



September 11, 2009
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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Response to U.S. EPR Design Certification Application RAI No. 236, Supplement 2

Ref. 1: E-mail, Getachew Tesfaye (NRC) to Ronda Pederson, et al (AREVA NP Inc.), "U.S. EPR Design Certification Application RAI No. 236 (3292), FSAR Ch. 19," June 12, 2009.

Ref. 2: E-mail, Ronda M. Pederson (AREVA NP Inc.) to Getachew Tesfaye (NRC), et al., "Response to U.S. EPR Design Certification Application RAI No. 236, FSAR Ch 19, July 13, 2009.

Ref. 3: E-mail, Ronda M. Pederson (AREVA NP Inc.) to Getachew Tesfaye (NRC), et al., "Response to U.S. EPR Design Certification Application RAI No. 236, FSAR Ch 19, Supplement 1," September 10, 2009.

In Reference 1, the NRC provided a request for additional information (RAI) regarding the U.S. EPR Design Certification Application (i.e., RAI No. 262). In Reference 2, AREVA NP Inc. (AREVA NP) provided responses to 3 of the 5 questions of RAI No. 236. In Reference 3, AREVA NP submitted Supplement 1 to the response to address one of the remaining 5 questions. A technically correct and accurate response to the one remaining question is enclosed with this letter.

The following table indicates the respective page(s) in the enclosure that contains AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 236—19-312	2	44

This concludes the formal AREVA NP response to RAI 257, and there are no questions from this RAI for which AREVA NP has not provided responses.

AREVA NP considers some of the material contained in the enclosure to be proprietary. As required by 10 CFR 2.390(b), an affidavit is enclosed to support the withholding of the information from public disclosure. Proprietary and non-proprietary versions of the enclosure to this letter are provided.

DOTT
NRC

AREVA NP INC.
An AREVA and Siemens company

3315 Old Forest Road, P.O. Box 10935, Lynchburg, VA 24506-0935
Tel.: (434) 832-3000 - Fax: (434) 832-3840

FORM 22709VA-1 (4/1/2006)

If you have any questions related to this submittal, please contact me. I may be reached by telephone at 434-832-2369 or by e-mail at sandra.sloan@areva.com.

Sincerely,

for SMS



Sandra M. Sloan, Manager
New Plants Regulatory Affairs
AREVA NP Inc.

Enclosures

cc: G. Tesfaye
Docket 52-020

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information".

6. The following criteria are customarily applied by AREVA NP to determine whether information should be classified as proprietary:

- (a) The information reveals details of AREVA NP's research and development plans and programs or their results.
- (b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.
- (c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA NP.
- (d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA NP in product optimization or marketability.
- (e) The information is vital to a competitive advantage held by AREVA NP, would be helpful to competitors to AREVA NP, and would likely cause substantial harm to the competitive position of AREVA NP.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b) and 6(c) above.

7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside AREVA NP only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

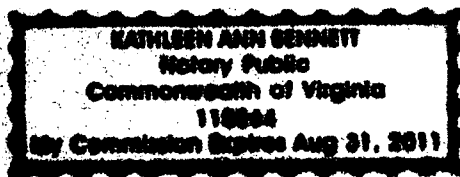
9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Jonda M Pedersen

SUBSCRIBED before me this *11th*
day of September, 2009.

Kathleen A. Bennett

Kathleen A. Bennett
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 8/31/2011



Response to

Request for Additional Information No. 236 (2589), Supplement 2, Revision 0

6/12/2009

U.S. EPR Standard Design Certification

AREVA NP Inc.

Docket No. 52-020

SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation

Application Section: 19

**QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 2
(ESBWR/ABWR Projects) (SPLB)**

Question 19-312:

(Follow-up to RAI 19-231)

Based on the report containing review of the available test data and results that was made available for NRC audit at the AREVA NP's Twinbrook office, please provide the following additional information for NRC review:

1. The material characteristics of the stabilized ZrO_2 with regard to radiation effect, materials interactions, phase transition, and the thermal/ mechanical shock for the Zirconia bricks planned for the U.S. EPR.
2. The expected loading conditions in the reactor pit/transfer channel relative to the ZrO_2 characteristics to show that thermal and mechanical stability can be maintained under all conceivable severe accidents.
3. The bonding maximum local temperature and thermal gradient with a melt of high temperature inside the reactor pit and the transfer channel under severe accident loading conditions (i.e., melt superheat, compositions, configurations, etc.)
4. A summary of the industrial knowledge base referenced in the report that is applicable to the Zirconia under consideration for U.S. EPR.
5. A summary of experimental data referenced in the report on interaction of metallic melts with ZrO_2 including the impact temperature, metallic melt composition with and without oxidic slag for U.S. EPR-specific Zirconia bricks.
6. Results of experimental data versus theoretical predictions referenced in the report for various severe accident loading conditions, as related to the behavior of ZrO_2 under U.S. EPR-specific conditions with regards to thermo-chemical stability, expected response under high radiation and high temperature conditions (e.g., thermal, mechanical, thermal shock).

