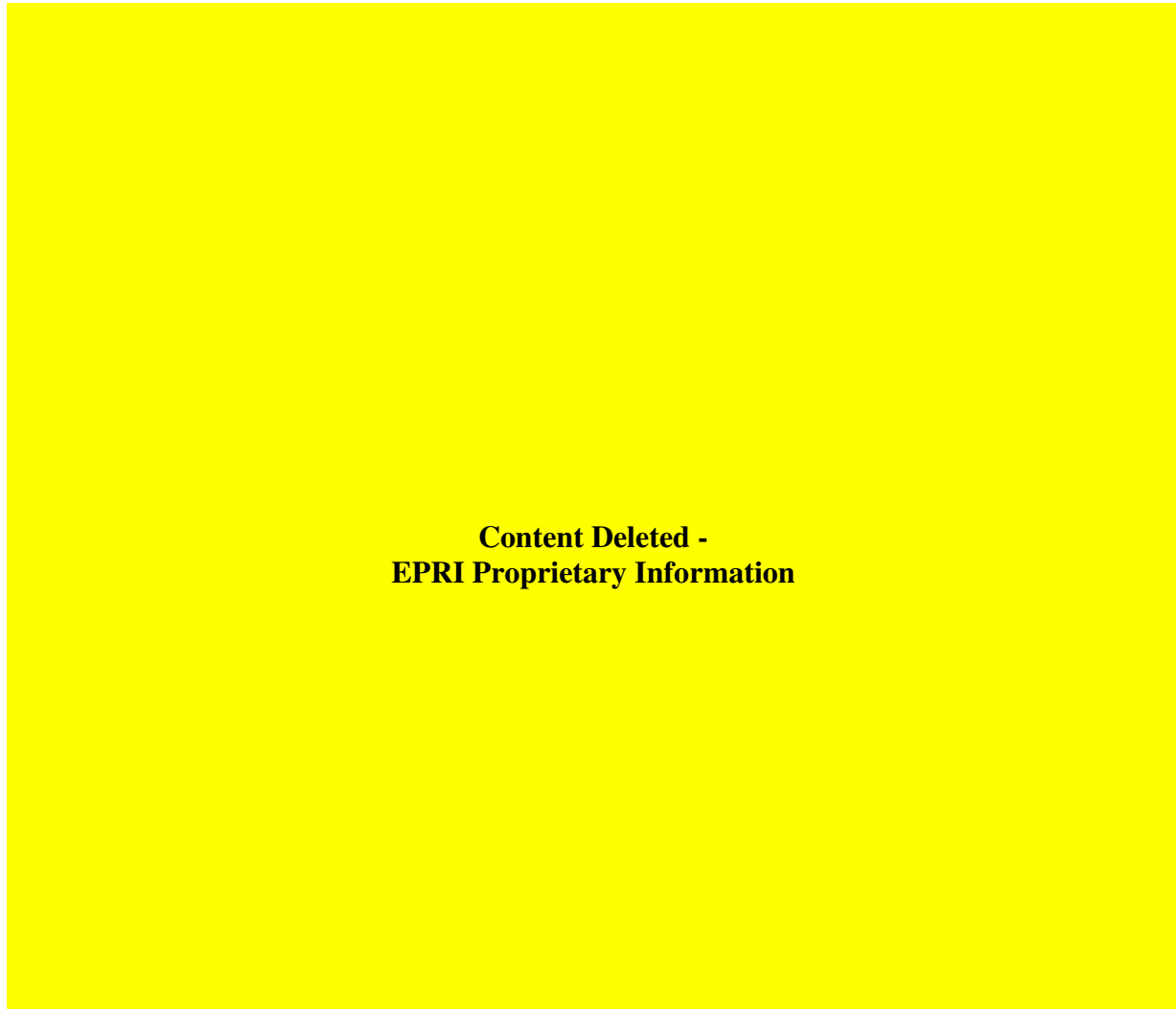


Figure 4.3.1.6-1. Mockup BWRVIP-G and BWRVIP-H, Representing the Ring Segment Weld

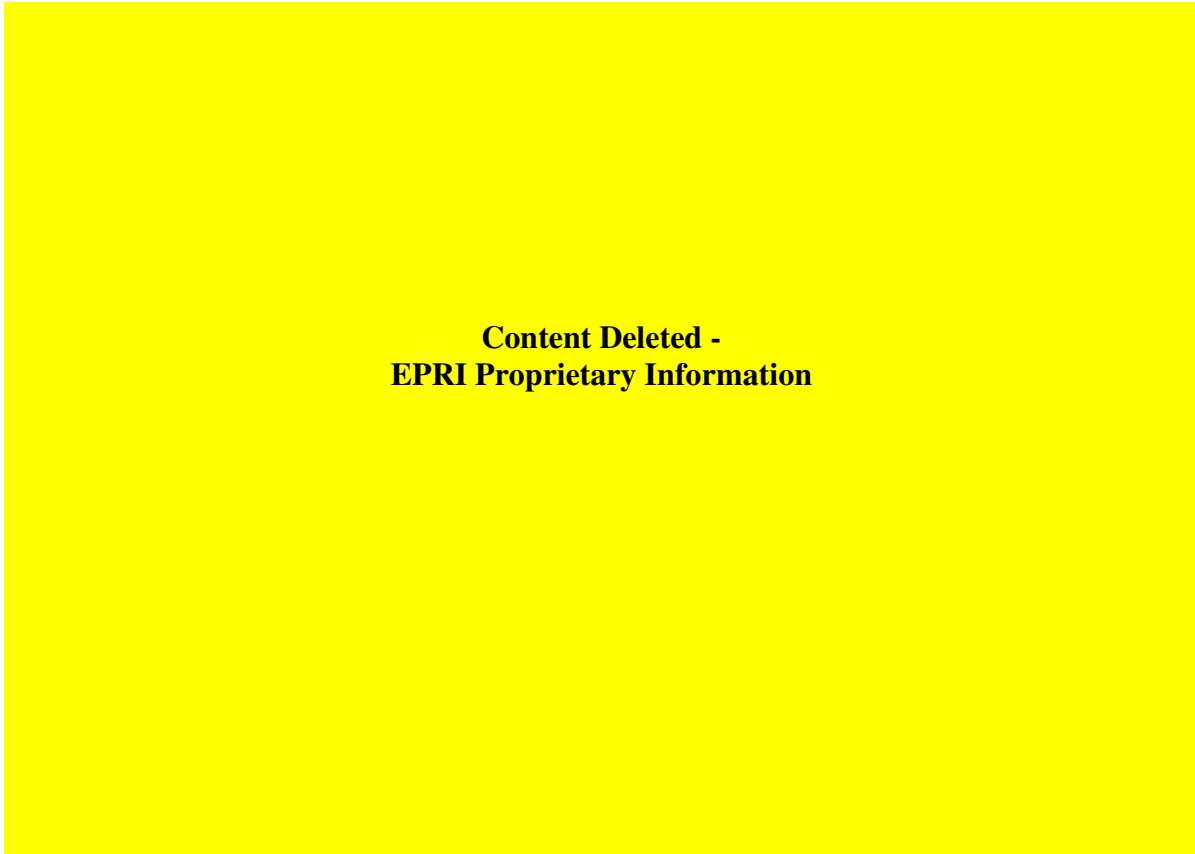


Figure 4.3.1.6-2. Cross Section of Mockup BWRVIP-G and BWRVIP-H

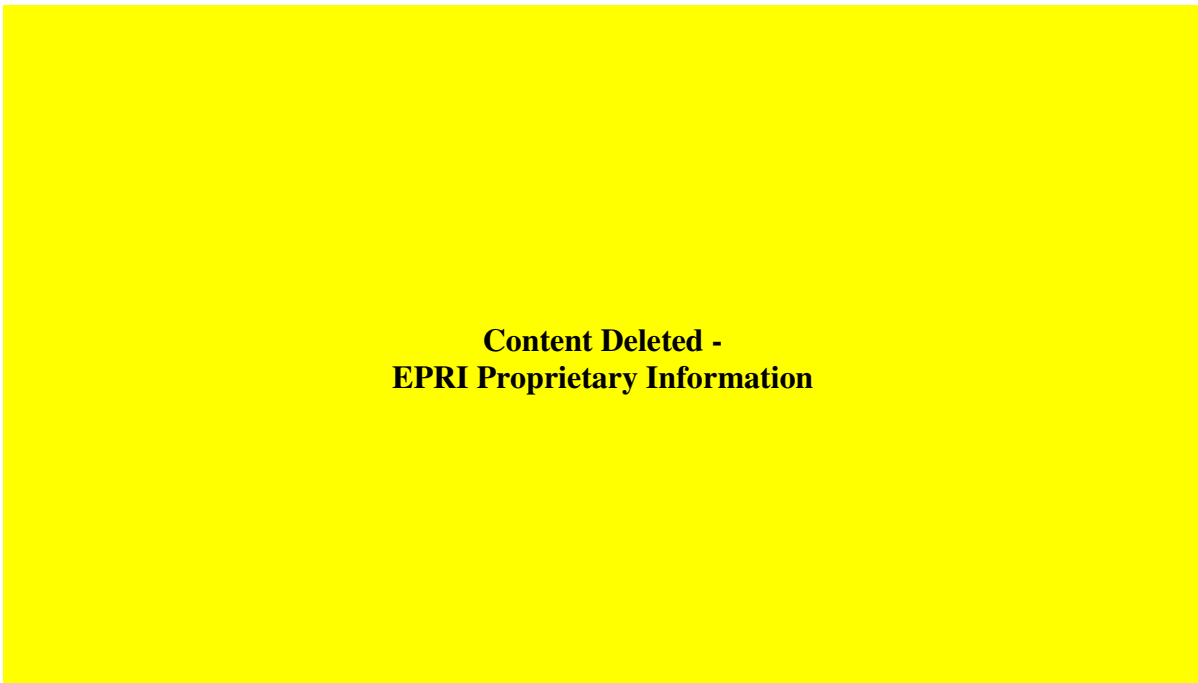


Figure 4.3.1.6-3. Shroud Ring Segment Weld

4.3.1.7 Shroud Mockup BWRVIP-H1: Shroud Weld H1

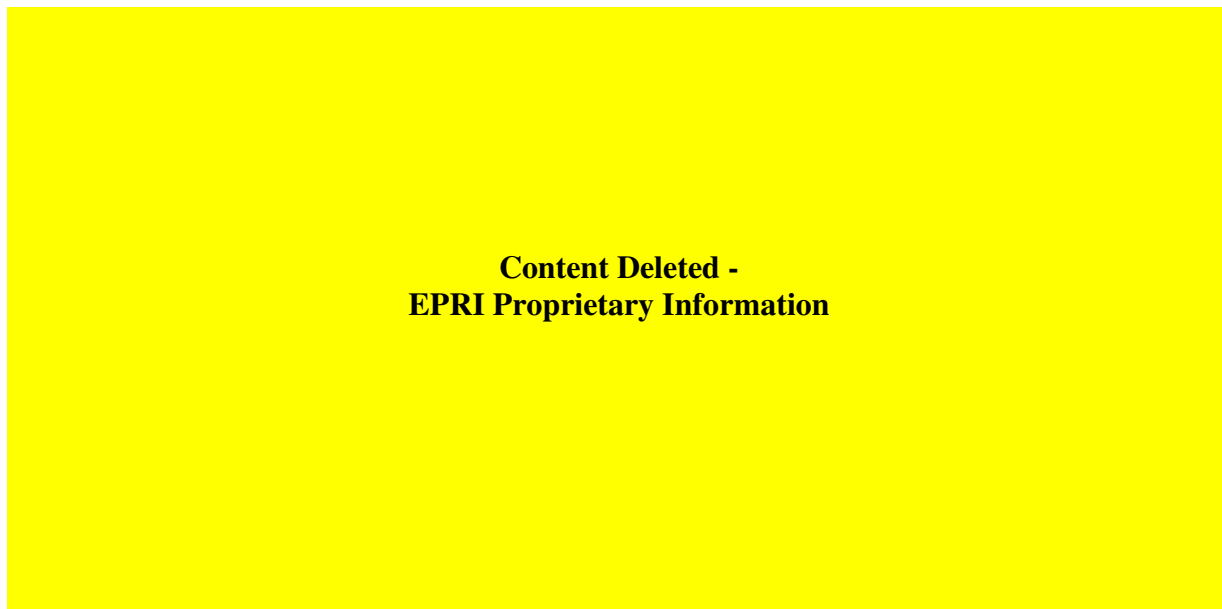
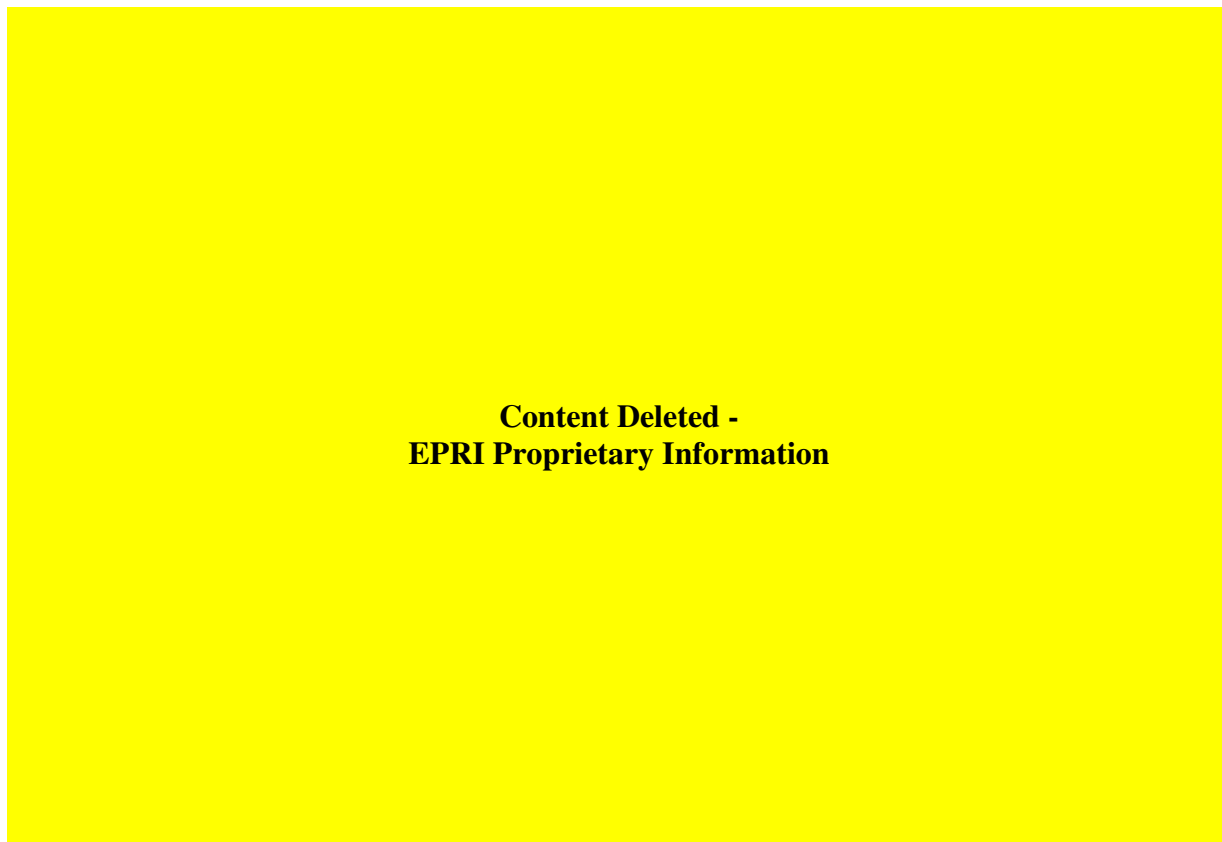


Figure 4.3.1.7-2. Configuration of BWRVIP-H1-R1 Mockup (New Sparger Brackets Shown in Blue)

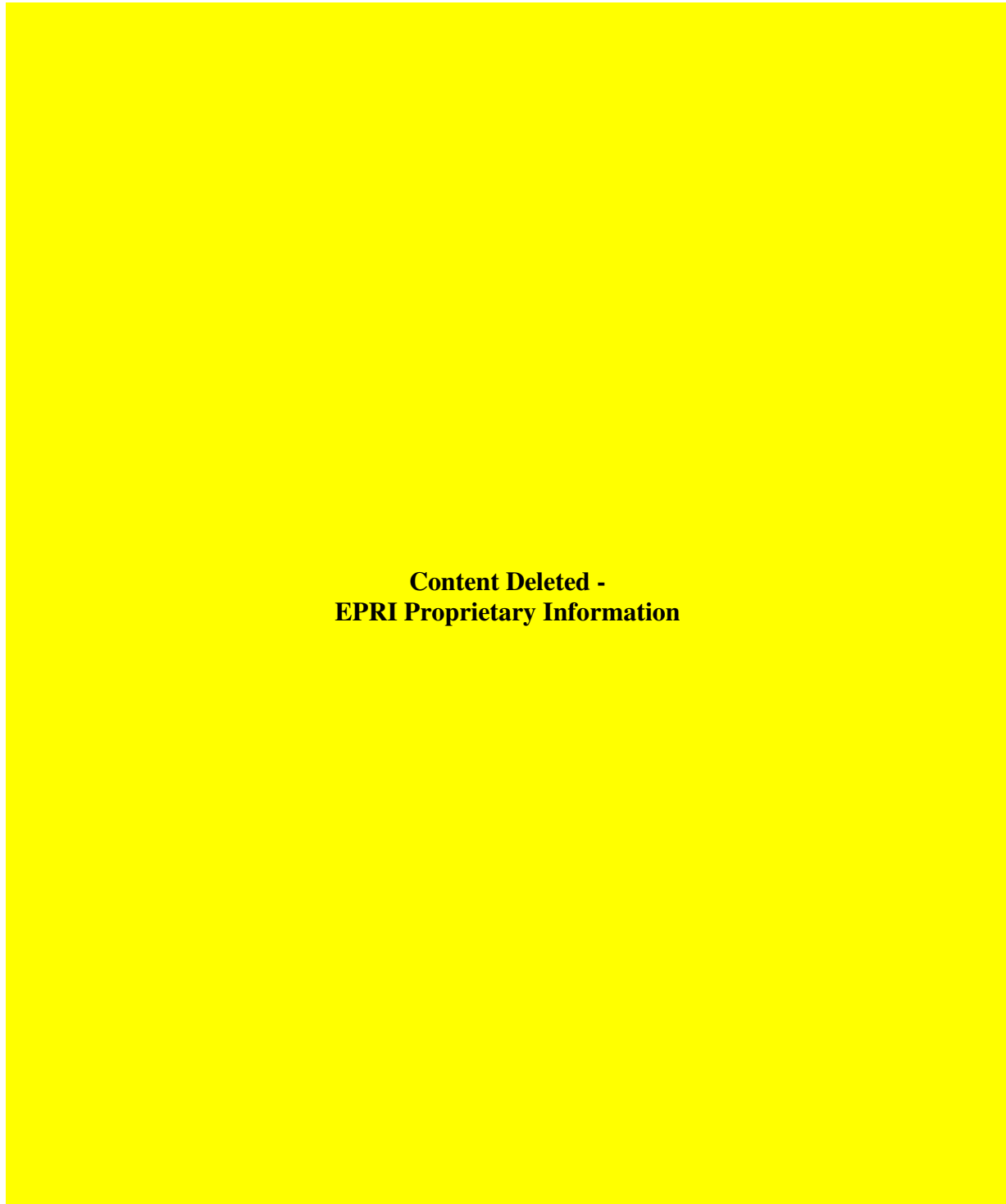


Figure 4.3.1.7-3. Details for BWRVIP-H1-R1 Sparger Bracket Flaws

4.3.1.8 Shroud Mockup BWRVIP-SSC1: Shroud Scallops

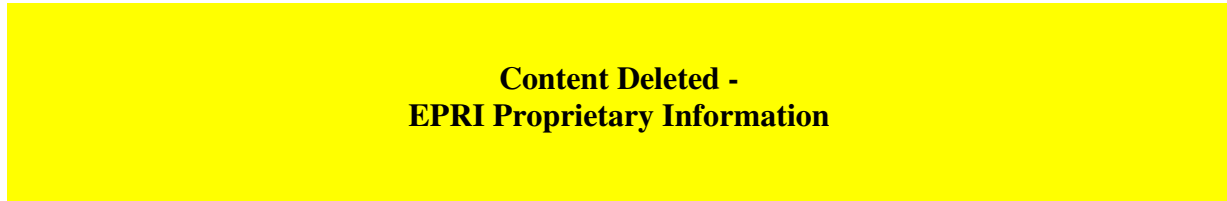


Table 4.3.1.8-1. Notches in Mockup BWRVIP-SSC-1

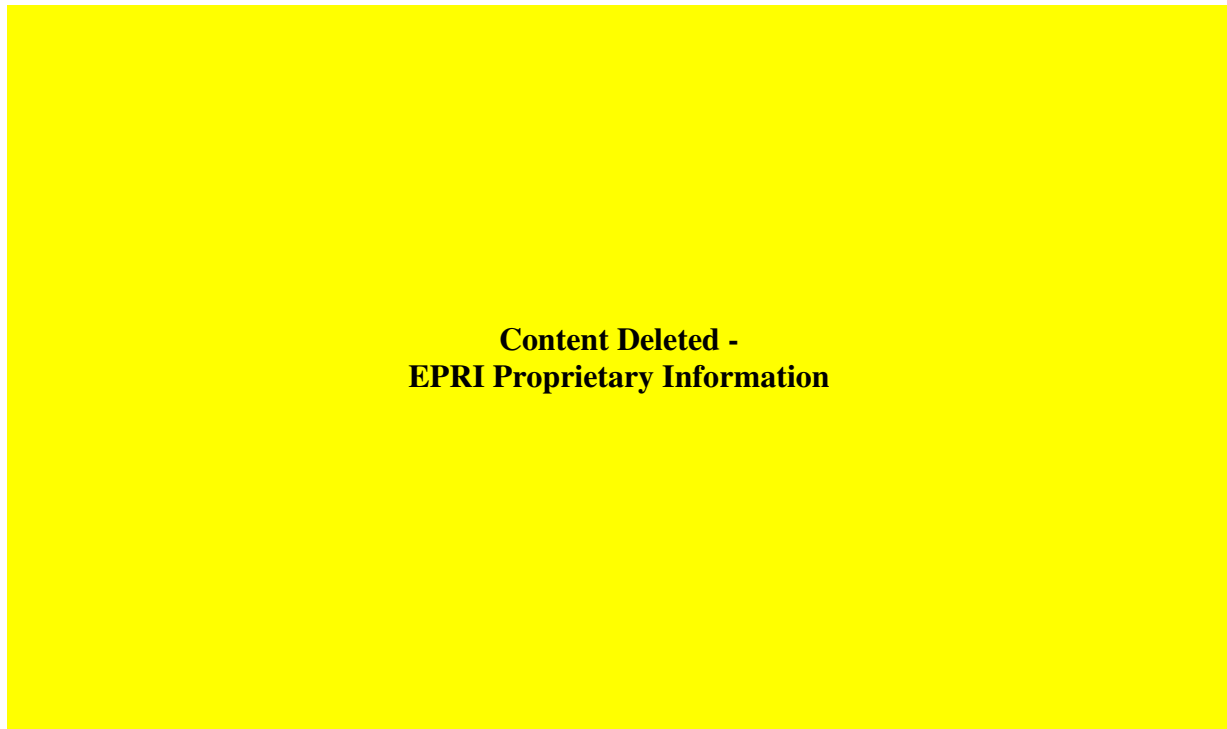
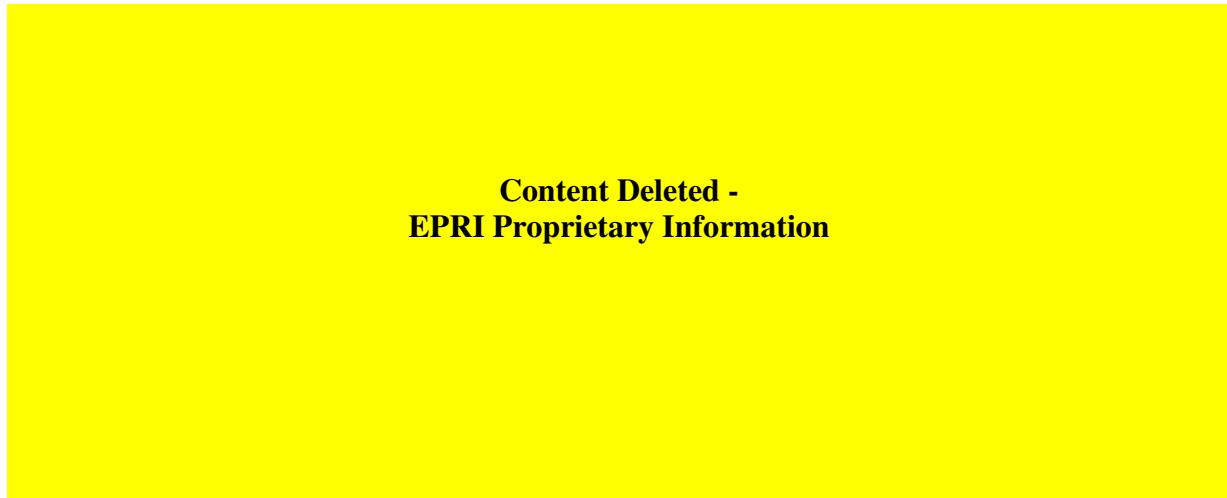


Figure 4.3.1.8-1. Mockup BWRVIP-SSC1

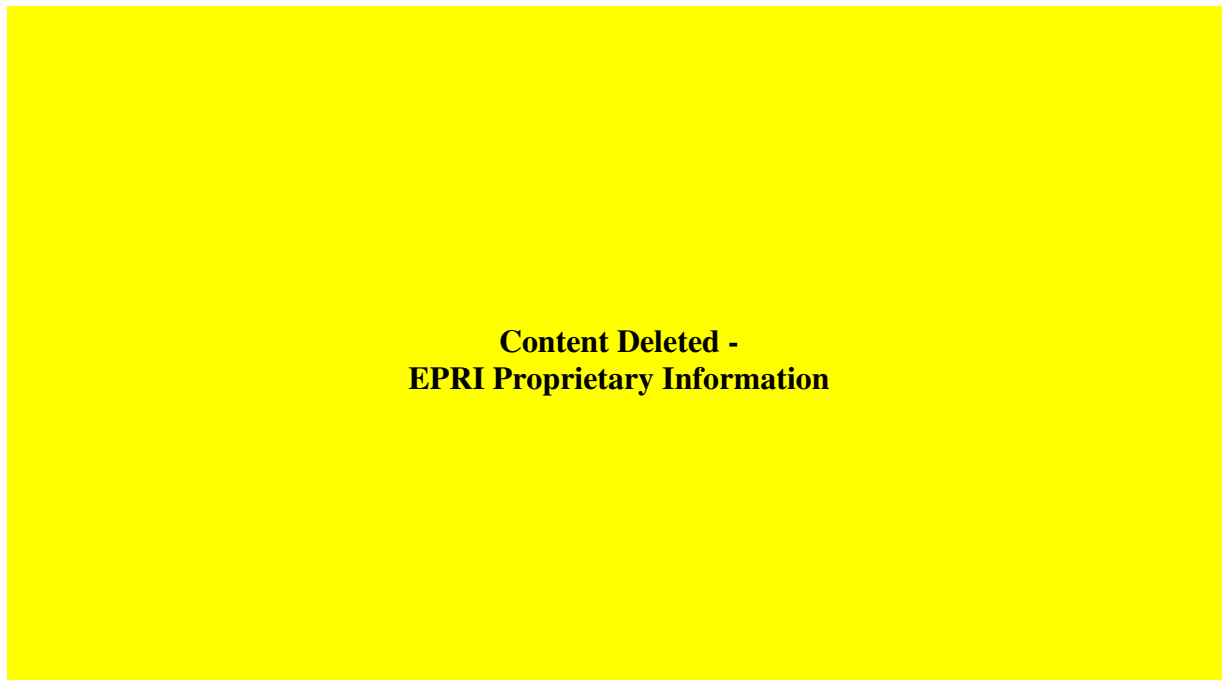


Figure 4.3.1.8-2. Mockup BWRVIP-SSC1; Detail of Notches 1-4

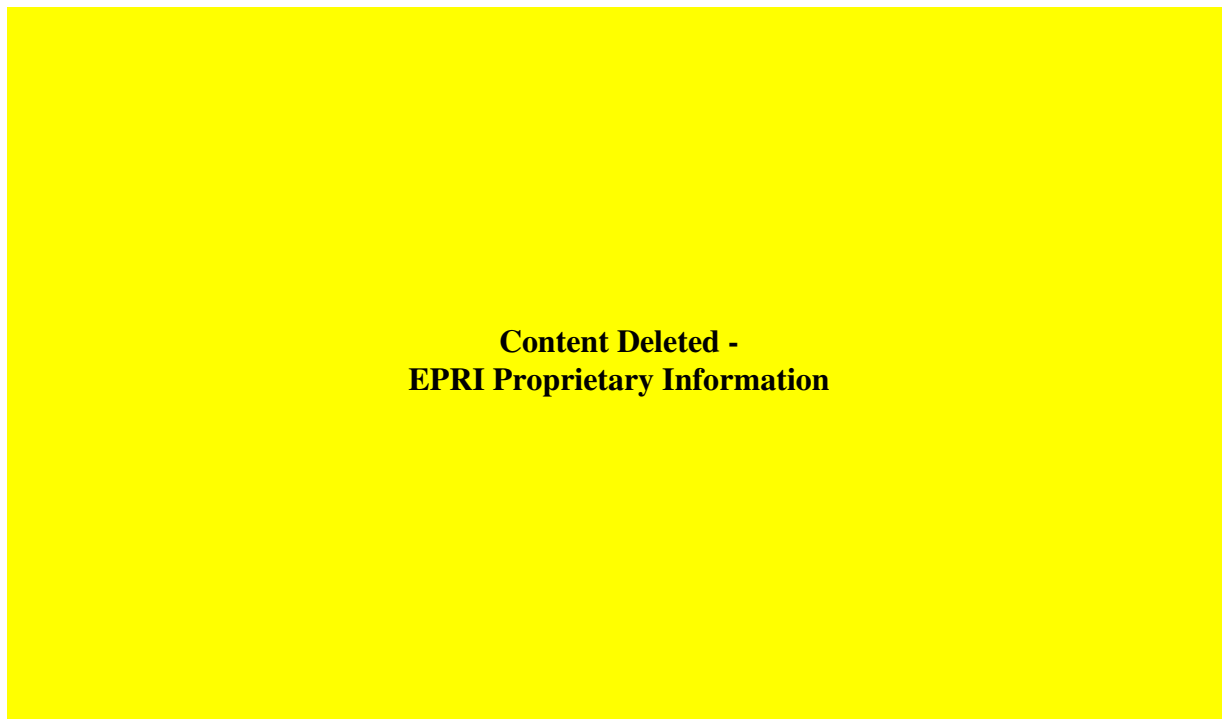


Figure 4.3.1.8-3. Mockup BWRVIP-SSC1; Detail of Notches 5-8

4.3.1.9 Shroud Mockup BWRVIP-H6OH: Overhanging Core Plate Support Ring

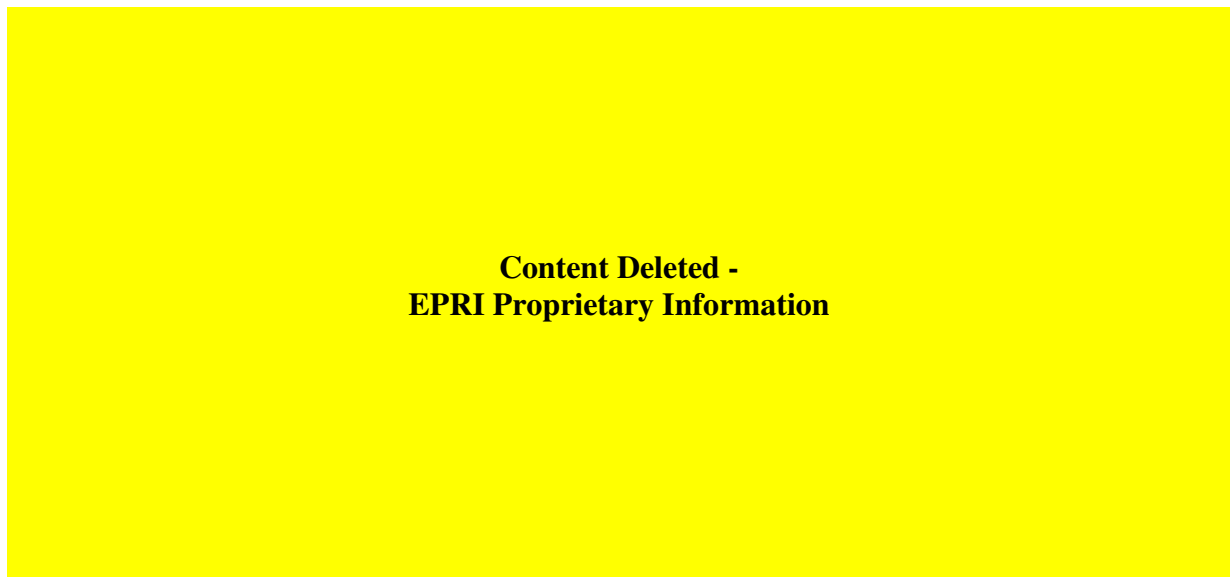
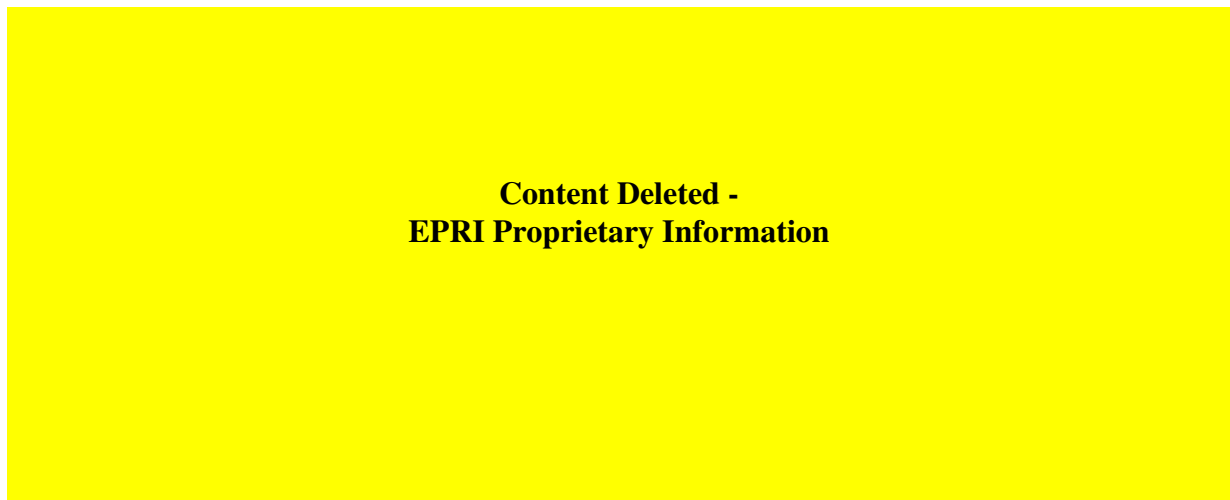
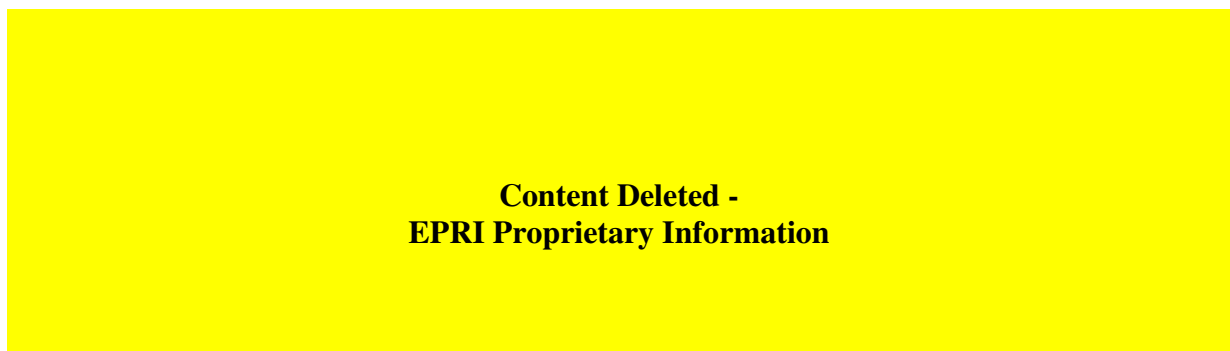


Figure 4.3.1.9-1. Illustration of the Overhanging Configuration of Weld H6b

4.3.1.10 Shroud Mockup BWRVIP-TGSR: Radial Ring Segment Mockup



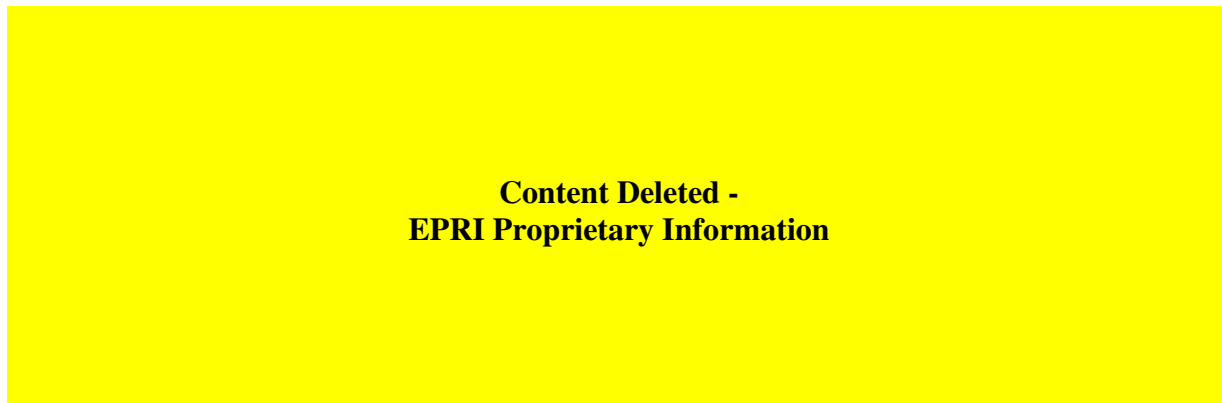


Figure 4.3.1.10-1. BWRVIP-TGSR Mockup (Photograph)

4.3.1.11 BWRVIP-H2/H3: Top Guide Support Ring-to-Cylinder Mockup



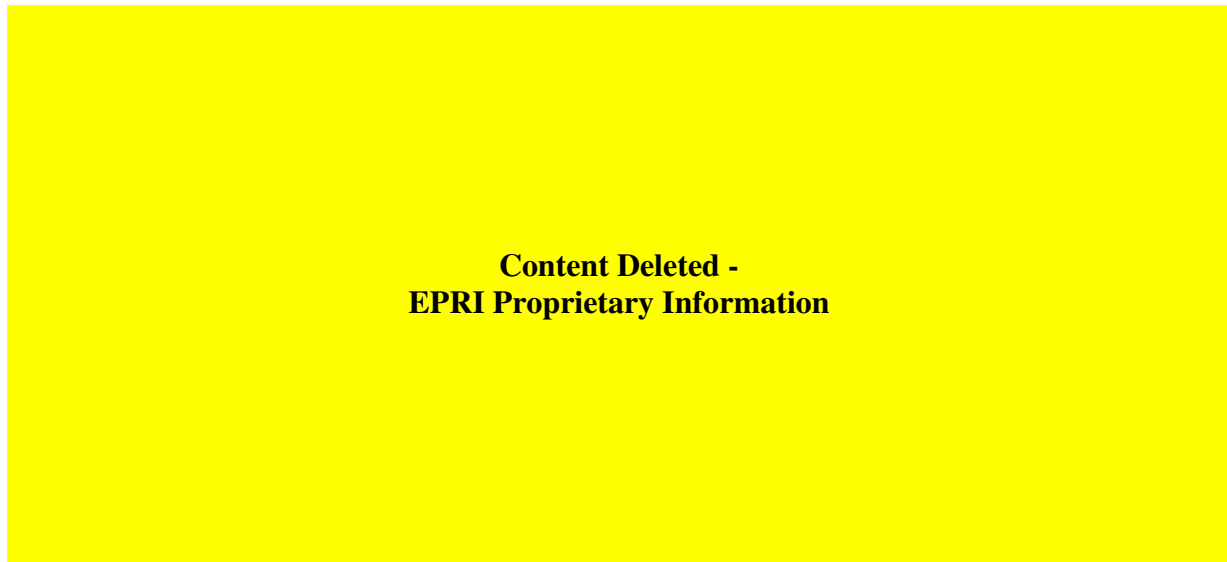
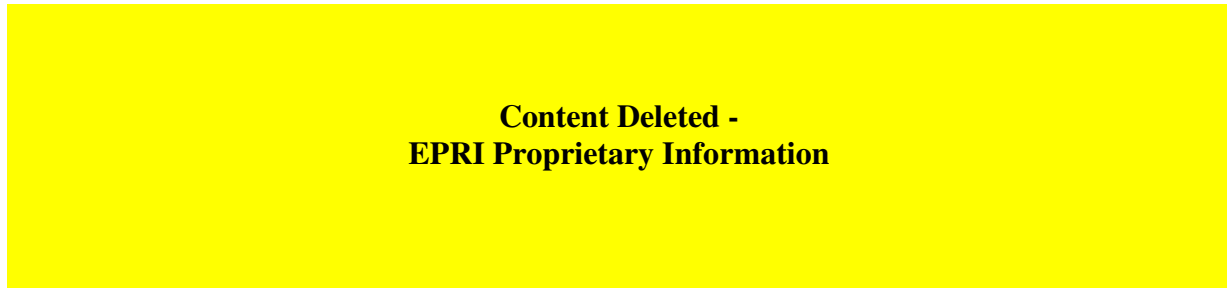


Figure 4.3.1.11-1. Typical Phased Array Technique for Examination of Core Shroud H2 Welds

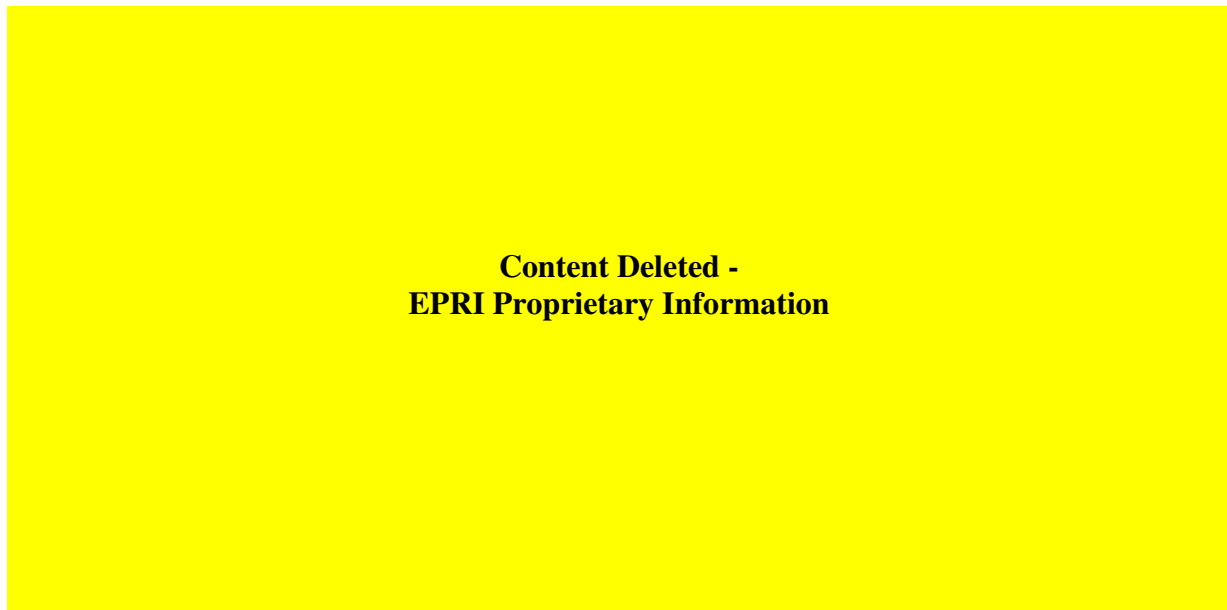


Figure 4.3.1.11-2. Typical Phased Array Technique for Examination of Core Shroud H3 Welds

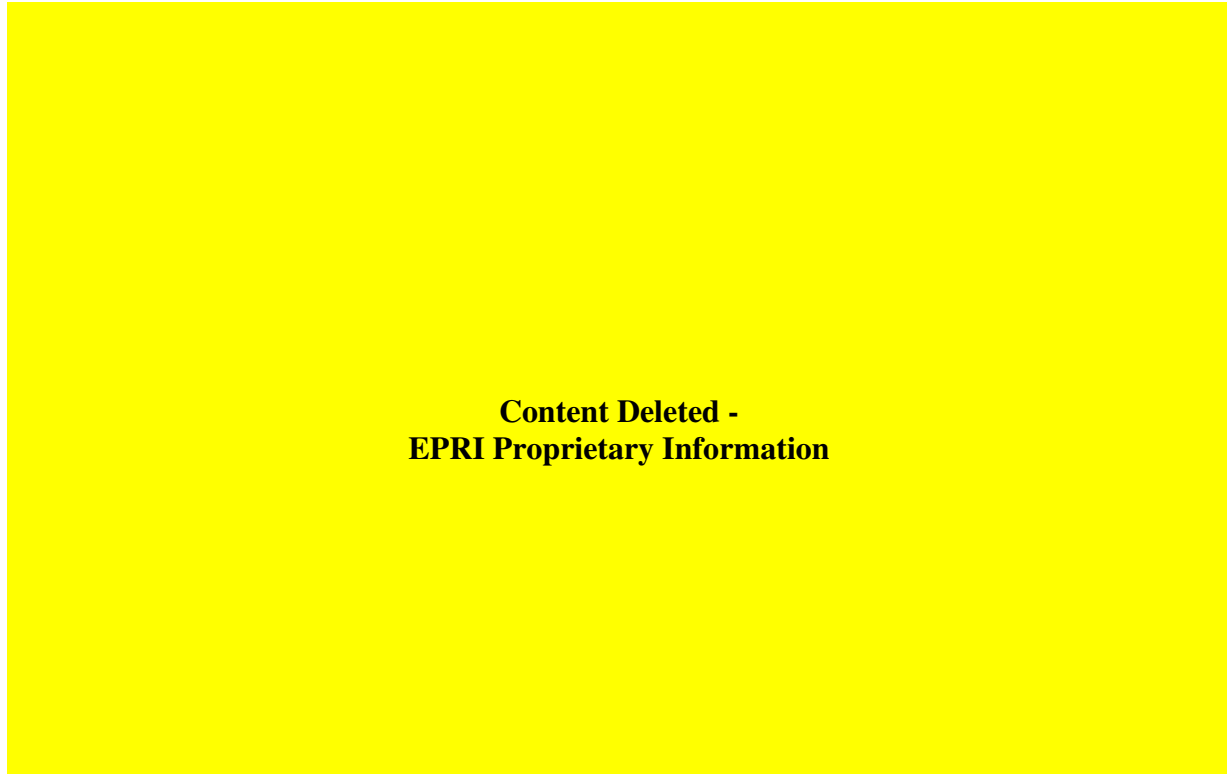


Figure 4.3.1.11-3. Photograph of BWRVIP-H2/H3 Mockup

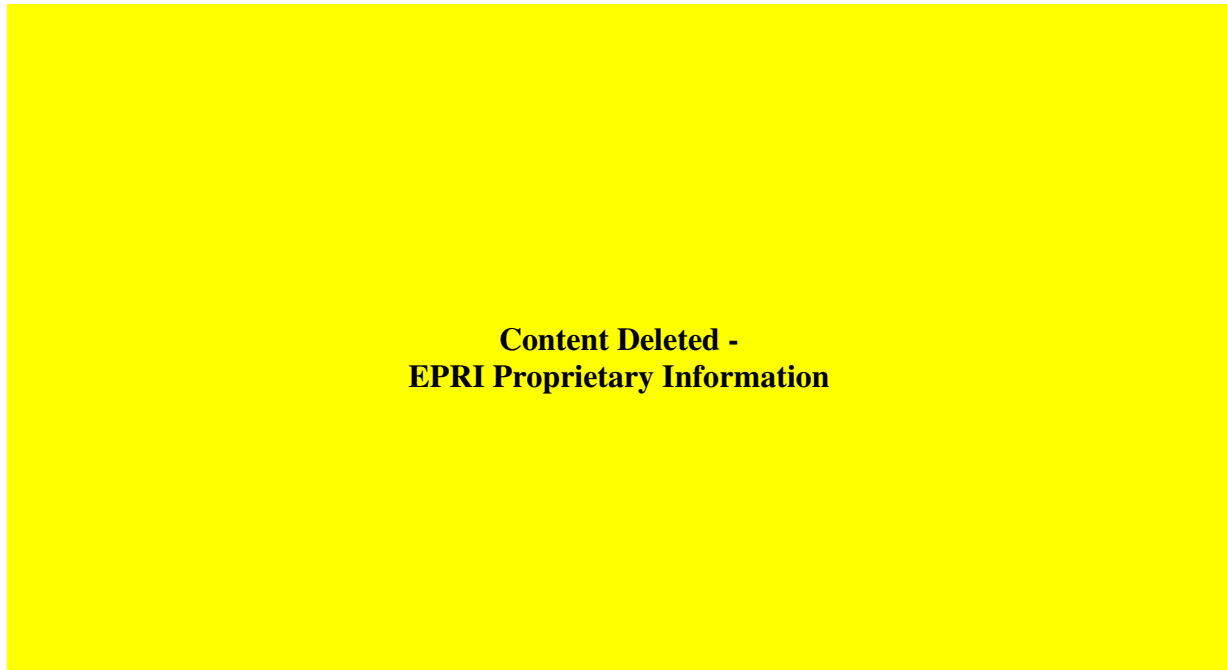


Figure 4.3.1.11-4. Configuration of BWRVIP-H2/H3 (Side View)

4.3.1.12 BWR/6 H3 Core Shroud Weld Mockups (BWRVIP-BWR6-H3-A and BWRVIP-BWR6-H3-B)

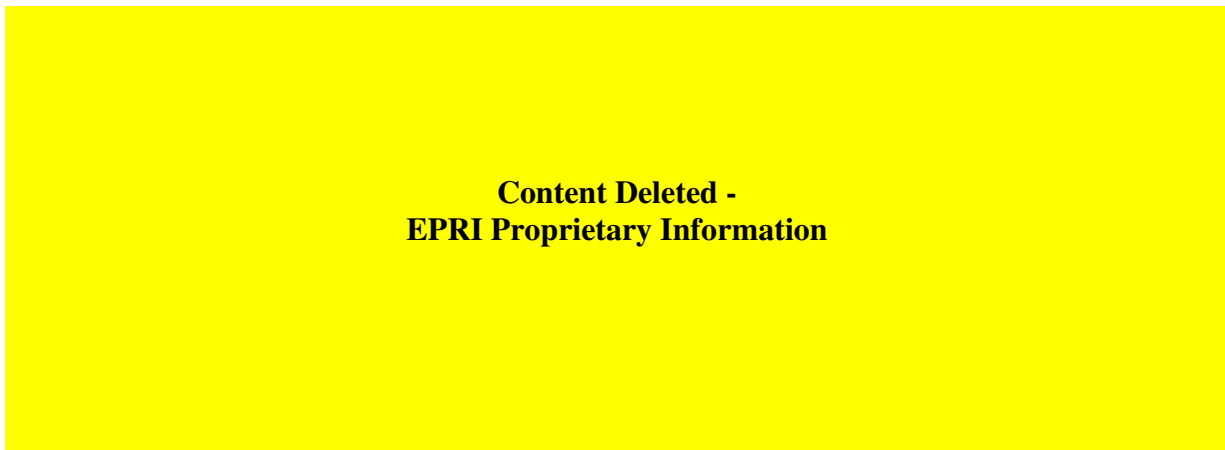


Figure 4.3.1.12-1. Roll-Out View of Shroud Flange, Showing Bolt Hole and Alignment Pinhole Locations



**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.12-4-1-2. BWR/6 H3 Weld Configurations (Bolt Hole Cross Section Shown)



**Content Deleted -
EPRI Proprietary Information**

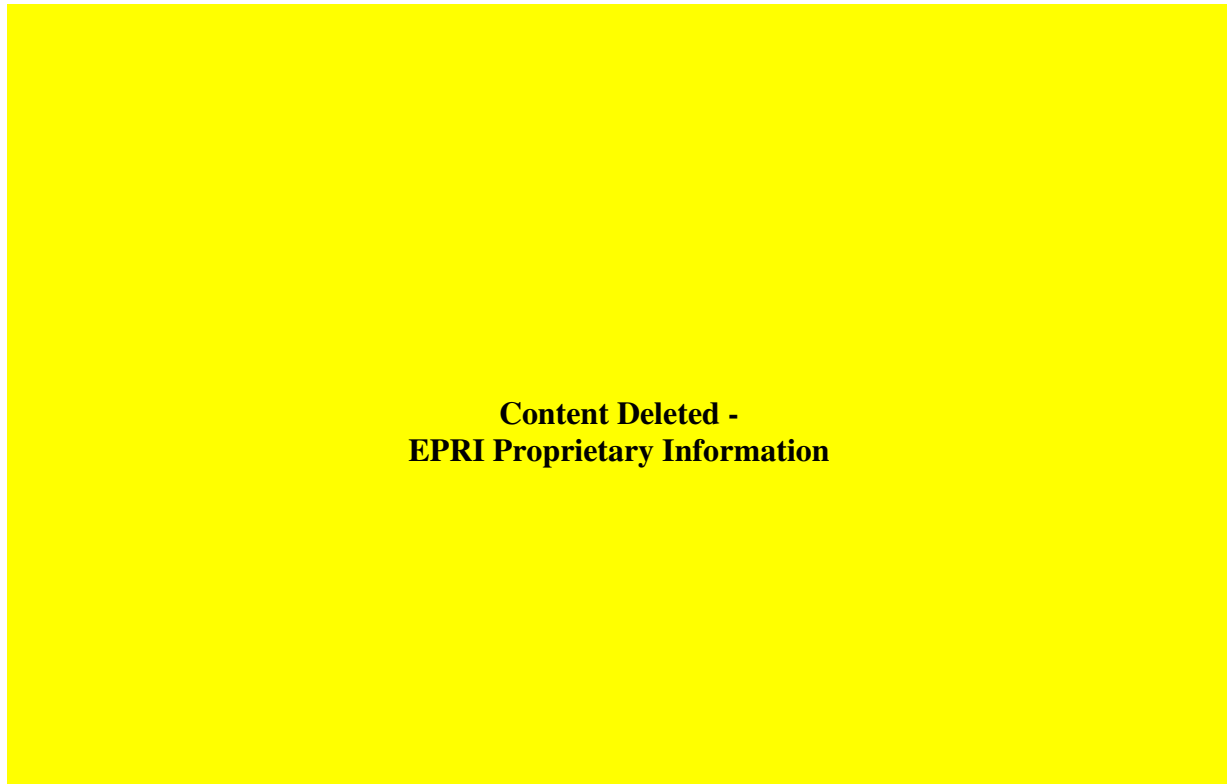


Figure 4.3.1.12-3. BWR/6 H3 Core Shroud Mockups (Photograph)

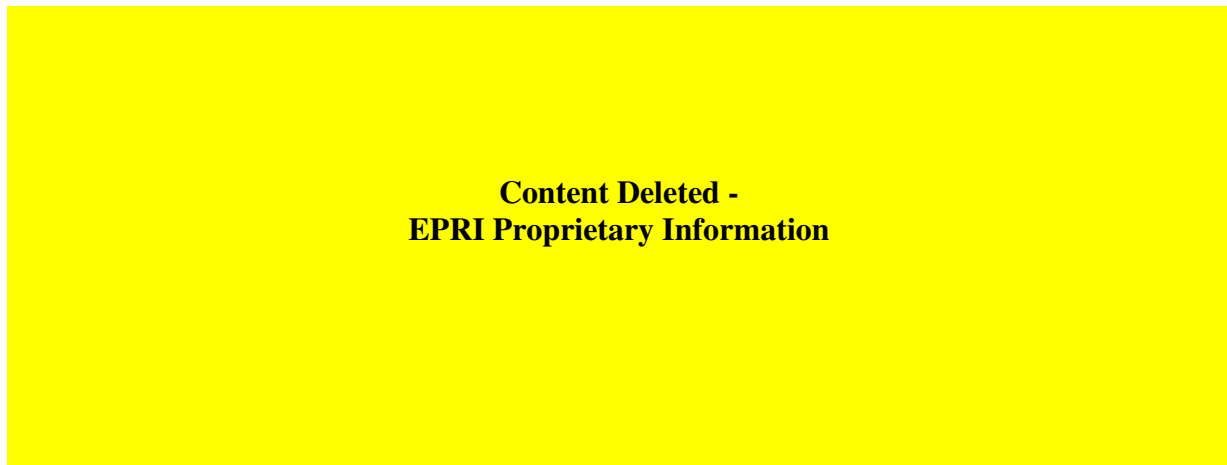


Figure 4.3.1.12-4. BWR/6 H3 Core Shroud Mockups (Photograph of Bolt Holes)

4.3.2 Special Purpose Mockups

**Content Deleted -
EPRI Proprietary Information**

4.3.2.1 Surface Roughness

**Content Deleted -
EPRI Proprietary Information**

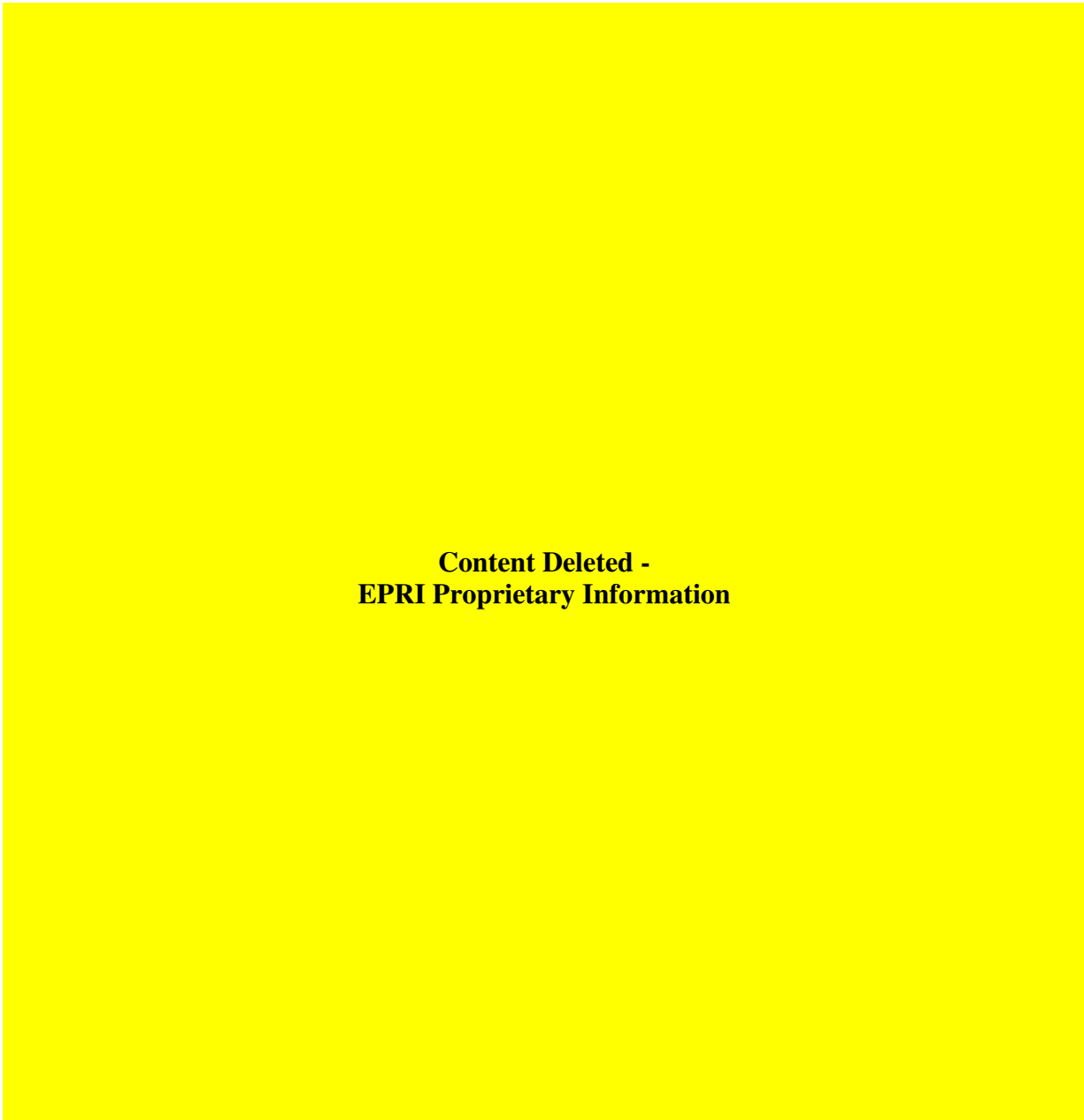
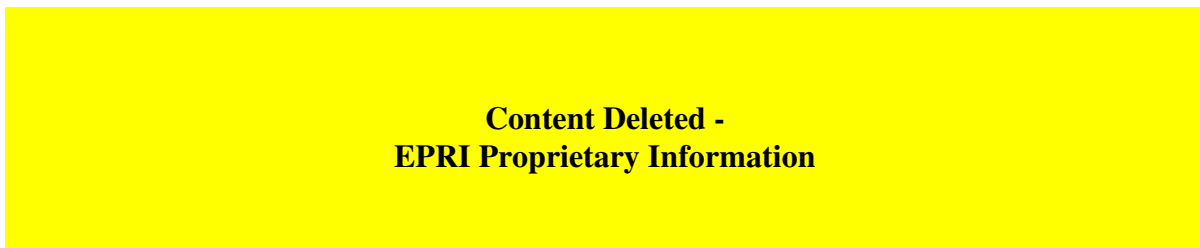


Figure 4.3.2.1-1. Surface Roughness Mockup

4.3.2.2 Multiple Parallel Cracks



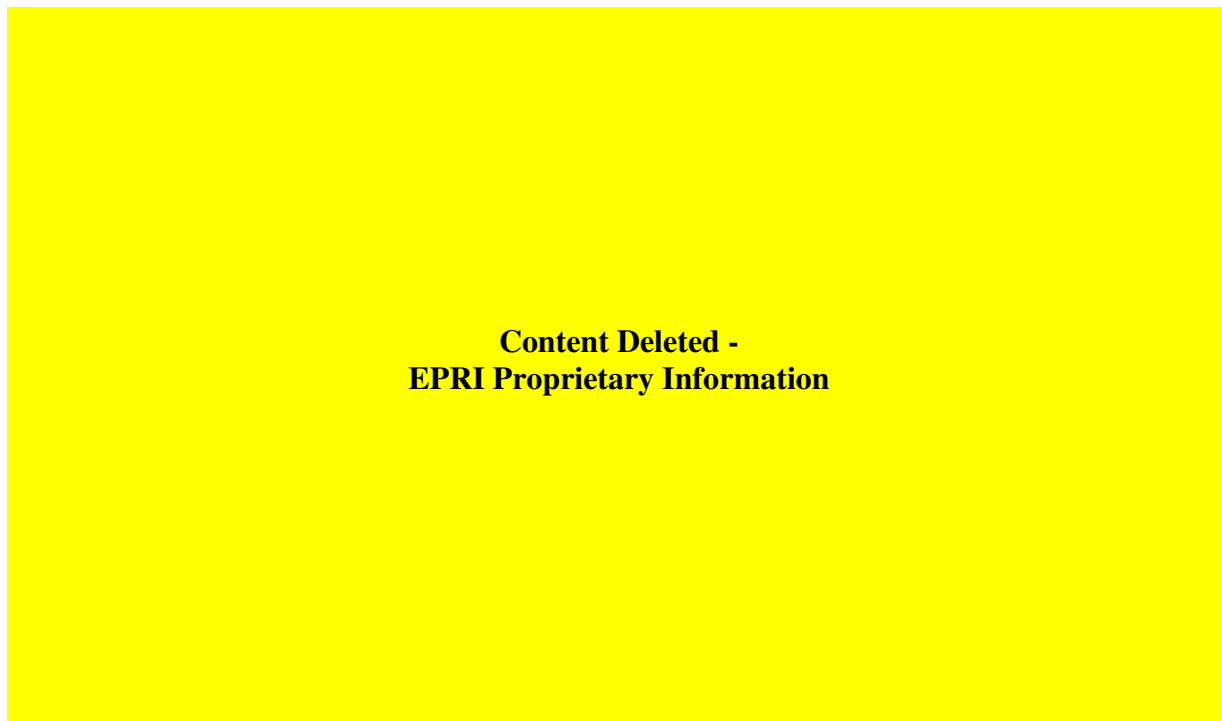
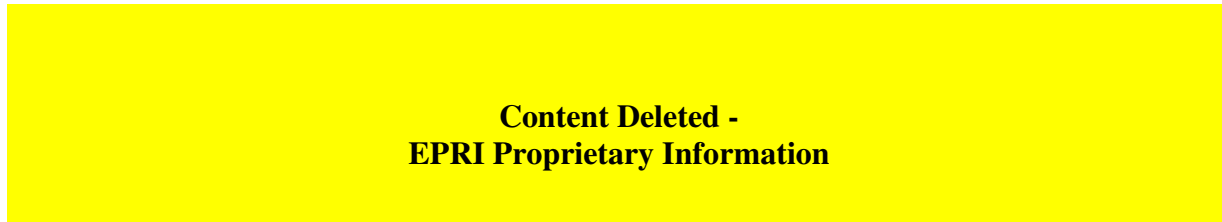
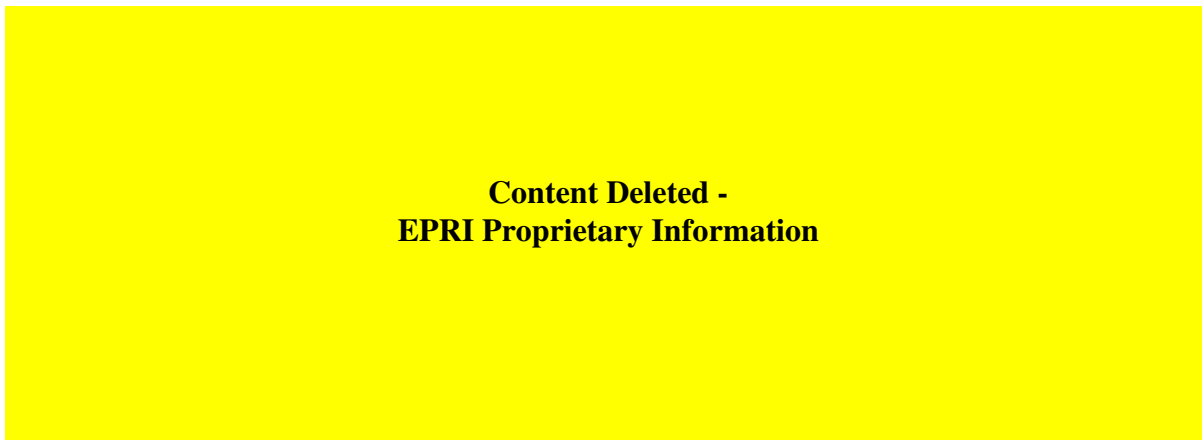


Figure 4.3.2.2-1. Mockup With Multiple, Parallel EDM Notches

4.3.2.3 EDM Notches in Weld Toe



4.4 UT Technique Demonstrations for Core Shroud Welds

**Content Deleted -
EPRI Proprietary Information**

4.4.1 General Findings for UT

**Content Deleted -
EPRI Proprietary Information**

4.4.1.1 Detection of Shallow Reflectors

**Content Deleted -
EPRI Proprietary Information**

4.4.1.2 Detection of Skewed Reflectors

**Content Deleted -
EPRI Proprietary Information**

May 2015

4.4.1.3 Effect of Multiple Parallel Defects

**Content Deleted -
EPRI Proprietary Information**

4.4.1.4 Effect of Roughness of Scanning Surface

**Content Deleted -
EPRI Proprietary Information**

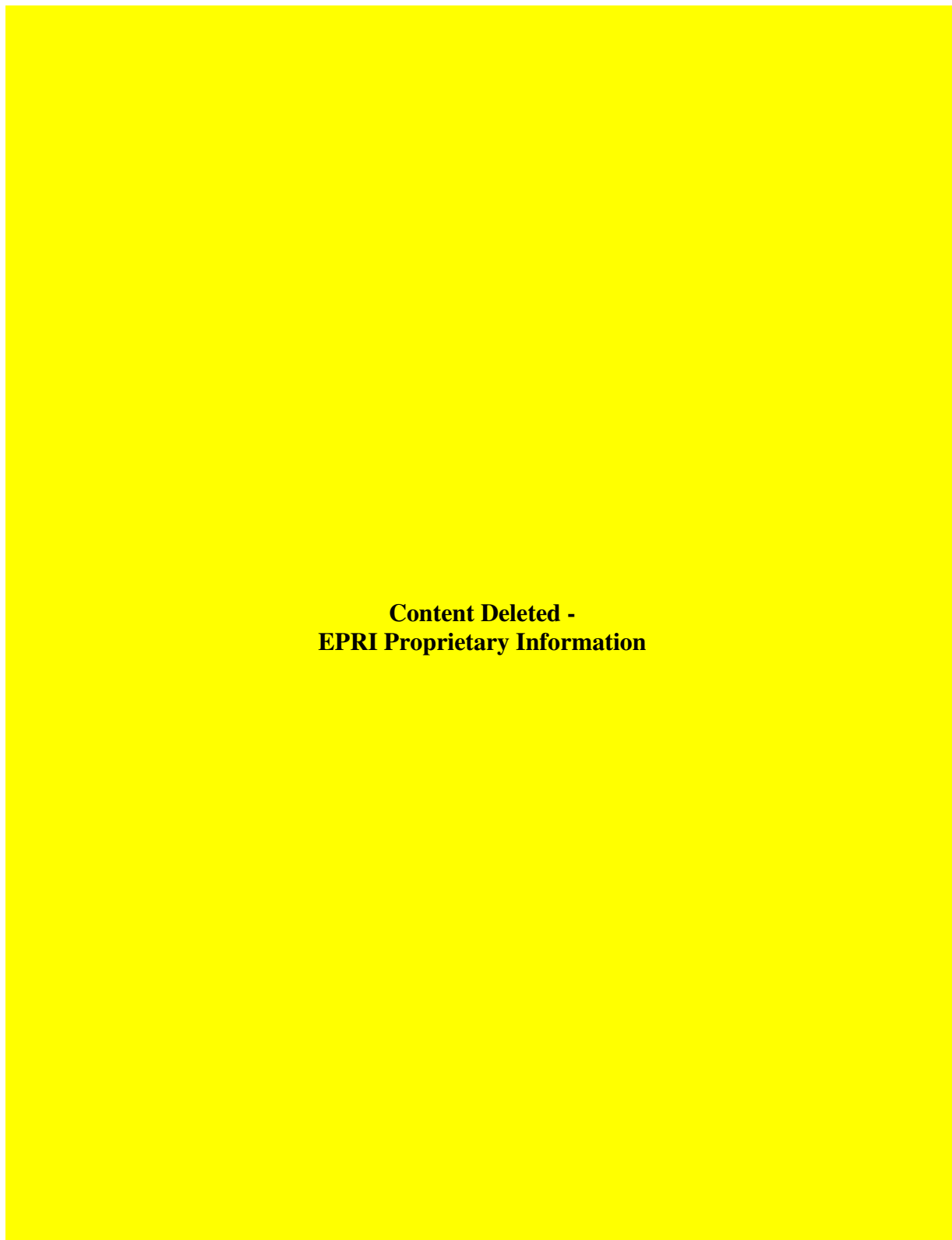
4.4.2 UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.2-1. UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.2-1. UT Demonstration Summary (continued)



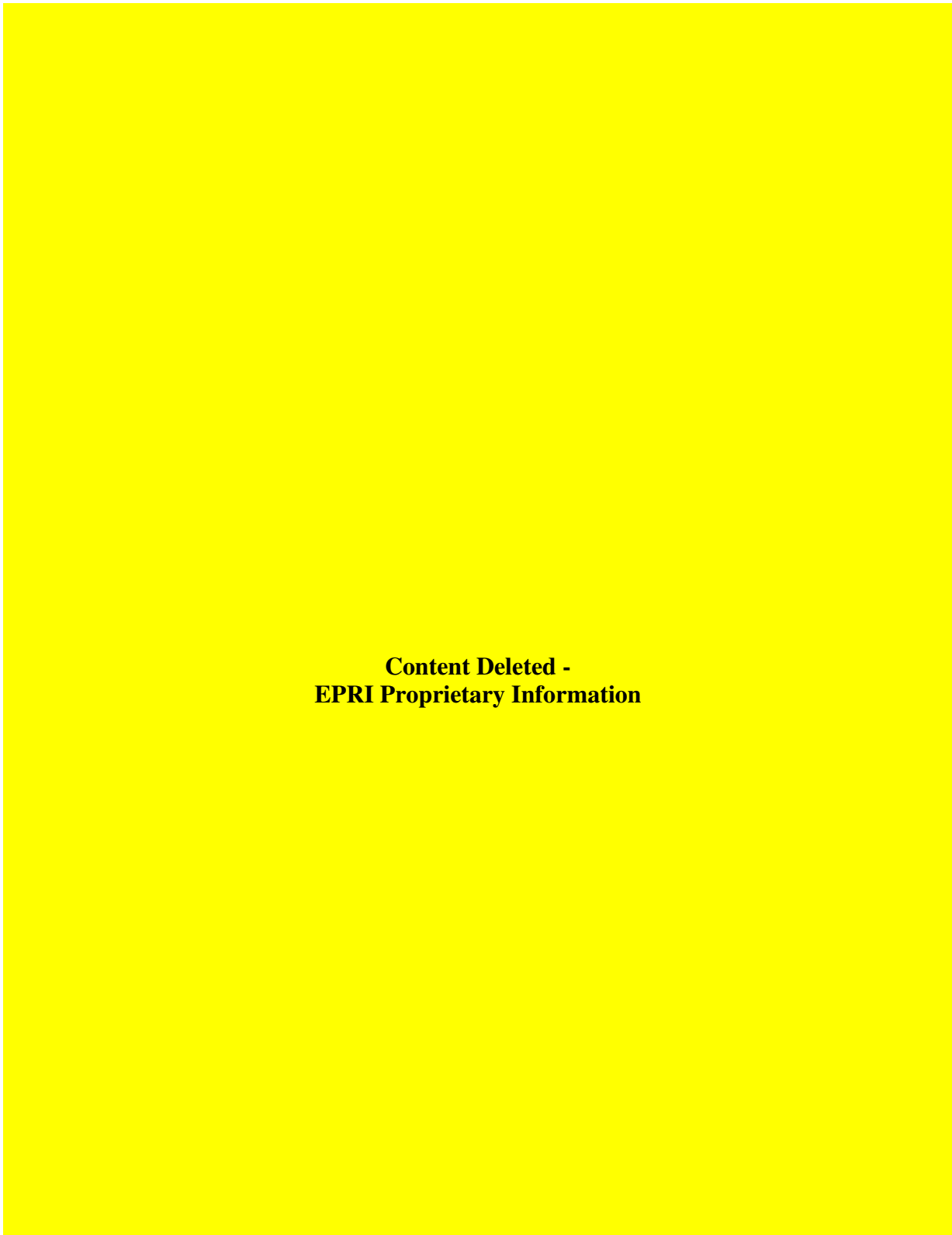
**Content Deleted -
EPRI Proprietary Information**

Table 4.4.2-1. UT Demonstration Summary (continued)



**Content Deleted -
EPRI Proprietary Information**

Table 4.4.2-1. UT Demonstration Summary (continued)



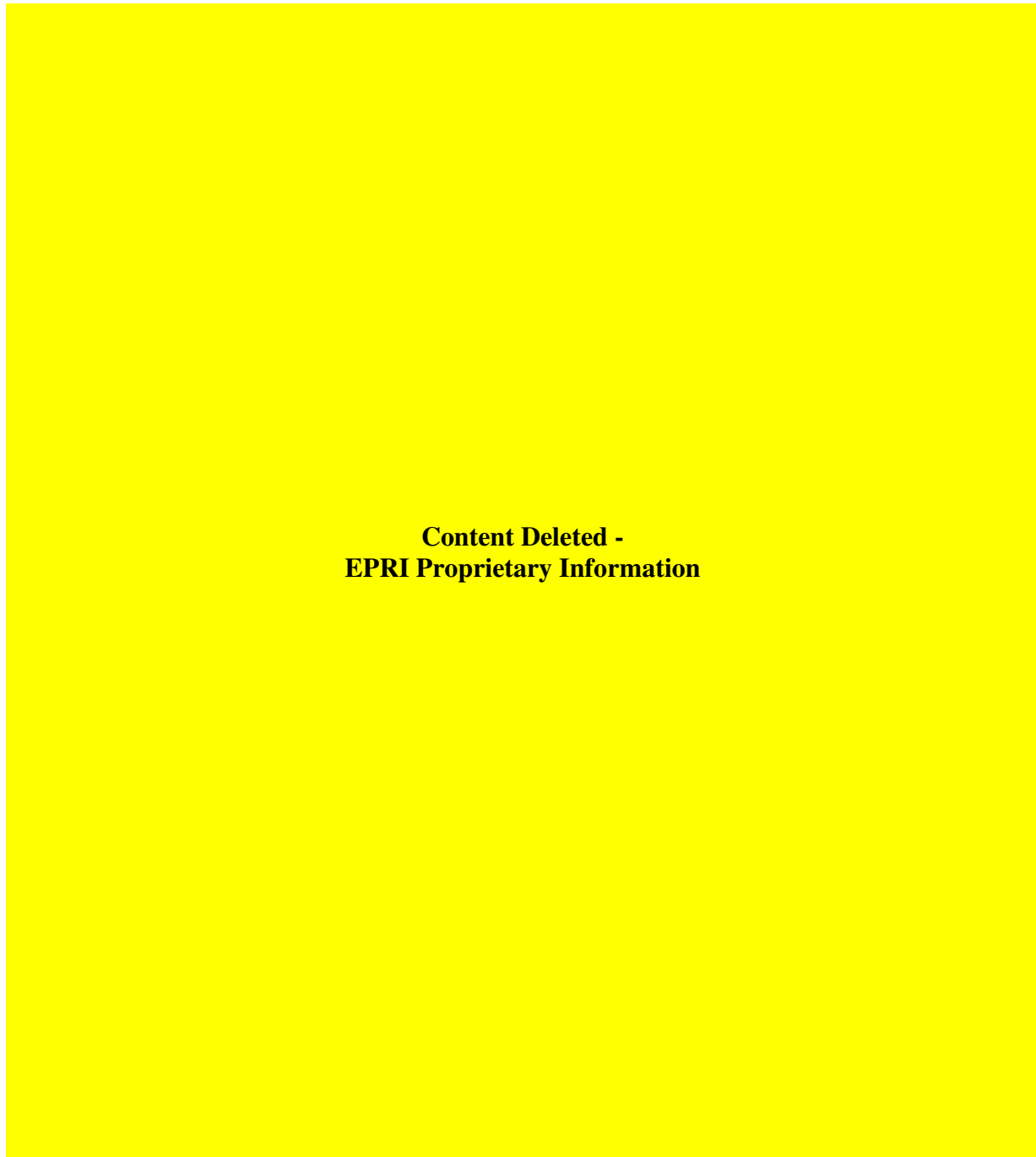
**Content Deleted -
EPRI Proprietary Information**

Table 4.4.2-1. UT Demonstration Summary (continued)



**Content Deleted -
EPRI Proprietary Information**

4.4.3 UT Demonstration 1



4.4.4 UT Demonstration 2



4.4.5 UT Demonstration 3



**Content Deleted -
EPRI Proprietary Information**

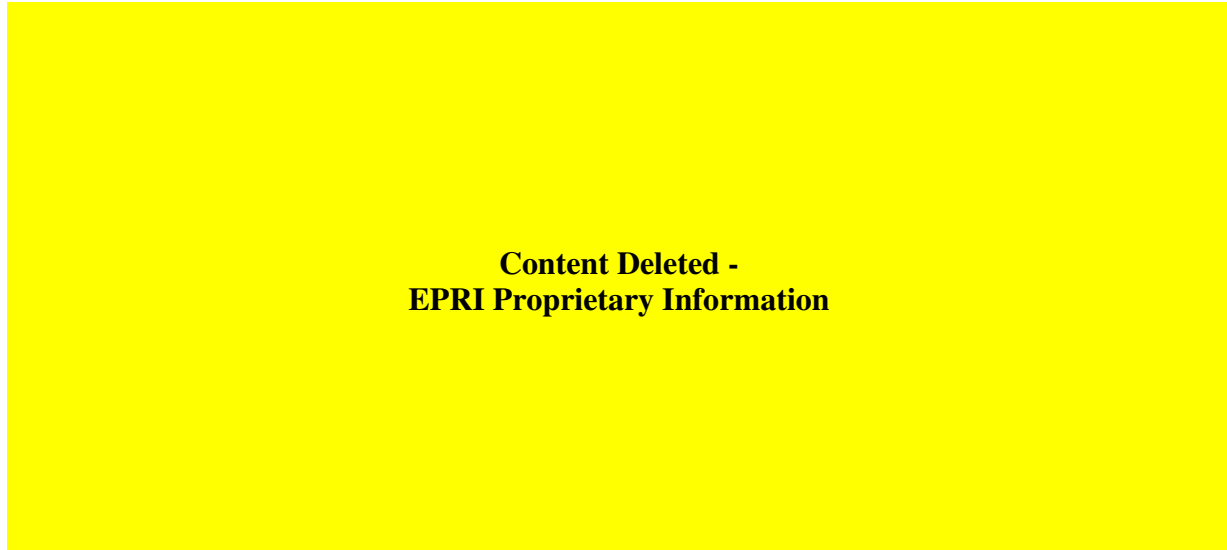


Figure 4.4.5-1. Principle of Operation of Creeping-Wave Probes

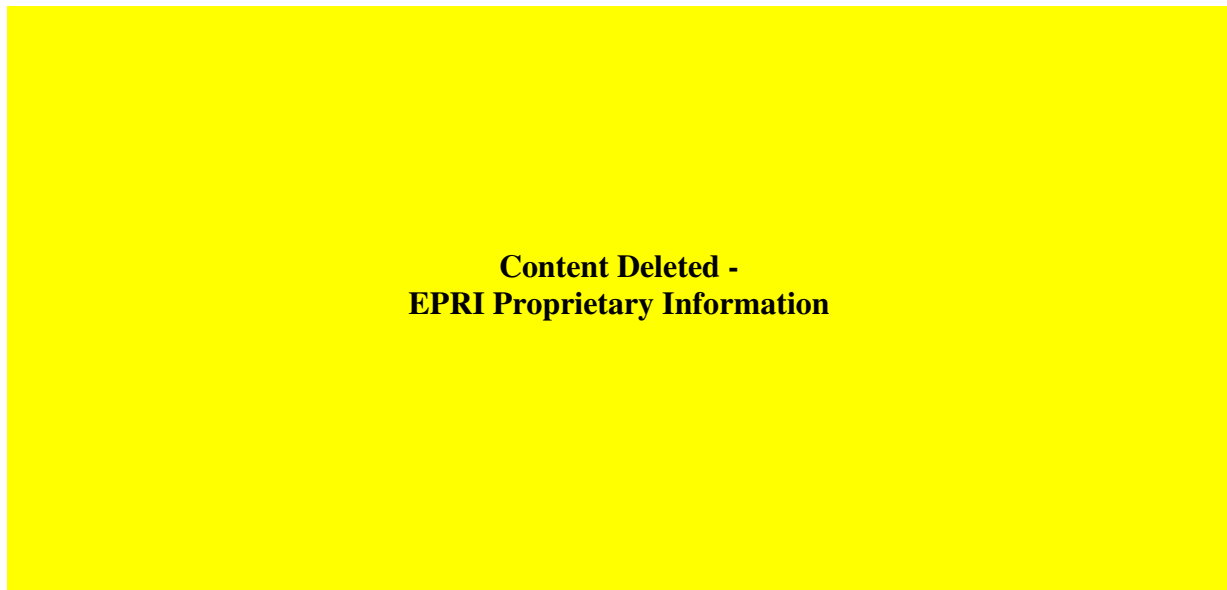
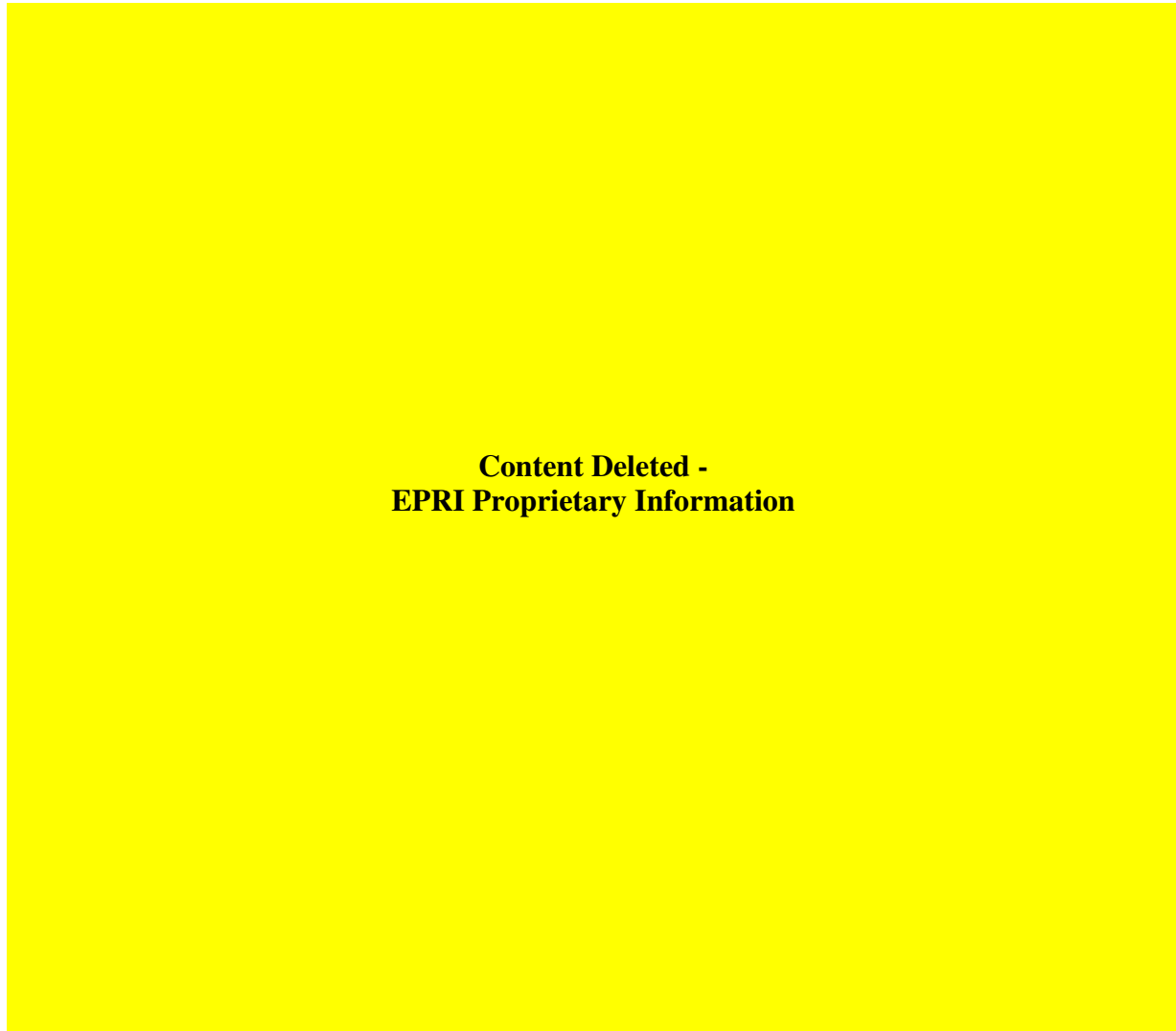
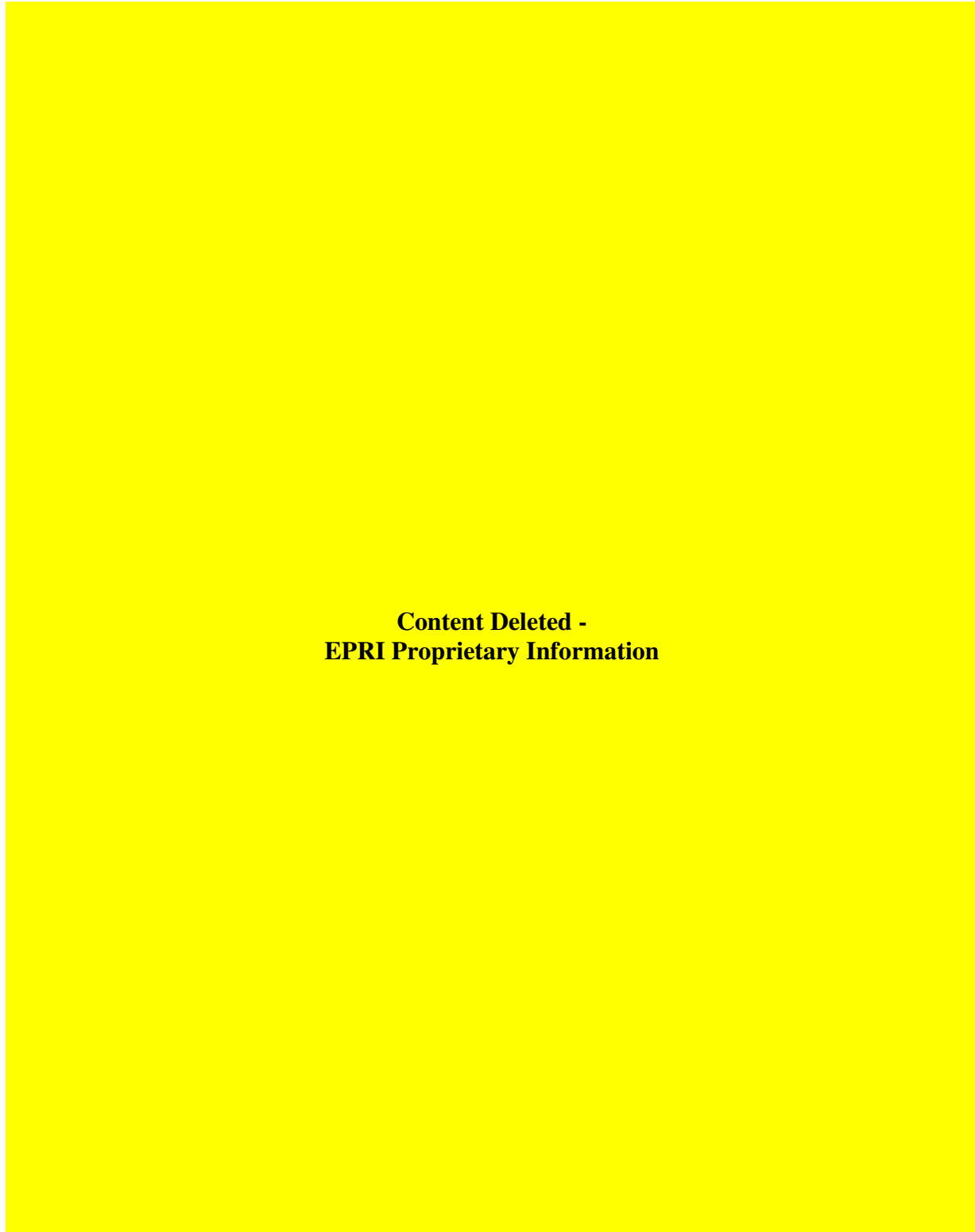


Figure 4.4.5-2. Principle of Operation of LLT Technique

4.4.6 UT Demonstration 4

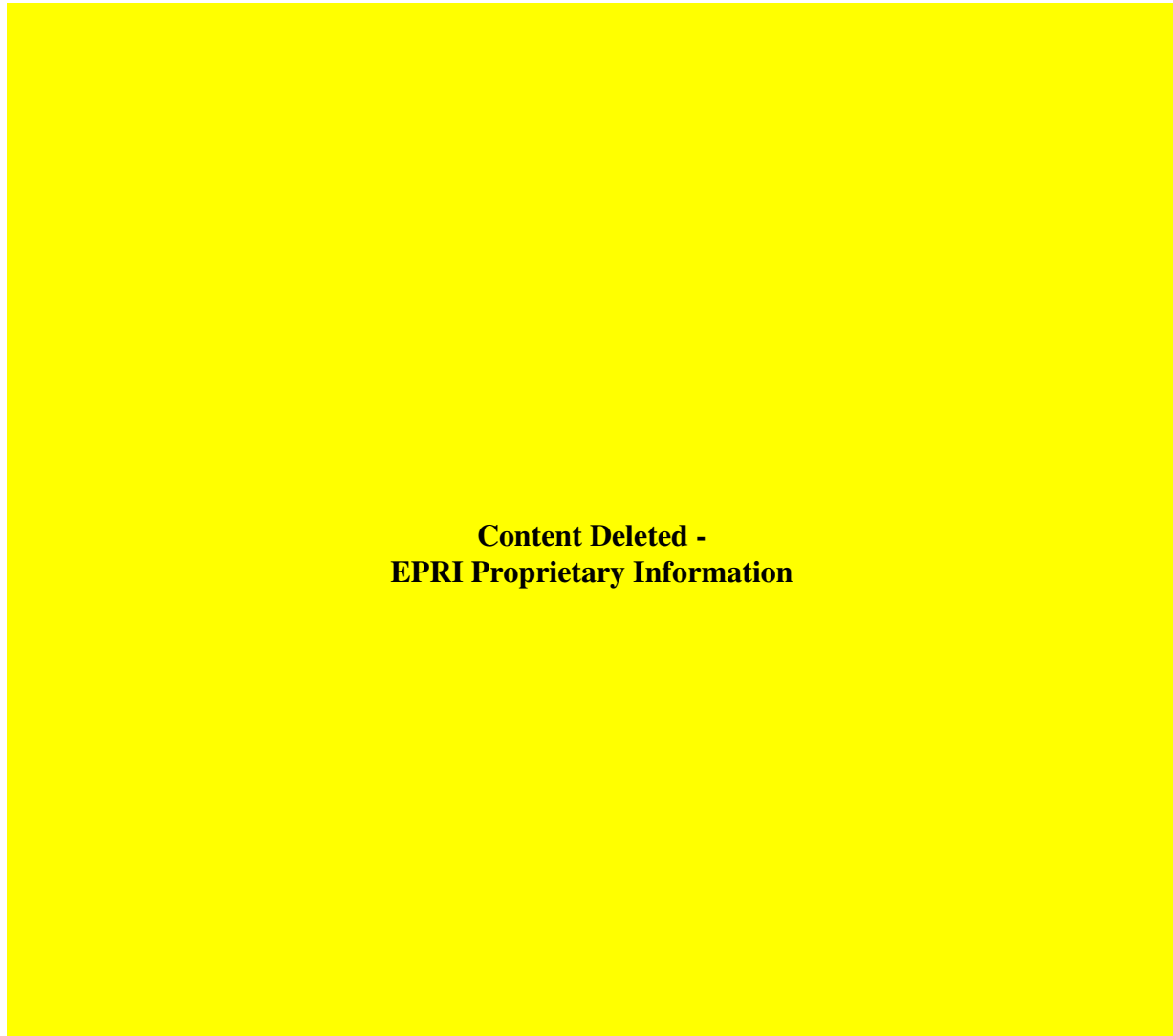


4.4.7 UT Demonstration 5

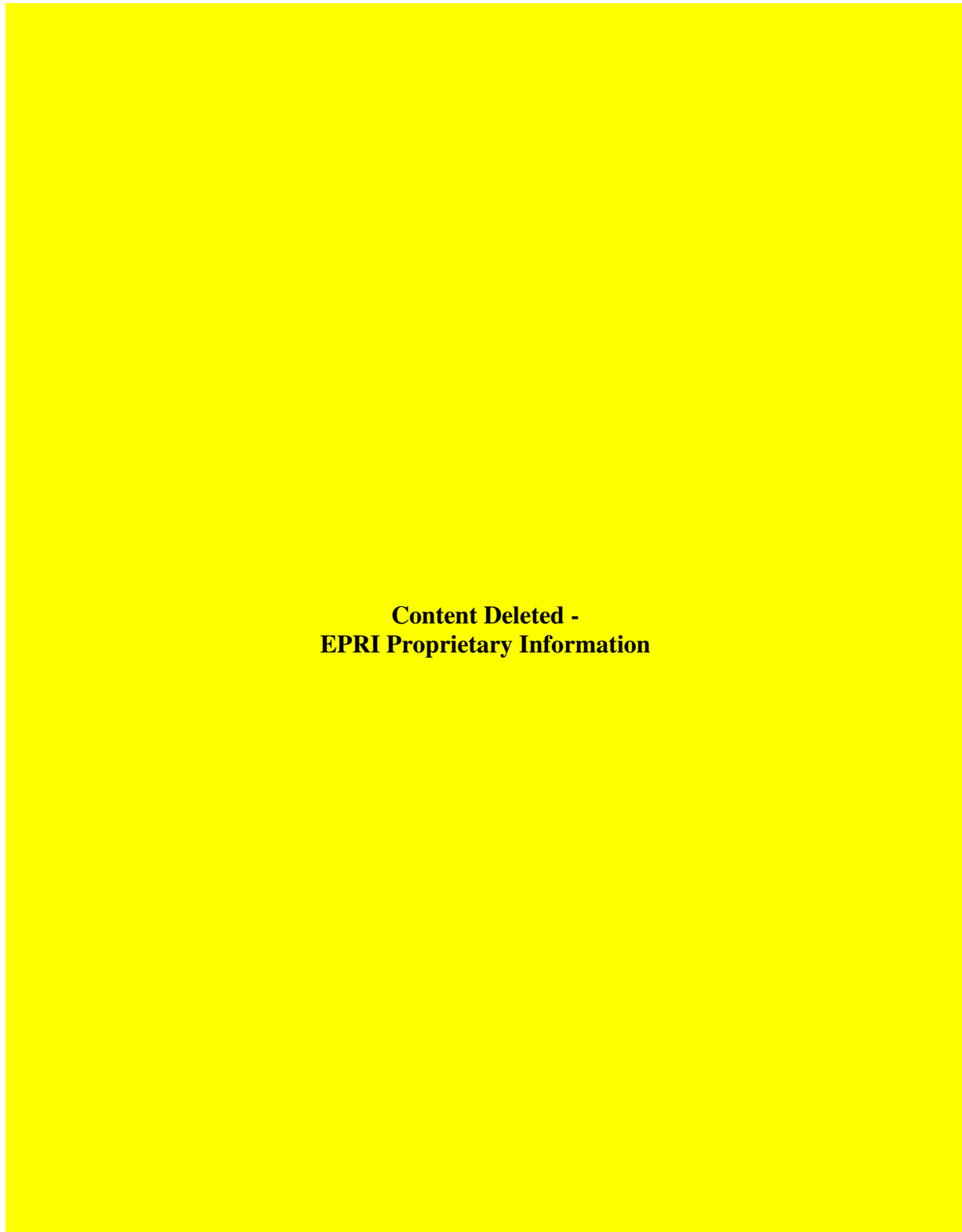


**Content Deleted -
EPRI Proprietary Information**

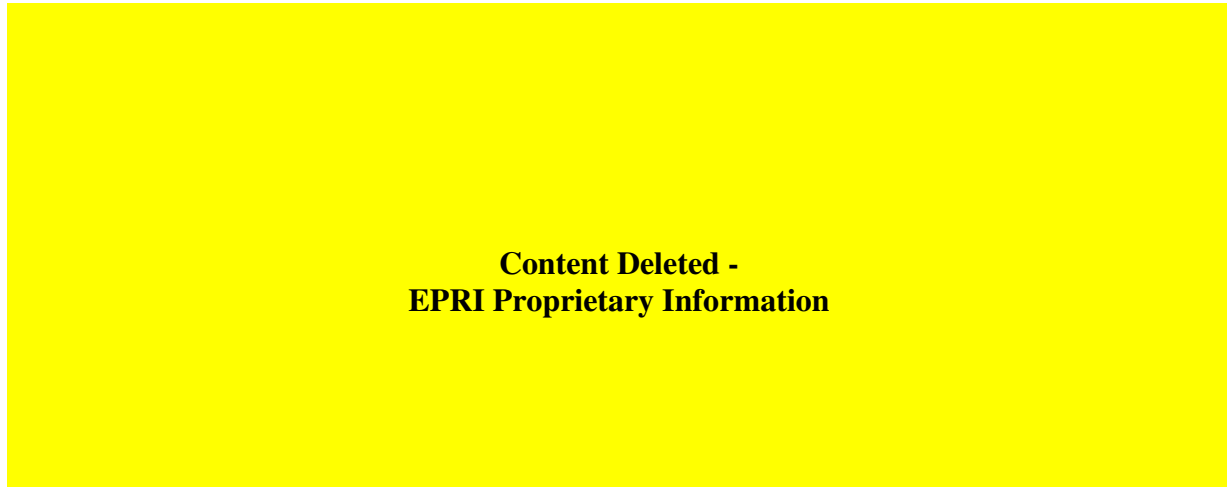
4.4.8 UT Demonstration 6



4.4.9 UT Demonstration 7



4.4.10 UT Demonstration 8



4.4.11 UT Demonstration 9



**Content Deleted -
EPRI Proprietary Information**

4.4.12 UT Demonstration 10

**Content Deleted -
EPRI Proprietary Information**

4.4.13 UT Demonstration 11

**Content Deleted -
EPRI Proprietary Information**

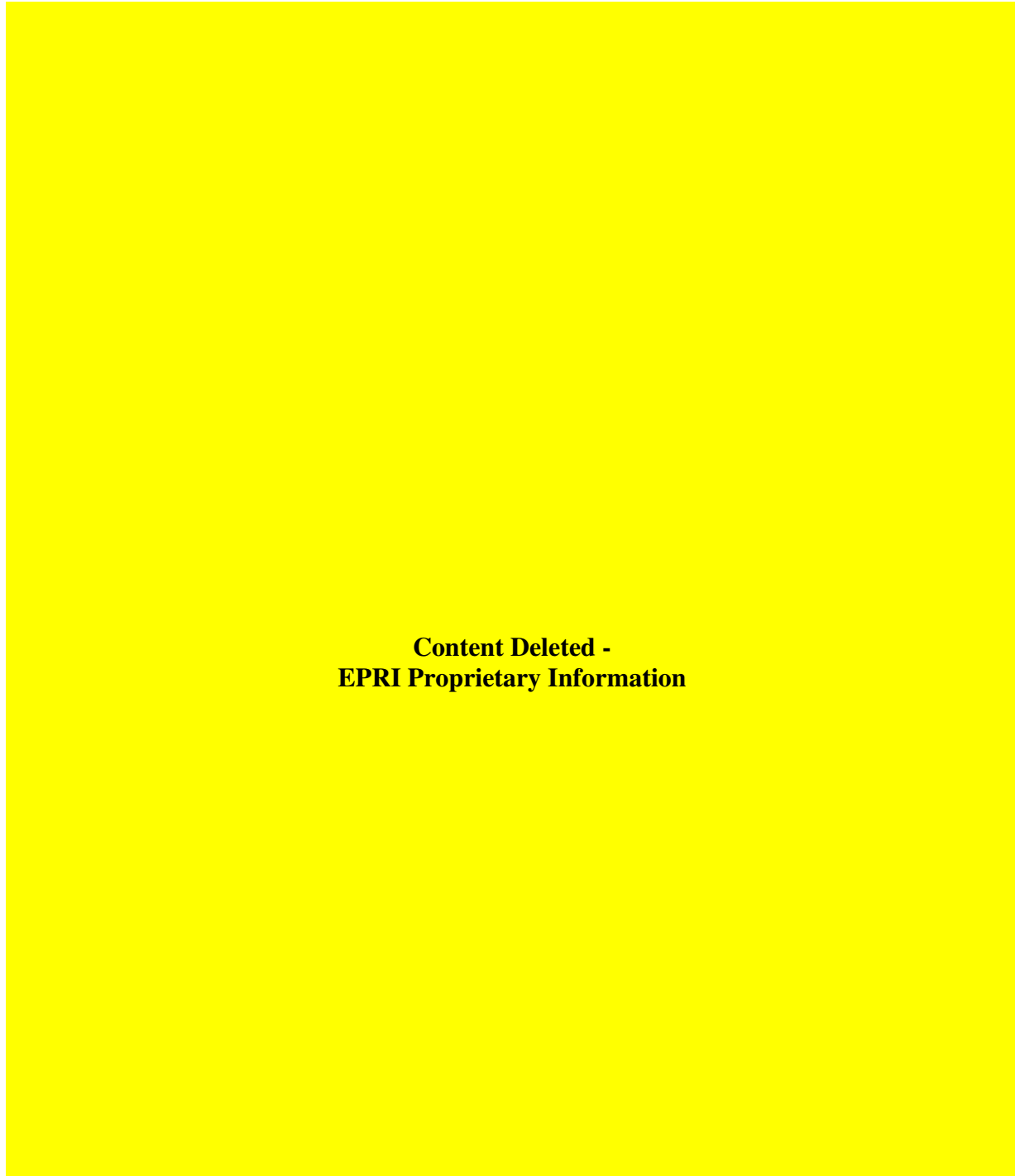
4.4.14 UT Demonstration 12

**Content Deleted -
EPRI Proprietary Information**

4.4.15 UT Demonstration 13

**Content Deleted -
EPRI Proprietary Information**

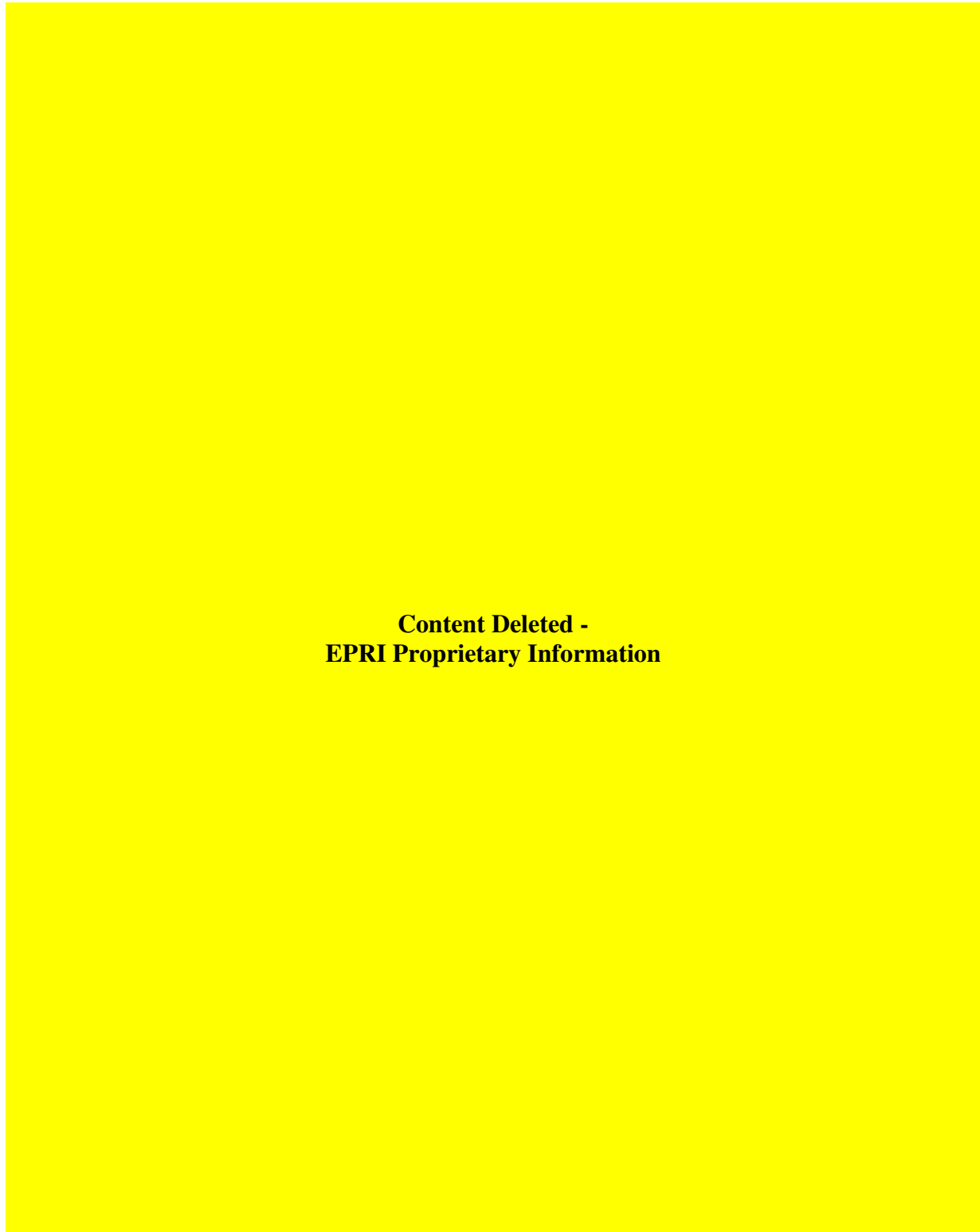
4.4.16 UT Demonstration 14



4.4.17 UT Demonstration 15



4.4.18 UT Demonstration 16

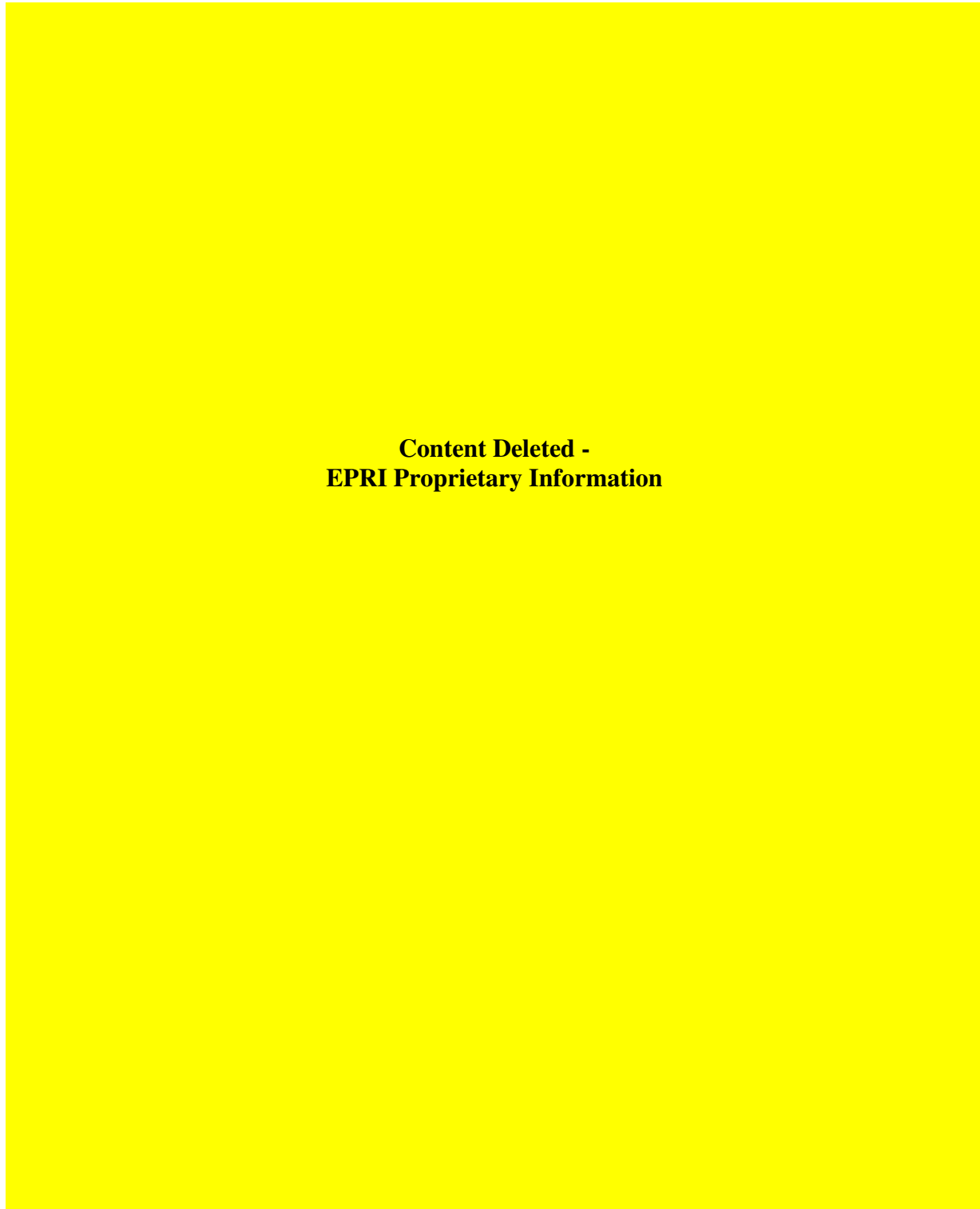


**Content Deleted -
EPRI Proprietary Information**

Table 4.4.18-1. Definition of Scan Patterns Used in UT Demonstration 16

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.18-2. Results of UT Demonstration 16



4.4.19 UT Demonstration 17



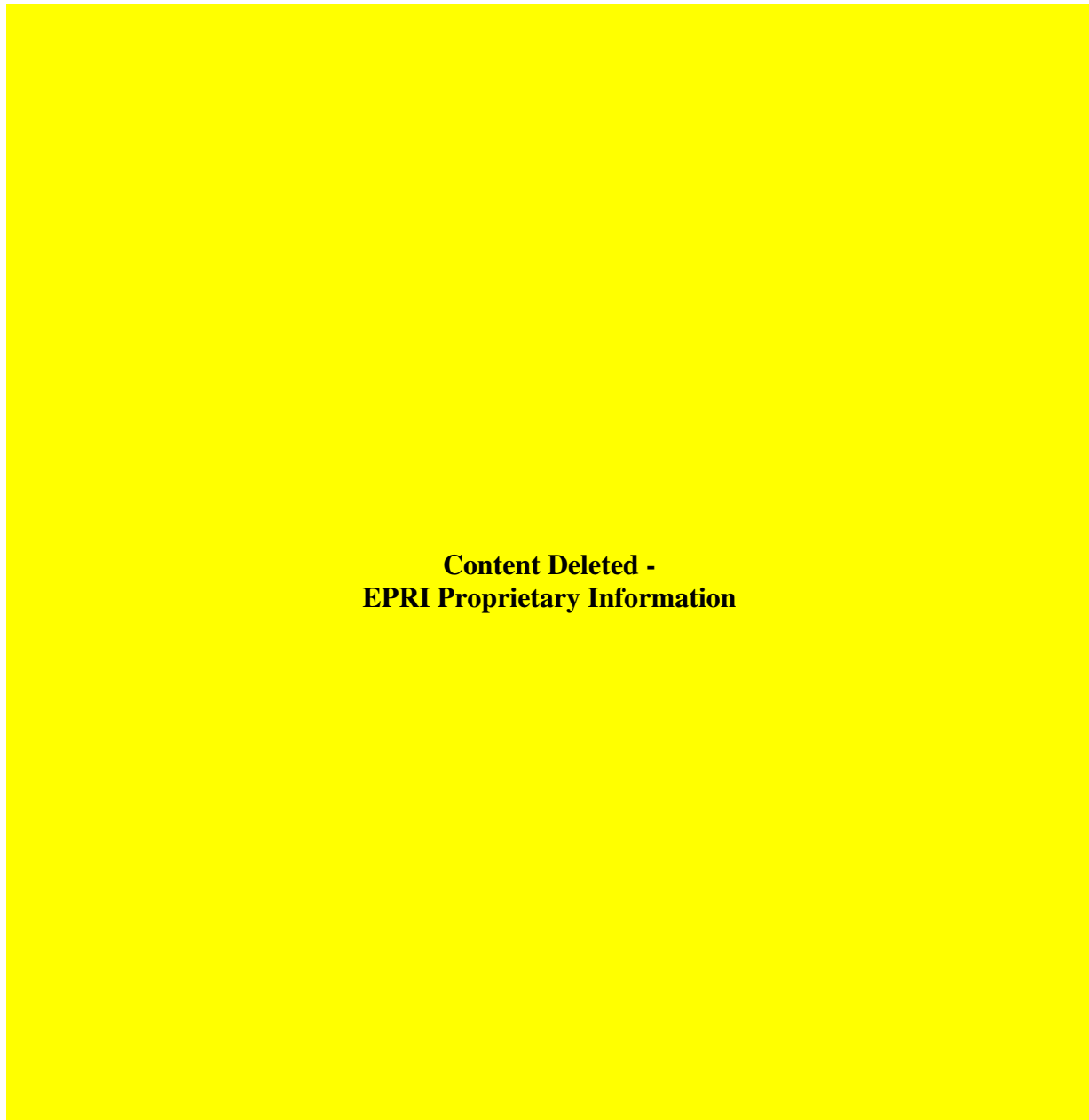
**Content Deleted -
EPRI Proprietary Information**

4.4.20 UT Demonstration 18

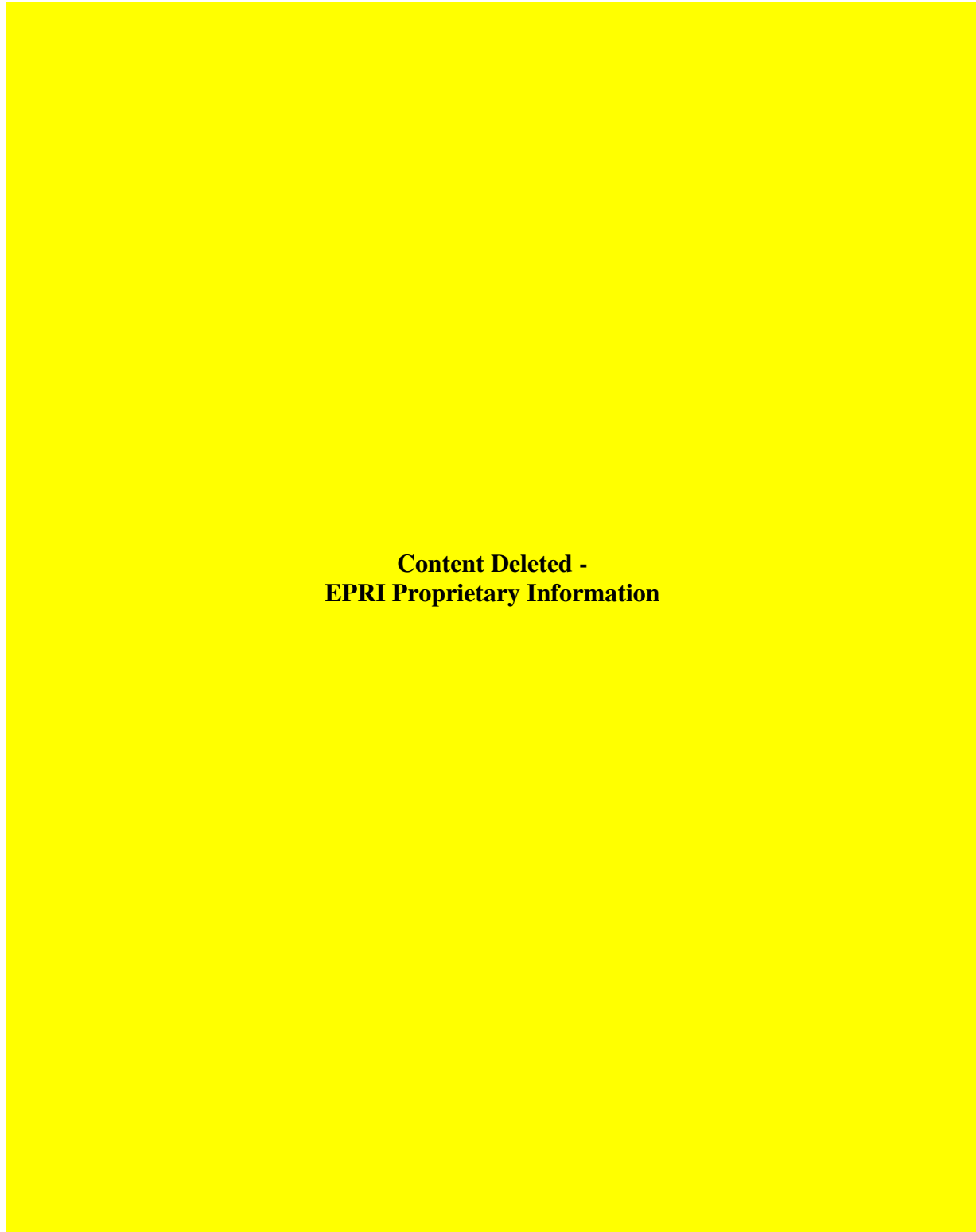


**Content Deleted -
EPRI Proprietary Information**

4.4.21 UT Demonstration 19



4.4.22 UT Demonstration 20



**Content Deleted -
EPRI Proprietary Information**

4.4.23 UT Demonstration 21



**Content Deleted -
EPRI Proprietary Information**

4.4.24 UT Demonstration 22

**Content Deleted -
EPRI Proprietary Information**

4.4.25 UT Demonstration 23

**Content Deleted -
EPRI Proprietary Information**

4.4.26 UT Demonstration 24

**Content Deleted -
EPRI Proprietary Information**

4.4.27 UT Demonstration 25

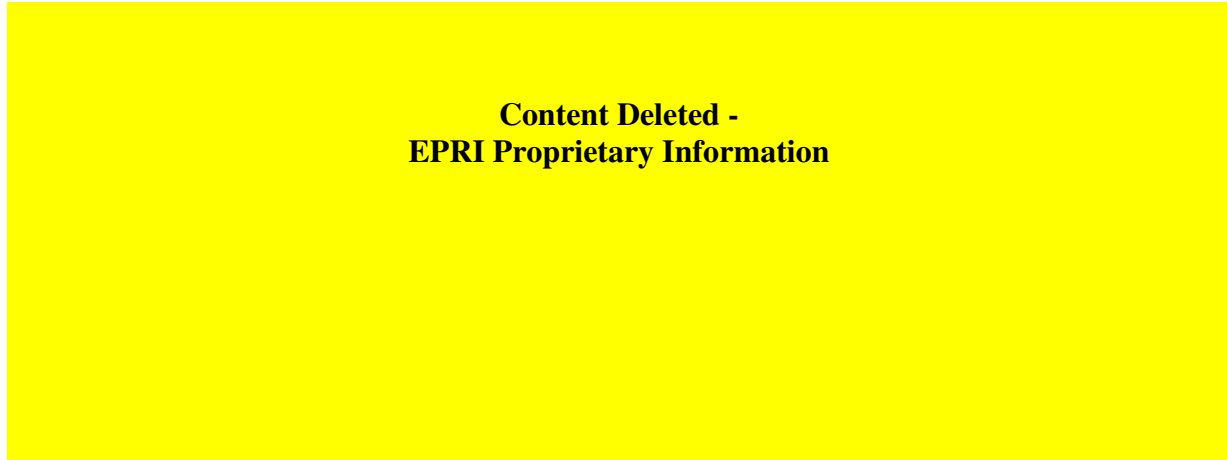
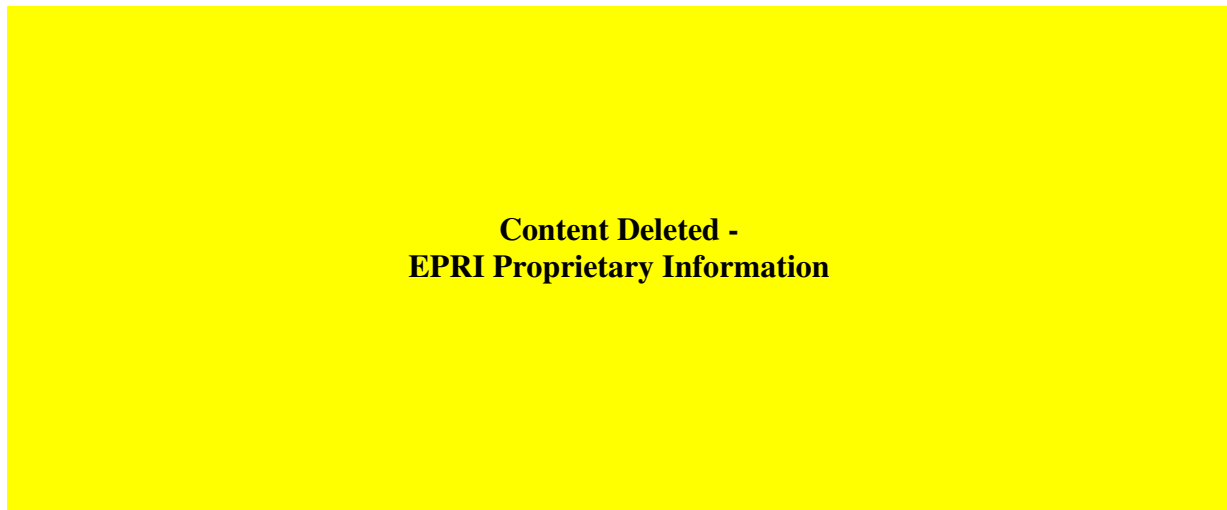
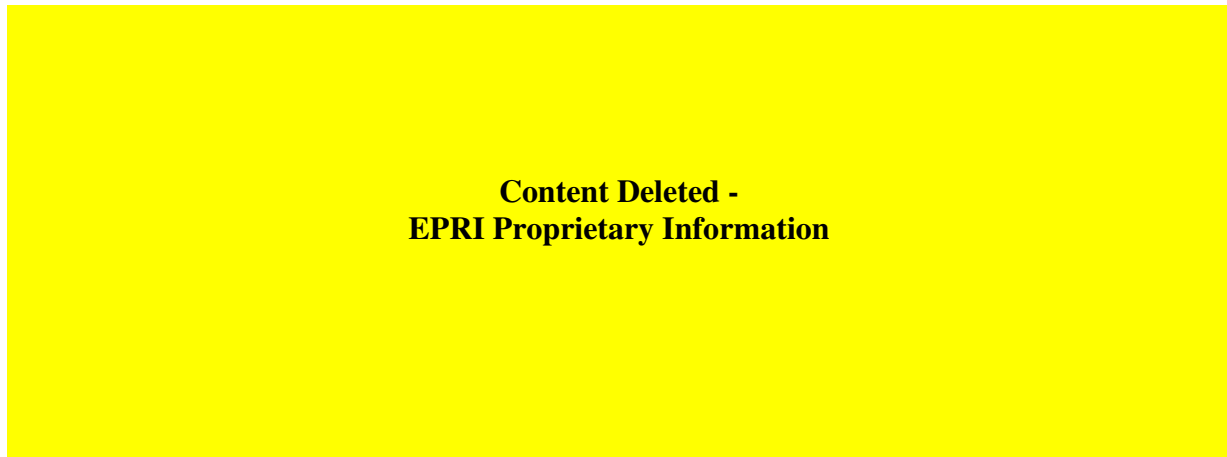


Table 4.4.27-1. Sizing Performance and Evaluation Factors for UT Demonstration 25





**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.28 UT Demonstration 26

**Content Deleted -
EPRI Proprietary Information**

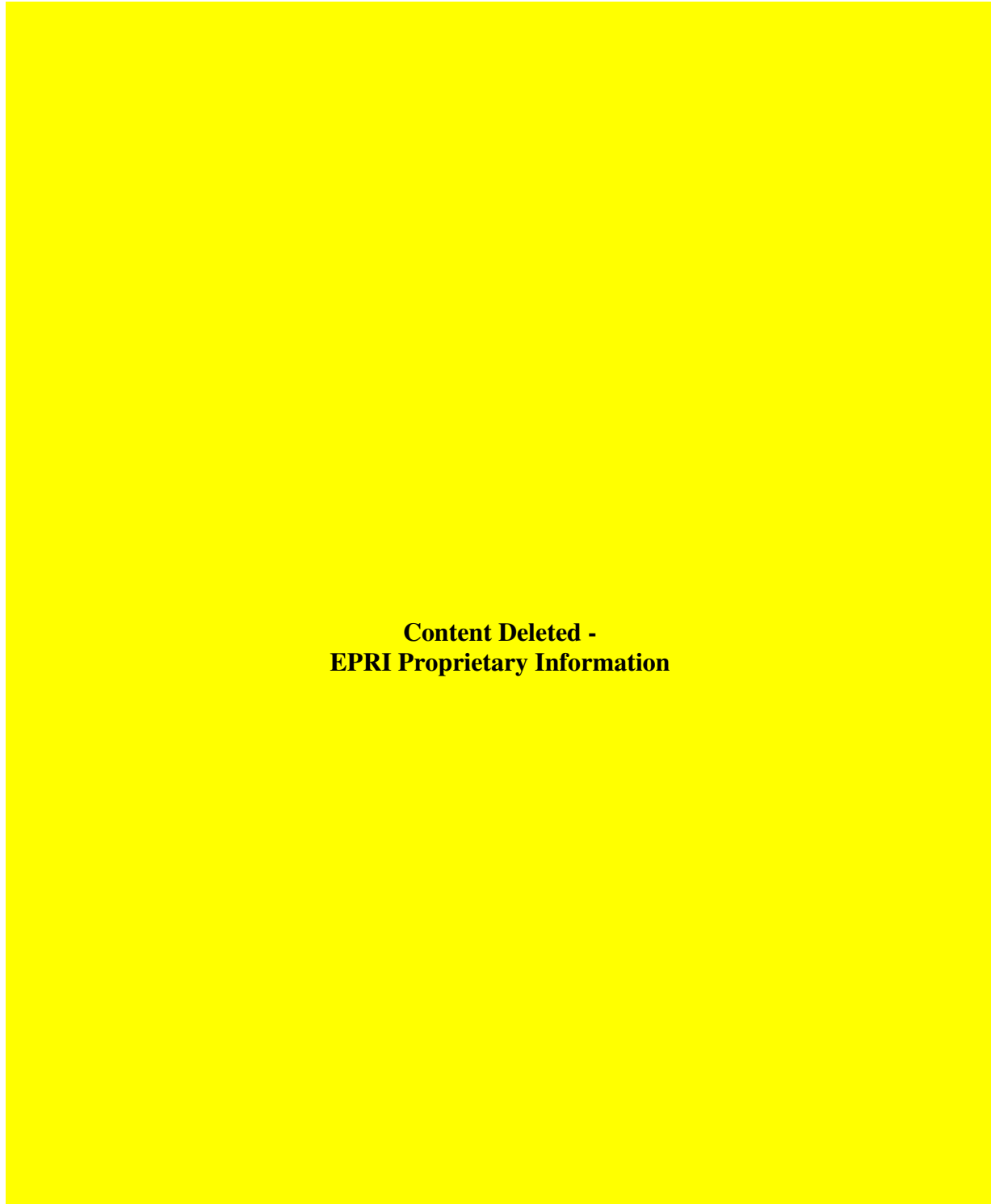
4.4.29 UT Demonstration 27

**Content Deleted -
EPRI Proprietary Information**

4.4.30 UT Demonstration 28

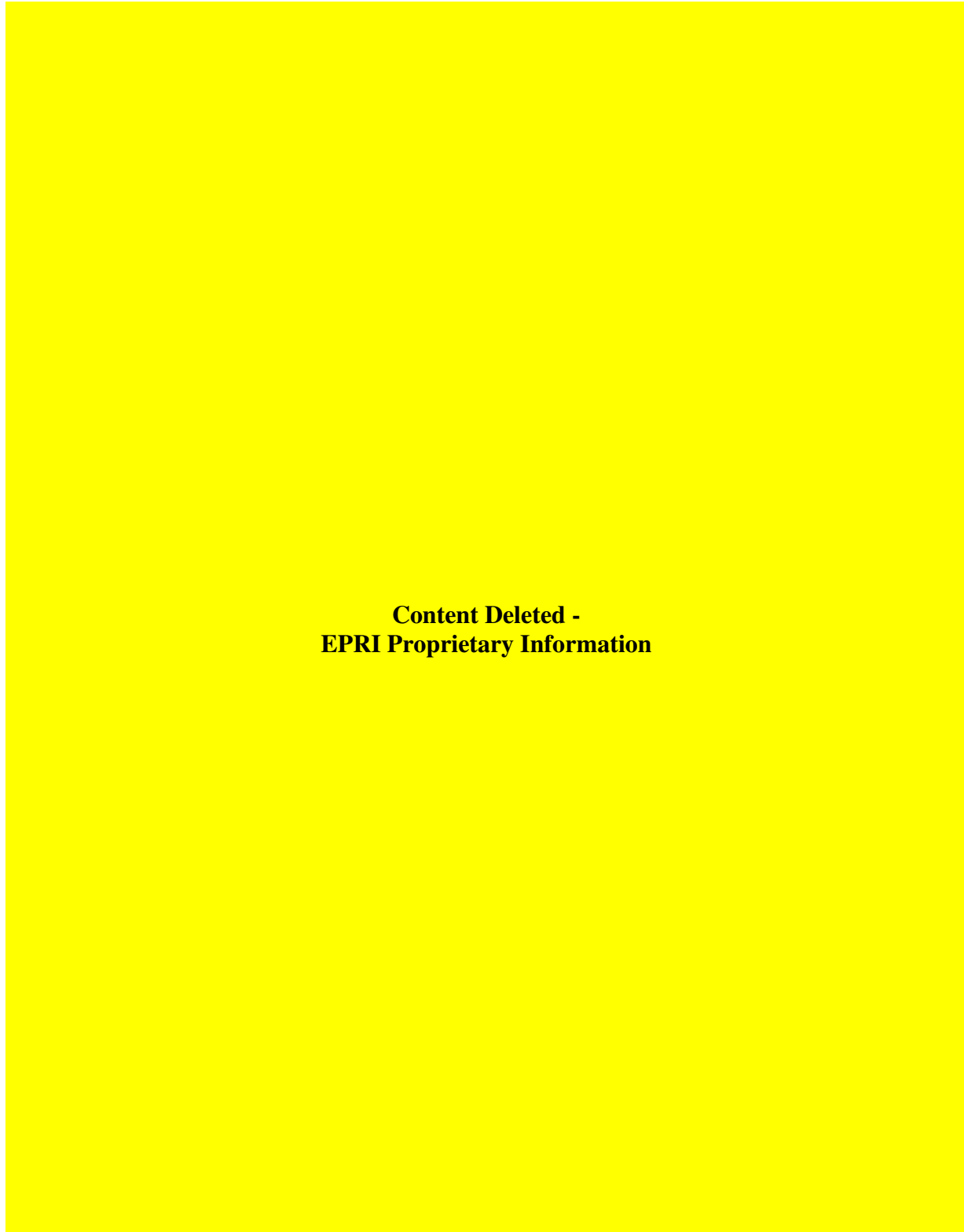
**Content Deleted -
EPRI Proprietary Information**

4.4.31 UT Demonstration 29



**Content Deleted -
EPRI Proprietary Information**

4.4.32 UT Demonstration 30





**Content Deleted -
EPRI Proprietary Information**

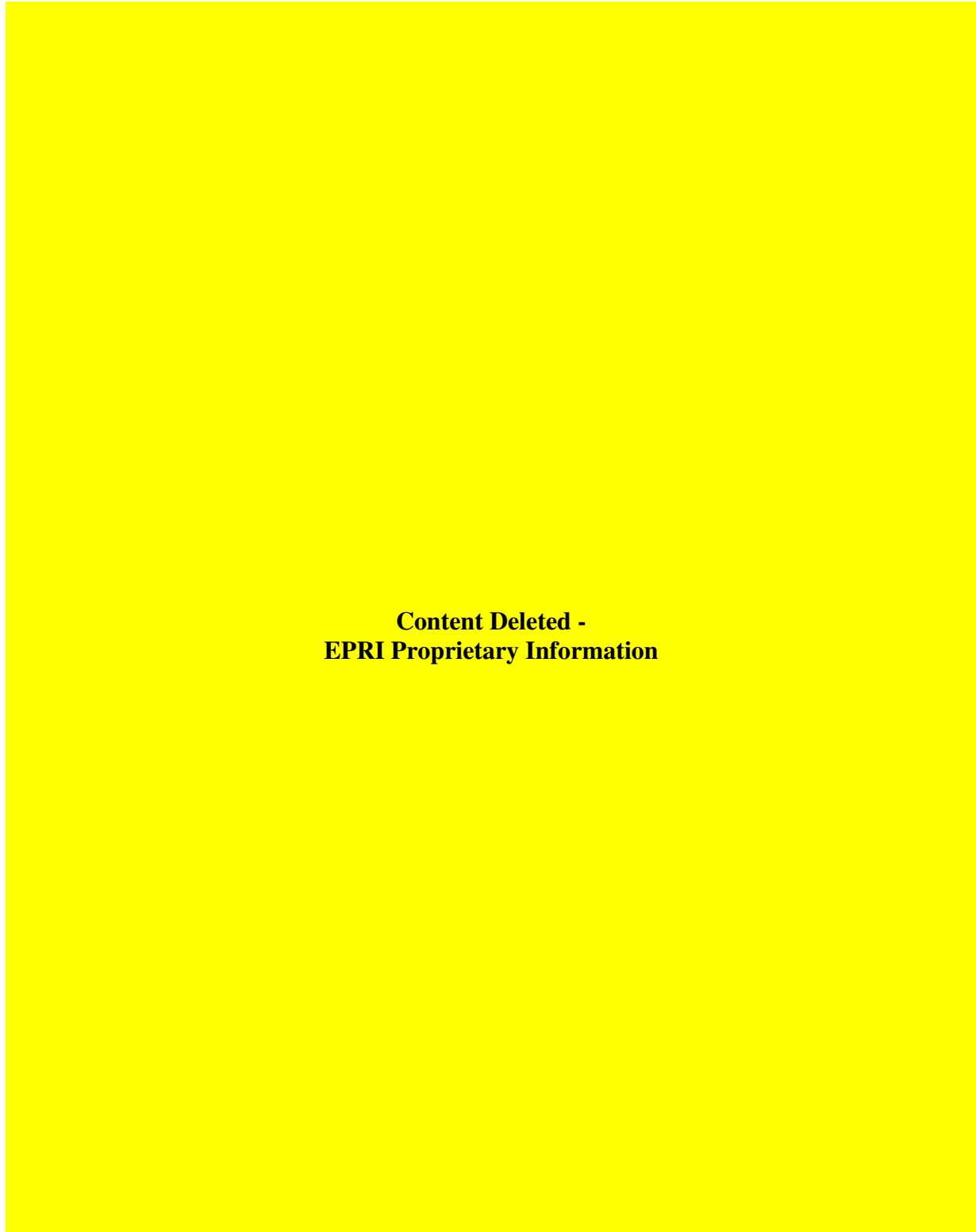
4.4.33 UT Demonstration 31

**Content Deleted -
EPRI Proprietary Information**

4.4.34 UT Demonstration 32

**Content Deleted -
EPRI Proprietary Information**

4.4.35 UT Demonstration 33





**Content Deleted -
EPRI Proprietary Information**

4.4.36 UT Demonstration 34

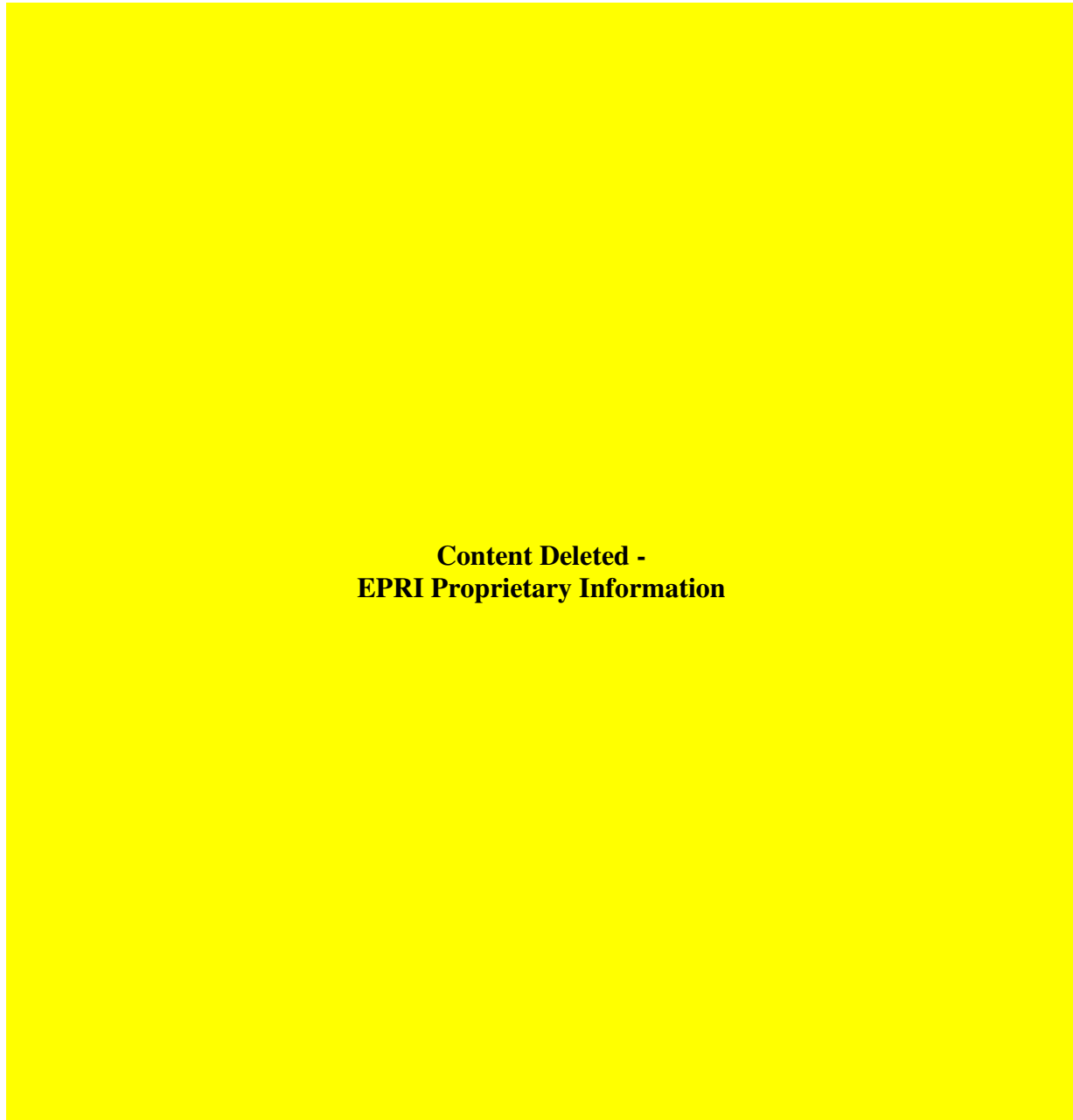
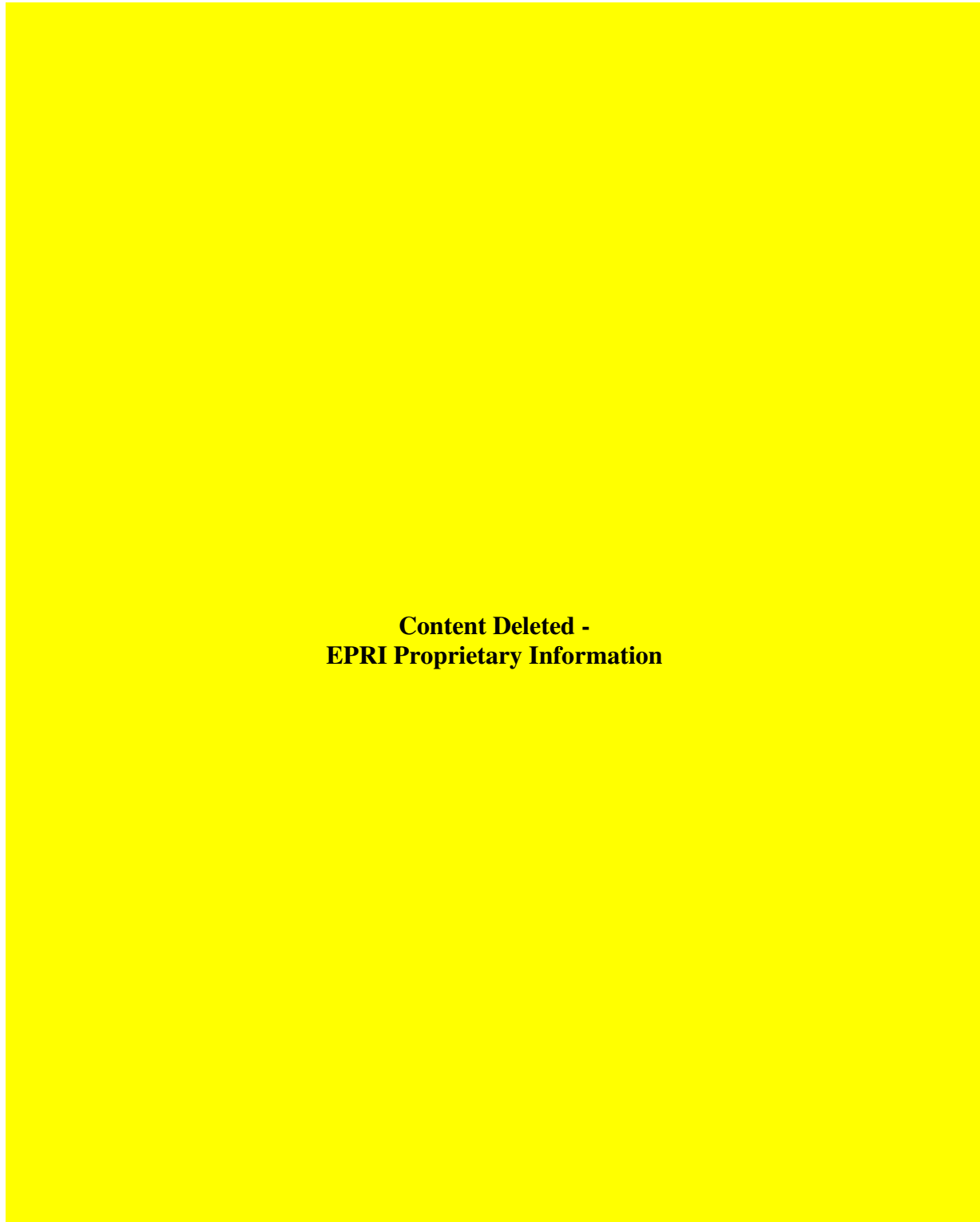


Table 4.4.36-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

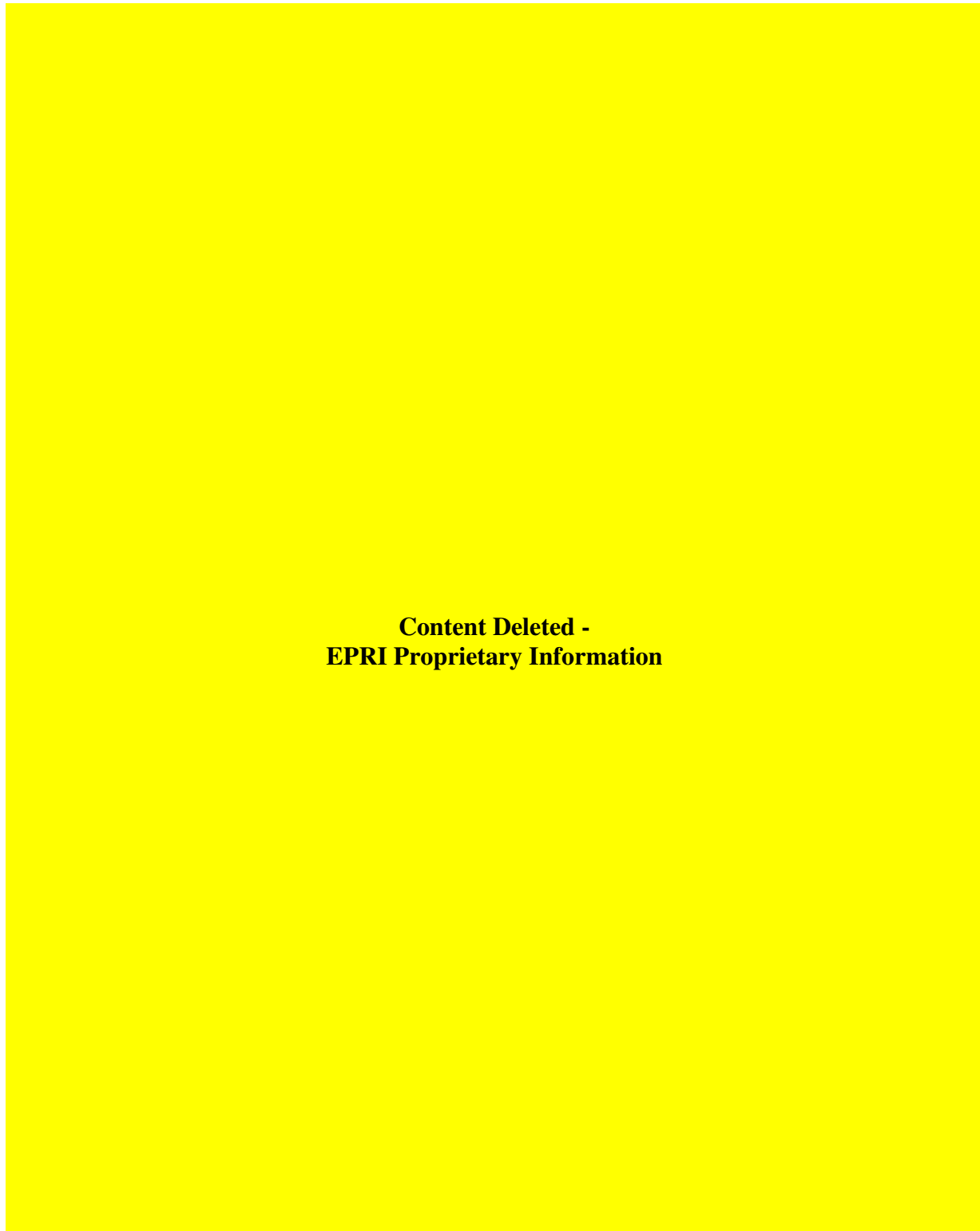
4.4.37 UT Demonstration 35



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.38 UT Demonstration 36

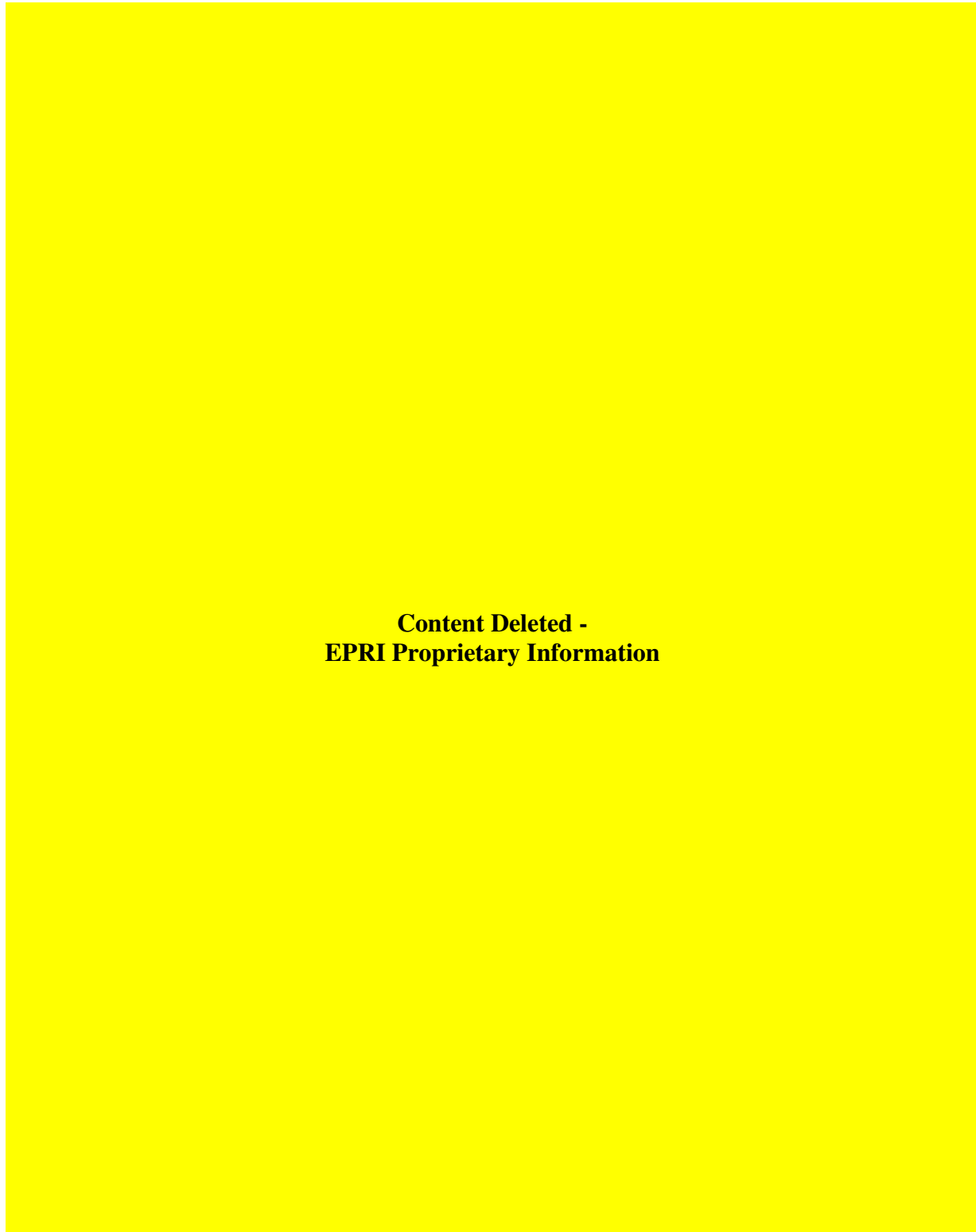


**Content Deleted -
EPRI Proprietary Information**

4.4.39 UT Demonstration 37

**Content Deleted -
EPRI Proprietary Information**

4.4.40 UT Demonstration 38



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

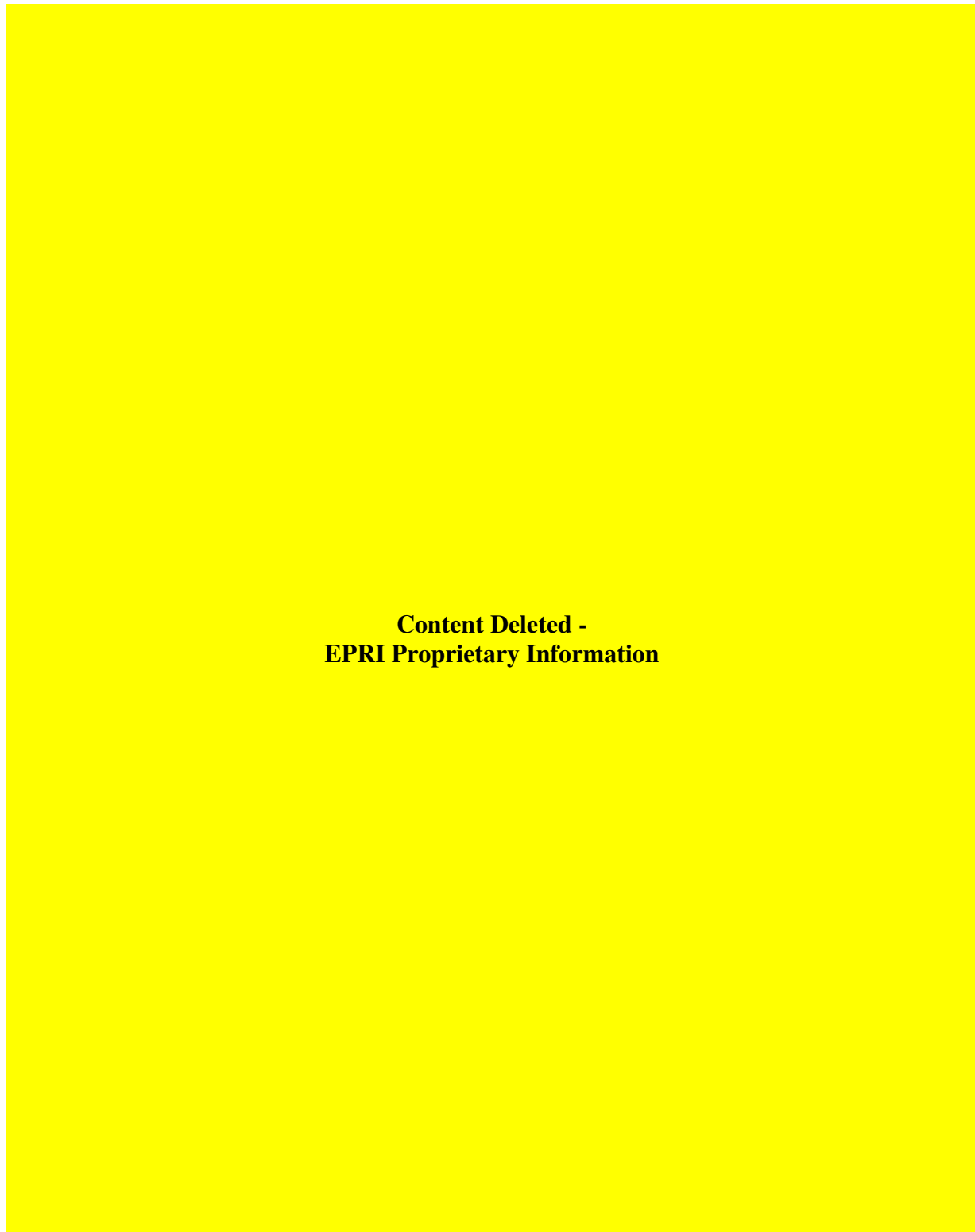


Figure 4.4.40-1. Illustration of Sector-Scan Examination of Weld H2 and Full-Vee Linear-Scan Examination of Weld H3

4.4.41 UT Demonstration 39

**Content Deleted -
EPRI Proprietary Information**

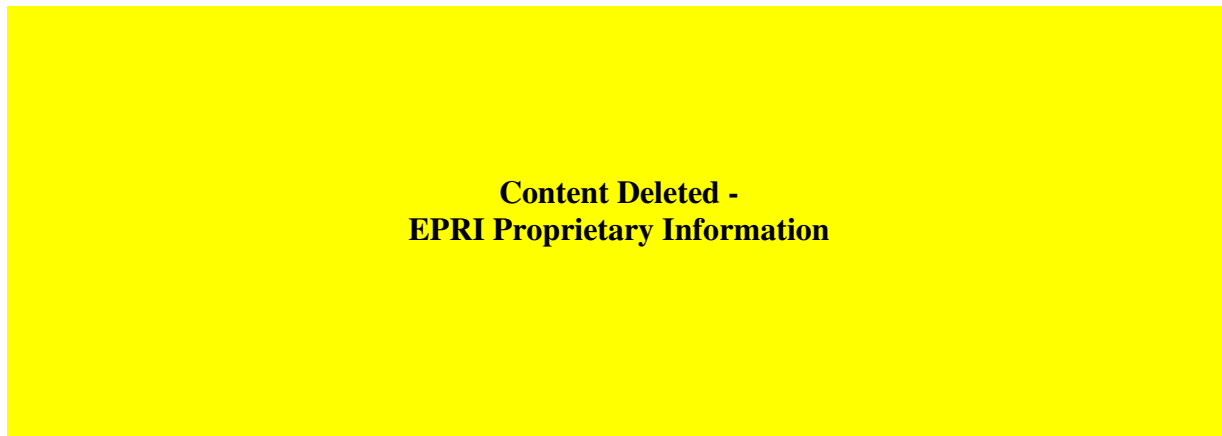
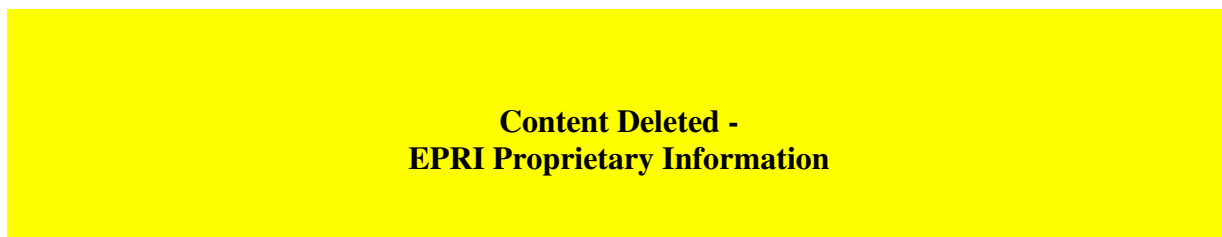
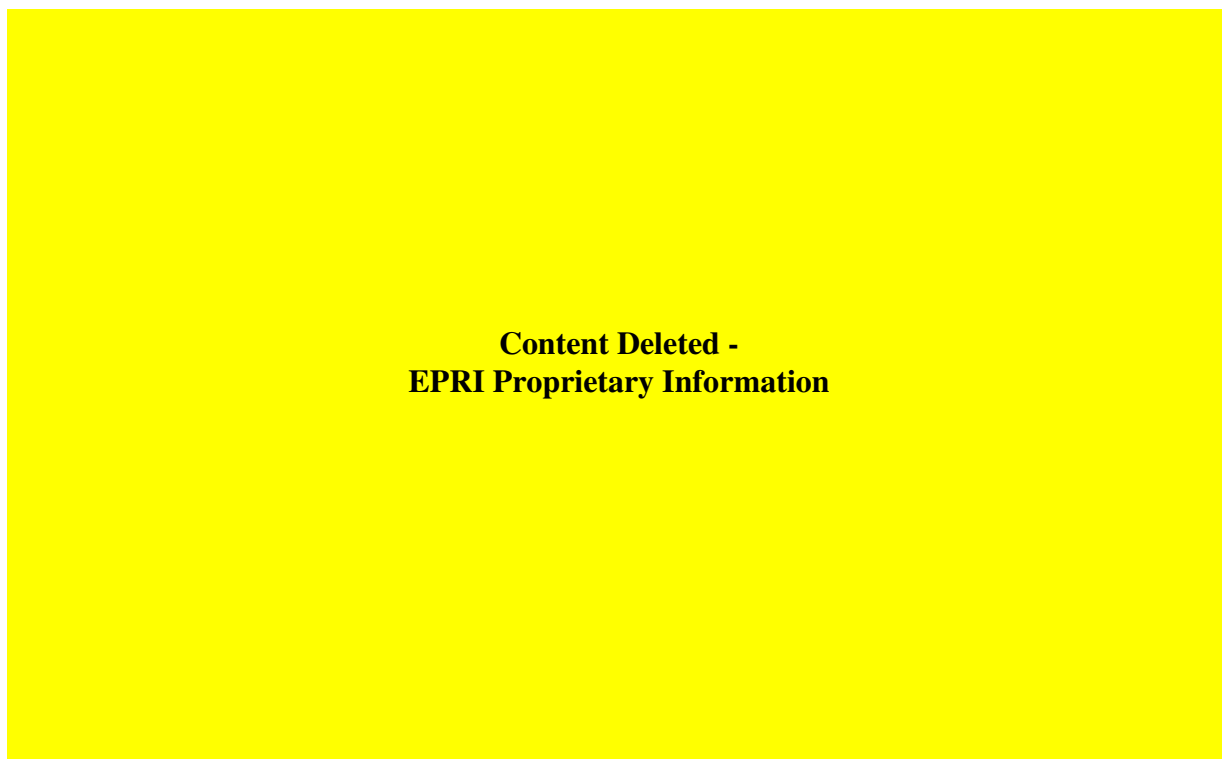


Table 4.4.41-1. Linear Scans Performed in Various Shroud Inspection Situations



4.4.42 UT Demonstration 40

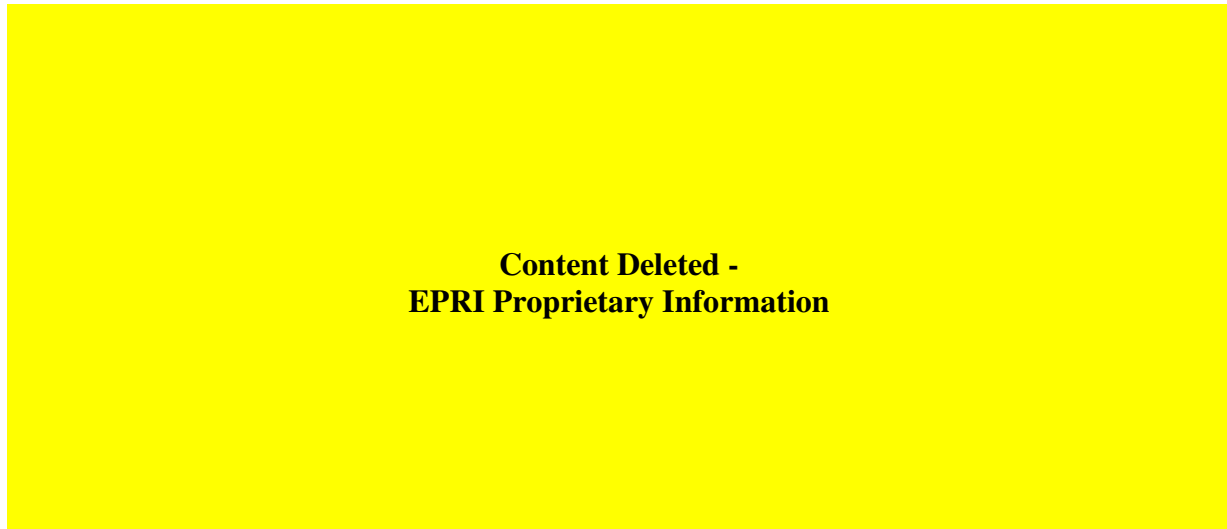
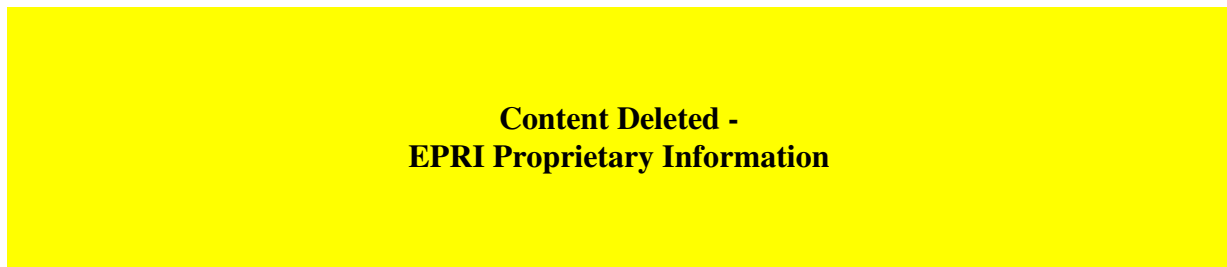
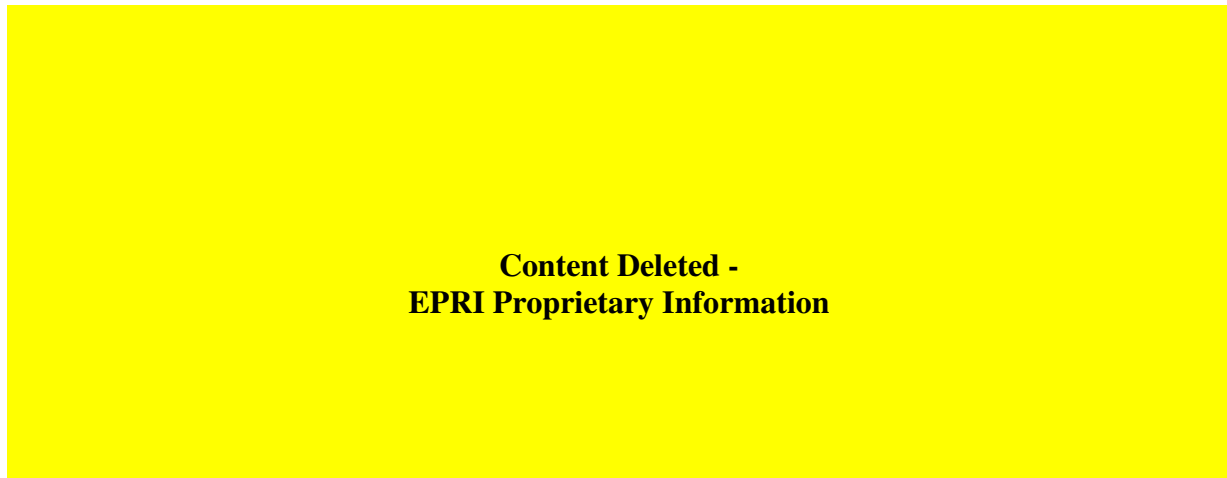


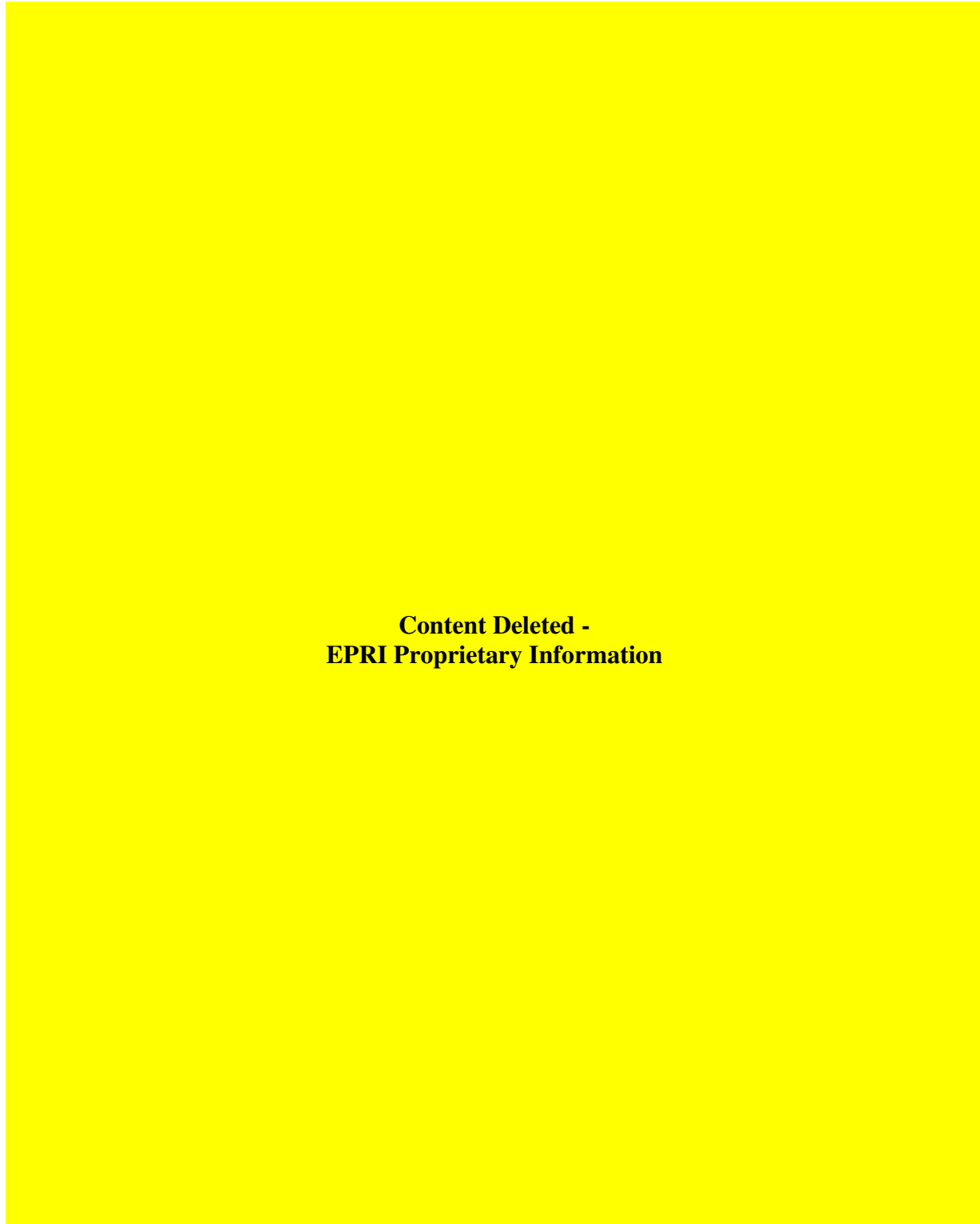
Table 4.4.42-1. Sizing Performance and Evaluation Factors for UT Demonstration 40



**Content Deleted -
EPRI Proprietary Information**

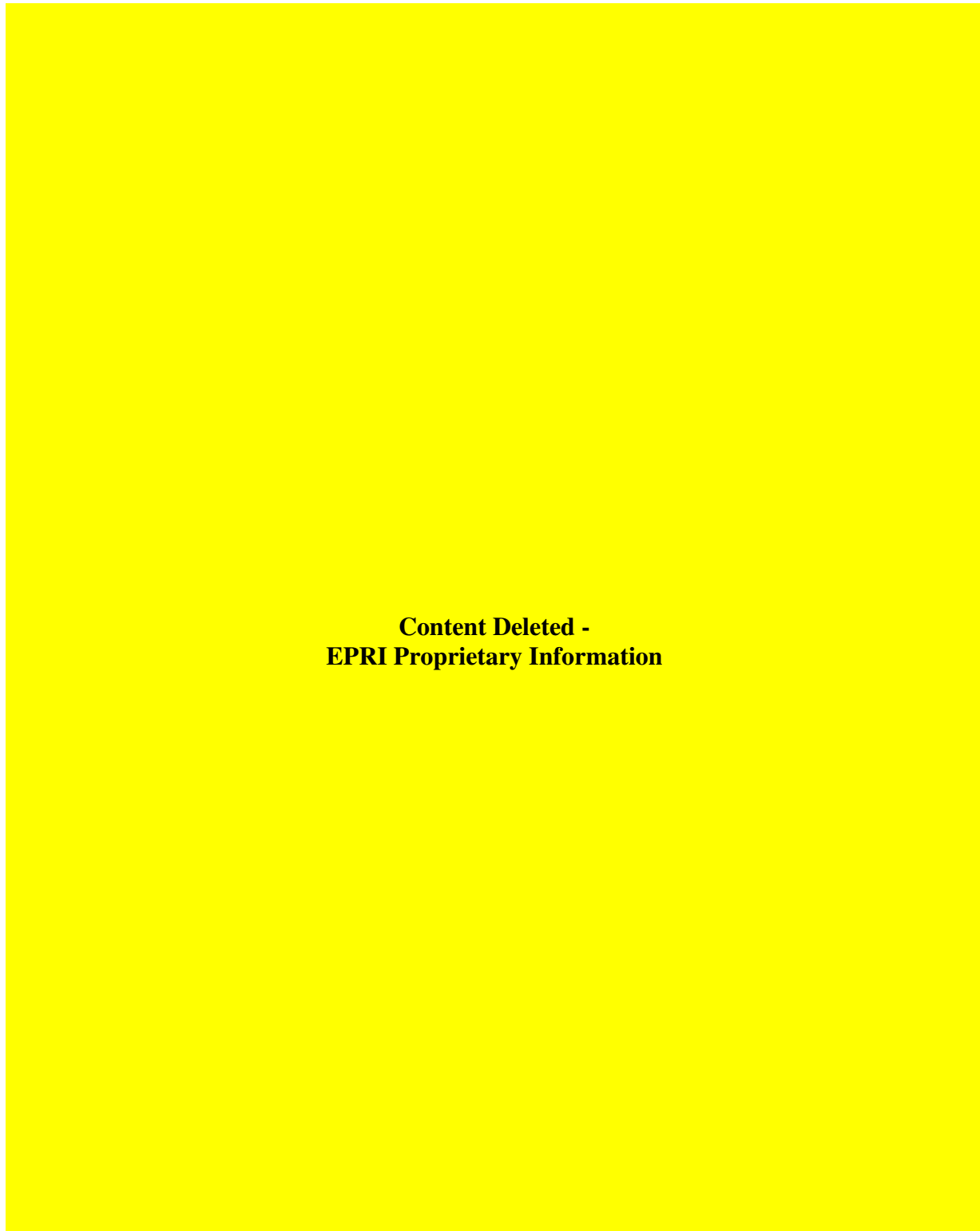
**Content Deleted -
EPRI Proprietary Information**

4.4.43 UT Demonstration 41



**Content Deleted -
EPRI Proprietary Information**

4.4.44 UT Demonstration 42



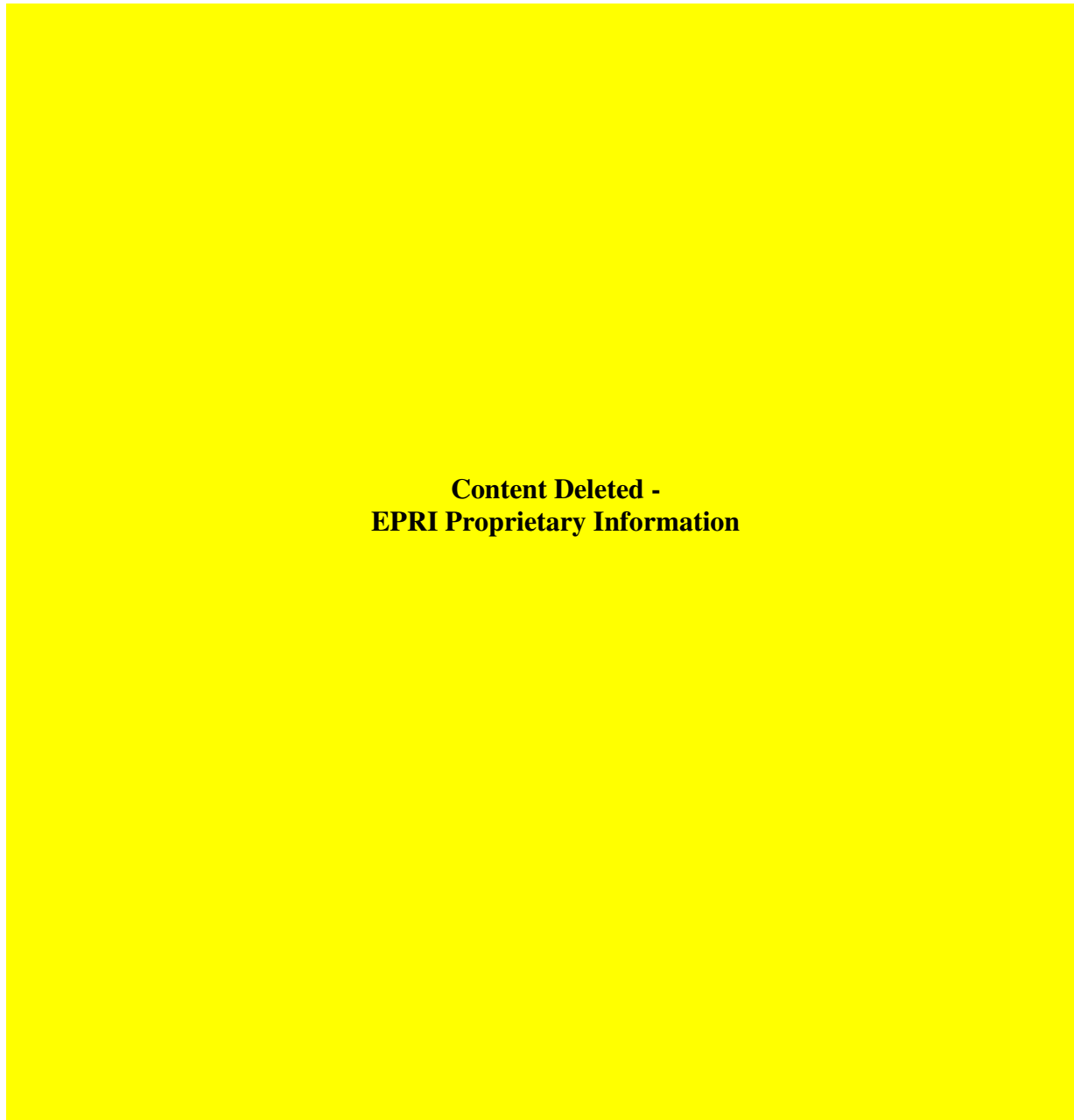
**Content Deleted -
EPRI Proprietary Information**

4.4.45 UT Demonstration 43



**Content Deleted -
EPRI Proprietary Information**

4.4.46 UT Demonstration 44



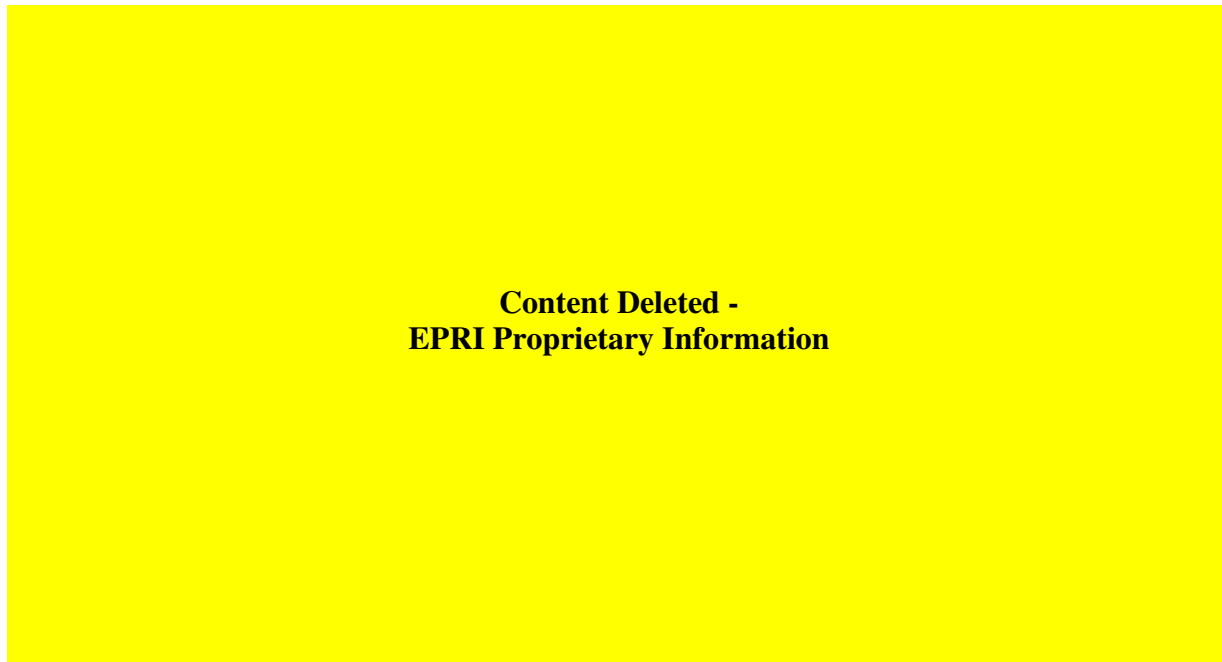
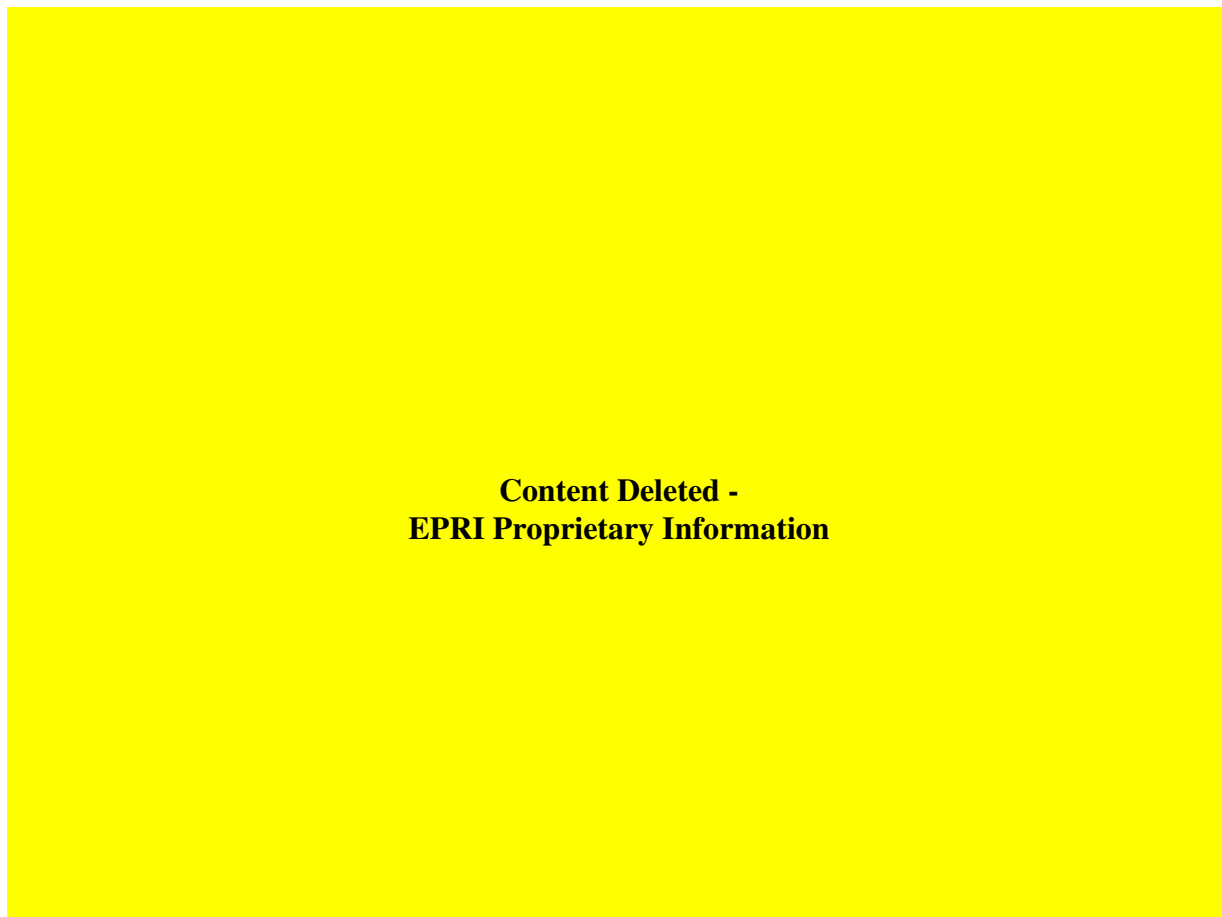


Figure 4.4.46-1. GE Immersion UT Technique for Weld H1



**Content Deleted -
EPRI Proprietary Information**

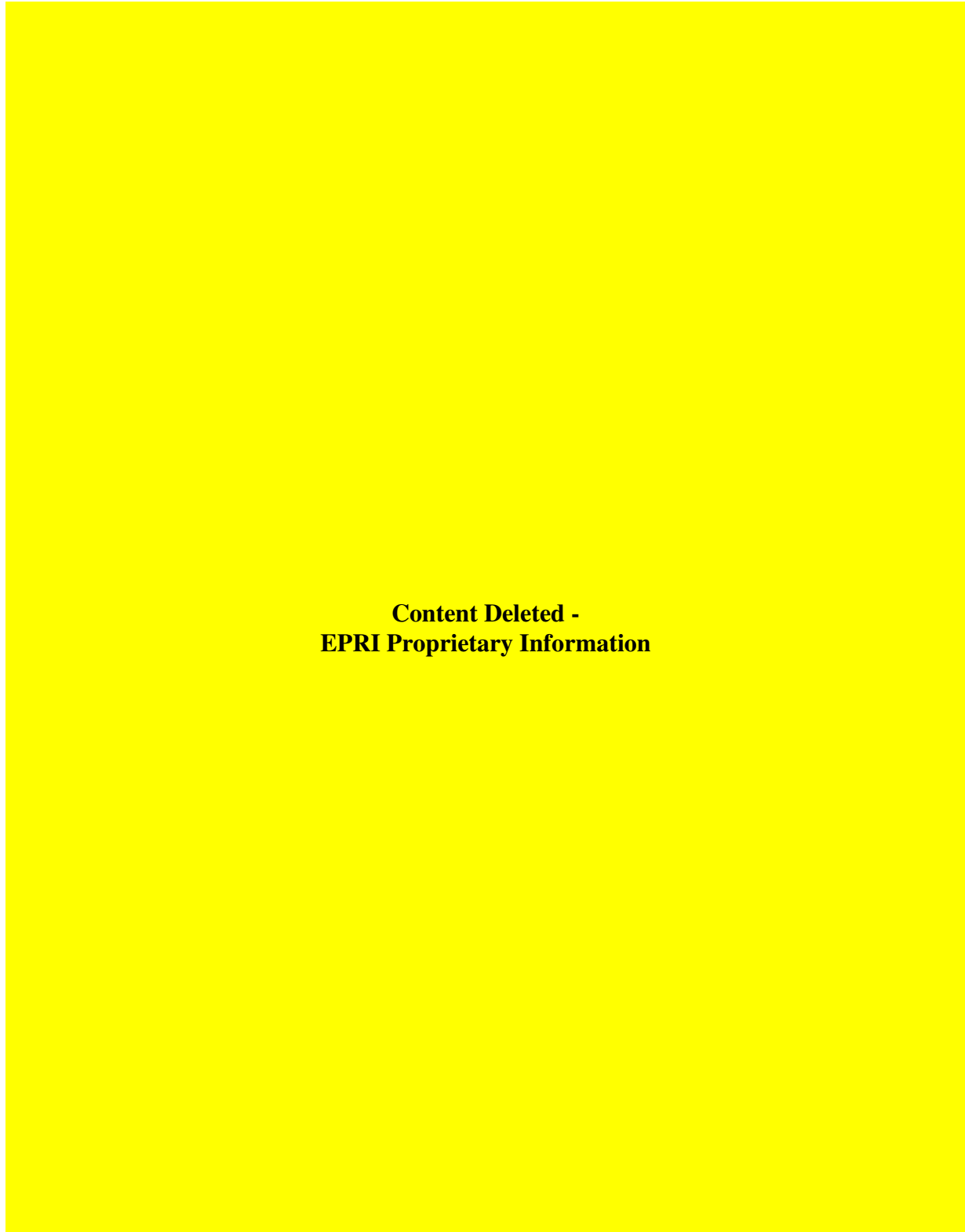
4.4.47 UT Demonstration 45





**Content Deleted -
EPRI Proprietary Information**

4.4.48 UT Demonstration 46



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

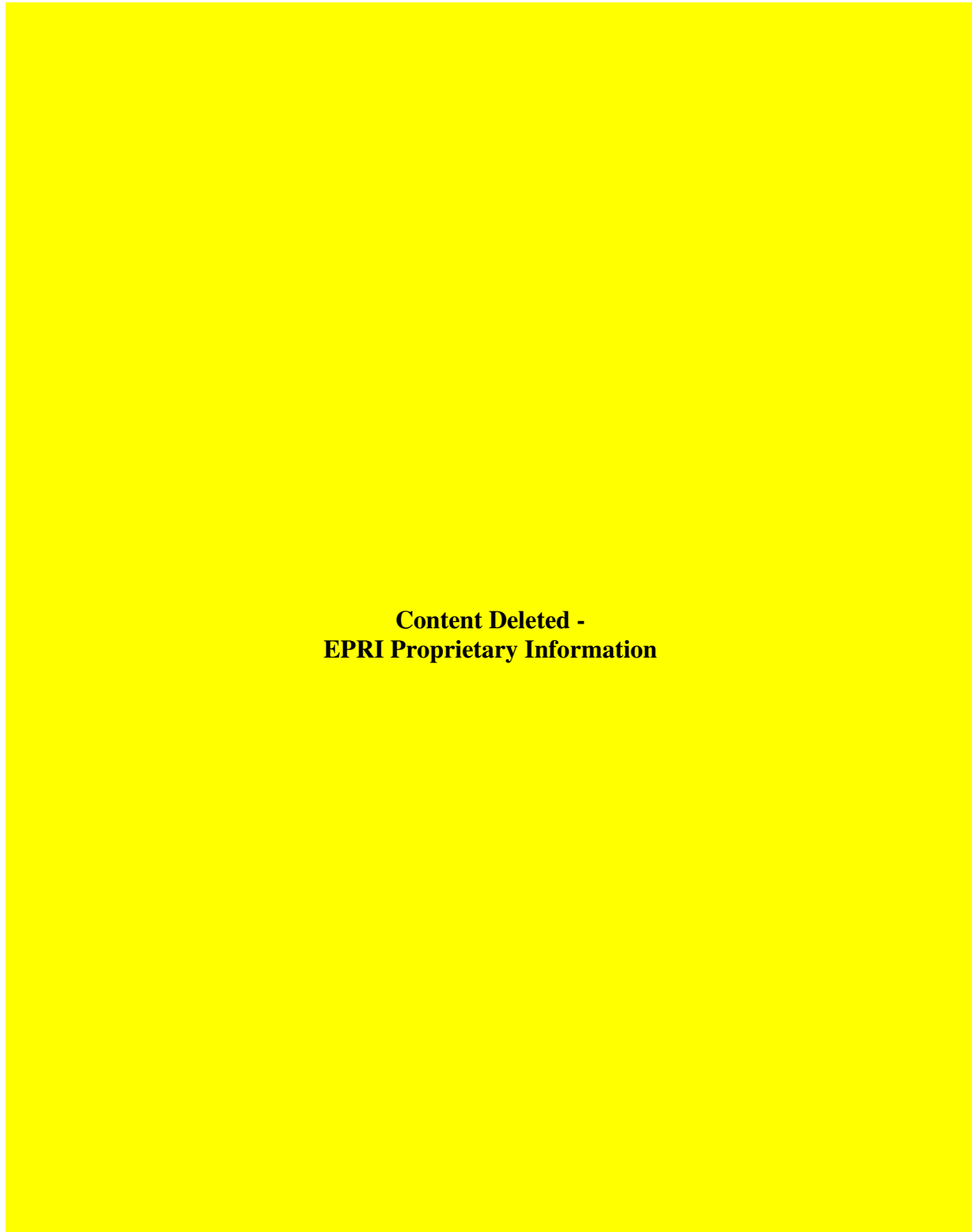
**Content Deleted -
EPRI Proprietary Information**

