ArevaEPRDCPEm Resource

From: WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent: Friday, February 17, 2012 12:26 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (AREVA); DELANO Karen (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); WELLS Russell (AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 15
Attachments: RAI 467 Supplement 15 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted Supplement 6 on July 27, 2011 to provide a revised schedule for the remaining 9 questions. AREVA NP submitted Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions. AREVA NP submitted Supplement 10 on September 9, 2011 to provide a revised schedule for the remaining 3 questions. AREVA NP submitted Supplement 11 on September 30, 2011 which provided a technically correct and complete final response to 1 of the remaining 3 questions. AREVA NP submitted Supplement 12 on October 3, 2011, Supplement 13 on October 28, 2011, and Supplement 14 on November 30, 2011, respectively, to provide a revised schedule for the remaining 2 questions.

The attached file, “RAI 467 Supplement 15 Response US EPR DC.pdf” provides a technically correct and complete final response to 1 of the remaining 2 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 467 Question 03.06.03-28.

The following table indicates the respective pages in the response document, “RAI 467 Supplement 15 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject question.

Question #	Start Page	End Page
RAI 467 — 03.06.03-28	2	2

The schedule for a technically correct and complete final response to the remaining question is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.09.02-161	March 7, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, November 30, 2011 5:21 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 14

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted Supplement 6 on July 27, 2011 to provide a revised schedule for the remaining 9 questions. AREVA NP submitted Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions. AREVA NP submitted Supplement 10 on September 9, 2011 to provide a revised schedule for the remaining 3 questions. AREVA NP submitted Supplement 11 on September 30, 2011 which provided a technically correct and complete final response to 1 of the remaining 3 questions. AREVA NP submitted Supplement 12 on October 3, 2011, and Supplement 13 on October 28, 2011, respectively, to provide a revised schedule for the remaining 2 questions.

The schedule for a technically correct and complete final response to the remaining 2 questions has been changed as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	**March 7, 2012**
RAI 467 — 03.09.02-161	**March 7, 2012**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, October 28, 2011 2:49 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell

(RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 13

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted Supplement 6 on July 27, 2011 to provide a revised schedule for the remaining 9 questions. AREVA NP submitted Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions. AREVA NP submitted Supplement 10 on September 9, 2011 to provide a revised schedule for the remaining 3 questions. AREVA NP submitted Supplement 11 on September 30, 2011 which provided a technically correct and complete final response to 1 of the remaining 3 questions. AREVA NP submitted Supplement 12 on October 3, 2011 to provide a revised schedule for the remaining 2 questions.

The schedule for a technically correct and complete final response to the remaining 2 questions has been changed as provided below.

Question #	**Response Date**
RAI 467 — 03.06.03-28	**November 30, 2011**
RAI 467 — 03.09.02-161	**November 30, 2011**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Monday, October 03, 2011 1:56 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 12

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted Supplement 6 on July 27, 2011 to provide a revised schedule for the remaining 9 questions. AREVA NP submitted Supplement 7 on July 29,

2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions. AREVA NP submitted Supplement 10 on September 9, 2011 to provide a revised schedule for the remaining 3 questions. AREVA NP submitted Supplement 11 on September 30, 2011 which provided a technically correct and complete final response to 1 of the remaining 3 questions.

The schedule for technically correct and complete final responses to the remaining 2 questions has been changed as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	**October 31, 2011**
RAI 467 — 03.09.02-161	**October 31, 2011**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, September 30, 2011 4:14 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 11

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted Supplement 6 on July 27, 2011 to provide a revised schedule for the remaining 9 questions. AREVA NP submitted Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions. AREVA NP submitted Supplement 10 on September 9, 2011 to provide a revised schedule for the remaining 3 questions.

The attached file, “RAI 467 Supplement 11 Response US EPR DC.pdf” provides a technically correct and complete final response to 1 of the remaining 3 questions. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 467 Question 03.09.02-160.

The following table indicates the respective pages in the response document, “RAI 467 Supplement 11 Response US EPR DC.pdf” that contain AREVA NP’s final response to the subject question.

Question #	Start Page	End Page
RAI 467 — 03.09.02-160	2	2

The schedule for technically correct and complete final responses to the remaining 2 questions is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	October 9, 2011
RAI 467 — 03.09.02-161	October 9, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, September 09, 2011 1:02 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 10

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted RAI 467 Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted RAI 467 Supplement 6 on July 27, 2011, which provided a revised schedule for the remaining 9 questions. AREVA NP submitted RAI 467 Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted RAI 467 Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. AREVA NP submitted RAI 467 Supplement 9 on August 5, 2011, which provided a technically correct and complete final response to 2 of the remaining 5 questions, as committed.

The schedule for the remaining 3 questions has been revised as shown below.

Question #	Response Date
RAI 467 — 03.06.03-28	**October 9, 2011**
RAI 467 — 03.09.02-160	**October 9, 2011**
RAI 467 — 03.09.02-161	**October 9, 2011**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, August 05, 2011 10:37 AM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 9

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted RAI 467 Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted RAI 467 Supplement 6 on July 27, 2011, which provided a revised schedule for the remaining 9 questions. AREVA NP submitted RAI 467 Supplement 7 on July 29, 2011, which provided a technically correct and complete final responses to 3 of the remaining 9 questions. AREVA NP submitted RAI 467 Supplement 8 on August 3, 2011, which provided a technically correct and complete final response to 1 of the 6 remaining questions. The attached file, "RAI 467 Supplement 9 Response US EPR DC.pdf" provides technically correct and complete FINAL responses to 2 of the remaining 5 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 467 Supplement 9 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject questions.

Question #	Start Page	End Page
RAI 467 — 03.09.02-157	2	4
RAI 467 — 03.09.02-165	5	5

The schedule for technically correct and complete final responses to the remaining 3 questions is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	September 15, 2011
RAI 467 — 03.09.02-160	September 9, 2011
RAI 467 — 03.09.02-161	September 9, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B

Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, August 03, 2011 12:38 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 8

Getachew,

AREVA NP Inc. letter NRC:11:084 dated August 2, 2011 provides a technically correct and complete final response to 1 of the 6 remaining questions in RAI 467. AREVA NP considers some of the material contained in the response to be proprietary information. As required by 10 CFR 2.390(b), an affidavit is provided to support the withholding of the proprietary information from public disclosure. Proprietary and non-proprietary versions of the enclosure to this letter are provided separately.

The following table indicates the respective pages in the enclosed response that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 467 — 03.09.02-163	2	5

The schedule for a technically correct and complete final response to Question 03.06.03-28 has been revised as shown below in bold. The schedule for technically correct and complete final responses to the remaining questions is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	**September 15, 2011**
RAI 467 — 03.09.02-157	September 9, 2011
RAI 467 — 03.09.02-160	September 9, 2011
RAI 467 — 03.09.02-161	September 9, 2011
RAI 467 — 03.09.02-165	September 9, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WELLS Russell (RS/NB)
Sent: Friday, July 29, 2011 2:45 PM
To: Tesfaye, Getachew
Cc: WILLIFORD Dennis (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 7

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted RAI 467 Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions. AREVA NP submitted RAI 467 Supplement 6 on July 27, 2011, which provided a revised schedule for the remaining 9 questions. The attached file, "RAI 467 Supplement 7 Response US EPR DC.pdf" provides technically correct and complete FINAL responses to 3 of the remaining 9 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 467 Supplement 7 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 467 — 03.09.02-155	2	3
RAI 467 — 03.09.02-156	4	4
RAI 467 — 03.09.02-162	5	6

The schedule for technically correct and complete FINAL responses to the remaining 6 questions is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-157	September 9, 2011
RAI 467 — 03.09.02-160	September 9, 2011
RAI 467 — 03.09.02-161	September 9, 2011
RAI 467 — 03.09.02-163	September 9, 2011
RAI 467 — 03.09.02-165	September 9, 2011

Sincerely,

Russ Wells for
Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WELLS Russell (RS/NB)
Sent: Wednesday, July 27, 2011 10:23 AM
To: 'Tesfaye, Getachew'
Cc: WILLIFORD Dennis (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 6

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions. AREVA NP submitted RAI 467 Supplement 5 on July 7, 2011, which provided a technically correct and complete response to 1 of the remaining 10 questions.

The schedule for technically correct and complete responses to the remaining 9 questions has been changed as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	**September 9, 2011**
RAI 467 — 03.09.02-156	**September 9, 2011**
RAI 467 — 03.09.02-157	**September 9, 2011**
RAI 467 — 03.09.02-160	**September 9, 2011**
RAI 467 — 03.09.02-161	**September 9, 2011**
RAI 467 — 03.09.02-162	**September 9, 2011**
RAI 467 — 03.09.02-163	**September 9, 2011**
RAI 467 — 03.09.02-165	**September 9, 2011**

Sincerely,

Russ Wells for

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, July 07, 2011 11:35 AM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 5

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011, Supplement 3 on May 27, 2011, and Supplement 4 on June 22, 2011, to provide a revised schedule for 9 of the 10 remaining questions.

The attached file, “RAI 467 Supplement 5 Response US EPR DC.pdf” provides a technically correct and complete response to 1 of the remaining 10 questions.

The following table indicates the respective pages in the response document, “RAI 467 Supplement 5 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 467 — 03.09.02-167	2	2

The schedule for technically correct and complete responses to the remaining 9 questions is unchanged as provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	July 27, 2011
RAI 467 — 03.09.02-156	July 27, 2011
RAI 467 — 03.09.02-157	July 27, 2011
RAI 467 — 03.09.02-160	July 27, 2011
RAI 467 — 03.09.02-161	July 27, 2011
RAI 467 — 03.09.02-162	July 27, 2011
RAI 467 — 03.09.02-163	July 27, 2011
RAI 467 — 03.09.02-165	July 27, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, June 22, 2011 12:57 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 4

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011 and Supplement 3 on May 27, 2011, to provide a revised schedule for 9 of the 10 remaining questions

The schedule for 9 of the 10 questions, shown in bold below, has been changed. The schedule for the remaining question is unchanged. The schedule for technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	**July 27, 2011**
RAI 467 — 03.09.02-156	**July 27, 2011**
RAI 467 — 03.09.02-157	**July 27, 2011**
RAI 467 — 03.09.02-160	**July 27, 2011**
RAI 467 — 03.09.02-161	**July 27, 2011**
RAI 467 — 03.09.02-162	**July 27, 2011**

RAI 467 — 03.09.02-163	**July 27, 2011**
RAI 467 — 03.09.02-165	**July 27, 2011**
RAI 467 — 03.09.02-167	**July 27, 2011**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, May 27, 2011 11:11 AM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions. AREVA NP submitted Supplement 2 on April 15, 2011 to provide a revised schedule for 9 of the 10 remaining questions

The schedule for 9 of the 10 questions, shown in bold below, has been changed. The schedule for the remaining question is unchanged. The schedule for technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	**June 27, 2011**
RAI 467 — 03.09.02-156	**June 27, 2011**
RAI 467 — 03.09.02-157	**June 27, 2011**
RAI 467 — 03.09.02-160	**June 27, 2011**
RAI 467 — 03.09.02-161	**June 27, 2011**
RAI 467 — 03.09.02-162	**June 27, 2011**
RAI 467 — 03.09.02-163	**June 27, 2011**
RAI 467 — 03.09.02-165	**June 27, 2011**
RAI 467 — 03.09.02-167	**June 27, 2011**

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WELLS Russell (RS/NB)
Sent: Friday, April 15, 2011 4:15 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. AREVA NP submitted Supplement 1 on April 1, 2011 to provide technically correct and complete responses to 4 of the remaining 14 questions.

To allow additional time to interact with NRC staff, the schedule for technically correct and complete responses to 9 of the 10 has been changed and is provided below. The schedule for a technically correct and complete response to the remaining question is unchanged and is provided below:

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	**May 27, 2011**
RAI 467 — 03.09.02-156	**May 27, 2011**
RAI 467 — 03.09.02-157	**May 27, 2011**
RAI 467 — 03.09.02-160	**May 27, 2011**
RAI 467 — 03.09.02-161	**May 27, 2011**
RAI 467 — 03.09.02-162	**May 27, 2011**
RAI 467 — 03.09.02-163	**May 27, 2011**
RAI 467 — 03.09.02-165	**May 27, 2011**
RAI 467 — 03.09.02-167	**May 27, 2011**

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager
AREVA NP, Inc.
3315 Old Forest Road, P.O. Box 10935
Mail Stop OF-57
Lynchburg, VA 24506-0935
Phone: 434-832-3884 (work)
434-942-6375 (cell)
Fax: 434-382-3884
Russell.Wells@Areva.com

From: WELLS Russell (RS/NB)
Sent: Friday, April 01, 2011 1:24 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for the 14 questions of RAI No. 467 on February 24, 2011. The attached file, "RAI 467 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the remaining 14 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 467 Questions 03.09.02-158, 03.09.02-159, and 03.09.02-164.