Response to Question 19-312:



Response to Question 19-312 (Part 1):



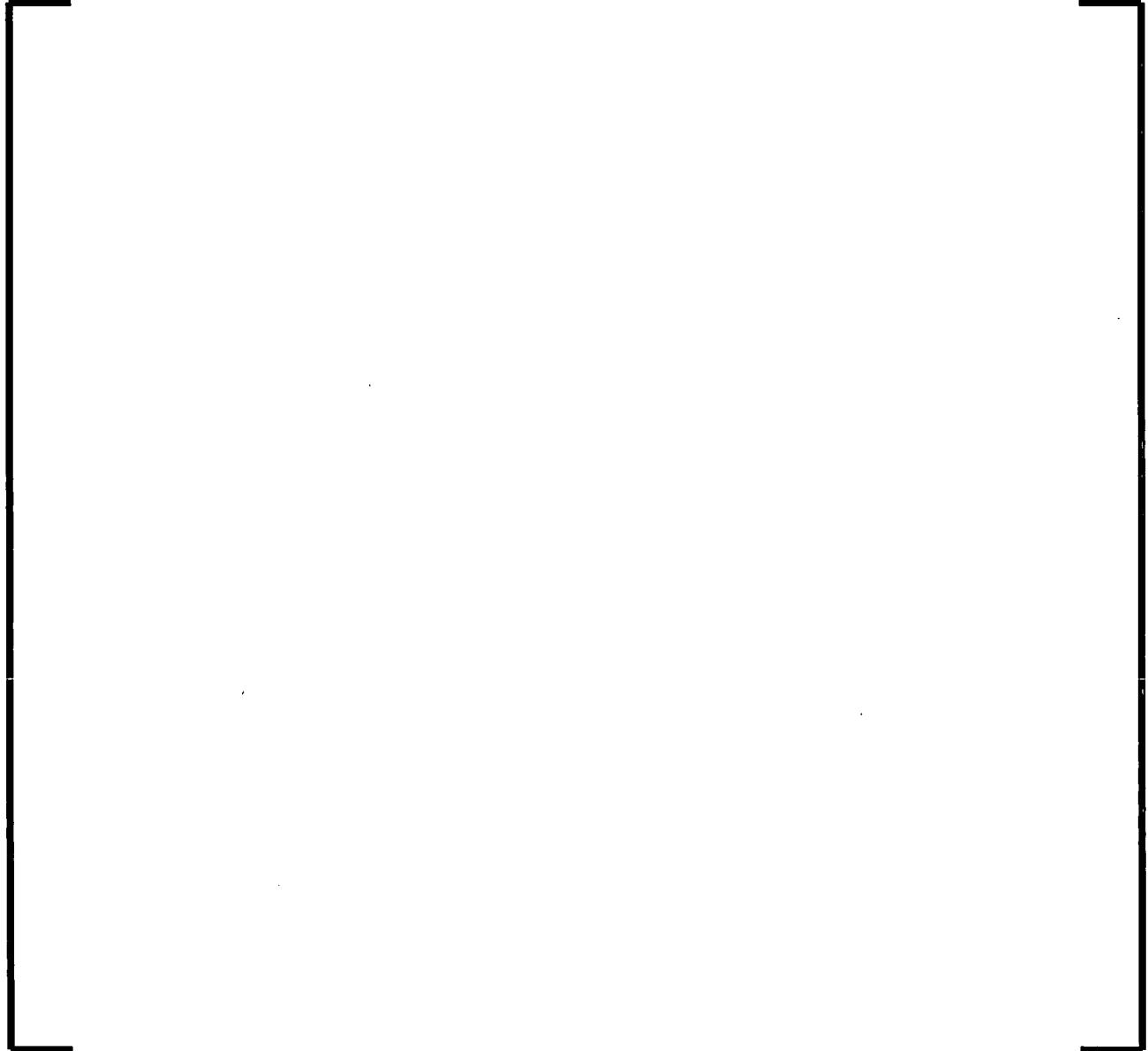


Figure 19-312(Part 1)-1 Swelling of Stabilized ZrO₂ after Irradiation



Response to Question 19-312 (Part 2):