4.4.49 UT Demonstration 47

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.50 UT Demonstration 48

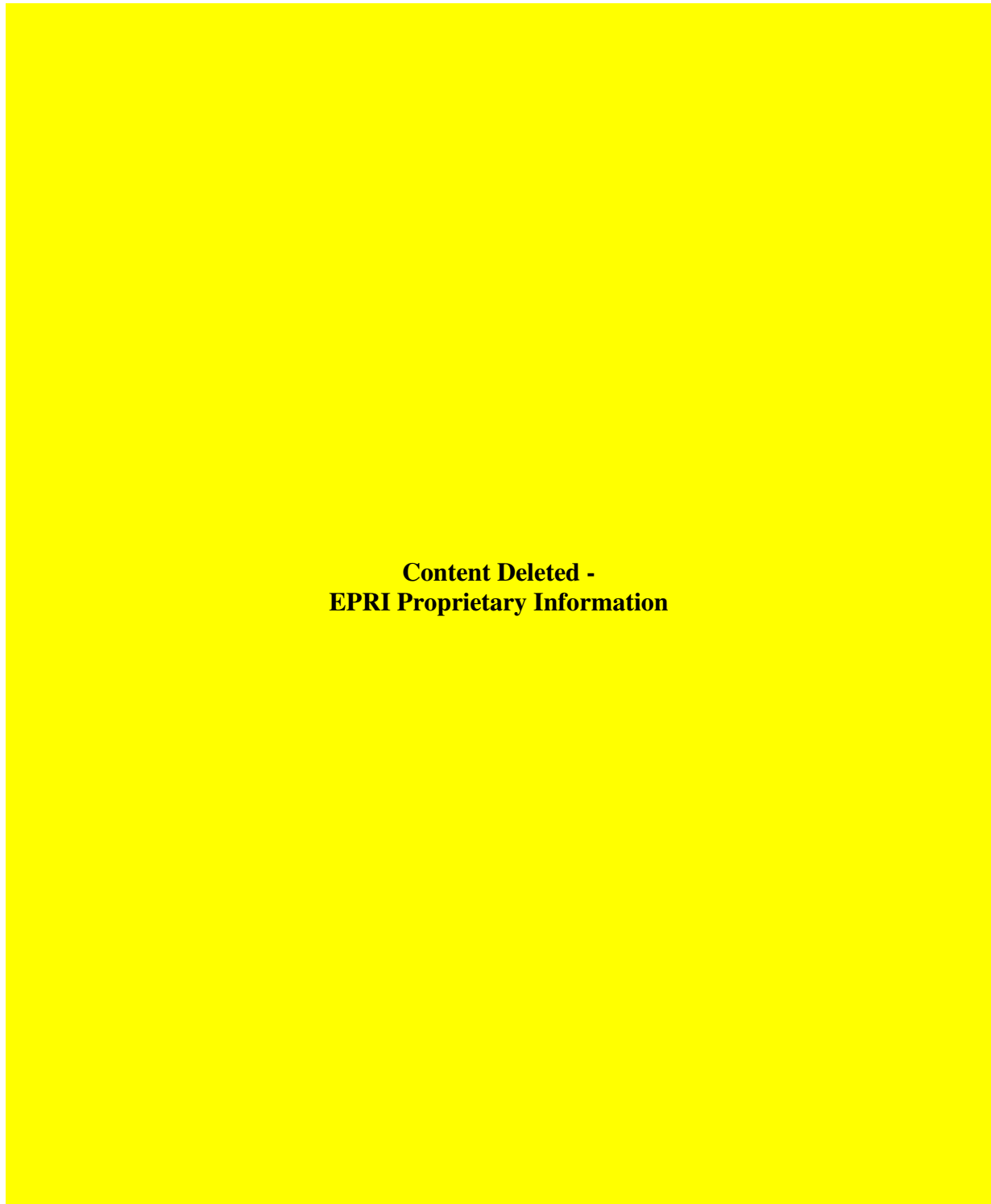


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

4.4.51 UT Demonstration 49



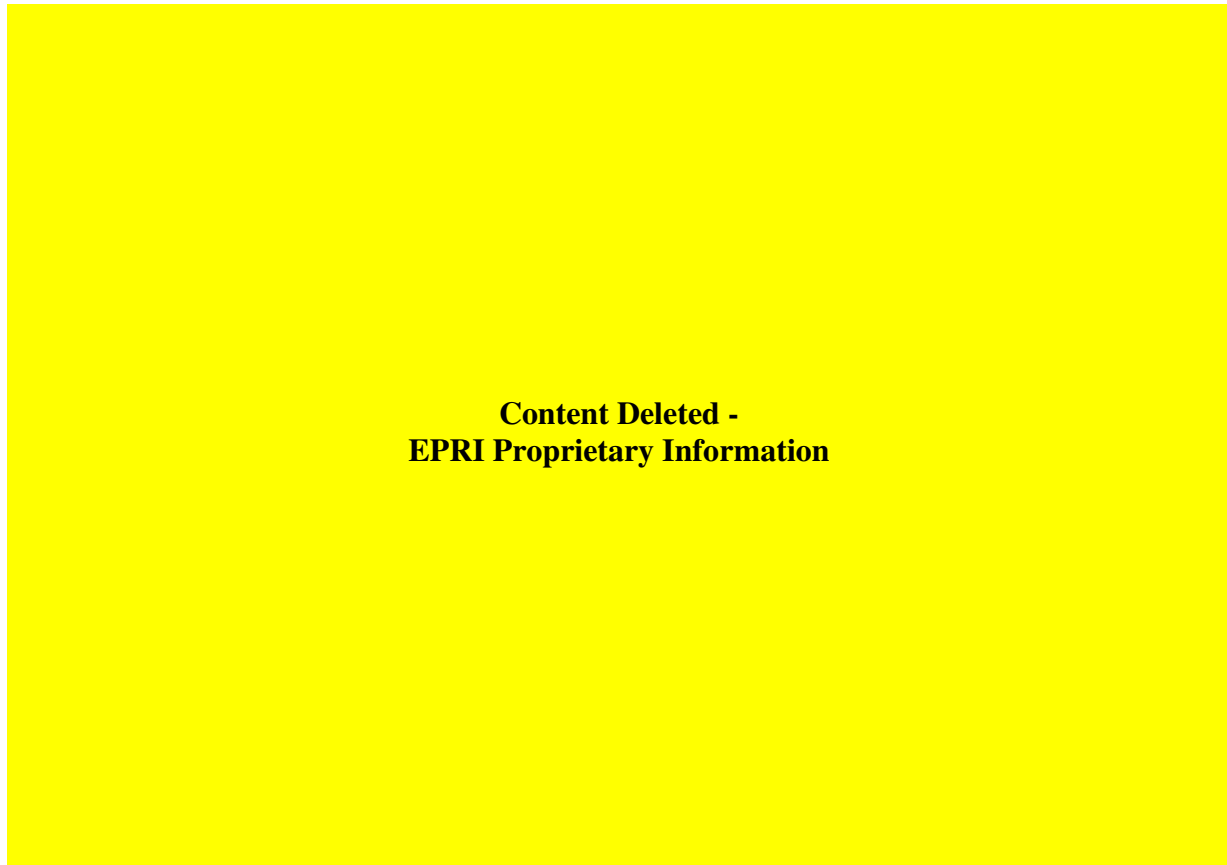
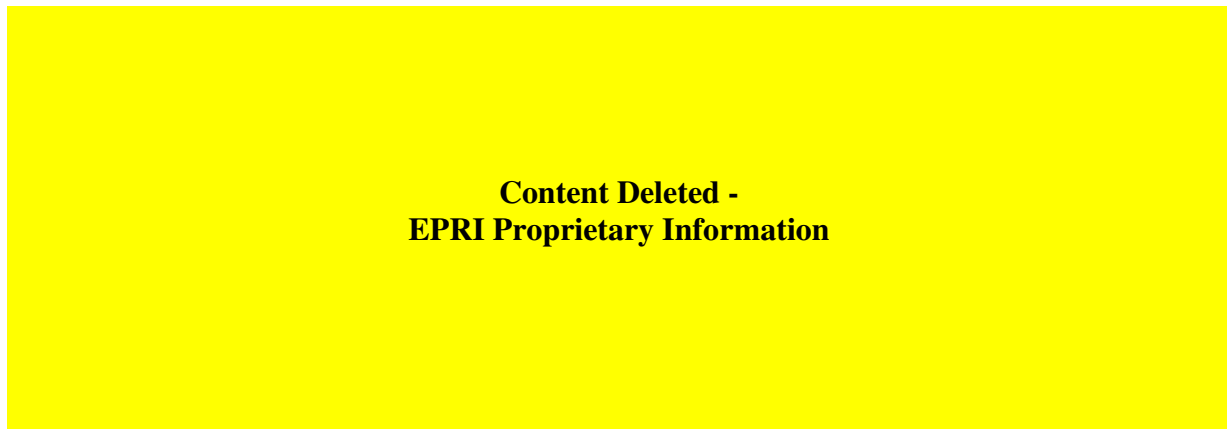
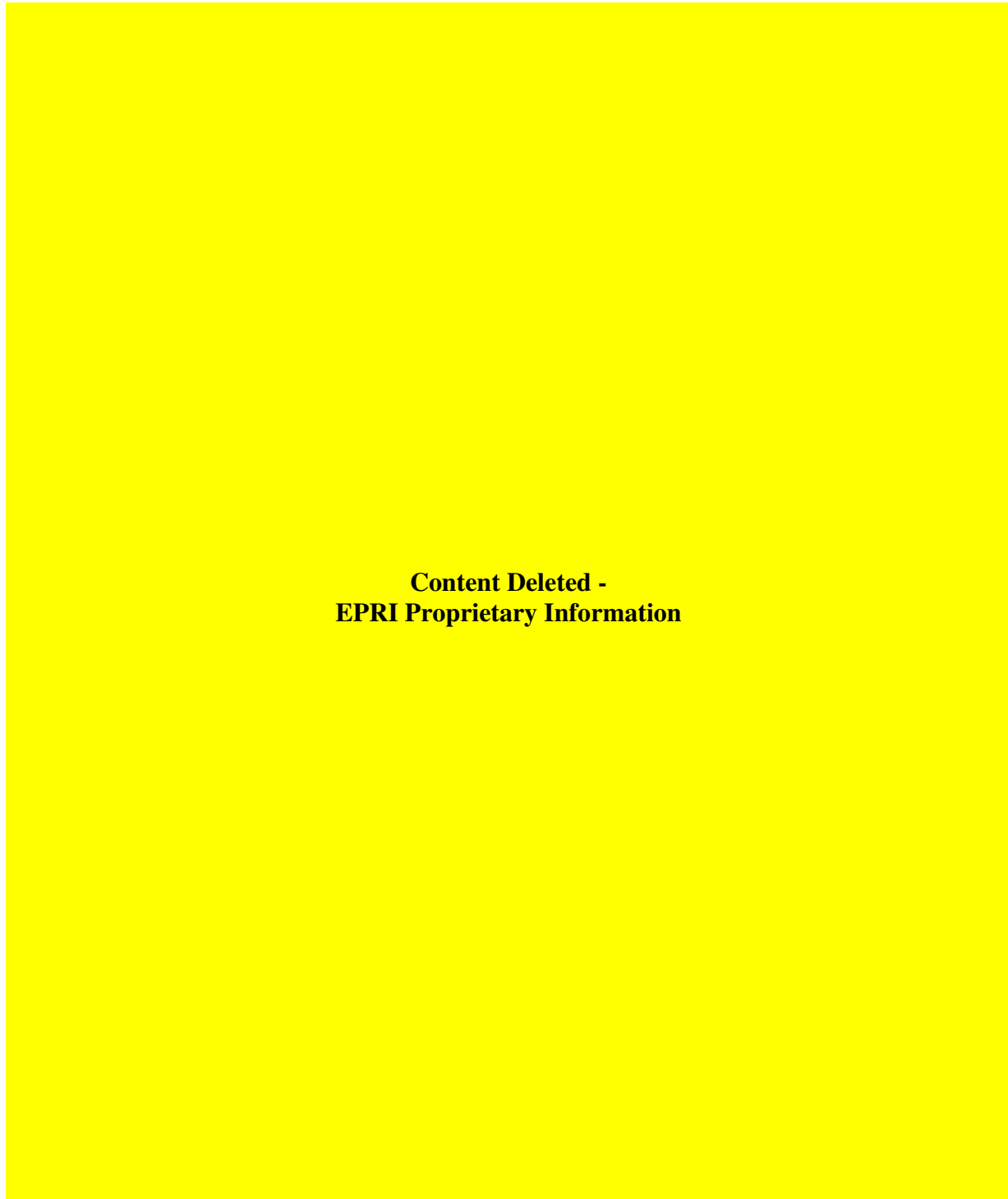


Figure 4.4.51-1. Configuration of H1 Inspection Using Array Probe at the Top of the Shroud Flange



**Content Deleted -
EPRI Proprietary Information**

4.4.52 UT Demonstration 50



**Content Deleted -
EPRI Proprietary Information**

4.4.53 UT Demonstration 51





**Content Deleted -
EPRI Proprietary Information**

4.4.54 UT Demonstration 52



**Content Deleted -
EPRI Proprietary Information**

4.4.55 UT Demonstration 53

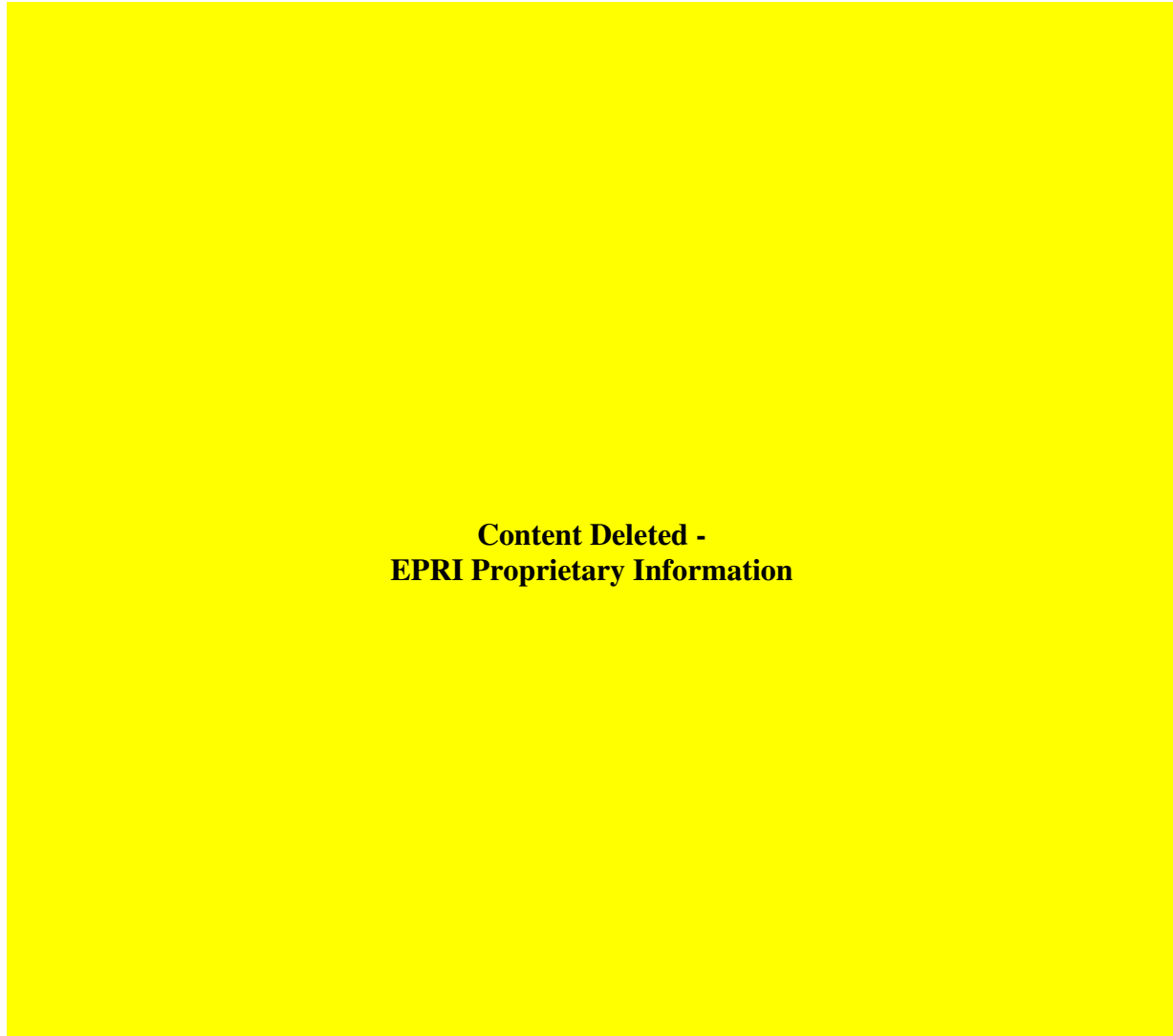
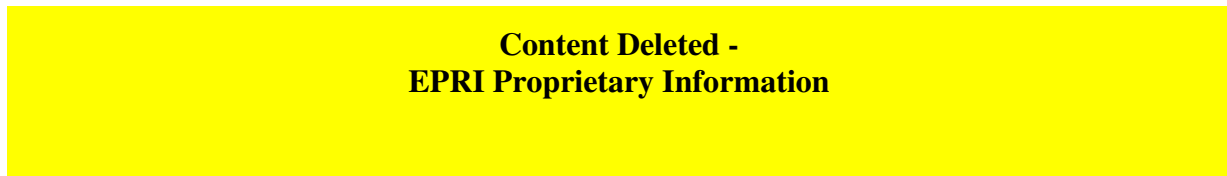
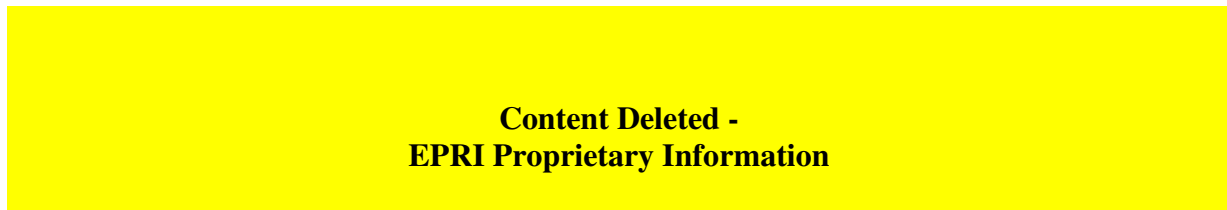


Table 4.4.55-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH



**Content Deleted -
EPRI Proprietary Information**

4.4.56 UT Demonstration 54

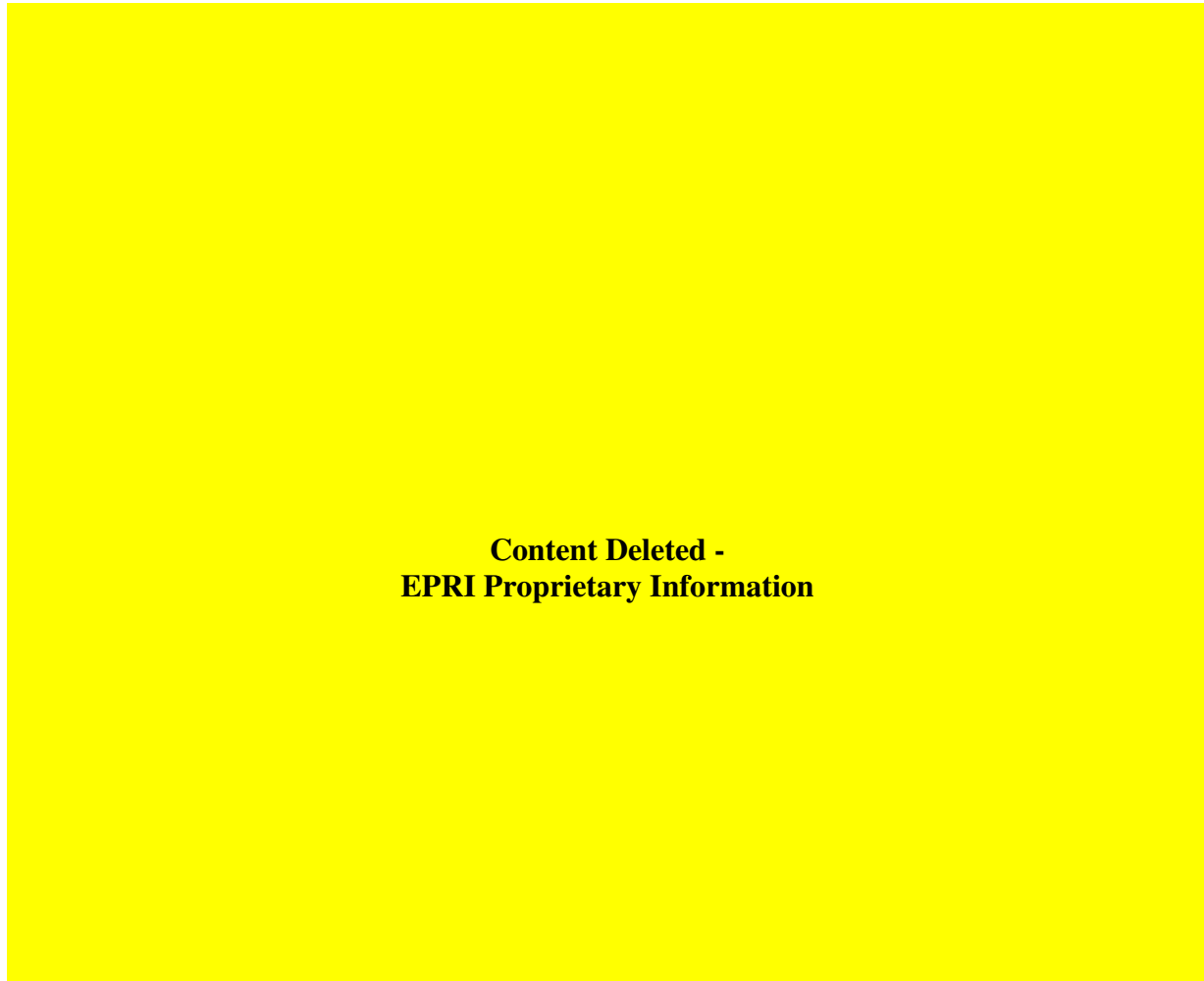
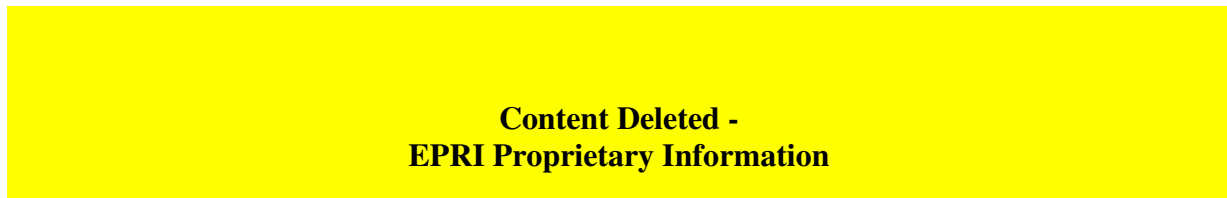
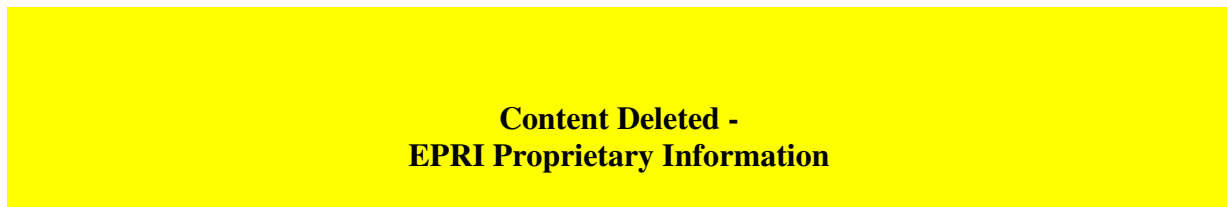


Table 4.4.56-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH

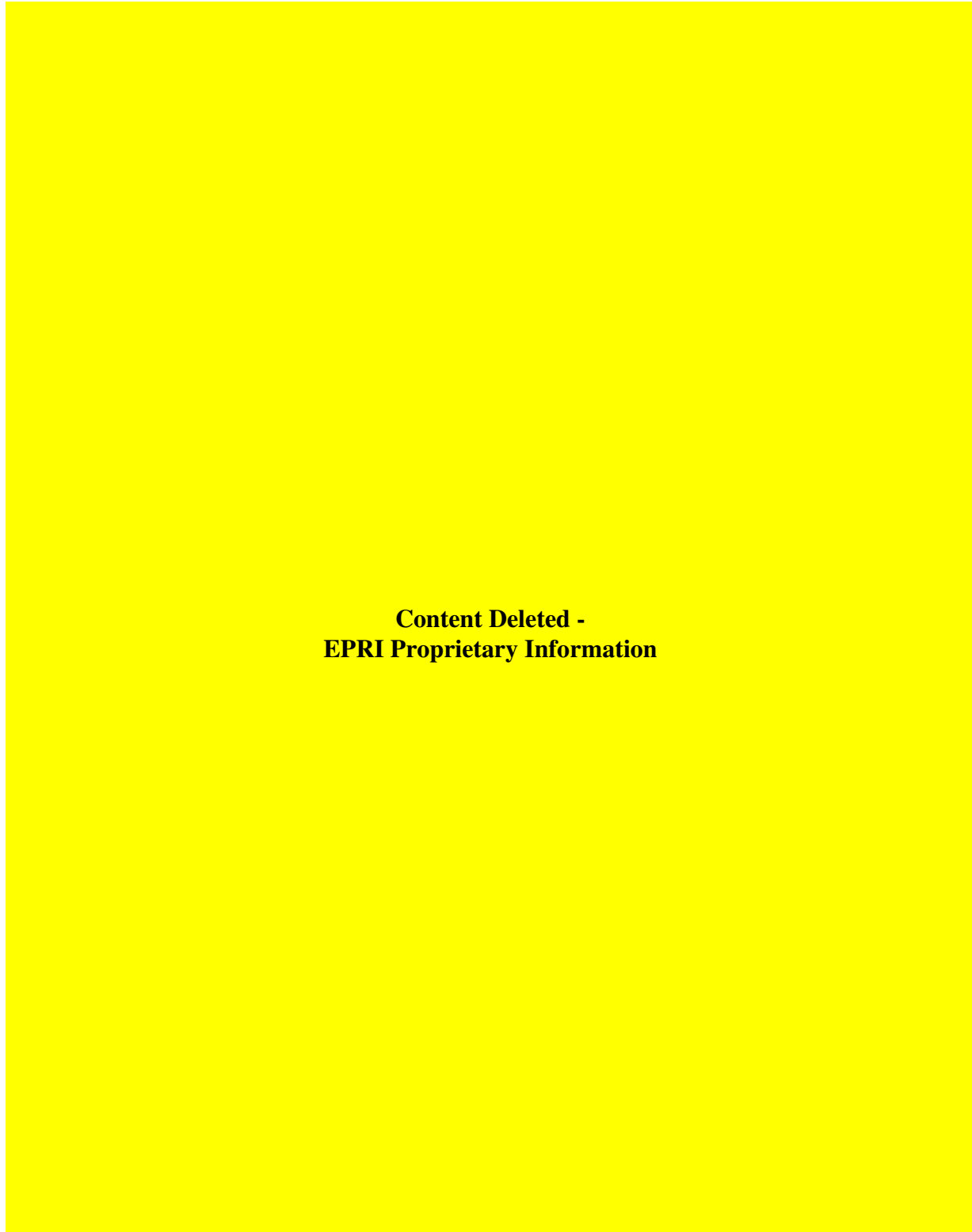




**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.57 UT Demonstration 55



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.57-1. Probe Scan Line Locations for Mockup BWRVIP-A

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.57-2. Probe Scan Line Locations for Mockup BWRVIP-B

4.4.58 UT Demonstration 56



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.58-1. BWRVIP-A and BWRVIP-B Scan Surface

**Content Deleted -
EPRI Proprietary Information**

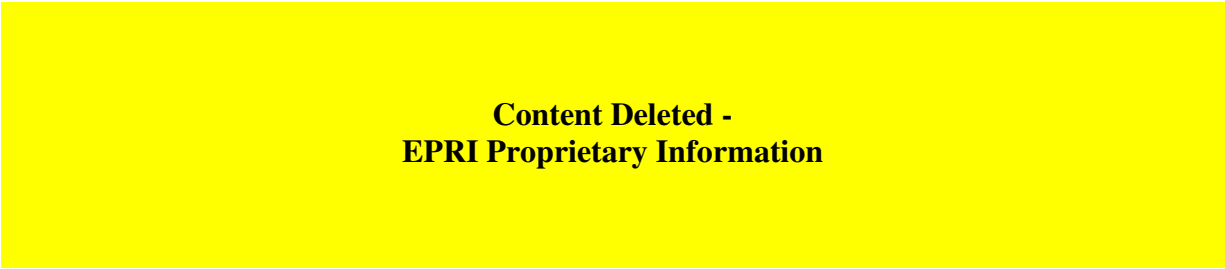


Figure 4.4.58-2. BWRVIP-A and BWRVIP-B (H3 and H6/H6B) Scan Surface

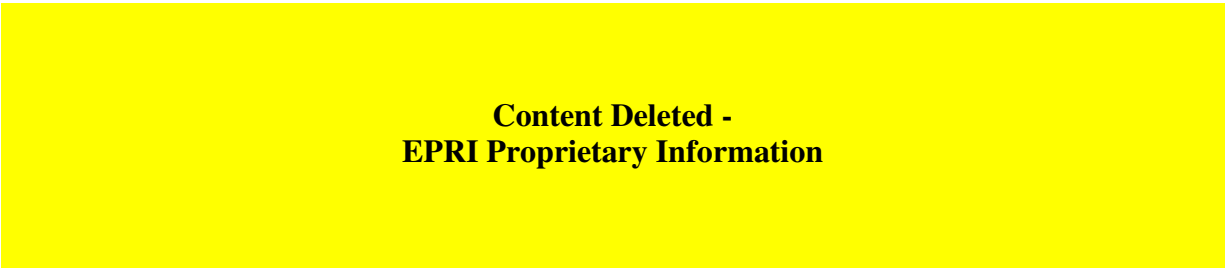
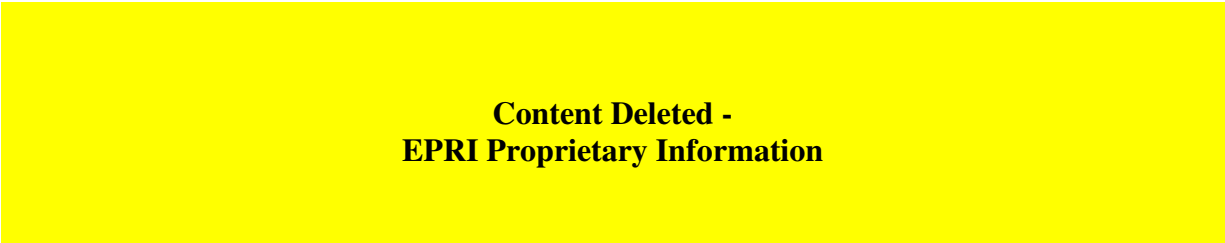


Figure 4.4.58-3. BWRVIP-C (H4/H5) Flaws Connected to the Scan Surface

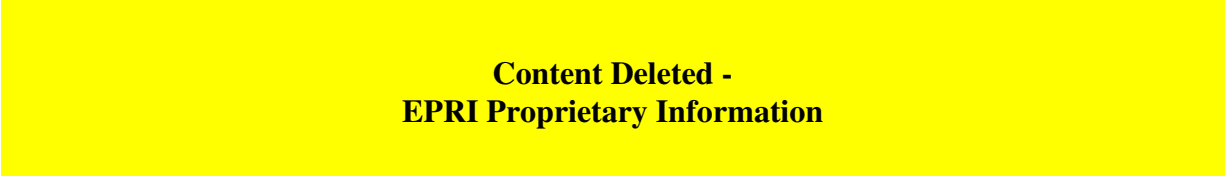
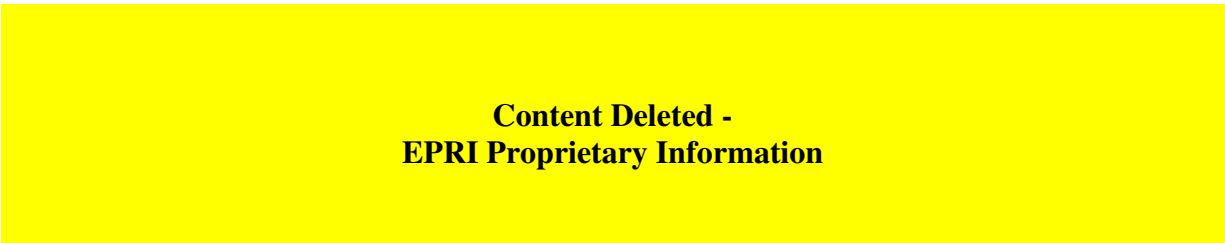
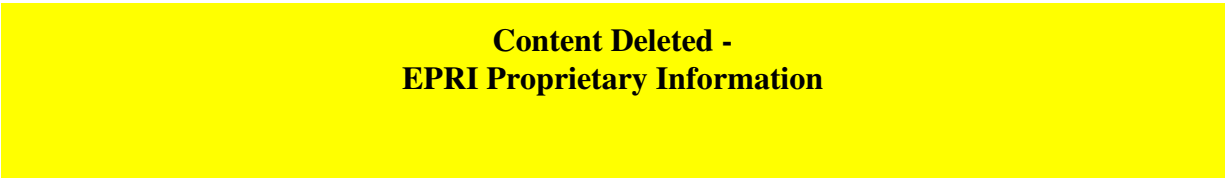
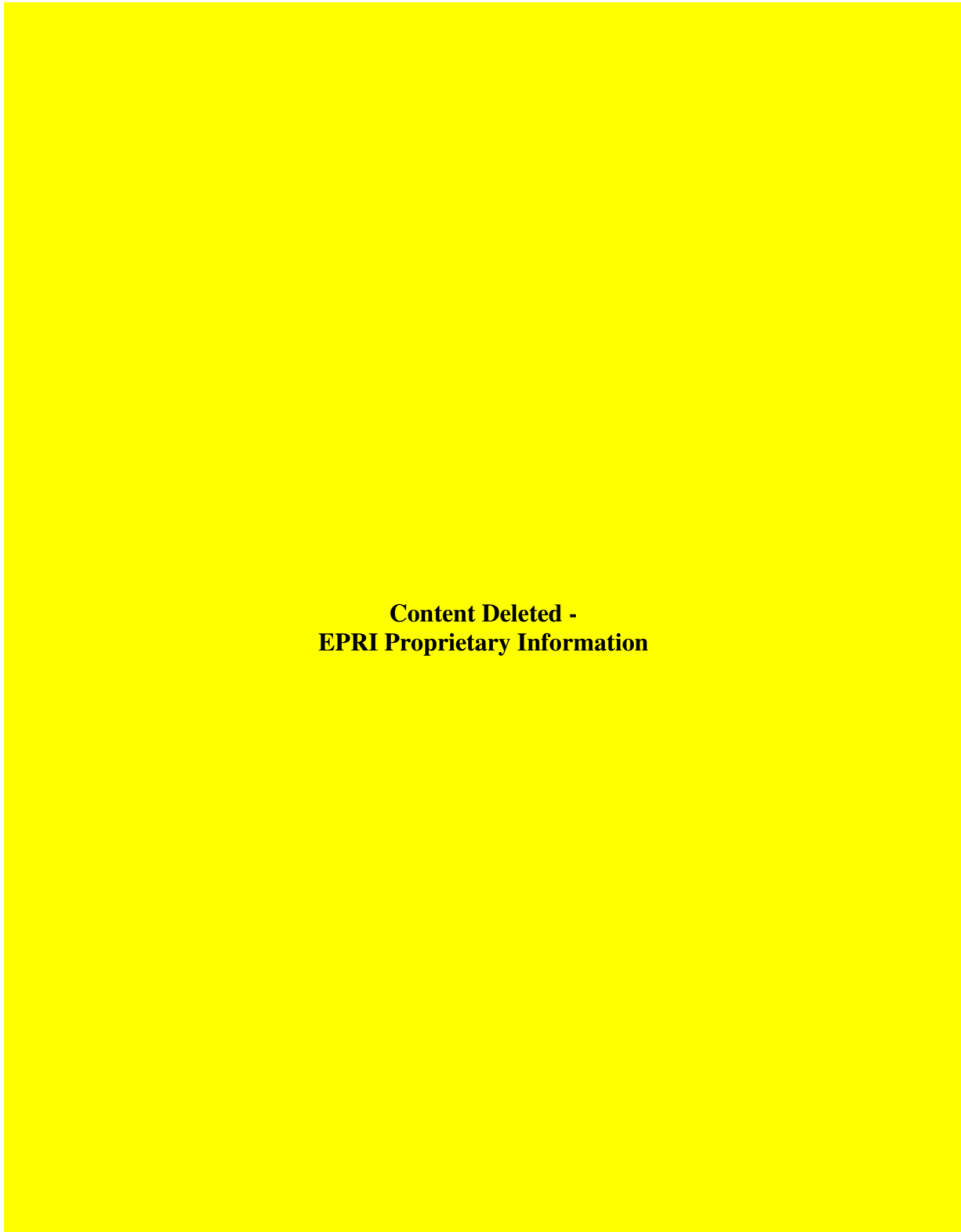


Figure 4.4.58-4. BWRVIP-C (H4/H5) Flaws Connected Opposite to the Scan Surface



**Content Deleted -
EPRI Proprietary Information**

4.4.59 UT Demonstration 57



**Content Deleted -
EPRI Proprietary Information**

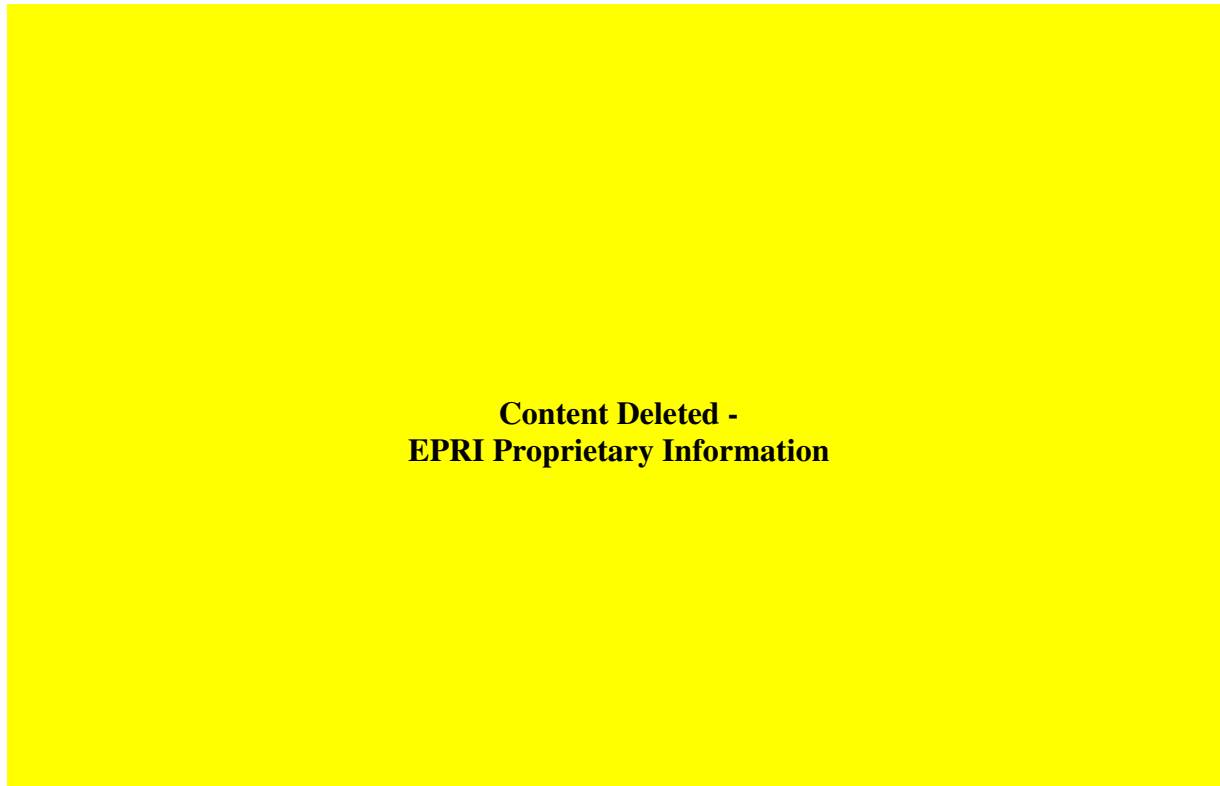
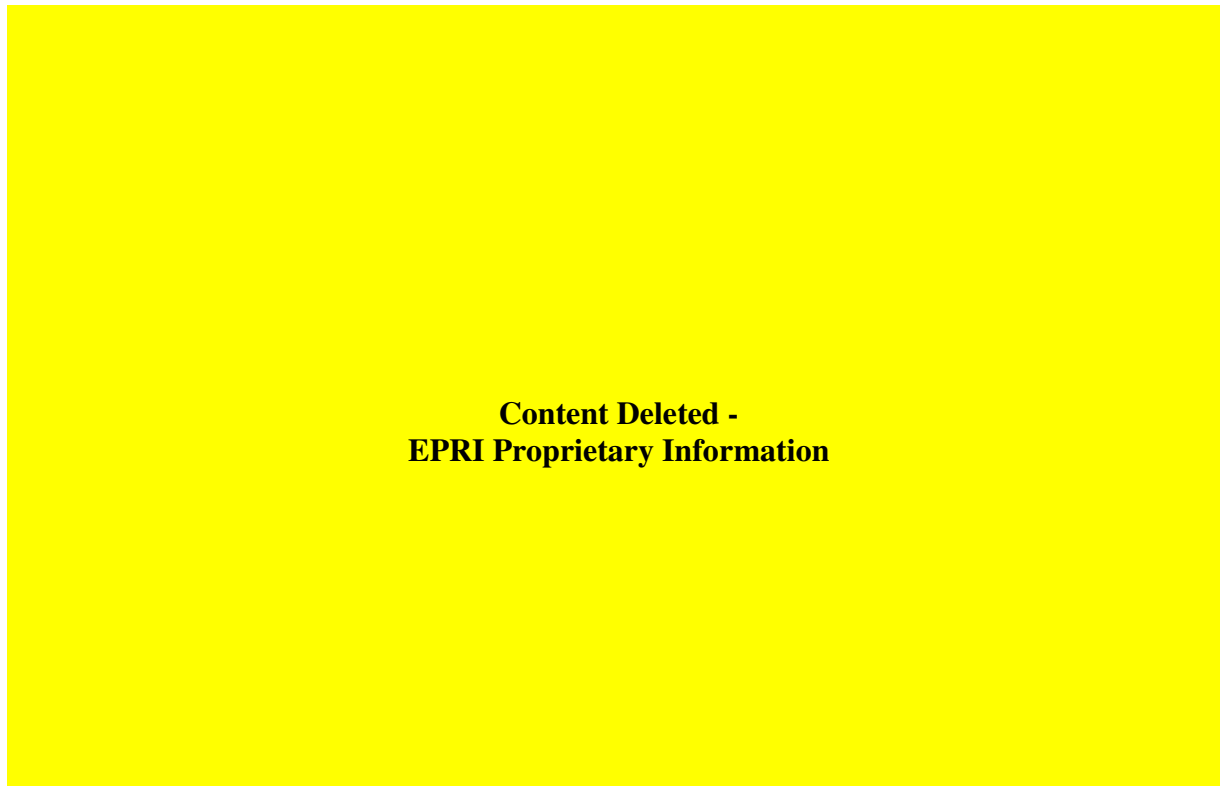


Figure 4.4.59-1. Surface Distance of First and Fourth Scan Lines



**Content Deleted -
EPRI Proprietary Information**

4.4.60 UT Demonstration 58

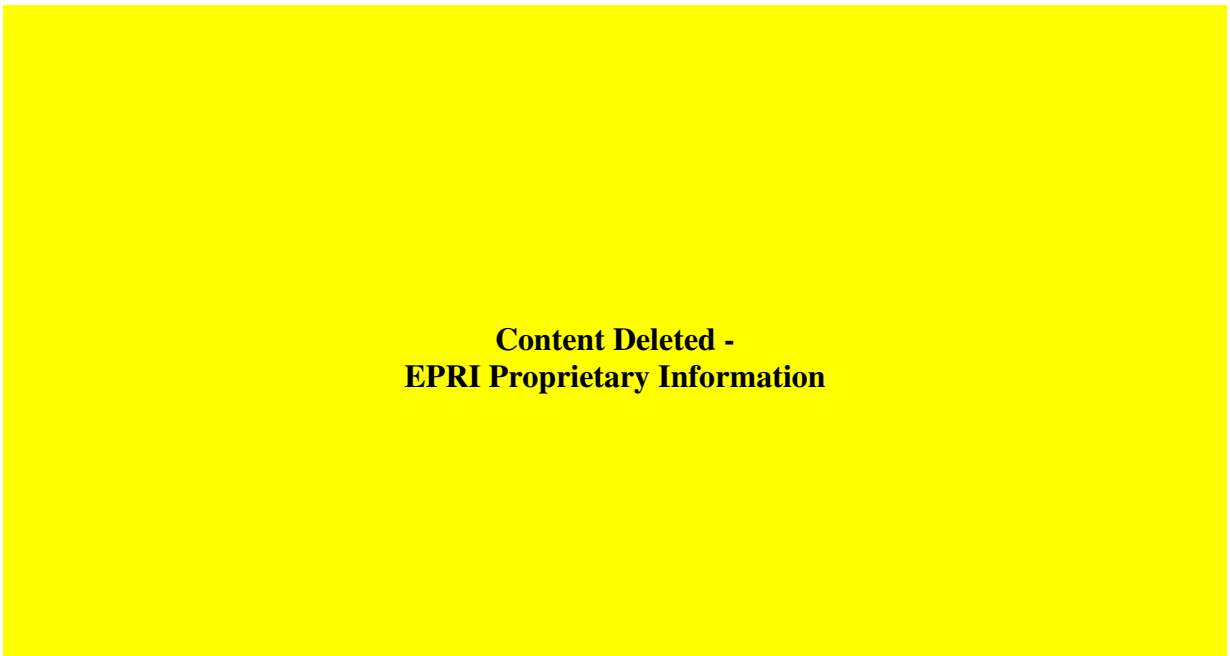
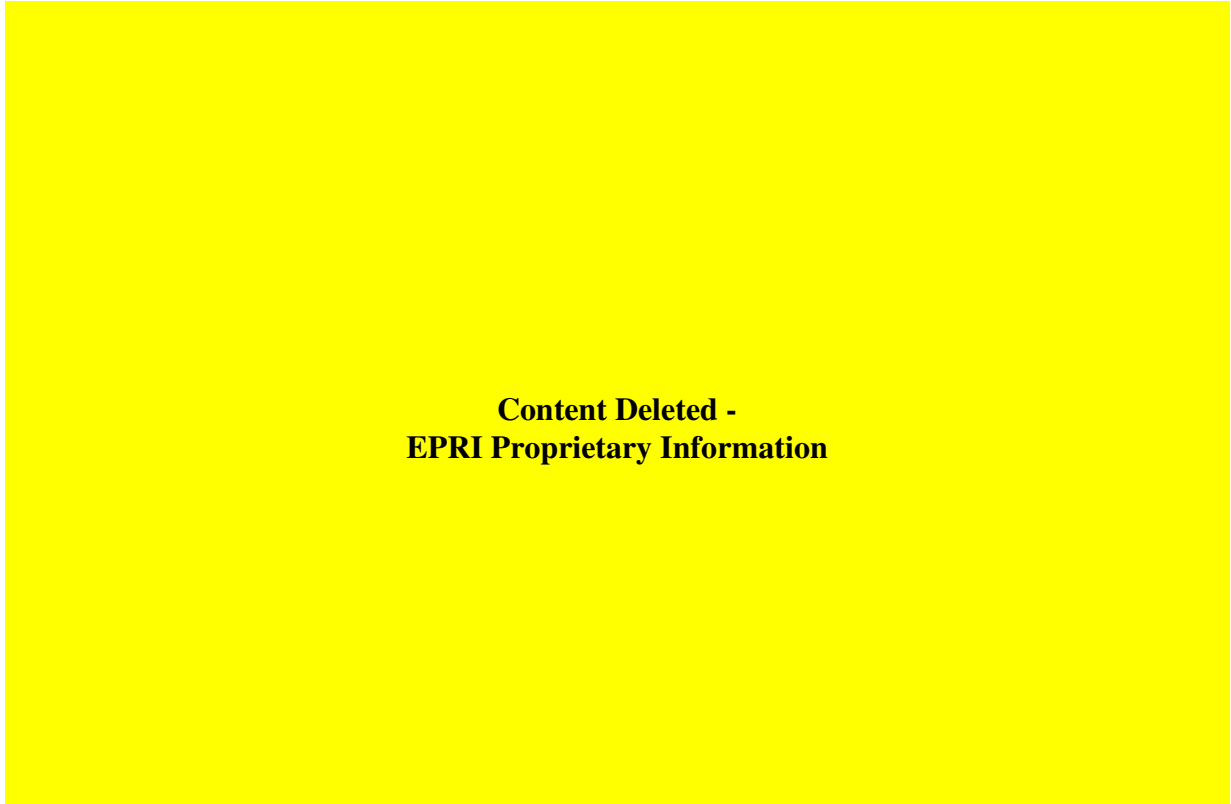


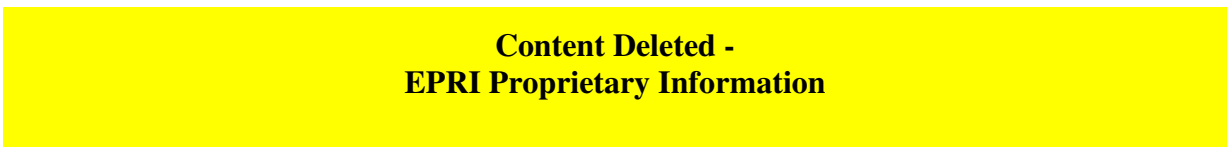
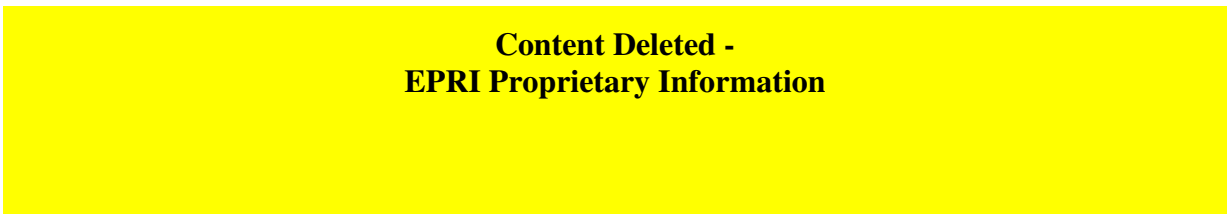
Figure 4.4.60-1. Vertical Ring Segment Weld Orientation

**Content Deleted -
EPRI Proprietary Information**

4.4.61 UT Demonstration 59



Table 4.4.61-1. Focal Law Groups for Demonstration 59

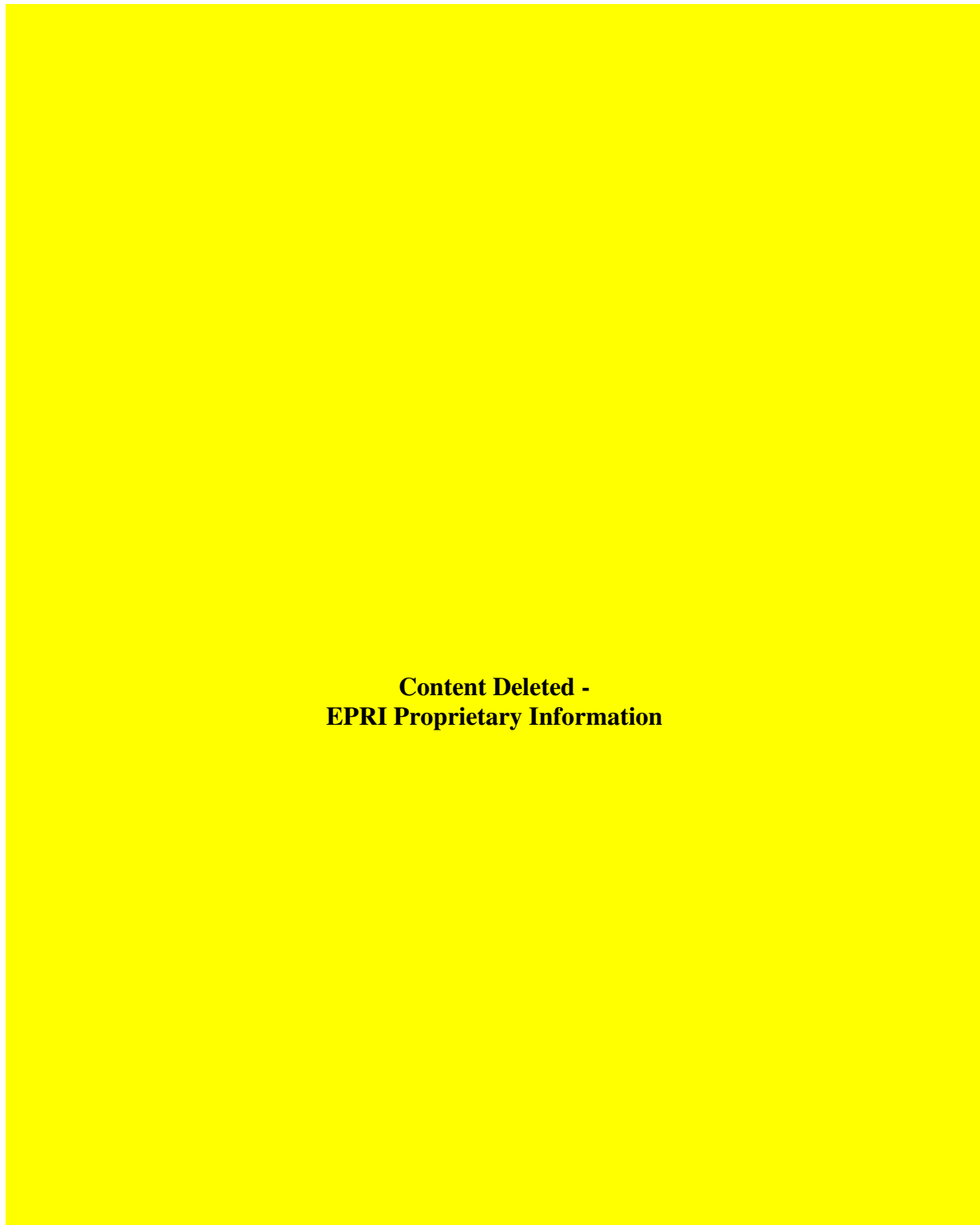




**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.62 UT Demonstration 60



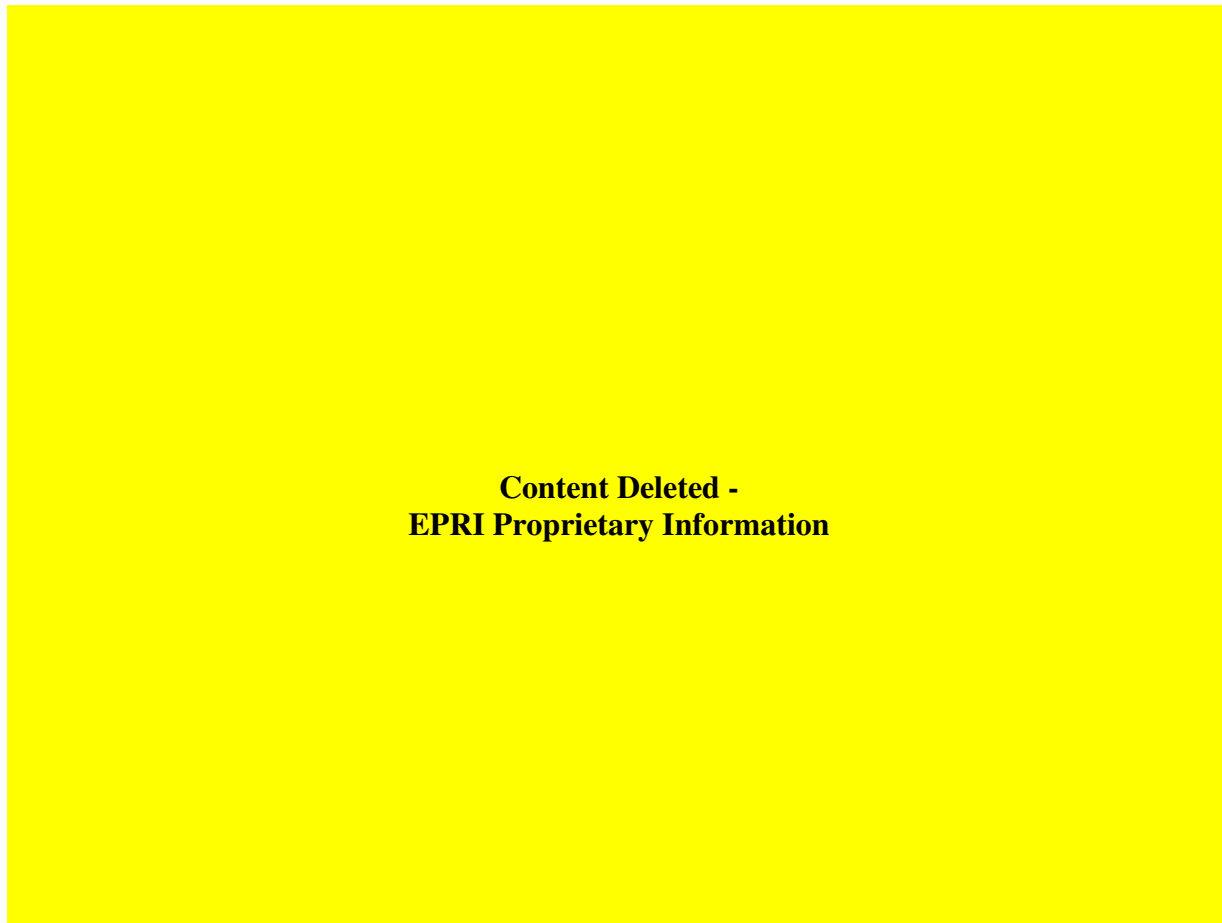
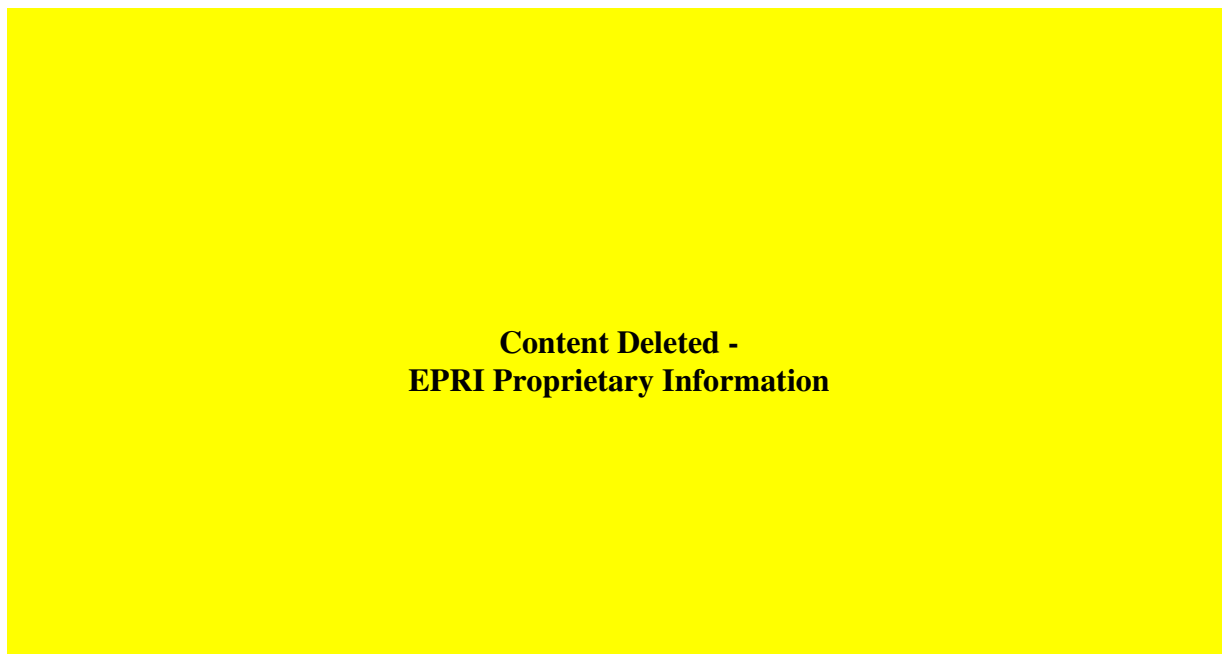
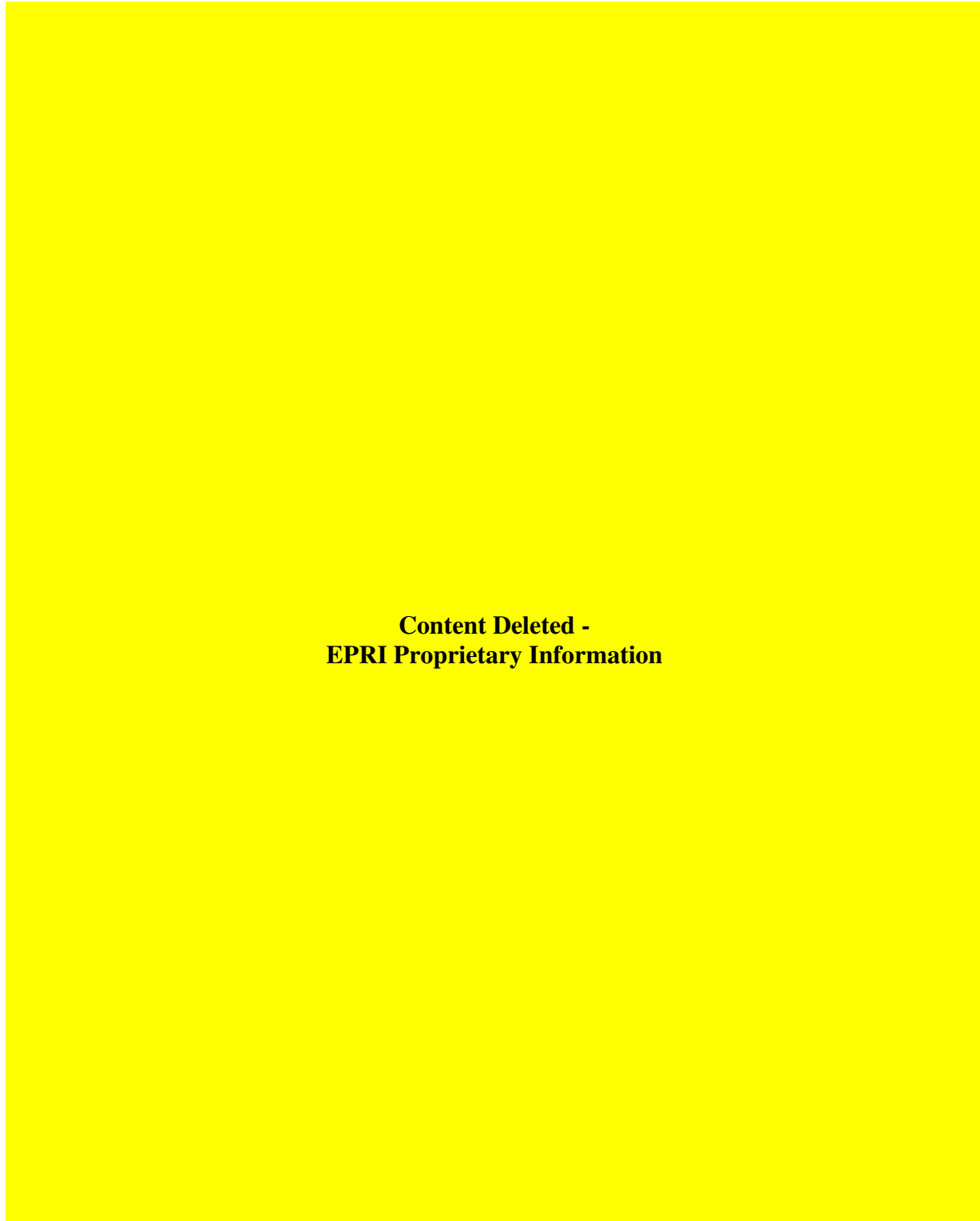


Figure 4.4.62-1. Scanning the H1 Weld from the Core Shroud Flange



**Content Deleted -
EPRI Proprietary Information**

4.4.63 UT Demonstration 61



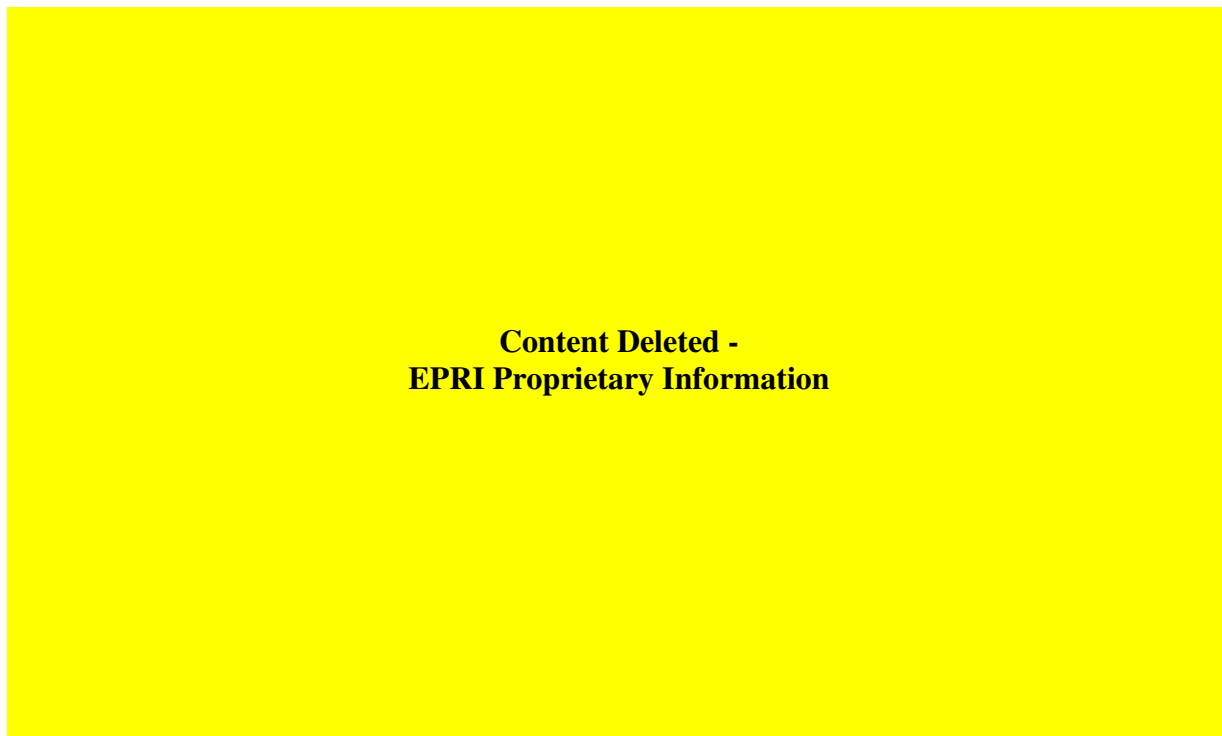
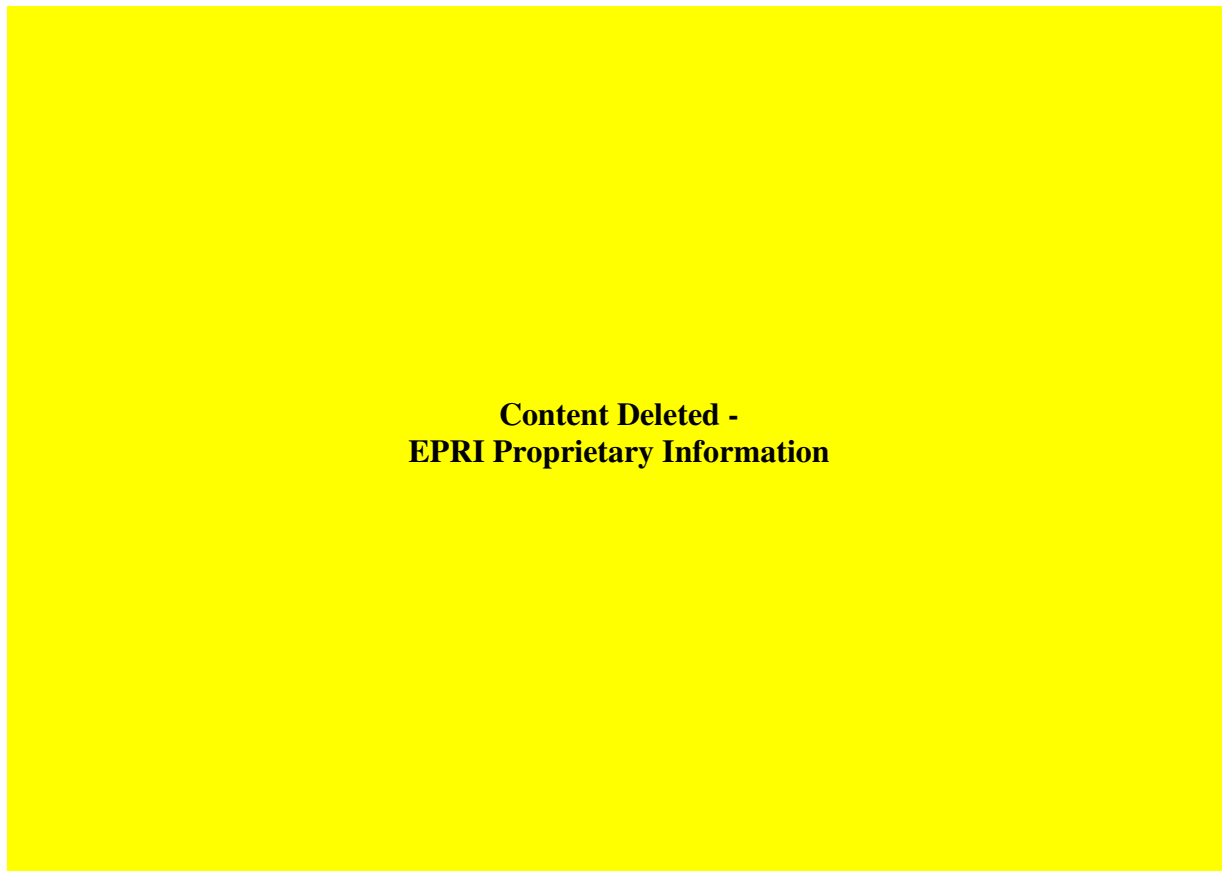


Figure 4.4.63-1. H5/H6A Looking Up and Looking Down Scan Configurations

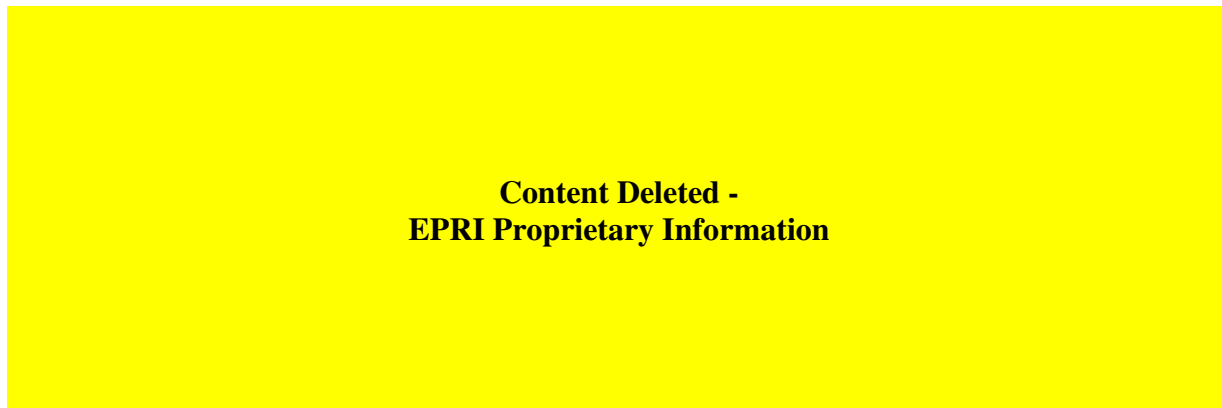
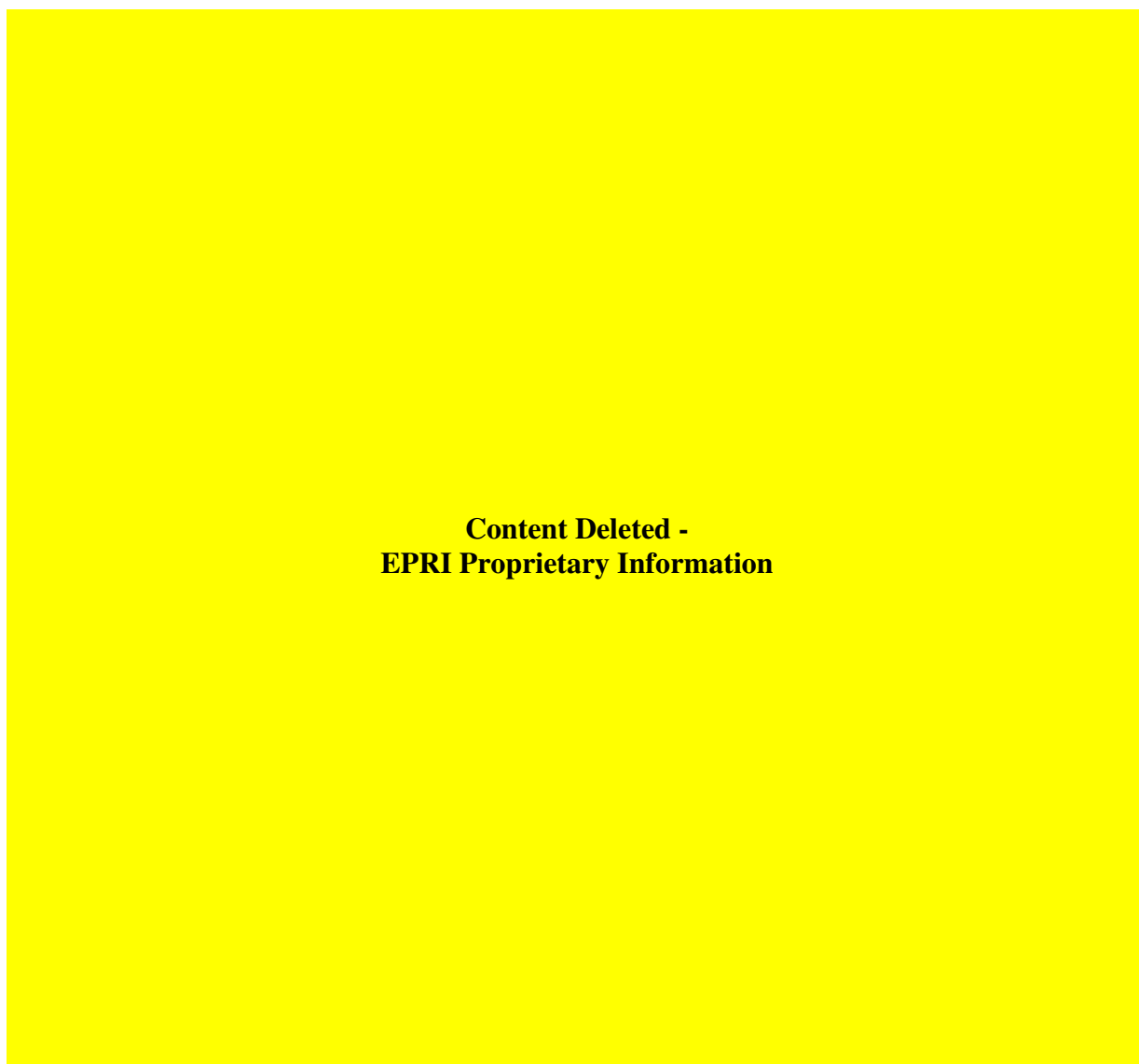
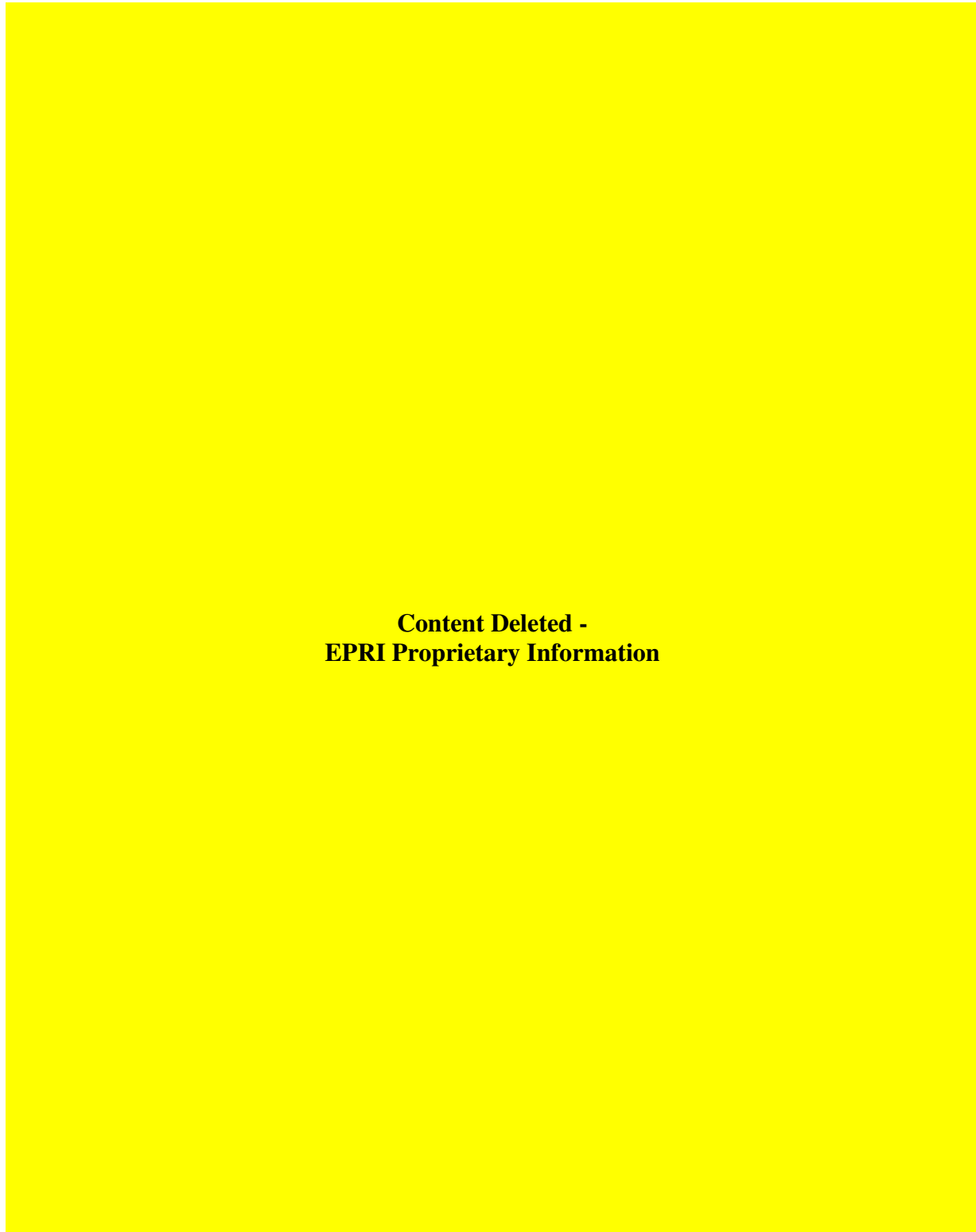


Figure 4.4.63-2. H4/H5 and Vertical Weld Scan Configuration



**Content Deleted -
EPRI Proprietary Information**

4.4.64 UT Demonstration 62



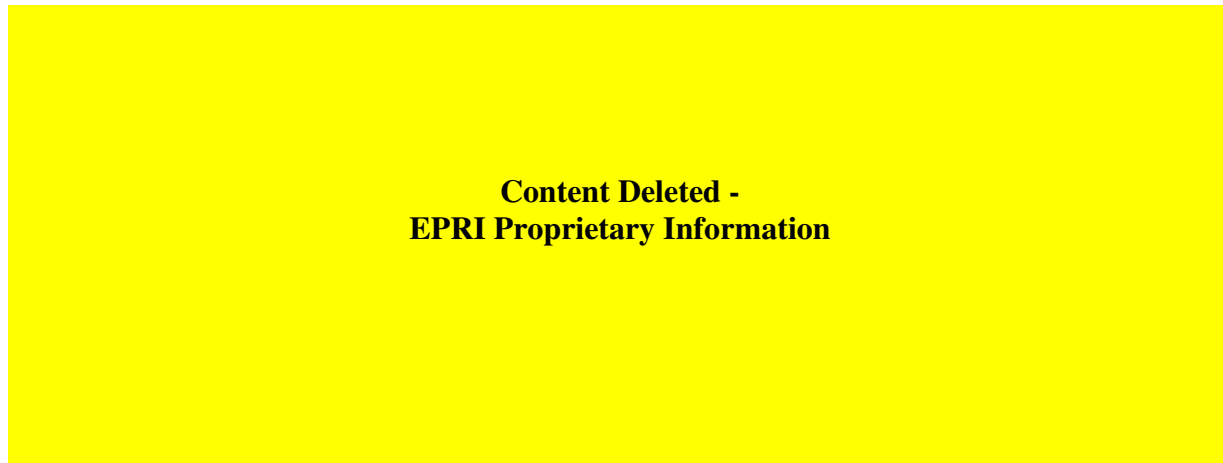
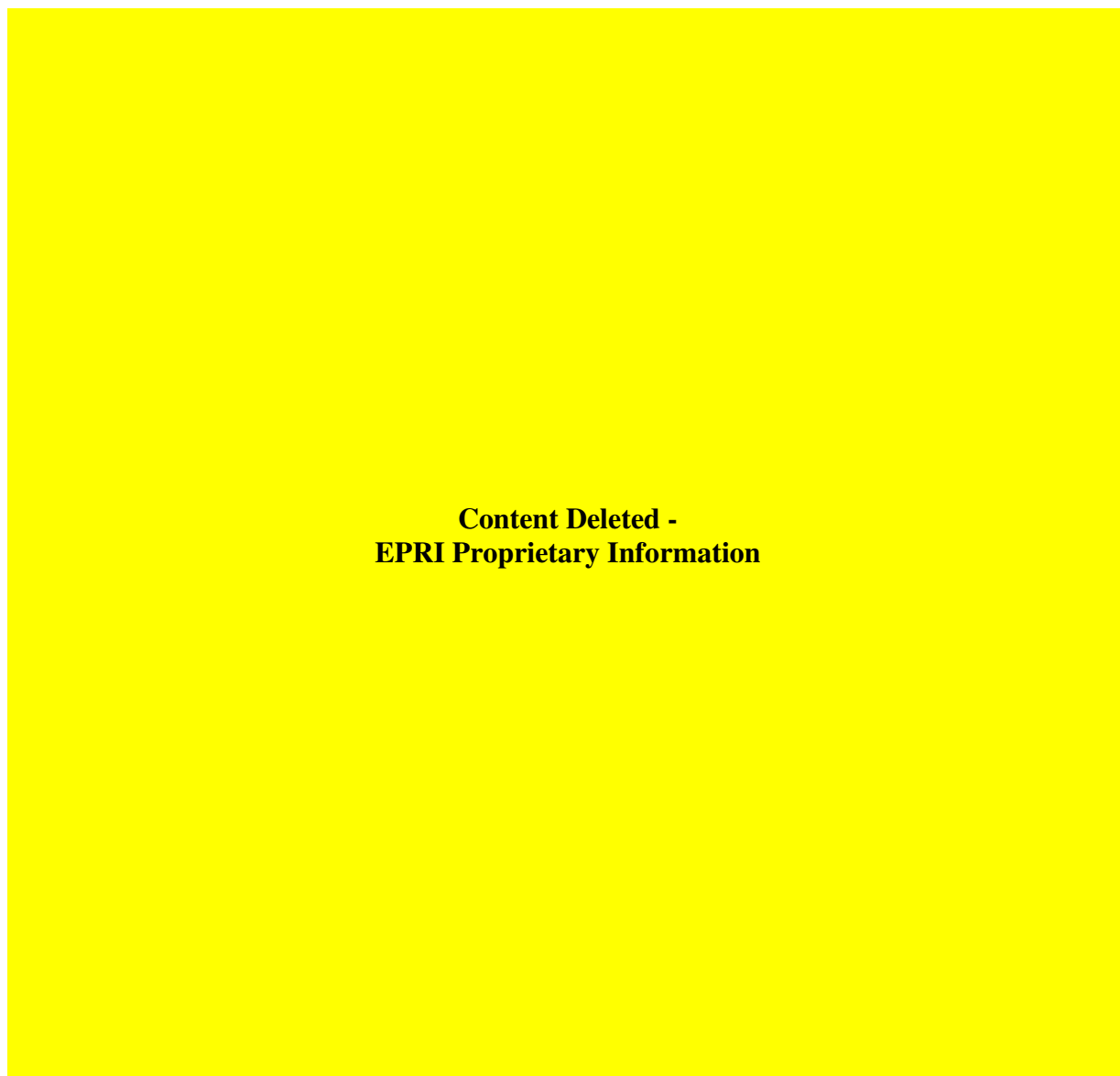
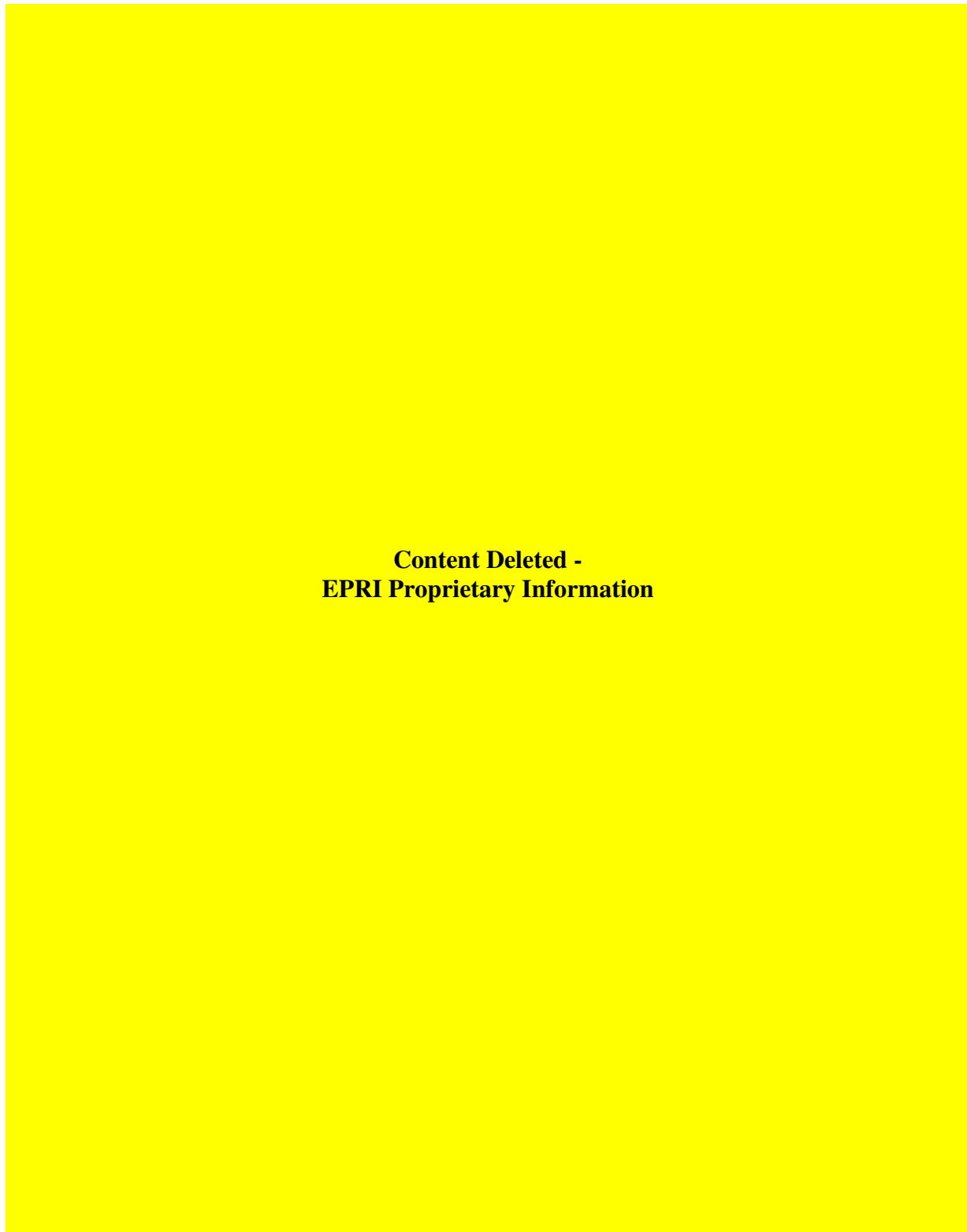


Figure 4.4.64-1. H2 Examination Technique



**Content Deleted -
EPRI Proprietary Information**

4.4.65 UT Demonstration 63



**Content Deleted -
EPRI Proprietary Information**

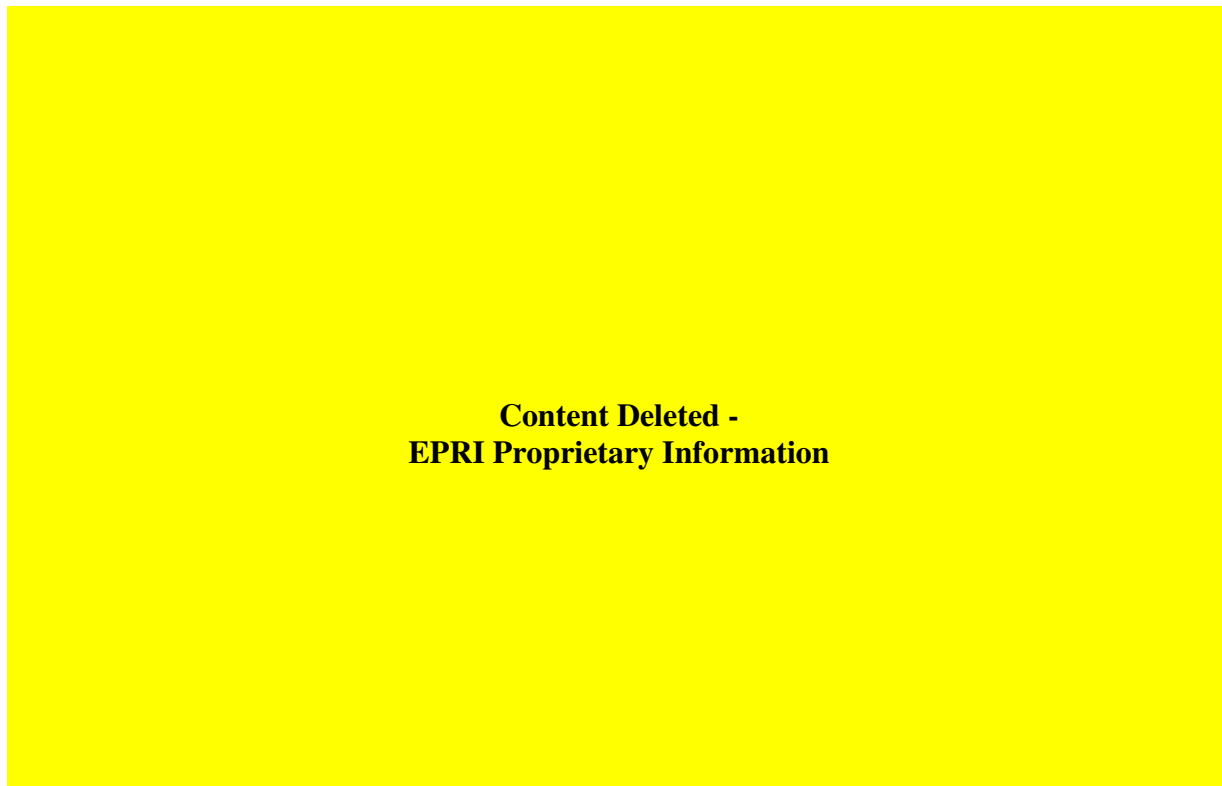


Figure 4.4.65-1. H3 Full-Vee Technique at Rear Scan Line Position

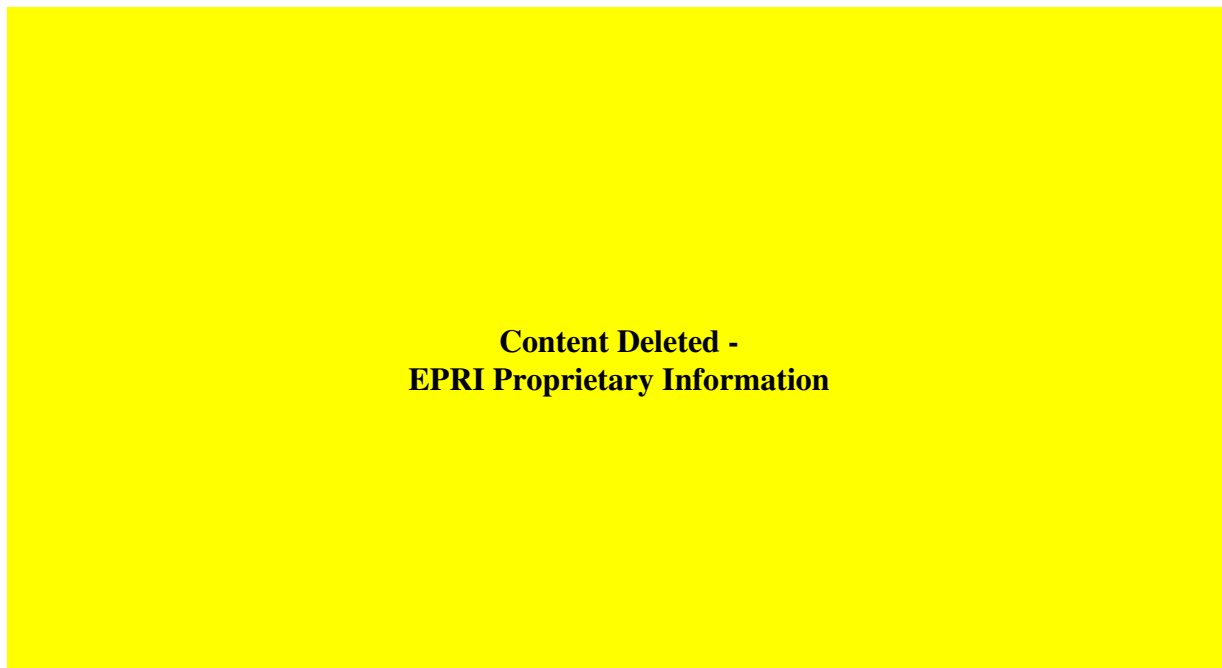


Figure 4.4.65-2. H3 Full-Vee (Red) and High-Angle (Pink) Technique at Forward Scan Line Position



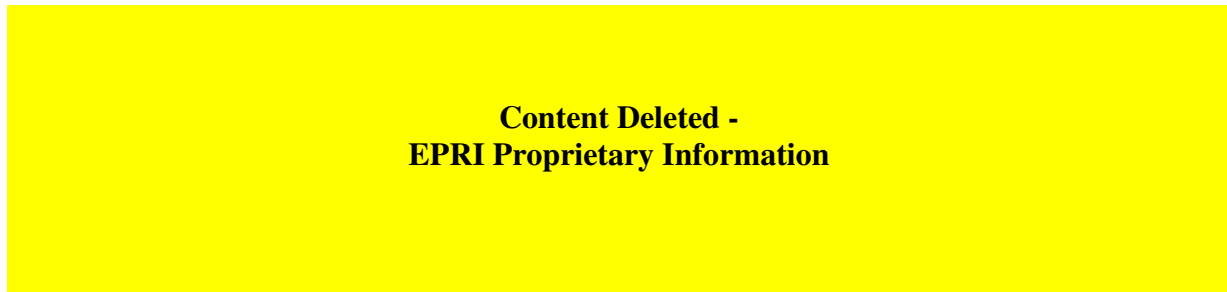
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.66 UT Demonstration 64



Table 4.4.66-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH



Content Deleted - EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

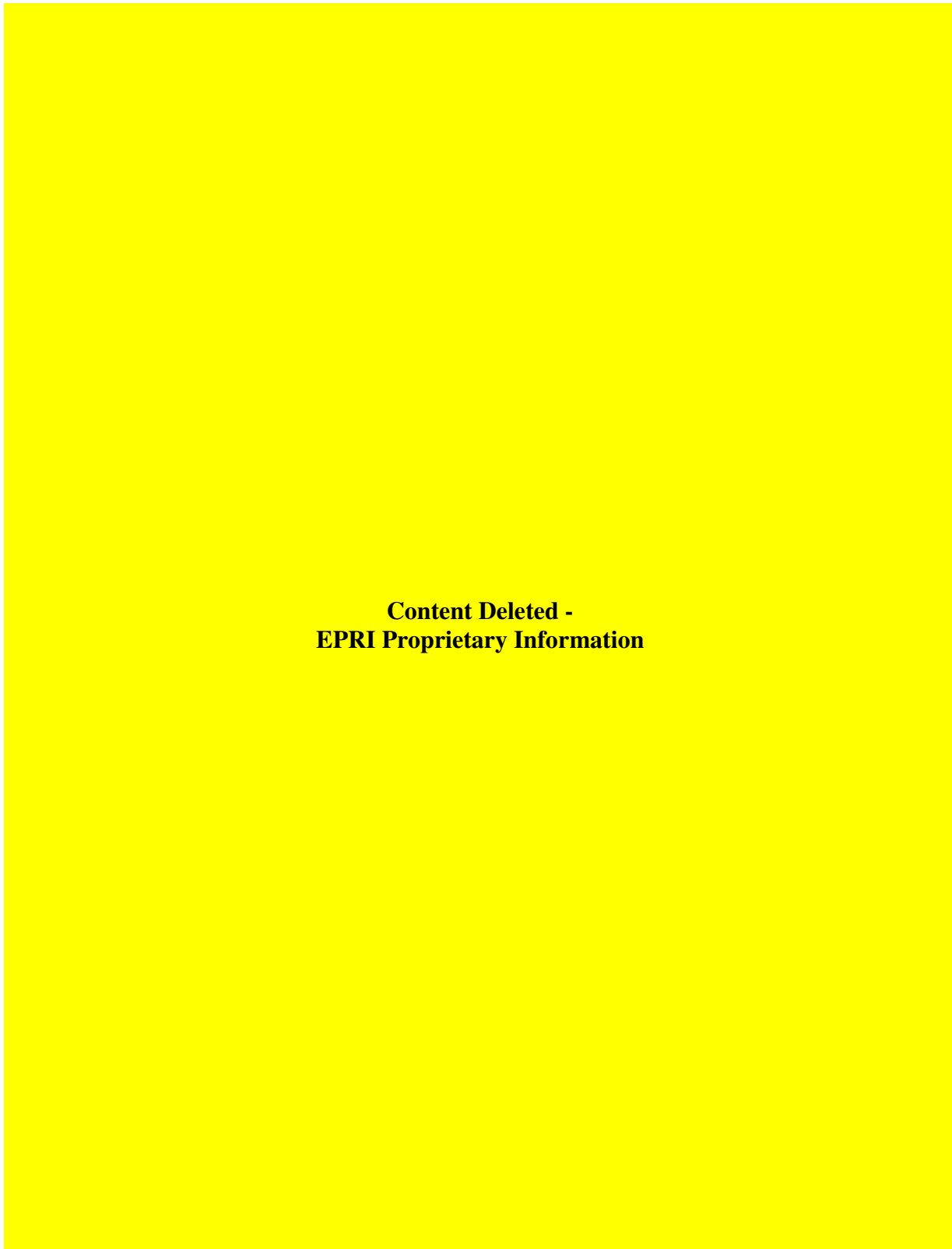
Figure 4.4.66-1. H6OH Examination Technique

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.67 UT Demonstration 65



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

4.4.68 UT Demonstration 66





**Content Deleted -
EPRI Proprietary Information**

Table 4.4.68-4-1. UT System Essential Variables



Figure 4.4.68-1. Top View of Data Collected with the UltraVision 3.2/Dynaray System

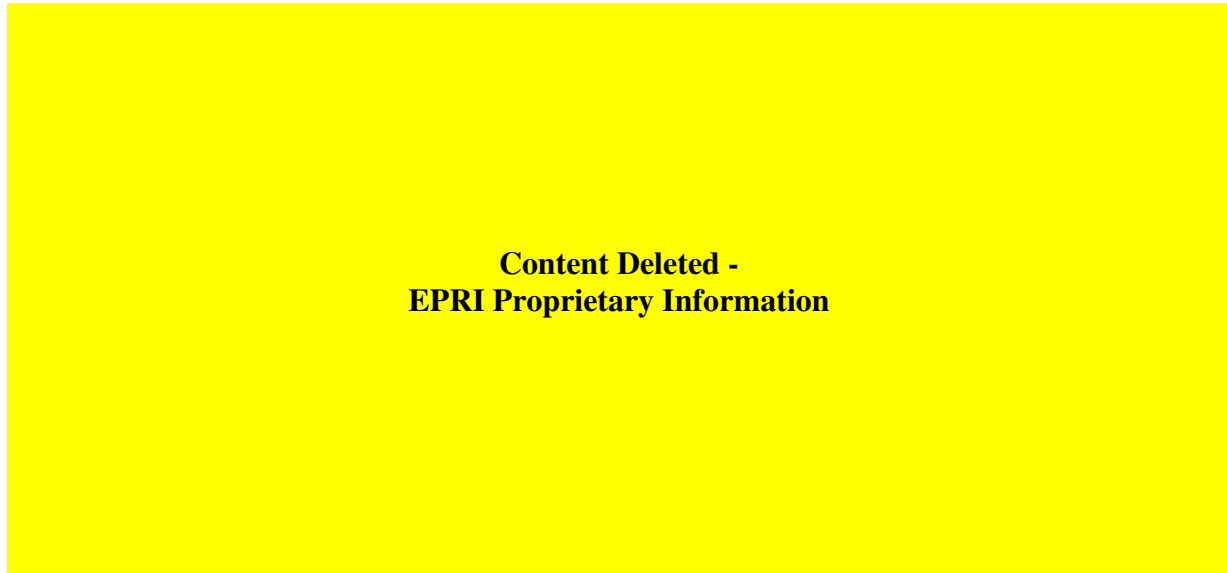
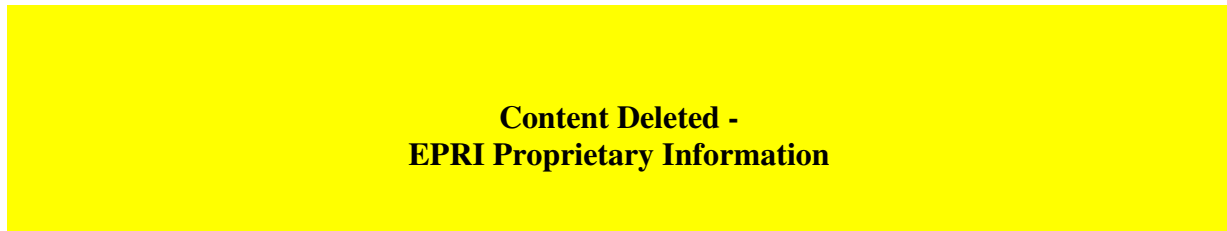


Figure 4.4.68-2. Top View of 2006 Data Collected with the TomoView/TomoScan-III System

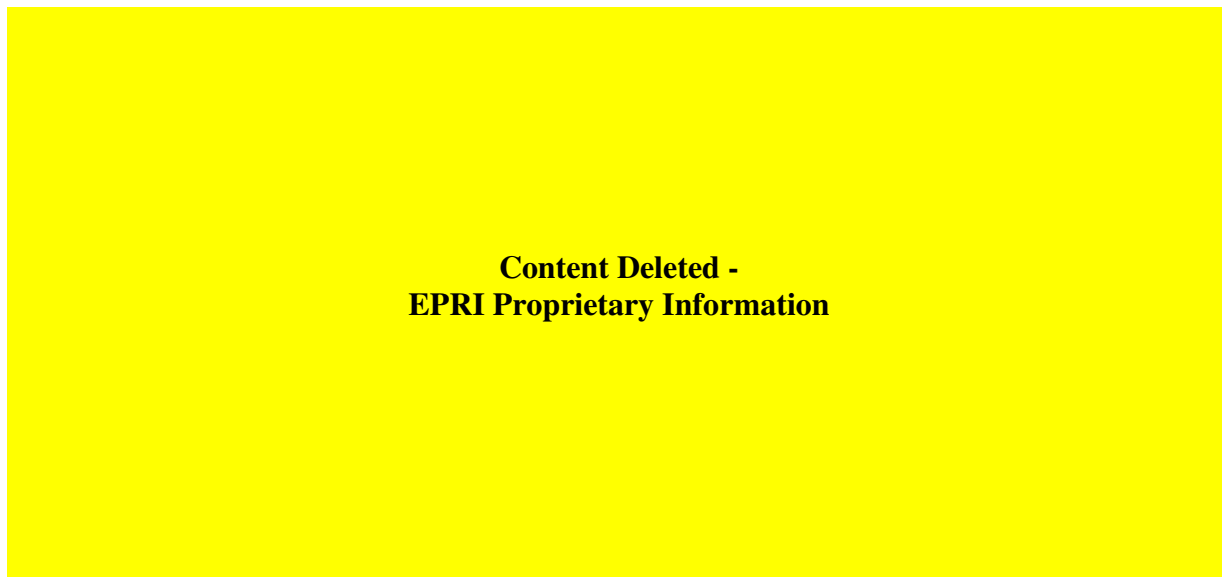


4.4.69 UT Demonstration 67





Figure 4.4.69-1. Probe Position on BWRVIP Mockup





**Content Deleted -
EPRI Proprietary Information**

4.4.70 UT Demonstration 68

**Content Deleted -
EPRI Proprietary Information**

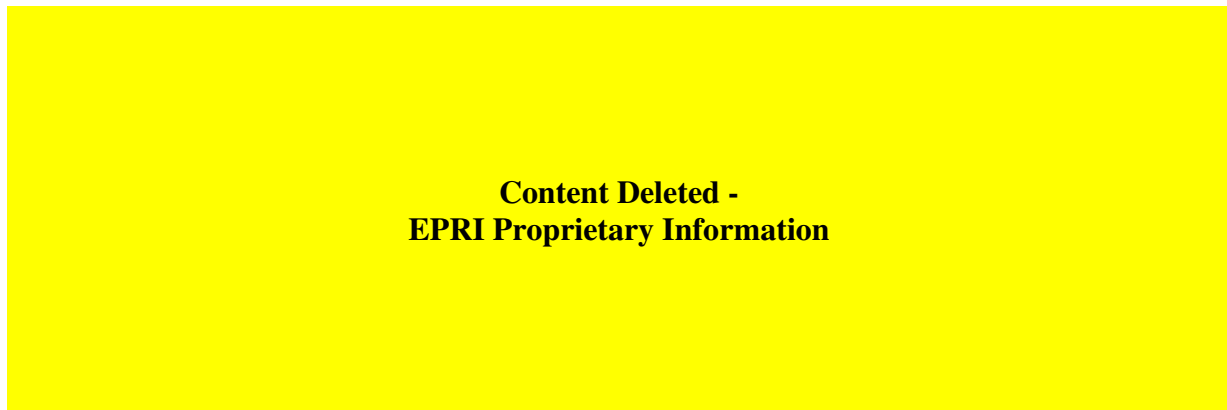
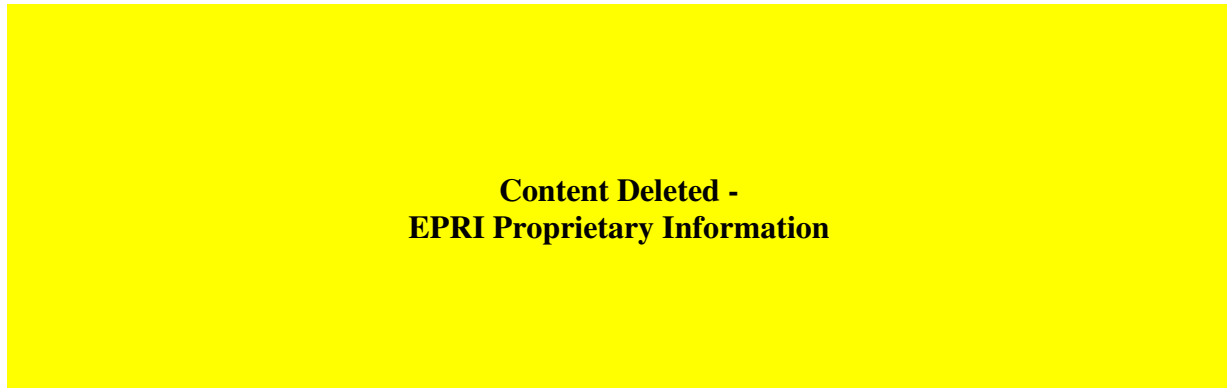


Figure 4.4.70-1. Mockups BWRVIP-A and BWRVIP-B (H1, H2, and H5/H6A Scan Surface)

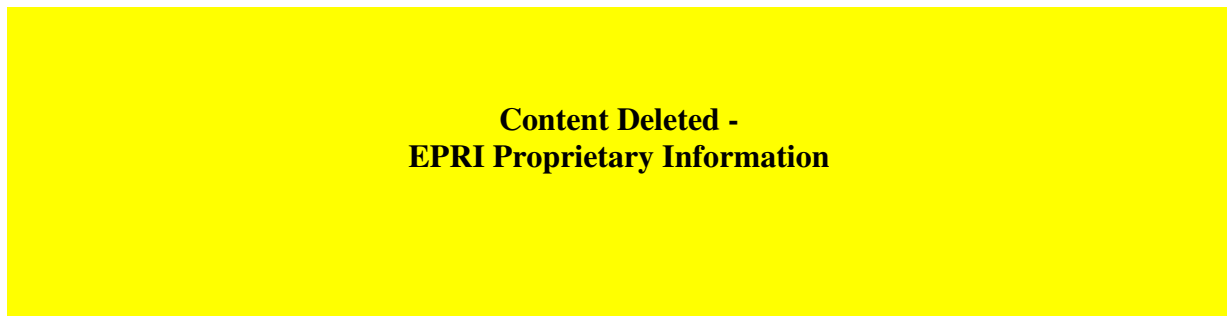


Figure 4.4.70-2. Mockups BWRVIP-A and BWRVIP-B (H3 and H6/H6B Scan Surface)

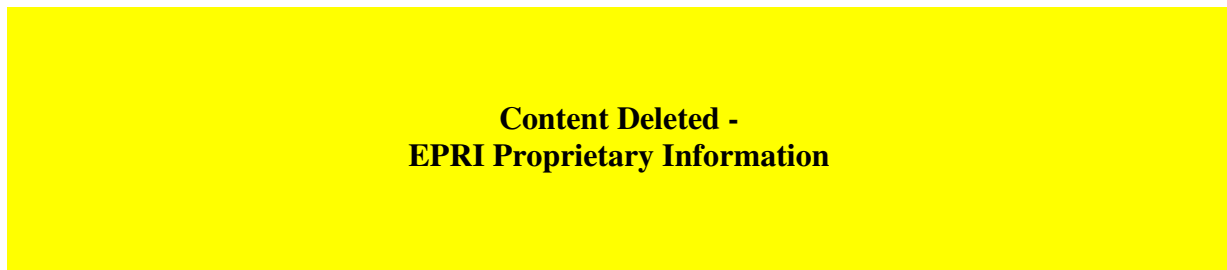


Figure 4.4.70-3. Mockup BWRVIP-C (H4/H5 Flaws Connected to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.70-4. Mockup BWRVIP-C (H4/H5 Flaws Connected Opposite to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.71 UT Demonstration 69

**Content Deleted -
EPRI Proprietary Information**

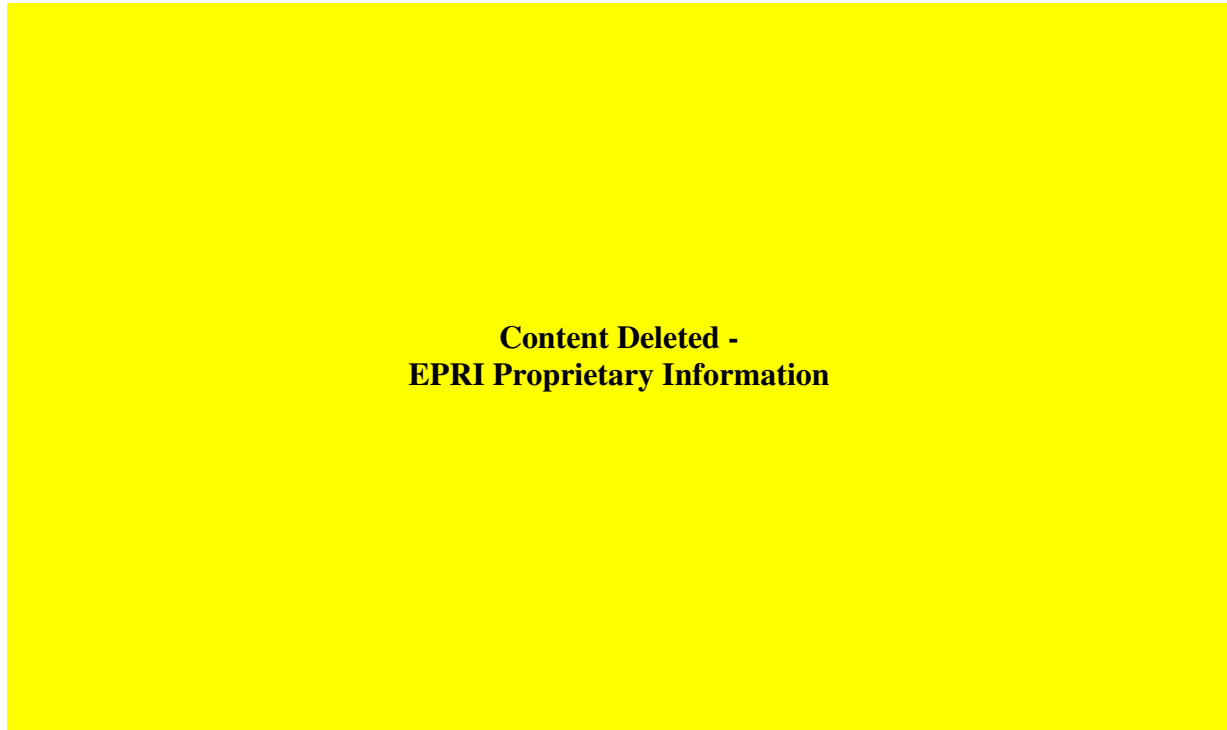
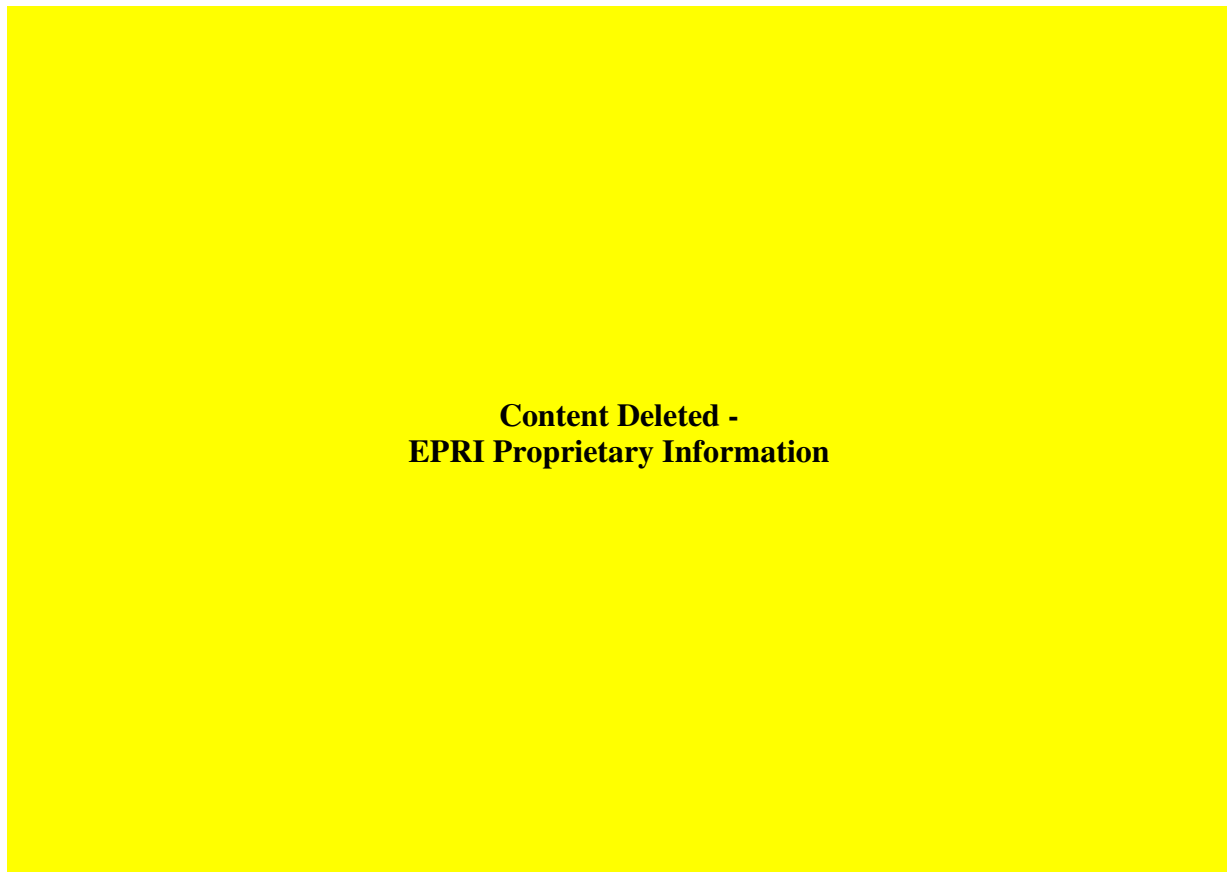
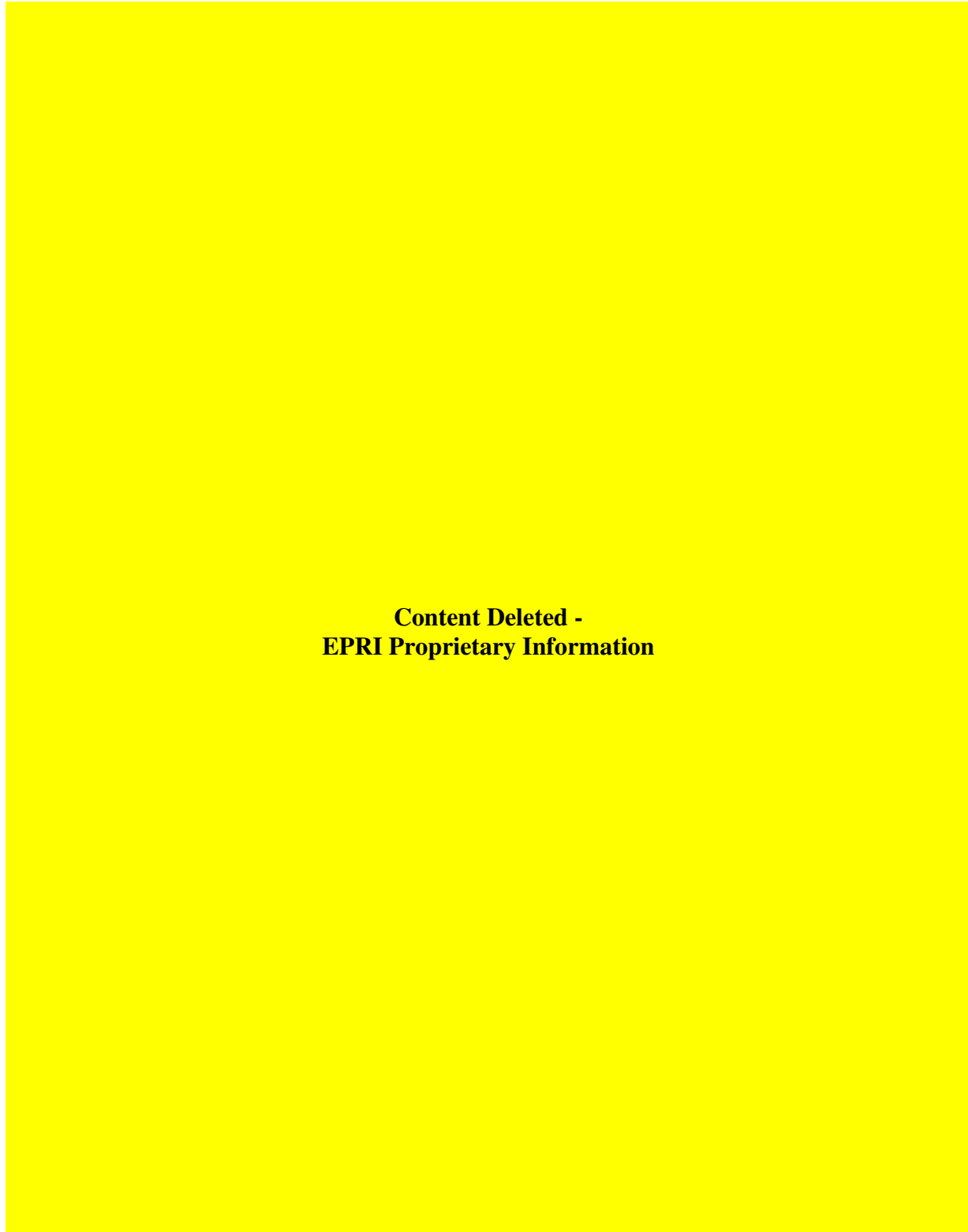


Figure 4.4.71-1. Probe Positions on BWRVIP Mockup



**Content Deleted -
EPRI Proprietary Information**

4.4.72 UT Demonstration 70



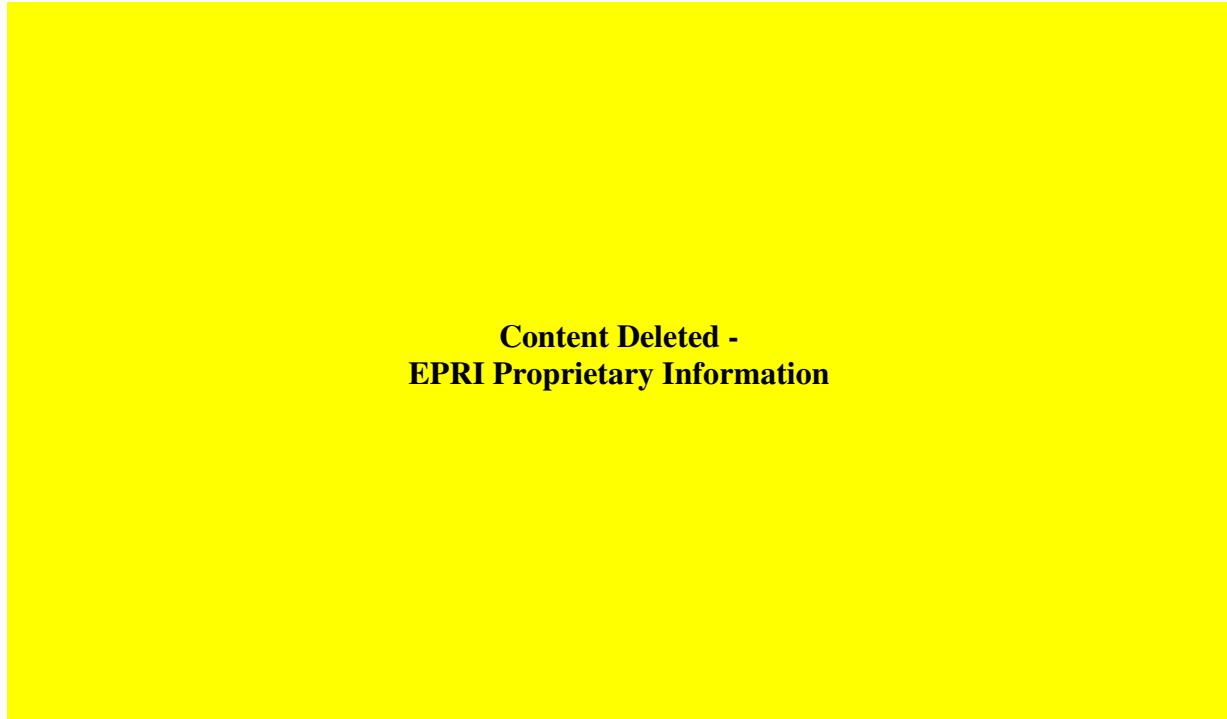


Figure 4.4.72-1. 25° to 55° Sector Scan Technique for H3 Weld Examination

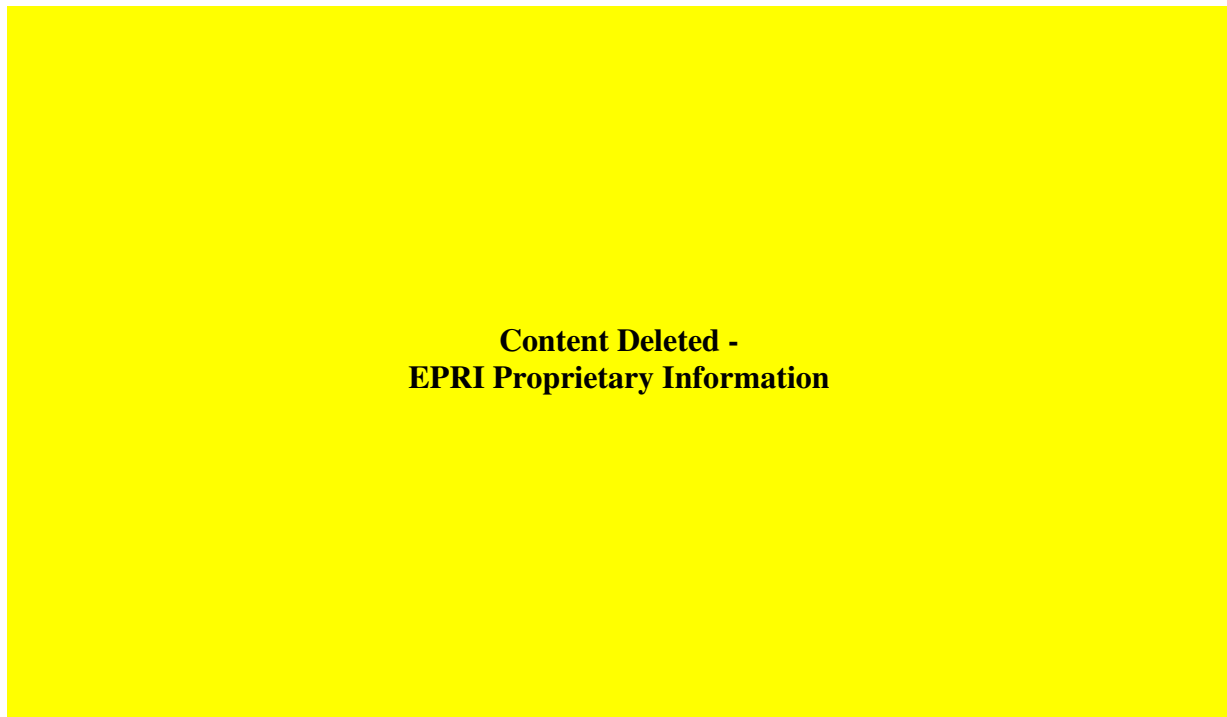


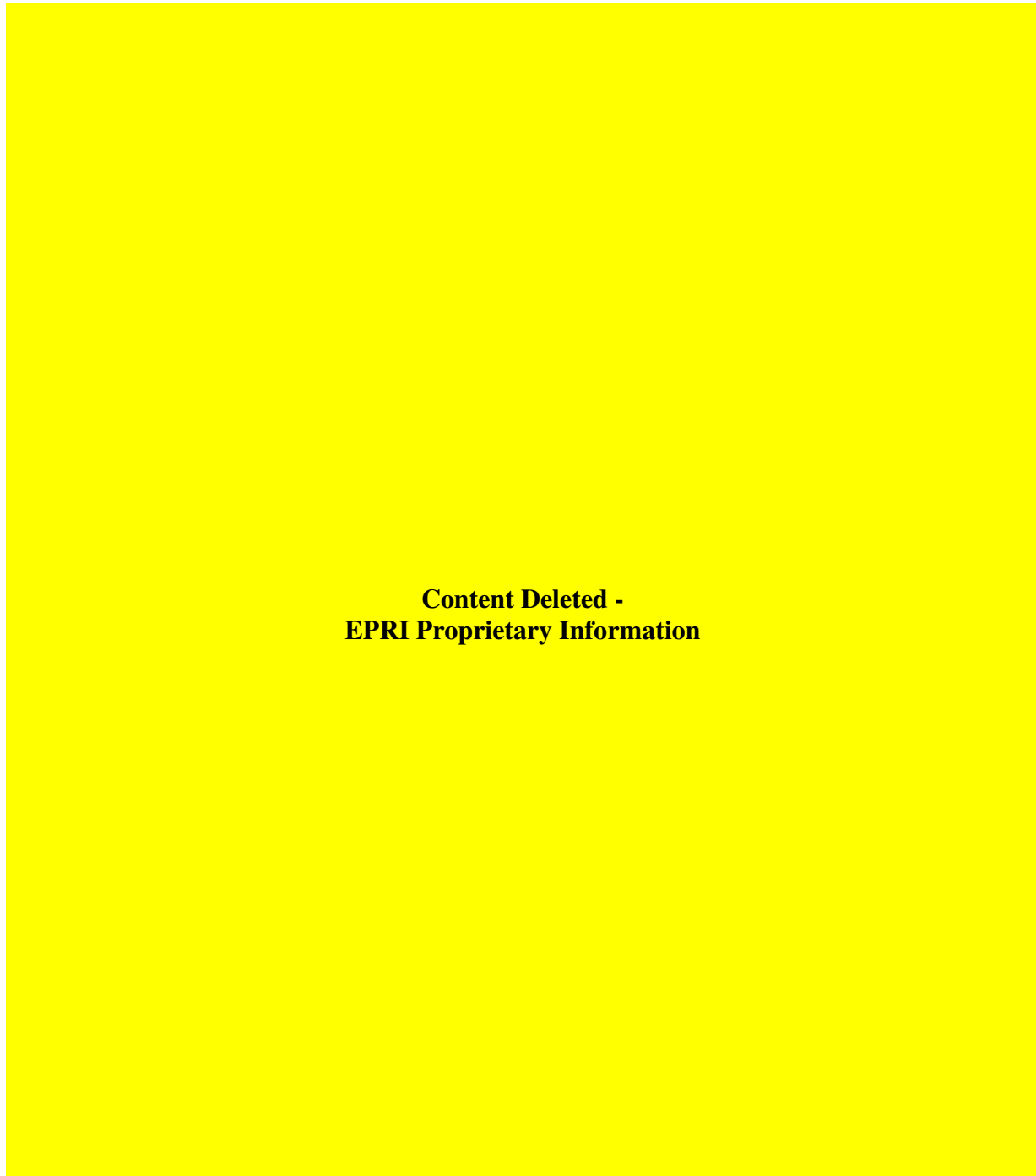
Figure 4.4.72-2. Creeping Wave (ODCR) Technique for H3 Weld Examination



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.73 UT Demonstration 71



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.73-1. Core Plate Support Ring and Top Guide Support Ring Scan Locations

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.74 UT Demonstration 72

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.74-1. Crack Location and Orientation Categories in Mockup BWRVIP-H6OH

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

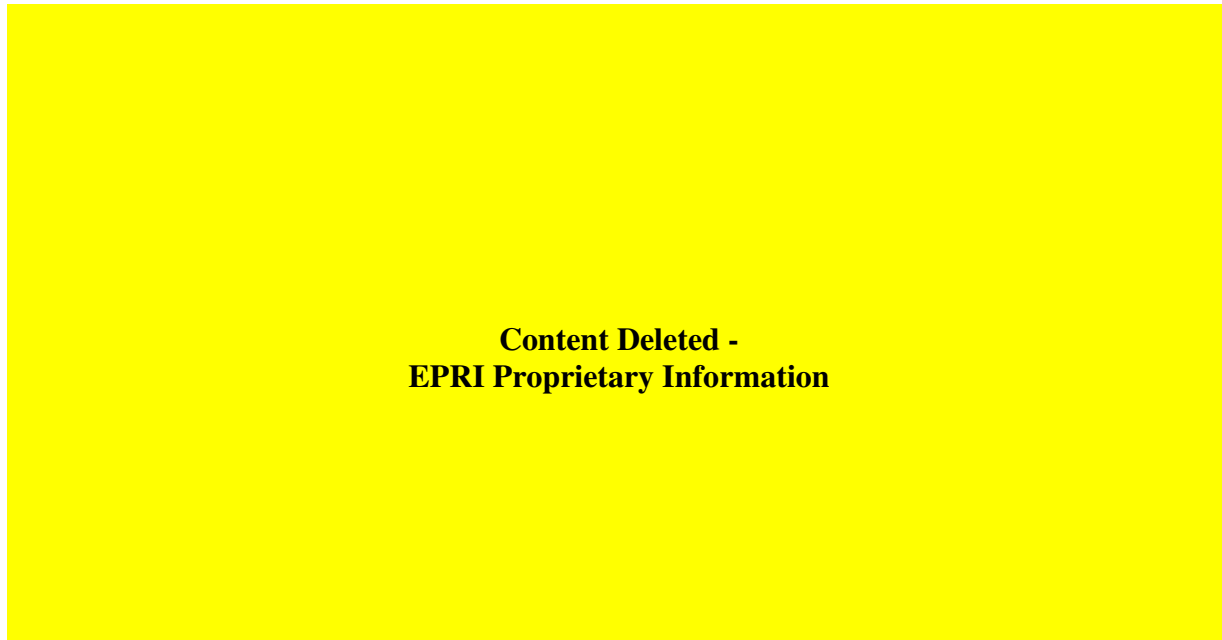
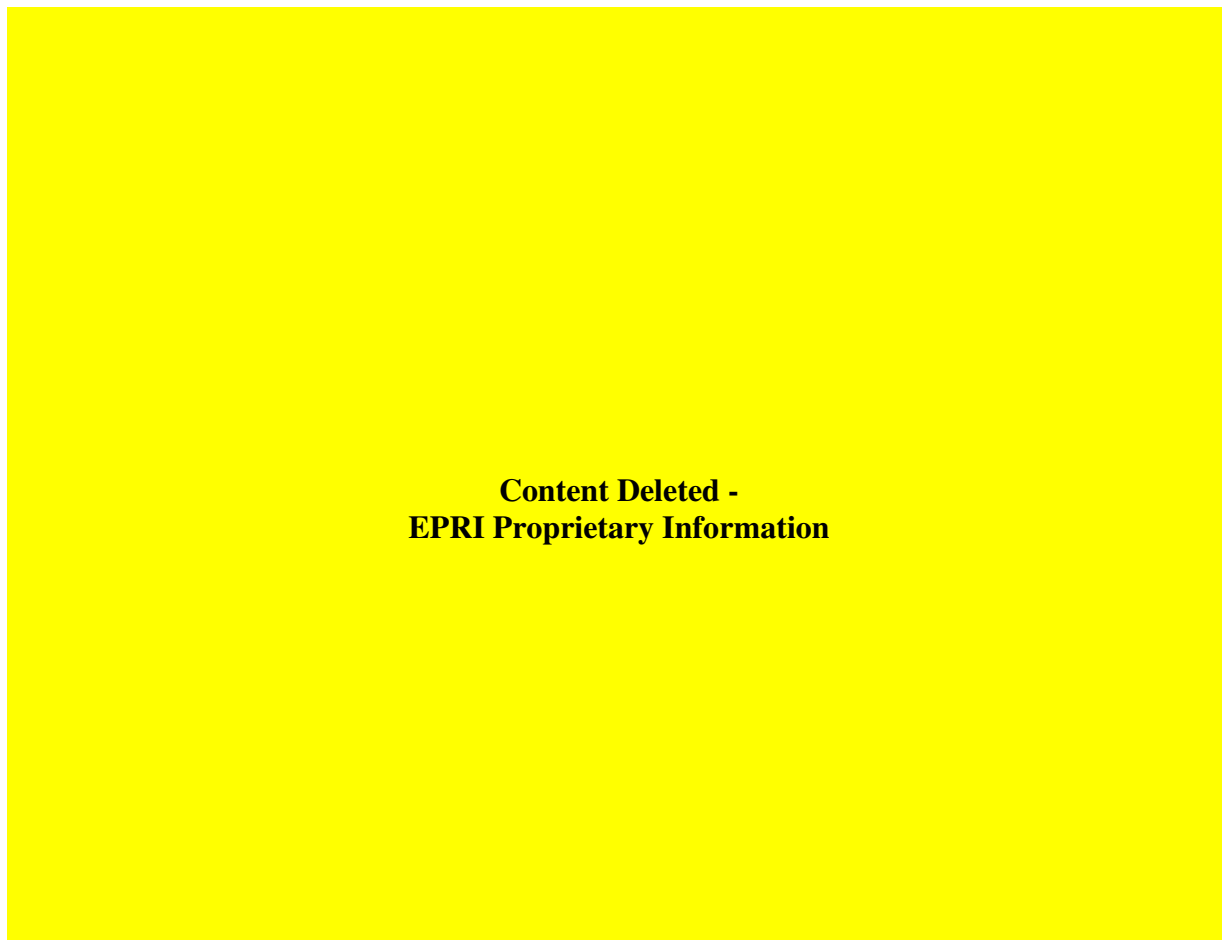


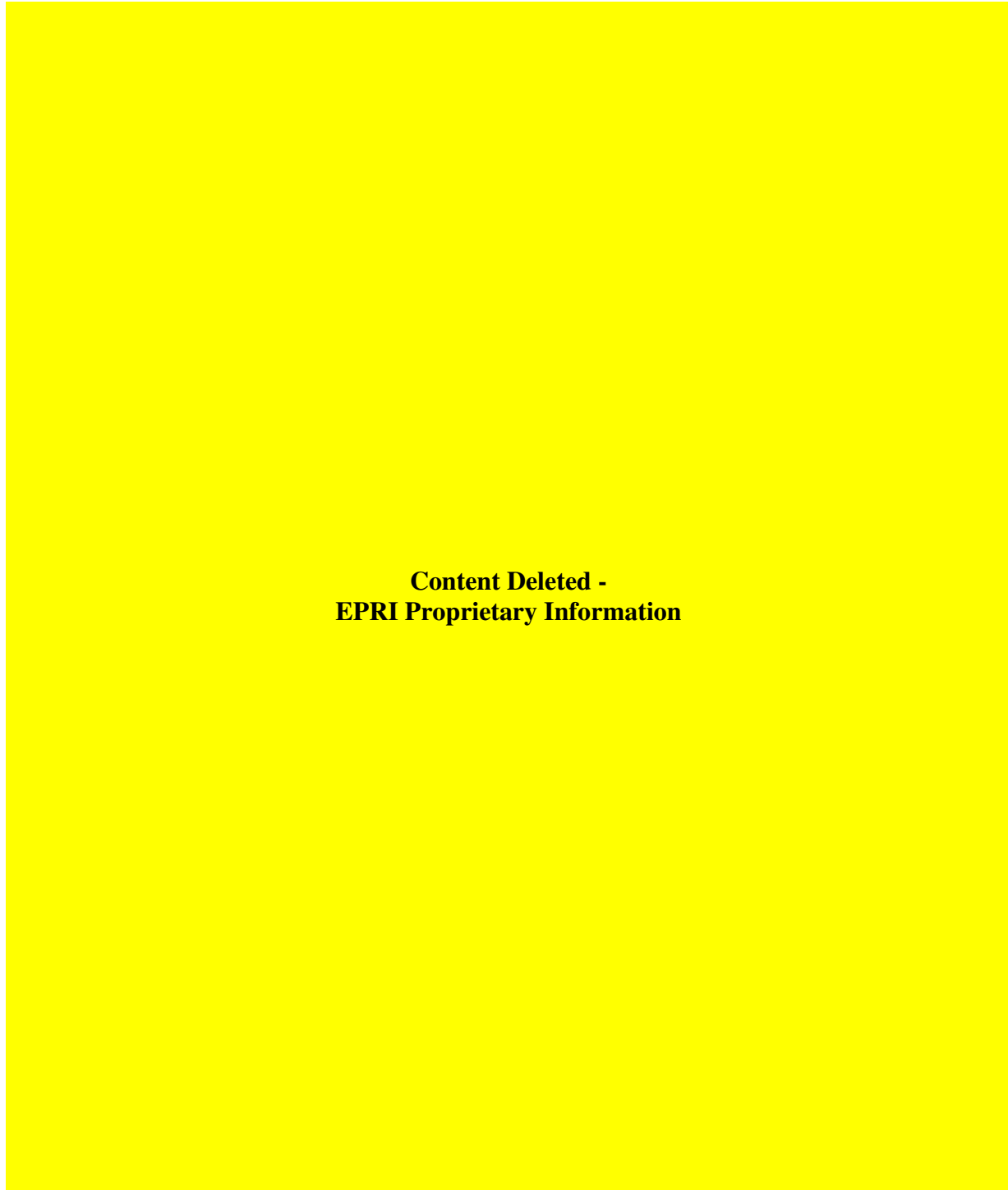
Figure 4.4.74-1. H6OH Line Scan Examination Technique



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.75 UT Demonstration 73



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.75-1. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.75-2. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected Opposite to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.75-1. Focal Laws for Line Scan Technique

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.75-2. Focal Laws for Raster Scan Technique

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.76 UT Demonstration 74



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.76-1. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**

Figure 4.4.76-2. Mockup BWRVIP-C (H4/H5 and Vertical Welds; Flaws Connected Opposite to the Scan Surface)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.76-1. Focal Laws for Line Scan Technique

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.4.76-2. Focal Laws for Raster Scan Technique

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.4.77 UT Demonstration 75

**Content Deleted -
EPRI Proprietary Information**

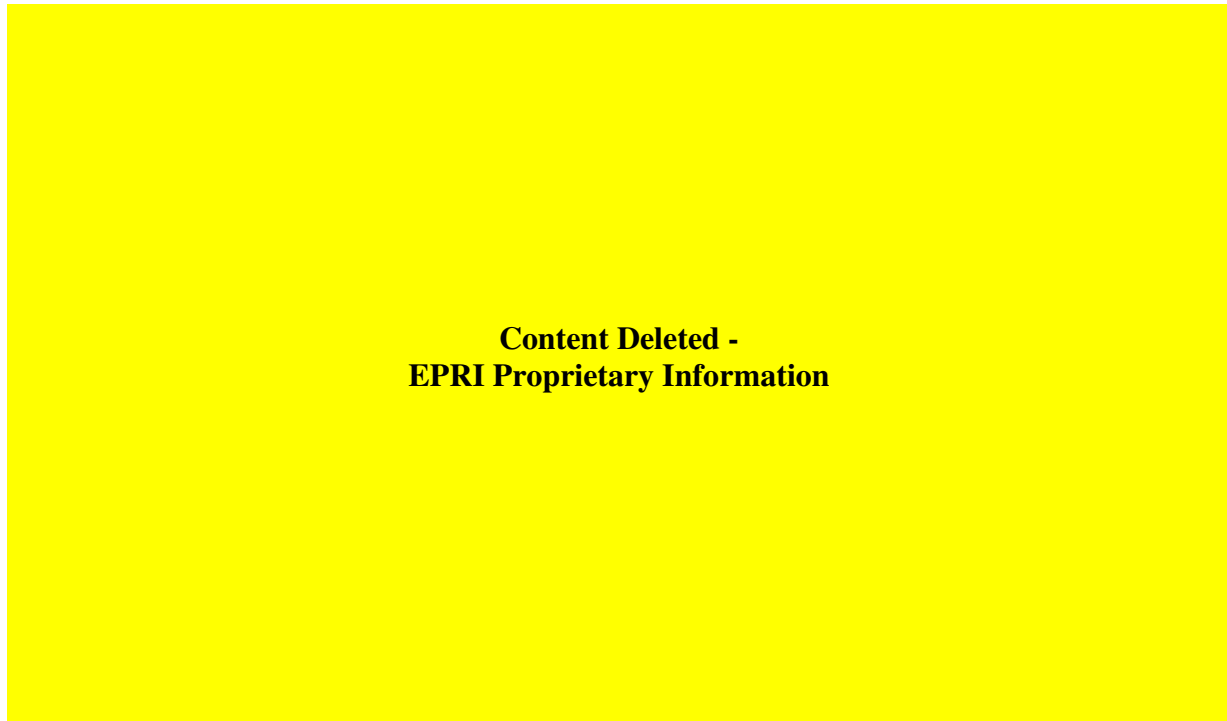
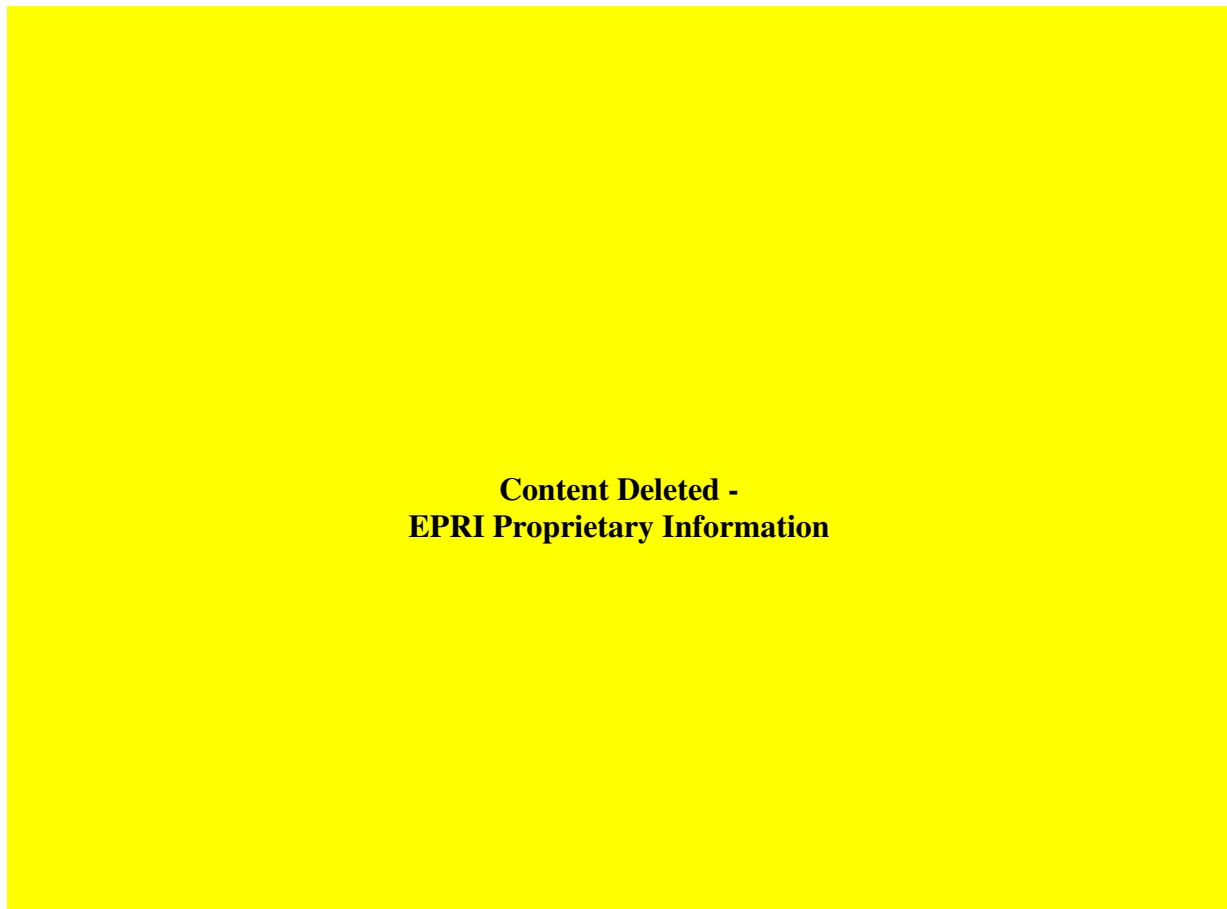


Figure 4.4.77-1. BWR/6 H3 Configuration Without Flange Extension Above the H3 Weld



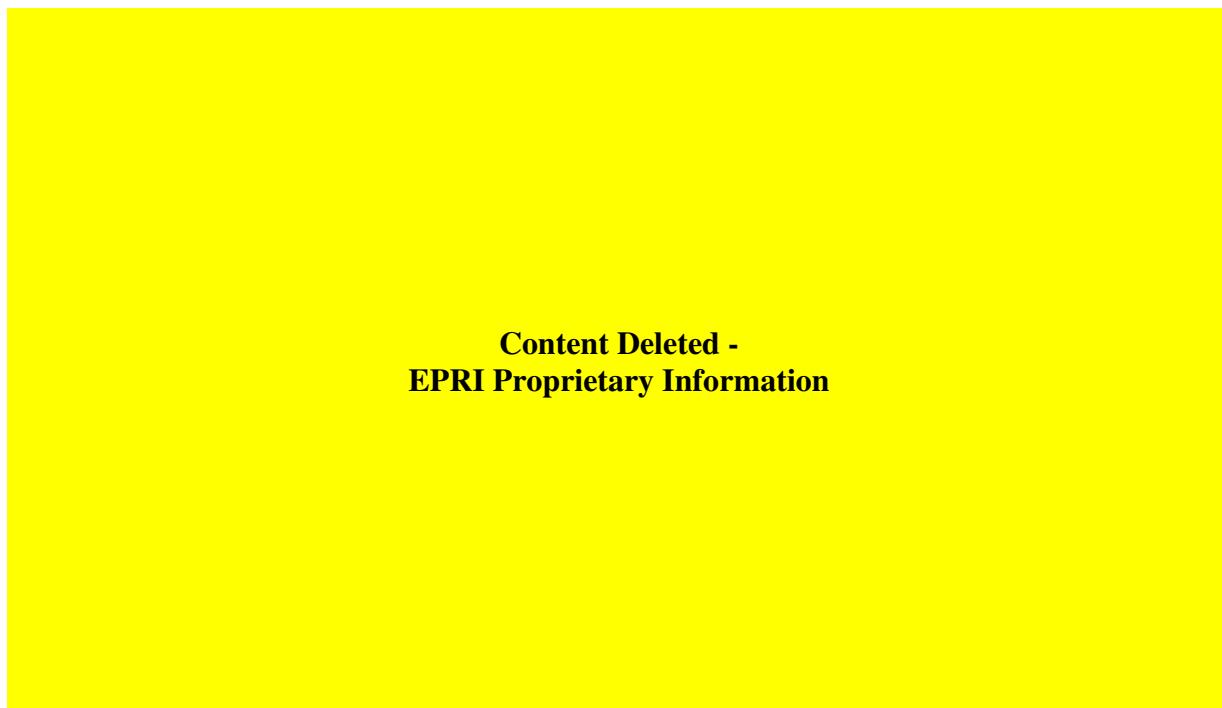
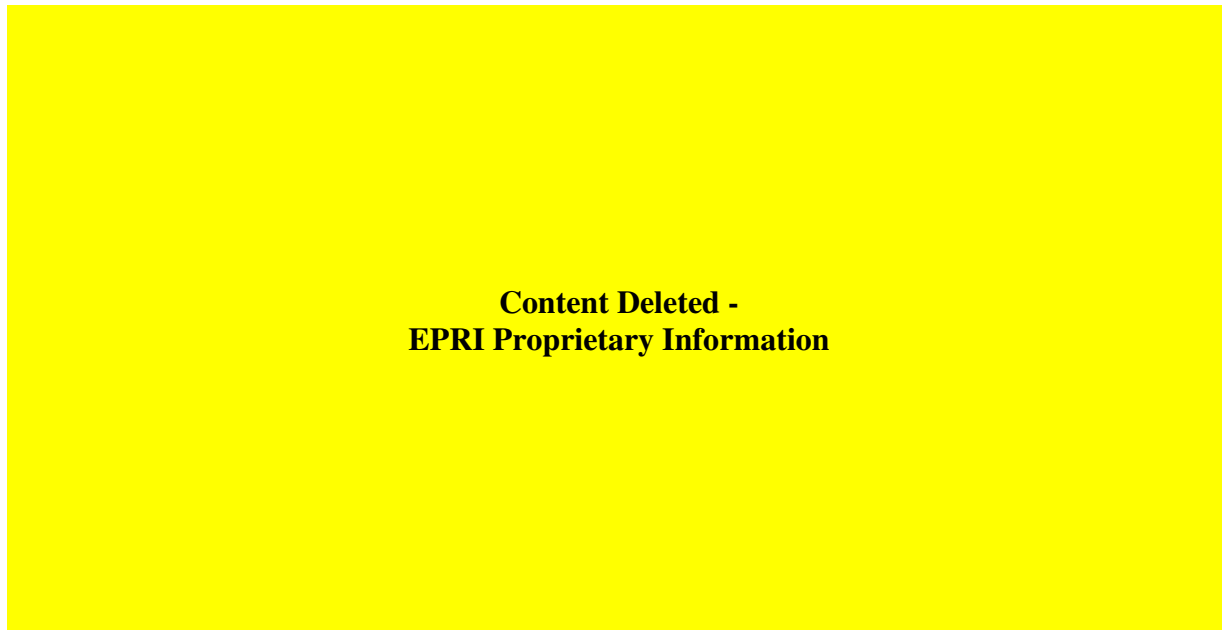
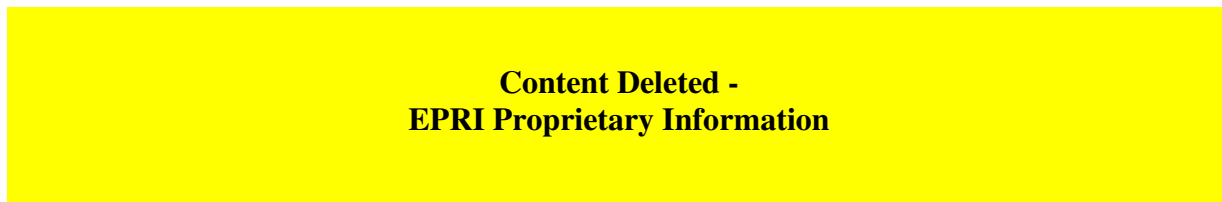


Figure 4.4.77-2. Demonstrated Scan Line Positions





**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

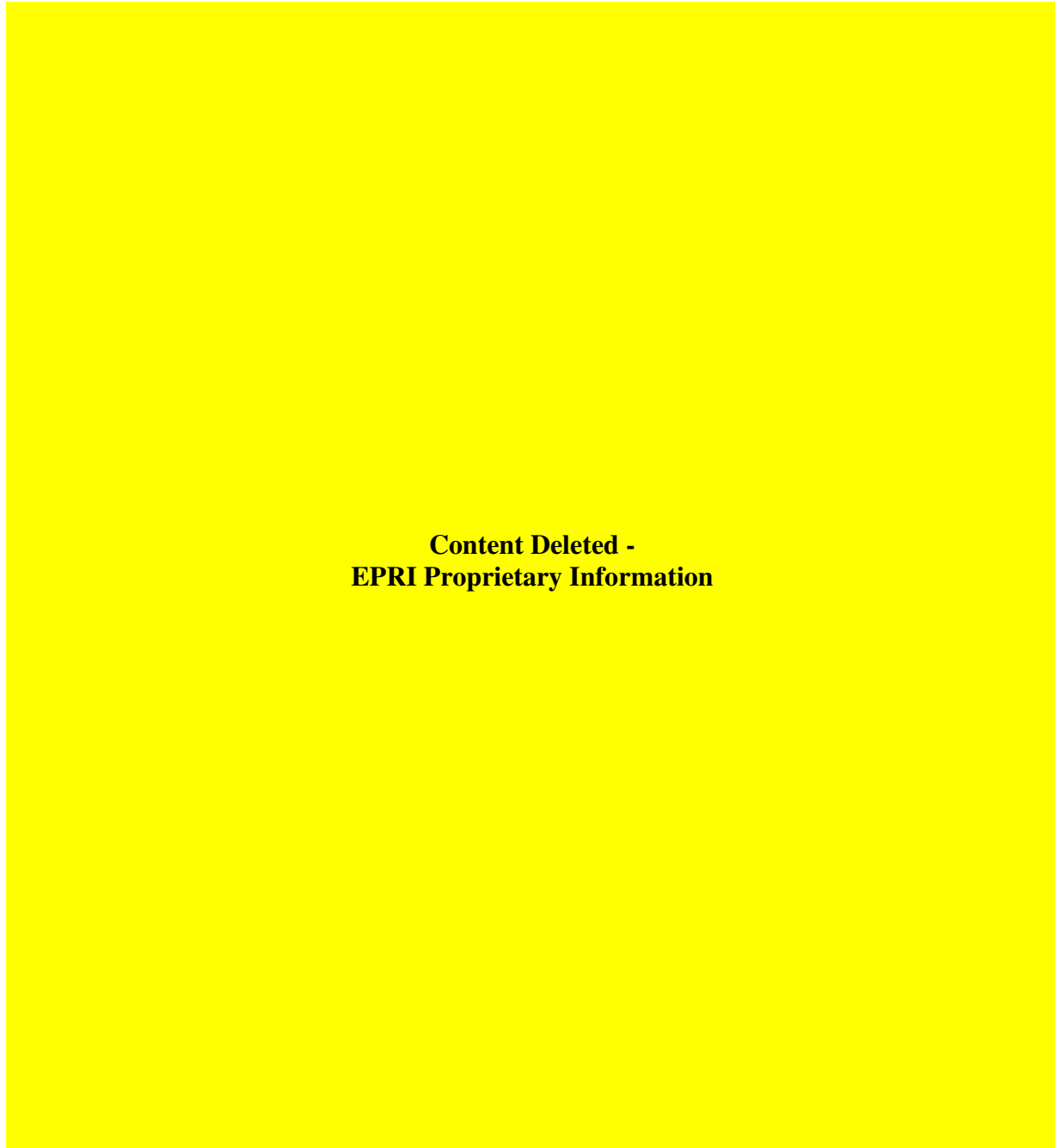


Figure 4.4.77-3. OD Looking Down D-Scan Images Showing Unflawed Region (Left) and Outside Surface Flaw A8 (Right)

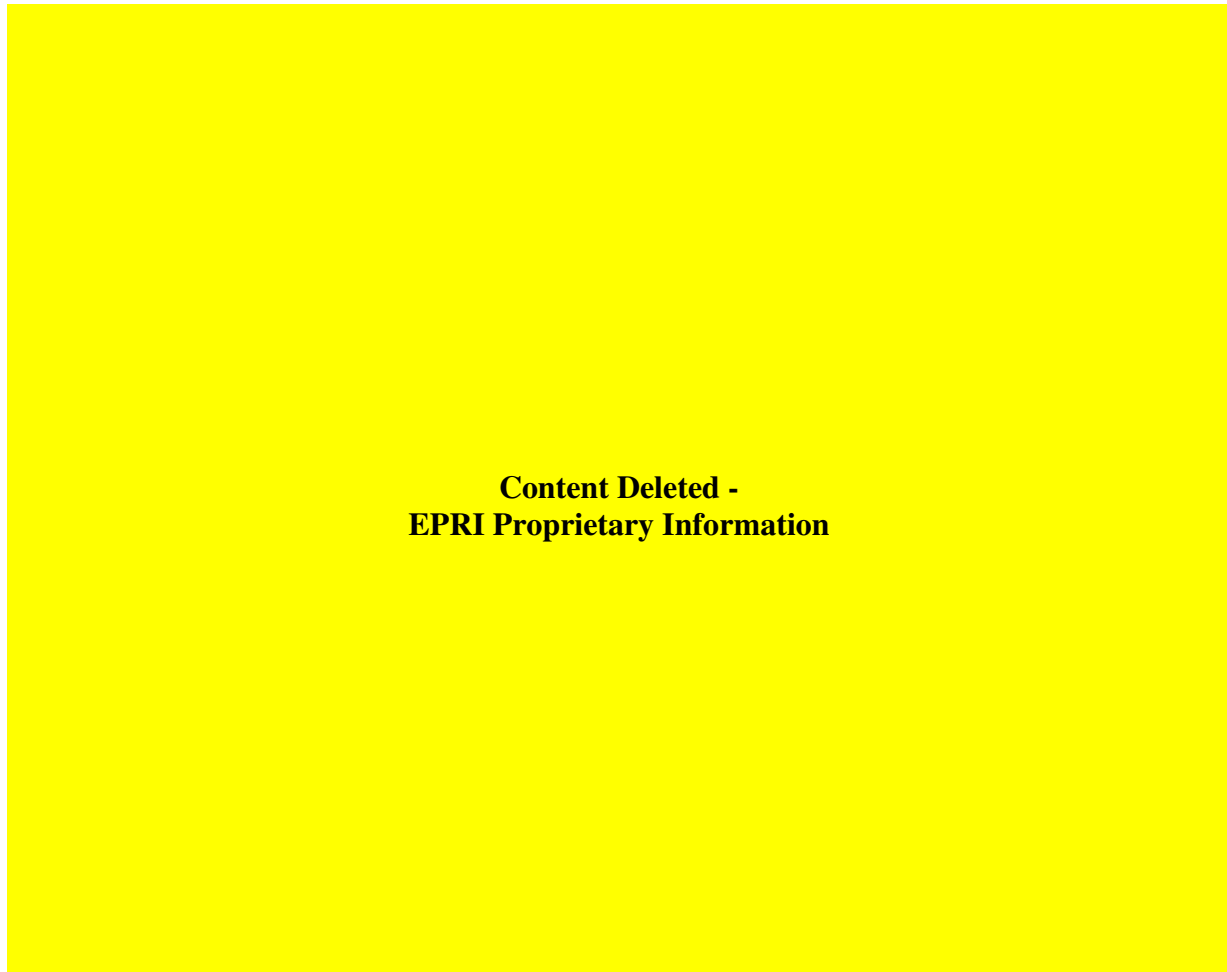


Figure 4.4.77-4. OD Looking Down D-Scan Images Showing Unflawed Region (Left) and Inside Surface Flaw A6 (Right)

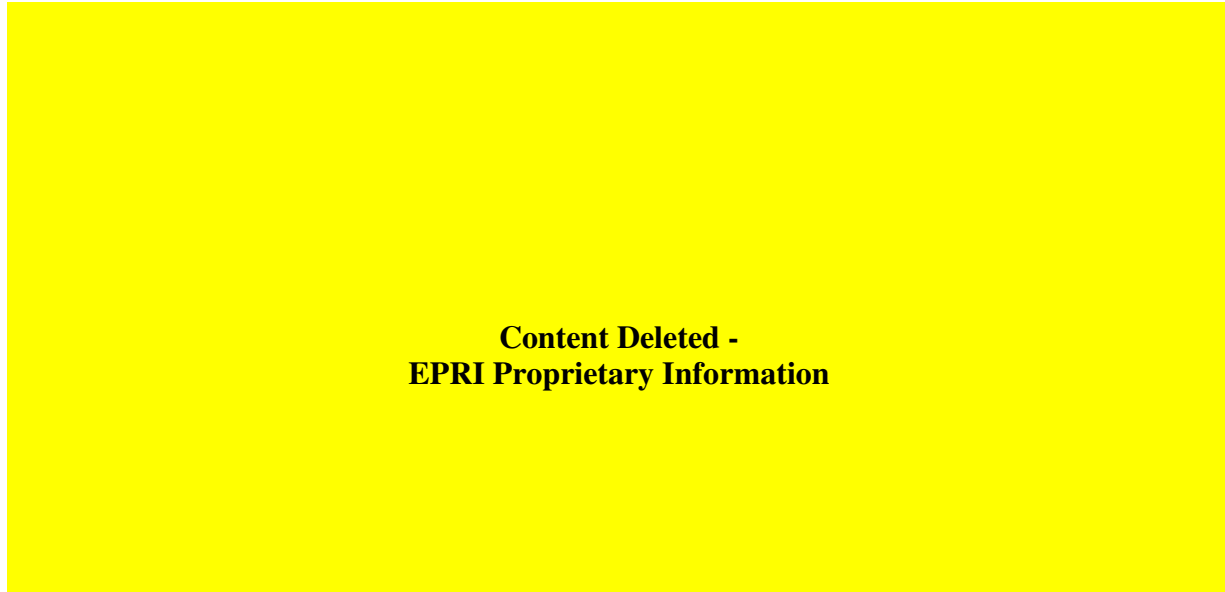


Figure 4.4.77-5. OD Looking Down B- and C-Scan Images Showing Shadowing of Geometric Response (Top) and Low-Amplitude Flaw Responses (Bottom)

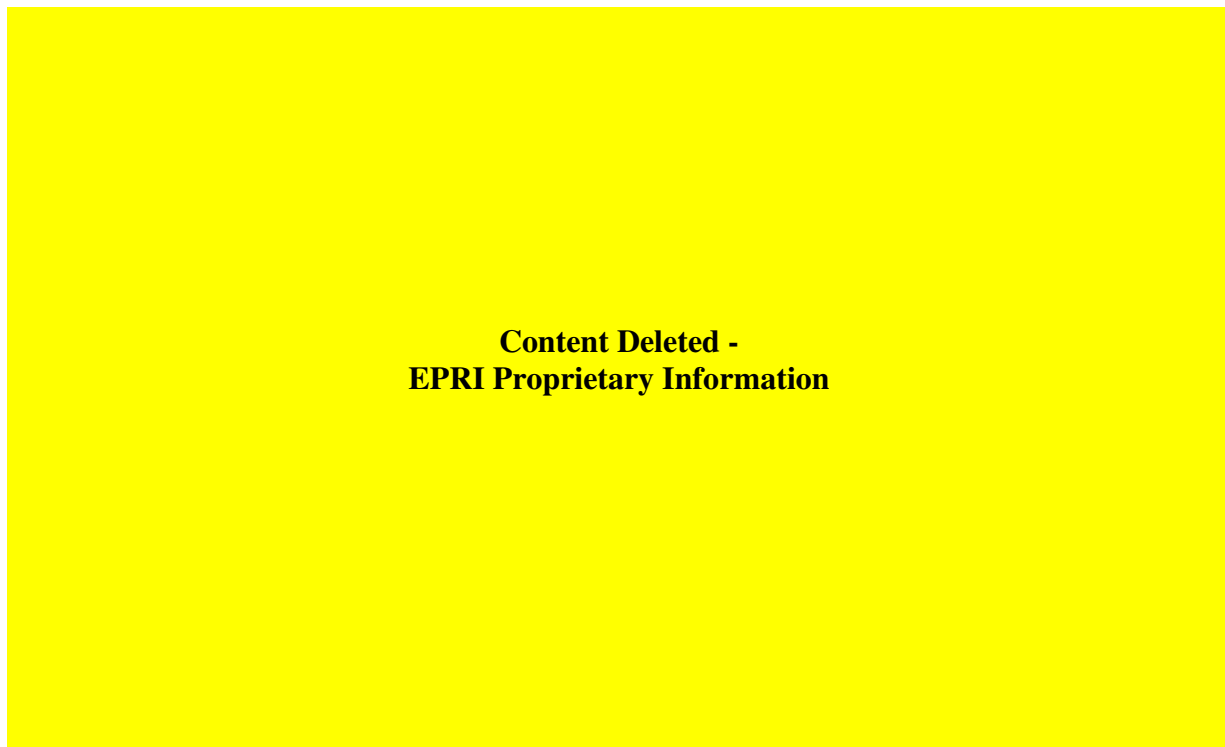


Figure 4.4.77-6. ID Looking Down B- and Sector-Scan Images Showing Shadowing of Geometric Response (Left) and A14 Flaw Response (Right)

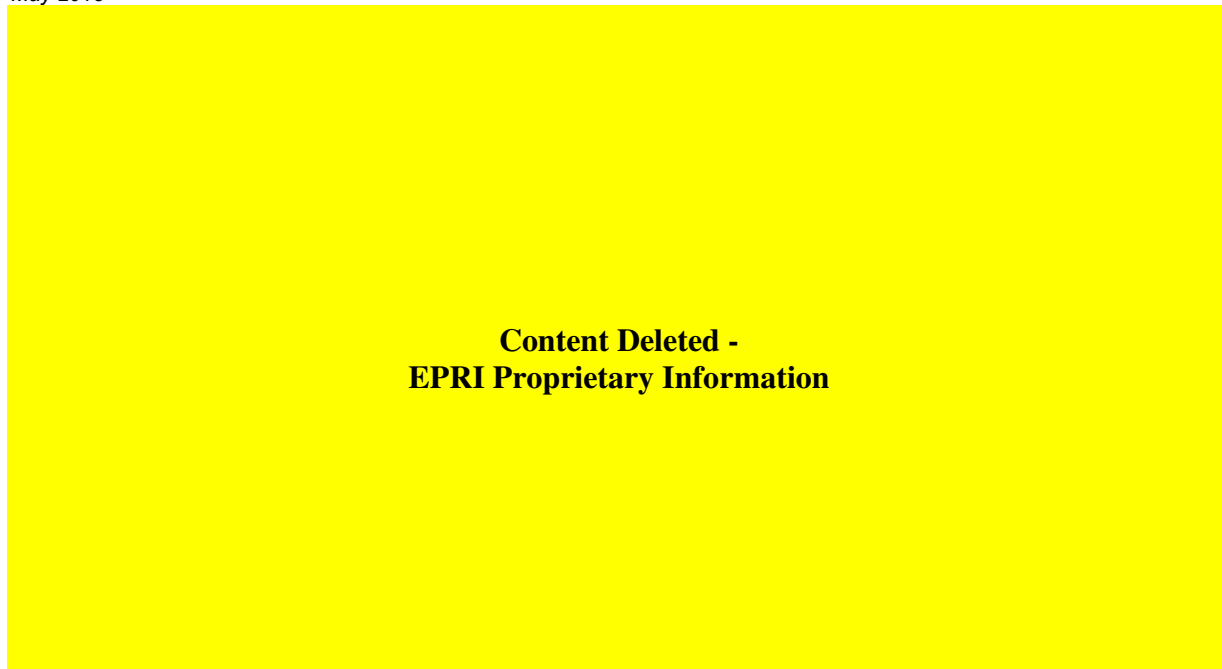
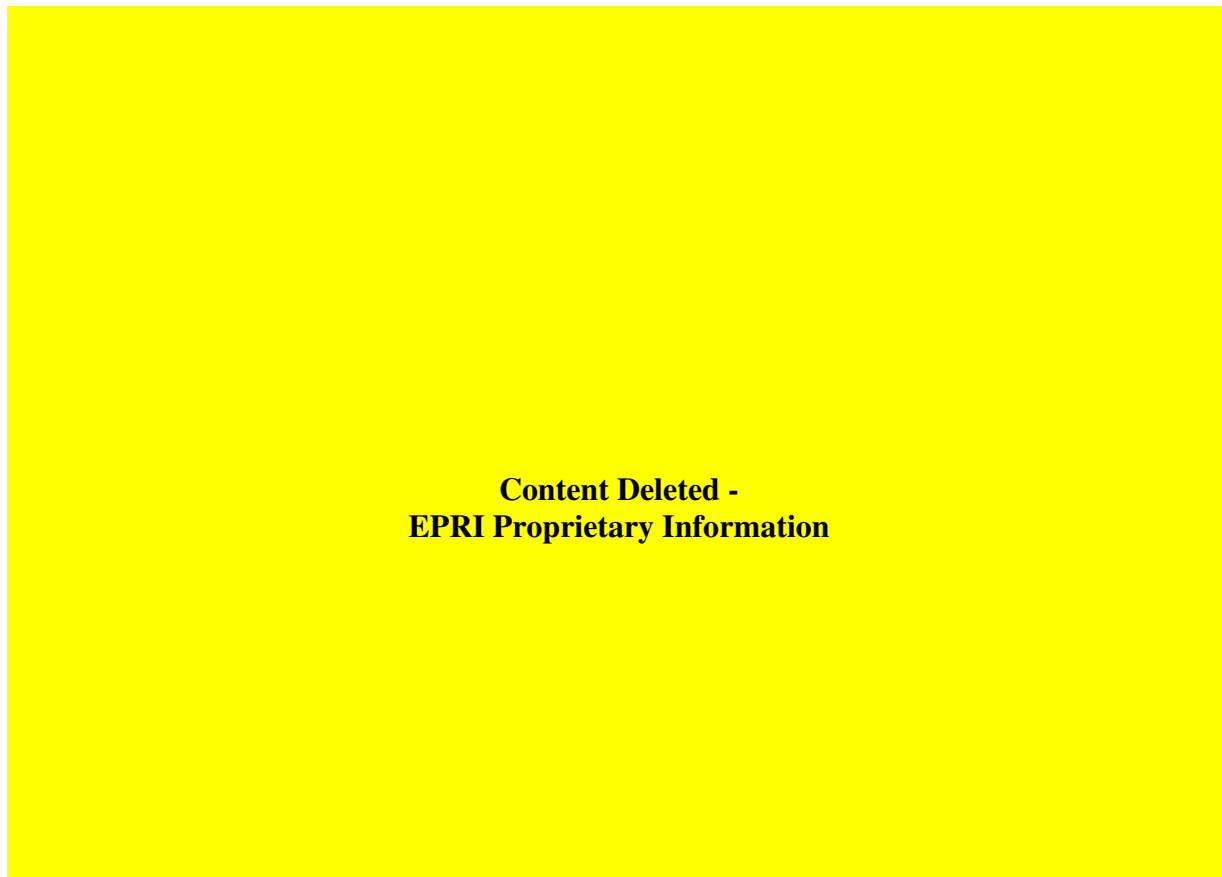


Figure 4.4.77-7. ID Looking Down Examination Data Showing Near-Side and Far-Side OD Flaw Responses



**Content Deleted -
EPRI Proprietary Information**

4.4.78 UT Demonstration 76



**Content Deleted -
EPRI Proprietary Information**

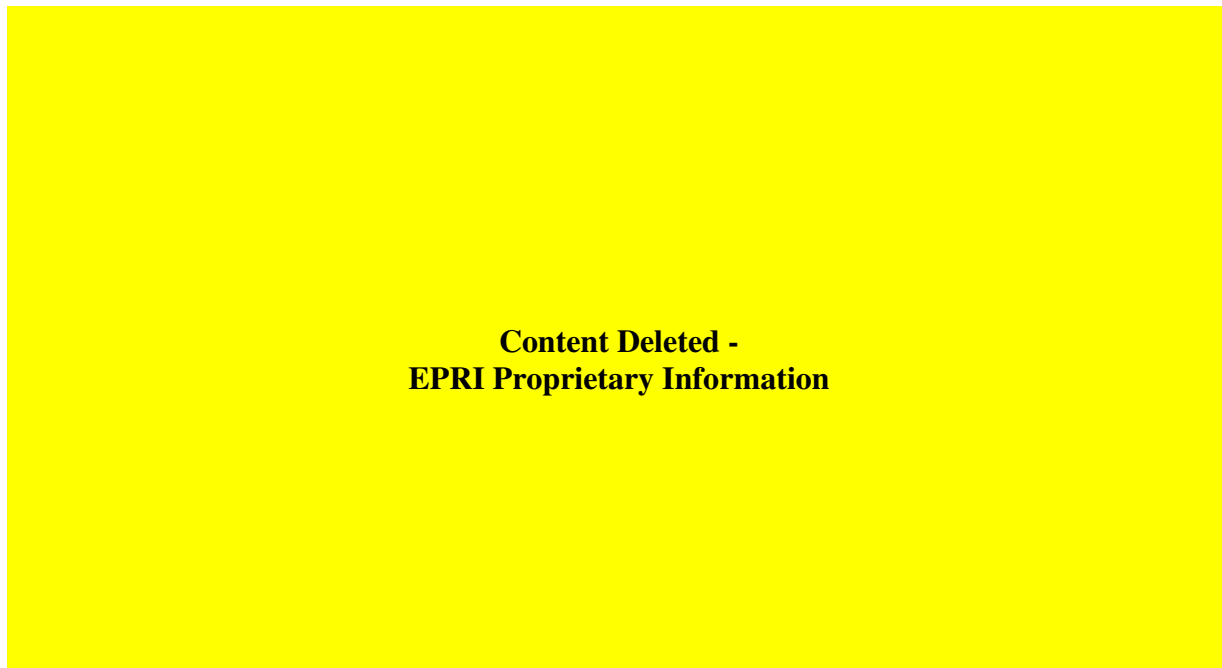


Figure 4.4.78-1. BWR/6 H3 Configuration with Flange Extension Above the H3 Weld



**Content Deleted -
EPRI Proprietary Information**

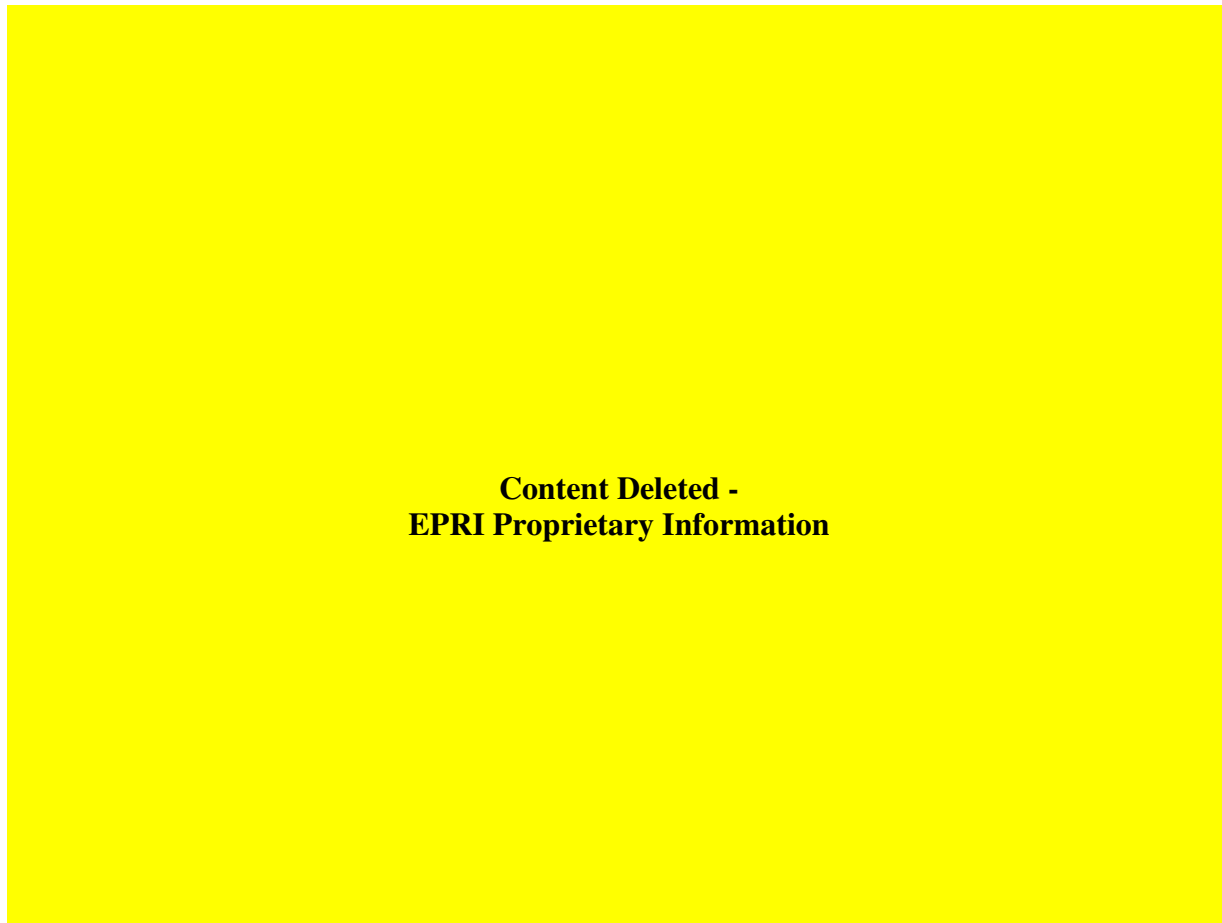
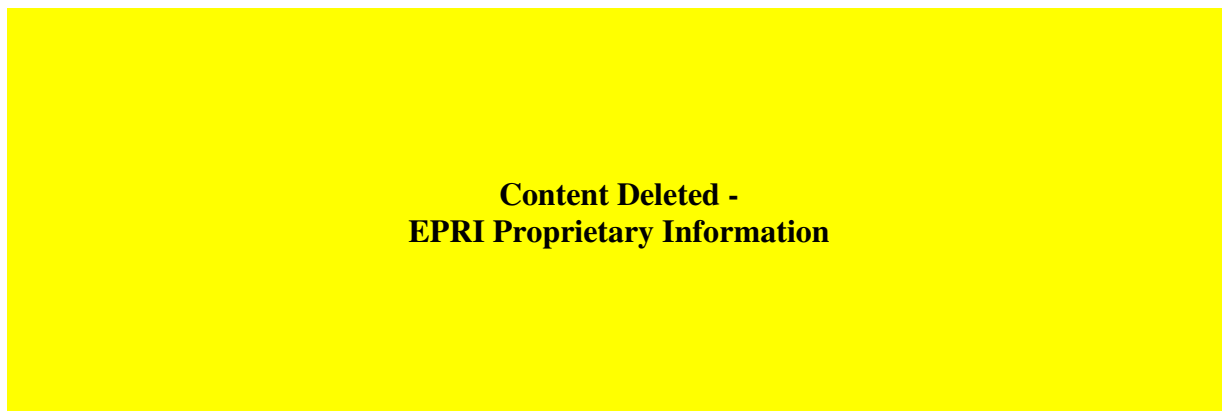


Figure 4.4.78-2. Inside Surface (Left) and Outside Surface (Right) Scan Line Positions



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

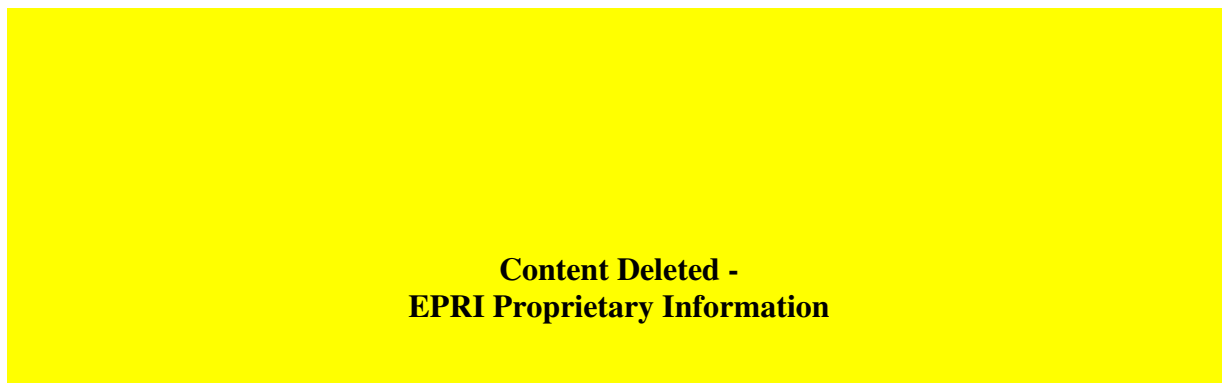
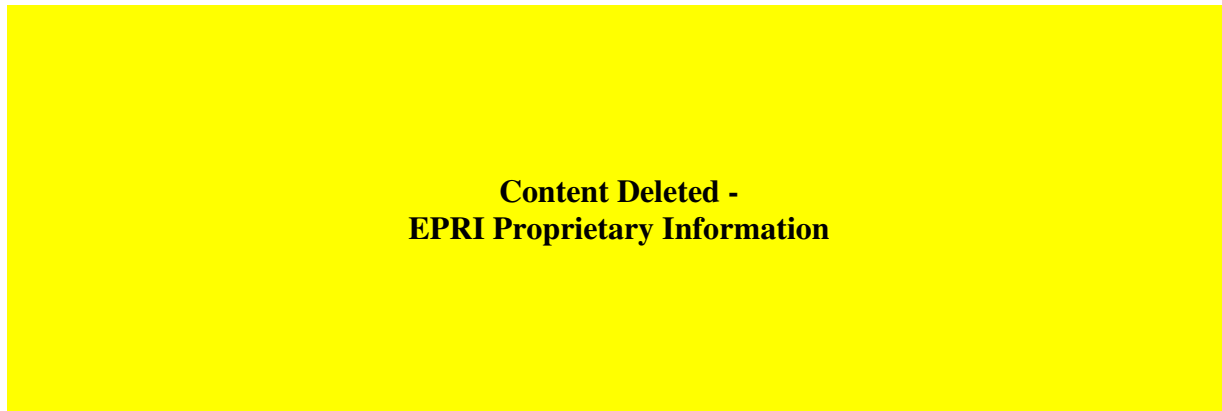


Figure 4.4.78-3. Looking Down Ultrasonic Data Display from Unflawed Region of BWRVIP-B Mockup (Probe Located on Outside Surface)

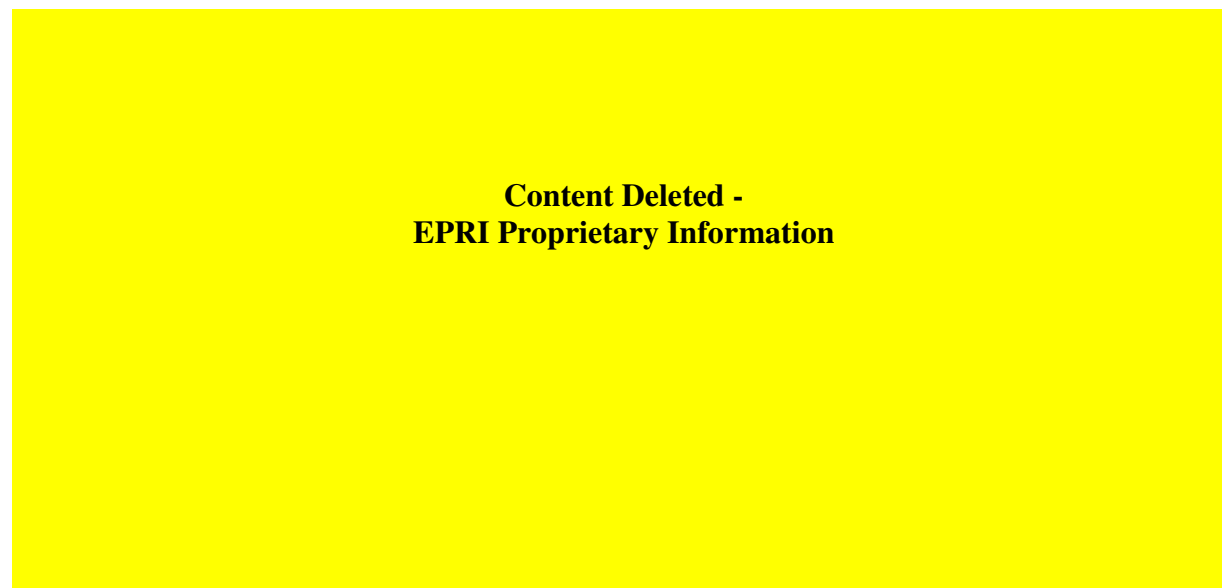


Figure 4.4.78-4. Looking Down Ultrasonic Data Display from Flaw B7 in Mockup BWRVIP-B (Probe Located on Outside Surface)

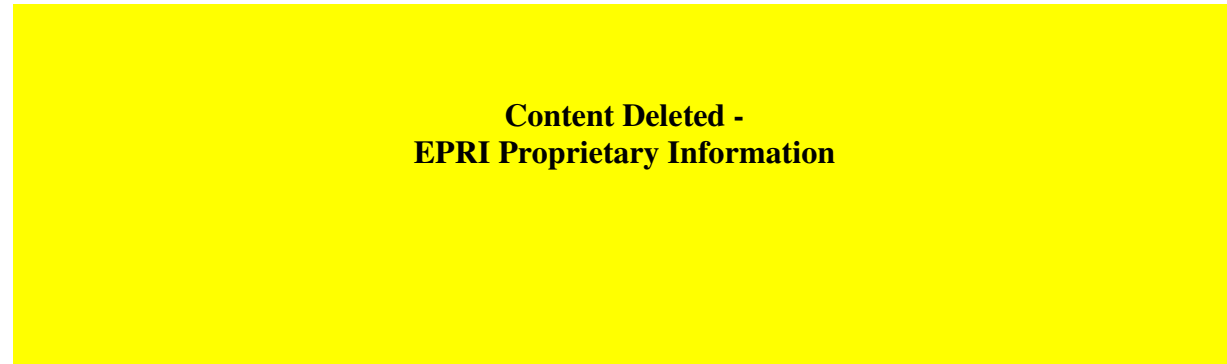
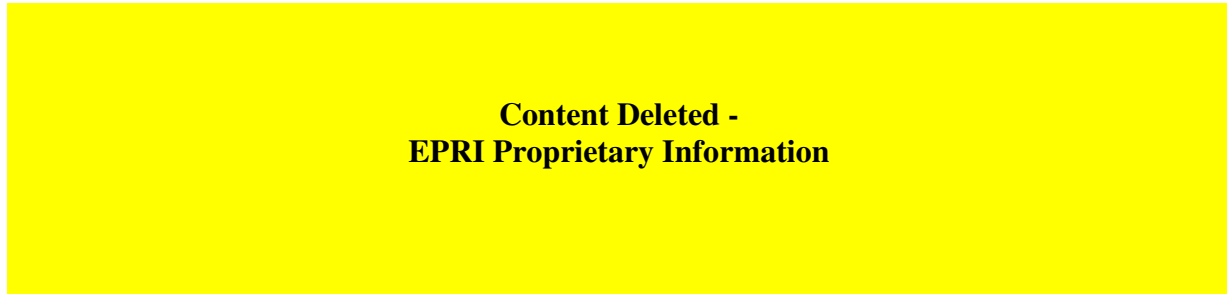


Figure 4.4.78-5. Looking Down Ultrasonic Data Display from Unflawed Region of BWRVIP-B Mockup (Probe Located on Inside Surface)

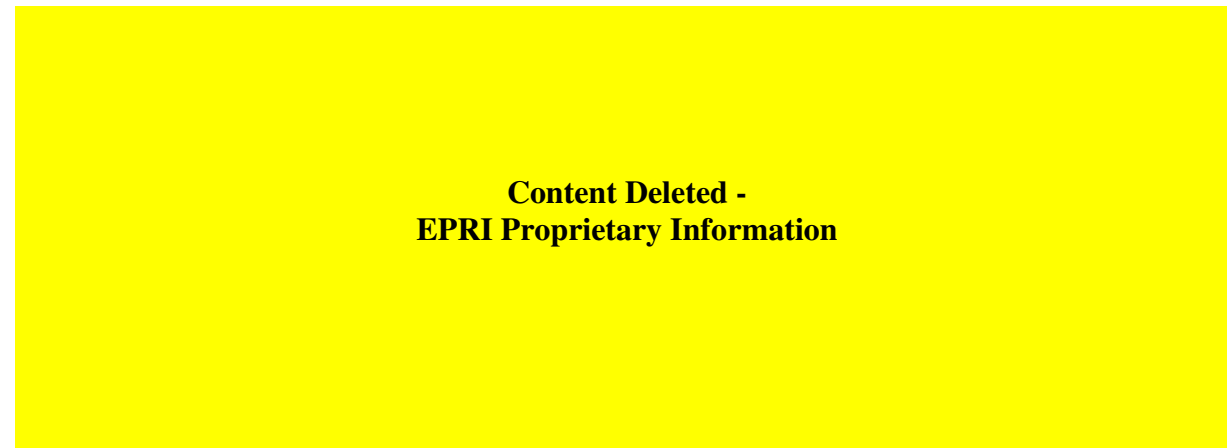
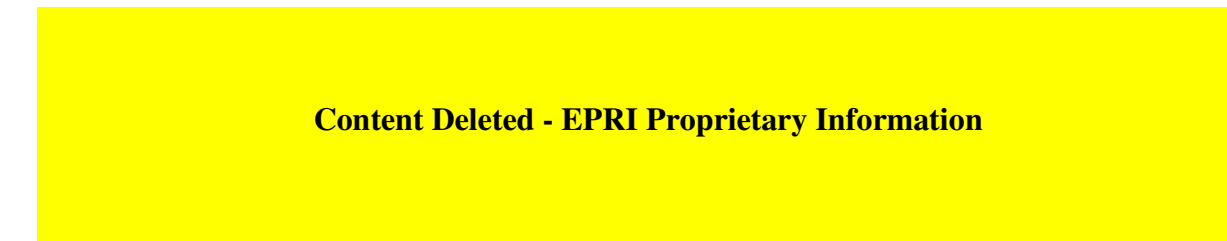


Figure 4.4.78-6. Looking Down Ultrasonic Data Display from Flaw B5 in Mockup BWRVIP-B (Probe Located on Inside Surface)





**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.5 VT Technique Demonstrations for Core Shroud Welds

Content Deleted - EPRI Proprietary Information

4.5.1 VT General Findings

**Content Deleted -
EPRI Proprietary Information**

4.5.1.1 Training

**Content Deleted -
EPRI Proprietary Information**

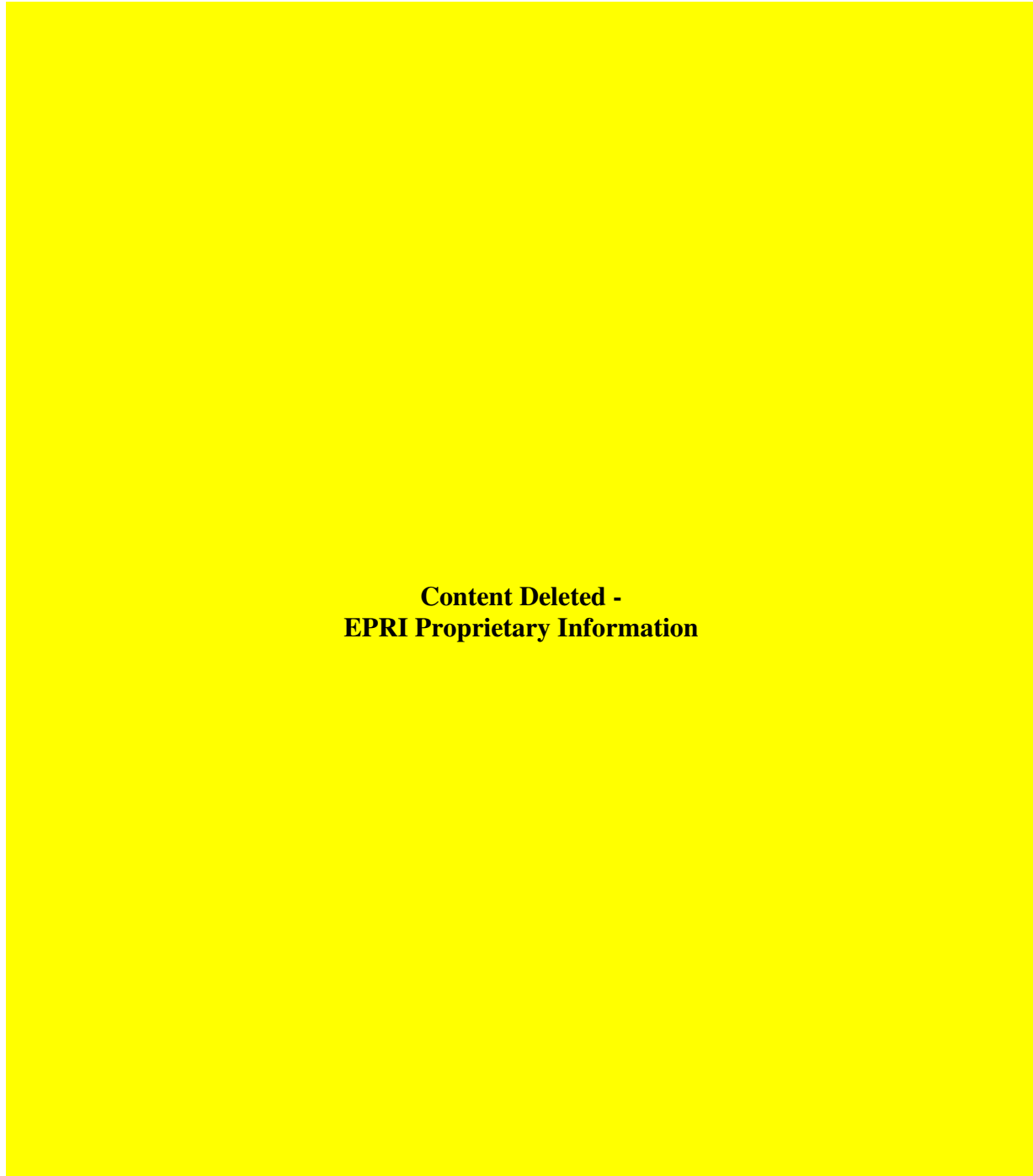
4.5.2 VT Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 4.5.2-1. Data and Analysis from Shroud VT Demonstration 1

Visual exam of shroud -- NDEC demo 8/31/94



**Content Deleted -
EPRI Proprietary Information**

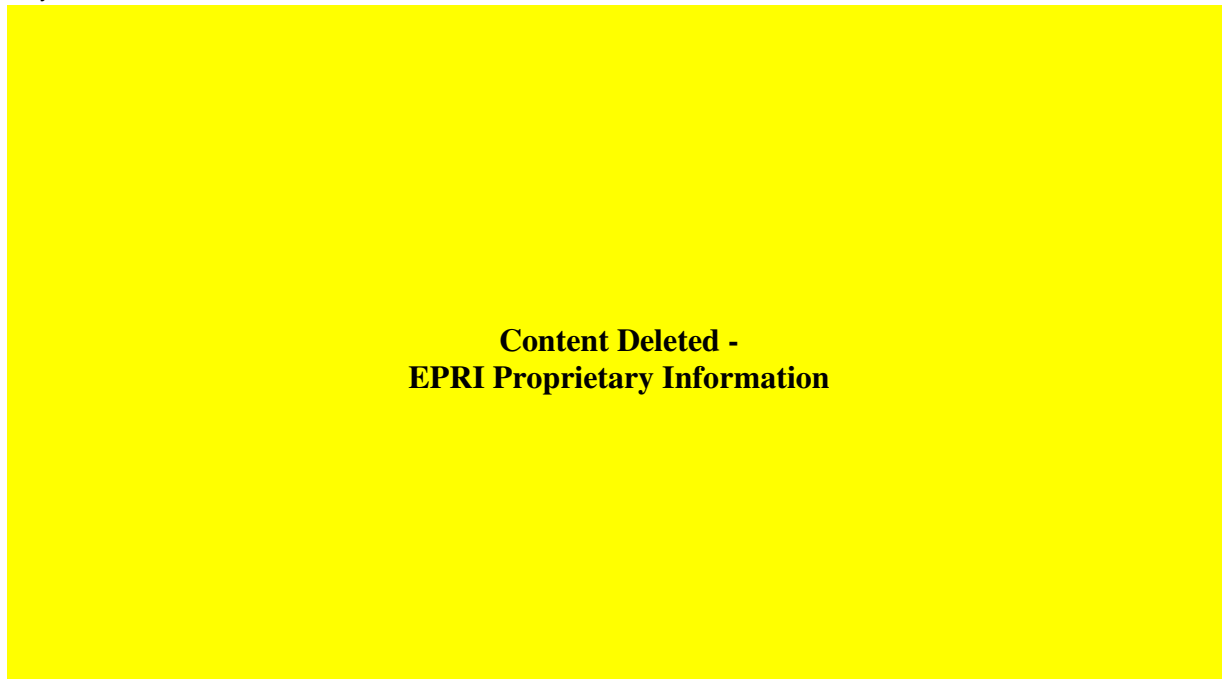
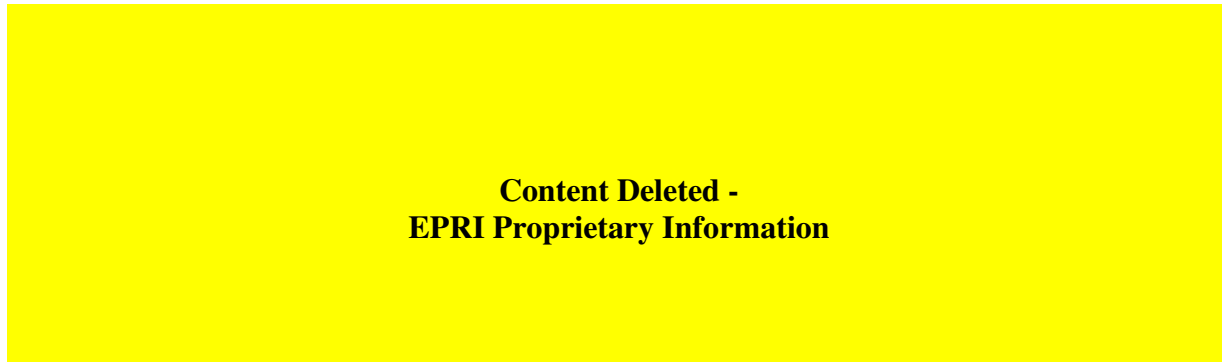
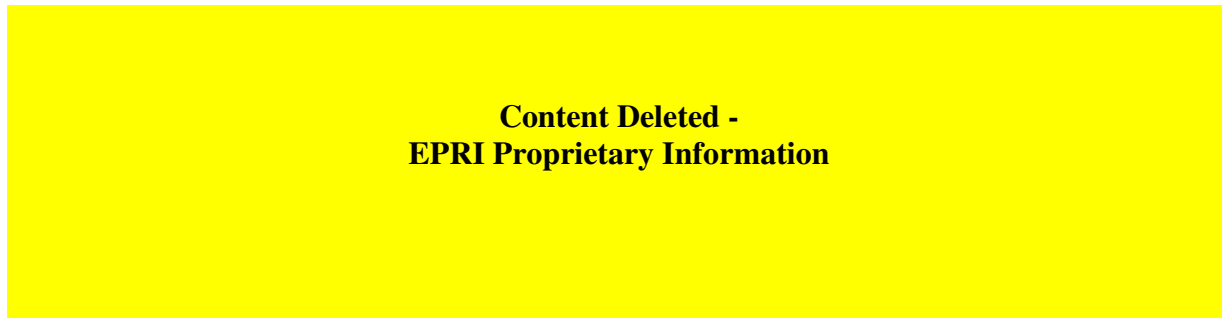


Figure 4.5.2-1. VT Length Measurement Performance on Simulated Cracks (Pieces of Tape) in NDE Center’s 20-foot-deep Water Tank