The following table indicates the respective pages in the response document, "RAI 467 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 467 — 03.09.02-158	6	6
RAI 467 — 03.09.02-159	7	7
RAI 467 — 03.09.02-164	12	12
RAI 467 — 03.09.02-166	14	14

The schedule for technically correct and complete responses to the remaining questions is unchanged and is provided below:

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	April 28, 2011
RAI 467 — 03.09.02-156	April 28, 2011
RAI 467 — 03.09.02-157	April 28, 2011
RAI 467 — 03.09.02-160	April 28, 2011
RAI 467 — 03.09.02-161	April 28, 2011
RAI 467 — 03.09.02-162	April 28, 2011
RAI 467 — 03.09.02-163	April 28, 2011
RAI 467 — 03.09.02-165	April 28, 2011
RAI 467 — 03.09.02-167	April 28, 2011

Sincerely,

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Russell.Wells@Areva.com

From: WELLS Russell (RS/NB)
Sent: Thursday, February 24, 2011 2:08 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); BRYAN Martin (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 467 Response US EPR DC.pdf" provides a schedule for a technically correct and complete response to the 14 questions.

The following table indicates the respective pages in the response document, "RAI 467 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 467 — 03.06.03-28	2	2
RAI 467 — 03.09.02-155	3	3
RAI 467 — 03.09.02-156	4	4
RAI 467 — 03.09.02-157	5	5
RAI 467 — 03.09.02-158	6	6
RAI 467 — 03.09.02-159	7	7
RAI 467 — 03.09.02-160	8	8
RAI 467 — 03.09.02-161	9	9
RAI 467 — 03.09.02-162	10	10
RAI 467 — 03.09.02-163	11	11
RAI 467 — 03.09.02-164	12	12
RAI 467 — 03.09.02-165	13	13
RAI 467 — 03.09.02-166	14	14
RAI 467 — 03.09.02-167	15	15

A complete answer is not provided for the 14 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 467 — 03.06.03-28	August 15, 2011
RAI 467 — 03.09.02-155	April 28, 2011
RAI 467 — 03.09.02-156	April 28, 2011
RAI 467 — 03.09.02-157	April 28, 2011
RAI 467 — 03.09.02-158	April 28, 2011
RAI 467 — 03.09.02-159	April 28, 2011
RAI 467 — 03.09.02-160	April 28, 2011
RAI 467 — 03.09.02-161	April 28, 2011
RAI 467 — 03.09.02-162	April 28, 2011
RAI 467 — 03.09.02-163	April 28, 2011
RAI 467 — 03.09.02-164	April 28, 2011
RAI 467 — 03.09.02-165	April 28, 2011
RAI 467 — 03.09.02-166	April 28, 2011
RAI 467 — 03.09.02-167	April 28, 2011

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager

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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, January 26, 2011 3:34 PM
To: ZZ-DL-A-USEPR-DL
Cc: Reichelt, Eric; Terao, David; Wong, Yuken; Dixon-Herrity, Jennifer; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 467 (5333, 5344), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on January 6, 2011, and discussed with your staff on January 20 and 24, 2011. No change is made to the draft RAI as a result of those discussions. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 3751

Mail Envelope Properties (2FBE1051AEB2E748A0F98DF9EEE5A5D4AE958D)

Subject: Response to U.S. EPR Design Certification Application RAI No. 467, FSAR Ch. 3, Supplement 15
Sent Date: 2/17/2012 12:25:40 PM
Received Date: 2/17/2012 12:25:22 PM
From: WILLIFORD Dennis (AREVA)

Created By: Dennis.Williford@areva.com

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"BENNETT Kathy (AREVA)" <Kathy.Bennett@areva.com>
Tracking Status: None
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Tracking Status: None
"RYAN Tom (AREVA)" <Tom.Ryan@areva.com>
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Tracking Status: None
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Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	36664	2/17/2012 12:25:22 PM
RAI 467 Supplement 15 Response US EPR DC.pdf		874348

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 467 (5333, 5344)
Supplement 15

1/26/2011

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.06.03 - Leak-Before-Break Evaluation Procedures
SRP Section: 03.09.02 - Dynamic Testing and Analysis of Systems Structures and Components
Application Section: FSAR Chapter 3

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)
QUESTIONS for Engineering Mechanics Branch 2 (ESBWR/ABWR Projects) (EMB2)

Question 03.06.03-28:

Follow-up to RAI 265, Question 03.06.03-26

The Allowable Load Limit (ALL) Diagrams are presented in FSAR Tier 2, Section 3.6.3, Figure 3.6.3-12 through Figure 3.6.3-23 for the Main Steam Line (MSL), Main Coolant Line (MCL), and the Surge Line (SL) cases. As a result of the confirmatory calculations performed by the staff and the resulting RAI 265 Question 03.06.03-26, AREVA proposed (i.e., in its Supplemental 5 response to RAI 265 dated September 30, 2010) revising FSAR Tier 2, Figures 3.6.3-18, 3.6.3-19 and 3.6.3-20. Based on a telephone conference call with the applicant on April 7, 2010, the staff understood that AREVA would also revise the remaining ALL diagrams for MCL, MSL, and SL per the same procedure used for the SL. As stated in the telecon dated December 15, 2010, AREVA is requested to provide the NRC staff with revised versions of FSAR Tier 2, Figures 3.6.3-12,-13,-14,-15,-16,-17,-21,-22, and -23.

Response to Question 03.06.03-28:

As noted in the question, the revised ALL diagrams for the SL were provided to the NRC in the Response to RAI 265, Supplement 5, Question 03.06.03-26. U.S. EPR FSAR Tier 2, Section 3.6.3 will be revised to include the revised ALL diagrams for the MCL. Corresponding changes will be made to the text and tables. The ALL diagrams for the MSL do not need to be revised for the following reasons:

- The MSL contains no dissimilar metal welds; therefore, no equivalent material properties calculations are needed.
- The reference strain in the Ramberg-Osgood (R-O) was correctly defined as the ratio of reference stress to the elastic modulus. The Response to RAI 265, Supplement 5, Question 03.06.03-26 corrected a typing error of the reference strain values for the MSL piping in U.S. EPR FSAR Tier 2, Table 3.6.3-7 (the reference strain values varied by an order of magnitude). In the calculations for the MSL, since the reference strain was calculated explicitly as the ratio of reference stress to the elastic modulus, the correct value was used. Therefore, the correction to the reference strain values in U.S. EPR FSAR Tier 2, Table 3.6.3-7 did not affect the ALL diagrams for the MSL in U.S. EPR FSAR Tier 2, Section 3.6.3.
- The leakage calculations for the MSL line were determined using SQUIRT with single phase steam, and the fatigue crack morphology was used demonstrating that the recommended number of turns was used. The NRC also performed independent confirmatory analysis and had similar leakage results to those performed by AREVA NP.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.6.3 will be revised as described in the response and indicated on the enclosed markup. Note that some of these changes were made in U.S. EPR FSAR Revision 3 and boxed and flagged where the changes were made.

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U.S. EPR Final Safety Analysis Report Markups

The tensile properties and the Ramberg-Osgood parameters for the hot and cold leg piping are presented in Table 3.6.3-4—Tensile Properties of Materials at Various Locations of Main Coolant Loop Piping. The material parameters for the J-R equation (C and N) are determined using the $J_{Deformation}$ and Δa experimental data of the applicable compact tension specimens. The power law formula for the J-R data is obtained using a linear regression analysis and is given below:

$$J_D = C(\Delta a)^N$$

where:

J_D = $J_{Deformation}$ in units of lbs/in

Δa is in inches

C = the material constant

N = the exponent

The J-R curve for the base metal of the MCL piping material is determined from the test results, as well as from similar materials in the industry as summarized in NUREG/CR-6446 (Reference 12), NUREG/CR-4082, Vol. 8 (Reference 13), and NUREG/CR-4599 (Reference 14). The lower bound J-R curve power law parameters for the MCL base metal are determined for the LBB analysis. Thermal aging of wrought 304 and 316 is expected to be negligible, therefore it is not considered in this evaluation.

3.6.3.4.3.2 Dissimilar Metal Weld between Component Nozzle and MCL Piping

Alloy 52/52M is the dissimilar metal weld that is used between the MCL piping and both the primary component nozzles of the reactor vessel and the primary nozzles of the steam generators. The J-R curve for the Alloy 52 weld metal is determined using specimens that are fatigue pre-cracked on the fusion line. The J-R curve parameters, using ASTM Standard E1820 (Reference 15), were used in this assessment considering the case without a limit on crack extension. The J-R curve for Alloy 52 weld metal, developed at the fusion line, is lower than the J-R curve for the base metal and the stainless steel weld metal of the MCL piping. For the Alloy 52 weld metal, the J-R parameters considering the fusion line toughness are used in the LBB analysis. The equivalent material tensile properties for the dissimilar metal weld (DMW) at the fusion line location are determined using finite element based elastic-plastic fracture mechanics analysis and provided in Table 3.6.3-4. These material properties at the DMW fusion line region are determined considering the adjoining base metal materials which are F304LN and SA-508 Grade 3 Class 2. The material properties for SA-508 Grade 3 Class 2 are approximated by the material properties for SA-508 Class 3 which are obtained from NUREG/CR-6837, Volume 2 (Reference 25).

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Main Coolant Loop

The leakage rate calculations are determined at the following locations (Location 1 through Location 9) in the MCL piping:

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1. RV Outlet Nozzle Region at Hot Leg.
2. Hot Leg Pipe.
3. SG Inlet Nozzle Region at Hot Leg.
4. SG Outlet Nozzle Region.
5. Crossover Leg.
6. RCP Inlet Nozzle Region.
7. RCP Outlet Nozzle Region.
8. Cold Leg Pipe.
9. RV Inlet Nozzle Region.

Surge Line

For the SL piping, the leakage rate calculations are determined at the following locations:

- Pressurizer surge nozzle end of the SL.
- Pressurizer SL
- Hot leg nozzle end of the SL.

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The leak rate analysis considers fatigue (air) crack morphology with applicable number of turns and roughness values reported in NUREG/CR-6004 (Reference 29) and shown in Table 3.6.3-26. The leakage crack lengths versus minimum moment at each of the above nine locations for the MCL are shown in Table 3.6.3-8—Minimum Moment versus Circumferential Crack Leakage Crack Sizes for 5 gpm at Various Main Coolant Loop Piping Locations and are illustrated in Figure 3.6.3-5—Minimum Moment versus Circumferential Leakage Crack Sizes for 5 gpm at Various Main Coolant Loop Locations. For the through-wall axial cracks, the leakage crack sizes are shown in Table 3.6.3-9—Axial Through-Wall Leakage Crack Sizes for 5 gpm at Various Main Coolant Loop Piping Locations. For SL piping, the leakage crack lengths versus moment at each of the above three locations are shown in Table 3.6.3-10—Minimum Moment versus Circumferential Leakage Crack Sizes for 5 gpm at Two Surge Line Piping Locations and are illustrated in Table 3.6.3-6—Surge Line Piping Locations Based on Key Geometry, Operating Conditions & Lower Bound Material Toughness.

For the through-wall axial cracks, the leakage crack sizes are shown in Table 3.6.3-11—Axial Through-Wall Leakage Crack Sizes for 5 gpm at Three Surge Line Piping Locations.

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3.6.3.5.3 Leak Rate Determination Method for Main Steam Line

The leak rate calculations for the MSL piping are performed using SQUIRT Code Version 1.1. The SQUIRT Code is described in NUREG/CR-5128 (Reference 20) and the SQUIRT User's Manual (Reference 21) and has been benchmarked to the experimental steam data developed in Japan, as described in NUREG/CR-6861 (Reference 22). The SQUIRT code has been updated with technical enhancements as part of the NRC large break LOCA program. The SQUIRT Code is used to calculate the leakage rate through the cracked pipe for single phase steam conditions.