Response to Question 19-312 (Part 3):



**Figure 19-312(Part 3)-1—Evolution of Temperature Profiles inside Zirconia
and Concrete (retention time in pit ~3 Hours)**



Response to Question 19-312(Part 4):





Table 19-312(Part 4)-1—Coarse and Fine Ceramic Main Physical Properties



Figure 19-312(Part 4)-1—Photographic Representation of the Cross-section of a Metering Nozzle after Service (1, Zirconia Nozzle; 2, Alumina Castable; 3, Steel Casing)

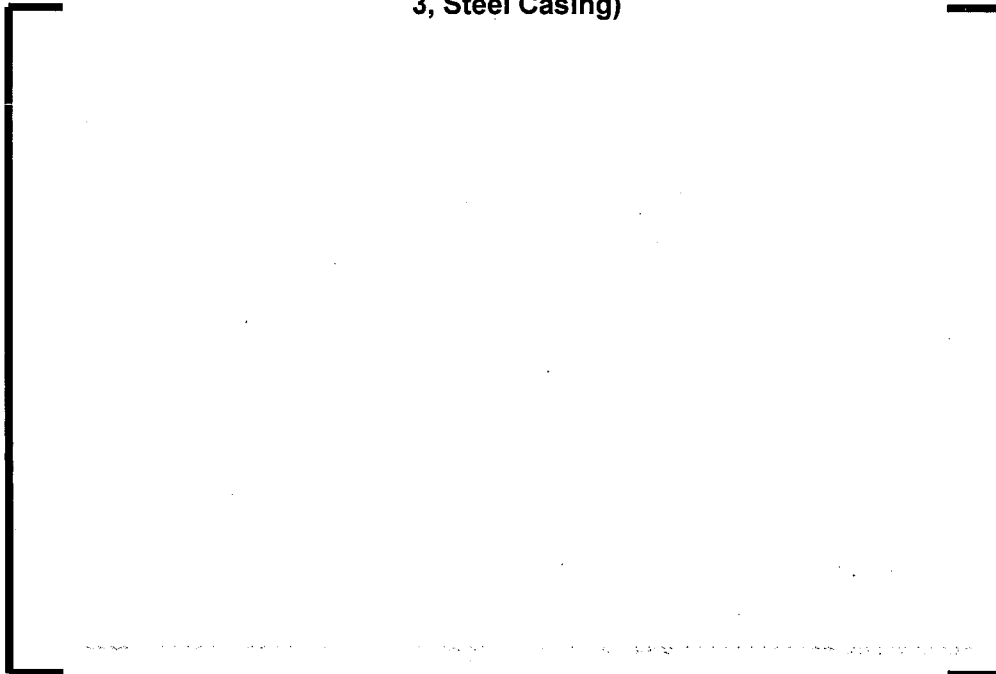


Figure 19-312(Part 4)-2—Contour Plots of Modeled Velocities in an Impact Pot

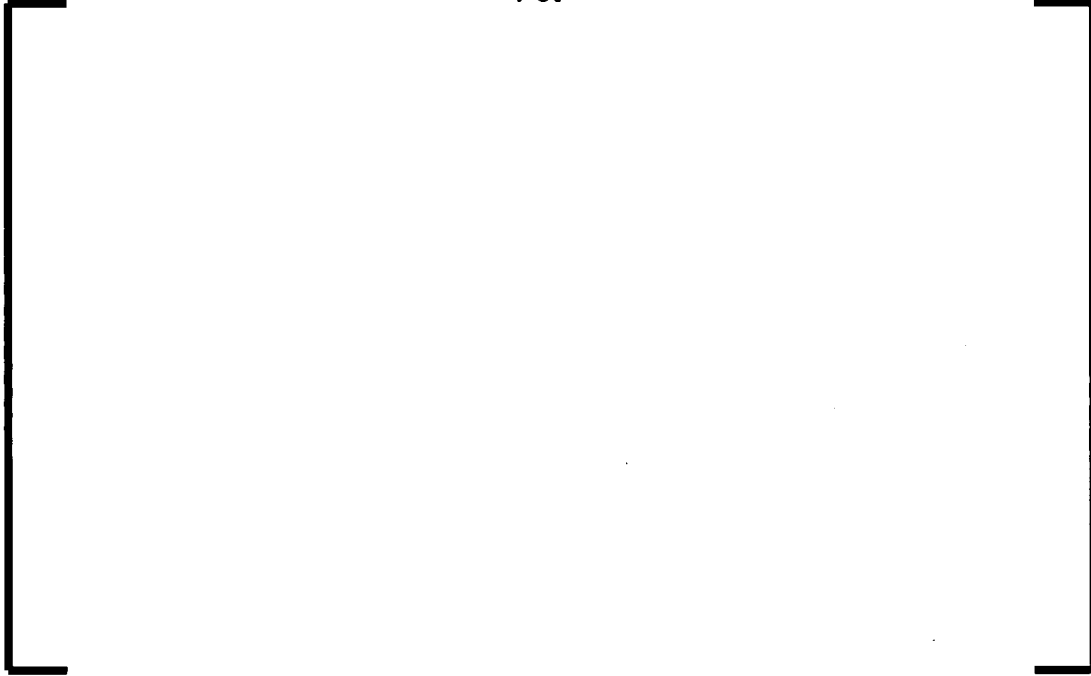


Figure 19-312(Part 4)-3—Impact pot for steel industry (as delivered)