4.6 ET Technique Demonstrations for Core Shroud Welds



4.6.1 ET General Findings



**Content Deleted -
EPRI Proprietary Information**

Figure 4.6.1-1. Cross-Wound ET Probe

4.6.1.1 Detection of Skewed Reflectors

**Content Deleted -
EPRI Proprietary Information**

4.6.1.2 Effect of Scanning on a Rough Surface

**Content Deleted -
EPRI Proprietary Information**

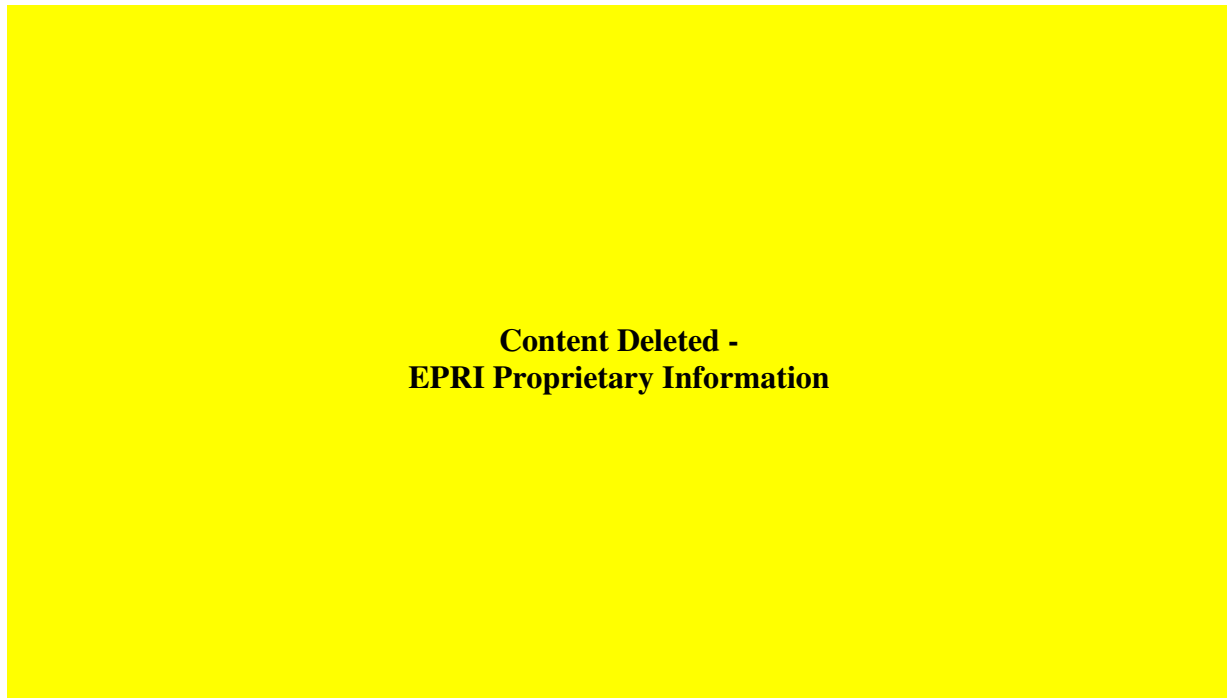
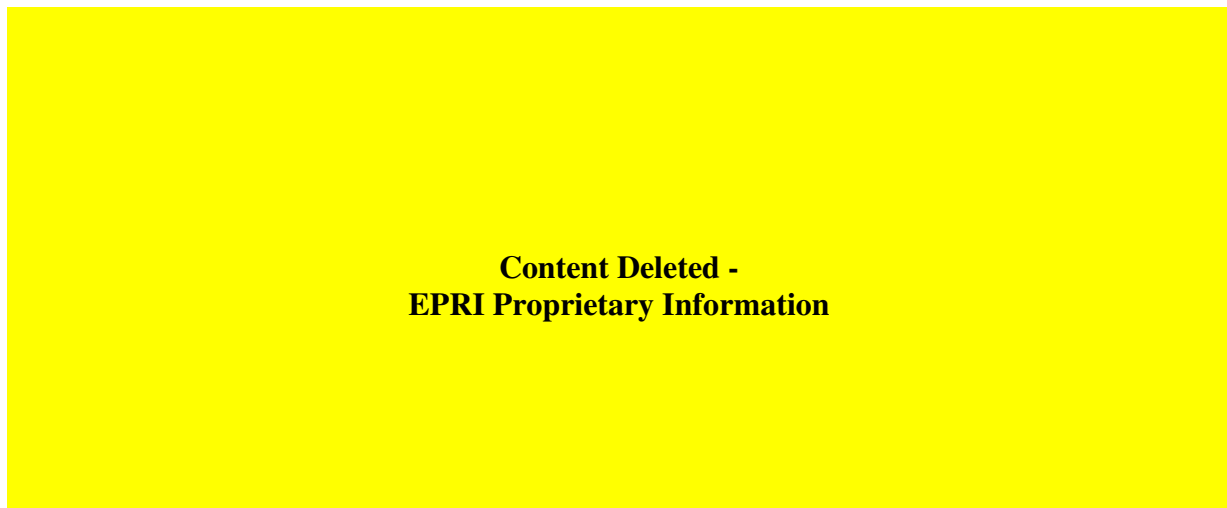


Figure 4.6.1.2-1. Eddy Current Image of Surface Roughness Mockup

4.6.1.3 Scan Pattern



4.6.2 ET Demonstration 1

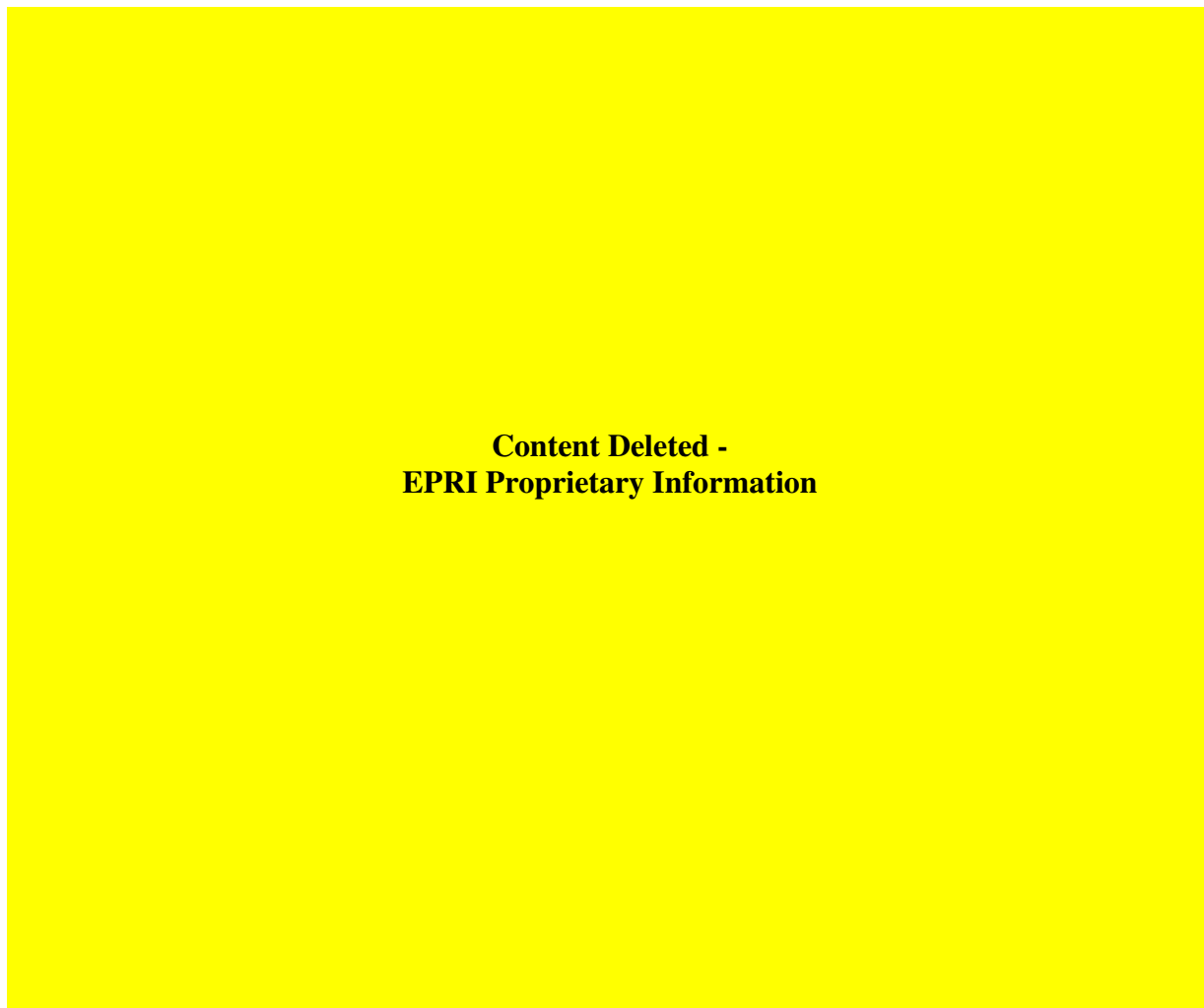
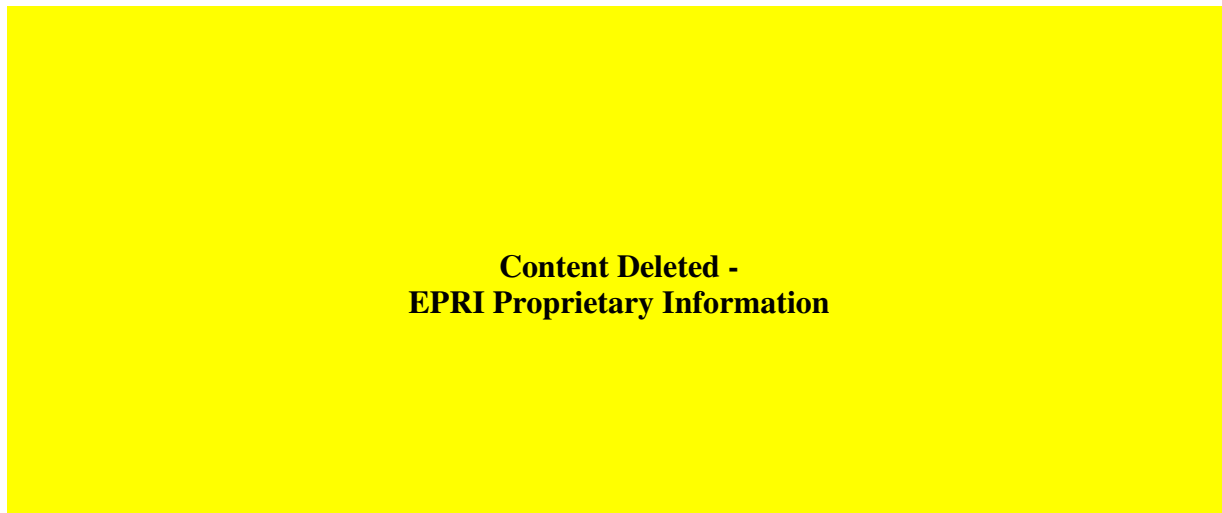
**Content Deleted -
EPRI Proprietary Information**

4.6.2.1 Crack Length Measurement

**Content Deleted -
EPRI Proprietary Information**

4.6.2.2 Optimum Parameters for ET Imaging

**Content Deleted -
EPRI Proprietary Information**



**Figure 4.6.2.2-1. Amplitude and Phase Eddy Current Images of Mockup BWRVIP-A.
(a) Amplitude, raw. (b) Amplitude, thresholded**

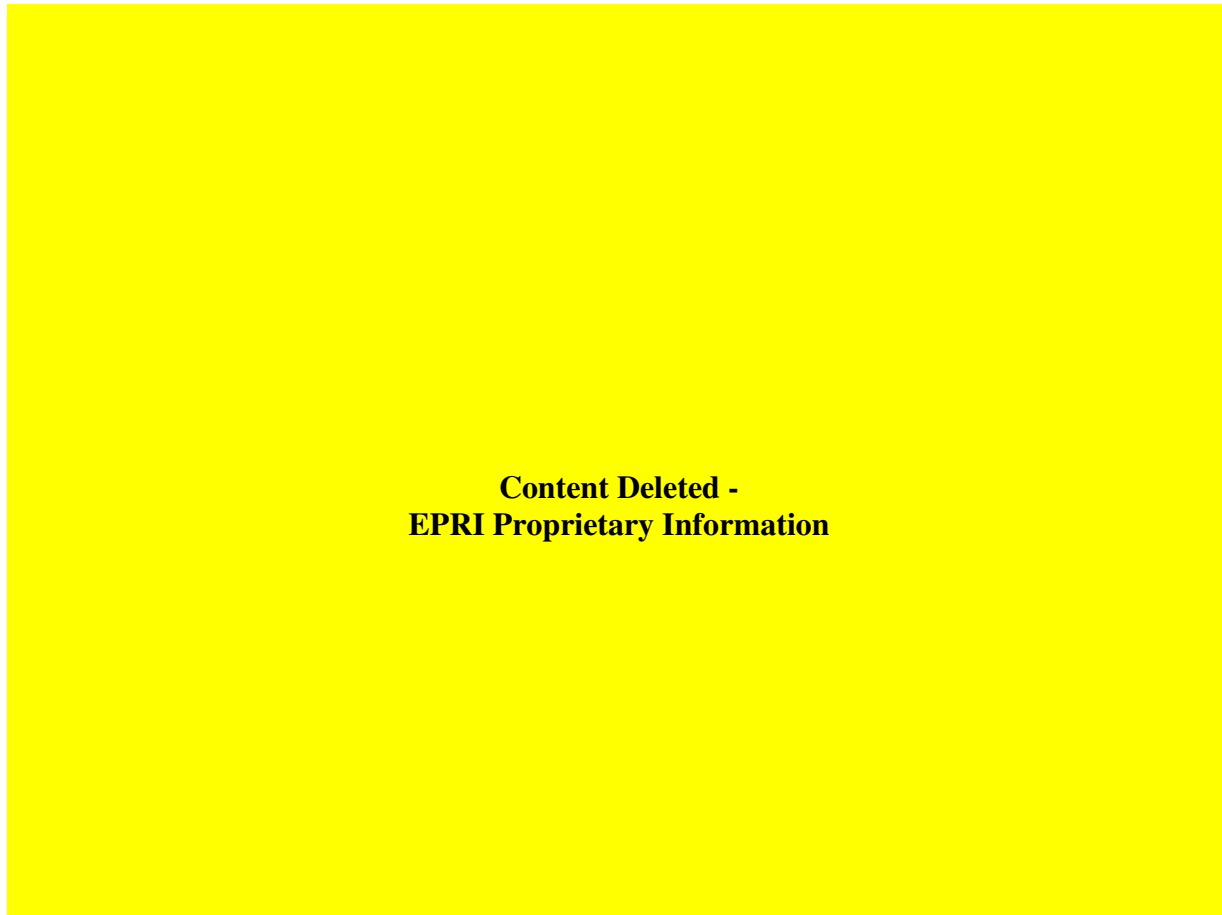
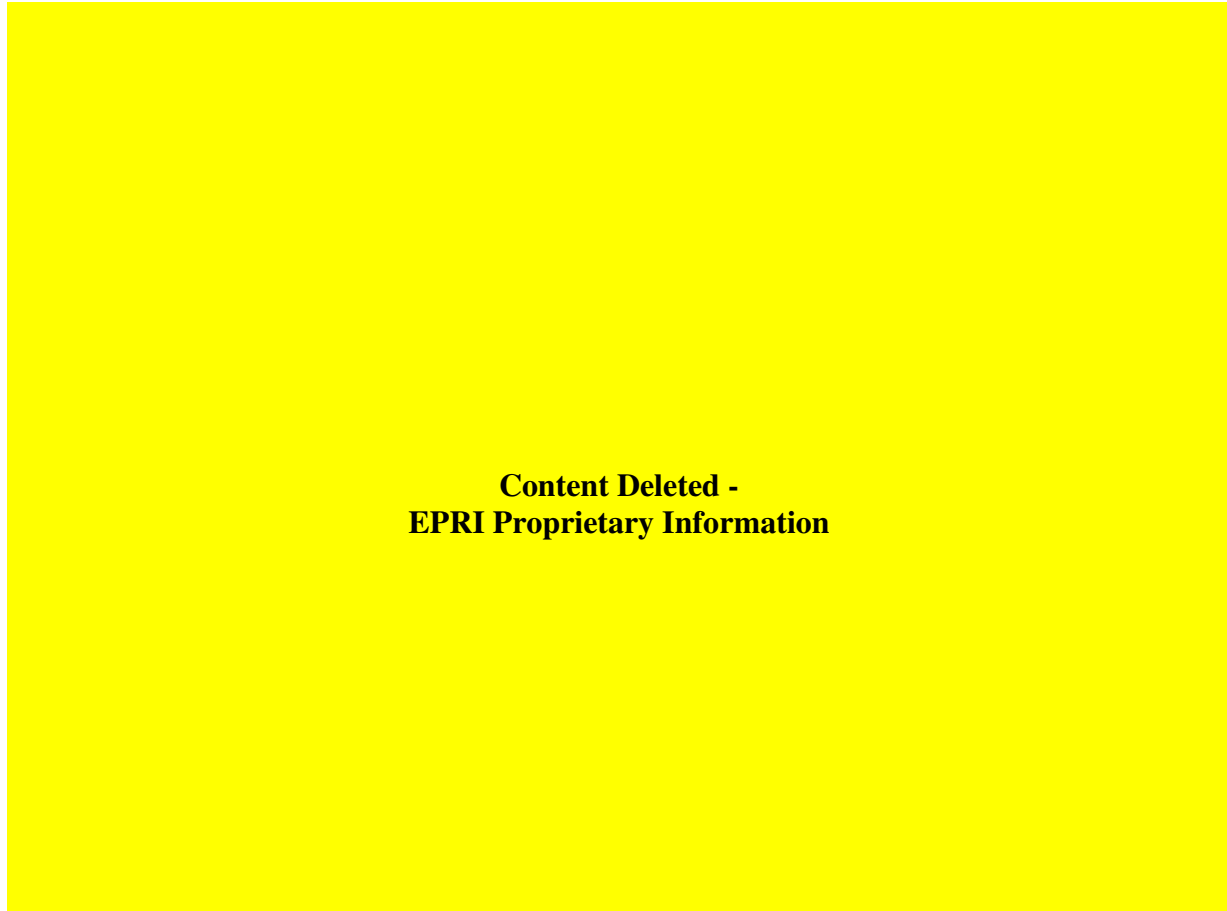


Figure 4.6.2.2-1 (continued). Amplitude and Phase Eddy Current Images of Mockup BWRVIP-A. (c) Phase, raw. (d) Phase, thresholded

4.6.3 ET Demonstration 2



4.6.4 ET Demonstration 3

**Content Deleted -
EPRI Proprietary Information**

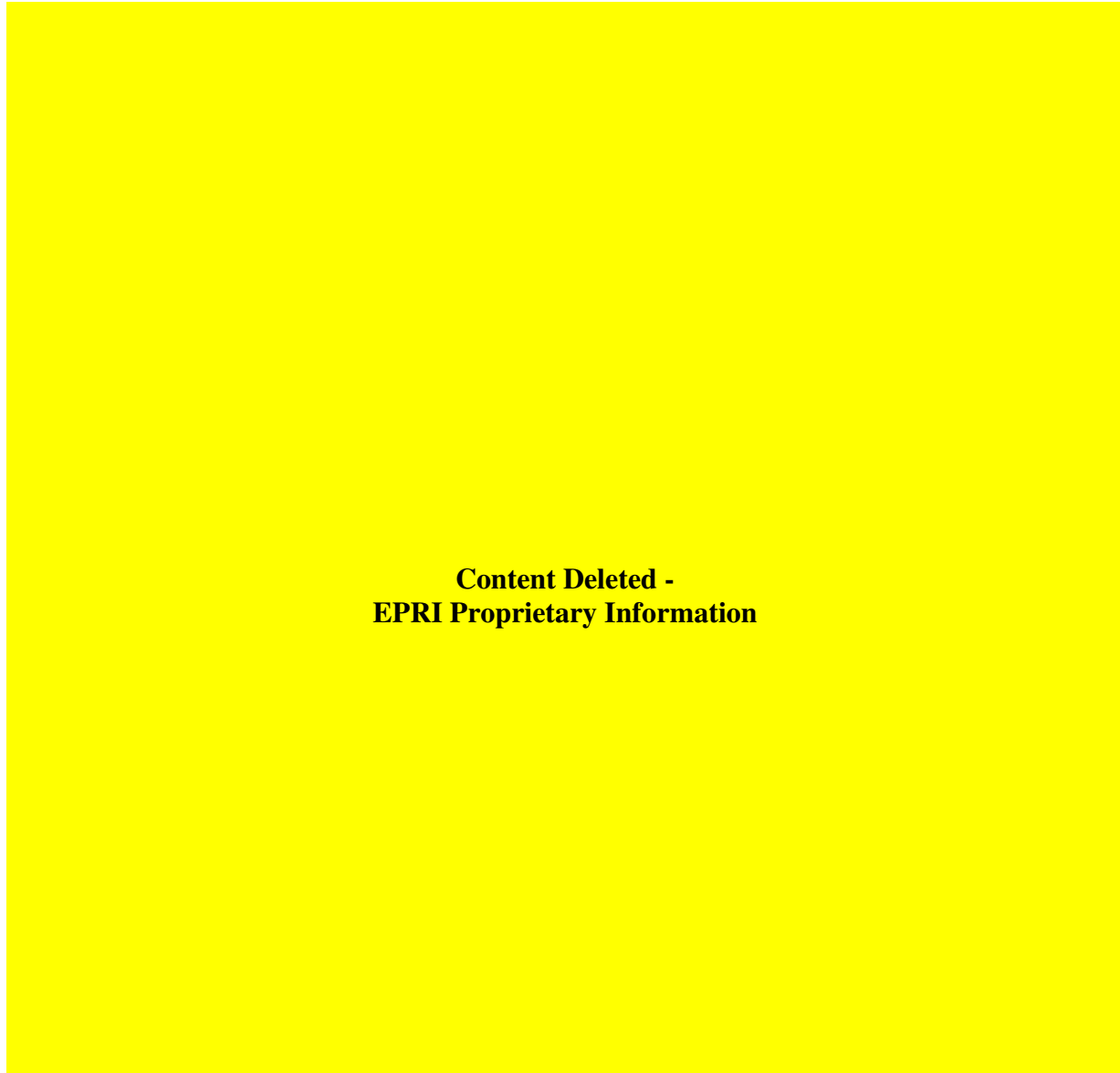
4.6.4.1 Data Acquisition

**Content Deleted -
EPRI Proprietary Information**

4.6.4.2 Data Evaluation

**Content Deleted -
EPRI Proprietary Information**

4.6.5 ET Demonstration 4



4.6.6 ET Demonstration 5

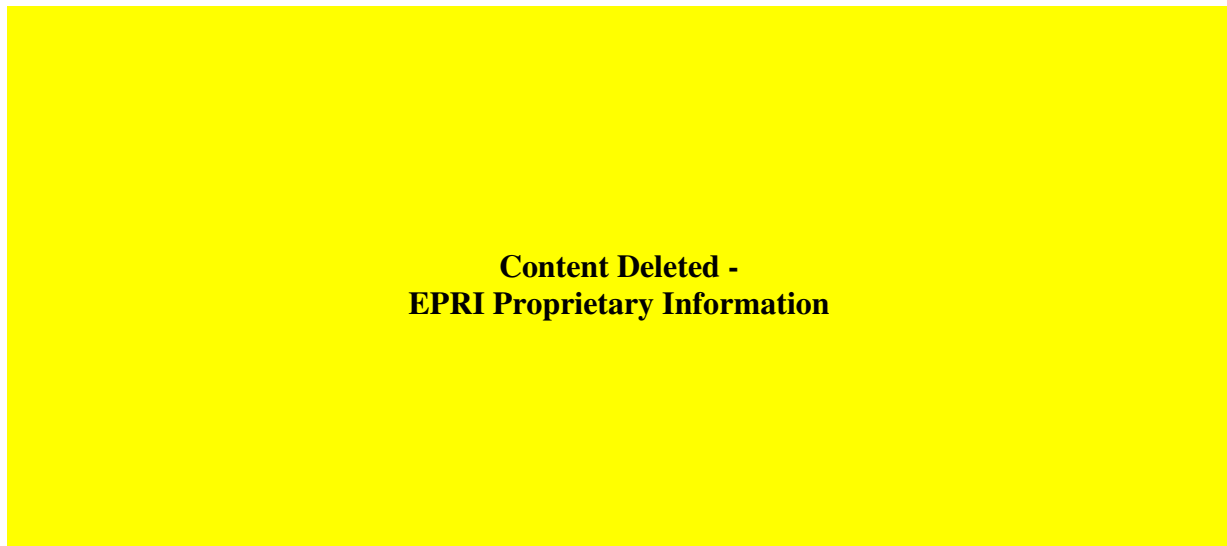
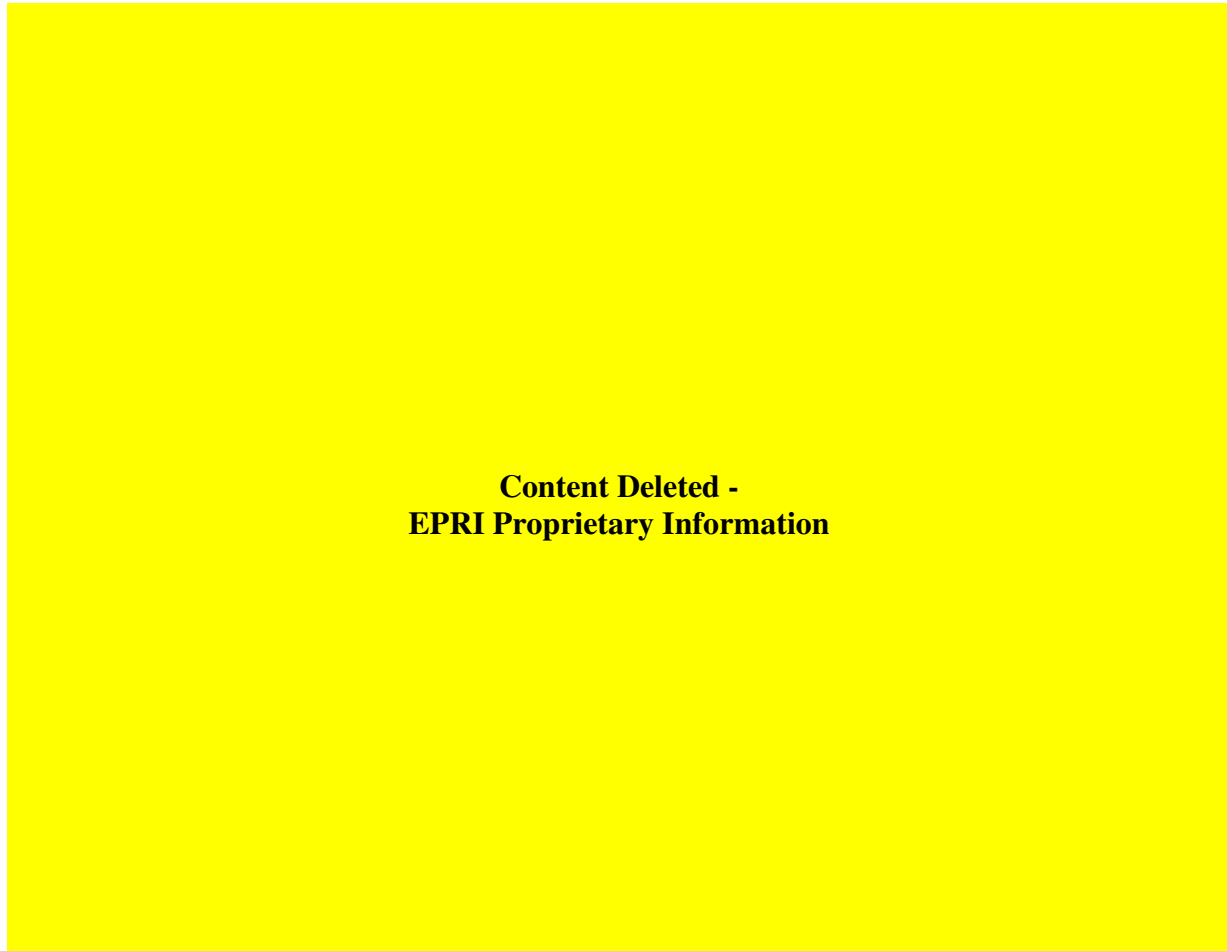


Figure 4.6.6-1. Eddy Current Surface Probe

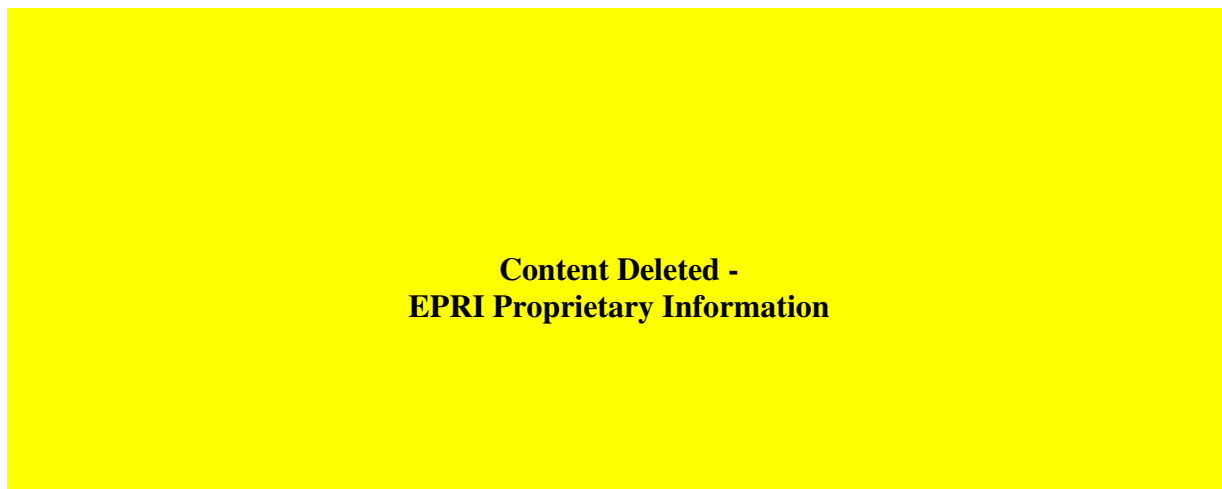
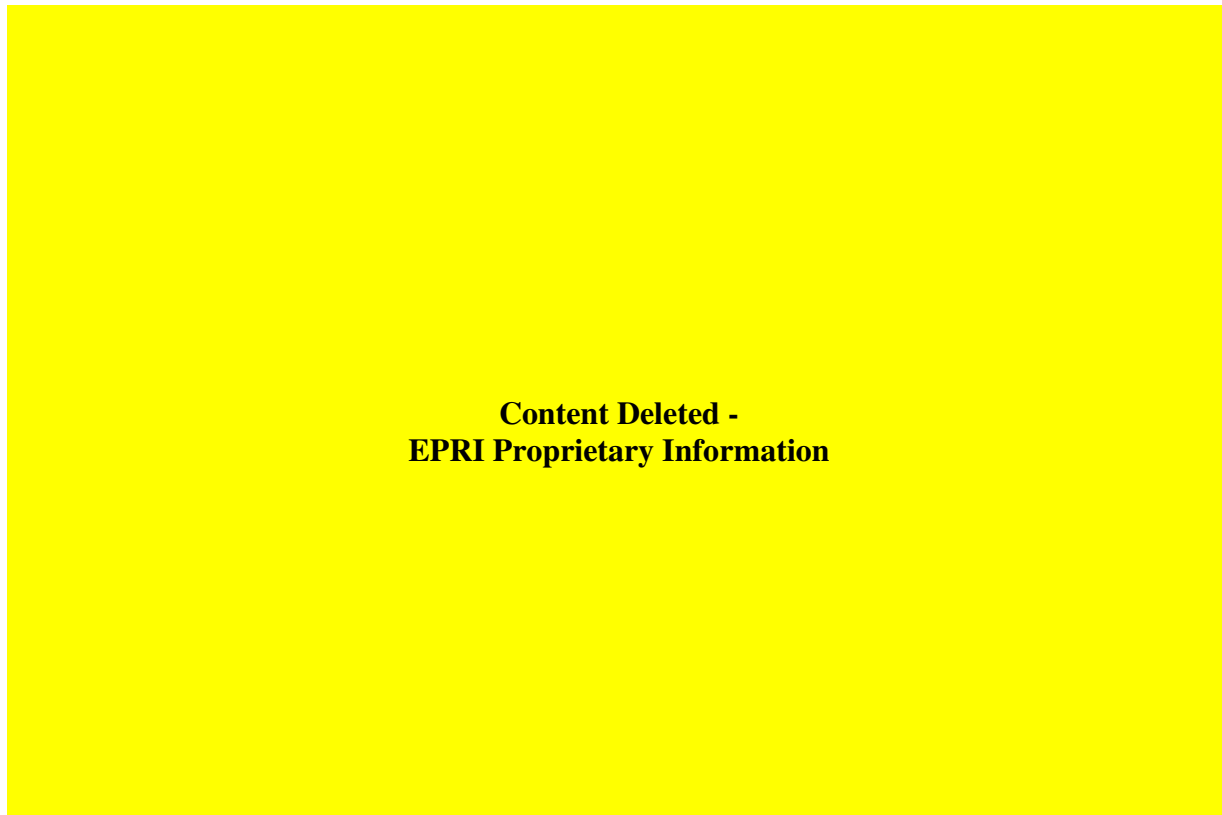
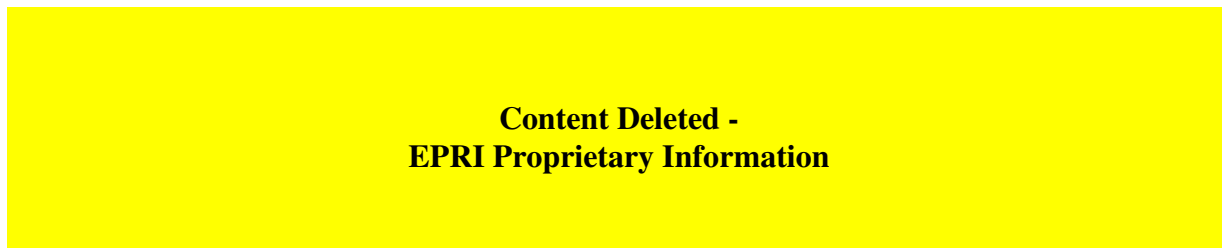


Figure 4.6.6-2. Eddy Current Responses from Ring Segment Weld Mockup



**Content Deleted -
EPRI Proprietary Information**

Figure 4.6.6-3. Eddy Current Responses Obtained from Surface Flaws of Various Depths

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 4.6.6-4. Shroud Mockup Containing Rough Weld Surface

Content Deleted - EPRI Proprietary Information

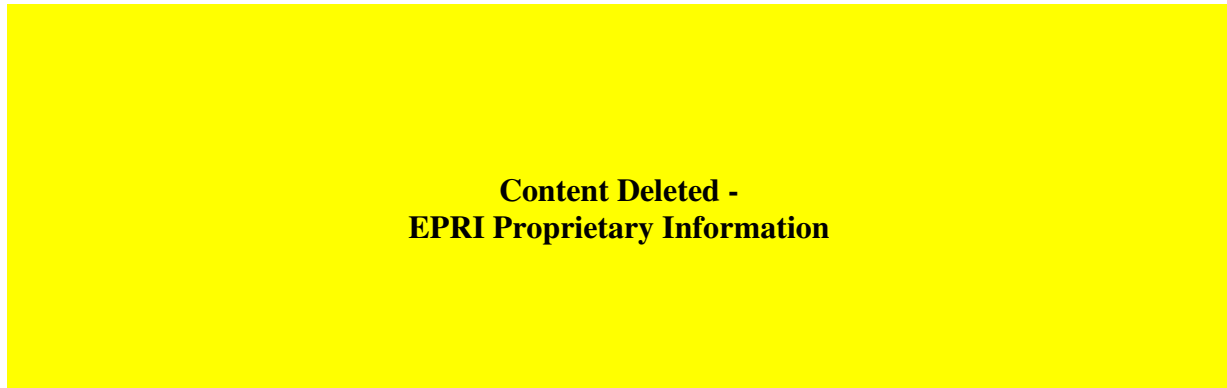
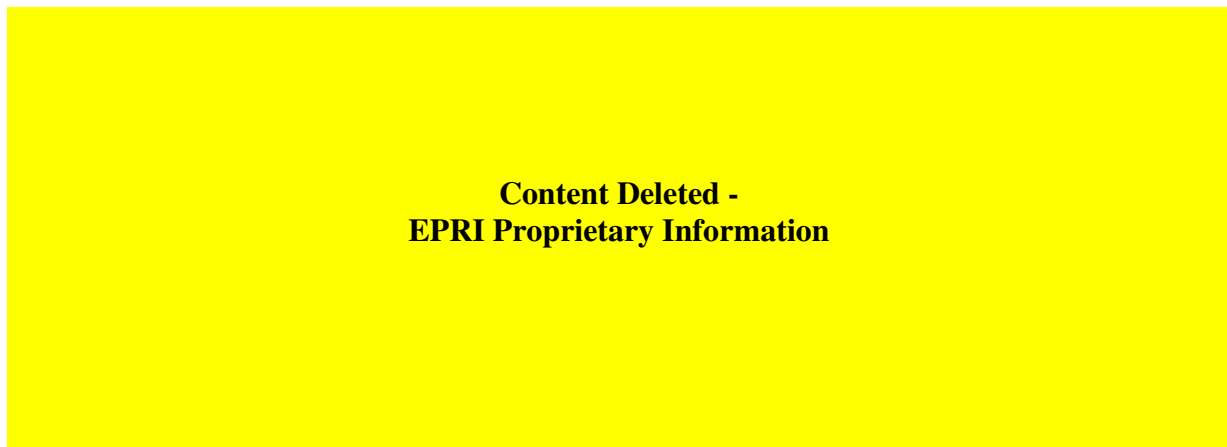


Figure 4.6.6-5. Eddy Current Response From Shroud Mockup with Rough Weld Surface



4.7 Delivery System Demonstrations for Core Shroud Welds

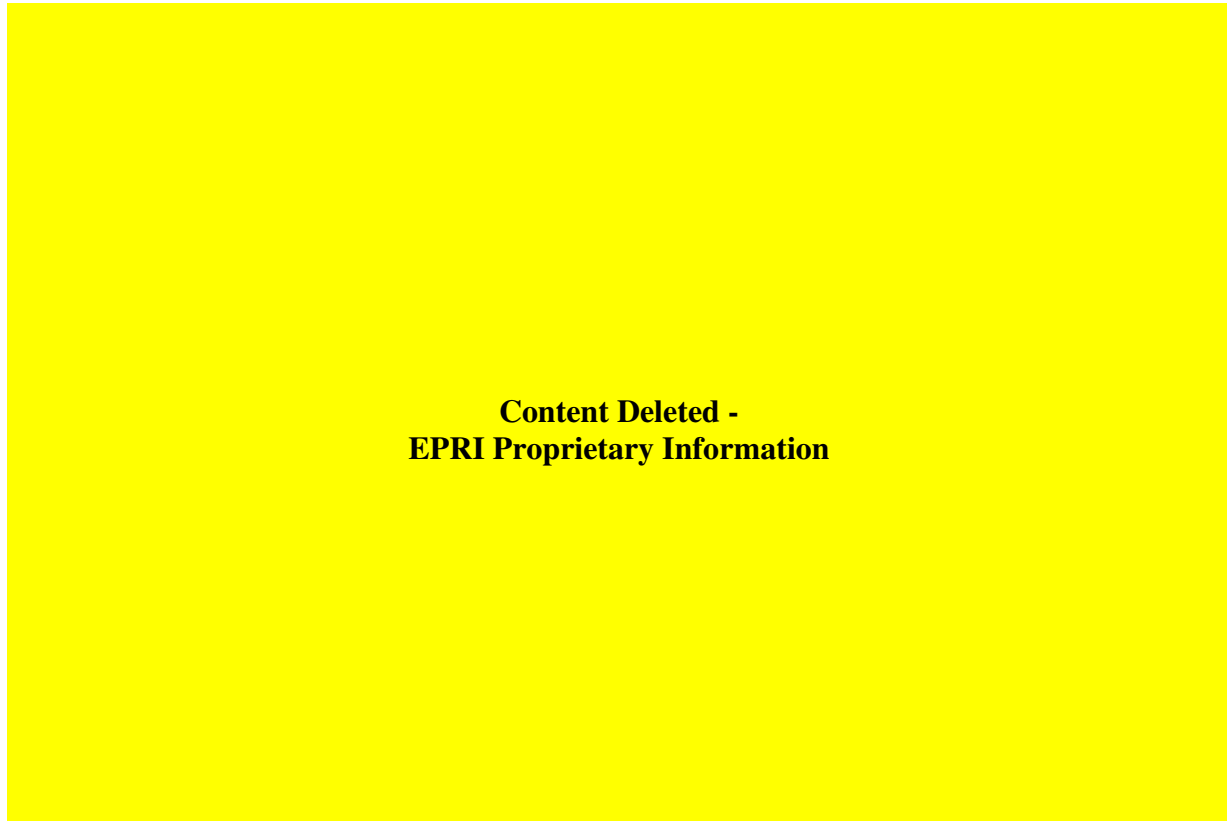


**Content Deleted -
EPRI Proprietary Information**

4.7.1 Delivery System Demonstration 1



4.7.2 Delivery System Demonstration 2



4.7.3 Delivery System Demonstration 3



**Content Deleted -
EPRI Proprietary Information**

4.7.4 Delivery System Demonstration 4

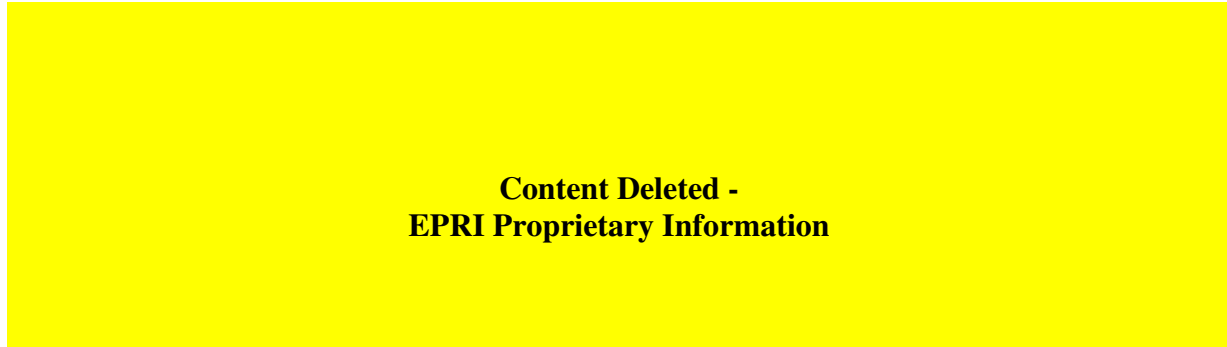
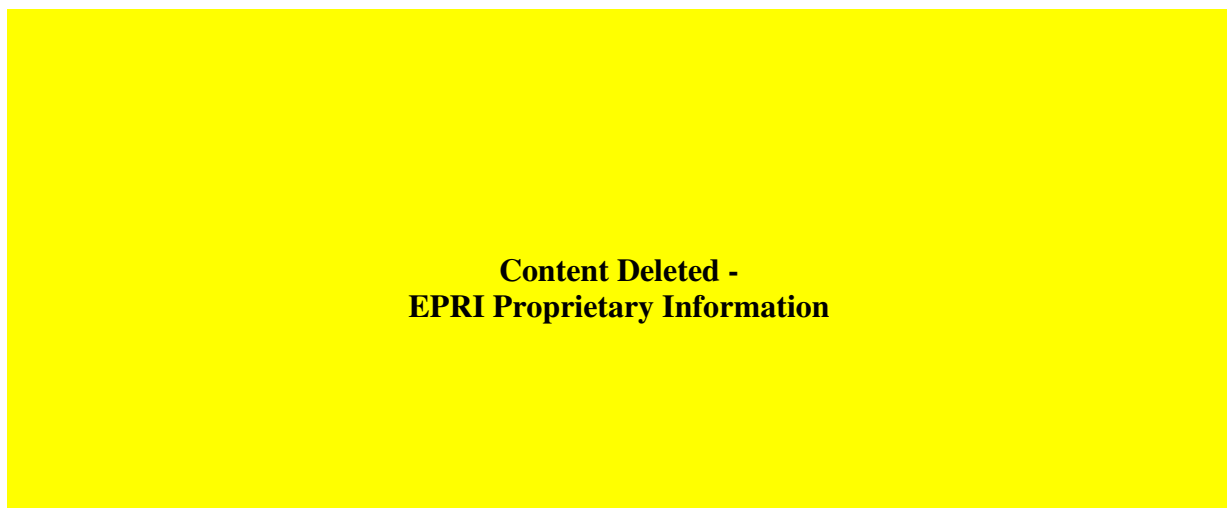
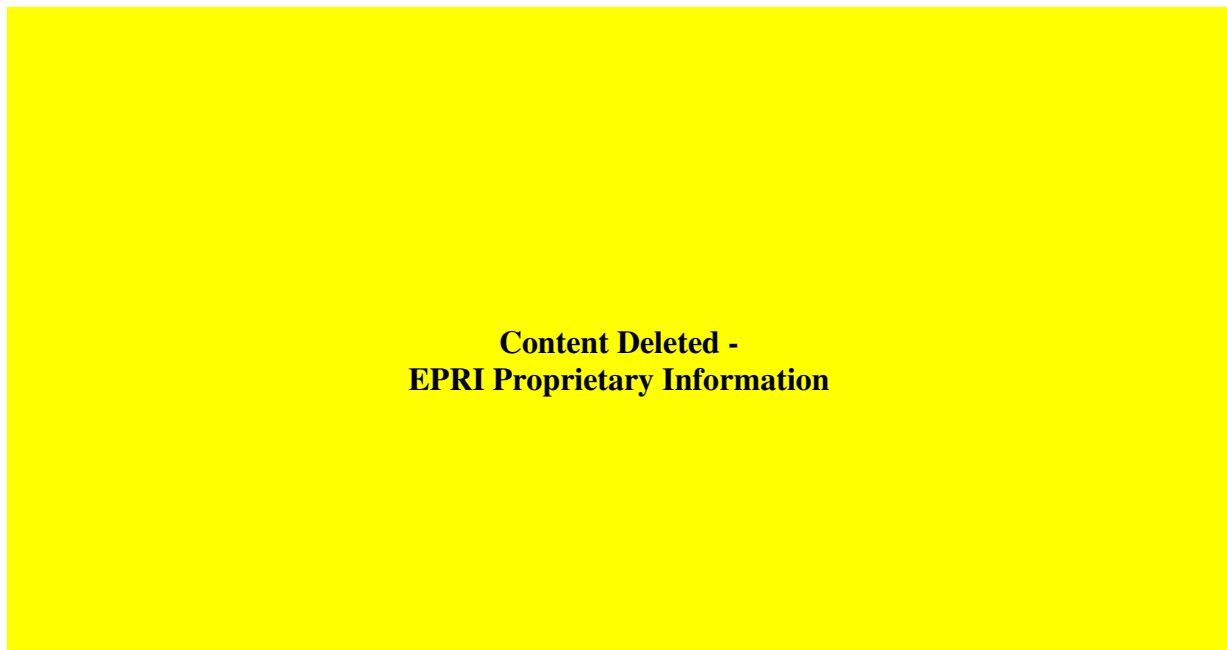


Table 4.7.4-1. Evaluation Factors for Carousel Scanner



**Content Deleted -
EPRI Proprietary Information**

4.7.5 Delivery System Demonstration 5



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.7.6 Delivery System Demonstration 6



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.7.7 Delivery System Demonstration

**Content Deleted -
EPRI Proprietary Information**

4.7.7.1 Flaw Length Measurement Within a Single Scan

**Content Deleted -
EPRI Proprietary Information**

4.7.7.2 Flaw Length Measurement Using More Than One Scan

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

4.7.8 Delivery System Demonstration 8

**Content Deleted -
EPRI Proprietary Information**

Table 4.7.8-1. Evaluation Factors for TS²

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

4.7.8.1 Horizontal Welds

**Content Deleted -
EPRI Proprietary Information**

4.7.8.2 Vertical Welds

**Content Deleted -
EPRI Proprietary Information**

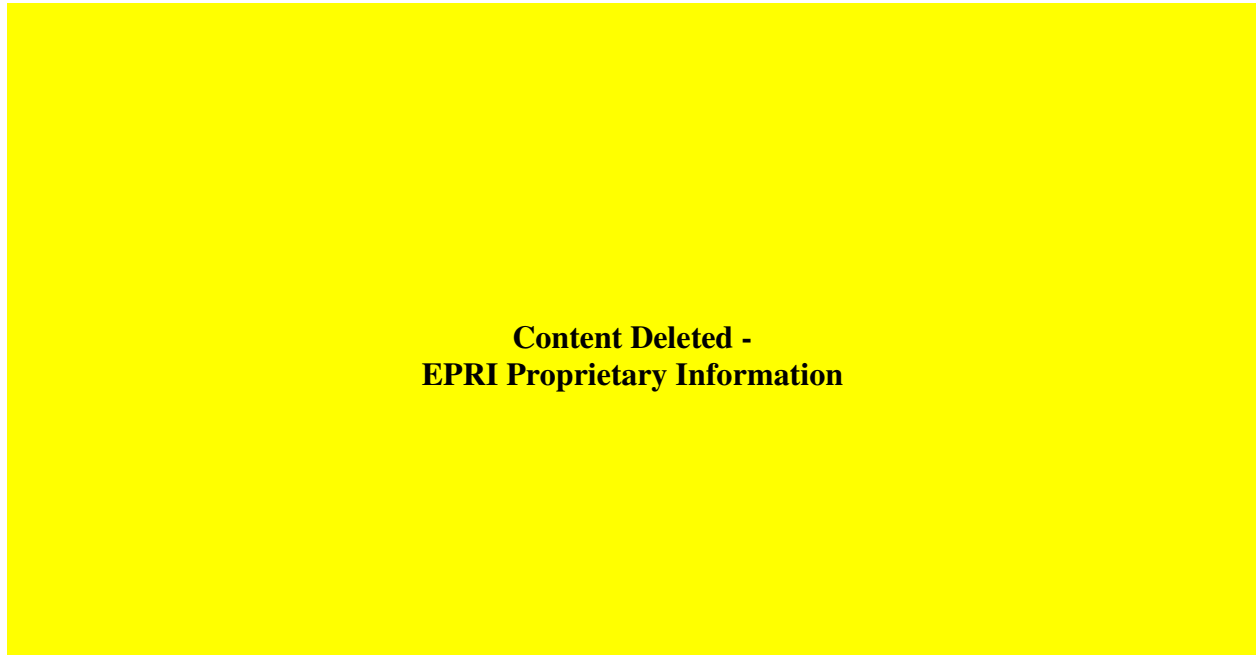
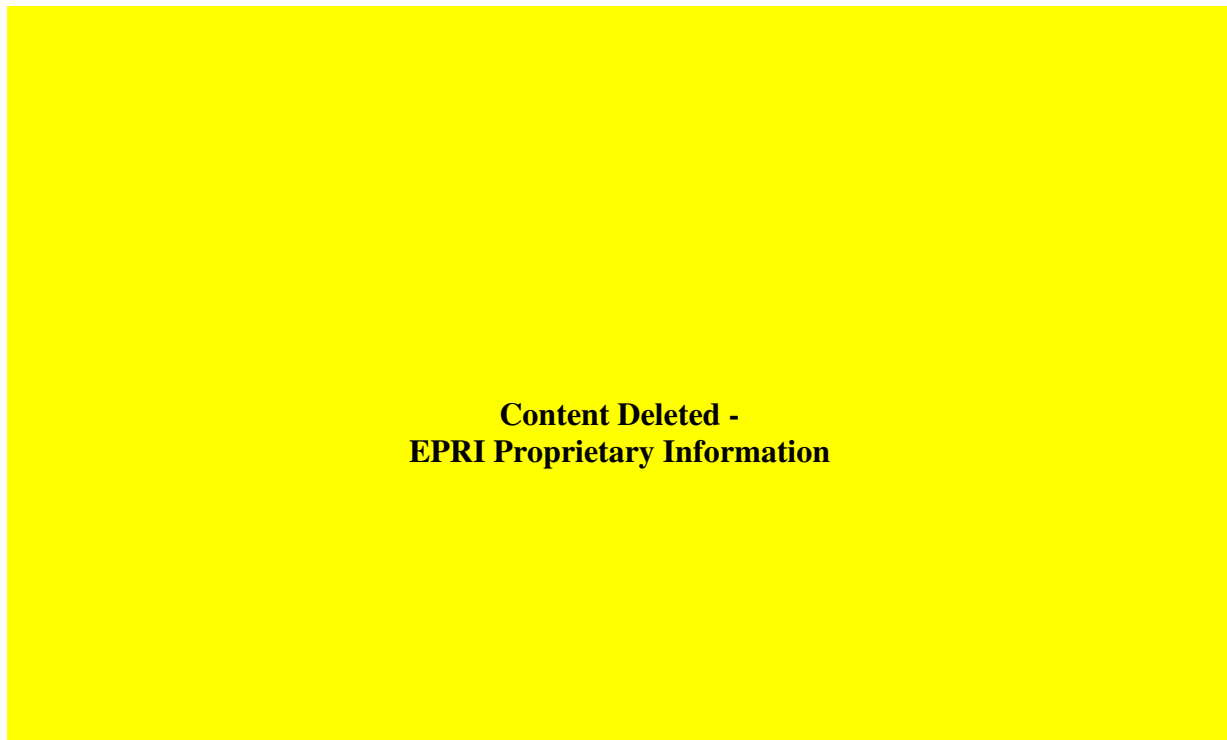


Figure 4.7.8-1. Illustration of Potential Location Error for BWR Vertical Weld UT Inspections

4.7.8.3 H2/H3 Welds (Scanned from the Ledge)



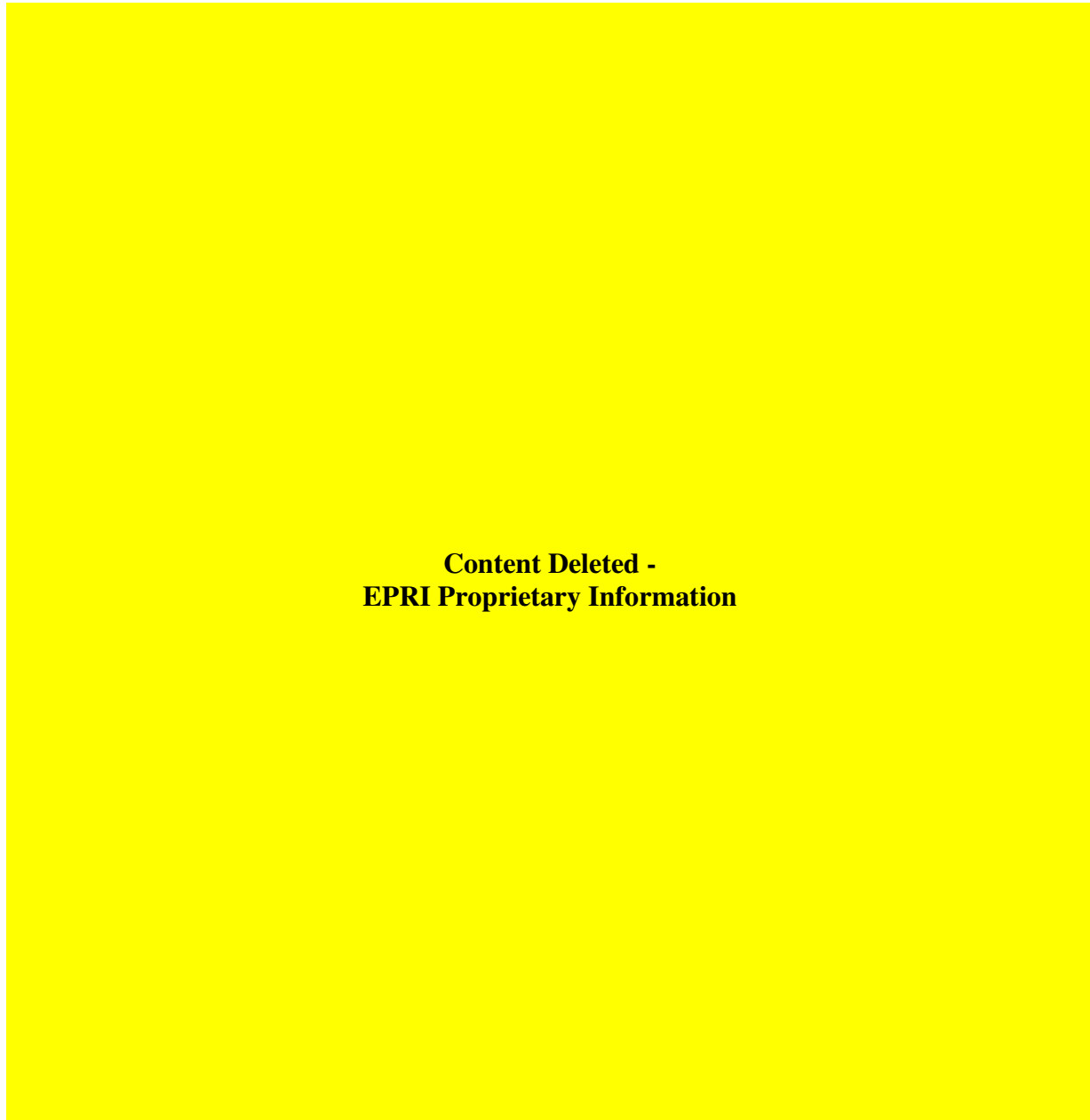


Figure 4.7.8-2. Illustration of Potential Location Error for Depth Sizing When Scanning on the H2/H3 Ledge

4.8 References



**Content Deleted -
EPRI Proprietary Information**

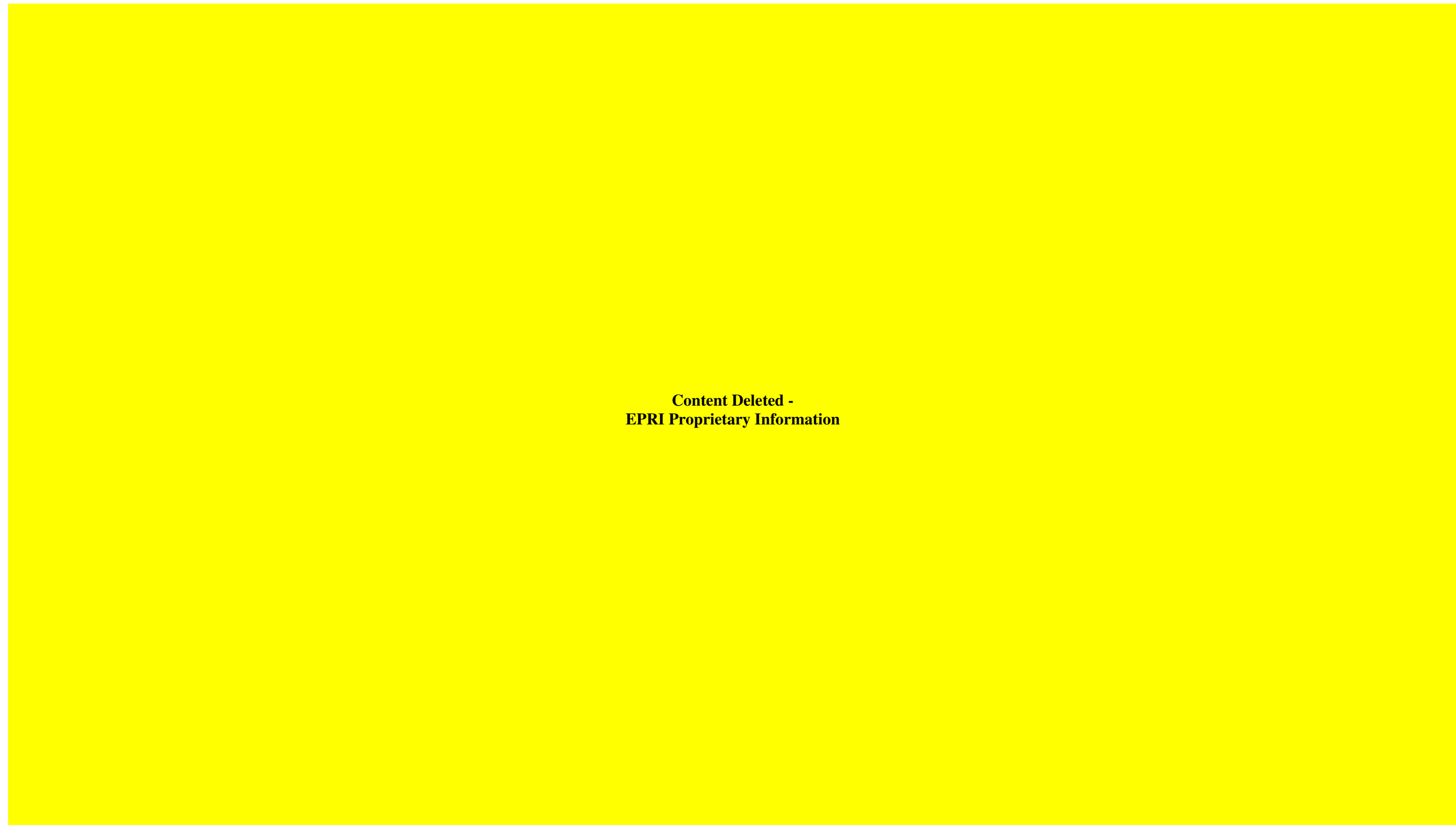
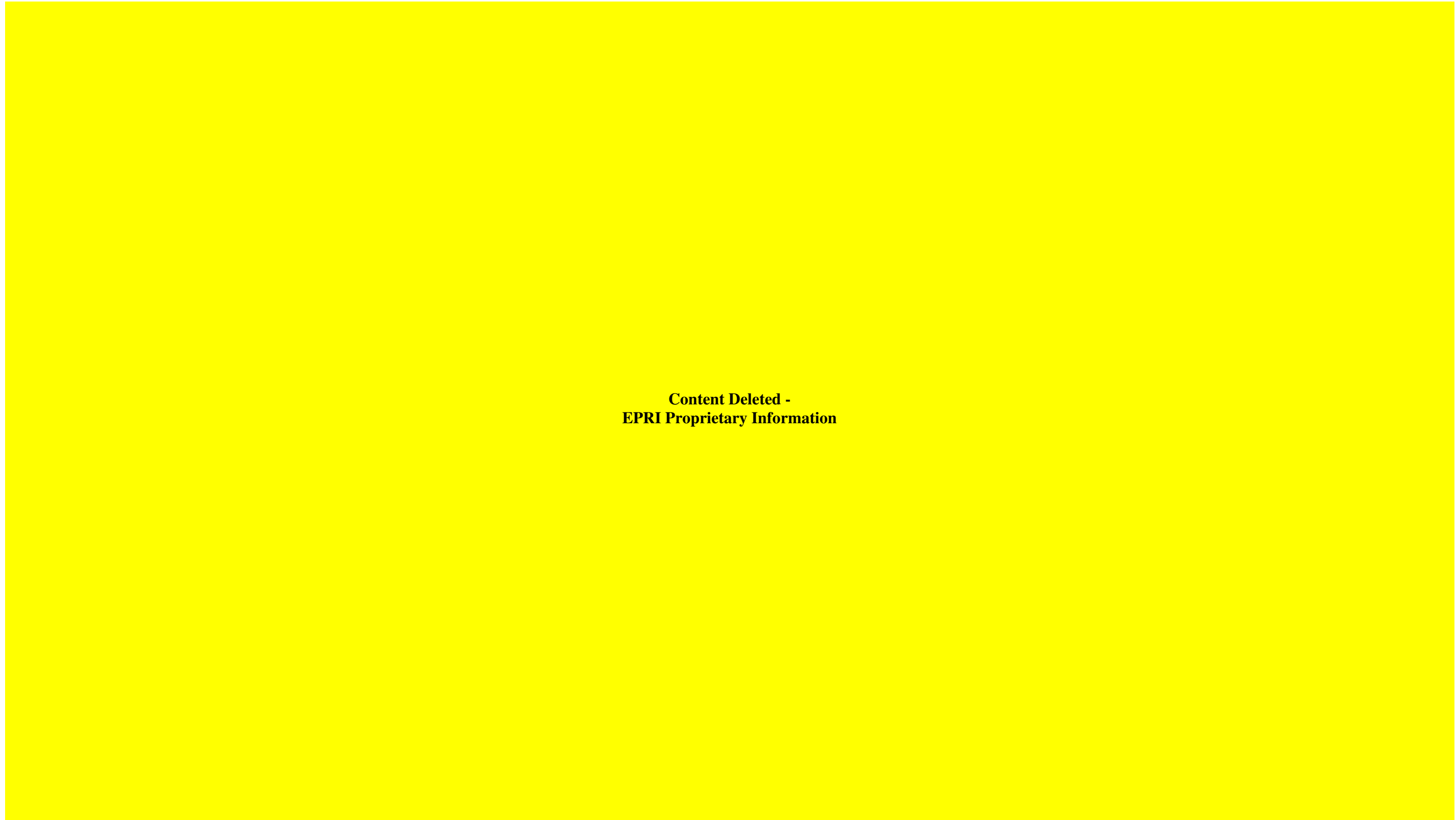


Figure 4.3.1.7-1. Mockup BWRVIP-H1 Shroud Weld H1



**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.9-2. BWRVIP-H6OH, Representing the Overhanging Core Plate Support Ring Weld Configuration

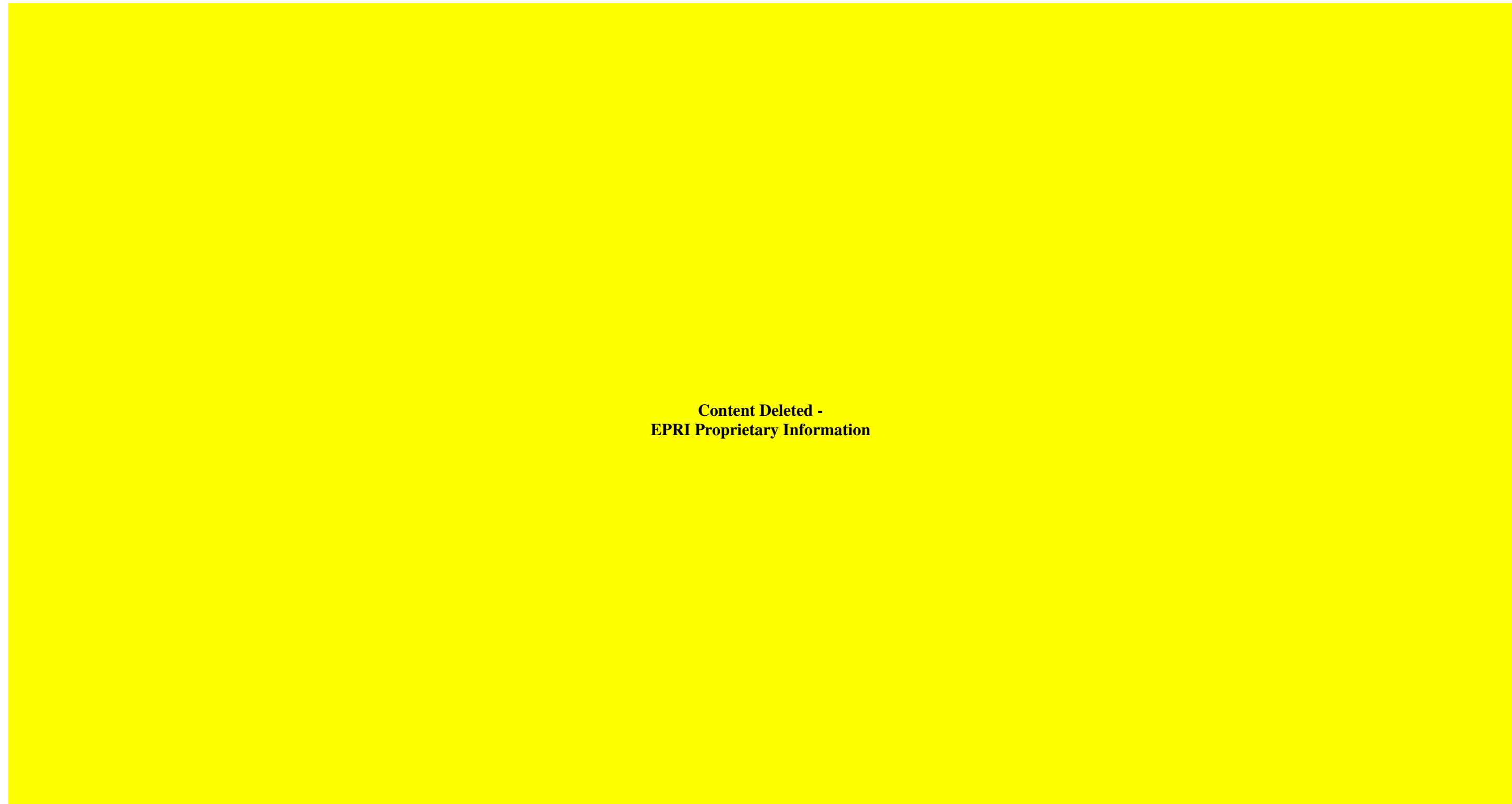
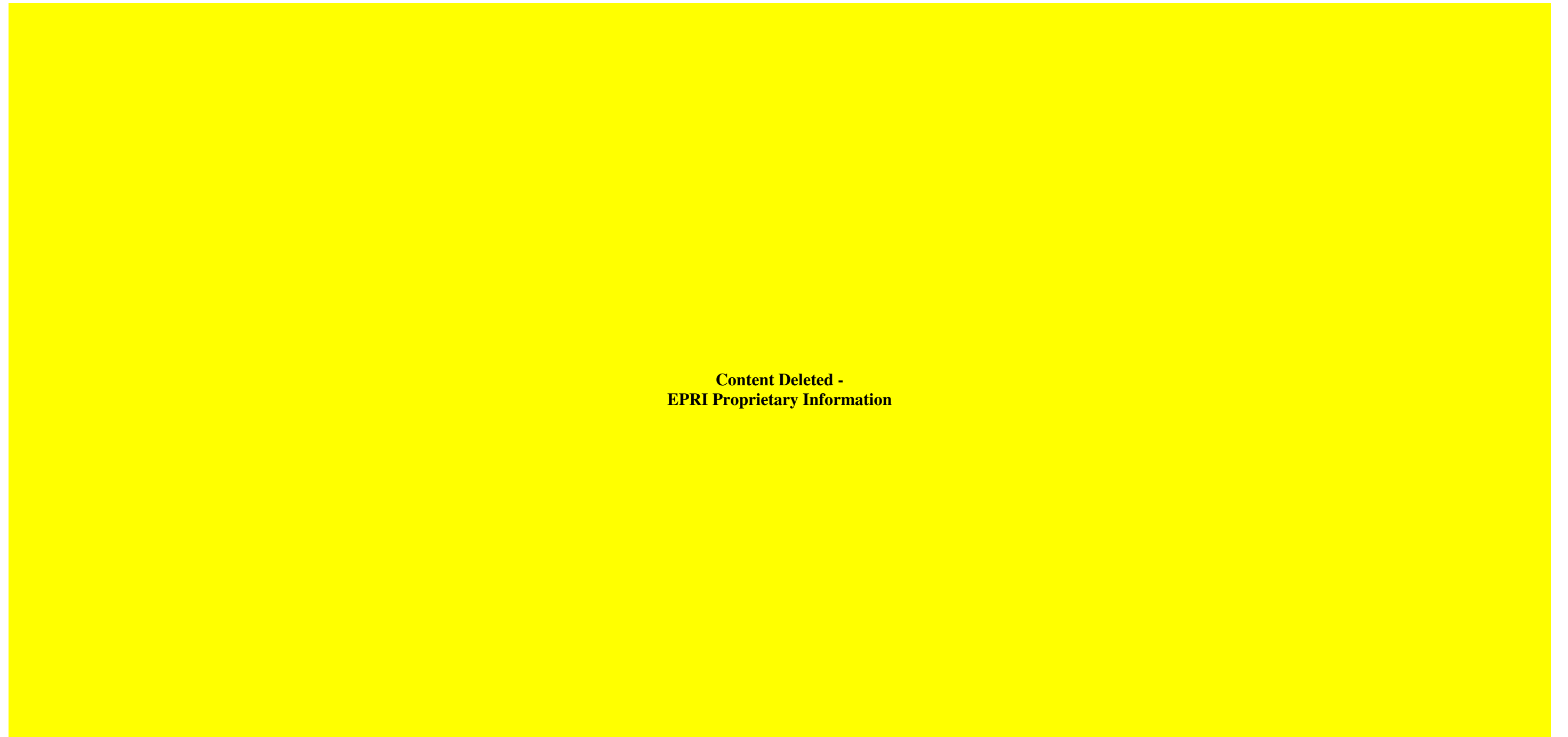


Figure 4.3.1.10-2. Configuration Drawing of Mockup BWRVIP-TGSR

**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.10-3. Flaw Details for Mockup BWRVIP-TGSR

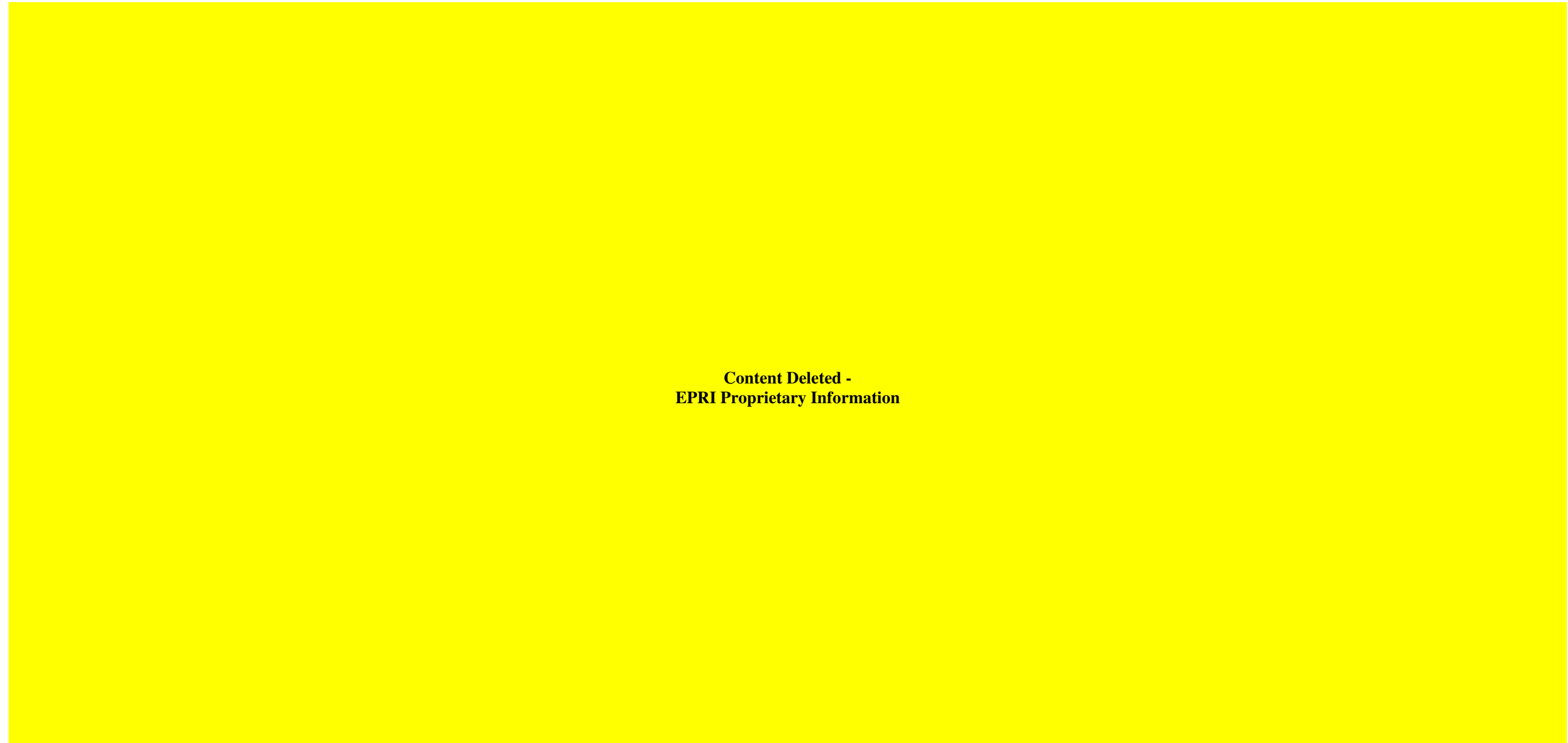


**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.11-5. Configuration of BWRVIP-H2/H3 (End View)

**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.11-6. BWRVIP-H2/H3 Ring Segment Weld Flaws



**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.11-7. BWRVIP-H2/H3 Ring-to-Cylinder Weld Flaws (Flaws 1 Through 4)

**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.11-8. BWRVIP-H2/H3 Ring-to-Cylinder Weld Flaws (Flaws 5 Through 8)

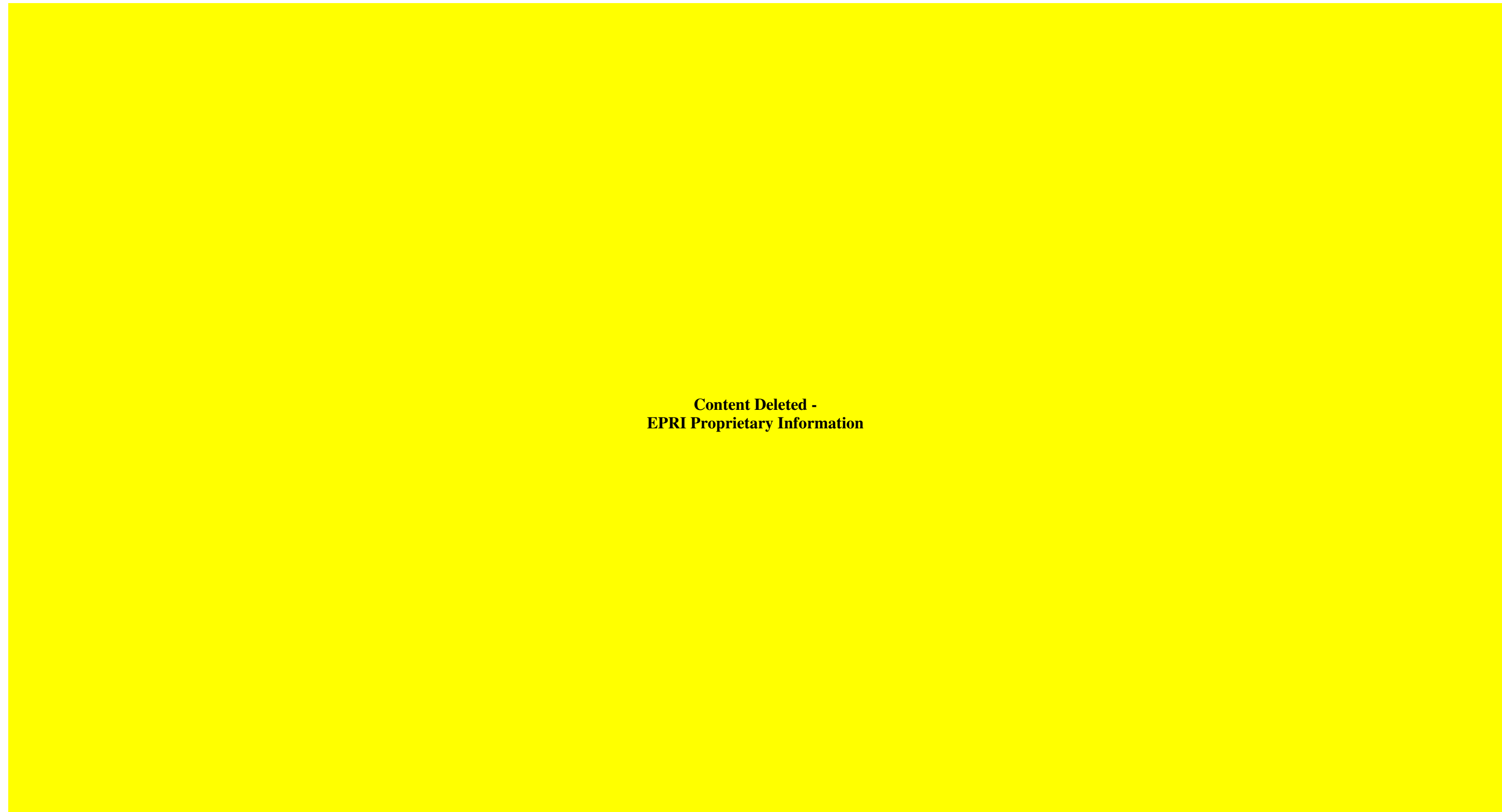


Figure 4.3.1.11-9. BWRVIP-H2/H3 Flaw Details

**Content Deleted -
EPRI Proprietary Information**

Figure 4.3.1.12-5. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 1 Through 4)

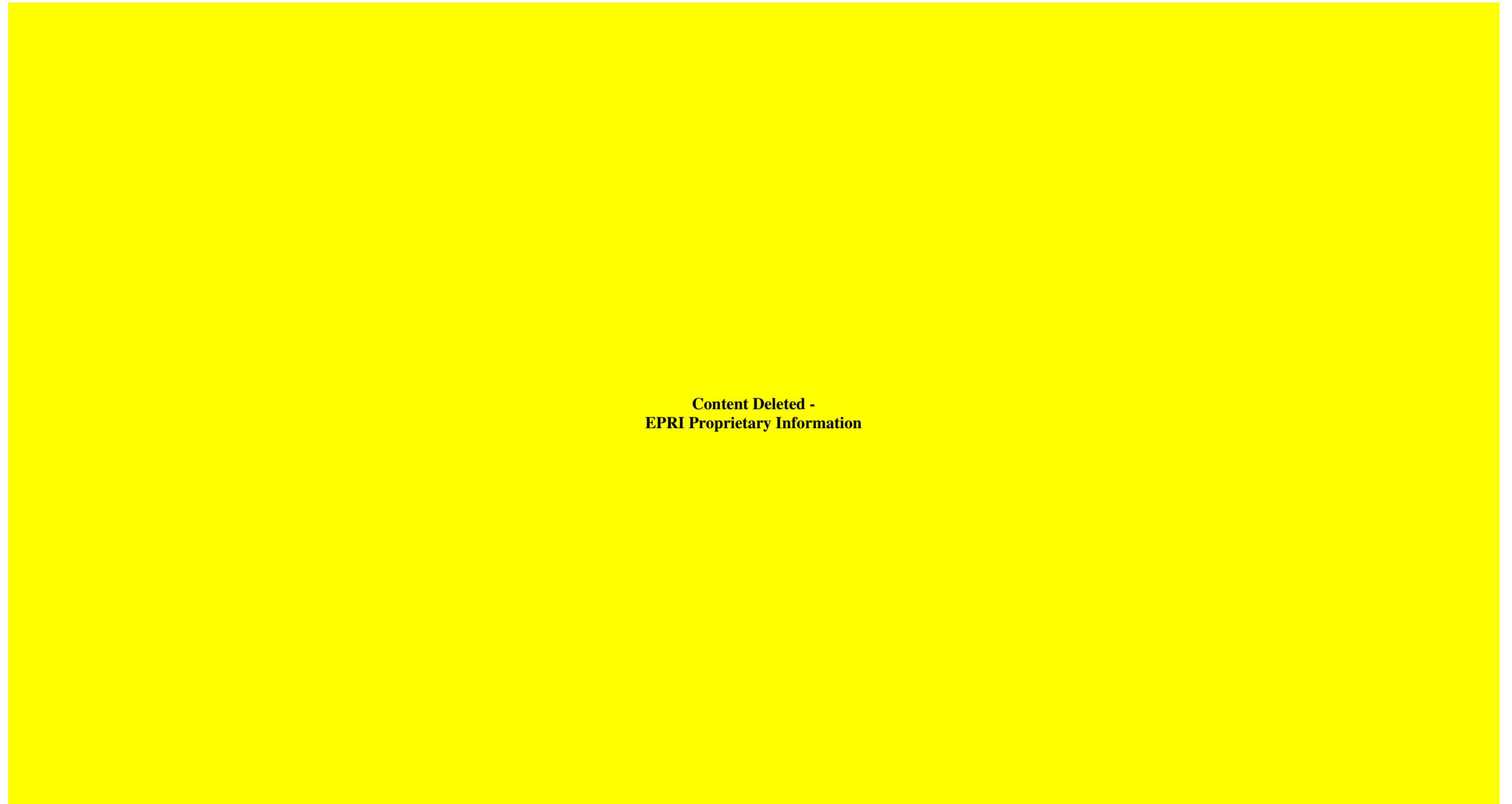


Figure 4.3.1.12-6. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 5 Through 11)



Figure 4.3.1.12-7. Flaw Details for BWRVIP-BWR6-H3-A (Flaws 12 Through 16)

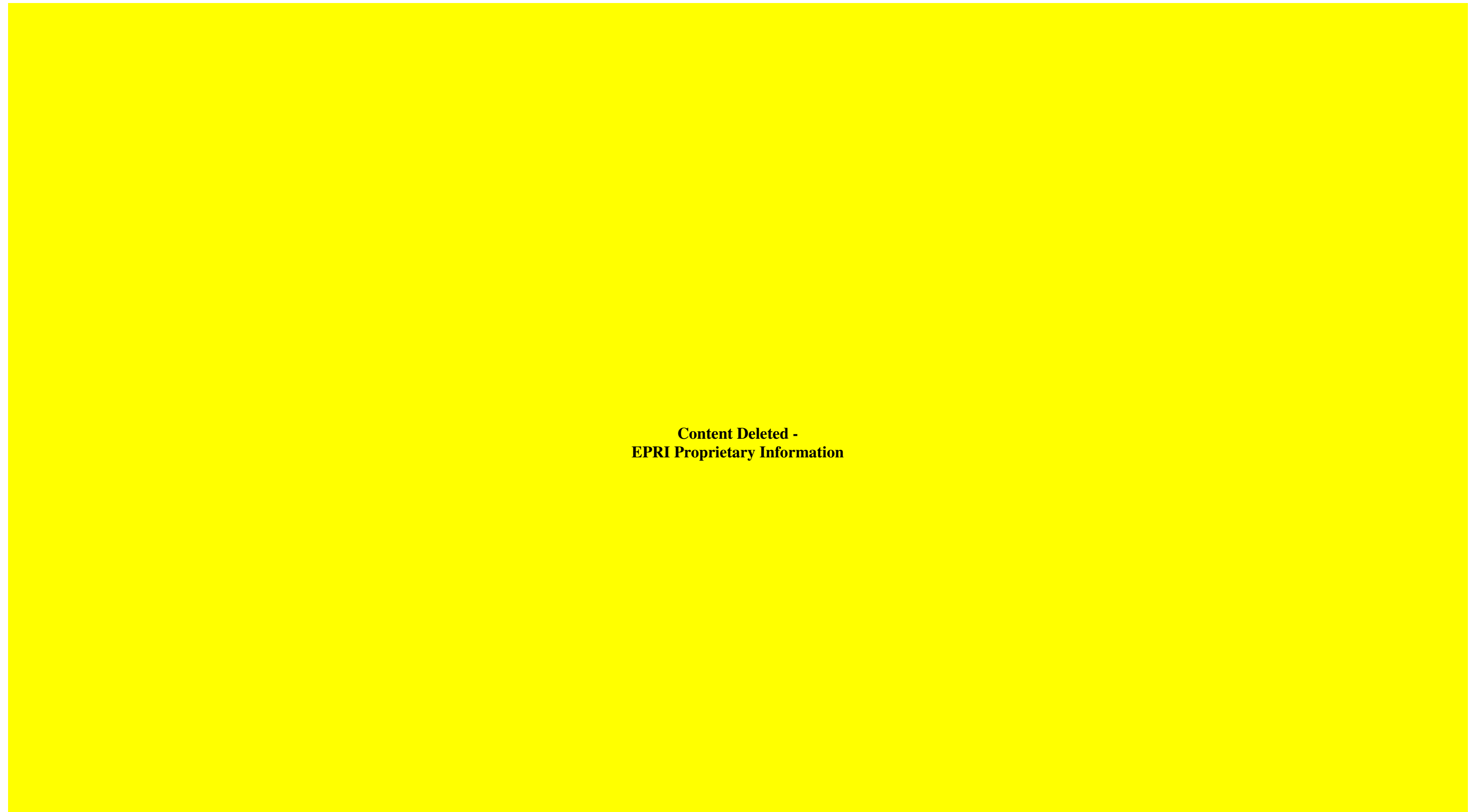


Figure 4.3.1.12-8. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 1 Through 5)

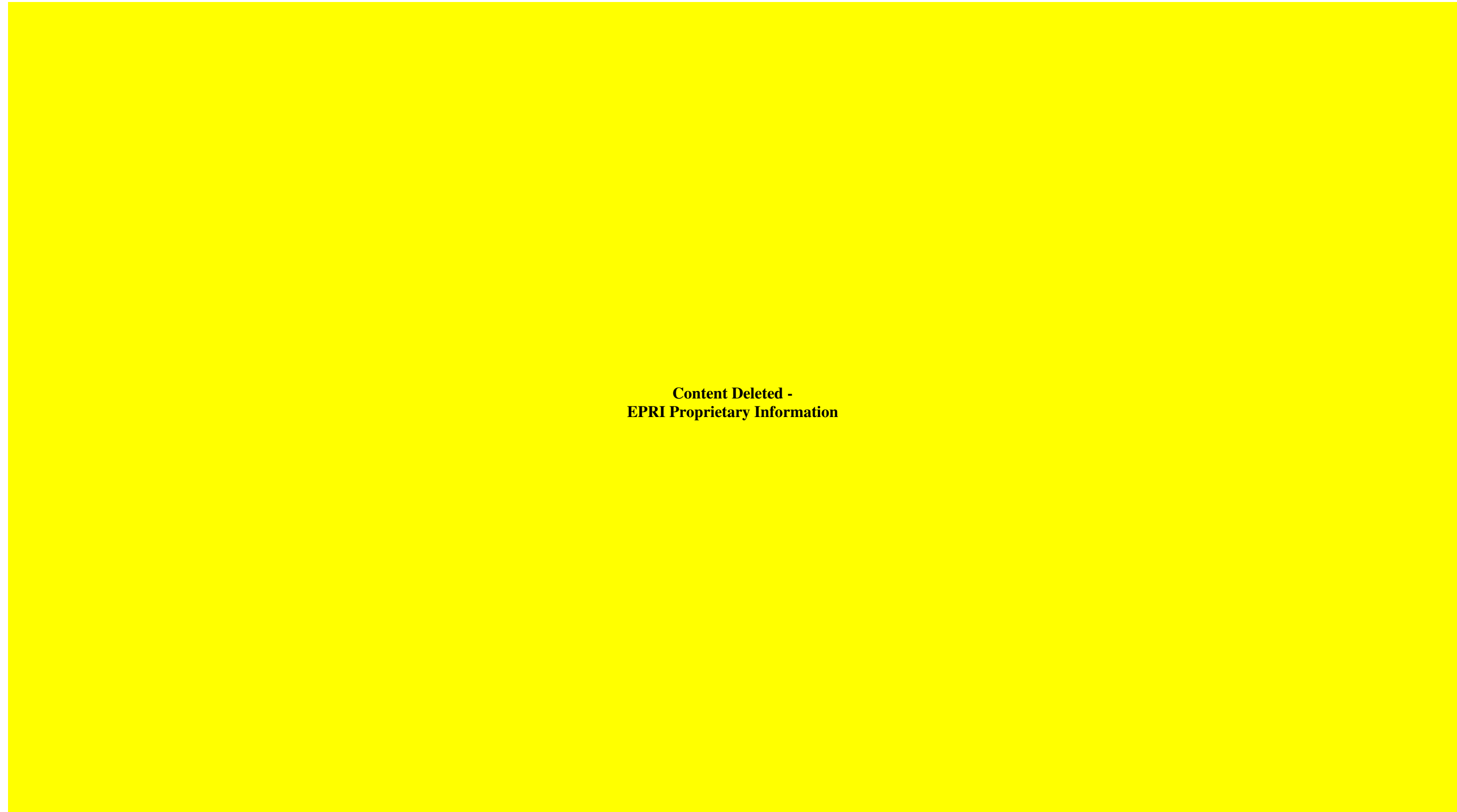


Figure 4.3.1.12-9. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 6 Through 11)



Figure 4.3.1.12-10. Flaw Details for BWRVIP-BWR6-H3-B (Flaws 12 Through 16)

5

SHROUD SUPPORT

5.1 Summary

**Content Deleted -
EPRI Proprietary Information**

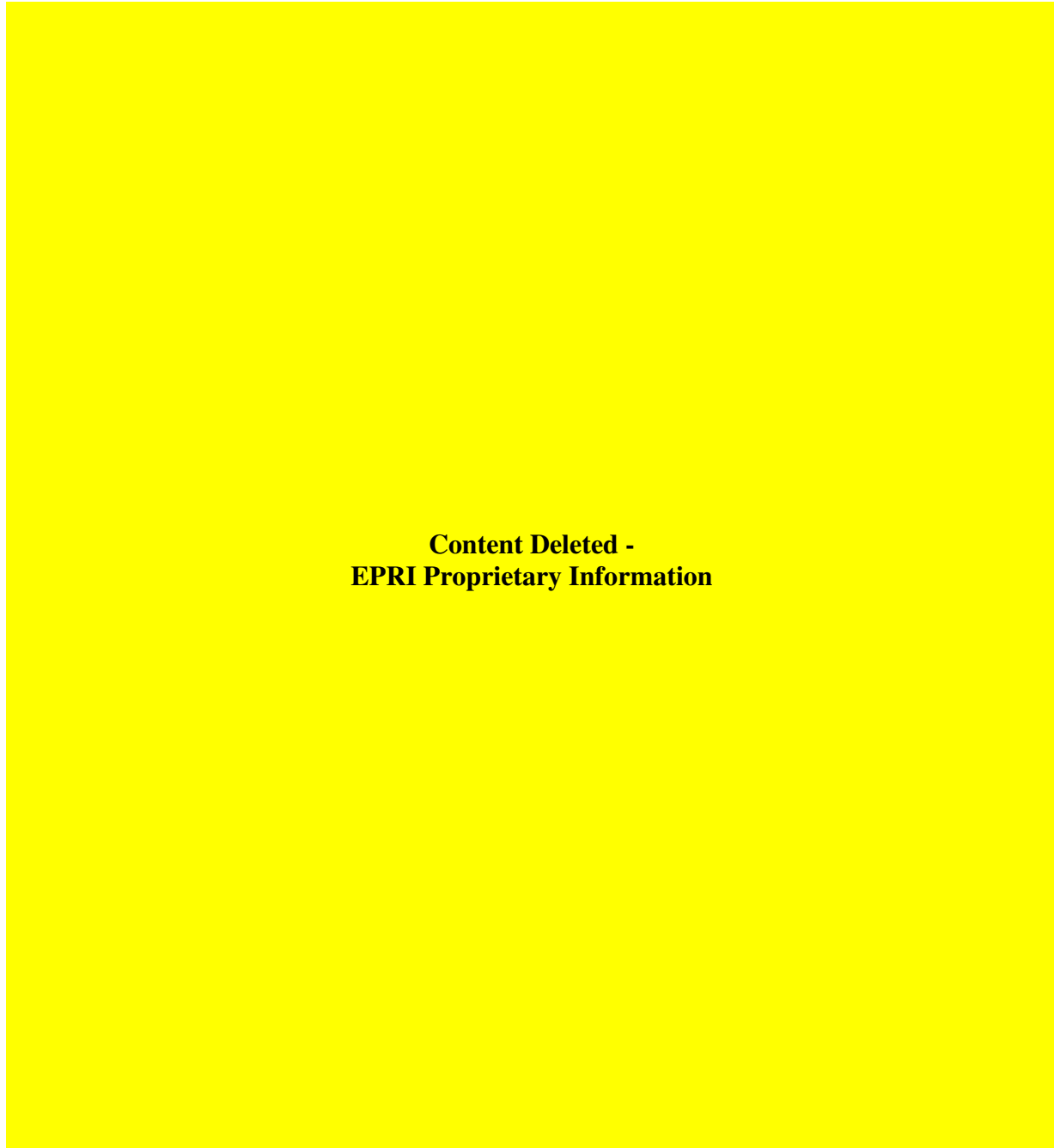
**Content Deleted -
EPRI Proprietary Information**

5.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

5.2.1 Chicago Bridge & Iron/CBI Nuclear Shroud Supports

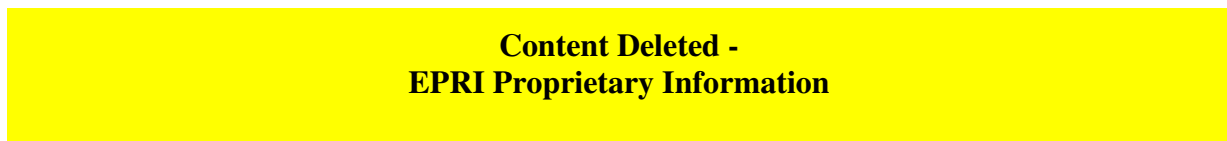
**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

Figure 5.2.1-1. CB&I/CBIN, B&W Shroud Support Configuration

5.2.2 Babcock & Wilcox Shroud Supports



**Content Deleted -
EPRI Proprietary Information**

5.2.3 Combustion Engineering Shroud Supports

**Content Deleted -
EPRI Proprietary Information**

5.2.3.1 Gusset Supports

**Content Deleted -
EPRI Proprietary Information**



Figure 5.2.3.1-1. CE Shroud Support Configuration

5.2.3.2 Cone Skirt Support



Figure 5.2.3.2-1. BWR/2 Cone Skirt Shroud Support Configuration

5.2.3.3 Heavy Steel Baffle Plate

Content Deleted -EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

Figure 5.2.3.3-1. Hatch Unit 2 Shroud Support Configuration

5.2.4 Inspection Access

**Content Deleted -
EPRI Proprietary Information**

5.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

5.3.1 Shroud Support Mockup BWRVIP-D: Weld H7

**Content Deleted -
EPRI Proprietary Information**

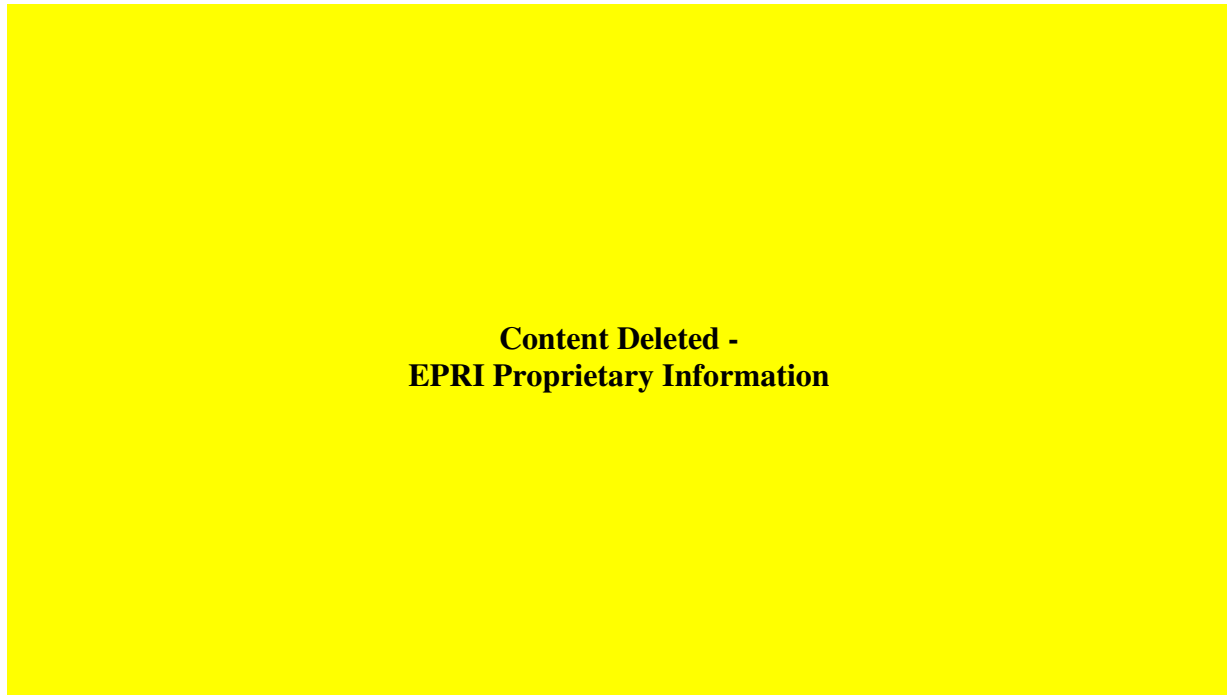
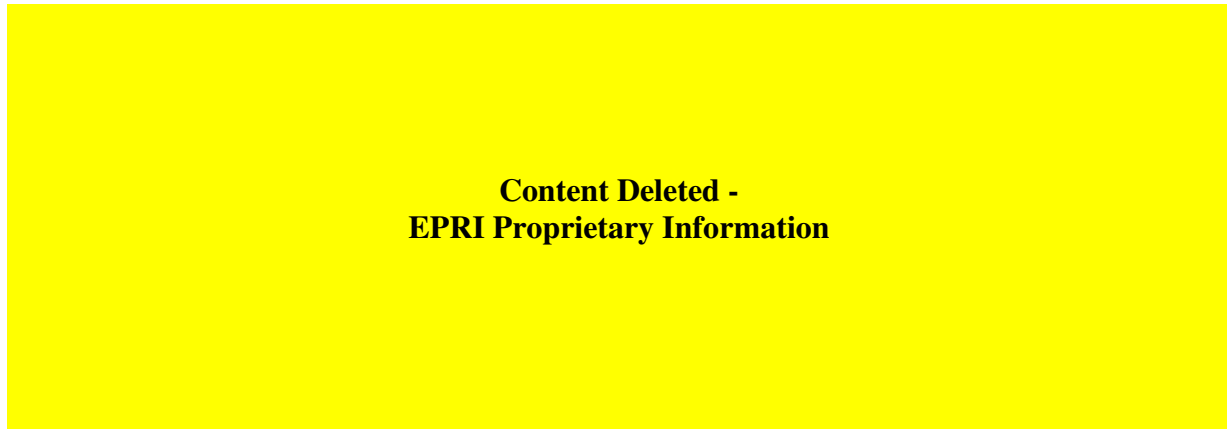


Figure 5.3.1-1. Configuration of Mockup BWRVIP-D, Representing Weld H7

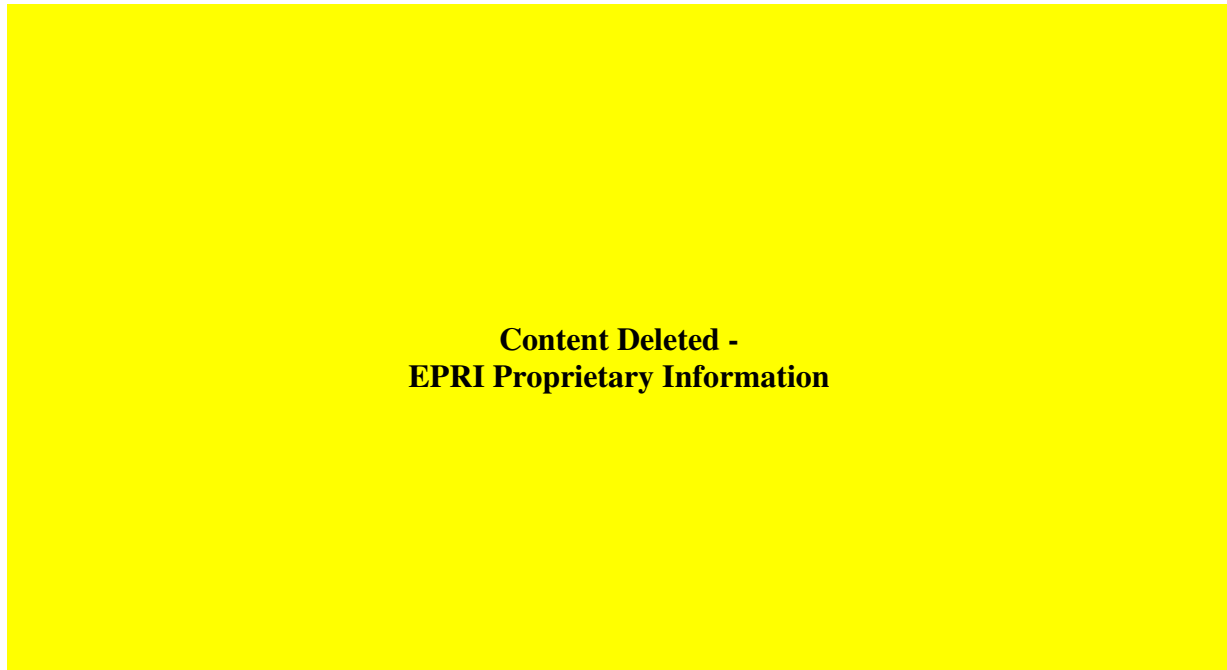


Figure 5.3.1-2. Cross Section of Mockup BWRVIP-D

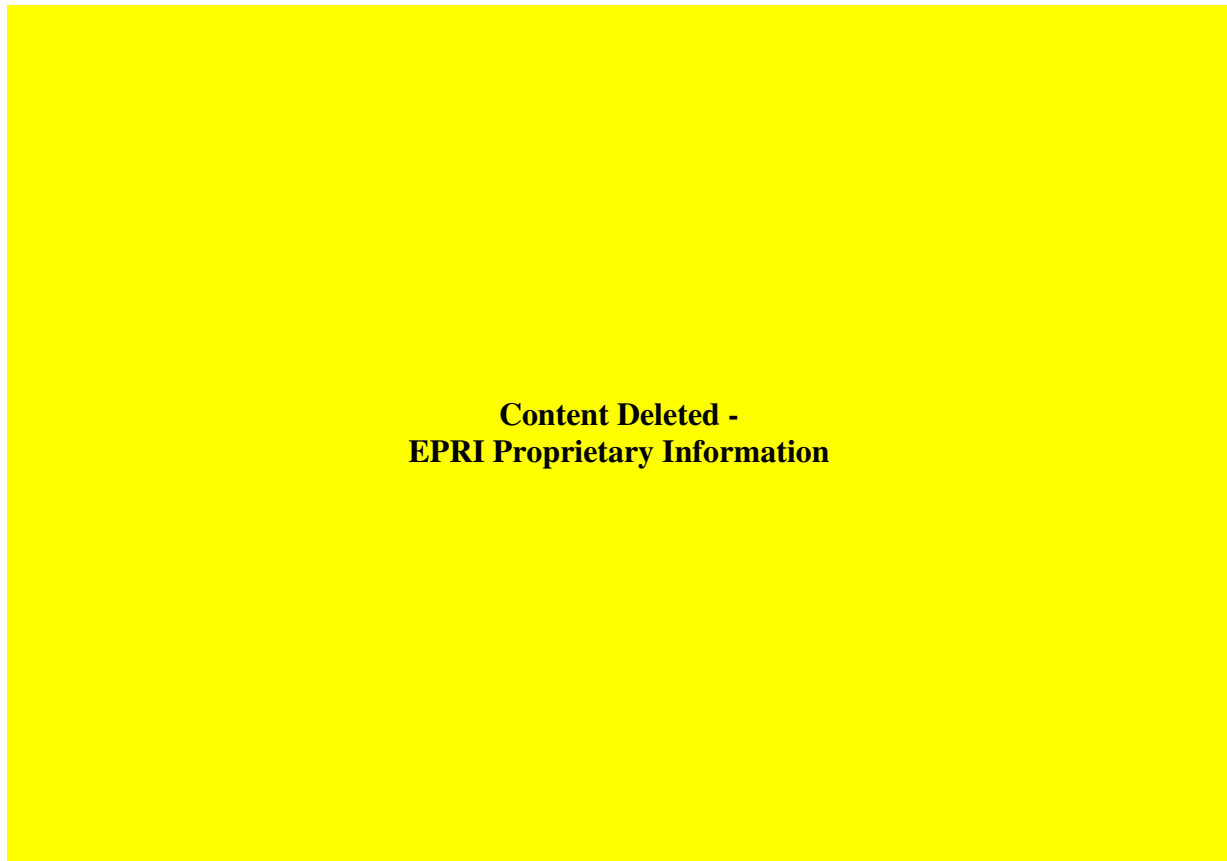


Figure 5.3.1-3. Distribution of Flaws in Mockup BWRVIP-D

**Content Deleted -
EPRI Proprietary Information**

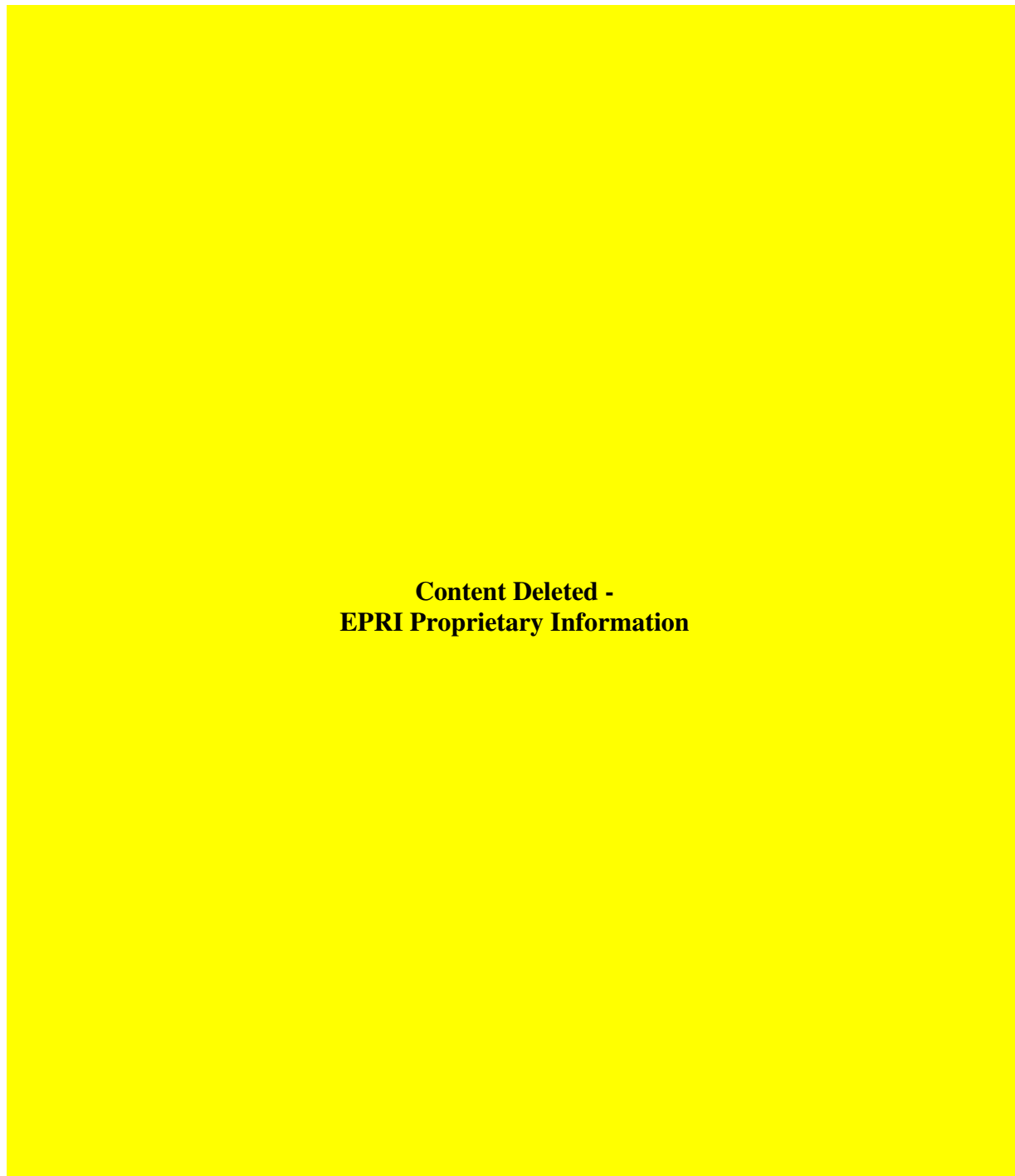


Figure 5.3.1-4. BWRVIP-D2 Flaws 5J Through 5Q

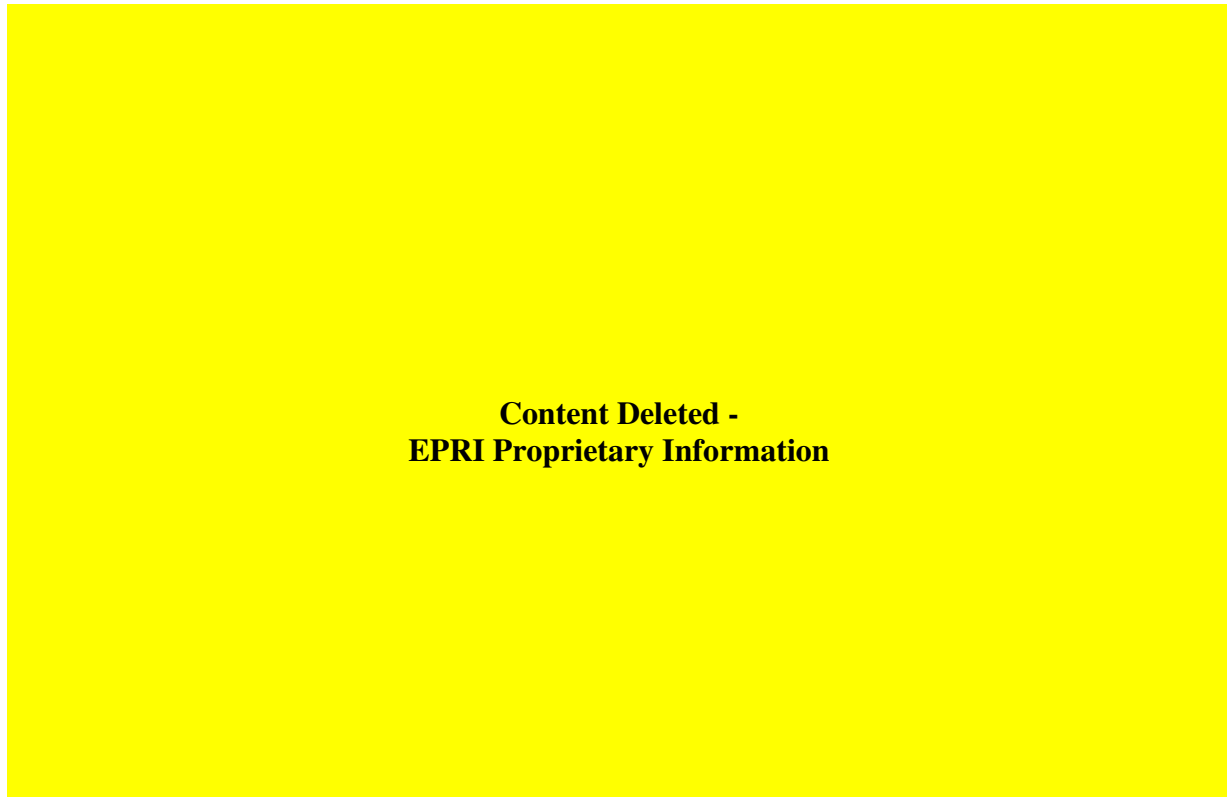
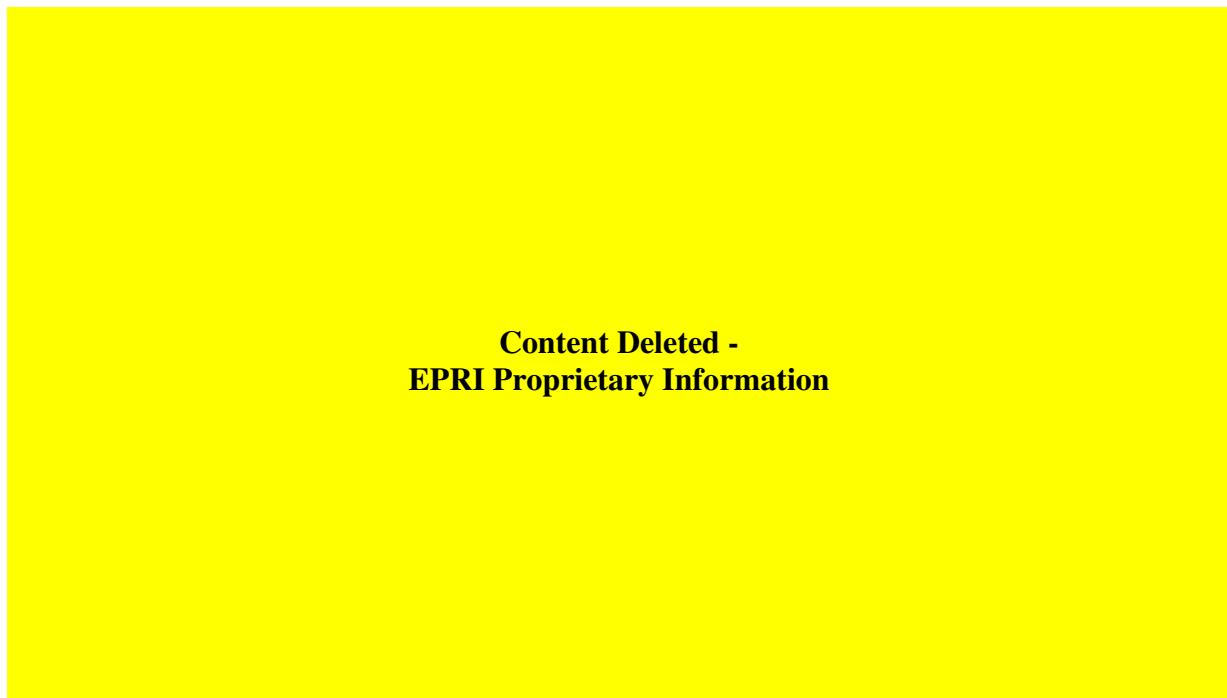


Figure 5.3.1-5. BWRVIP-D2 Flaws 5R Through 5U

**5.3.2 Shroud Support Mockups BWRVIP-E, BWRVIP-E1, and BWRVIP-E2:
Weld H9**



**Content Deleted -
EPRI Proprietary Information**



Figure 5.3.2-1. Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details

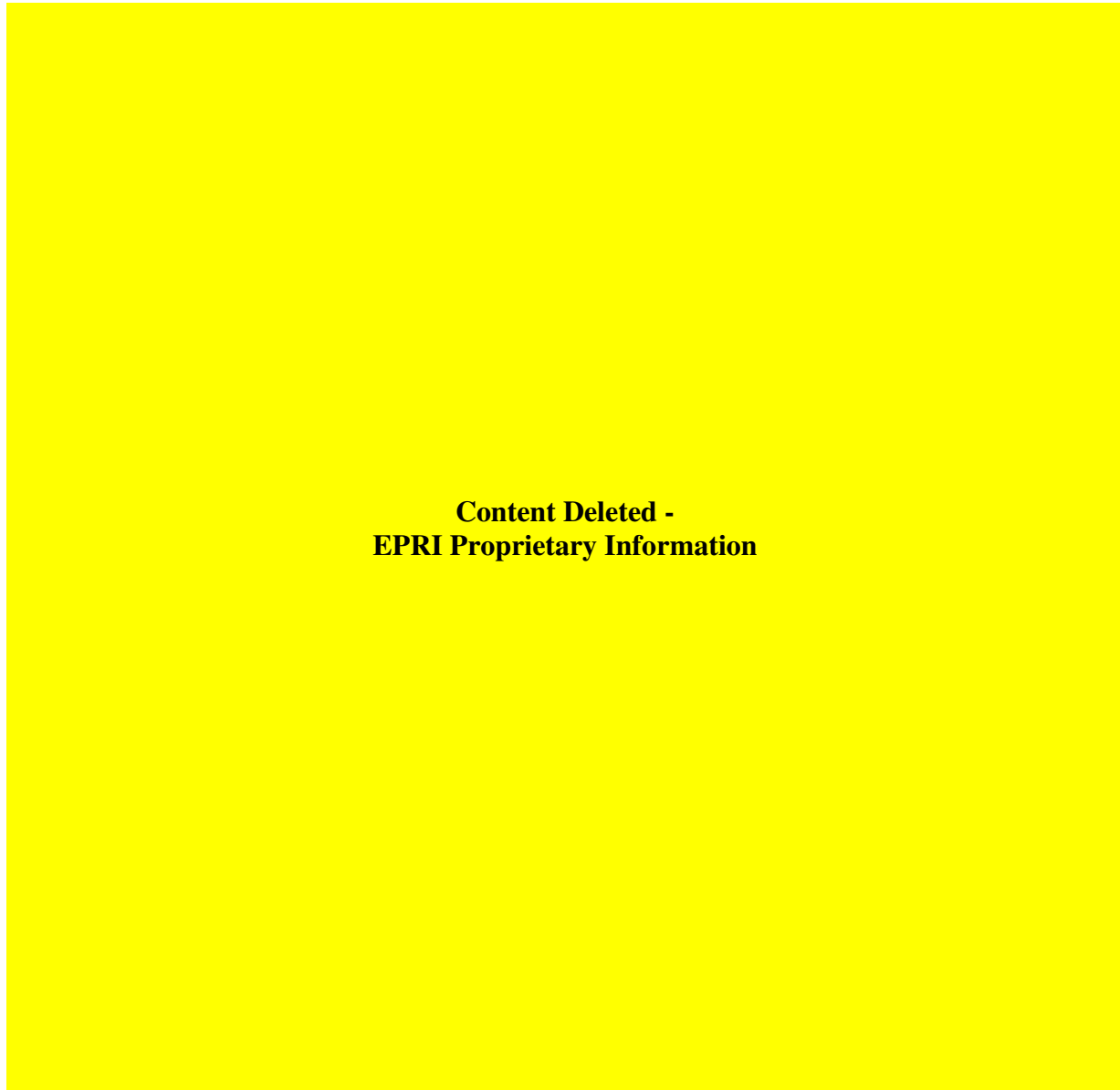


Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details



Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details



Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details

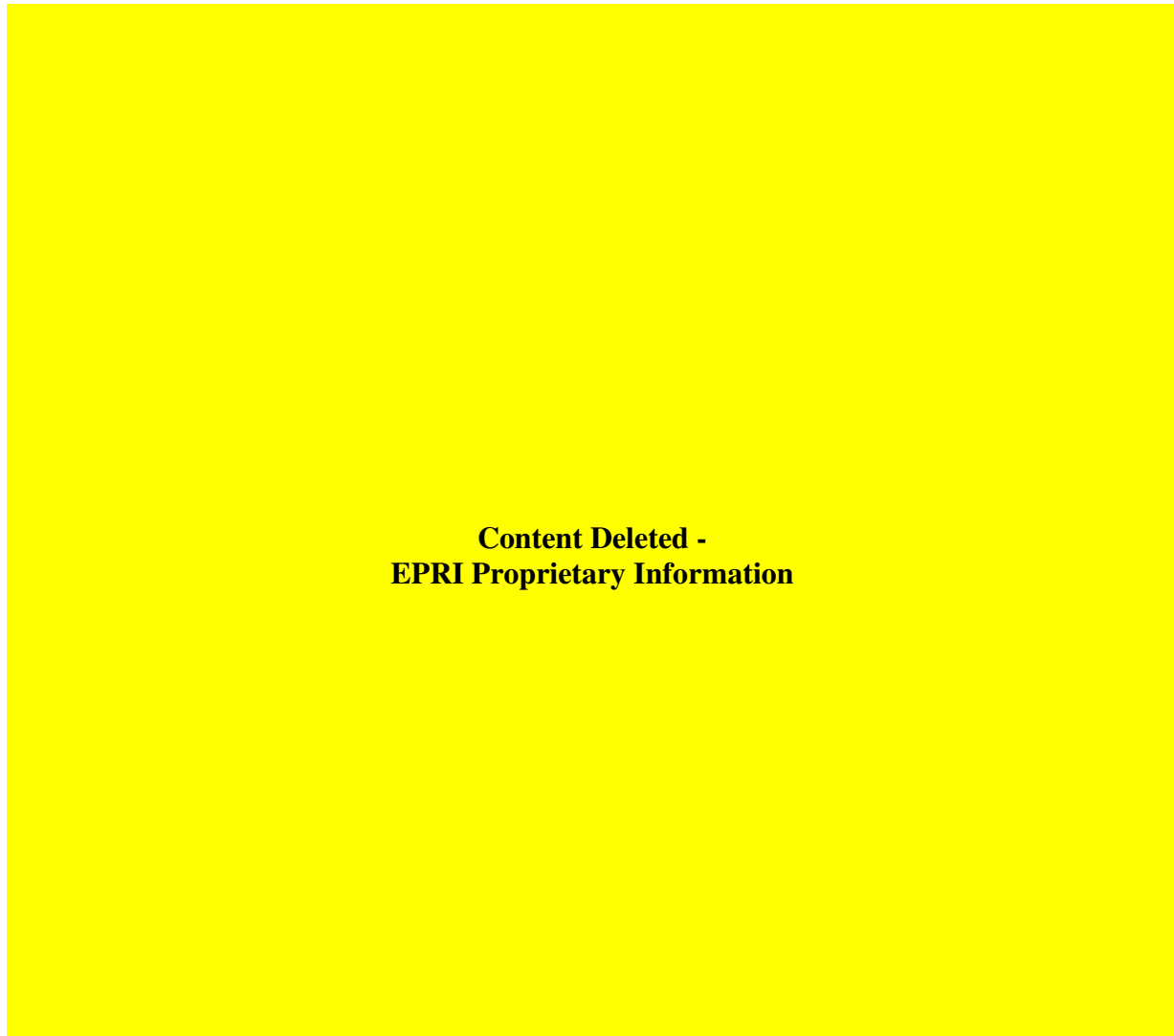


Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details



Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details

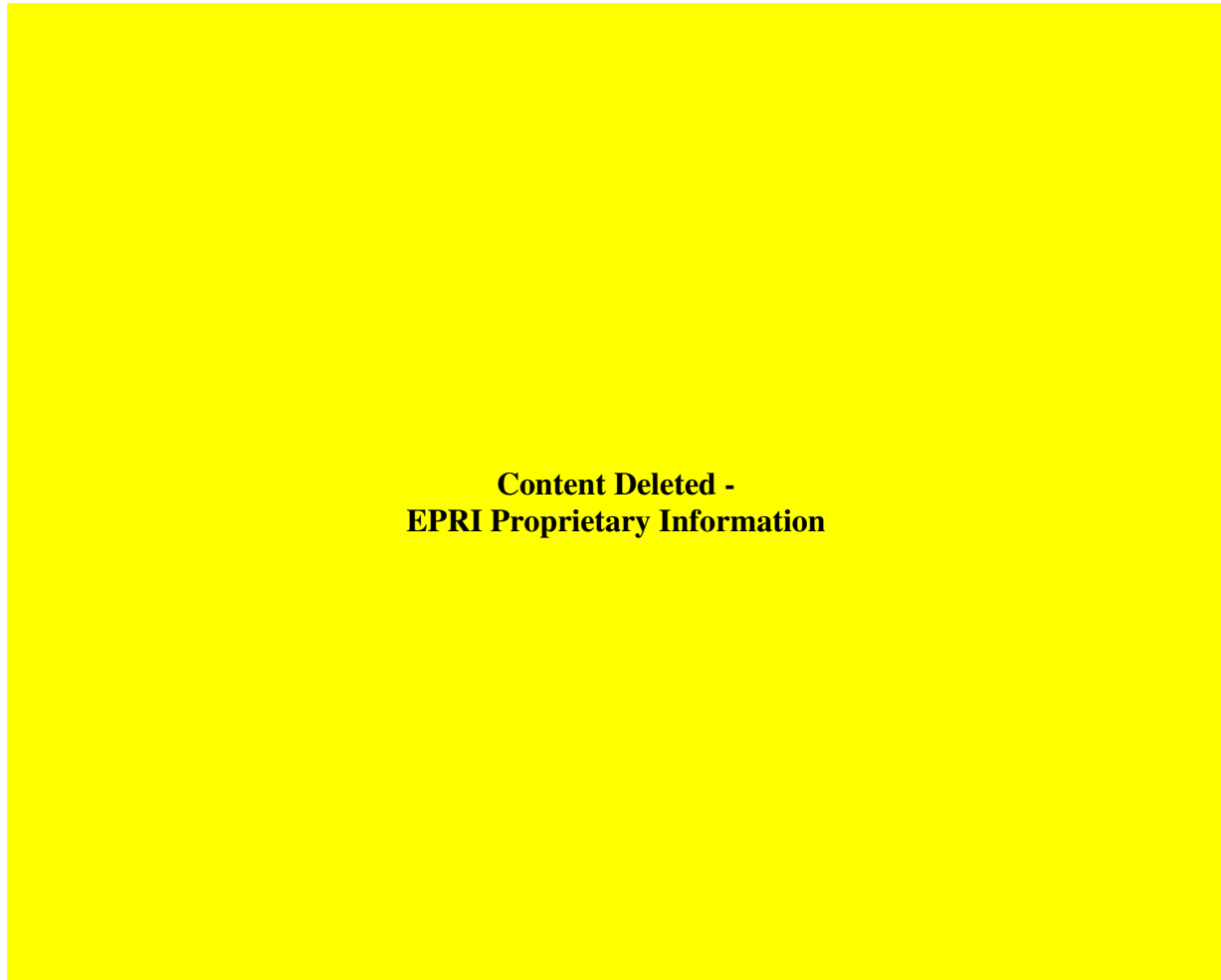


Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details.



Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details



Figure 5.3.2-1 (continued). Mockup BWRVIP-E, Representing Weld H9: Configuration and Flaw Details



Figure 5.3.2-2. Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

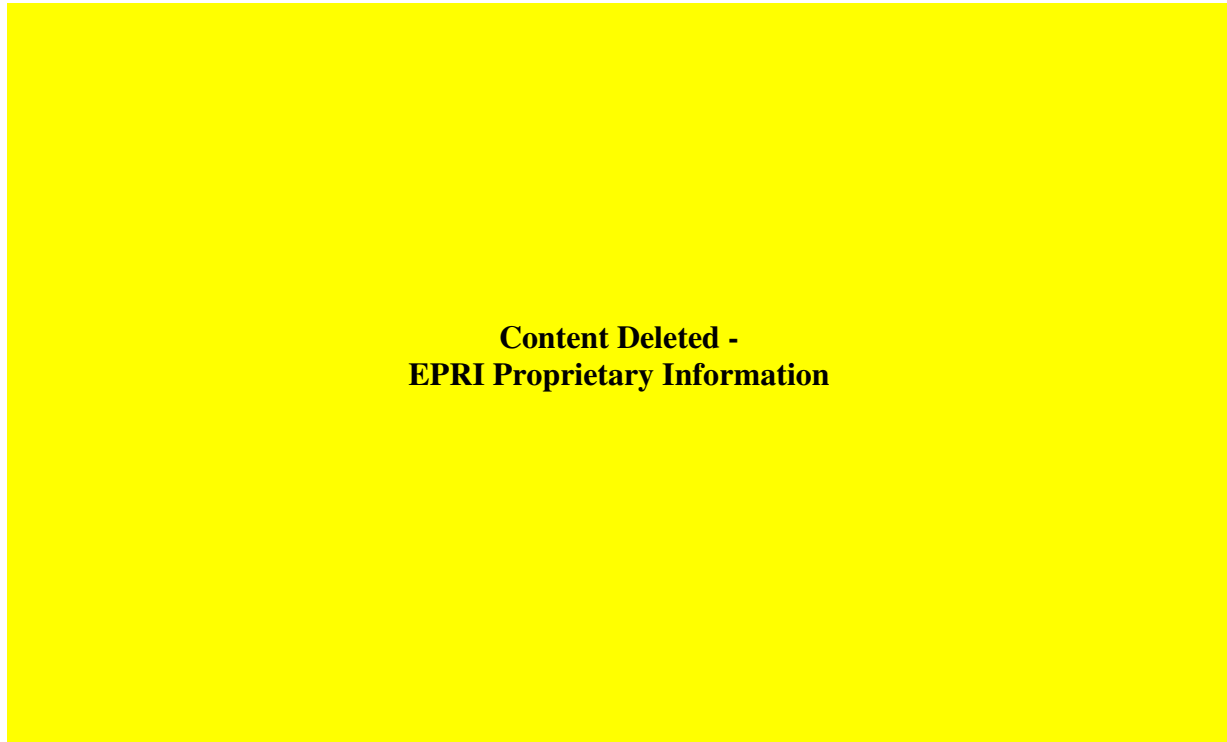


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

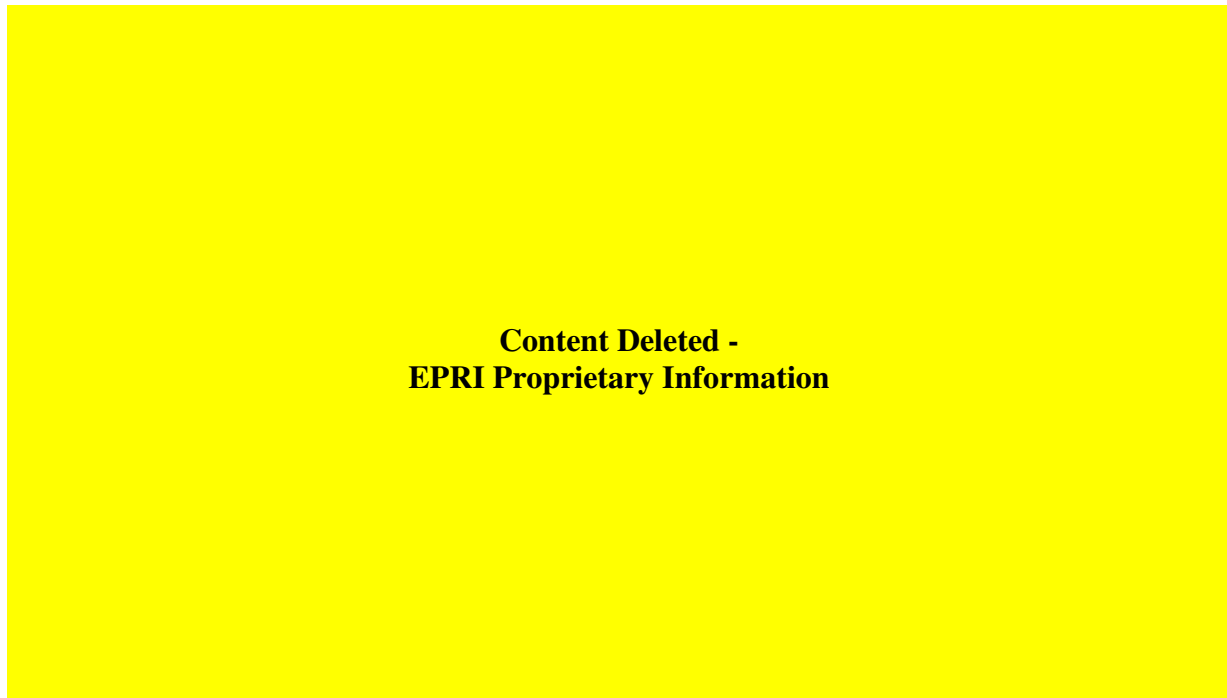


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

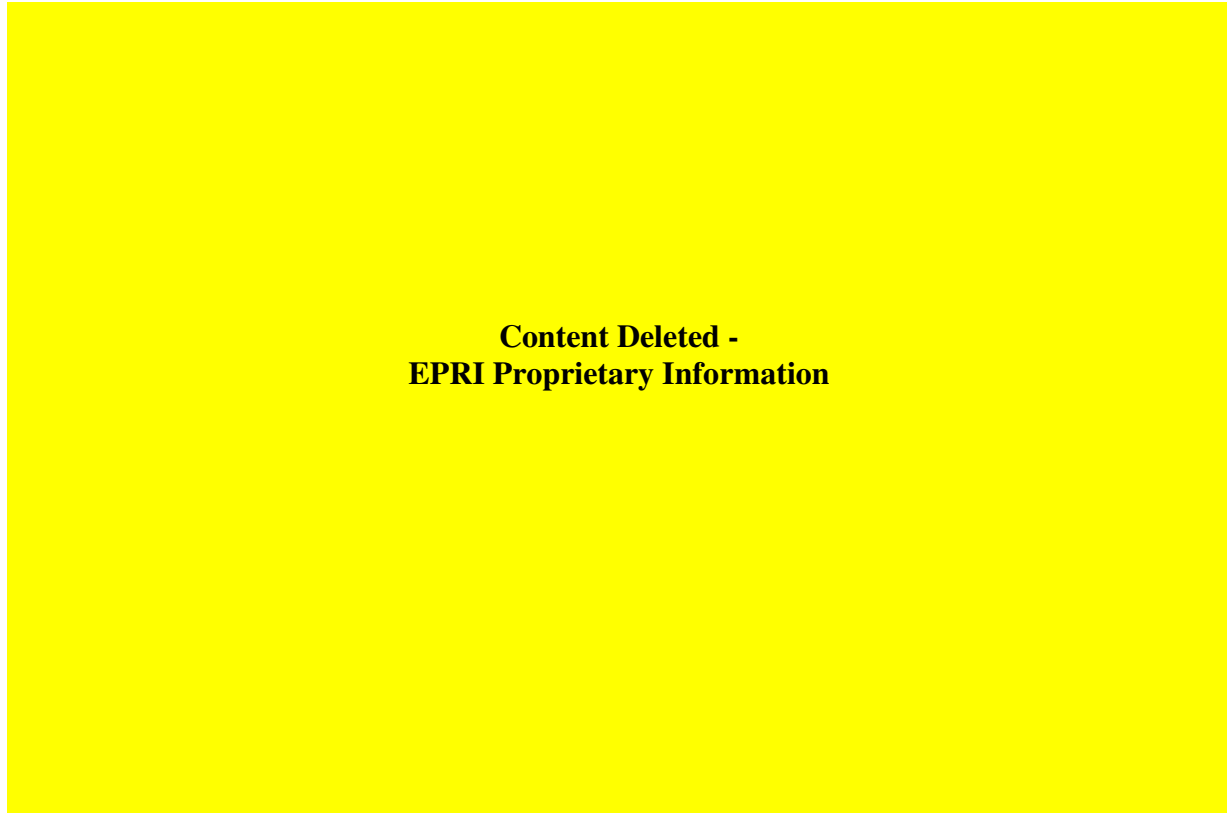


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

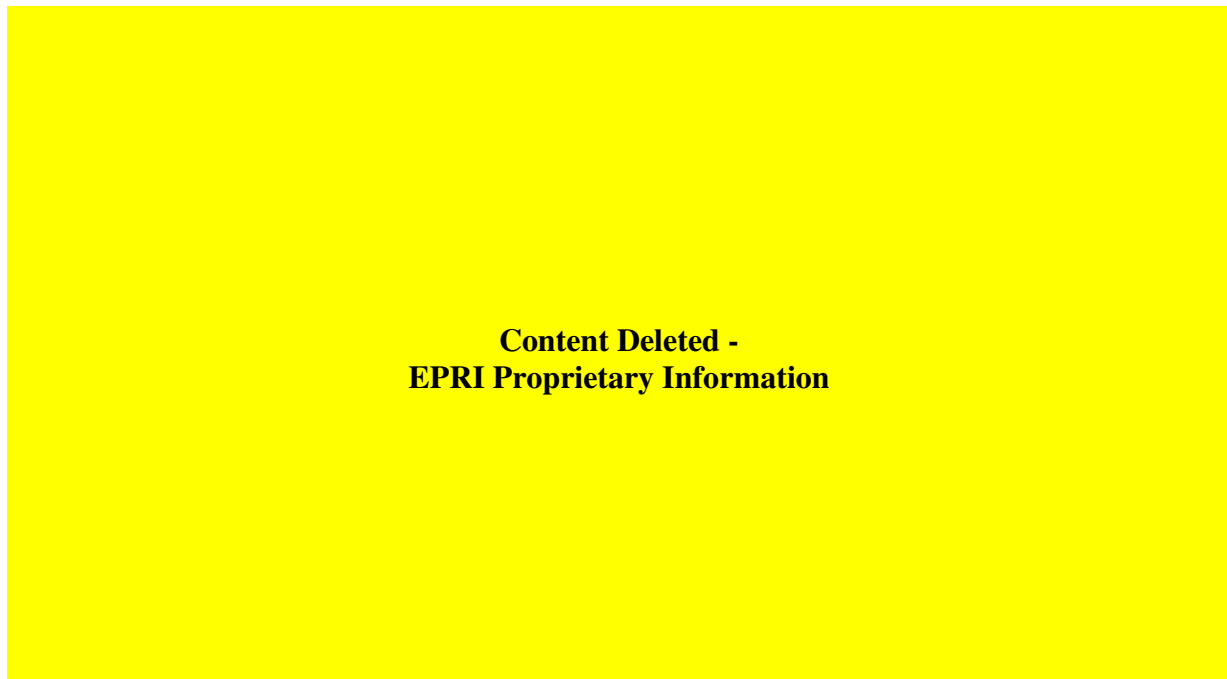


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

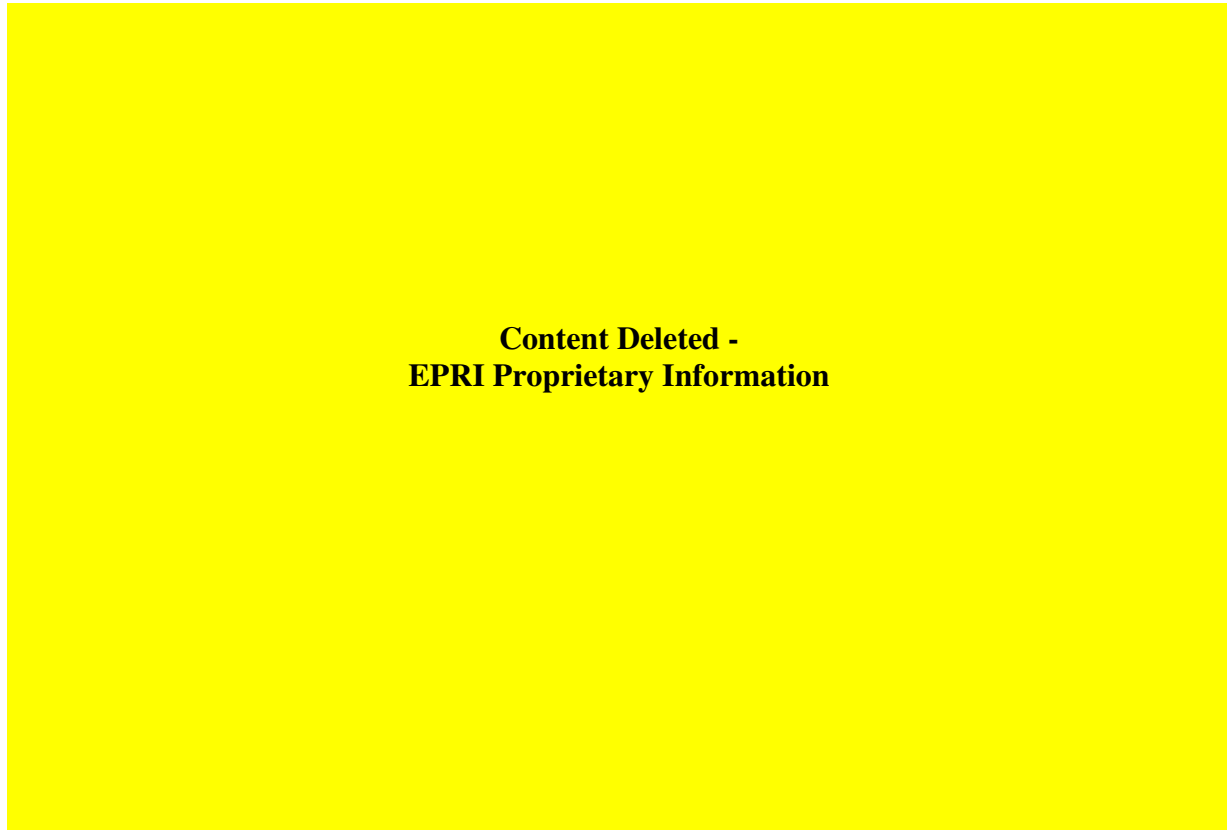


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

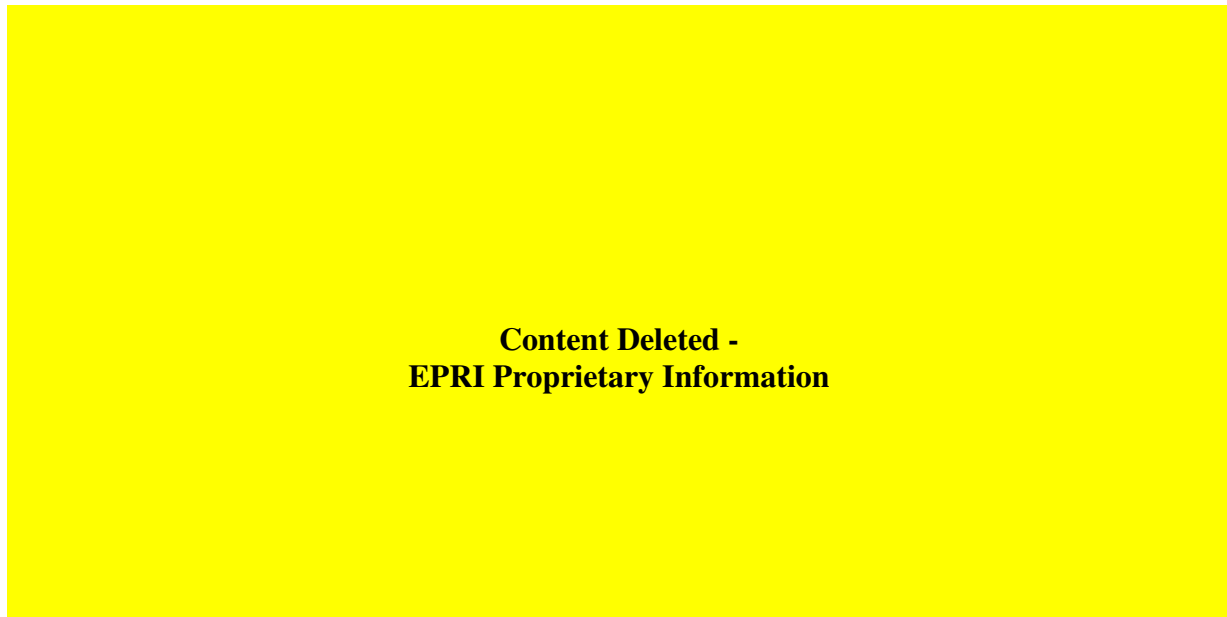


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

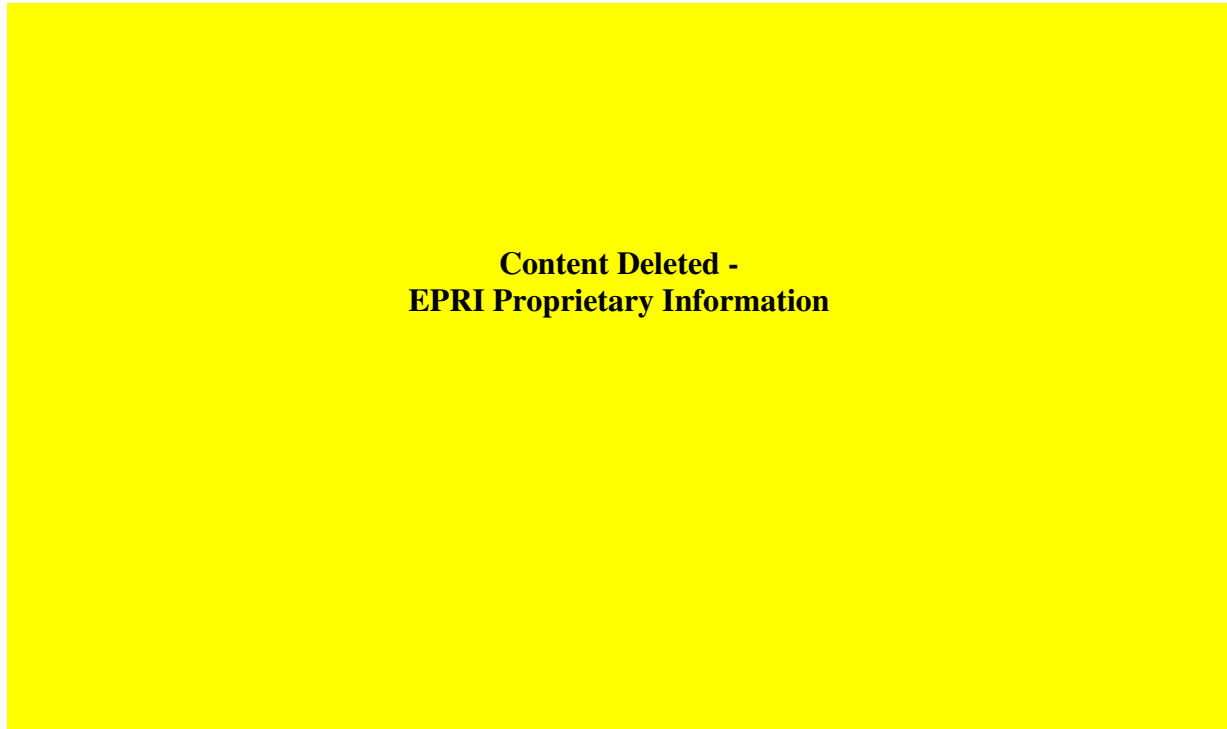


Figure 5.3.2-2 (continued). Mockup BWRVIP-E1, Representing Weld H9: Configuration and Flaw Details

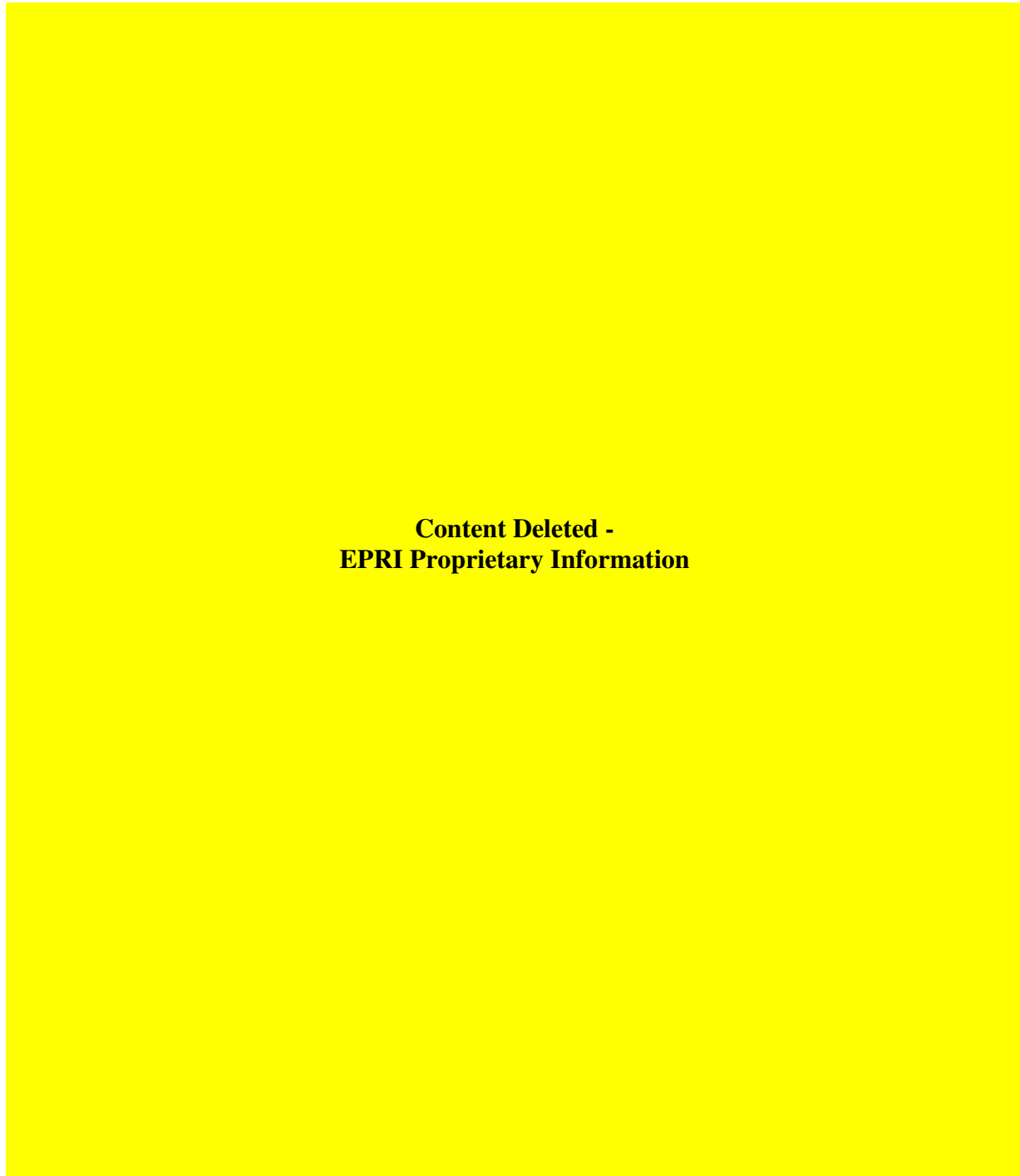


Figure 5.3.2-3. Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

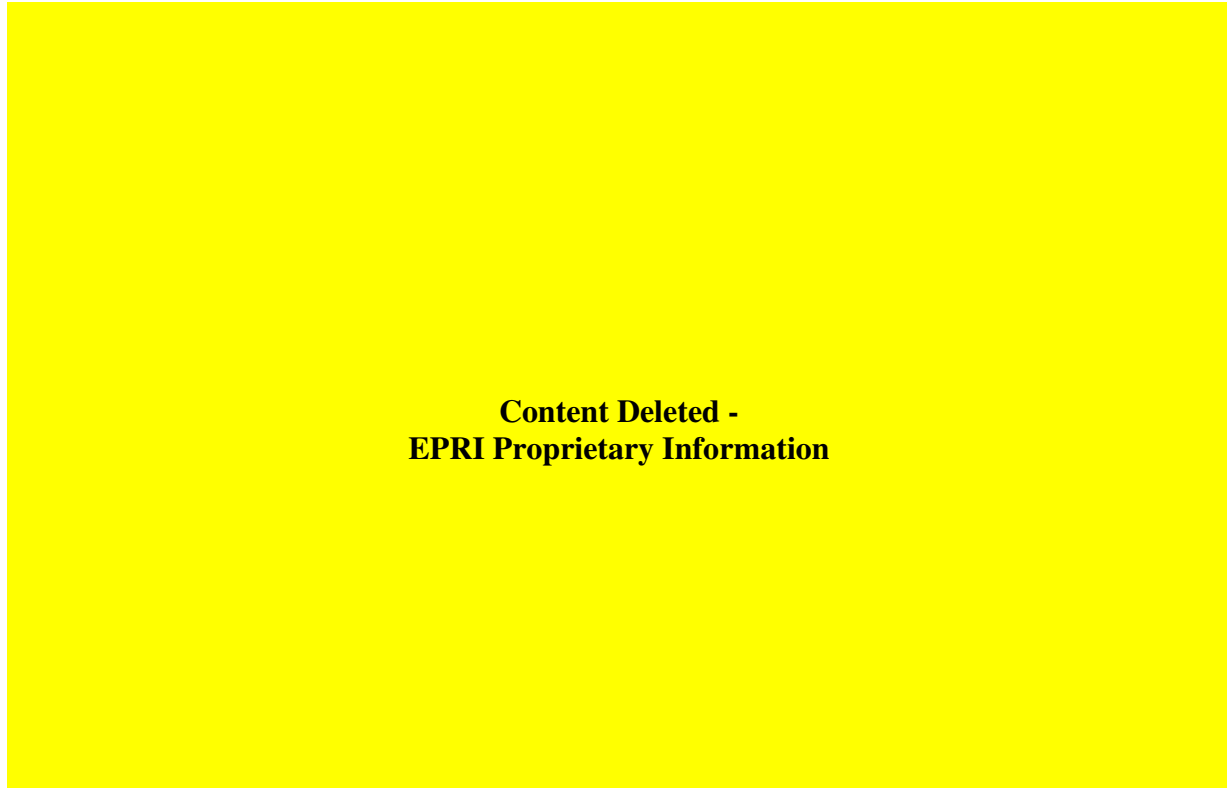


Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

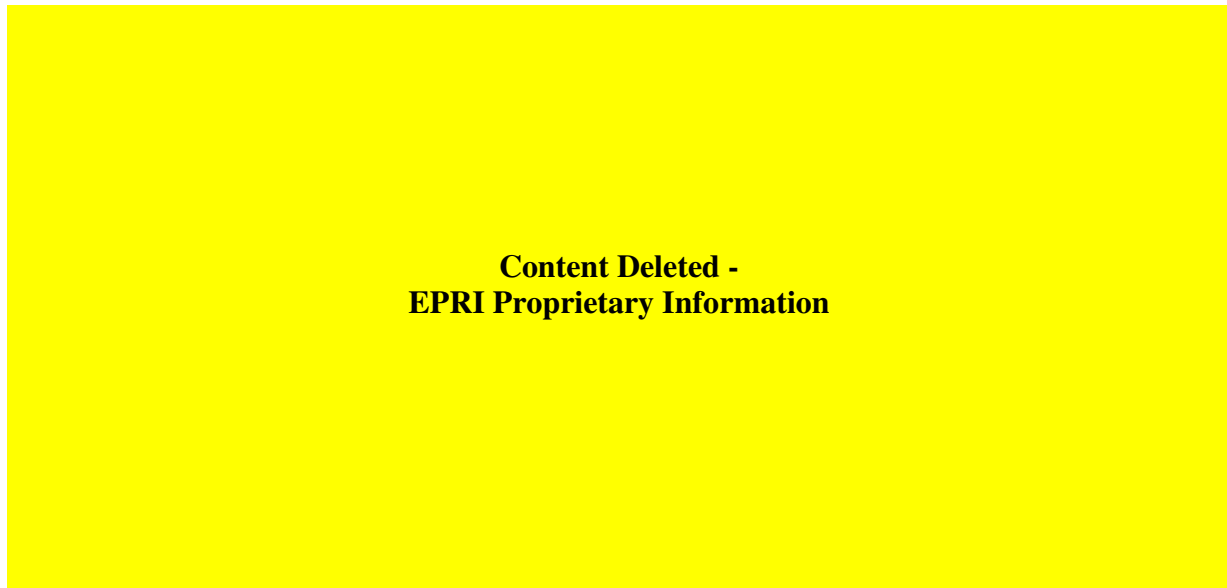


Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

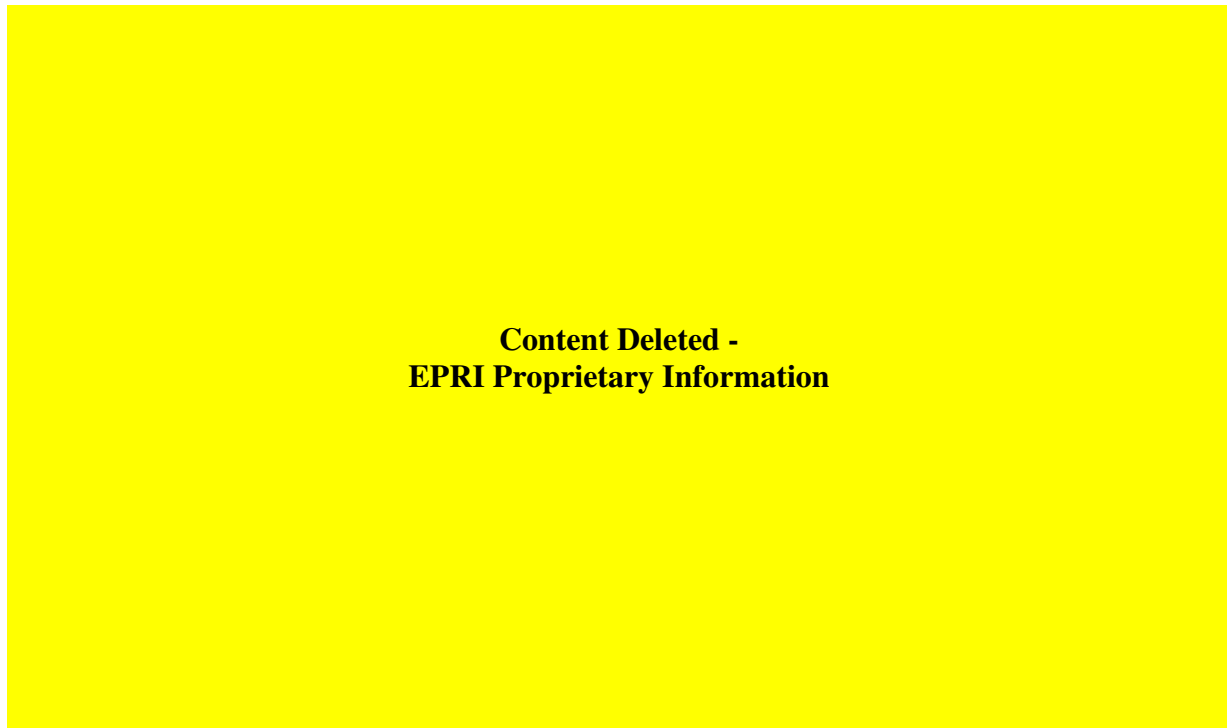


Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

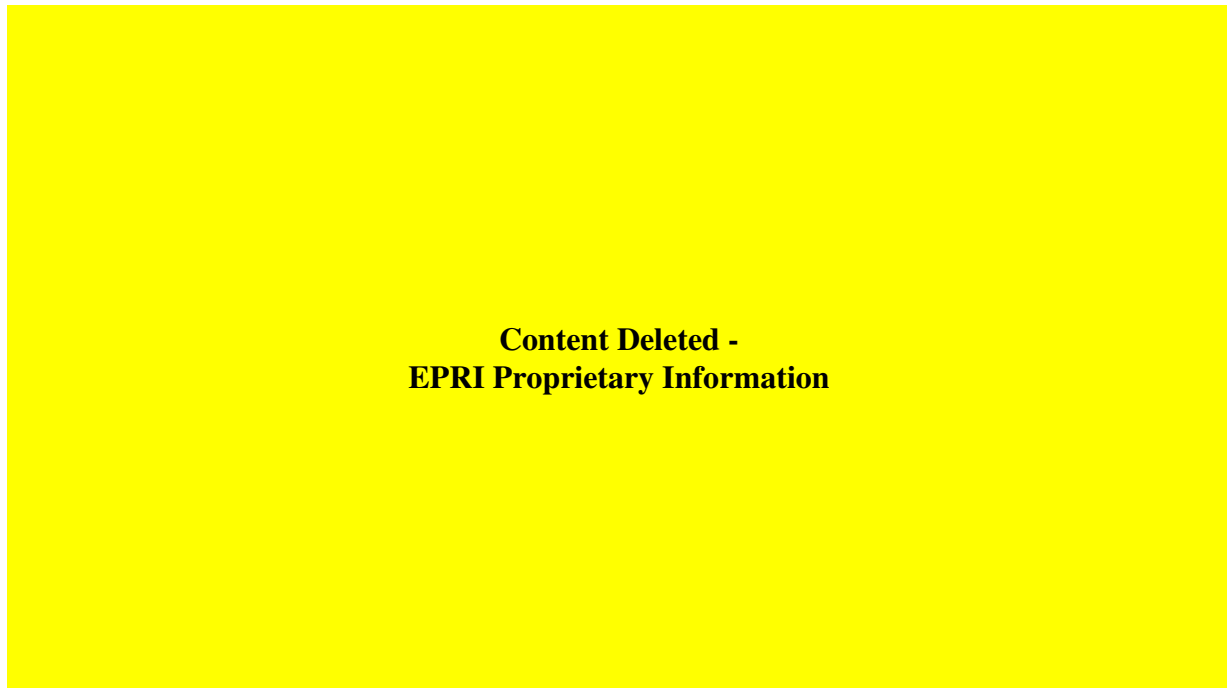


Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details



**Content Deleted -
EPRI Proprietary Information**

Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details



**Content Deleted -
EPRI Proprietary Information**

Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

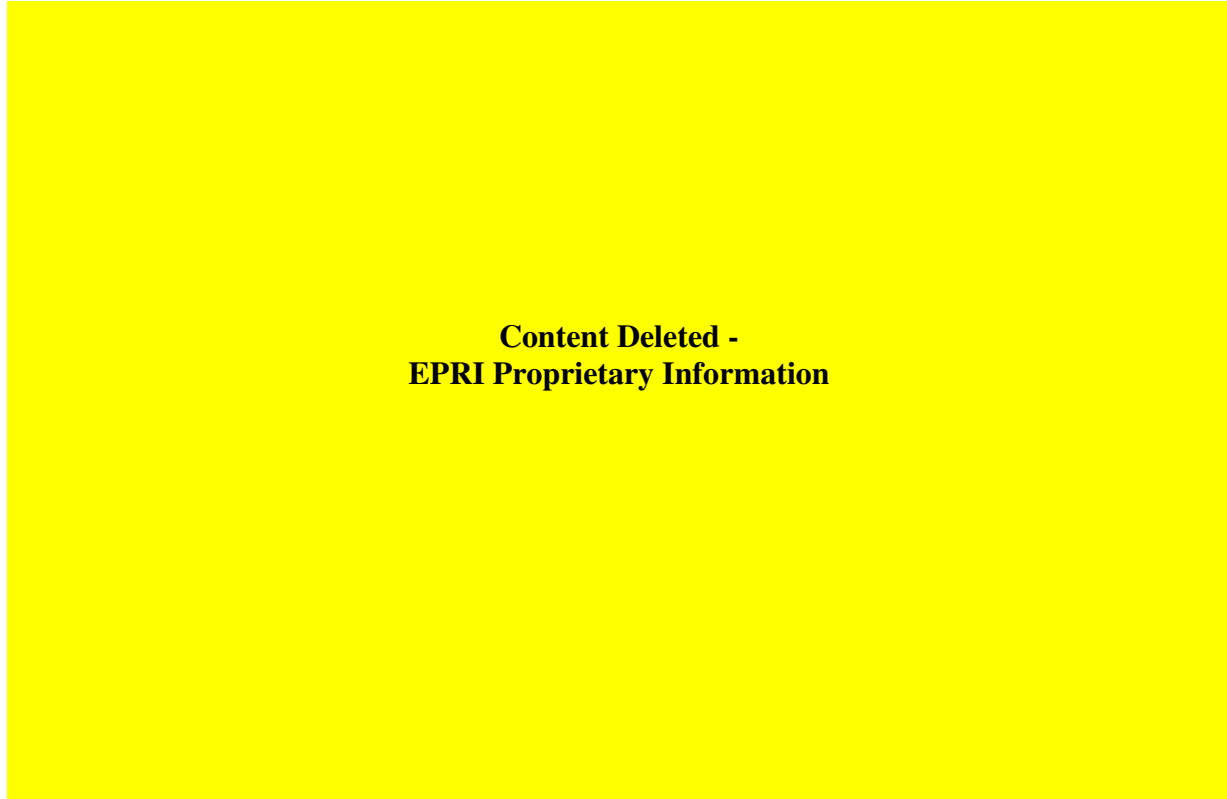


Figure 5.3.2-3 (continued). Mockup BWRVIP-E2, Representing Weld H9: Configuration and Flaw Details

5.3.3 Shroud Support Mockup BWRVIP-F: Weld H8

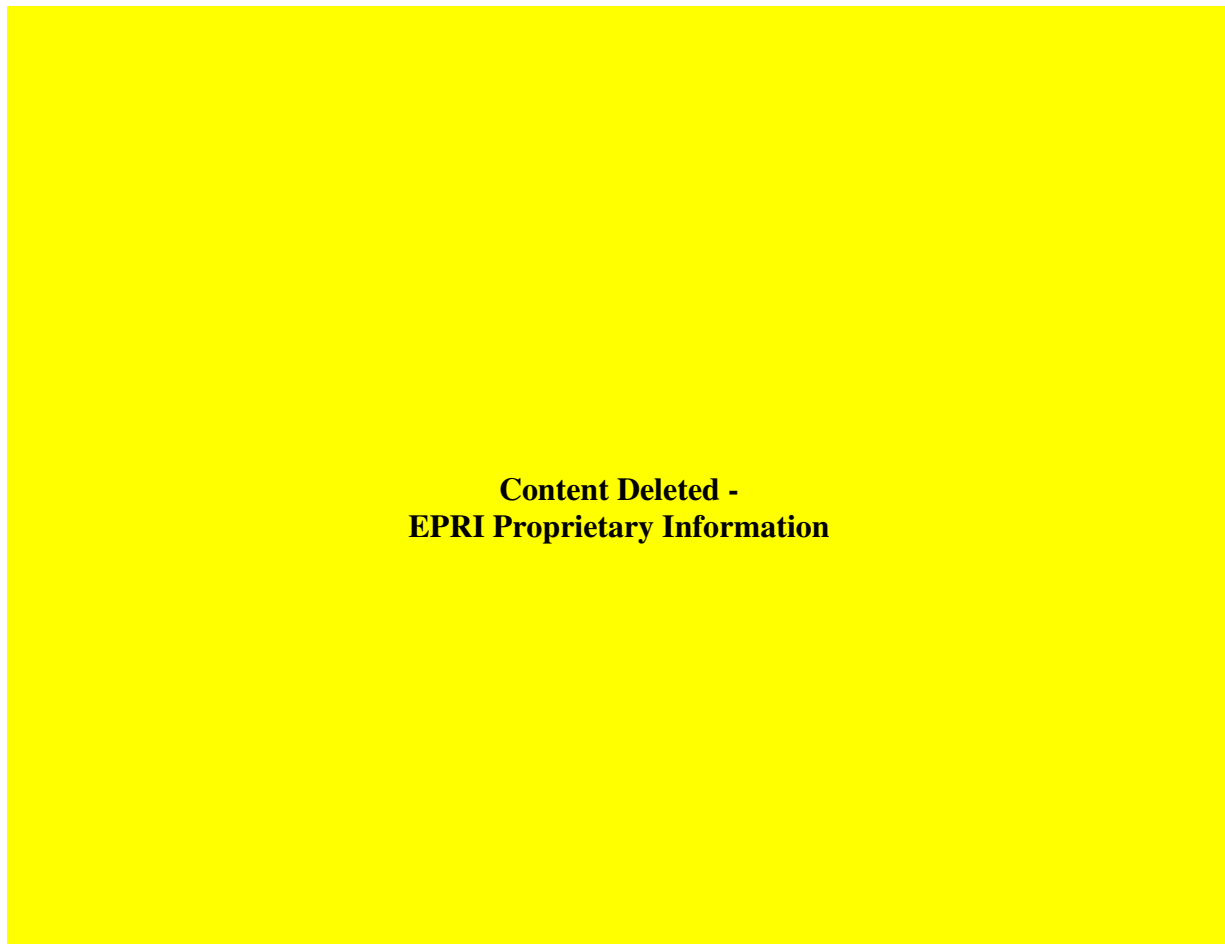
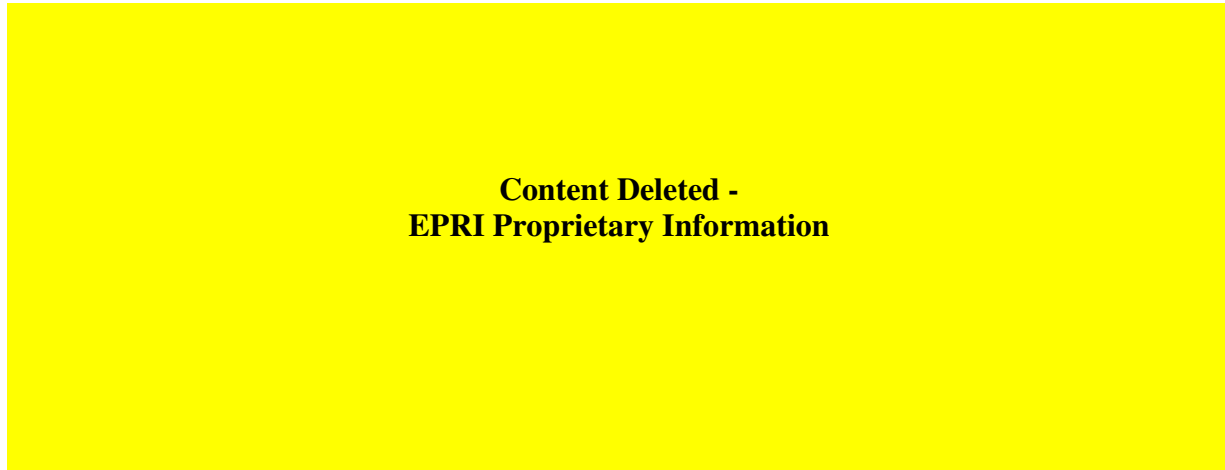


Figure 5.3.3-1. Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

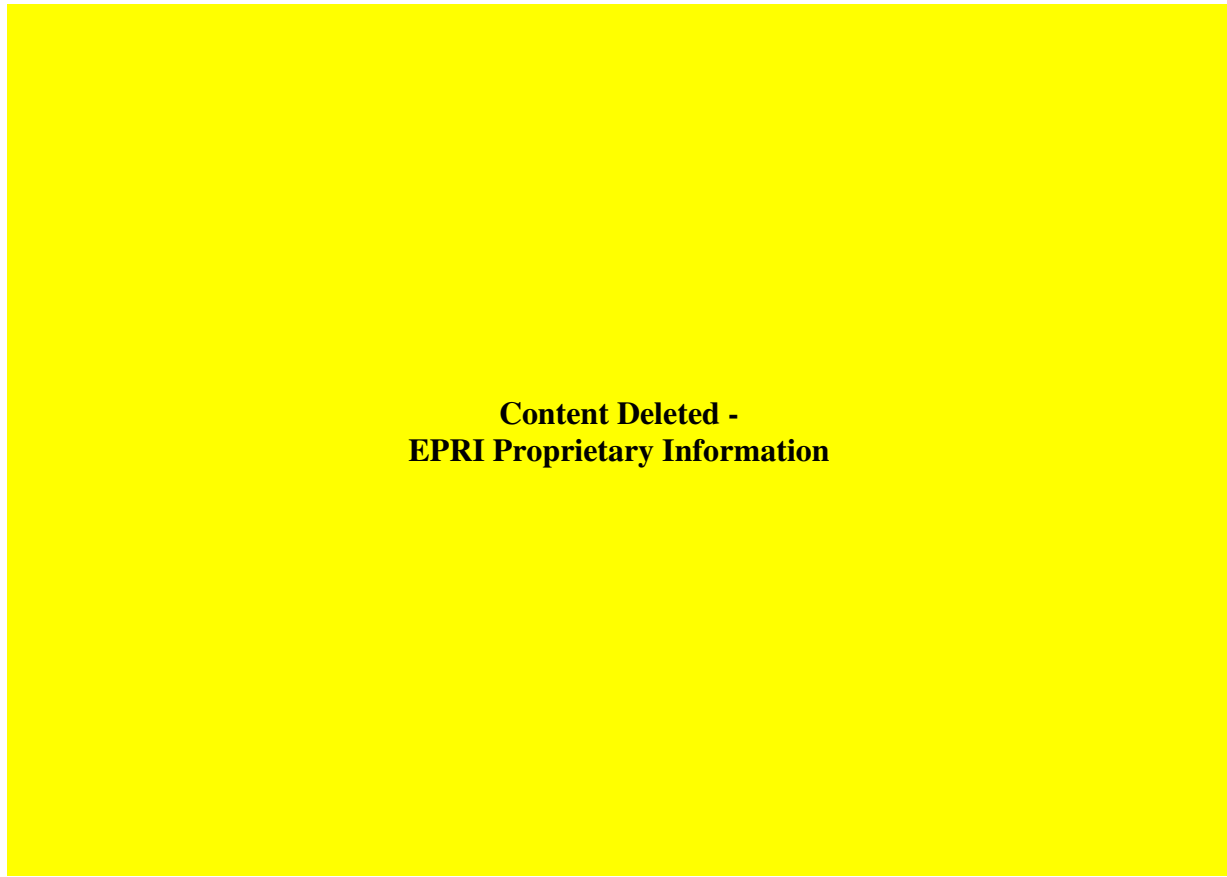


Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

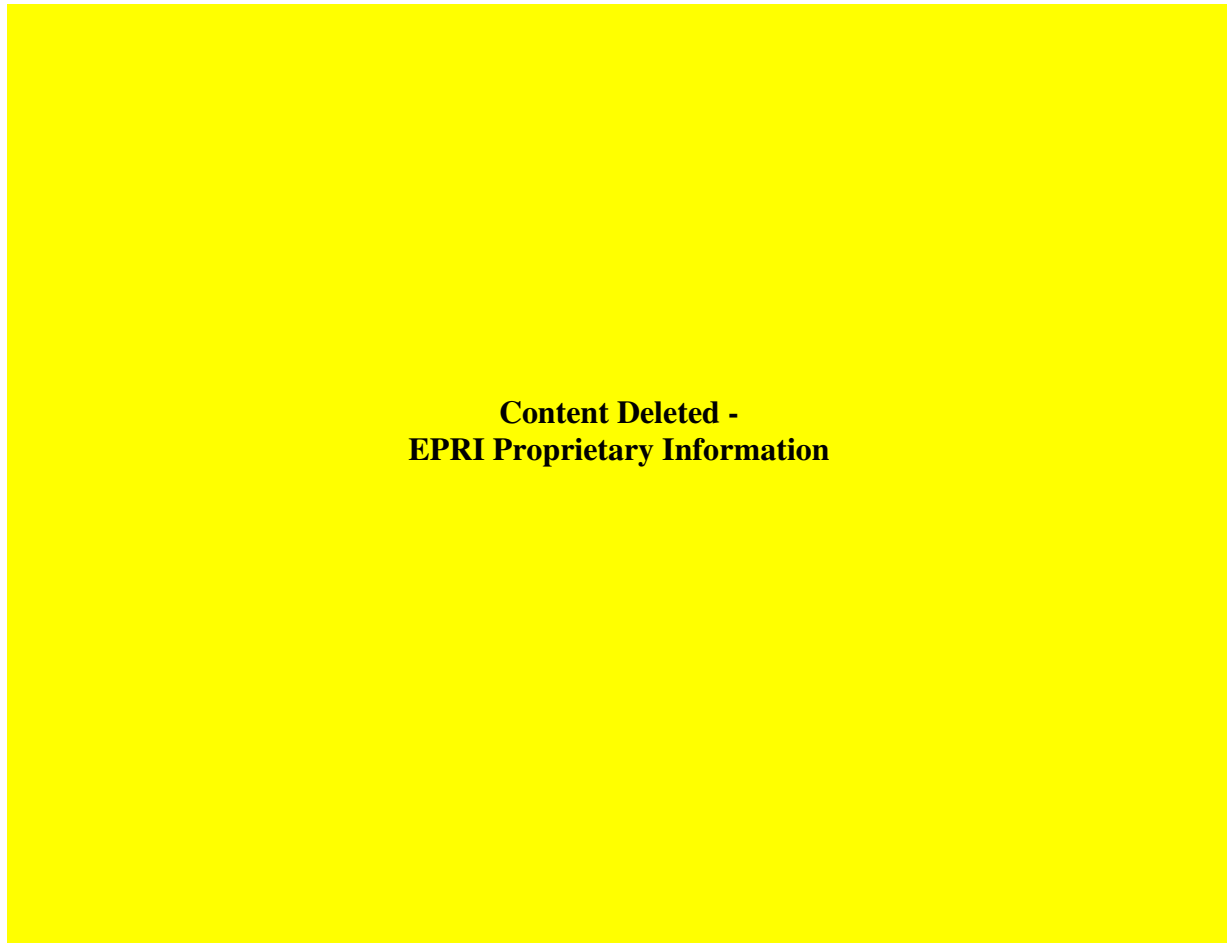


Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

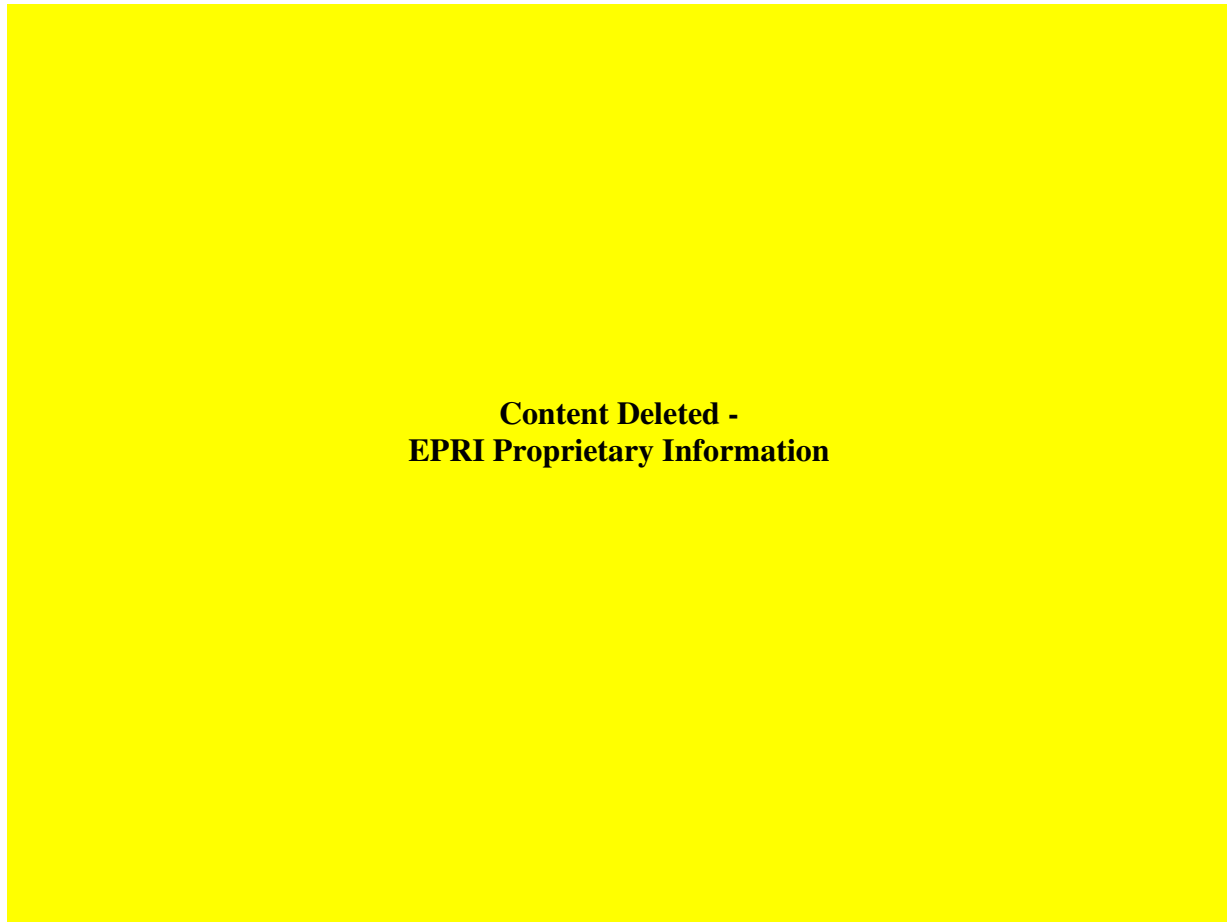


Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

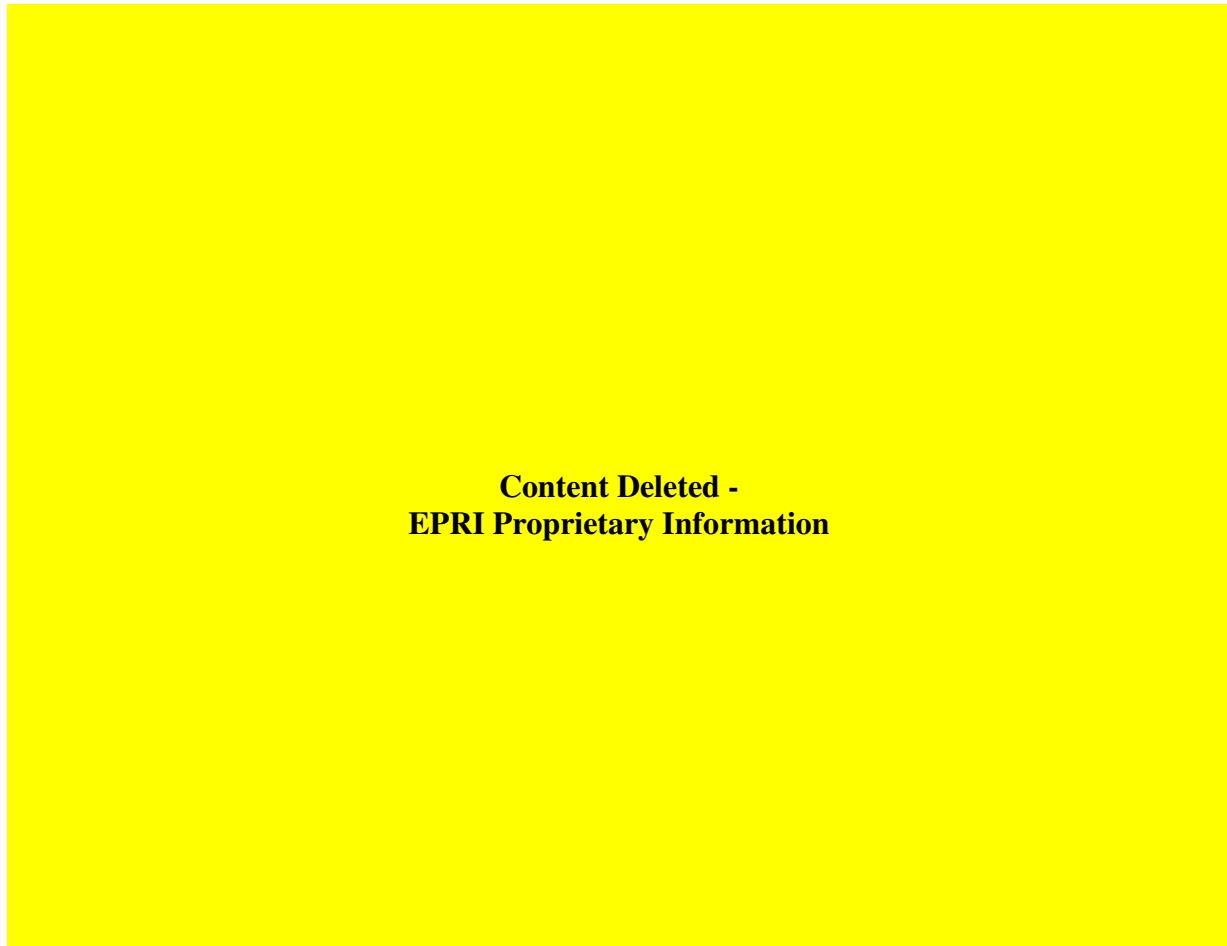


Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

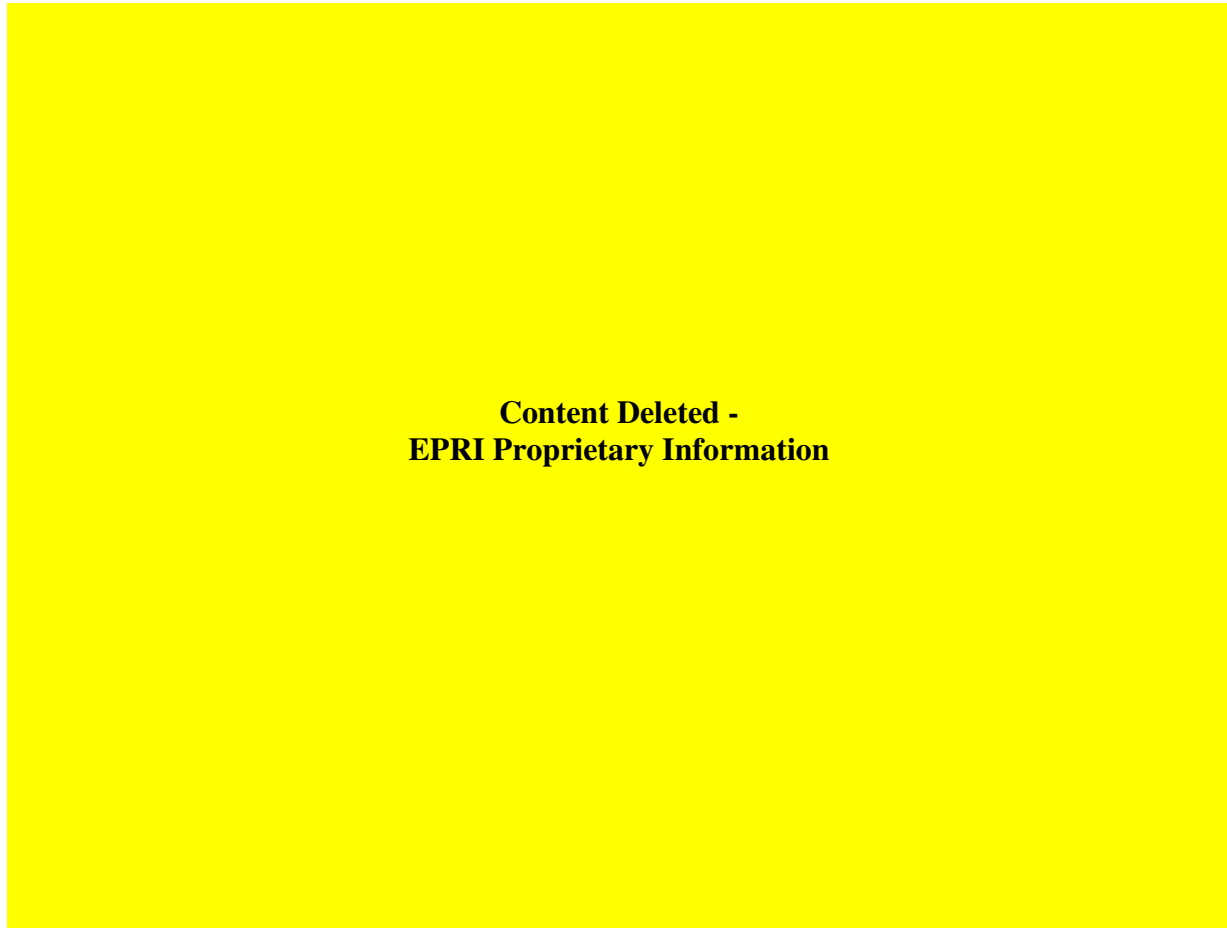


Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details



**Content Deleted -
EPRI Proprietary Information**

Figure 5.3.3-1 (continued). Mockup BWRVIP-F, Representing Weld H8: Configuration and Flaw Details

5.3.4 Shroud Support Mockups BWRVIP-P, BWRVIP-Q1, BWRVIP-Q2



**Content Deleted -
EPRI Proprietary Information**

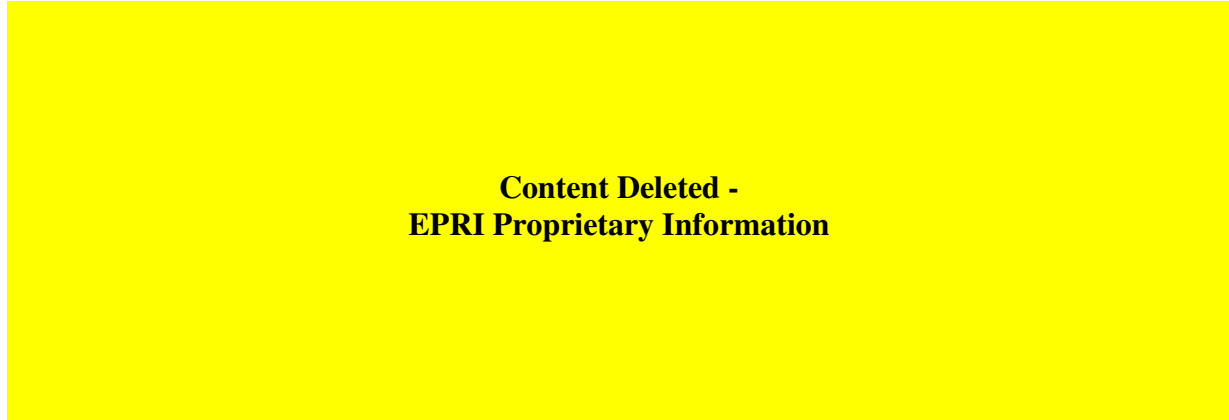


Table 5.3.4-1. Configuration of Cracks in Shroud Support Mockup BWRVIP-P

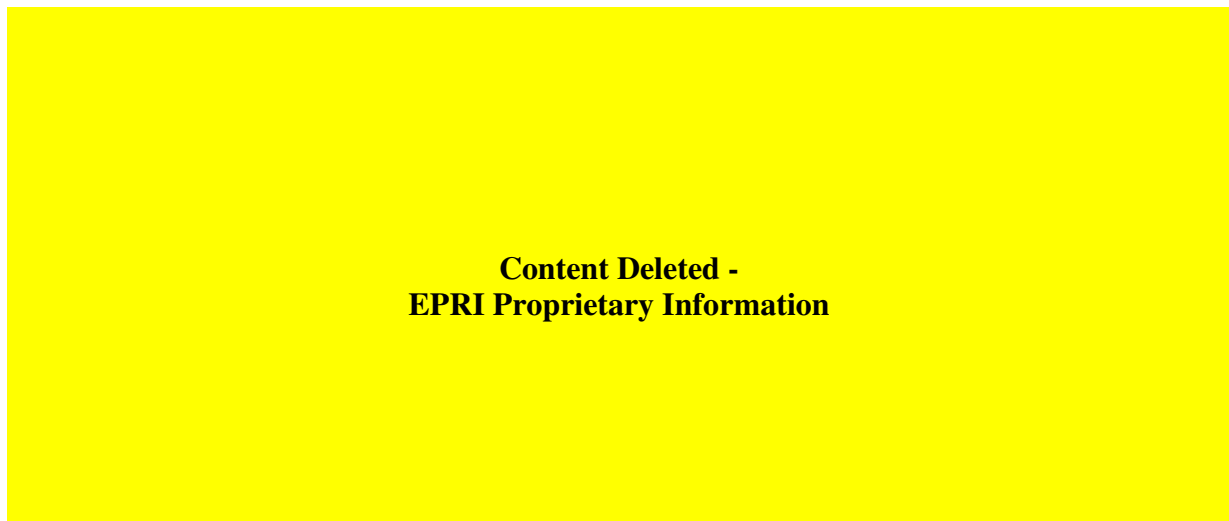
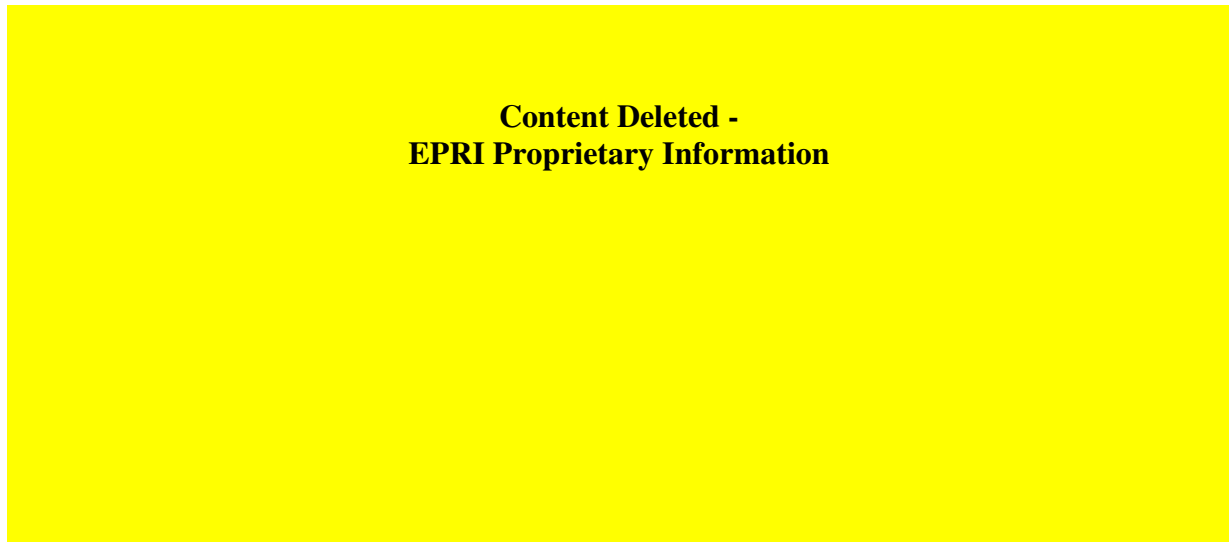


Figure 5.3.4-1. Shroud Support Mockup BWRVIP-P

**Content Deleted -
EPRI Proprietary Information**

Table 5.3.4-2. Configuration of EDM Notches in Shroud Support Mockup BWRVIP-Q1

**Content Deleted -
EPRI Proprietary Information**

5.3.5 Shroud Support Mockups BWRVIP-B2SS1 and BWRVIP-B2SS2

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 5.3.5-1. Mockup BWRVIP-B2SS1



**Content Deleted -
EPRI Proprietary Information**

Figure 5.3.5-2. Mockup BWRVIP-B2SS2

5.4 UT Technique Demonstrations for Core Shroud Support Welds



**Content Deleted -
EPRI Proprietary Information**

Table 5.4-1. UT Demonstration Summary



Table 5.4-1. UT Demonstration Summary (continued)



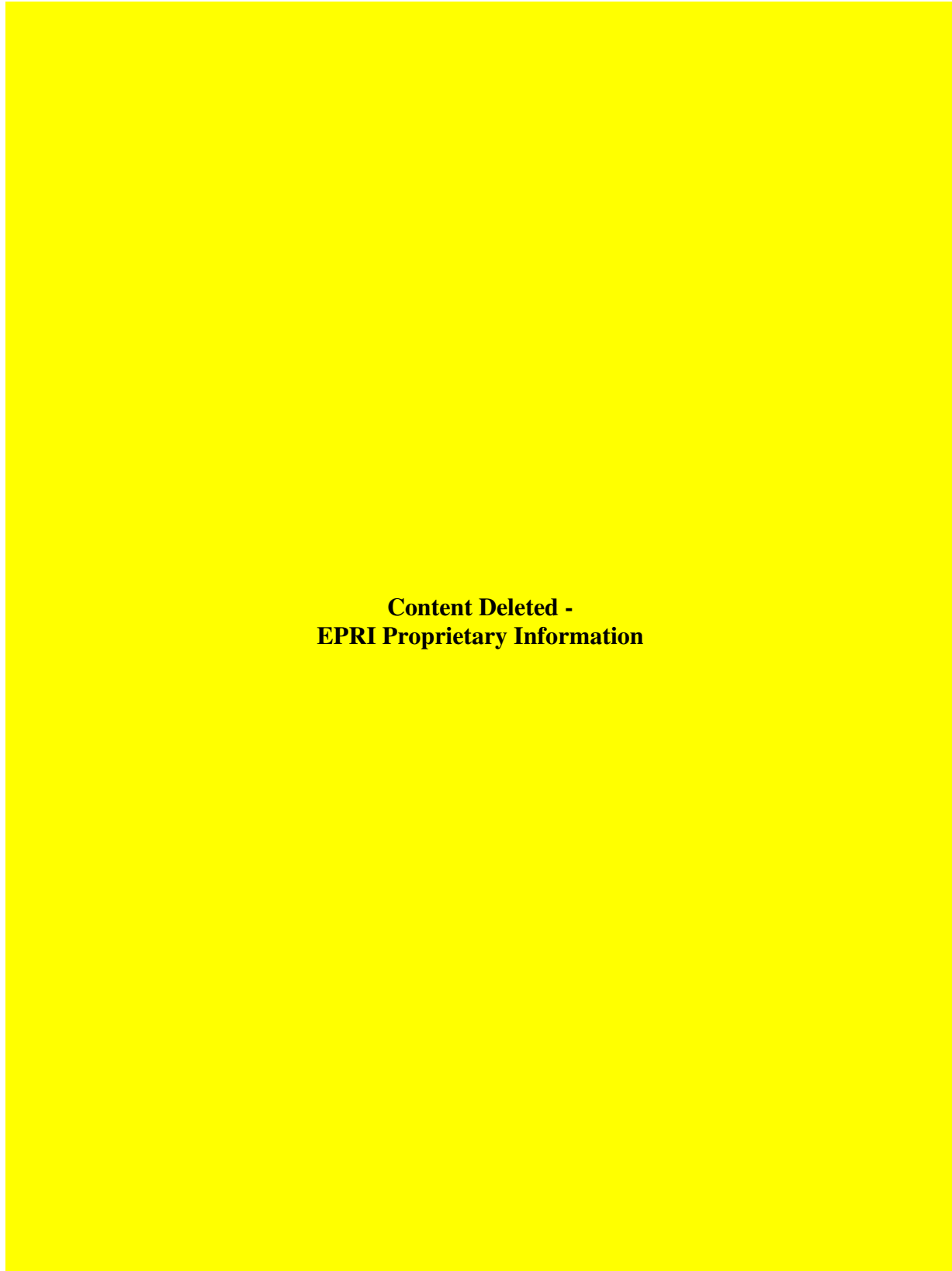
**Content Deleted -
EPRI Proprietary Information**