Leakage crack sizes associated with a leak rate of one gpm are determined in the analysis. This leak rate provides a factor of ten to the LDS capability. The leakage rate calculations are performed for straight pipe with both axial and circumferential through-wall cracks. Similar to MCL, for the axial through-wall crack orientation, pressure-only loading is considered while external bending and pressure loading is considered for the circumferential through-wall crack. The results of the pressure-only case, as depicted in Figure 3.6.3-7—Pressure Only Leakage Rate versus Crack Length for Both Axial and Circumferential Crack Morphologies in Main Steam Line, show that for a given crack size the axial through-wall cracks produced a higher leakage rate. As a result, the circumferential leakage crack sizes are conservatively used when analyzing axial leakage cracks. The results of the leak rate calculations provided in Table 3.6.3-12—Minimum Moment versus Circumferential Leakage Crack Leakage Sizes for 1 gpm in the Main Steam Line Piping. The results are also shown in Figure 3.6.3-8—Minimum Moment versus Circumferential Crack Leakage Crack Sizes for 1 gpm in Main Steam Line Piping, in terms of the minimum moment diagrams for a leakage rate of one gpm. The external axial load is set equal to zero in the leak rate calculations. This is considered conservative, since the crack size required to produce a given leakage rate will actually be smaller in the presence of external axial tensile loads. The leakage crack sizes calculated from the circumferential through-wall crack in straight pipe are also used for analyzing circumferential through-wall extrados crack in an elbow.

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3.6.3.5.4 Flaw Stability Analysis Method

The method employed for the flaw stability analysis is the tearing instability analysis method, using a J versus T diagram. The inputs for the flaw stability analysis include the applied J and the material J-R curves. The applied J ($J_{applied}$) depends on the geometry, material, and the applied loads. The material properties are described in terms of the J-R fracture resistance curves which are obtained from tests in accordance with Reference 15 as well as industry data of comparable materials.

To estimate the $J_{applied}$, a J-integral solution is needed. The J-integral solution is a function of geometry, material, and crack size and orientation. Each J-integral solution is usually tabulated in terms of influence coefficients that are calculated based on finite element analyses. The stability analysis covers the following crack geometries:

- Circumferential through-wall crack in a straight pipe.
- Axial through-wall crack in straight pipe.
- Circumferential through-wall extrados crack in an elbow.

A J-integral solution is used for each of the above crack orientations. The following sections address the J-integral solution for each of the crack geometries. For the circumferential through-wall cracks in a straight pipe, the EPRI/GE method reported in EPRI NP-5596 (Reference 23) is used to calculate the J-integral. For the MCL and SL piping, the alpha term in the $J_{Plastic}$ part of the equation given in Section 3.6.3.5.4.1 is modified based on the recommendation provided in Analysis of Experiments on Stainless Steel Flux Welds (Reference 24). This modification of the alpha term is provided as the last set of J-integral equations for SL piping in Section 3.6.3.5.4.1. For a circumferential through-wall extrados crack in an elbow, the criteria of NUREG/CR-6837 (Reference 25) are used to evaluate the J-integral.

3.6.3.5.4.1 Circumferential Through-Wall Crack in Straight Pipe Solution

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Main Steam Line Piping

The J-integral solution for a circumferentially through-wall cracked cylinder for a combined tension and bending loading condition is used for this analysis. A schematic of this cracked pipe geometry is illustrated in Figure 3.6.3-9—Schematics of Analyzed Crack Geometries Considered for Straight Pipe Section. The solution procedure is summarized as follows:

$$J = J_{Bending-Elastic} + J_{Axial-Elastic} + J_{Plastic}$$

where:

$$J_{Bending-Elastic} = \frac{M^2}{E}\pi a\left(\frac{R}{I}\right)^2 F_B^2\left(\frac{a_e}{b},\frac{R}{T}\right)$$

$$J_{Axial-Elastic} = \frac{P^2}{E}\,\frac{aF_T^2\left(\frac{a_e}{b},\frac{R}{t}\right)}{4\pi R^2 t^2}$$

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$$J_{Plastic} = \alpha \sigma_o \varepsilon_o c \frac{a}{b} h_1 \left(\frac{a}{b}, n, \lambda, \frac{R}{t} \right) \left[\frac{P}{P_o'} \right]^{n+1}$$

The P_o' in the $J_{Plastic}$ equation is the reference load for the combined tension and bending loads given as:

$$P_o' = \frac{1}{2} \left[\frac{-\lambda P_o^{\,2} R}{M_o} + \sqrt{ \left(\frac{\lambda P_o^{\,2} R}{M_o} \right)^2 + 4 P_o^{\,2} } \right]$$

where:

Limit Load

$$P_o = 2\sigma_o R t \left(\pi - \gamma - 2 \arcsin\left(\frac{1}{2} \sin\gamma \right) \right)$$

Limit Moment

$$M_o = 4\sigma_o R^2 t \left(\cos\left(\frac{\gamma}{2} \right) - \frac{1}{2} \sin\gamma \right)$$

Un-Cracked Ligament

$$2c = 2R(\pi - \gamma)$$

Non-Dimensional Parameter

$$\lambda = \frac{M}{PR}$$

Plastic Zone Correction

$$a_e = a + \frac{1}{1 + \left(\frac{P}{P_o} \right)^2} \frac{1}{6\pi} \left[\frac{n-1}{n+1} \right] \frac{E J_{Elastic}}{\sigma_o^2}$$

where:

R = the pipe mean radius

t = the pipe thickness

I = area moment of inertia of the pipe section

a = the flaw size or one-half the leakage crack size

b = one-half the pipe circumference

c = uncracked ligament (b – a)

E = Young's modulus

M = the bending moment

P = the tensile load

σ_o and ε_o= the reference stress and reference strain in the Ramberg-Osgood material model

γ = the crack half-angle

F_B and F_T = the tabulated elastic solution coefficients for bending and axial loading (functions of geometry only – a/b and R/t) as provided in Reference 23

h_1 = the tabulated fully plastic solution parameter, function of (material strain hardening exponent, n and geometry, a/b and R/t)

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For the MSL piping, the elastic solution coefficients (F_B and F_T) from the EPRI reports are linearly interpolated where applicable to generate the solution for the specific R/t geometry that is being evaluated.

Main Coolant Loop and Surge Line Piping

A J-integral solution for a circumferentially through-wall cracked cylinder subjected to bending loads is used in the analysis for the SL piping. This EPRI/GE solution is provided in Reference 23. The alpha term in the solution is corrected based on Reference 24. This particular J-integral solution is chosen since the SL geometry has an R_m/t ratio of approximately five (with Ramberg-Osgood material constant n=7) and the h-function for $R_m/t = 5$ is available for through-wall cracks in bending. For the SL piping, the J-integral solution for combined tension and bending provided above (main coolant loop and main steam line piping) is not used, since the coefficients for this solution are only developed for R_m/t of 10 or greater.

In order to use the J-integral solution for bending loads only, the axial forces due to end cap pressure or external loads are converted into an equivalent moment. The equivalent bending is then combined with the applied moment to obtain the total moment to which the pipe is subjected. The general approach of calculating an equivalent moment is outlined below.

vessel outlet nozzle at the Alloy 52 weld fusion line region are depicted in Figure 3.6.3-12—ALL for Reactor Vessel Outlet Nozzle Region at Hot Leg (Location 1). Similarly, the results for other components are shown in the figures as listed below:

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- Figure 3.6.3-13—ALL for Hot Leg Pipe (Location 2).
- Figure 3.6.3-14—ALL for Steam Generator Inlet Nozzle at Hot Leg (Location 3).
- Figure 3.6.3-15—ALL for Steam Generator Outlet Nozzle (Location 4).
- Figure 3.6.3-16—ALL for Crossover & Cold Leg Pipe (Locations 5 & 8).
- Figure 3.6.3-17—ALL for RCP Inlet Nozzle (Location 6).
- Figure 3.6.3-24—ALL for RCP Outlet Nozzle (Location 7)
- Figure 3.6.3-25—ALL for RV Inlet Nozzle (Location 9)

These regions are identified in Table 3.6.3-13. The Alloy 52 weld locations (see Figure 3.6.3-12, Figure 3.6.3-14, Figure 3.6.3-15, and Figure 3.6.3-25 ~~through Figure 3.6.3-14~~) that use the fusion line toughness values were evaluated using the equivalent material tensile properties. The locations in Figure 3.6.3-17 and Figure 3.6.3-24 were evaluated using the lower bound toughness properties for the CASS RCP casing so that the cold leg pipe and RPV inlet nozzles are conservatively evaluated. The locations in Figure 3.6.3-13 and Figure 3.6.3-16 were evaluated considering the tensile and toughness properties of the base metal of the piping.

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The explanations for the interpretation of the ALL diagrams are provided in Figure 3.6.3-12 through Figure 3.6.3-17, Figure 3.6.3-24 and Figure 3.6.3-25. As long as the maximum applicable moment (normal operating plus SSE loading) load for the applicable location is within the "ALL LBB Zone," LBB is justified for that location. The maximum moment loads are derived considering various coincident axial loading conditions (1000 kilo lbs (kips), 1500 kilo lbs (kips), 2000 kilo lbs (kips), 2500 kips, and 3000 kips). The maximum axial loading (i.e., external applied loading plus 100 percent normal operating pressure end-cap load) that is applicable for the location is used as the maximum moment curve for the location. The "ALL LBB Zone" region is reduced as the axial loading is increased from 1000 kips to 3000 kips. The corresponding tabulated values for the ALL diagrams in Figure 3.6.3-12 through Figure 3.6.3-17, Figure 3.6.3-24 and Figure 3.6.3-25 are provided in the following tables:

RAI 467 Q.03.06.03-28

- ~~Figure 3.6.3-14—ALL for Steam Generator Inlet Nozzle at Hot Leg (Location 3)~~.Table 3.6.3-14—ALL for RV Outlet Nozzle Region at the Hot Leg (Location 1)
- ~~Figure 3.6.3-15—ALL for Steam Generator Outlet Nozzle (Location 4)~~.Table 3.6.3-15—ALL for Hot Leg Pipe (Location 2)

- Table 3.6.3-16—ALL for SG Inlet Nozzle at Hot Leg (Location 3).
- Table 3.6.3-17—ALL for SG Outlet Nozzle (Location 4).
- Table 3.6.3-18—ALL for Crossover & Cold Leg Pipe (Locations 5 & 8).
- Table 3.6.3-19—ALL for RCP Inlet Nozzle (Location 6).
- Table 3.6.3-27—ALL for RCP Outlet Nozzle (Location 7)
- Table 3.6.3-28—ALL for RV Inlet Nozzle (Location 9)

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3.6.3.6.1.2 Circumferential Through-Wall Extrados Crack in an Elbow

A sample problem was evaluated to demonstrate that this cracked geometry is bounded by the results of the circumferential through-wall crack in the adjoining straight pipe at a given location. That analysis showed that the maximum allowable moment in the steam generator inlet elbow with a flaw size of 12.4 in is 54,067 in-kips. This evaluation accounts for the wall thinning at the extrados of the elbow where the wall thickness is 2.91 in. The adjoining straight pipe at the steam generator inlet has a wall thickness of <3.66 in. Even with consideration of the greater wall thickness, the maximum allowable moment for a circumferential crack of the same size in a straight pipe is only 52,133 in-kips considering the base metal properties. This corresponds to a 3.7 percent increase in allowable moment obtained for the circumferential extrados crack in the elbow compared to the circumferential crack in the straight pipe. The ALL diagram results provided in Section 3.6.3.6.1.1 are also applicable for the circumferential extrados crack in an elbow.

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3.6.3.6.1.3 Axial Through-Wall Crack in a Straight Pipe

The axial through-wall cracks in a straight pipe were evaluated at each of the regions identified for the circumferential through-wall crack in a straight pipe. The critical crack sizes for each of the regions are shown in Table 3.6.3-20—Critical Axial Crack Size at Main Coolant Loop Piping Locations. The minimum critical crack size was greater than 33 in. The appropriate lower bound material properties for each of the regions are also considered for the axial through-wall cracks. The minimum safety margin (ratio of critical crack size to leakage crack size) was determined to be 4.89 and occurs in the RPV outlet nozzle region. This is greater than the required safety factor of two for LBB analysis. Therefore, the LBB required safety margins are met for this cracked pipe geometry.

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3.6.3.6.2 Surge Line Piping

3.6.3.6.2.1 Circumferential Through-Wall Crack in a Straight Pipe (ALL Diagrams)

The results of the flaw stability analysis are shown in terms of ALL diagrams for circumferential through-wall cracks in a straight pipe. The results for the pressurizer

Table 3.6.3-1—Main Coolant System Piping Dimensions and Operating Condition

Location	Description of Pipe Geometry	Temperature (°F)	Pressure (psia)	ID[1] (in)	Pipe Wall[2] Thickness (in)
1	RV Outlet at Hot Leg	625	2250	30.71	2.99
2	Hot Leg Pipe	625	2250	30.71	2.99
3	SG Inlet at Hot Leg	625	2250	30.71	3.82
4	SG Outlet	563	2250	30.71	3.82
5	Crossover Leg	563	2250	30.71	2.99
6	RCP Inlet	563	2250	30.71	3.54
7	RCP Outlet	563	2250	30.71	2.99
8	Cold Leg Pipe	563	2250	30.71	2.99
9	RPV Inlet	563	2250	30.71	2.99

Notes:

1. ID of the pipe. At the weld prep location the ID of pipe is 30.87 in.
2. For detailed J-T analysis the weld prep thickness is conservatively used. For leak rate analysis, the pipe wall thickness given in the table is used.