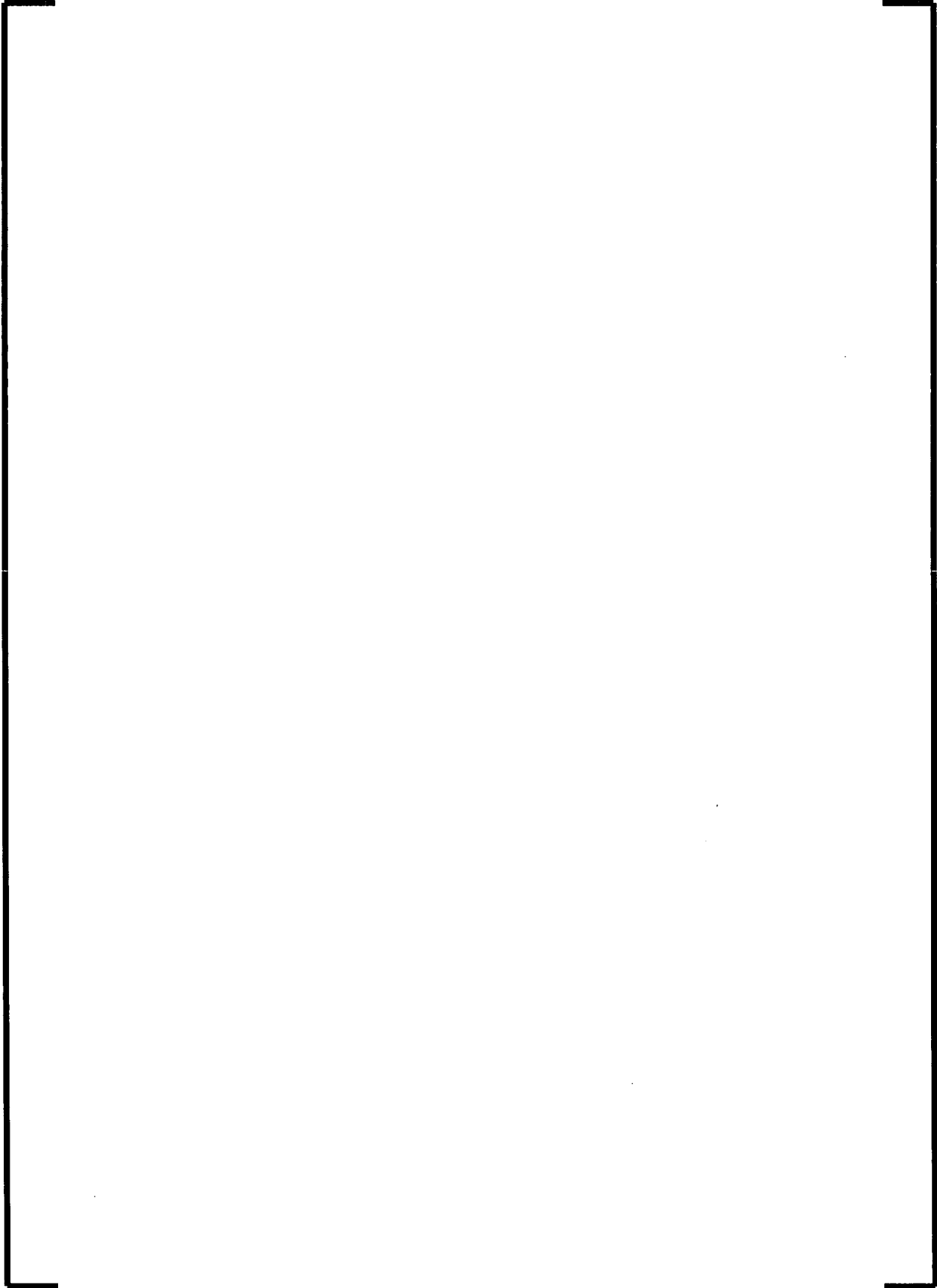


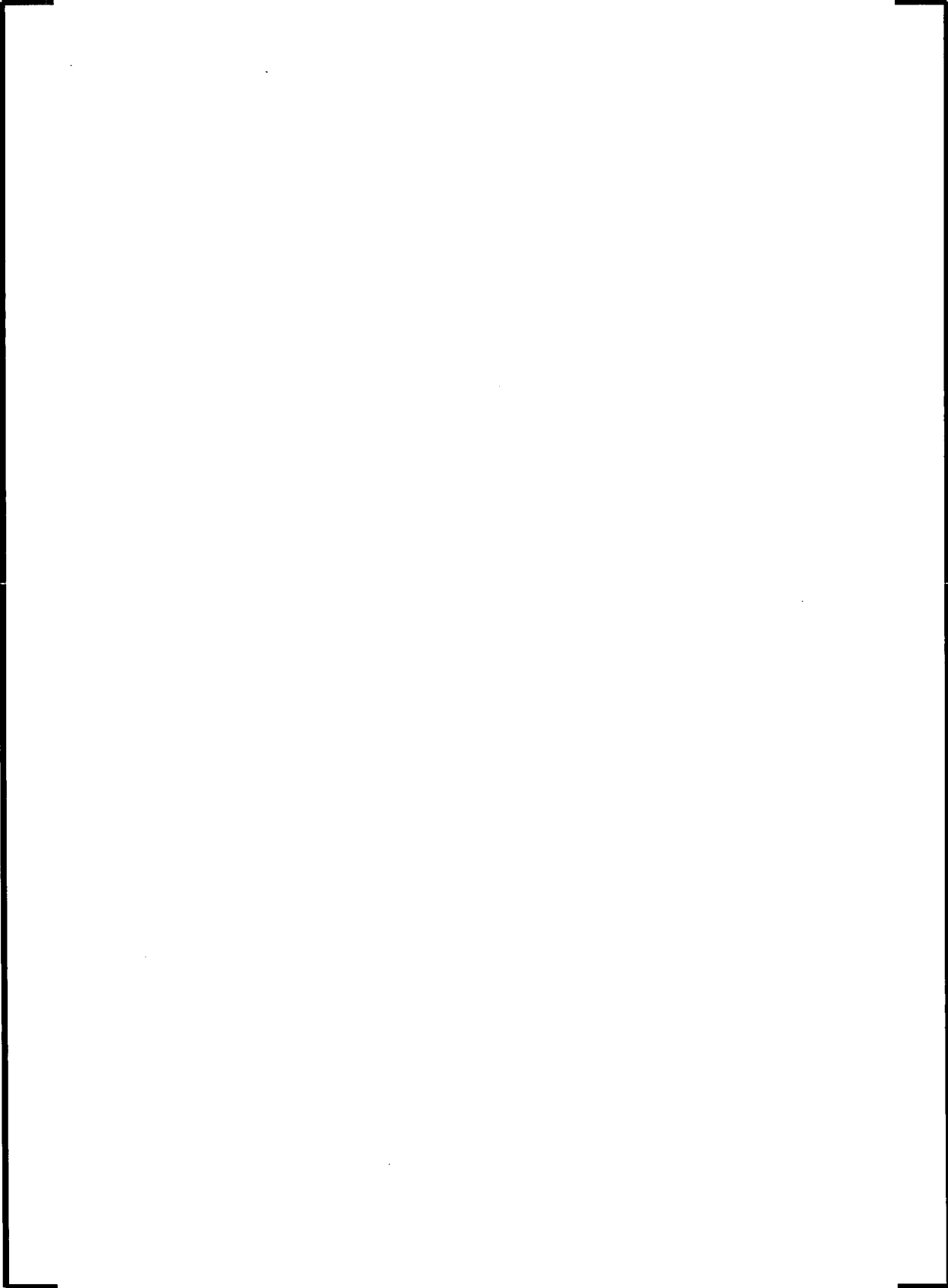
Figure 19-312(Part 4)-4—Impact Pot after 24 Hours in Service