Table 5.4-1. UT Demonstration Summary (continued)



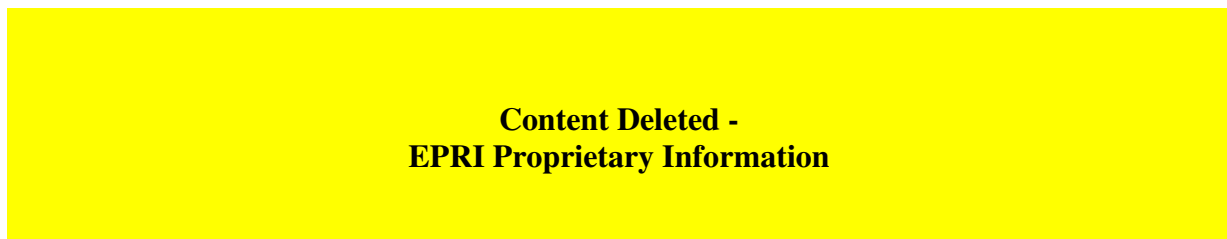
**Content Deleted -
EPRI Proprietary Information**

Table 5.4-1. UT Demonstration Summary (continued)



**Content Deleted -
EPRI Proprietary Information**

Table 5.4-1. UT Demonstration Summary (continued)



5.4.1 General Findings for UT

**Content Deleted -
EPRI Proprietary Information**

5.4.1.1 Effect of Alloy 82/182 Weld Material

**Content Deleted -
EPRI Proprietary Information**

5.4.1.2 Effect of Mismatch in the Fit-up of Weld H7

**Content Deleted -
EPRI Proprietary Information**

5.4.2 UT Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

5.4.3 UT Demonstration 2

**Content Deleted -
EPRI Proprietary Information**

5.4.4 UT Demonstration 3



5.4.5 UT Demonstration 4

**Content Deleted -
EPRI Proprietary Information**

5.4.6 UT Demonstration 5

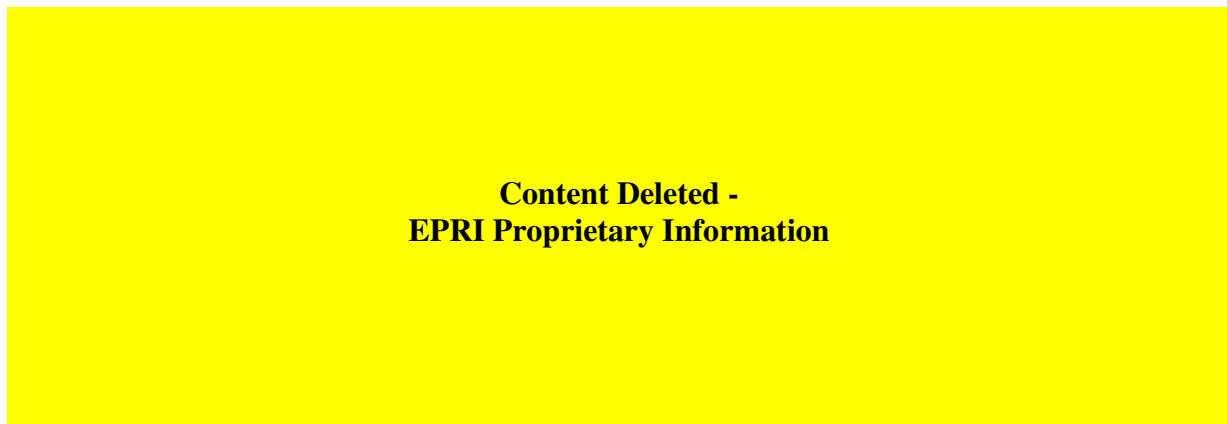
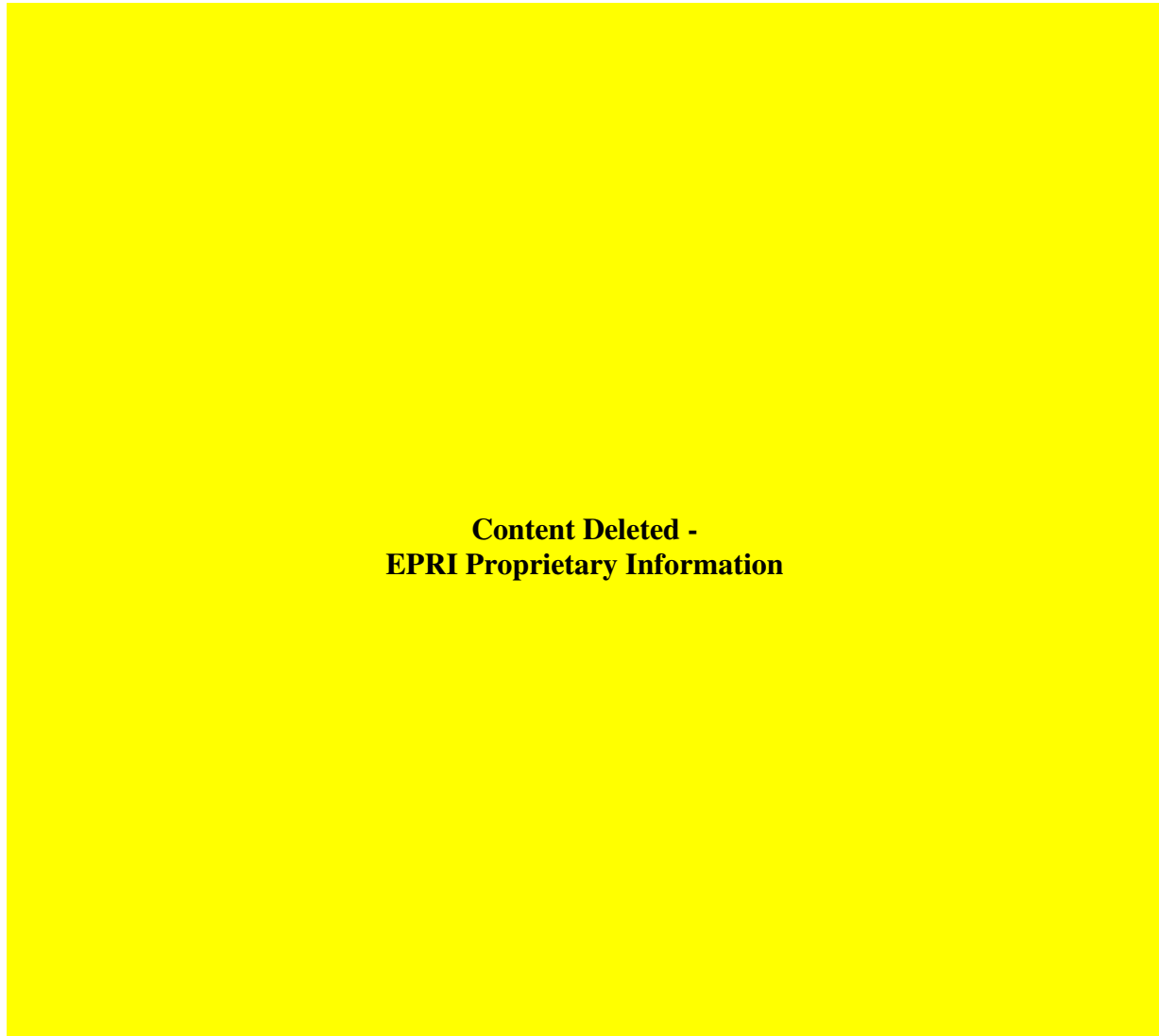


**Content Deleted -
EPRI Proprietary Information**

Table 5.4.6-1. Definition of Scan Patterns Used in UT Demonstration 5

**Content Deleted -
EPRI Proprietary Information**

Table 5.4.6-2. Results of UT Demonstration 5



5.4.7 UT Demonstration 6

**Content Deleted -
EPRI Proprietary Information**

5.4.8 UT Demonstration 7

**Content Deleted -
EPRI Proprietary Information**

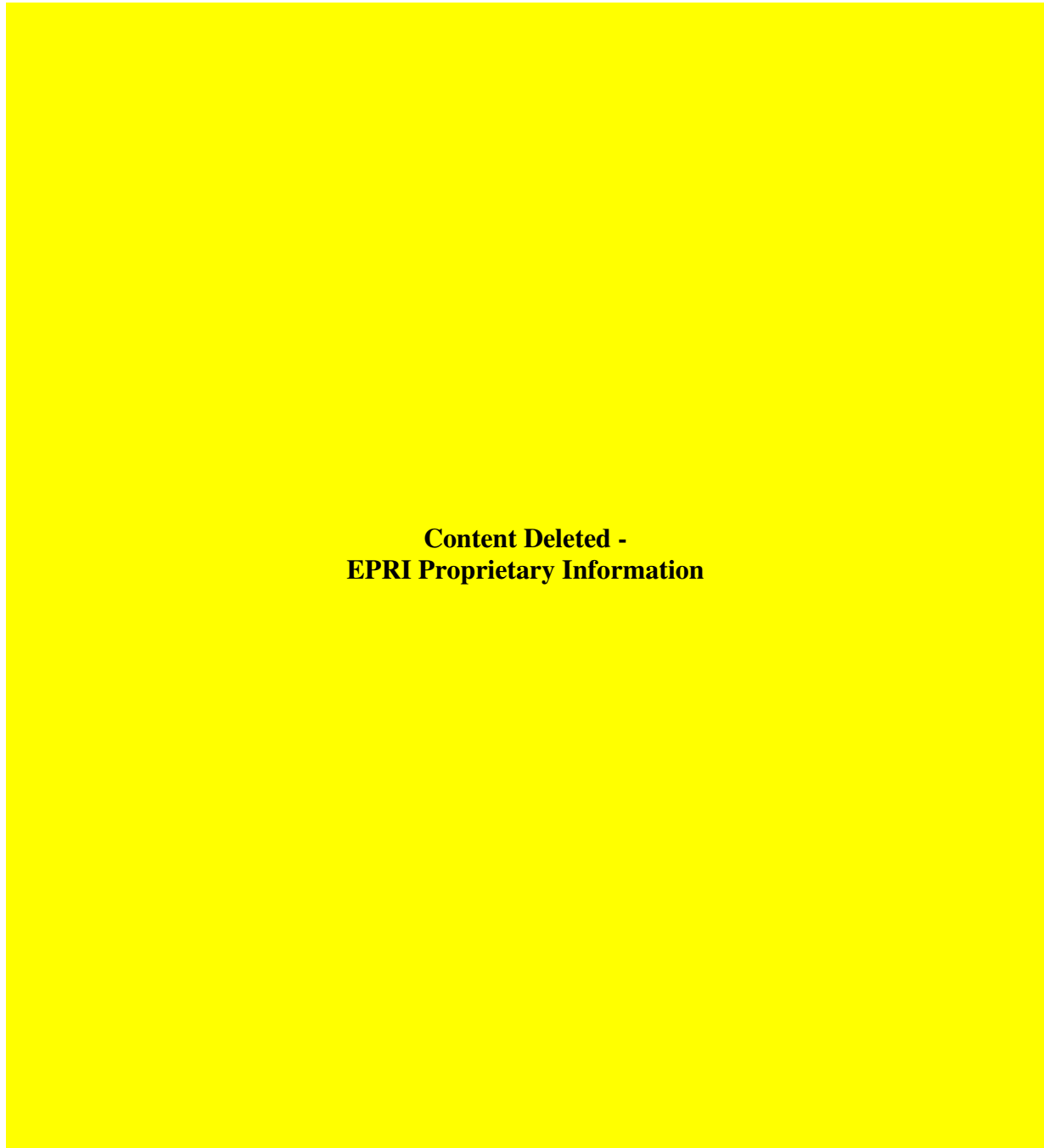
5.4.9 UT Demonstration 8

**Content Deleted -
EPRI Proprietary Information**

5.4.10 UT Demonstration 9

**Content Deleted -
EPRI Proprietary Information**

5.4.11 UT Demonstration 10



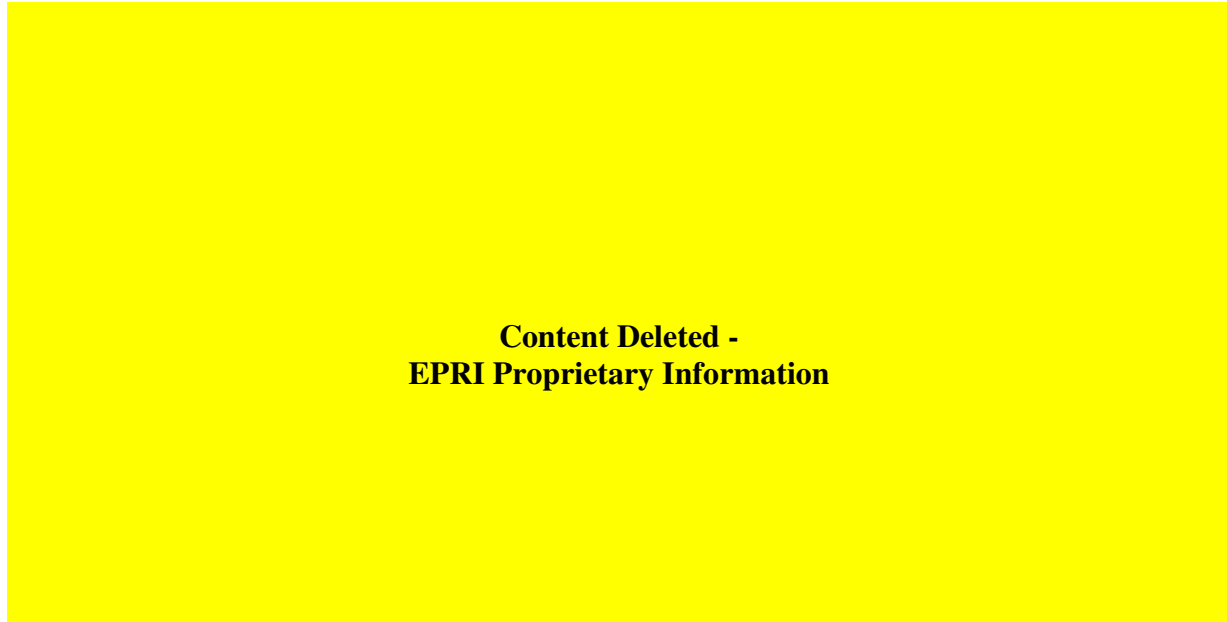
5.4.12 UT Demonstration 11

**Content Deleted -
EPRI Proprietary Information**

5.4.13 UT Demonstration 12

**Content Deleted -
EPRI Proprietary Information**

5.4.14 UT Demonstration 13



5.4.15 UT Demonstration 14

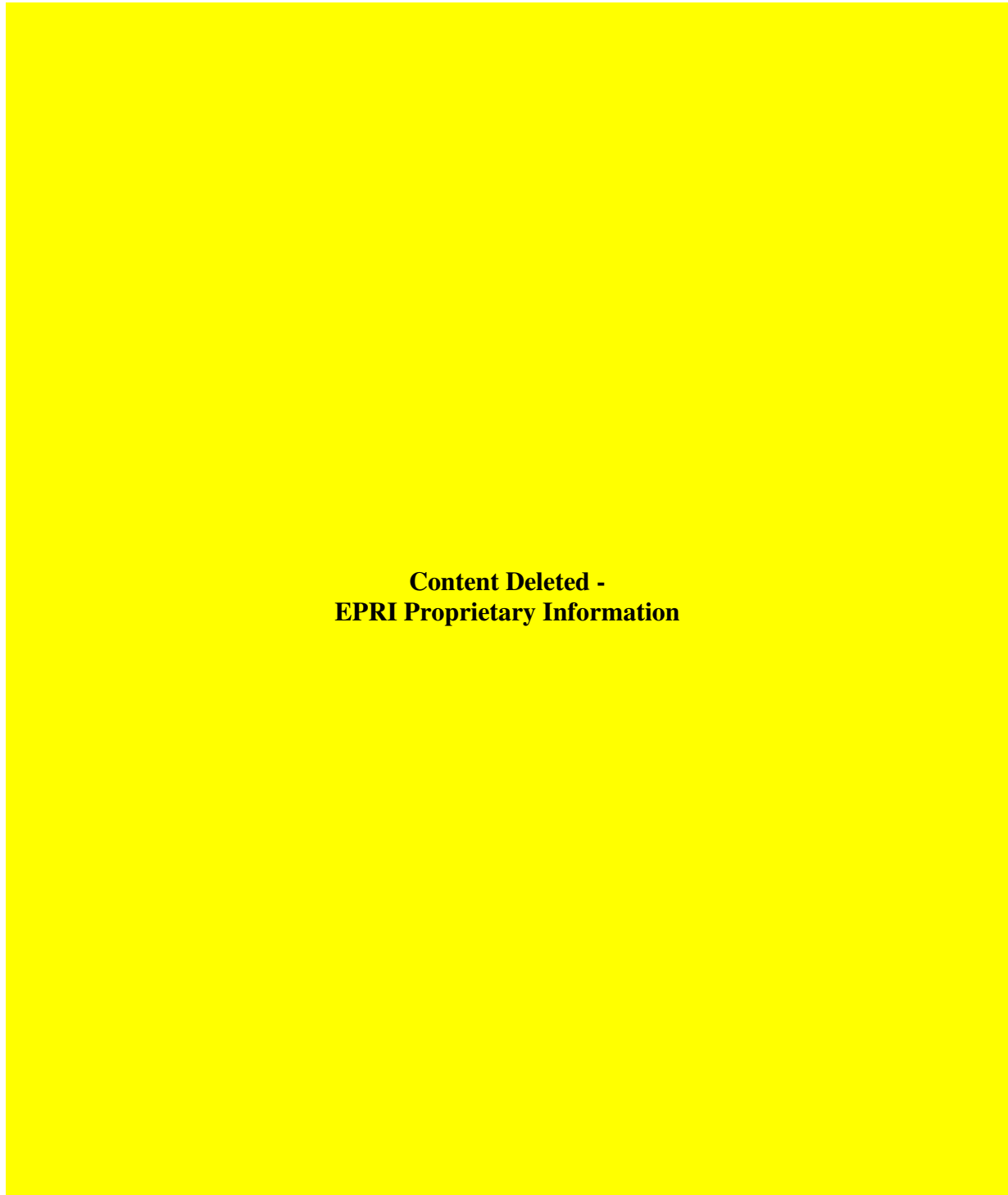
**Content Deleted -
EPRI Proprietary Information**

5.4.16 UT Demonstration 15

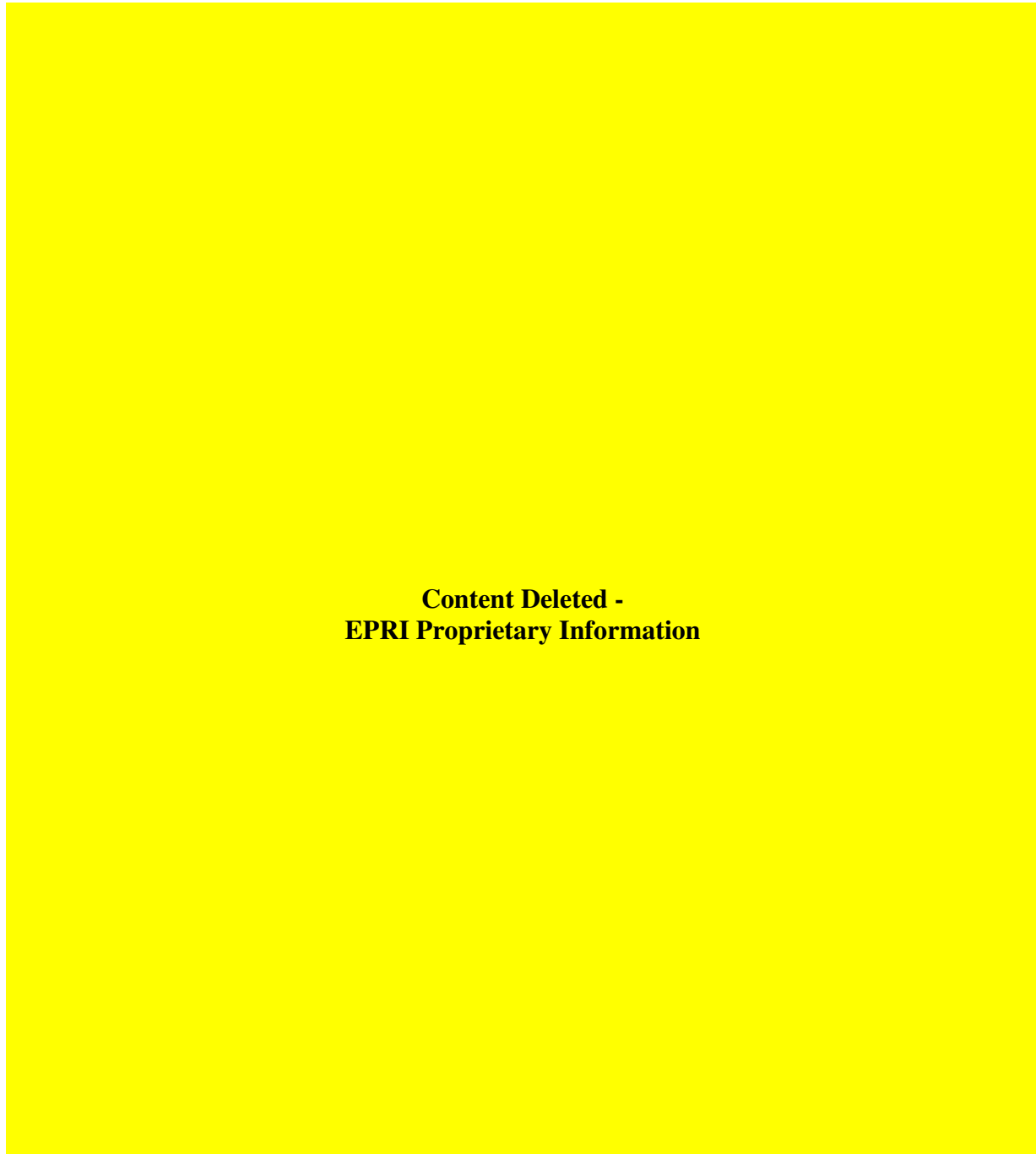


**Content Deleted -
EPRI Proprietary Information**

5.4.17 UT Demonstration 16



5.4.18 UT Demonstration 17



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.18-1. Configuration for Inspecting Weld H10 from the Outside of the Bottom Head of the Pressure Vessel

5.4.19 UT Demonstration 18

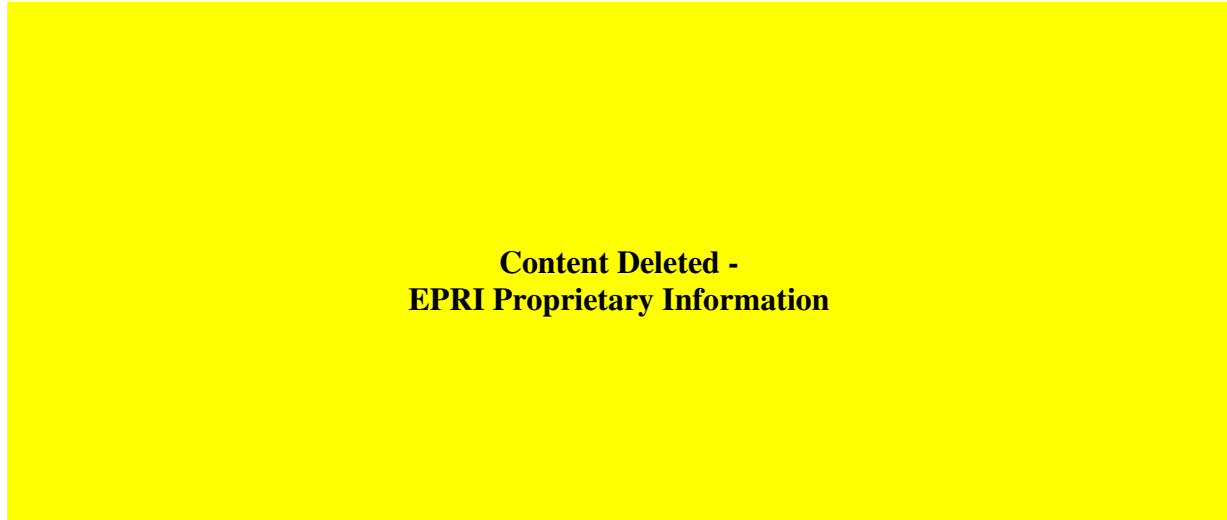
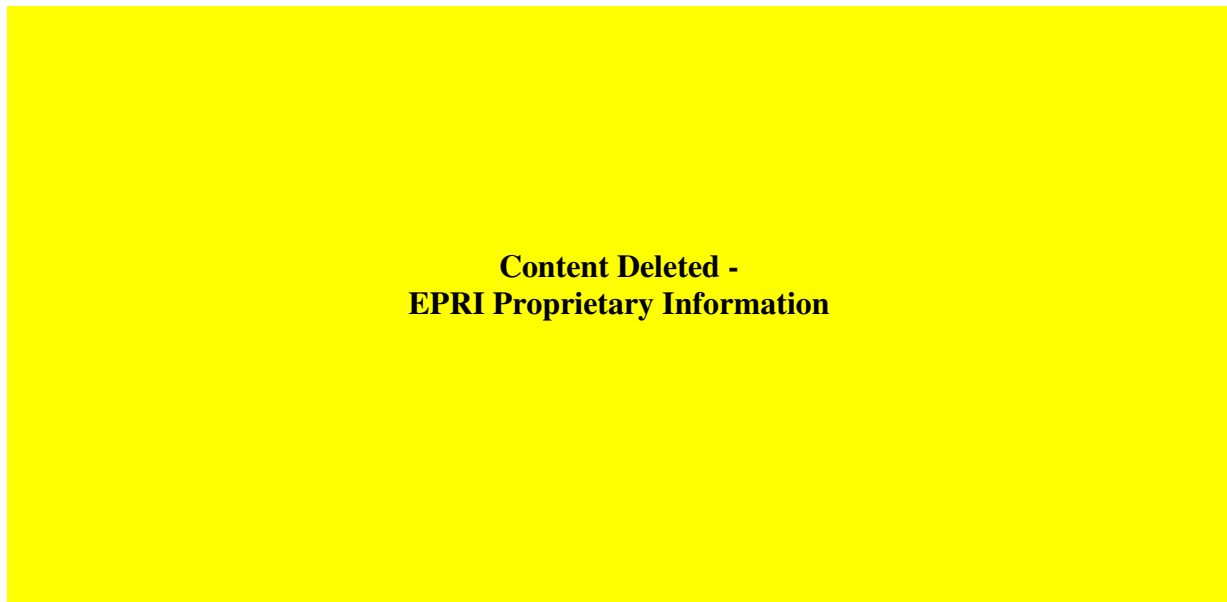
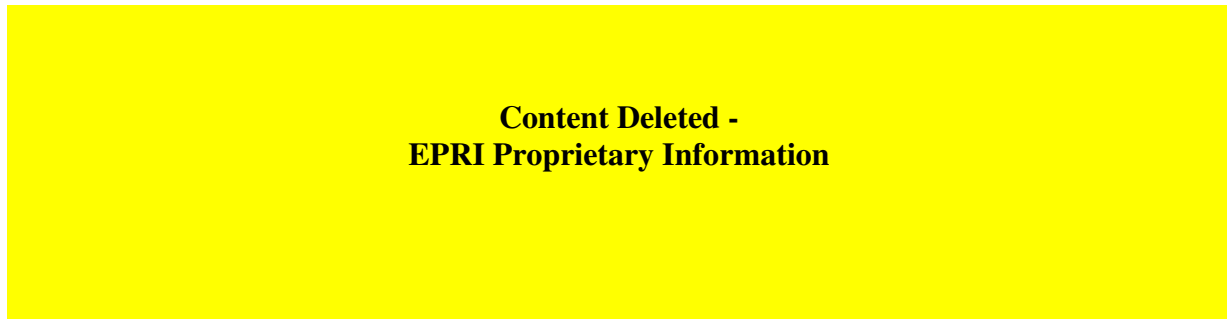


Table 5.4.19-1. Sizing Performance and Evaluation Factors for UT Demonstration 18



**Content Deleted -
EPRI Proprietary Information**

5.4.20 UT Demonstration 19

**Content Deleted -
EPRI Proprietary Information**

5.4.21 UT Demonstration 20

**Content Deleted -
EPRI Proprietary Information**

5.4.22 UT Demonstration 21

**Content Deleted -
EPRI Proprietary Information**

5.4.23 UT Demonstration 22



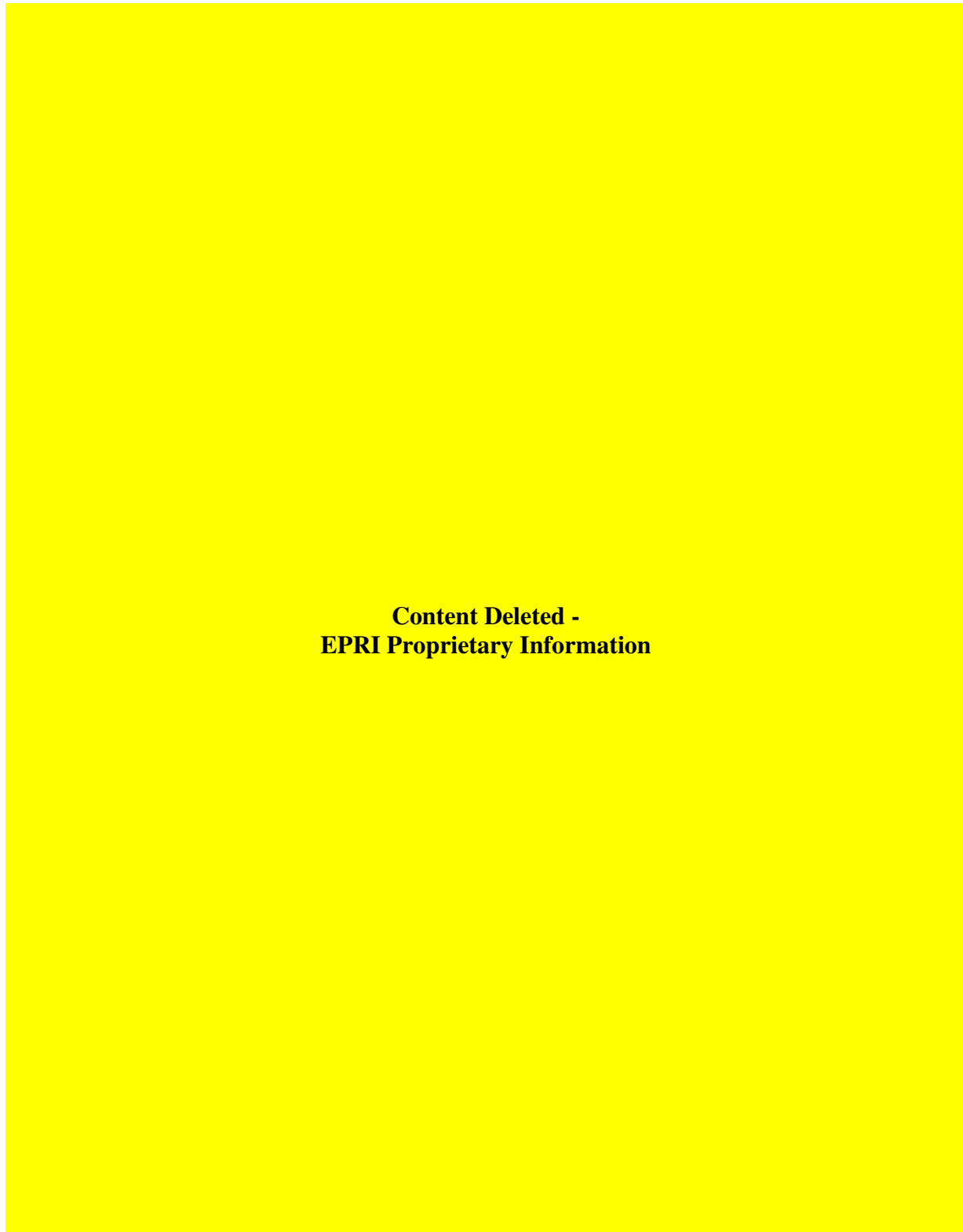
**Content Deleted -
EPRI Proprietary Information**

5.4.24 UT Demonstration 23



**Content Deleted -
EPRI Proprietary Information**

5.4.25 UT Demonstration 24

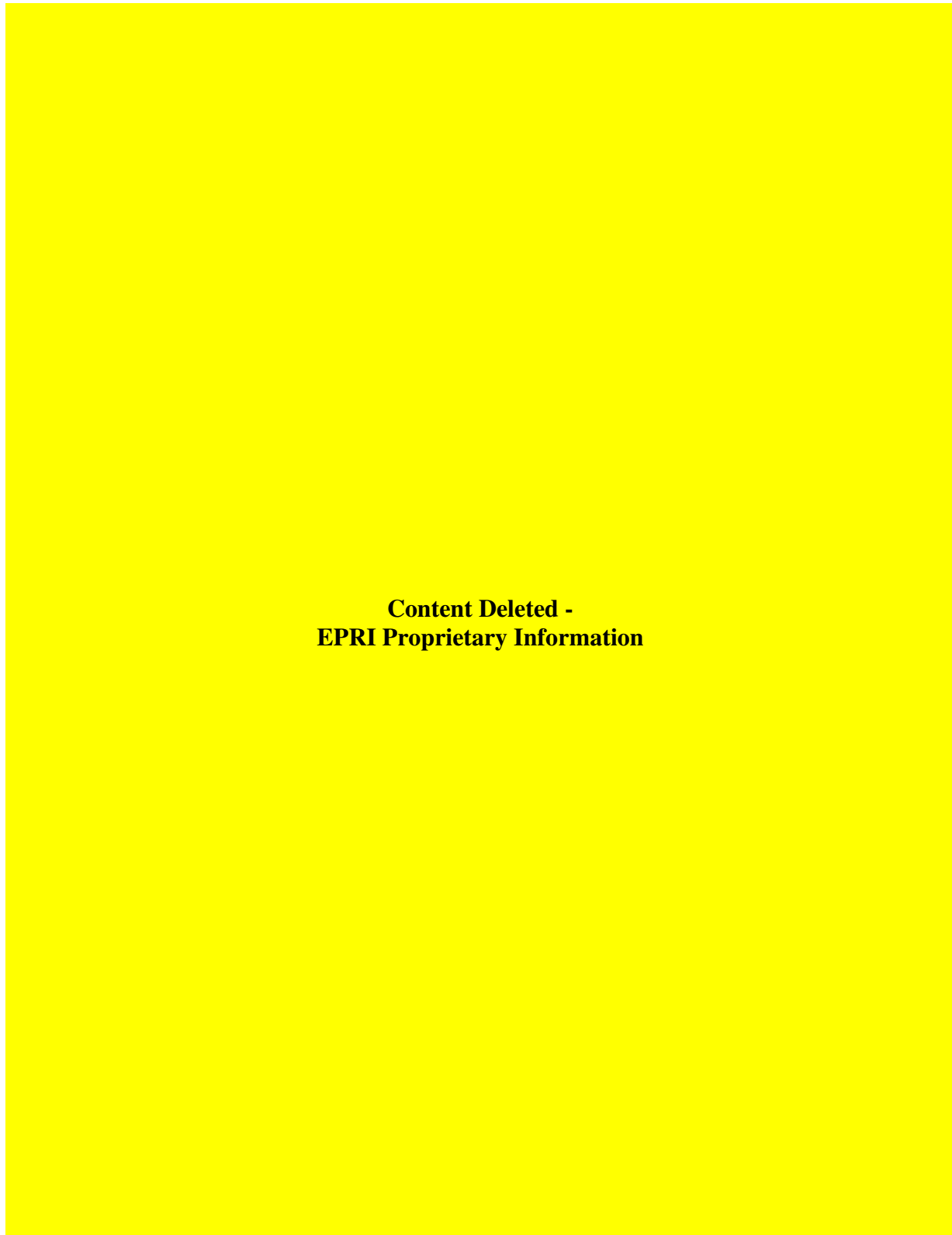


**Content Deleted -
EPRI Proprietary Information**

5.4.26 UT Demonstration 25

**Content Deleted -
EPRI Proprietary Information**

5.4.27 UT Demonstration 26





**Content Deleted -
EPRI Proprietary Information**

5.4.28 UT Demonstration 27

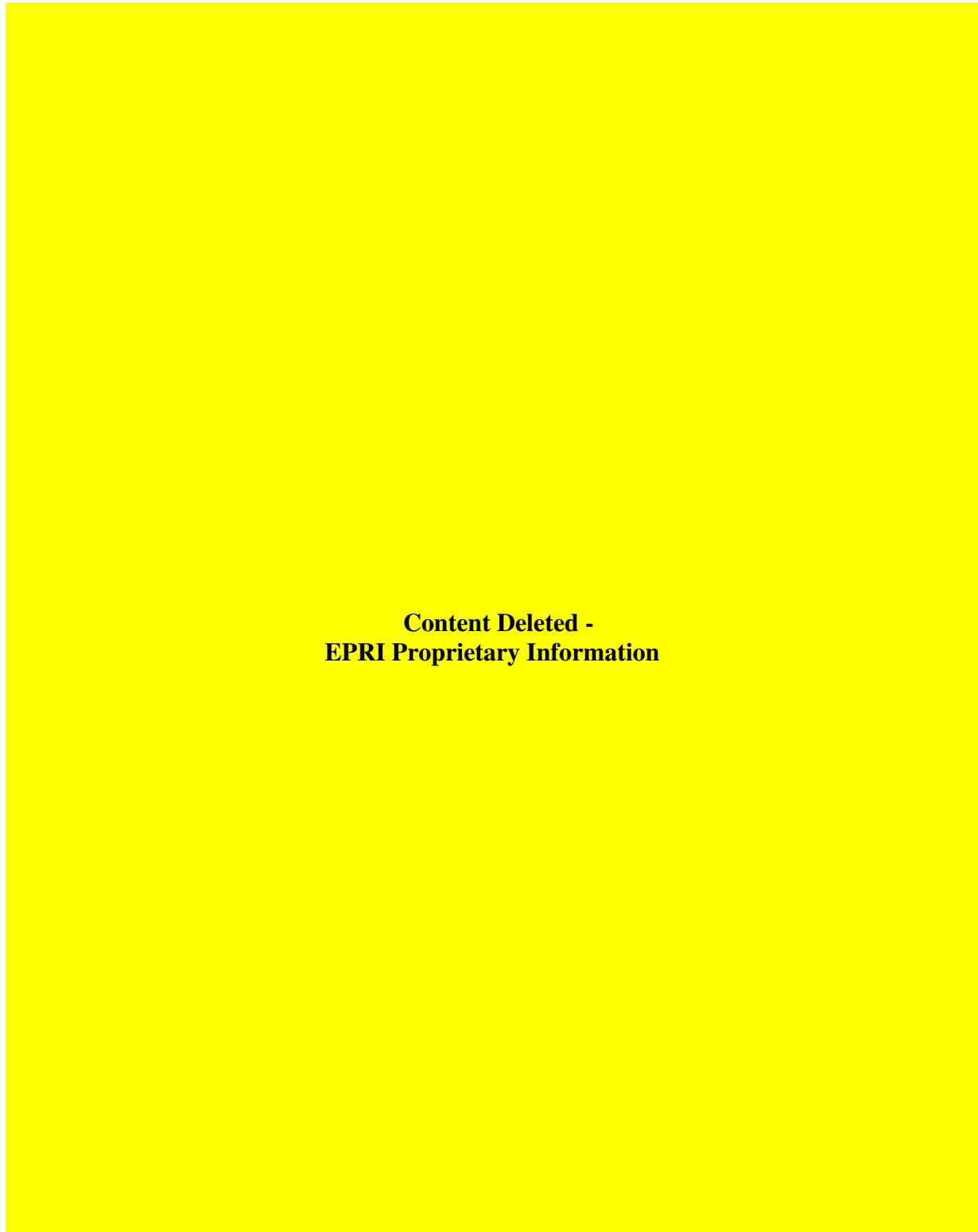




Figure 5.4.28-1. Setting the Sensitivity for Inspection of Weld H9

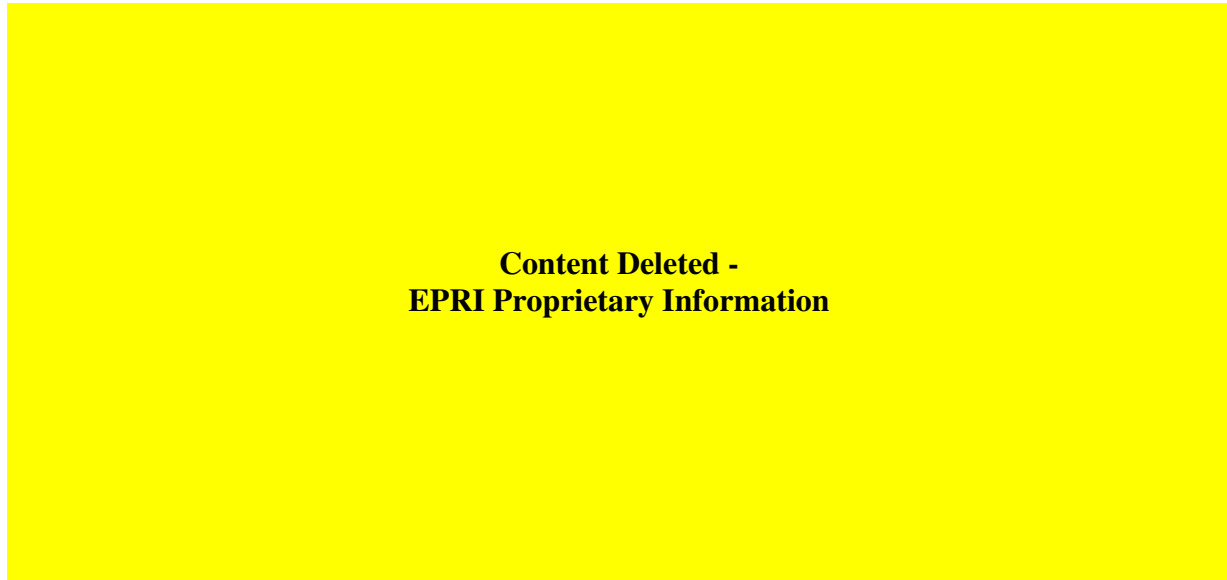


Figure 5.4.28-2. Geometry for Inspection of Weld H8

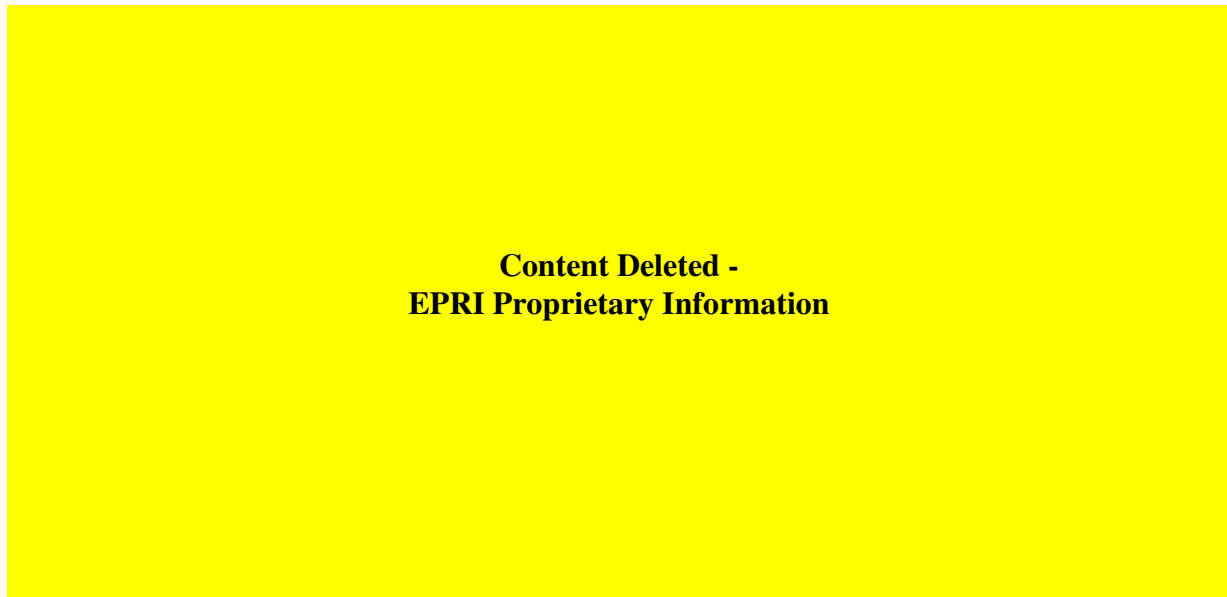


Figure 5.4.28-3. Coverage for Inspection of Weld H8

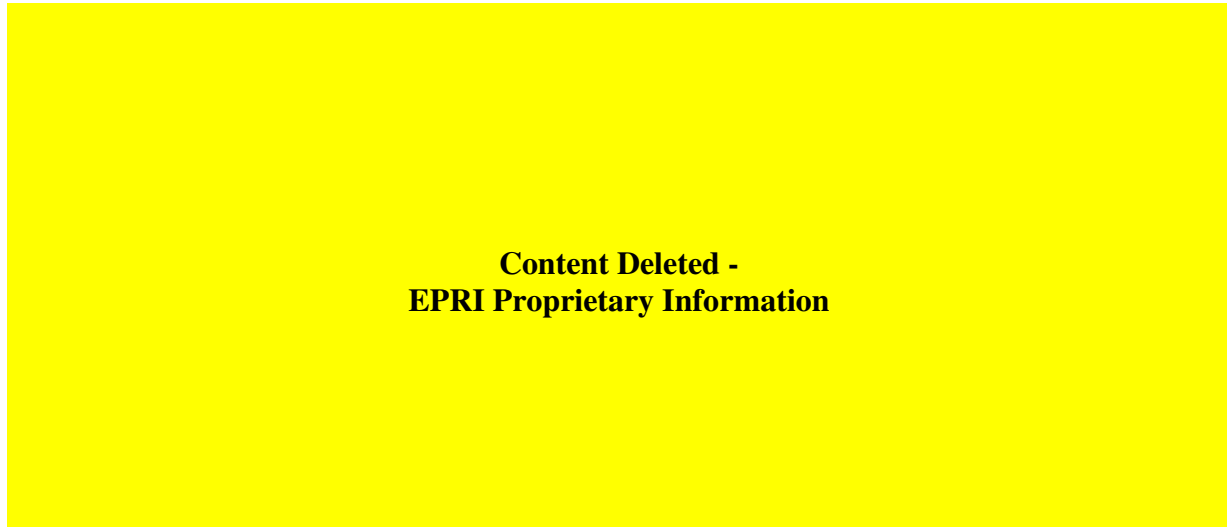
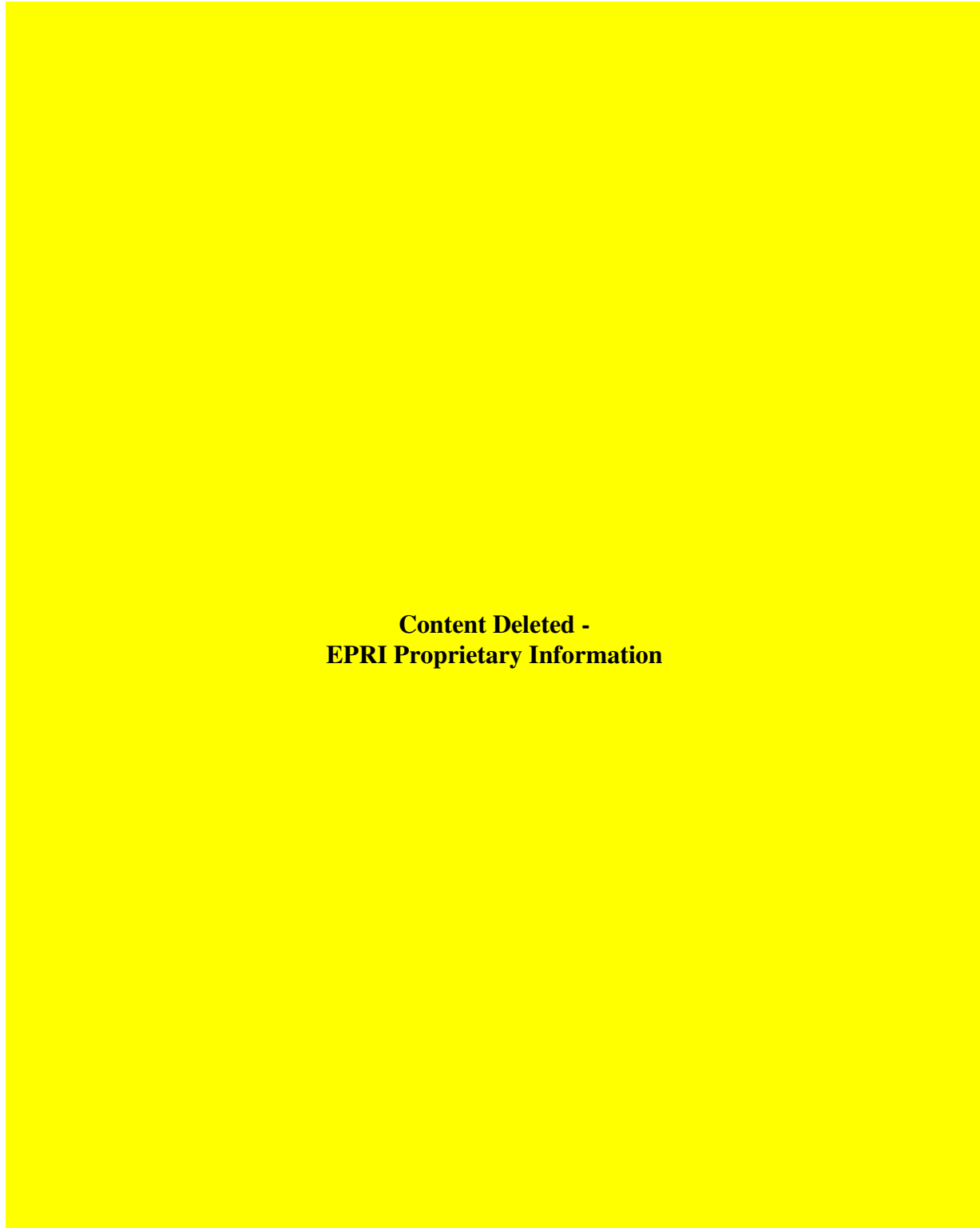


Figure 5.4.28-4. Some Potential Flaw Locations and Orientations in Weld H8

5.4.29 UT Demonstration 28



**Content Deleted -
EPRI Proprietary Information**

5.4.30 UT Demonstration 29



**Content Deleted -
EPRI Proprietary Information**

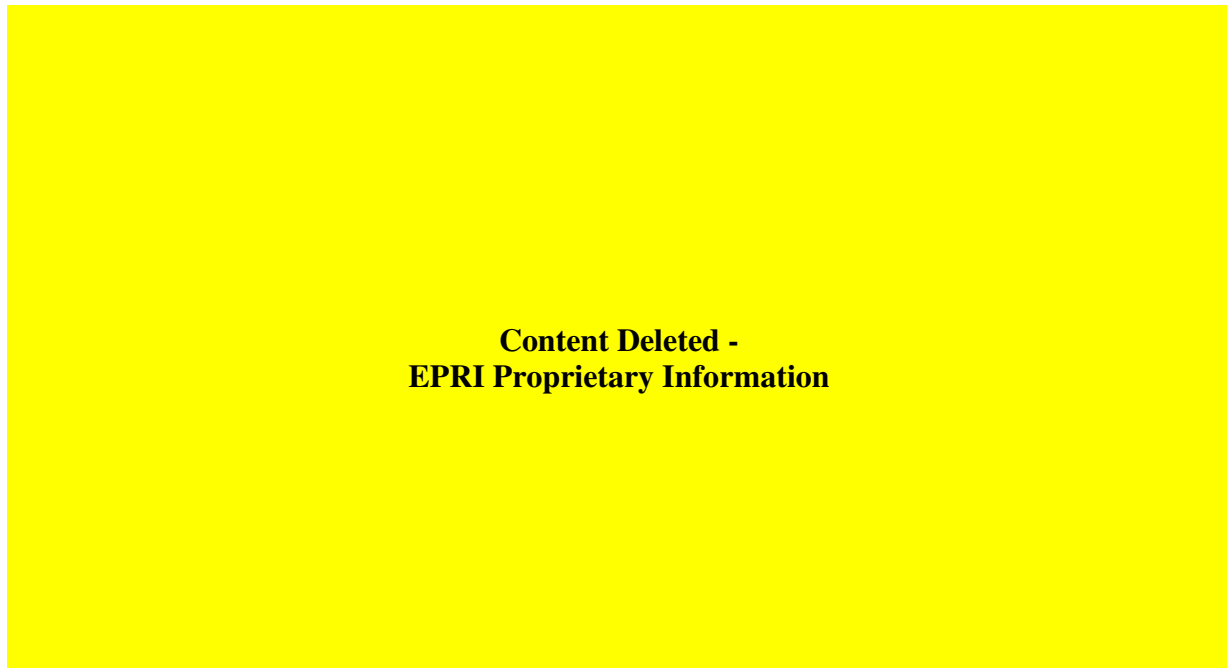
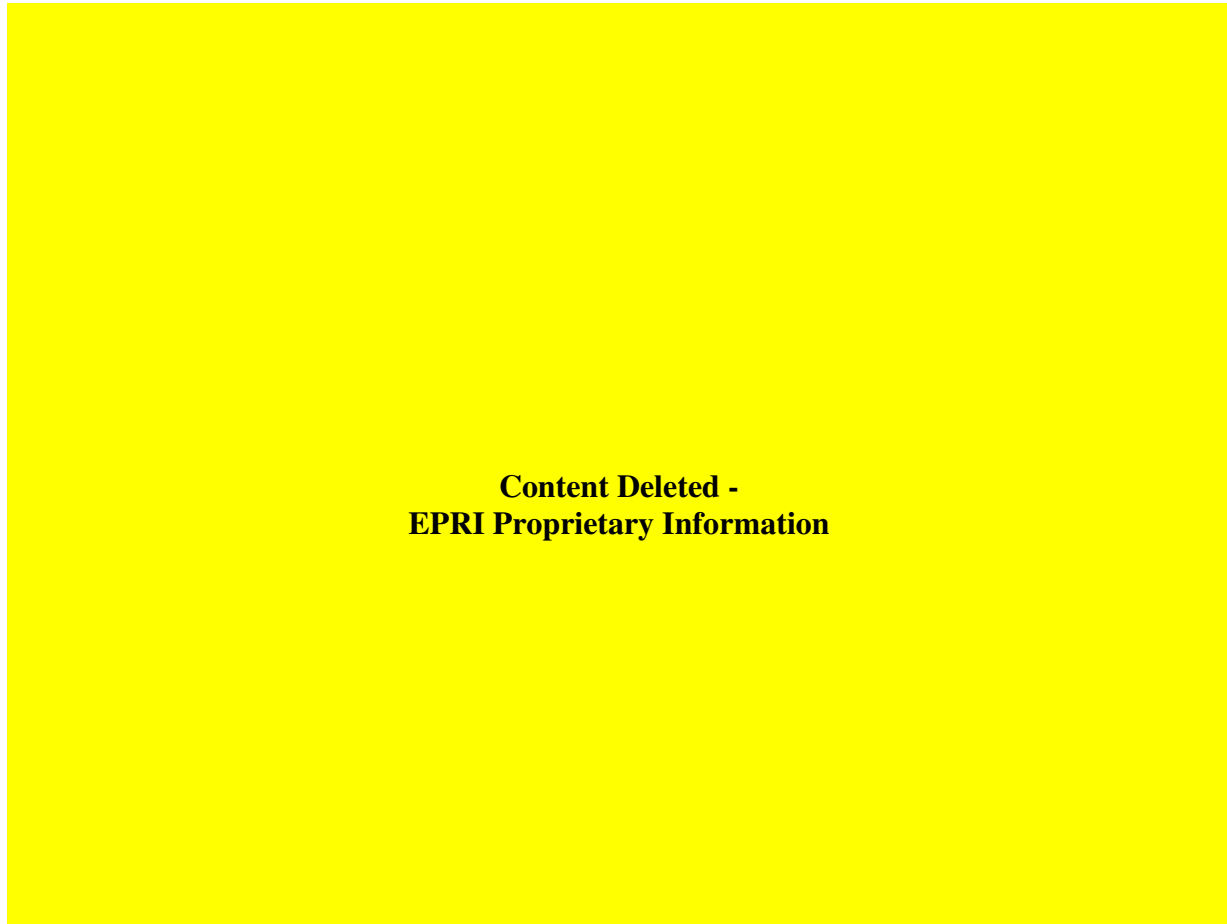


Figure 5.4.30-1. Setting the Sensitivity for Inspection of Weld H9

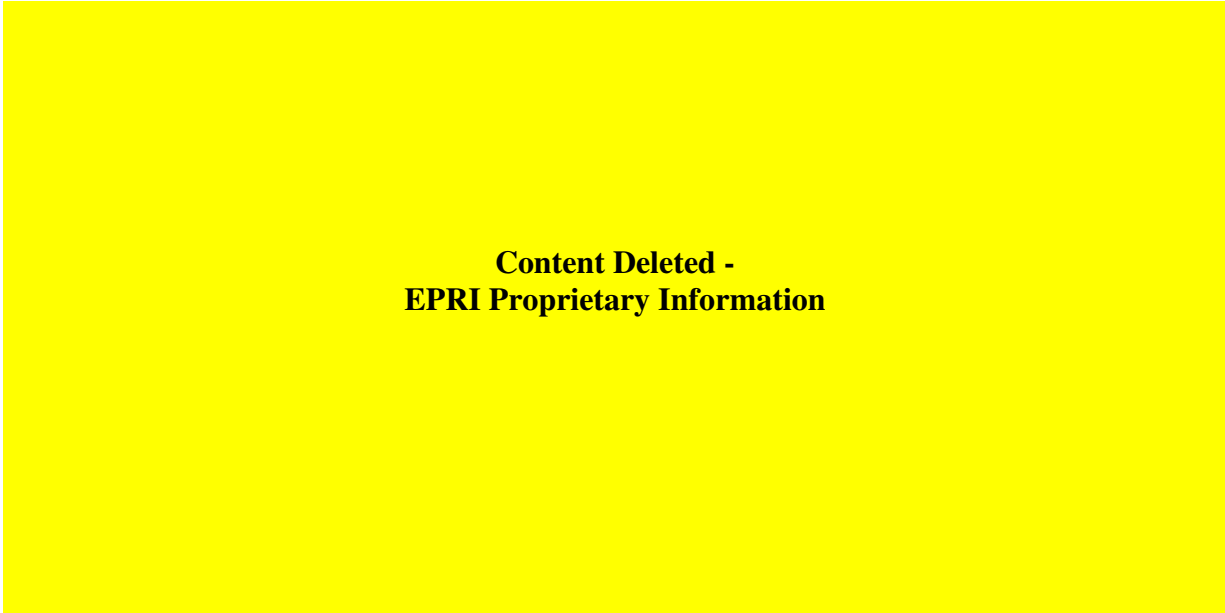


Figure 5.4.30-2. Geometry for Inspection of Weld H8

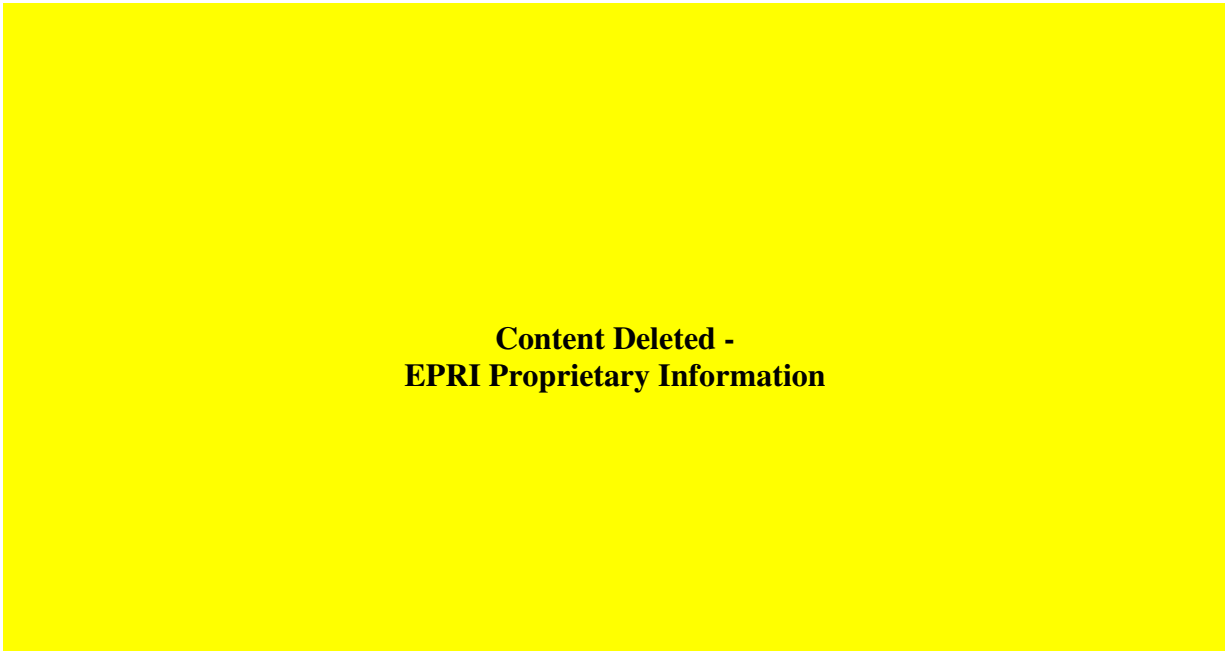


Figure 5.4.30-3. Coverage for Inspection of Weld H8

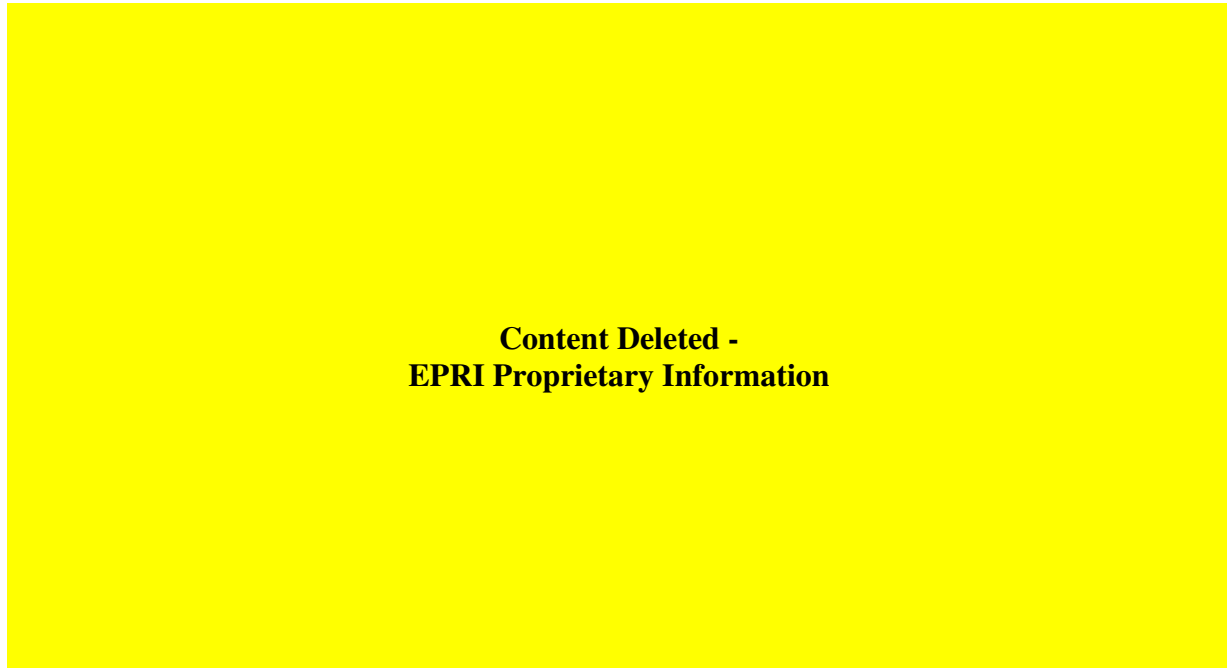
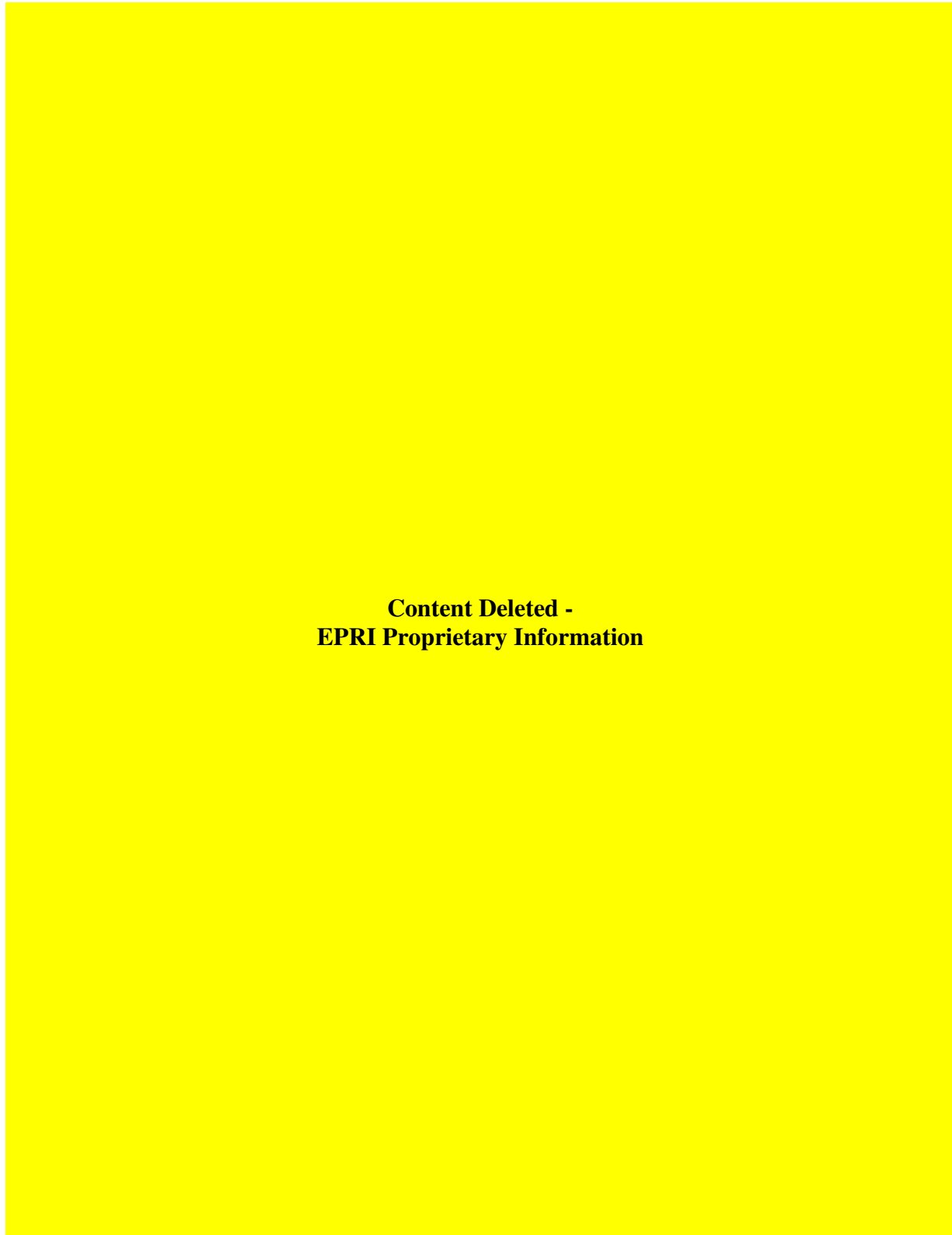


Figure 5.4.30-4. Some Potential Flaw Locations and Orientations in Weld H8

5.4.31 UT Demonstration 30



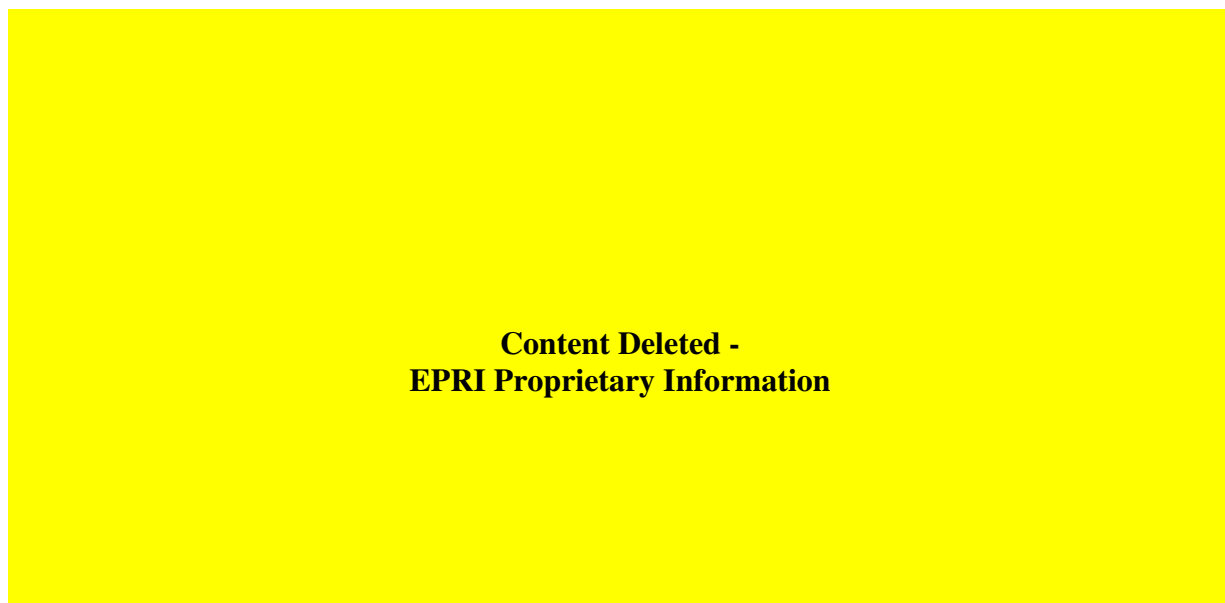
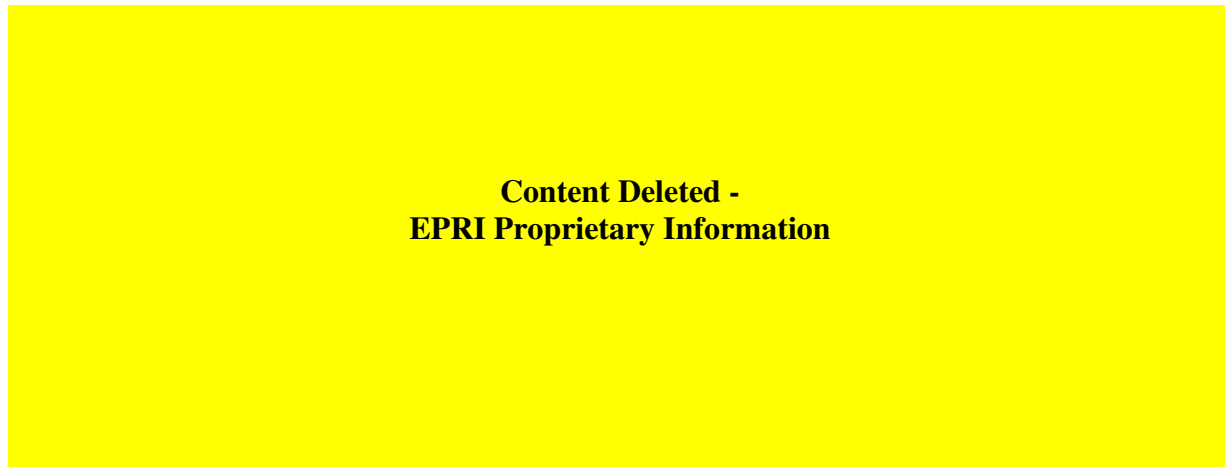


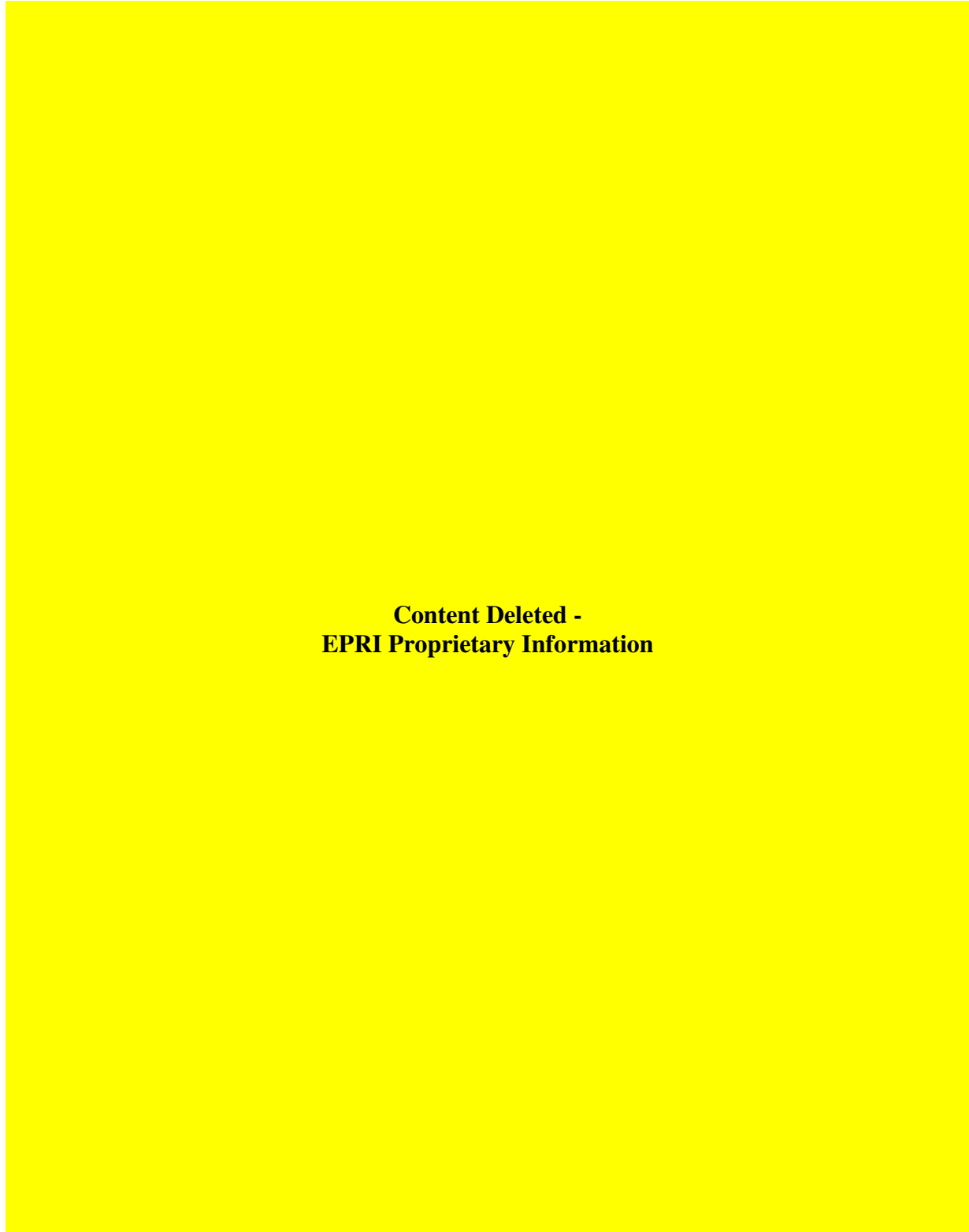
Figure 5.4.31-1 Example Display Showing Responses of Weld Crown Geometry in Mockup BWRVIP-E



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.31-2 Response from Flaw 6b in Mockup BWRVIP-E

5.4.32 UT Demonstration 31



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.33 UT Demonstration 32

**Content Deleted -
EPRI Proprietary Information**

5.4.34 UT Demonstration 33

**Content Deleted -
EPRI Proprietary Information**

5.4.35 UT Demonstration 34

**Content Deleted -
EPRI Proprietary Information**

5.4.36 UT Demonstration 35

**Content Deleted -
EPRI Proprietary Information**

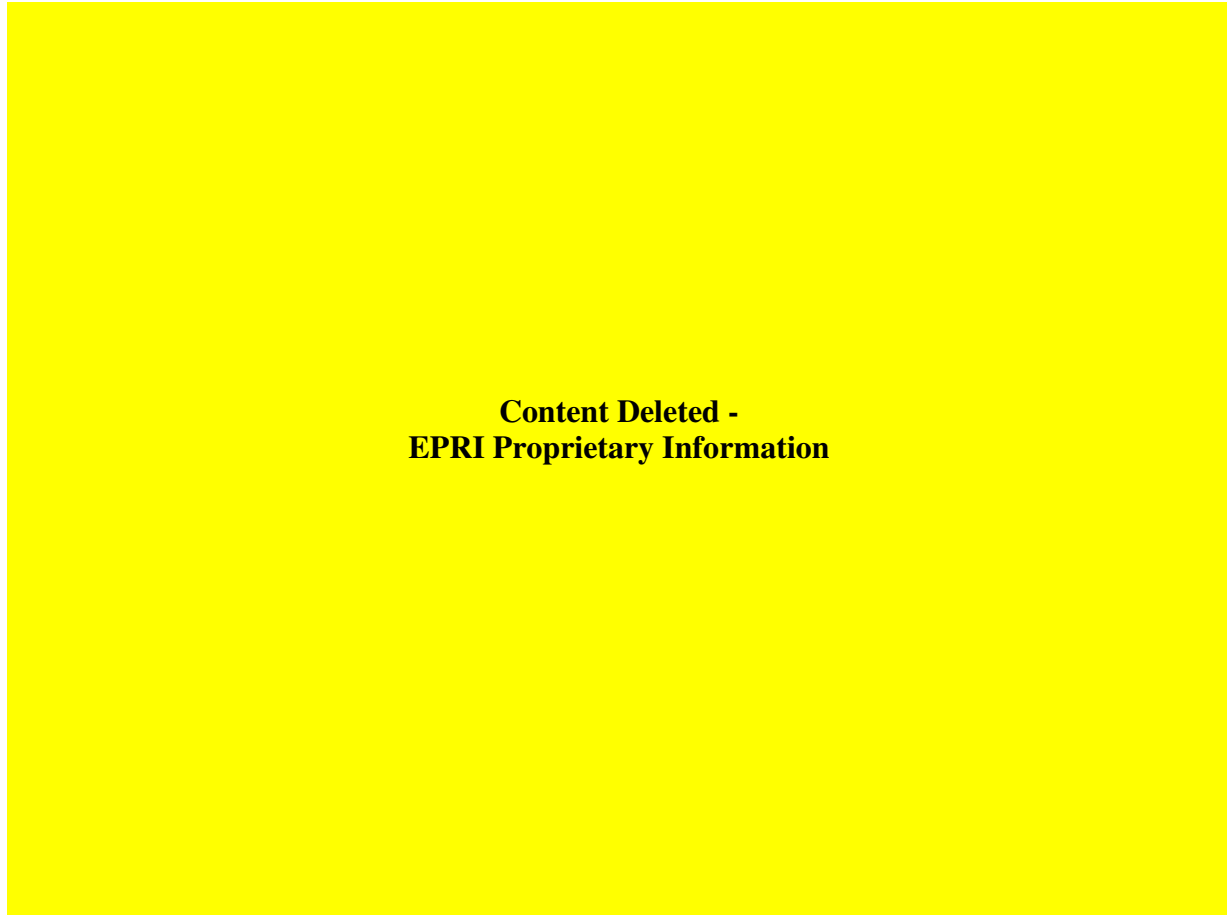


Figure 5.4.36-1. Geometry for Inspection of Weld H8

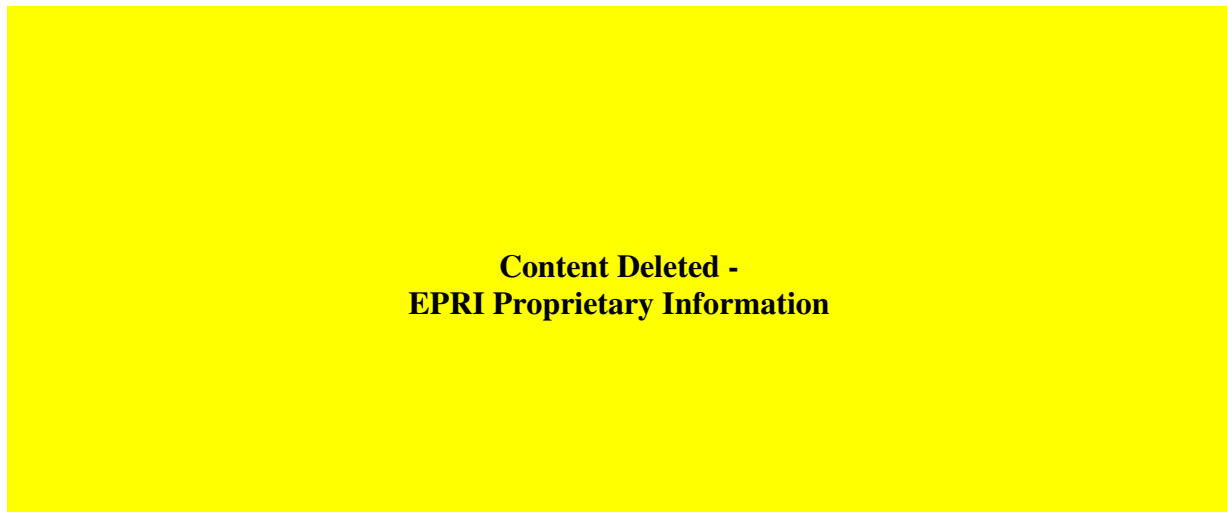


Figure 5.4.36-2. Coverage for Inspection of Weld H8

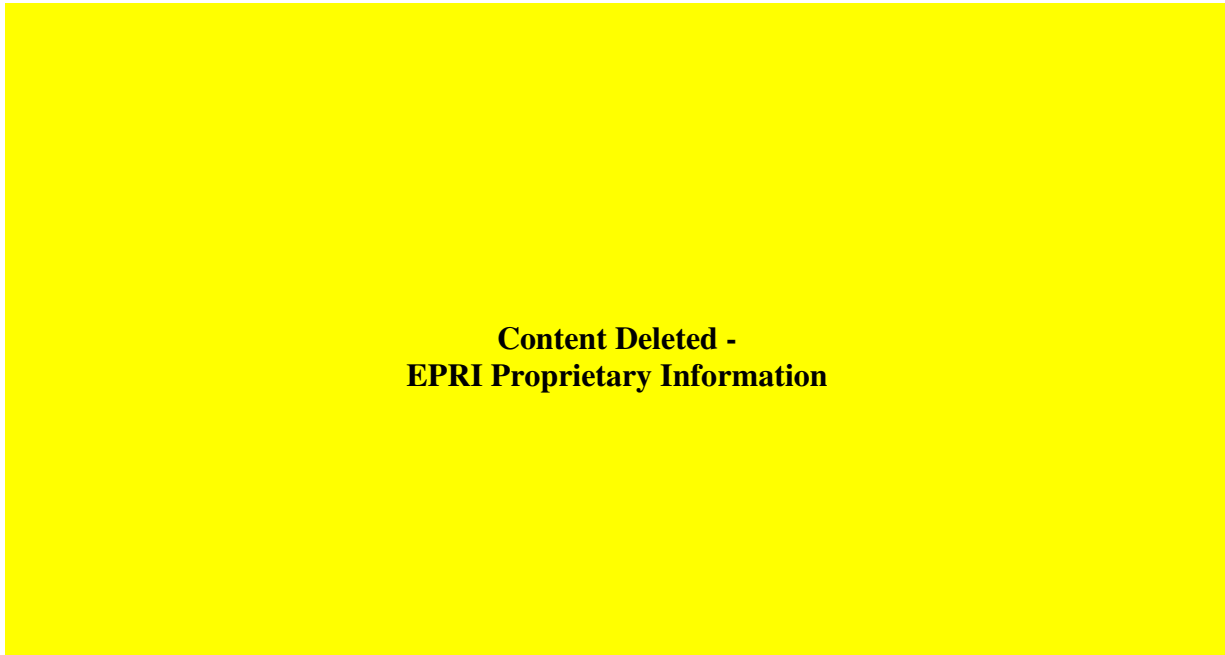
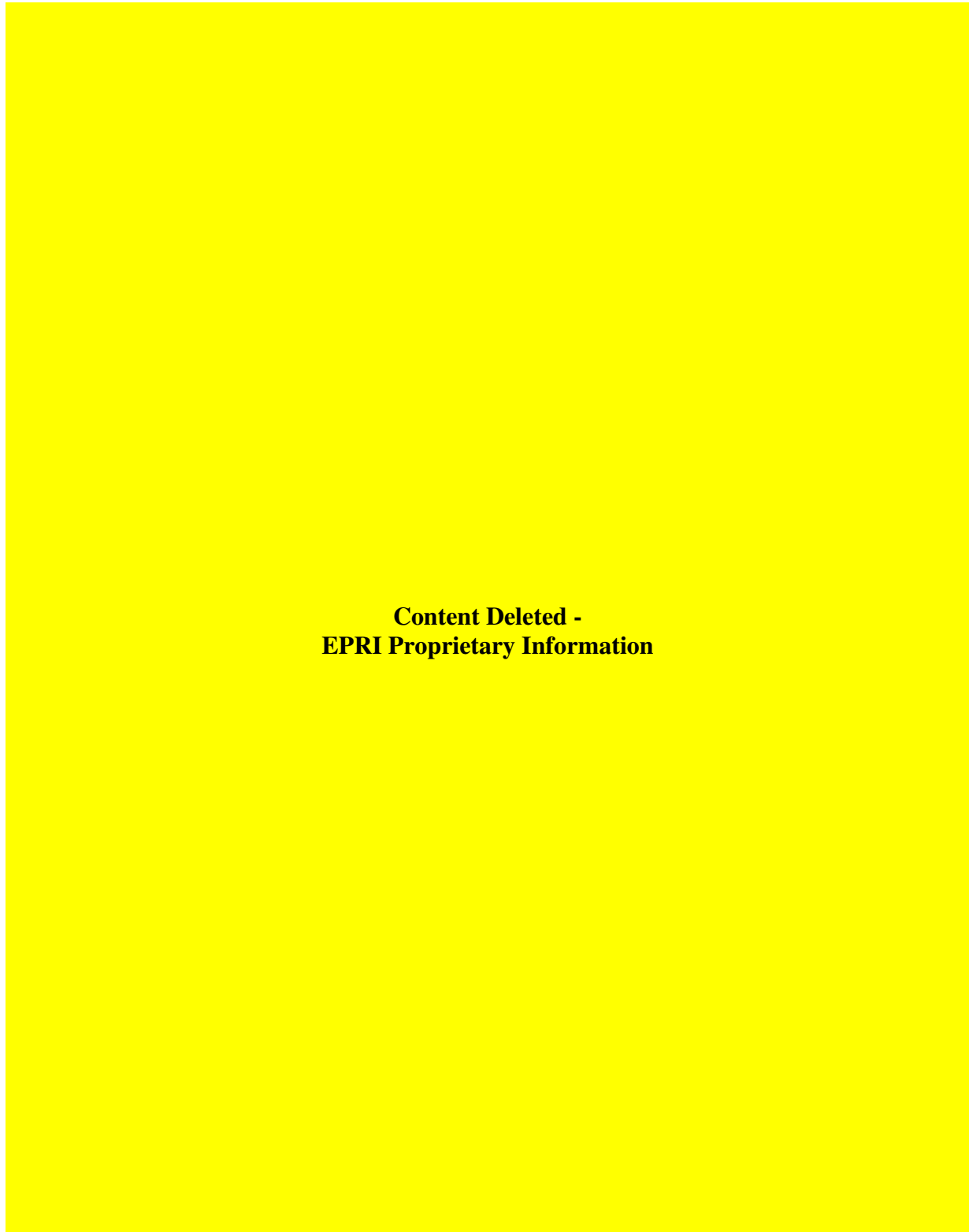


Figure 5.4.36-3. Some Potential Flaw Locations and Orientations in Weld H8

5.4.37 UT Demonstration 36



**Content Deleted -
EPRI Proprietary Information**

5.4.38 UT Demonstration 37



**Content Deleted -
EPRI Proprietary Information**

5.4.39 UT Demonstration 38

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 5.4.39-1. Linear Scans Performed in Various Shroud Inspection Situations

**Content Deleted -
EPRI Proprietary Information**

Content Deleted - EPRI Proprietary Information

5.4.40 UT Demonstration 39



**Content Deleted -
EPRI Proprietary Information**

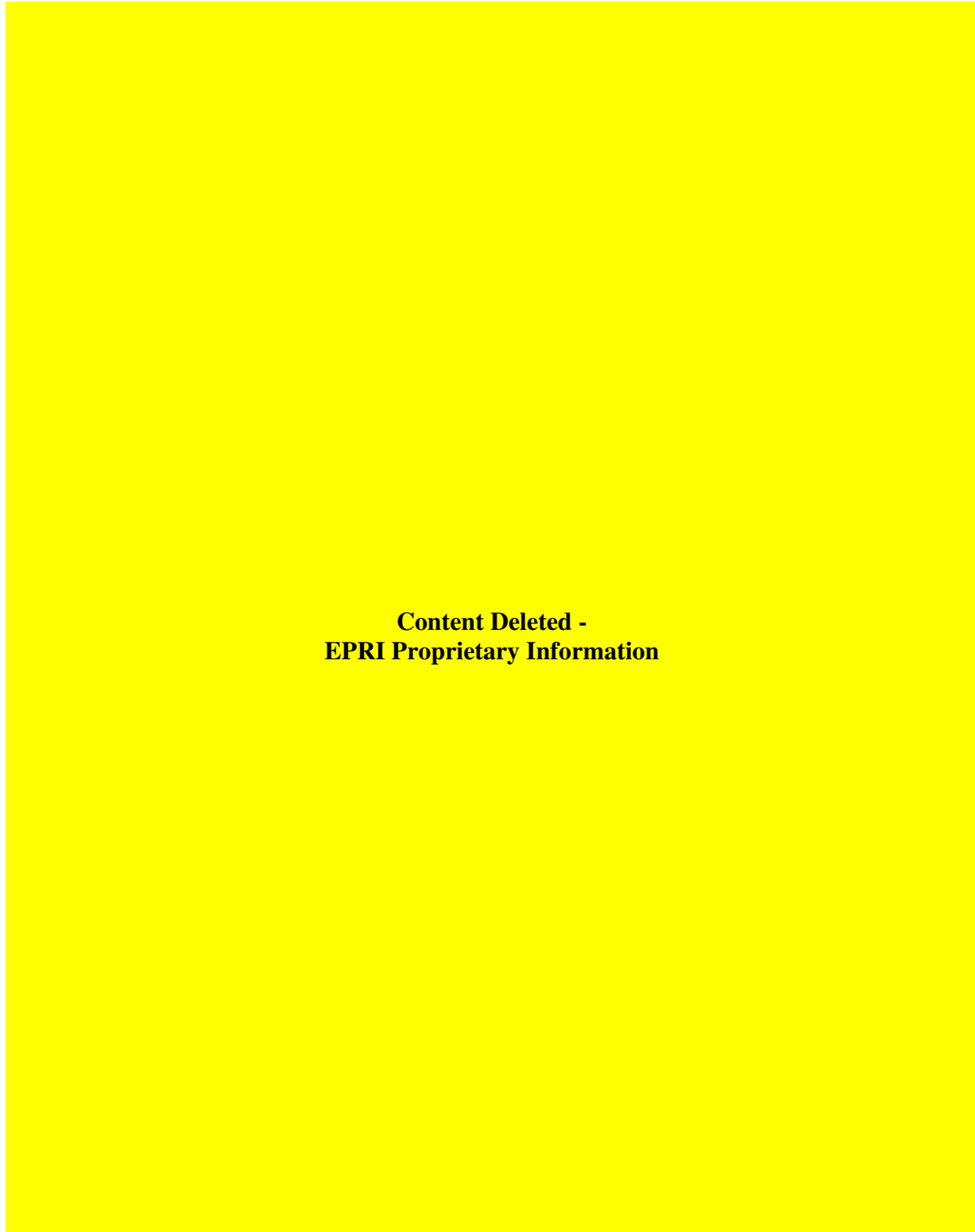
5.4.41 UT Demonstration 40





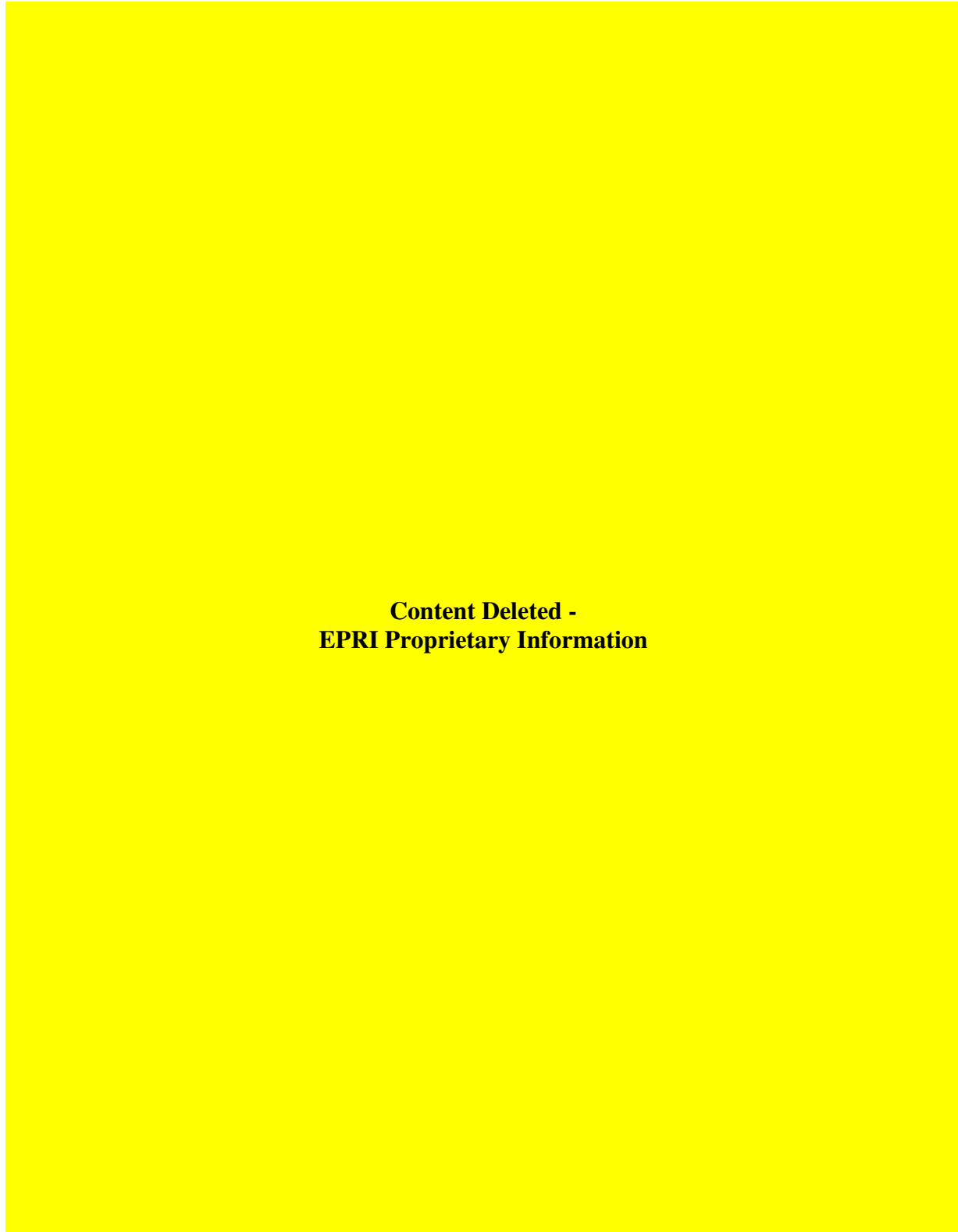
**Content Deleted -
EPRI Proprietary Information**

5.4.42 UT Demonstration 41



**Content Deleted -
EPRI Proprietary Information**

5.4.43 UT Demonstration 42



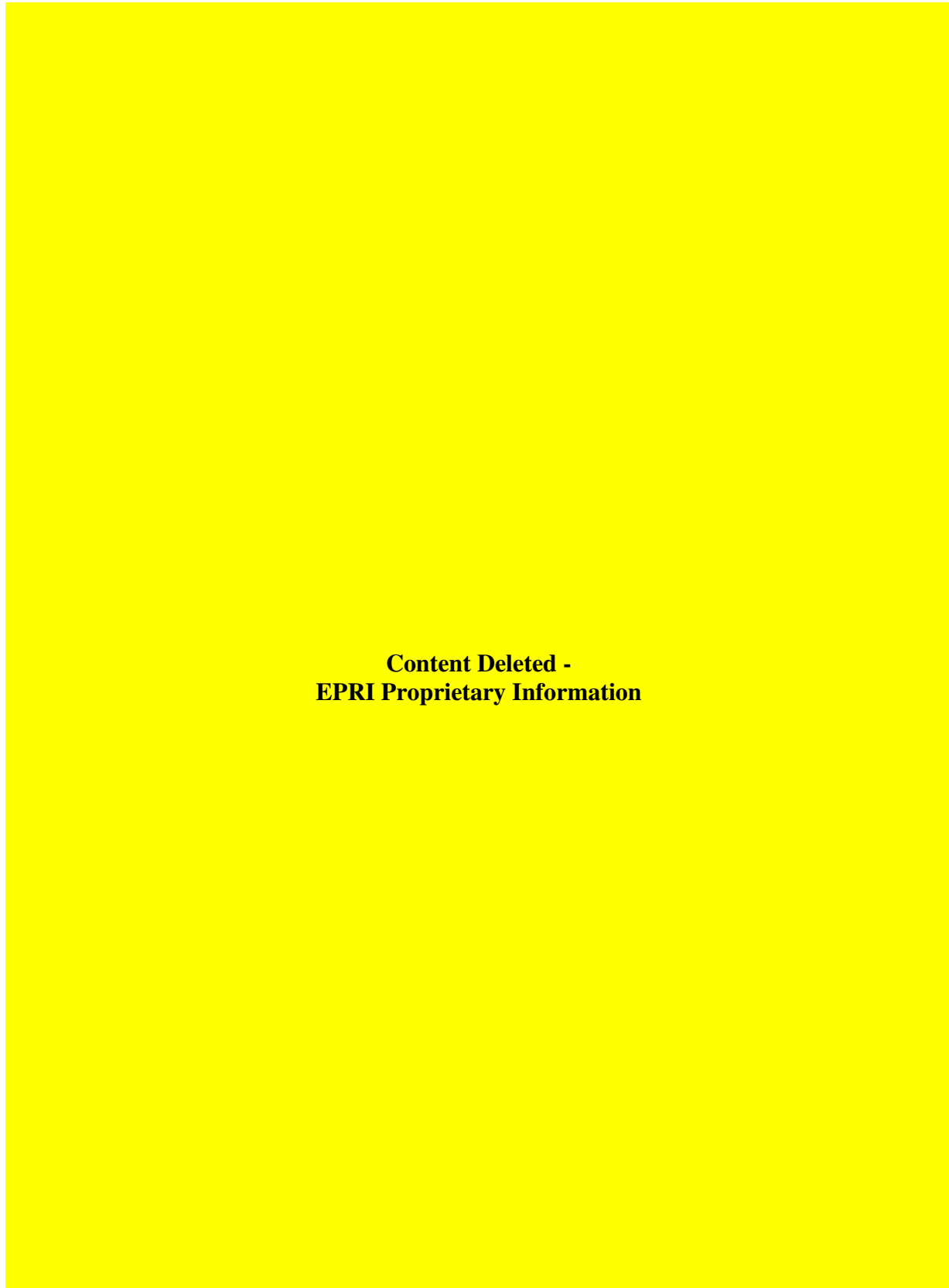
**Content Deleted -
EPRI Proprietary Information**

5.4.44 UT Demonstration 43

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.45 UT Demonstration 44

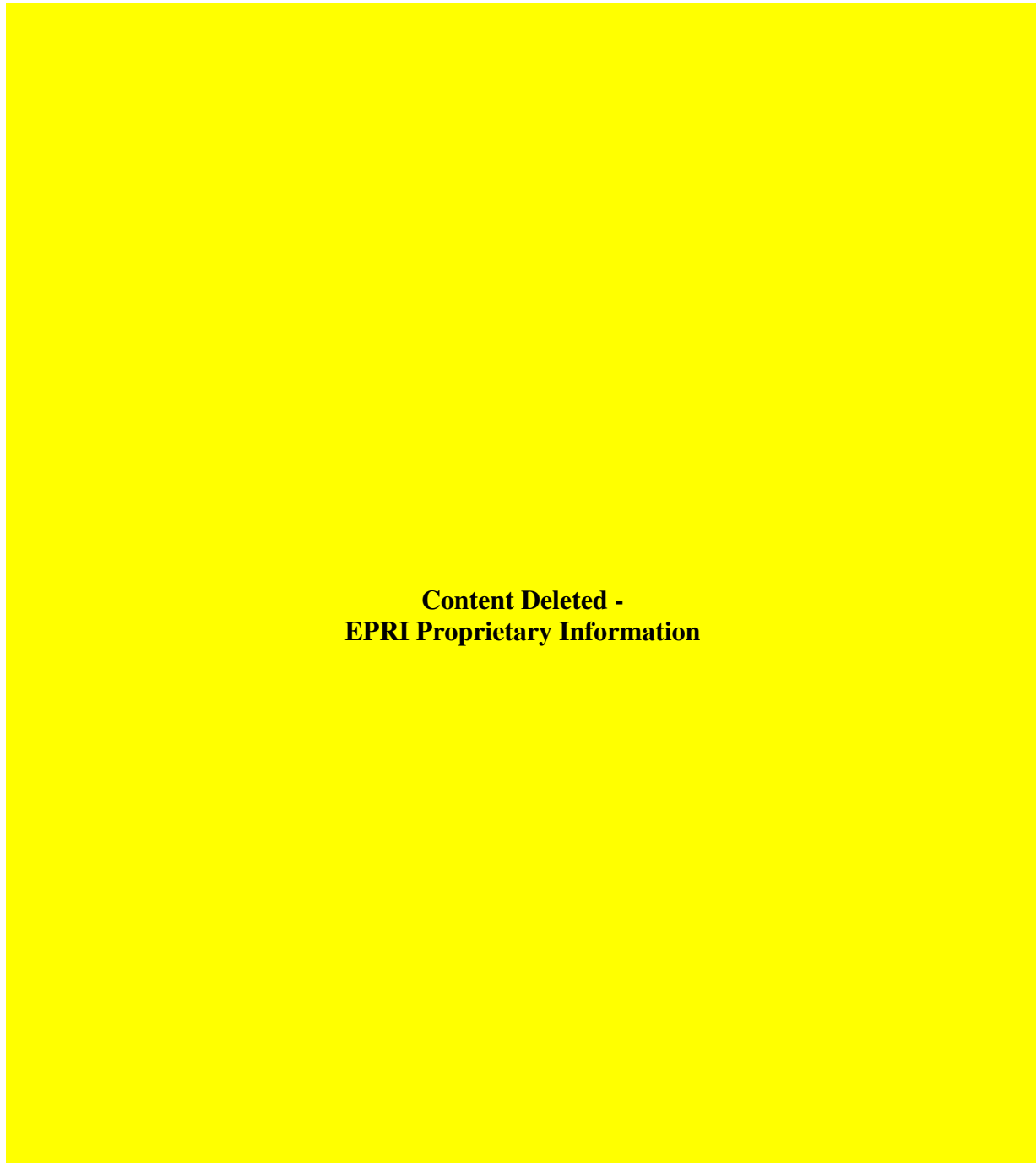


**Content Deleted -
EPRI Proprietary Information**



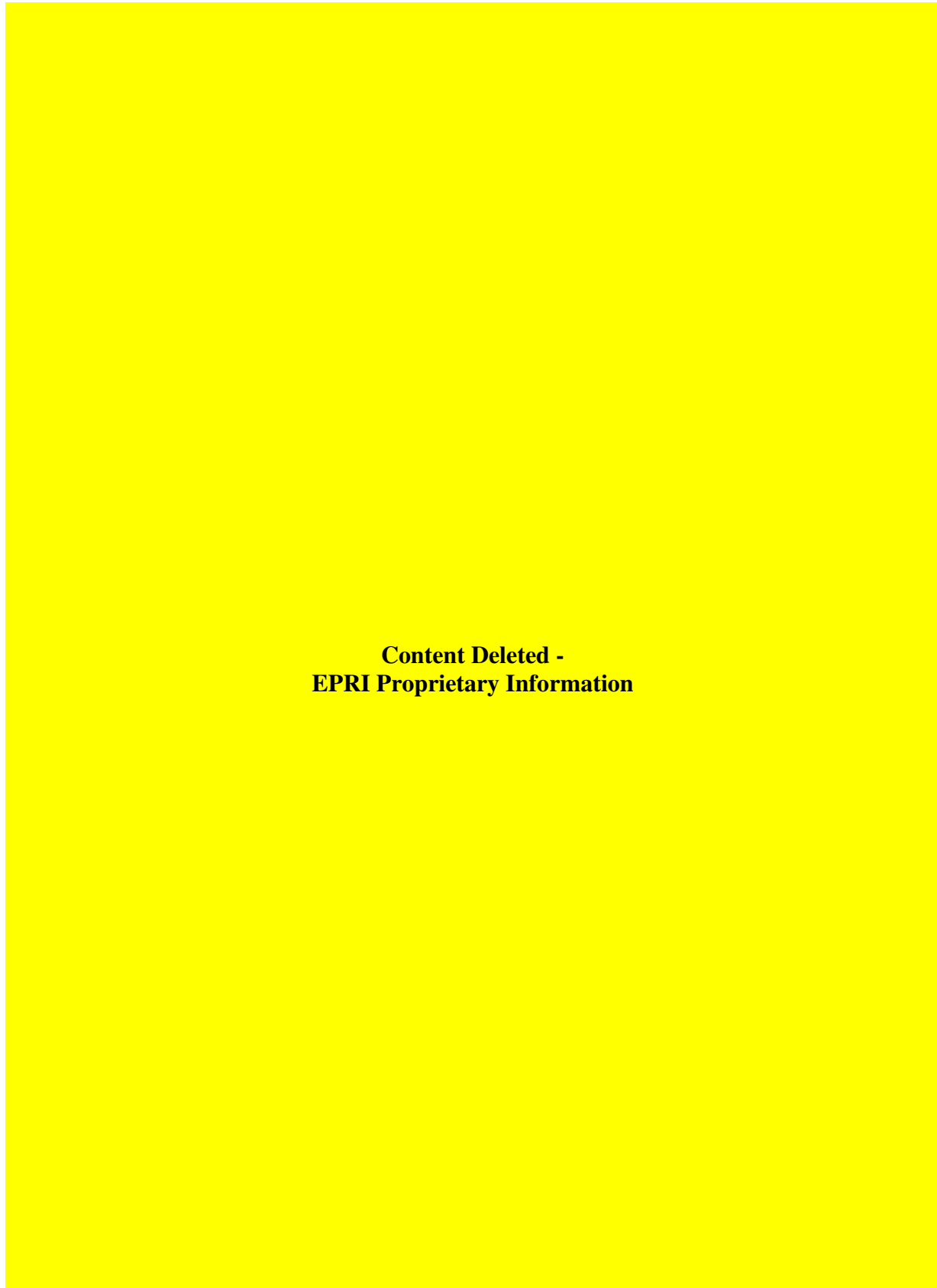
**Content Deleted -
EPRI Proprietary Information**

5.4.46 UT Demonstration 45



**Content Deleted -
EPRI Proprietary Information**

5.4.47 UT Demonstration 46



**Content Deleted -
EPRI Proprietary Information**

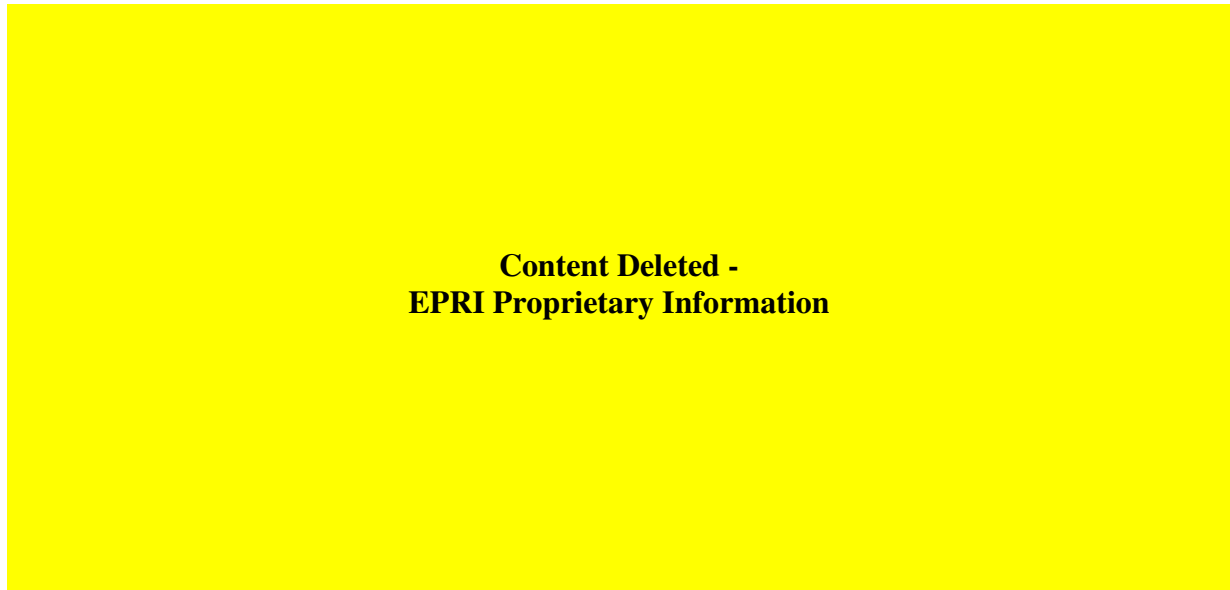
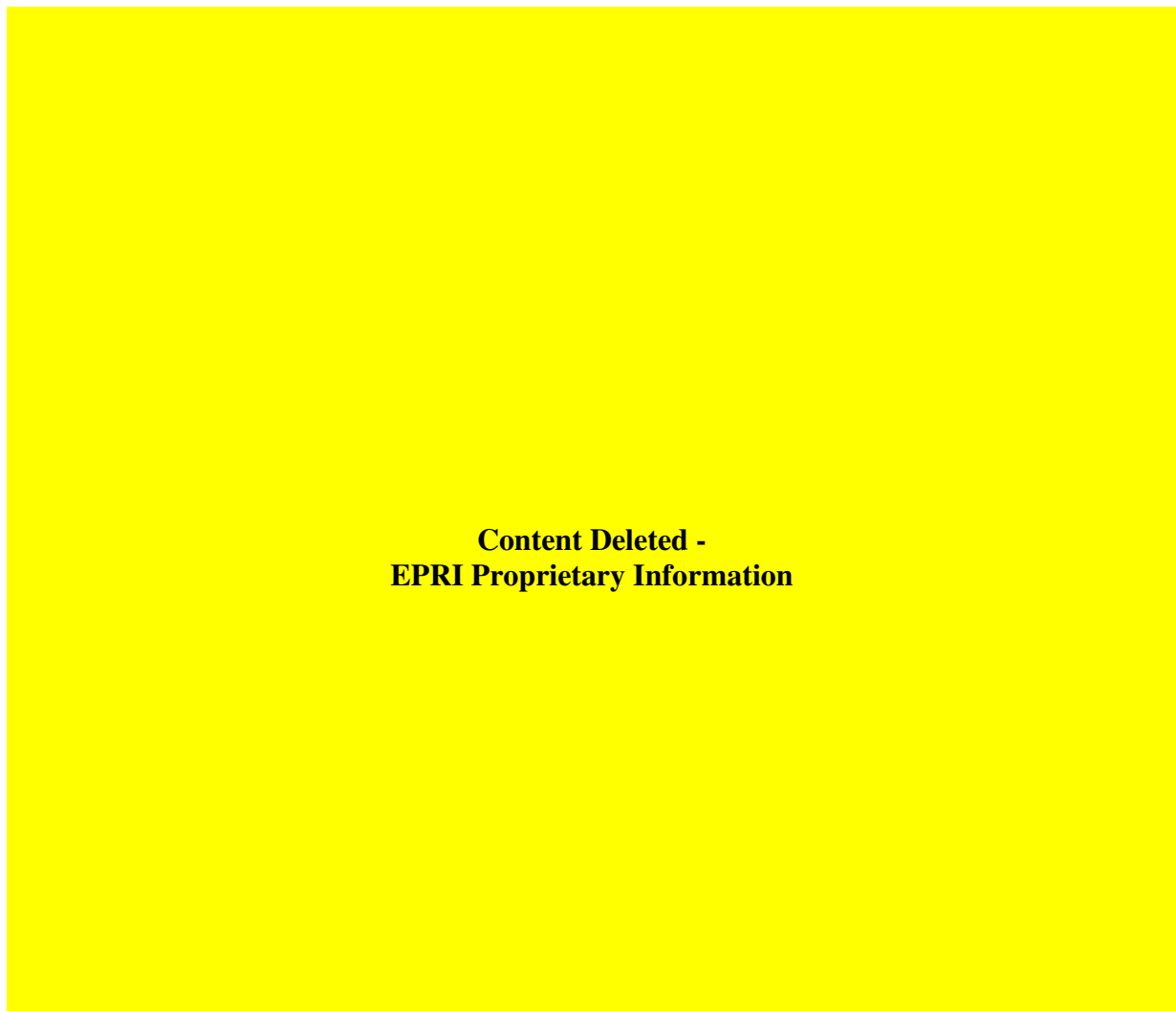


Figure 5.4.47-1. Scan Line Positions



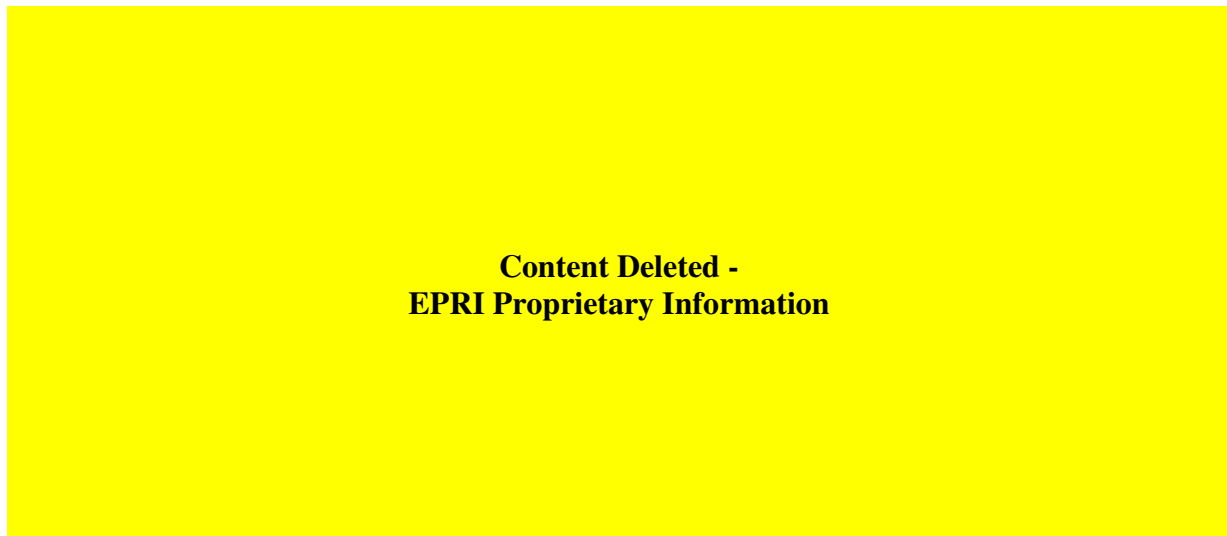
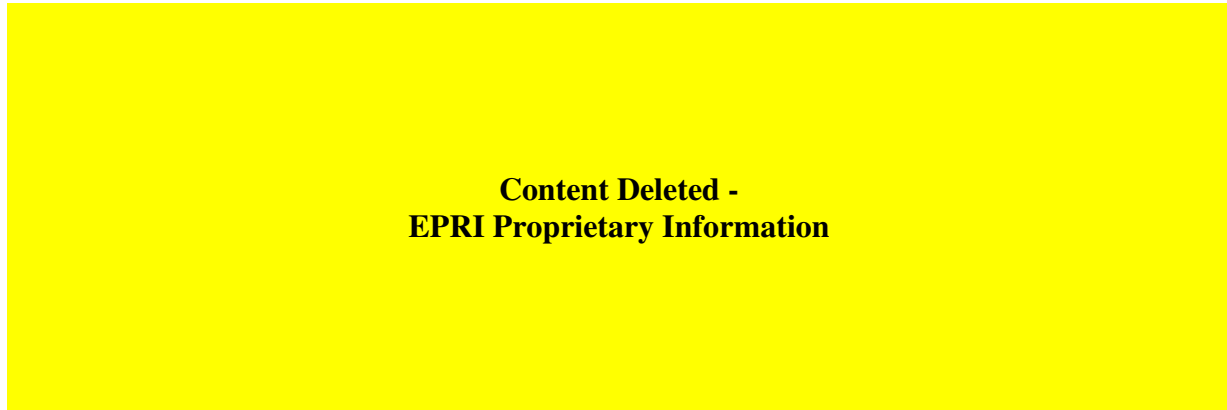


Figure 5.4.47-2. Inside Surface Flaw Depth Sizing Error If Correction Is Not Used

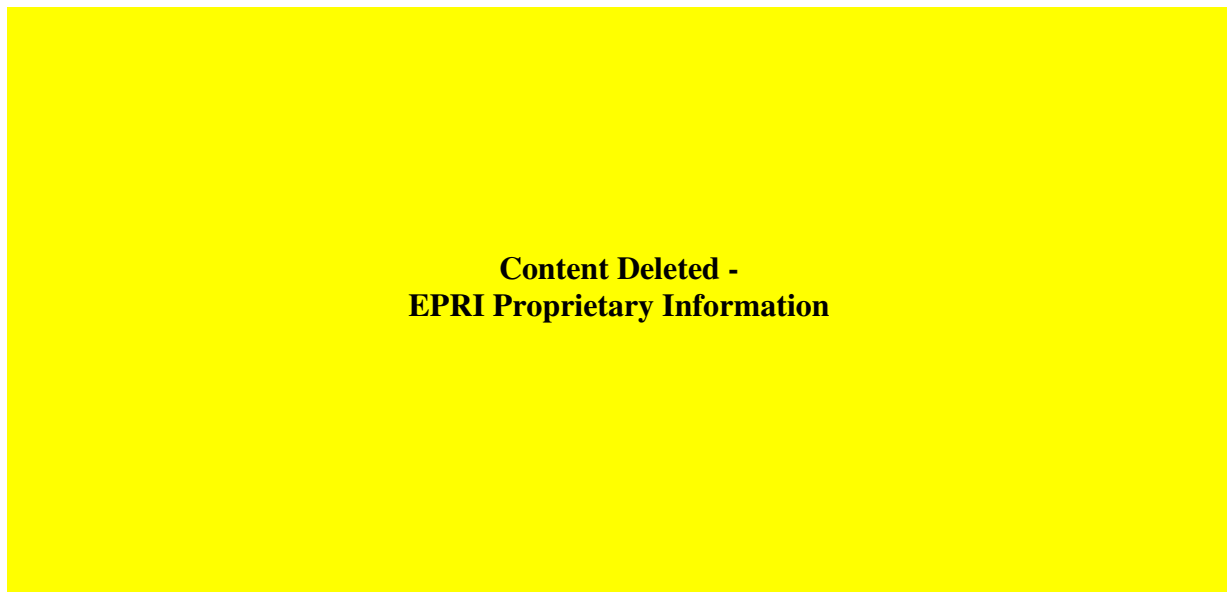


Figure 5.4.47-3. Outside Surface Flaw Depth Sizing Error If Correction Is Not Used

**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.47-4. Geometric Reflector Used to Measure the Amount of Weld Mismatch

**Content Deleted -
EPRI Proprietary Information**

5.4.48 UT Demonstration 47



**Content Deleted -
EPRI Proprietary Information**

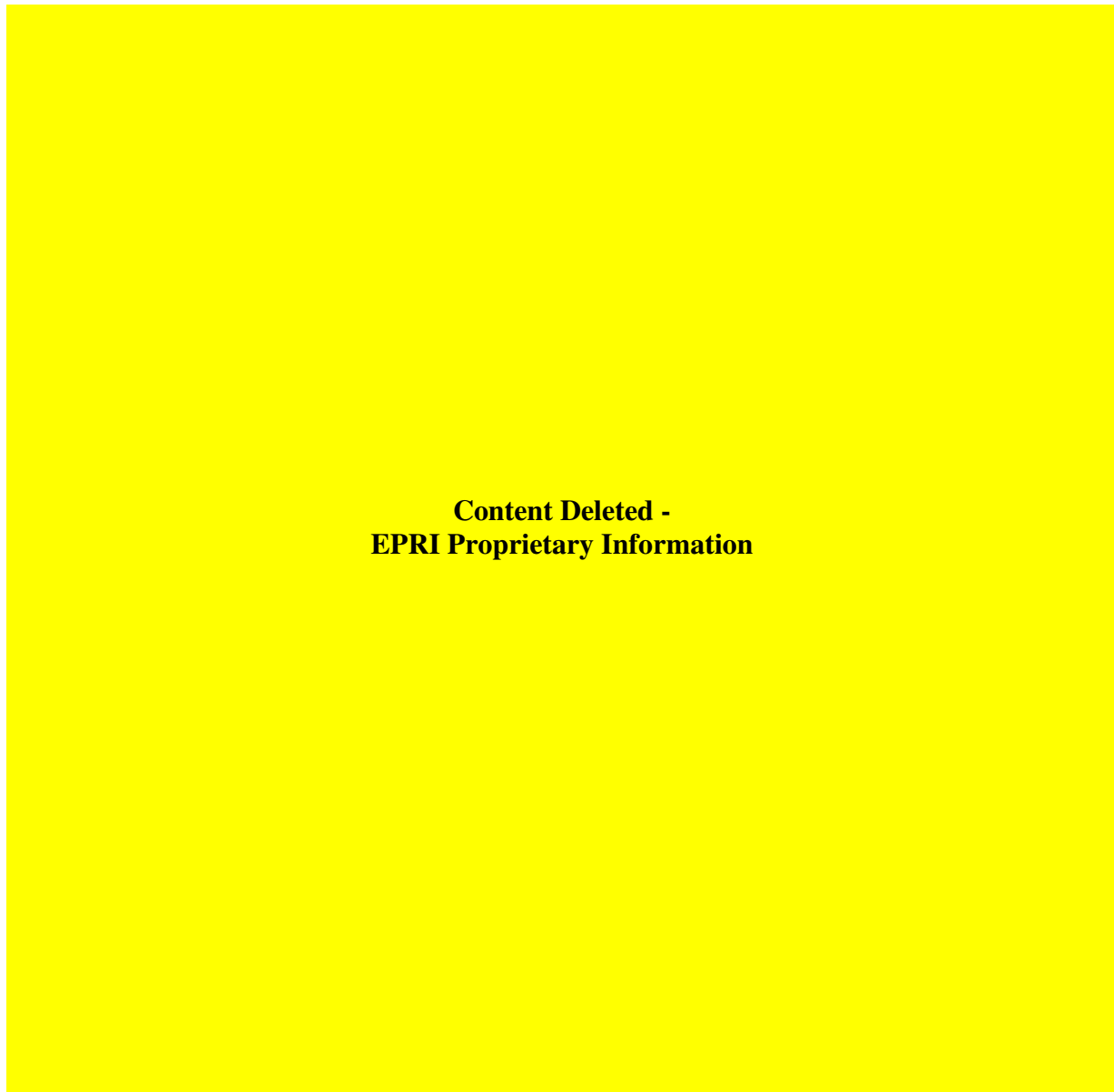


Figure 5.4.48-1. Geometry and Ultrasonic Beam Simulation for Inspection of Weld H8

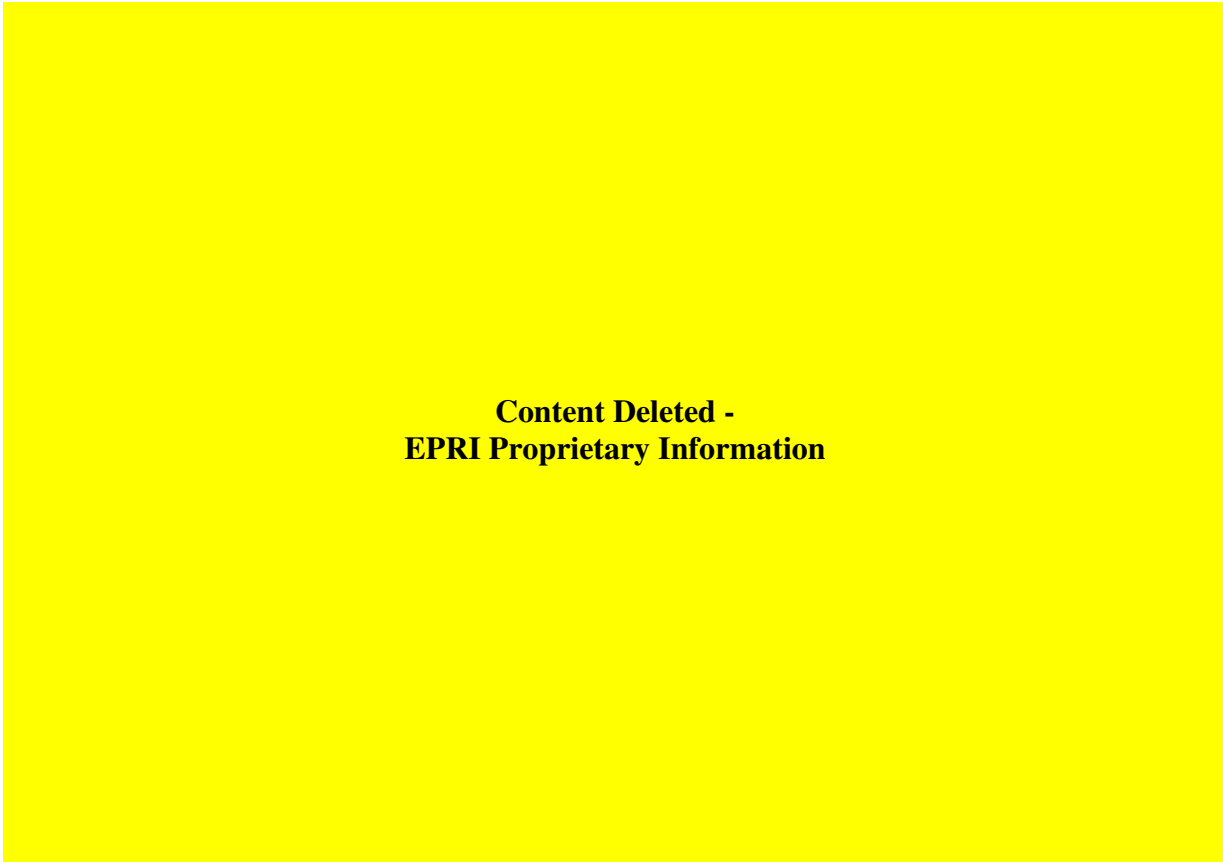


Figure 5.4.48-2. Coverage for Inspection of Weld H8

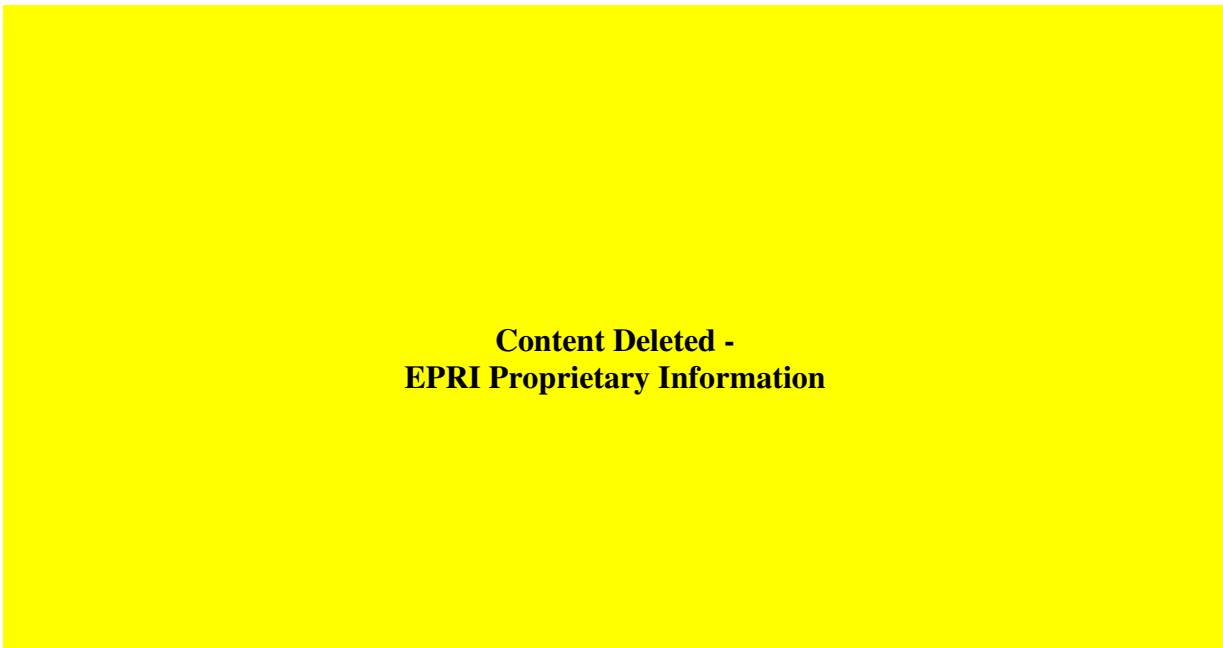


Figure 5.4.48-3. Some Potential Flaw Locations and Orientations in Weld H8

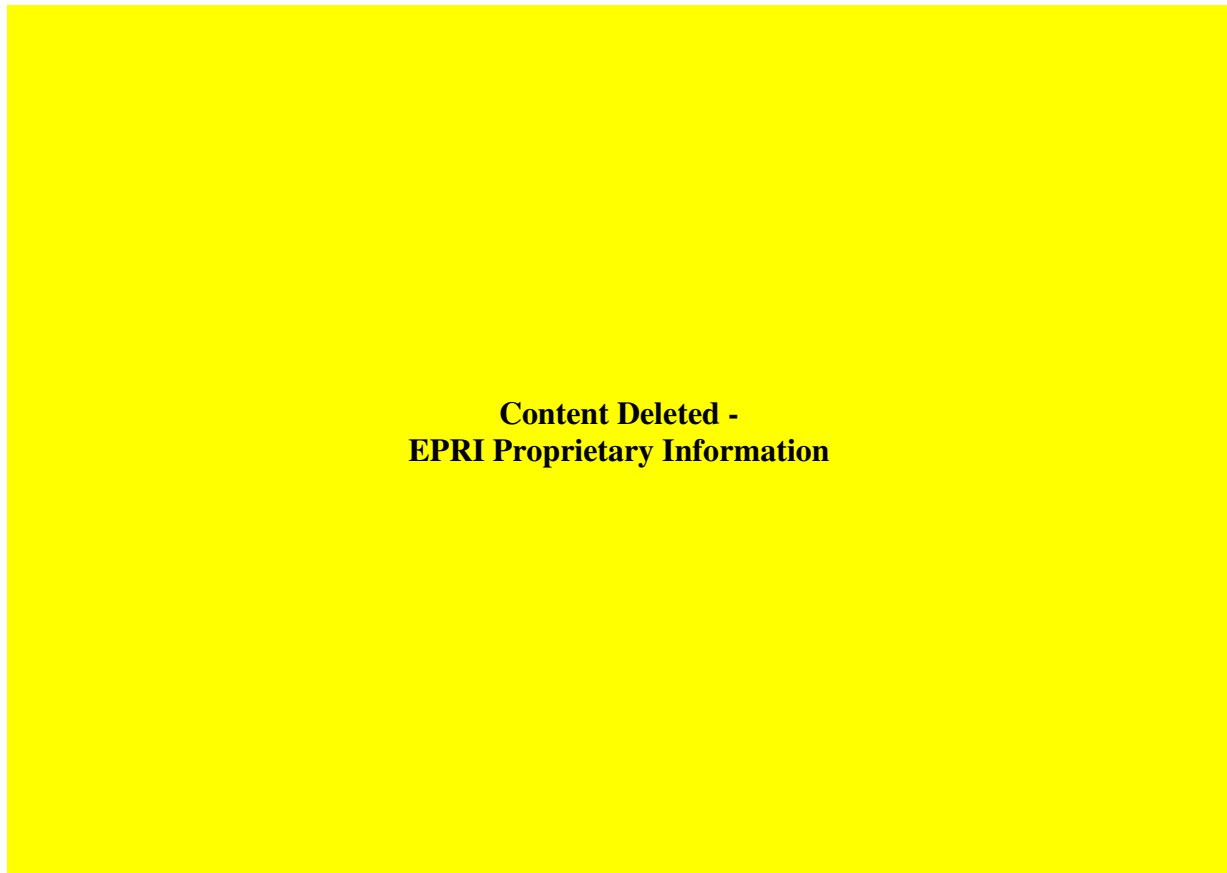


Figure 5.4.48-4. Setting the Sensitivity for Inspection of Weld H8

5.4.49 UT Demonstration 48

**Content Deleted -
EPRI Proprietary Information**

Table 5.4.49-1. Search Unit Angles and Beam Orientations for Demonstration 48

**Content Deleted -
EPRI Proprietary Information**

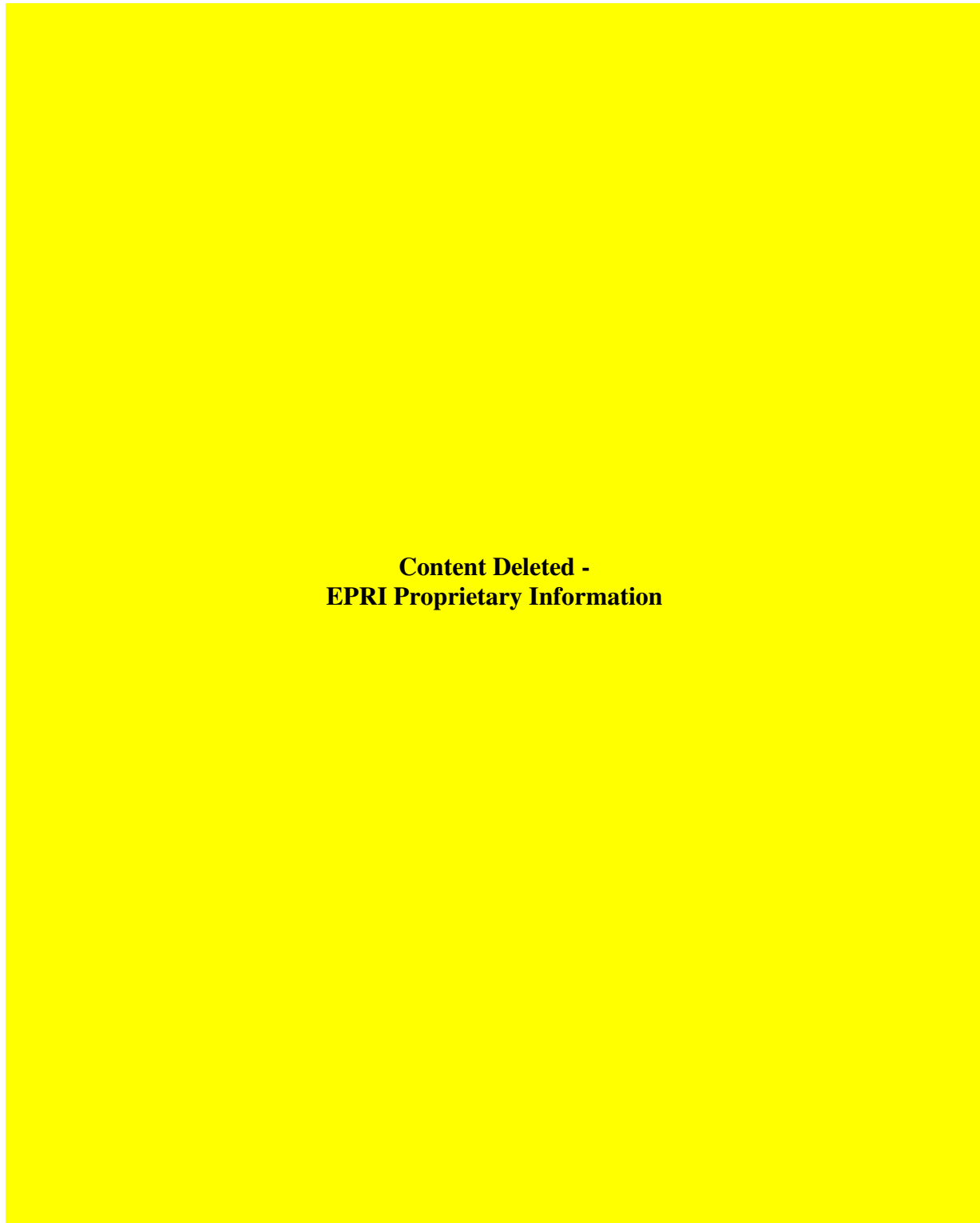
**Content Deleted -
EPRI Proprietary Information**

Table 5.4.49-2. Summary of Detection Results for Demonstration 48

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.50 UT Demonstration 49



Content Deleted - EPRI Proprietary Information

Table 5.4.50-1. Demonstrated Search Unit Angles and Beam Orientations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.50-1. Reported Flaw Depth for Circumferential Flaws Oriented Perpendicular to the Scan Surface (Measurements Made Along the Ultrasound Axis)

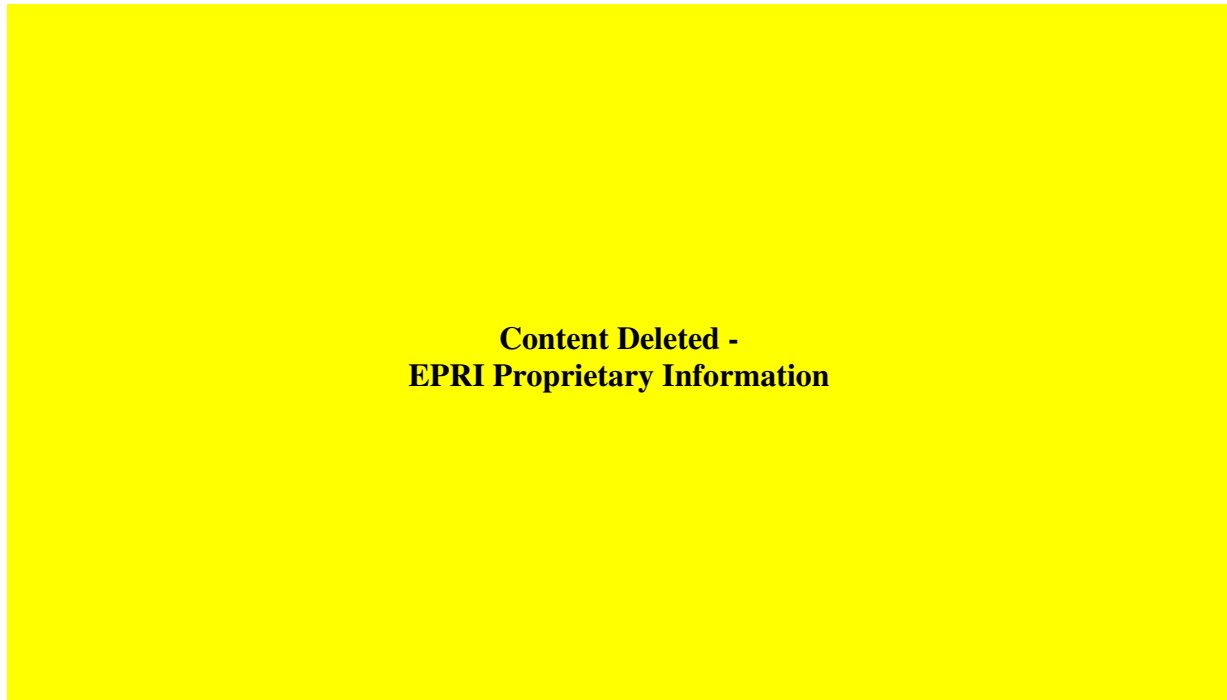


Figure 5.4.50-2. Reported Flaw Depth for Circumferential Flaws Oriented Parallel to the Scan Surface (Measurements Made Along the Ultrasound Axis)

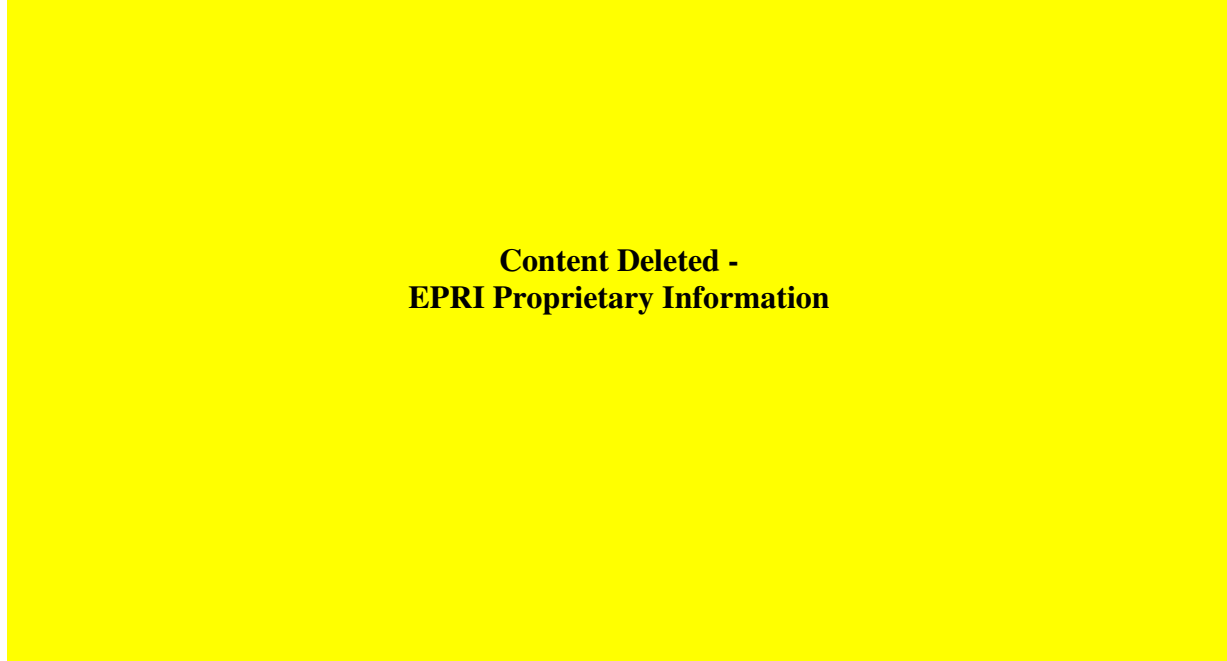


Figure 5.4.50-3. Reported Flaw Depth for Circumferential Flaws Oriented Parallel to the Scan Surface (Measurements Made Along the Scan Axis)



Figure 5.4.50-4. Reported Flaw Depth for Axial Flaws (Measurements Made Along the Ultrasound Axis)

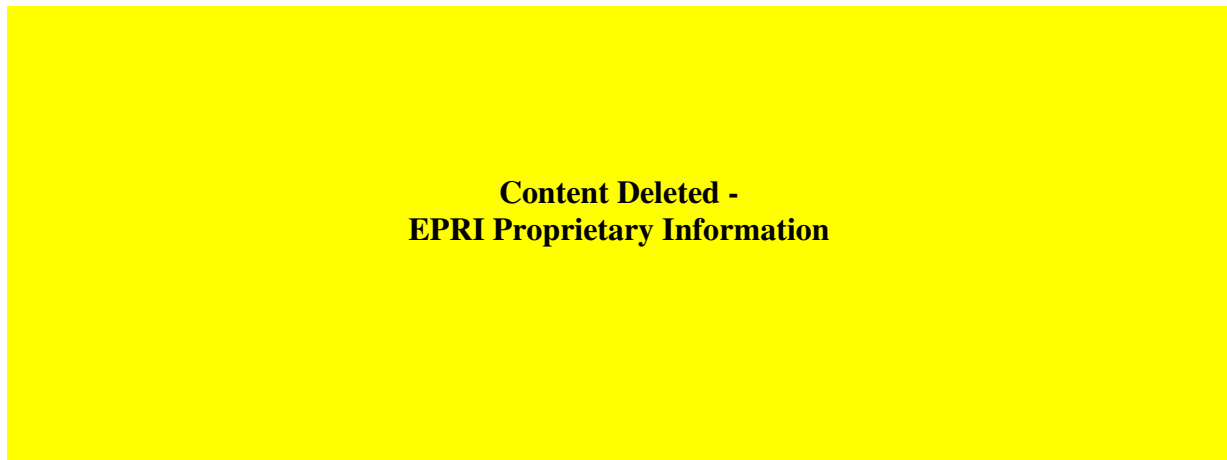


Figure 5.4.50-5. Reported Flaw Depth for Axial Flaws (Measurements Made Along the Scan Axis)

Table 5.4.50-2. Reported Length Sizing Errors

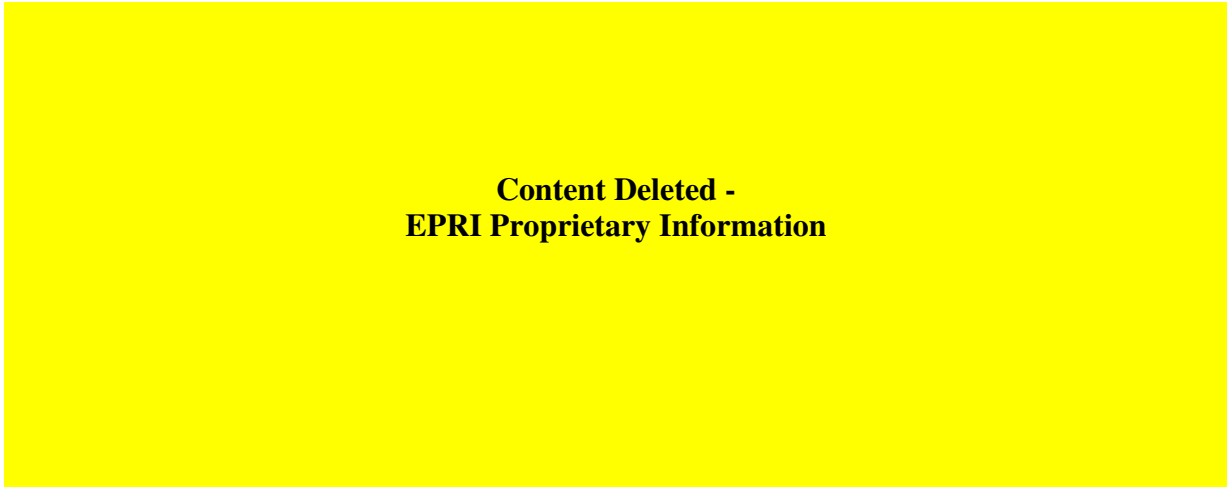
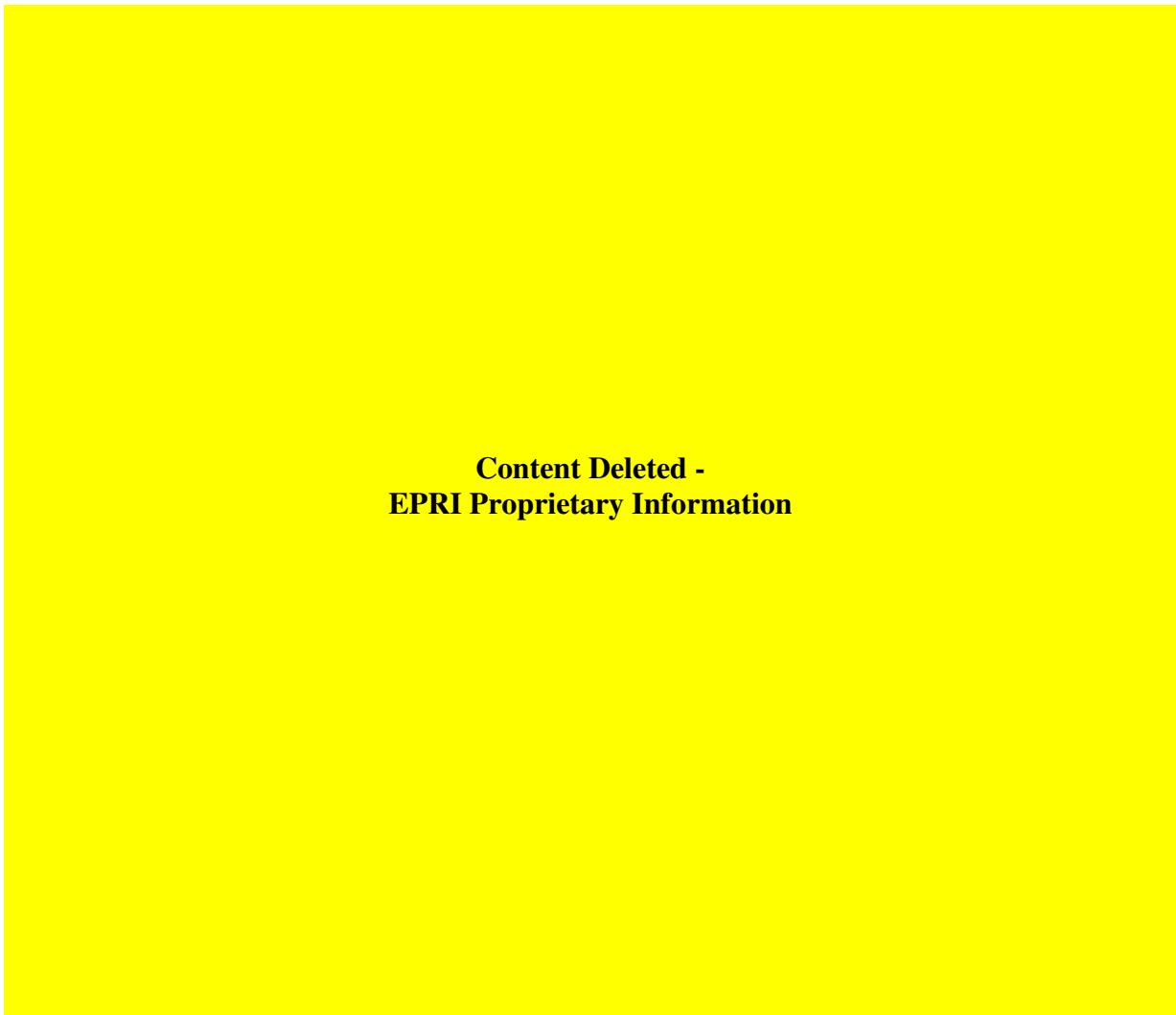
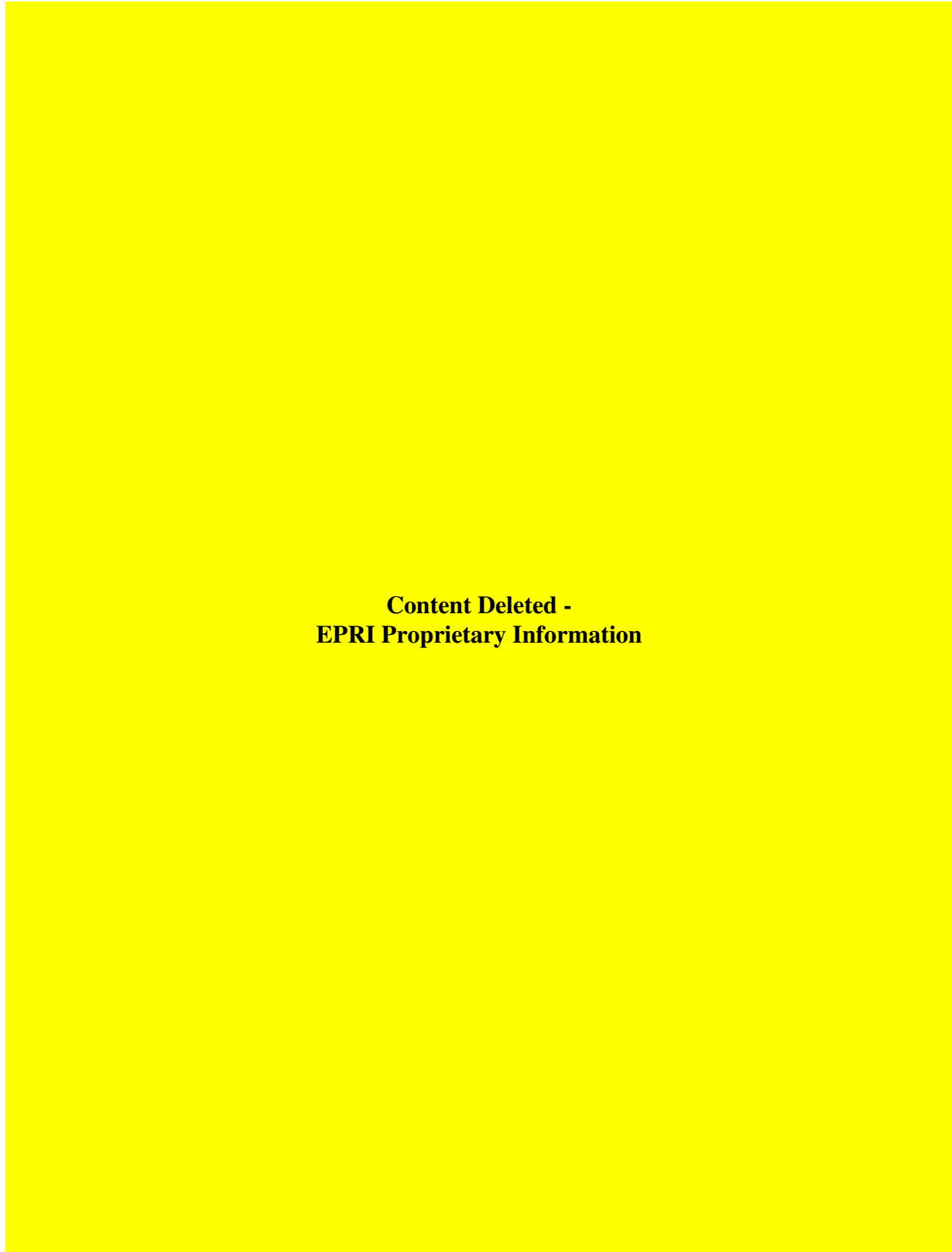


Table 5.4.50-3. Reported Depth Sizing Errors



5.4.51 UT Demonstration 50



**Content Deleted -
EPRI Proprietary Information**

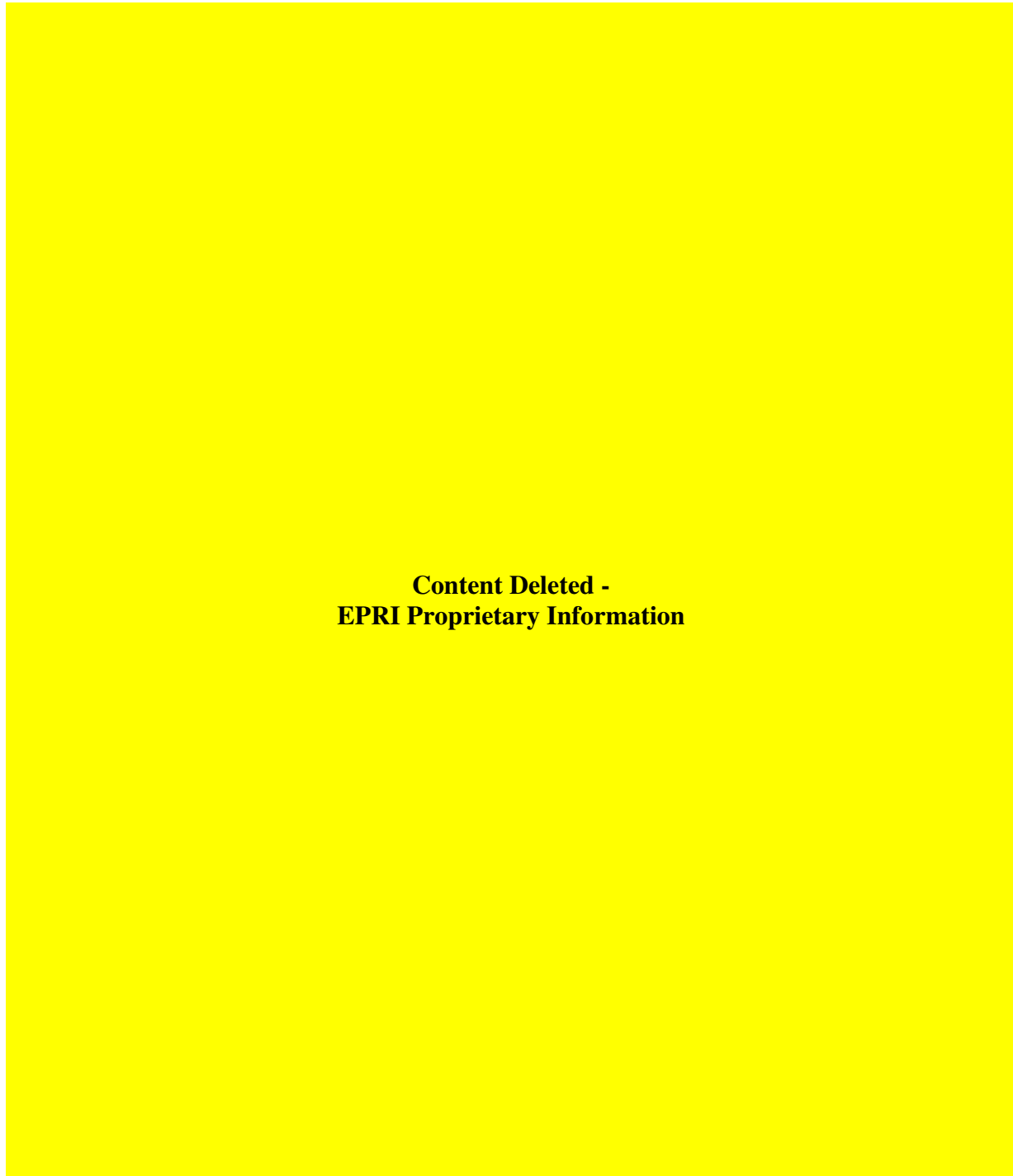
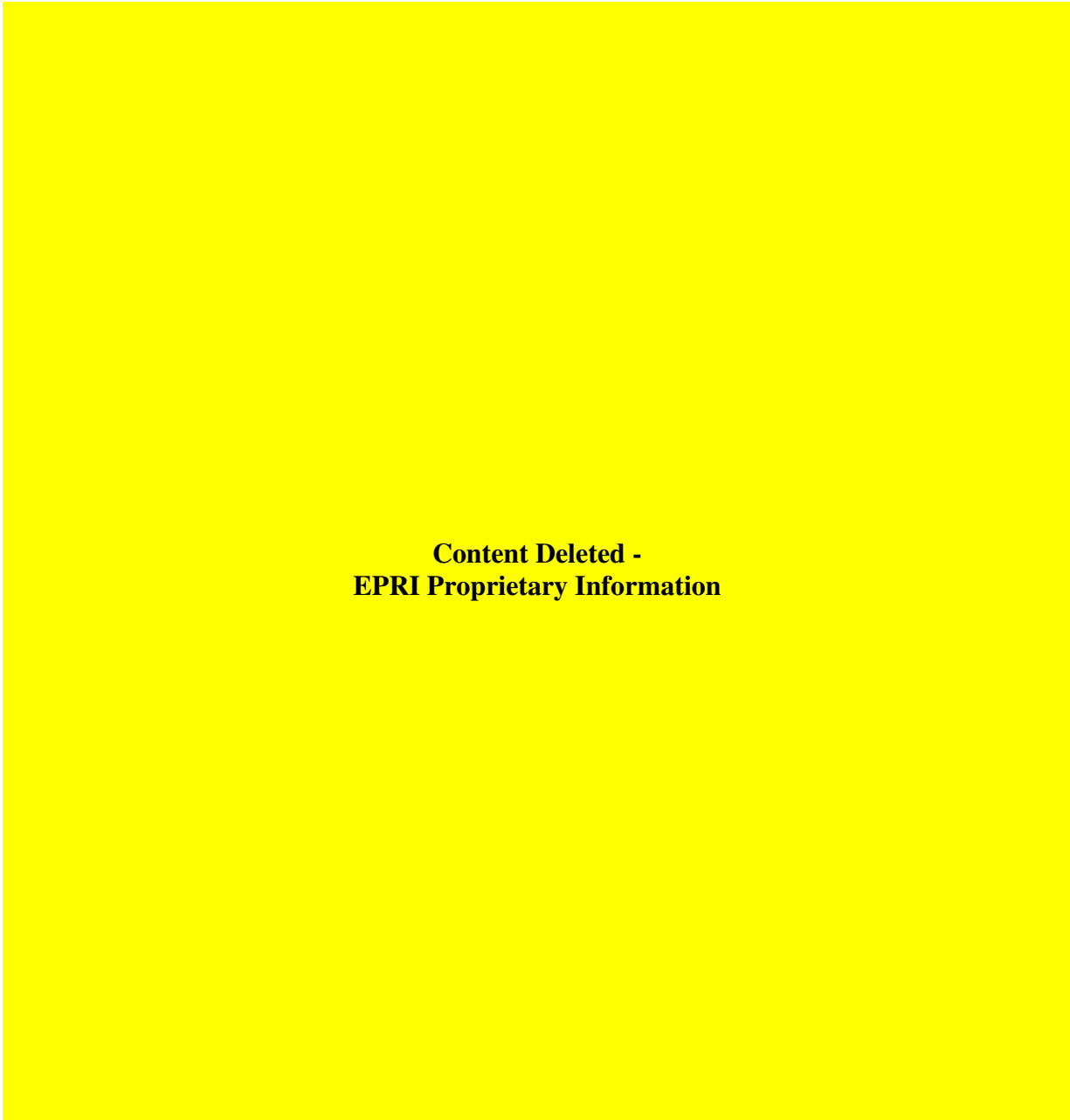


Figure 5.4.51-1. BWRVIP-P NDE Mockup (Scan and Index Orientations)

5.4.52 UT Demonstration 51



**Content Deleted -
EPRI Proprietary Information**

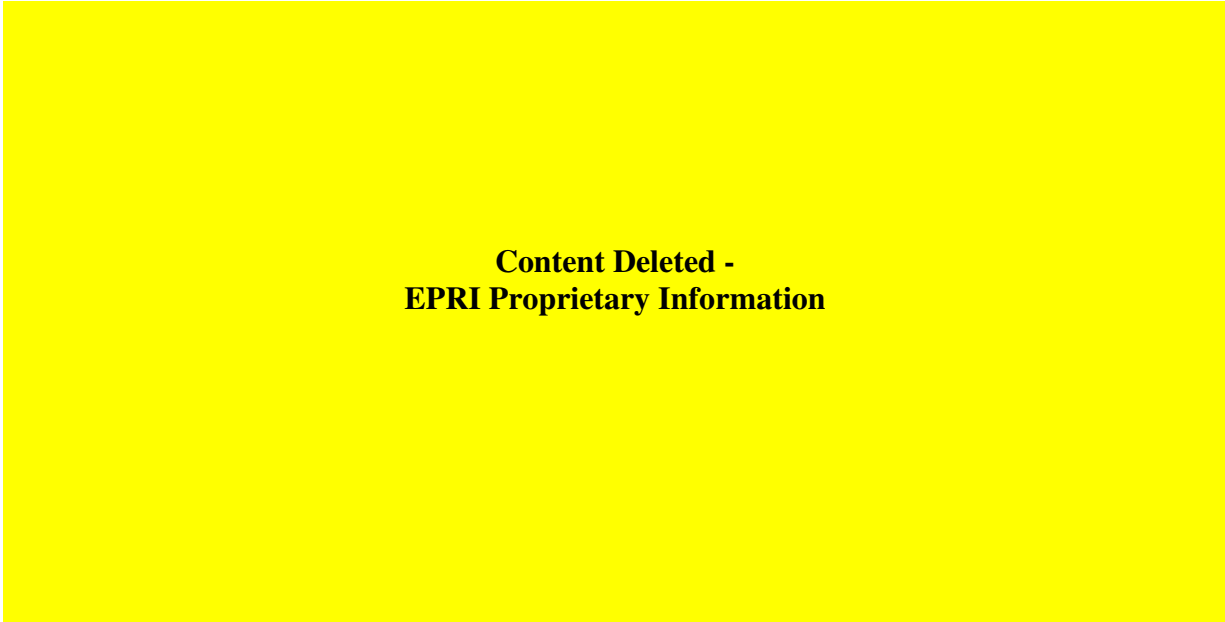
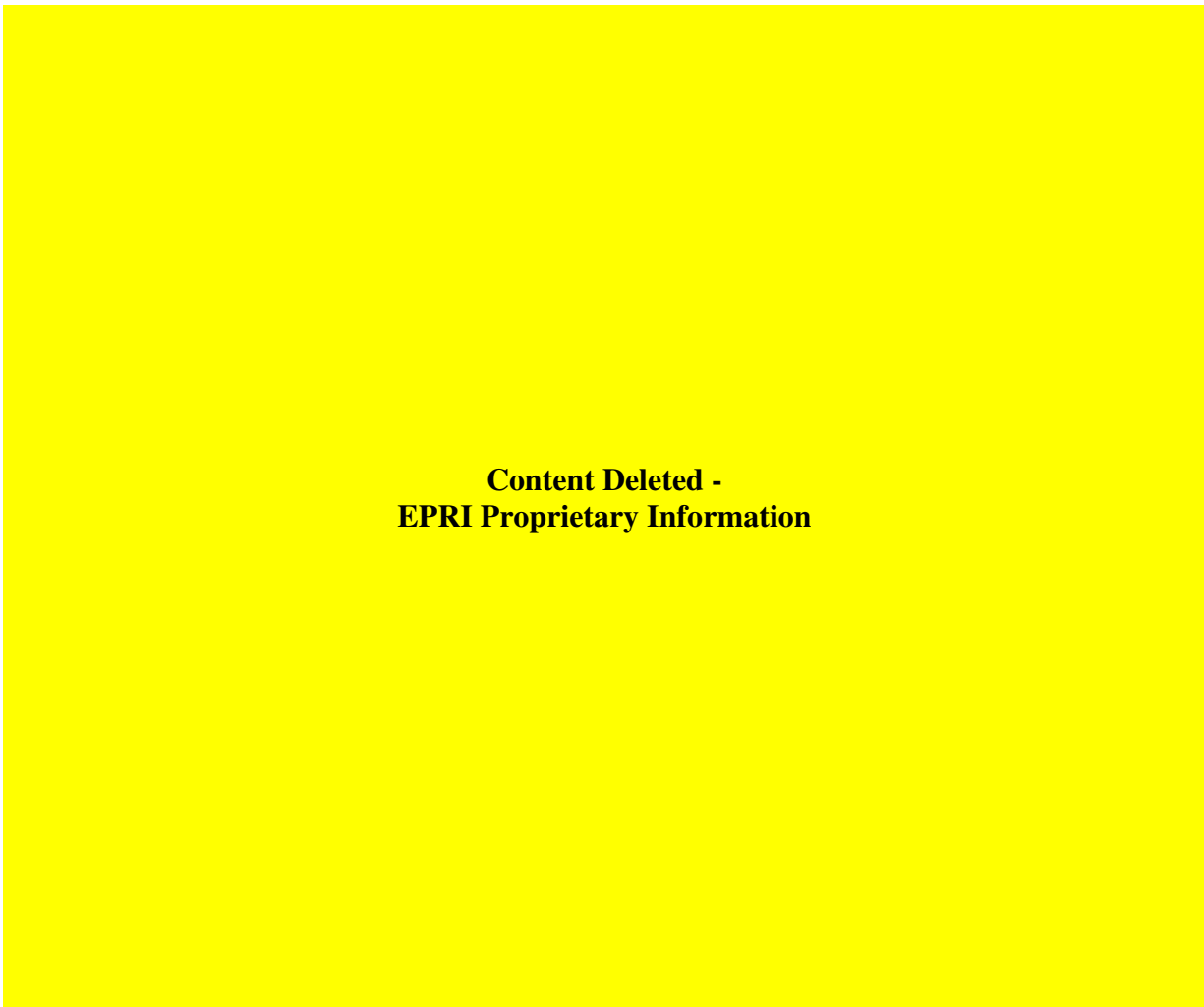


Figure 5.4.52-1. H7 Scan Configuration



**Content Deleted -
EPRI Proprietary Information**

5.4.53 UT Demonstration 52

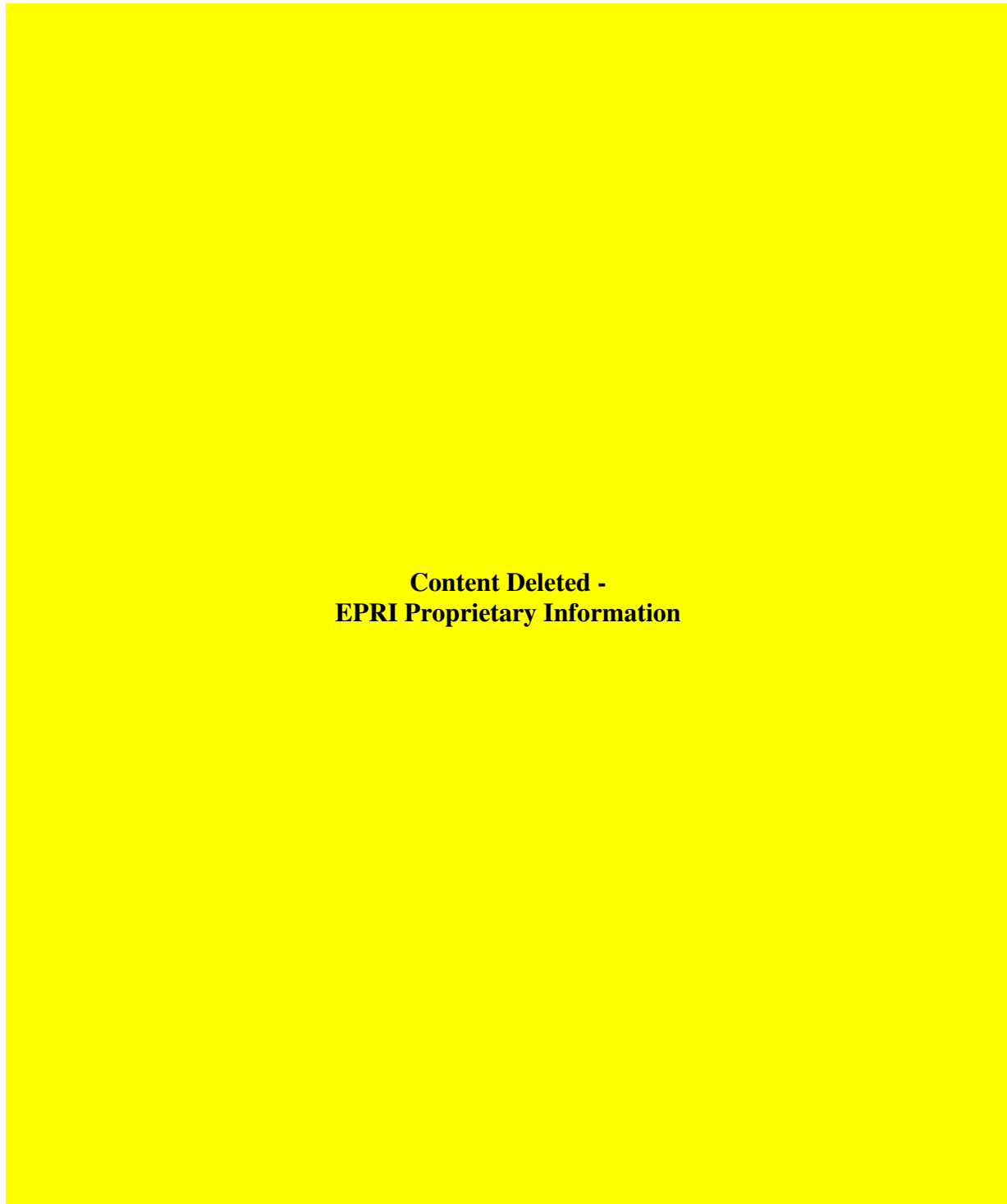
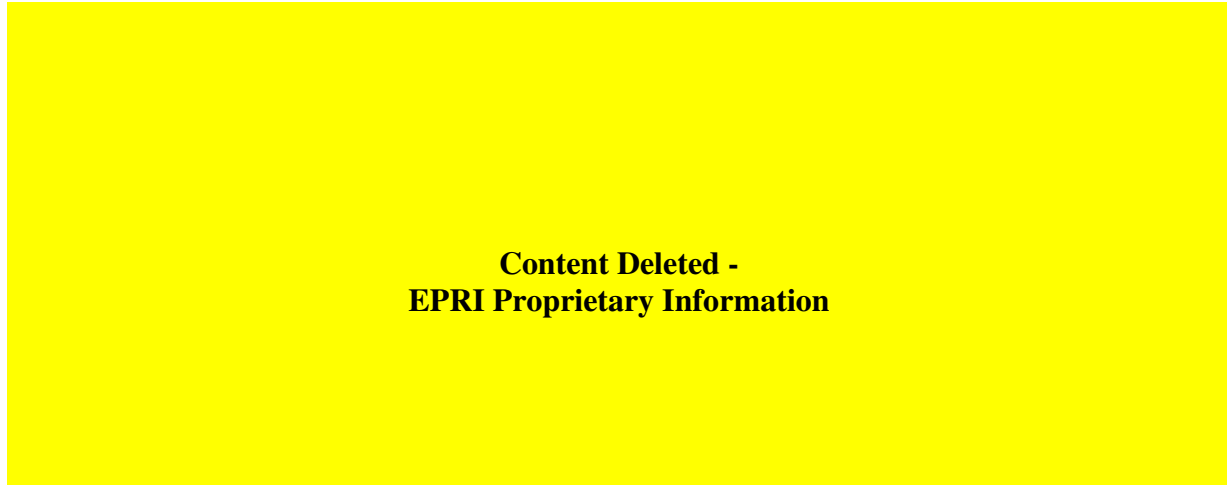


Table 5.4.53-1. Demonstrated Focal Law Parameters and Resolutions



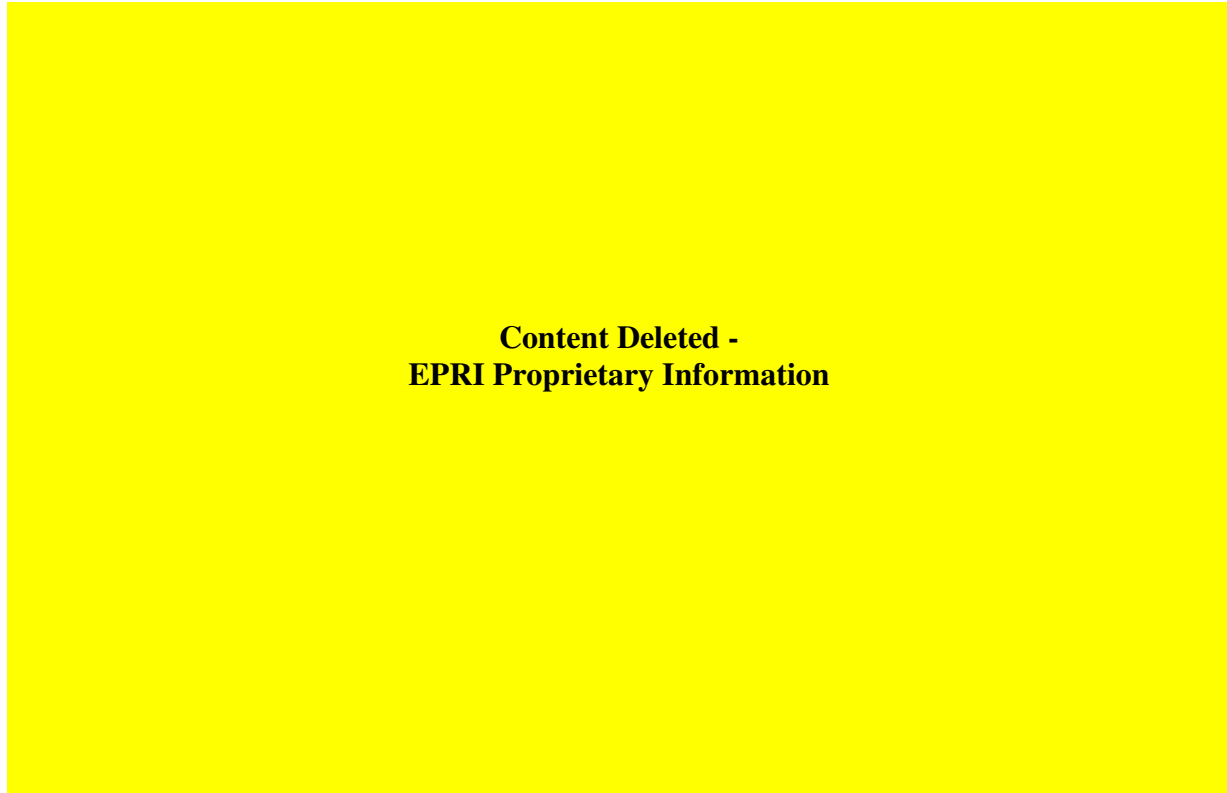


Figure 5.4.53-1. Axial Beam Direction Scan for H8 Weld

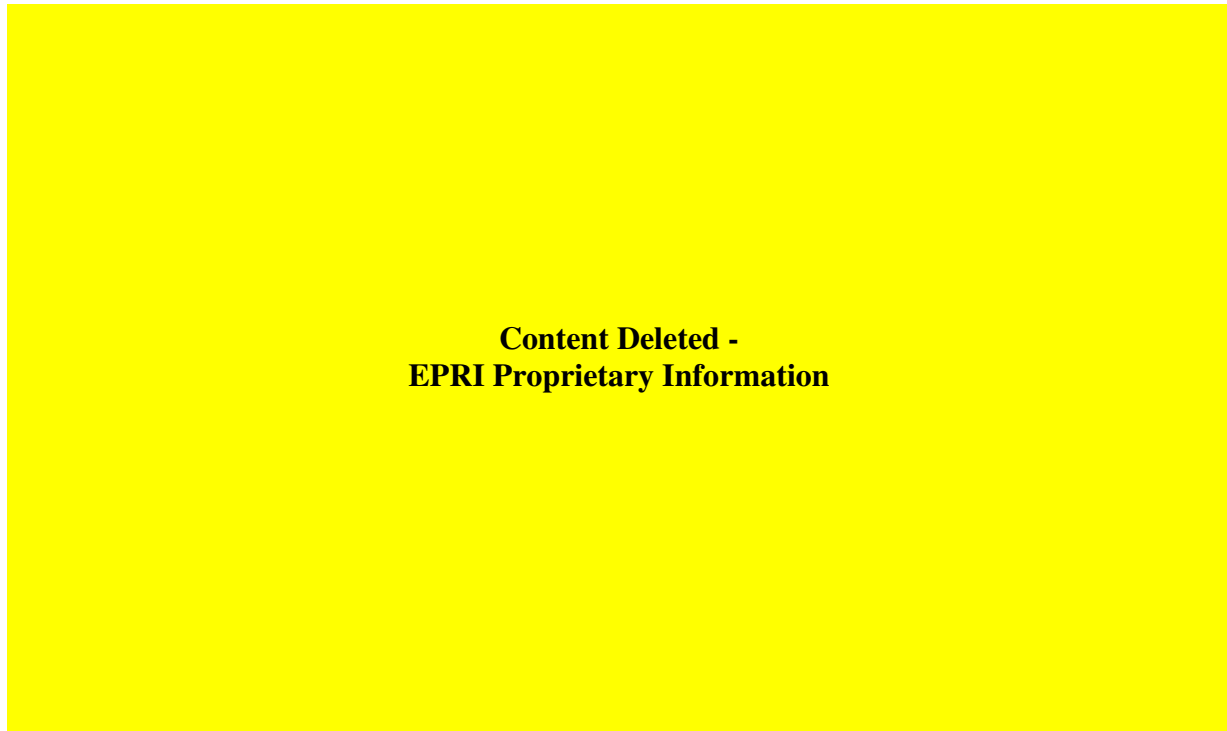


Figure 5.4.53-2. Circumferential Beam Direction Scan for H8 Weld

**Content Deleted -
EPRI Proprietary Information**

Table 5.4.53-2. Demonstrated Parameters for Volumetric Merge

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.54 UT Demonstration 53

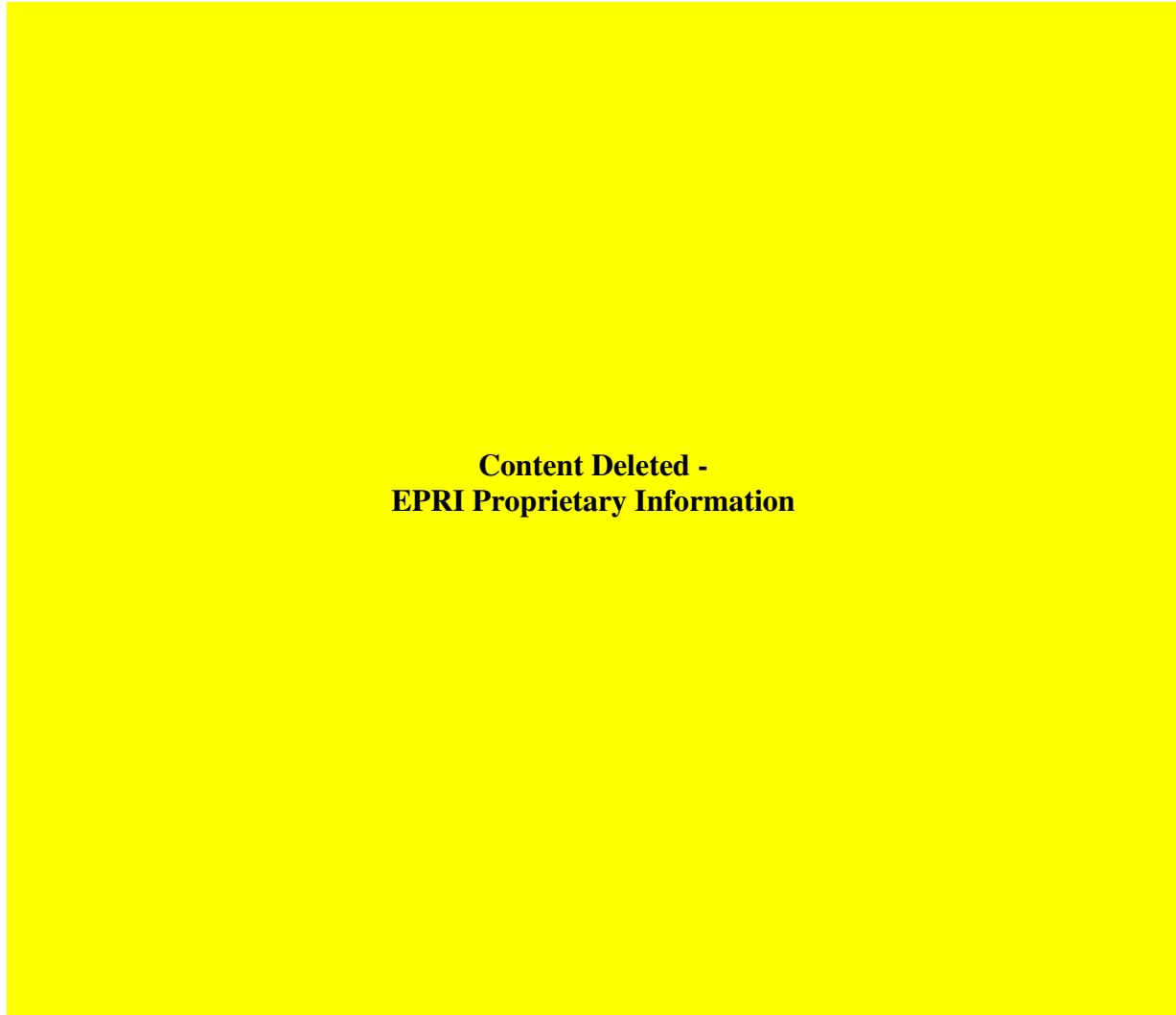
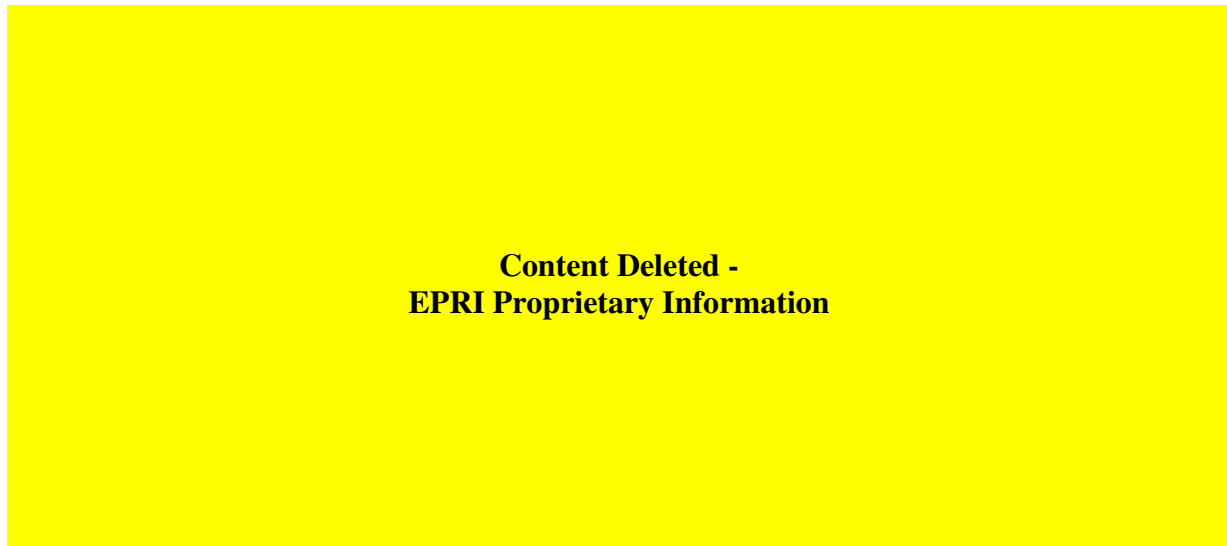


Table 5.4.54-1. Demonstrated Focal Law Parameters and Resolutions



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

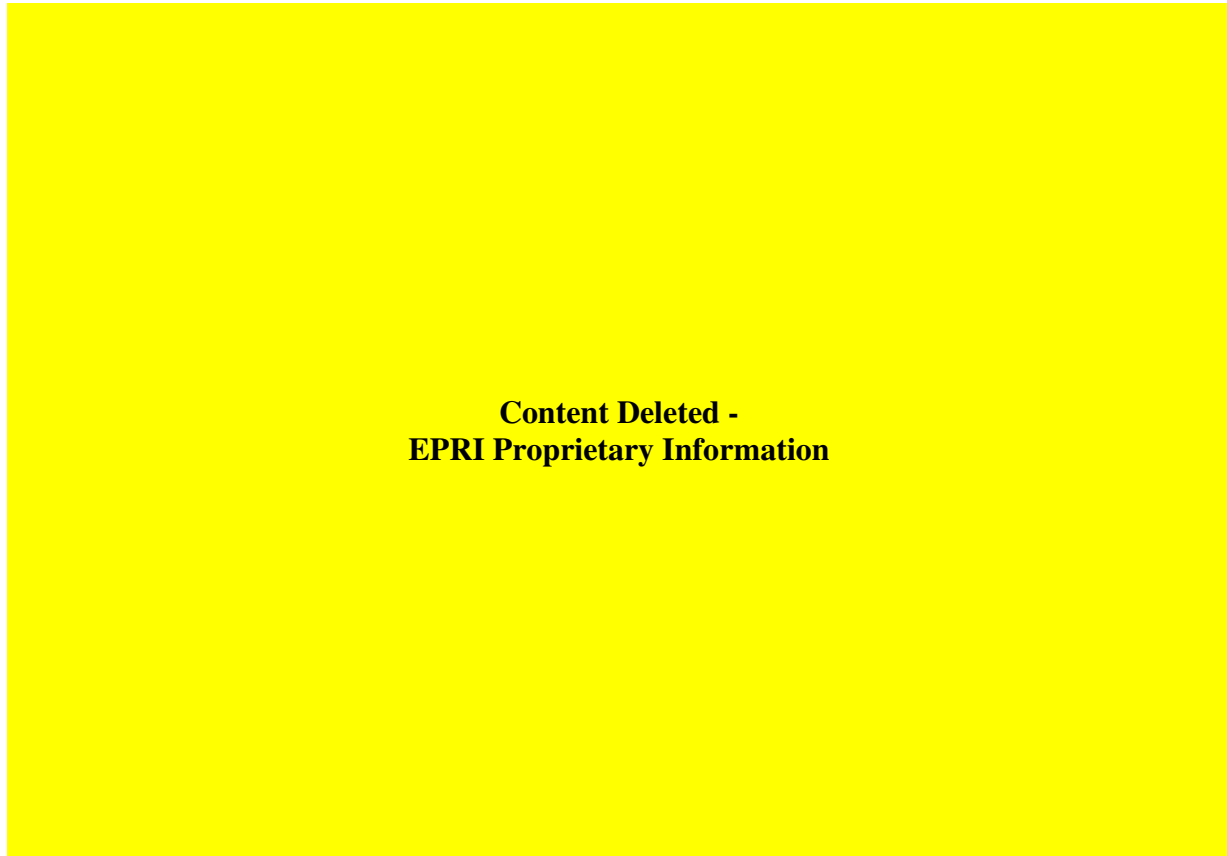


Figure 5.4.54-1. Axial Beam Direction Scan for H9 Weld (Side View)

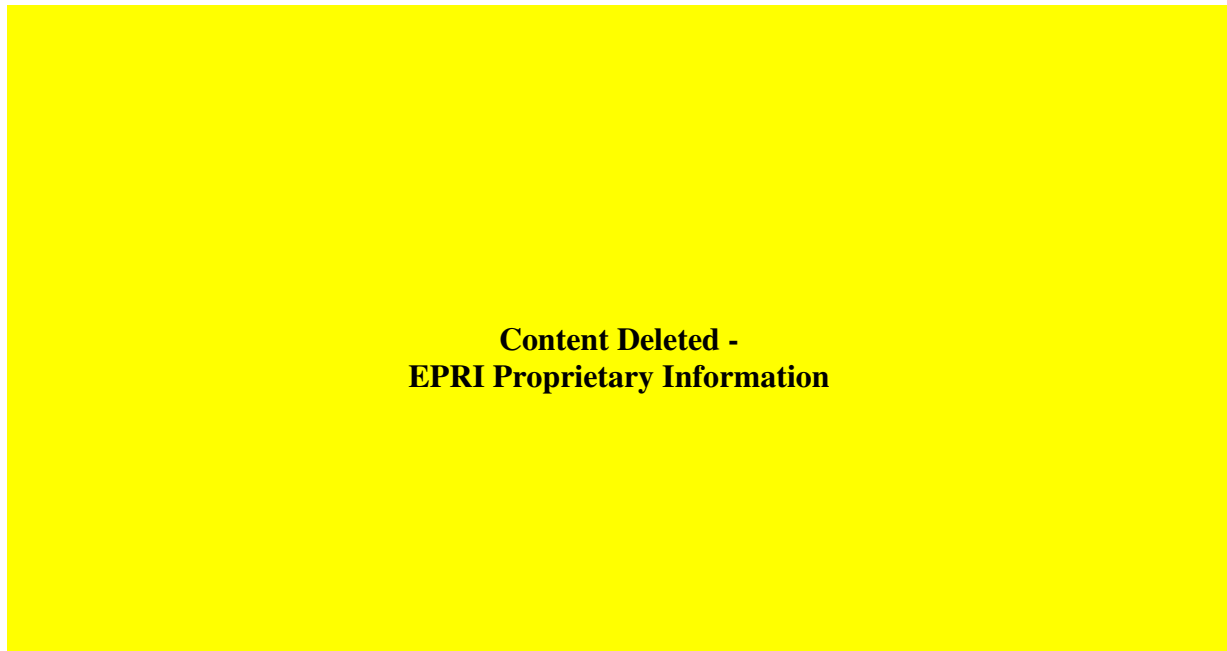


Figure 5.4.54-2. Circumferential Beam Direction Scan for H9 Weld (Top View)

**Content Deleted -
EPRI Proprietary Information**

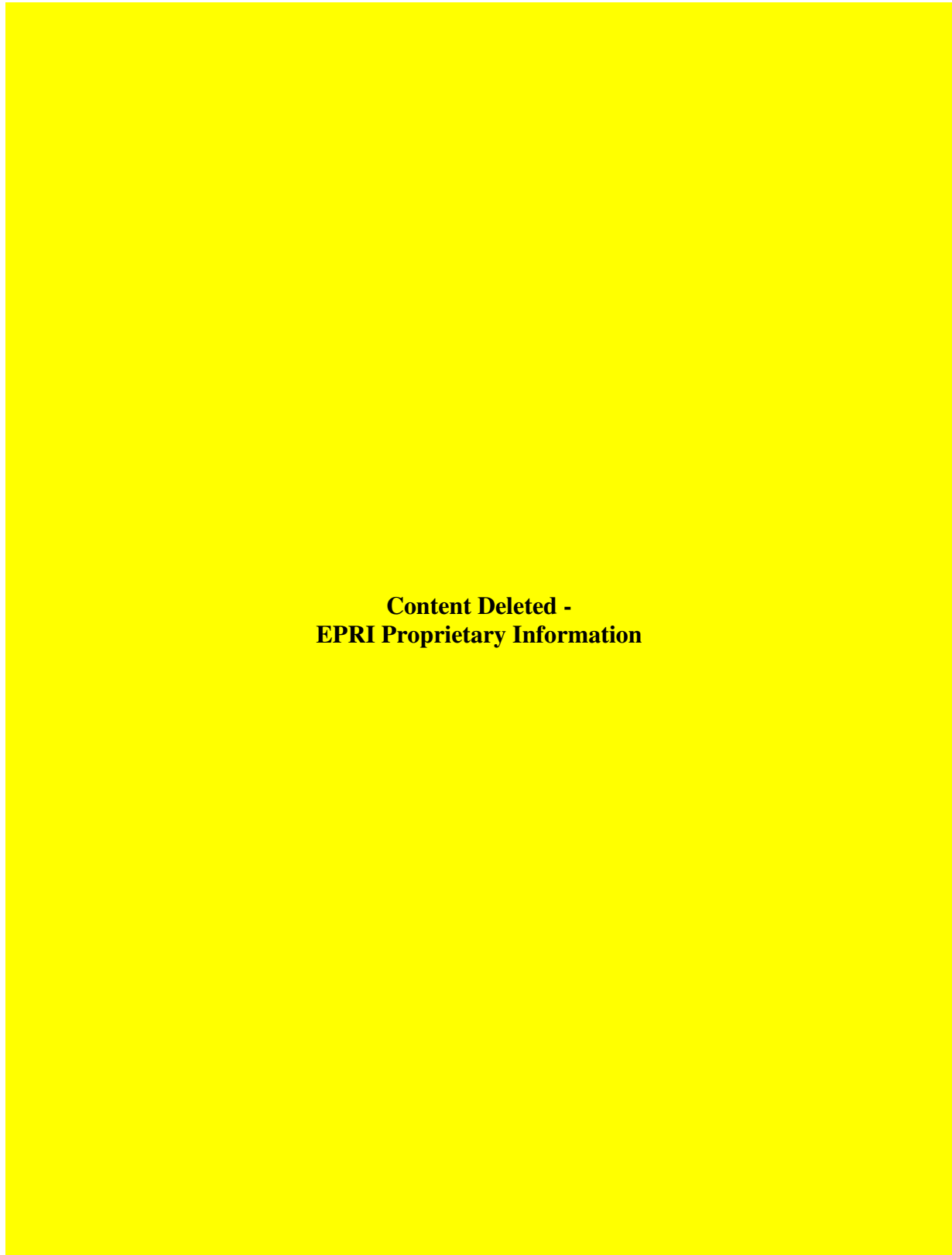
Table 5.4.54-2. Demonstrated Parameters for Volumetric Merge

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

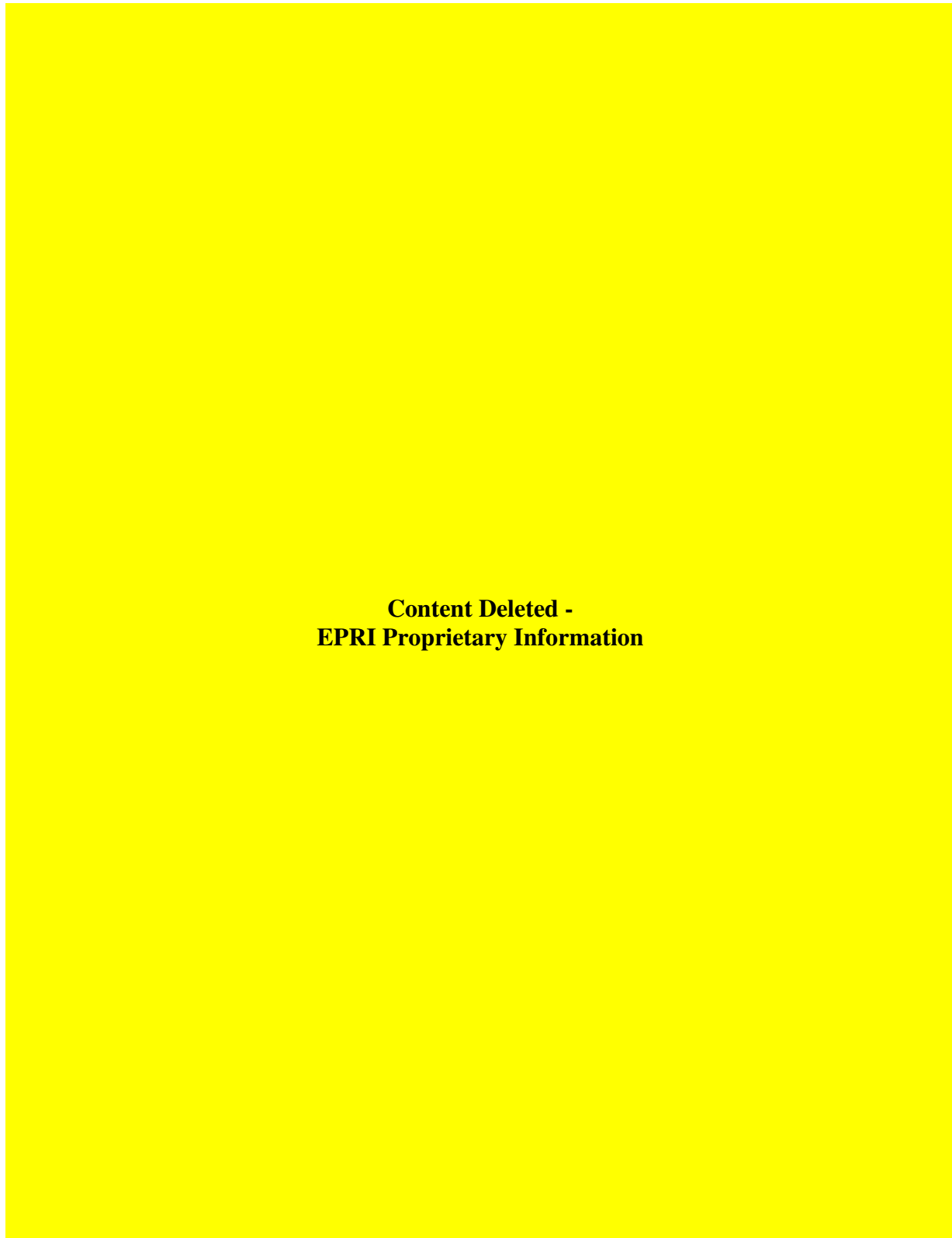
5.4.55 UT Demonstration 54



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.56 UT Demonstration 55



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.56-1. Axial Flaw Located in the H9 Weld and Attachment Pad. (Axial flaw detection in this area was possible.)