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Table 3.6.3-2—Surge Line Piping Dimensions and Operating Condition

Location	Description of Pipe Geometry	Temperature (°F)	Pressure (psia)	ID[1] (in)	Pipe Wall[2] Thickness (in)
1	Pressurizer Surge Nozzle	653	2250	13.61	2.055
2	Surge Line Piping near Pressurizer	653	2250	12.81	1.595
3	Hot Leg Nozzle	624	2250	12.91	1.545

Notes:

1. ID of the pipe. At the weld prep location, the ID of the pipe is 12.91 in.
2. For consistency, the pipe wall thickness is used in both the leak rate and flaw stability analysis.

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Table 3.6.3-3—Main Steam Line Dimensions and Operating Condition

Location	Description of Pipe Geometry	Temperature (°F)	Pressure (psia)	ID (in)	Pipe Wall[1] Thickness (in)
1	Main Steam Line Piping	556	1111	27.5	1.86

Note:

1. Pipe wall thickness is used for both the J-T analysis and the leak rate analysis.

Table 3.6.3-4—Tensile Properties of Materials at Various Locations of Main Coolant Loop Piping

Locations	Temp., °F	E (ksi)	σ_o (= σ_y, ksi)	ε_o	a	n	σ_u (ksi)
1*	625	25252	21.545	0.000853	5.570	4.090	61.356
2	625	25000	19.200	0.000768	5.850	3.878	59.200
3*	625	25396	22.885	0.000901	5.420	4.210	62.588
4*	563	25879	23.523	0.000909	4.930	4.290	62.588
5	563	25500	19.790	0.000776	5.280	3.997	59.200
6	563	25500	19.790	0.000776	5.280	3.997	59.200
7	563	25500	19.790	0.000776	5.280	3.997	59.200
8	563	25500	19.790	0.000776	5.280	3.997	59.200
9*	563	25741	22.167	0.000861	5.060	4.180	61.356

Note:

1. *Note: Dissimilar metal weld (DMW) at fusion line determined using elastic-plastic fracture mechanics (EPFM) and finite element method.

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Table 3.6.3-5—Tensile Properties for the Surge Line Piping

Tensile Properties (ksi)			
	SL Piping near Pressurizer	Pressurizer Nozzle DMW[1]	Hot Leg Nozzle
Yield Stress (σ_y)	18.0	22.9	18.21
Ultimate Strength (σ_{ult})	59.2	62.6	59.2
Flow Stress (σ_f)	38.6	42.8	38.7
Young's Modulus (E)	25,000	25,400	25,180
Ramberg-Osgood Parameters ($\frac{\varepsilon}{\varepsilon_o} = \frac{\sigma}{\sigma_o} + \alpha\left(\frac{\sigma}{\sigma_o}\right)^n$)			
	SL Piping near Pressurizer	Pressurizer Nozzle	Hot Leg Nozzle
α	5.90	5.38	6.13
n	3.50	4.28	3.50
Reference Stress (σ_o)	18.0 ksi	22.9 ksi	18.21 ksi
Reference Strain (ε)	0.00072	0.000901	0.000723

Note:

1. Dissimilar metal weld (DMW) at fusion line determined using elastic-plastic fracture mechanics (EPFM) and finite element method.

Table 3.6.3-8—Minimum Moment versus Circumferential Crack Leakage ~~Crack~~ Sizes for 5 gpm at Various Main Coolant Loop Piping Locations

Min Moment In-kips	Circumferential Leakage Flaw Size at 5.0 GPM, inch						
	1	2	3	4	5, 7, 8	6	9
0	11.322	10.314	14.683	12.824	9.592	11.549	9.985
10000	8.630	8.378	11.153	9.547	7.328	8.759	7.466
20000	6.764	6.442	9.035	7.709	5.688	6.948	5.889
30000	5.140	4.616	7.372	6.361	4.191	5.400	4.617
40000	3.662	3.214	5.927	5.205	2.975	4.074	3.344
50000	2.625	2.265	4.672	4.187	2.115	3.179	2.433
60000	1.912	1.645	3.653	3.358	1.536	2.283	1.784
70000	1.455	1.234	2.861	2.635	1.149	1.746	1.403
80000	1.095	0.954	2.262	2.097	0.884	1.361	1.021
90000	0.861	0.757	1.865	1.683	0.698	1.083	0.801
100000	0.691	0.614	1.468	1.366	0.563	0.879	0.641
110000	0.568	0.507	1.207	1.124	0.462	0.725	0.522
120000	0.472	0.427	1.028	0.956	0.386	0.606	0.434
130000	0.398	0.363	0.849	0.787	0.328	0.515	0.365
140000	0.340	0.318	0.723	0.670	0.282	0.442	0.310
150000	0.294	0.273	0.623	0.576	0.244	0.383	0.268
160000	0.258	0.251	0.542	0.500	0.214	0.335	0.234

Table 3.6.3-9—Axial Through-Wall Leakage Crack Sizes for 5 gpm at Various Main Coolant Loop Piping Locations

MCL Locations	Description	Leakage Crack Size (in)
1	RV Outlet at Hot Leg	7.189
2	Hot Leg Pipe	7.311
3	SG Inlet at Hot Leg	8.529
4	SG Outlet	7.395
5	Crossover Leg	6.342
6	RCP Inlet	7.124
7	RCP Outlet	6.342
8	Cold Leg Pipe	6.342
9	RV Inlet	6.254

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Table 3.6.3-12—Minimum Moment versus Circumferential Leakage Crack ~~Leakage~~ Sizes for 1 gpm in the Main Steam Line Piping

Leakage Size (in)	Minimum Moment (in-kips)
13.85	2400
12.05	4820
10.73	7270
9.75	9620
8.93	12,100
8.25	14,700
7.70	17,200
7.20	19,800
6.76	22,500
6.33	25,600
5.94	28,800

Table 3.6.3-13—Main Coolant Loop Piping Locations based on Key Geometry, Operating Conditions and Lower Bound Material Toughness

LBB Piping Location	Description of Pipe Geometry	Temperature (°F)	Pipe Wall Thickness[1], t (in)	Rm/t	Lower Bounding Material
1	RV Outlet at Hot Leg	625	2.913	5.80	Alloy 52
2	Hot Leg Pipe	625	2.835	5.94	Base Metal
3	SG Inlet at Hot Leg	625	3.661	4.72	Alloy 52
4	SG Outlet	563	3.661	4.72	Alloy 52
5	Crossover Leg	563	2.835	5.94	Base Metal
6	RCP Inlet	563	3.386	5.06	CASS
7	RCP Outlet	563	2.913	5.80	CASS
8	Cold Leg Pipe	563	2.913	5.80	Base Metal
9	RPV Inlet	563	2.913	5.80	Alloy 52

Note:

1. Corresponds to the minimum thickness at the weld prep location. However, for consistency with leak rate analysis, the thickness from Table 3.6.3-1 are used.

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Table 3.6.3-14—ALL for RV Outlet Nozzle Region at the Hot Leg (Location 1)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
11.322	0	37,974	33,471	28,969	24,552	19,965
8.630	10,000	48,654	44,249	39,843	35,449	31,032
6.764	20,000	56,679	52,327	47,975	43,622	39,271
5.140	30,000	64,380	60,068	55,757	51,445	47,134
3.662	40,000	72,497	68,219	63,942	59,663	55,386
2.625	50,000	79,479	75,224	70,968	66,712	62,456
1.912	60,000	85,560	81,319	77,077	72,836	68,594
1.455	70,000	90,534	86,301	82,068	77,836	73,603
1.095	80,000	95,564	91,337	87,111	82,885	78,659
0.861	90,000	99,763	95,541	91,319	87,096	82,874
0.691	100,000	103,596	99,377	95,157	90,937	86,718
0.568	110,000	107,024	102,806	98,588	94,370	90,152
0.472	120,000	110,284	106,067	101,851	97,634	93,417
0.398	130,000	113,313	109,098	104,882	100,666	96,450
0.340	140,000	116,140	111,924	107,709	103,494	99,279
0.294	150,000	118,776	114,561	110,346	106,132	101,917
0.258	160,000	121,169	116,955	112,741	108,526	104,312

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Table 3.6.3-15—ALL for Hot Leg Pipe (Location 2)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
10.314	0	51,970	47,519	43,069	38,632	34,168
8.378	10,000	60,759	56,371	51,984	47,529	43,209
6.442	20,000	70,317	65,983	61,648	57,313	52,978
4.616	30,000	80,643	76,351	72,059	67,767	63,475
3.214	40,000	90,395	86,133	81,870	77,608	73,345
2.265	50,000	98,991	94,747	90,503	86,259	82,015
1.645	60,000	106,485	102,252	98,019	93,786	89,553
1.234	70,000	113,105	108,878	104,652	100,426	96,200
0.954	80,000	119,029	114,807	110,585	106,362	102,140
0.757	90,000	121,754	118,551	114,863	110,702	106,088
0.614	100,000	122,516	119,346	115,690	111,561	106,976
0.507	110,000	123,085	119,940	116,307	112,202	107,639
0.427	120,000	123,509	120,383	116,768	112,680	108,135
0.363	130,000	123,848	120,737	117,137	113,063	108,531
0.318	140,000	124,086	120,985	117,396	113,331	108,809
0.273	150,000	124,324	121,234	117,654	113,600	109,087
0.251	160,000	124,441	121,355	117,781	113,731	109,222

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Table 3.6.3-16—ALL for SG Inlet Nozzle at Hot Leg (Location 3)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
14.683	0	45,852	41,087	36,324	31,675	26,796
11.153	10,000	63,088	58,493	53,898	49,337	44,707
9.035	20,000	74,262	69,742	65,222	60,701	56,182
7.372	30,000	83,615	79,145	74,674	70,202	65,732
5.927	40,000	92,372	87,939	83,505	79,072	74,639
4.672	50,000	100,755	96,352	91,948	87,544	83,141
3.653	60,000	108,471	104,090	99,709	95,328	90,948
2.861	70,000	115,441	111,077	106,713	102,349	97,985
2.262	80,000	121,680	117,328	112,977	108,625	104,273
1.865	90,000	126,566	122,222	117,878	113,535	109,191
1.468	100,000	132,421	128,085	123,749	119,413	115,077
1.207	110,000	137,100	132,769	128,437	124,106	119,774
1.028	120,000	140,892	136,563	132,235	127,907	123,578
0.849	130,000	145,383	141,058	136,732	132,407	128,081
0.723	140,000	149,148	144,825	140,501	136,178	131,854
0.623	150,000	152,642	148,320	143,998	139,676	135,354
0.542	160,000	155,924	151,603	147,282	142,961	138,640

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Table 3.6.3-17—ALL for SG Outlet Nozzle (Location 4)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
12.824	0	56,353	51,686	47,019	42,485	37,685
9.547	10,000	73,420	68,884	64,347	59,849	55,274
7.709	20,000	83,753	79,273	74,793	70,312	65,832
6.361	30,000	91,860	87,416	82,972	78,527	74,084
5.205	40,000	99,371	94,956	90,540	86,124	81,709
4.187	50,000	106,671	102,278	97,886	93,493	89,101
3.358	60,000	113,384	109,009	104,635	100,261	95,886
2.635	70,000	120,176	115,817	111,458	107,099	102,740
2.097	80,000	126,173	121,825	117,477	113,128	108,780
1.683	90,000	131,693	127,353	123,013	118,673	114,333
1.366	100,000	136,774	132,440	128,106	123,772	119,438
1.124	110,000	141,434	137,104	132,774	128,444	124,114
0.956	120,000	145,275	140,948	136,621	132,294	127,966
0.787	130,000	149,841	145,517	141,192	136,868	132,543
0.670	140,000	153,627	149,304	144,981	140,659	136,336
0.576	150,000	157,190	152,869	148,548	144,226	139,905
0.500	160,000	160,540	156,220	151,899	147,579	143,259

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Table 3.6.3-18—ALL for Crossover & Cold Leg Pipe (Locations 5 & 8)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
9.592	0	56,384	51,959	47,535	43,126	38,685
7.328	10,000	67,088	62,731	58,374	53,951	49,659
5.688	20,000	75,660	71,344	67,028	62,711	58,395
4.191	30,000	84,645	80,362	76,079	71,796	67,514
2.975	40,000	93,589	89,332	85,074	80,816	76,559
2.115	50,000	101,800	97,558	93,317	89,076	84,834
1.536	60,000	109,177	104,946	100,715	96,484	92,253
1.149	70,000	115,773	111,548	107,323	103,098	98,873
0.884	80,000	121,736	117,515	113,294	109,073	104,852
0.698	90,000	123,105	119,937	116,286	112,165	107,592
0.563	100,000	123,827	120,691	117,070	112,979	108,435
0.462	110,000	124,367	121,254	117,656	113,587	109,064
0.386	120,000	124,772	121,677	118,096	114,044	109,537
0.328	130,000	125,081	121,999	118,431	114,392	109,897
0.282	140,000	125,325	122,254	118,697	114,668	110,183
0.244	150,000	125,527	122,465	118,917	114,896	110,418
0.214	160,000	125,687	122,631	119,090	115,075	110,604

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Table 3.6.3-19—ALL for RCP Inlet Nozzle (Location 6)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
11.549	0	46,509	41,933	37,357	32,873	28,206
8.759	10,000	58,946	54,470	49,995	45,525	41,043
6.948	20,000	67,733	63,309	58,886	54,462	50,038
5.400	30,000	75,995	71,610	67,225	62,840	58,456
4.074	40,000	84,053	79,698	75,344	70,990	66,635
3.179	50,000	90,422	86,087	81,752	77,417	73,082
2.283	60,000	98,210	93,893	89,577	85,260	80,943
1.746	70,000	104,147	99,840	95,534	91,228	86,922
1.361	80,000	109,488	105,189	100,890	96,591	92,292
1.083	90,000	114,311	110,016	105,722	101,428	97,133
0.879	100,000	118,692	114,401	110,109	105,818	101,527
0.725	110,000	122,739	118,450	114,162	109,873	105,584
0.606	120,000	126,527	122,239	117,952	113,665	109,378
0.515	130,000	129,990	125,704	121,418	117,132	112,846
0.442	140,000	133,273	128,988	124,703	120,418	116,133
0.383	150,000	136,382	132,097	127,813	123,528	119,244
0.335	160,000	139,317	135,033	130,749	126,465	122,182

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Table 3.6.3-20—Critical Axial Crack Size at Main Coolant Loop Piping Locations

Location	Component	Leakage Flaw Size at 5.0 GPM, inch	Critical Flaw Sizes, inch	Safety Margin
1	RV Outlet Nozzle at Hot Leg	7.189	35.19	4.89
2	Hot Leg Pipe	7.311	37.68	5.15
3	SG Inlet Nozzle at Hot Leg	8.529	51.46	6.03
4	SG Outlet Nozzle	7.395	51.93	7.02
5	Crossover Leg	6.342	38.04	6.00
6	RCP Inlet Nozzle	7.124	42.84	6.01
7	RCP Outlet Nozzle	6.342	33.37	5.26
8	Cold Leg Pipe	6.342	38.04	6.00
9	RV Inlet Nozzle	6.254	35.52	5.68

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Table 3.6.3-21—ALL for Pressurizer Surge Nozzle at Alloy 52 Weld
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With Axial Load of:			0 kips	1.5 kips	15 kips	30 kips	40 kips	50 kips	60 kips	70 kips
Set No.	Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
1	12.318	0	2,076	2,068	1,993	1,910	1,855	1,800	1,745	1,690
2	11.094	500	2,934	2,927	2,855	2,779	2,728	2,676	2,625	2,573
3	10.142	1000	3,710	3,702	3,636	3,562	3,513	3,464	3,415	3,366
4	9.353	1500	4,435	4,428	4,363	4,292	4,245	4,197	4,150	4,103
5	8.634	2000	5,152	5,145	5,083	5,014	4,968	4,921	4,875	4,829
6	8.006	2500	5,819	5,813	5,752	5,684	5,639	5,594	5,549	5,504
7	7.377	3000	6,524	6,517	6,458	6,392	6,347	6,303	6,259	6,215
8	6.758	3500	7,251	7,244	7,185	7,120	7,077	7,034	6,990	6,947
9	6.152	4000	7,992	7,986	7,928	7,864	7,821	7,779	7,736	7,693
10	5.565	4500	8,737	8,731	8,674	8,611	8,569	8,527	8,485	8,442
11	5.008	5000	9,469	9,463	9,407	9,344	9,303	9,261	9,219	9,178
12	4.493	5500	10,168	10,162	10,106	10,044	10,003	9,962	9,920	9,879
13	4.021	6000	10,830	10,824	10,768	10,707	10,666	10,625	10,584	10,543
14	3.597	6500	11,445	11,439	11,384	11,323	11,282	11,241	11,201	11,160
15	3.219	7000	12,014	12,008	11,953	11,892	11,852	11,811	11,771	11,730
16	2.883	7500	12,540	12,534	12,479	12,419	12,378	12,338	12,298	12,257
17	2.587	8000	13,024	13,018	12,963	12,903	12,863	12,823	12,783	12,743
18	2.326	8500	13,471	13,465	13,411	13,351	13,311	13,271	13,231	13,191
19	2.098	9000	13,882	13,876	13,822	13,762	13,722	13,682	13,642	13,602

Table 3.6.3-21—ALL for Pressurizer Surge Nozzle at Alloy 52 Weld
Sheet 2 of 2

With Axial Load of:			0 kips	1.5 kips	15 kips	30 kips	40 kips	50 kips	60 kips	70 kips
Set No.	Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
20	1.897	9500	14,264	14,258	14,204	14,145	14,105	14,065	14,025	13,985
21	1.719	10000	14,622	14,616	14,562	14,503	14,463	14,423	14,383	14,344

Table 3.6.3-27—ALL for RCP Outlet Nozzle (Location 7)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
9.592	0	40,627	36,192	31,757	27,400	22,888
7.328	10,000	49,557	45,192	40,826	36,462	32,096
5.688	20,000	56,673	52,350	48,027	43,704	39,381
4.191	30,000	64,055	59,766	55,478	51,190	46,902
2.975	40,000	71,283	67,021	62,759	58,497	54,235
2.115	50,000	77,791	73,546	69,302	65,057	60,812
1.536	60,000	83,532	79,298	75,065	70,831	66,598
1.149	70,000	88,586	84,360	80,133	75,906	71,680
0.884	80,000	93,102	88,880	84,657	80,435	76,213
0.698	90,000	97,172	92,952	88,732	84,513	80,293
0.563	100,000	100,899	96,681	92,463	88,246	84,028
0.462	110,000	104,362	100,145	95,929	91,712	87,496
0.386	120,000	107,547	103,332	99,116	94,901	90,685
0.328	130,000	110,470	106,255	102,040	97,825	93,610
0.282	140,000	113,217	109,002	104,788	100,573	96,359
0.244	150,000	115,882	111,668	107,454	103,240	99,025
0.214	160,000	118,329	114,115	109,901	105,687	101,473

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Table 3.6.3-28—ALL for RV Inlet Nozzle (Location 9)

With Axial Load of:		1,000 kips	1,500 kips	2,000 kips	2,500 kips	3,000 kips
Flaw Size (in)	Min Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)	Max Moment (in-kips)
9.985	0	44,523	40,072	35,622	31,264	26,720
7.466	10,000	55,084	50,713	46,342	41,984	37,601
5.889	20,000	62,307	57,978	53,648	49,319	44,990
4.617	30,000	68,749	64,450	60,150	55,851	51,552
3.344	40,000	76,201	71,930	67,659	63,388	59,117
2.433	50,000	82,740	78,488	74,236	69,984	65,733
1.784	60,000	88,632	84,393	80,154	75,915	71,676
1.403	70,000	92,997	88,765	84,534	80,302	76,070
1.021	80,000	98,607	94,382	90,157	85,932	81,708
0.801	90,000	102,844	98,622	94,401	90,180	85,958
0.641	100,000	106,729	102,510	98,291	94,072	89,853
0.522	110,000	110,326	106,108	101,891	97,673	93,456
0.434	120,000	113,583	109,367	105,151	100,934	96,718
0.365	130,000	116,667	112,452	108,236	104,021	99,805
0.310	140,000	119,607	115,392	111,177	106,963	102,748
0.268	150,000	122,256	118,042	113,827	109,613	105,399
0.234	160,000	124,752	120,538	116,323	112,109	107,895

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Figure 3.6.3-5—Minimum Moment versus Circumferential Leakage Crack Sizes for 5 gpm at Various Main Coolant Loop Locations

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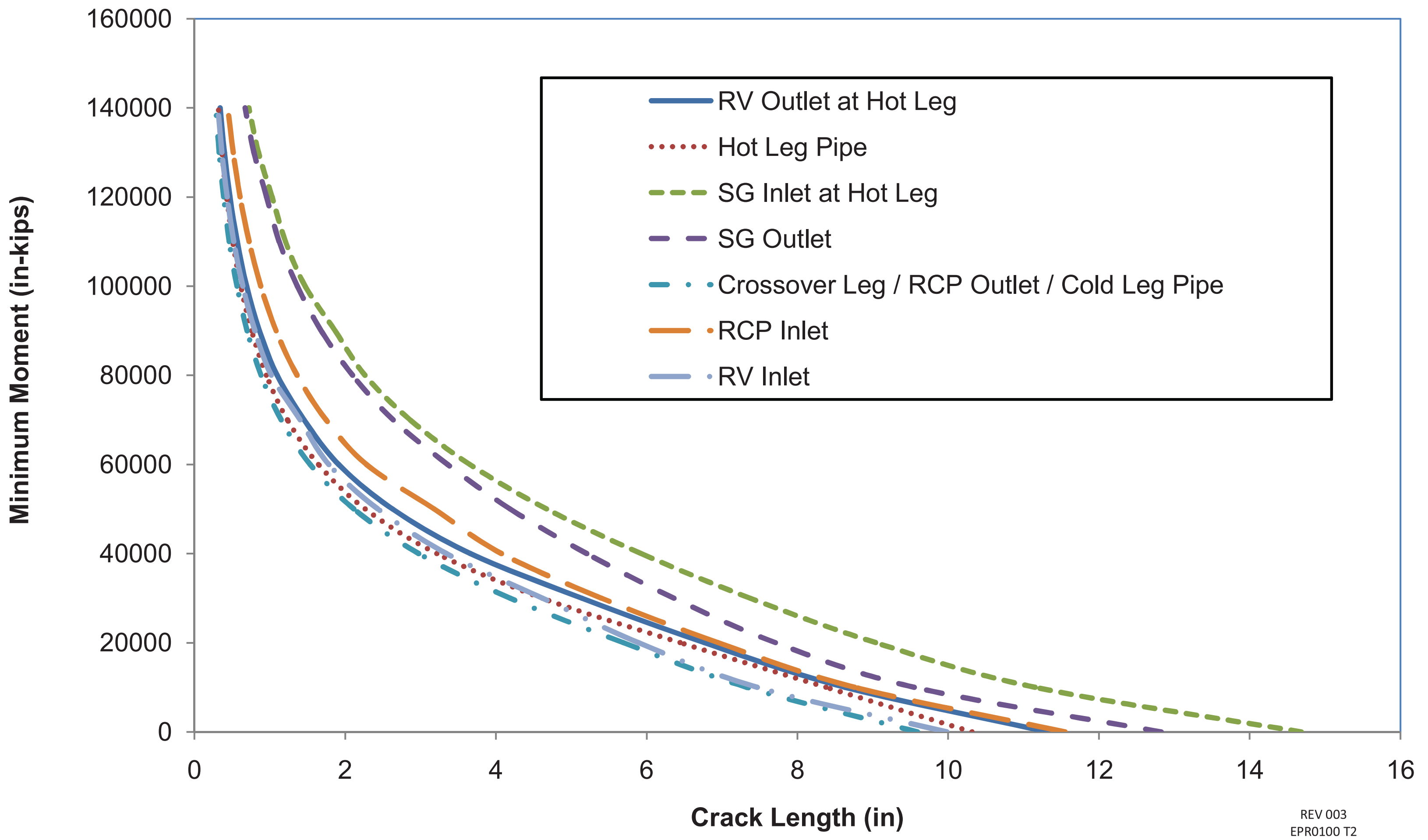

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Figure 3.6.3-7—Pressure Only Leakage Rate versus Crack Length for Both Axial and Circumferential Crack Morphologies in Main Steam Line