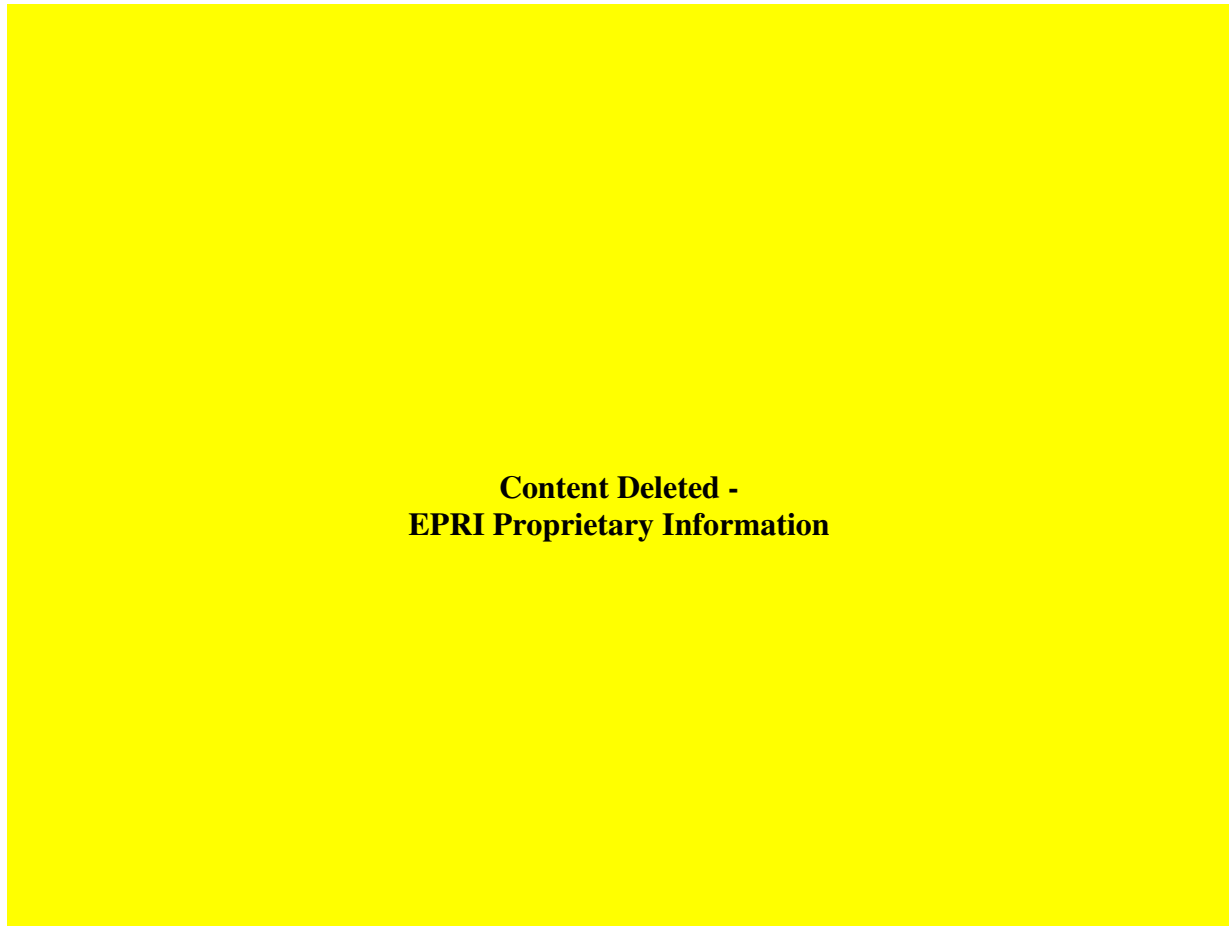


Figure 5.4.56-2. Axial Flaw Located in H9 Weld and Shroud Support Plate. (Axial flaw detection in this area was unreliable.)

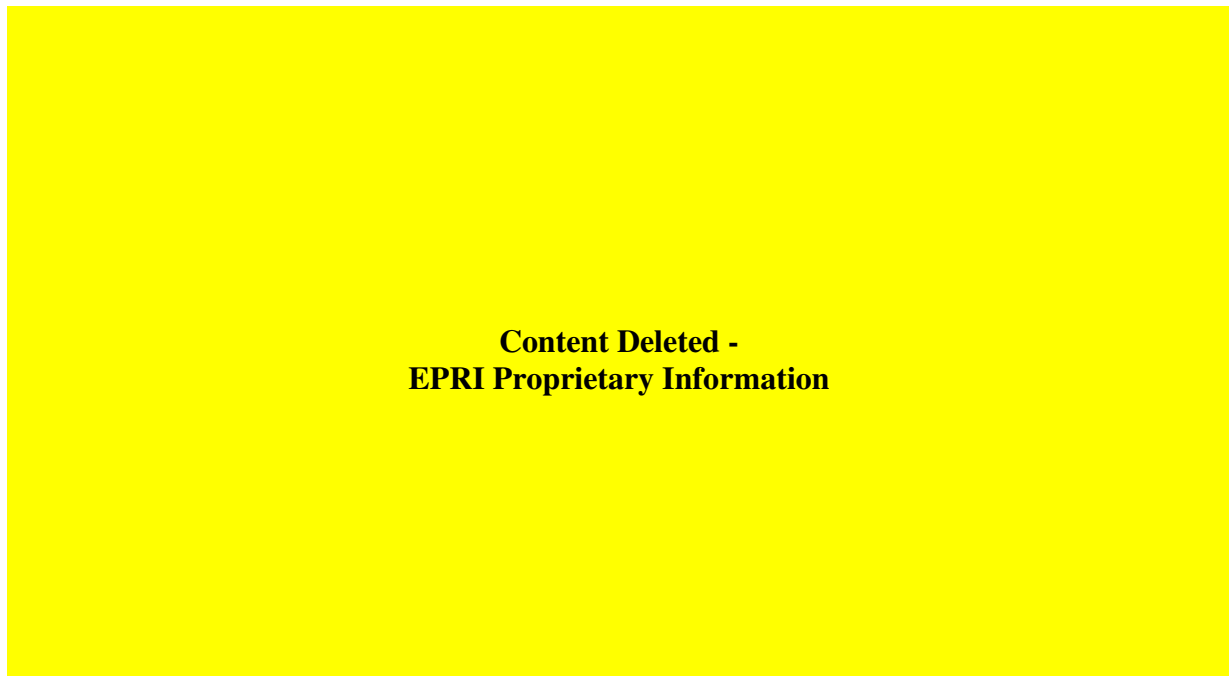


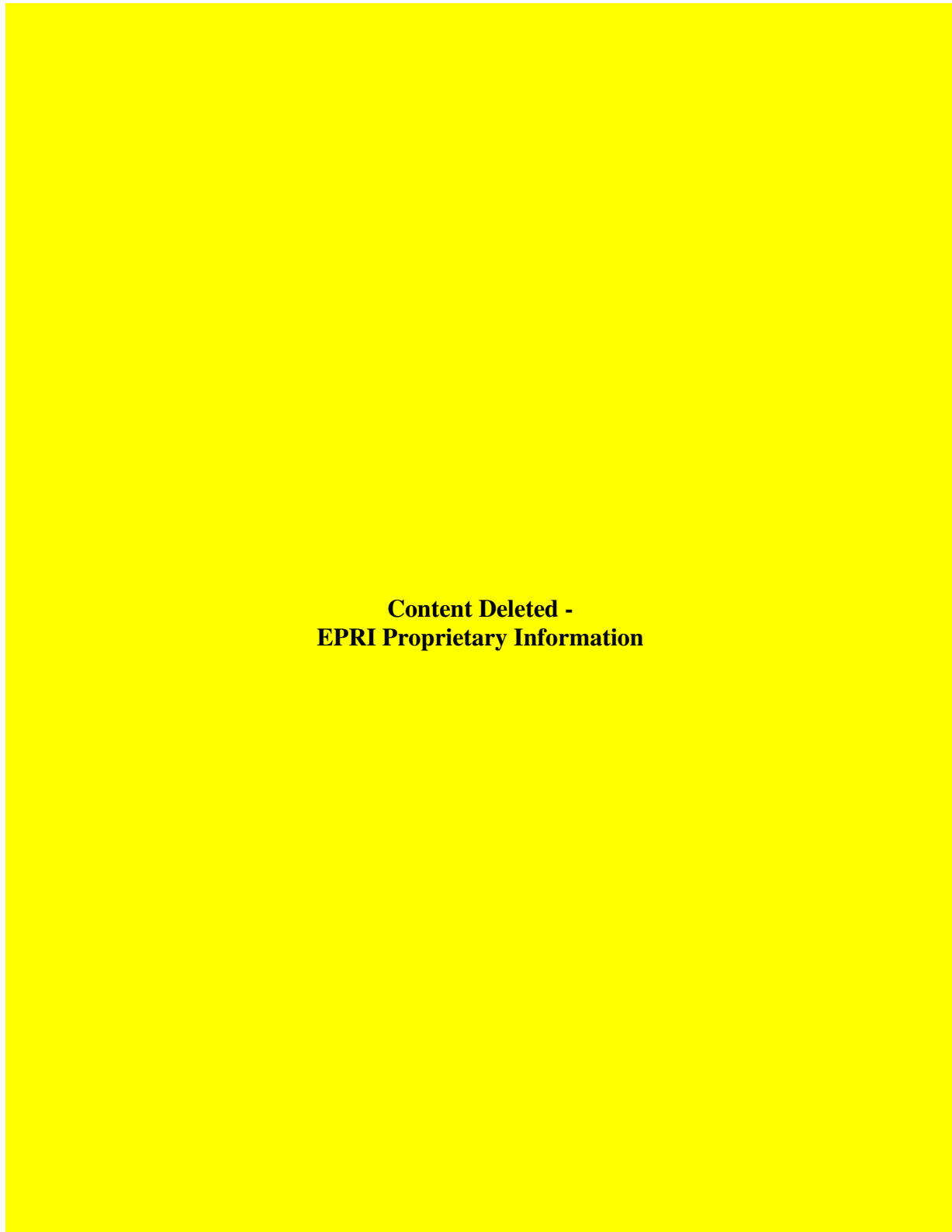


Figure 5.4.56-3. Reported RPV Extent (Flaw Depth Reported Along the Ultrasound Depth Axis)



Figure 5.4.56-4. Reported Shroud Support Plate Extent (Flaw Depth Based on Axial Distance Measurements)

5.4.57 UT Demonstration 56



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

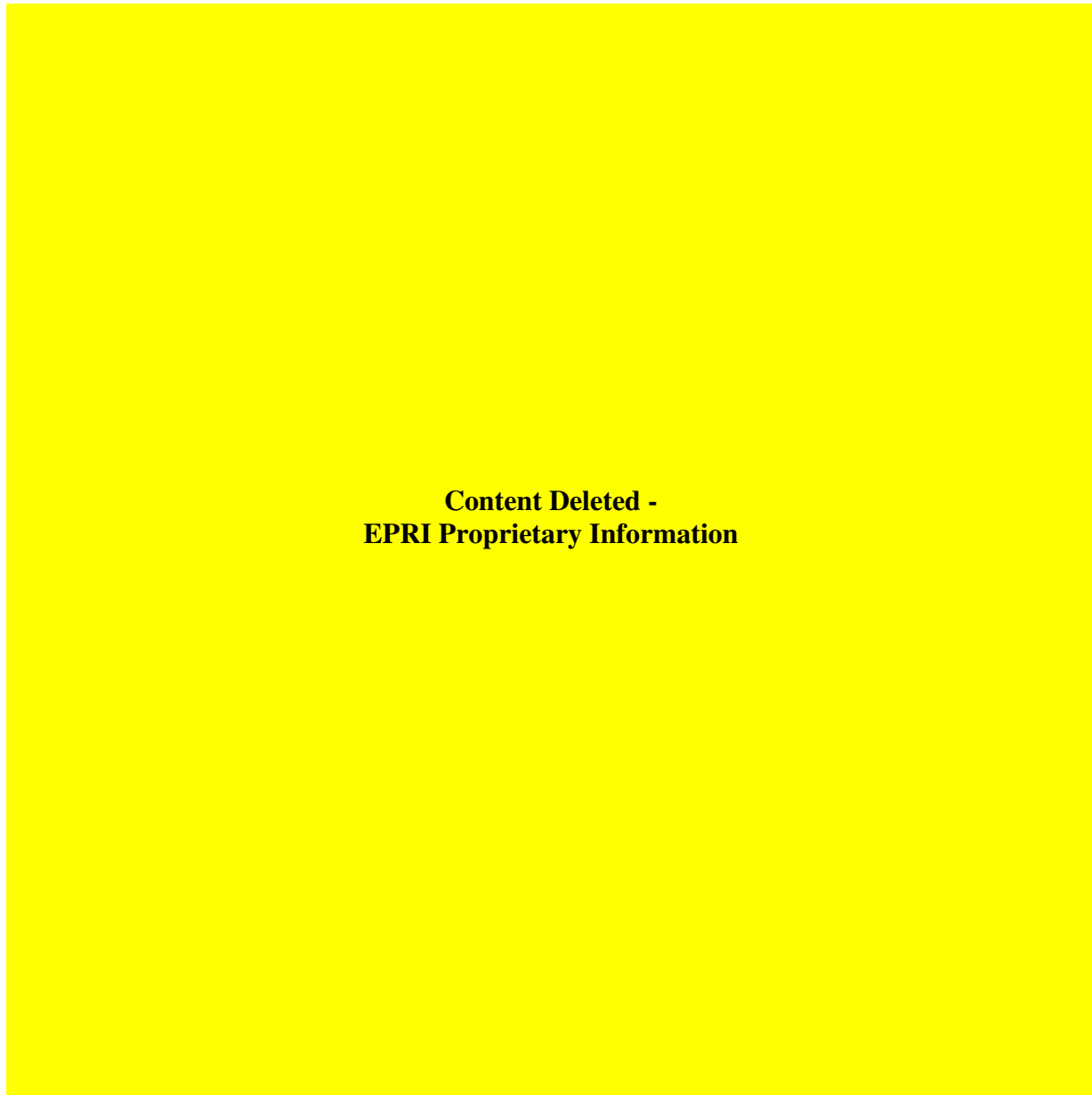
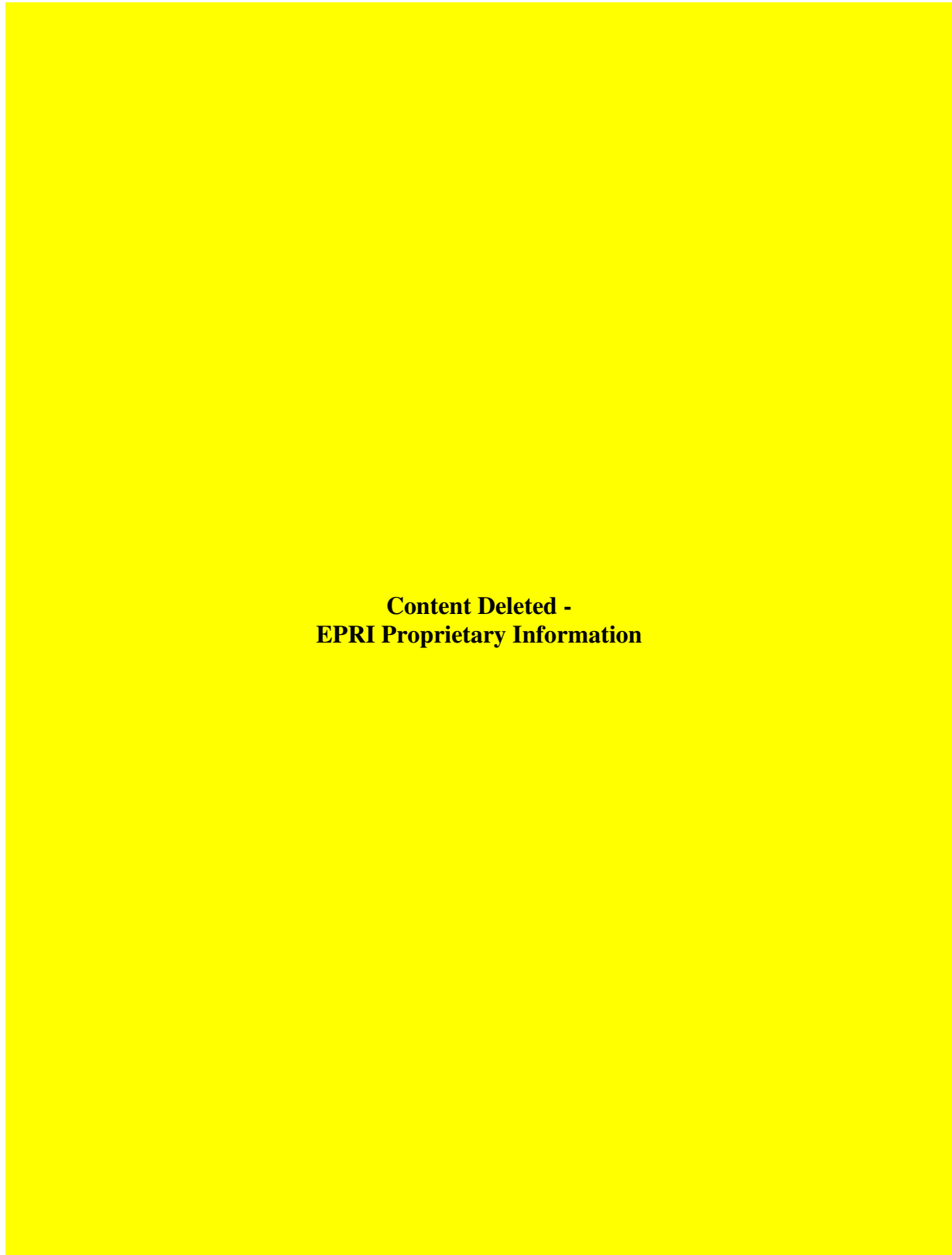


Figure 5.4.57-1. H12 Flaw Depth Measurements

5.4.58 UT Demonstration 57



**Content Deleted -
EPRI Proprietary Information**

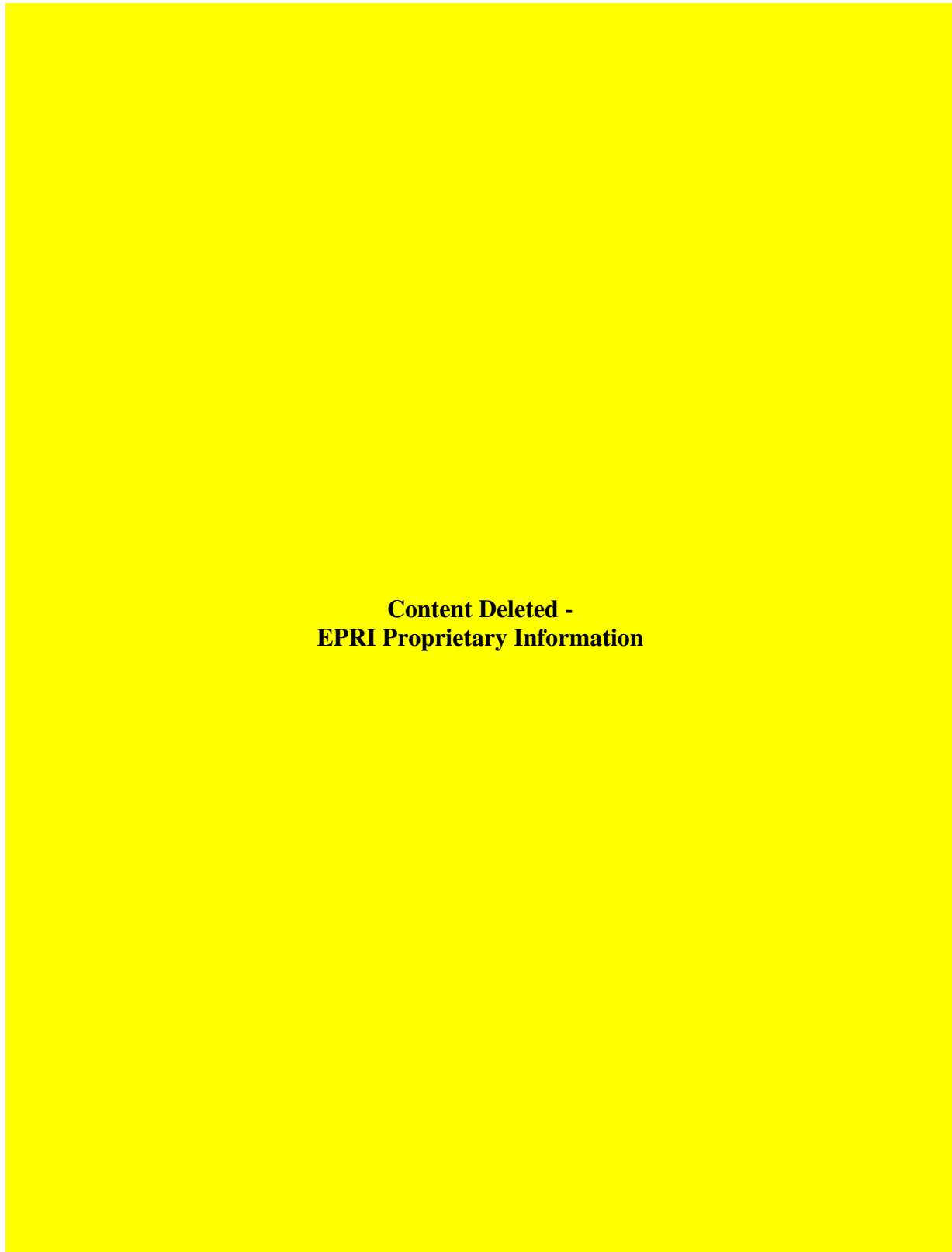
**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.4.59 UT Demonstration 58



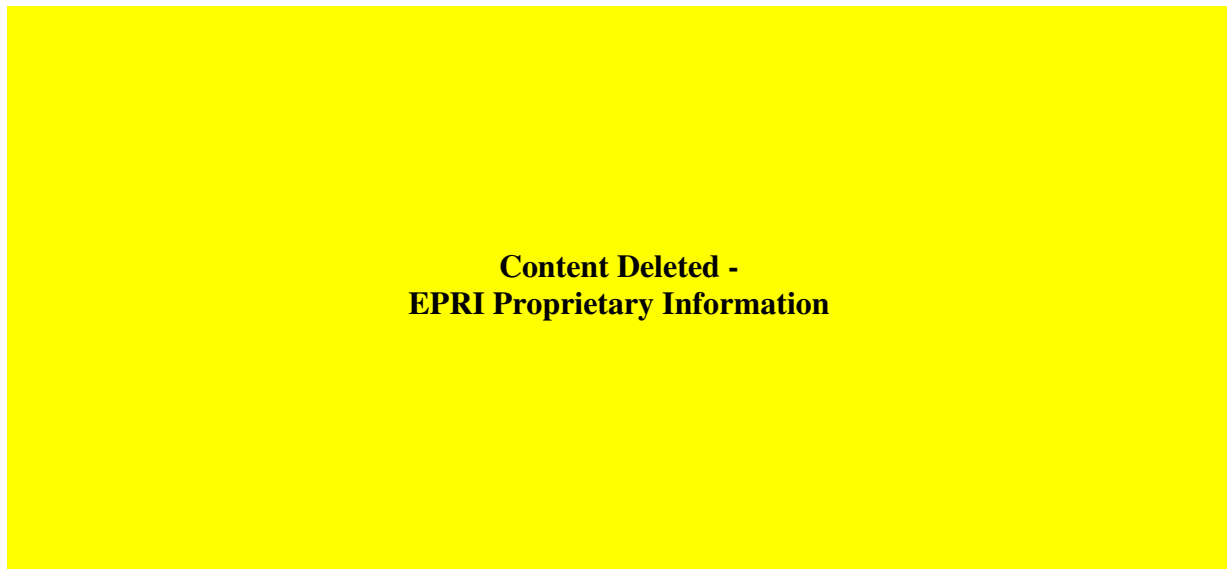
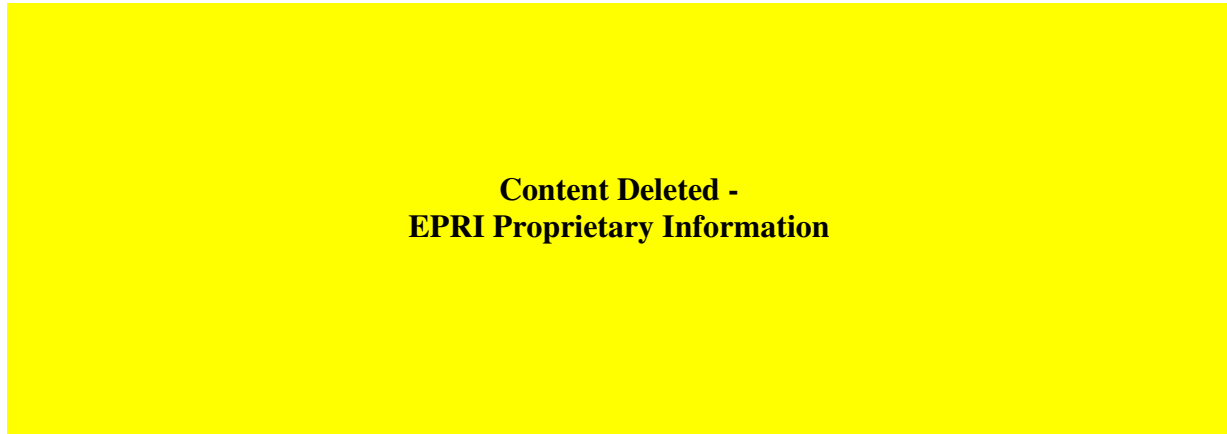


Figure 5.4.59-1. Probe Positions for Axial Scan Lines

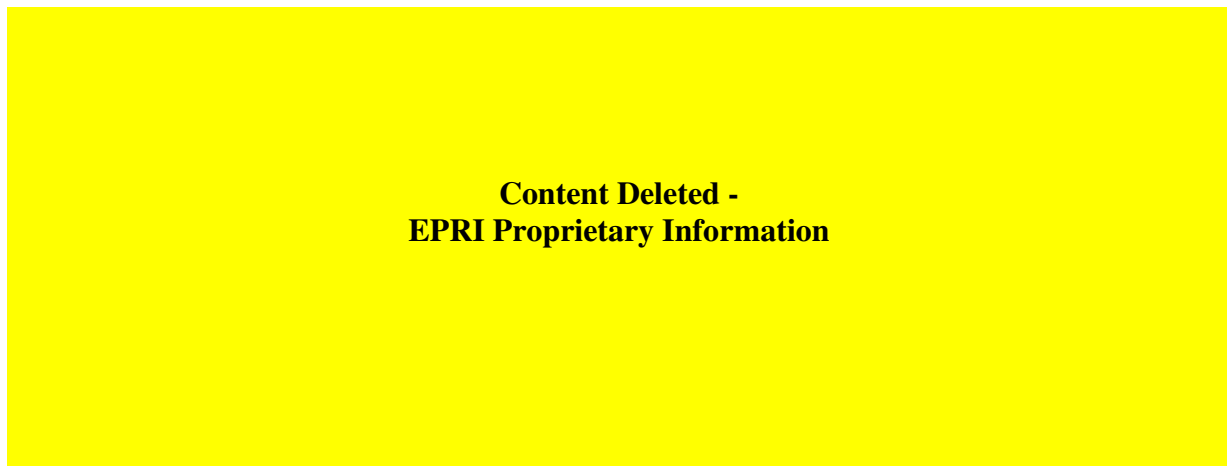


Figure 5.4.59-2. Probe Positions for Circumferential Scan Lines



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.59-3. Reported Circumferential Flaw Depth (Flaw Depth Reported Along the Ultrasound Axis Using Data Acquired During the Axial Scan Examination Shown in Figure 5.4.59-1)



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.59-4. Reported Circumferential Flaw Depth (Flaw Depth Measured From the Electronic Sector Scan Sweep During the Axial Scans Shown in Figure 5.4.59-1)



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.59-5. Reported Axial Flaw Horizontal Depth (Flaw Depth Reported Along the Ultrasound Axis Using Data Acquired During the Circumferential Scan Shown in Figure 5.4.59-2)



**Content Deleted -
EPRI Proprietary Information**

Figure 5.4.59-6. Estimated Axial Flaw Vertical Depth (Flaw Depth Estimated Using the 0.5-inch Incremental Scan Line Positions in Scans Performed Between the Two Elevations Shown in Figure 5.4.59-2)

5.5 ET Technique Demonstrations for Core Shroud Support Welds

**Content Deleted -
EPRI Proprietary Information**

5.5.1 General Findings for ET

**Content Deleted -
EPRI Proprietary Information**

5.5.2 ET Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

5.6 Delivery System Demonstrations for Core Shroud Support Welds

**Content Deleted -
EPRI Proprietary Information**

5.6.1 Delivery System Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

5.6.2 Delivery System Demonstration 2



**Content Deleted -
EPRI Proprietary Information**

5.6.3 Delivery System Demonstration 3

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

5.6.4 Delivery System Demonstration 4

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6

CORE SPRAY PIPING AND SPARGER

6.1 Summary

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

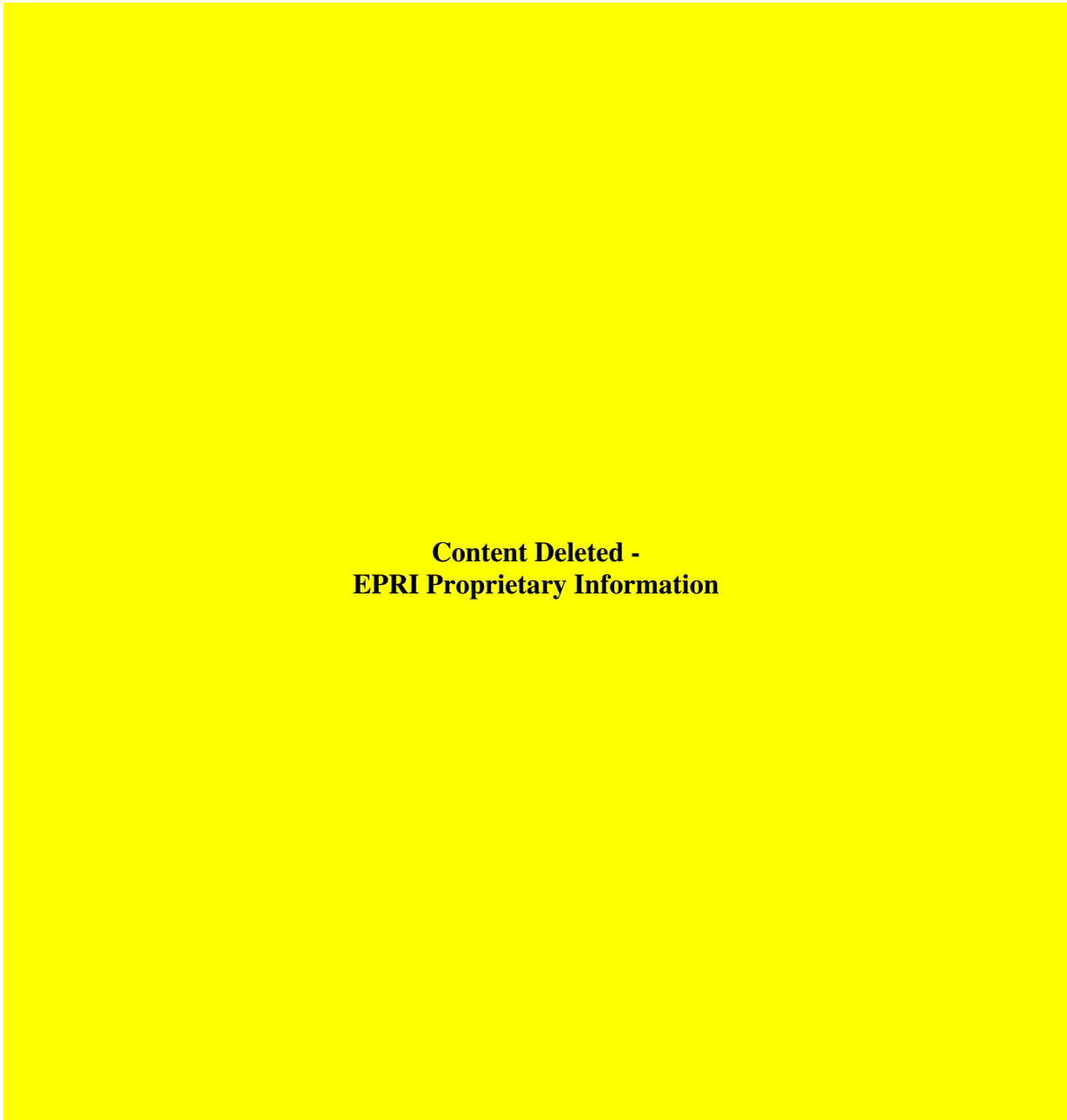


Figure 6.2-1. Typical BWR/2 Core Spray Piping Configuration

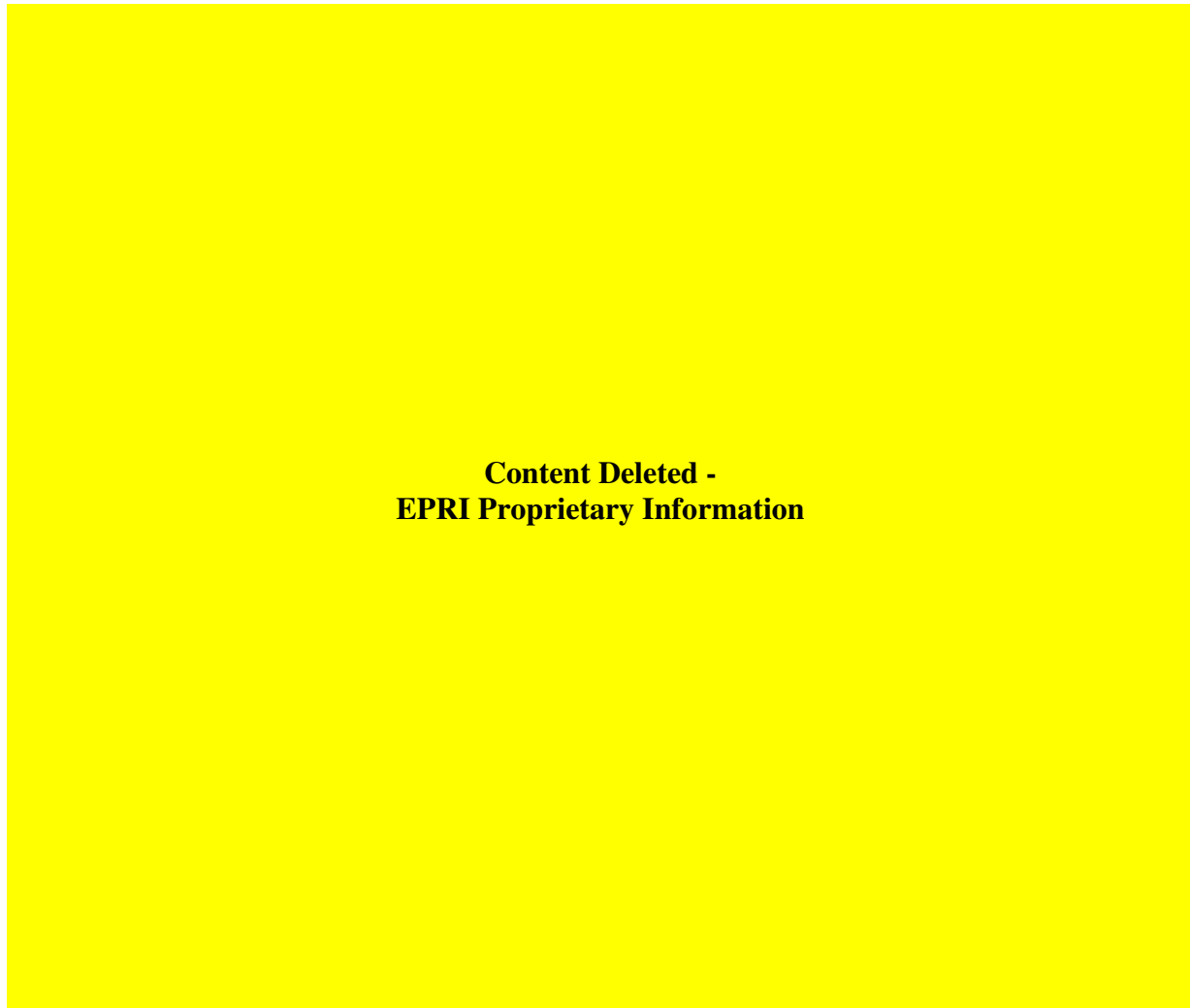


Figure 6.2-2. Typical BWR/3-5 Core Spray Piping Configuration

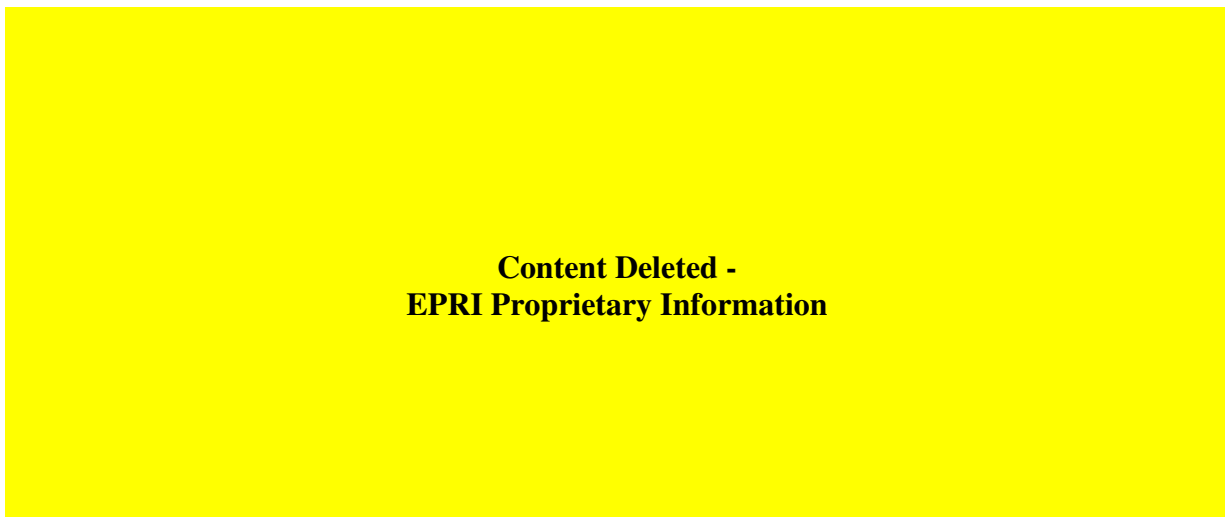


Figure 6.2-3. Typical BWR/6 Core Spray Piping Configuration



Figure 6.2-4. Typical Core Spray Sparger

6.2.1 Downcomer Sleeve



**Content Deleted -
EPRI Proprietary Information**

6.2.2 Tee Box Assembly

**Content Deleted -
EPRI Proprietary Information**

6.2.3 Shroud Connection Region

**Content Deleted -
EPRI Proprietary Information**

6.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

6.3.1 Core Spray Mockups

**Content Deleted -
EPRI Proprietary Information**

6.3.1.1 Downcomer Sleeve Joint Mockup (BWRVIP-J)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



Figure 6.3.1.1-1. Mockup BWRVIP-J: Downcomer Slip Joint

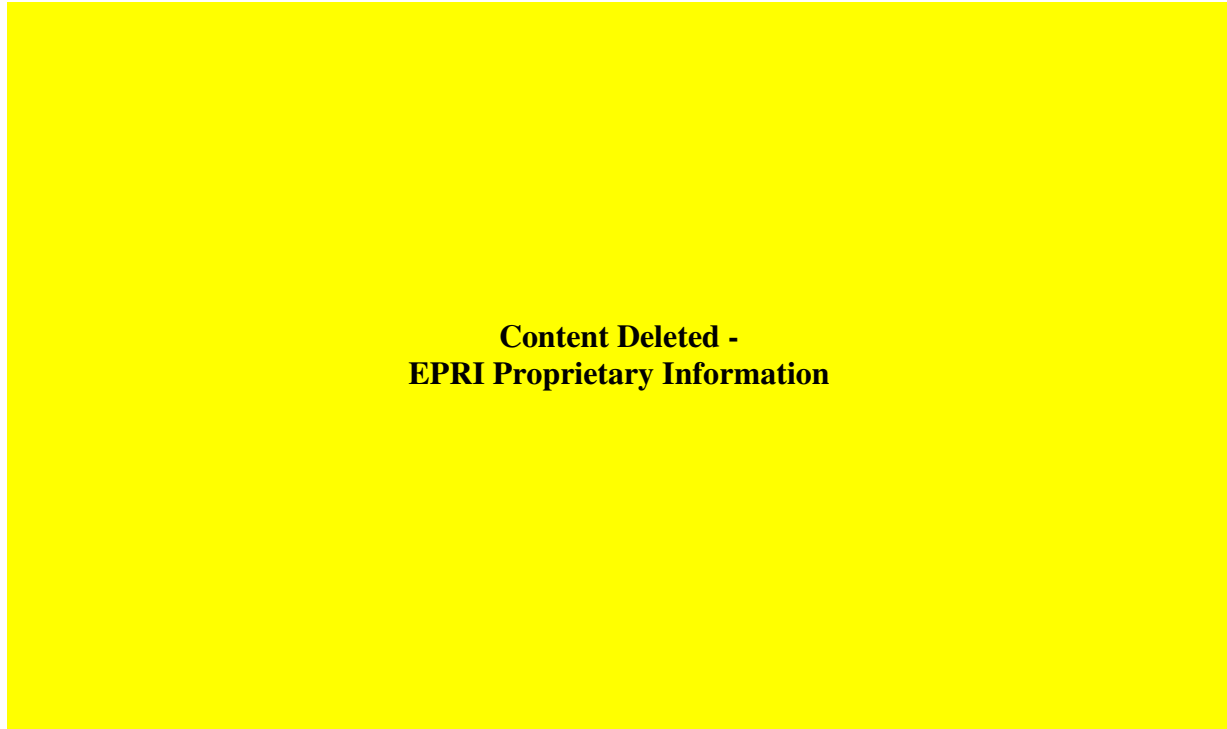


Figure 6.3.1.1-2. Downcomer Sleeve Mockup (BWRVIP-J)

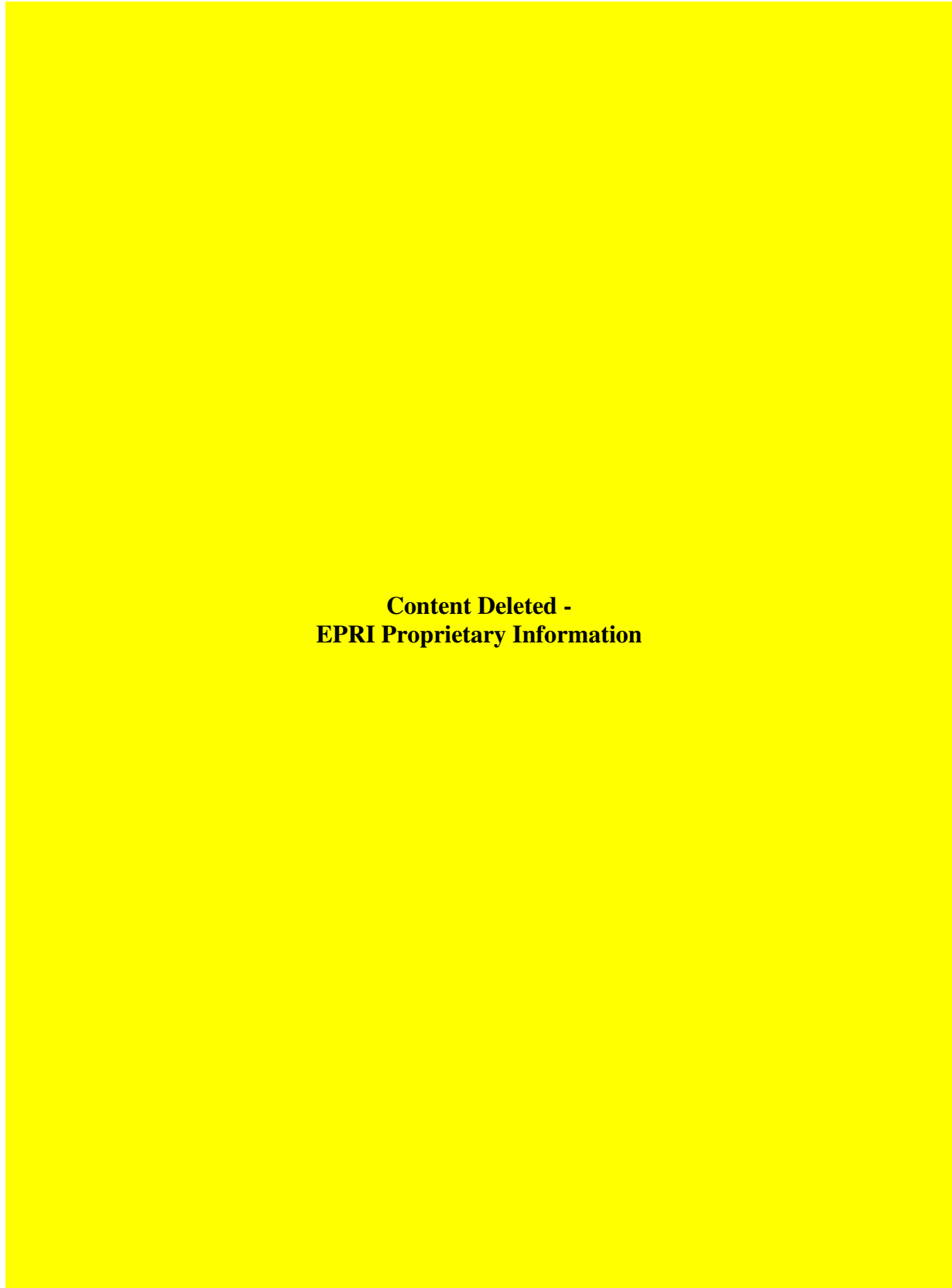


Figure 6.3.1.1-3. Mockup BWRVIP-J: Downcomer Slip Joint: Configuration

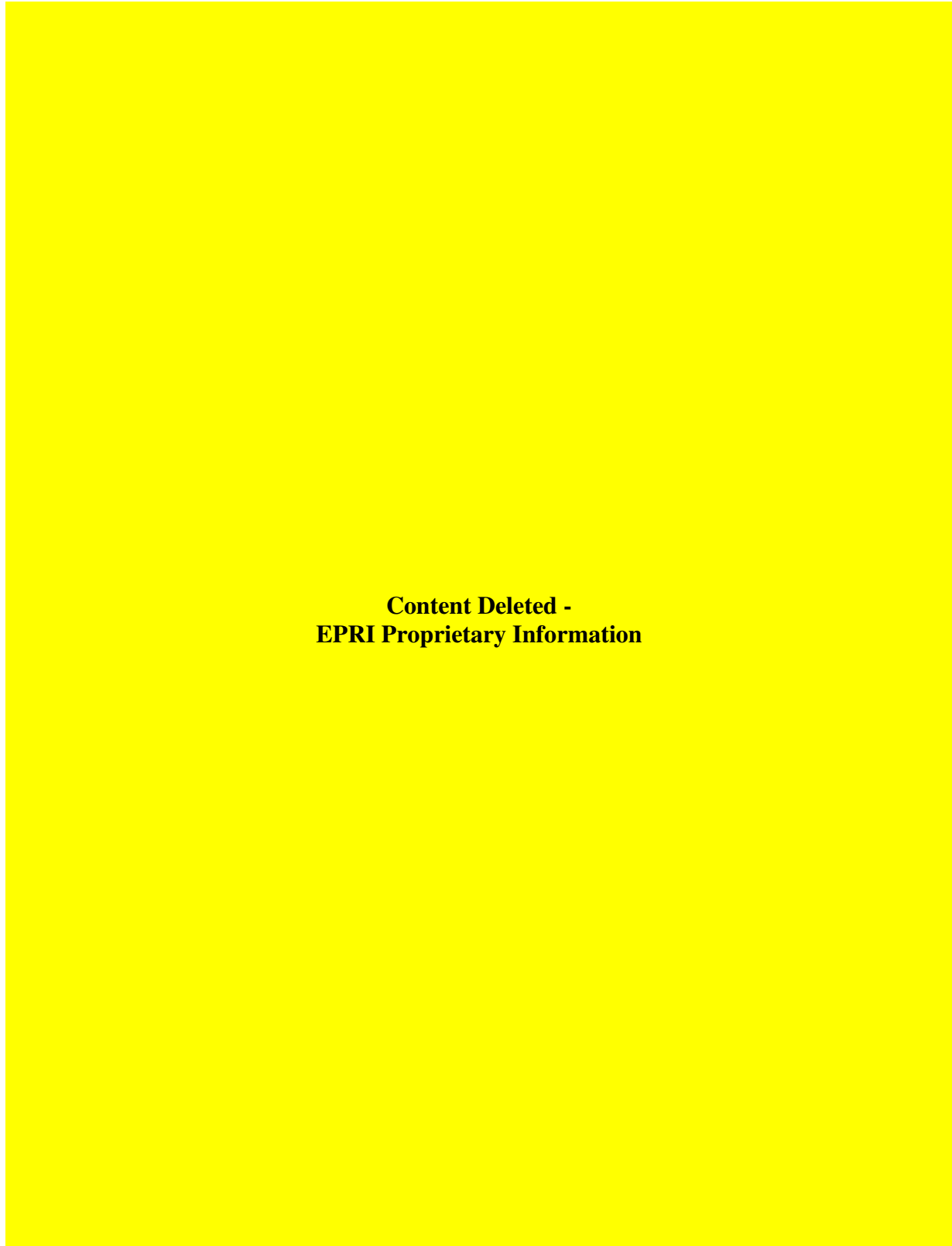


Figure 6.3.1.1-4. Mockup BWRVIP-J: Downcomer Slip Joint: Flaw Details

6.3.1.2 BWR/2 Shroud Penetration Mockup (BWRVIP-K)



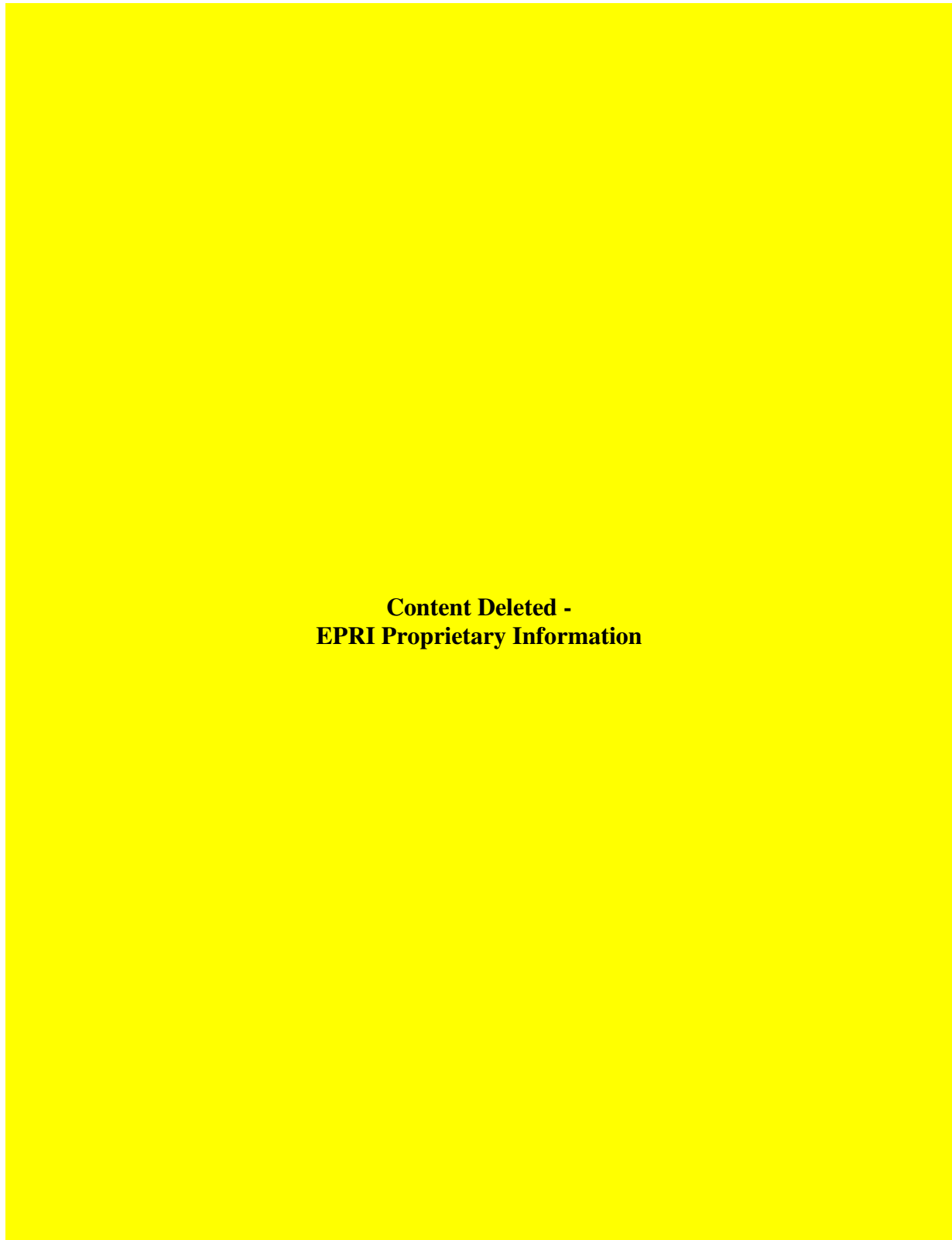


Figure 6.3.1.2-1. BWRVIP-K Mockup: Shroud Penetration (BWR/2)



Figure 6.3.1.2-2. BWR/2 Shroud Penetration Mockup (BWRVIP-K)

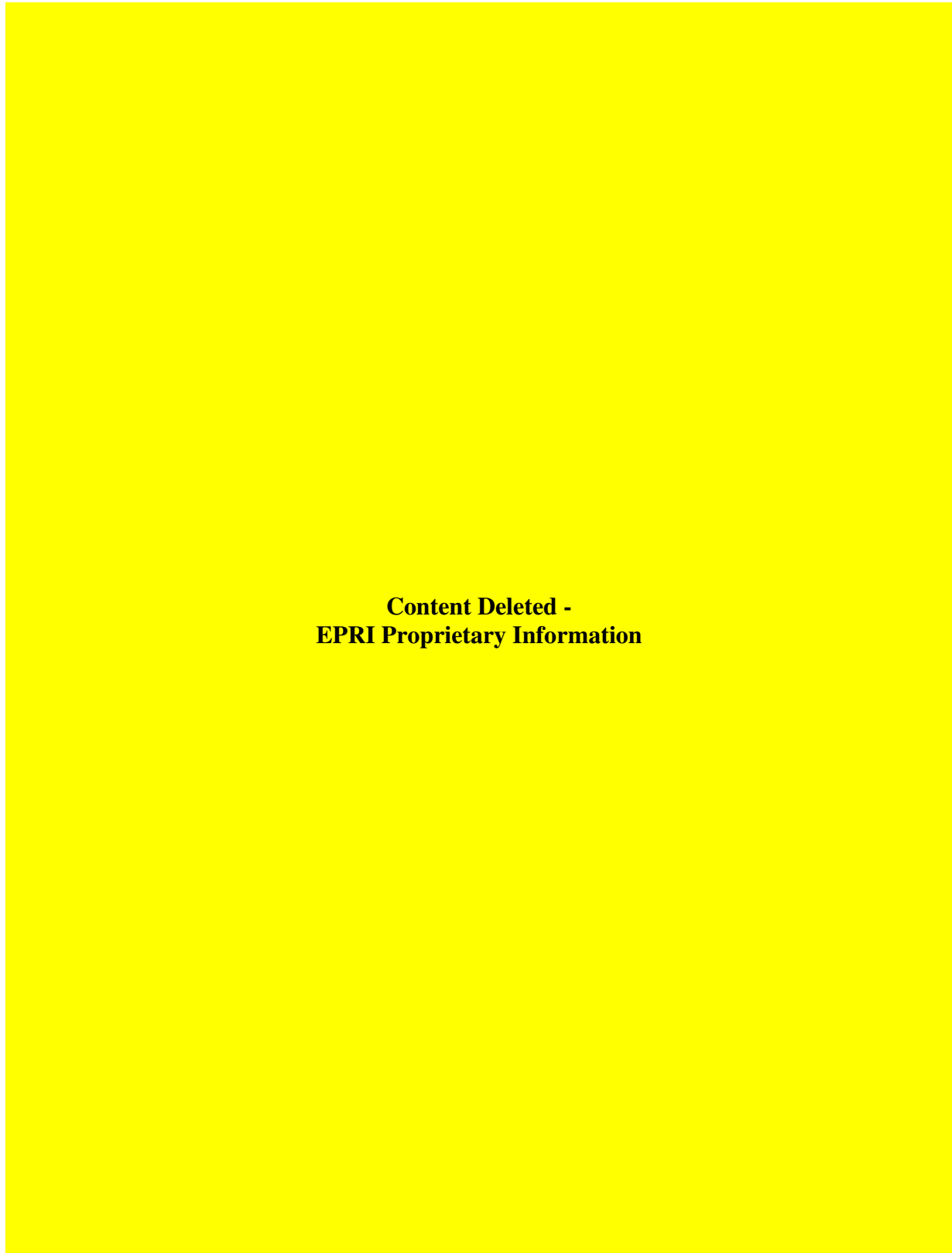


Figure 6.3.1.2-3. Mockup BWRVIP-K: BWR/2 Shroud Penetration: Configuration

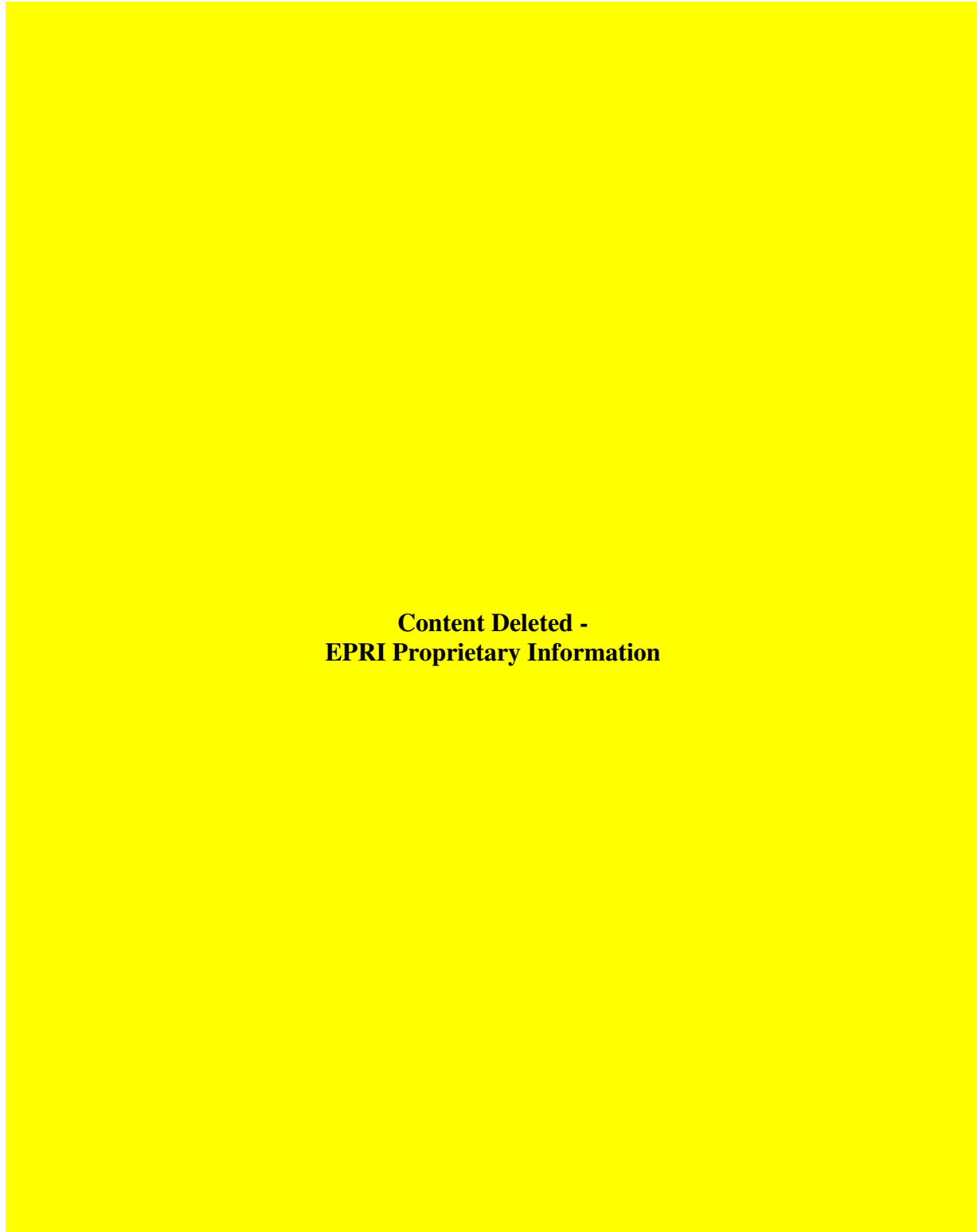
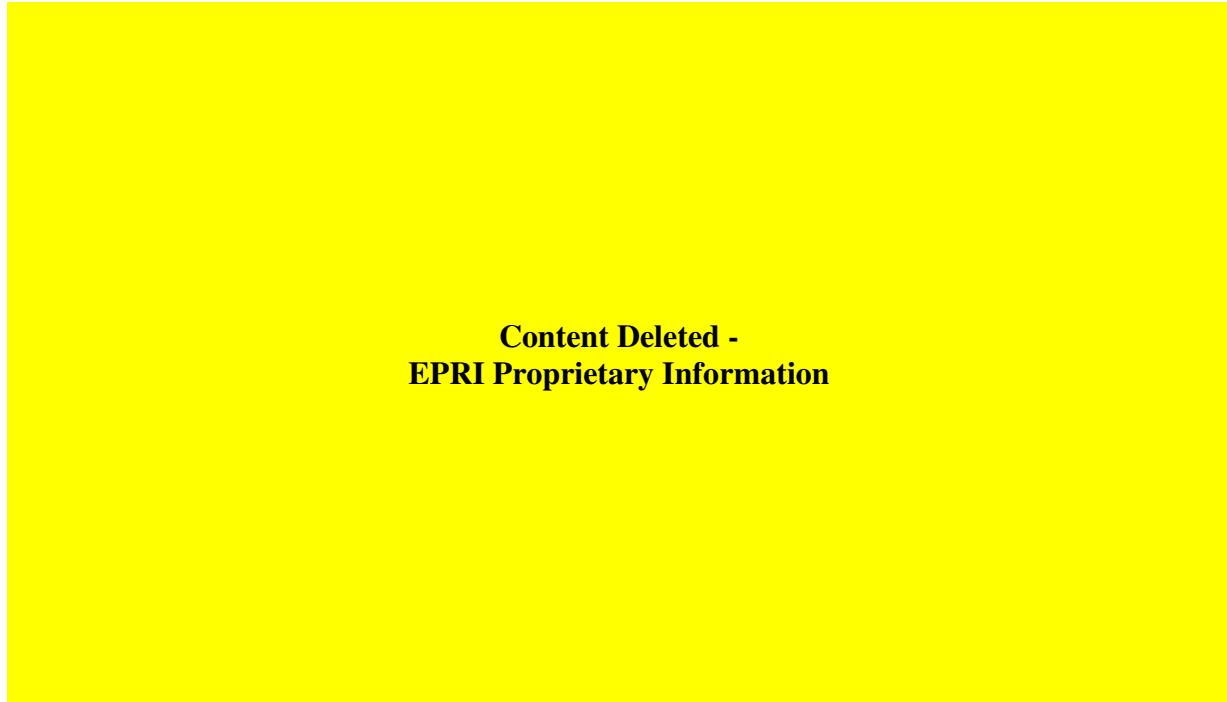


Figure 6.3.1.2-4. Mockup BWRVIP-K: BWR/2 Shroud Penetration: Flaw Details

6.3.1.3 BWR/3-5 Shroud Penetration Mockup (BWRVIP-L)



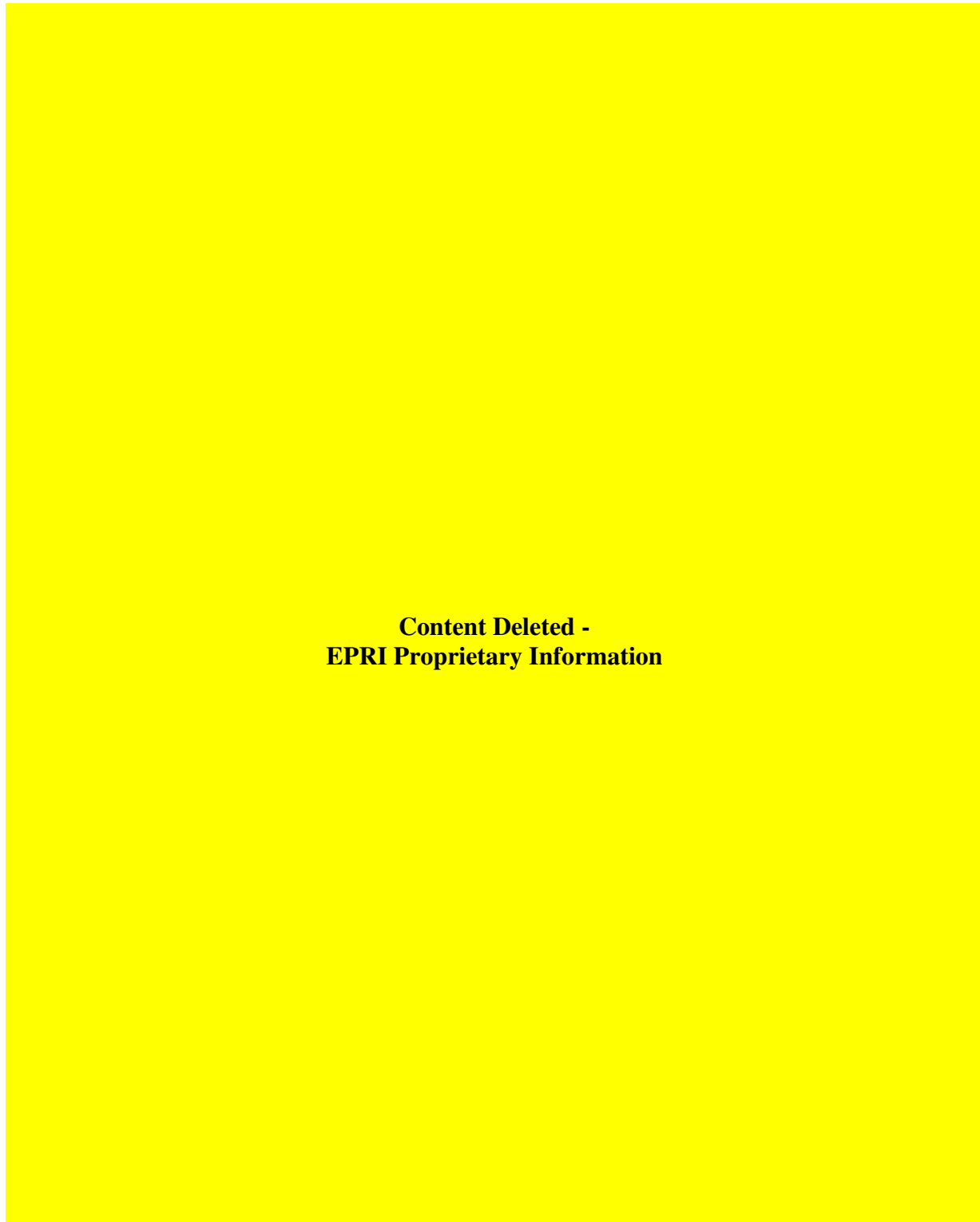


Figure 6.3.1.3-1. BWRVIP-L Mockup: Shroud Penetration (BWR/3-5)

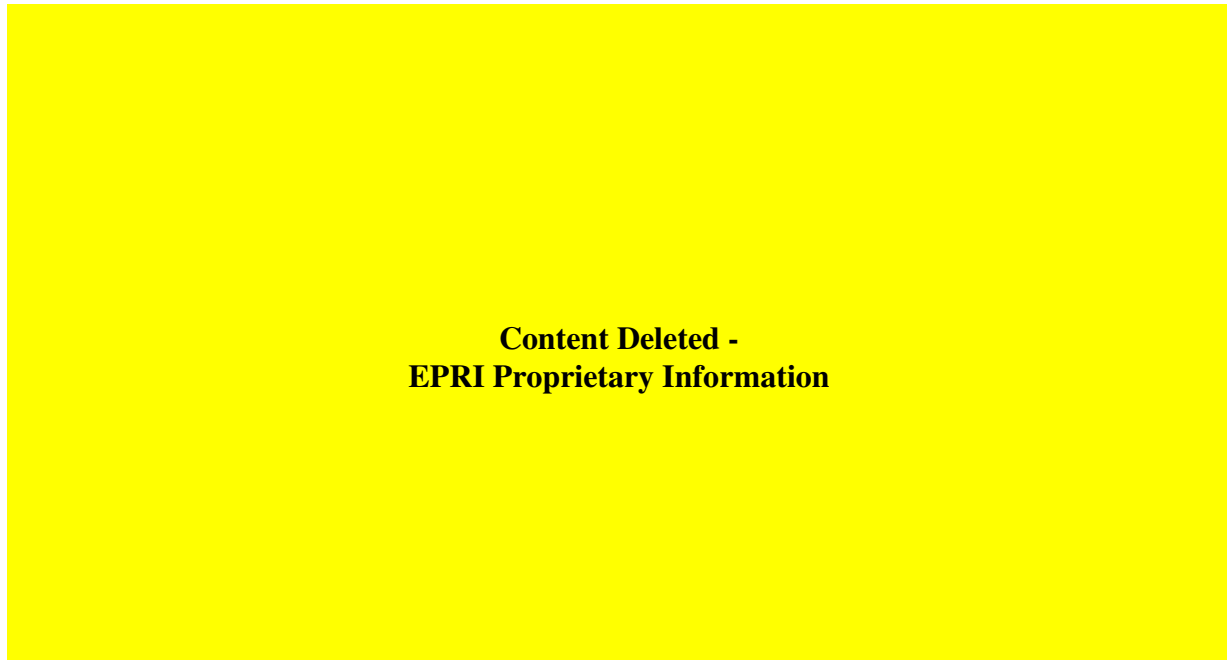
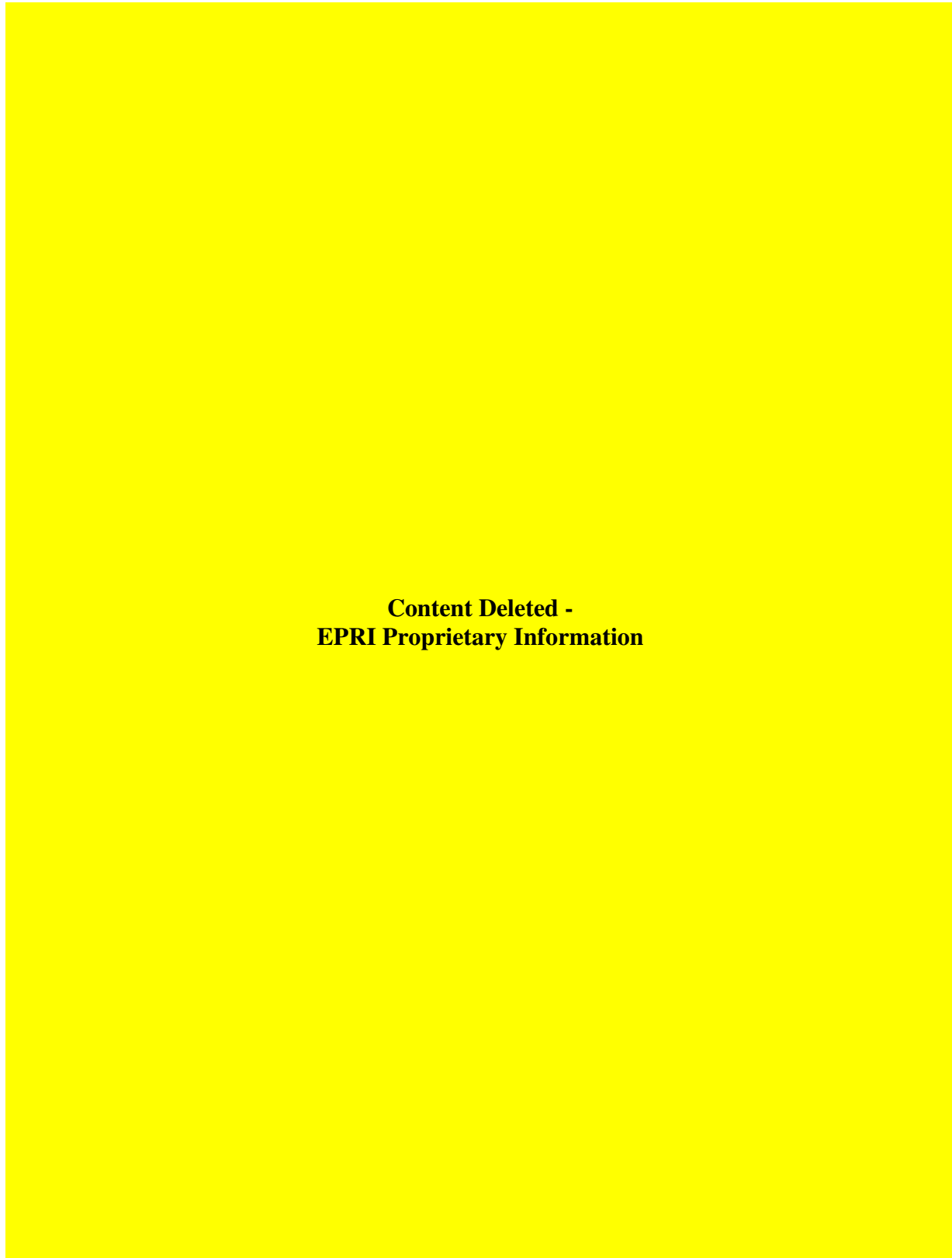


Figure 6.3.1.3-2. BWR/3-5 Shroud Penetration Mockup (BWRVIP-L)



Figure 6.3.1.3-3. Mockup BWRVIP-L: BWR/3-5 Shroud Penetration: Configuration



**Content Deleted -
EPRI Proprietary Information**

Figure 6.3.1.3-4. Mockup BWRVIP-L: BWR/3-5 Shroud Penetration: Flaw Details

6.3.1.4 BWR/3-5 Core Spray Header Tee Box Mockups (BWRVIP-M and -N)

**Content Deleted -
EPRI Proprietary Information**

6.3.1.5 BWR/6 Core Spray Pipe Coupling Assembly Mockup (BWRVIP-CS6)

**Content Deleted -
EPRI Proprietary Information**

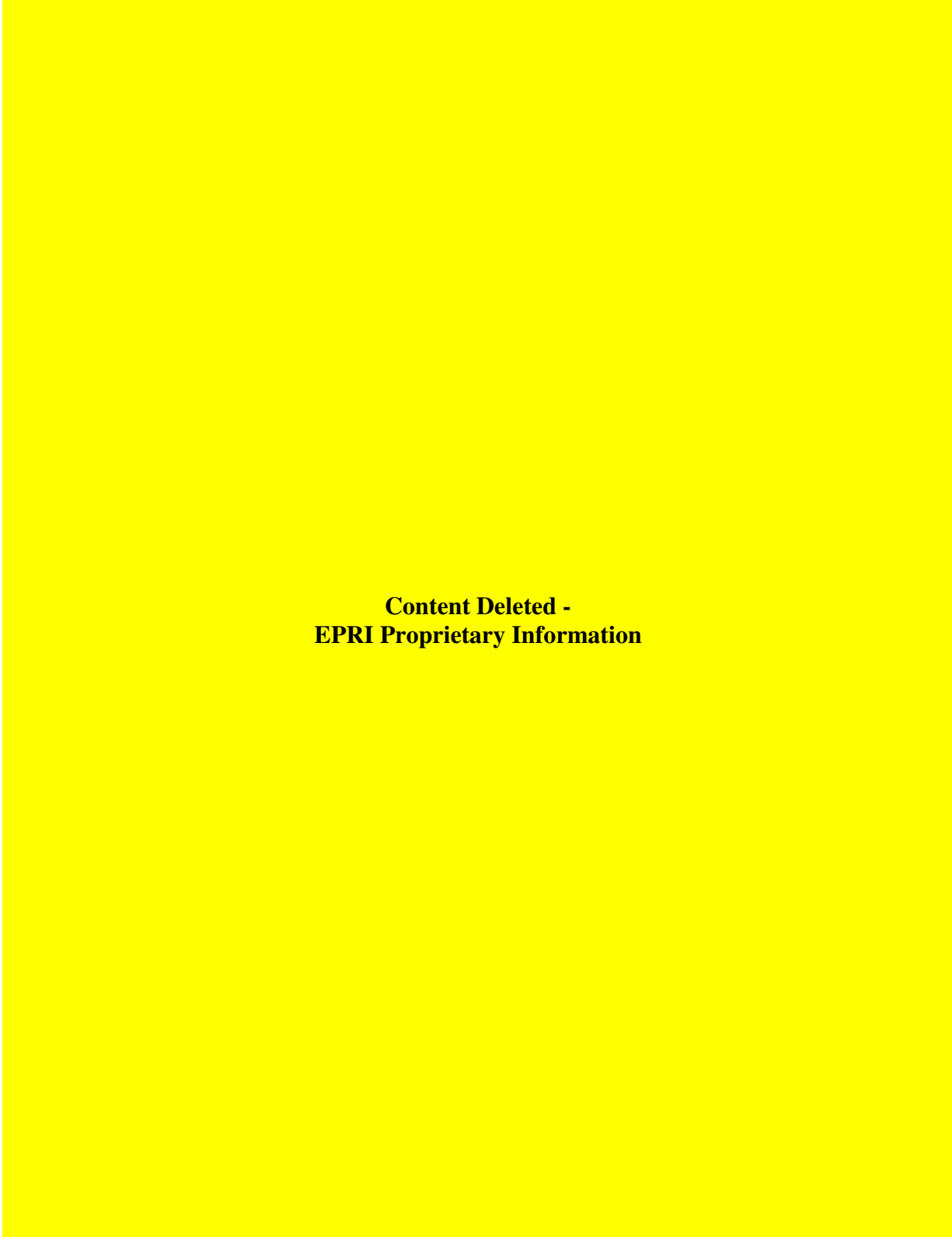


Figure 6.3.1.4-1. BWRVIP-M Mockup: Header Tee Box

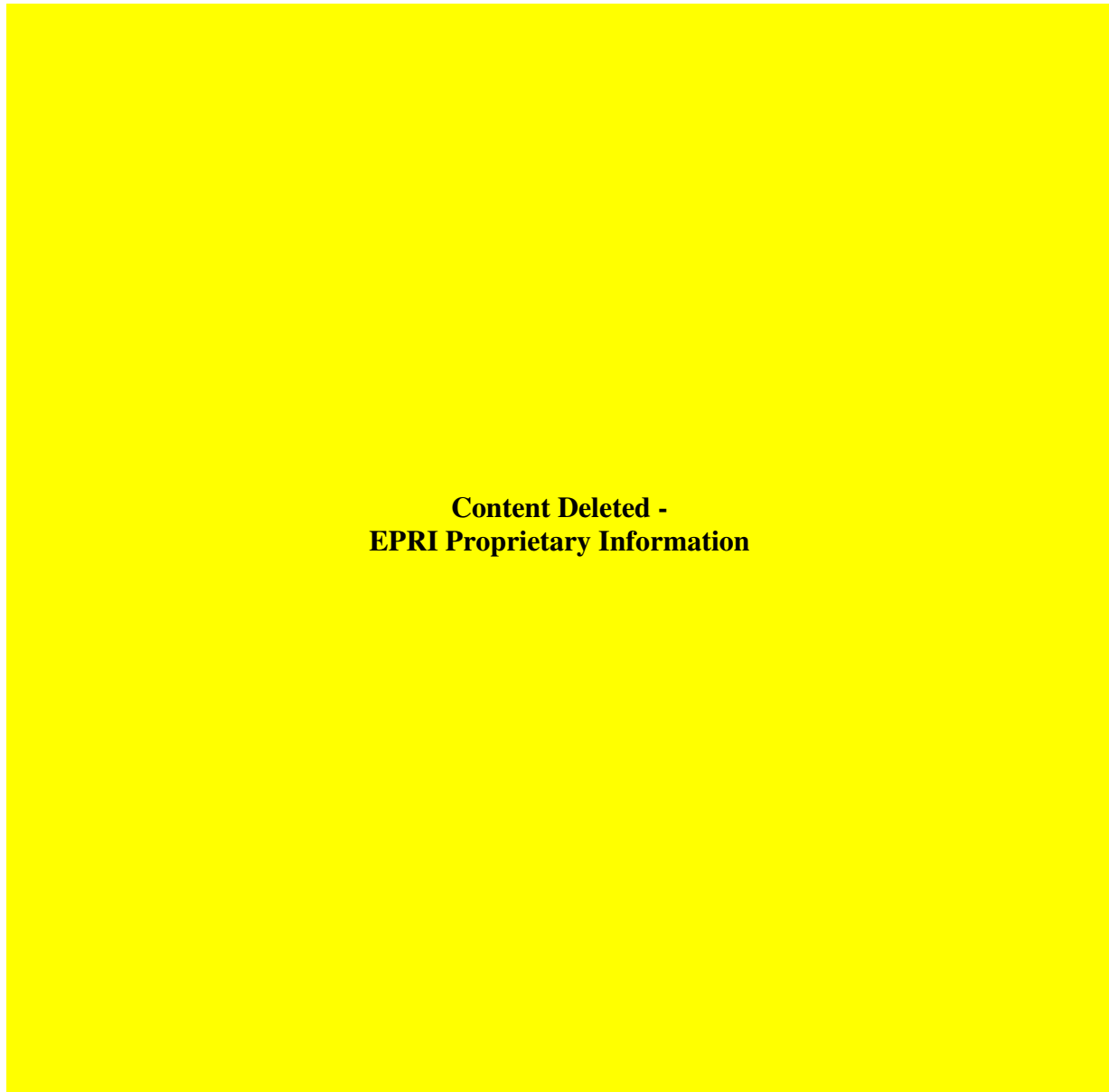


Figure 6.3.1.4-2. BWR/3-5 Core Spray Header Tee Box Mockup (BWRVIP-M)

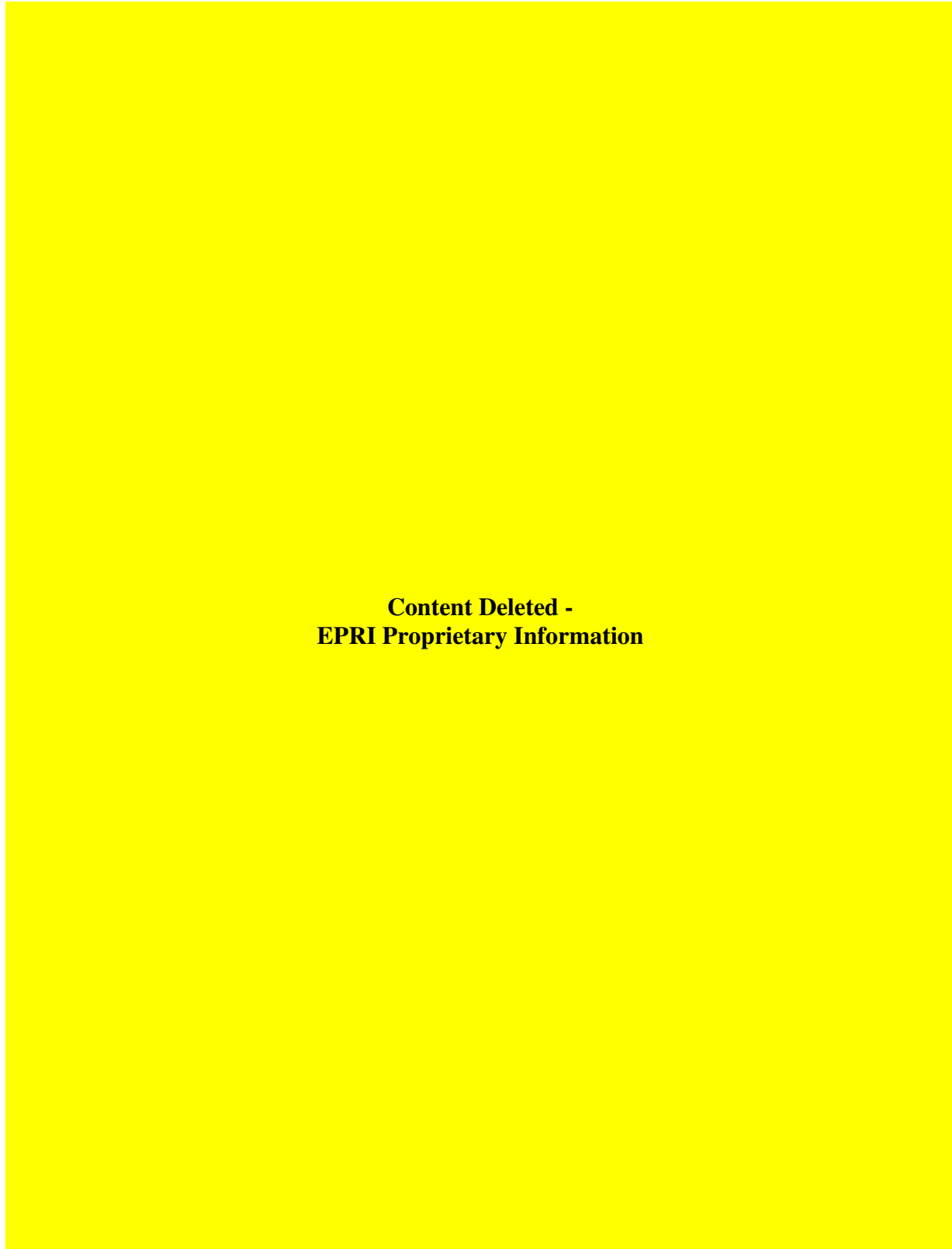


Figure 6.3.1.4-3. Mockup BWRVIP-M: BWR/3-5 Header Tee Box: Configuration



Figure 6.3.1.4-4. Mockup BWRVIP-M: BWR/3-5 Header Tee Box: Flaw Details



Figure 6.3.1.5-1. BWR/6 Core Spray Pipe Coupling Assembly Mockup BWRVIP-CS6: Weld Configuration and Flaw Details

6.3.1.6 BWR/3-6 P4a, P4b, and P4c Pipe-to-Elbow Mockups (BWRVIP-P4-1r, BWRVIP-P4-2r, and BWRVIP-P4-3)

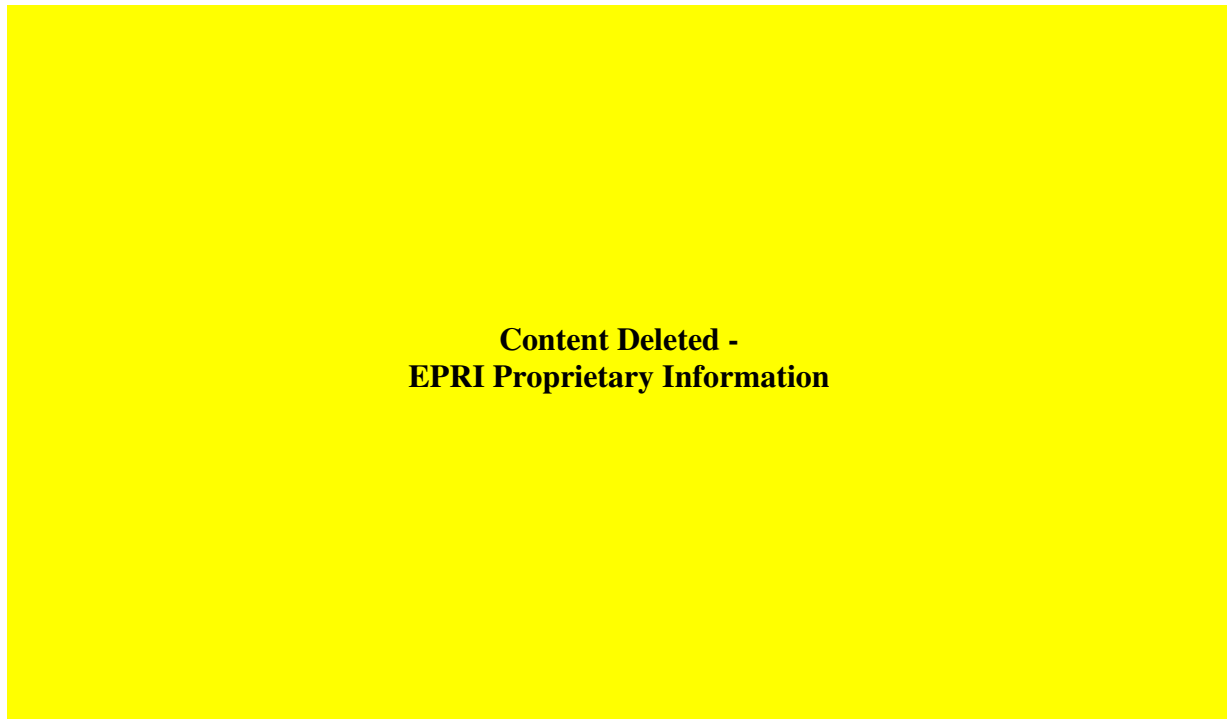
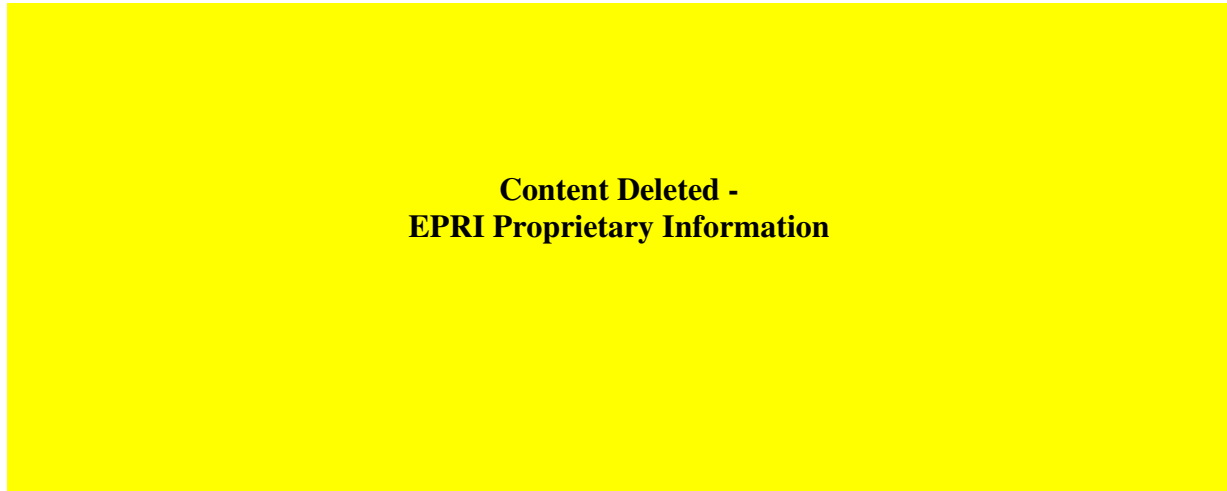


Figure 6.3.1.6-1. Photograph of BWRVIP-P4-1r and BWRVIP-P4-2r



Figure 6.3.1.6-2. Flaw Details of BWRVIP-P4-1r



Figure 6.3.1.6-3. Flaw Details of BWRVIP-P4-2r



Figure 6.3.1.6-4. Flaw Details of BWRVIP-P4-3

6.4 UT Technique Demonstrations for Core Spray Welds

6.4.1 General Findings for UT

**Content Deleted -
EPRI Proprietary Information**

6.4.1.1 Detection and Sizing of Flaws Parallel to the Weld

**Content Deleted -
EPRI Proprietary Information**

6.4.1.2 Detection of Flaws Transverse to the Weld

**Content Deleted -
EPRI Proprietary Information**

6.4.1.3 Effect of Roughness of Scanning Surface

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.2 UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

Table 6.4.2-1. UT Demonstration Summary

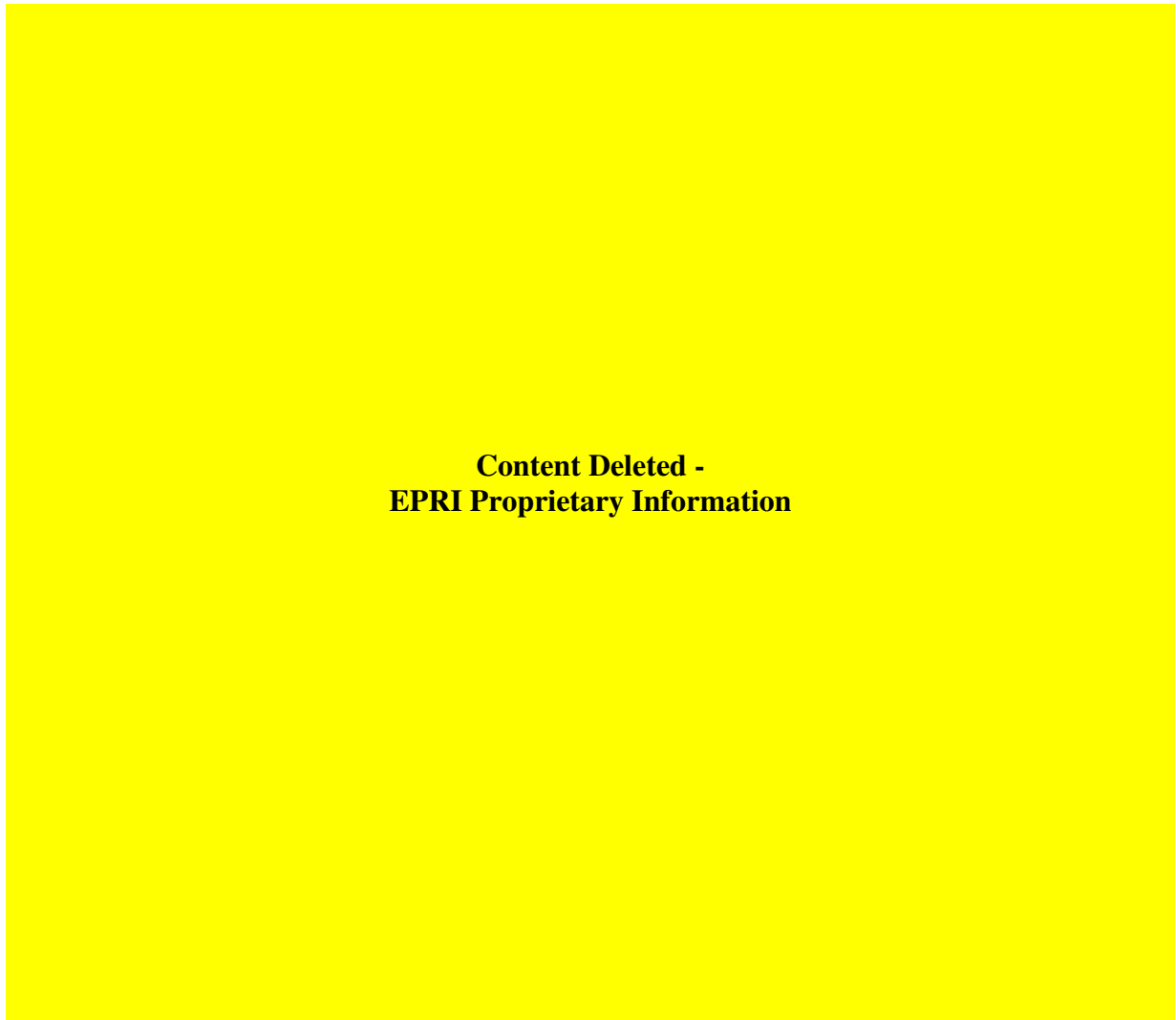
**Content Deleted -
EPRI Proprietary Information**

Table 6.4.2-1. UT Demonstration Summary (continued)

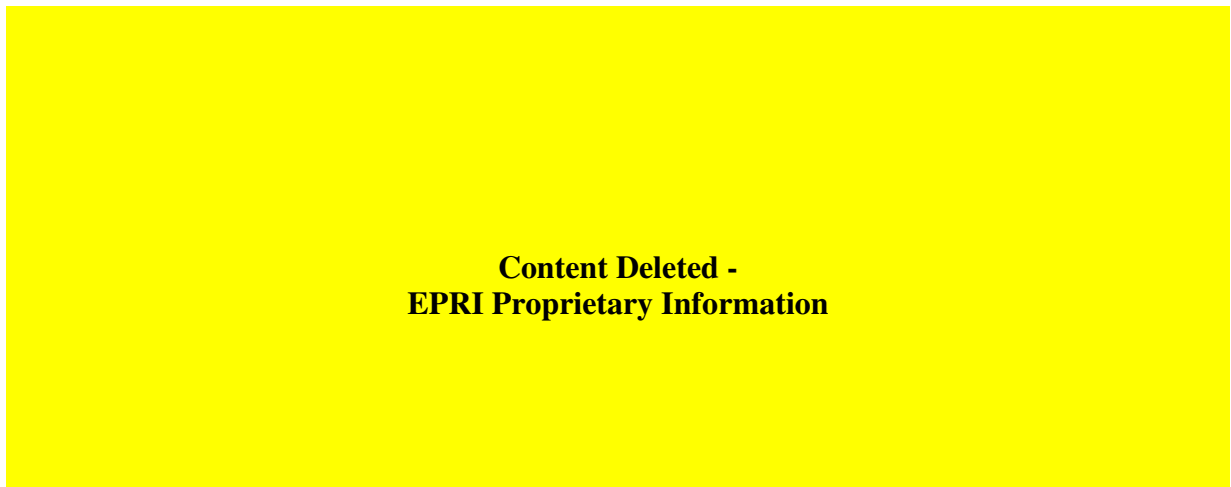


**Content Deleted -
EPRI Proprietary Information**

Table 6.4.2-1. UT Demonstration Summary (continued)



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.3 UT Demonstration 1

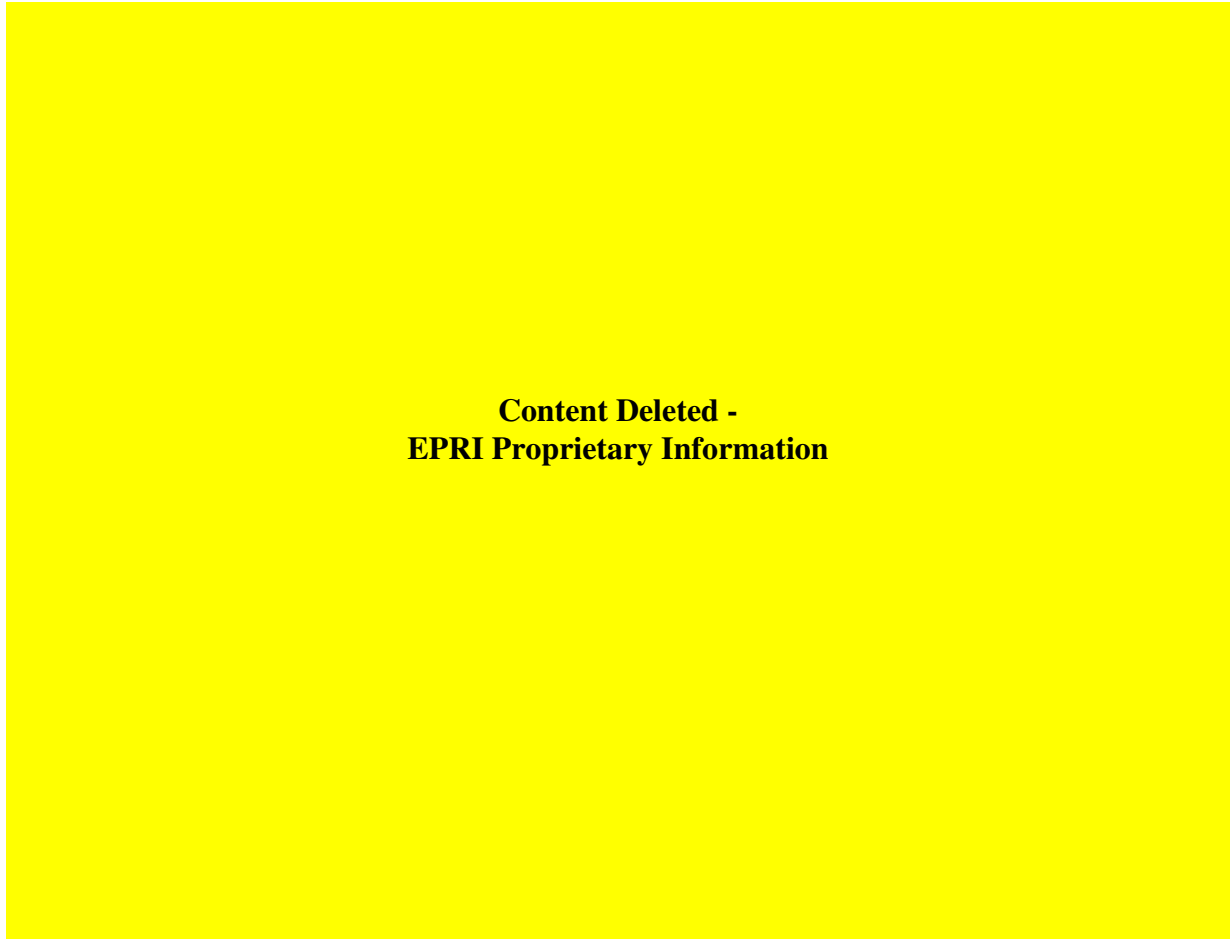
**Content Deleted -
EPRI Proprietary Information**

6.4.4 UT Demonstration 2

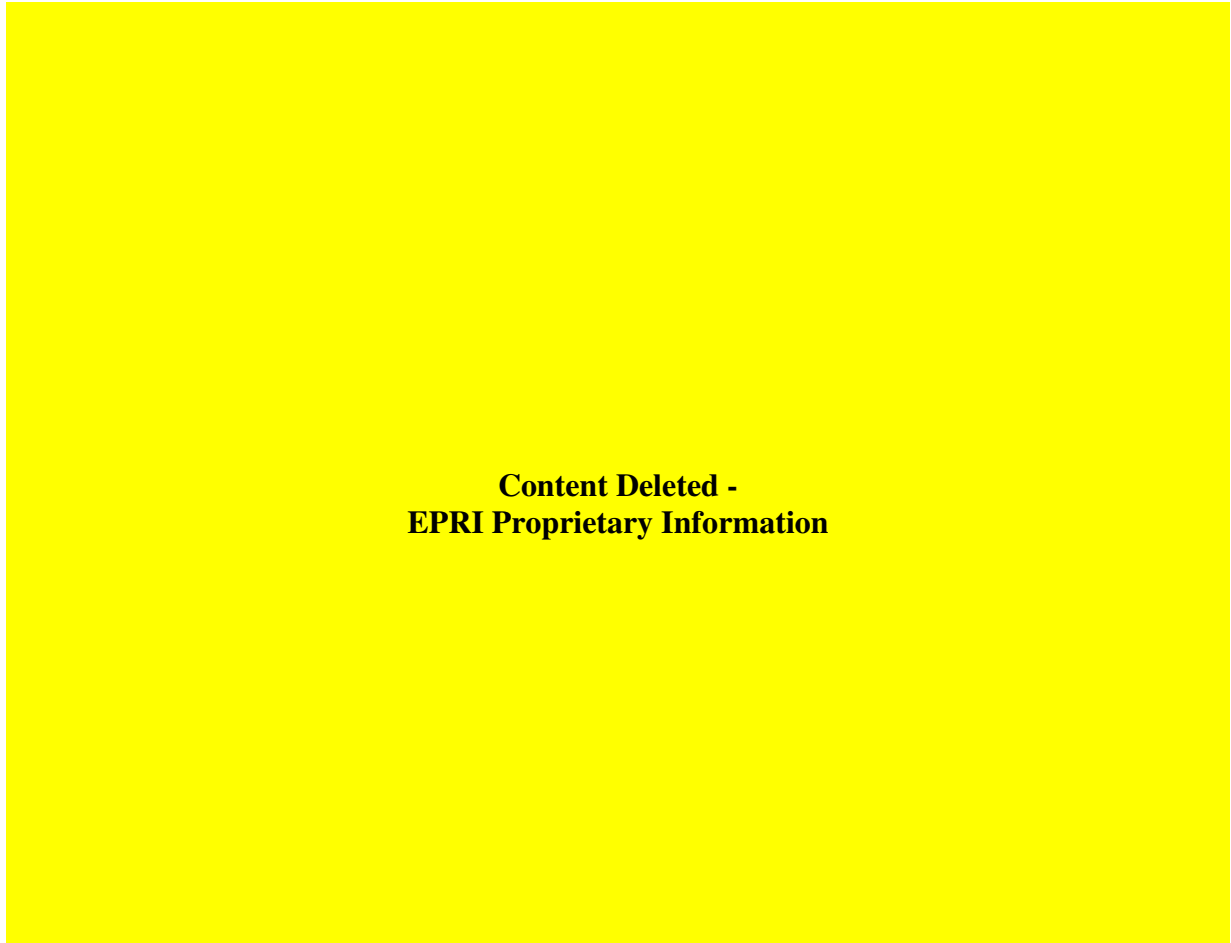


**Content Deleted -
EPRI Proprietary Information**

6.4.5 UT Demonstration 3



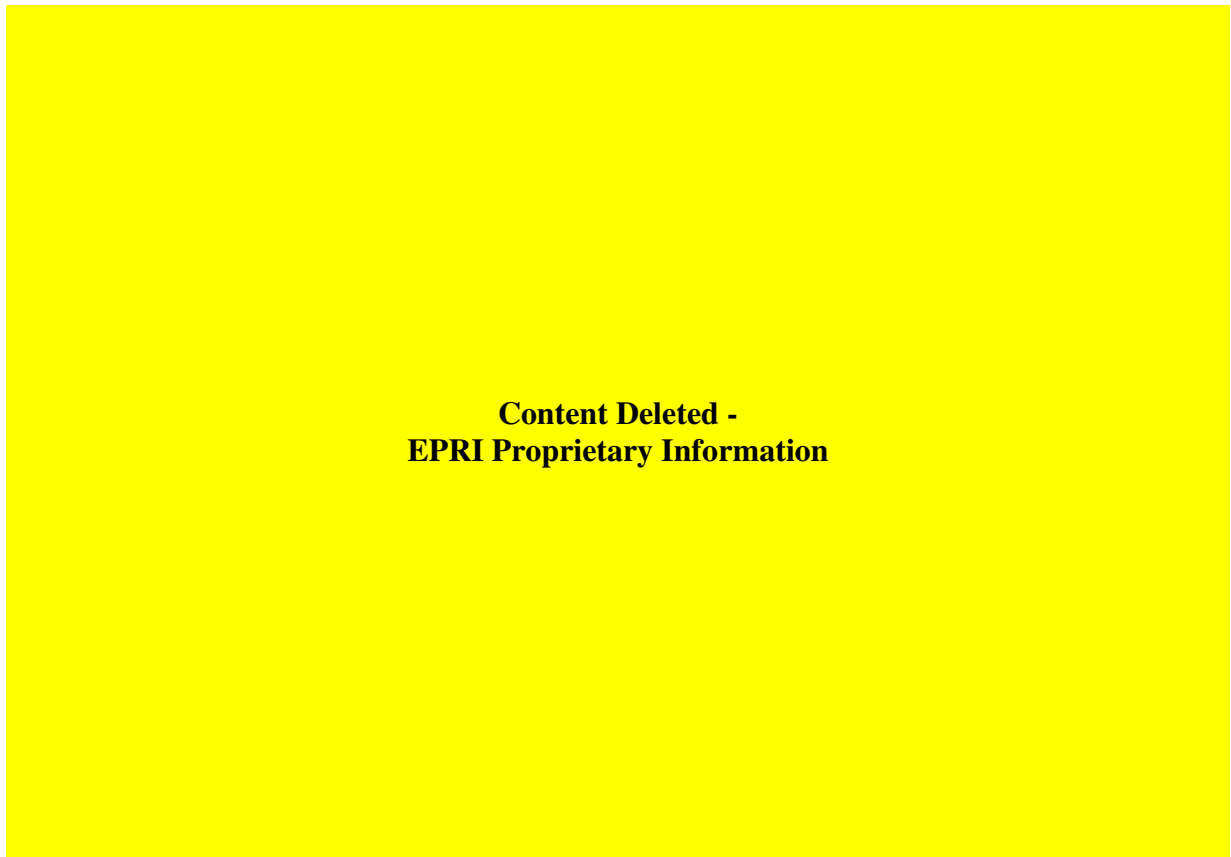
6.4.6 UT Demonstration 4



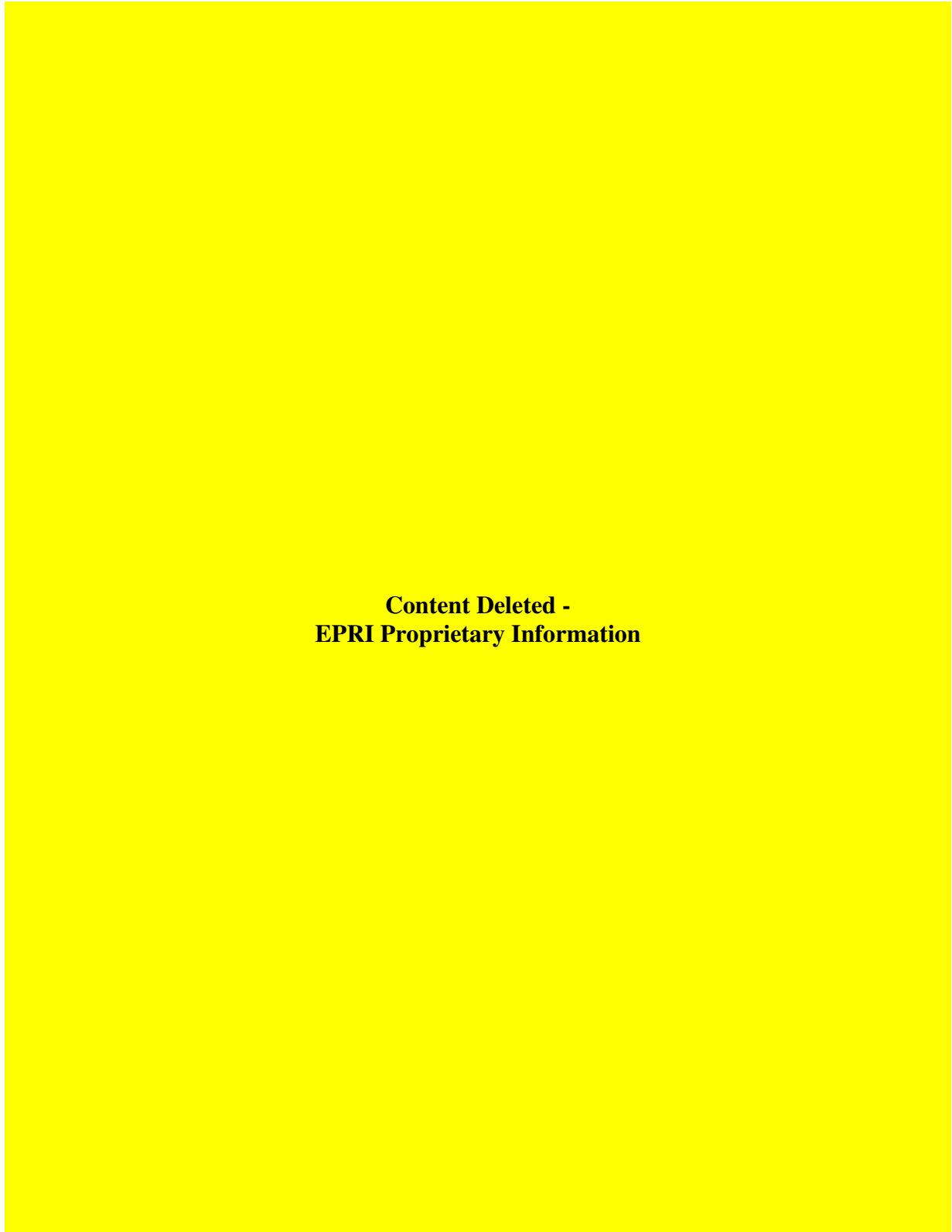
6.4.7 UT Demonstration 5



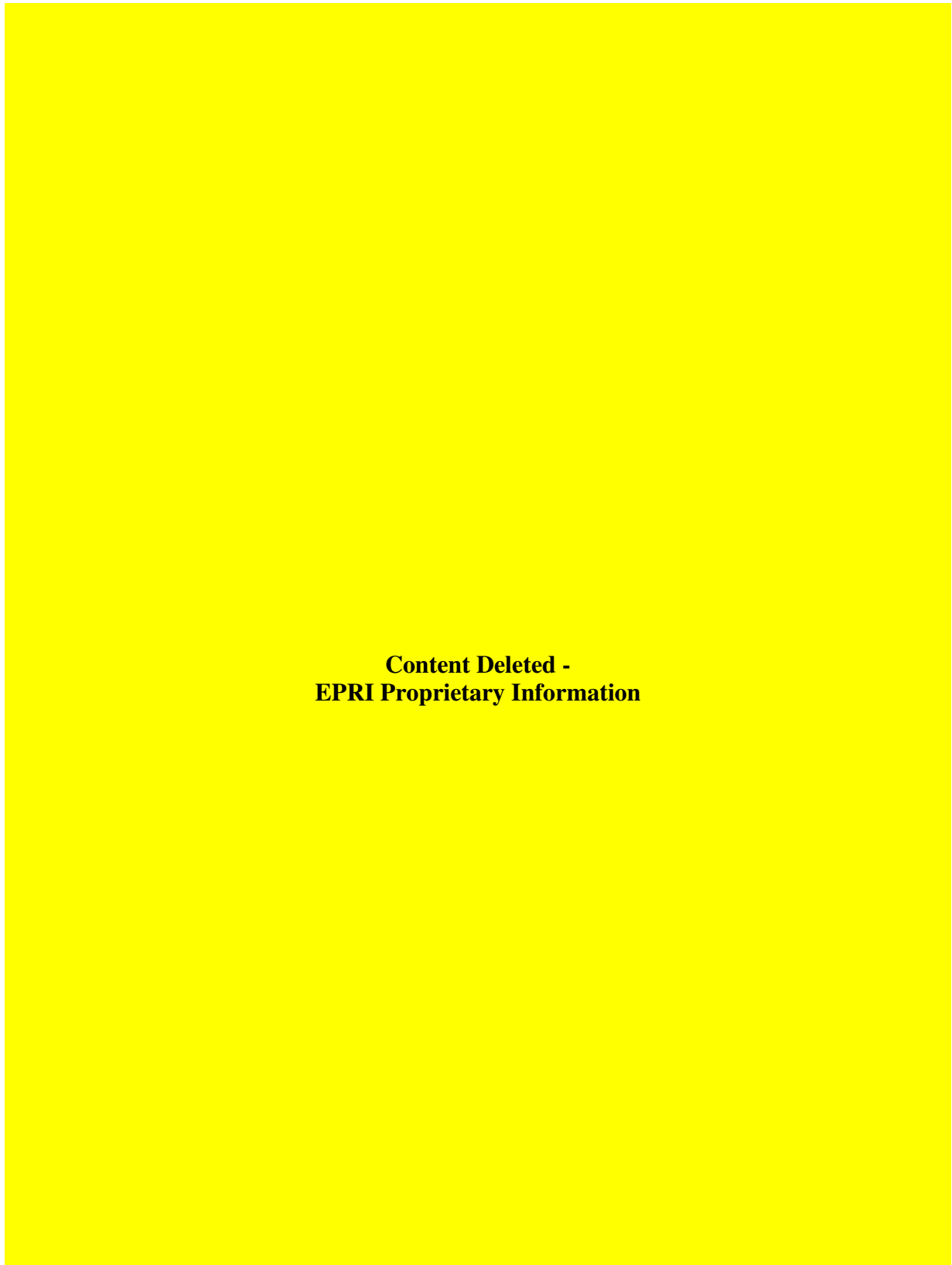
6.4.8 UT Demonstration 6



6.4.9 UT Demonstration 7



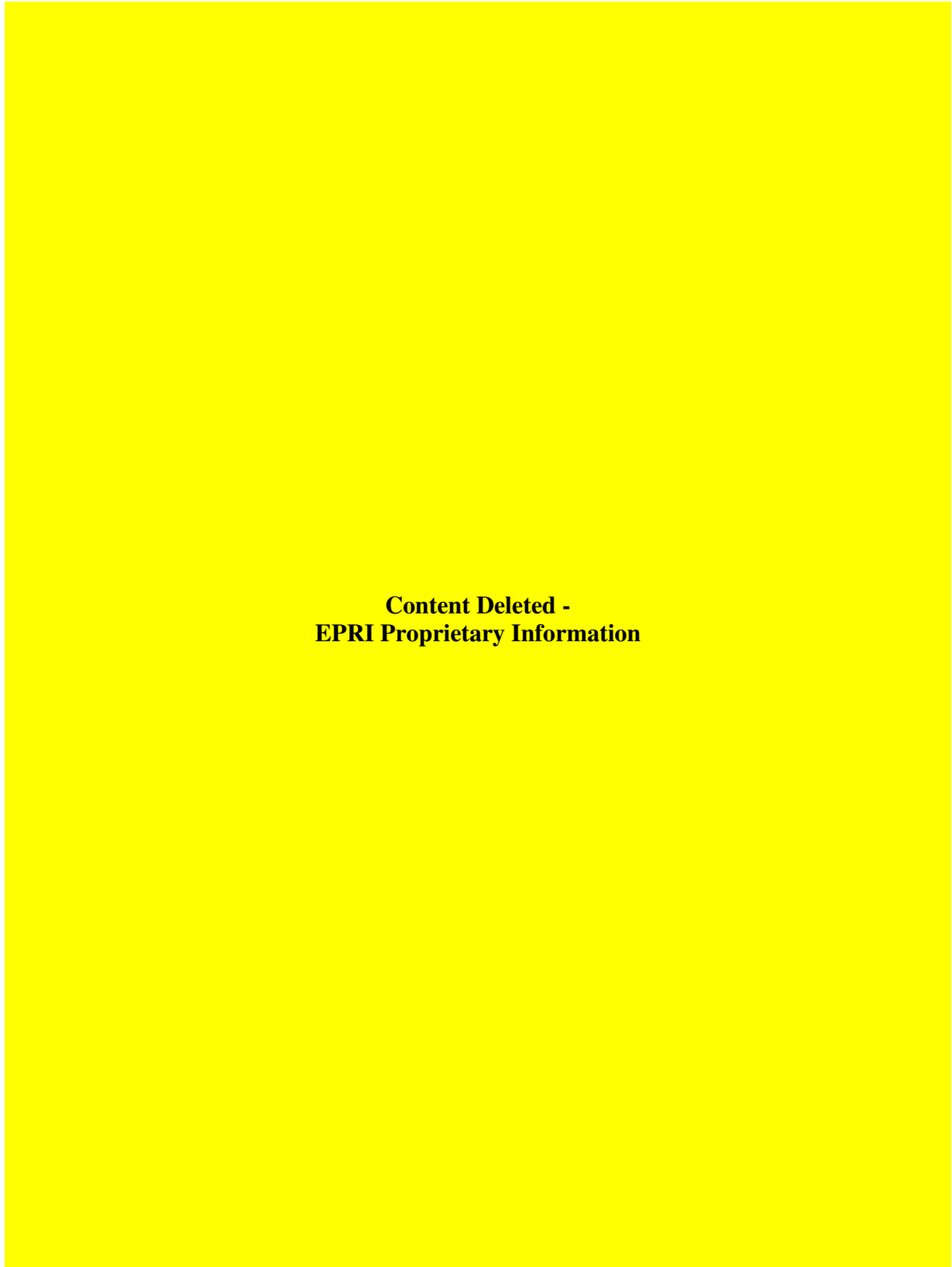
6.4.10 UT Demonstration 8





**Content Deleted -
EPRI Proprietary Information**

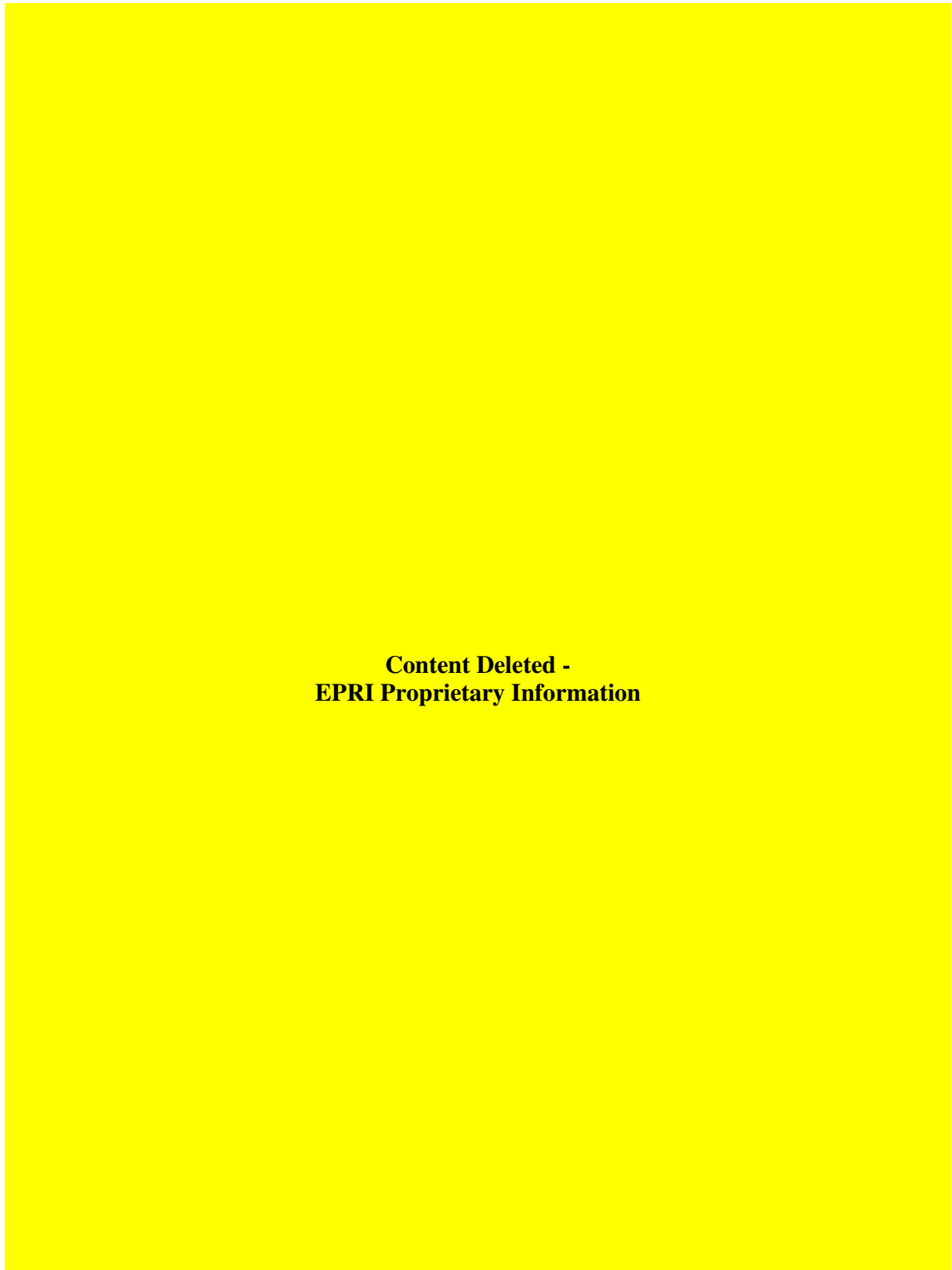
6.4.11 UT Demonstration 9



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.12 UT Demonstration 10



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.13 UT Demonstration 11



**Content Deleted -
EPRI Proprietary Information**

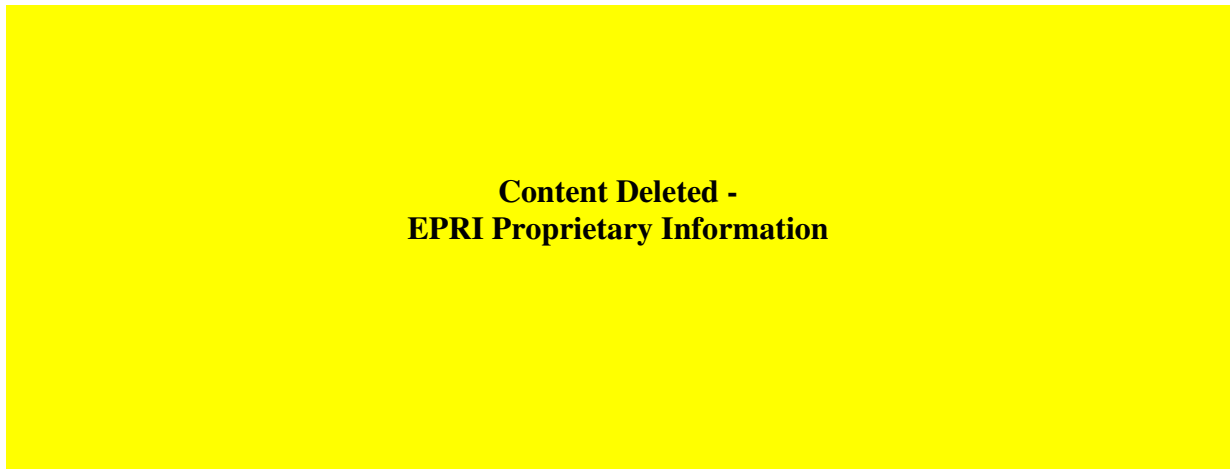
6.4.14 UT Demonstration 12



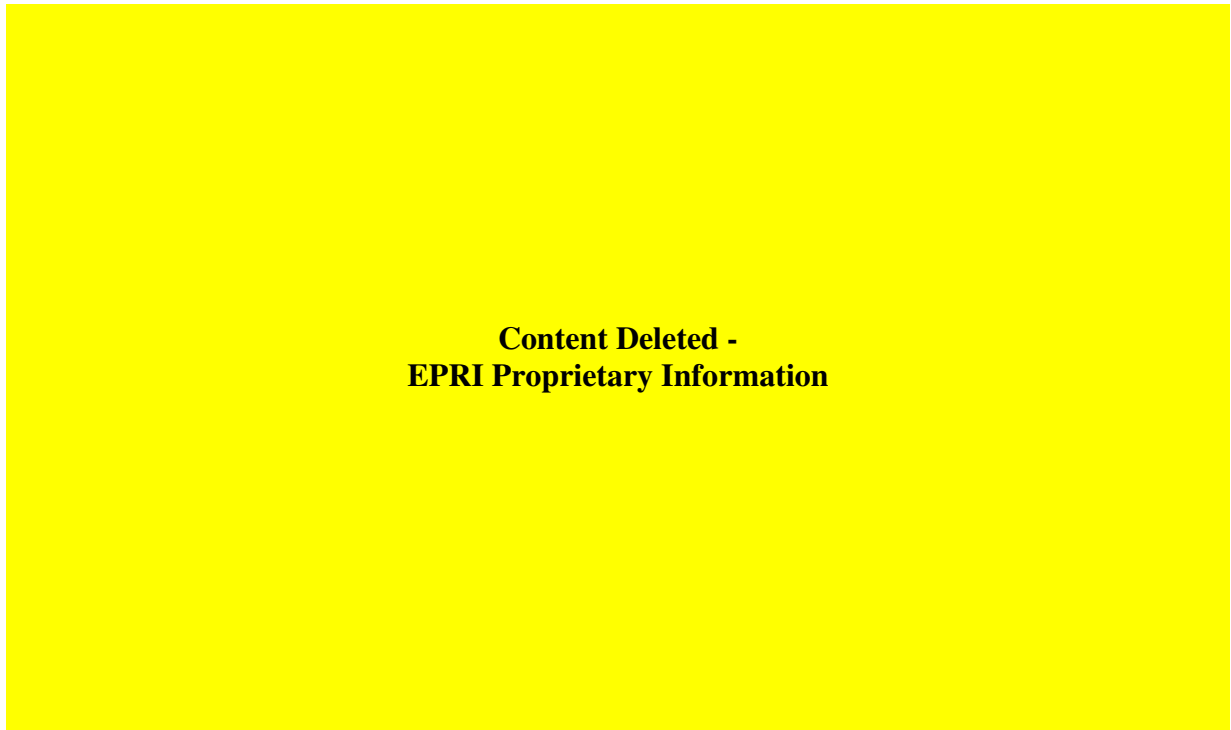
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

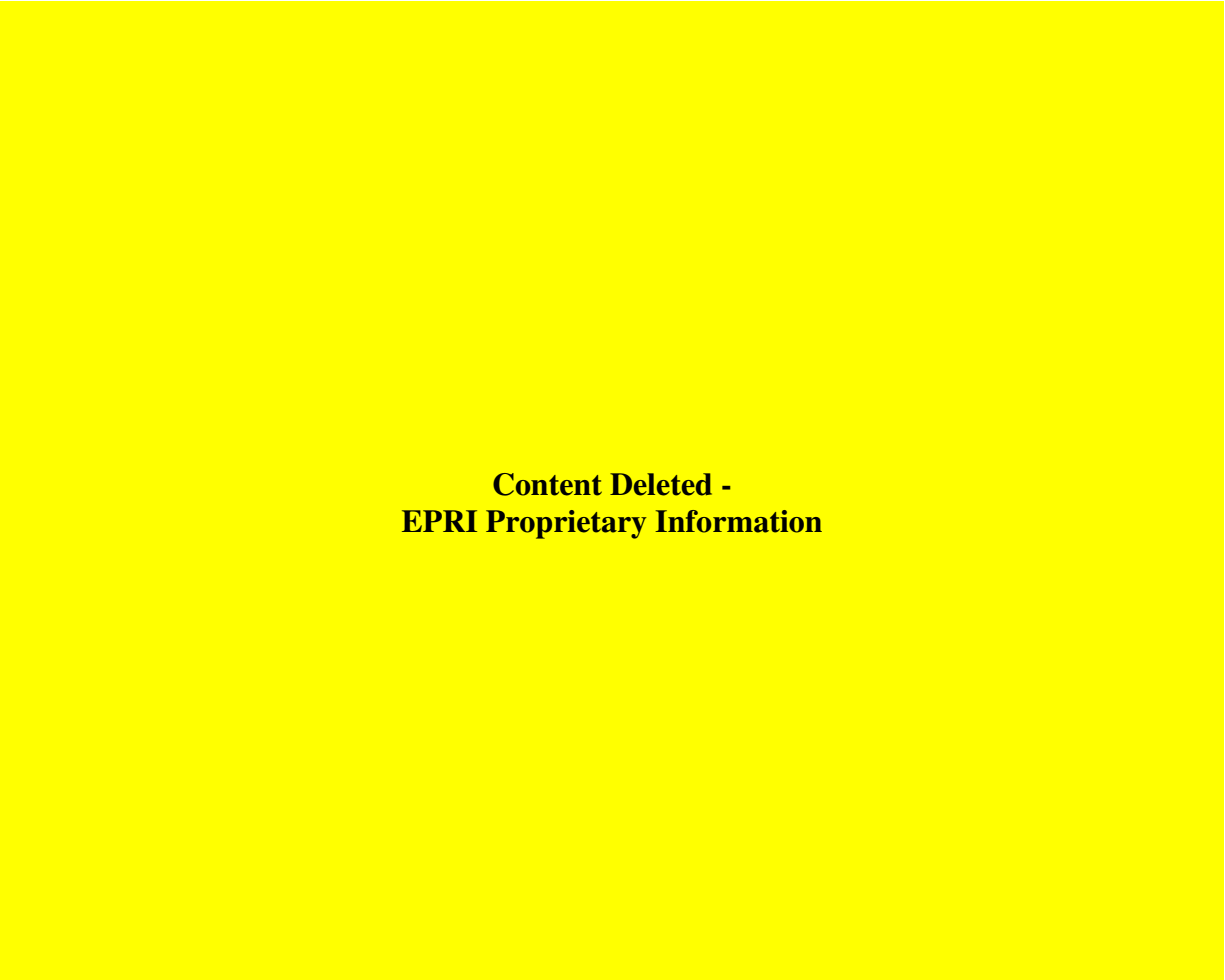
6.4.15 UT Demonstration 13



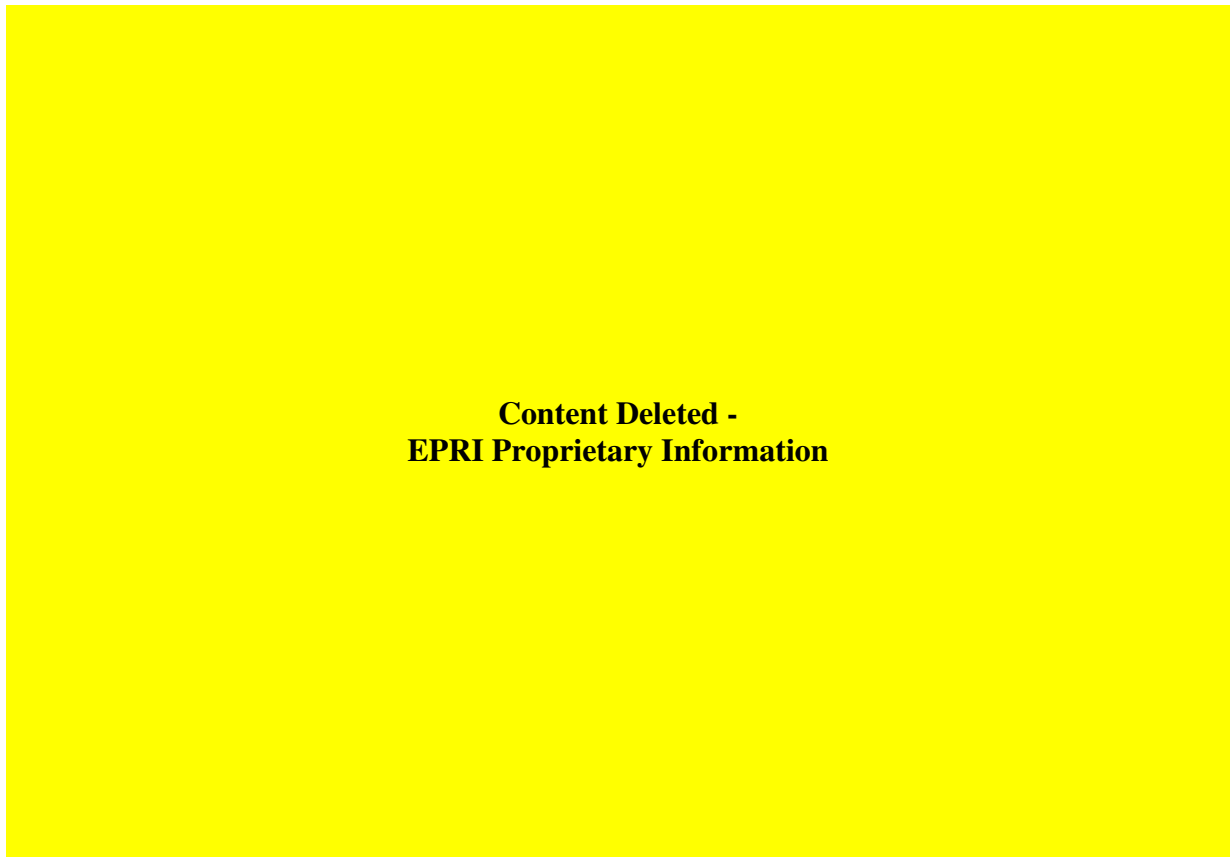
6.4.16 UT Demonstration 14



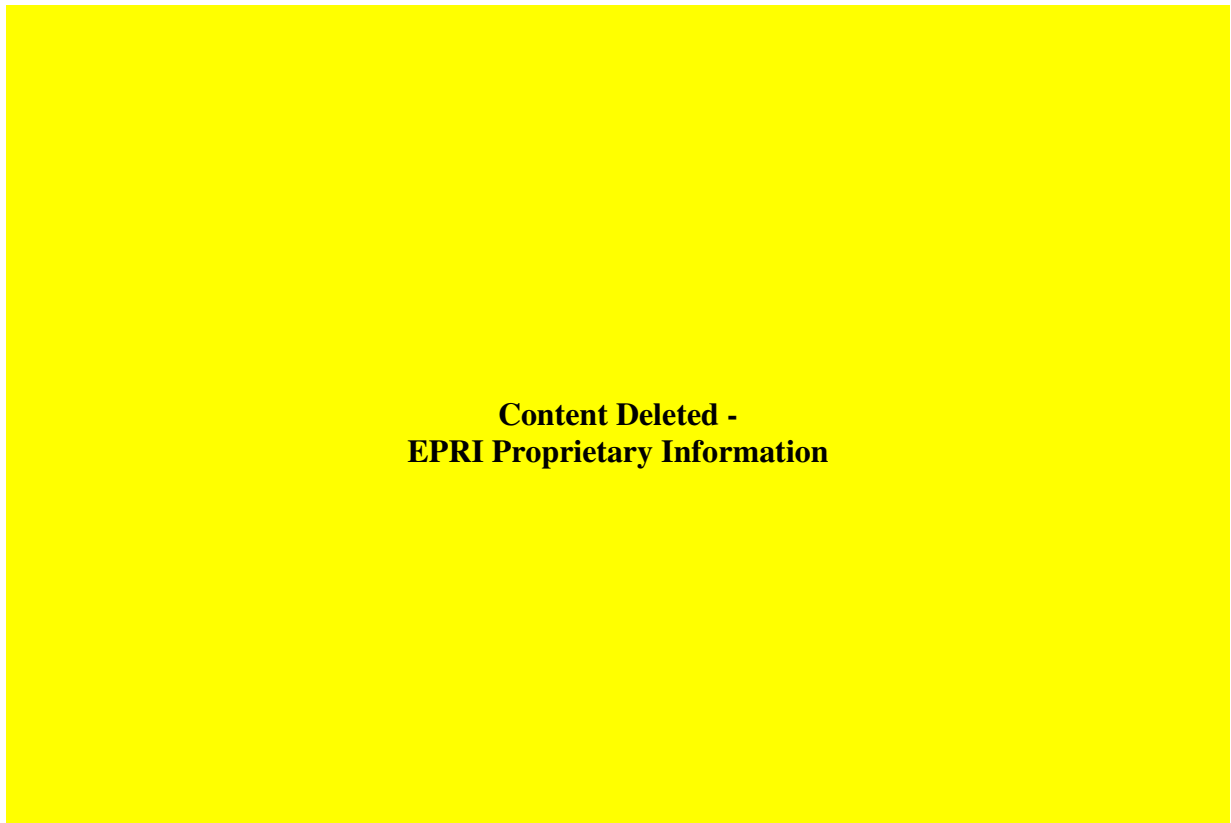
6.4.17 UT Demonstration 15



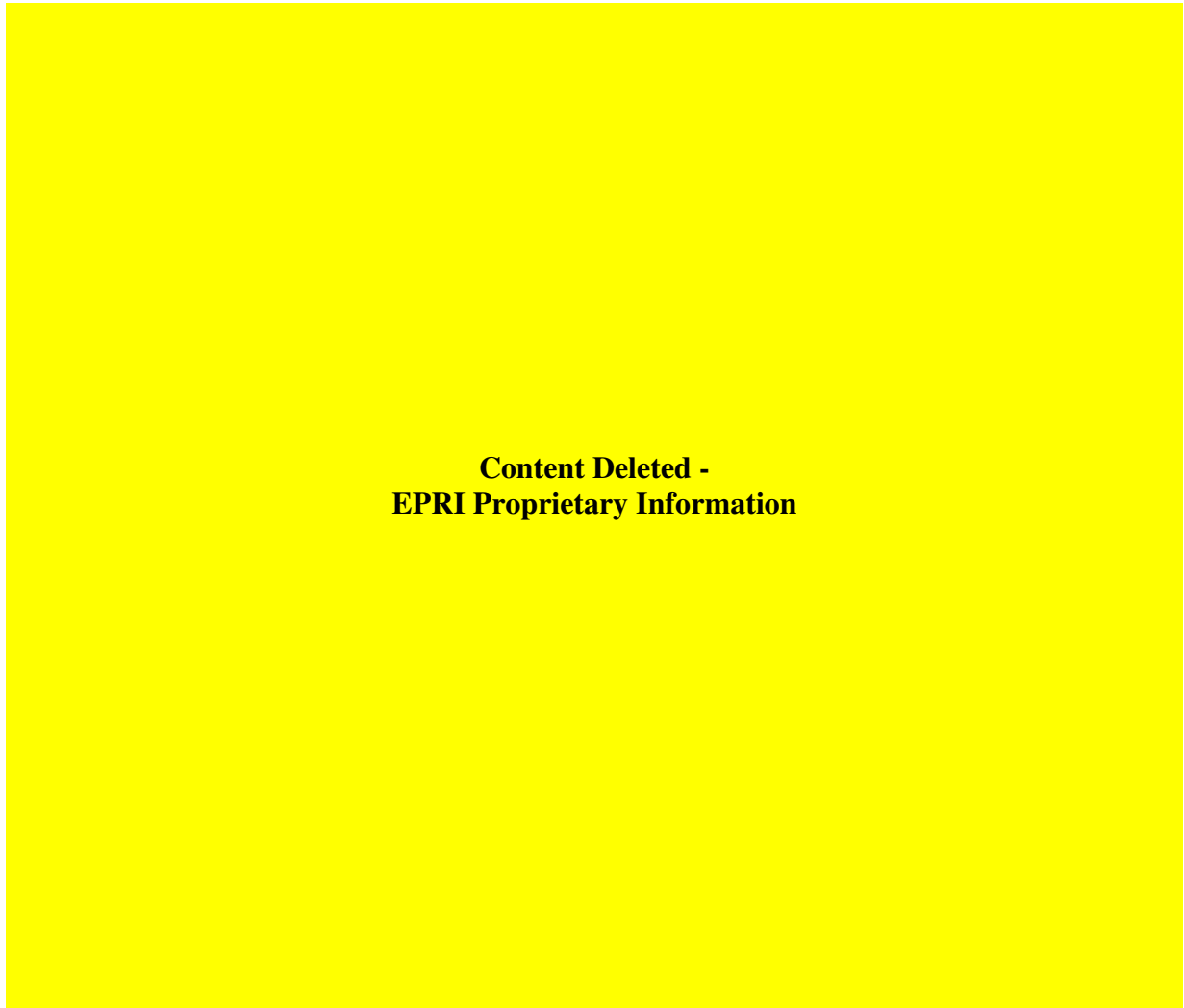
6.4.18 UT Demonstration 16



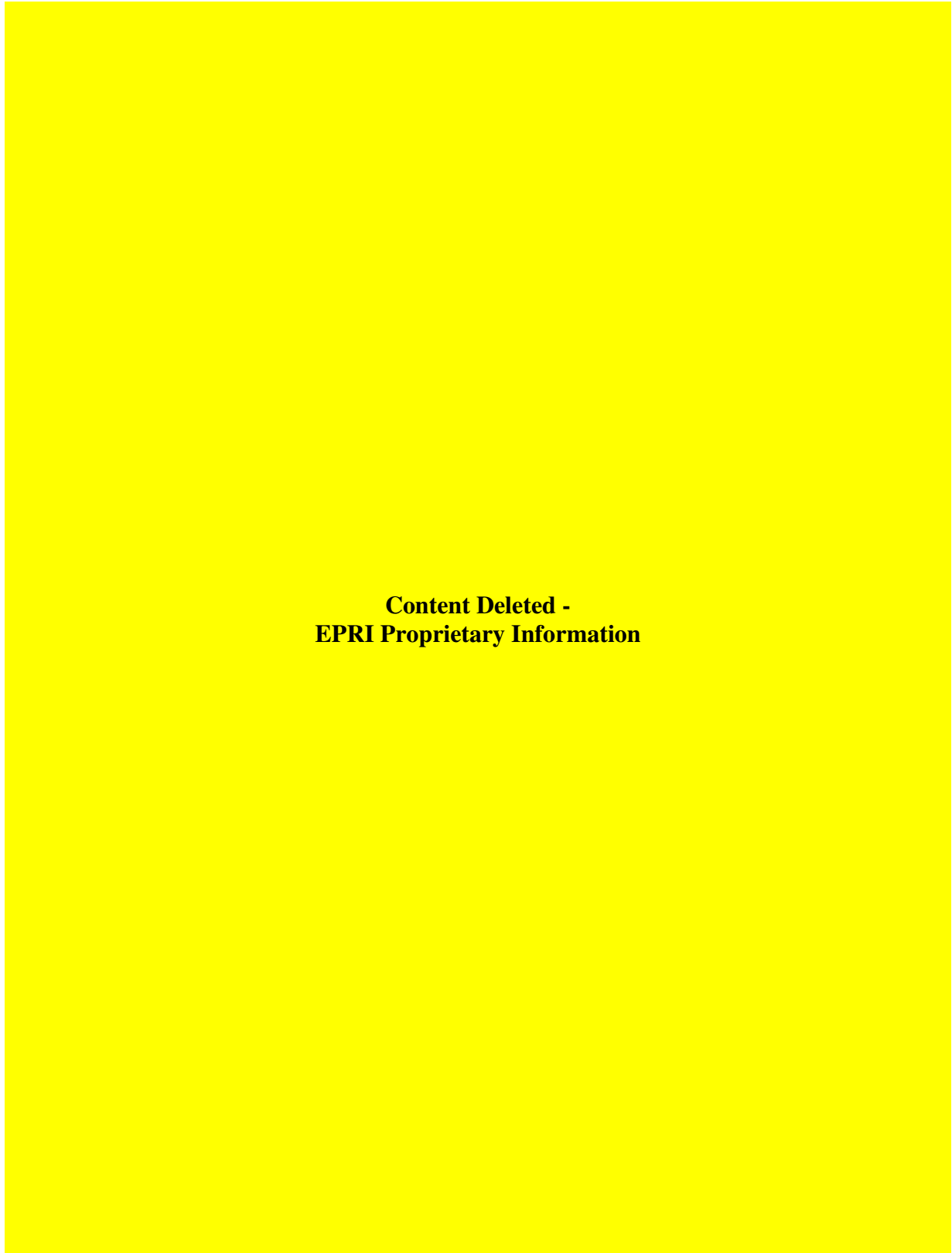
6.4.19 UT Demonstration 17



6.4.20 UT Demonstration 18



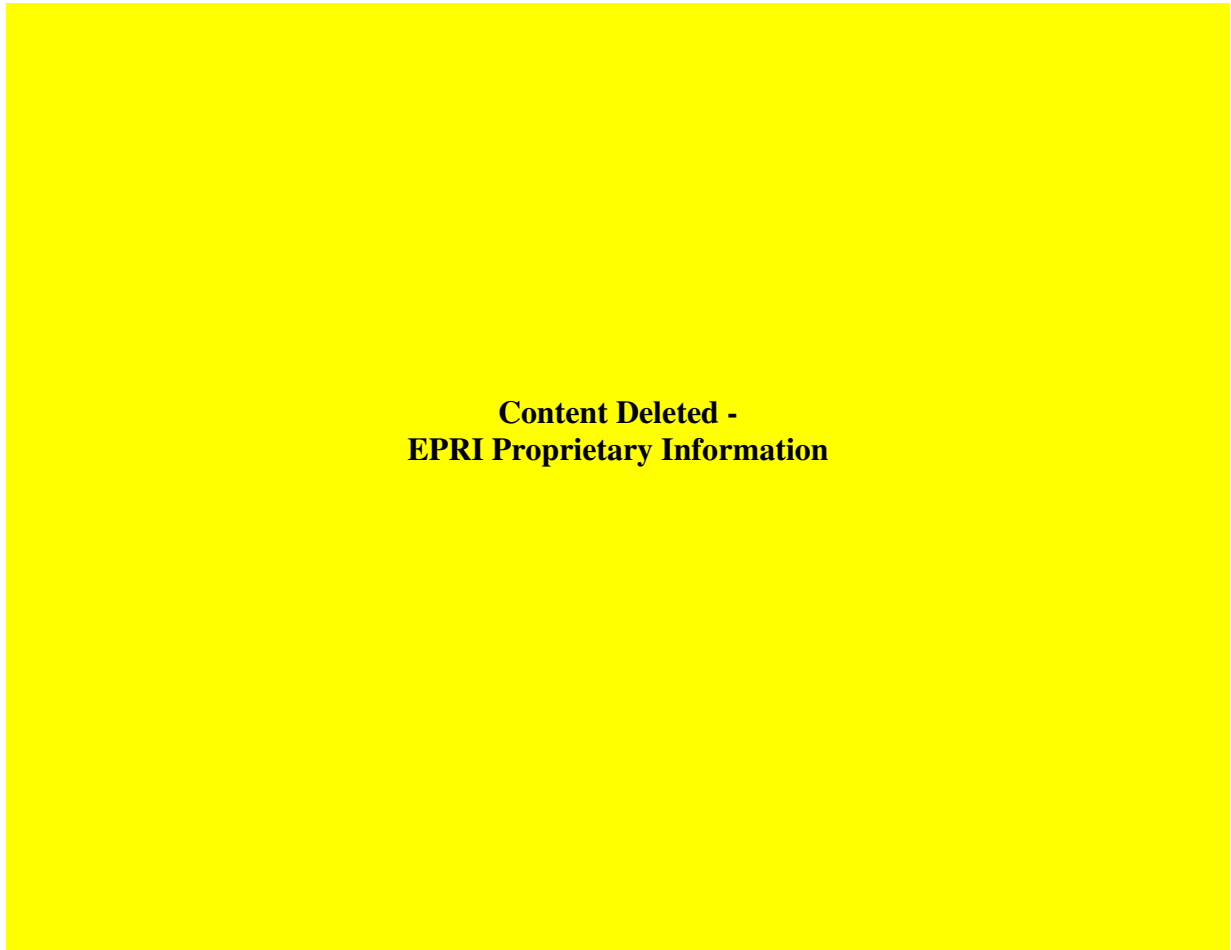
6.4.21 UT Demonstration 19



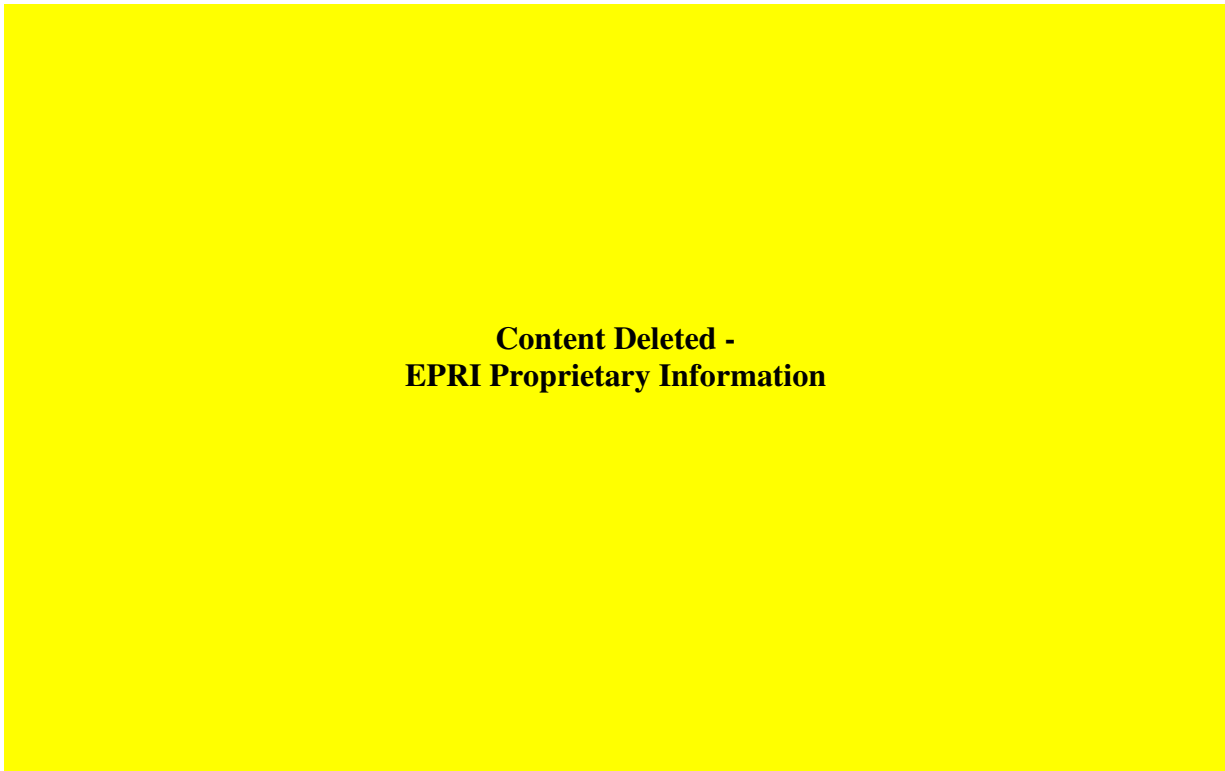
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

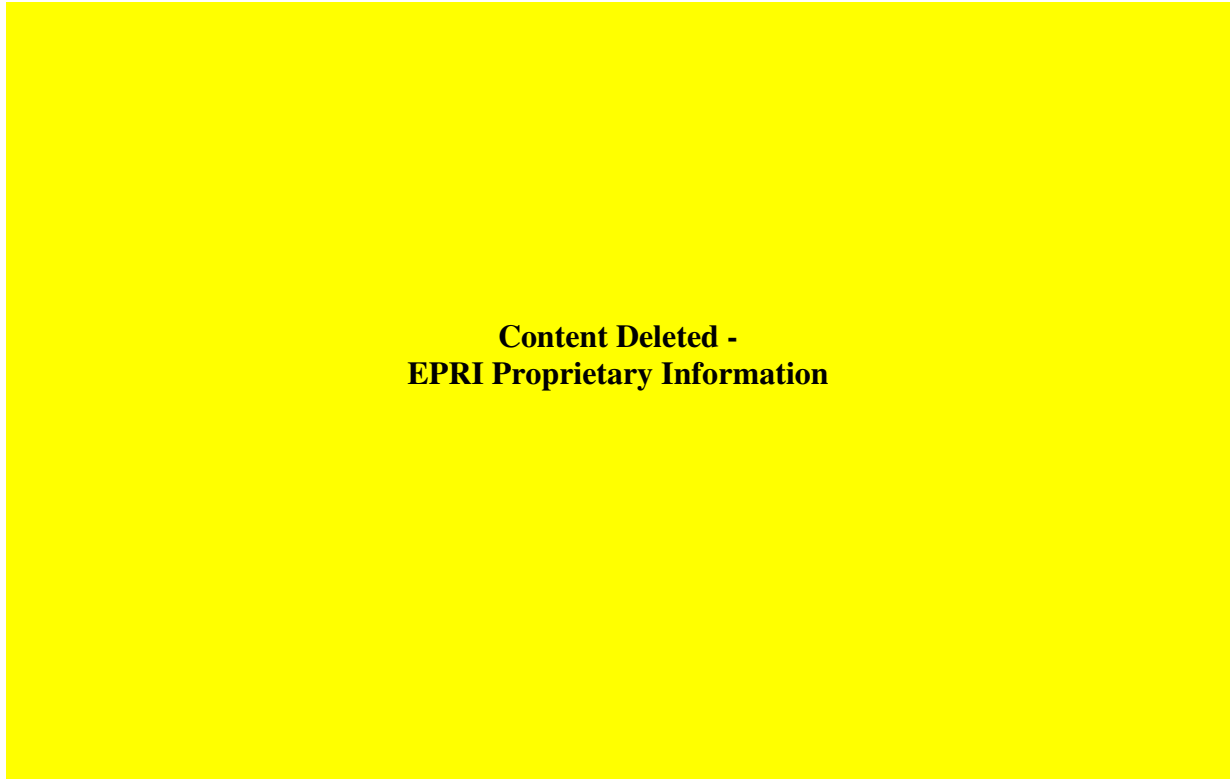
6.4.22 UT Demonstration 20



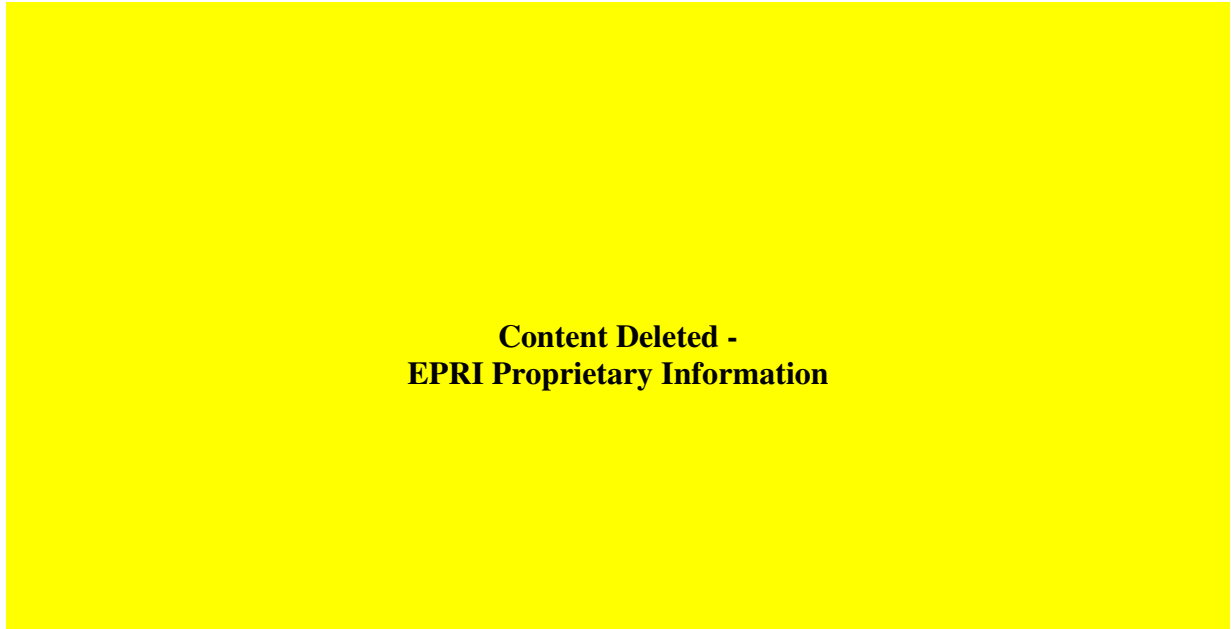
6.4.23 UT Demonstration 21



6.4.24 UT Demonstration 22



6.4.25 UT Demonstration 23



6.4.26 UT Demonstration 24



**Content Deleted -
EPRI Proprietary Information**

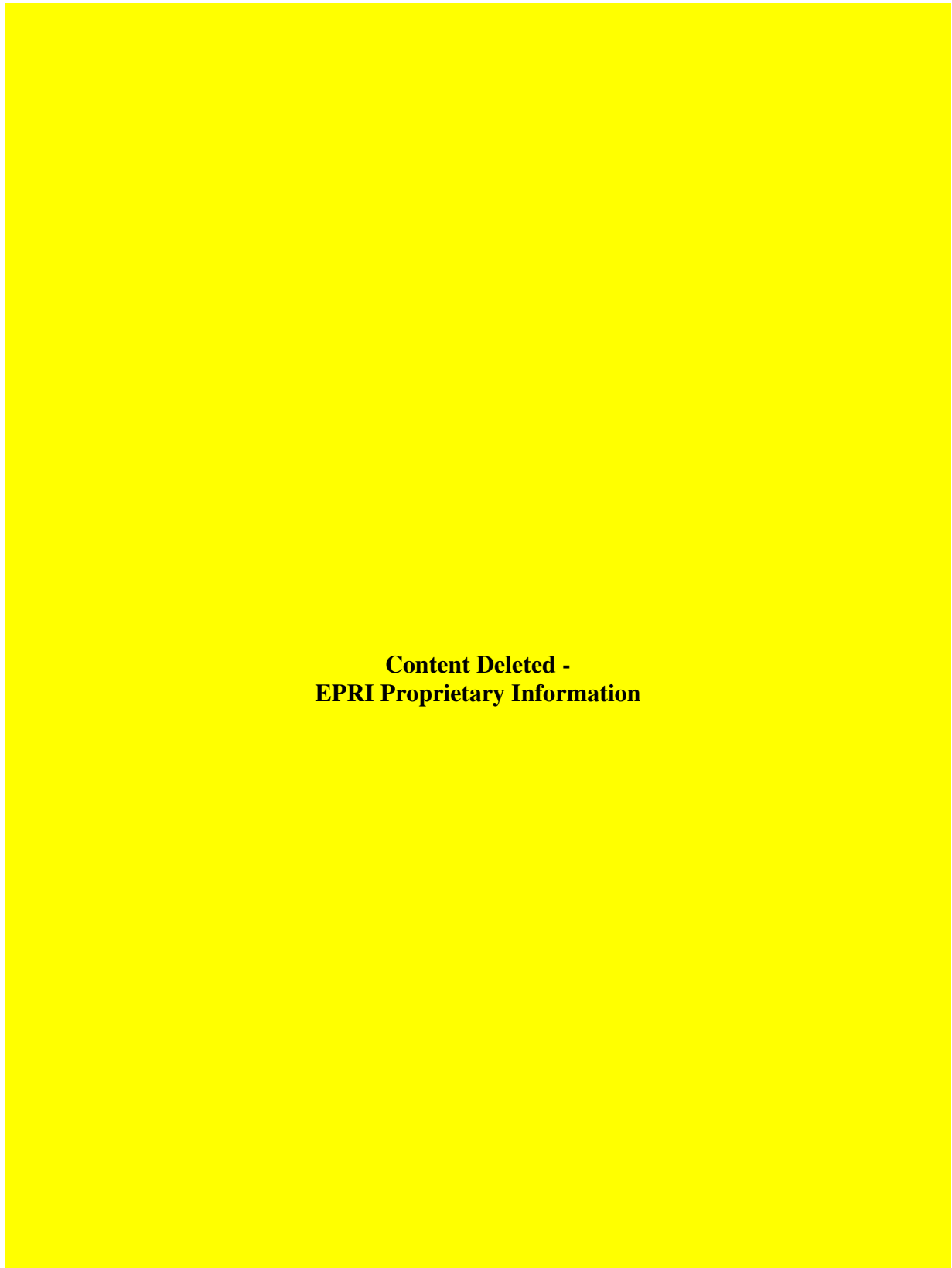
**Content Deleted -
EPRI Proprietary Information**

6.4.27 UT Demonstration 25



**Content Deleted -
EPRI Proprietary Information**

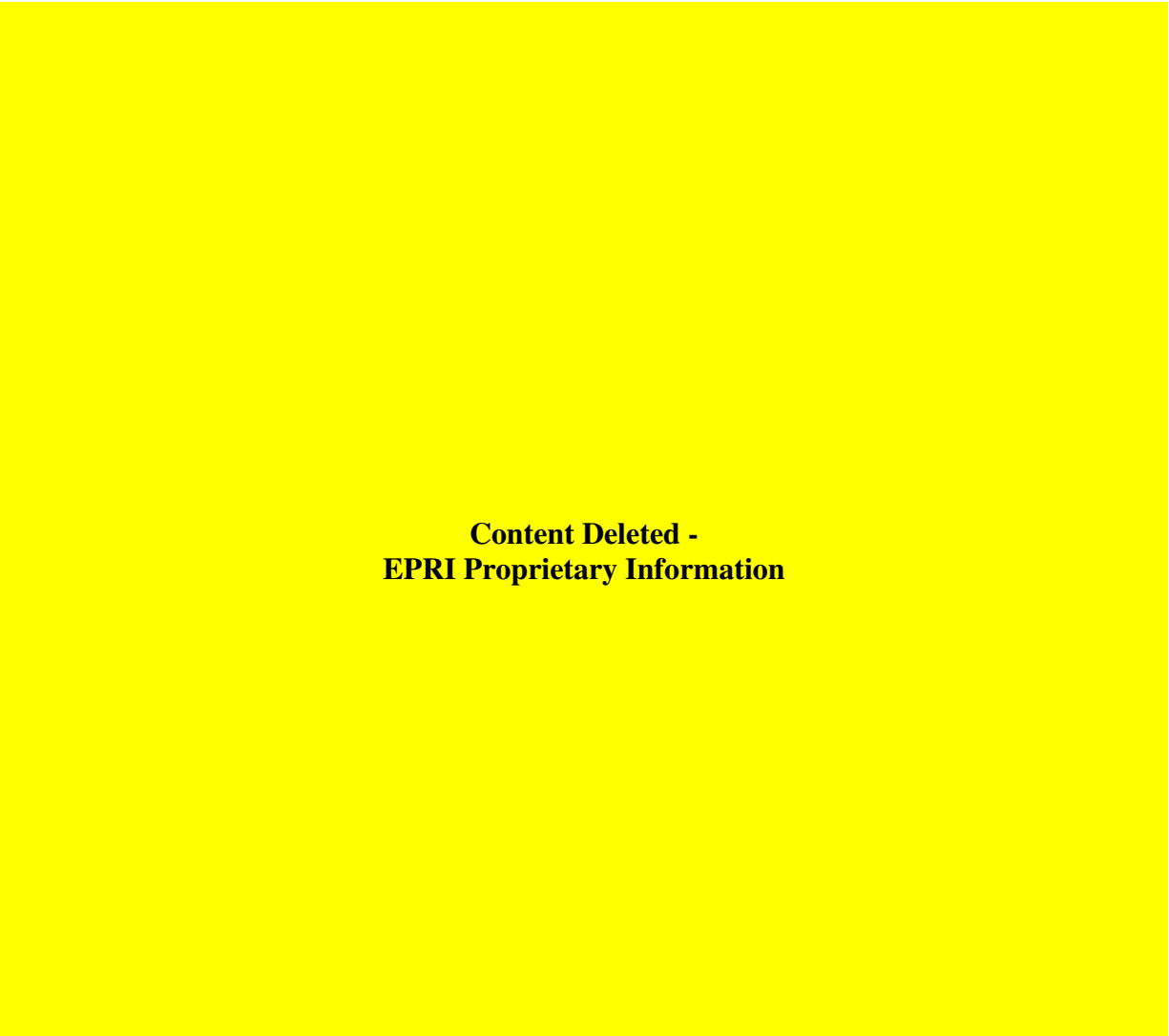
6.4.28 UT Demonstration 26



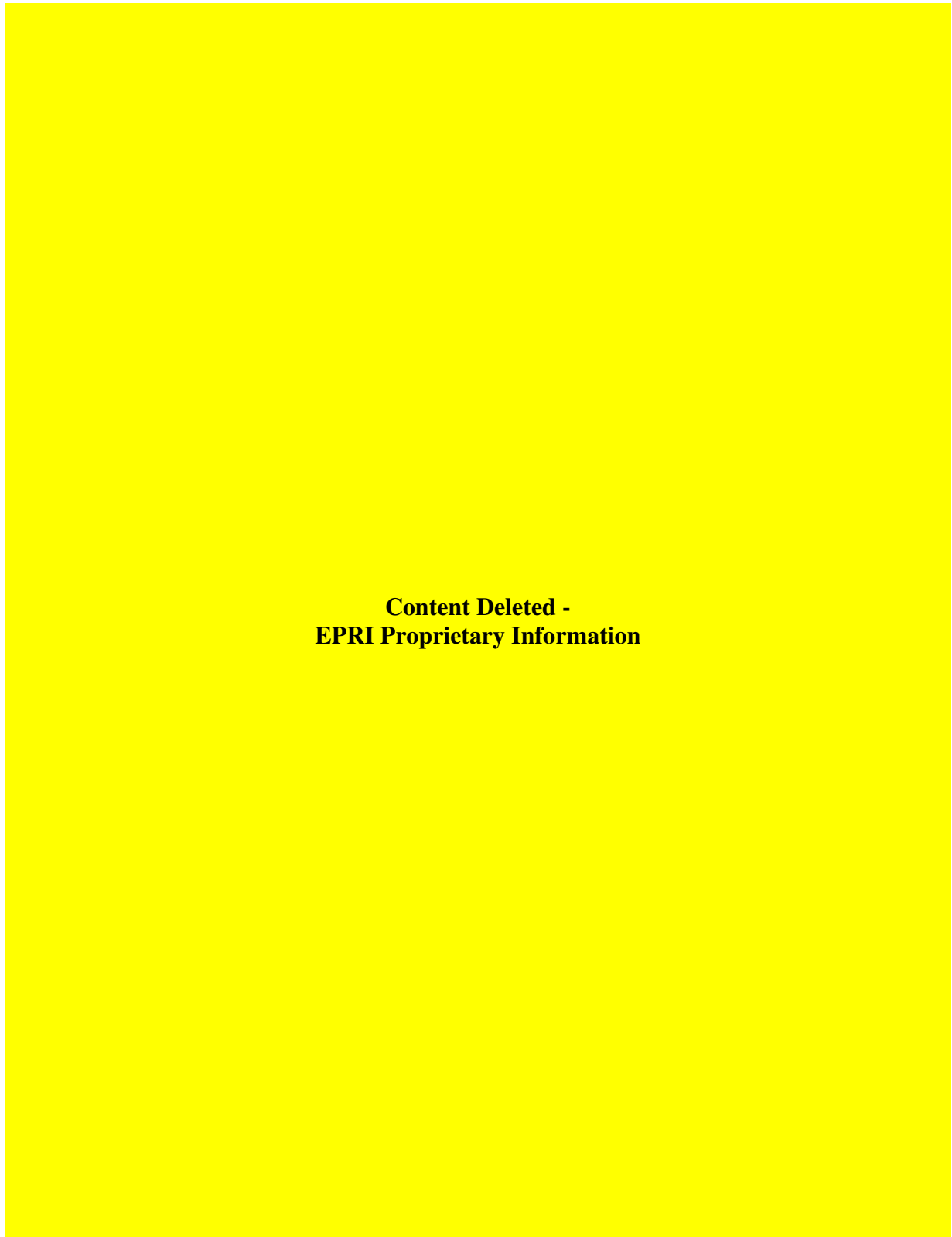
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.29 UT Demonstration 27



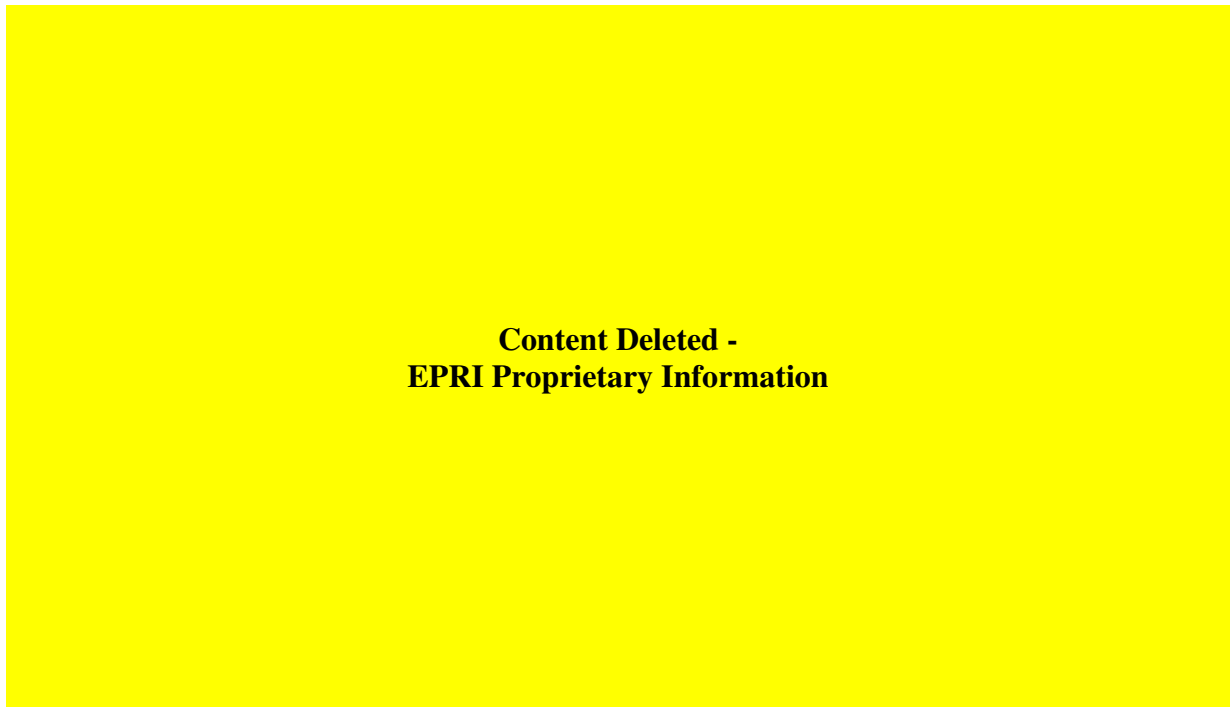
6.4.30 UT Demonstration 28



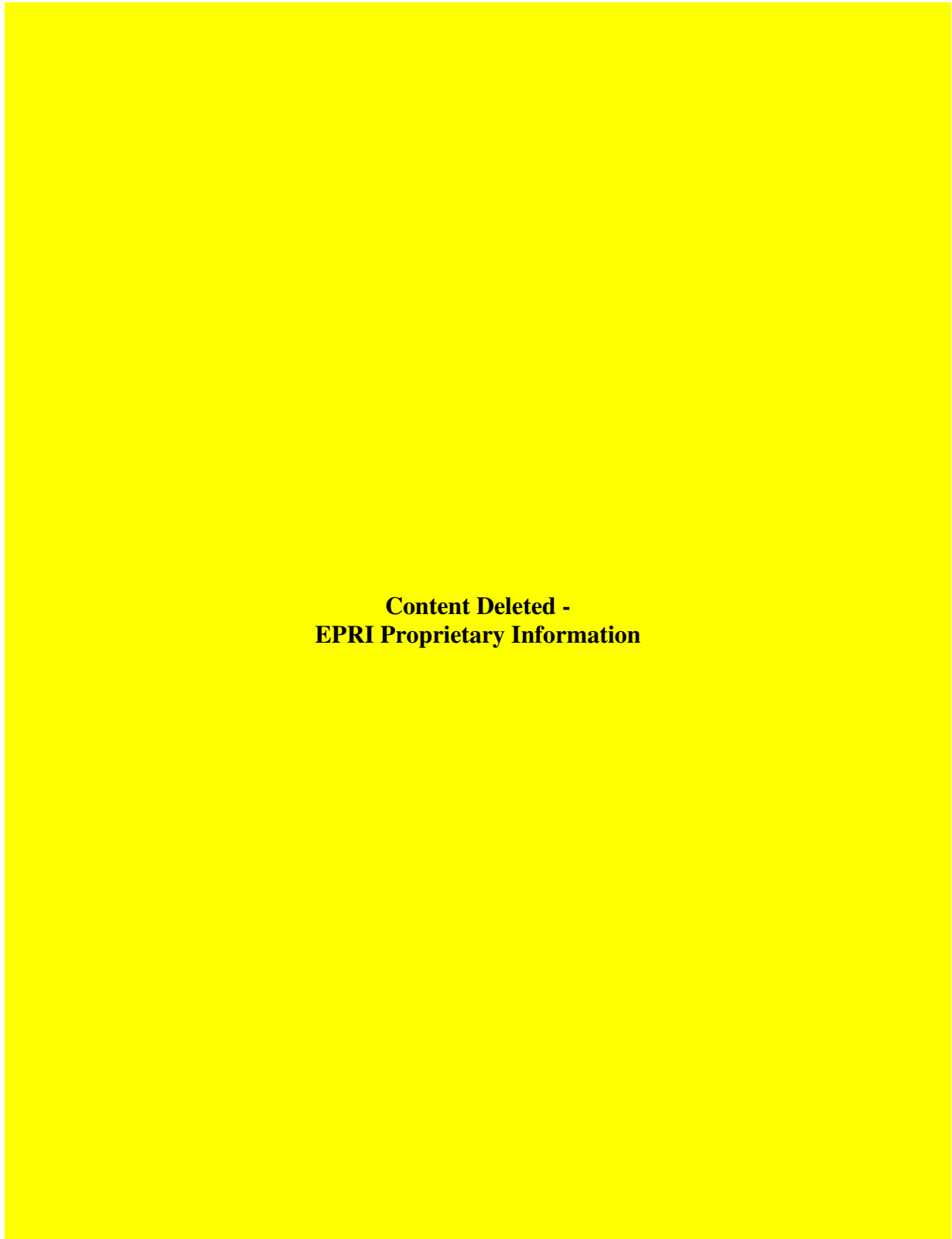
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.31 UT Demonstration 29



6.4.32 UT Demonstration 30



**Content Deleted -
EPRI Proprietary Information**

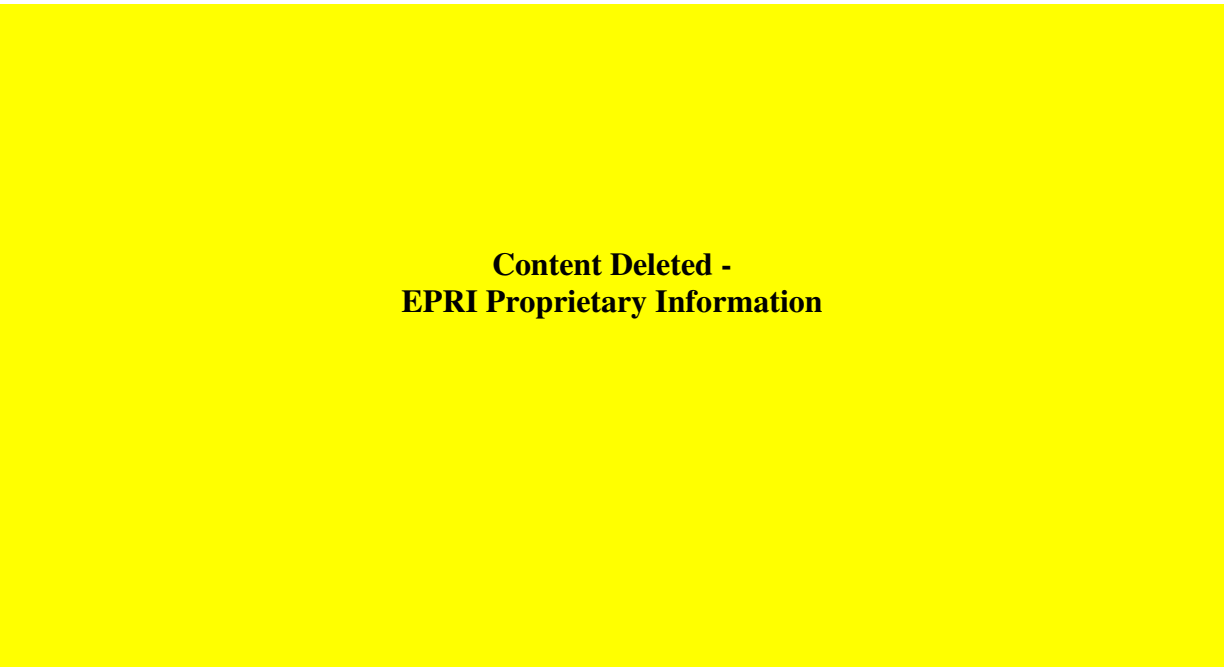
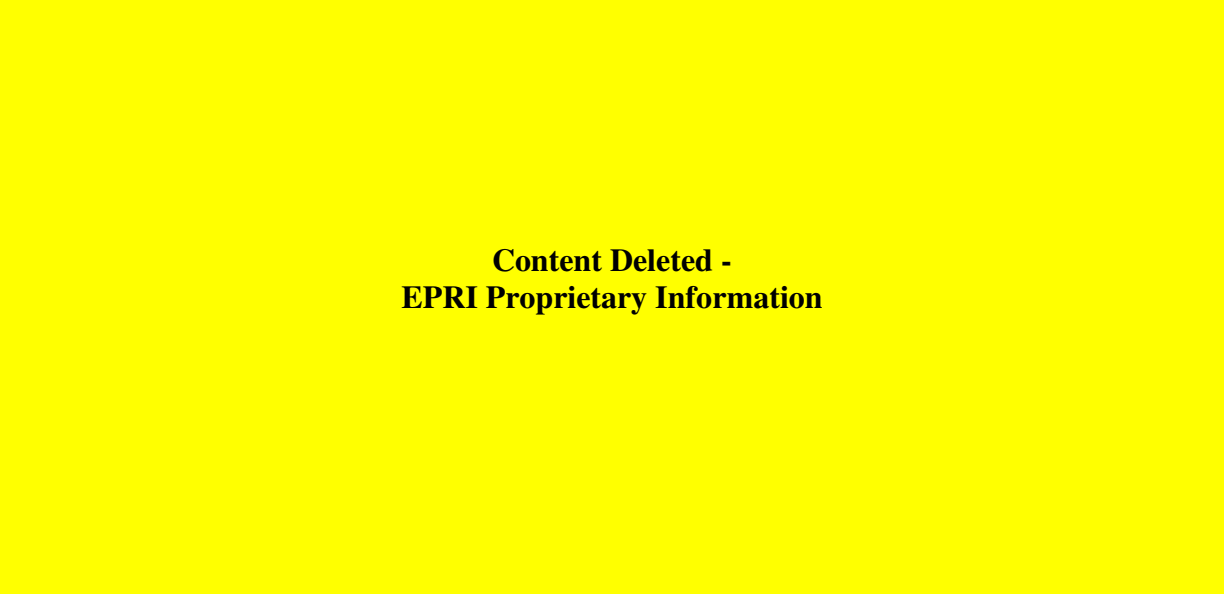
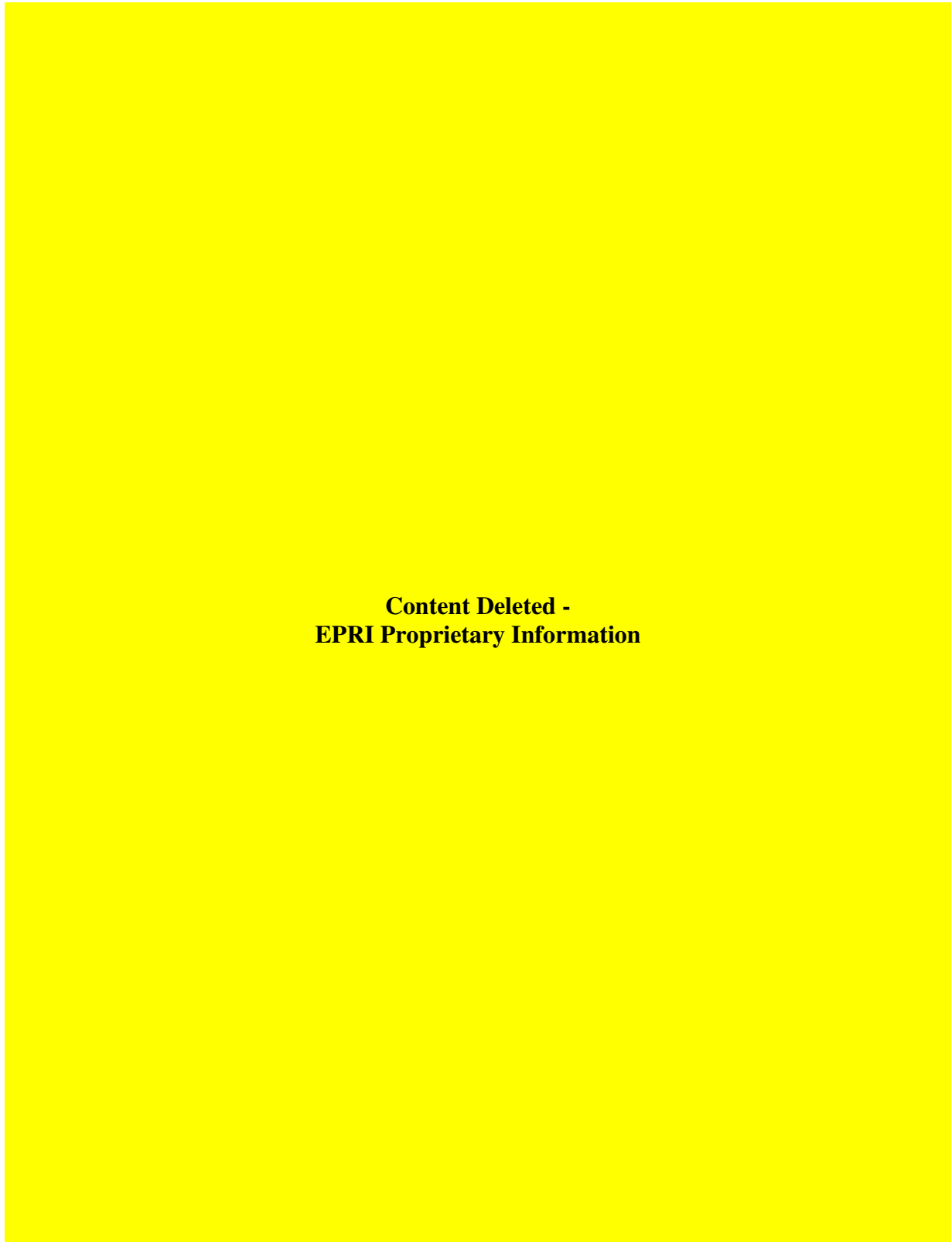


Figure 6.4.32-1. Correspondence of Flaws in Mockup BWRVIP-J to the Inspection Configuration of BWR/2 Weld P8



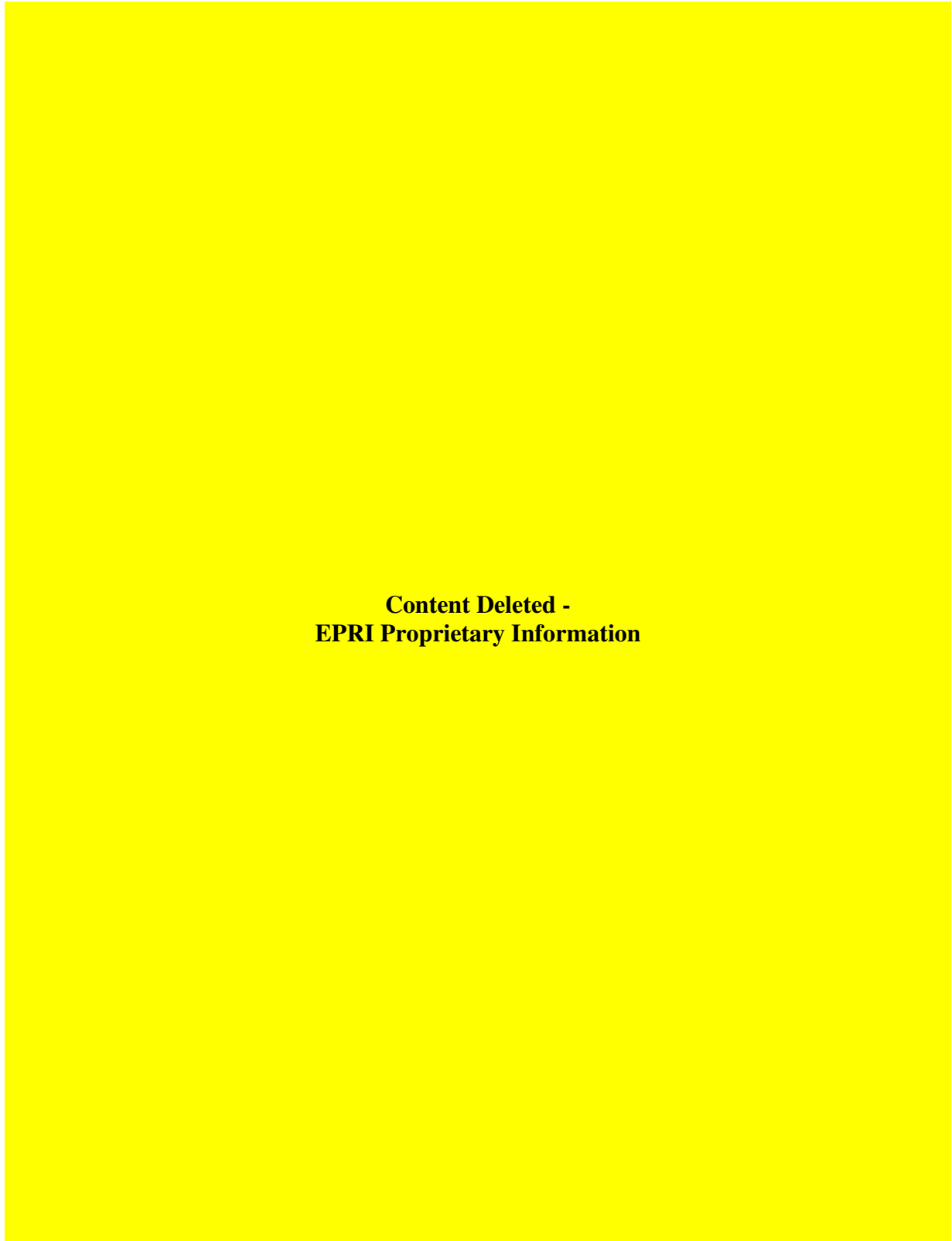
Figure 6.4.32-2. Inability to Detect OD Pipe-Side Flaws Using the Single-Stroke Scan Technique