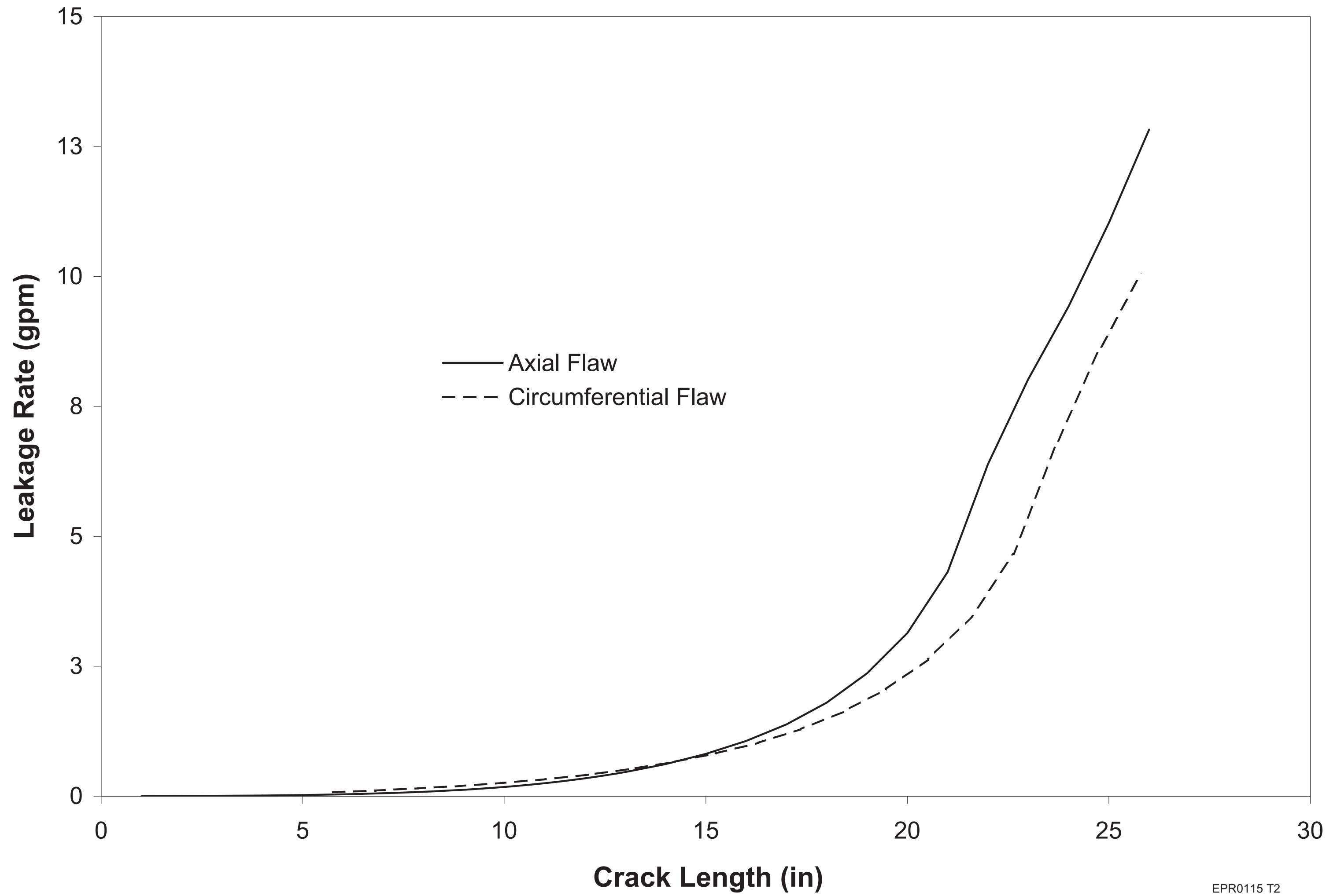

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Figure 3.6.3-8—Minimum Moment versus Circumferential Crack Leakage ~~Crack~~ Sizes for 1 gpm in Main Steam Line Piping

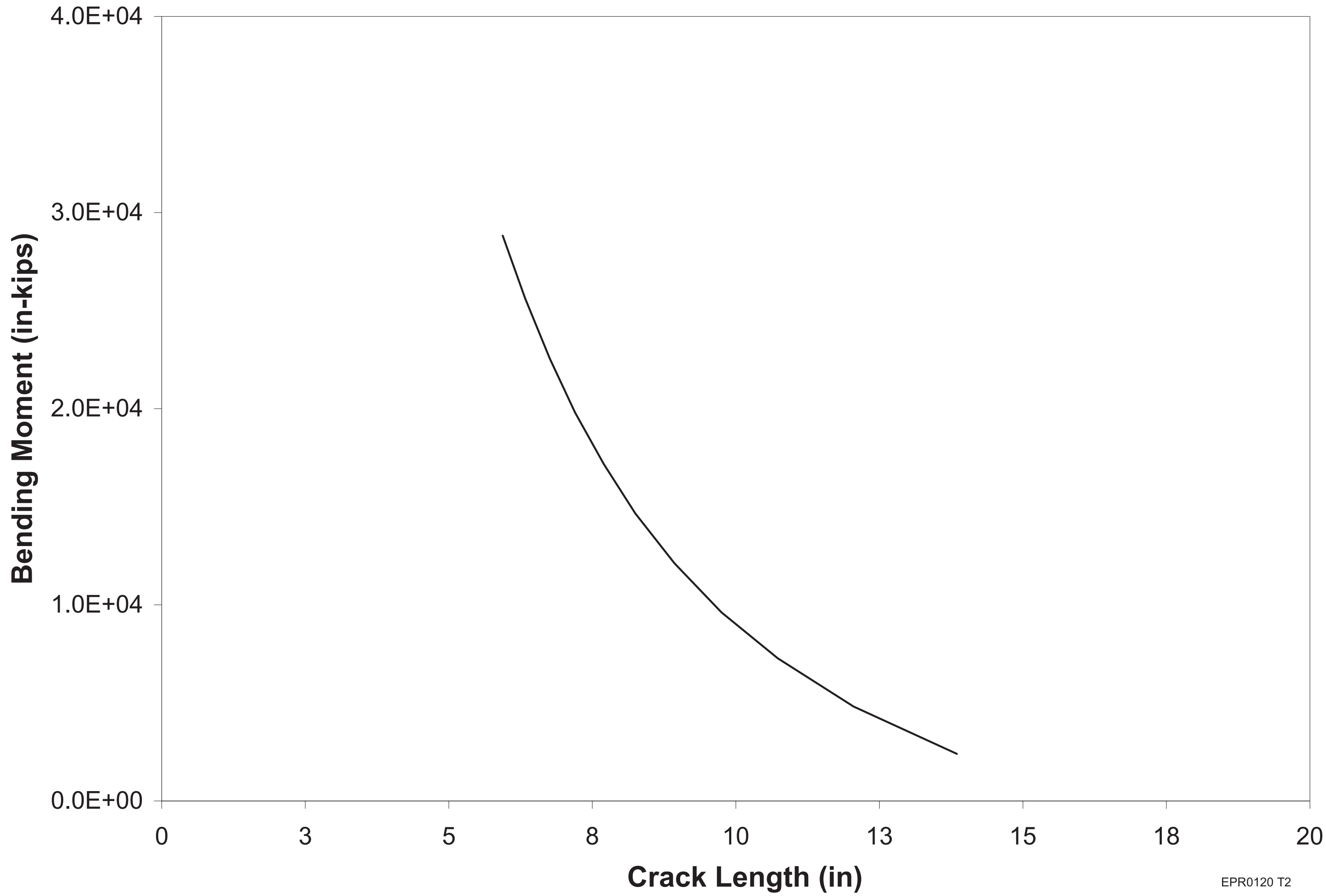

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Figure 3.6.3-12—ALL for Reactor Vessel Outlet Nozzle Region at Hot Leg (Location 1)

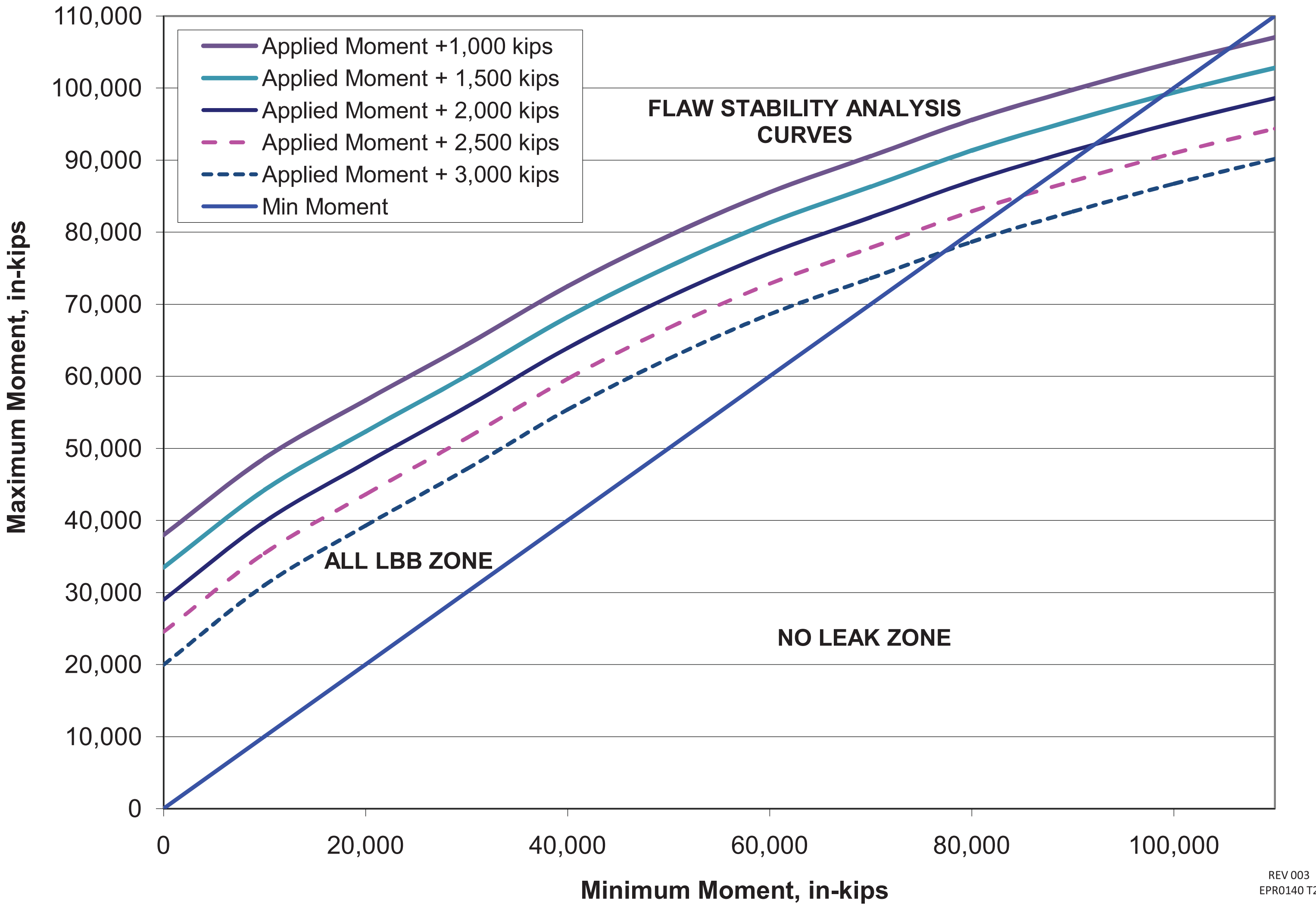

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Figure 3.6.3-13—ALL for Hot Leg Pipe (Location 2)

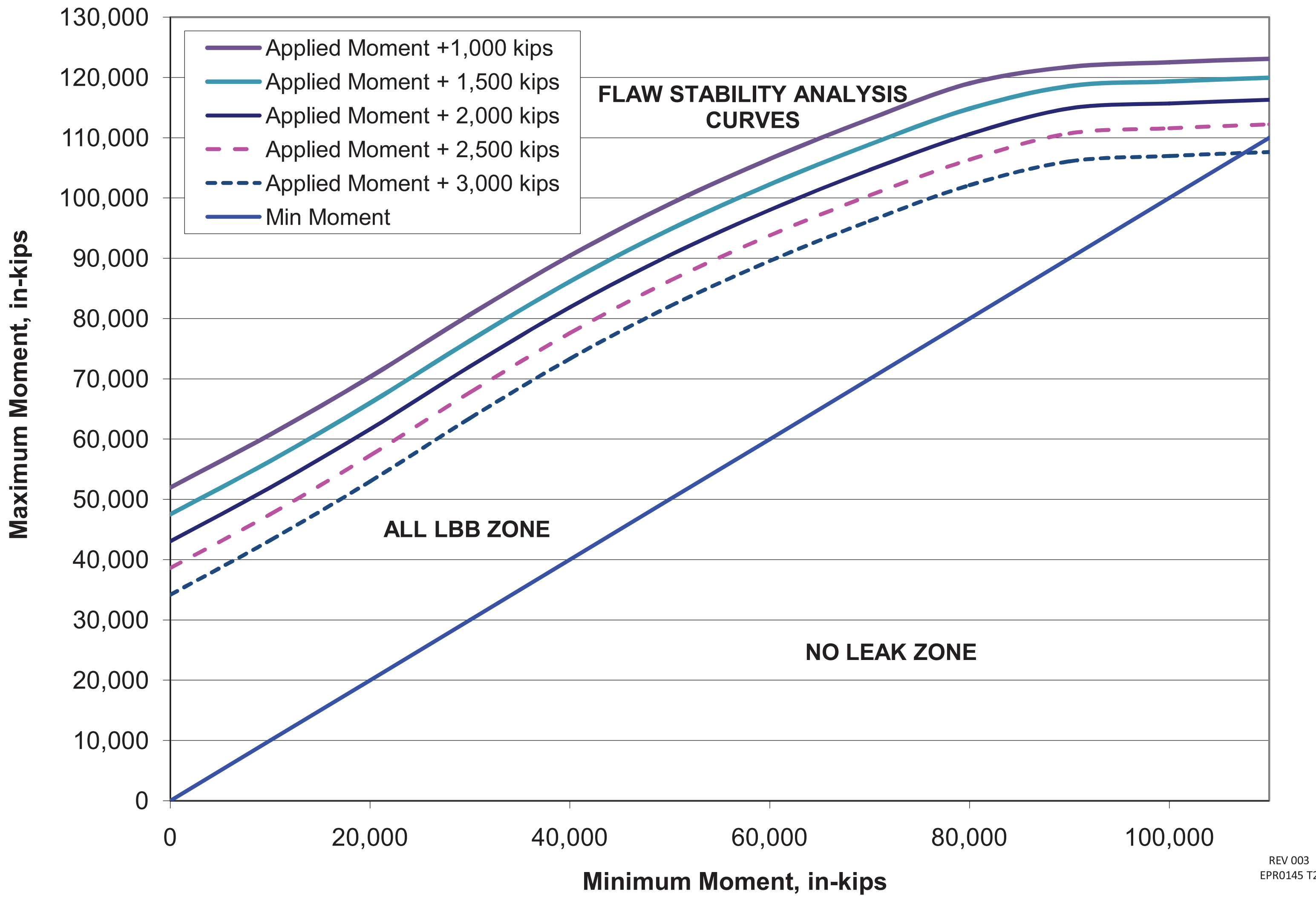

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Figure 3.6.3-14—ALL for Steam Generator Inlet Nozzle at Hot Leg (Location 3)

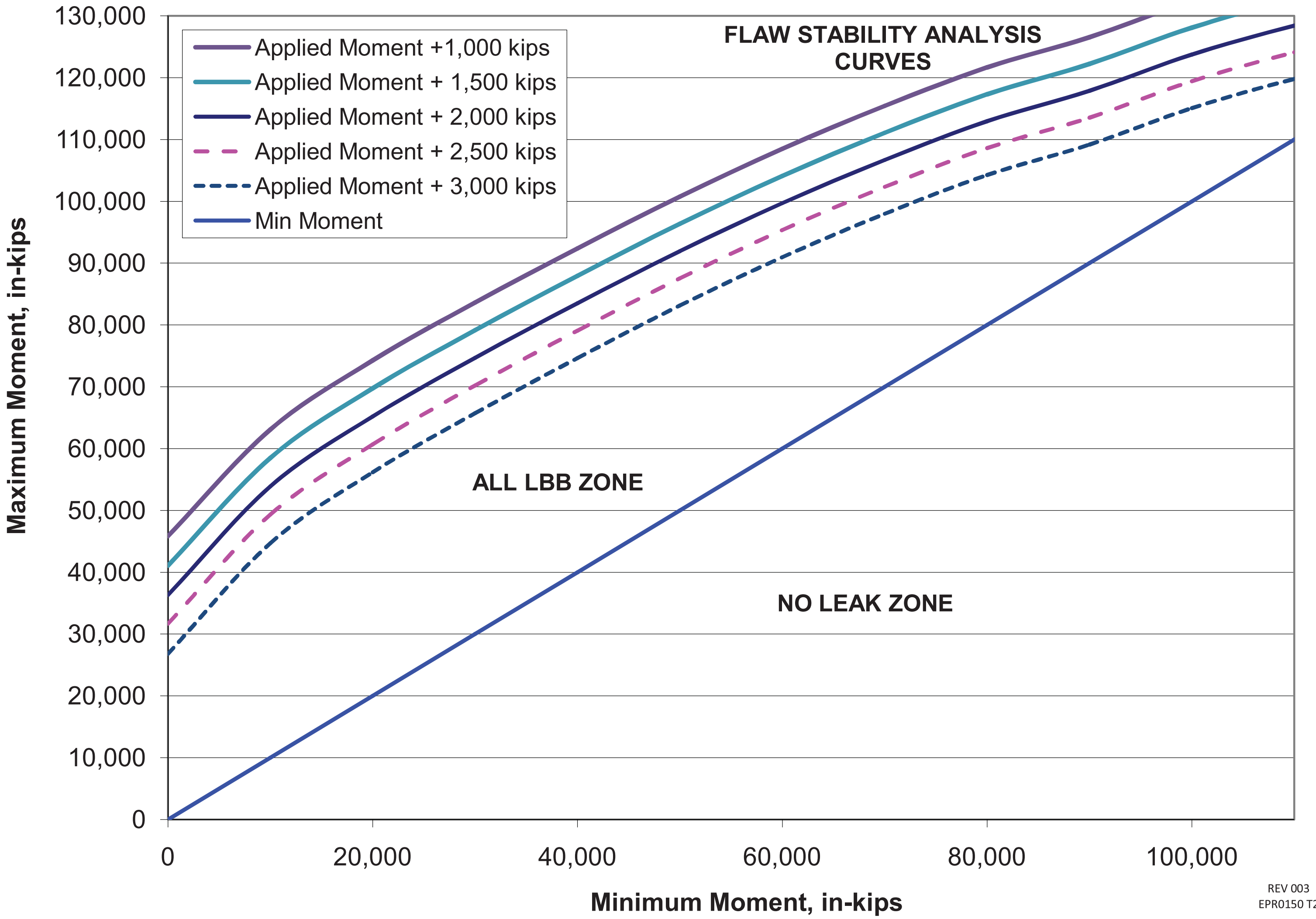

Figure 3.6.3-15—ALL for Steam Generator Outlet Nozzle (Location 4)

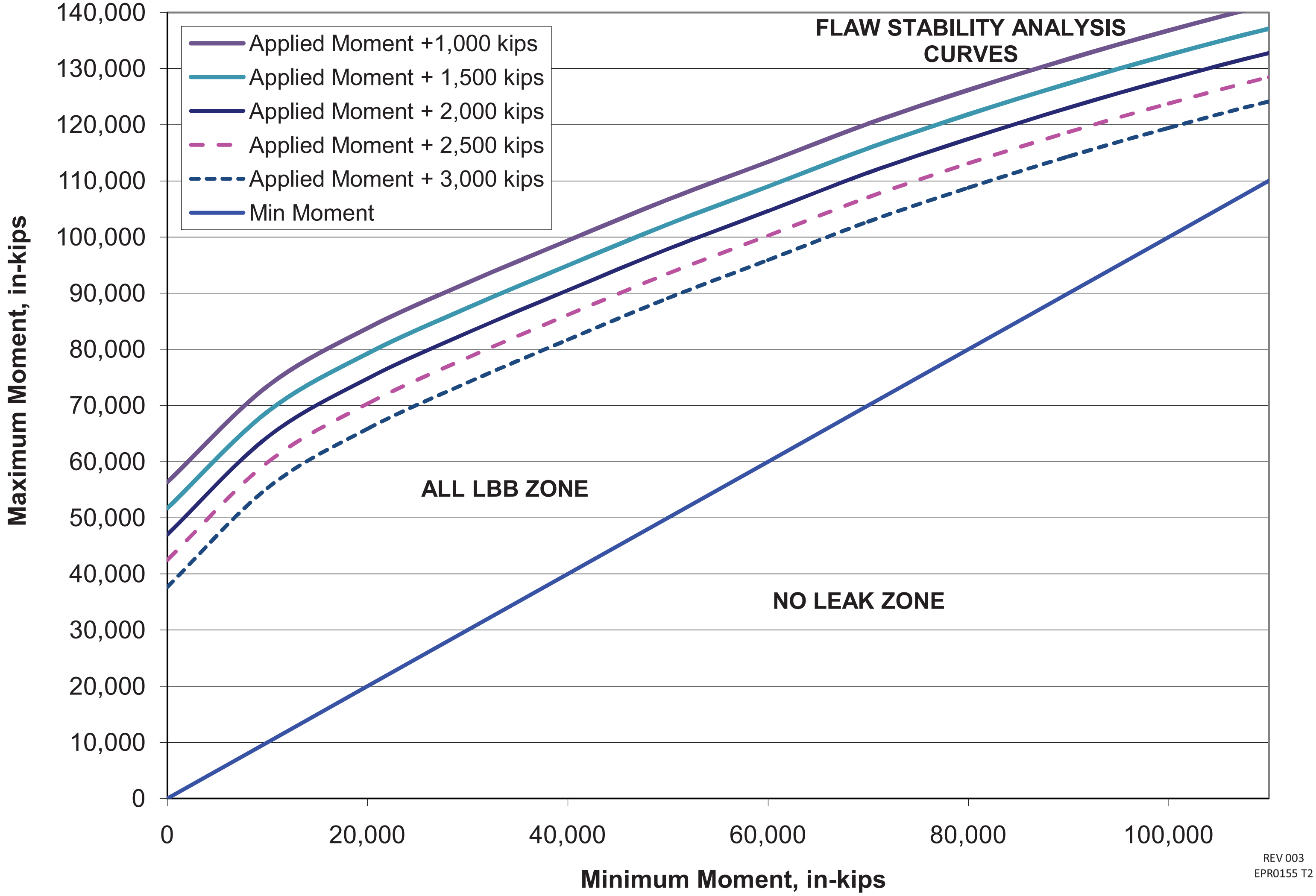

Figure 3.6.3-16—ALL for Crossover & Cold Leg Pipe (Locations 5 & 8)

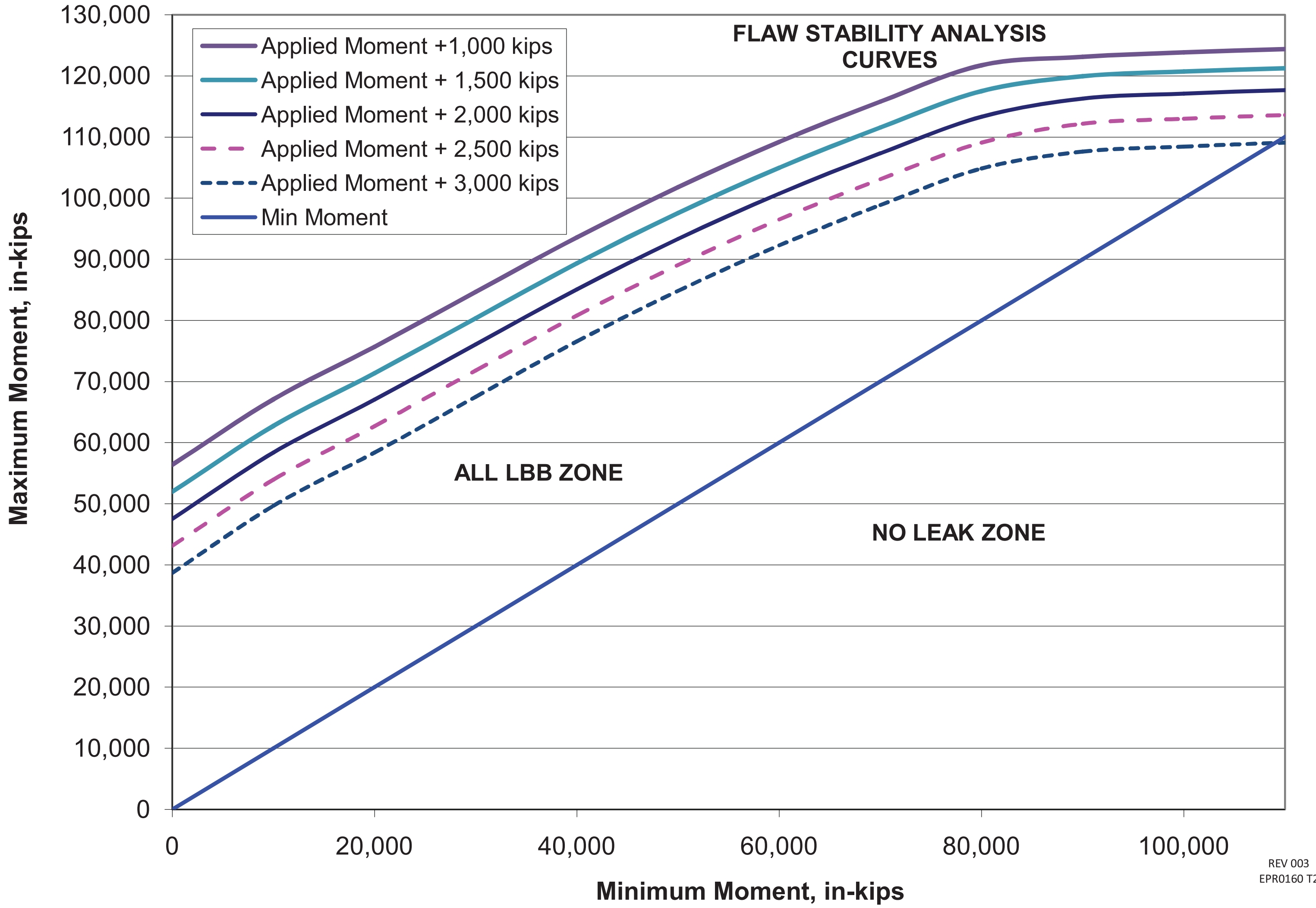

Figure 3.6.3-17—ALL for RCP Inlet Nozzle (Location 6)