6.4.33 UT Demonstration 31



**Content Deleted -
EPRI Proprietary Information**

6.4.34 UT Demonstration 32



6.4.35 UT Demonstration 33



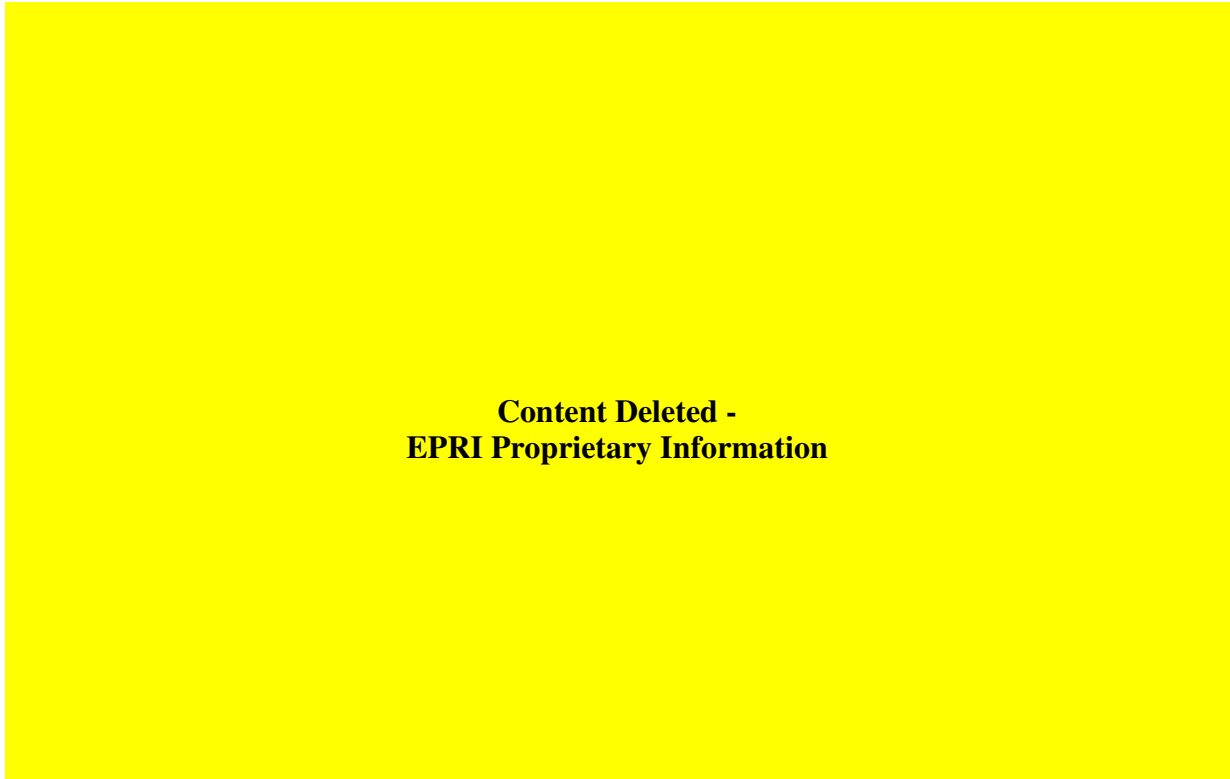


Figure 6.4.35-1. Detection Paths for Flaws in Mockup BWRVIP-K

6.4.36 UT Demonstration 34



6.4.37 UT Demonstration 35



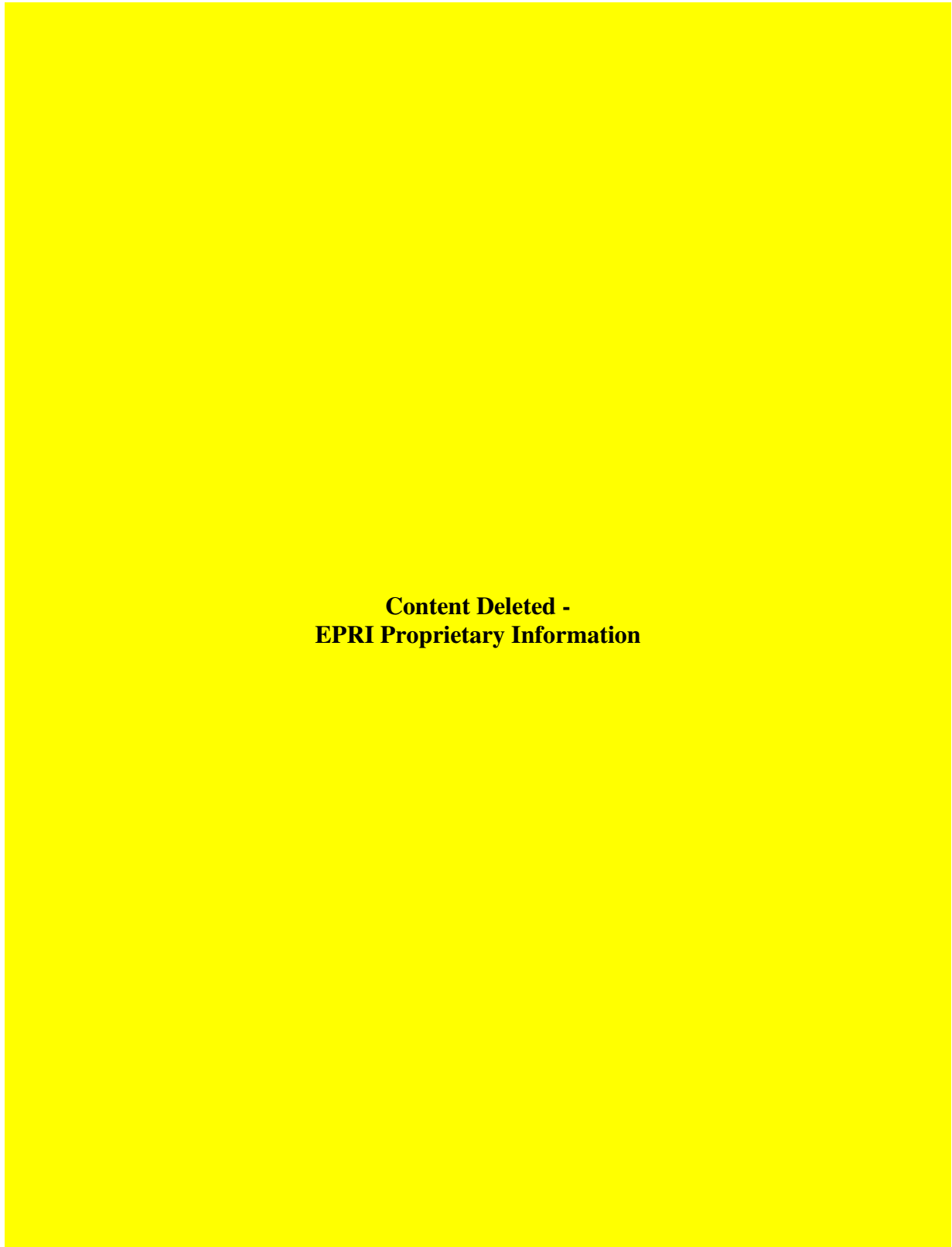
6.4.38 UT Demonstration 36



6.4.39 UT Demonstration 37



6.4.40 UT Demonstration 38



**Content Deleted -
EPRI Proprietary Information**

6.4.41 UT Demonstration 39



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.42 UT Demonstration 40



**Content Deleted -
EPRI Proprietary Information**

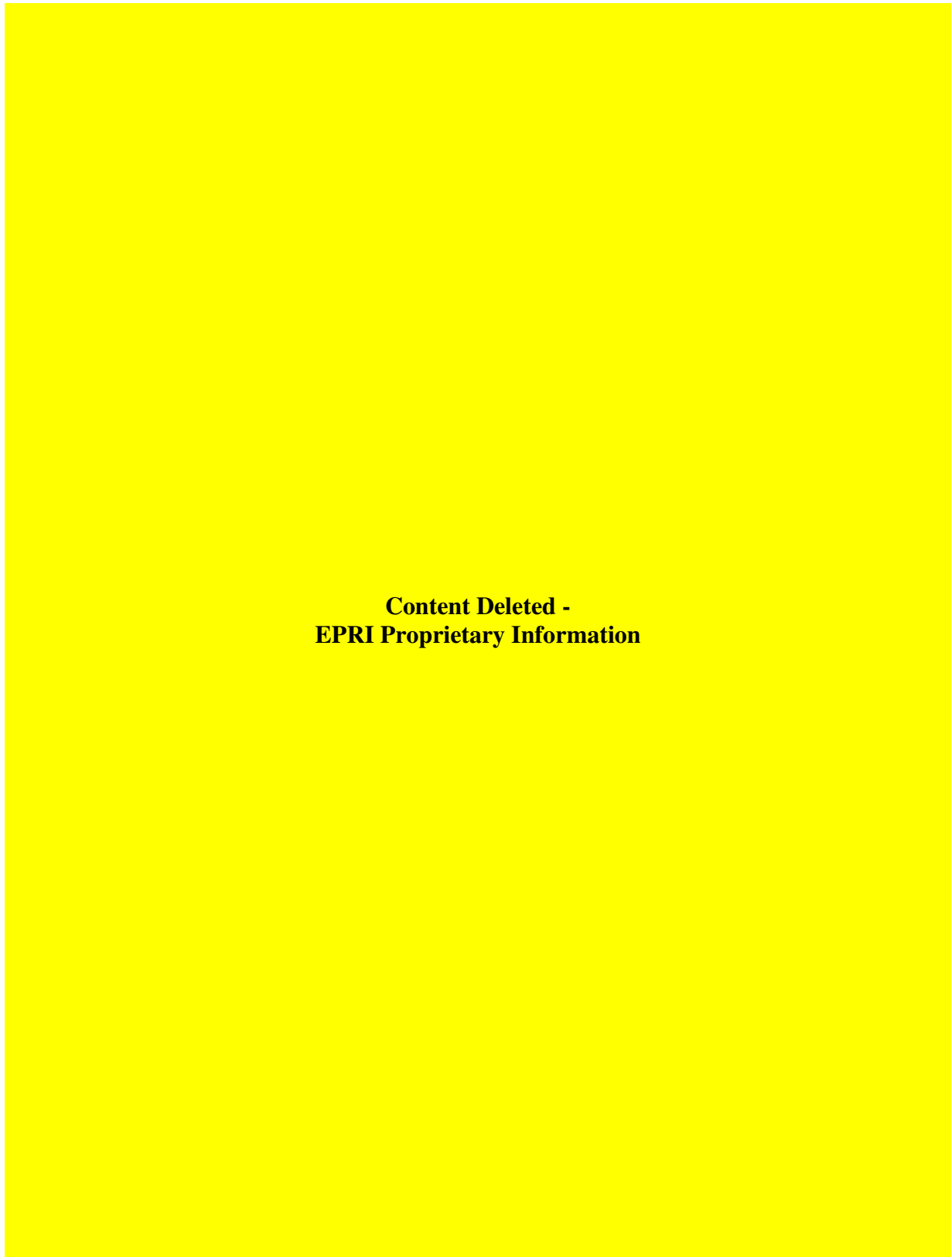
6.4.43 UT Demonstration 41





**Content Deleted -
EPRI Proprietary Information**

6.4.44 UT Demonstration 42



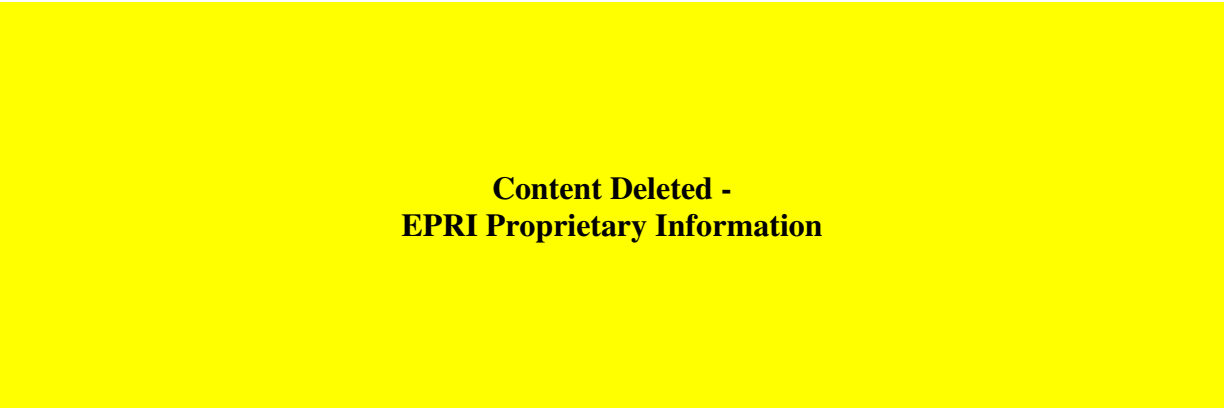
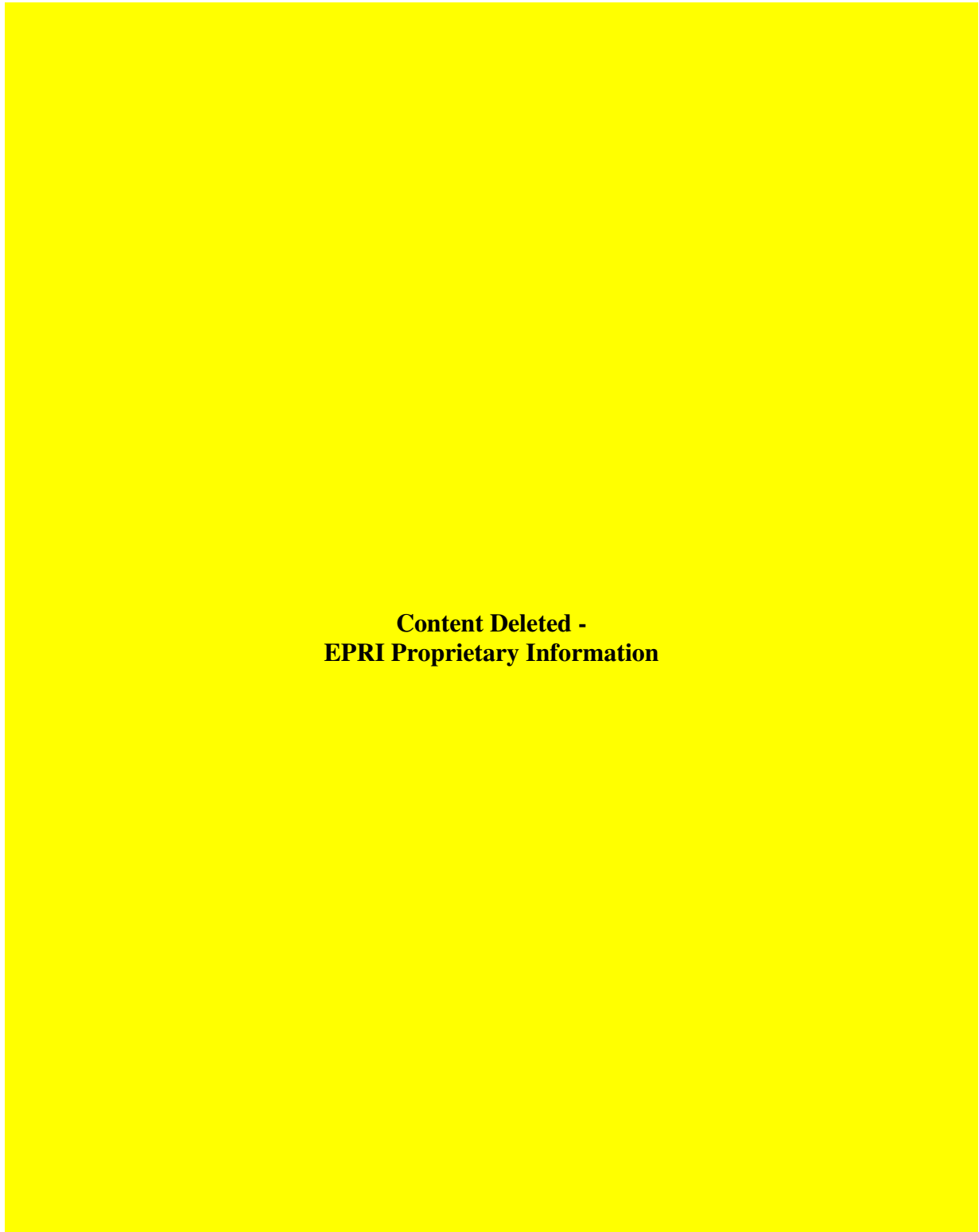


Figure 6.4.44-1. Array Probe Positioning on T-Box



**Content Deleted -
EPRI Proprietary Information**

6.4.45 UT Demonstration 43



**Content Deleted -
EPRI Proprietary Information**

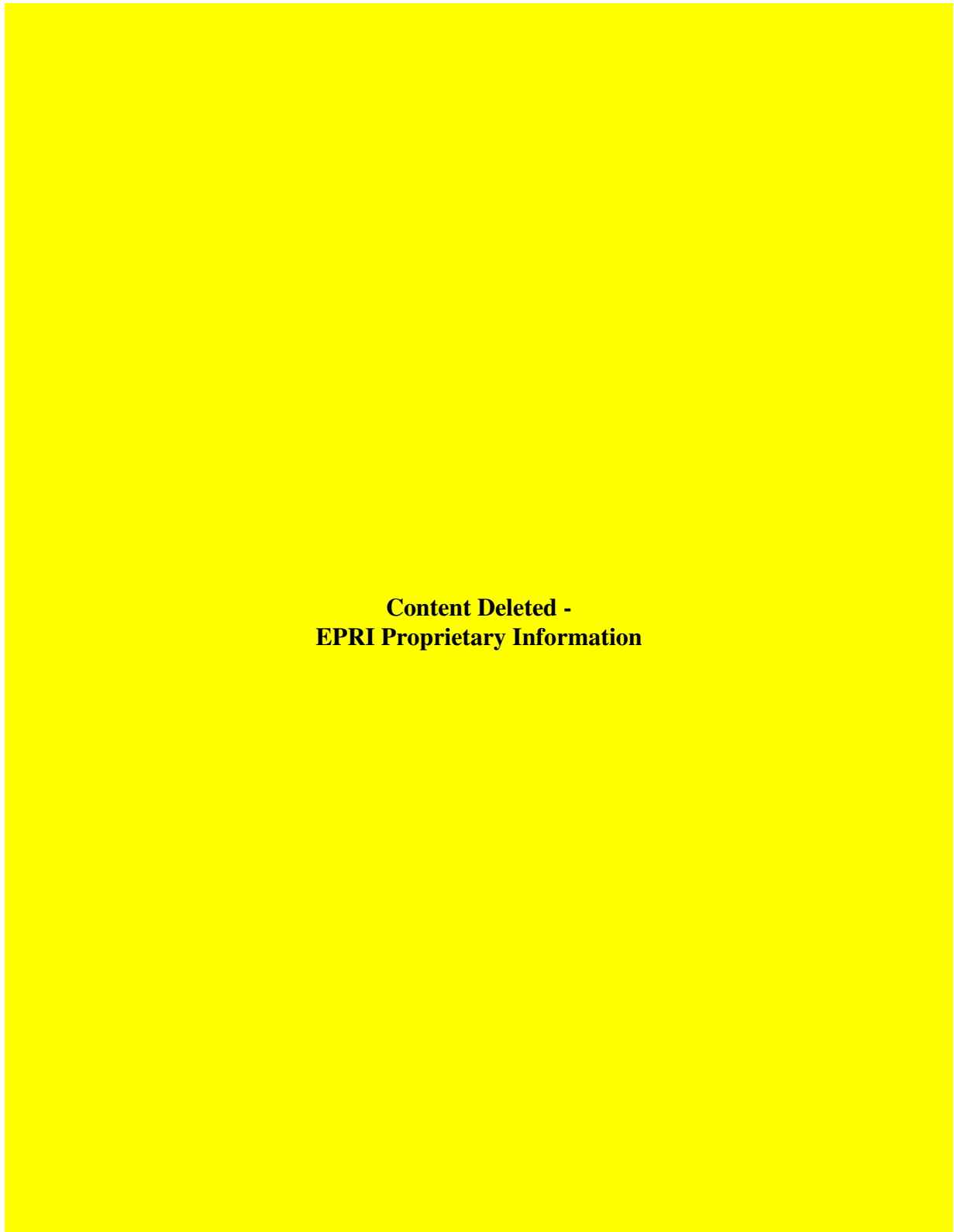
**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.45-1. Array Probe Positioning for Scanning from the Cover Plate Side

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.46 UT Demonstration 44



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.46-1. 45° and 50° Examination Angles

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.46-2. 0° Skew Examination

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.46-3. Supplemental $\pm 10^\circ$ Skew Examination

**Content Deleted -
EPRI Proprietary Information**

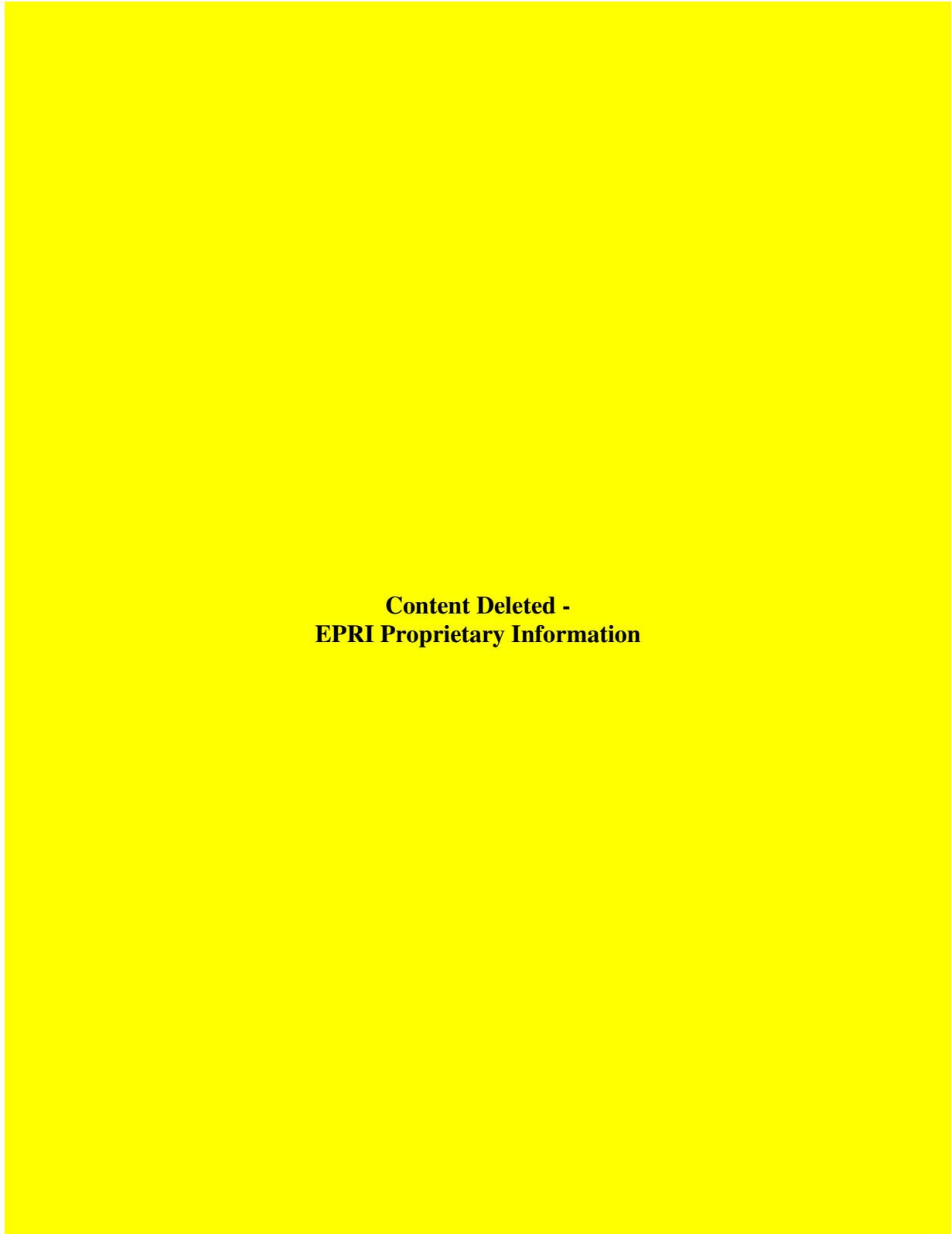
Figure 6.4.46-4. Primary 360° Scan (Blue) and Supplemental Scan (Green)

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.47 UT Demonstration 45



Content Deleted -EPRI Proprietary Information

Figure 6.4.47-1. 1/2-Vee Technique for ID Flaws (Pipe Side)

Content Deleted -EPRI Proprietary Information

Figure 6.4.47-2. Full-Vee Technique for OD Flaws (Pipe Side)

**Content Deleted -
EPRI Proprietary Information**

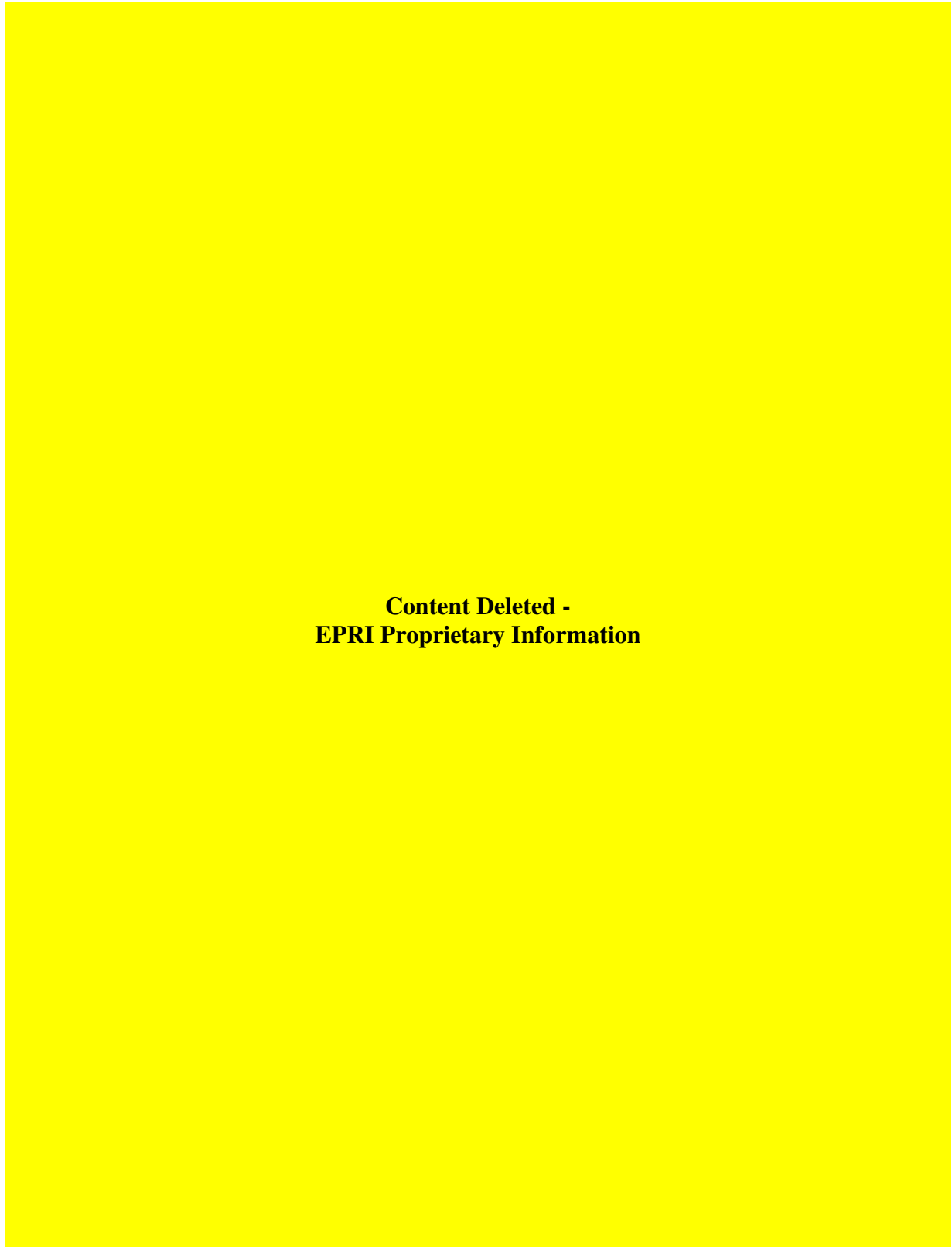
Figure 6.4.47-3. Probe Position for Elbow-Side Scanning (P4d Weld Shown)

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.48 UT Demonstration 46



**Content Deleted -
EPRI Proprietary Information**

Content Deleted - EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.48-1. 45° and 50° Examination Angles from Riser Pipe Side (P5 Shown)

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.48-2. 45° Examination Angles from Sliding Sleeve Side (P5 Shown)

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.48-3. 45° Examination Angle from Outer Sleeve Side (P7 Shown)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.49 UT Demonstration 47



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.49-1. Direction of Sound Beams

**Content Deleted -
EPRI Proprietary Information**

6.4.50 UT Demonstration 48



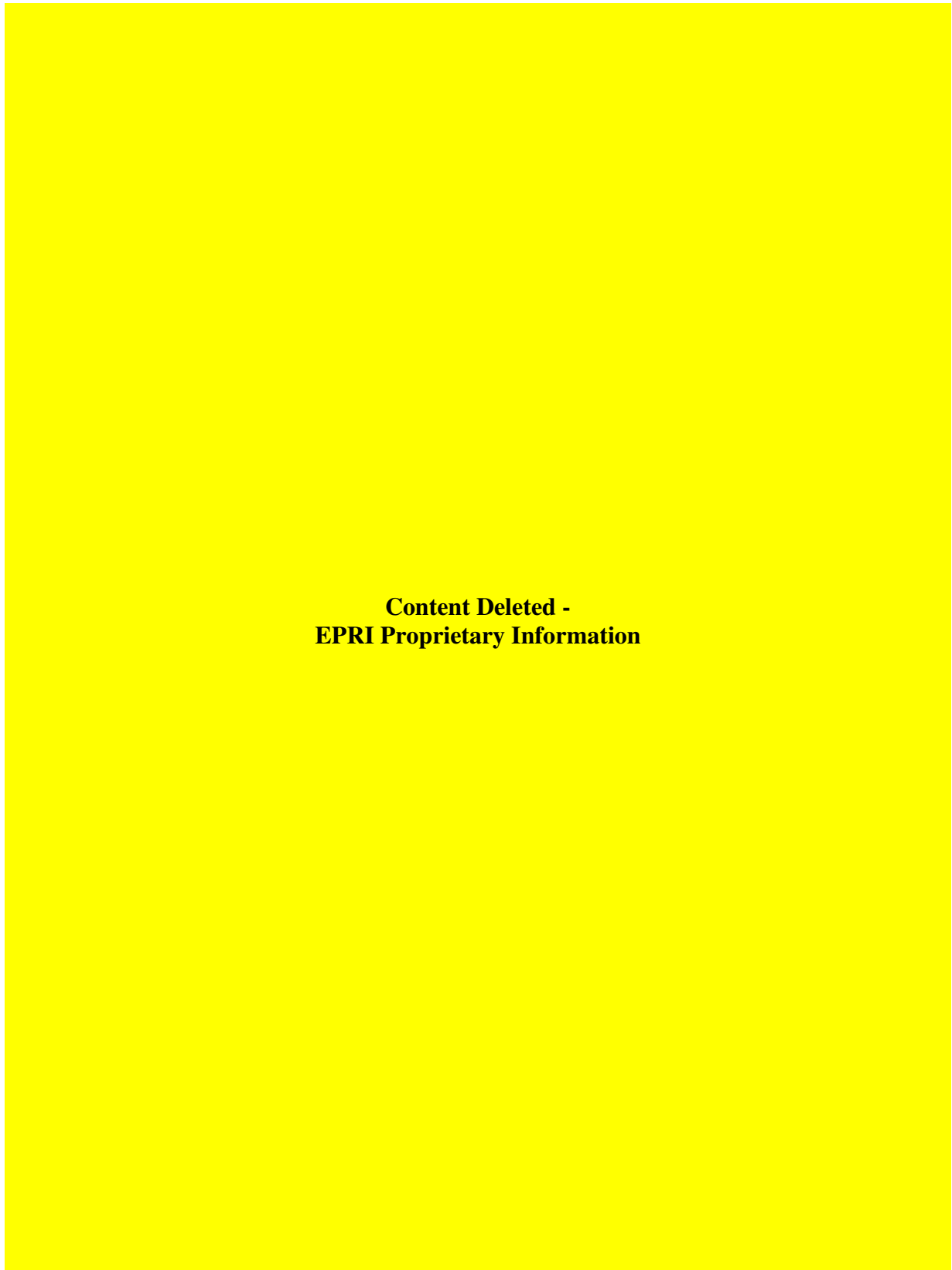
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.50-1. Direction of Sound Beams

**Content Deleted -
EPRI Proprietary Information**

6.4.51 UT Demonstration 49



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.51-1. BWR/2 P8 Weld Examination

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

Figure 6.4.51-2. BWR/2 P9 Weld Examination

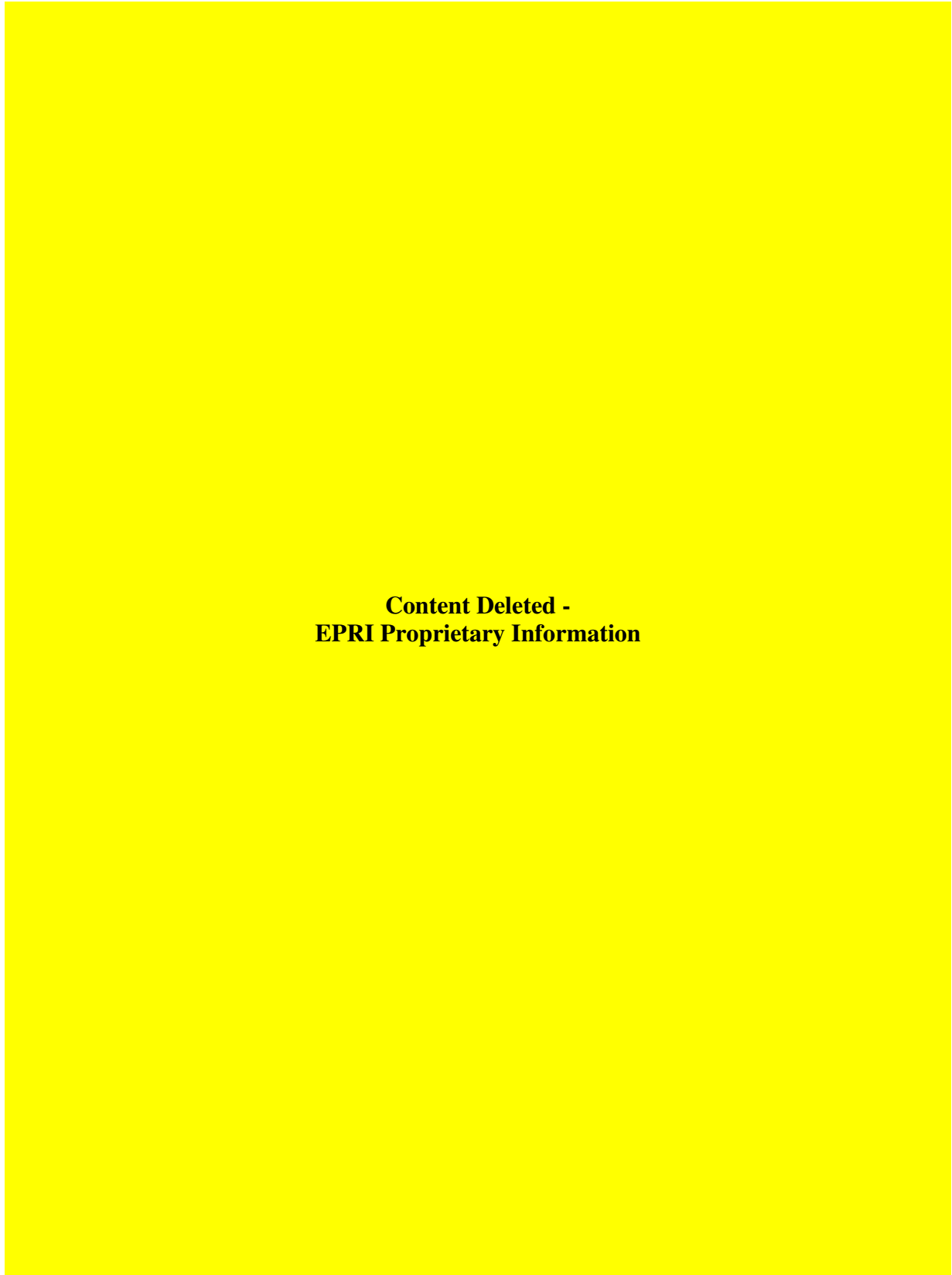


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.52 UT Demonstration 50



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

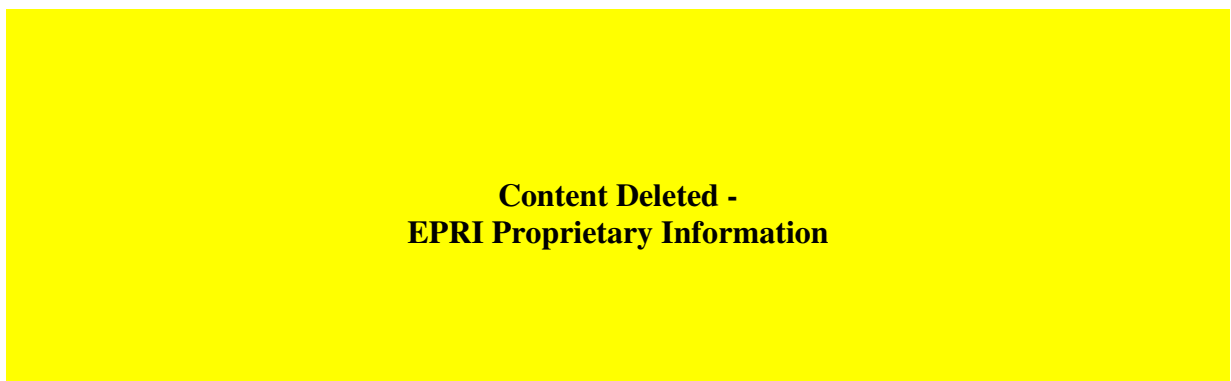
6.4.53 UT Demonstration 51



**Content Deleted -
EPRI Proprietary Information**



Figure 6.4.53-1. Scan Surface for P1 Weld Examination





**Content Deleted -
EPRI Proprietary Information**

6.4.54 UT Demonstration 52



**Content Deleted -
EPRI Proprietary Information**

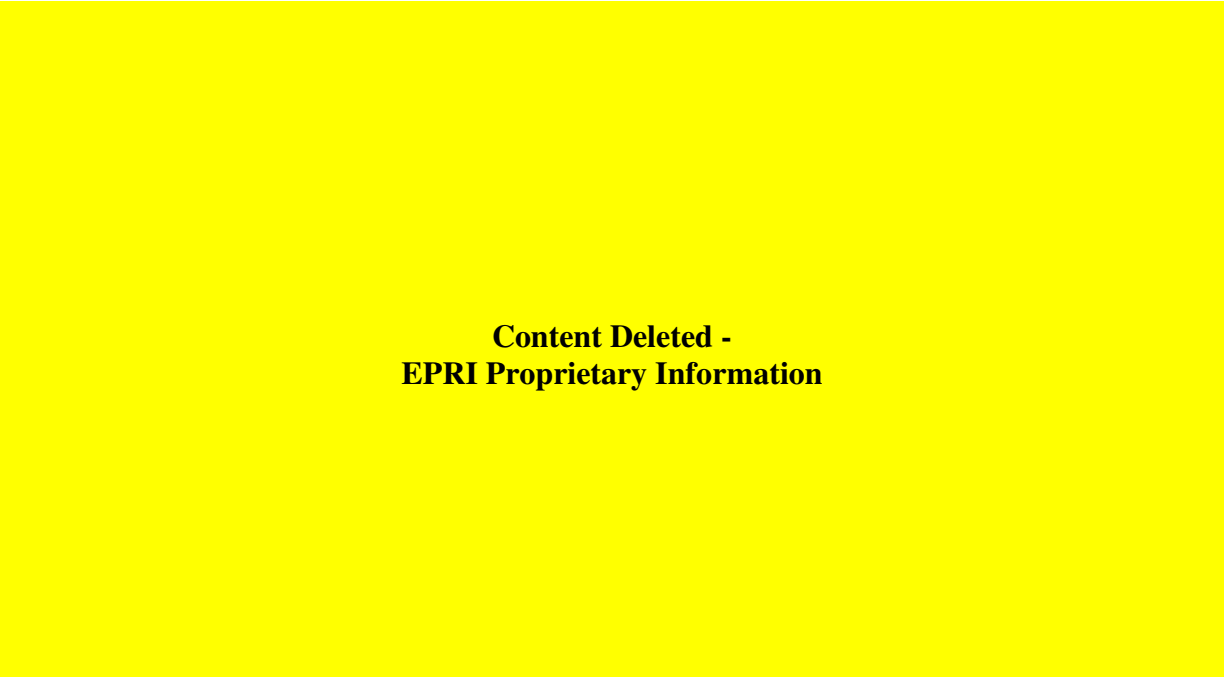
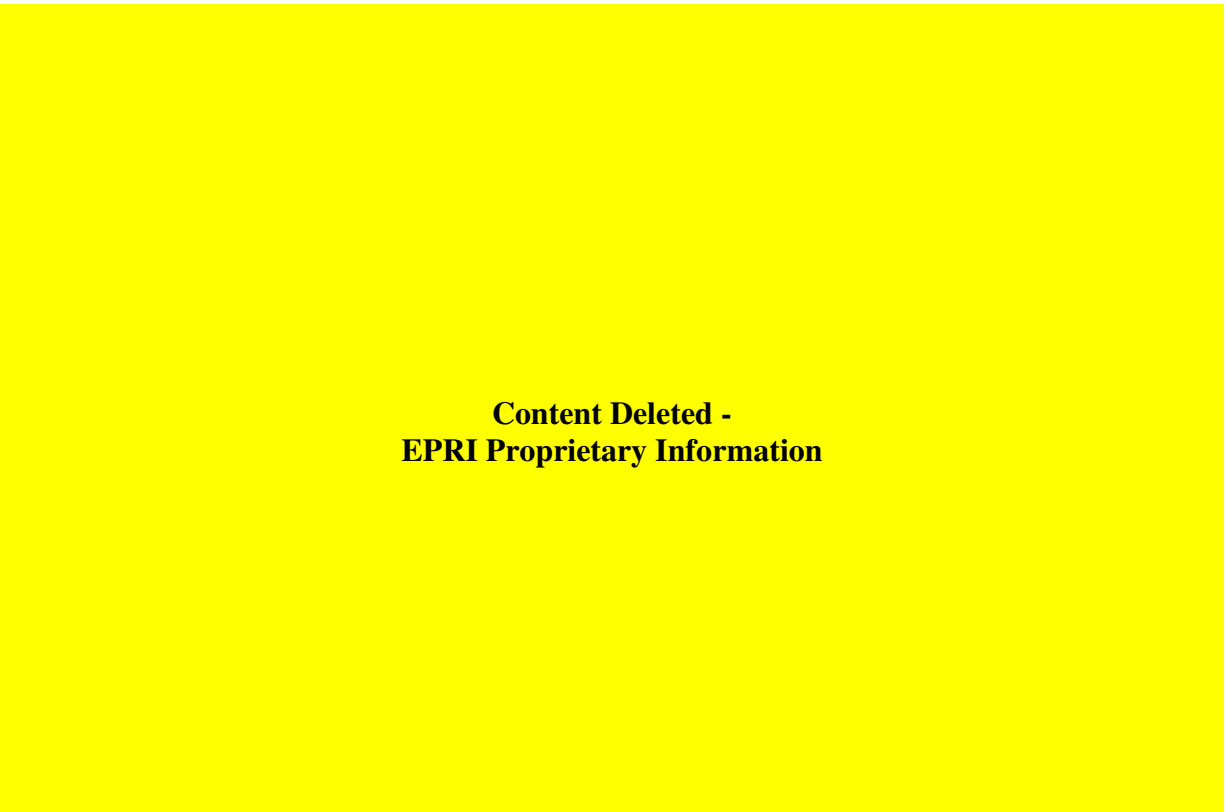
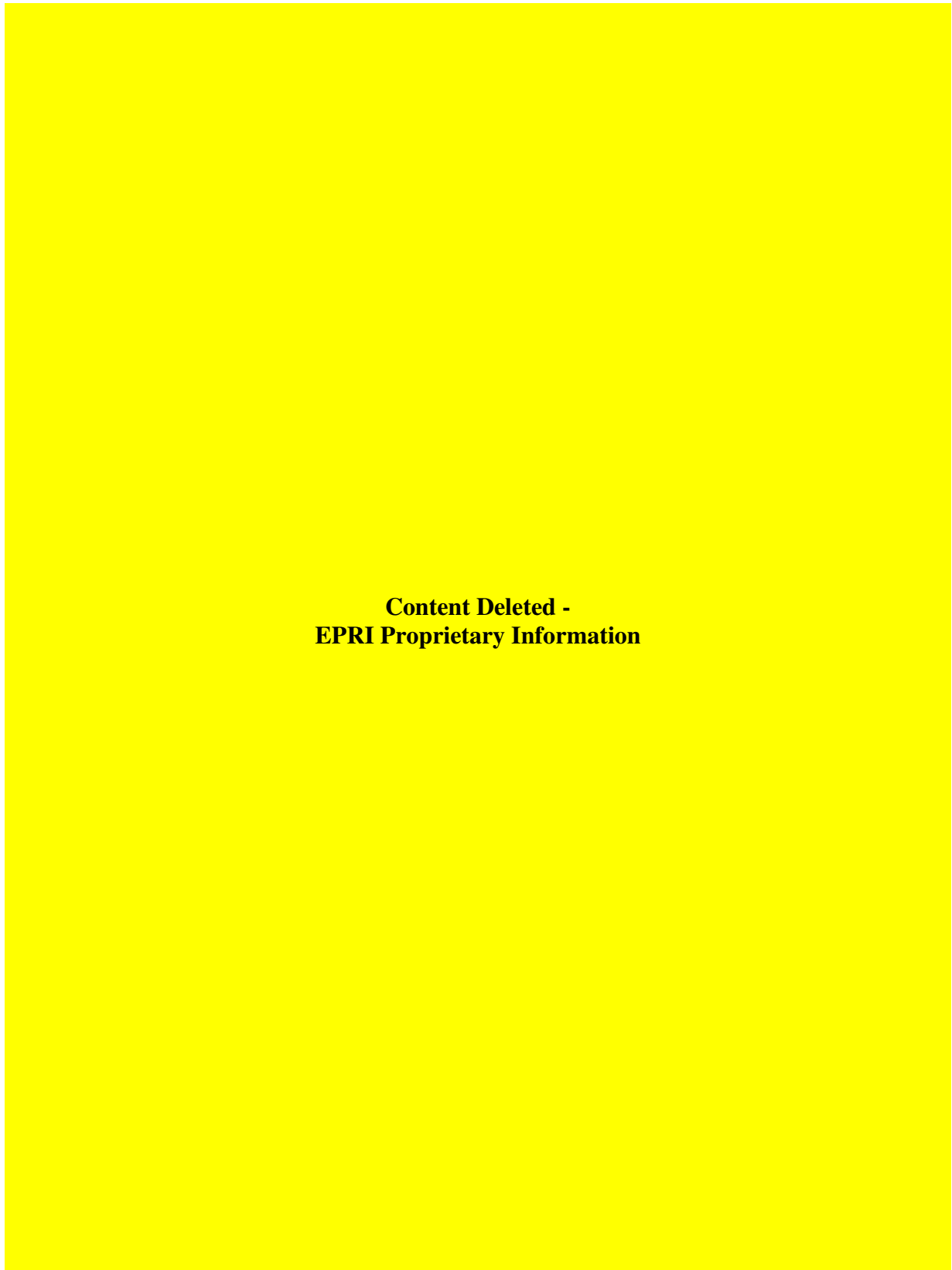


Figure 6.4.54-1. Scan Surface for P2 Weld Examination



**Content Deleted -
EPRI Proprietary Information**

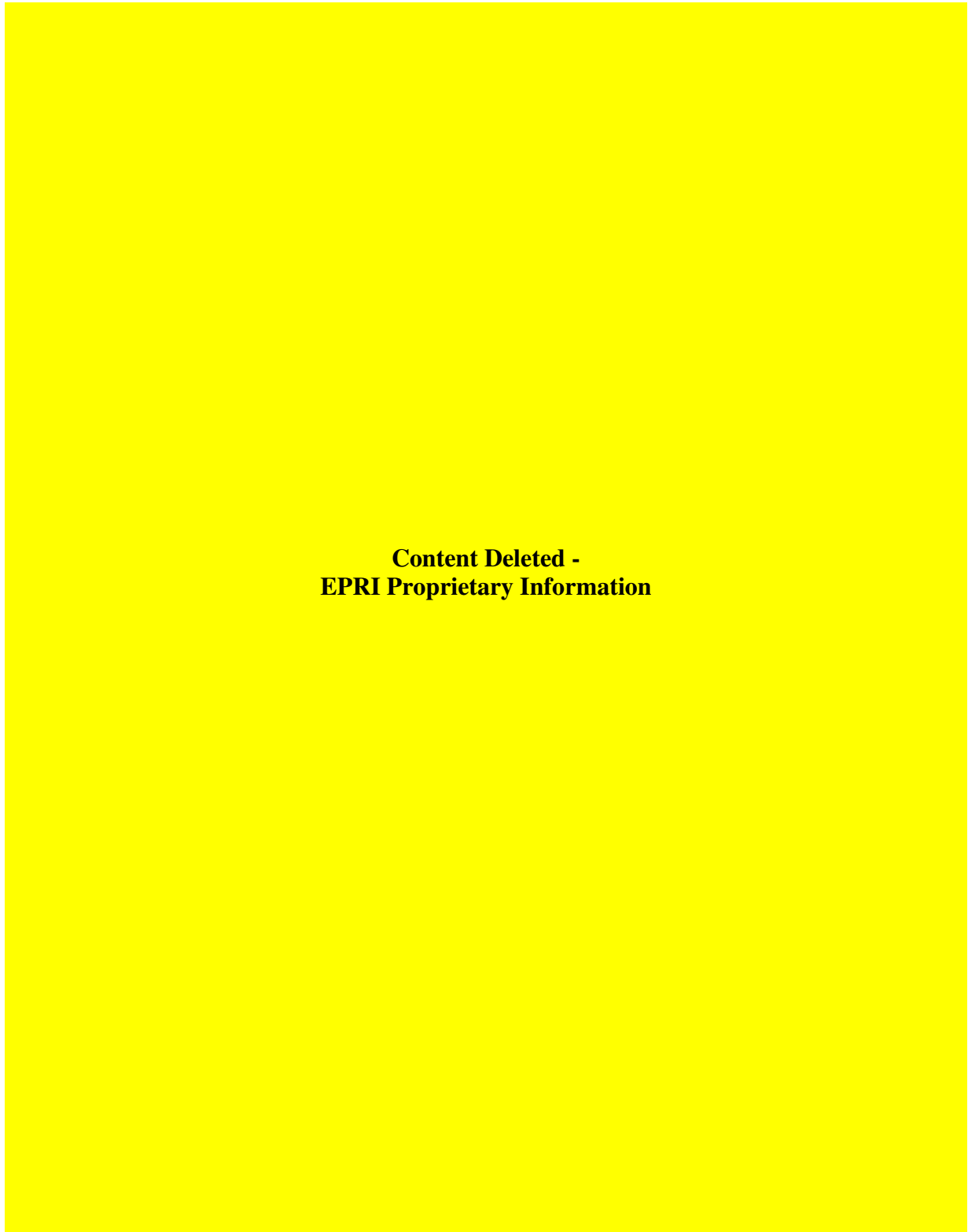
6.4.55 UT Demonstration 53



**Content Deleted -
EPRI Proprietary Information**

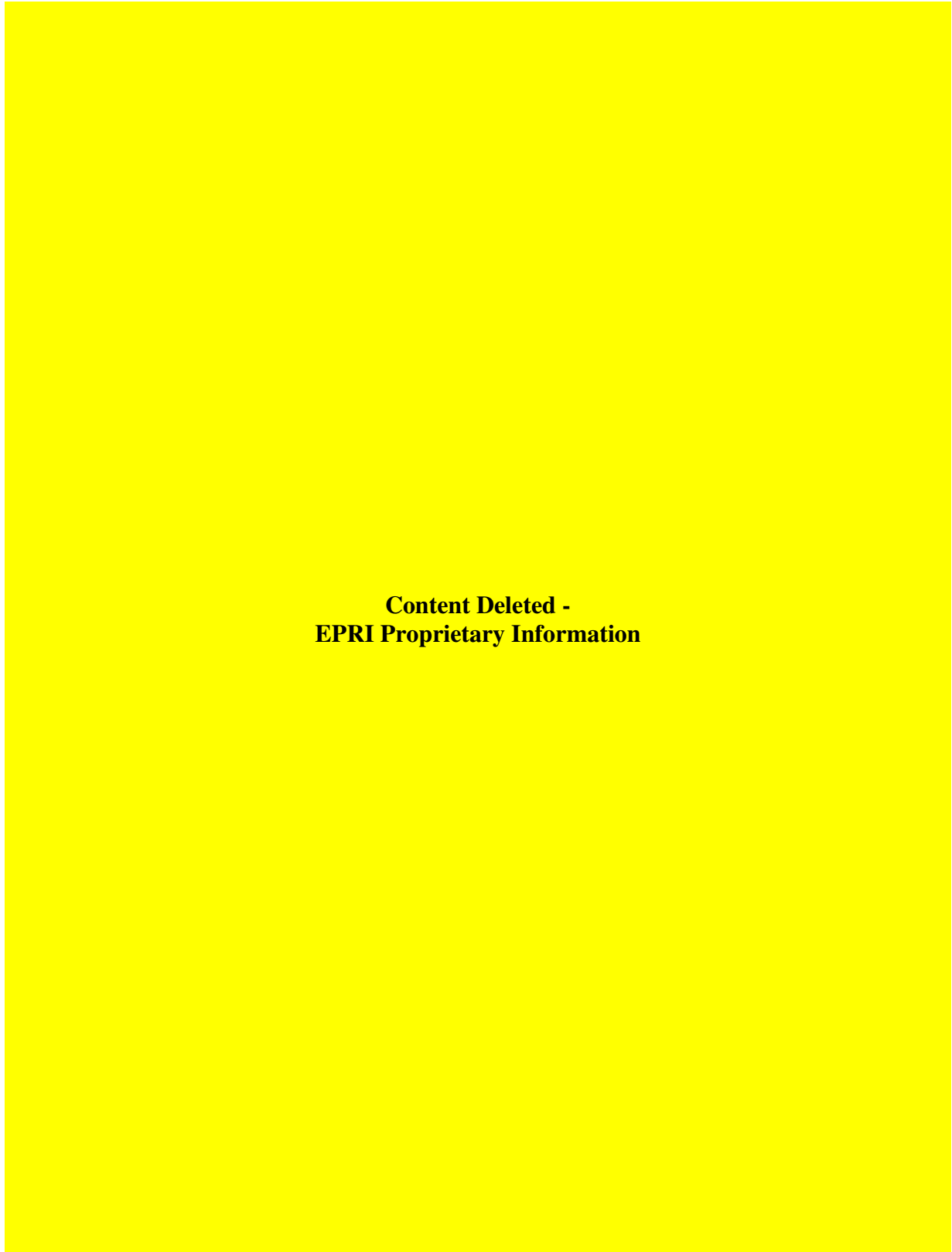
**Content Deleted -
EPRI Proprietary Information**

6.4.56 UT Demonstration 54



**Content Deleted -
EPRI Proprietary Information**

6.4.57 UT Demonstration 55



**Content Deleted -
EPRI Proprietary Information**

6.4.58 UT Demonstration 56

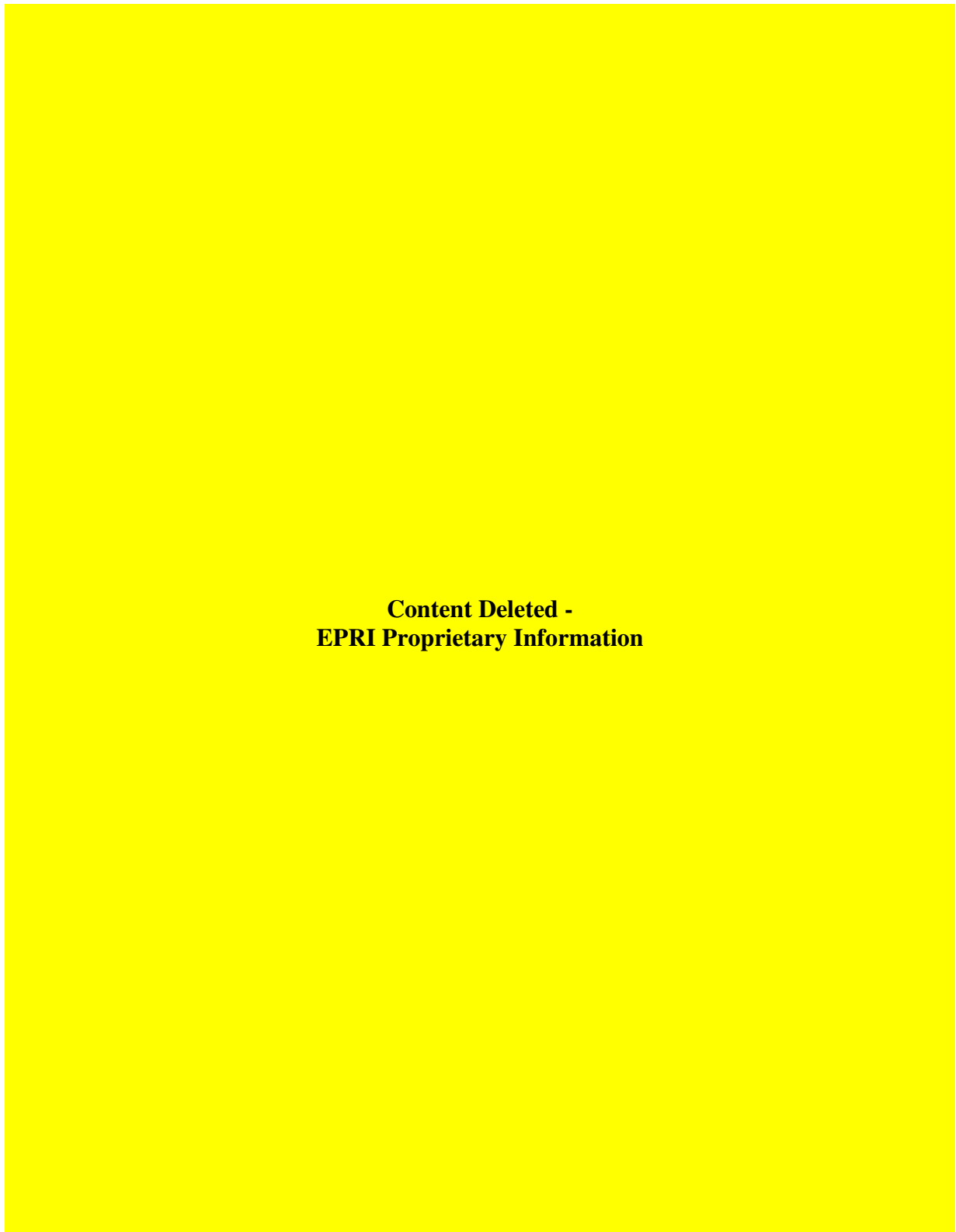


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

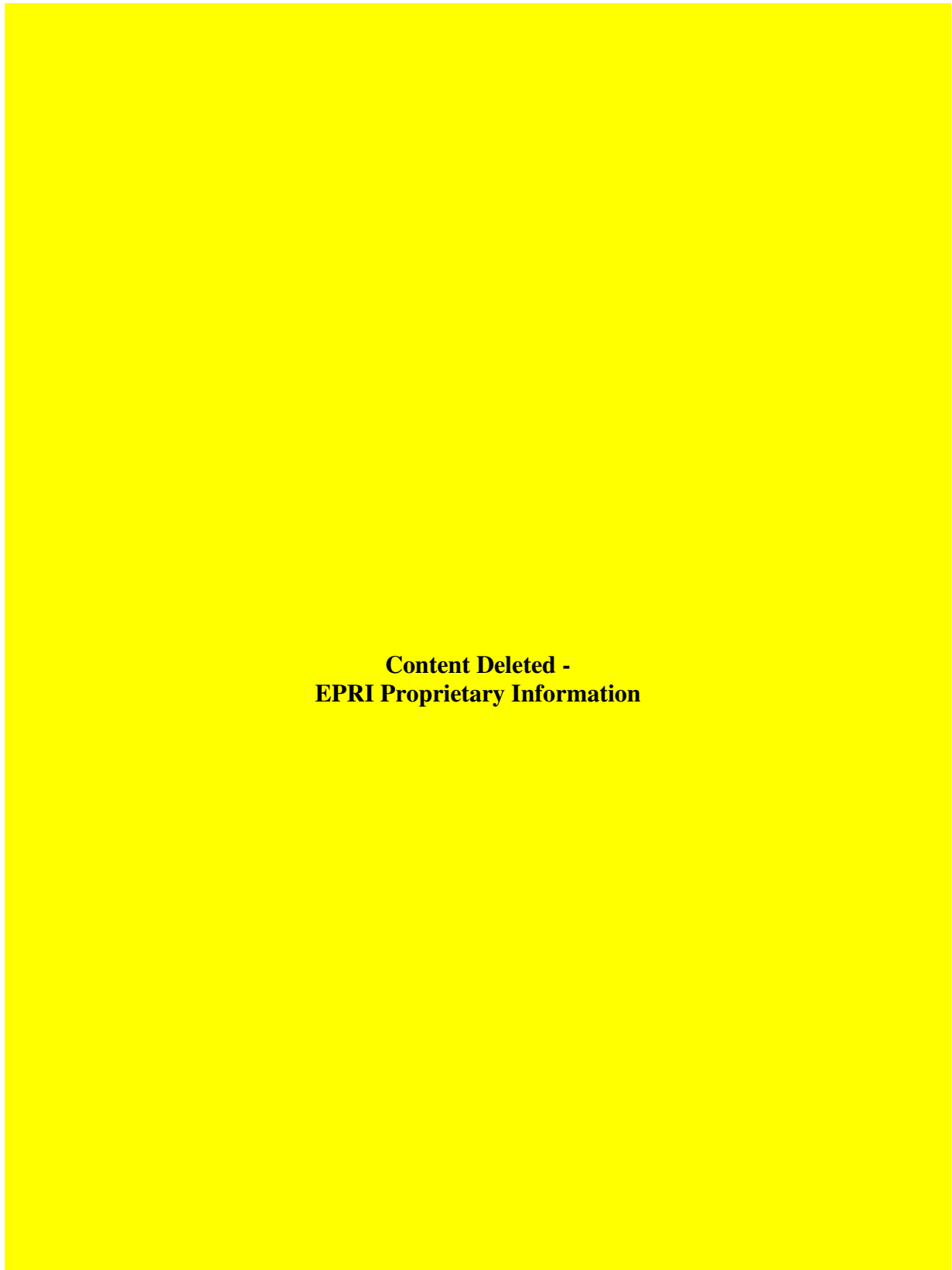
6.4.59 UT Demonstration 57



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.60 UT Demonstration 58



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.61 UT Demonstration 59



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.62 UT Demonstration 60



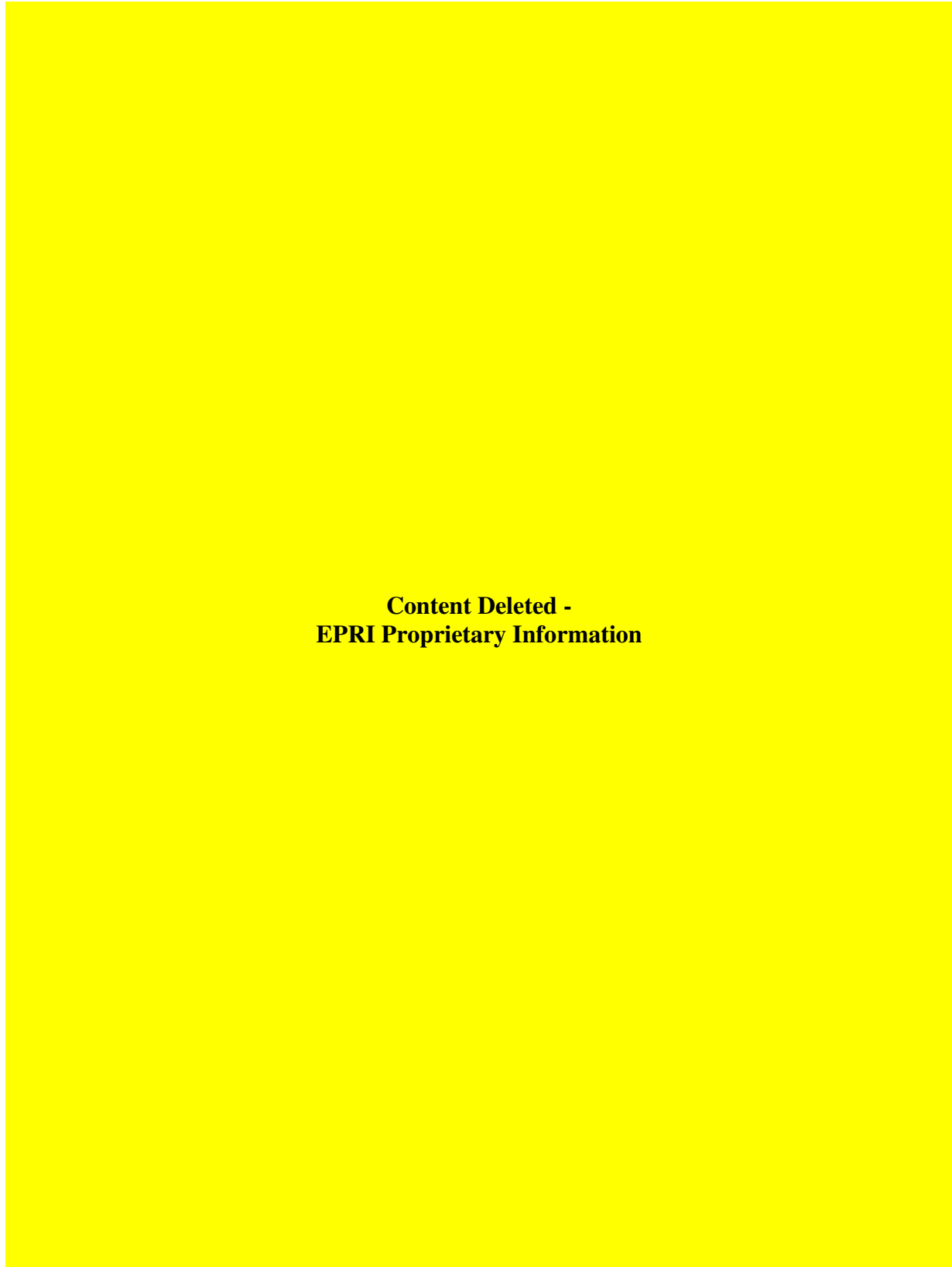
**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.63 UT Demonstration 61



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.64 UT Demonstration 62

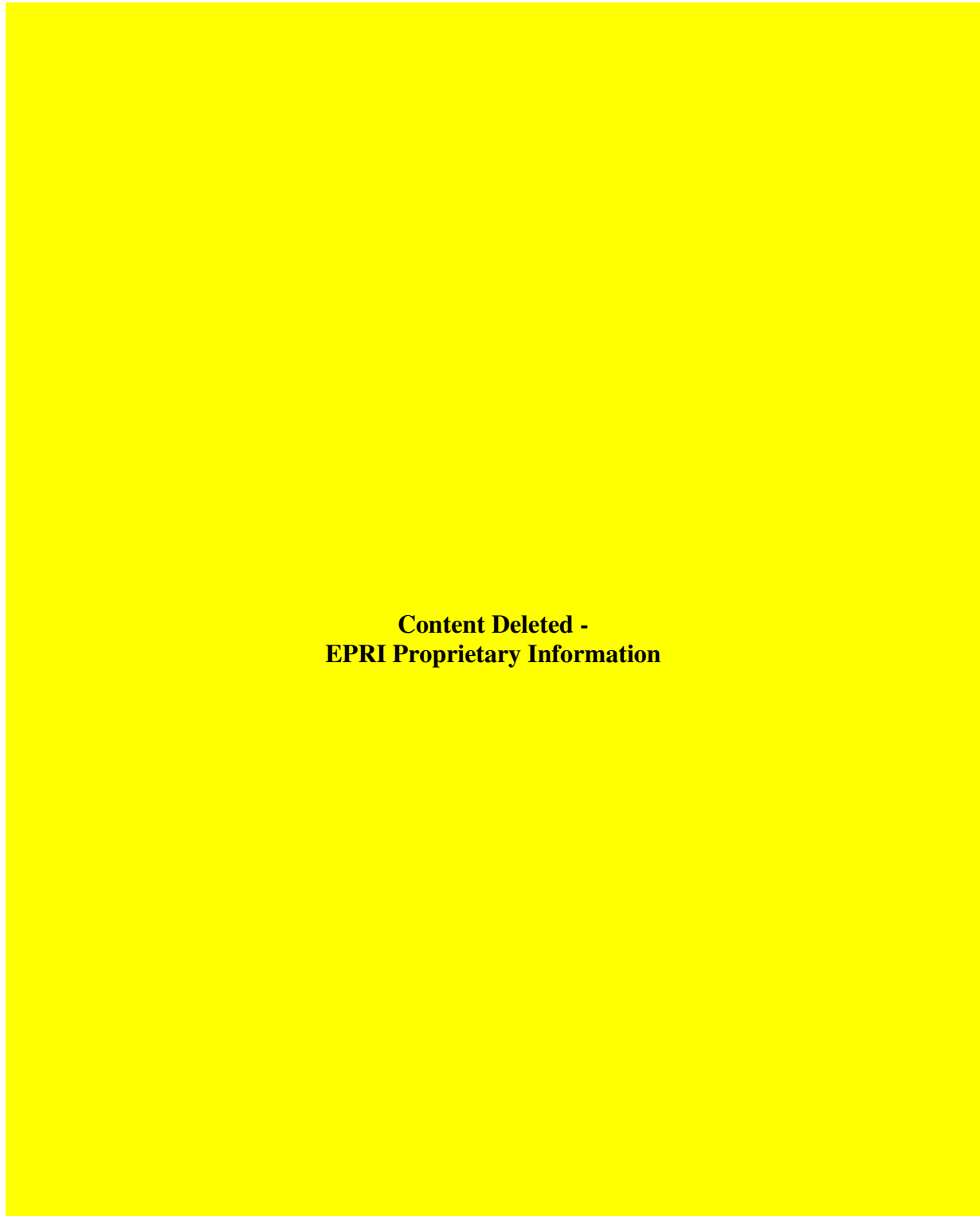


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

6.4.65 UT Demonstration 63



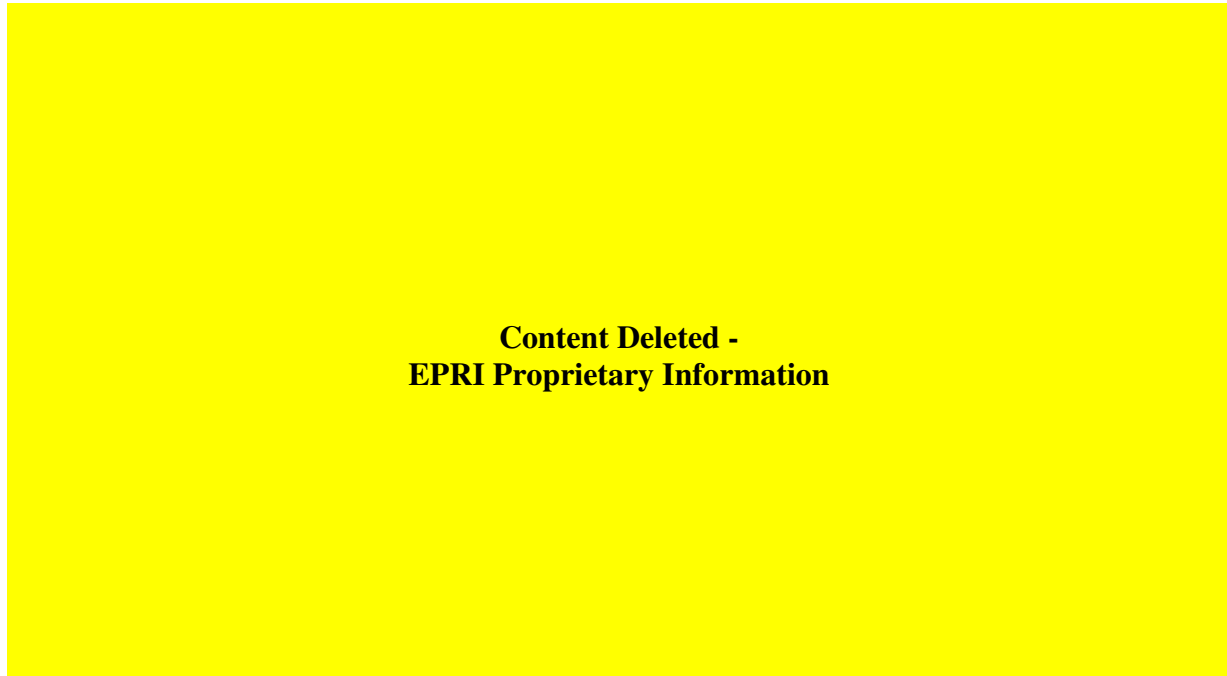


Figure 6.4.65-1. Example of the Original Demonstration Data (Zetec μ TomoScan Instrument)

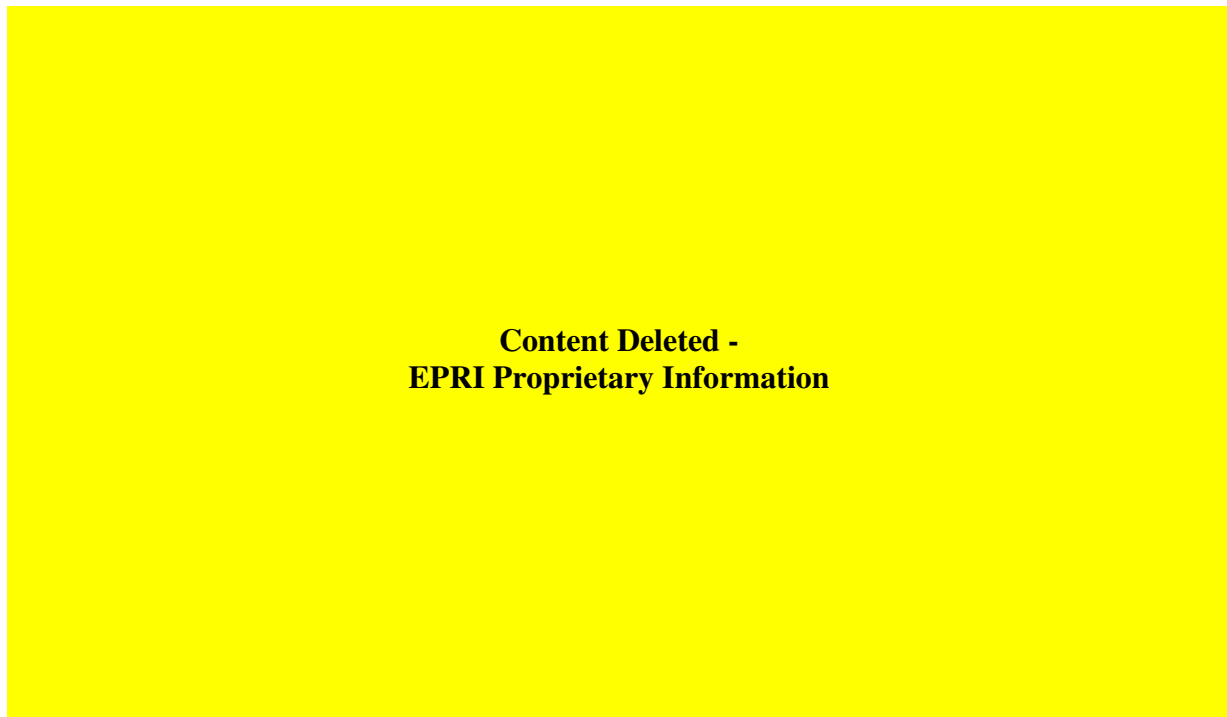
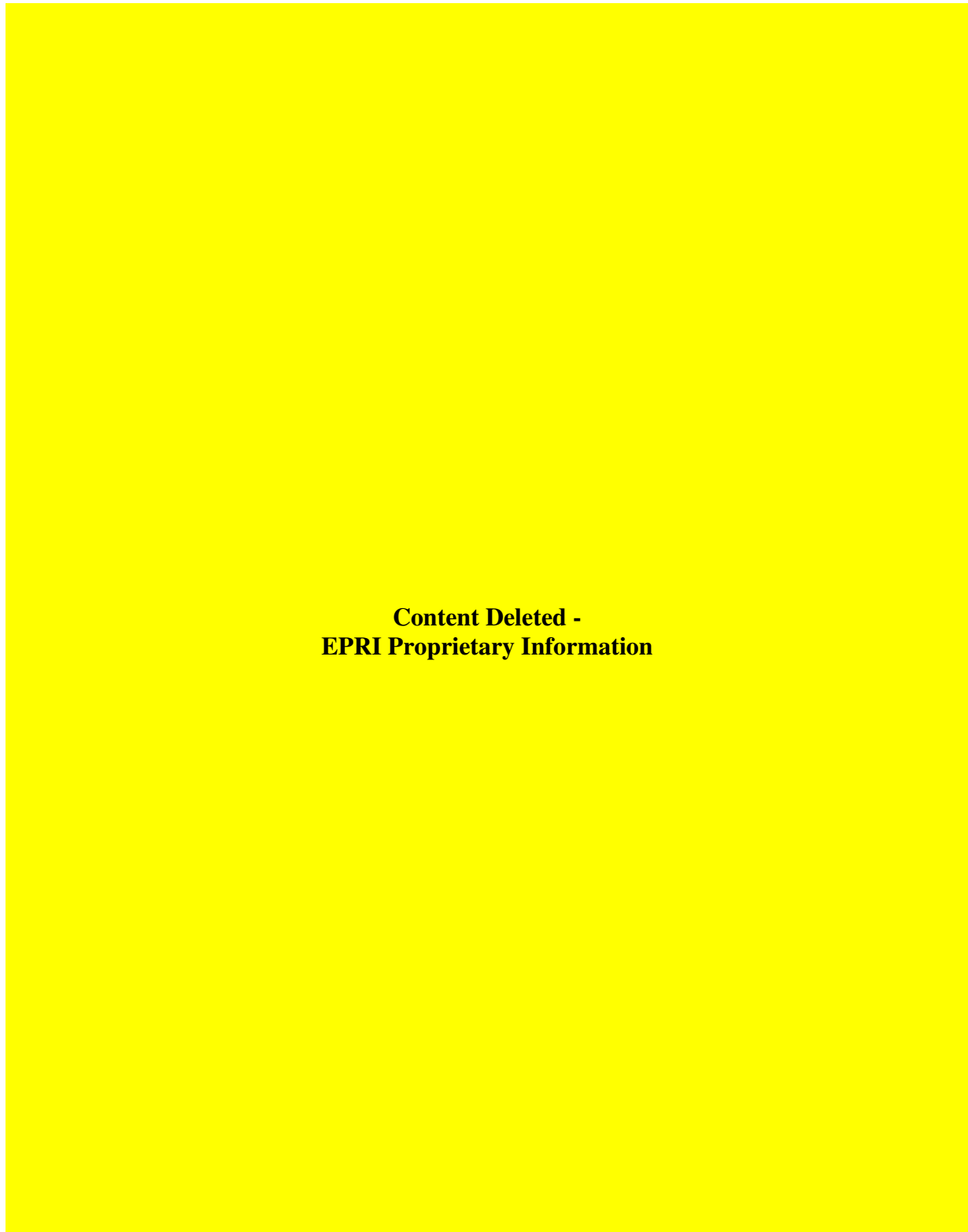


Figure 6.4.65-2. Example of the Equivalency Demonstration Data (Zetec Z-Scan UT Instrument)

**Content Deleted -
EPRI Proprietary Information**

6.4.66 UT Demonstration 64



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6.4.67 UT Demonstration 65

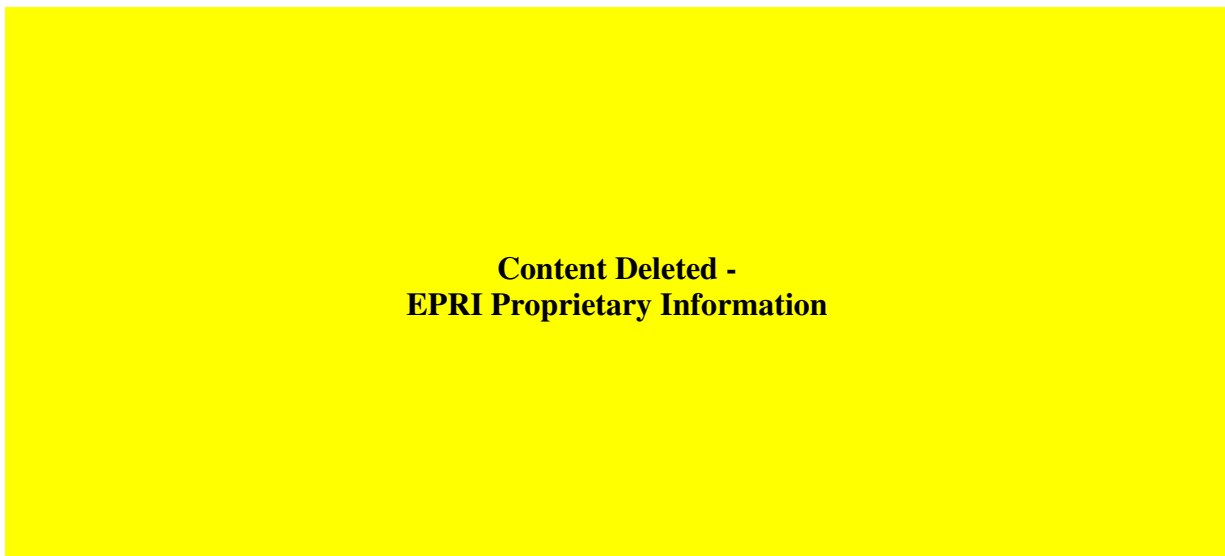
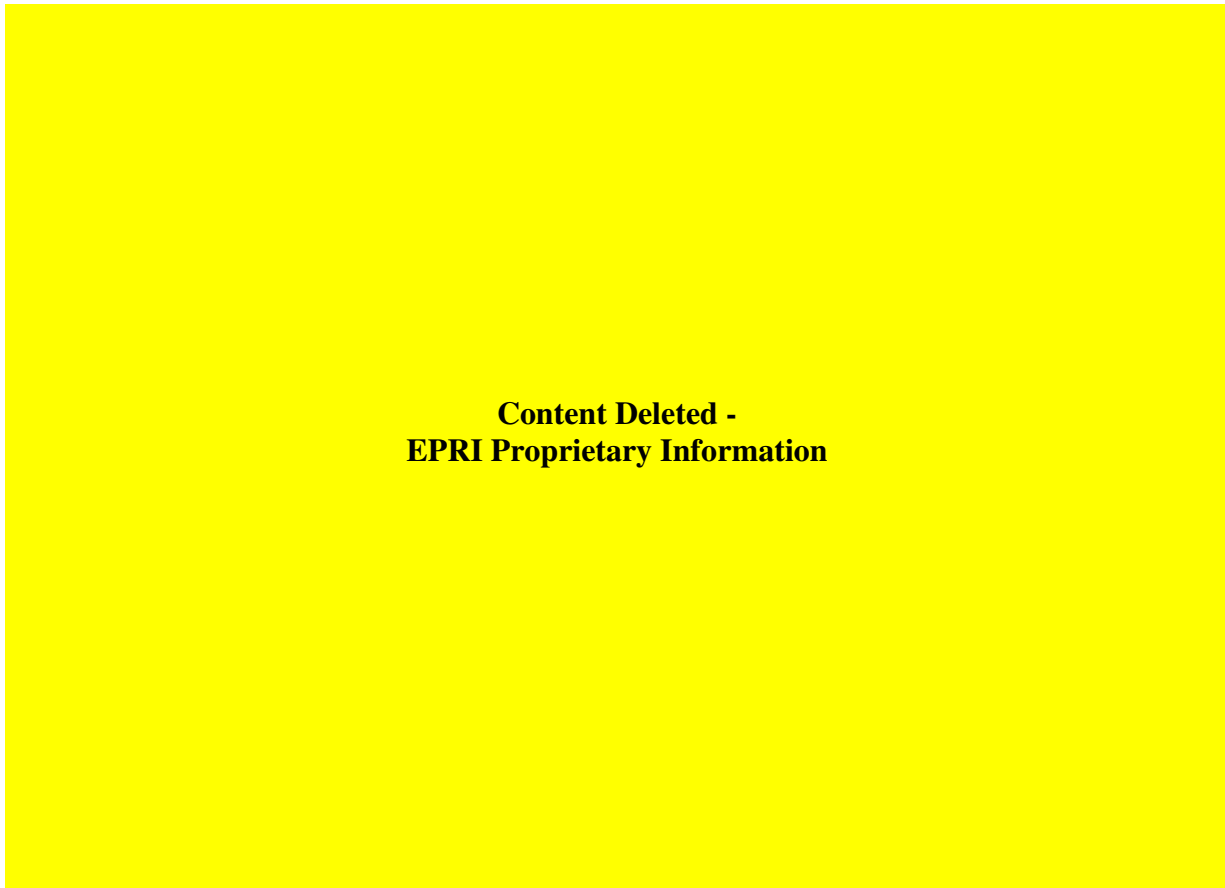


Figure 6.4.67-1. C-Scan Display Showing the Four Different Engagement Responses in Mockup BWRVIP-J

6A

INVESTIGATION OF CORE SPRAY INTERNAL PIPING OVERLAY INSPECTION

**Content Deleted -
EPRI Proprietary Information**

6A.1 Materials

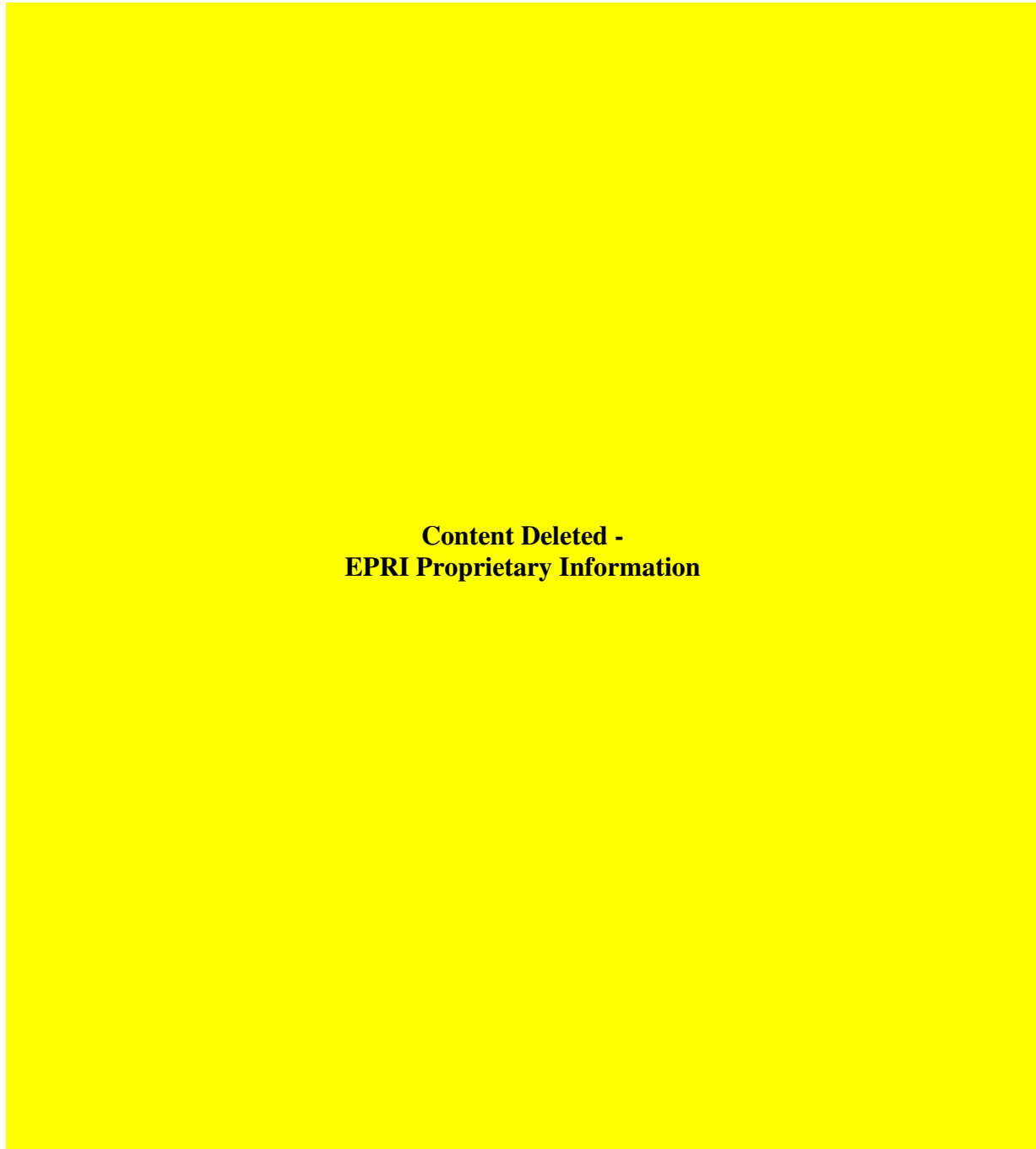
6A.1.1 Probes

**Content Deleted -
EPRI Proprietary Information**

6A.1.2 Ultrasonic Instrument

**Content Deleted -
EPRI Proprietary Information**

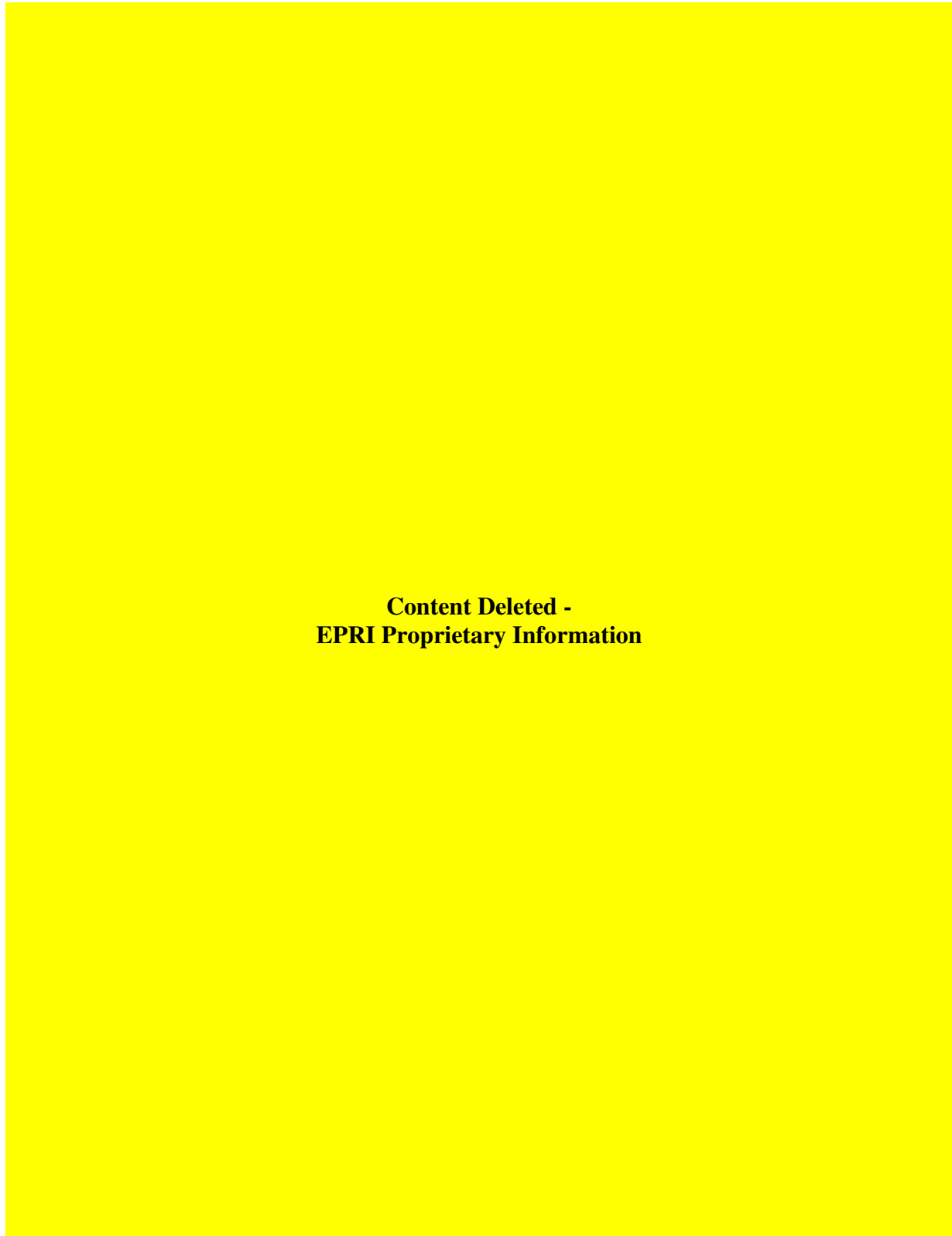
6A.1.3 Mockups





**Content Deleted -
EPRI Proprietary Information**

Figure 6A.1.3-1. Mockup BWRVIP-CSRA: Weld Overlay Repair with Cracks Propagating from Existing Throughwall Defects: Configuration and Flaw Details



**Figure 6A.1.3-2. Mockup BWRVIP-CSRC: Weld Overlay Repair with Sidewall Lack of Fusion:
Configuration and Flaw Details**

6A.2 Surface Condition

**Content Deleted -
EPRI Proprietary Information**

6A.3 Examination Results

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

6A.4 Conclusions

**Content Deleted -
EPRI Proprietary Information**

6A.5 References

**Content Deleted -
EPRI Proprietary Information**

7

TOP GUIDE

7.1 Summary

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

7.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2-1 Grid Beam Regions to Be Inspected for BWR/2-5 Designs

7.2.1 Aligner Pin Assemblies

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

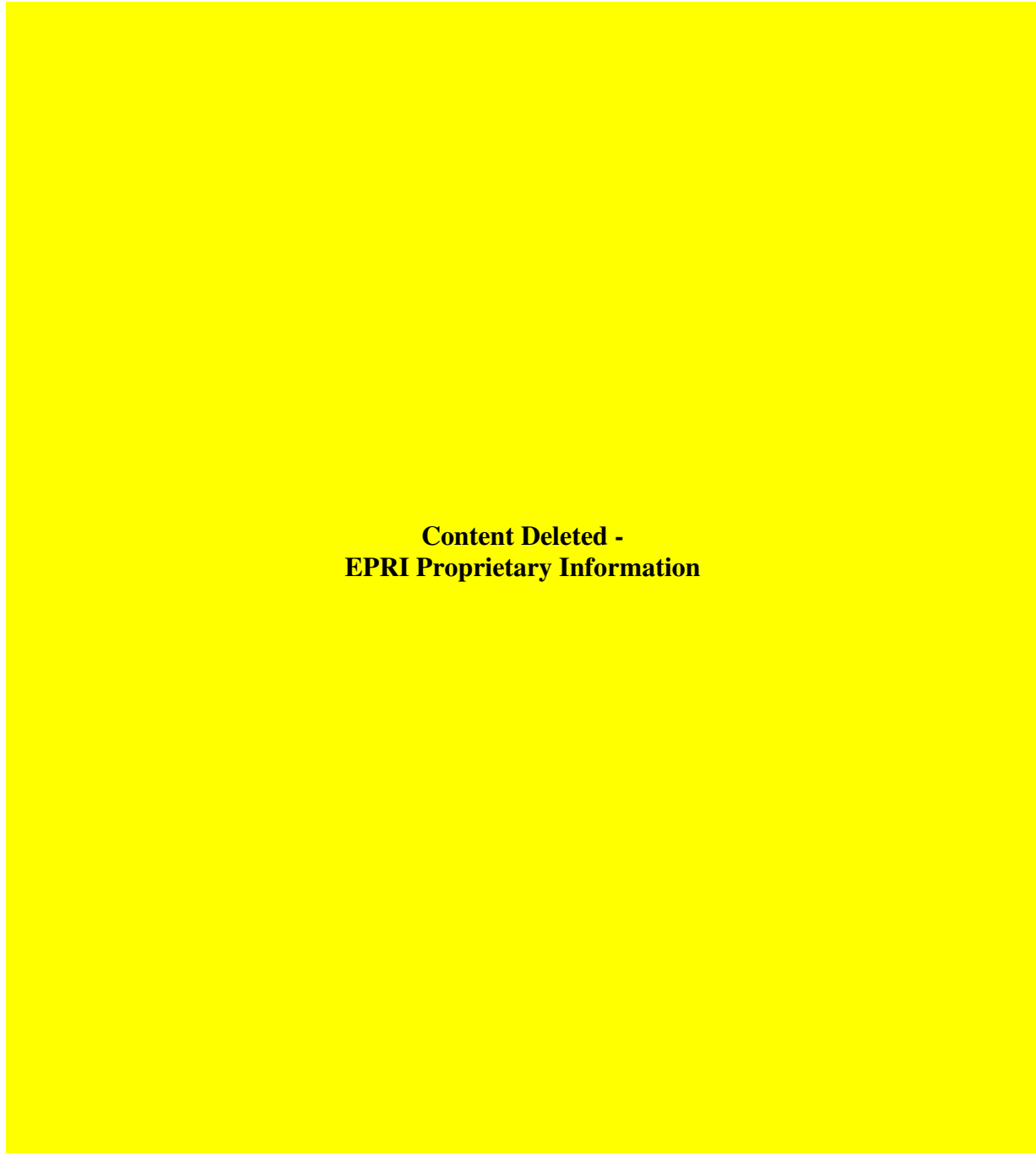


Figure 7.2.1-1. Typical Vertical Aligner Pin Assembly



**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.1-2. Aligner Pin Assembly Variations

7.2.2 Hold-Down Assemblies



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.2-1. Hold-Down Assembly



**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.2-2. Hold-Down Assembly

7.2.3 Wedges



**Content Deleted -
EPRI Proprietary Information**

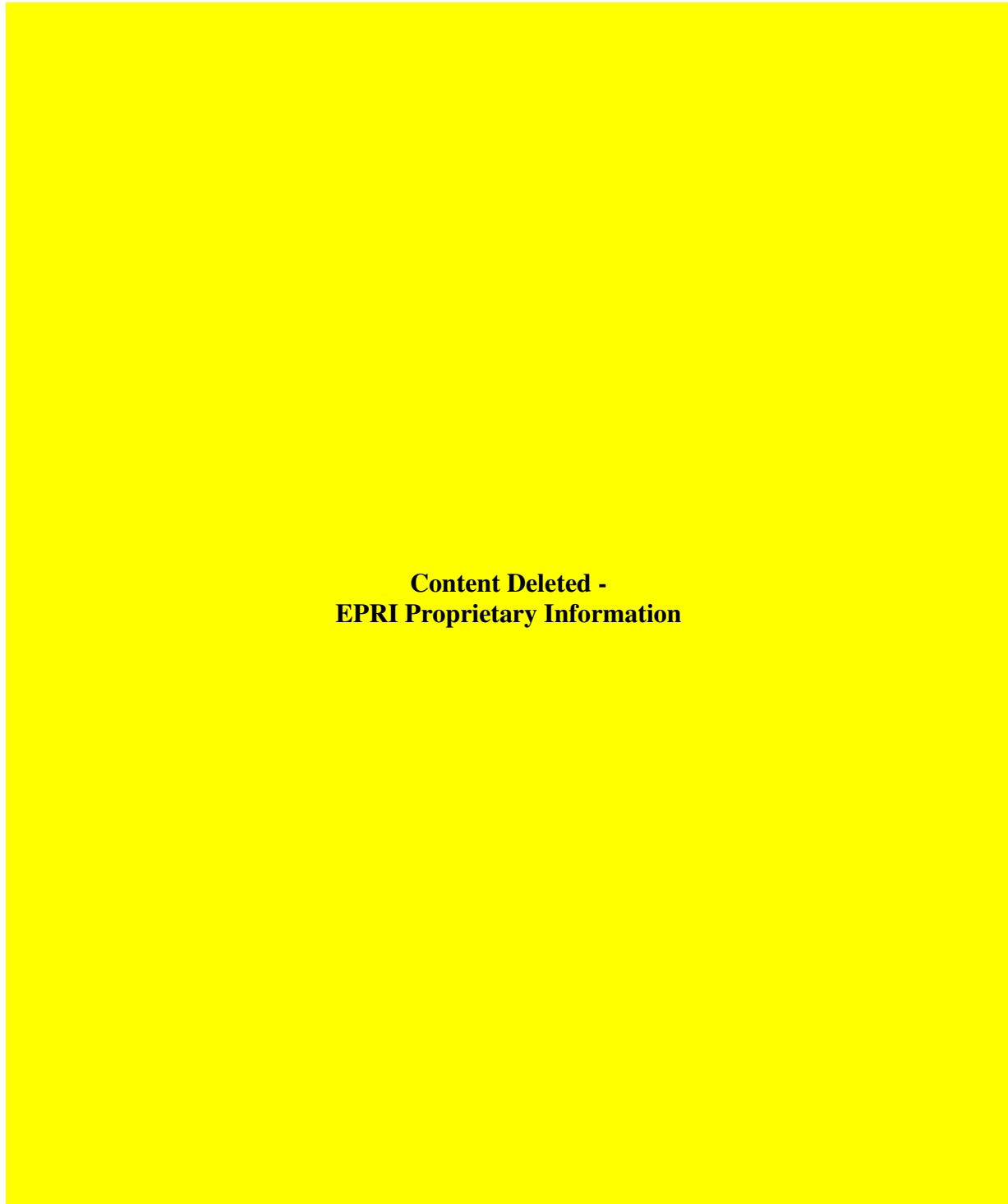


Figure 7.2.3-1. Lateral Restraint Brackets and Wedges

7.2.4 BWR/6 Hold-Down Studs

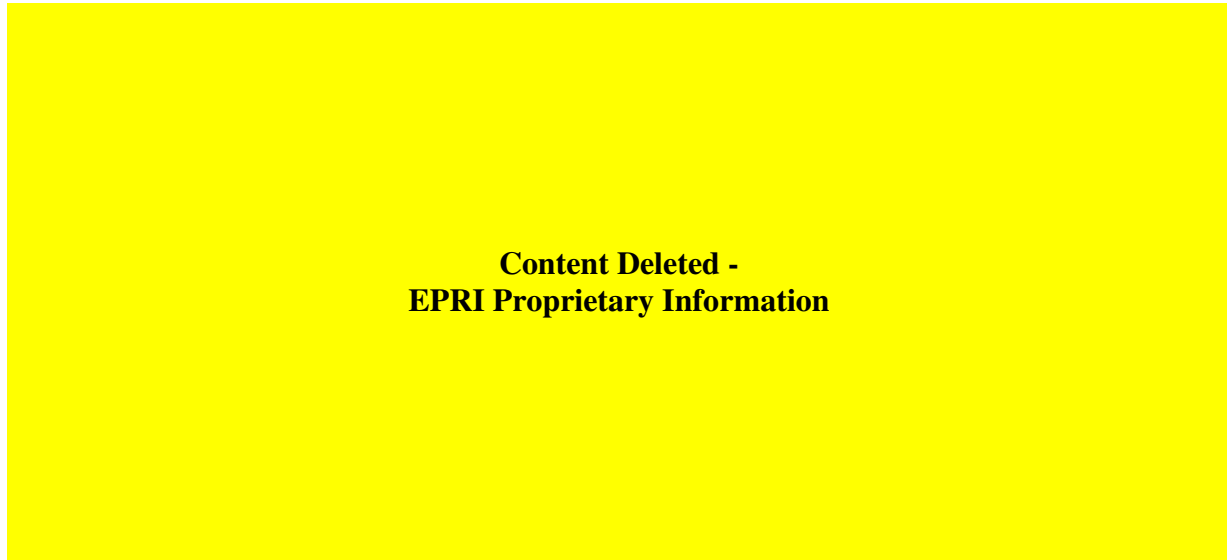
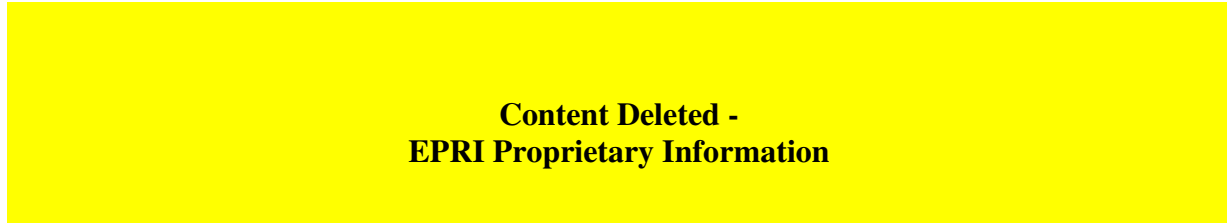
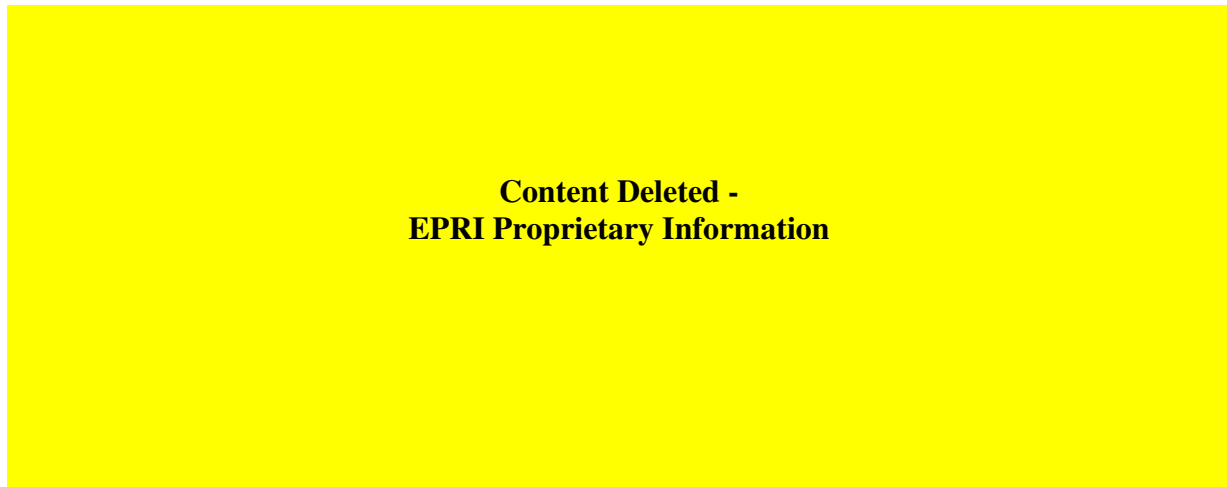


Figure 7.2.4-1. Hold-Down Assembly

7.2.5 Rim-to-Bottom Plate Weld



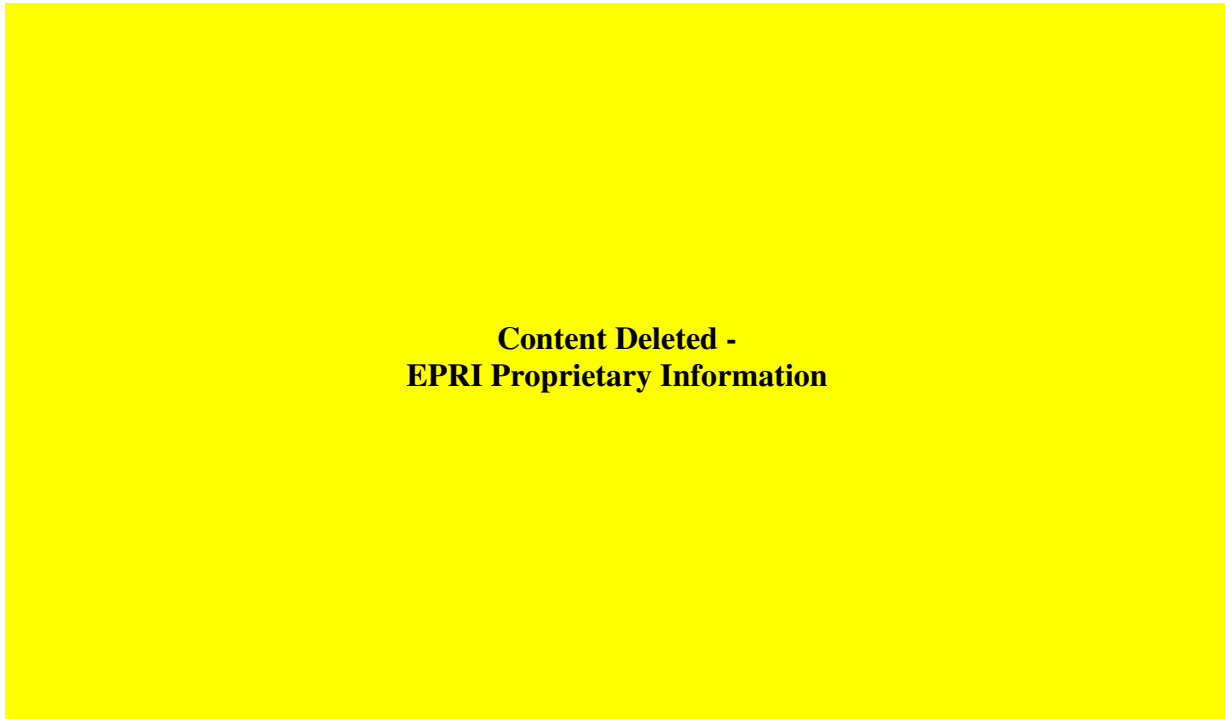
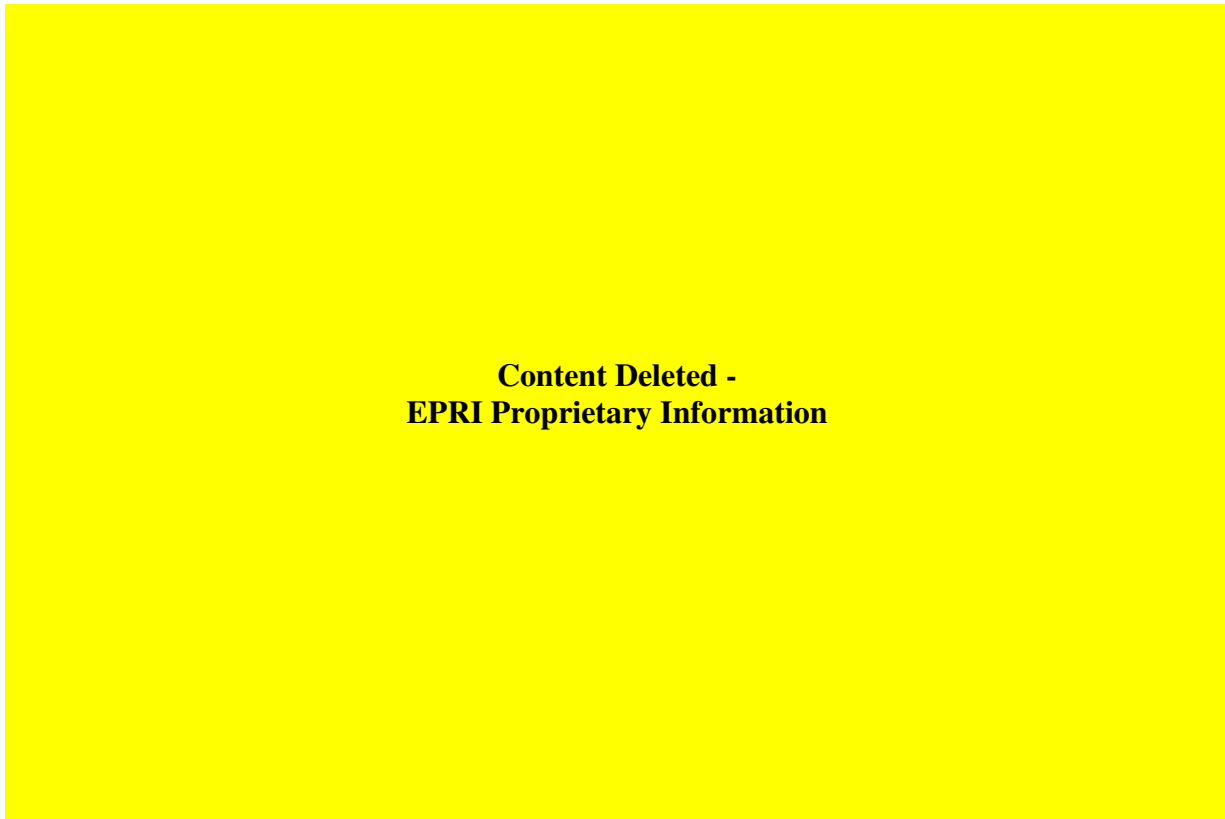


Figure 7.2.5-1. Rim-to-Bottom Plate Weld

7.2.6 Grid Beams



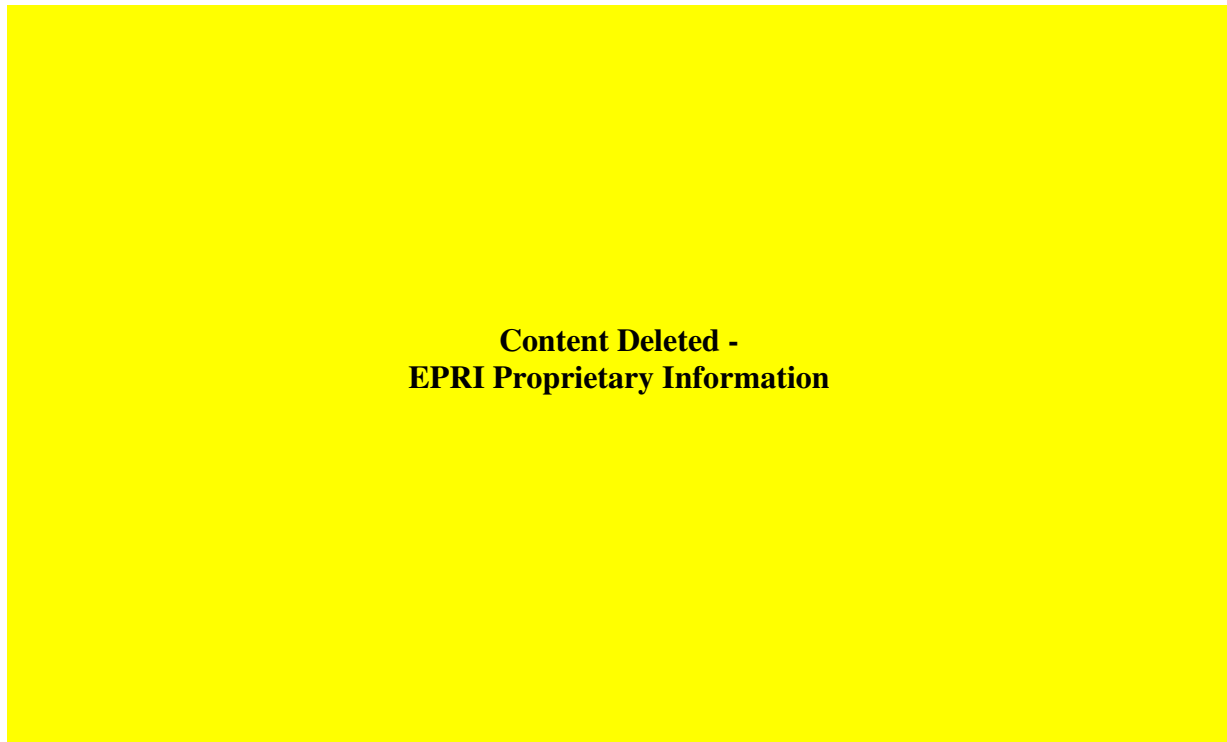
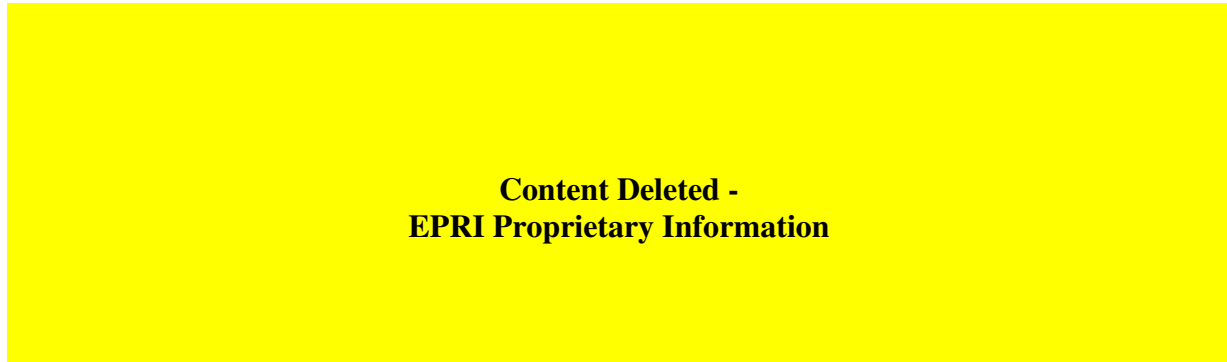


Figure 7.2.6-1. Typical 0.36-Inch Wide Top Guide Grid Structure

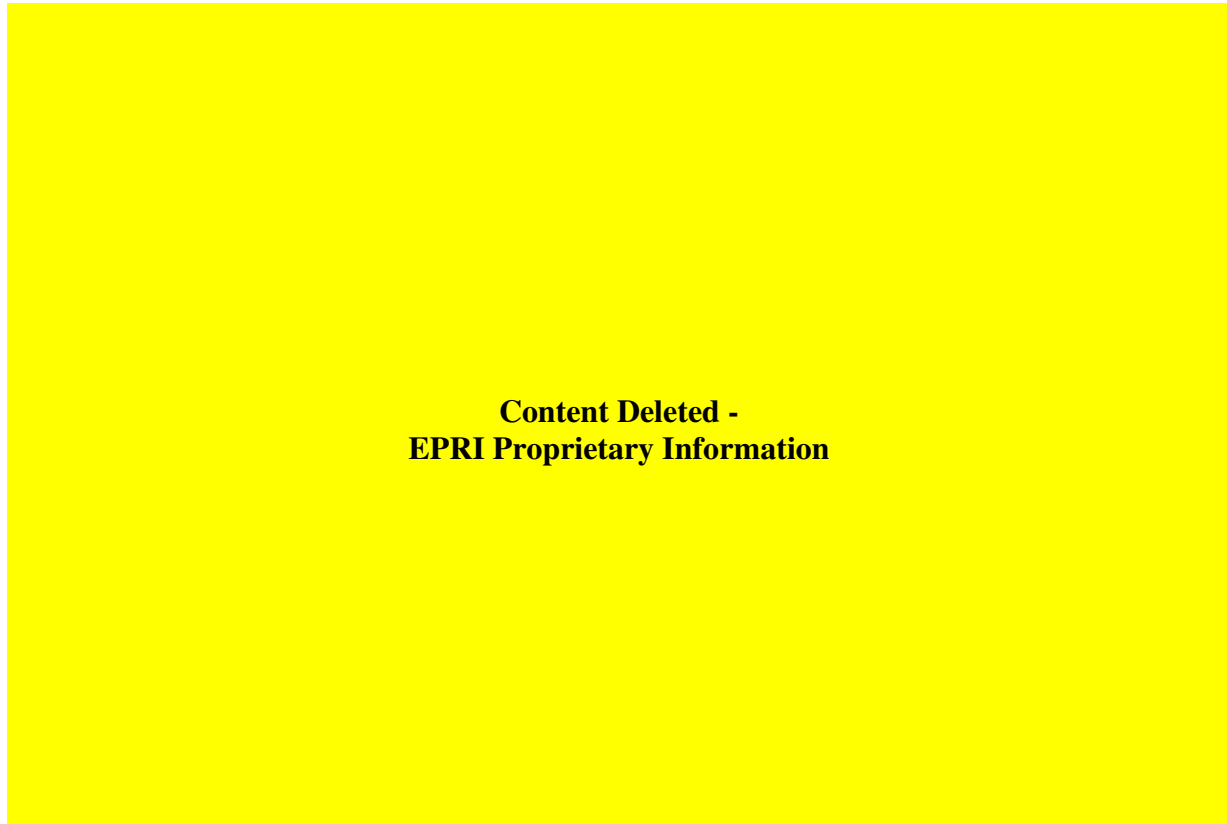


Figure 7.2.6-2. Typical 0.55-Inch Wide Top Guide Grid Structure

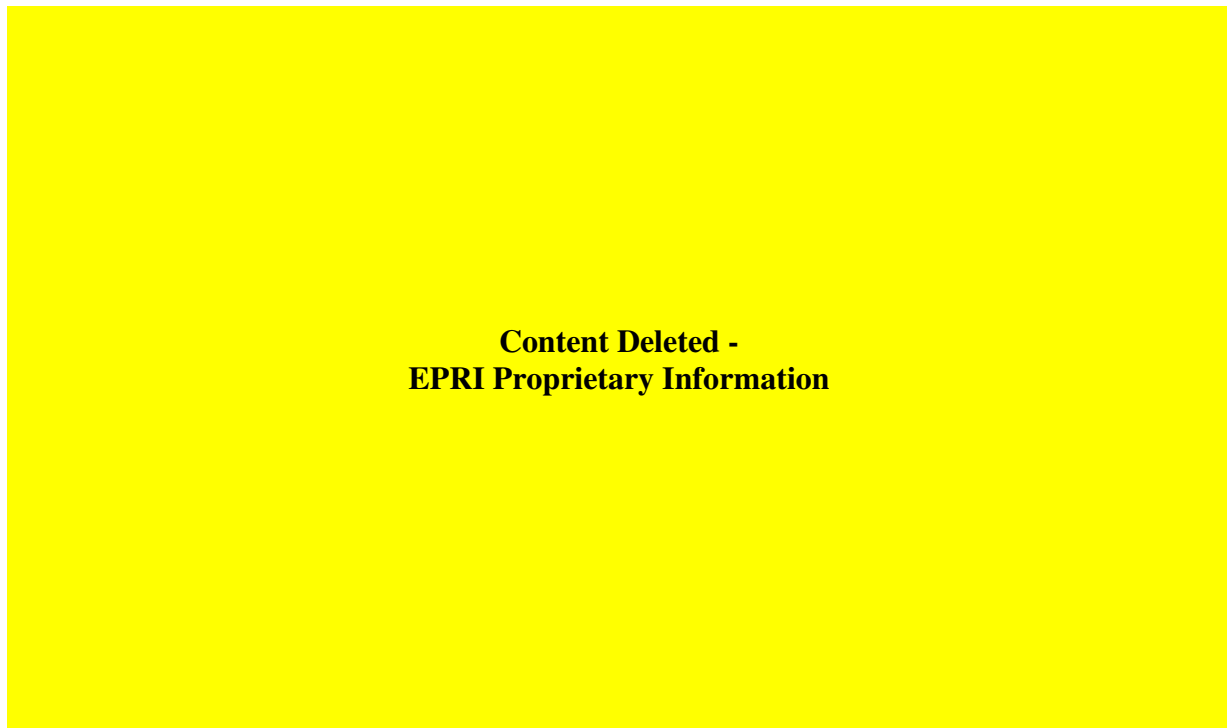


Figure 7.2.6-3. Typical BWR/6 Top Guide Grid Structure

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.6-4. Photograph of BWR/2 Grid Beam Cracking Observed During Metallurgic Evaluation

**Content Deleted -
EPRI Proprietary Information**

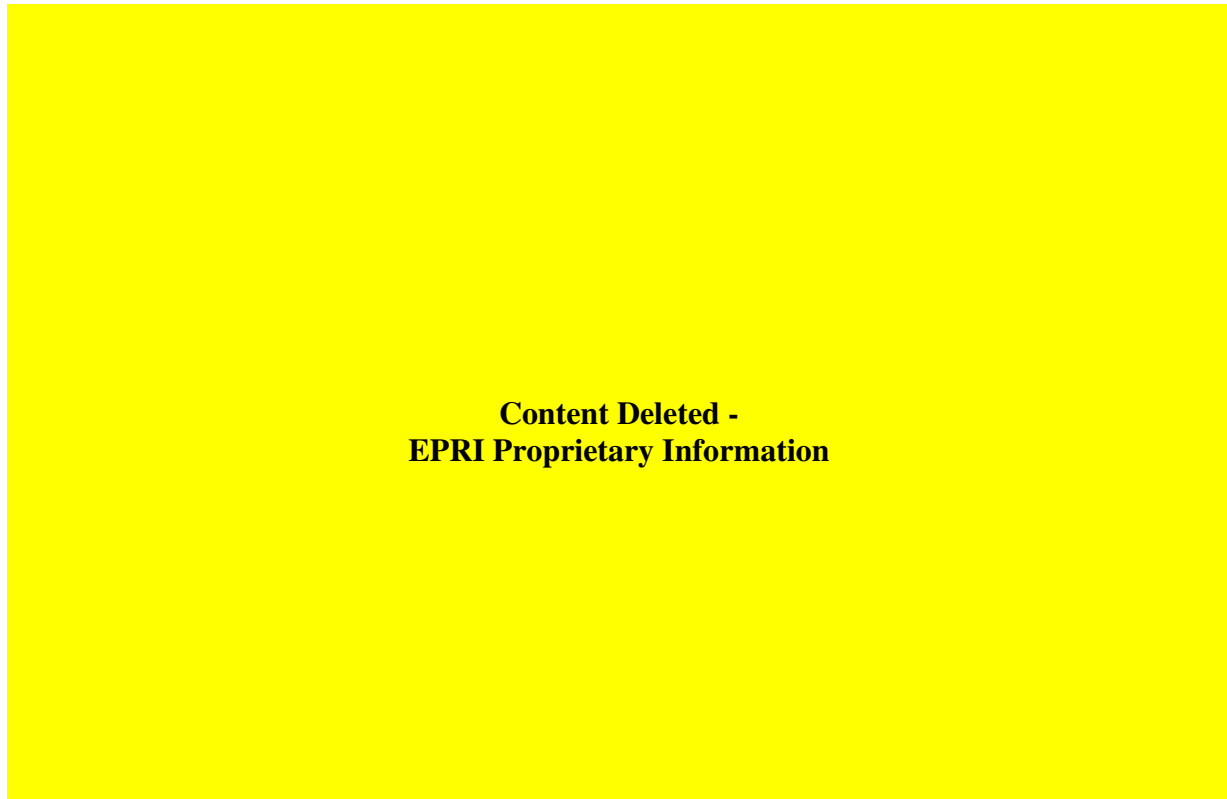


Figure 7.2.6-5. Mid-Span Flaw in Upper Grid Beam

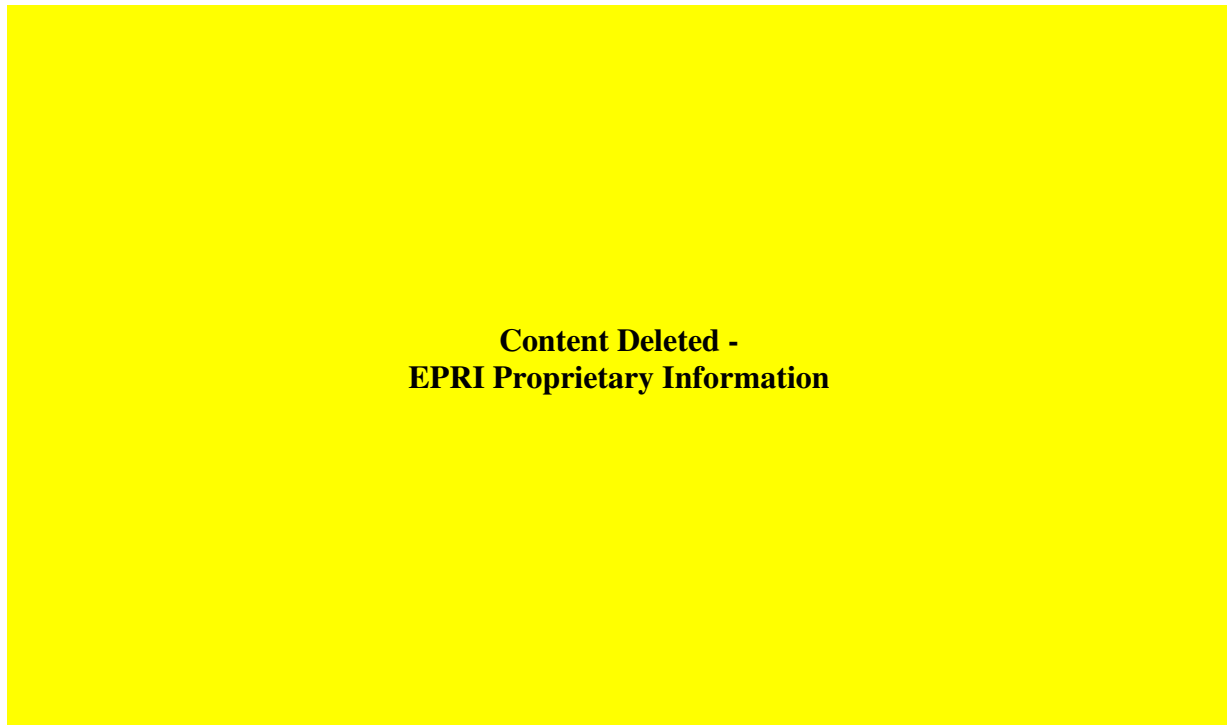


Figure 7.2.6-6. Intersecting Slot Flaw in Upper Grid Beam

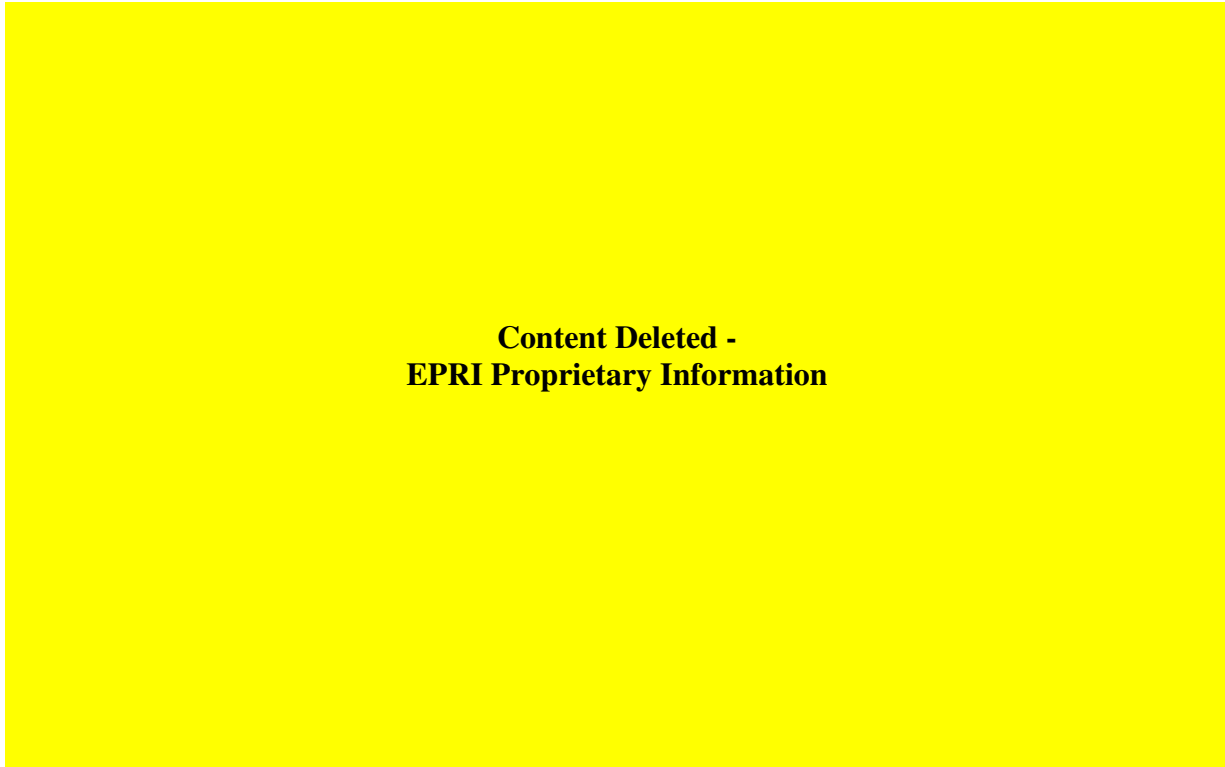


Figure 7.2.6-7. Mid-Span Flaw in Lower Grid Beam

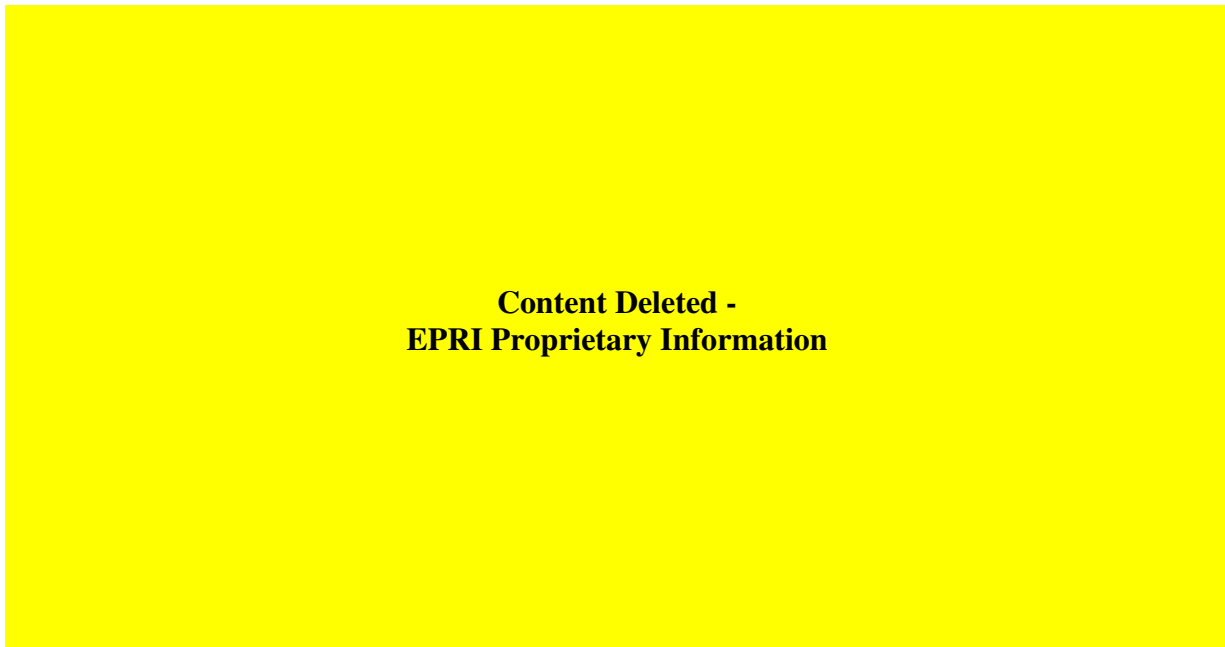


Figure 7.2.6-8. Flaw Located at Incore Instrumentation Notch Location of Lower Grid Beam

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.6-9. Intersecting Slot Flaw in Lower Grid Beam

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.6-10. Flaw Emanating from Poison Notch

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.6-11. Configuration of Top Guide Grid, Fuel Channels, and Control Blades

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.2.6-12. Phased Array Sector Scan Techniques for Top Guide Grid Beam Examinations

**Content Deleted -
EPRI Proprietary Information**

7.3 Applicable Mockups

7.3.1 Top Guide Grid Mockup BWRVIP-I

**Content Deleted -
EPRI Proprietary Information**

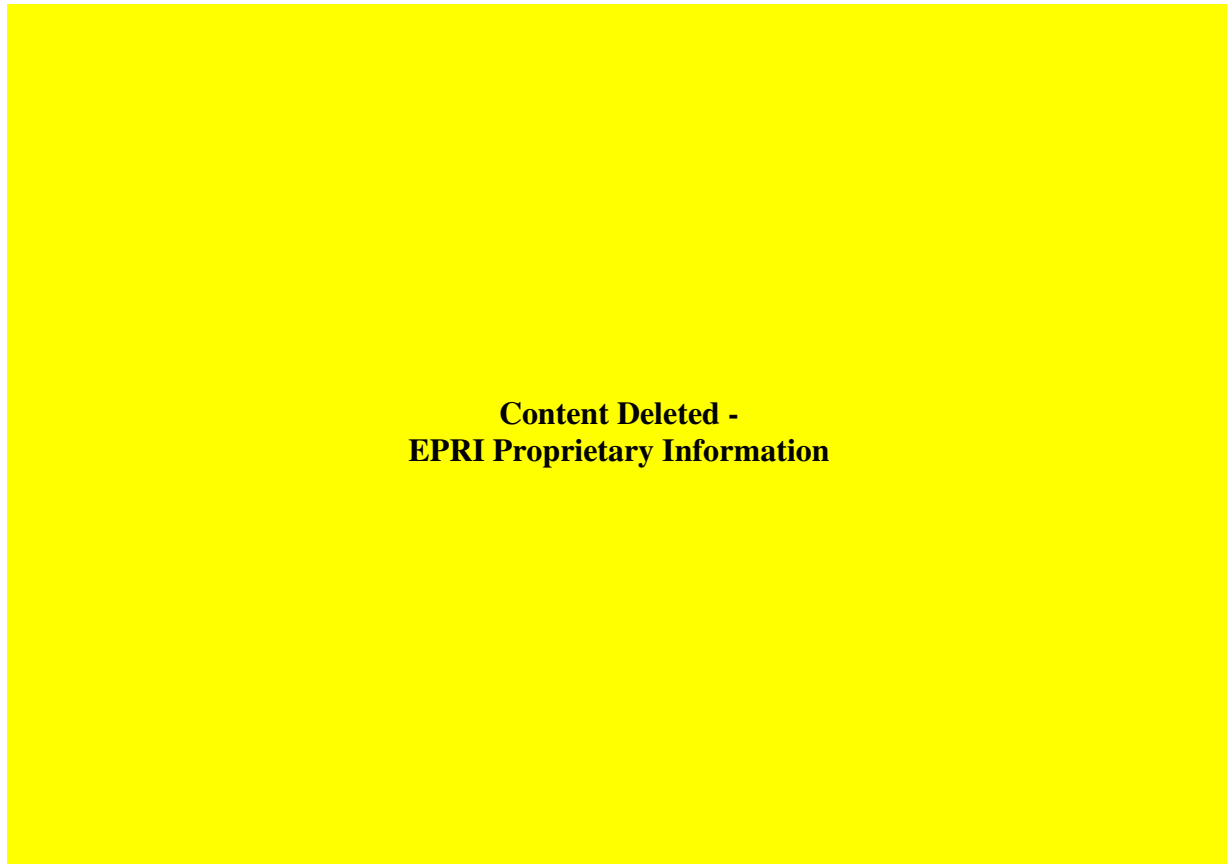


Figure 7.3.1-1. Configuration of Top Guide Grid Mockup BWRVIP-I

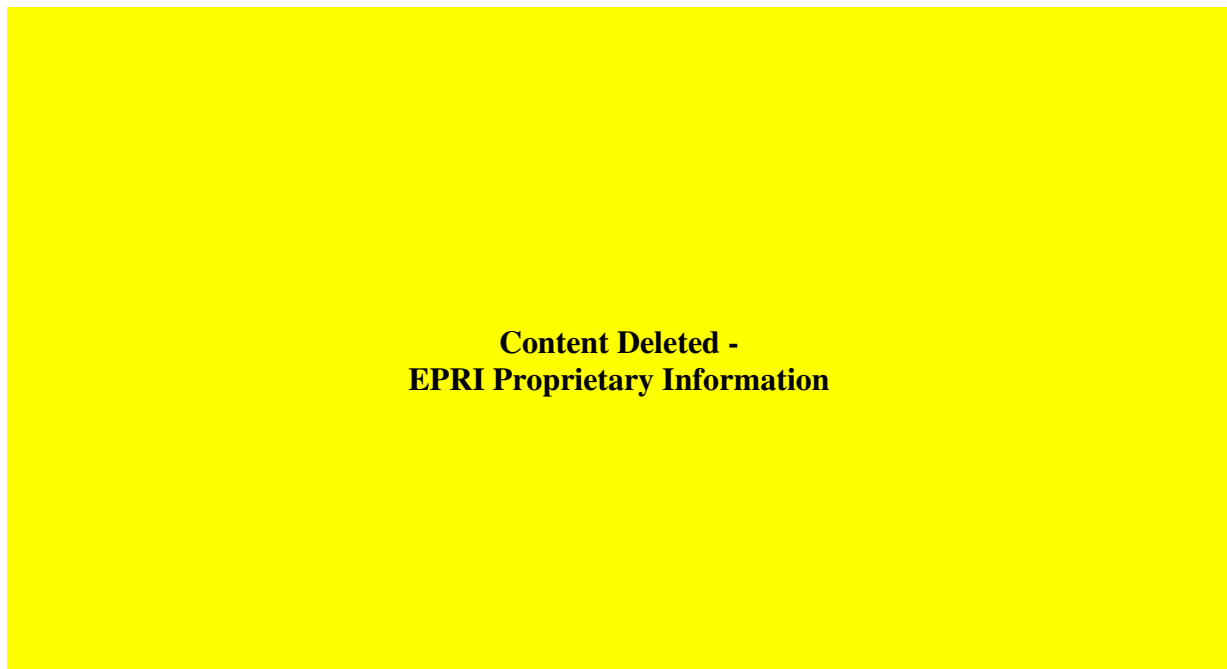


Figure 7.3.1-2. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-A: Configuration and Flaw Details

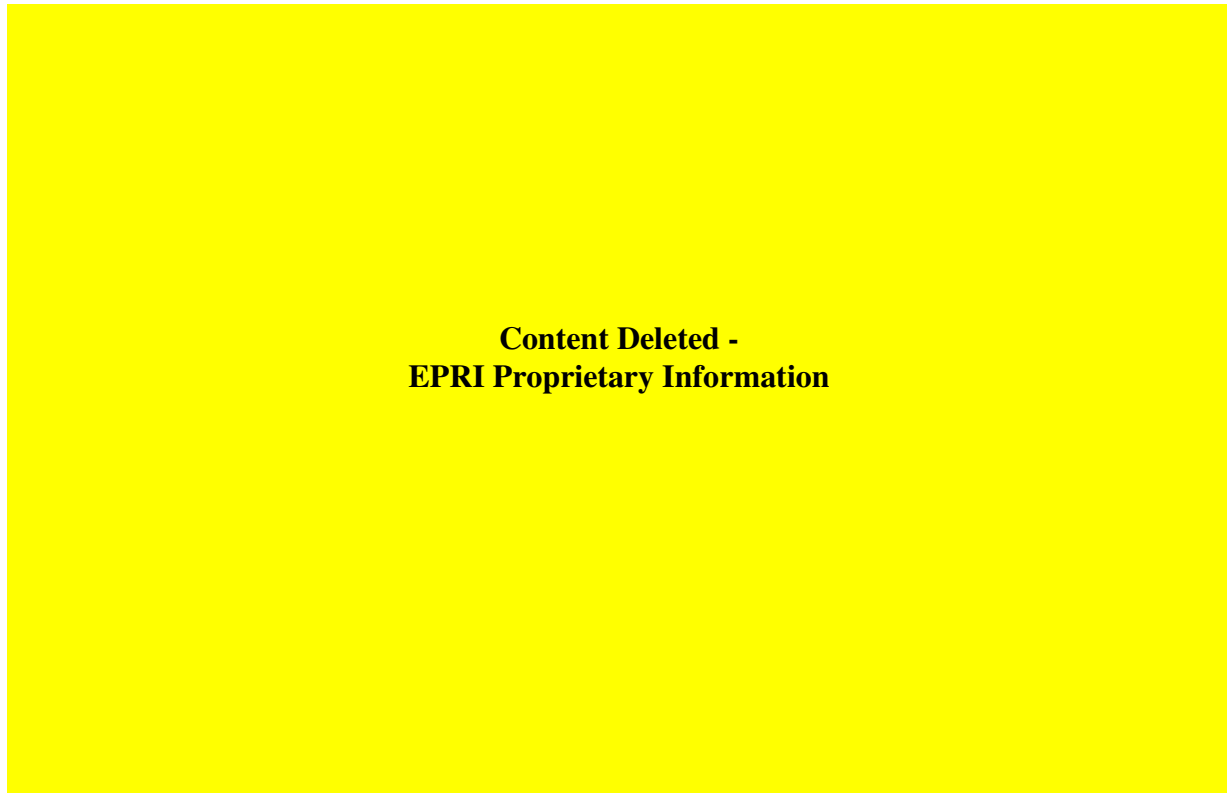


Figure 7.3.1-3. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-B: Configuration and Flaw Details

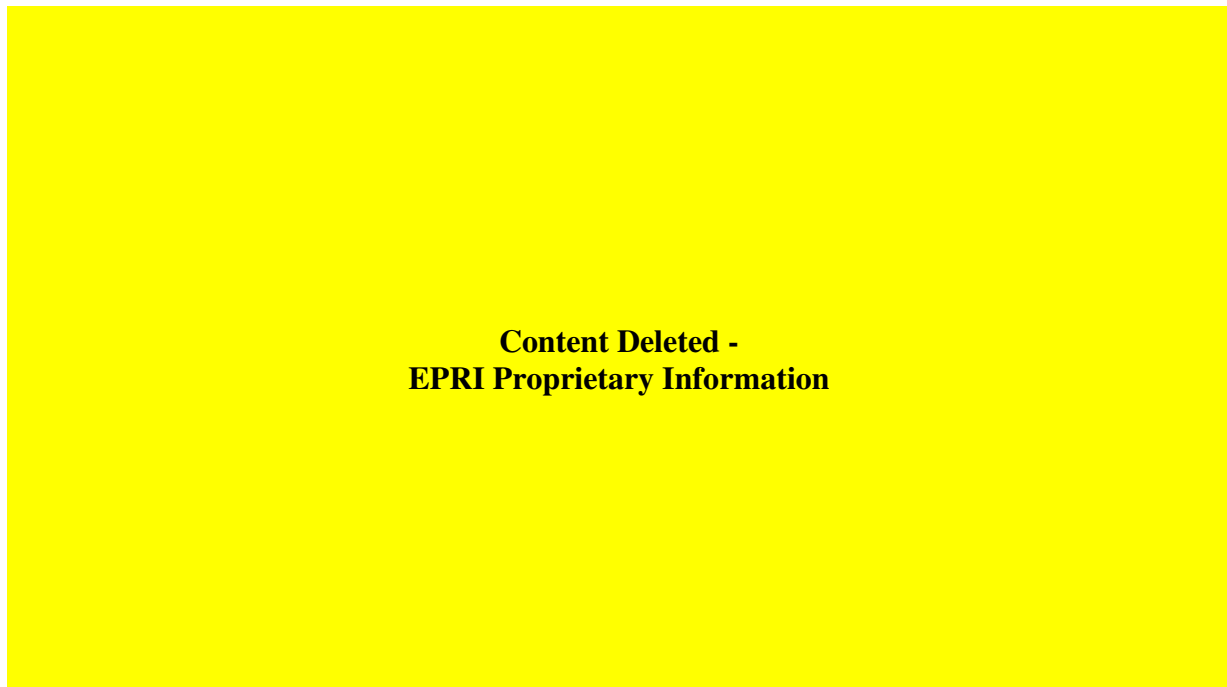


Figure 7.3.1-4. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-C: Configuration and Flaw Details

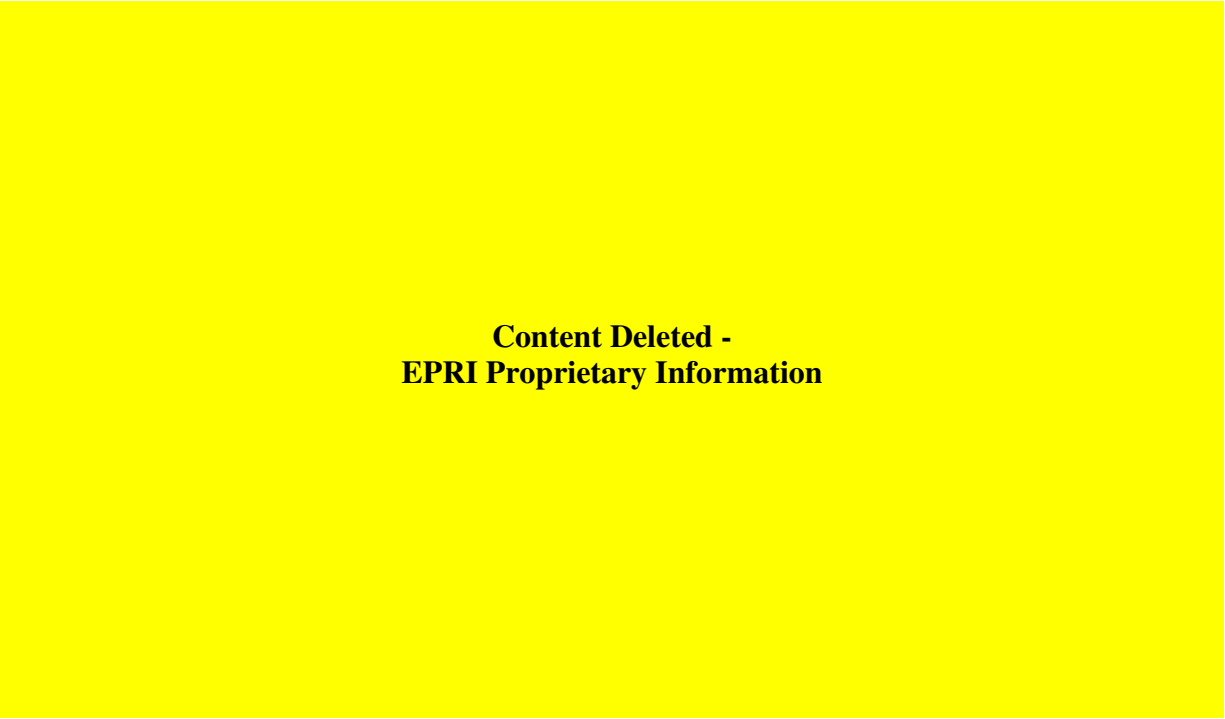


Figure 7.3.1-5. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-D: Configuration and Flaw Details

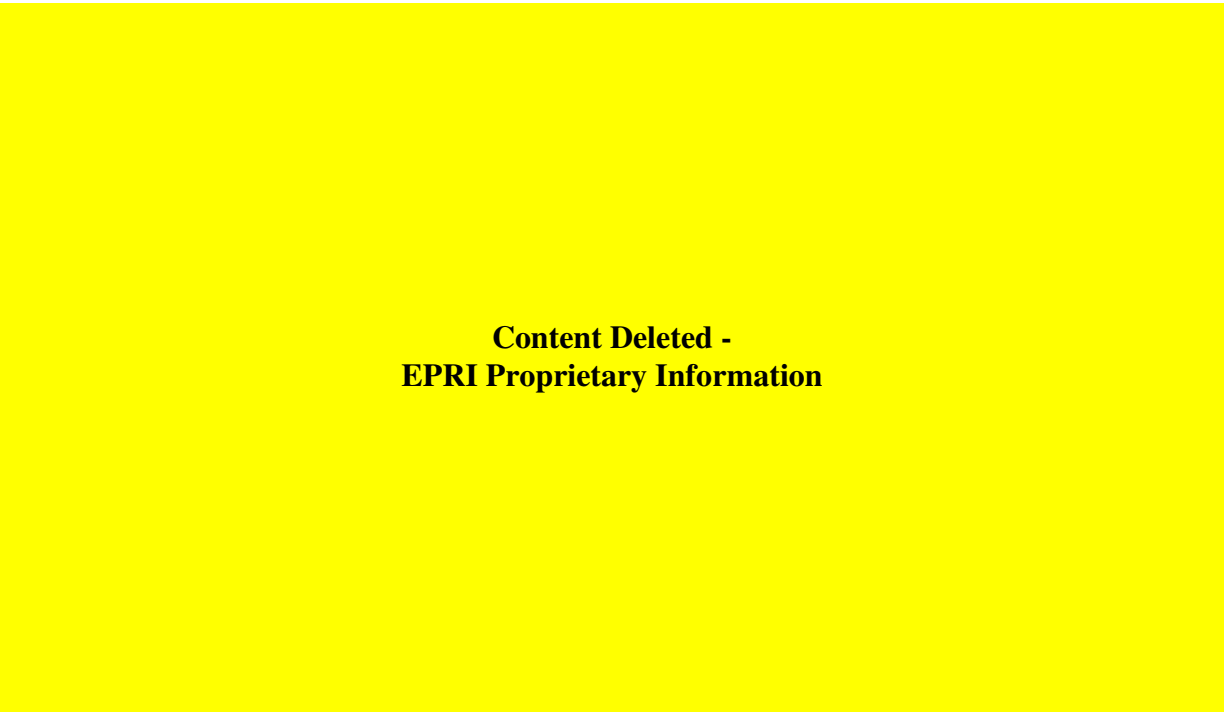


Figure 7.3.1-6. Top Guide Grid Mockup BWRVIP-I, Plate BWRVIP-I-E: Configuration and Flaw Details

7.3.2 Top Guide Grid Mockups BWRVIP-TG1-x Through BWRVIP-TG13-x Series

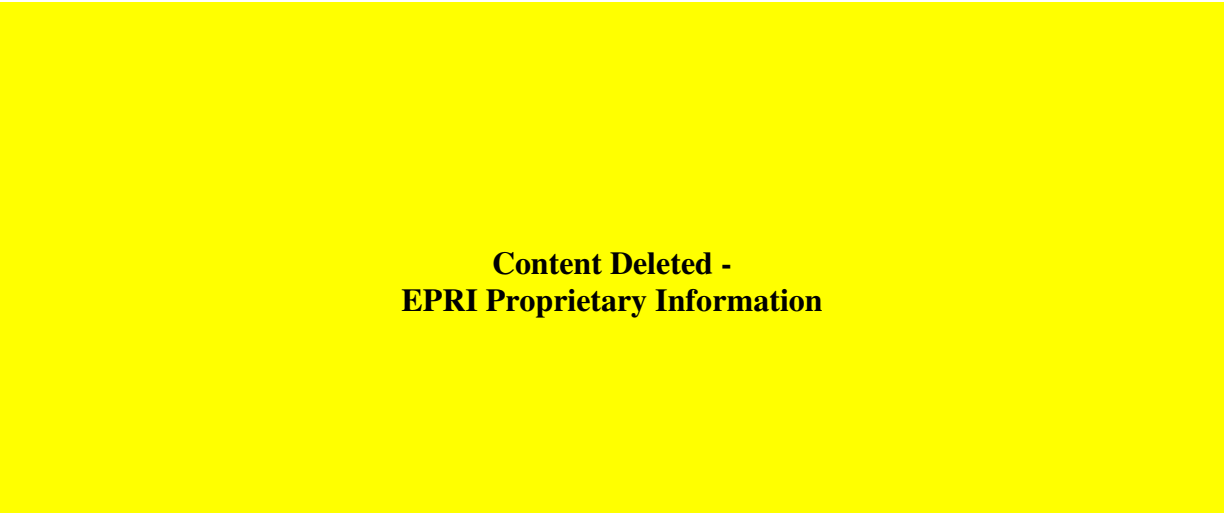


Table 7.3.2-1. BWRVIP Top Guide Grid Beam Mockups

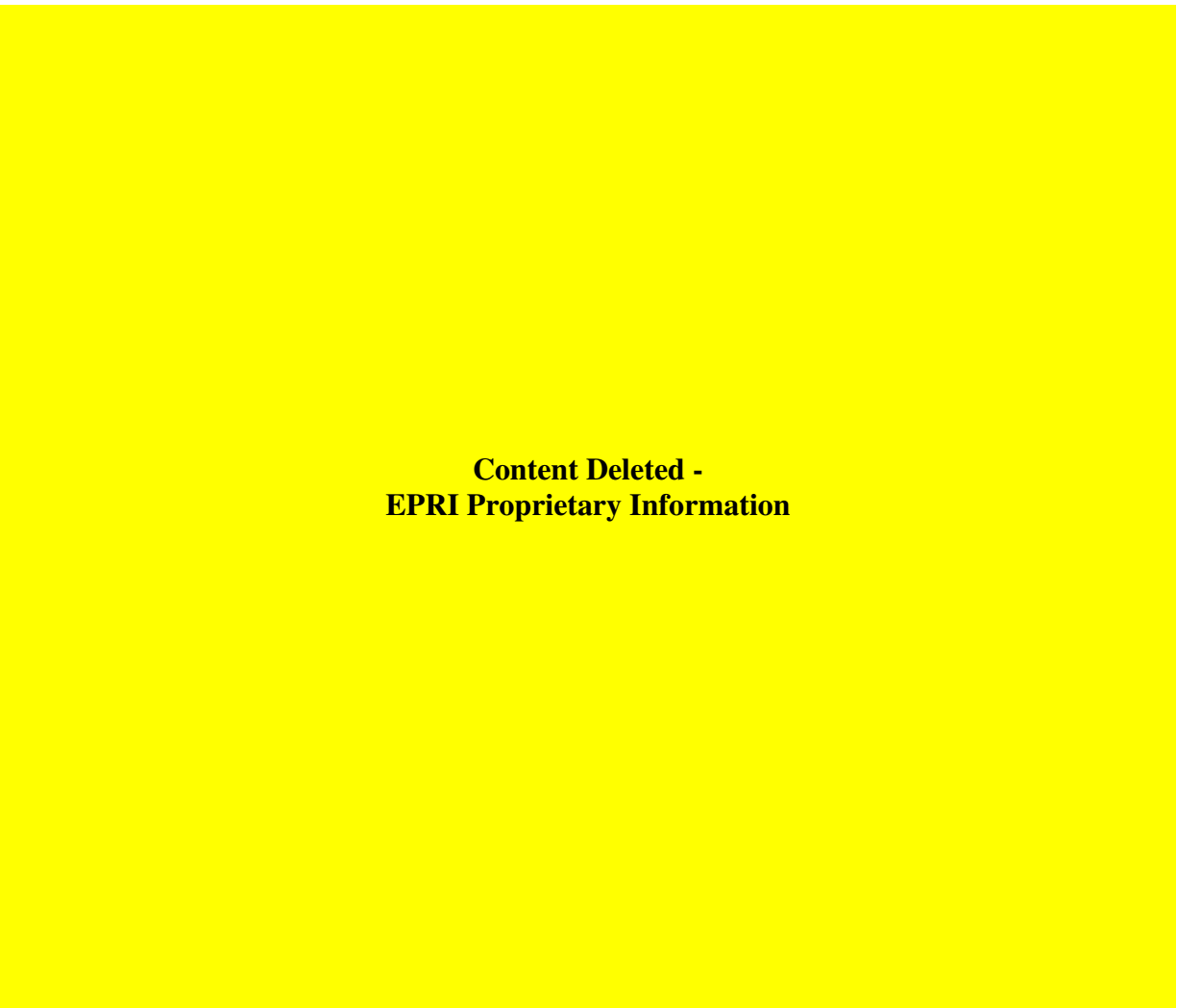
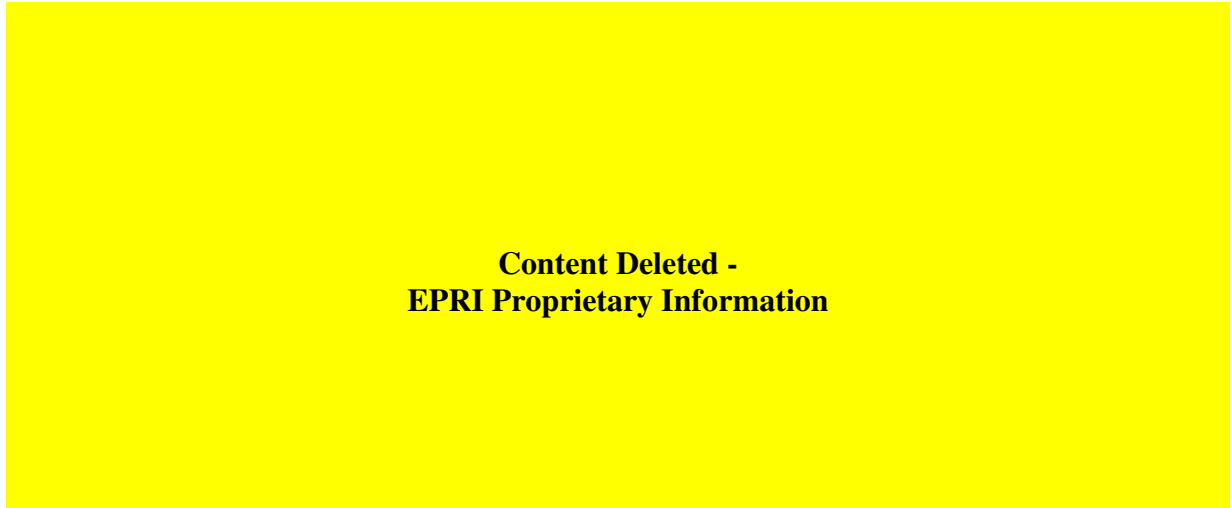
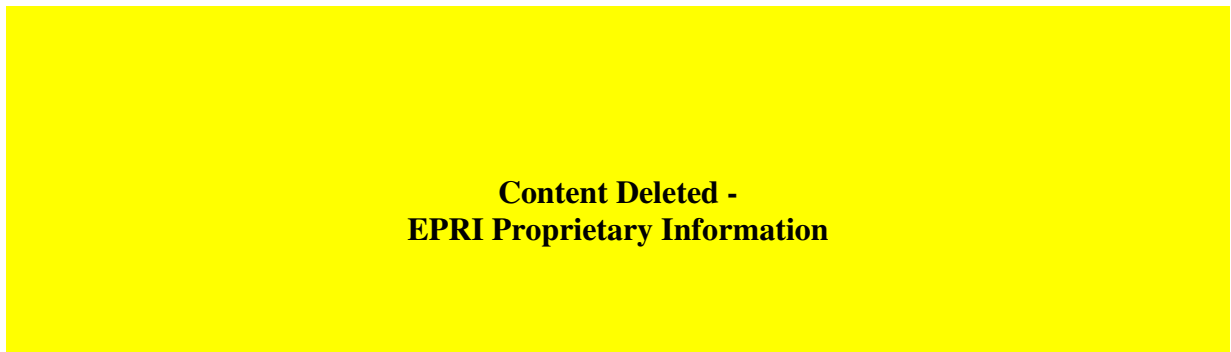


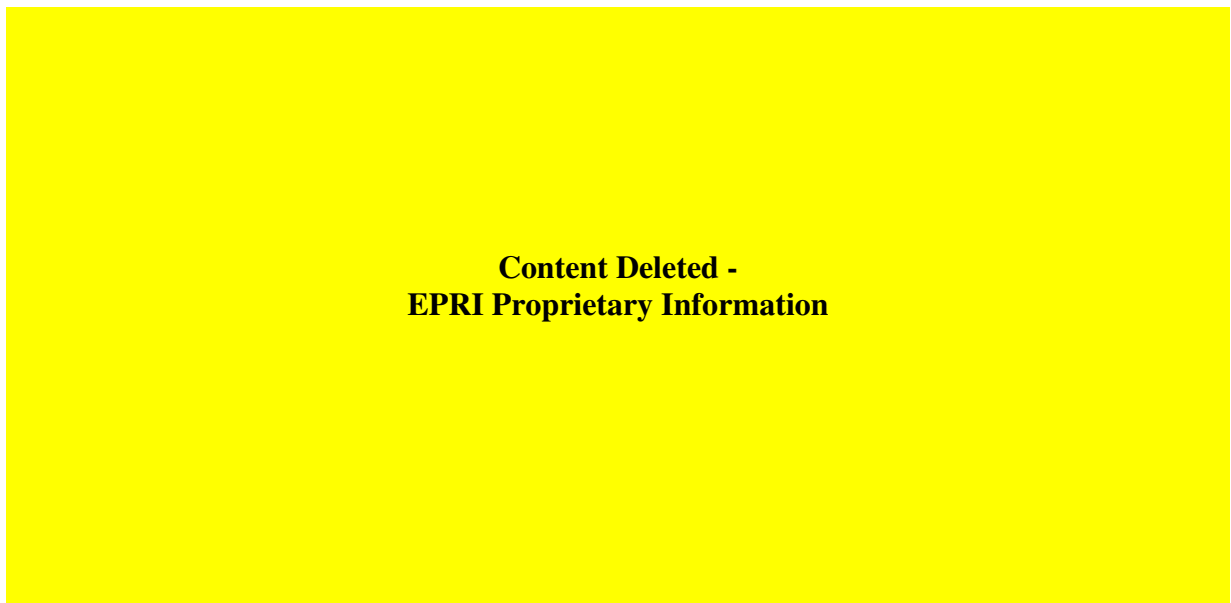
Table 7.3.2-1. BWRVIP Top Guide Grid Beam Mockups (continued)



7.4 UT Technique Demonstrations for Top Guide Components



7.4.1 General Findings for UT



7.4.1.1 Grid Beams



7.4.2 UT Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

7.4.3 UT Demonstration 2

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

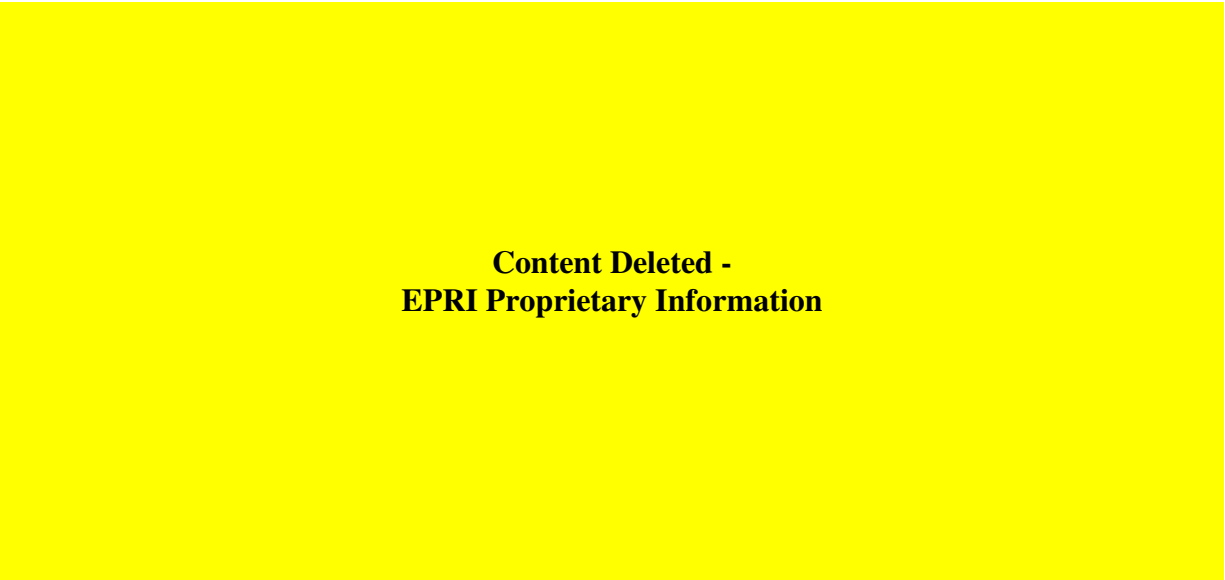


Figure 7.4.3-1. Example of CAD-Generated Drawing Overlaid on Examination Data Display

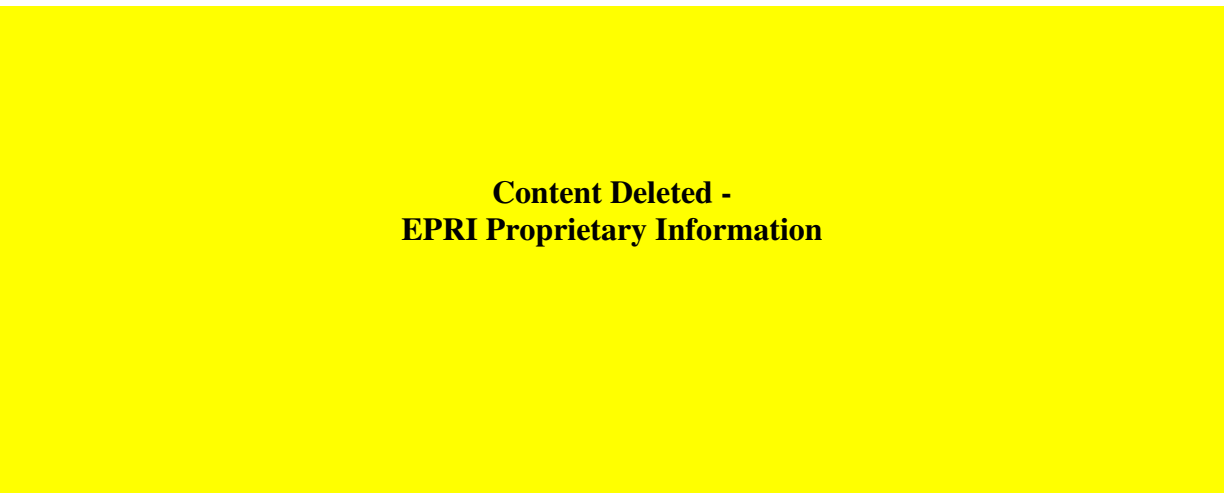
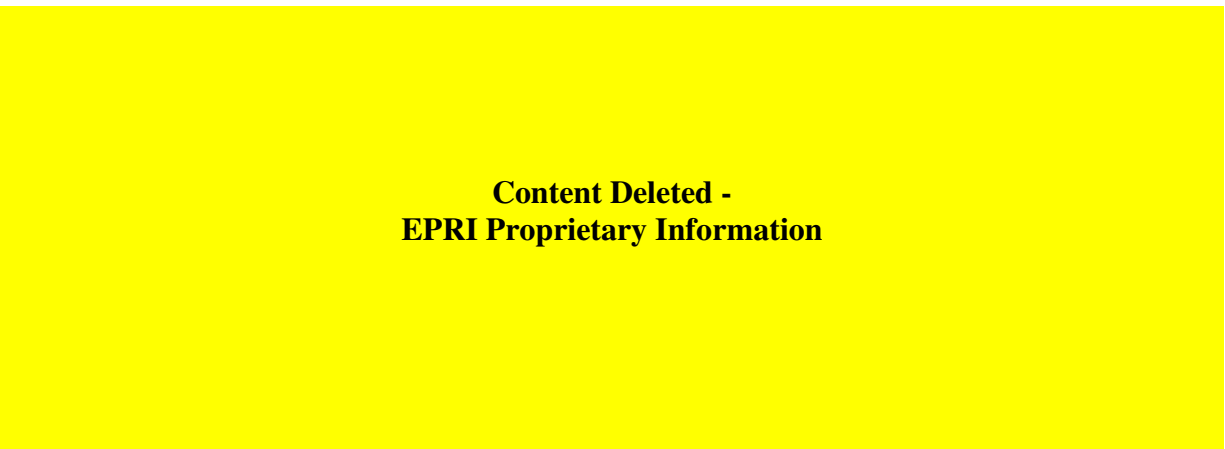


Figure 7.4.3-2. Example of Flaws That Initiate from Geometric Reflectors





**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 7.3.2-1. BWRVIP-TG1-x and BWRVIP-TG2-x Flaw Details

**Content Deleted -
EPRI Proprietary Information**

Figure 7.3.2-2. BWRVIP-TG3-x and BWRVIP-TG4-x Flaw Details

**Content Deleted -
EPRI Proprietary Information**

Figure 7.3.2-3. BWRVIP-TG5-x and BWRVIP-TG6-x Flaw Details



Figure 7.3.2-4. BWRVIP-TG7-x Flaw Details



Figure 7.3.2-5. BWRVIP-TG8-x and BWRVIP-TG9-x Flaw Details



**Content Deleted -
EPRI Proprietary Information**

Figure 7.3.2-6. BWRVIP-TG10-x and BWRVIP-TG11-x Flaw Details



Figure 7.3.2-7. BWRVIP-TG12-x and BWRVIP-TG13-x Flaw Details

8

CORE PLATE

8.1 Summary

**Content Deleted -
EPRI Proprietary Information**

8.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

8.2.1 Rim Hold-Down Bolt Locations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

8.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

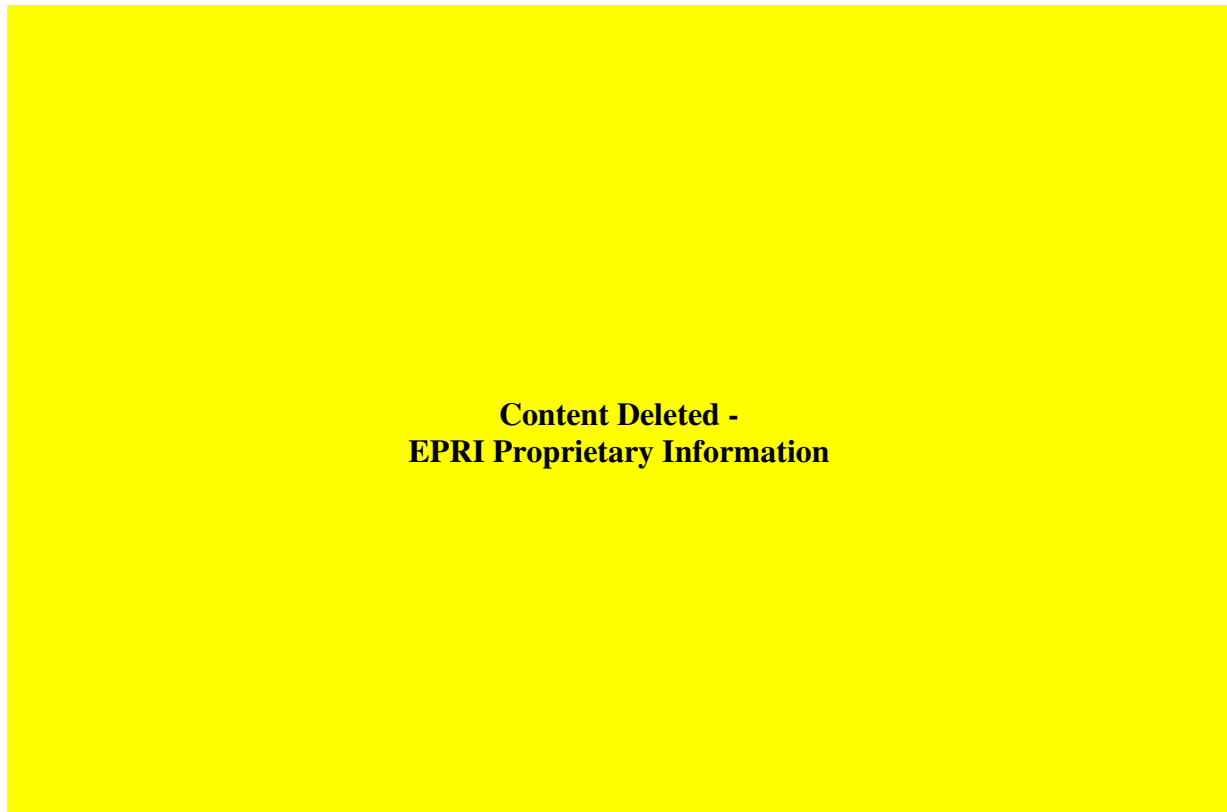


Figure 8.3-1. EDM Notches in Upper and Lower Threaded Regions of Core Plate Bolt Mockup

8.4 UT Technique Demonstrations for Core Plate Rim Hold-Down Bolts

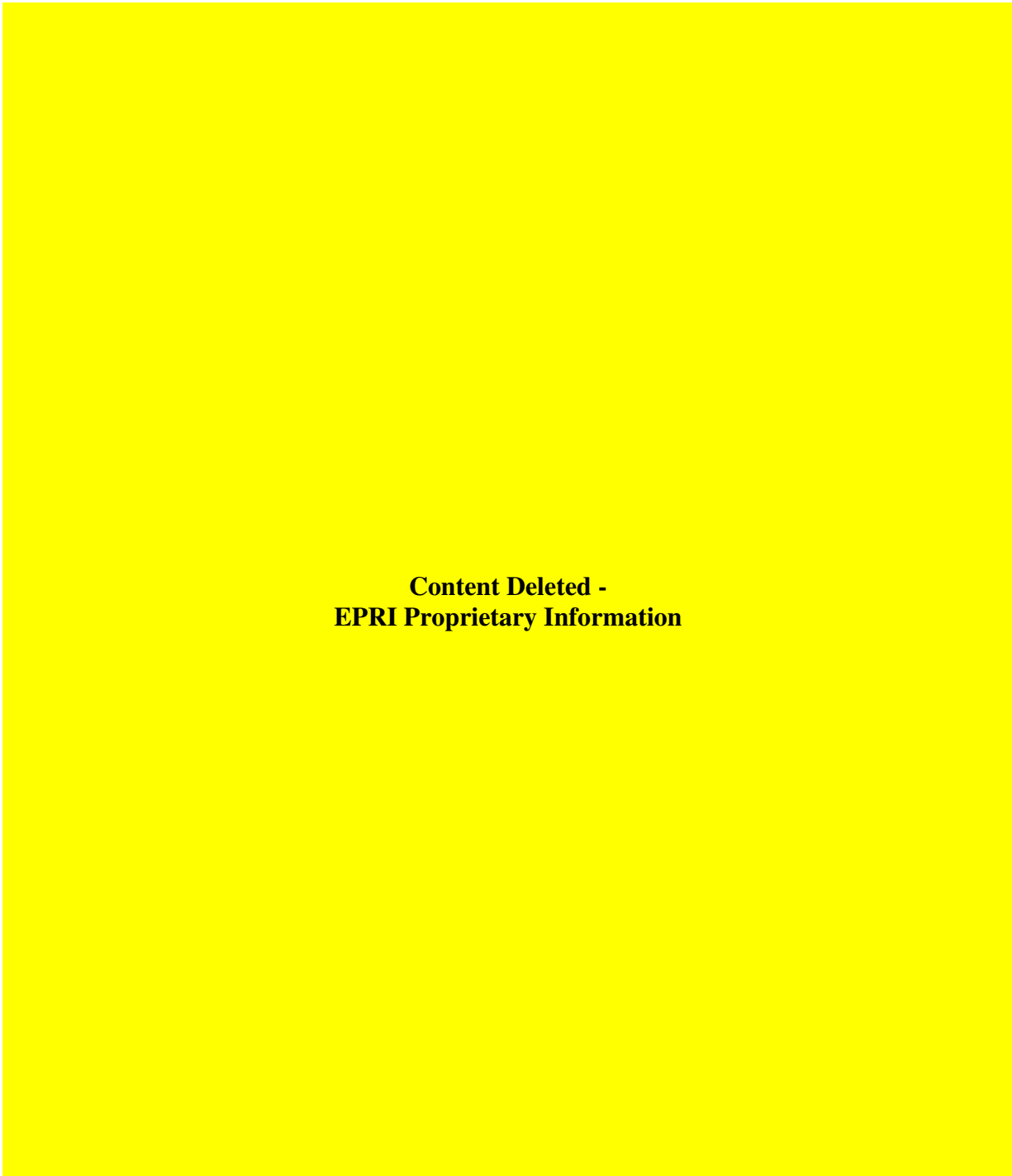
**Content Deleted -
EPRI Proprietary Information**

Table 8.4-1. UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

8.4.1 UT Demonstration 1



**Content Deleted -
EPRI Proprietary Information**

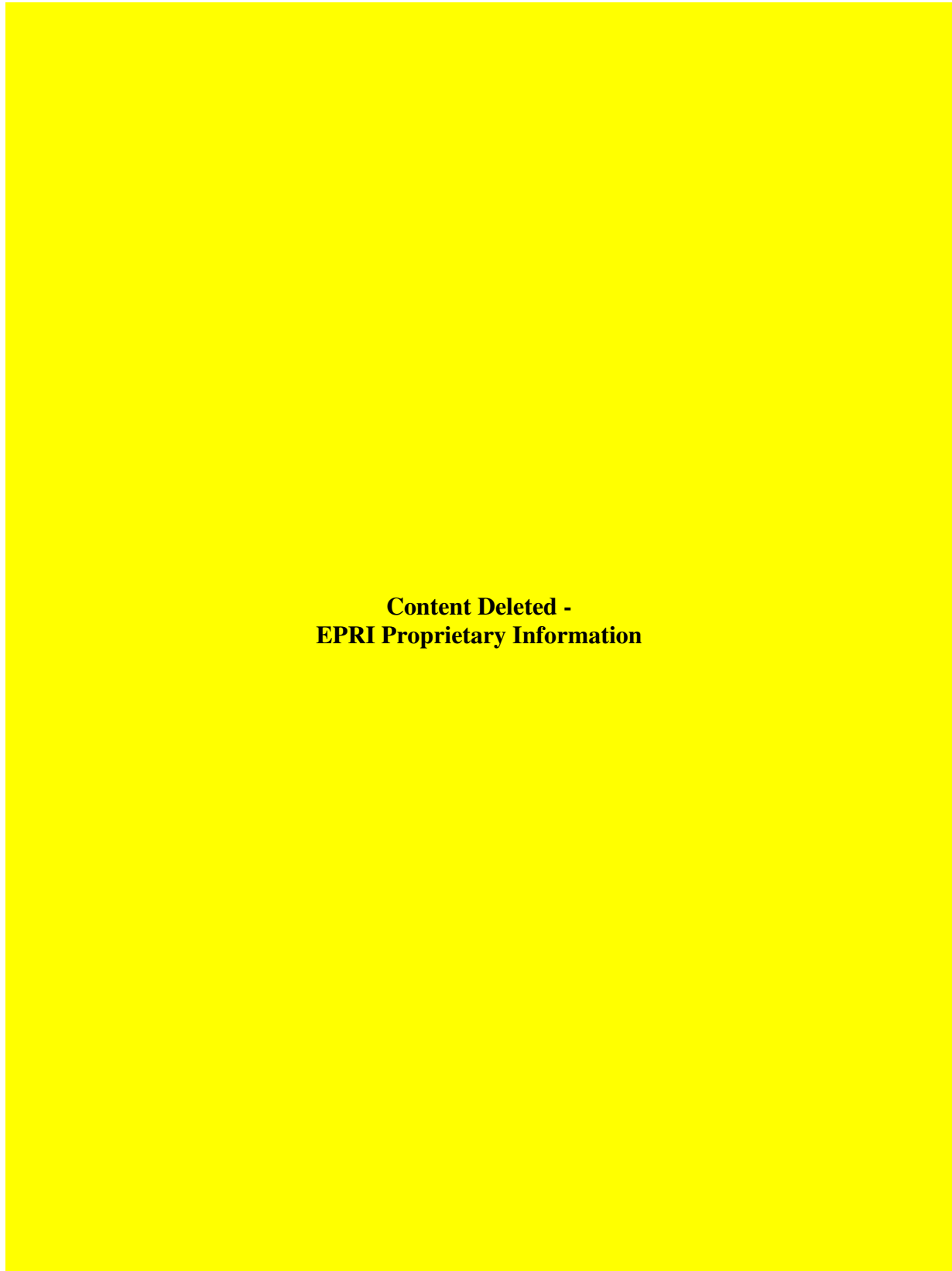
8.4.2 UT Demonstration 2

**Content Deleted -
EPRI Proprietary Information**

8.4.3 UT Demonstration 3

**Content Deleted -
EPRI Proprietary Information**

8.4.4 UT Demonstration 4



**Content Deleted -
EPRI Proprietary Information**

8.4.5 UT Demonstration 5

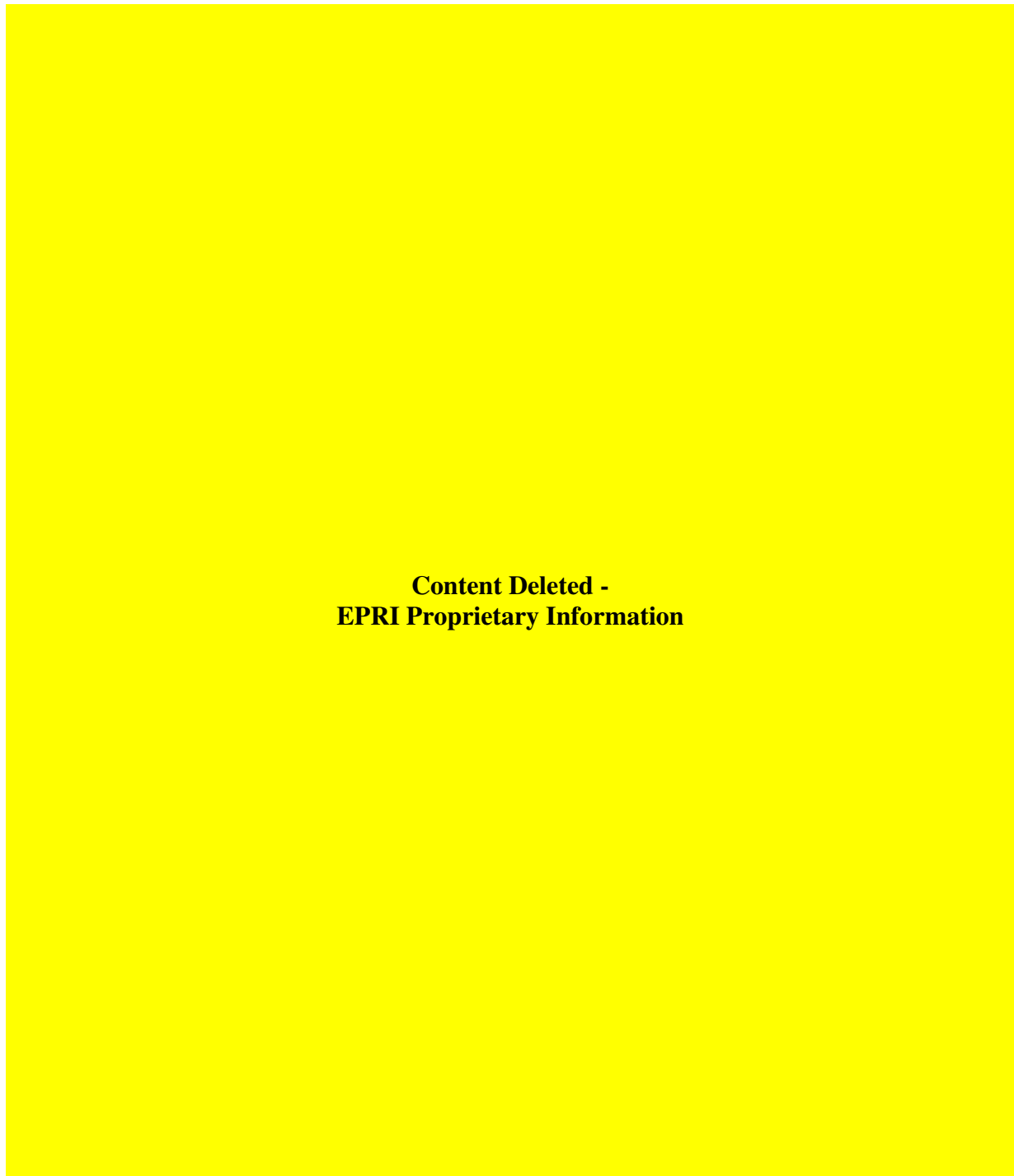




Figure 8.4.5-1 BWRVIP-B Mockup Configuration (with Bolt Installed)

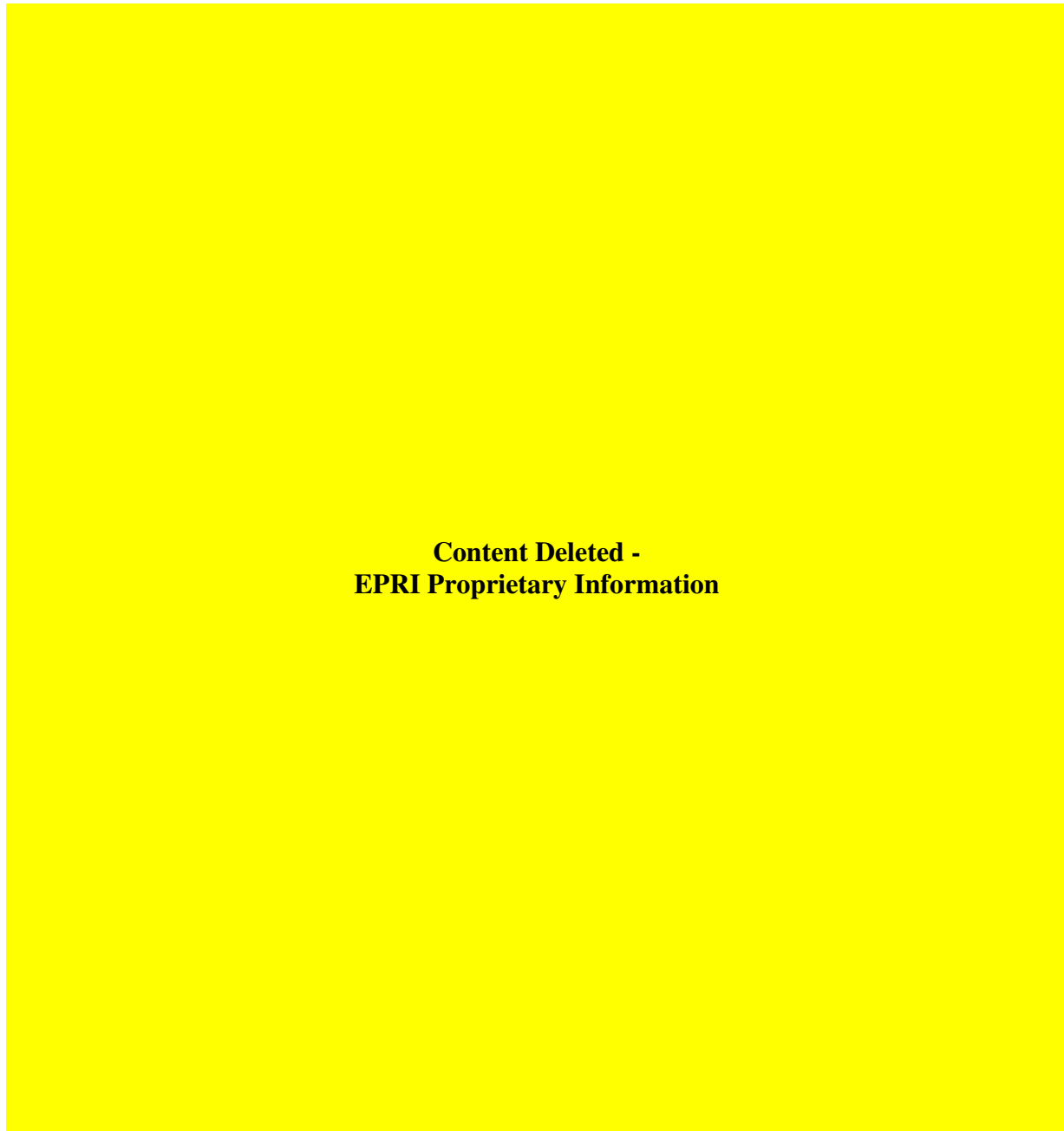


Figure 8.4.5-2 BWRVIP-H6OH Mockup Configuration (with Bolt Installed)



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

9

LPCI COUPLING

9.1 Summary

**Content Deleted -
EPRI Proprietary Information**

9.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

9.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

9.4 UT Technique Demonstrations for LPCI Coupling Welds

**Content Deleted -
EPRI Proprietary Information**

10

JET PUMP ASSEMBLY

10.1 Summary

**Content Deleted -
EPRI Proprietary Information**

10.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

10.3.1 Mockup BWRVIP-U

**Content Deleted -
EPRI Proprietary Information**

10.3.2 Mockup BWRVIP-V

**Content Deleted -
EPRI Proprietary Information**

10.3.3 Mockups BWRVIP-Z3 and BWRVIP-Z3R

**Content Deleted -
EPRI Proprietary Information**

10.3.4 Mockup BWRVIP-Z4

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.3.5 Jet Pump Beam Mockups

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.5-1. EPRI Jet Pump Beam Mockup A

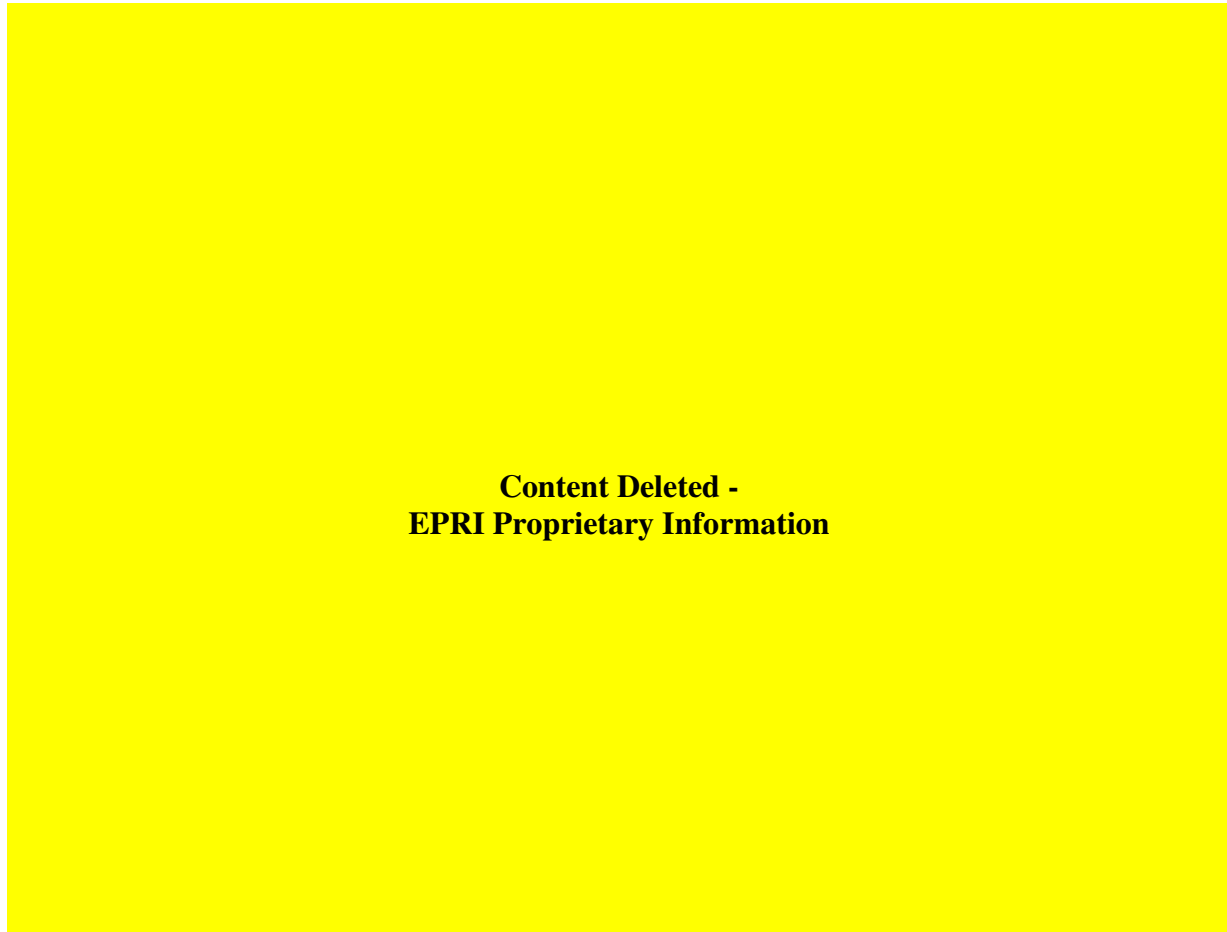


Figure 10.3.5-2. EPRI Jet Pump Beam Mockup B (No Flaws)



**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.5-3. EPRI Jet Pump Beam Mockup C



**Content Deleted -
EPRI Proprietary Information**



Figure 10.3.5-4. Jet Pump Beam Mockup BWRVIP-G2JPB1



Figure 10.3.5-5. Jet Pump Beam Mockup BWRVIP-G2JPB2-R1

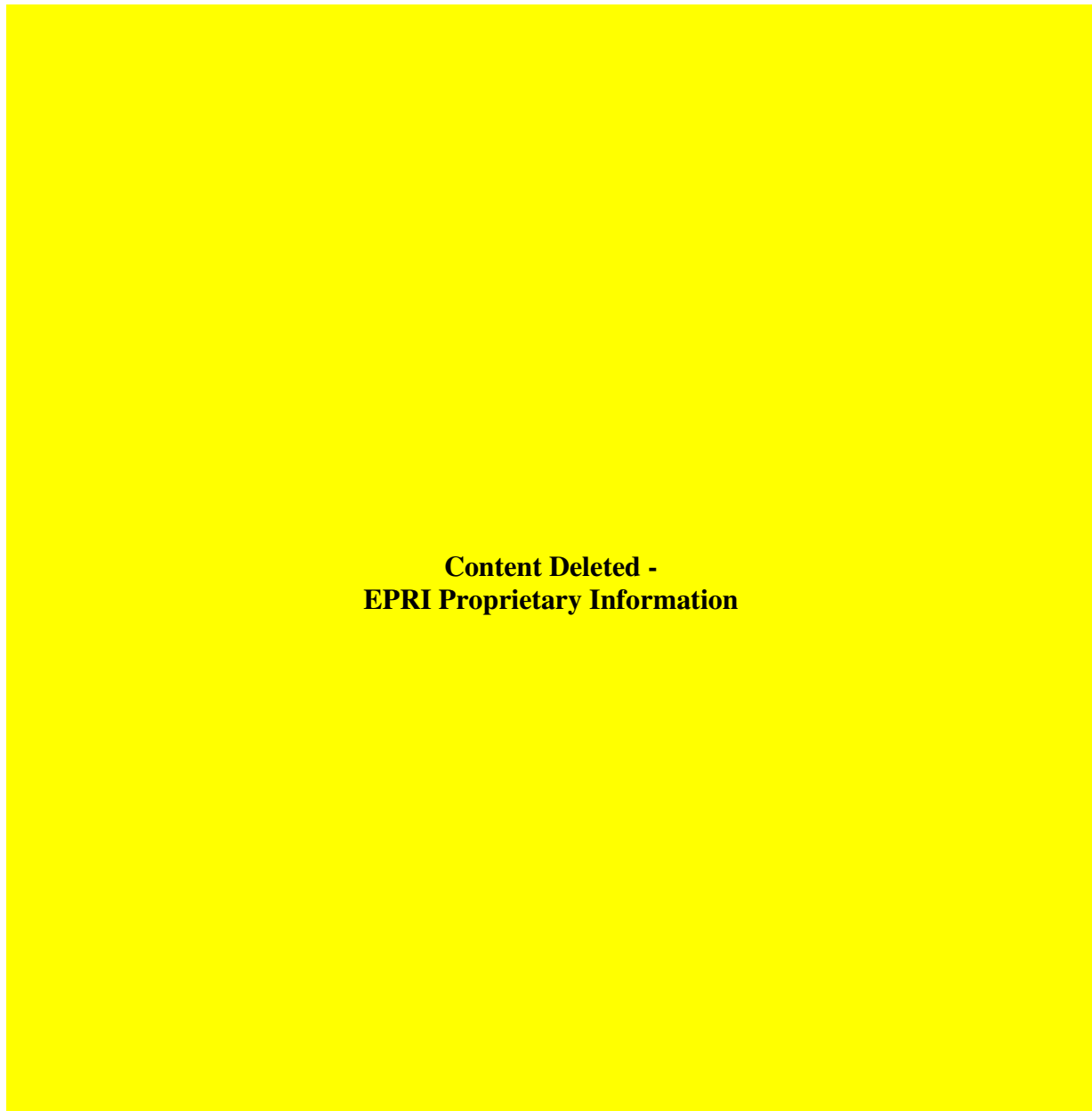
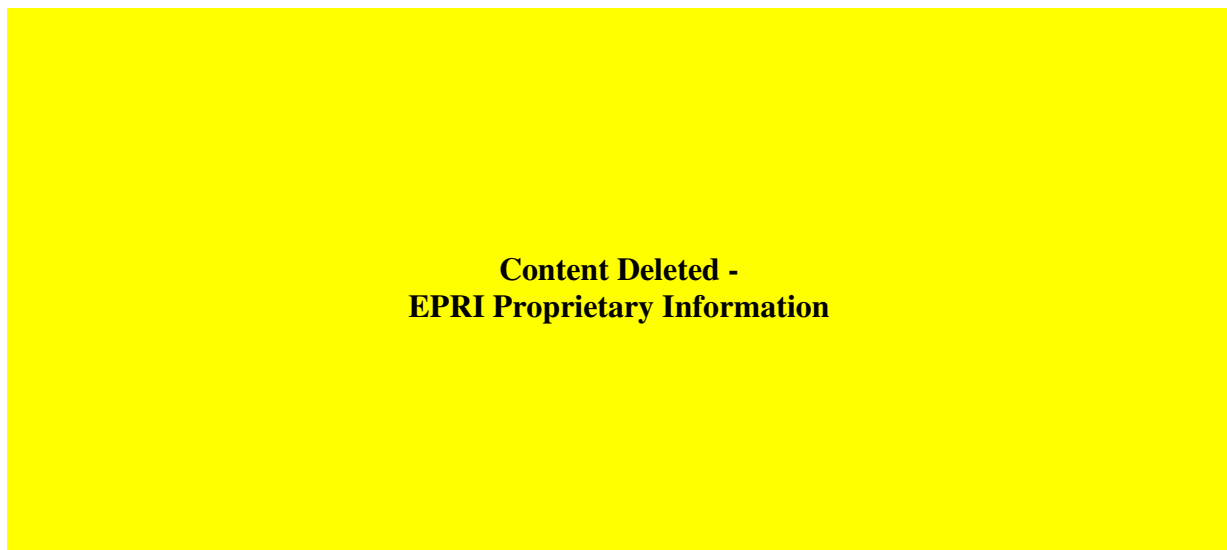


Figure 10.3.5-6. Jet Pump Beam Mockup BWRVIP-G2JPB3



Figure 10.3.5-7. Jet Pump Beam Mockup BWRVIP-G2JPB4





**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.5-8. Jet Pump Beam Taper-to-Radius Transition Mockups (Perspective Drawing)



**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.5-9. Jet Pump Beam Taper-to-Radius Transition Mockups (Photo)



**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.5-10. Jet Pump Beam Taper-to-Radius Transition Mockups (Side View Drawing)

10.3.6 Riser Brace Mockups BWRVIP-RB-1 and BWRVIP-RB-2



**Content Deleted -
EPRI Proprietary Information**

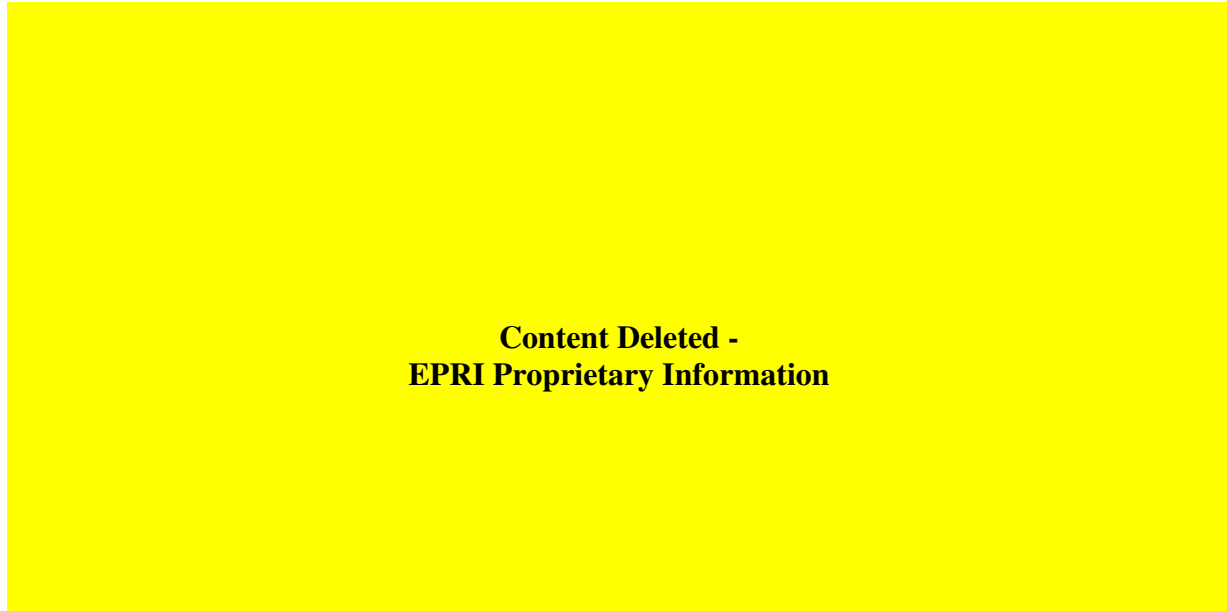


Figure 10.3.6-1. BWRVIP-RB-1 and BWRVIP-RB-2 Mockups (Photograph)