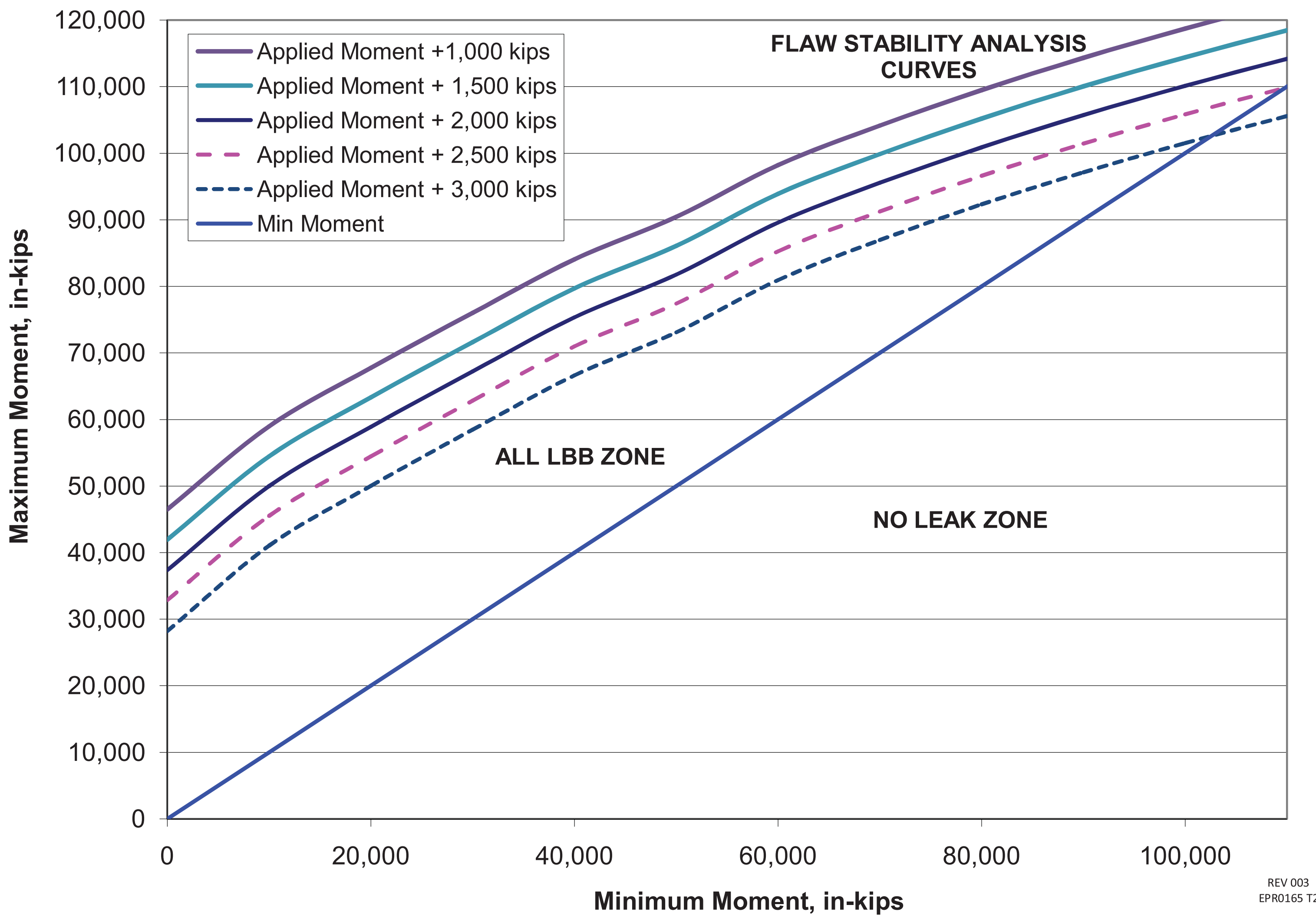

Figure 3.6.3-24—ALL for RCP Outlet Nozzle (Location 7)

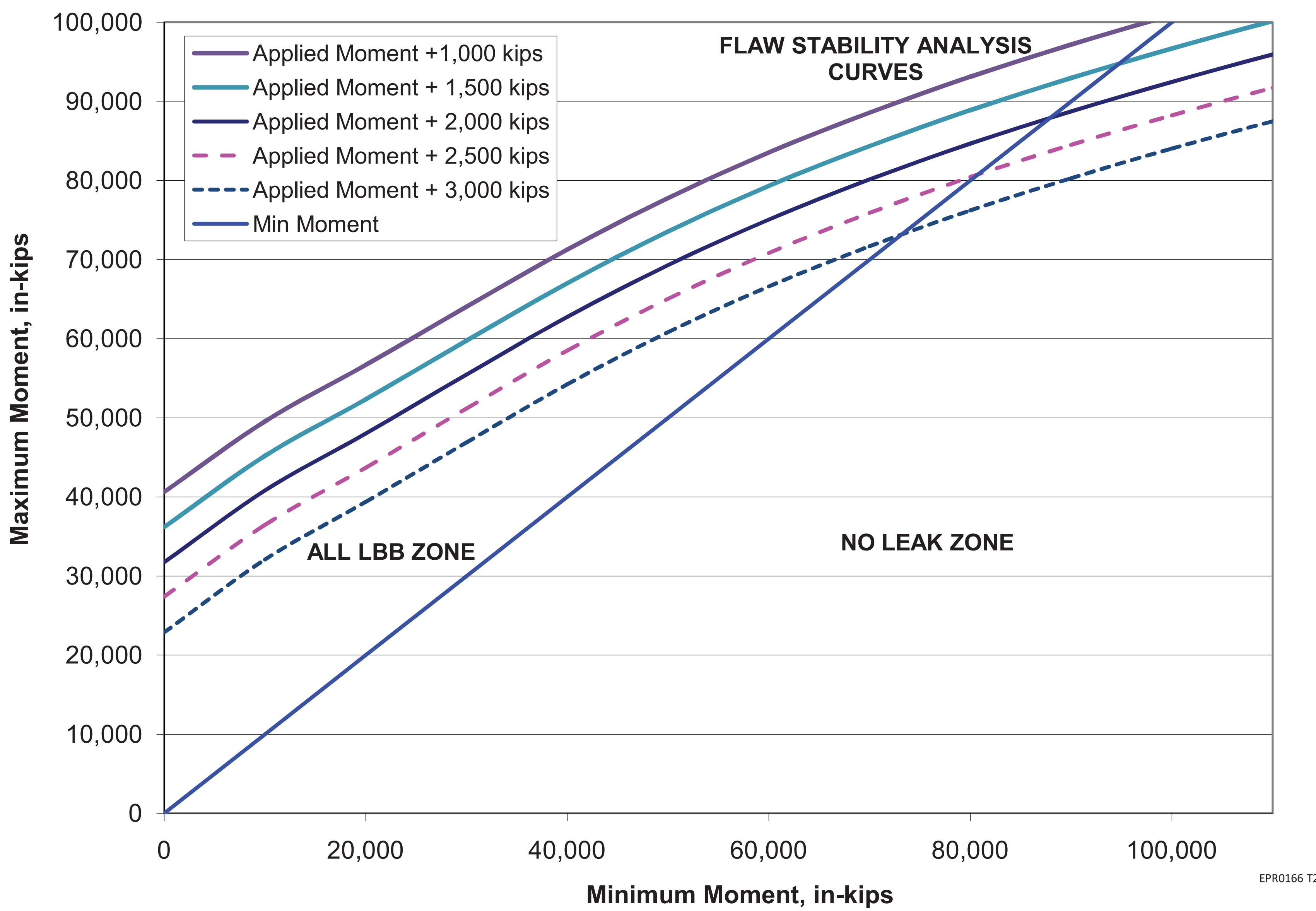

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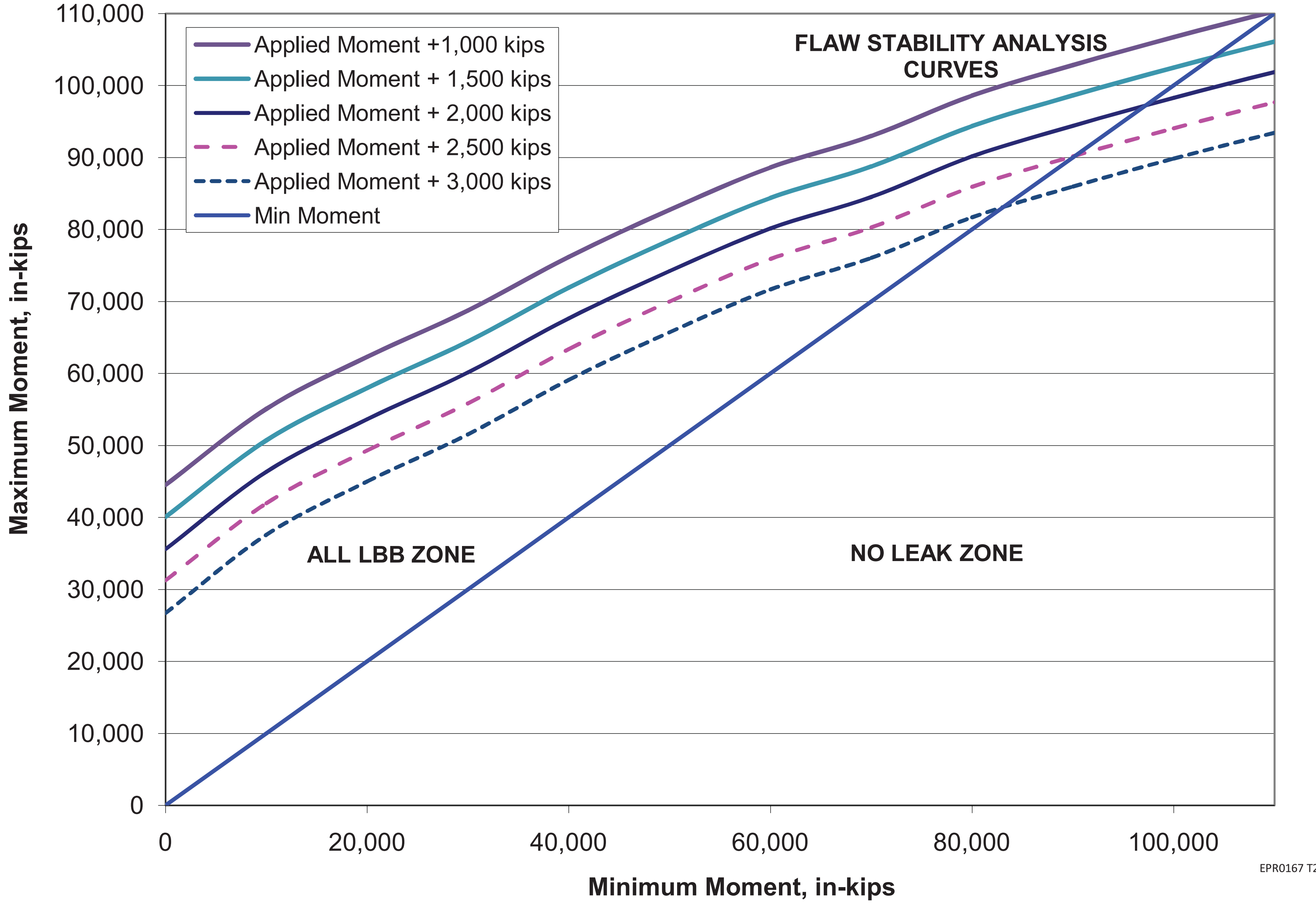
Figure 3.6.3-25—ALL for RV Inlet Nozzle (Location 9)



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