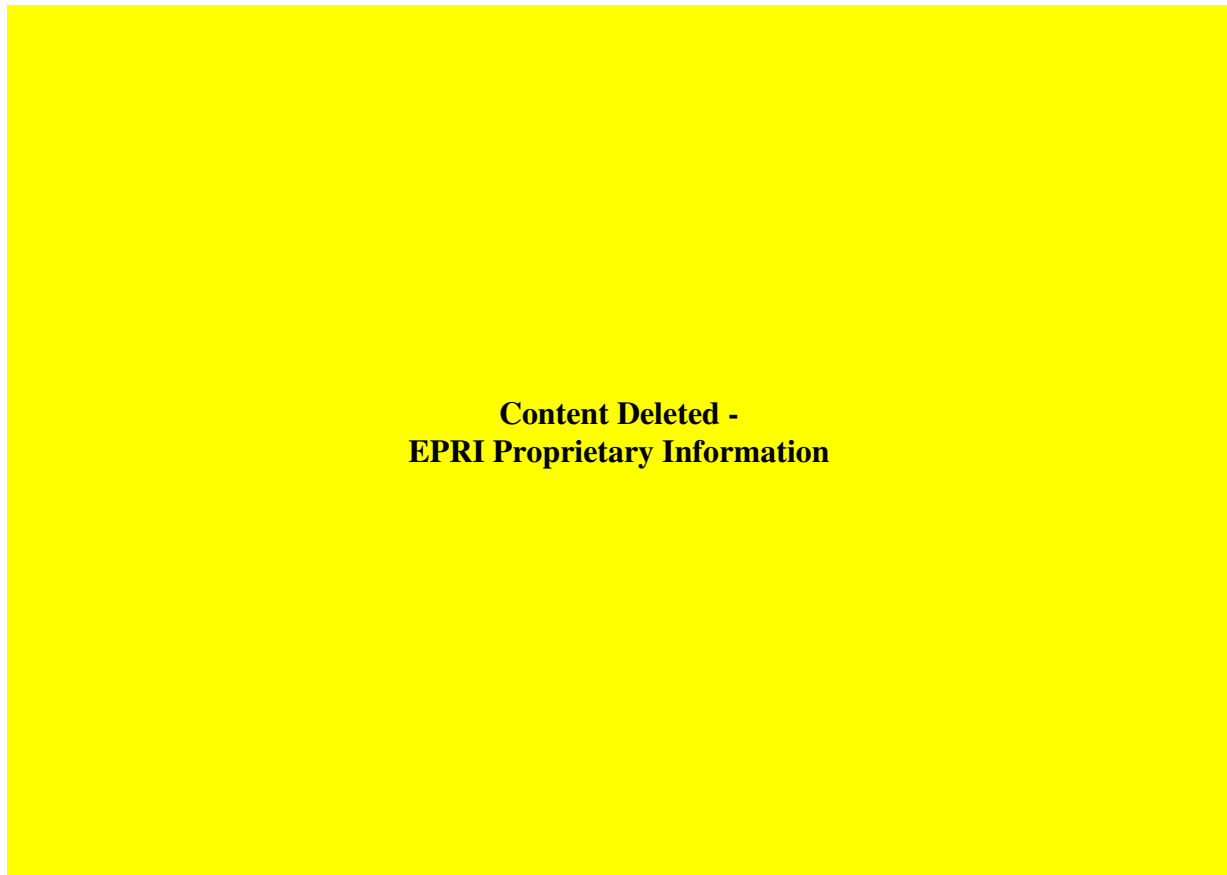
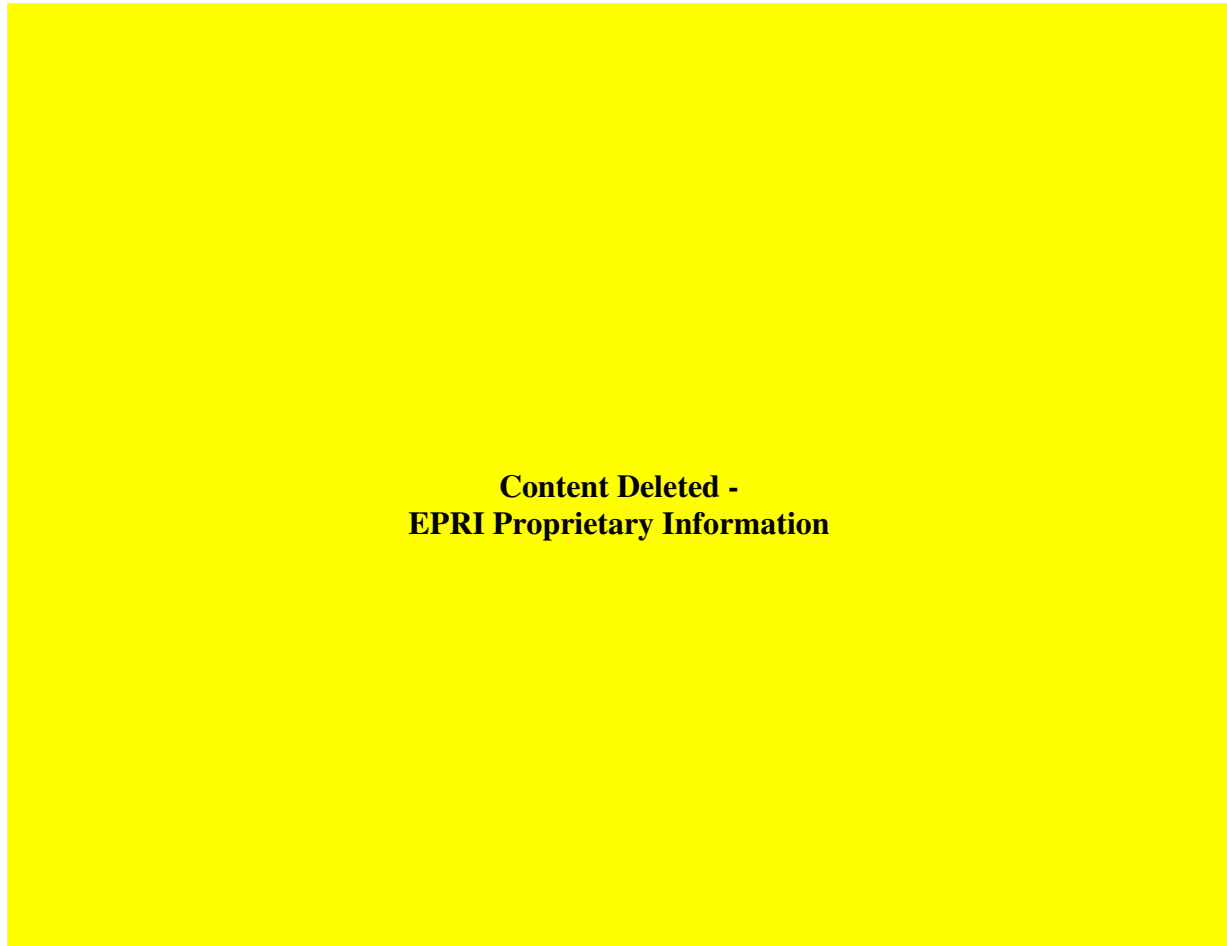


Figure 10.3.6-2. Flaw Layout and Electrode Profiles

Table 10.3.6-1. Flaw Table for BWRVIP-RB-1 and BWRVIP-RB-2

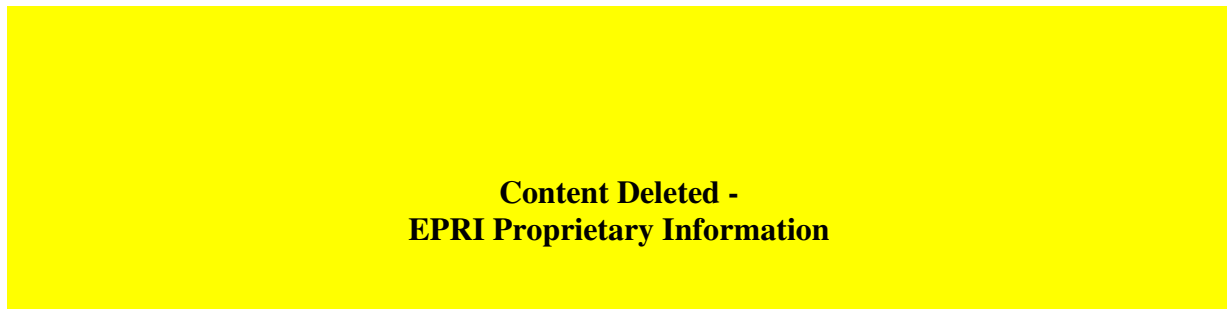


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

10.4 UT Technique Demonstrations



**Content Deleted -
EPRI Proprietary Information**

Table 10.4-1. UT Demonstration Summary

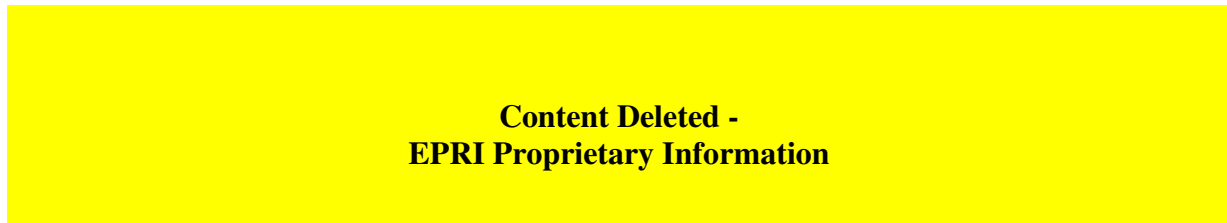


**Content Deleted -
EPRI Proprietary Information**

Table 10.4-1. UT Demonstration Summary (continued)

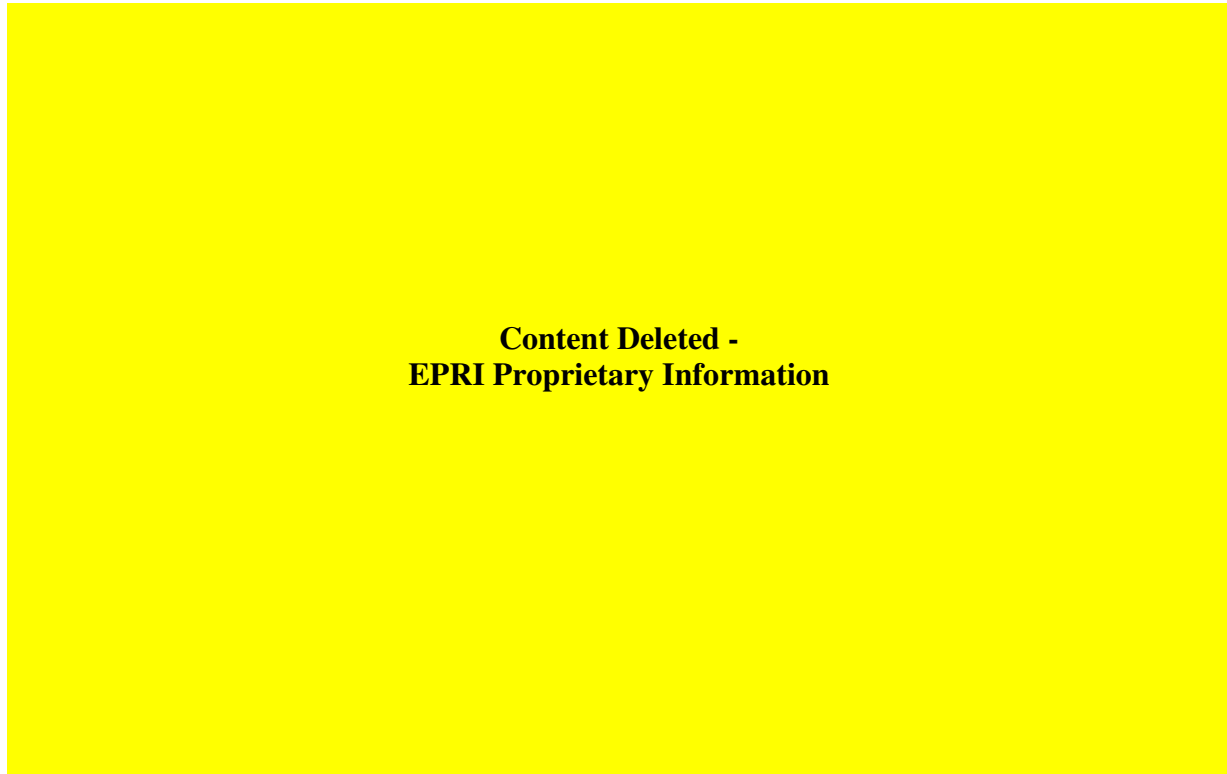


**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

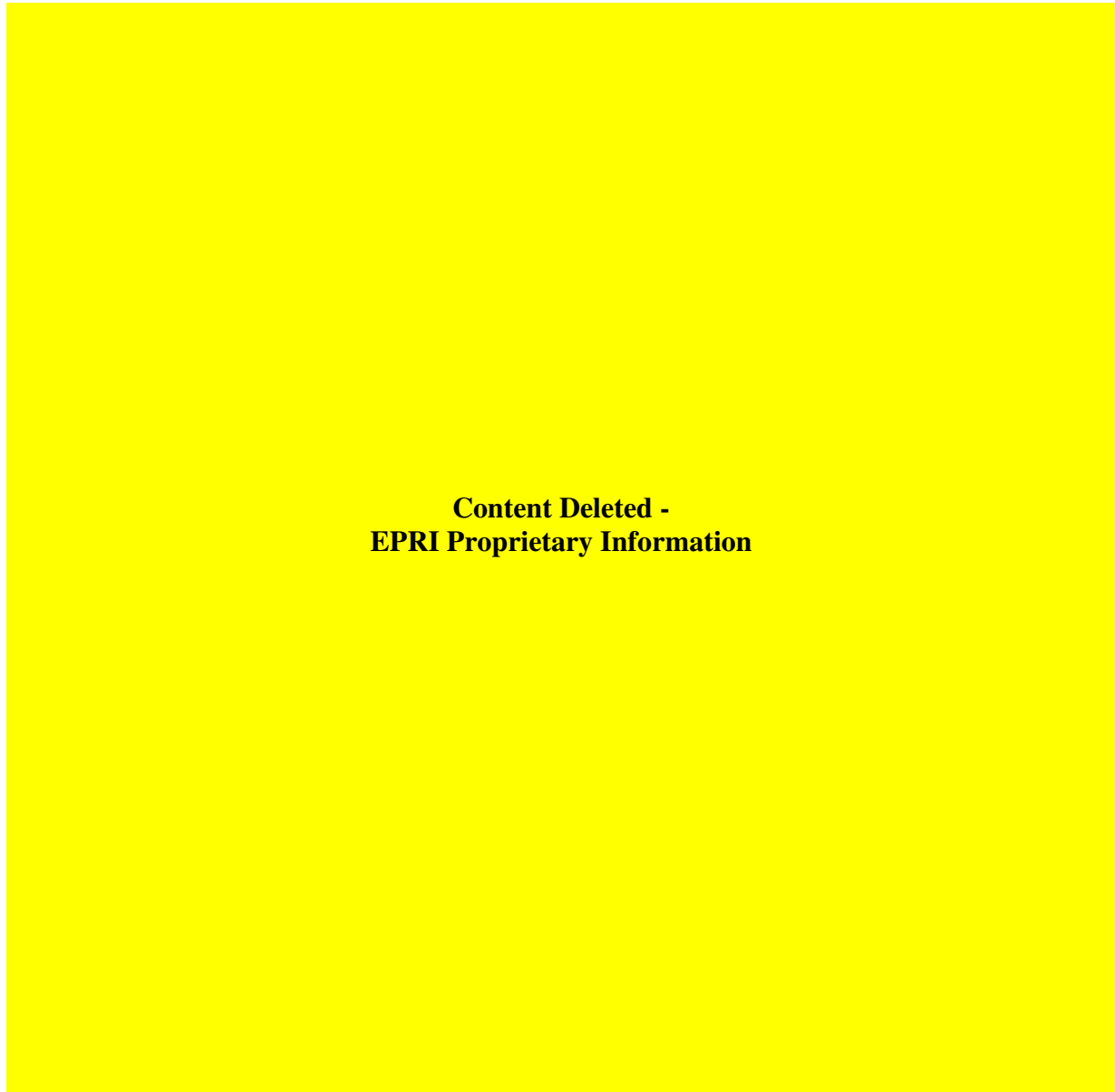
10.4.1 General Findings for UT



10.4.2 UT Demonstration 1



10.4.3 UT Demonstration 2



10.4.4 UT Demonstration 3

**Content Deleted -
EPRI Proprietary Information**

10.4.5 UT Demonstration 4

**Content Deleted -
EPRI Proprietary Information**

10.4.6 UT Demonstration 5

**Content Deleted -
EPRI Proprietary Information**

10.4.7 UT Demonstration 6

**Content Deleted -
EPRI Proprietary Information**

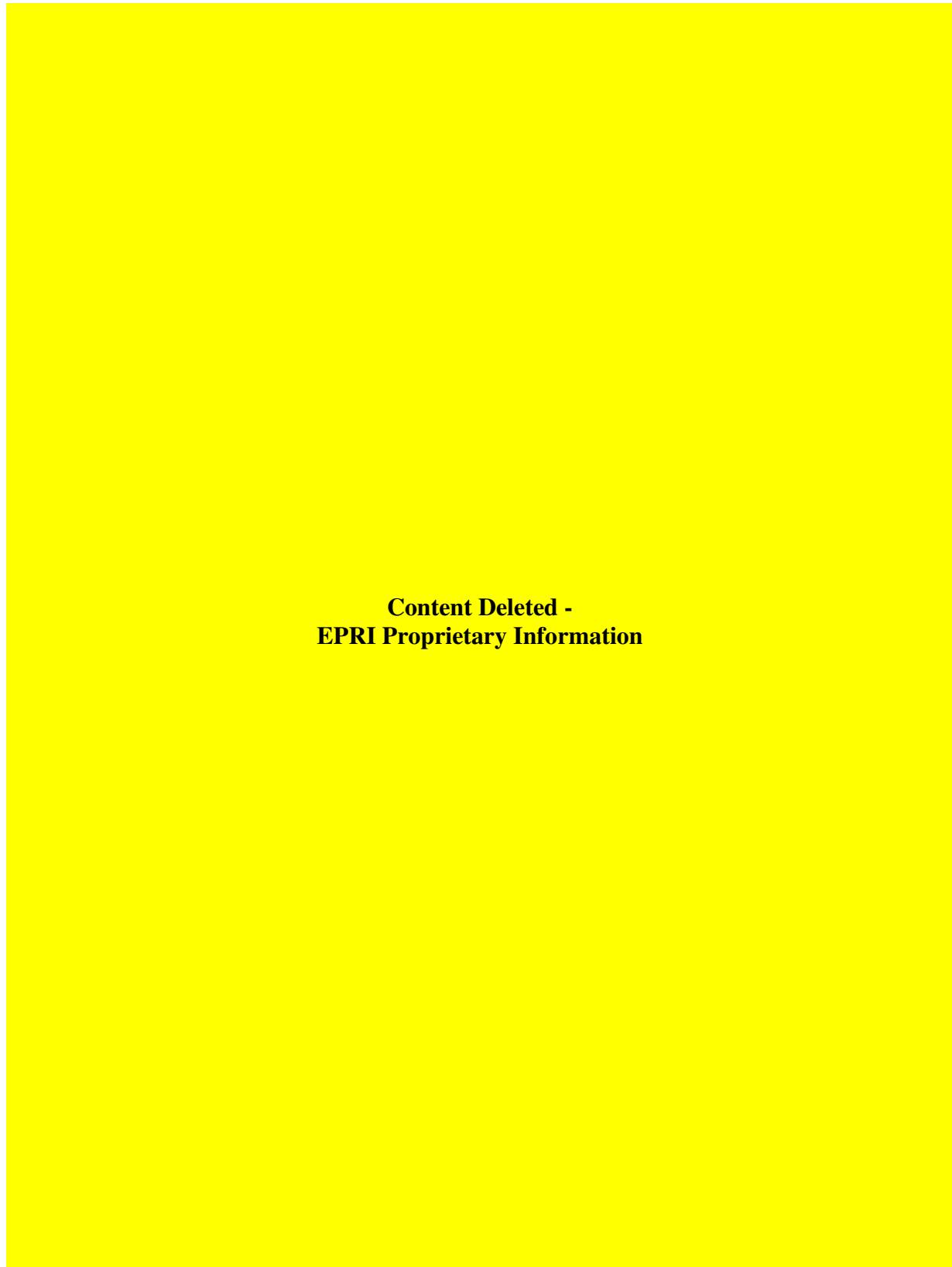
10.4.8 UT Demonstration 7

**Content Deleted -
EPRI Proprietary Information**

10.4.9 UT Demonstration 8



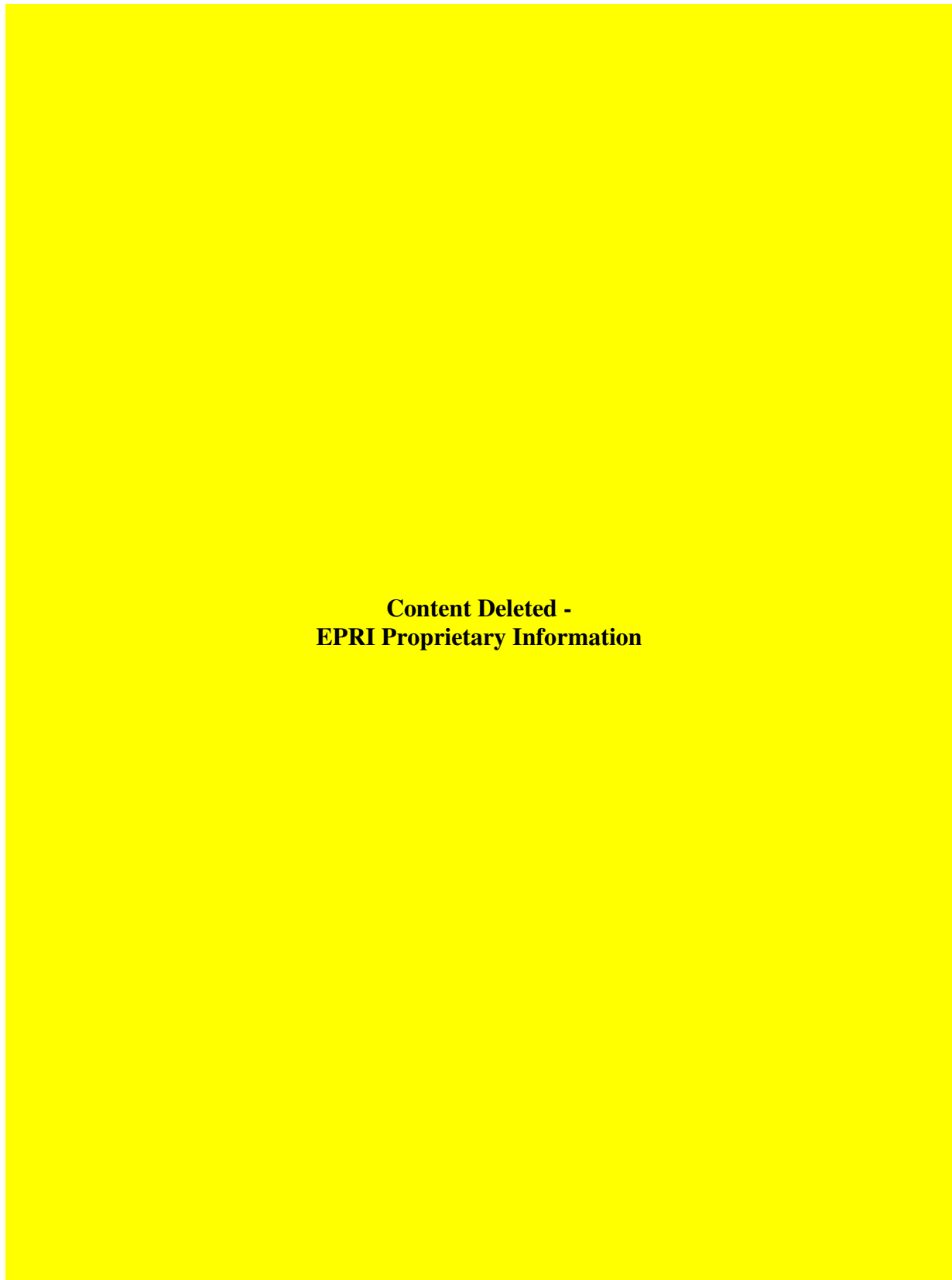
10.4.10 UT Demonstration 9



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.4.11 UT Demonstration 10



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.4.12 UT Demonstration 11



**Content Deleted -
EPRI Proprietary Information**

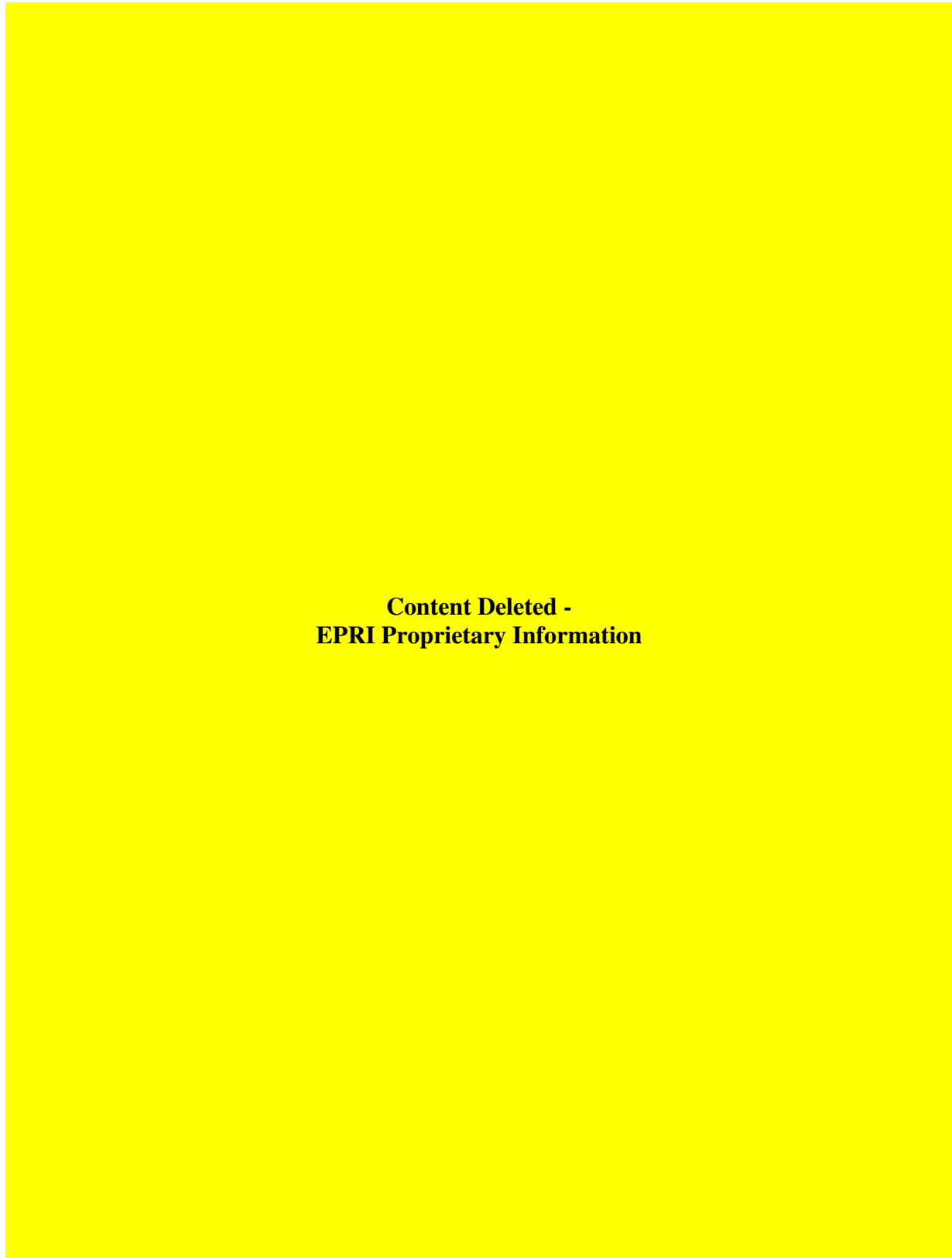
10.4.13 UT Demonstration 12

**Content Deleted -
EPRI Proprietary Information**

10.4.14 UT Demonstration 13

**Content Deleted -
EPRI Proprietary Information**

10.4.15 UT Demonstration 14



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 10.4.15-1. Examination Sequence

**Content Deleted -
EPRI Proprietary Information**

10.4.16 UT Demonstration 15

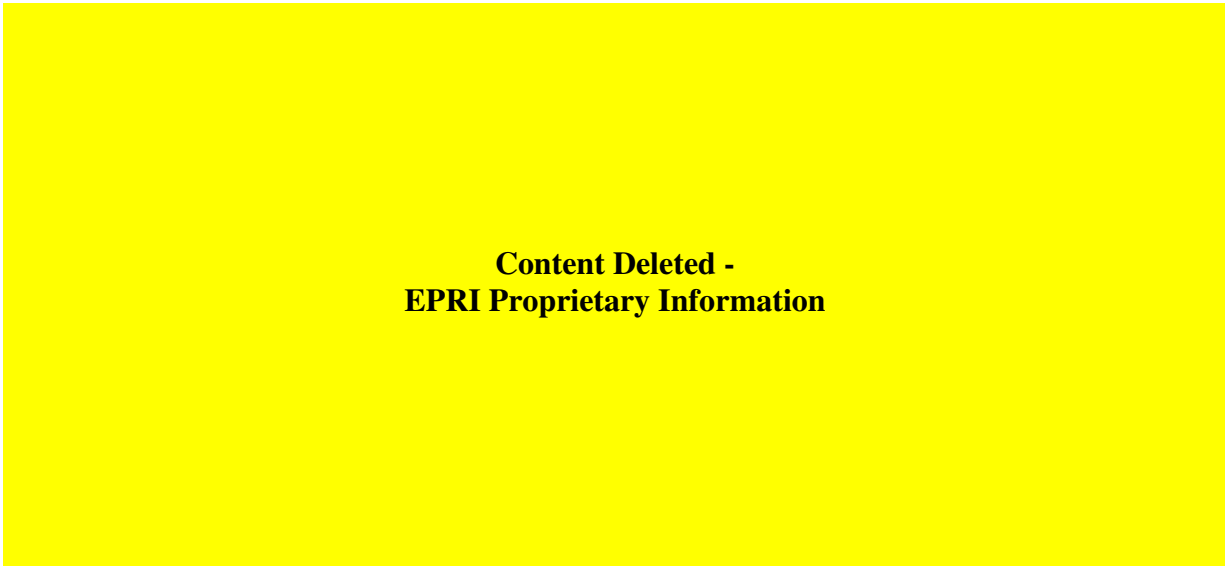
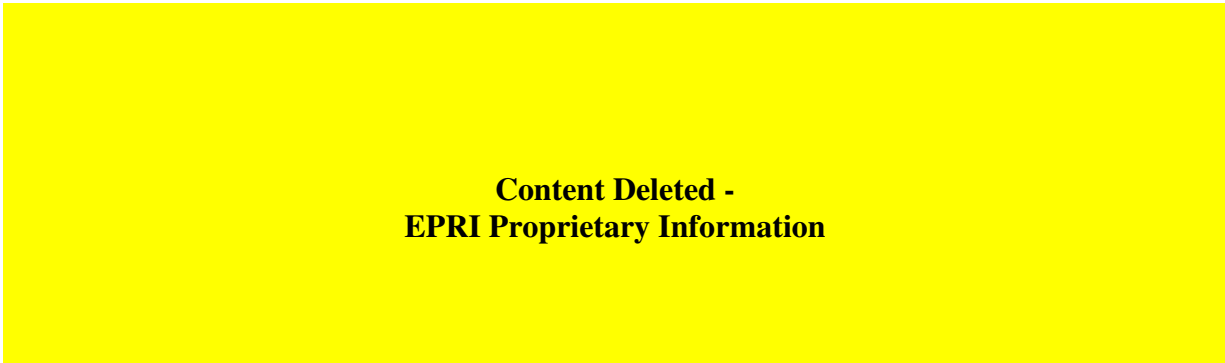
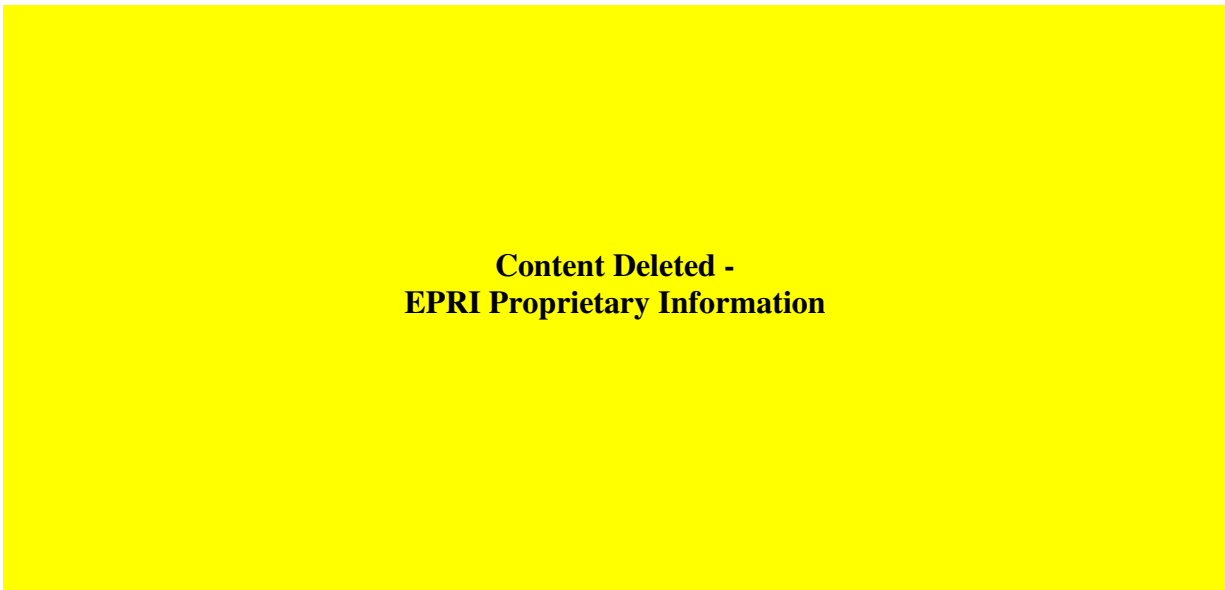


Figure 10.4.16-1. LaSalle 1, Fermi Jet Pump Adapter Configuration



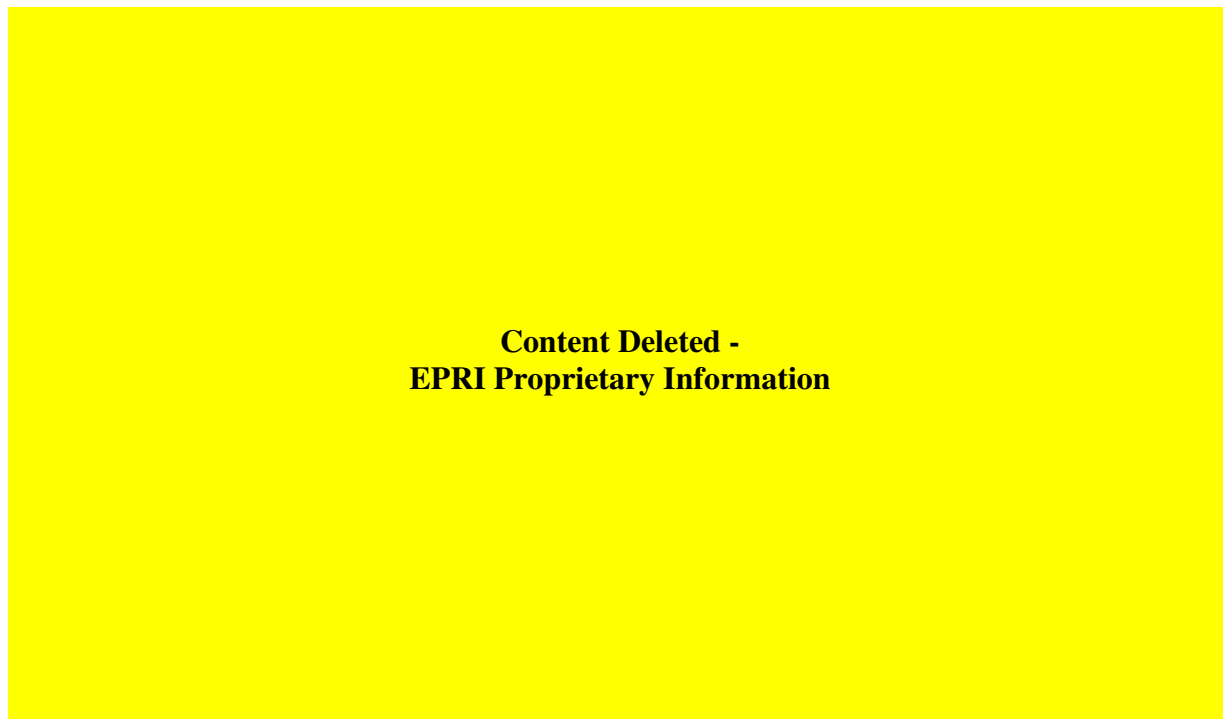
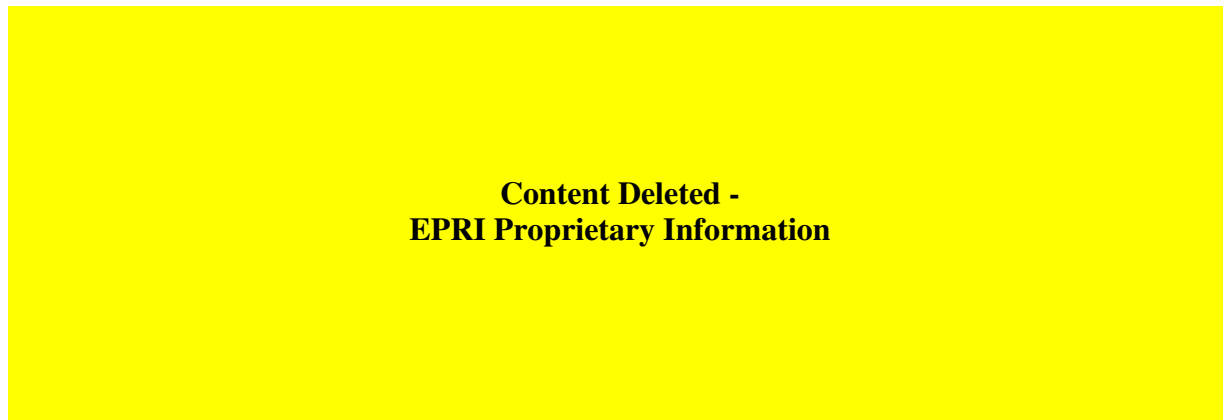


Figure 10.4.16-2. Demonstration for Weld AD-1

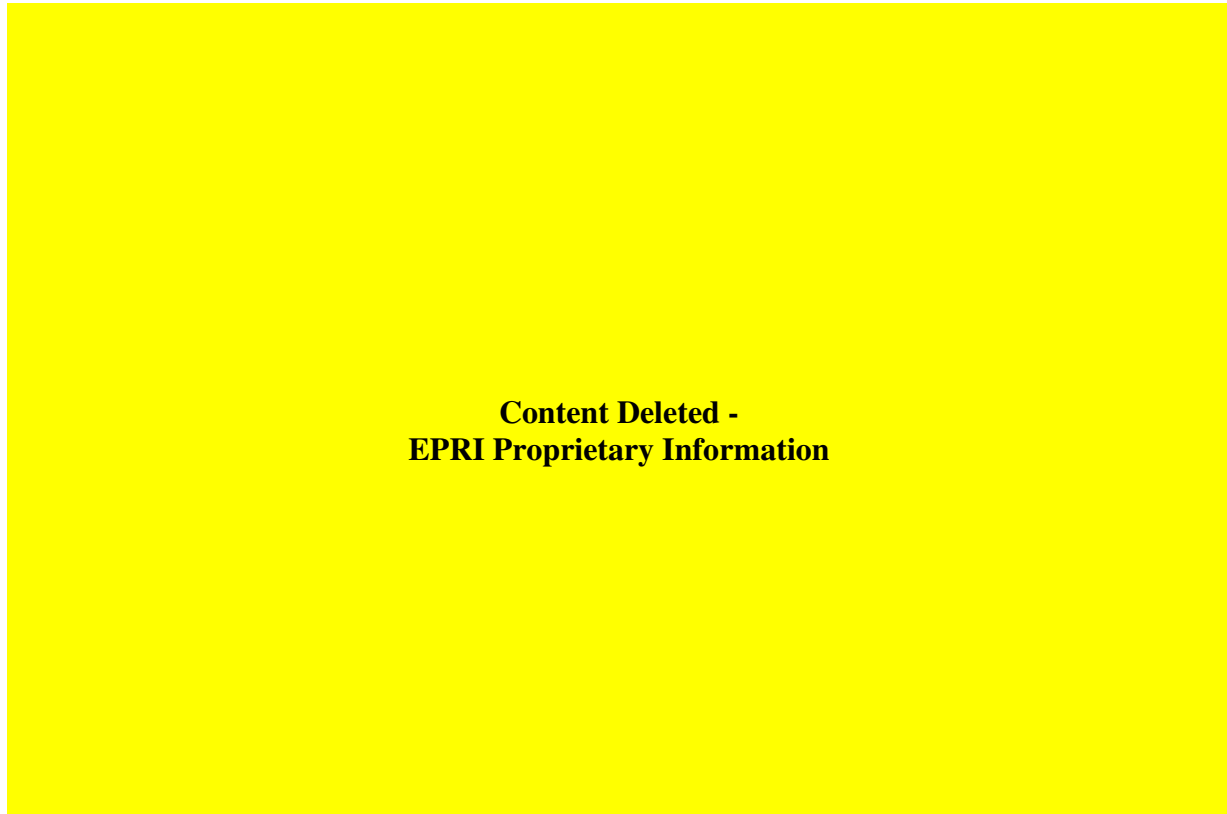


Figure 10.4.16-3. Demonstration for Weld AD-2

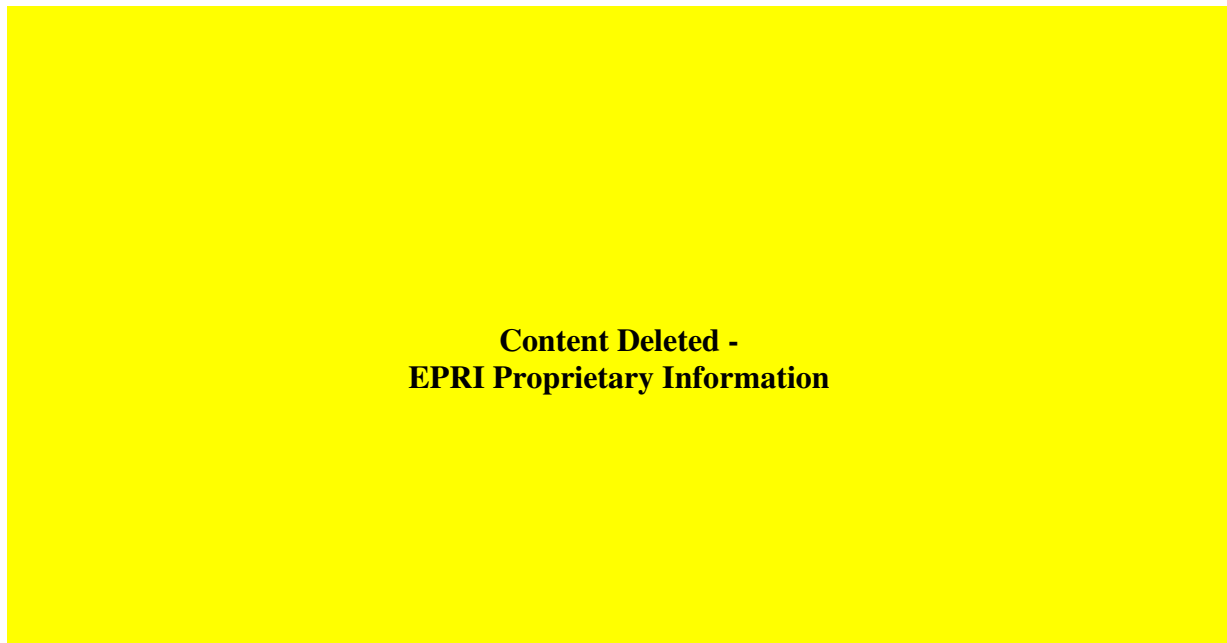
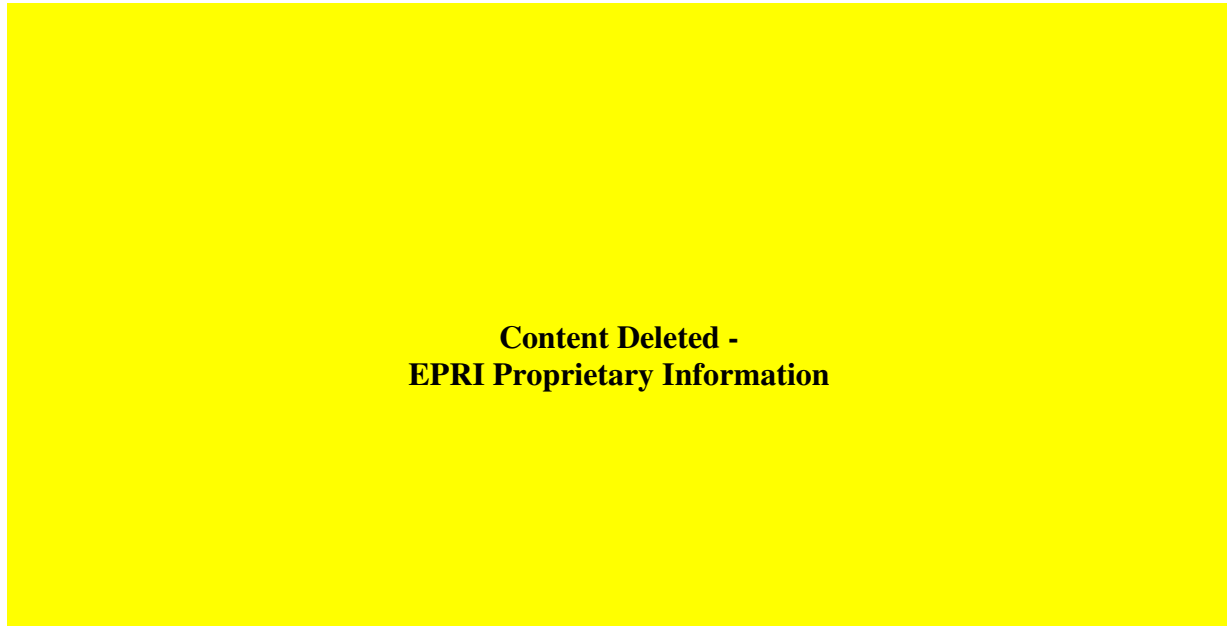


Figure 10.4.16-4. Demonstration for Weld DF-3

10.4.17 UT Demonstration 16

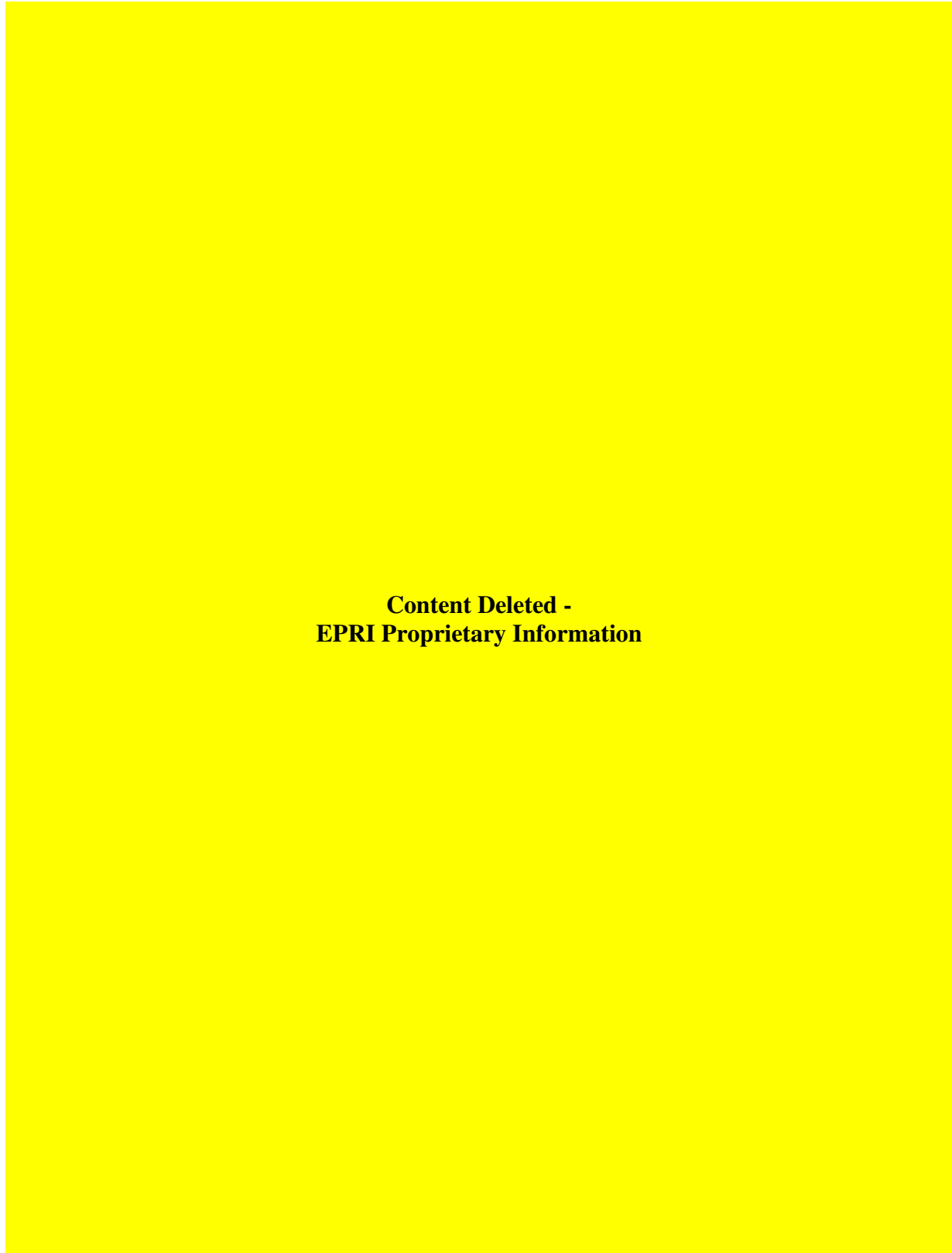


10.4.18 UT Demonstration 17



**Content Deleted -
EPRI Proprietary Information**

10.4.19 UT Demonstration 18



**Content Deleted -
EPRI Proprietary Information**

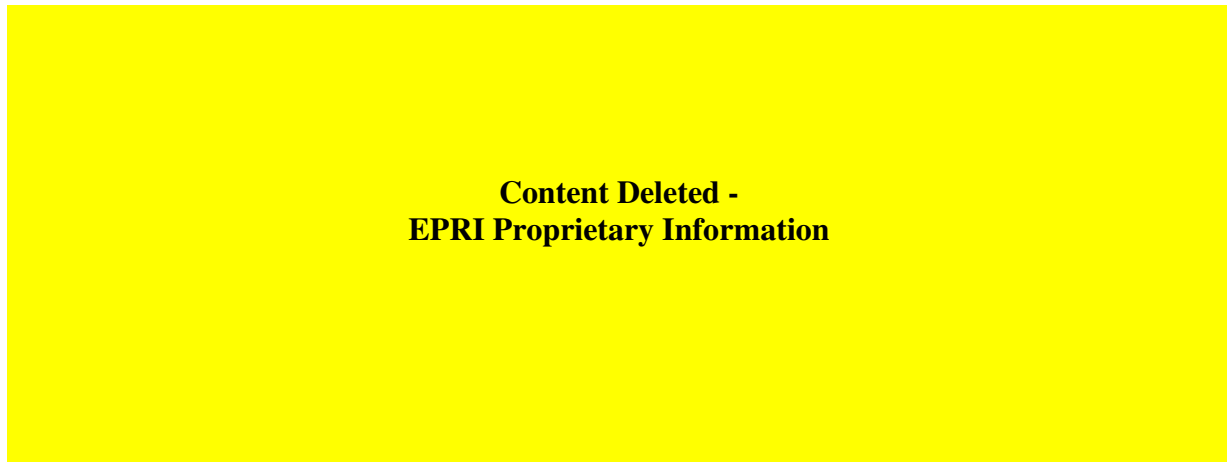
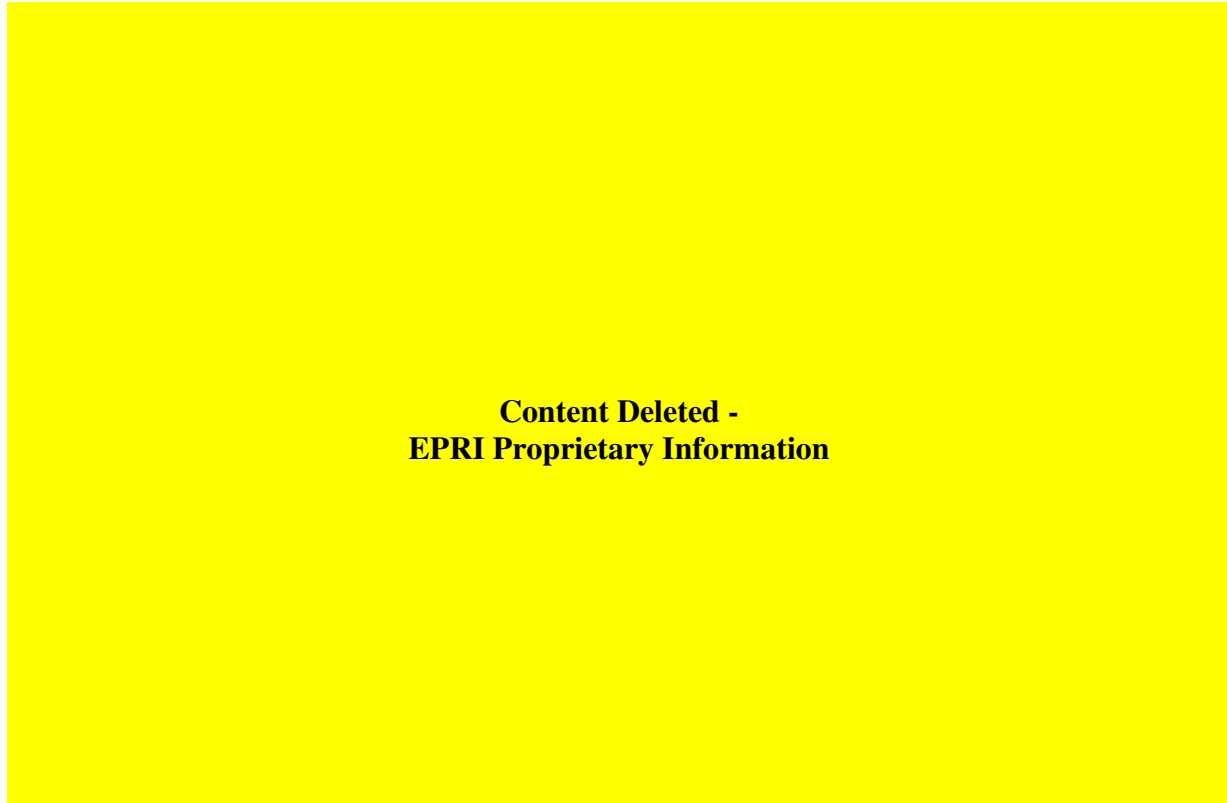
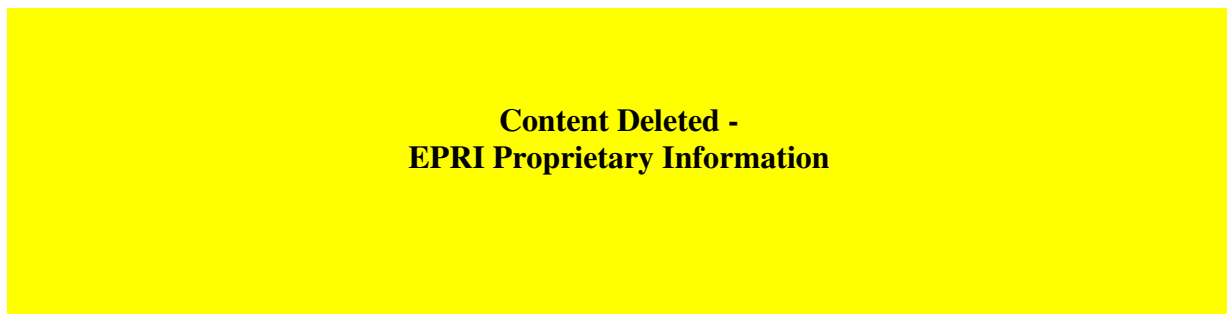


Figure 10.4.19-1. Area BB-2 and BB-3 Examination Technique



**Content Deleted -
EPRI Proprietary Information**

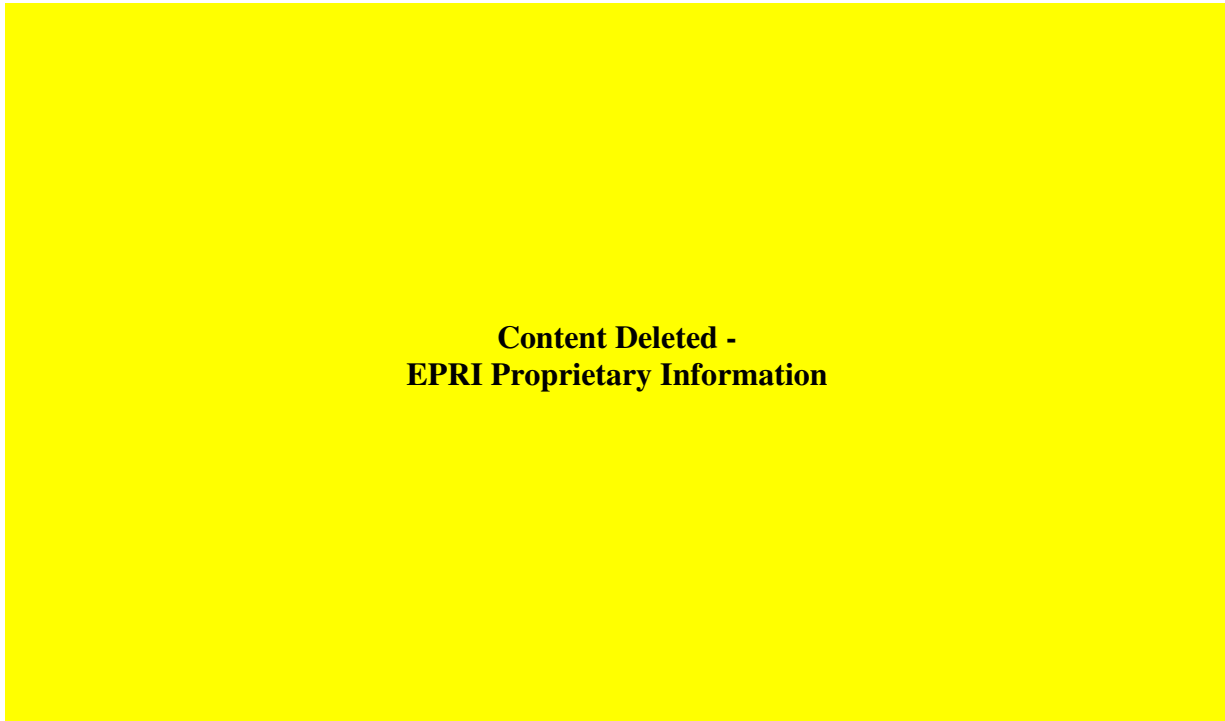
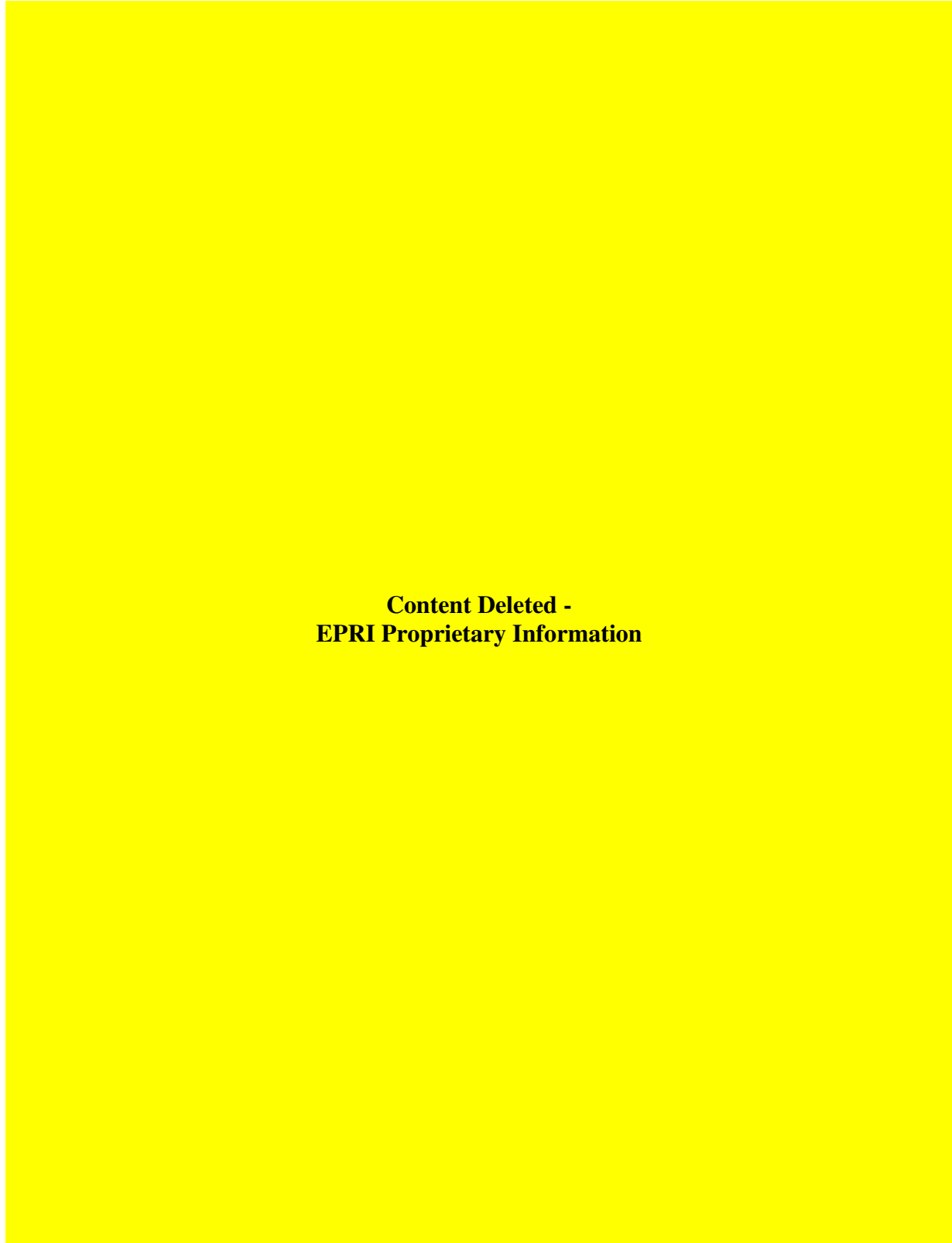


Figure 10.4.19-2. Jet Pump Beam Taper-to-Radius Transition Mockups

10.4.20 UT Demonstration 19



**Content Deleted -
EPRI Proprietary Information**

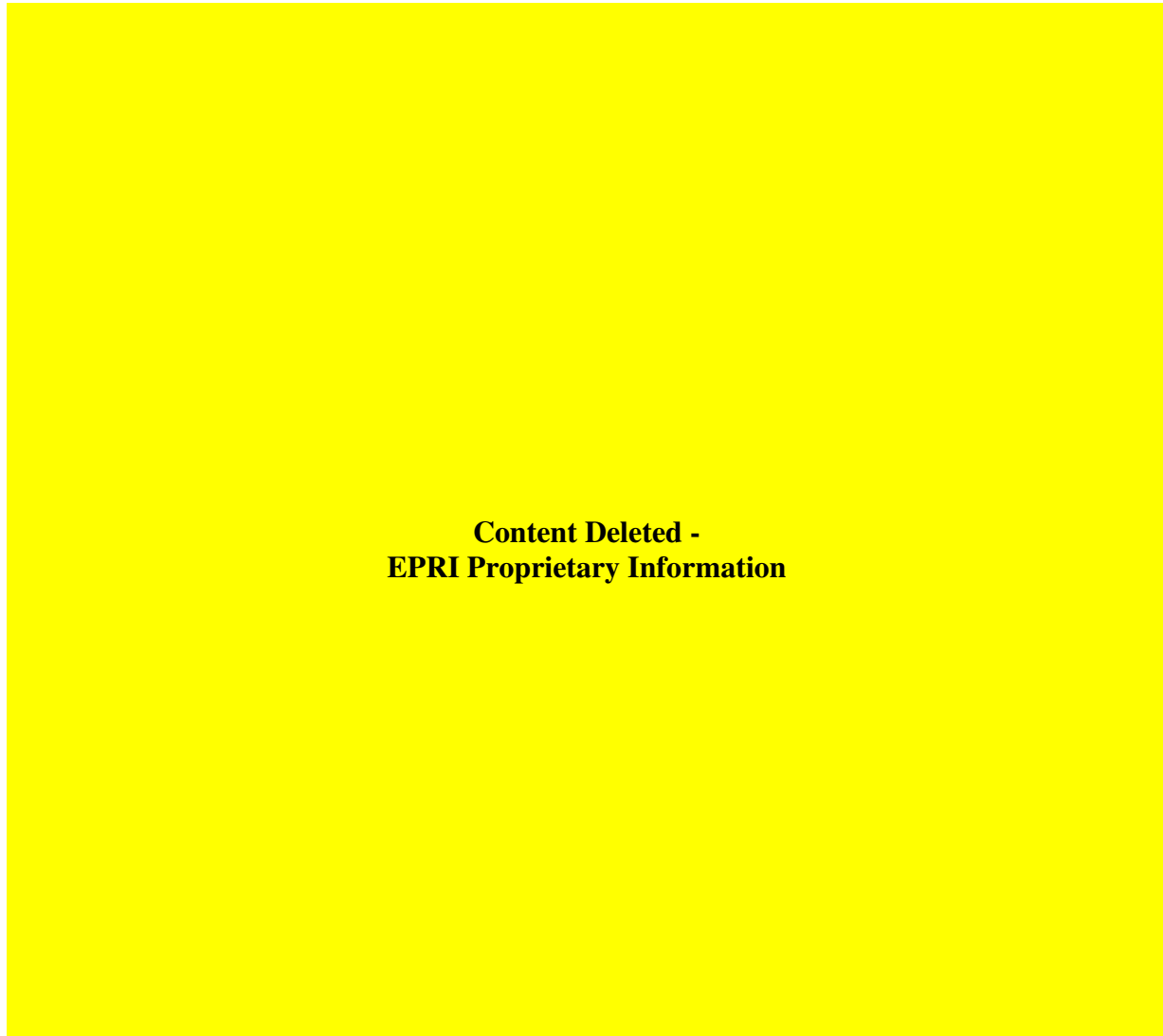
10.4.21 UT Demonstration 20



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.4.22 UT Demonstration 21





**Content Deleted -
EPRI Proprietary Information**

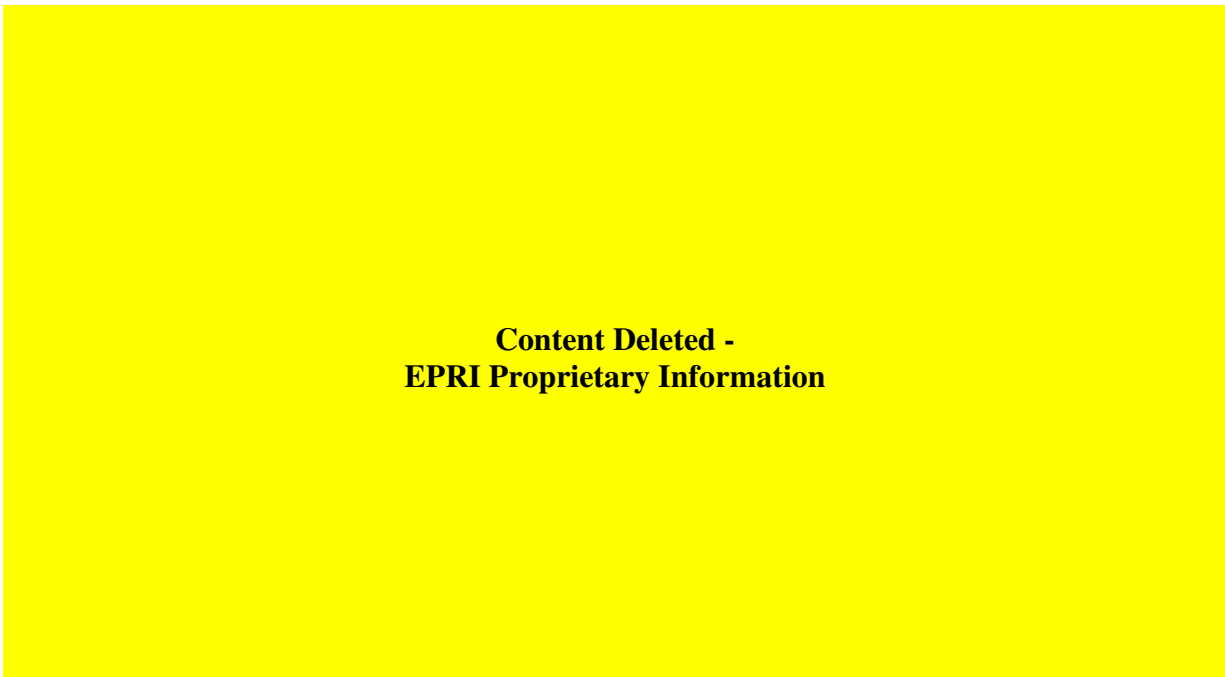
Figure 10.4.22-1. Fermi-2 and LaSalle-1 (“U-Shaped”) Curved Adapter Configuration



**Content Deleted -
EPRI Proprietary Information**



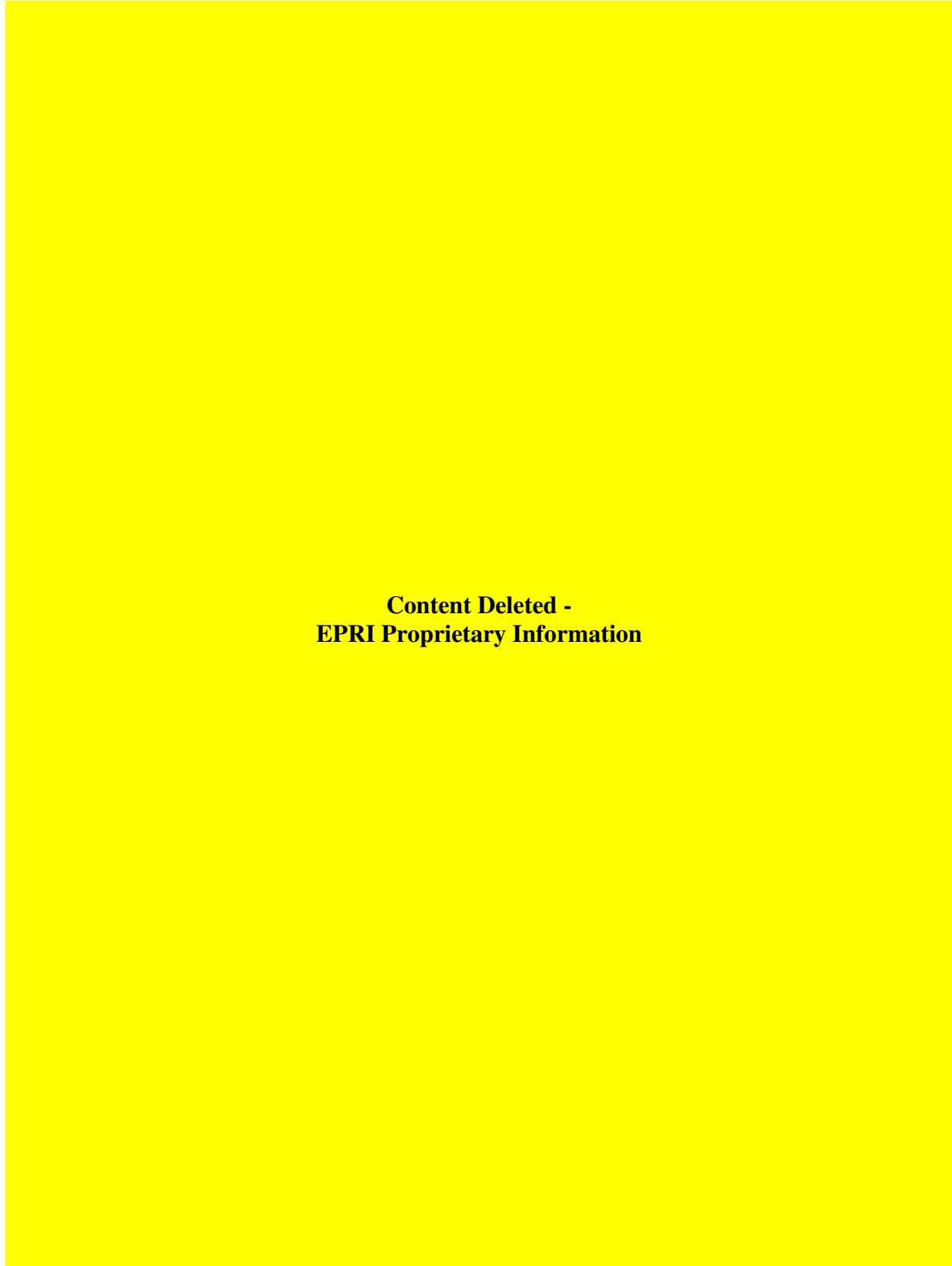
Figure 10.4.22-2. Fermi-2 and LaSalle-1 DF-3 Weld Inspection Location





**Content Deleted -
EPRI Proprietary Information**

10.4.23 UT Demonstration 22



**Content Deleted -
EPRI Proprietary Information**

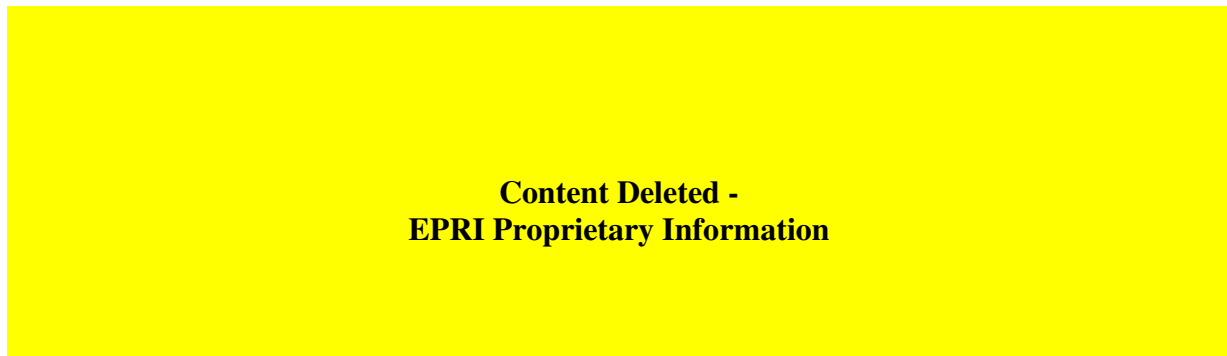
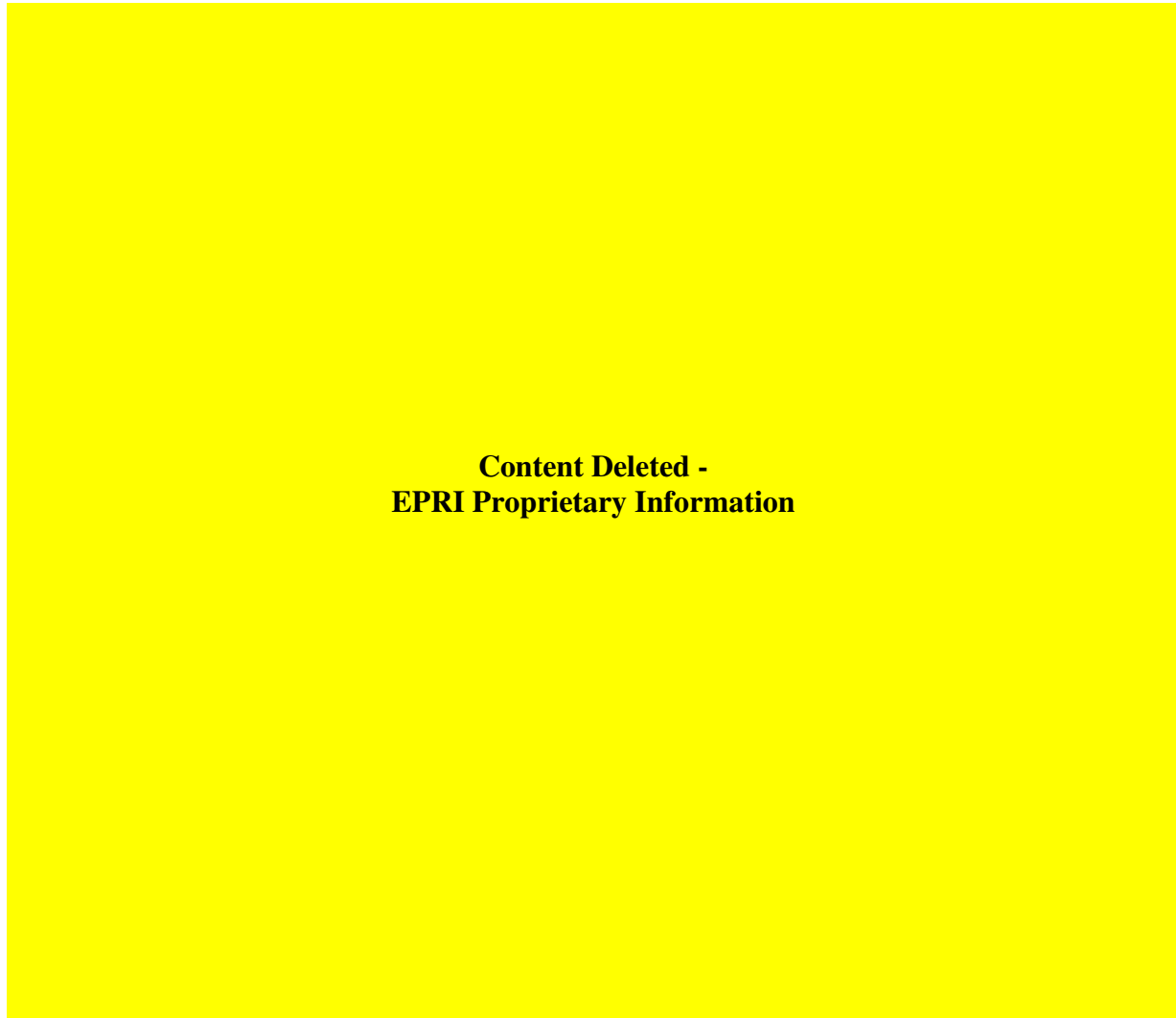


Figure 10.4.23-1. Azimuthal Focal Laws (Technique 2 Shown on AD-1 Weld Configuration)

**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.23-2. Linear Focal Laws (Shown on AD-1 Weld Configuration)

Table 10.4.23-1. Demonstrated Parameters for Technique 1

**Content Deleted -
EPRI Proprietary Information**

Table 10.4.23-2. Demonstrated Parameters for Technique 2

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.4.24 UT Demonstration 23



Content Deleted -
EPRI Proprietary Information

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.24-1. Area BB-2 and BB-3 Examination Technique

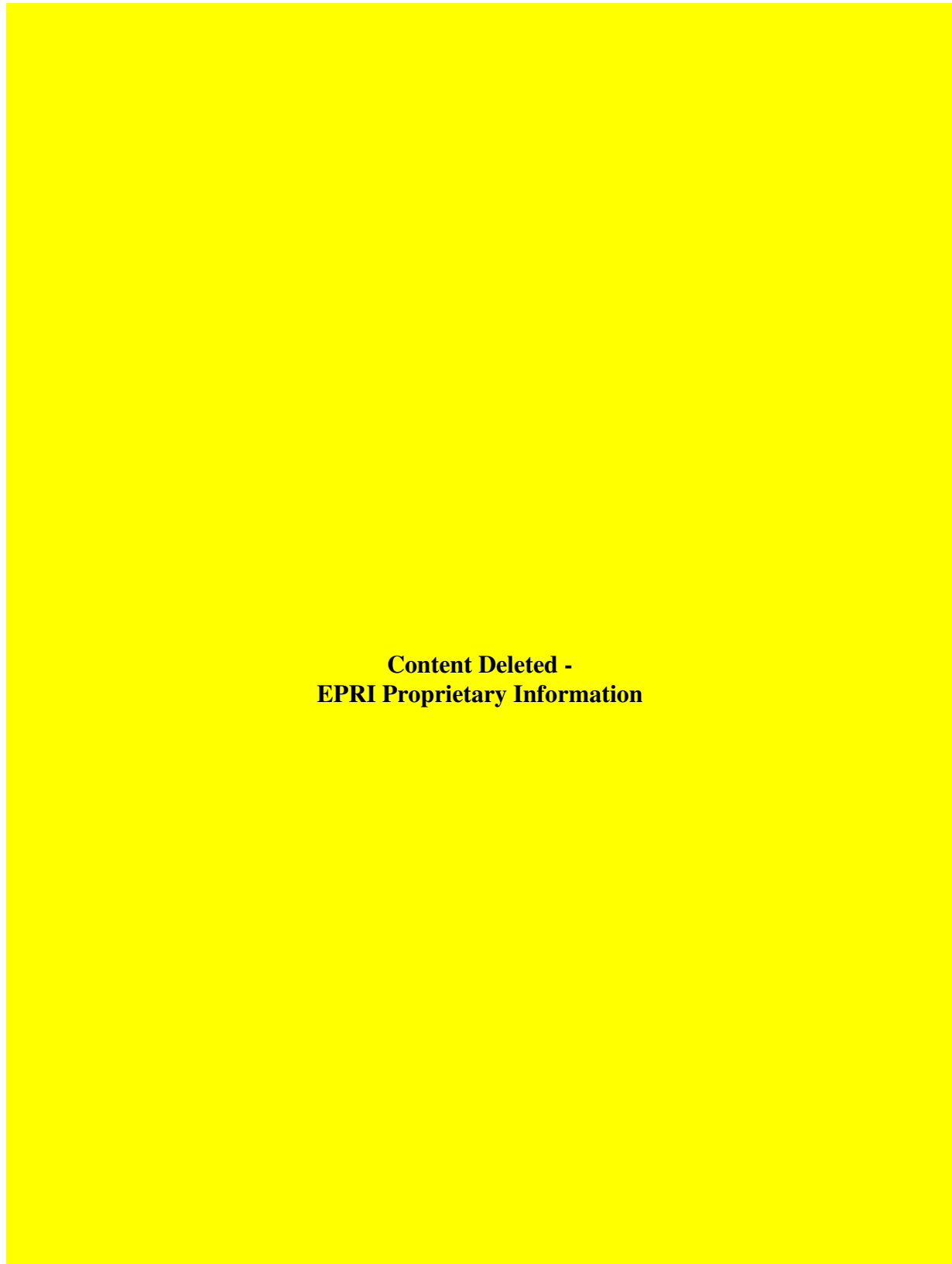
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.24-2. Jet Pump Beam Taper-to-Radius Transition Mockups

10.4.25 UT Demonstration 24



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.25-1. Lateral and Raster Scan Techniques (Including Focal Laws)

**Content Deleted -
EPRI Proprietary Information**

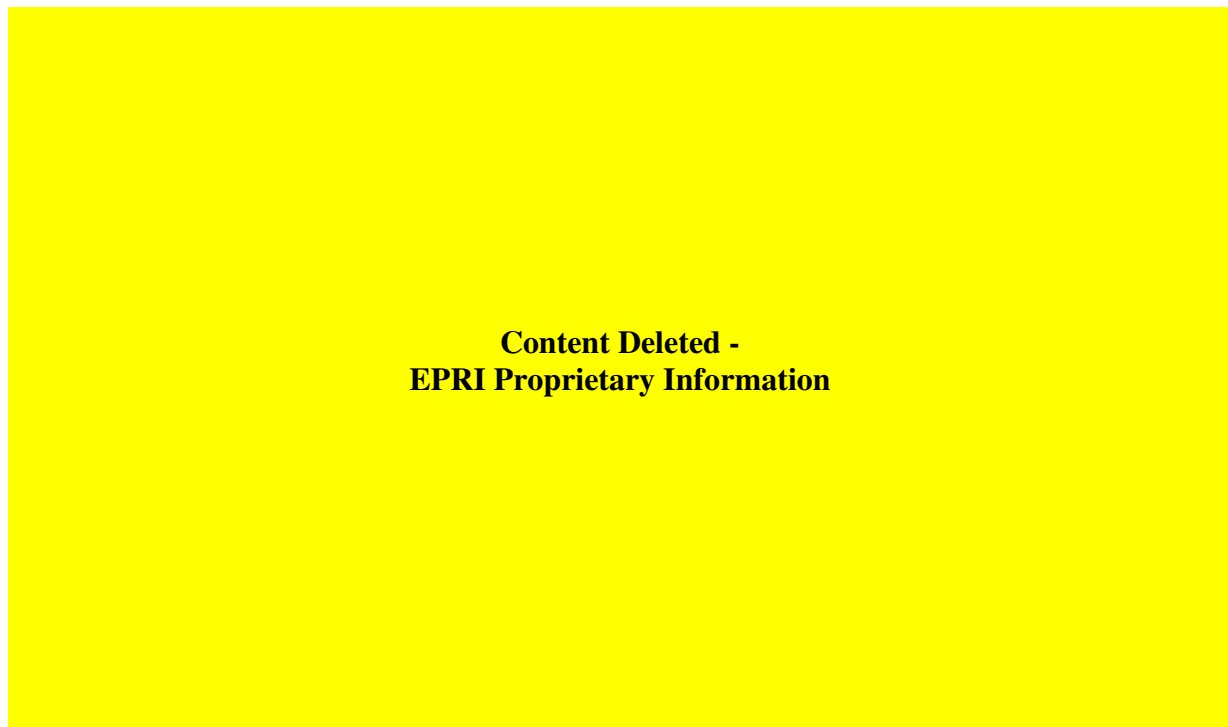
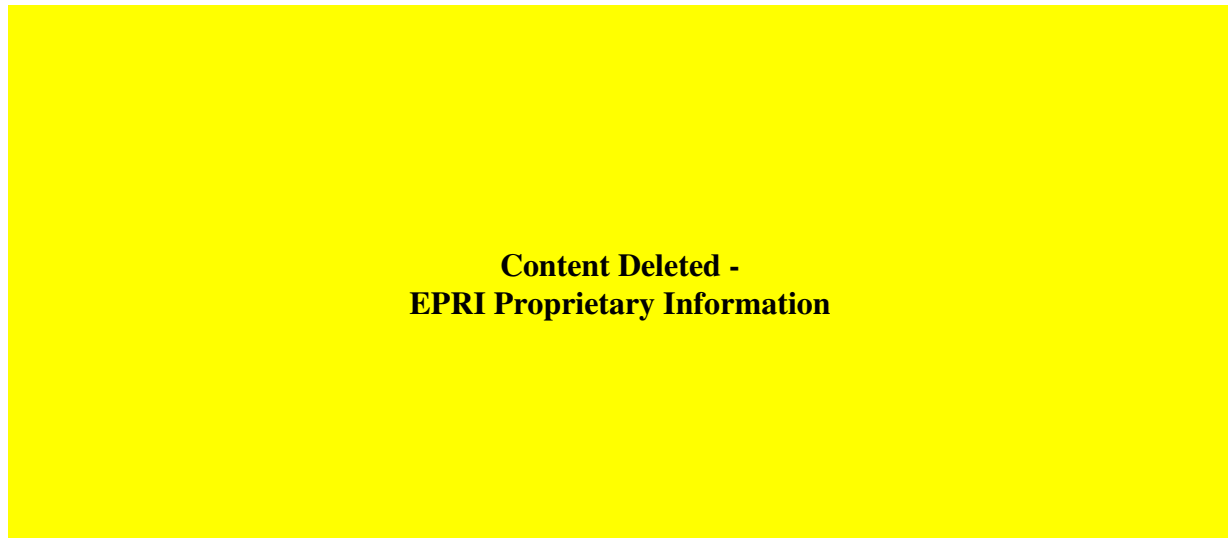
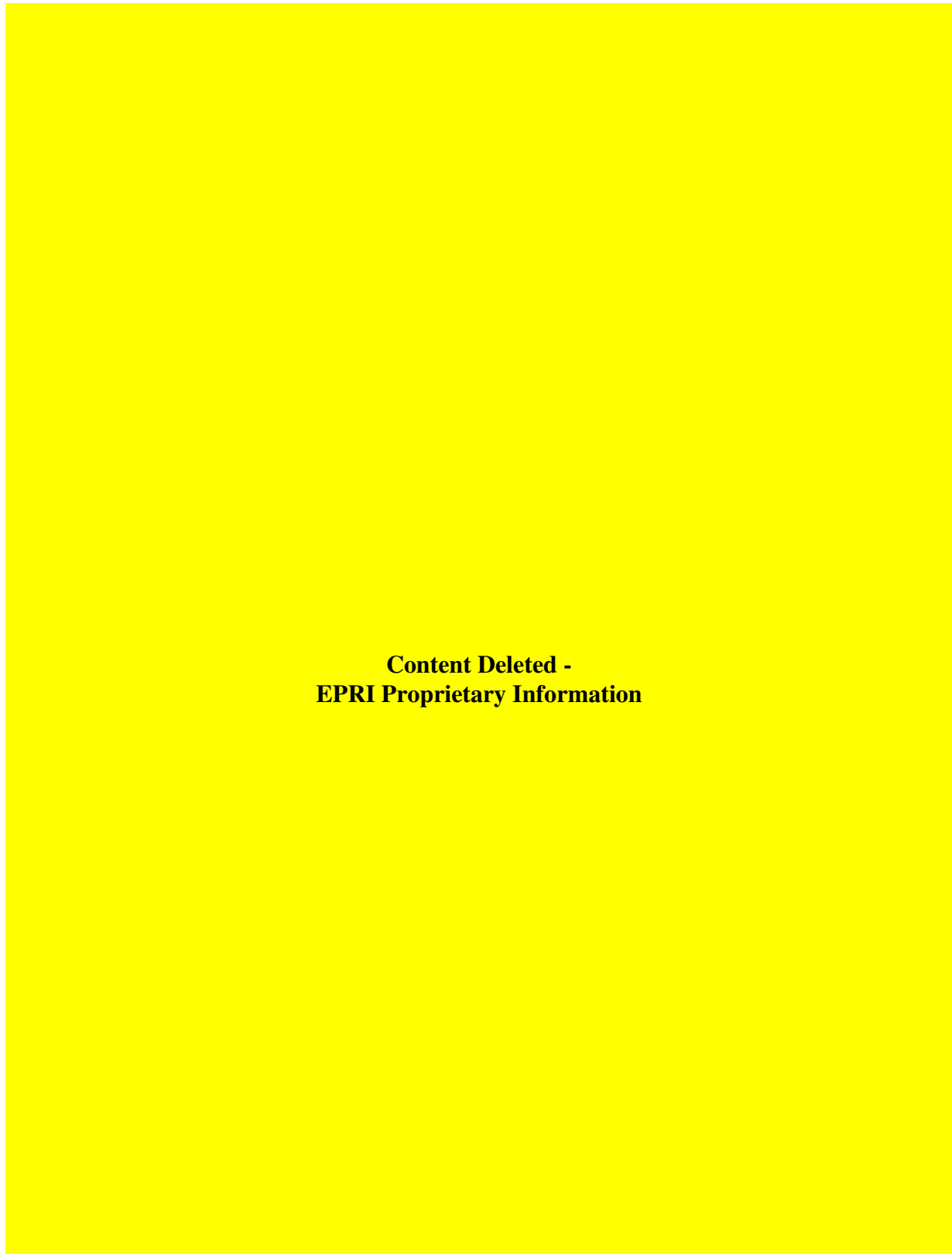


Figure 10.4.25-2. Reported Versus Actual Length Measurements

**Content Deleted -
EPRI Proprietary Information**

10.4.26 UT Demonstration 25



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 10.4.26-1. Scan Surface and Probe Orientation for RS-1 Weld Locations

**Content Deleted -
EPRI Proprietary Information**

Table 10.4.26-2. Scan Surface and Probe Orientation for RS-2 Weld Locations

**Content Deleted -
EPRI Proprietary Information**

Table 10.4.26-3. Scan Surface and Probe Orientation for RS-3 Weld Locations

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.26-1. Actual Ultrasonic Beam Path for Flaw Depth Sizing (Outside Surface of Elbow Affects Refracted Angle, Inside Surface of Elbow Affects Reflected Angle)



**Content Deleted -
EPRI Proprietary Information**

Figure 10.4.26-2. Assumed Geometry for Reporting Flaw Depth (Does Not Account for Elbow Curvature / Assumes Flat and Parallel Surfaces)



**Content Deleted -
EPRI Proprietary Information**

10.4.27 UT Demonstration 26



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

10.5 ET Technique Demonstrations

10.5.1 ET Demonstration 1



**Content Deleted -
EPRI Proprietary Information**

10.5.2 ET Demonstration 2



**Content Deleted -
EPRI Proprietary Information**

10.6 Delivery System Demonstrations

10.6.1 Delivery System Demonstration 1



**Content Deleted -
EPRI Proprietary Information**

10.6.2 Delivery System Demonstration 2



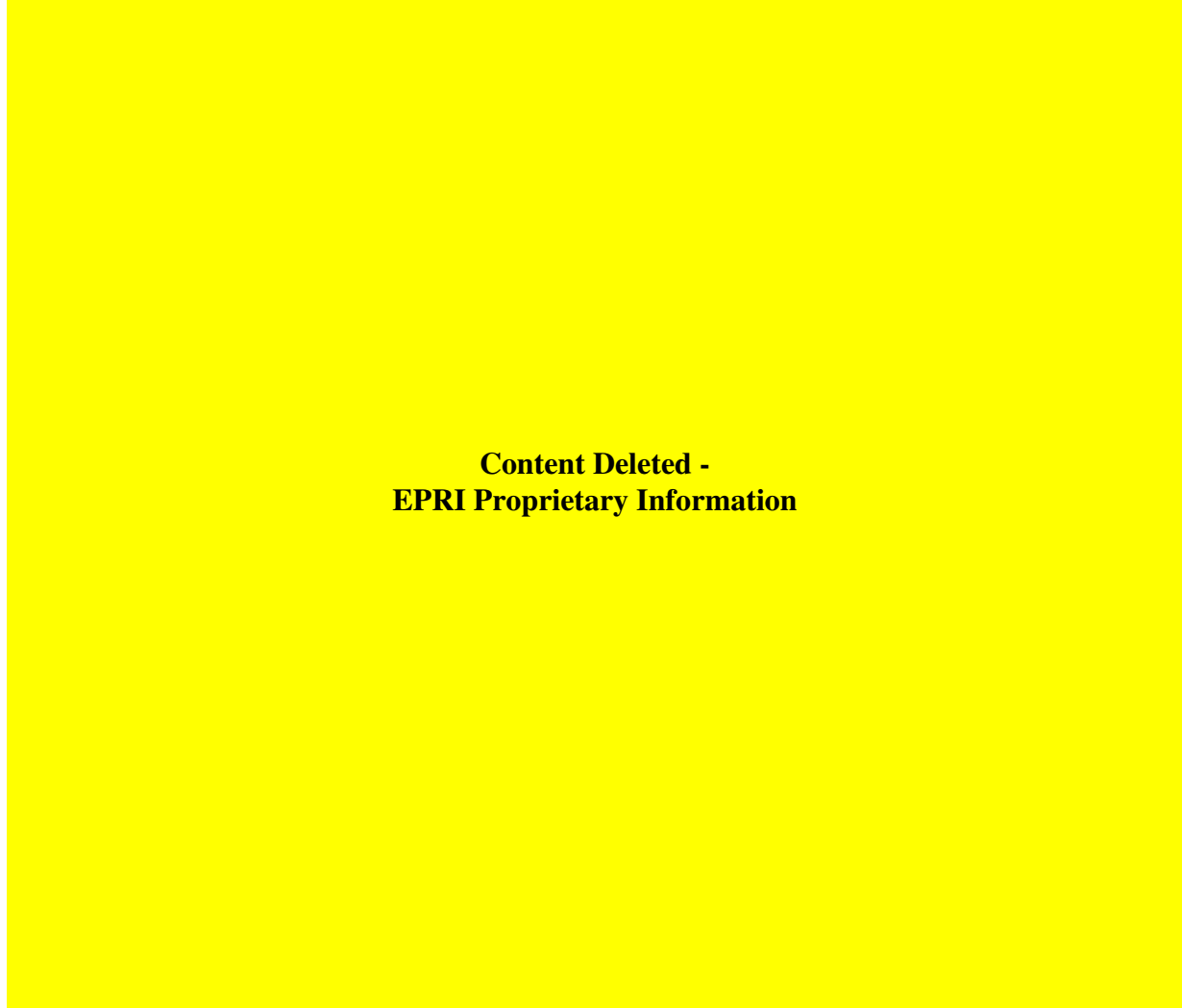
**Content Deleted -
EPRI Proprietary Information**

10.6.3 Delivery System Demonstration 3



**Content Deleted -
EPRI Proprietary Information**

10.6.4 Delivery System Demonstration 4



10.6.5 Delivery System Demonstration 5



**Content Deleted -
EPRI Proprietary Information**

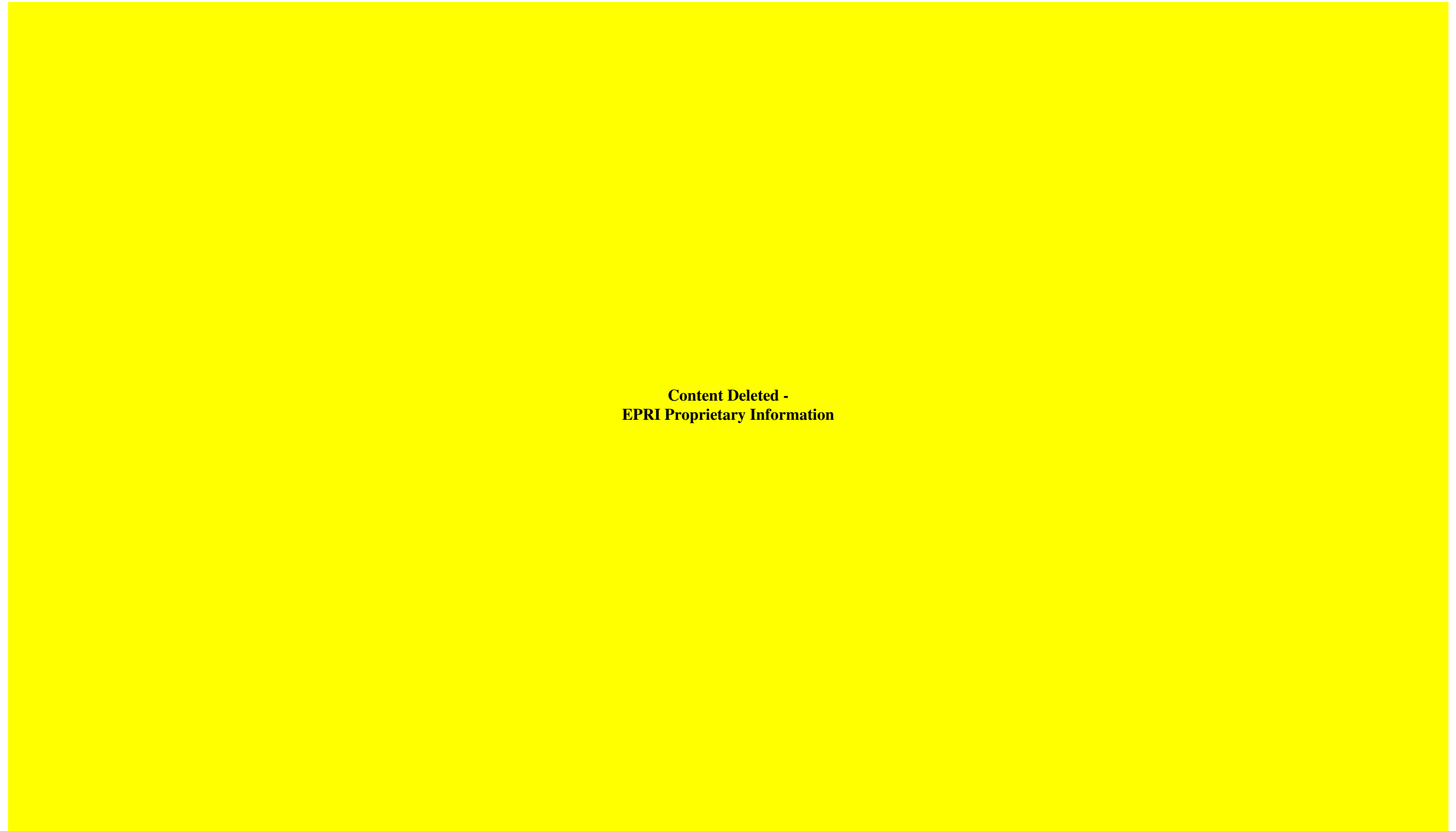


Figure 10.3.1-1. Jet Pump Riser Mockup BWRVIP-U: Configuration and Flaw Details

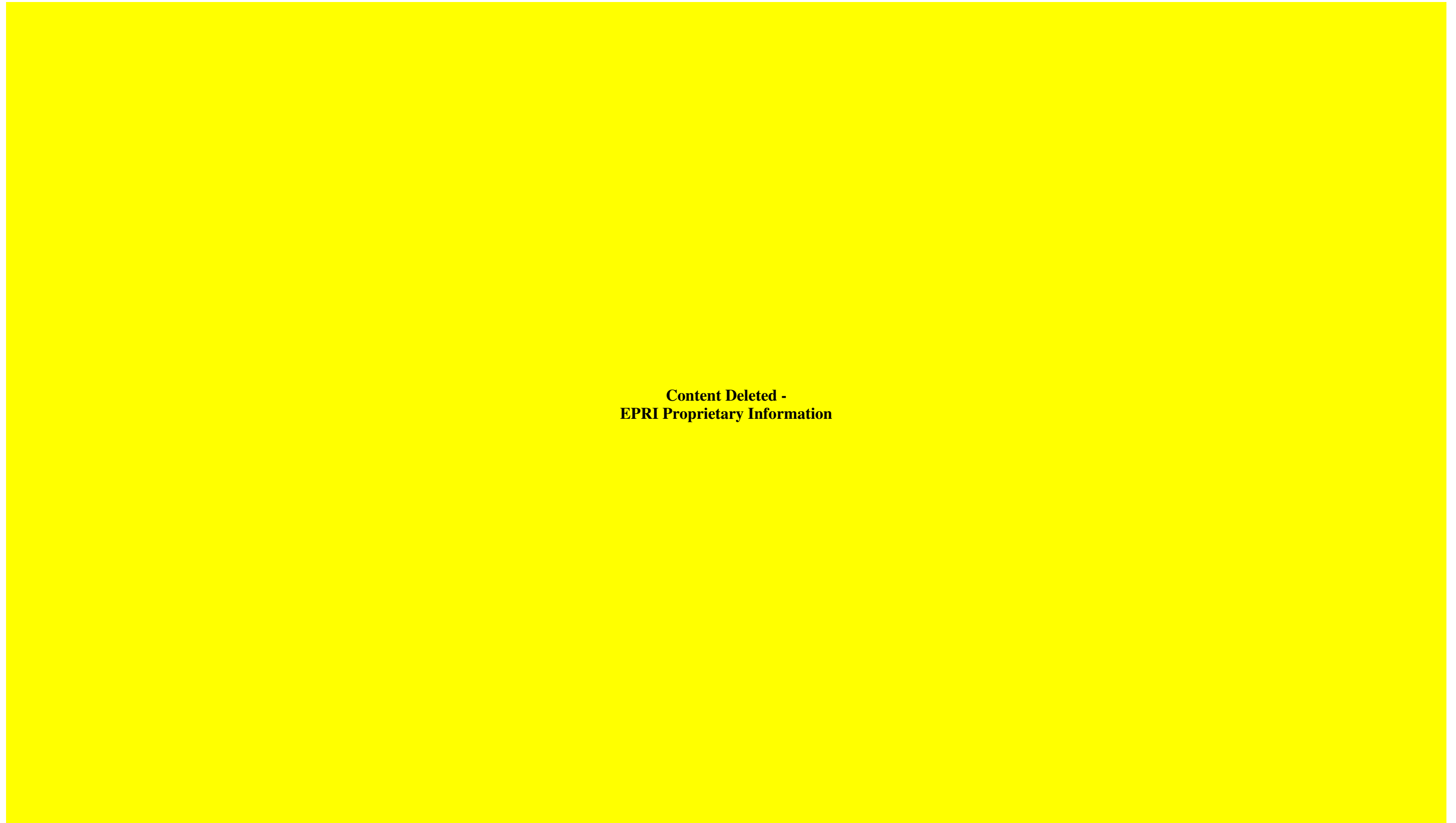


Figure 10.3.2-1. Jet Pump Riser Mockup BWRVIP-V: Configuration and Flaw Details

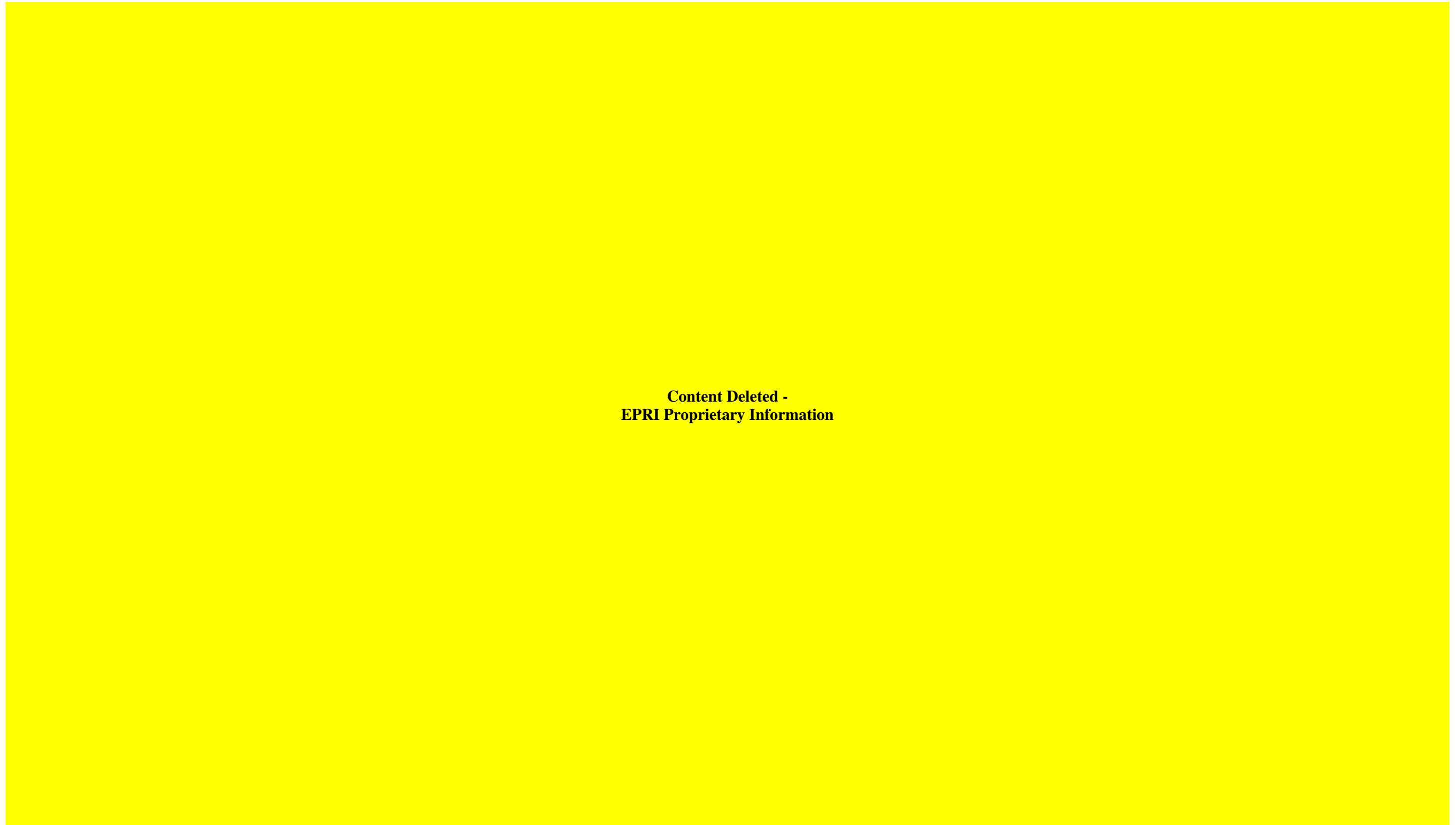


Figure 10.3.3-1. Jet Pump Mixer Mockup BWRVIP-Z3: Configuration and Flaw Details



**Content Deleted -
EPRI Proprietary Information**

Figure 10.3.4-1. Jet Pump Mixer Mockup BWRVIP-Z4: Configuration



Figure 10.3.4-2. Jet Pump Mixer Mockup BWRVIP-Z4: Flaw Details

11

STANDBY LIQUID CONTROL

11.1 Summary

**Content Deleted -
EPRI Proprietary Information**

Content Deleted - EPRI Proprietary Information

11.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

11.2.1 Nozzle-to-Vessel Weld

**Content Deleted -
EPRI Proprietary Information**

11.2.2 Penetration-to-Vessel Weld

**Content Deleted -
EPRI Proprietary Information**

11.2.3 Nozzle-to-Safe-End Weld

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

11.2.4 Penetration-to-Safe-End Extension Weld

**Content Deleted -
EPRI Proprietary Information**

11.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

11.3.1 Mockup BWRVIP-X1

**Content Deleted -
EPRI Proprietary Information**

11.3.2 Mockup BWRVIP-X2

**Content Deleted -
EPRI Proprietary Information**

11.3.3 Mockup BWRVIP-Y3

**Content Deleted -
EPRI Proprietary Information**

11.3.4 Mockup BWRVIP-Y4

**Content Deleted -
EPRI Proprietary Information**

11.3.5 Mockup BWRVIP-Y5

**Content Deleted -
EPRI Proprietary Information**

11.4 UT Technique Demonstrations for SLC Components

**Content Deleted -
EPRI Proprietary Information**

11.4.1 General Findings for UT

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

11.4.2 UT Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

11.4.3 UT Demonstration 2



**Content Deleted -
EPRI Proprietary Information**

Figure 11.3.1-1. SLC Nozzle Mockup BWRVIP-X1: Configuration and Flaw Details

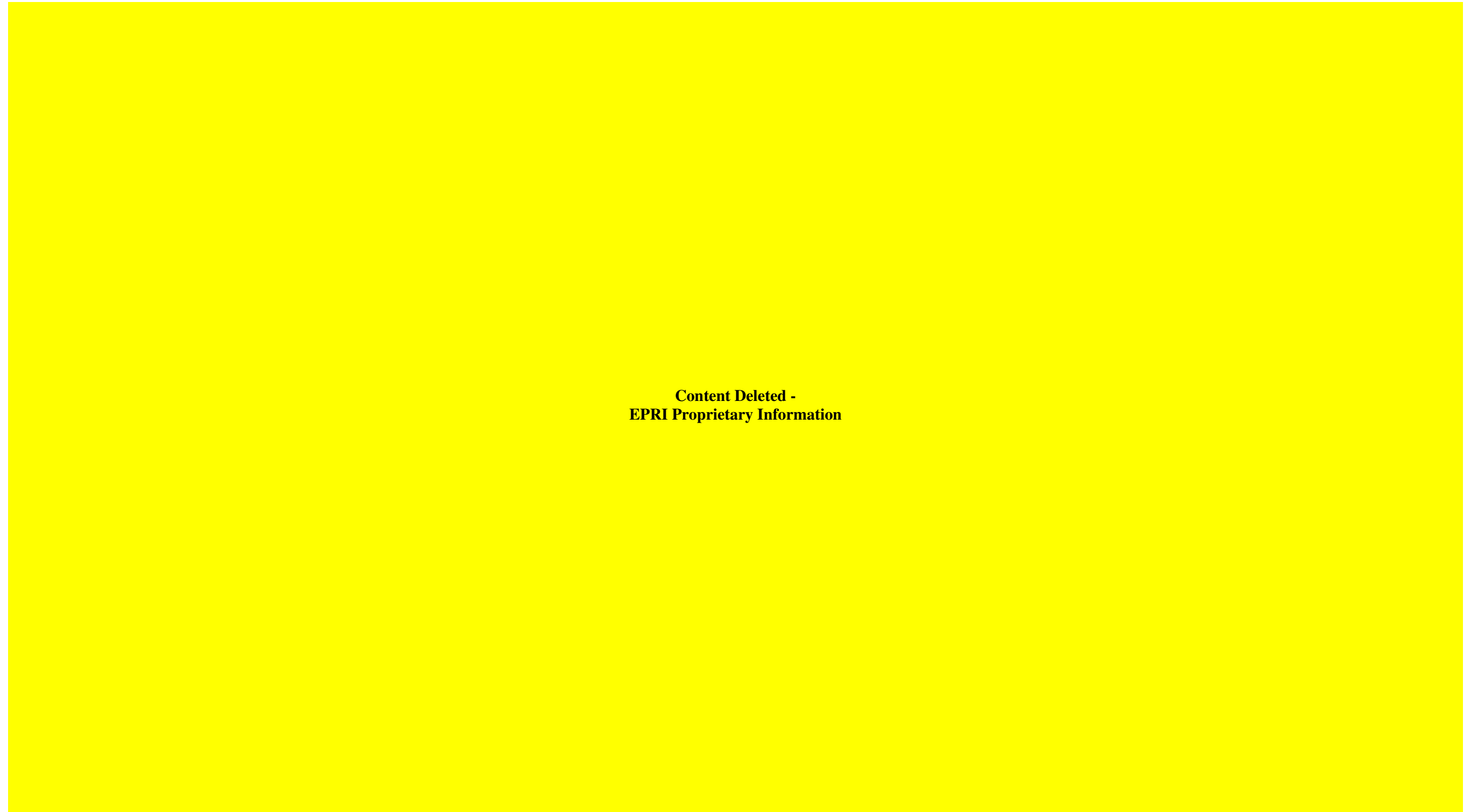


Figure 11.3.2-1. SLC Nozzle Mockup BWRVIP-X2: Configuration and Flaw Details

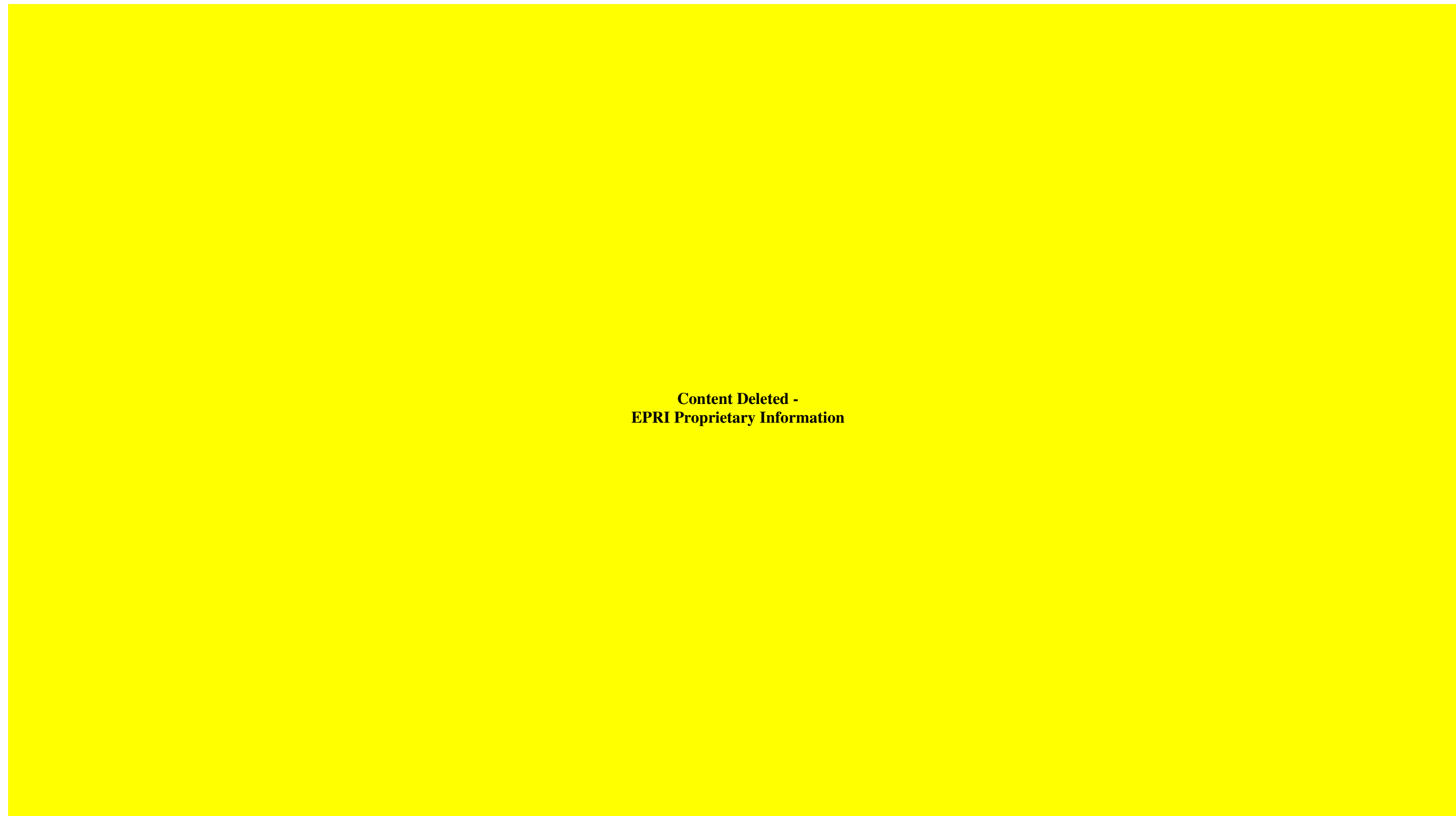


Figure 11.3.3-1. SLC Penetration Mockup BWRVIP-Y3: Configuration and Flaw Details

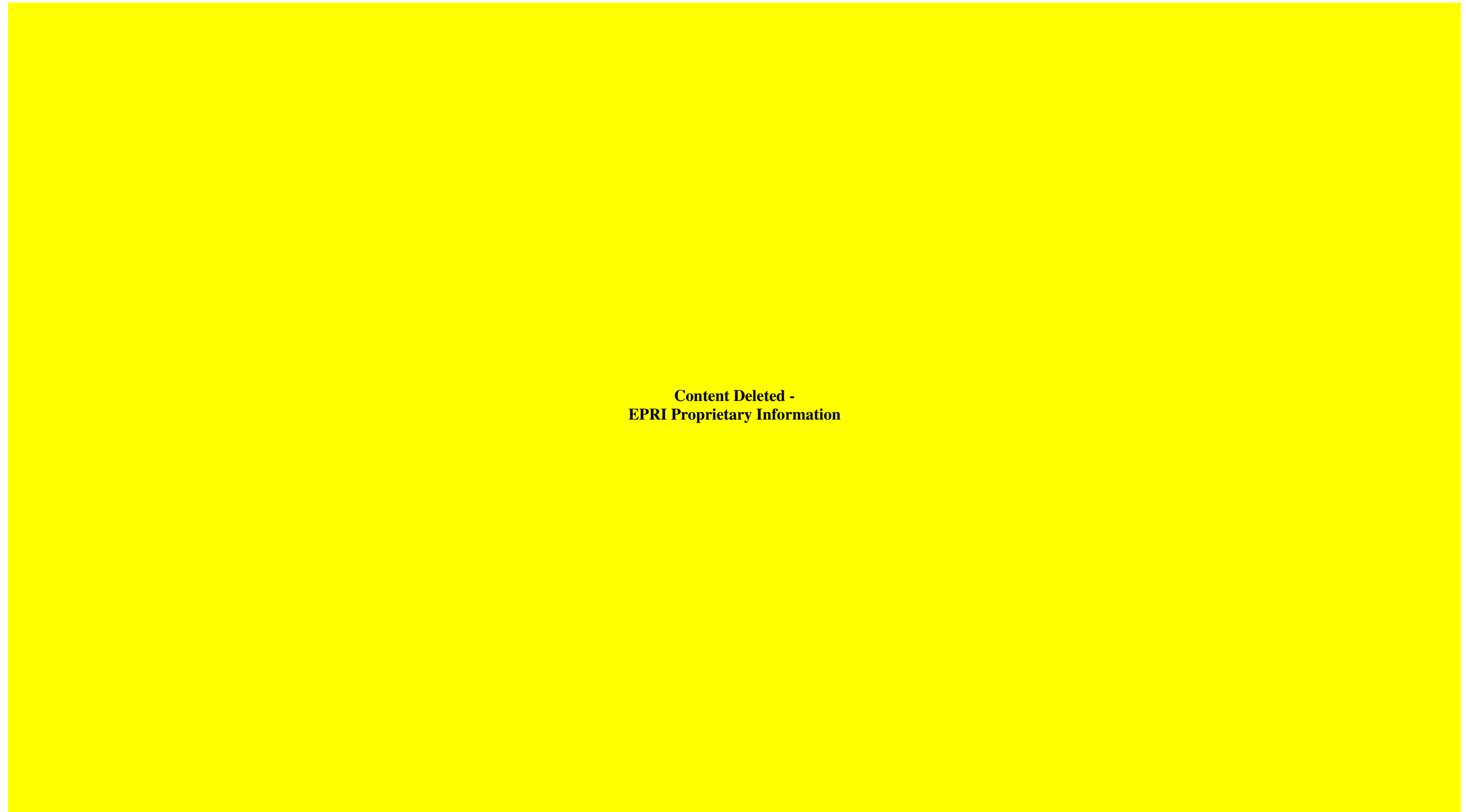


Figure 11.3.4-1. SLC Penetration Mockup BWRVIP-Y4: Configuration and Flaw Details

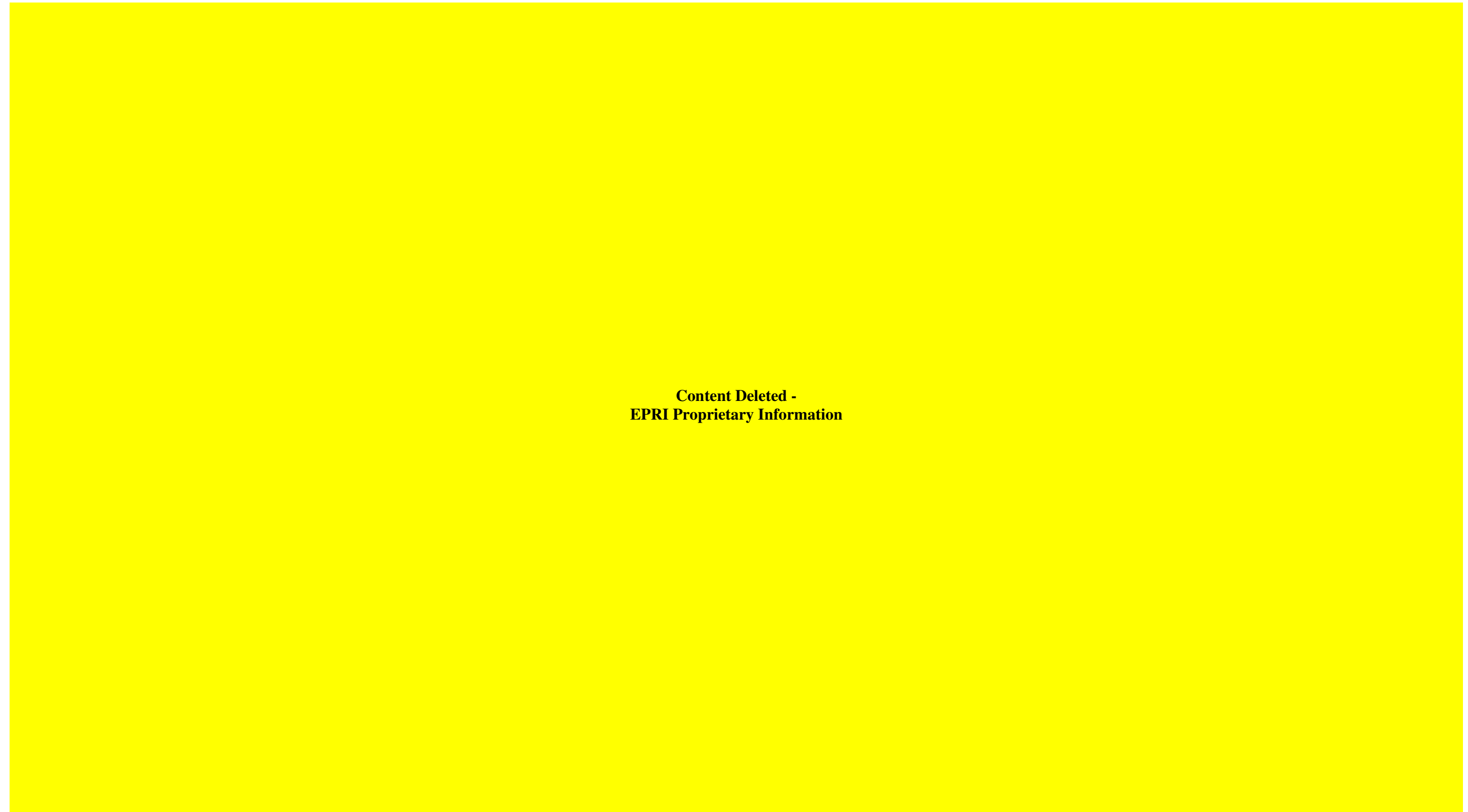


Figure 11.3.5-1. SLC Penetration Mockup BWRVIP-Y5: Configuration and Flaw Details

12

VESSEL ATTACHMENTS

12.1 Summary

**Content Deleted -
EPRI Proprietary Information**

12.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

12.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

12.3.1 Steam Dryer Support Lug Attachment Weld

**Content Deleted -
EPRI Proprietary Information**

12.3.1.1 BWRVIP-SDL1 (Steam Dryer Support Lug Mockup)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 12.3.1.1-1. BWRVIP-SDL-1 Mockup (Photograph)

**Content Deleted -
EPRI Proprietary Information**

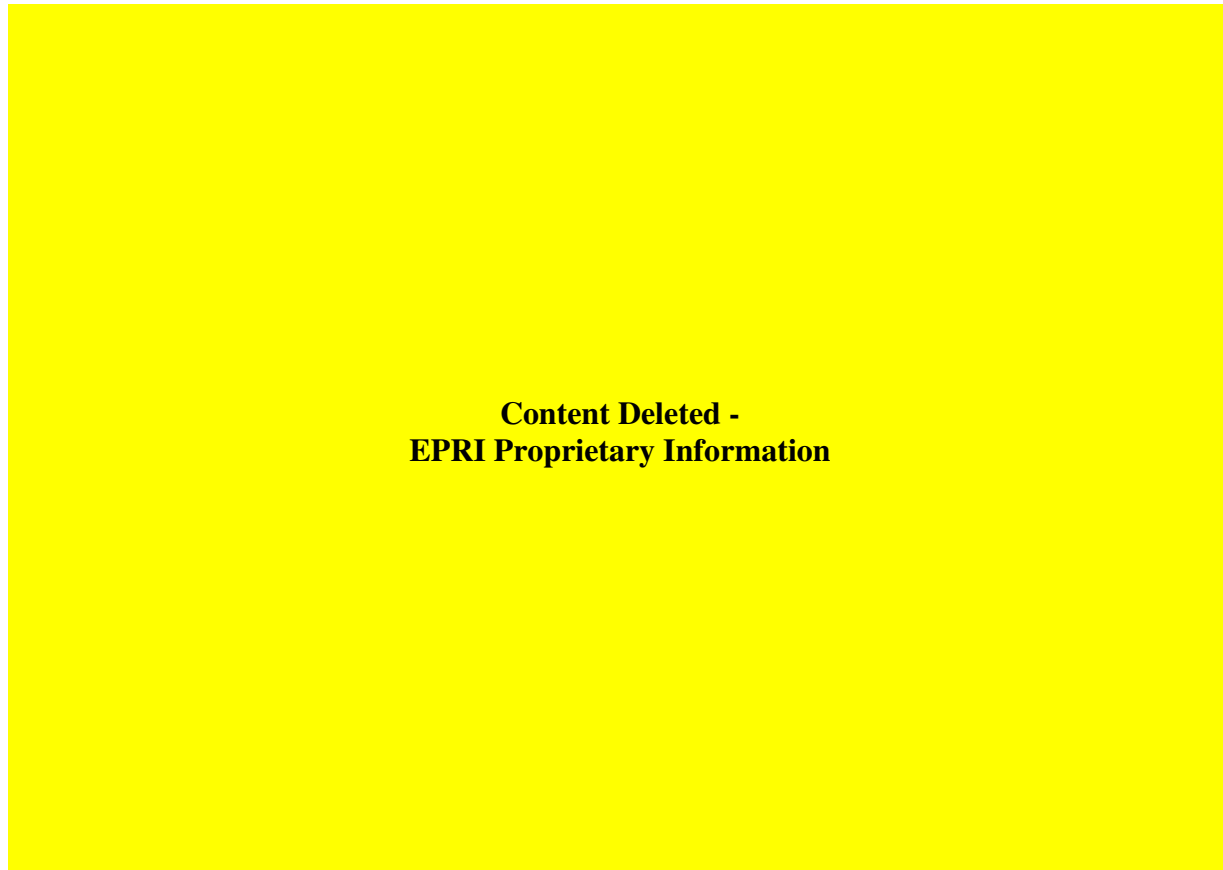
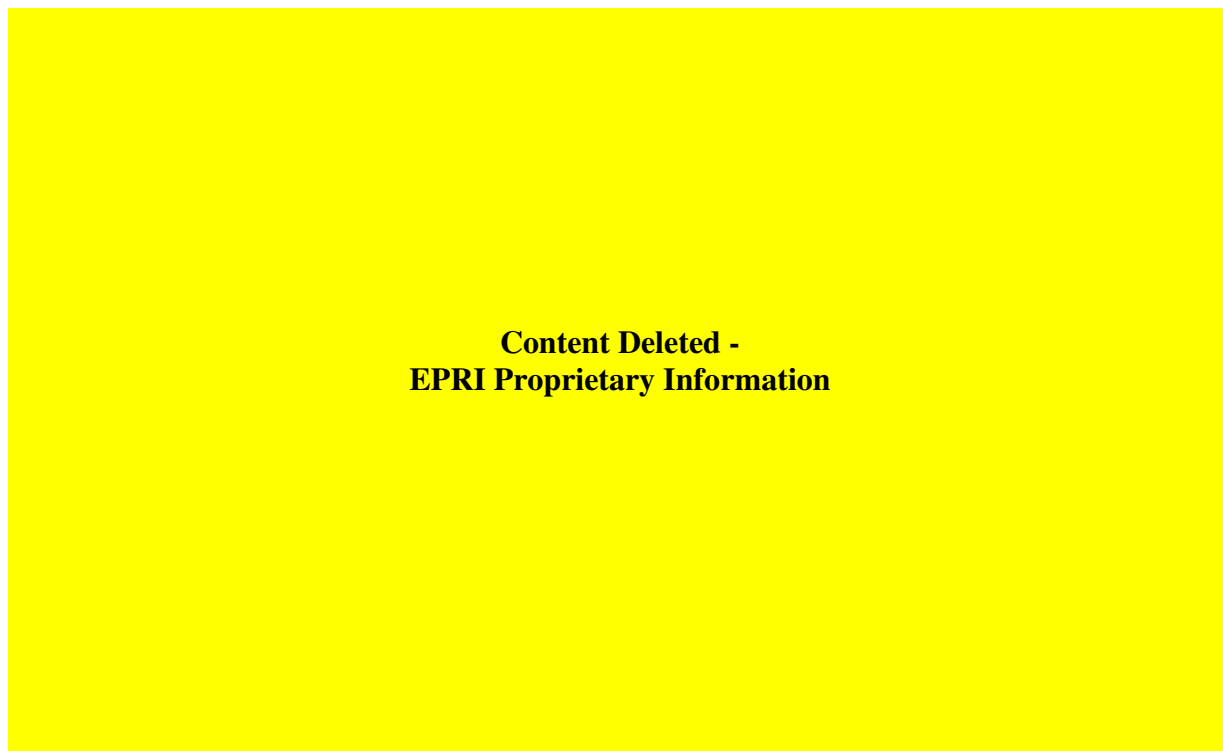


Figure 12.3.1.1-2. "Set-in" Lug Configuration (Cross-Sectional View)



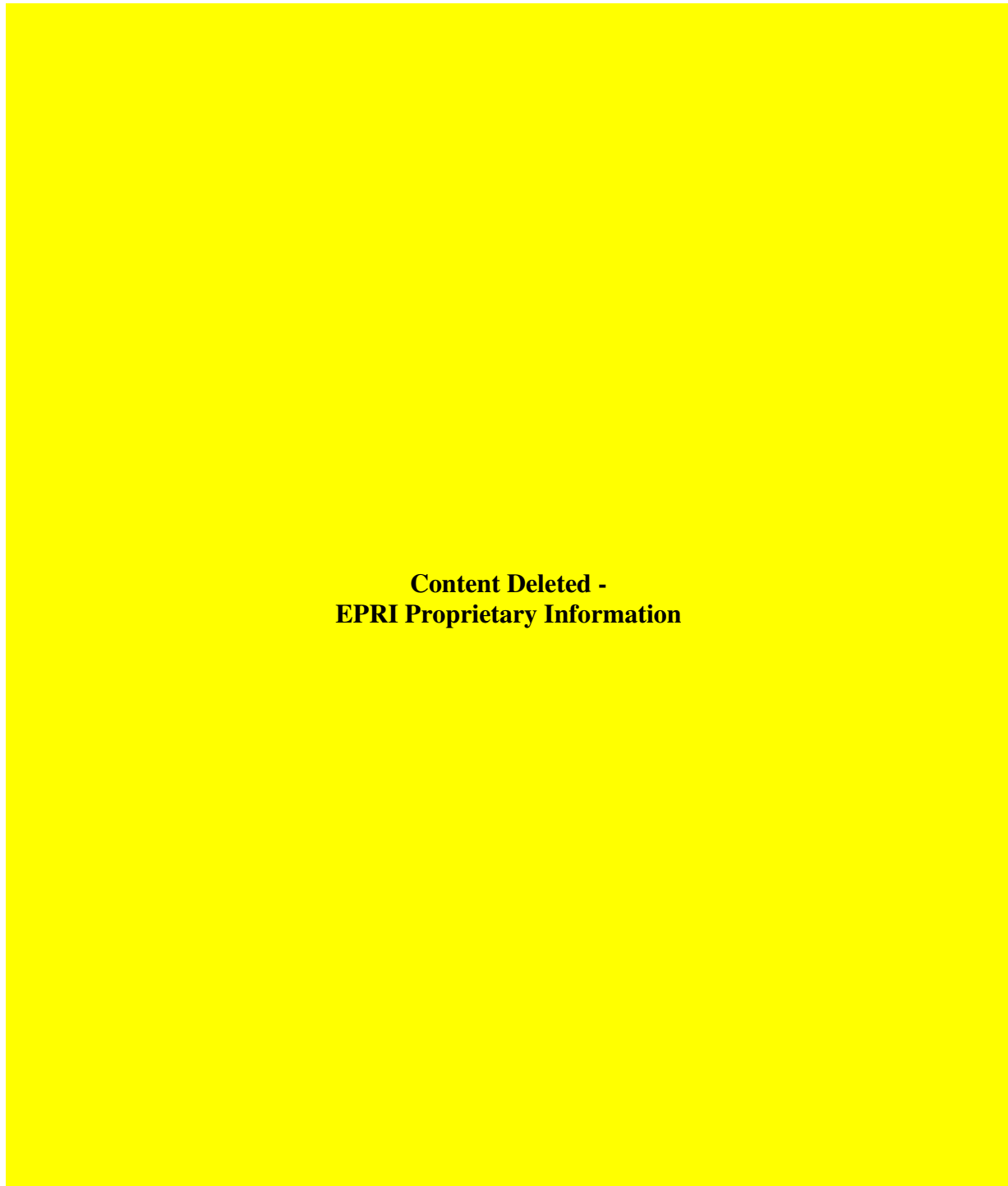


Figure 12.3.1.1-3. Flaws in Lugs A, B, and C



Figure 12.3.1.1-4. Flaws in Lugs D, E, and F

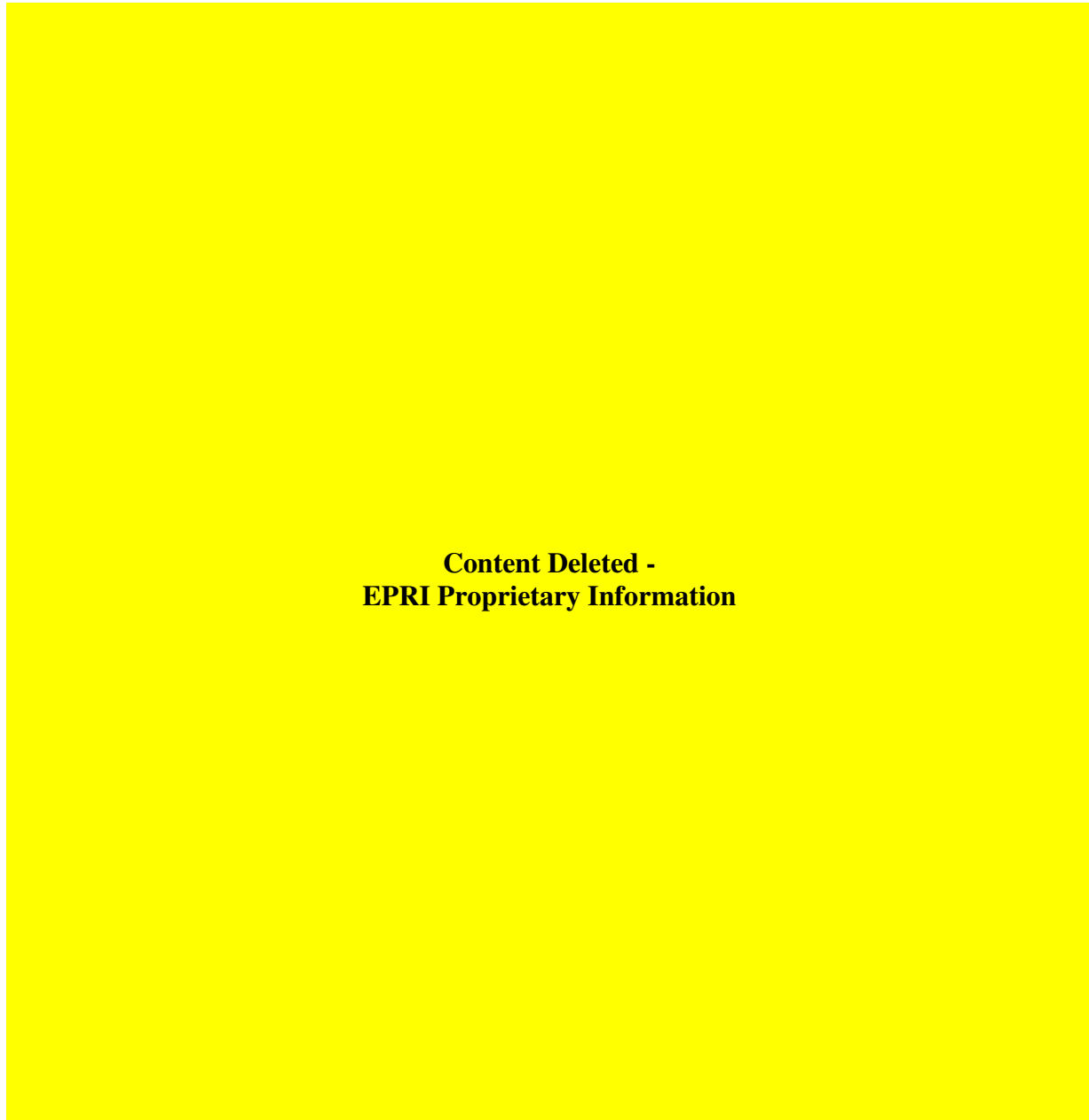
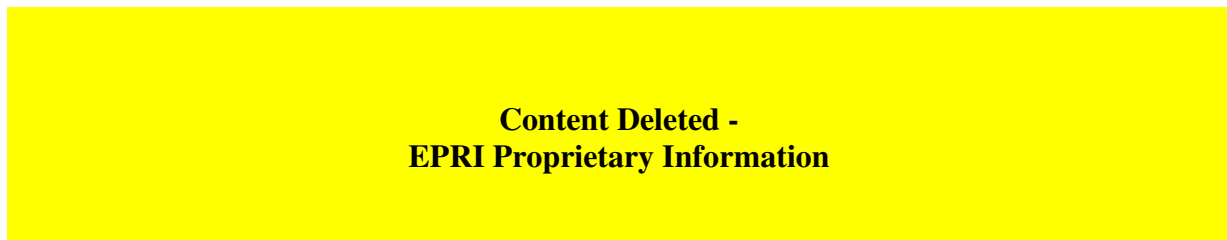


Figure 12.3.1.1-5. Typical Fabrication Flaws in Close Proximity to Flaw F1



Figure 12.3.1.1-6. Repaired Lack-of-Fusion Flaw

12.4 UT Technique Demonstrations for Vessel Attachment Welds



12.4.1 UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

Table 12.4.1-1 UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

12.4.2 UT Demonstration 1

**Content Deleted -
EPRI Proprietary Information**

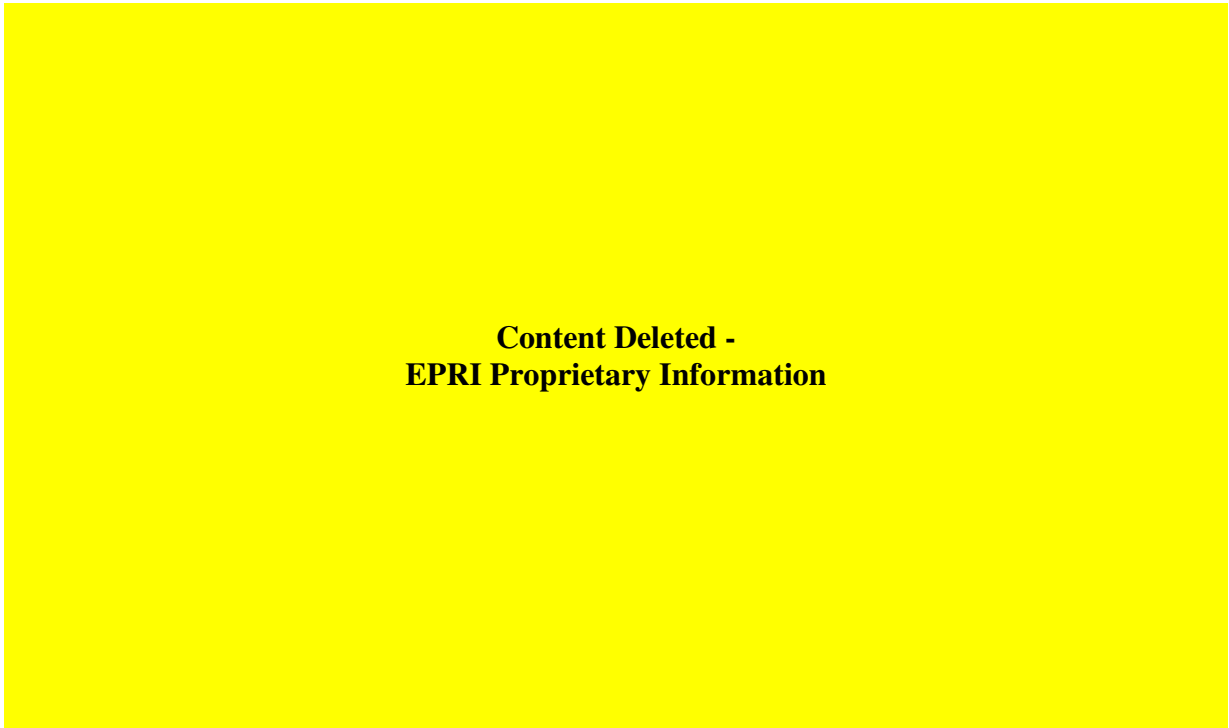
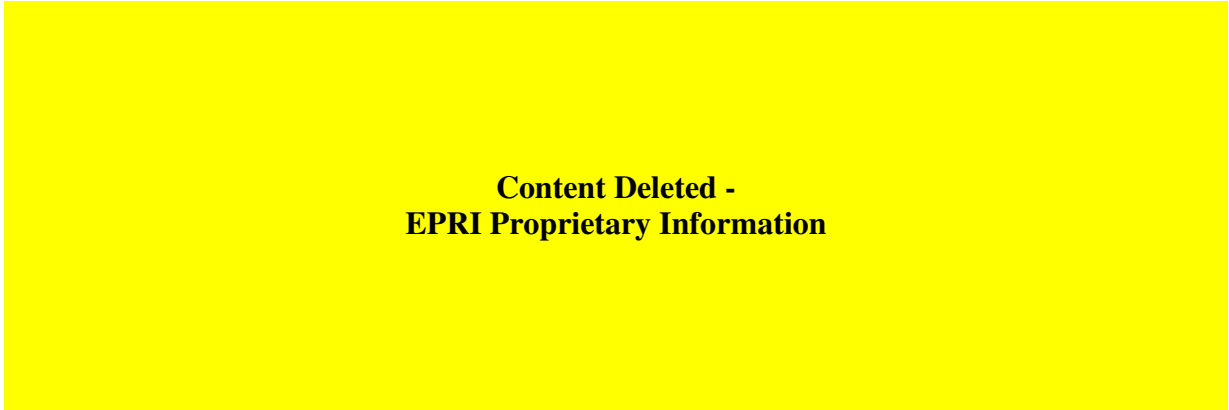


Figure 12.4.2-1. Probe Position and Scan Distance on the BWRVIP Mockup

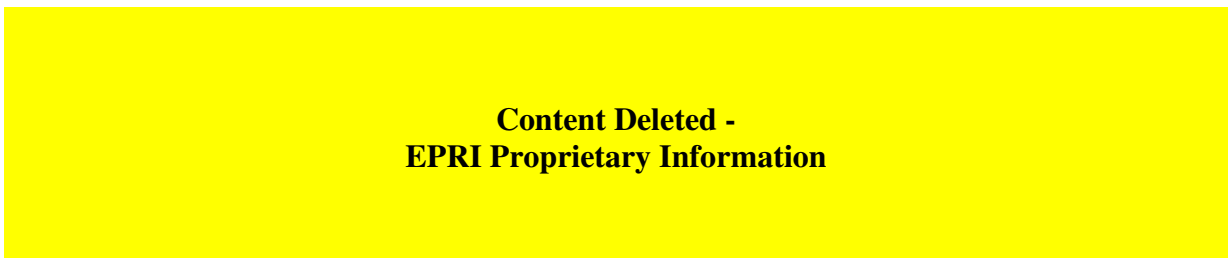
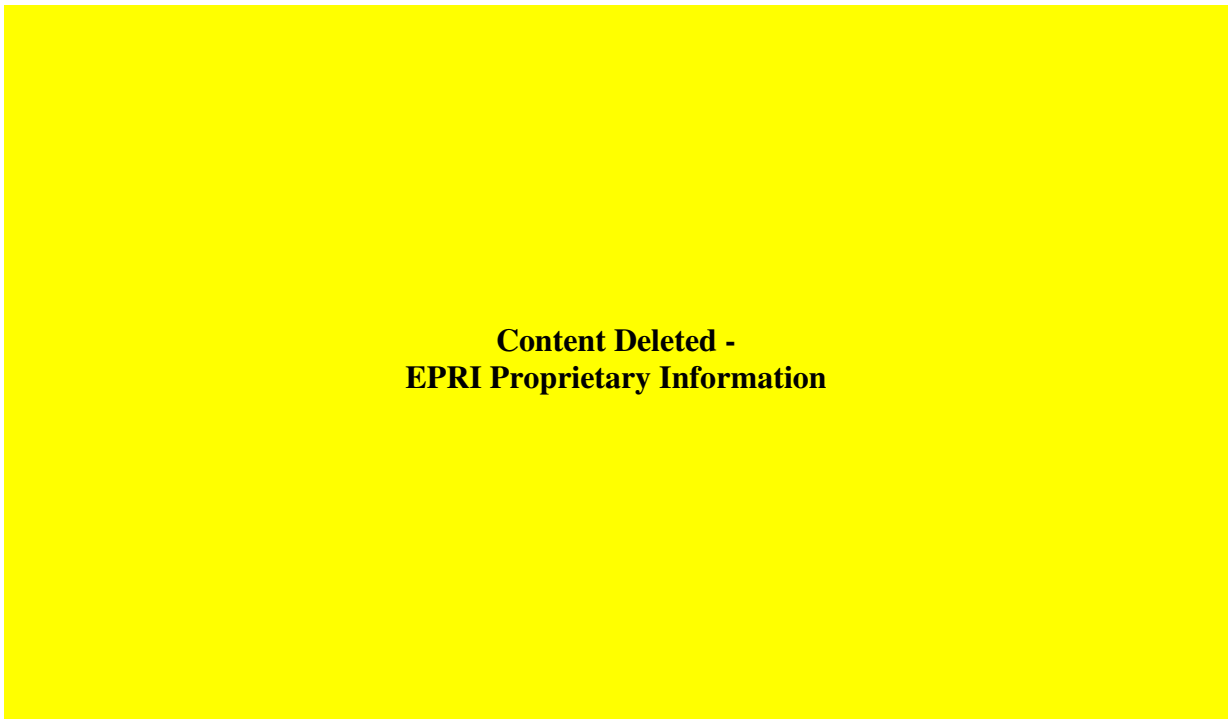




Figure 12.4.2-2. Focal Law Calculator Image Showing All Three Sets of Sector Scans





**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 12.4.2-3. Length Measurements for Flaws with Orientations Similar to the Orientations of A-1, B-1, B-2, D-1, and D-2

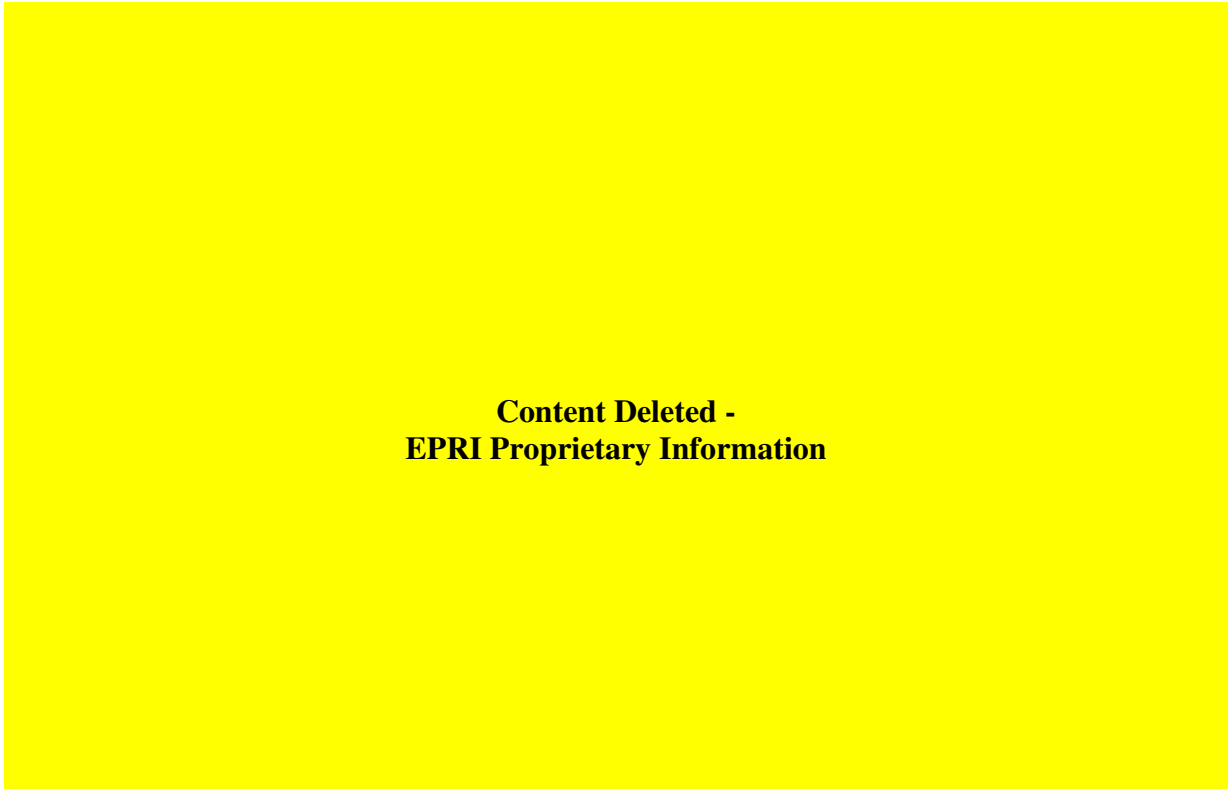


Figure 12.4.2-4. Depth Measurements for Flaws with Orientations Similar to the Orientations of A-1, B-1, B-2, D-1, and D-2

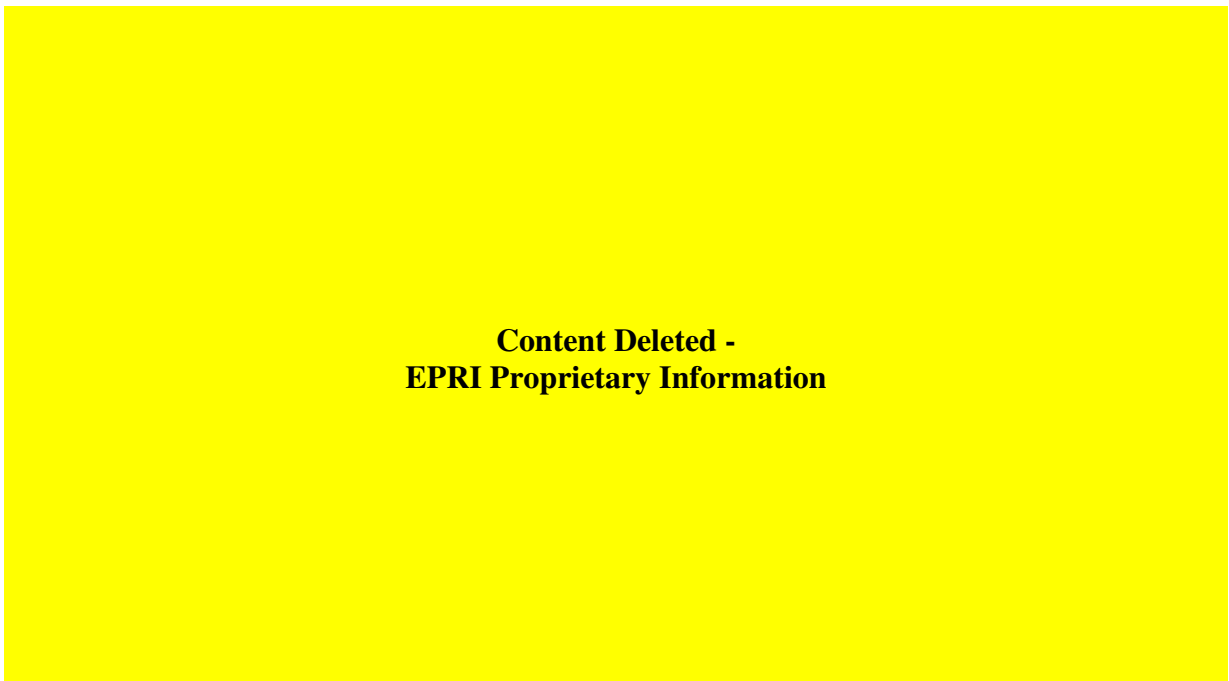


Figure 12.4.2-5. Length and Depth Measurements for Flaws with Orientations Similar to the Orientation of C-2

**Content Deleted -
EPRI Proprietary Information**

Figure 12.4.2-6. Length and Depth Measurements for Flaws with Orientations Similar to the Orientation of A-2 (Note That Flaw Extents Are Measured from the Edge of the Lug and Not from the Flaw Initiating Point in the Weld)

**Content Deleted -
EPRI Proprietary Information**

13

LOWER PLENUM

**Content Deleted -
EPRI Proprietary Information**

13.1 Summary

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

13.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

13.3 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

13.3.1 BWRVIP-CRDH1

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 13.3.1-1. Specifications of Applicable Flaws for BWRVIP-CRDH1

**Content Deleted -
EPRI Proprietary Information**

Content Deleted -EPRI Proprietary Information

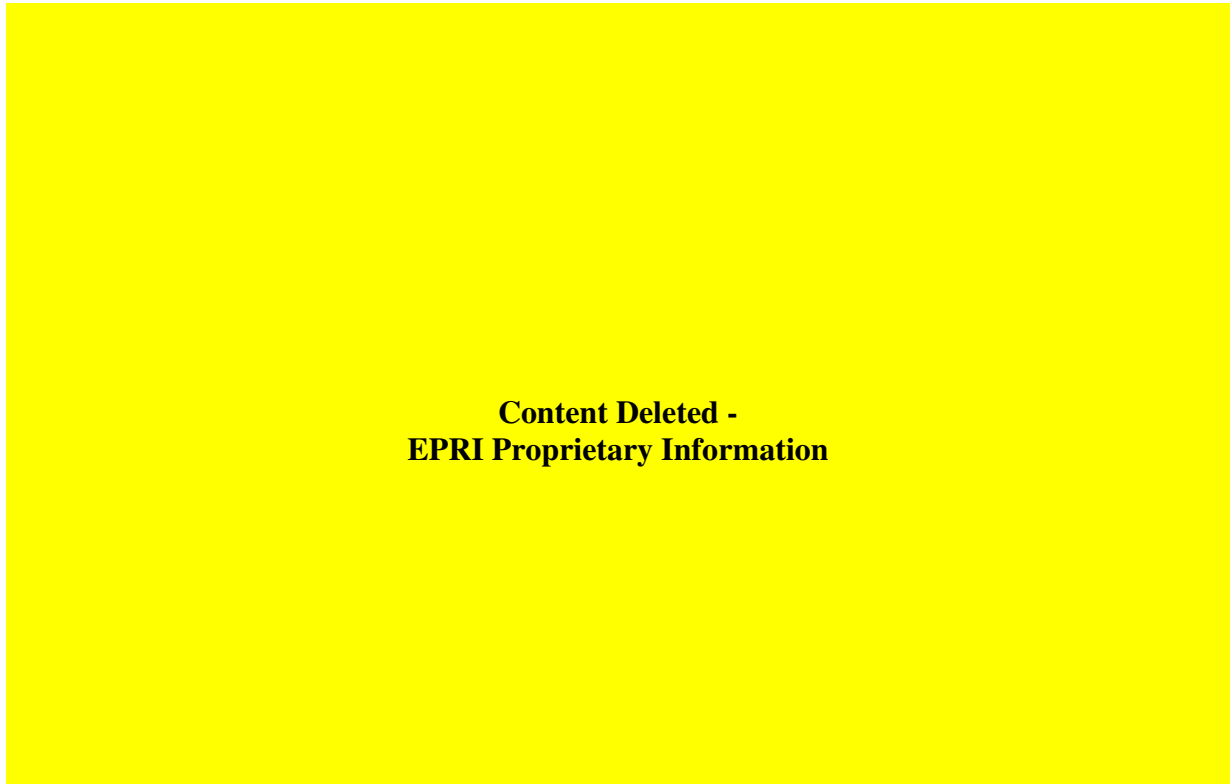
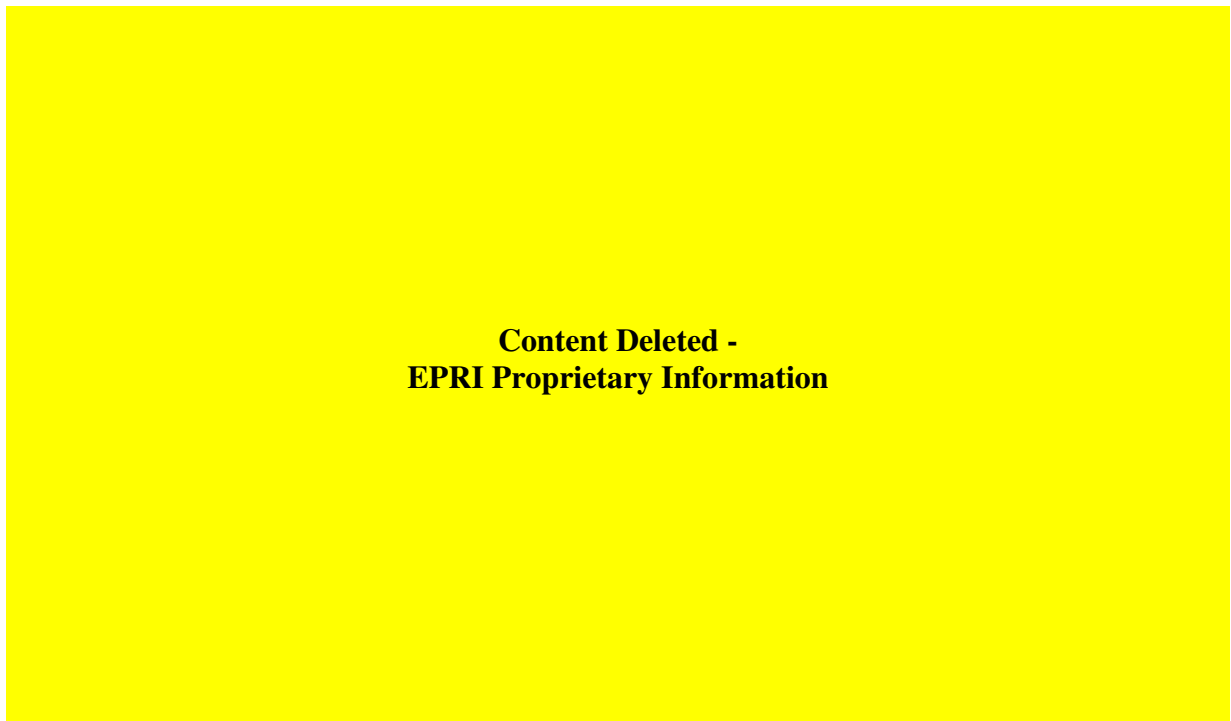


Figure 13.3.1-1. BWRVIP-CRDH1 Mockup (Photograph)

13.3.2 BWRVIP-CRDH2



**Content Deleted -
EPRI Proprietary Information**

Table 13.3.2-1. Specifications of Applicable Flaws for BWRVIP-CRDH2

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



Figure 13.3.2-1. BWRVIP-CRDH2 Mockup (Photograph)

13.4 UT Technique Demonstrations for Lower Plenum Welds

13.4.1 UT Demonstration 1



**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

14

INSTRUMENT PENETRATIONS

14.1 Summary

**Content Deleted -
EPRI Proprietary Information**

14.2 Configurations

**Content Deleted -
EPRI Proprietary Information**

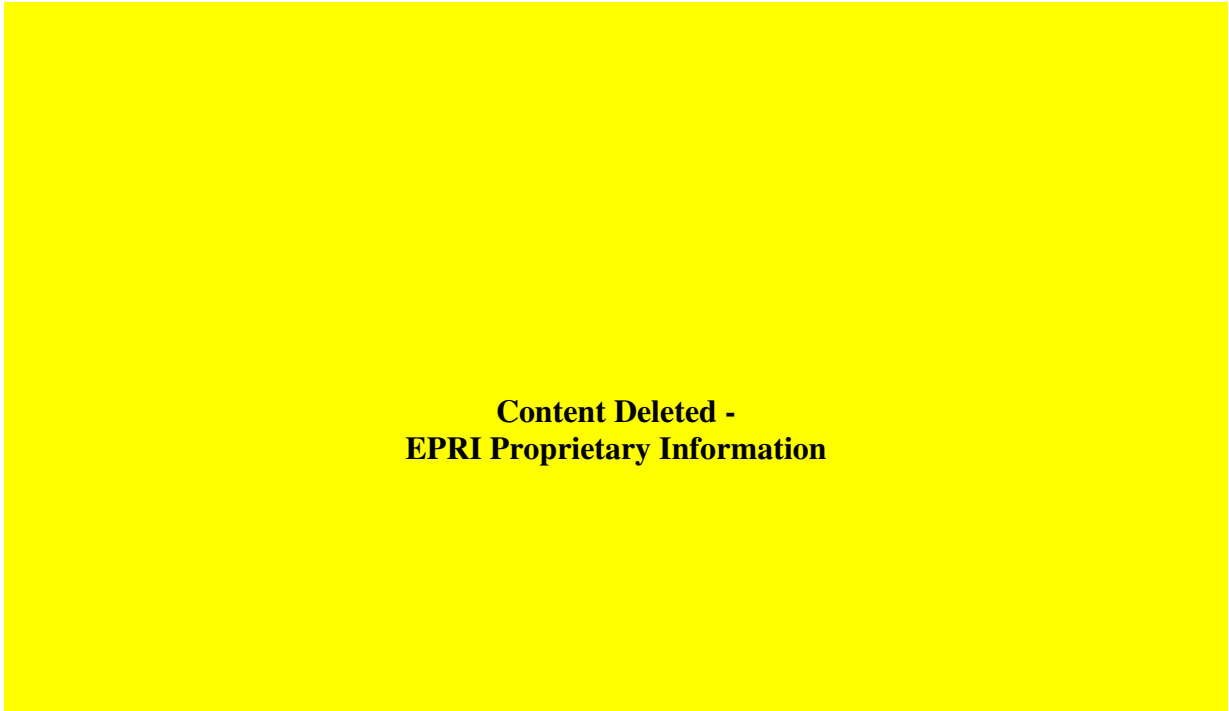
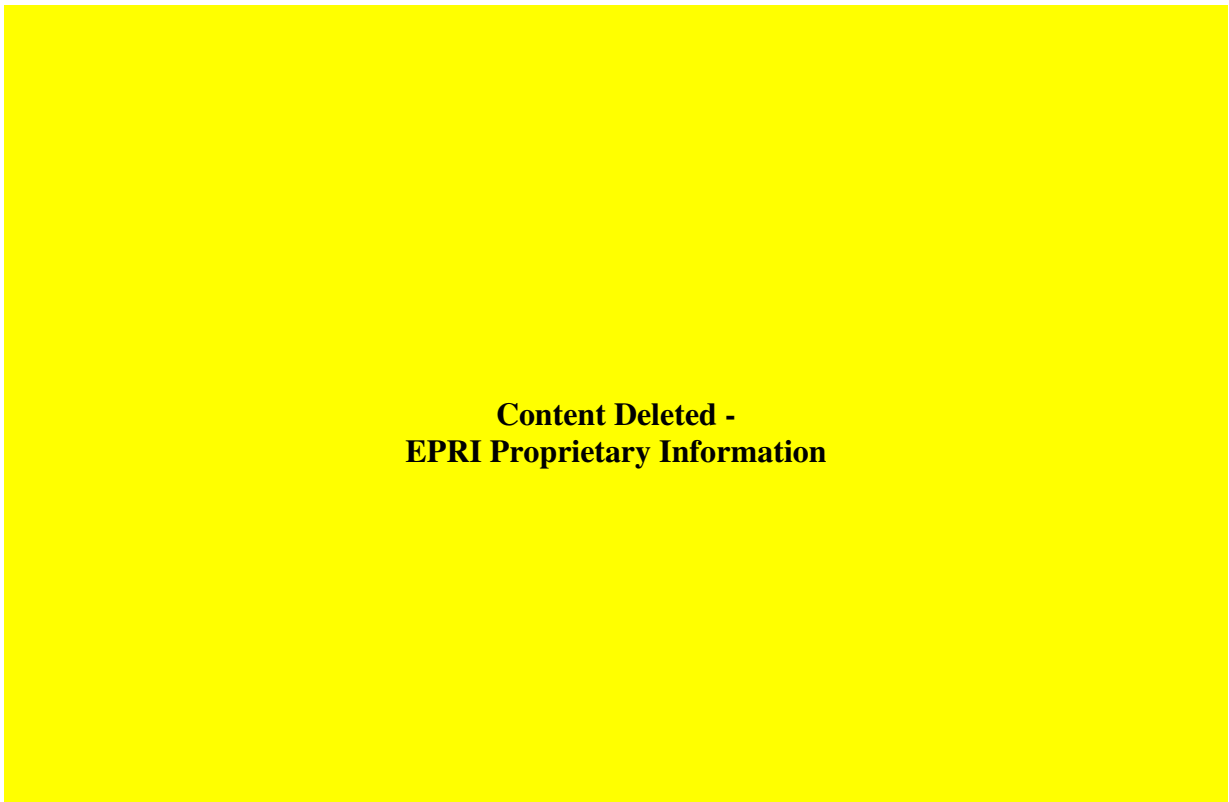


Figure 14.2-1. Example of Instrument Penetration (Partial Penetration J-Groove Weld Configuration)



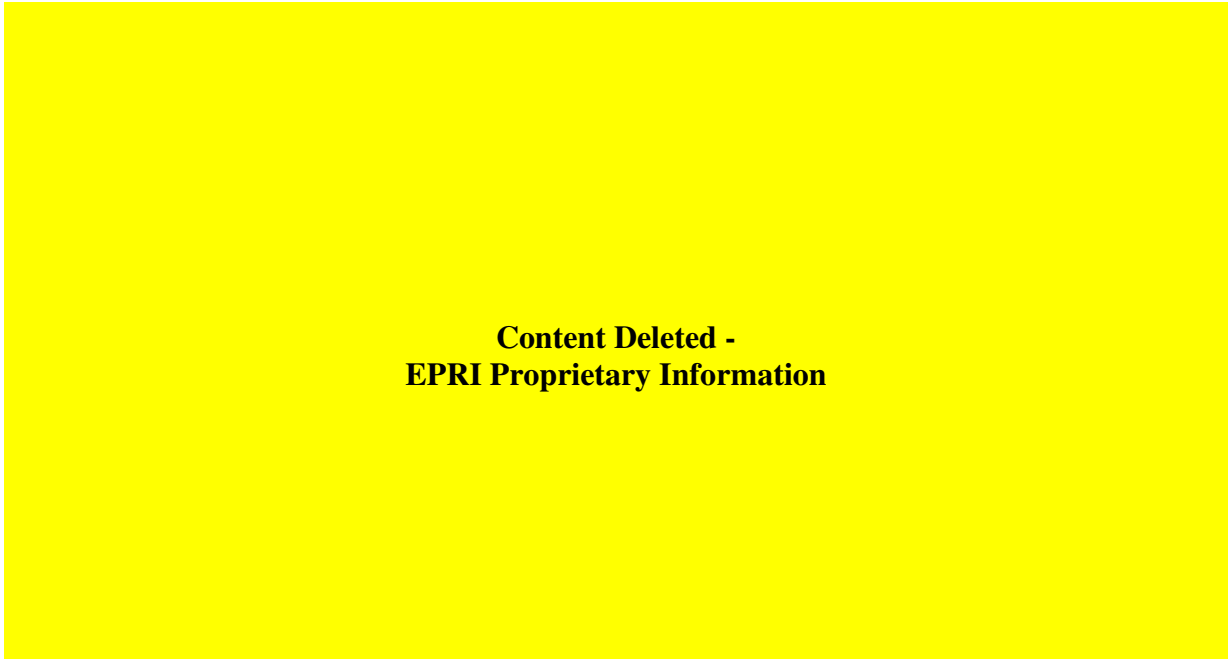
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 14.2-2. Example of Instrument Penetration (Full-Penetration Welded Low-Alloy Steel Nozzle Configuration)

14.3 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**



14.3.1 Inspection Considerations for Partial Penetration J-Groove Welds

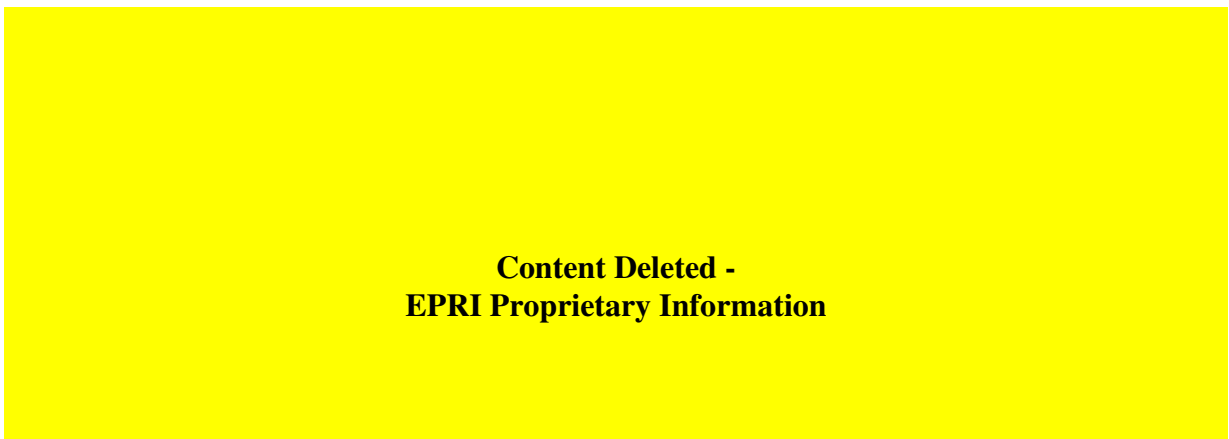
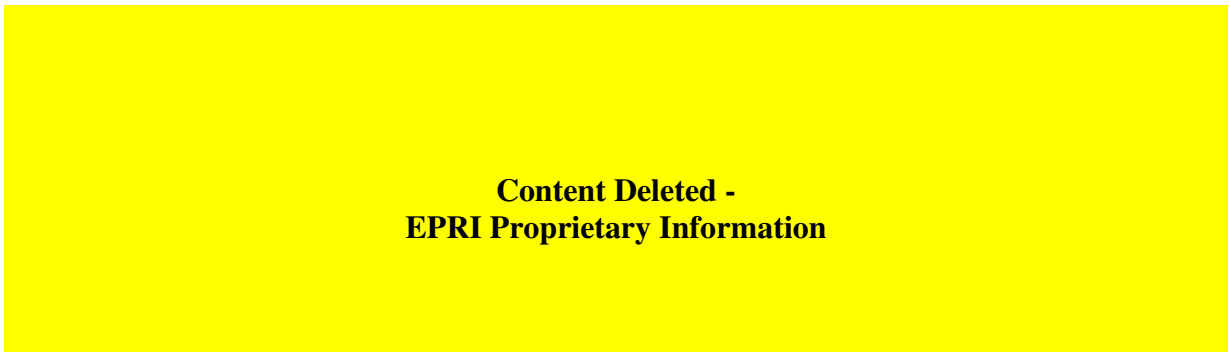


Figure 14.3.1-1. BWR/6-Style Instrument Penetration That Contains the Low-Alloy Weld Pad



**Content Deleted -
EPRI Proprietary Information**

14.3.2 Inspection Considerations for the Penetration Tube Material



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

14.4 Applicable Mockups

**Content Deleted -
EPRI Proprietary Information**

14.4.1 Mockup BWRVIP-IP-1

14.4.1.1 BWRVIP-IP-1 Configuration

**Content Deleted -
EPRI Proprietary Information**

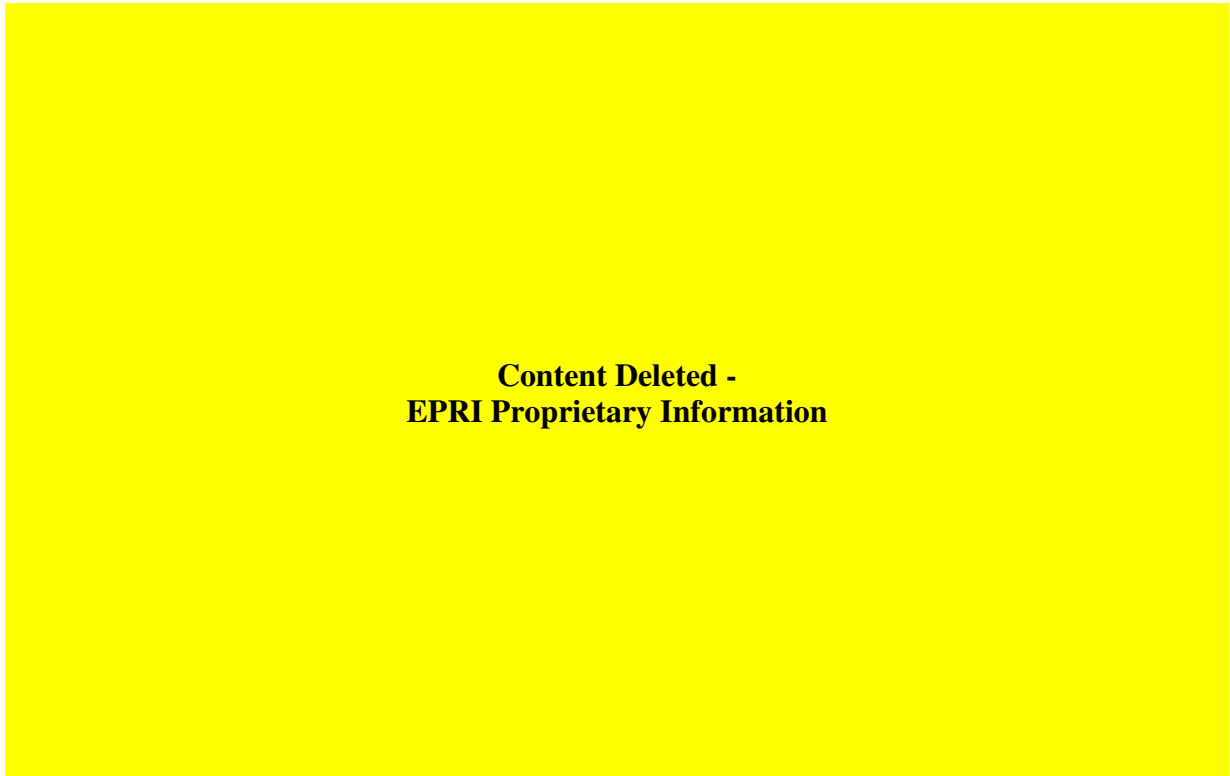
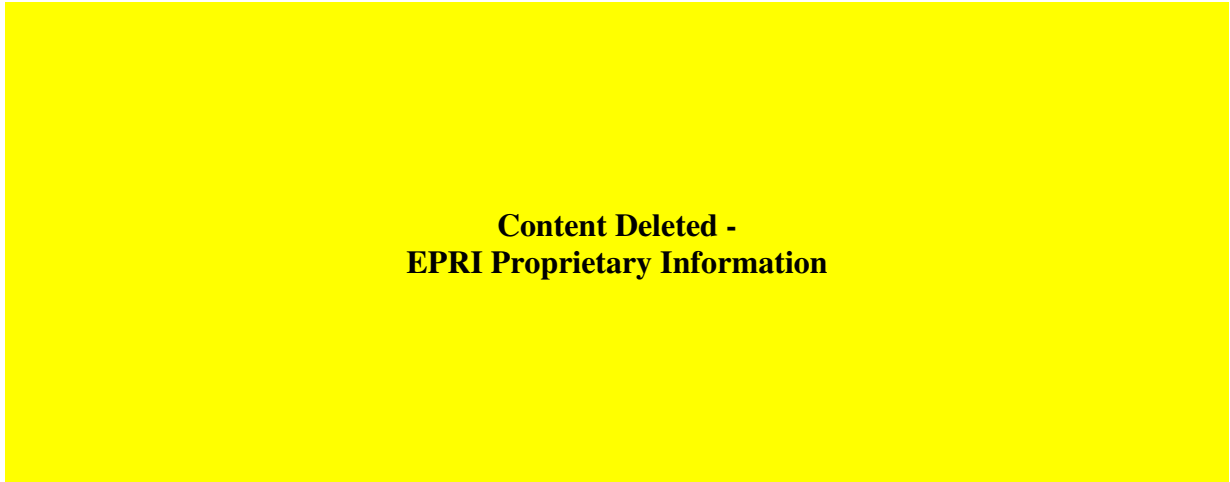
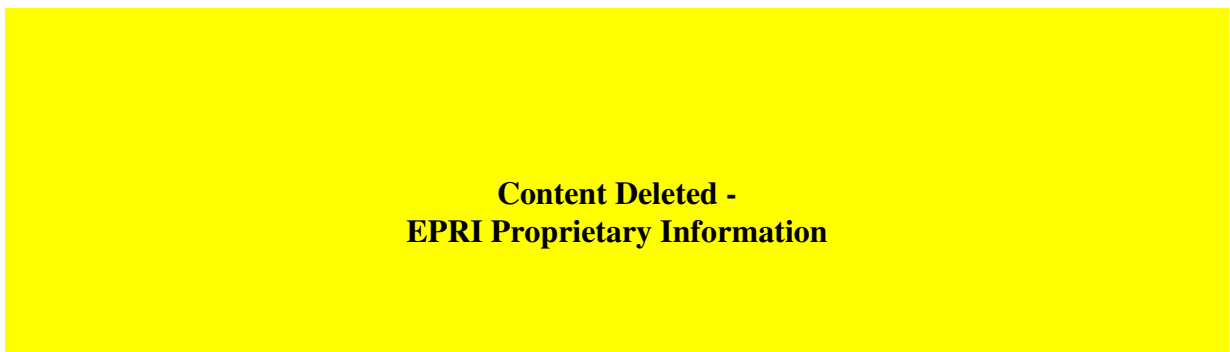


Figure 14.4.1.1-1. BWRVIP-IP-1 Instrumentation Penetration Mockup (OD Surface)



Figure 14.4.1.1-2. BWRVIP-IP-1 Instrumentation Penetration Mockup (ID Surface)



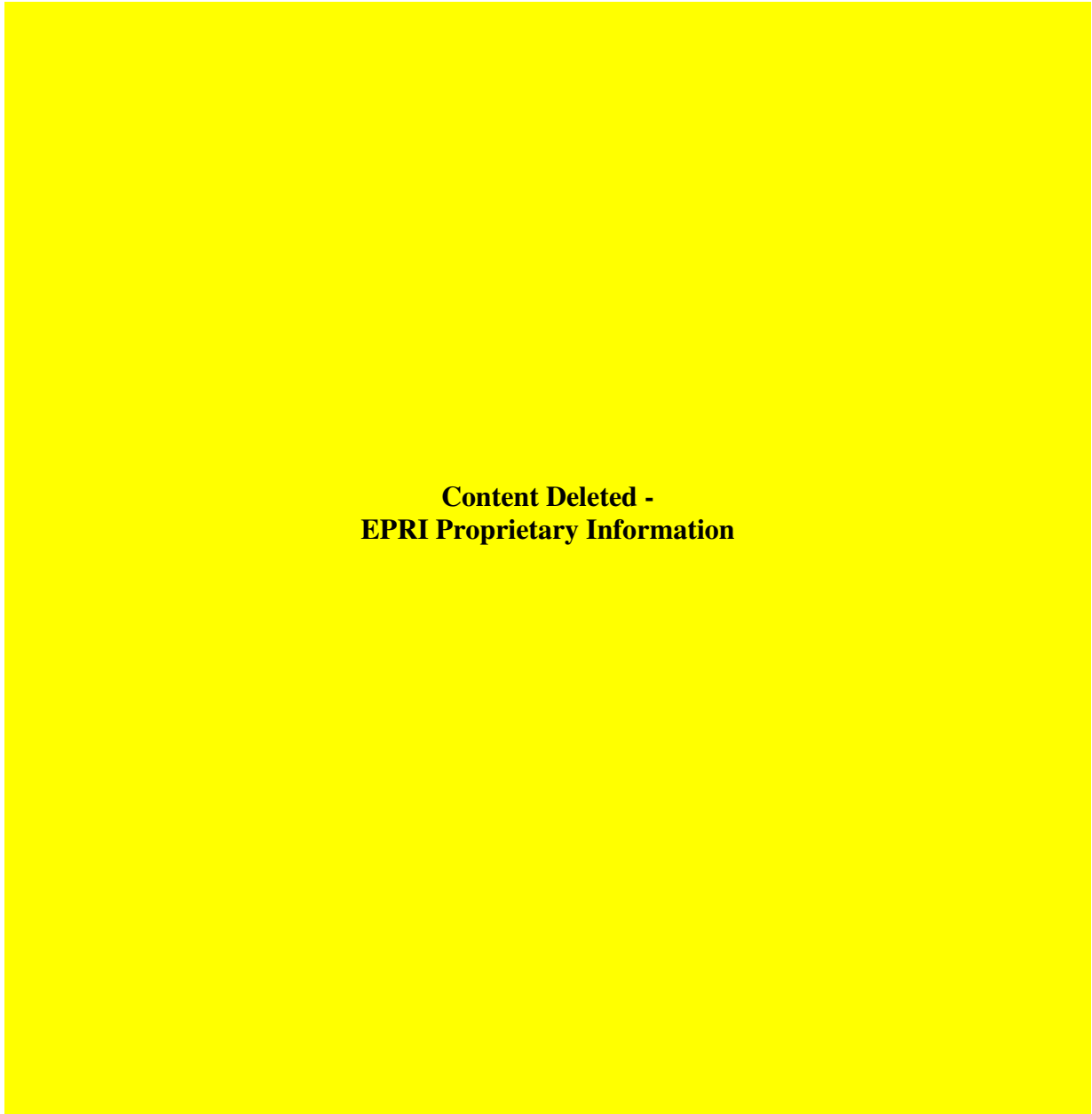


Figure 14.4.1.1-3. Penetration #1 Configuration (Nominal Dimensions)

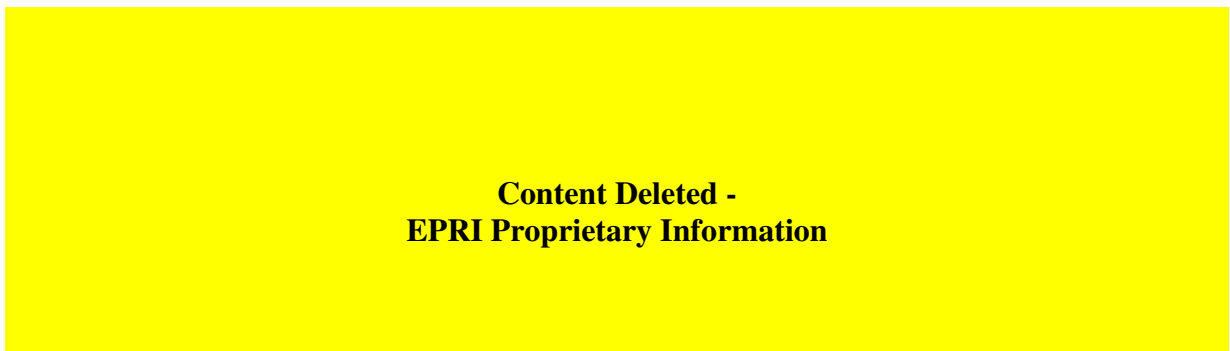
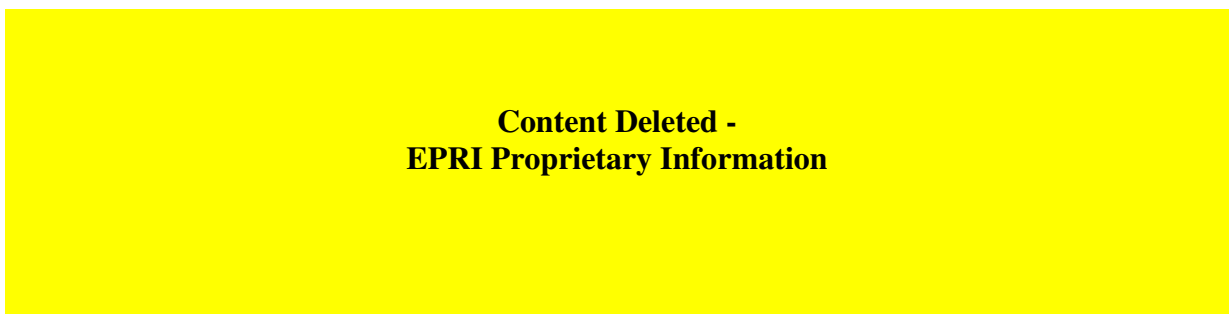




Figure 14.4.1.1-4. Penetration #2 Configuration (Nominal Dimensions)

14.4.1.2 Penetration Tube Flaws

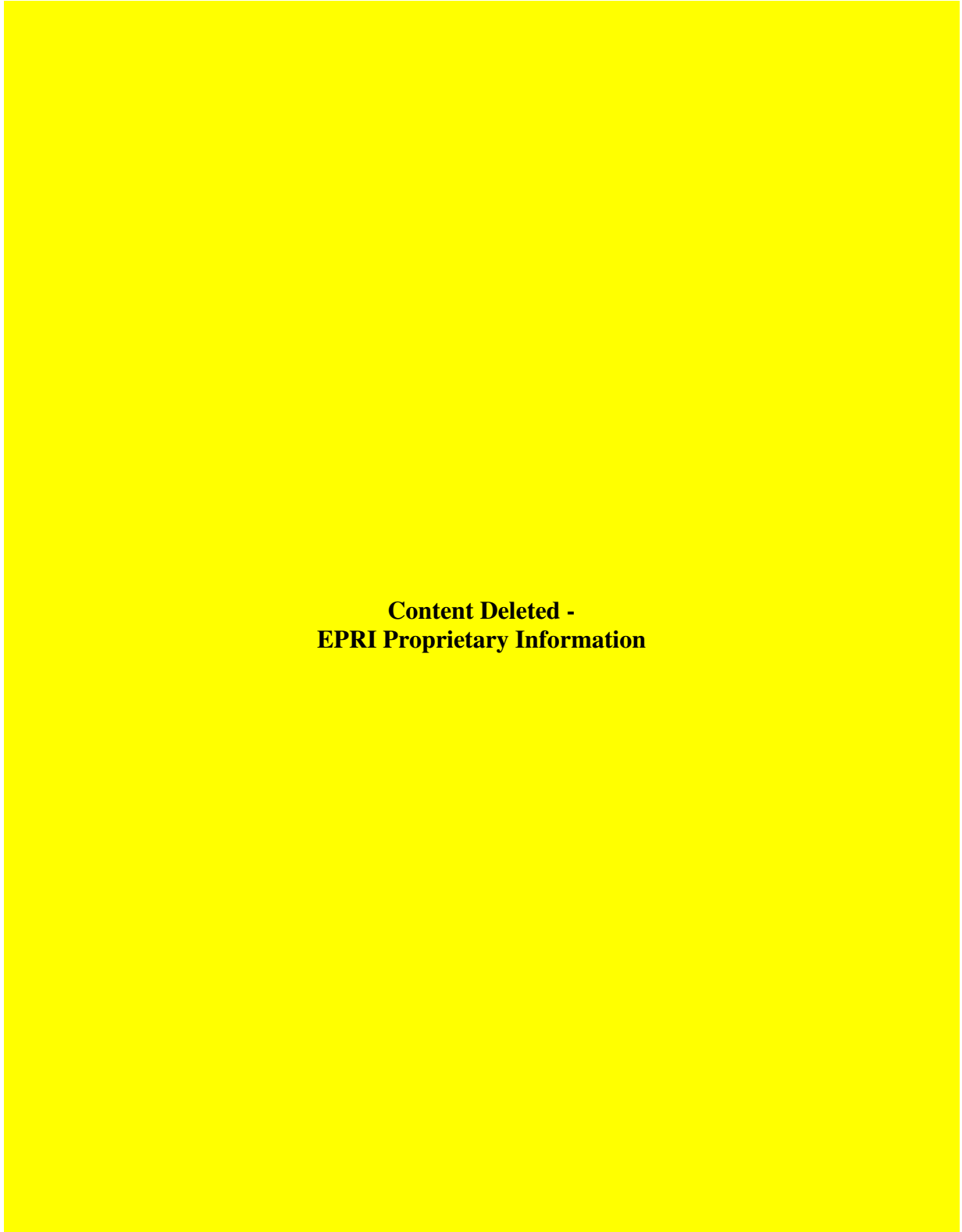


Content Deleted - EPRI Proprietary Information

Table 14.4.1.2-1. 10 CFR 50.55a Requirements for PWR Reactor Vessel Head Specimens Versus BWRVIP Mockup Design Inputs

**Content Deleted -
EPRI Proprietary Information**

Table 14.4.1.2-1. (continued) 10 CFR 50.55a Requirements for PWR Reactor Vessel Head Specimens Versus BWRVIP Mockup Design Inputs



**Content Deleted -
EPRI Proprietary Information**

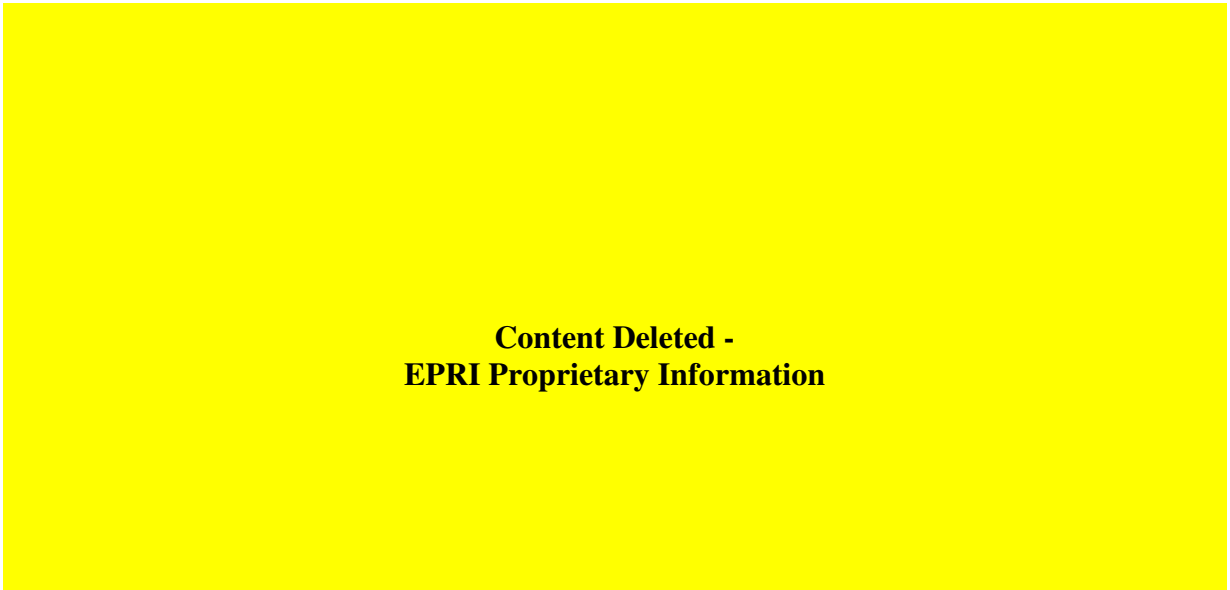
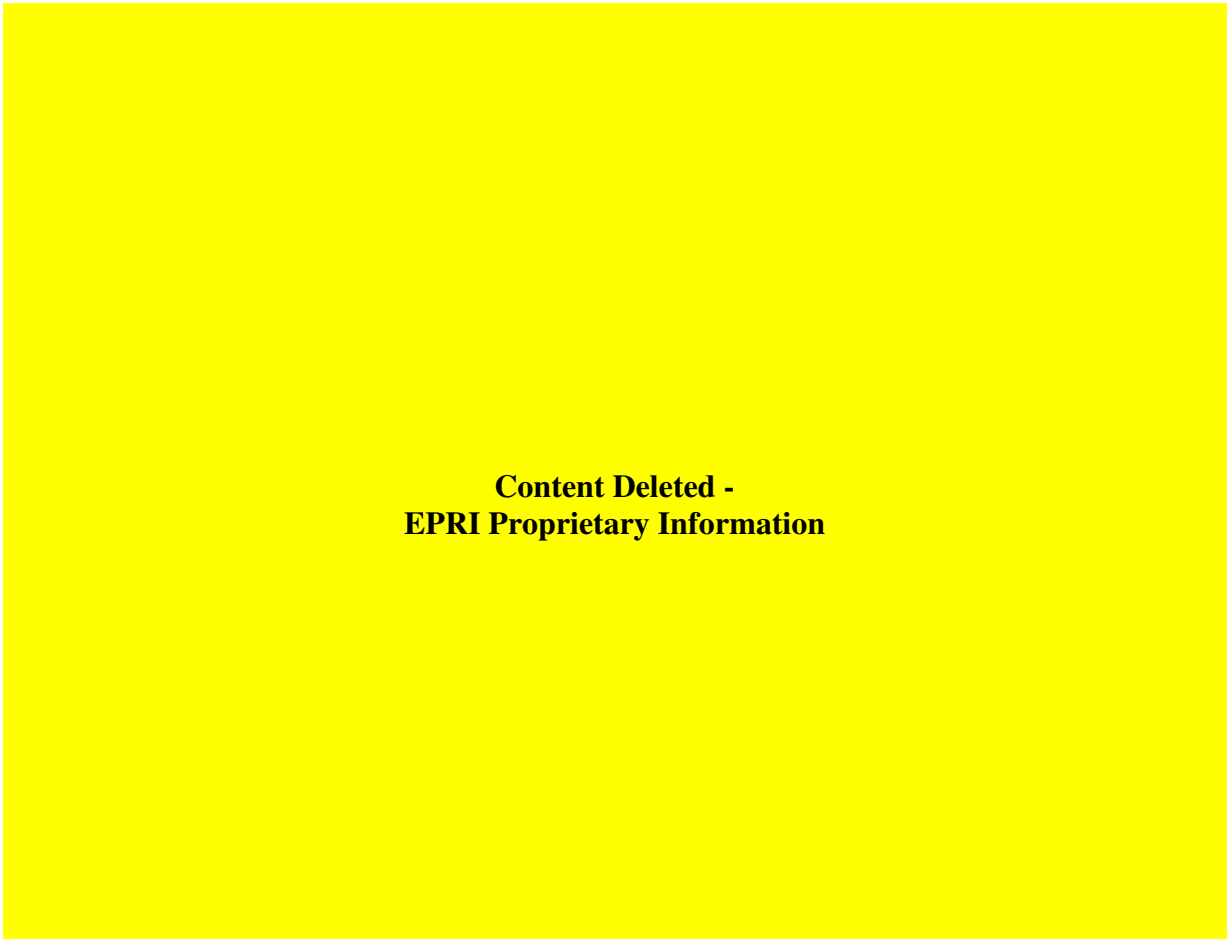


Figure 14.4.1.2-1. Penetration #1 Flaw Details (Nominal Design Intent)

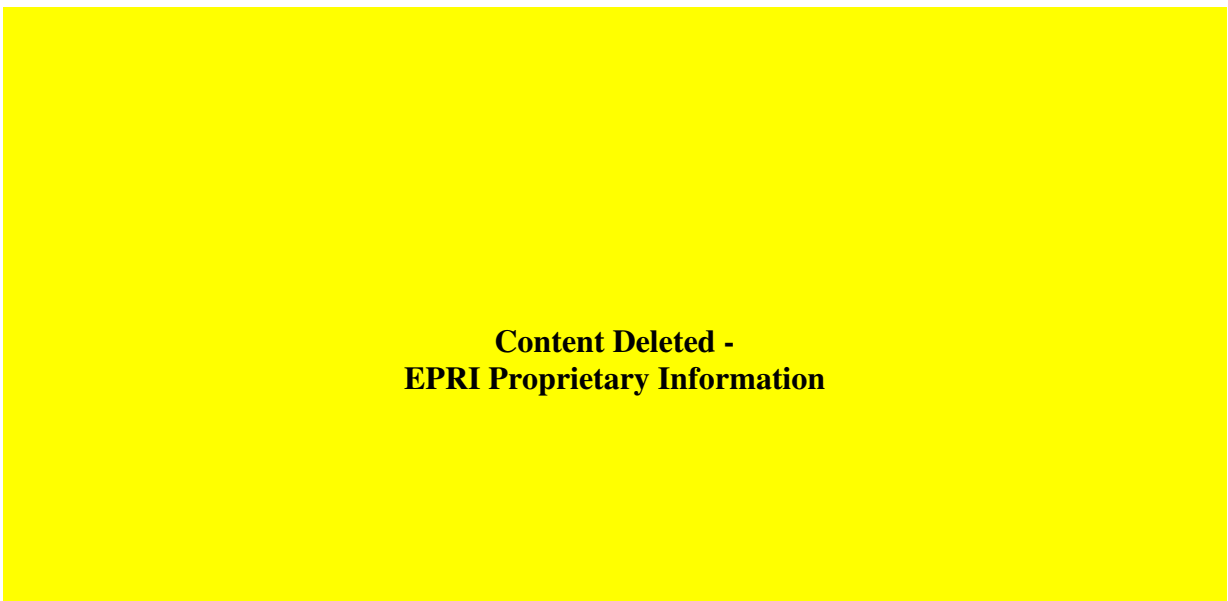


Figure 14.4.1.2-2. Penetration #2 Flaw Details (Nominal Design Intent)

Table 14.4.1.2-2. As-Built Flaw Details (Penetration Tube Flaws)



14.4.1.3 J-Groove Weld Flaws





**Content Deleted -
EPRI Proprietary Information**

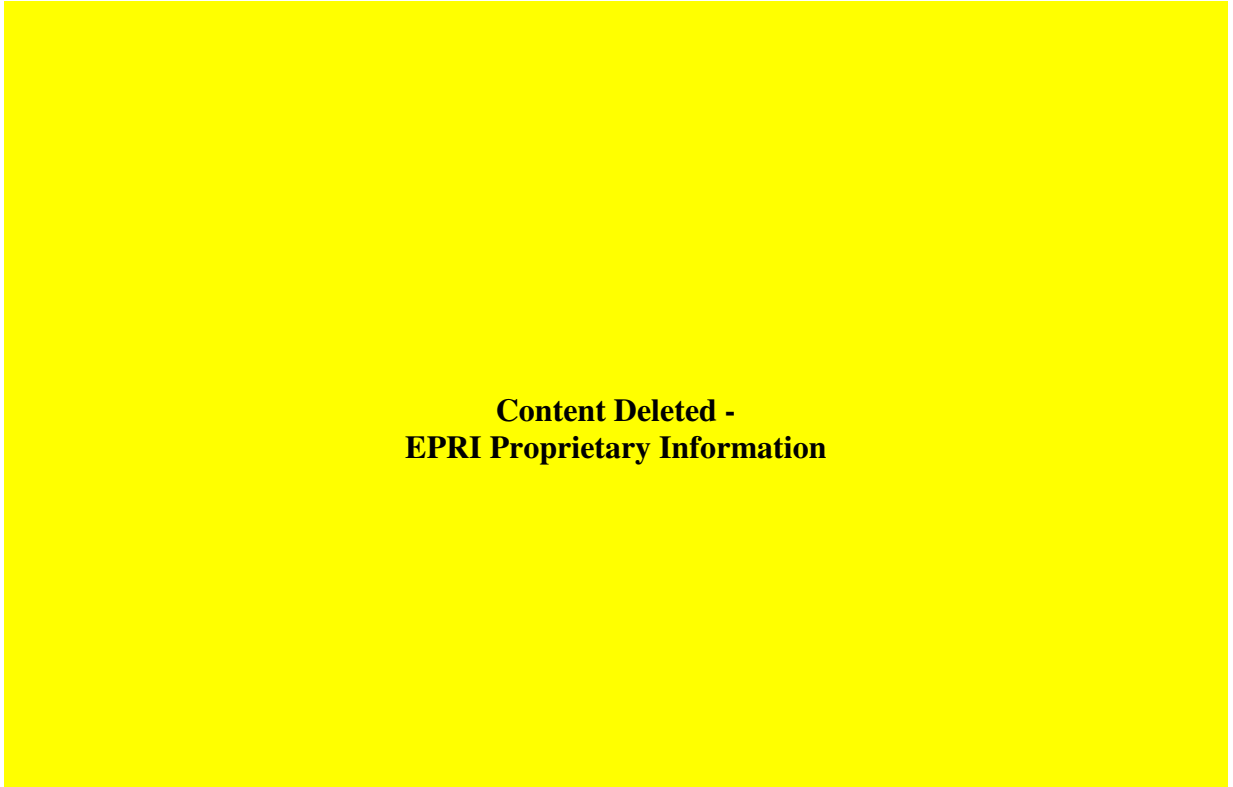


Figure 14.4.1.3-1. As-Built Details of J-Groove Weld Flaw 1a

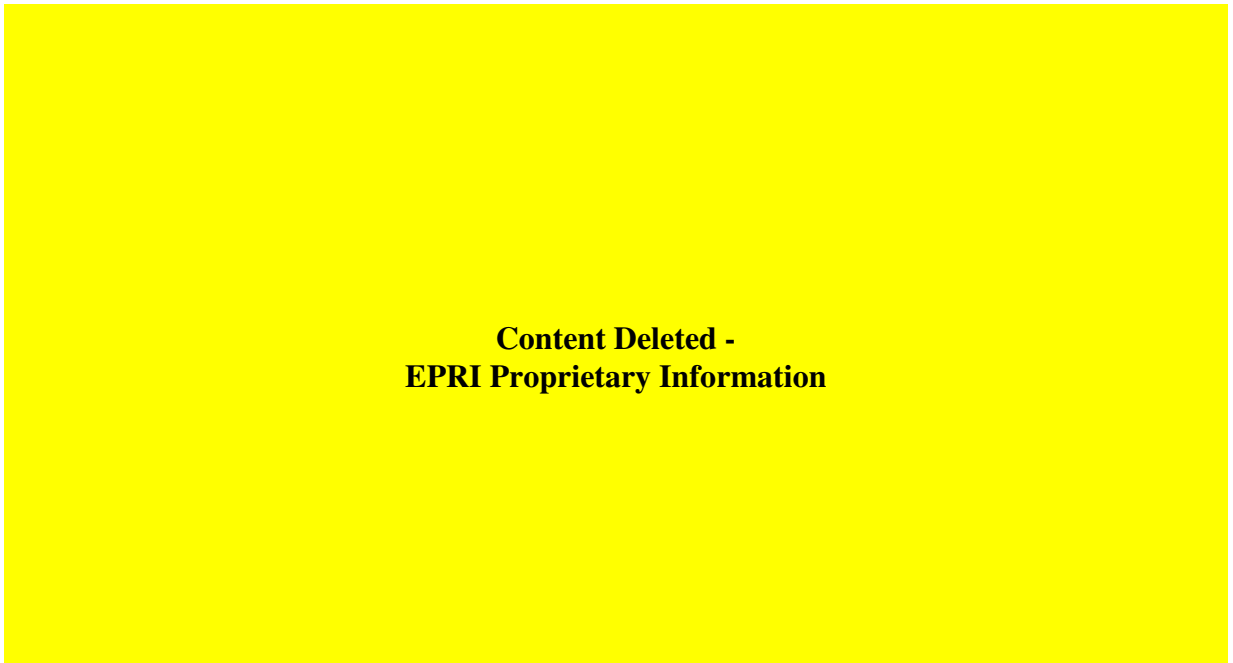


Figure 14.4.1.3-2. As-Built Details of J-Groove Weld Flaw 1b

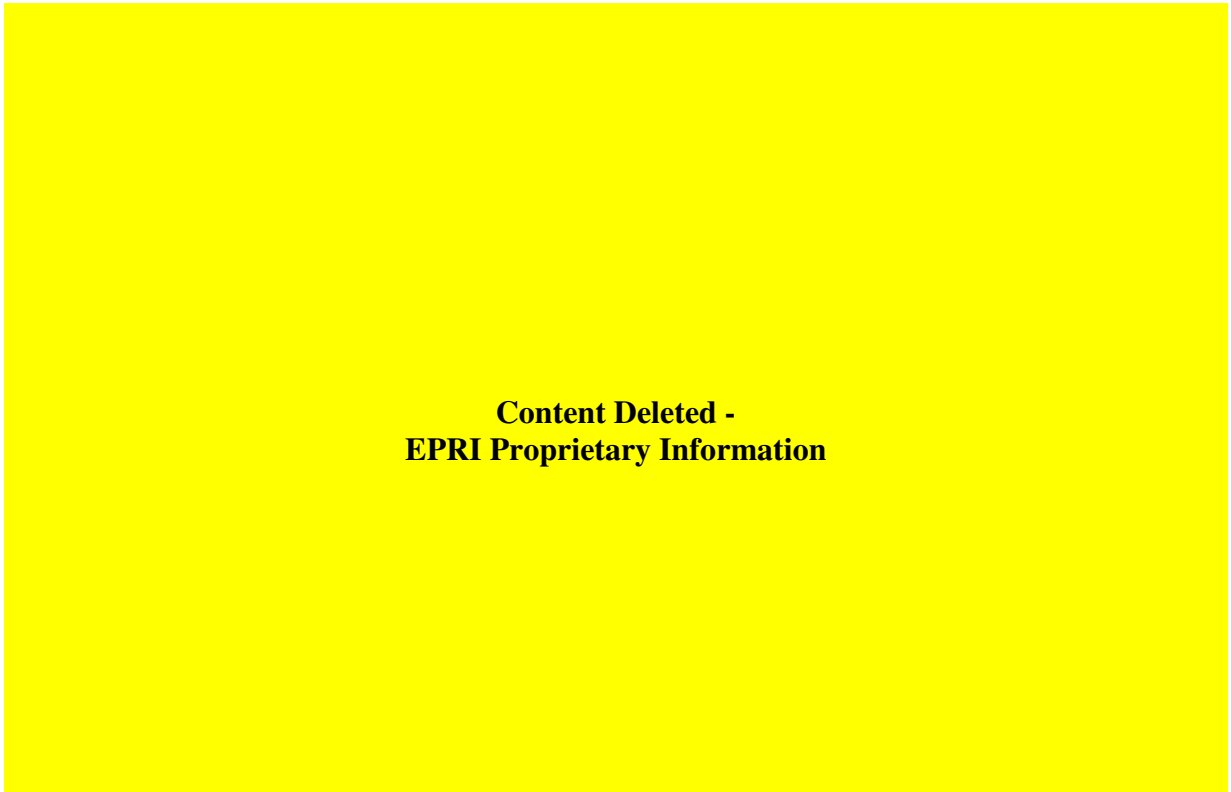


Figure 14.4.1.3-3. As-Built Details of J-Groove Weld Flaw 1c

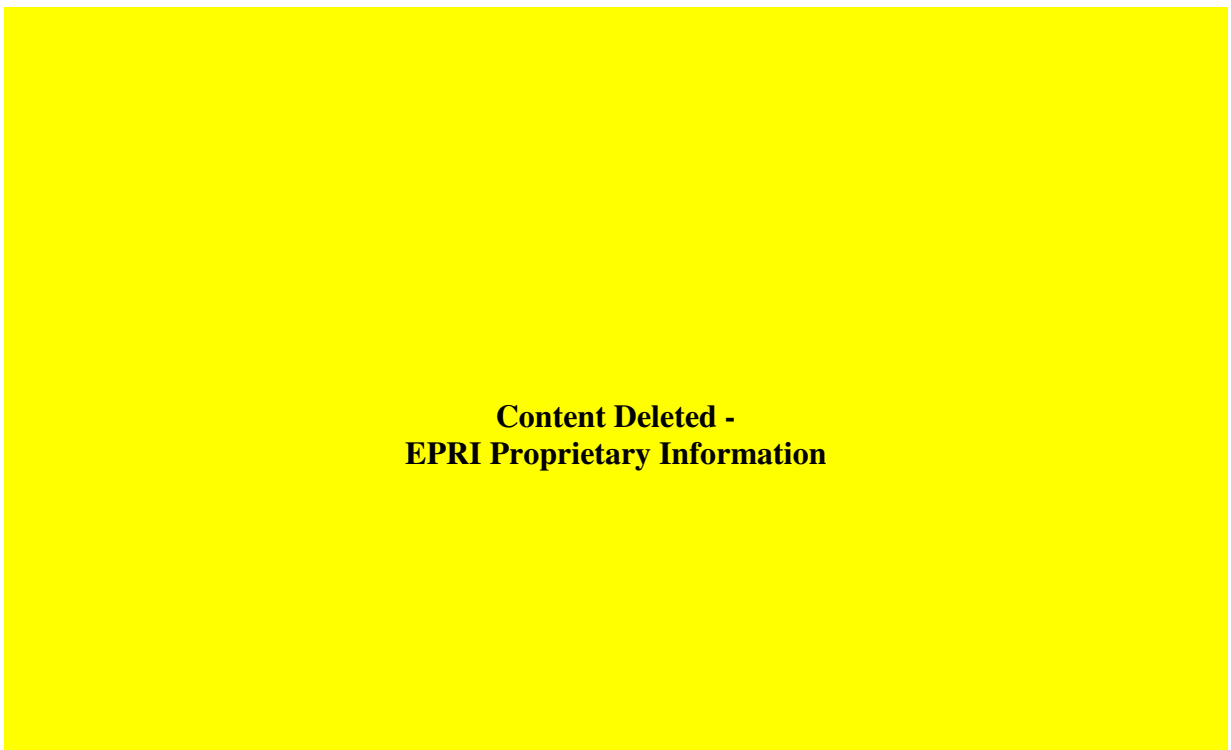


Figure 14.4.1.3-4. As-Built Details of J-Groove Weld Flaw 2a

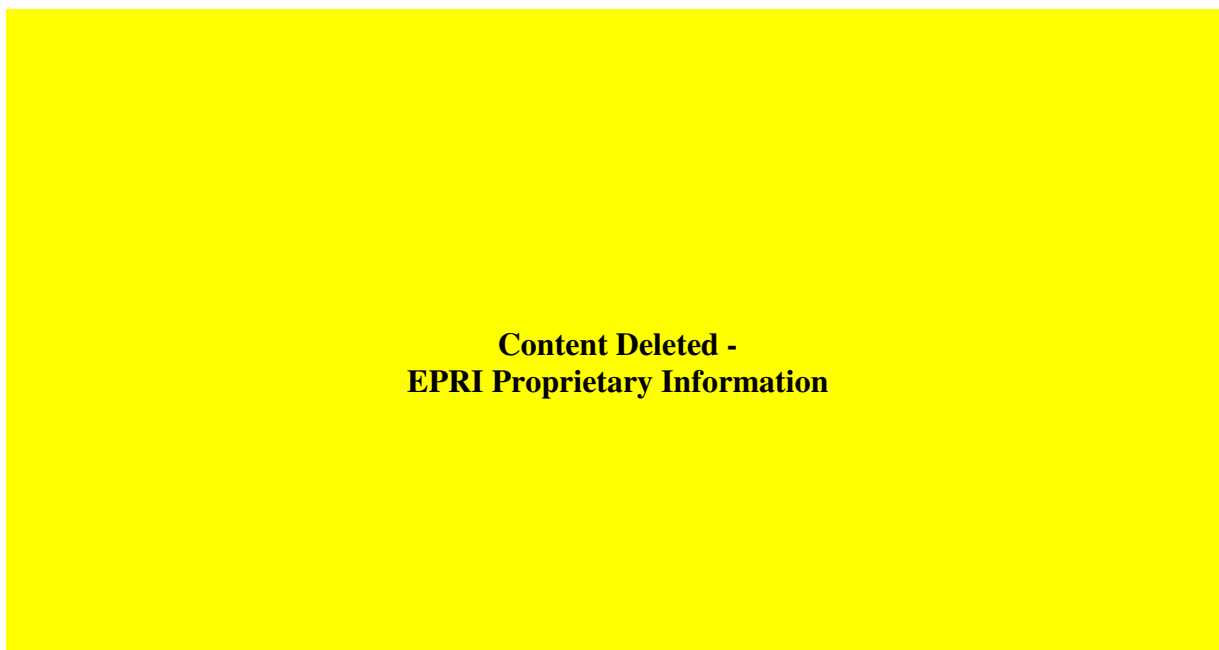


Figure 14.4.1.3-5. As-Built Details of J-Groove Weld Flaw 2b

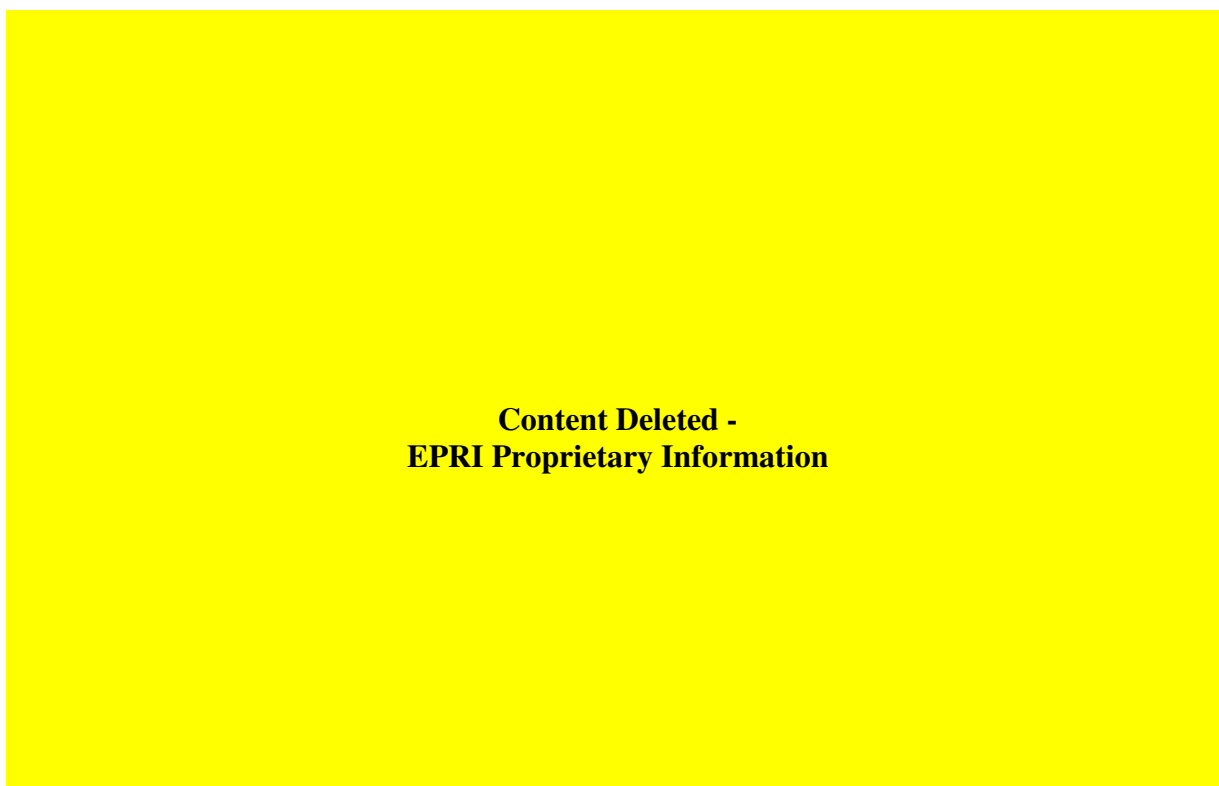


Figure 14.4.1.3-6. As-Built Details of J-Groove Weld Flaw 2c

14.4.1.4 Simulated Erosion

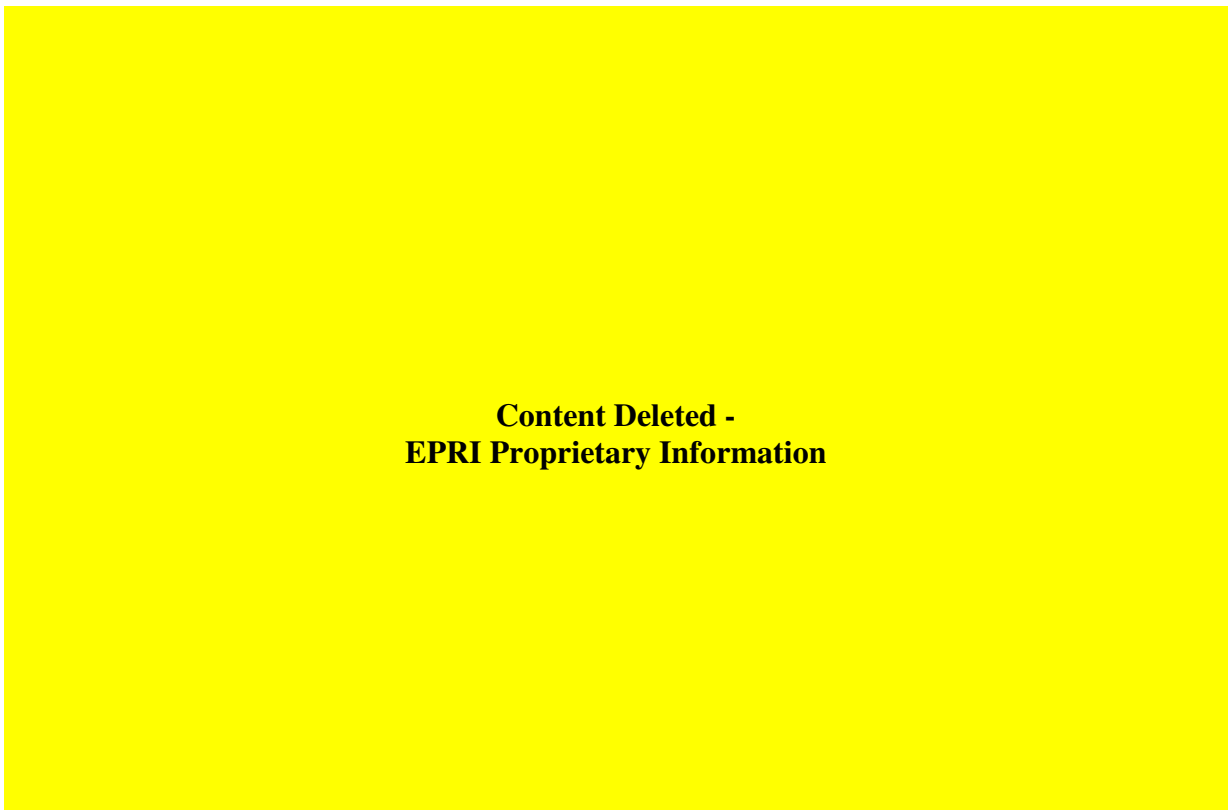
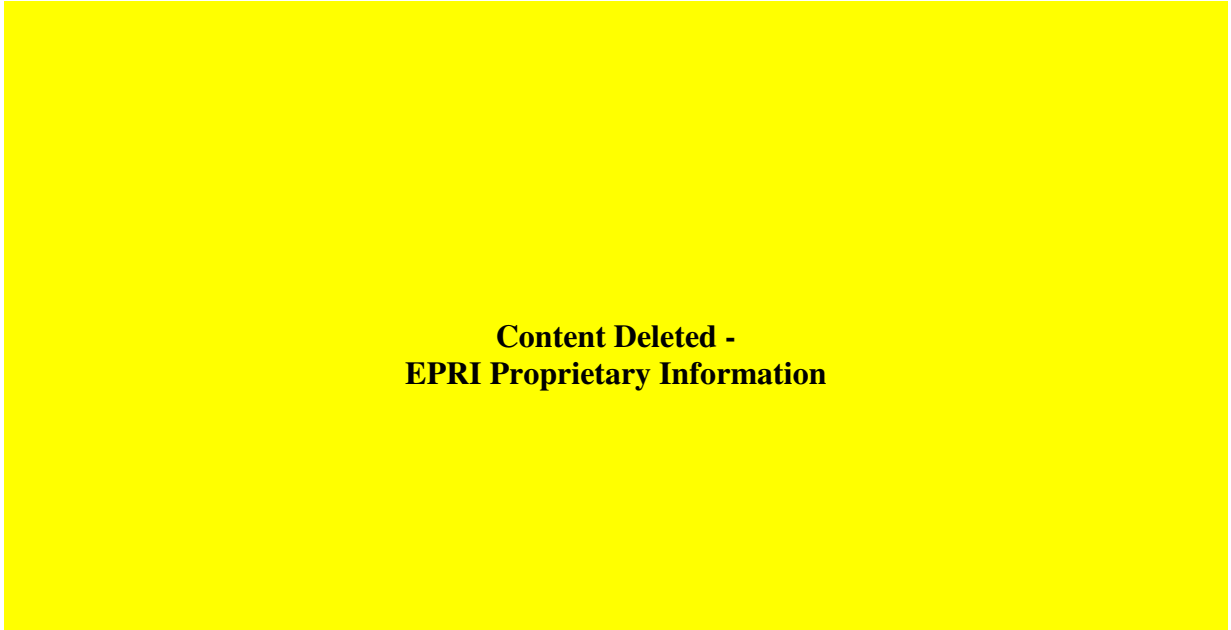


Figure 14.4.1.4-1. Simulated Erosion Path Ground into Penetration #1 Bore Hole (Photograph)

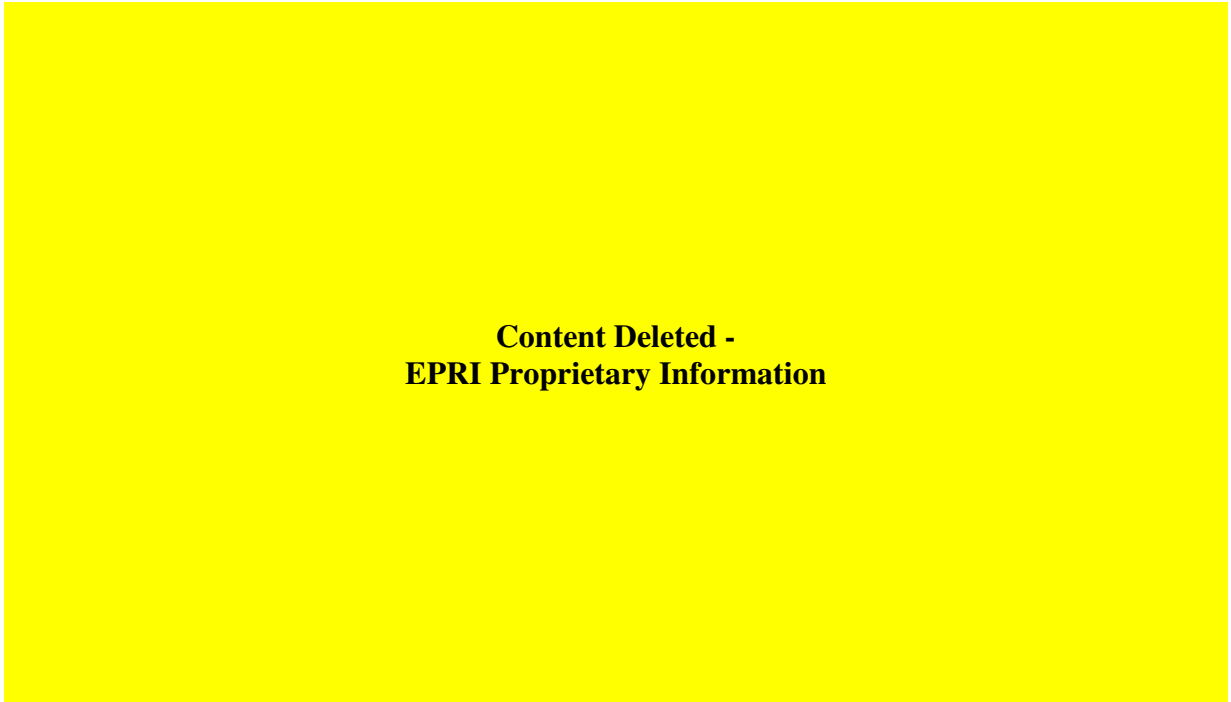


Figure 14.4.1.4-2. Simulated Erosion Path Ground into Penetration #1 Bore Hole (CAD Roll-Out Drawing)

15

ACCESS HOLE COVERS

15.1 Summary

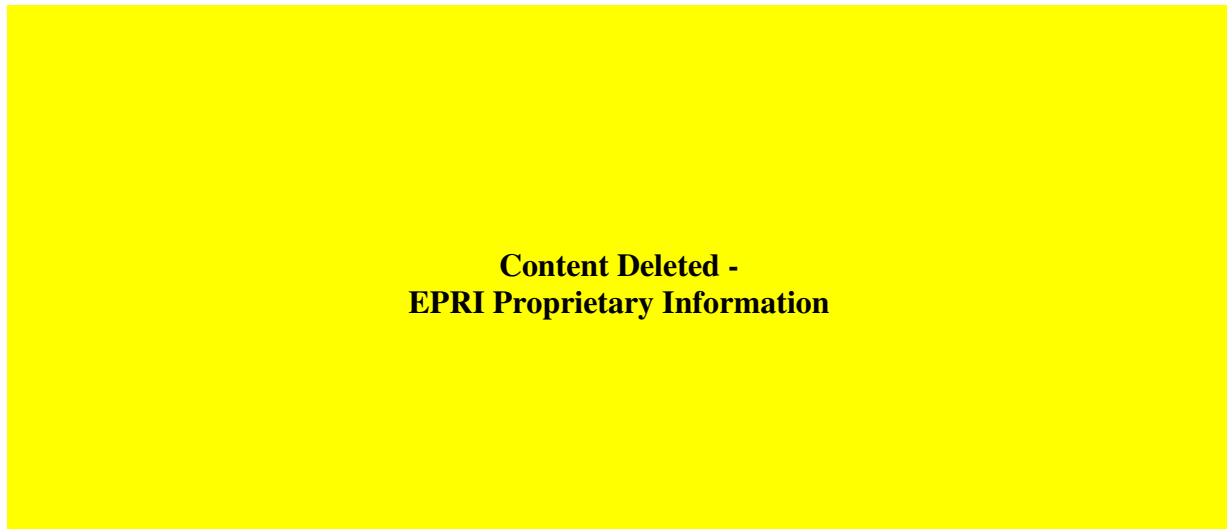
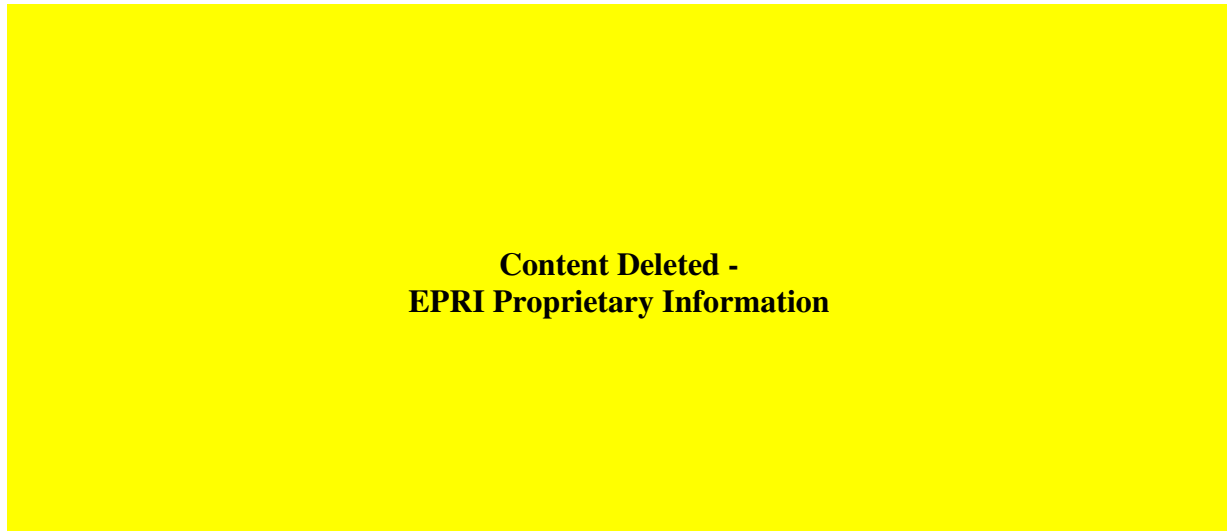
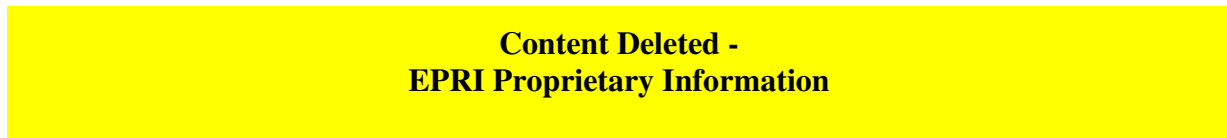


Figure 15.1-1. Access Hole Cover



15.2 Inspection Considerations

**Content Deleted -
EPRI Proprietary Information**

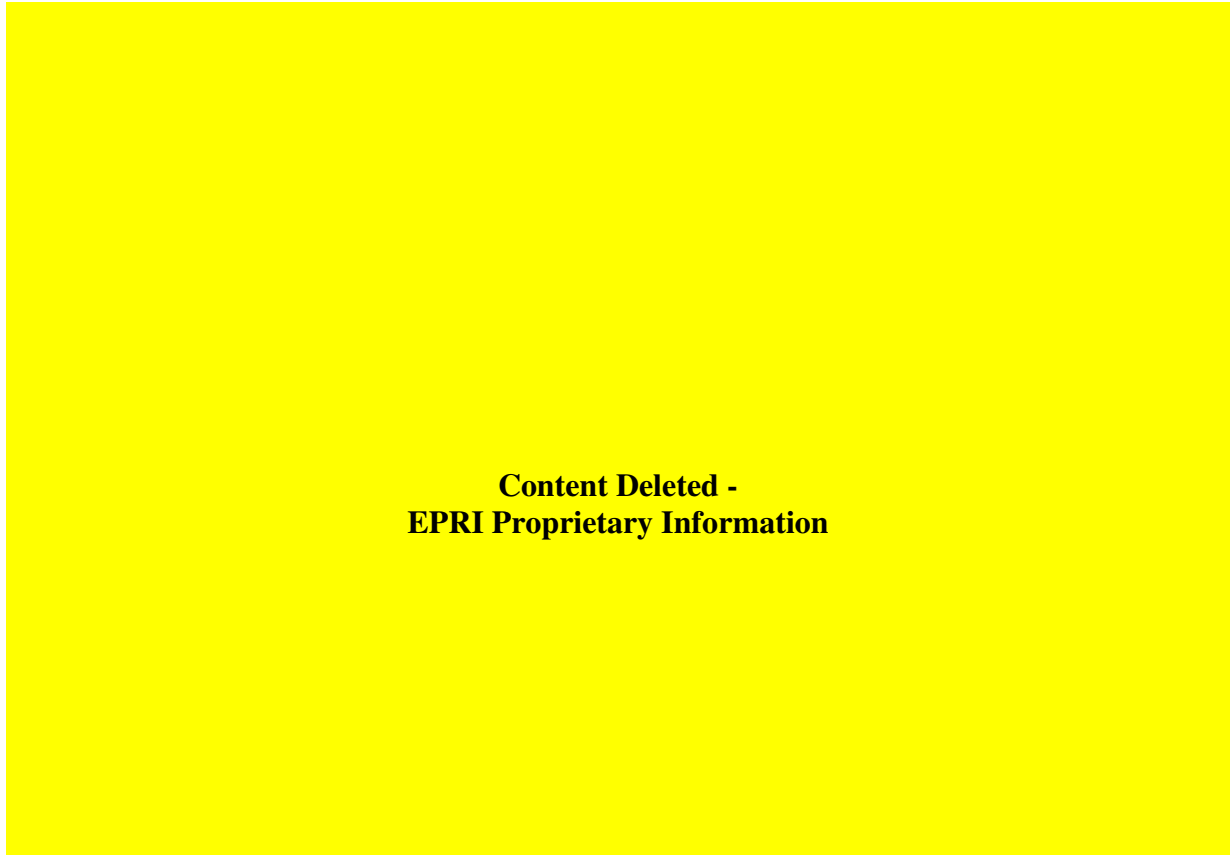
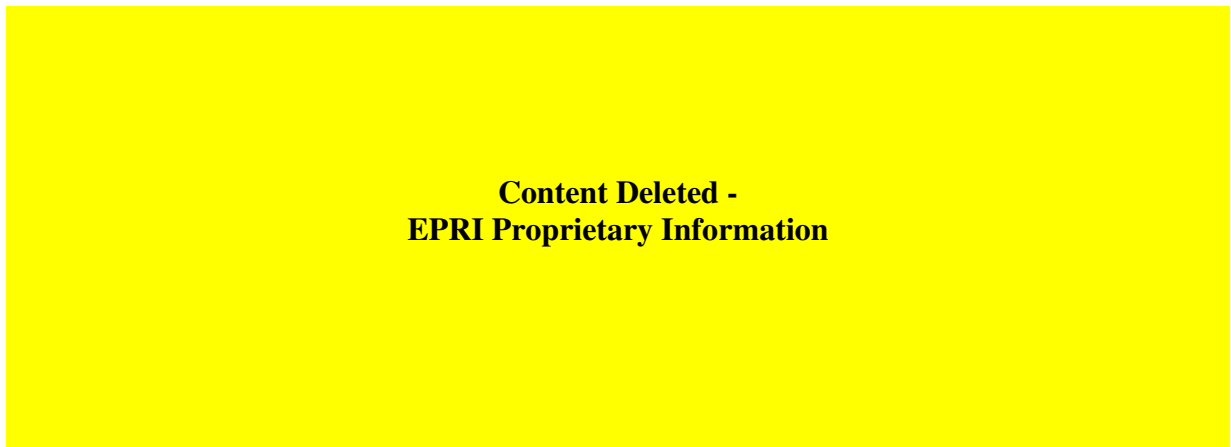


Figure 15.2-1. Examples of Shroud Support Plate Side Ultrasonic Examination Techniques



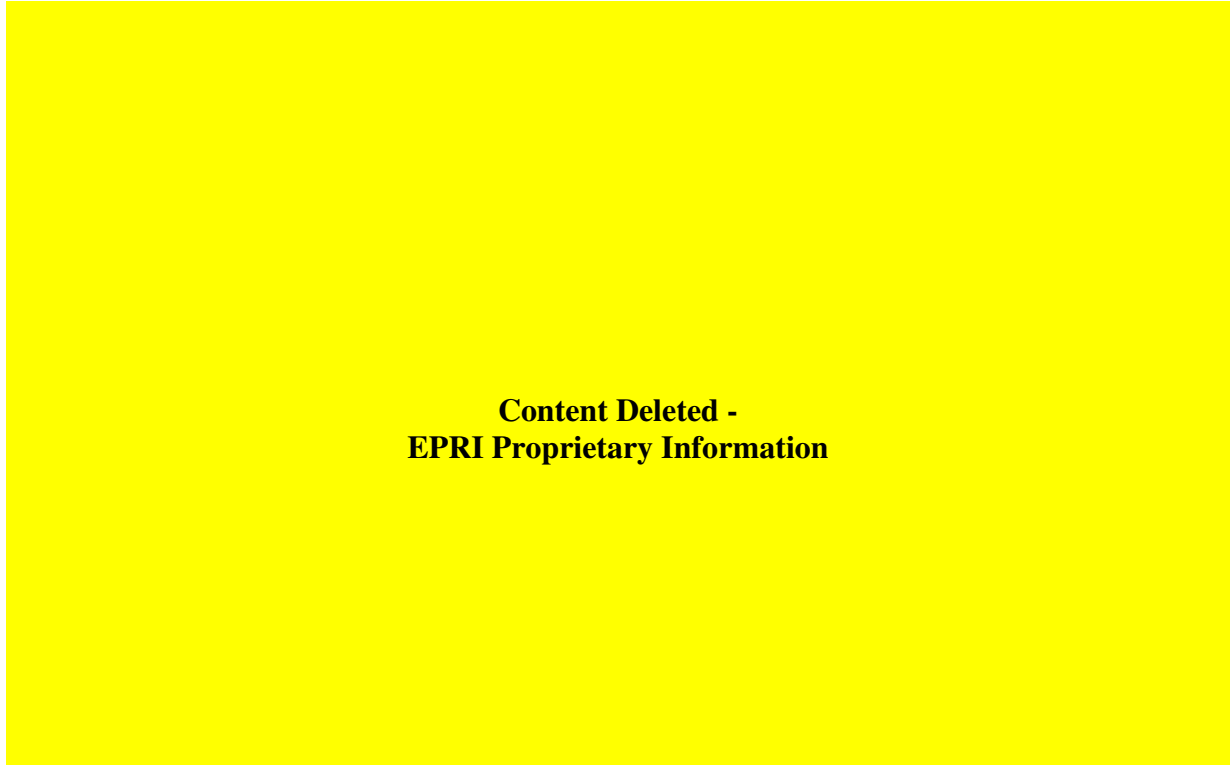
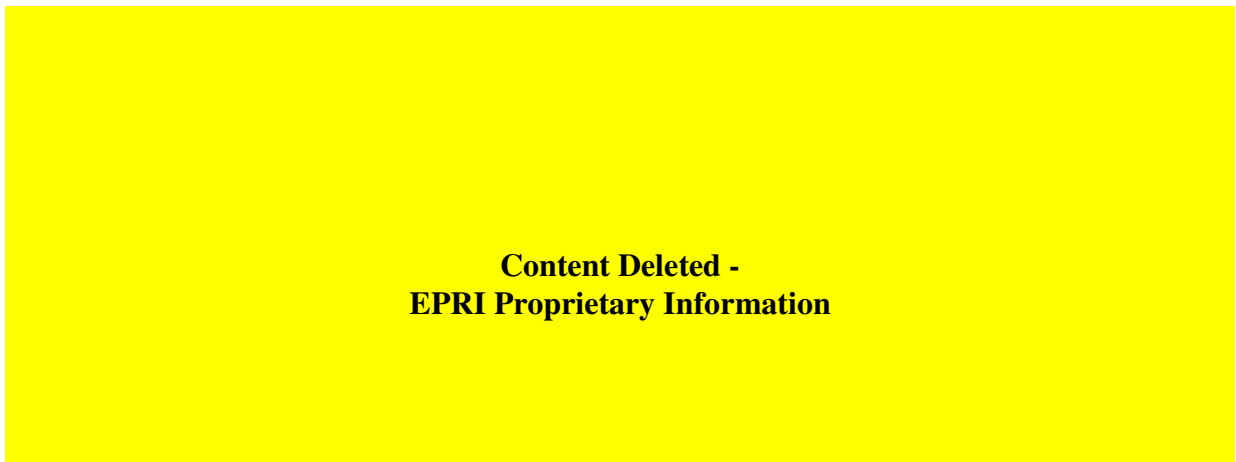


Figure 15.2-2. Retrofit Top Hat Access Hole Cover Configuration

15.2.1 Thin Access Hole Covers



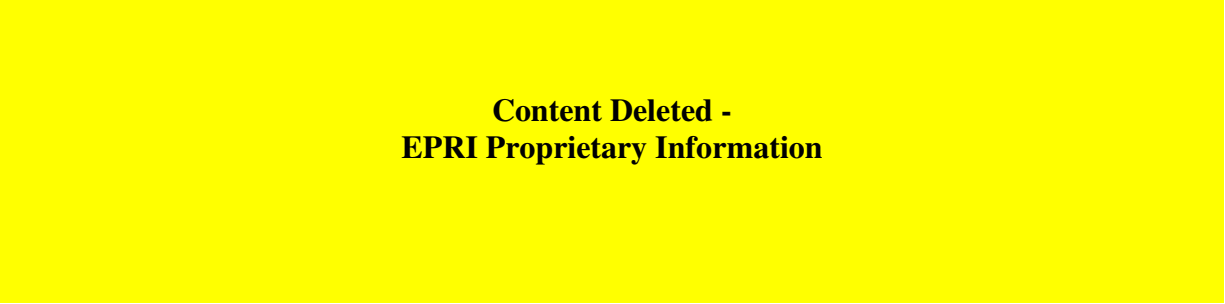


Figure 15.2.1-1. Thin AHC and Conventional Shroud Support Plate with Ledge



15.2.2 Intermediate Thickness Access Hole Covers

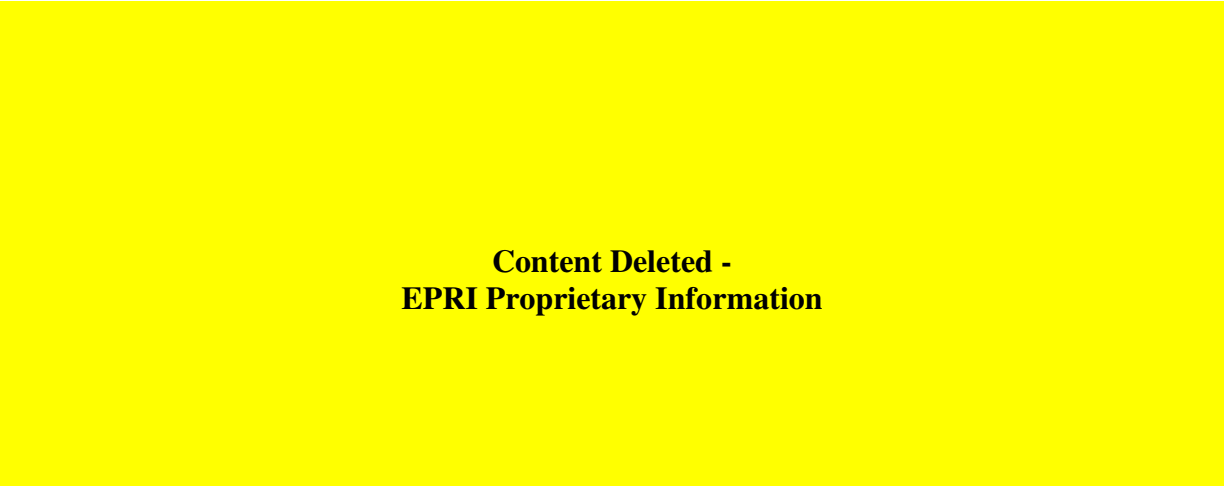
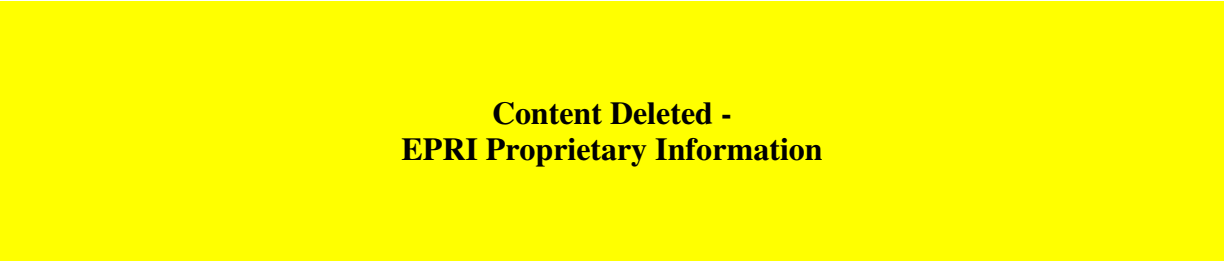


Figure 15.2.2-1. Intermediate Thickness Access Hole Cover and Conventional Shroud Support Plate Without Ledge

15.2.3 Thick Access Hole Covers

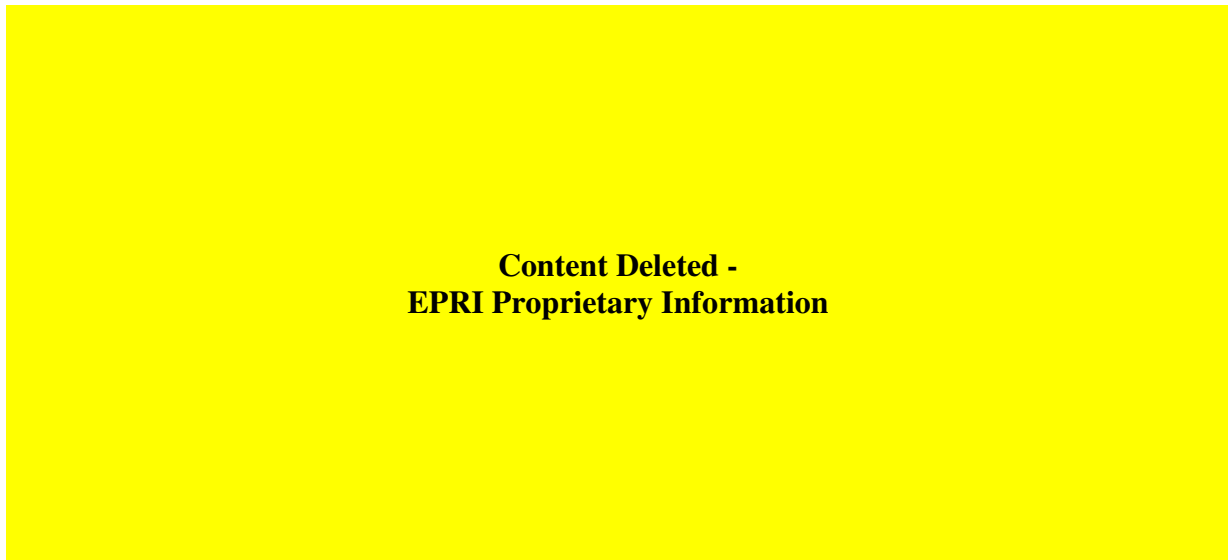
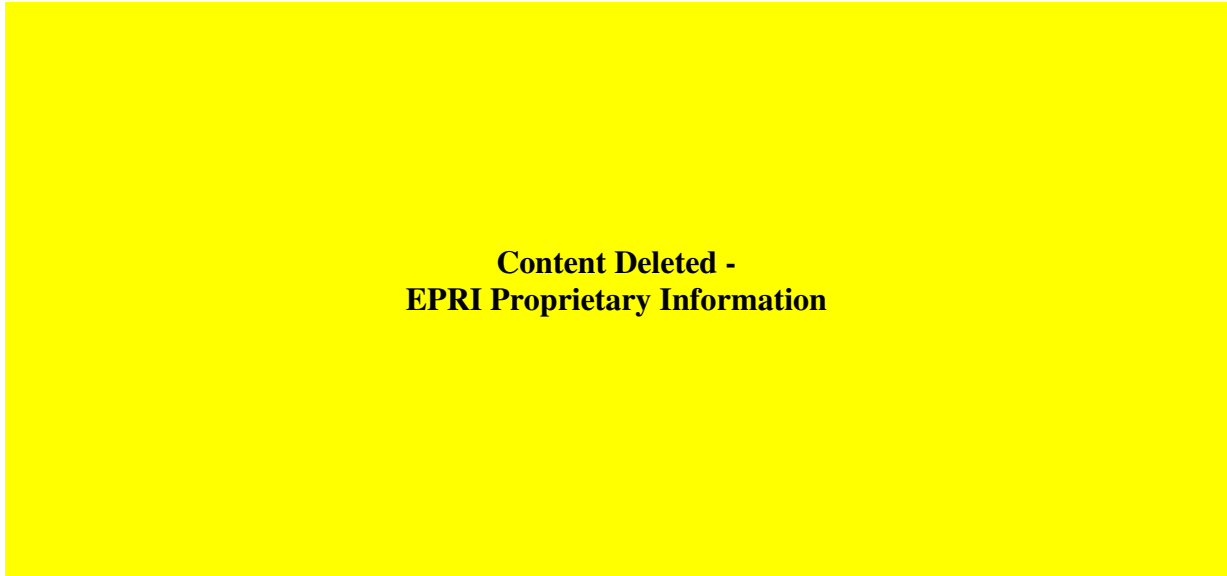
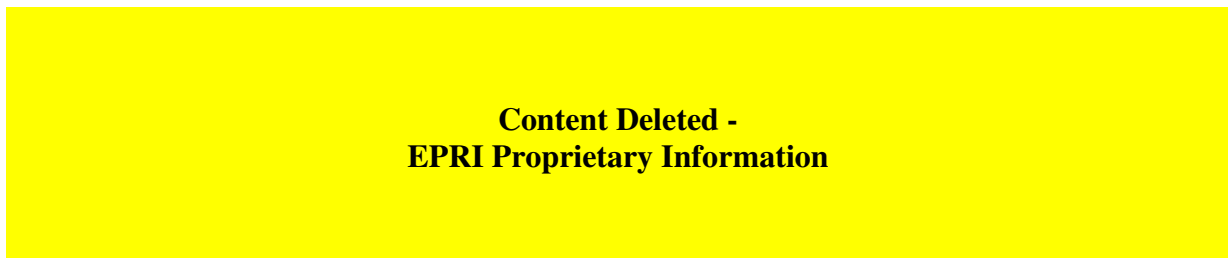


Figure 15.2.3-1. Thick Access Hole Cover and Conventional Shroud Support Plate with Ledge

15.2.4 Non-Creviced Retrofit Design for Some BWR/4 and BWR/5 Plant



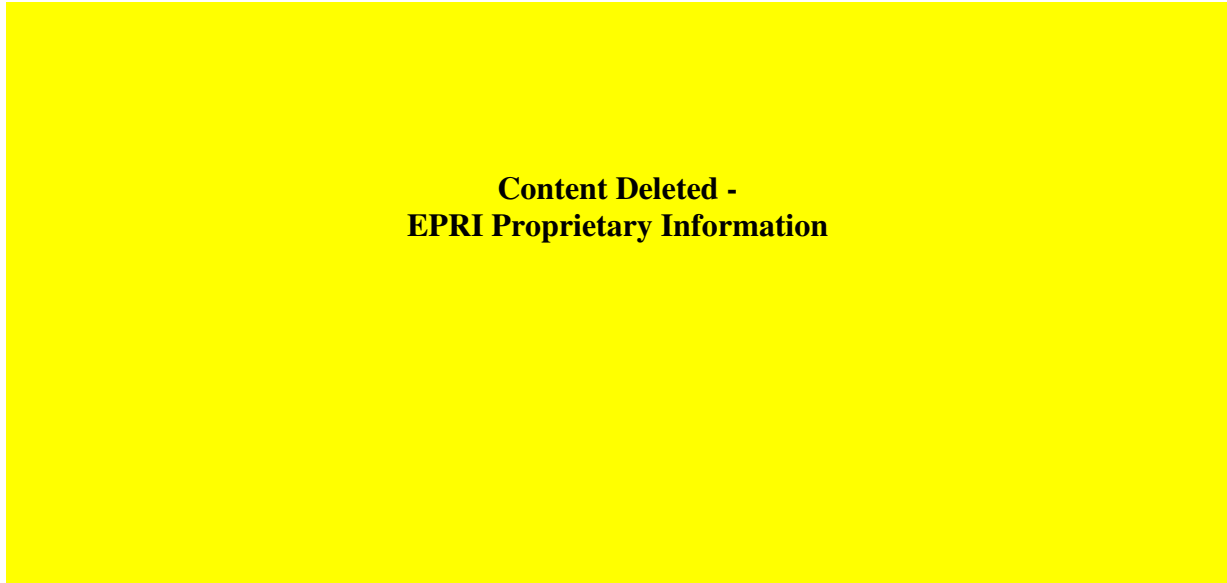
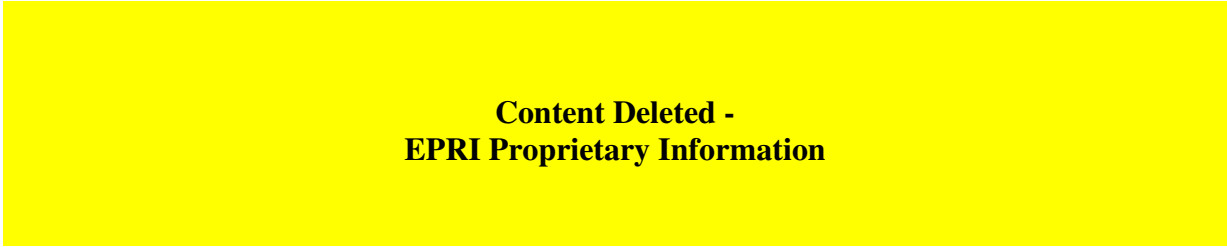
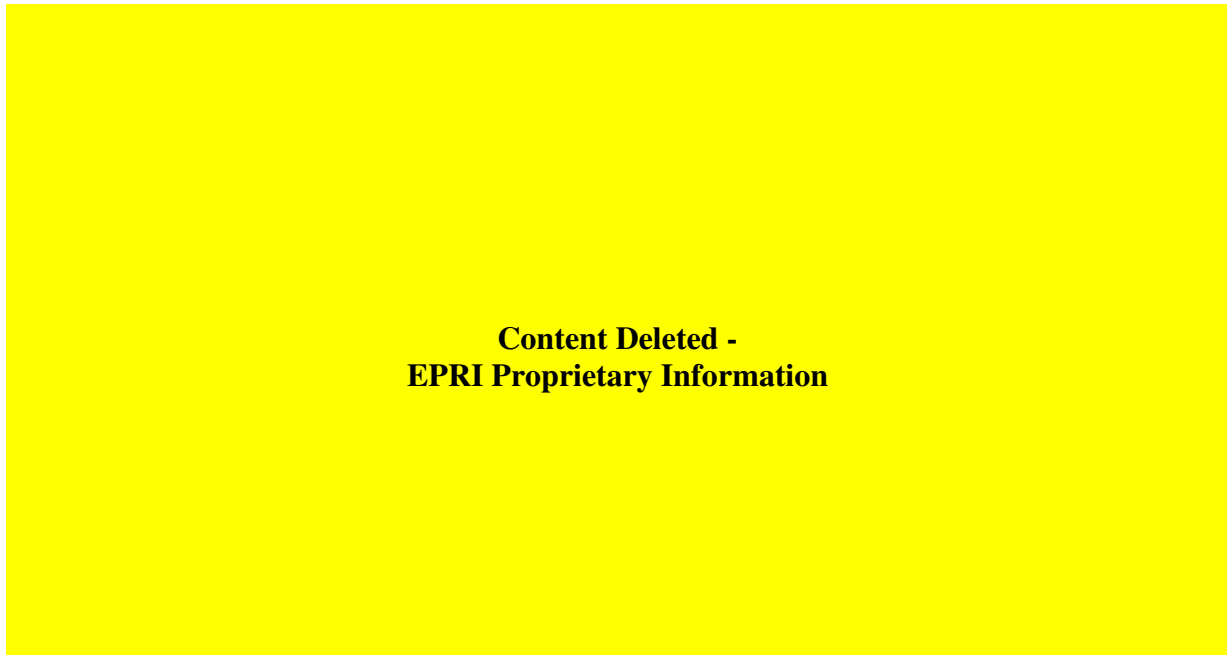


Figure 15.2.4-1. Retrofit Design for Some BWR/4 and BWR/5 Plants

15.2.5 Non-Creviced Single Access Hole Cover Design



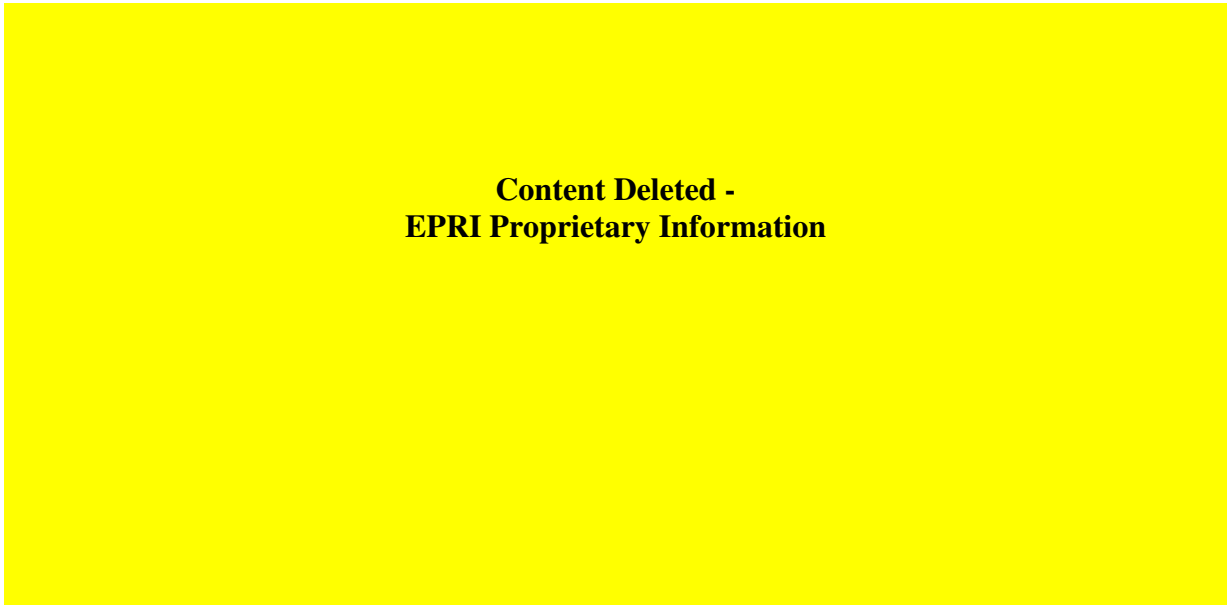
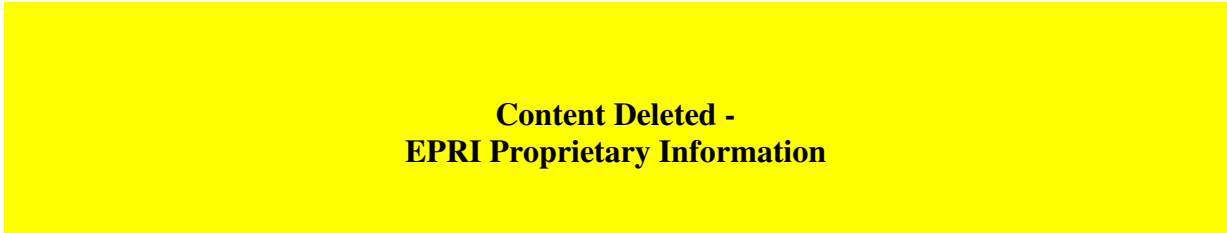
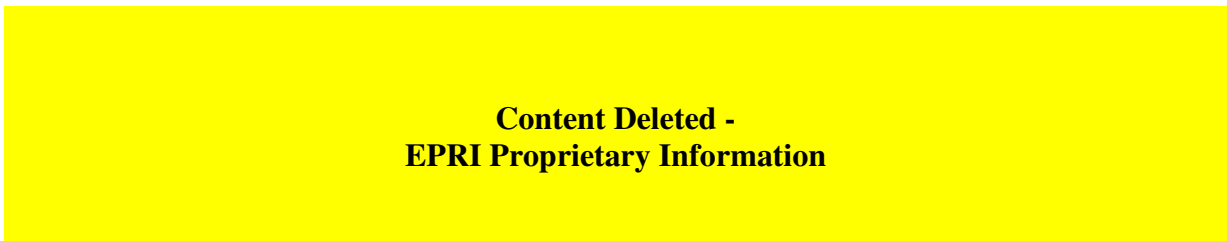
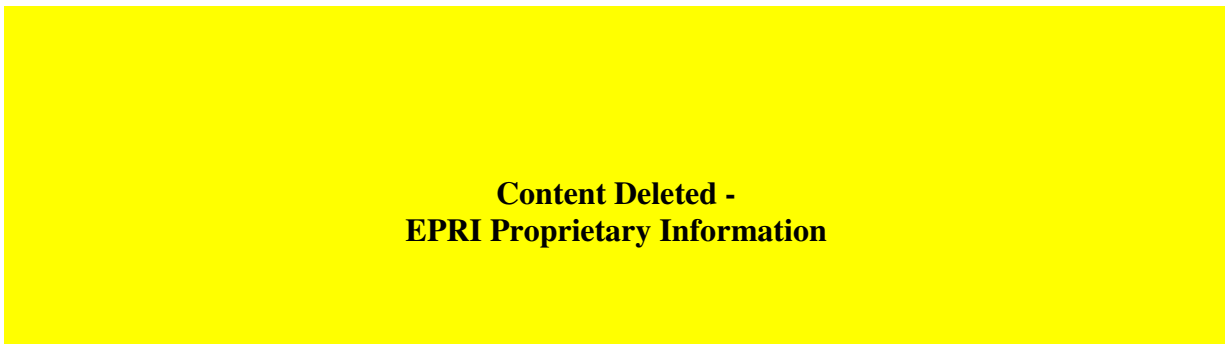


Figure 15.2.5-1. BWR/6 Single Oval Design

15.3 Applicable Mockups



15.3.1 Access Hole Cover Mockups



15.3.1.1 BWRVIP-AHC1

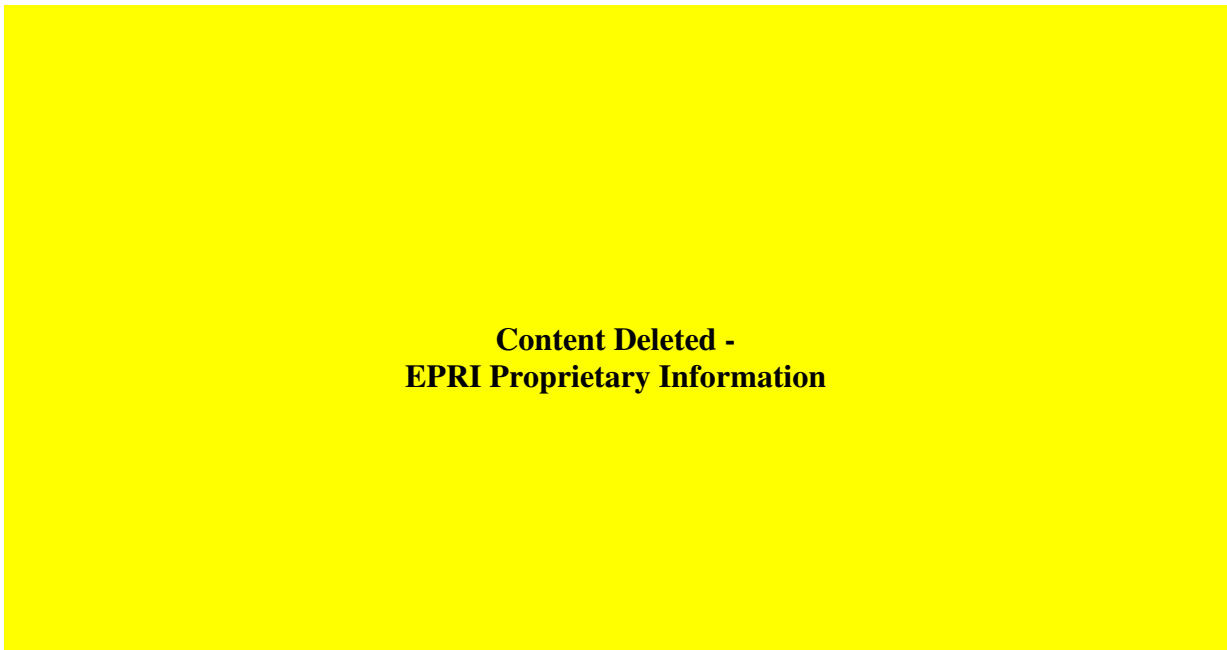
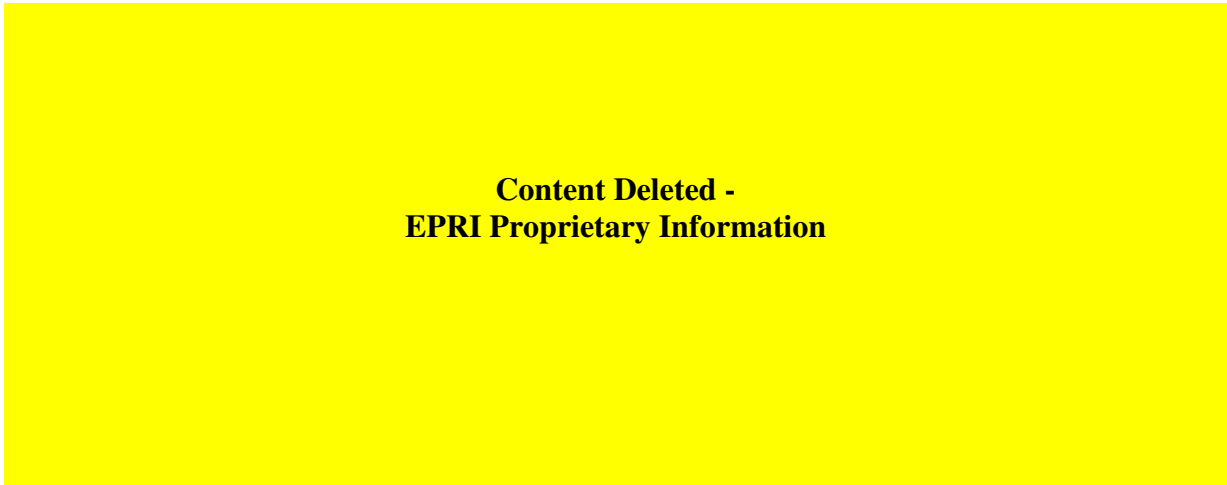


Figure 15.3.1.1-1. BWRVIP-AHC1 Mockup (Photograph)

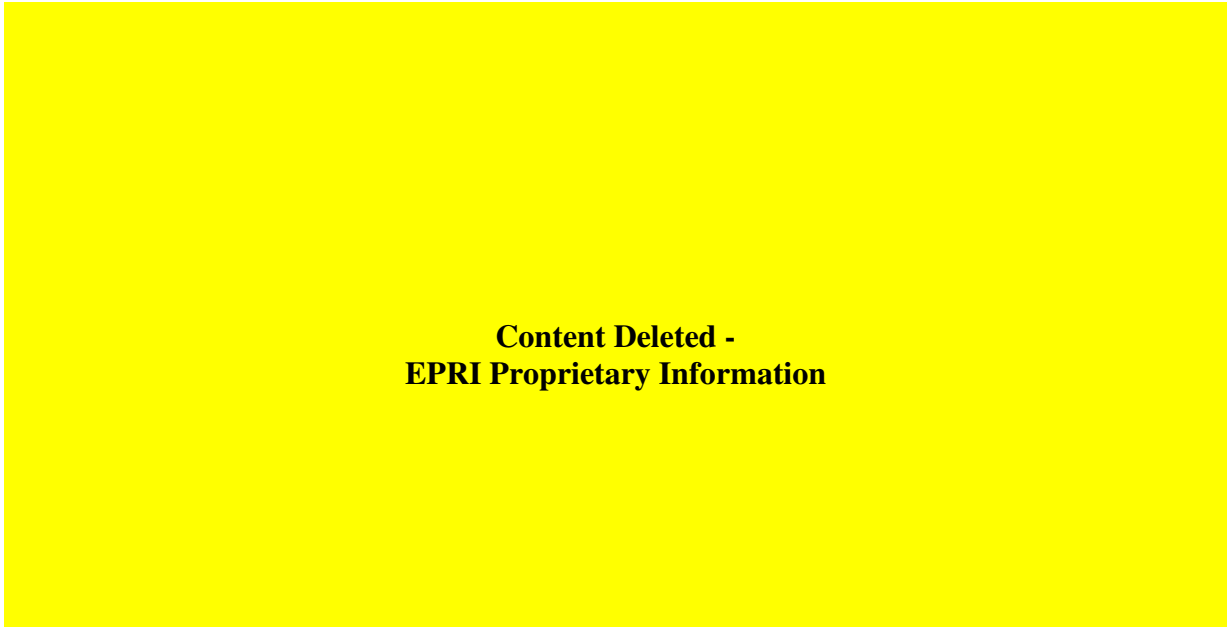
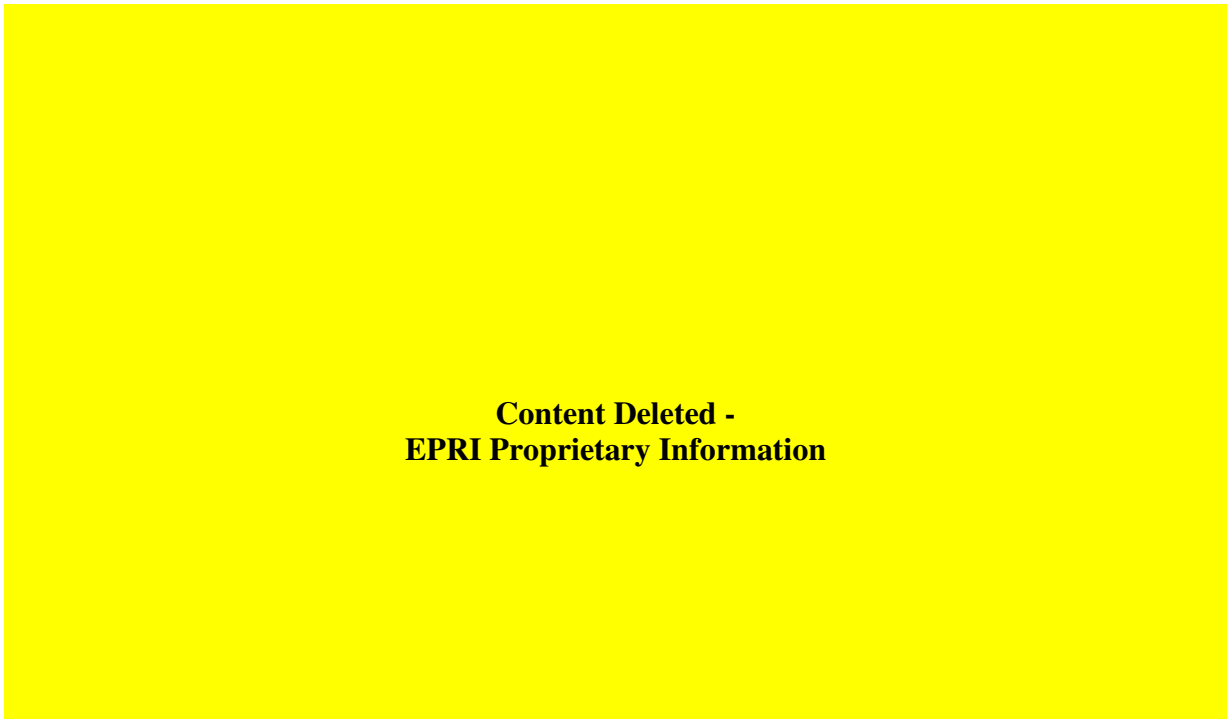


Figure 15.3.1.1-2. Bottom Side of BWRVIP-AHC1 Mockup (Photograph)

15.3.1.2 BWRVIP-AHC2



**Content Deleted -
EPRI Proprietary Information**

Figure 15.3.1.2-1. BWRVIP-AHC2 Mockup (Photograph)

15.3.1.3 BWRVIP-AHC3 and BWRVIP-AHC4

**Content Deleted -
EPRI Proprietary Information**

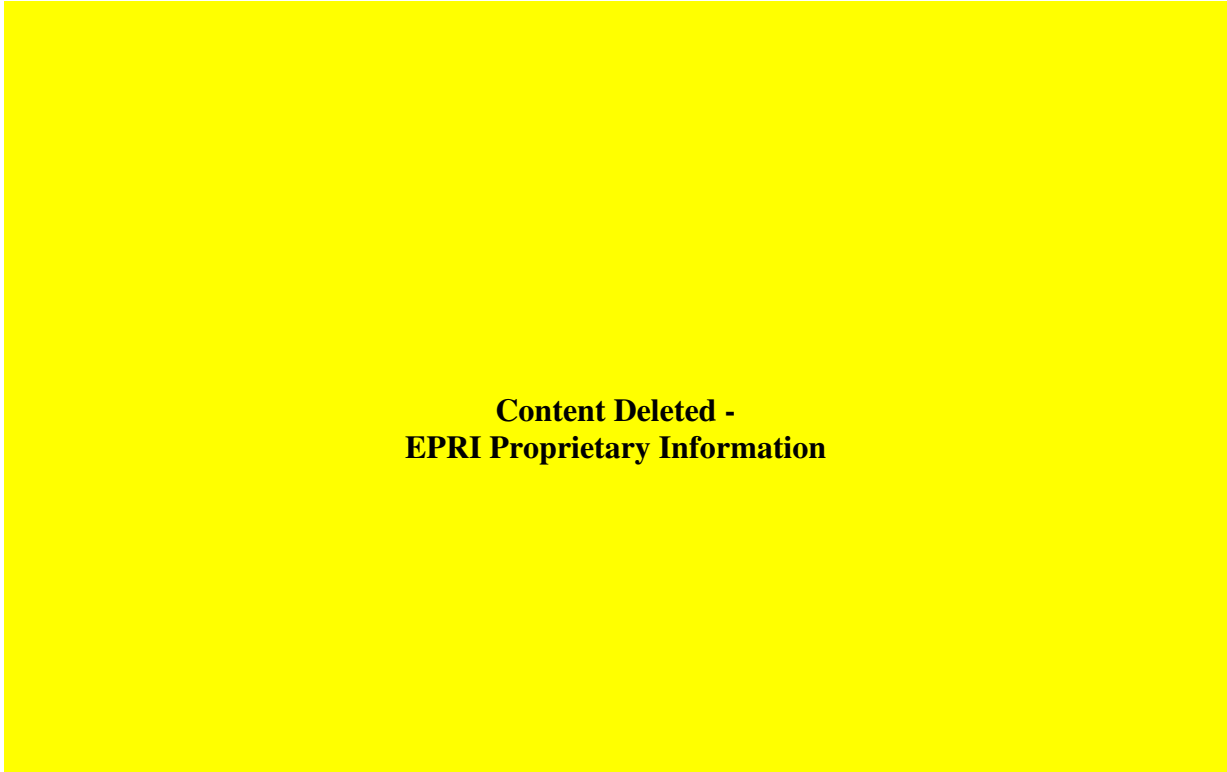
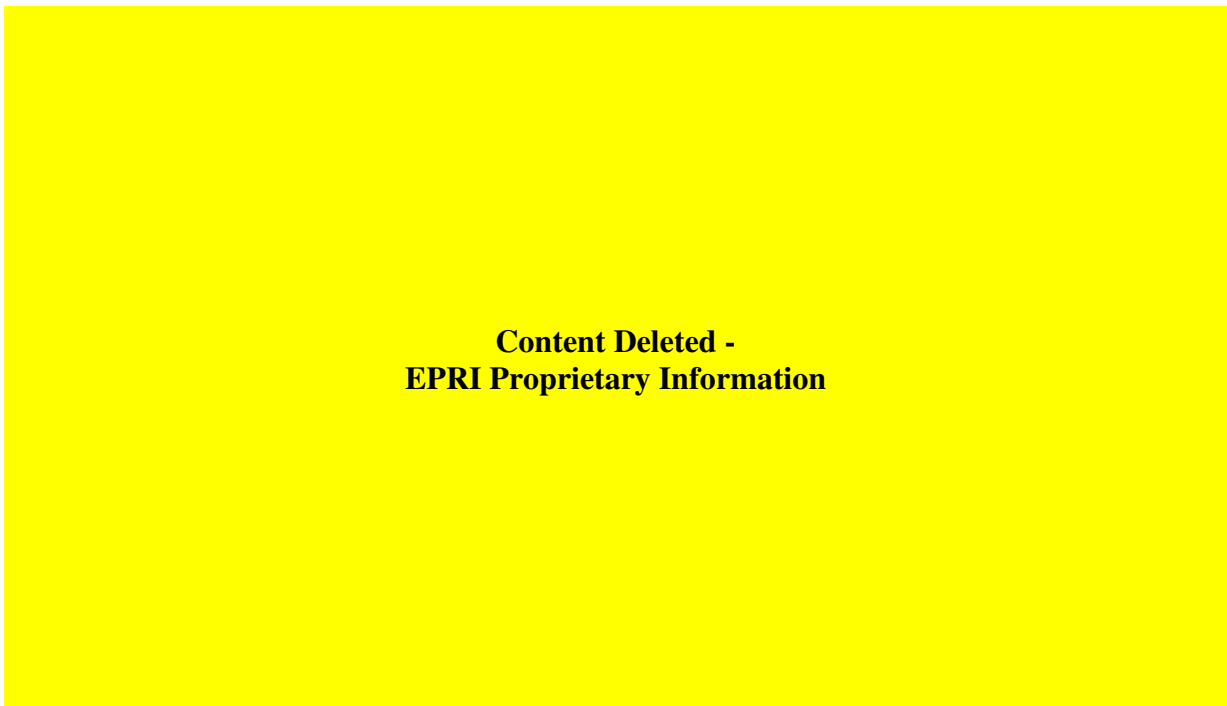


Figure 15.3.1.3-1. BWRVIP-AHC3 and BWRVIP-AHC4 (Photograph)

15.3.1.4 BWRVIP-AHC5



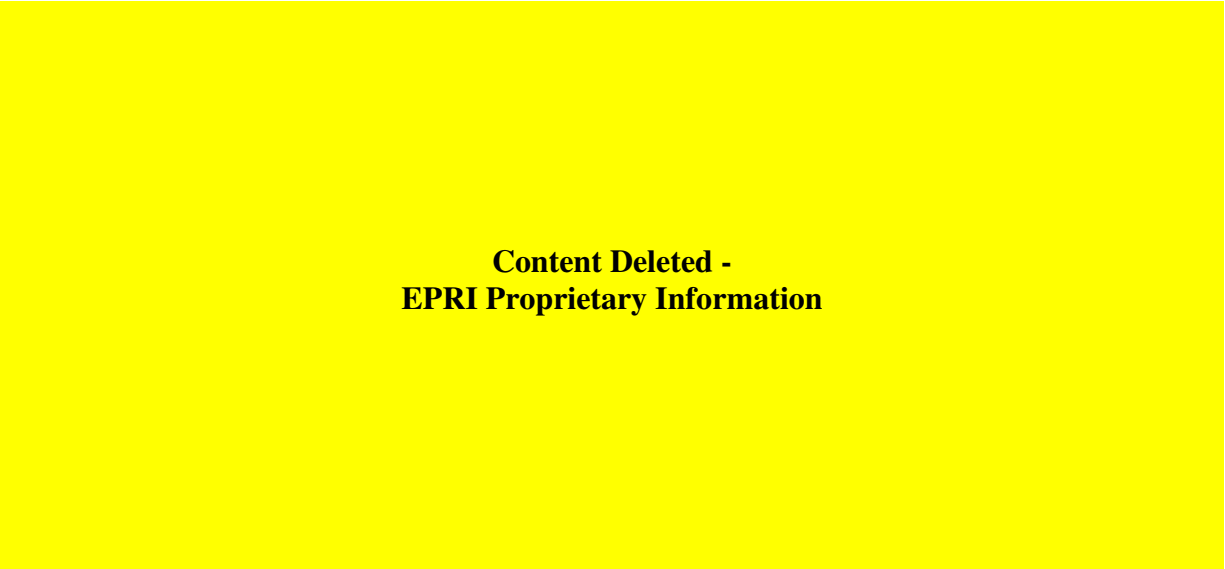


Figure 15.3.1.4-1. BWRVIP-AHC5 Mockup (Photograph)

15.3.1.5 BWRVIP-AHC6

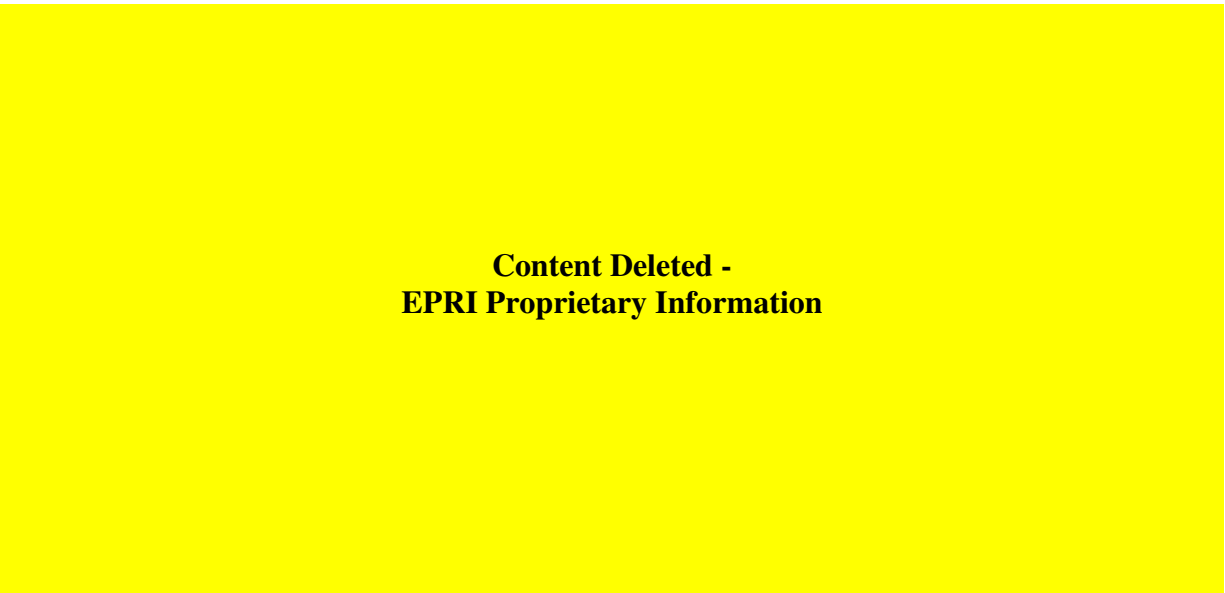
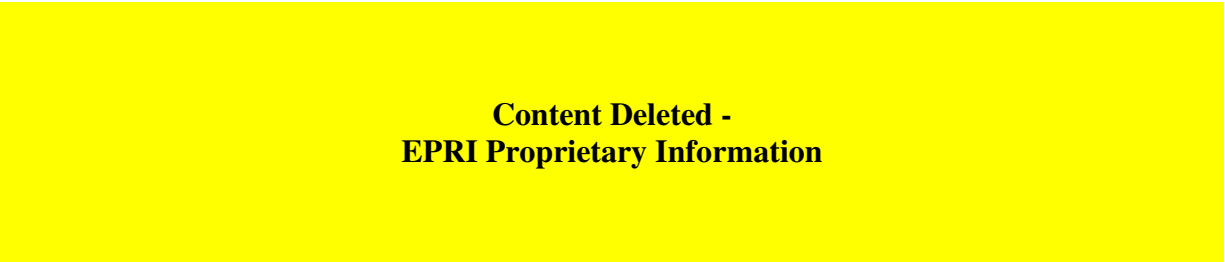


Figure 15.3.1.5-1. BWRVIP-AHC6 Mockup (Photograph)

15.4 UT Technique Demonstrations for Access Hole Covers

**Content Deleted -
EPRI Proprietary Information**

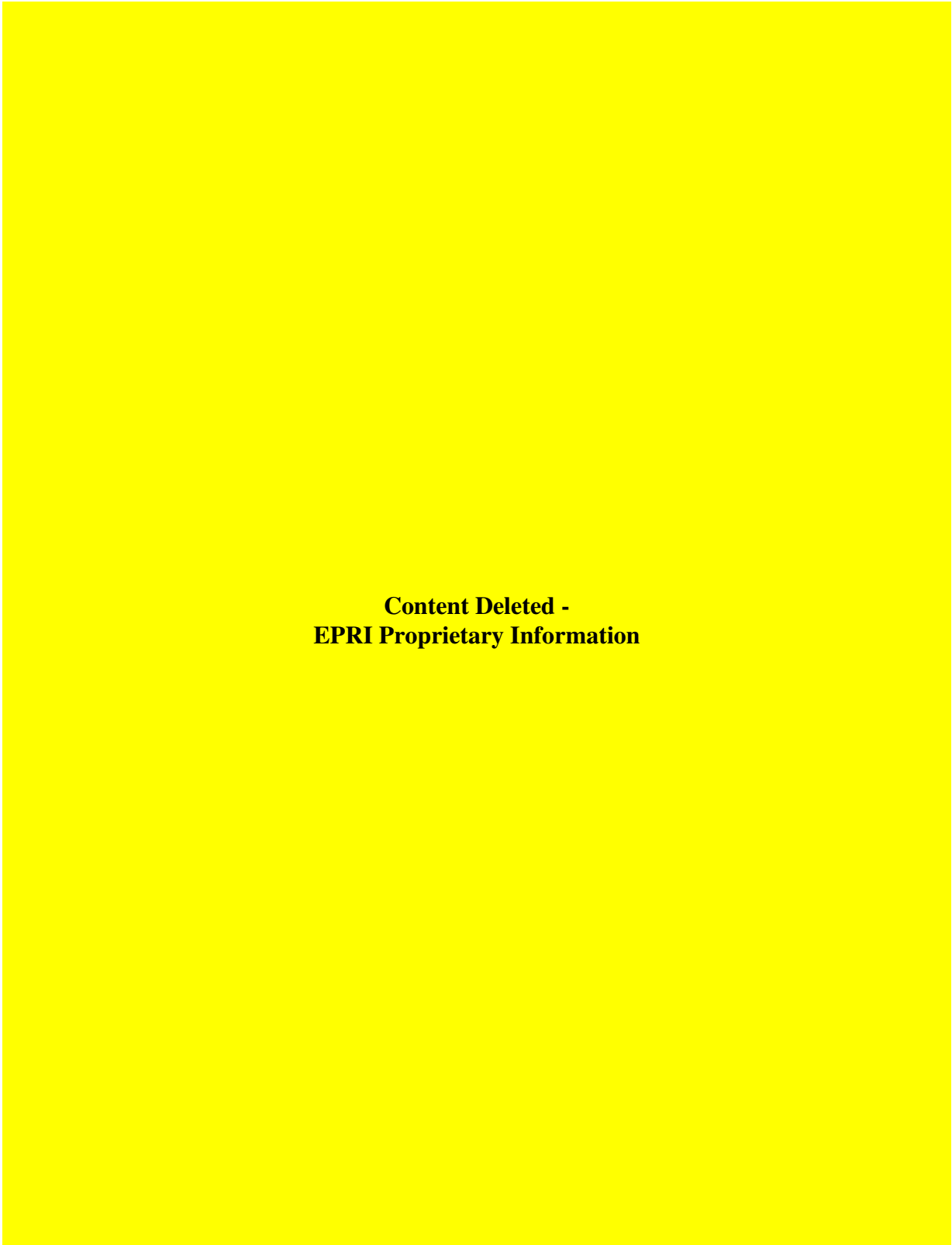
15.4.1 UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

Table 15.4.1-1. UT Demonstration Summary

**Content Deleted -
EPRI Proprietary Information**

15.4.2 UT Demonstration 1



**Content Deleted -
EPRI Proprietary Information**

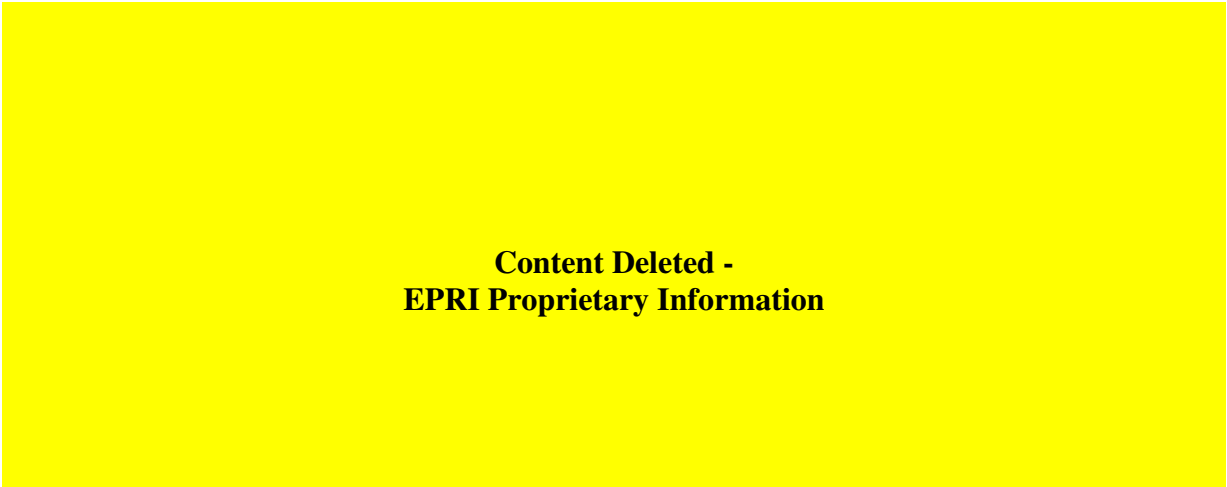
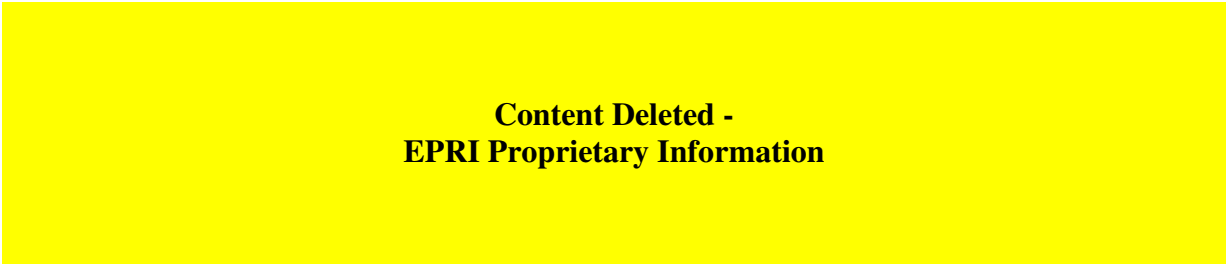


Figure 15.4.2-1. Surface Distance Required for Azimuthal (Sector) Scan

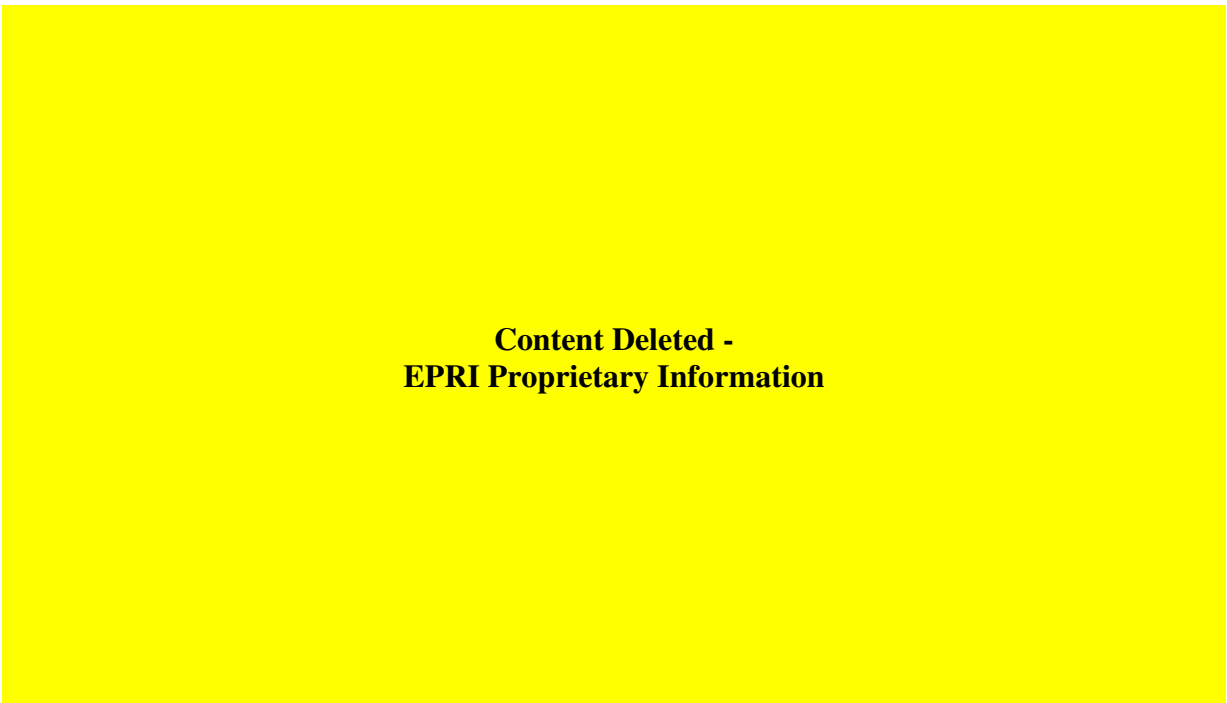
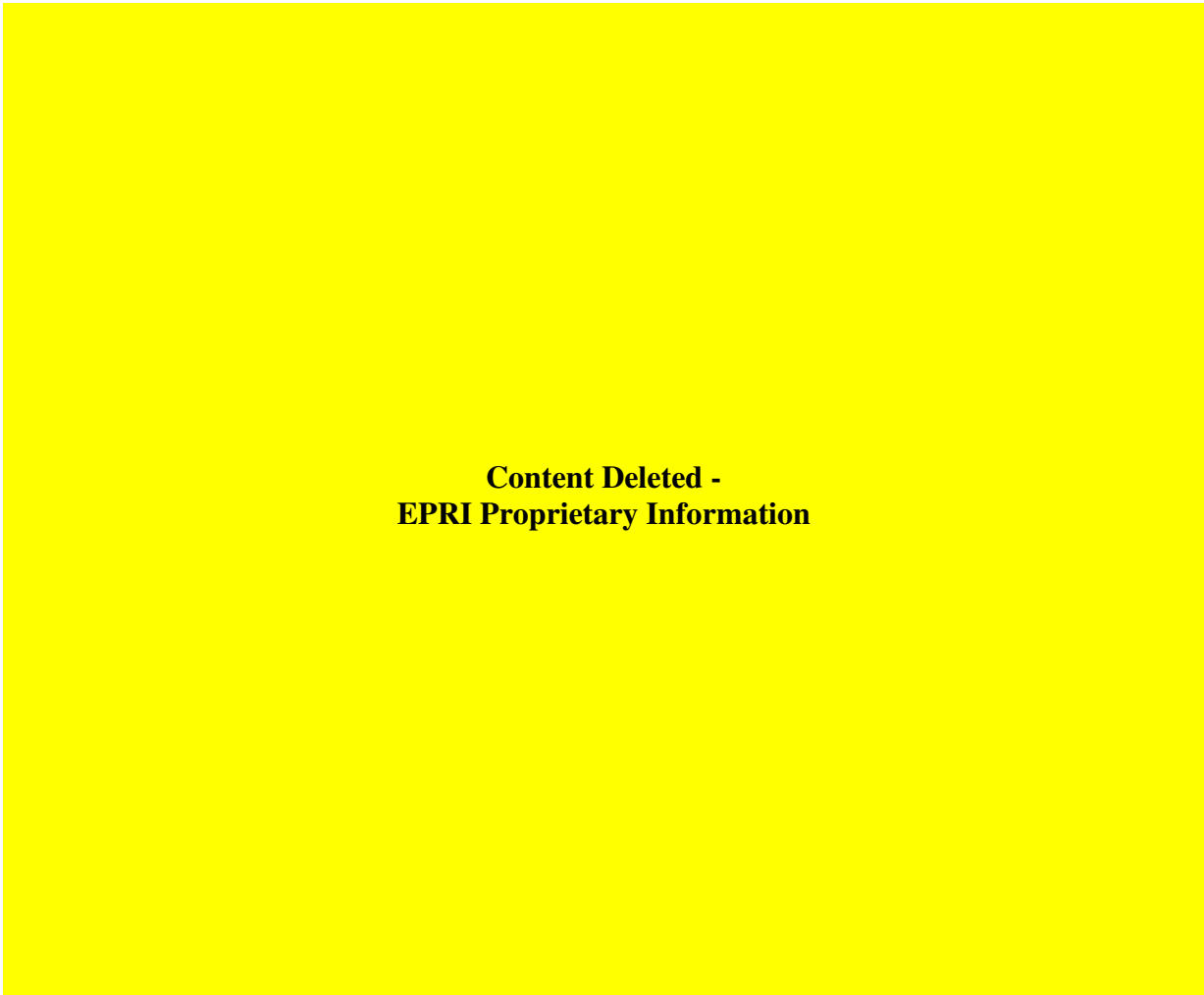
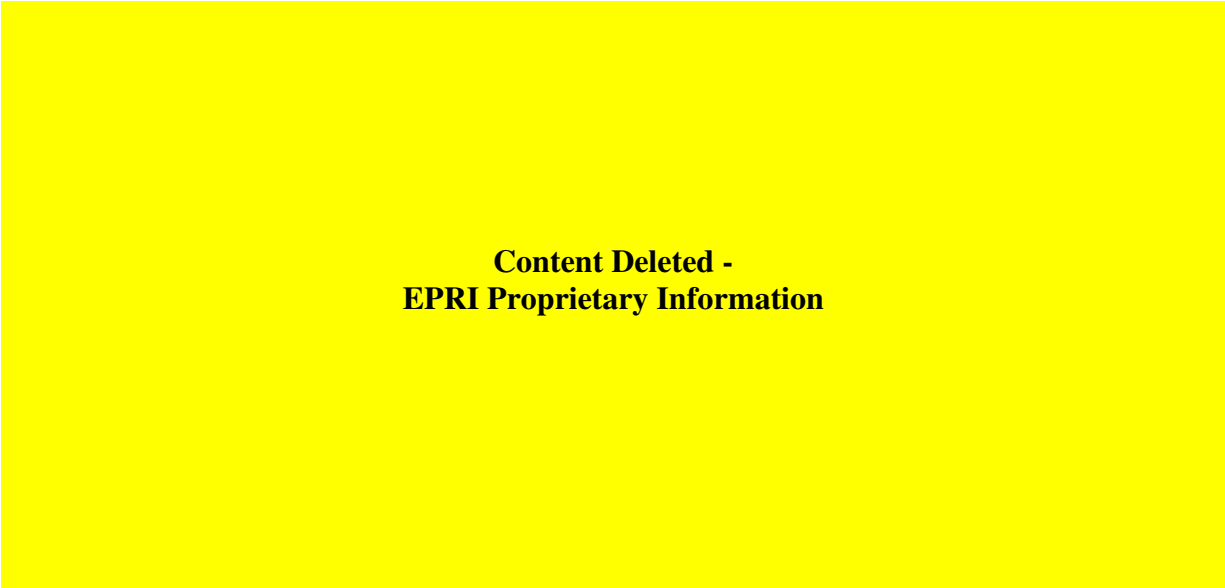


Figure 15.4.2-2. Surface Distance Required for Linear Scans (Electronic Raster)

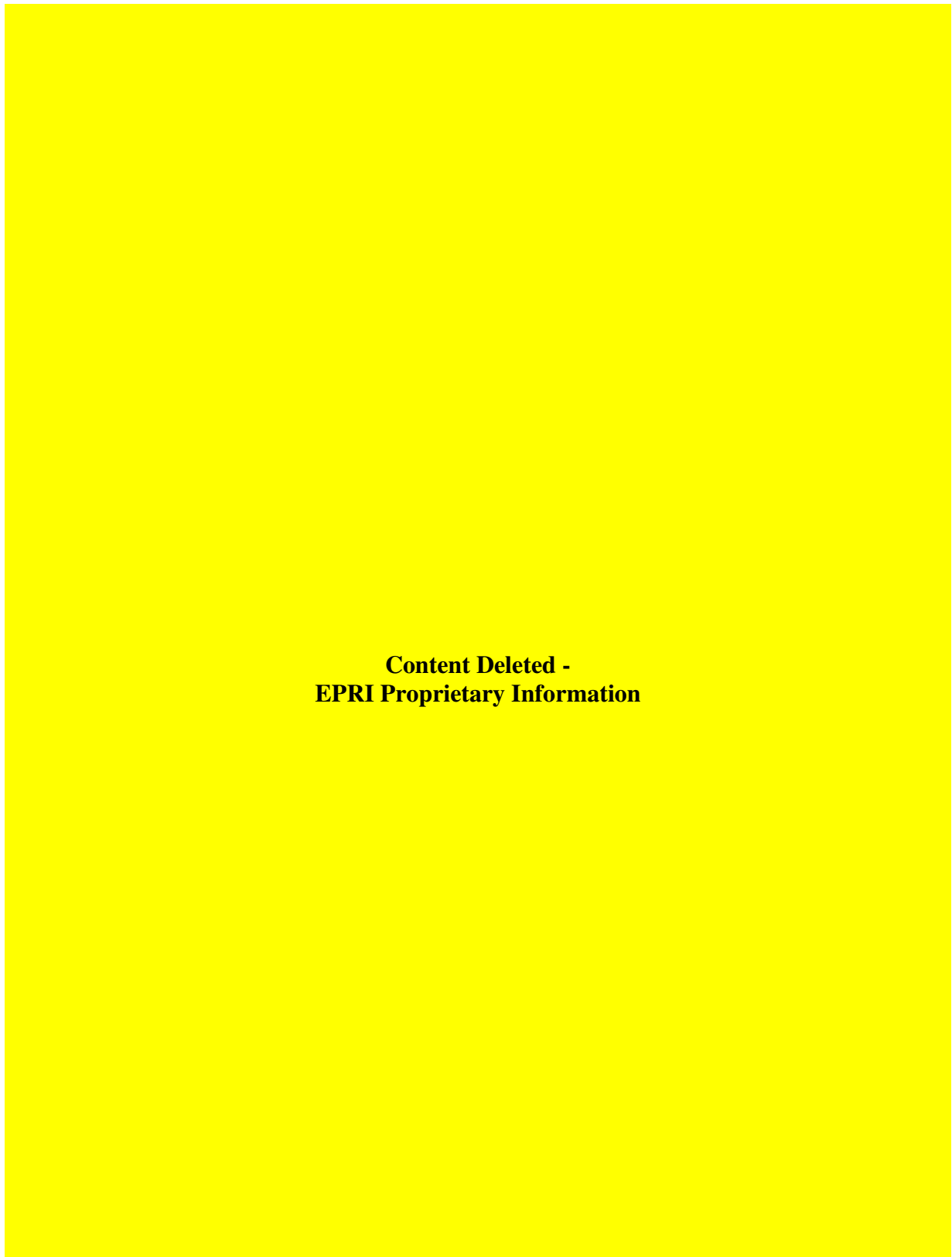
Table 15.4.2-1. Demonstrated Examination Groups and Scan/Index Resolutions





**Content Deleted -
EPRI Proprietary Information**

15.4.3 UT Demonstration 2



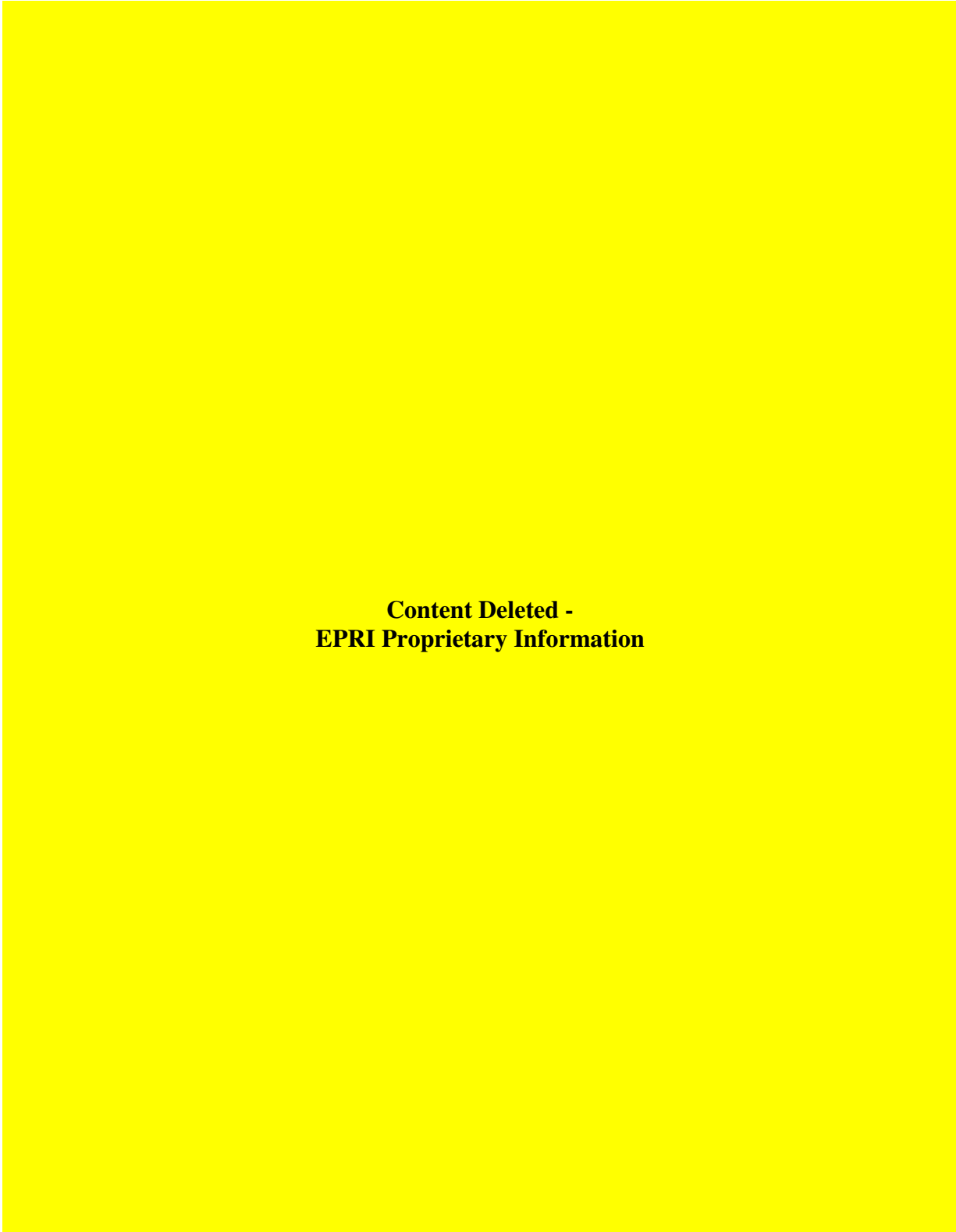
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**



**Content Deleted -
EPRI Proprietary Information**

15.4.4 UT Demonstration 3



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 15.4.4-1. Demonstrated Scan and Index Variables



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

15.4.5 UT Demonstration 4



**Content Deleted -
EPRI Proprietary Information**

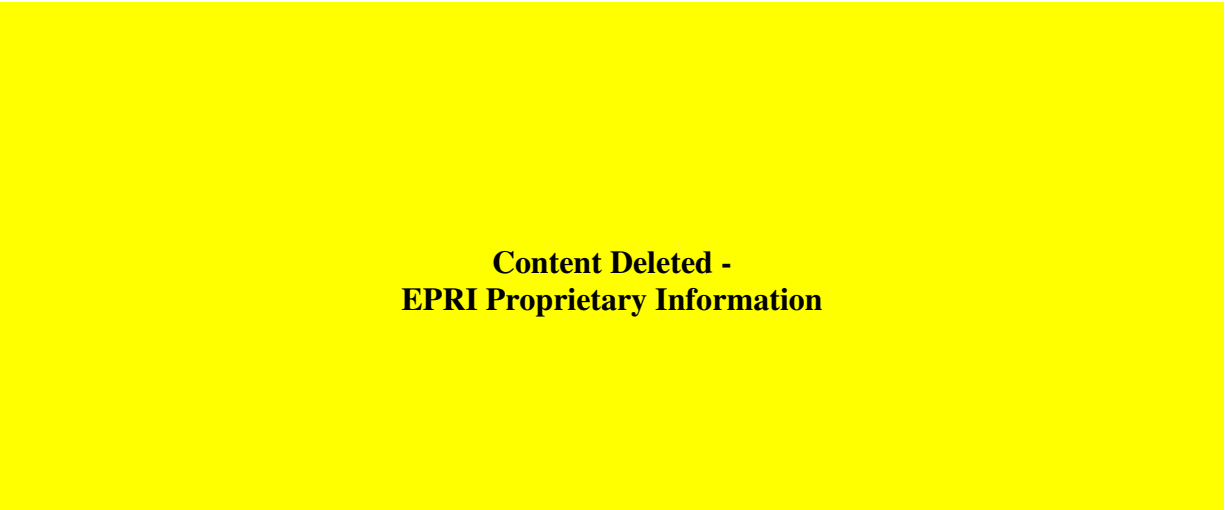
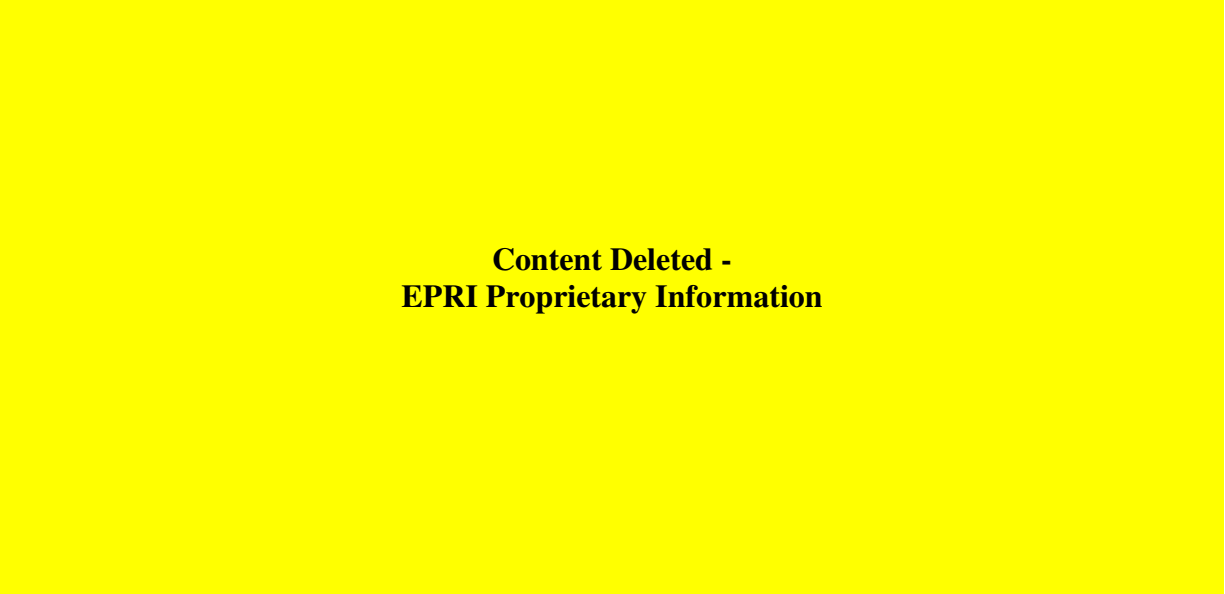
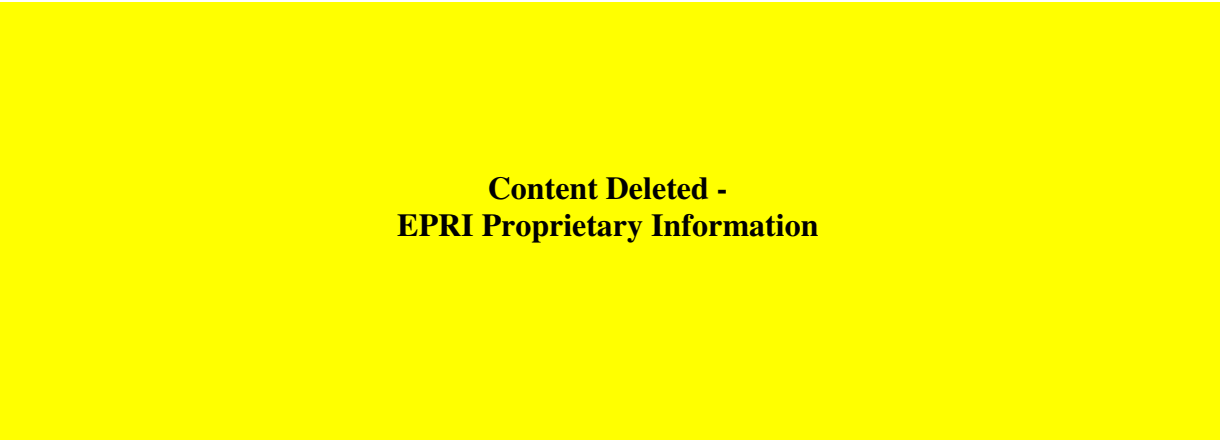


Figure 15.4.5-1. Demonstrated Immersion Technique (1-inch Water Path)



**Content Deleted -
EPRI Proprietary Information**

Table 15.4.5-1. Demonstrated Scan and Index Variables

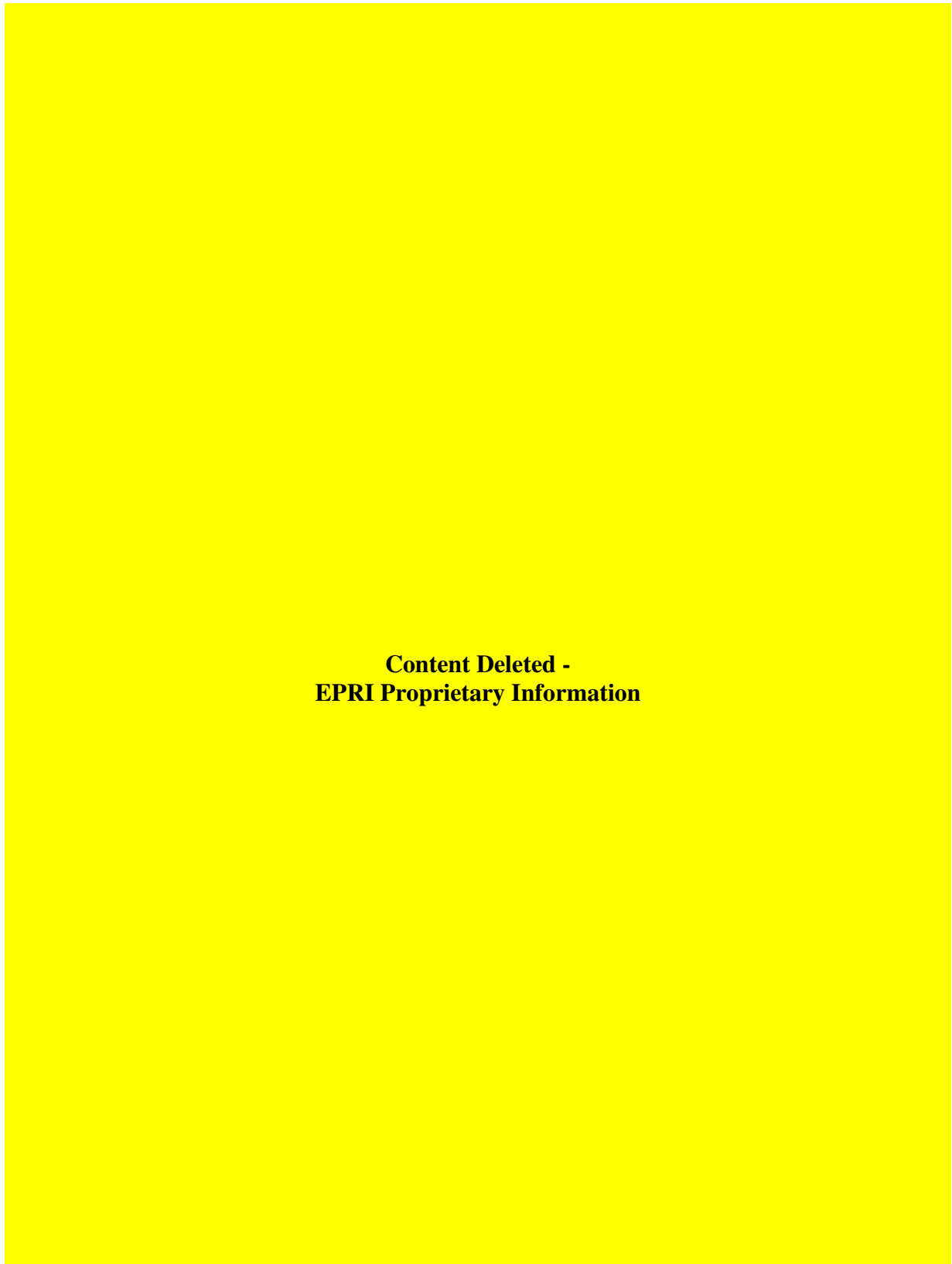
**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

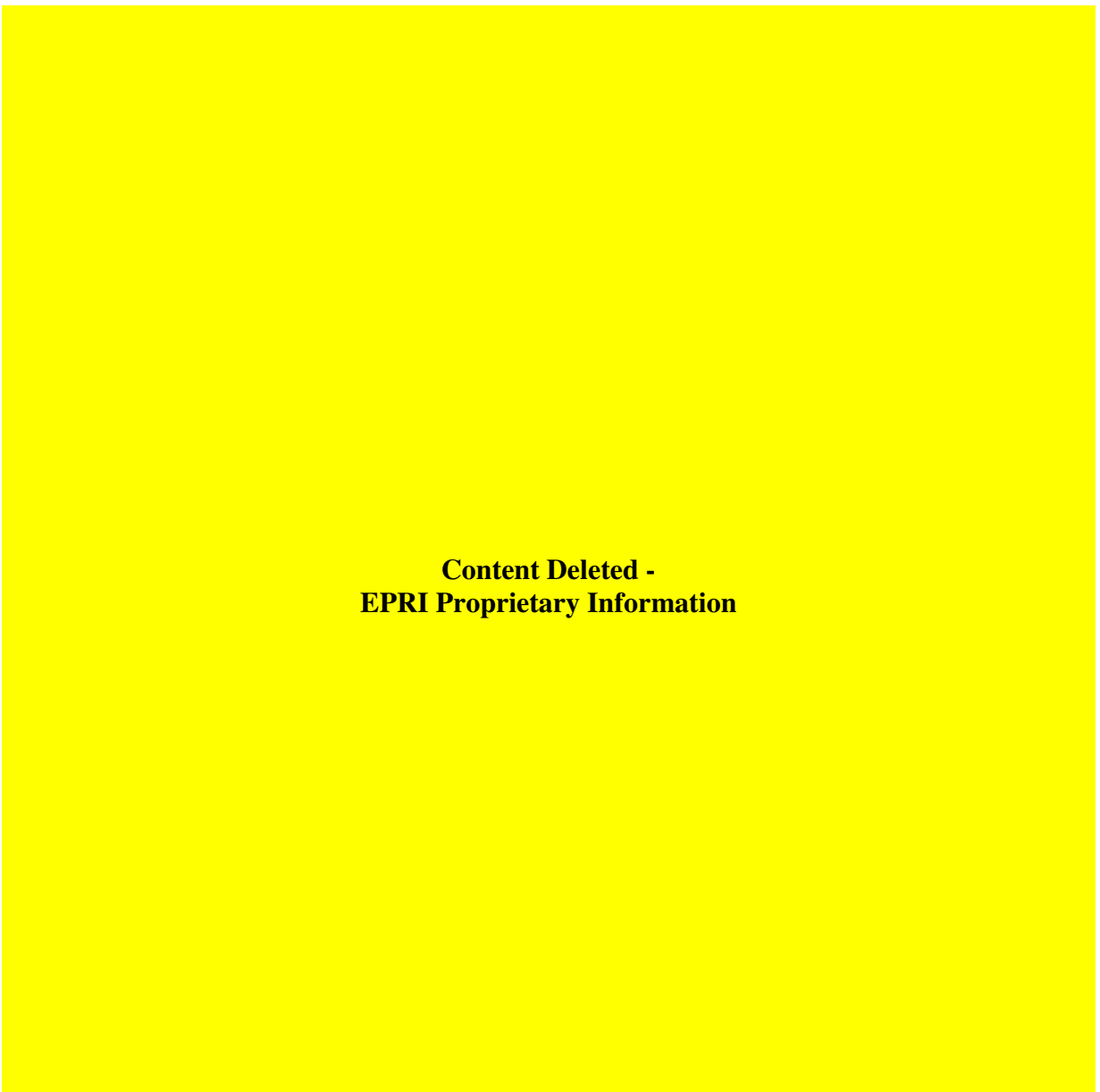
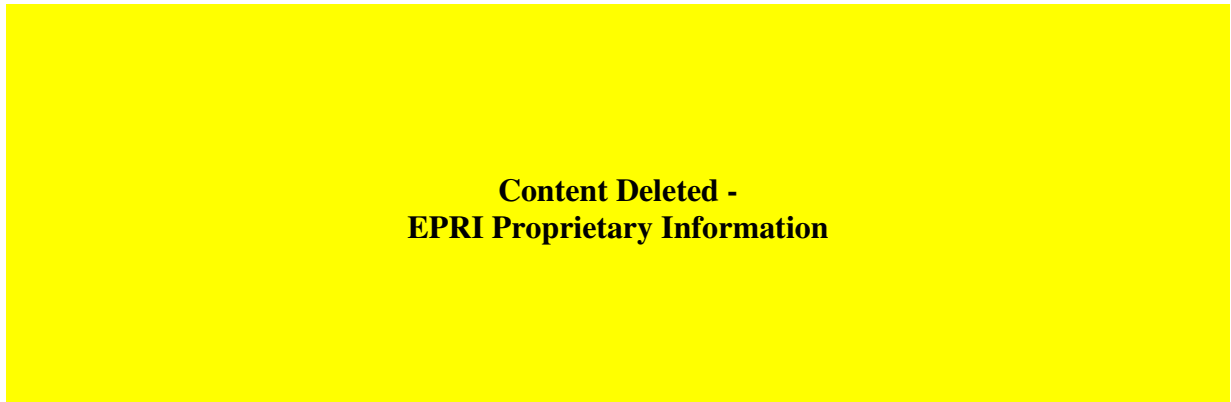
15.4.6 UT Demonstration 5



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

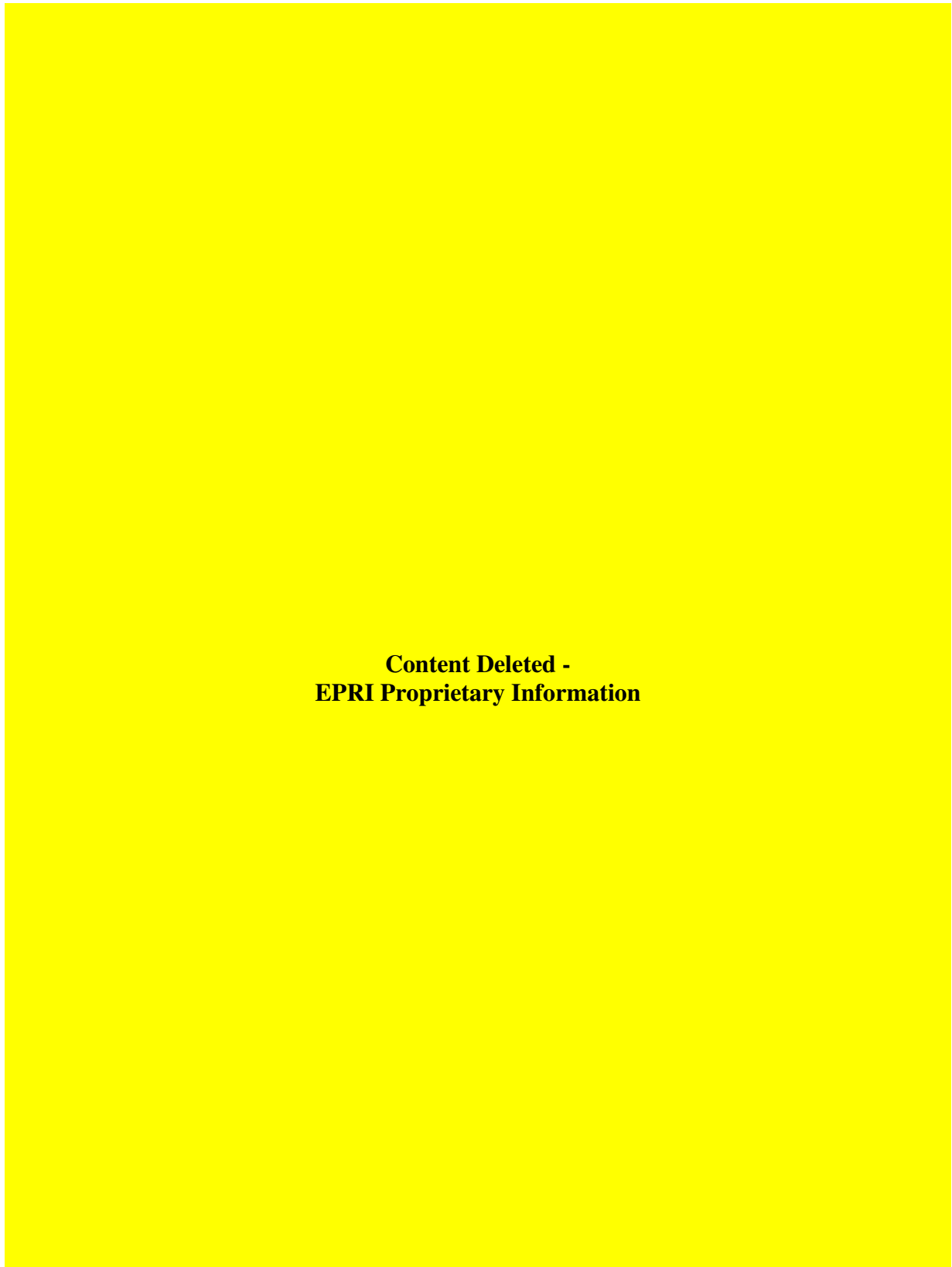
Table 15.4.6-1. Demonstrated Scan and Index Variables



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

15.4.7 UT Demonstration 6



**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Figure 15.4.7-1. Demonstrated Immersion Technique (1-inch Water Path)

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

Table 15.4.7-1. Demonstrated Scan and Index Variables

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

**Content Deleted -
EPRI Proprietary Information**

15.5 References

**Content Deleted -
EPRI Proprietary Information**

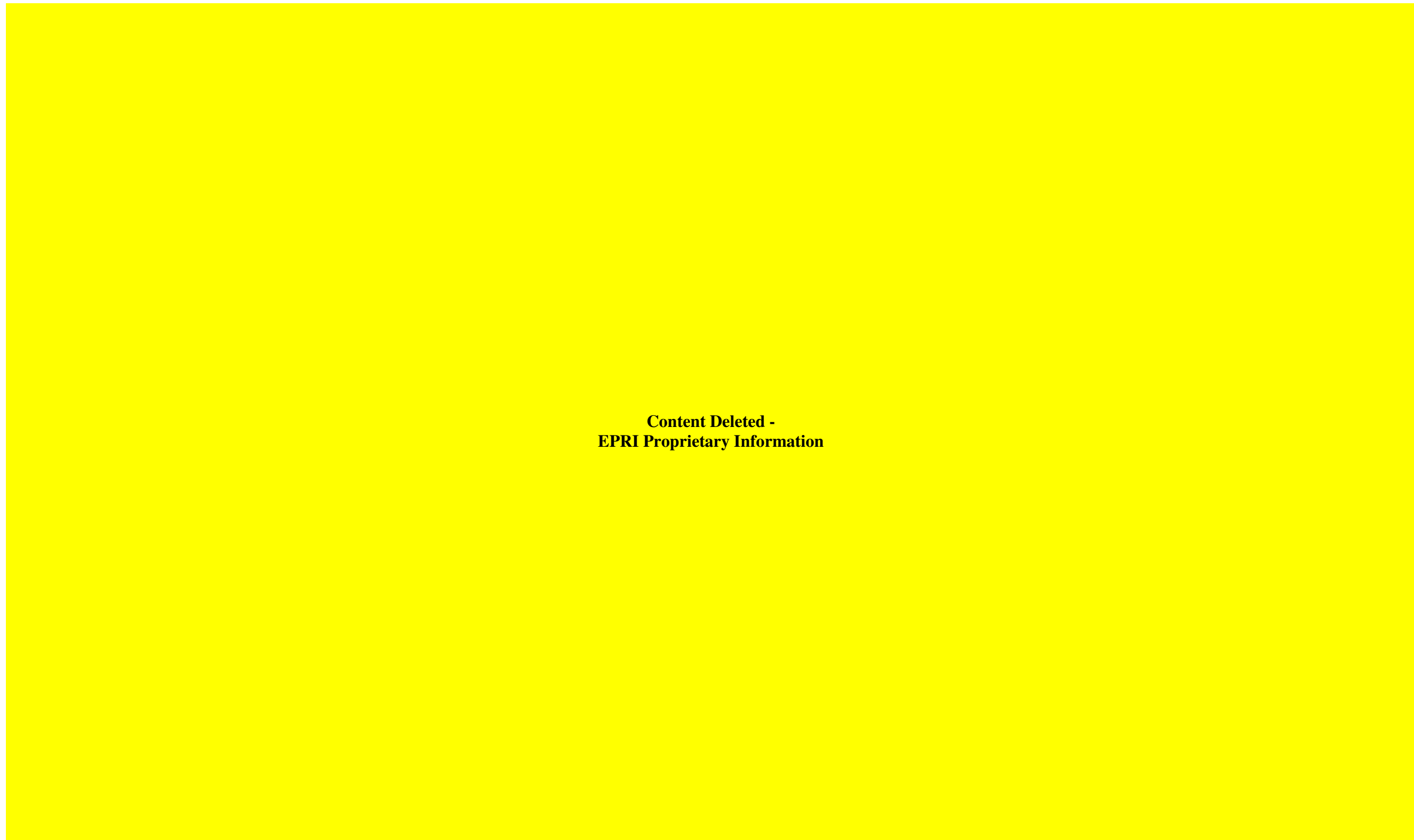


Figure 15.3.1.1-3. Configuration Drawing of BWRVIP-AHC1

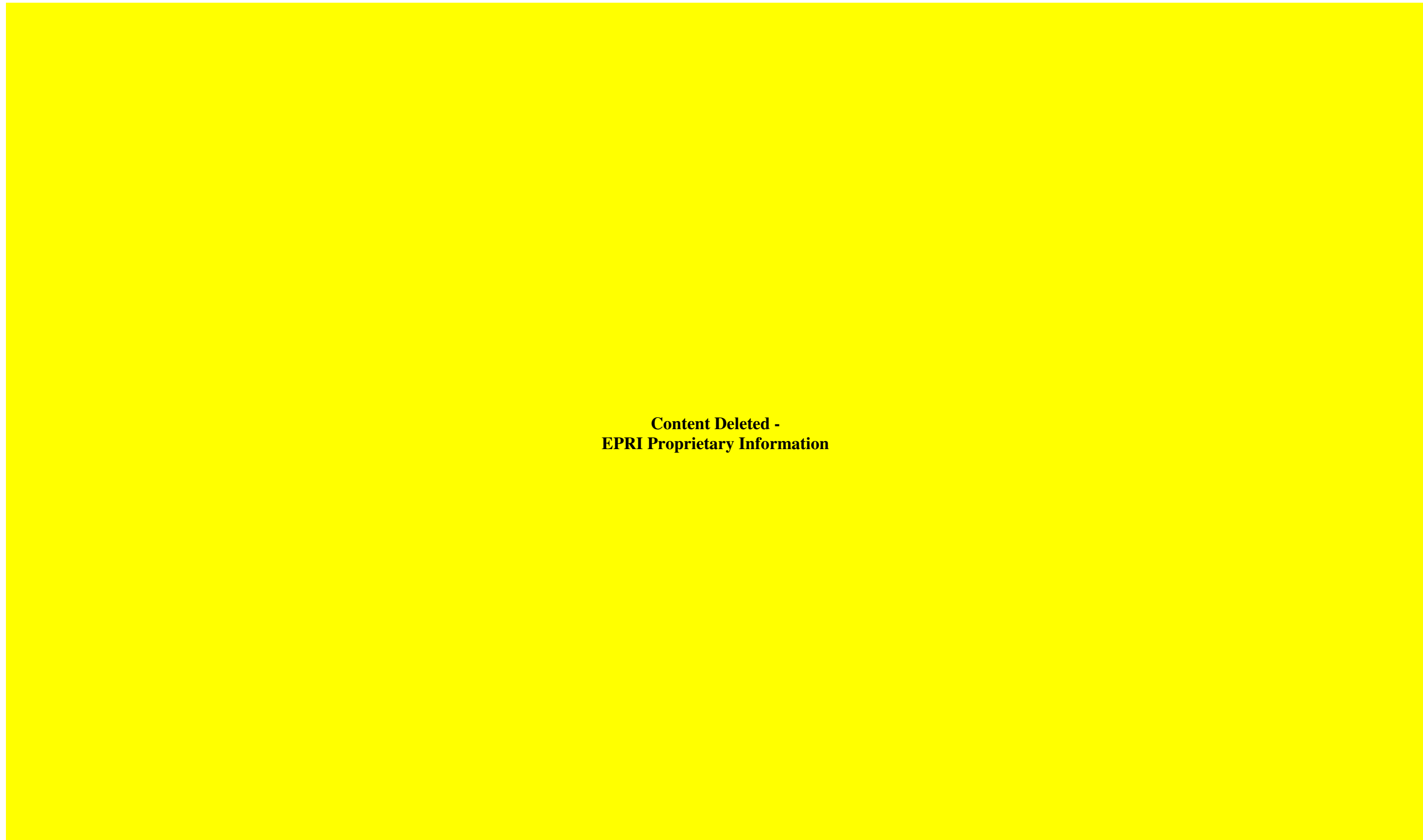
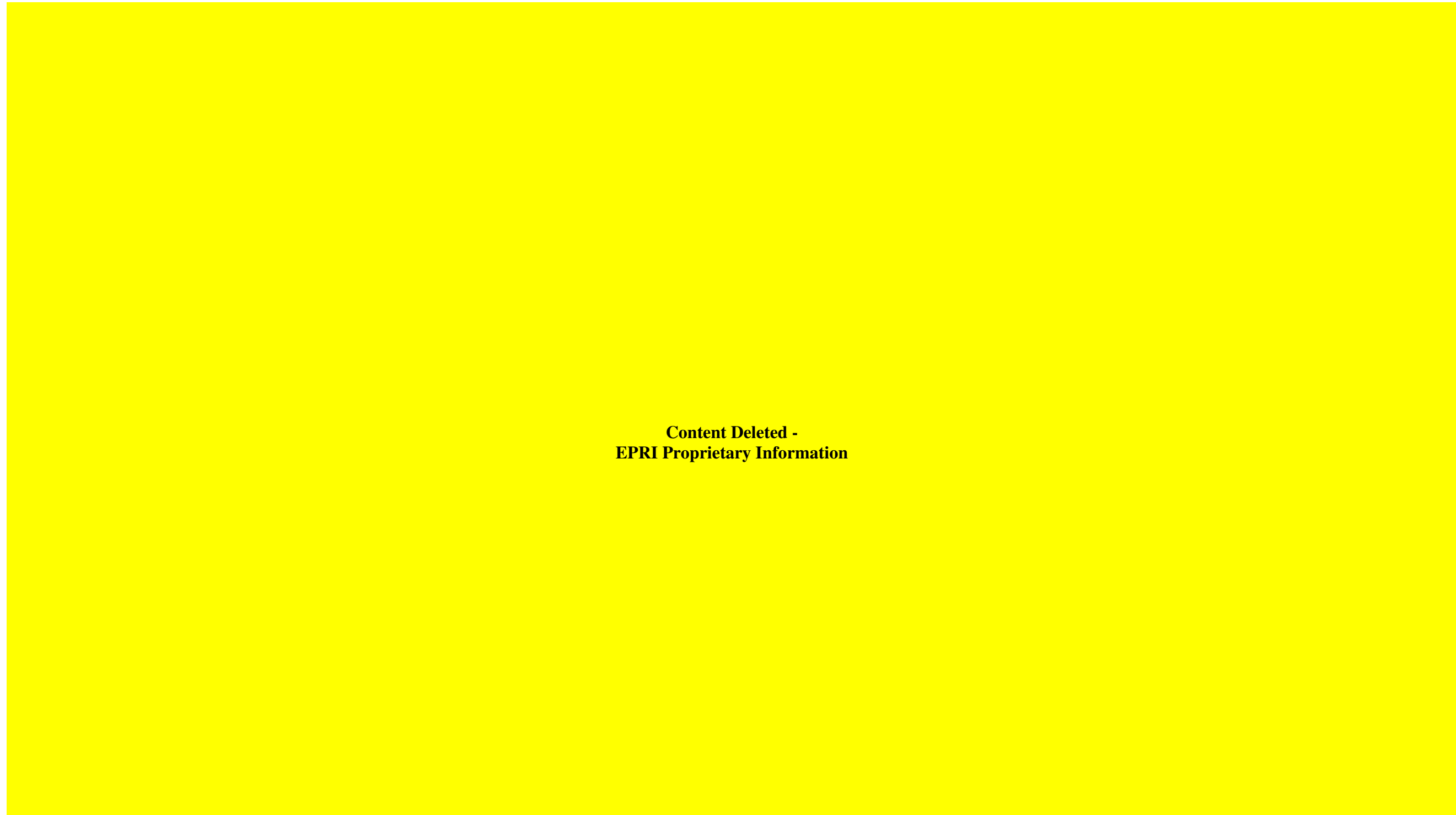


Figure 15.3.1.1-4. Partial Top View of BWRVIP-AHC1 (1 of 2)



Figure 15.3.1.1-5. Partial Top View of BWRVIP-AHC1 (2 of 2)



**Content Deleted -
EPRI Proprietary Information**

Figure 15.3.1.1-6. BWRVIP-AHC1 (Flaws 1a Through 1e)

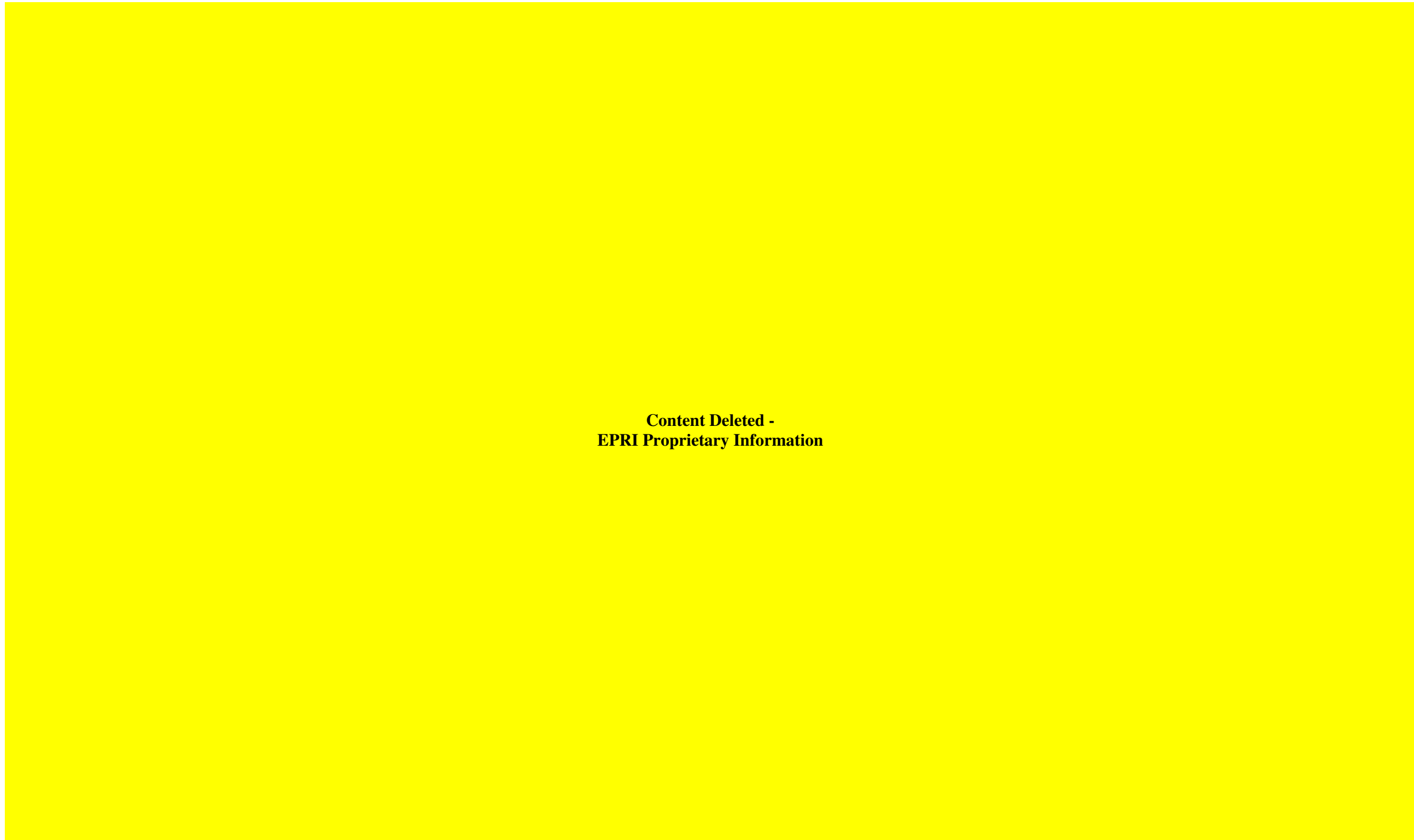


Figure 15.3.1.1-7. BWRVIP-AHC1 (Flaws 1f Through 1i)



Figure 15.3.1.1-8. BWRVIP-AHC1 (Flaws 1j Through 1n)

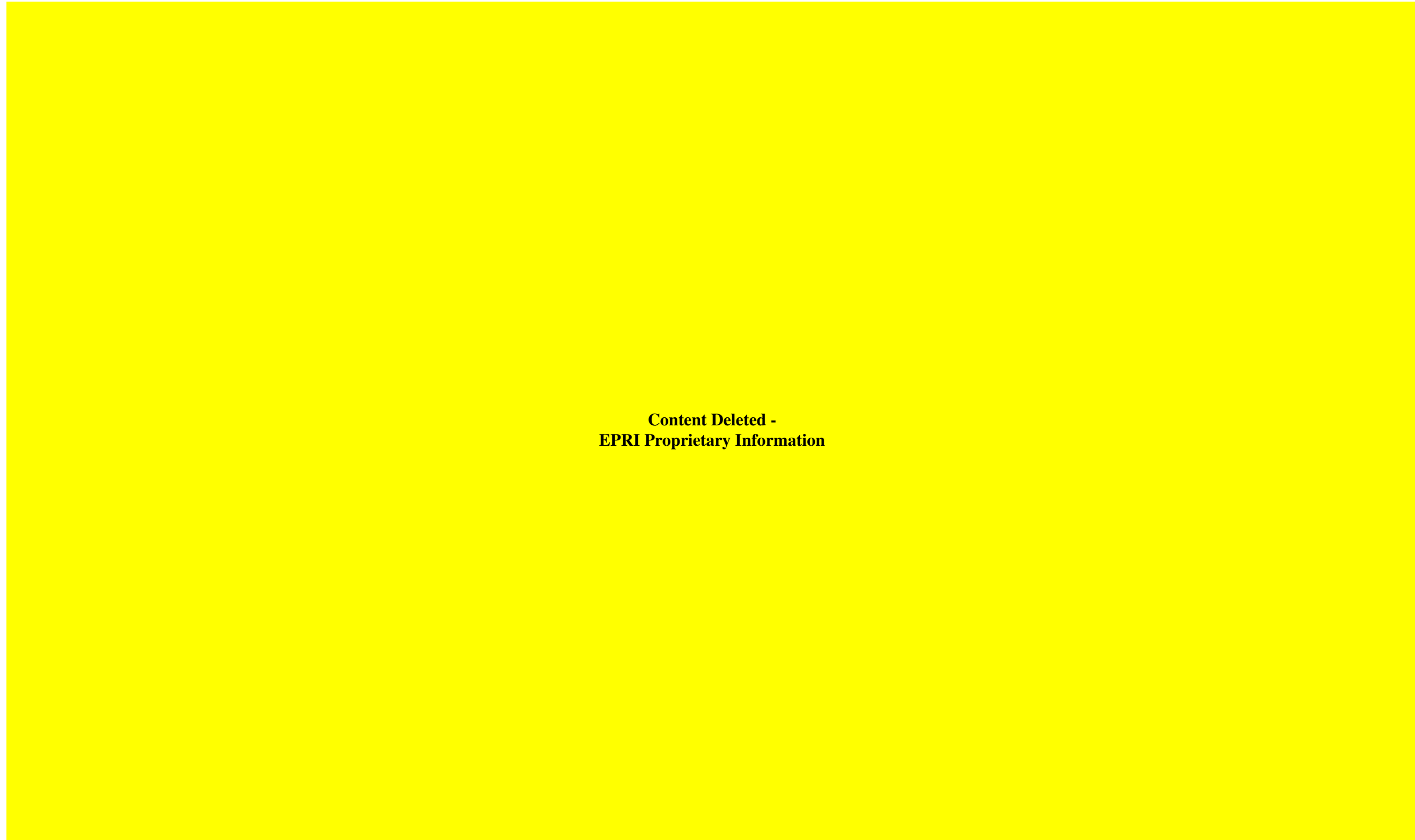


Figure 15.3.1.2-2. Configuration Drawing for BWRVIP-AHC2



**Content Deleted -
EPRI Proprietary Information**

Figure 15.3.1.2-3. BWRVIP-AHC2 Flaw Drawings (Flaws 2a Through 2d)

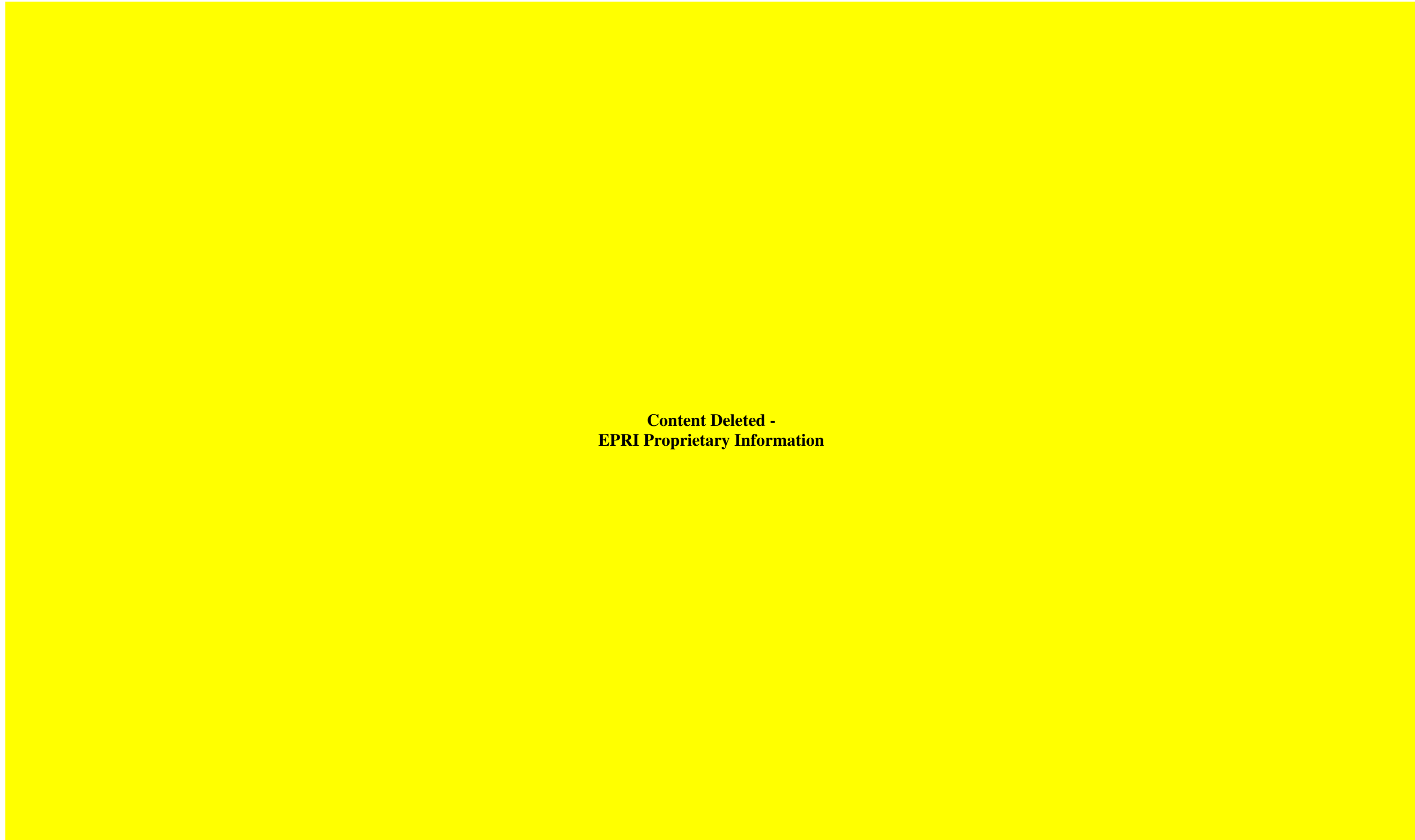


Figure 15.3.1.2-4. BWRVIP-AHC2 Flaw Drawings (Flaws 2e Through 2h)

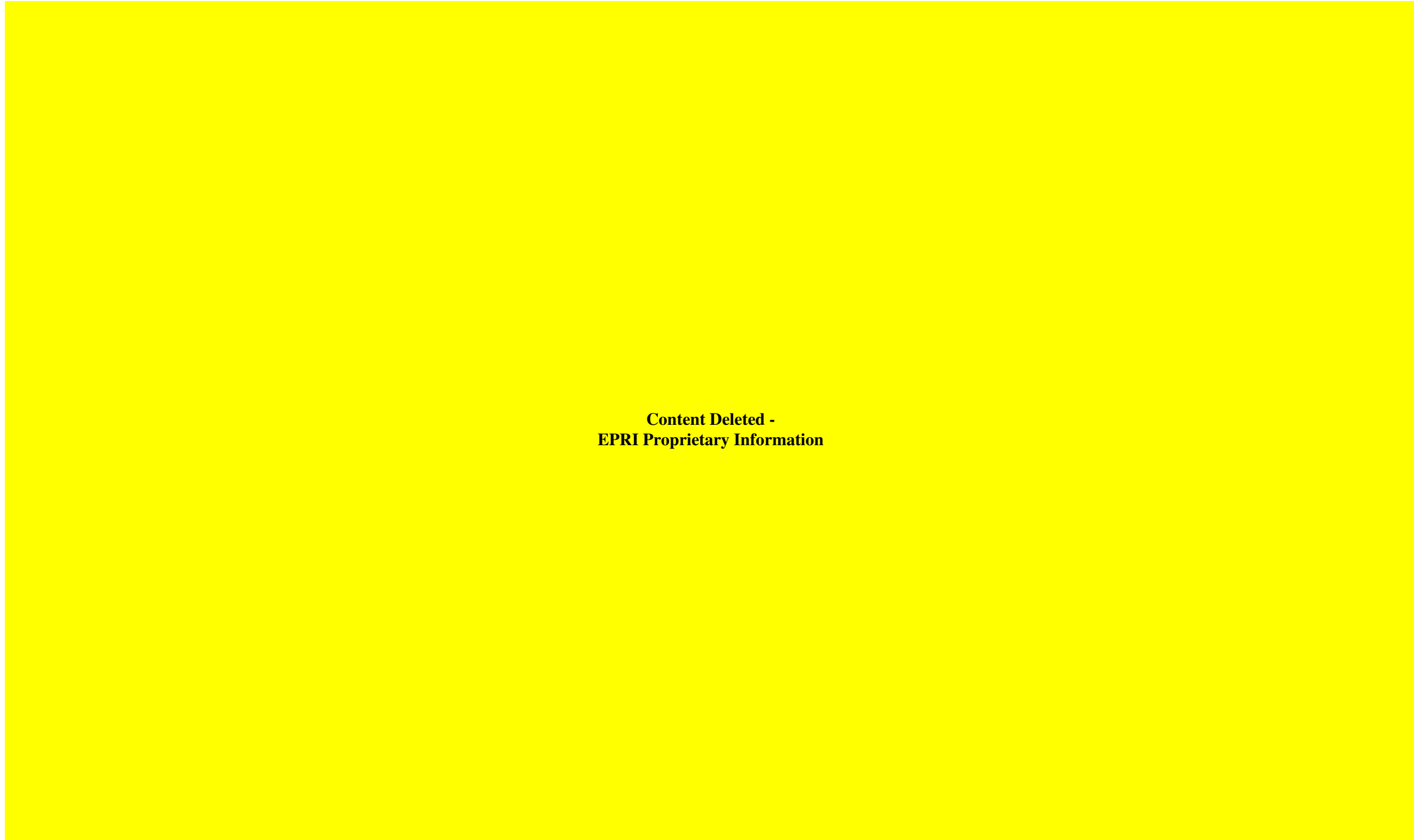


Figure 15.3.1.2-5. BWRVIP-AHC2 Flaw Drawings (Flaws 2i Through 2l)

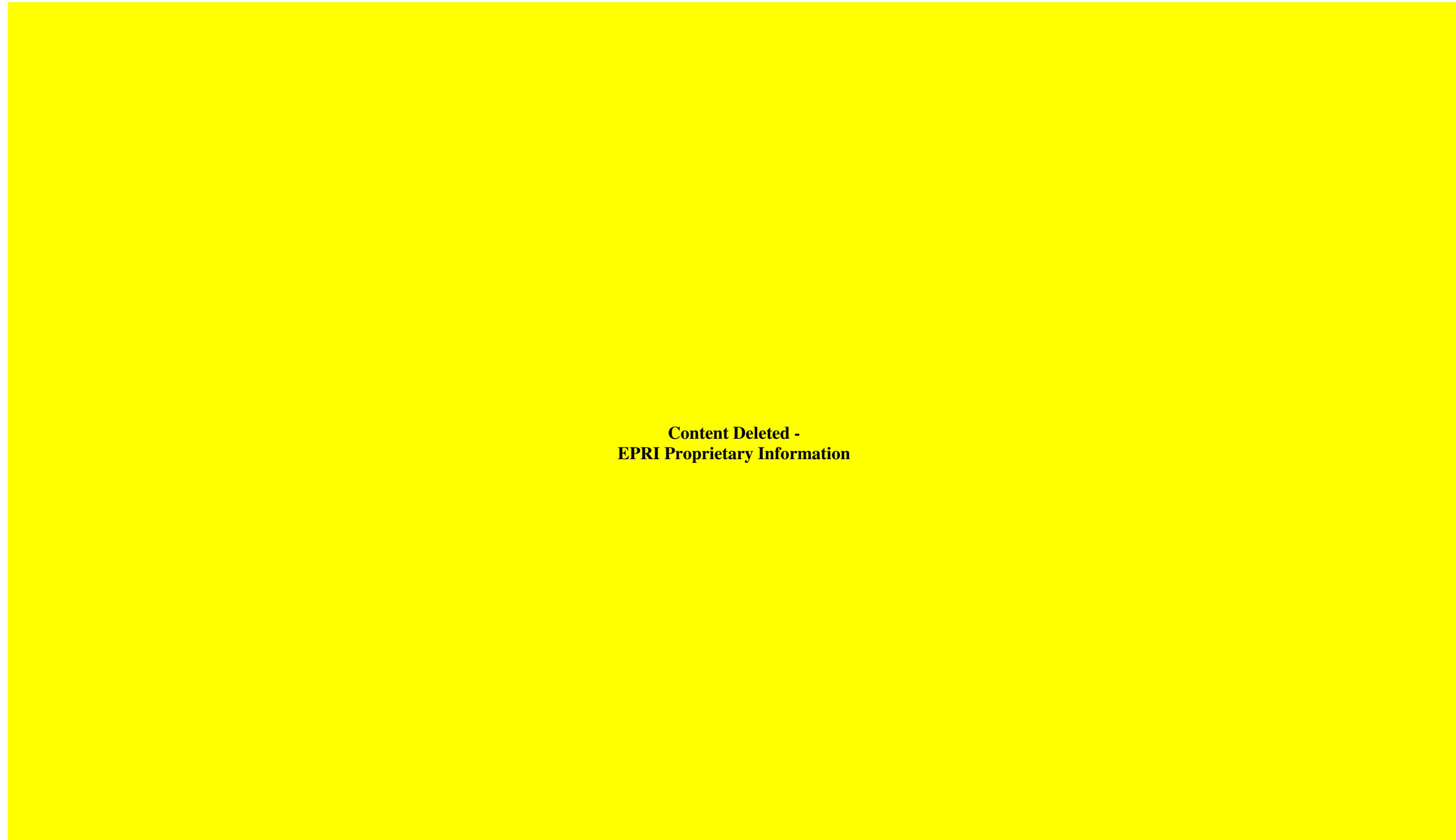


Figure 15.3.1.3-2. Configuration Drawing of BWRVIP-AHC3

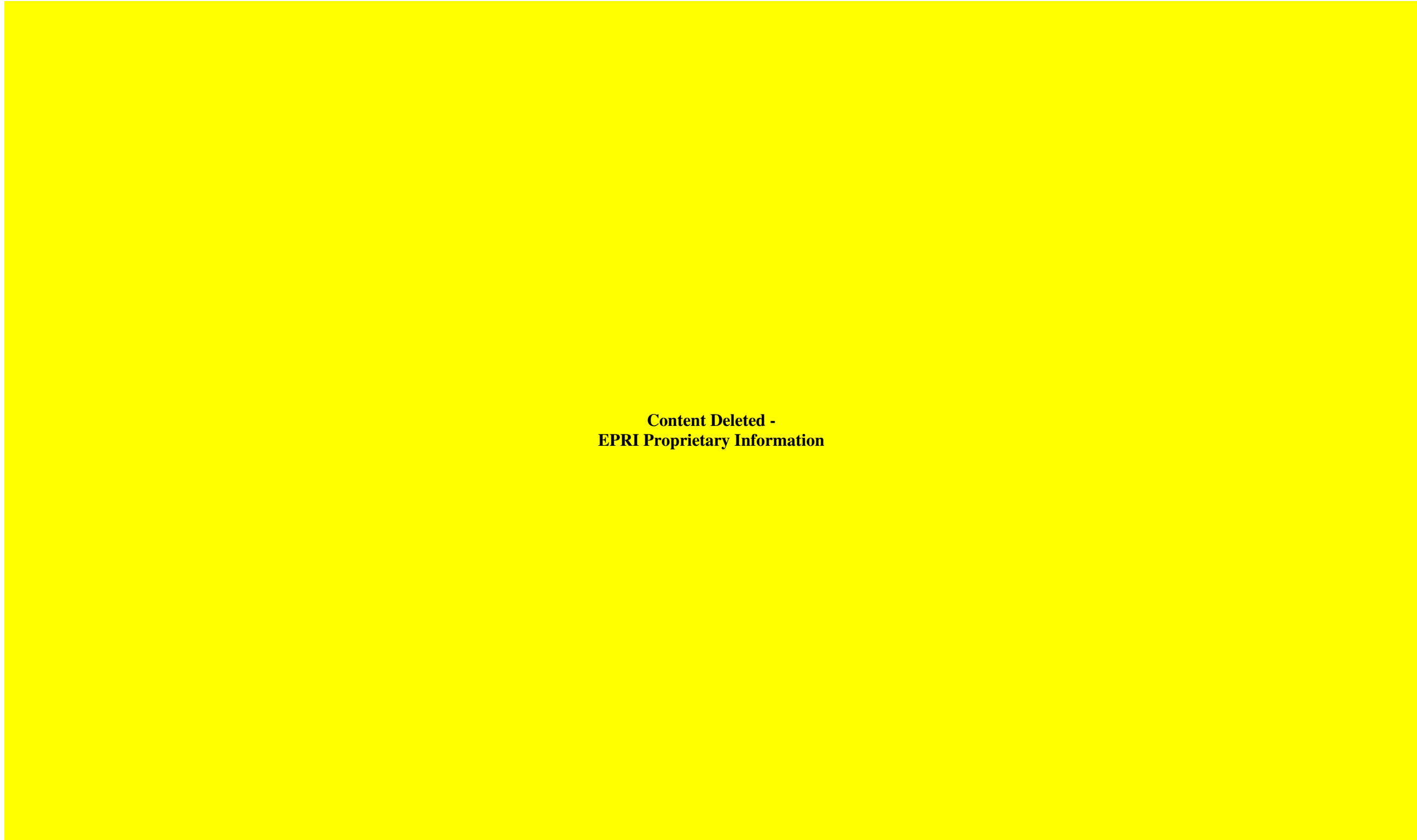


Figure 15.3.1.3-3. Flaw Detail Drawing of BWRVIP-AHC3

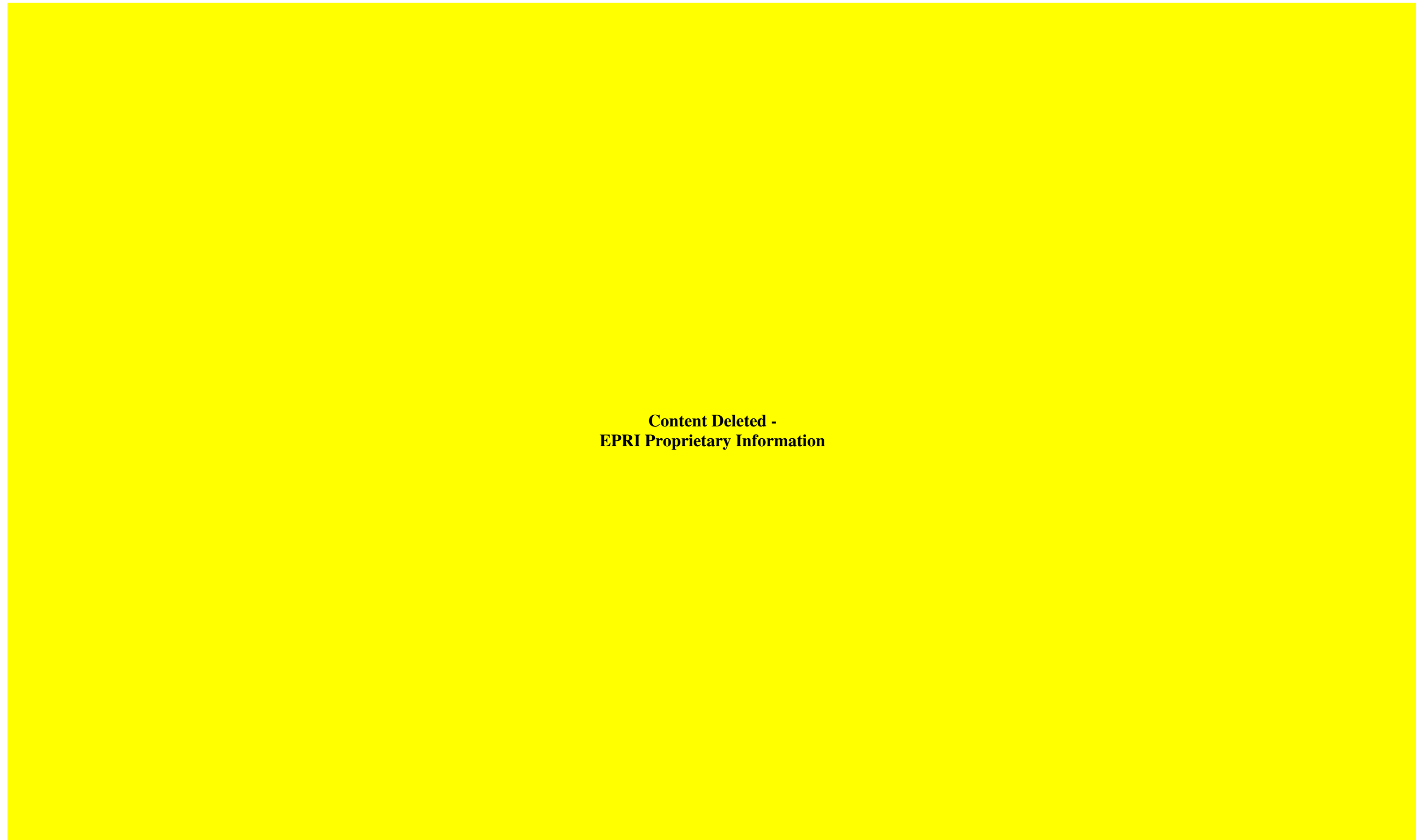


Figure 15.3.1.3-4. Configuration Drawing of BWRVIP-AHC4



Figure 15.3.1.3-5. Flaw Detail Drawing of BWRVIP-AHC4

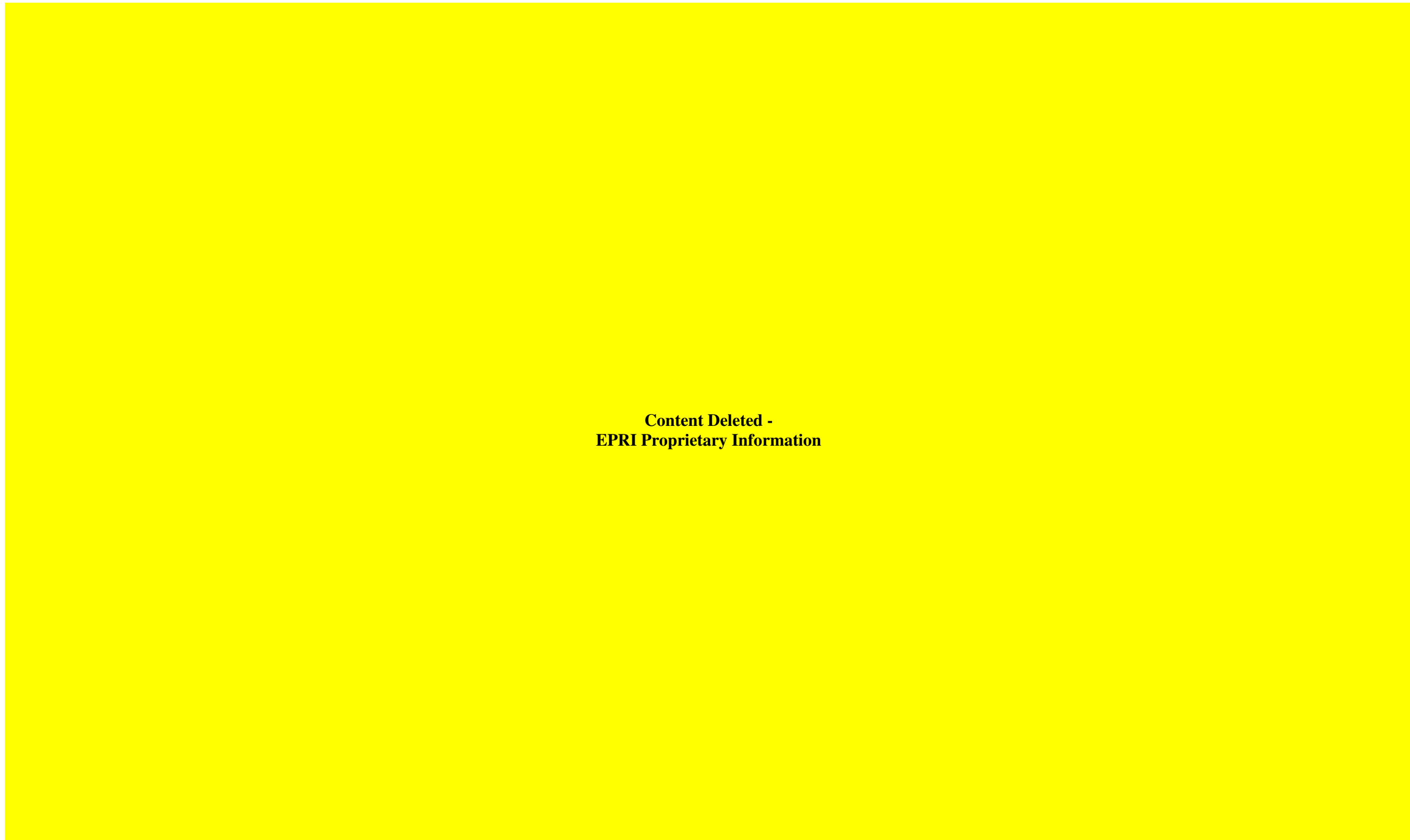


Figure 15.3.1.4-2. BWRVIP-AHC5 (Flaw Table and Configuration Dimensions)

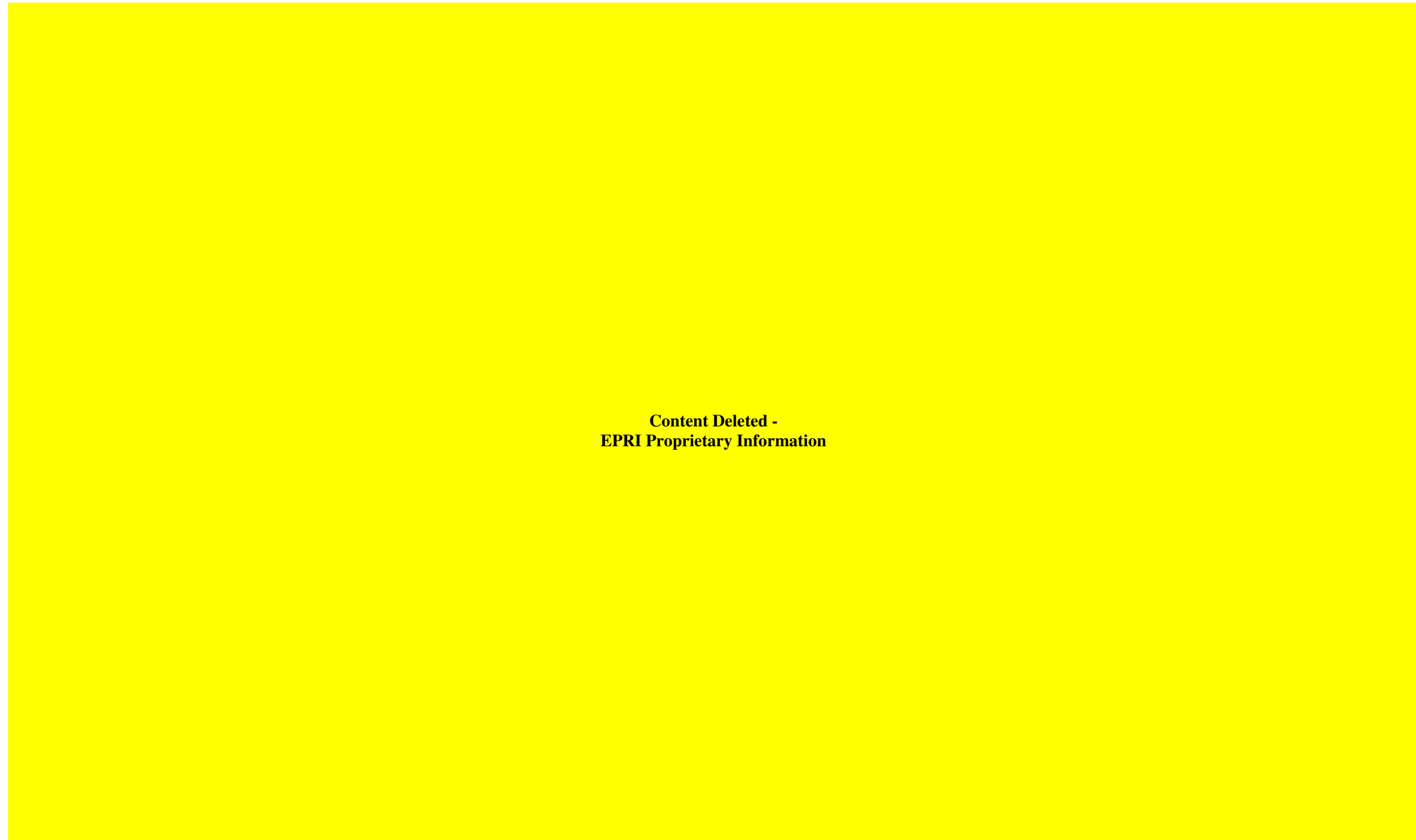


Figure 15.3.1.4-3. BWRVIP-AHC5 (Ring-to-Cover Weld Flaw Locations)

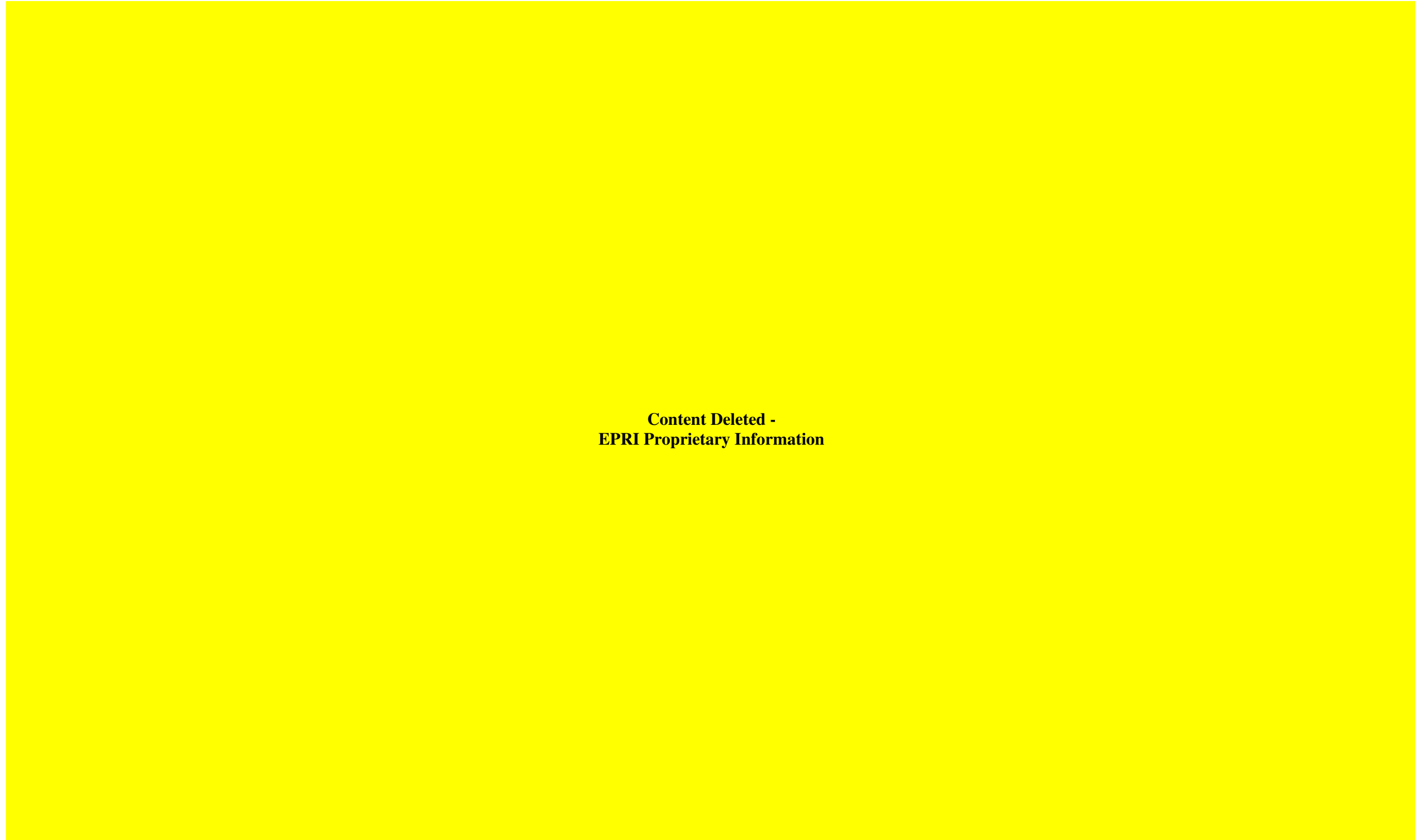


Figure 15.3.1.4-4. BWRVIP-AHC5 (Ring-to-Cover Weld Flaw Details)

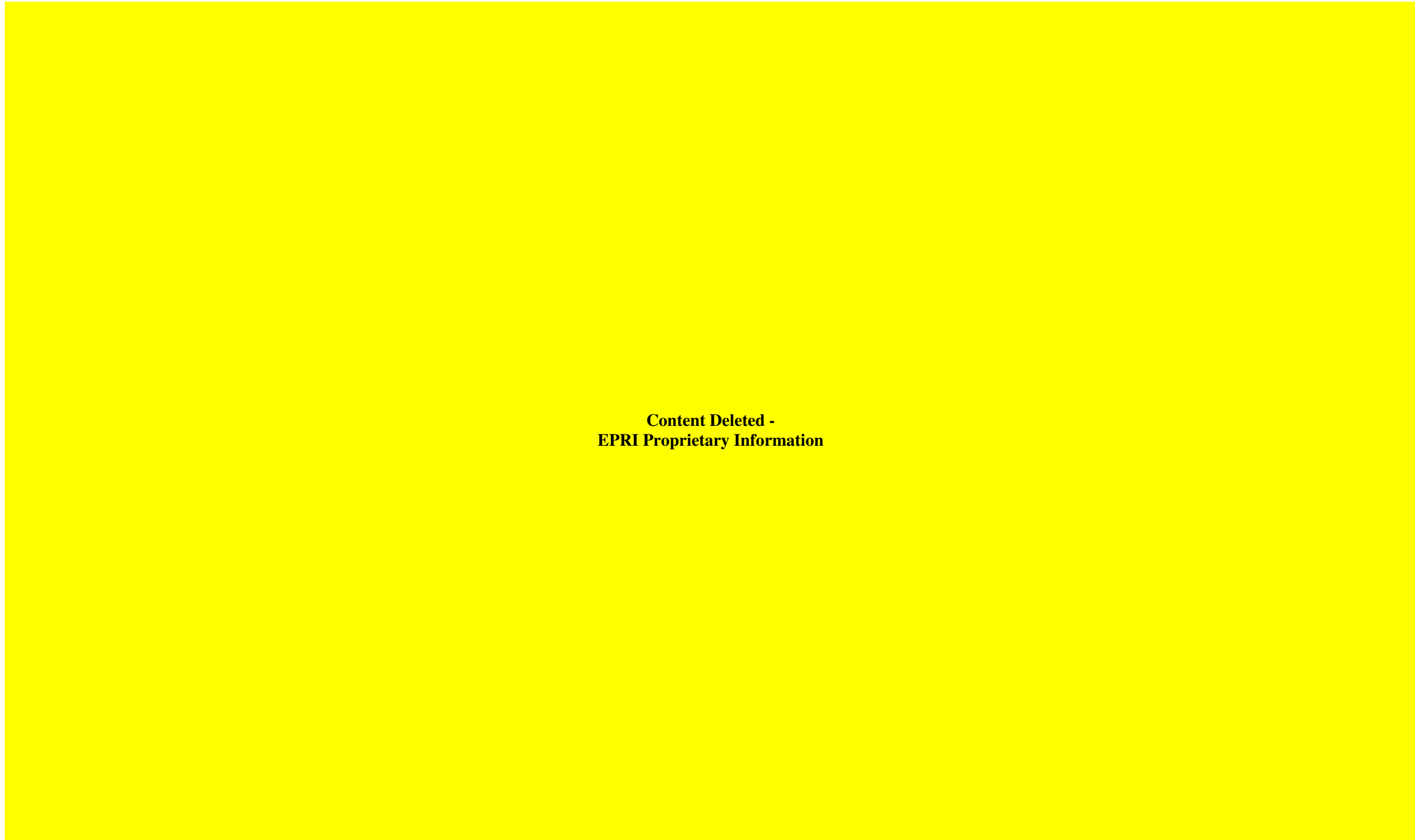


Figure 15.3.1.4-5. BWRVIP-AHC5 (Adapter Ring-to-Ring Weld Flaw Locations)

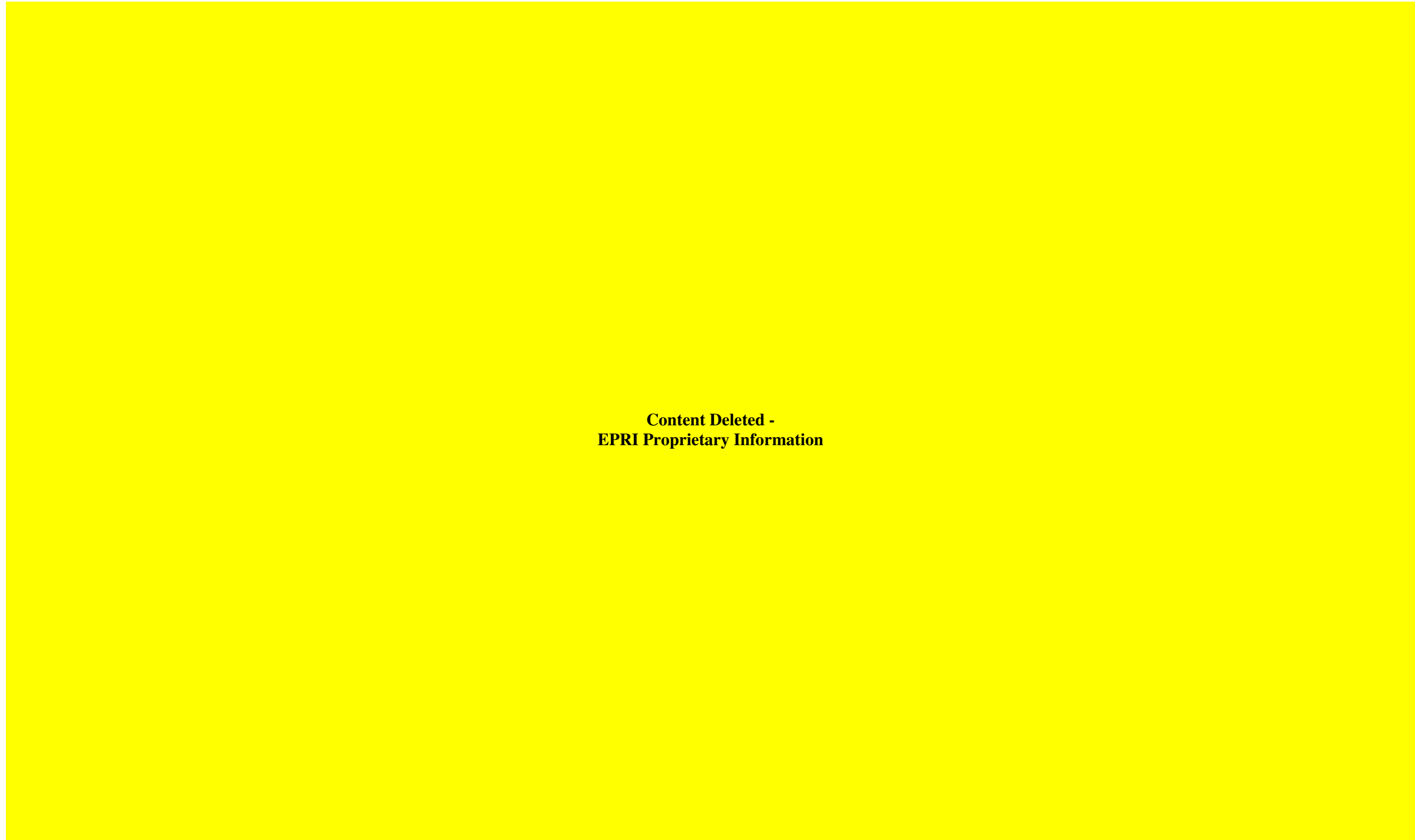


Figure 15.3.1.4-6. BWRVIP-AHC5 (Adapter Ring-to-Ring Weld Flaw Details)

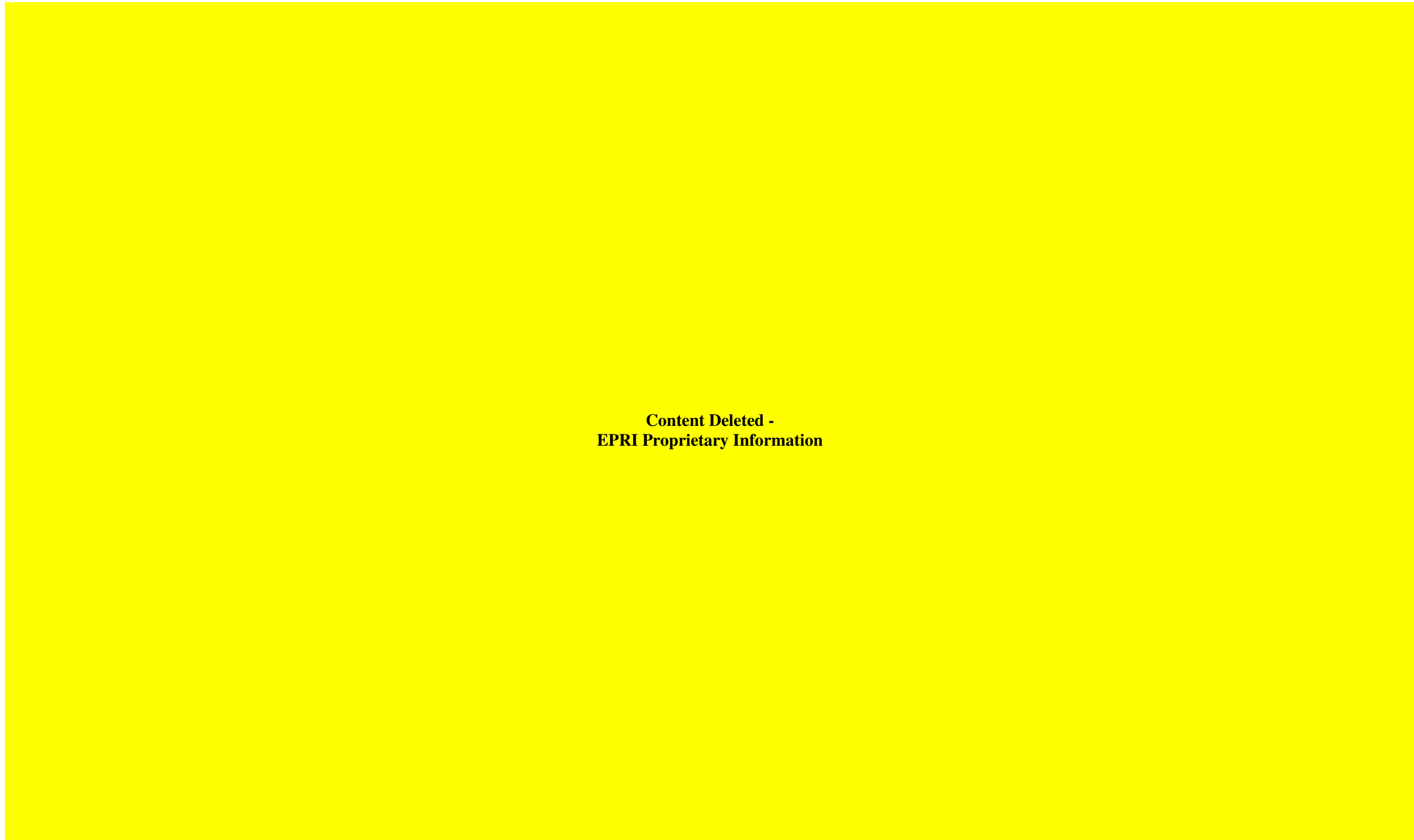


Figure 15.3.1.5-2. Configuration Drawing of BWRVIP-AHC6

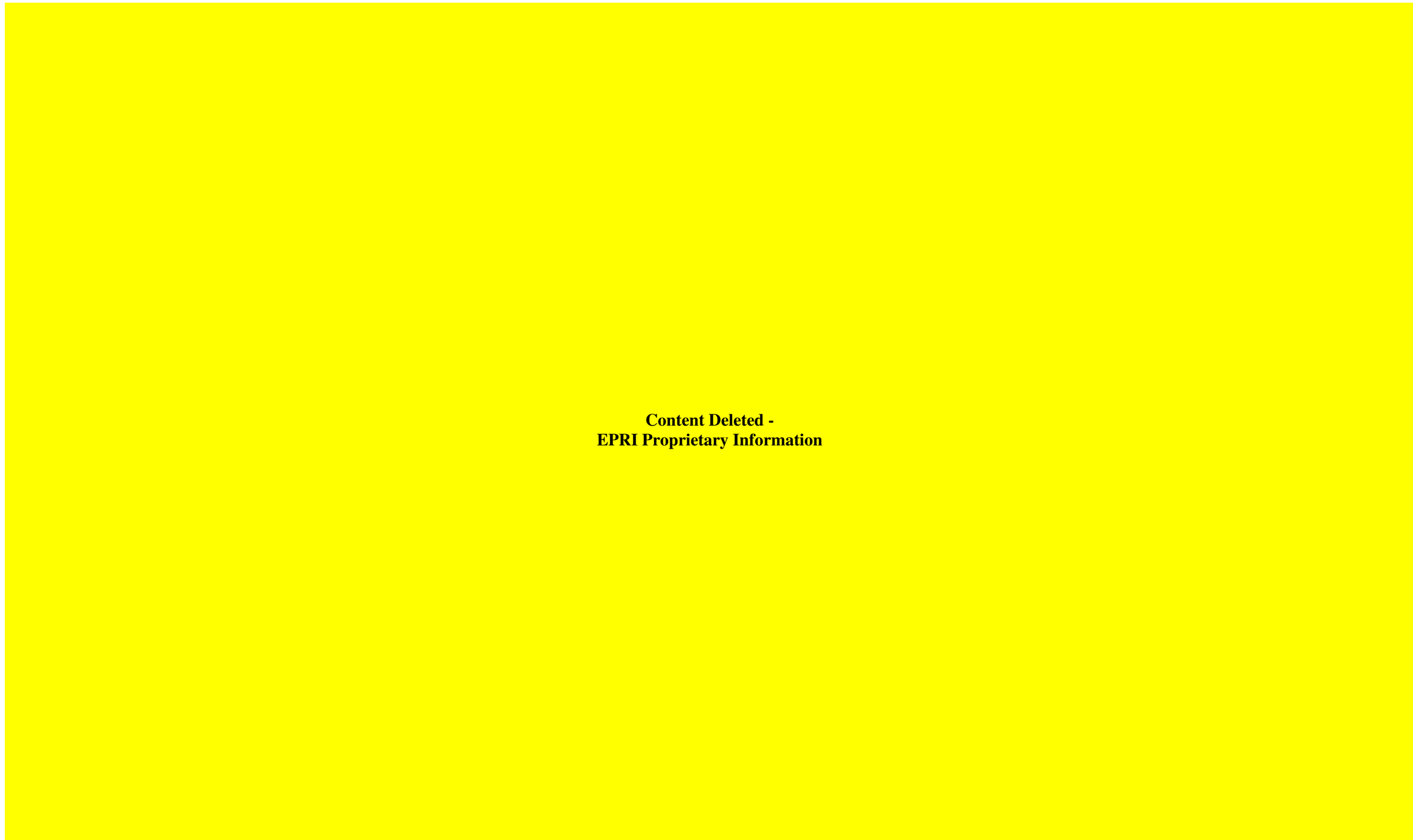


Figure 15.3.1.5-3. Flaw Detail Drawing for BWRVIP-AHC6 (Flaws 6a Through 6d)

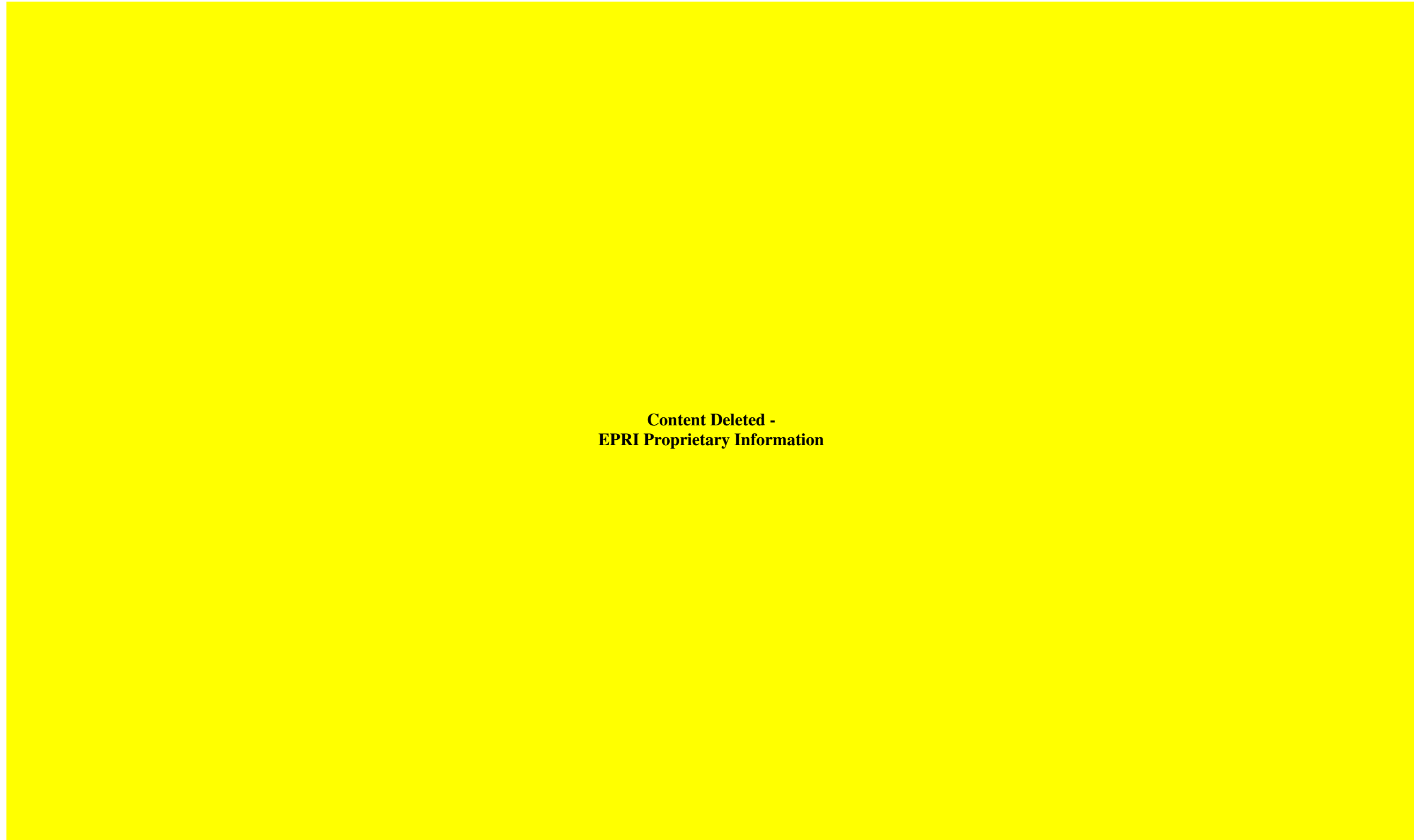


Figure 15.3.1.5-4. Flaw Detail Drawings for BWRVIP-AHC6 (Flaws 6e Through 6h)

Export Control Restrictions

Access to and use of EPRI Intellectual Property is granted with the specific understanding and requirement that responsibility for ensuring full compliance with all applicable U.S. and foreign export laws and regulations is being undertaken by you and your company. This includes an obligation to ensure that any individual receiving access hereunder who is not a U.S. citizen or permanent U.S. resident is permitted access under applicable U.S. and foreign export laws and regulations. In the event you are uncertain whether you or your company may lawfully obtain access to this EPRI Intellectual Property, you acknowledge that it is your obligation to consult with your company's legal counsel to determine whether this access is lawful. Although EPRI may make available on a case-by-case basis an informal assessment of the applicable U.S. export classification for specific EPRI Intellectual Property, you and your company acknowledge that this assessment is solely for informational purposes and not for reliance purposes. You and your company acknowledge that it is still the obligation of you and your company to make your own assessment of the applicable U.S. export classification and ensure compliance accordingly. You and your company understand and acknowledge your obligations to make a prompt report to EPRI and the appropriate authorities regarding any access to or use of EPRI Intellectual Property hereunder that may be in violation of applicable U.S. or foreign export laws or regulations.

The Electric Power Research Institute, Inc. (EPRI, www.epri.com), conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

Together...Shaping the Future of Electricity

Program:

Nuclear Power

BWR Vessel and Internals Project

© 2015 Electric Power Research Institute (EPRI), Inc. All rights reserved. Electric Power Research Institute, EPRI, and TOGETHER...SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.

3002003091NP

Electric Power Research Institute

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com