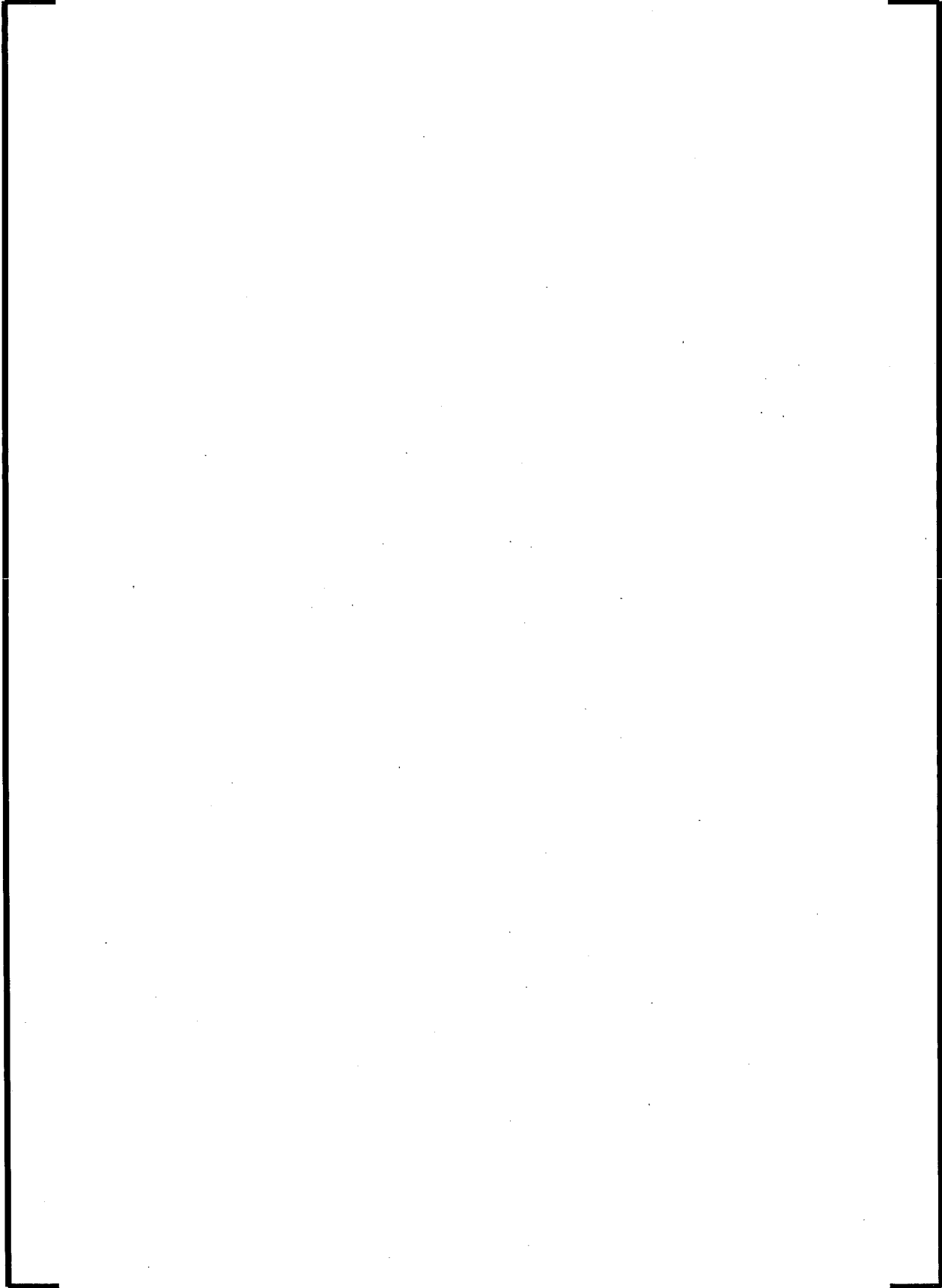


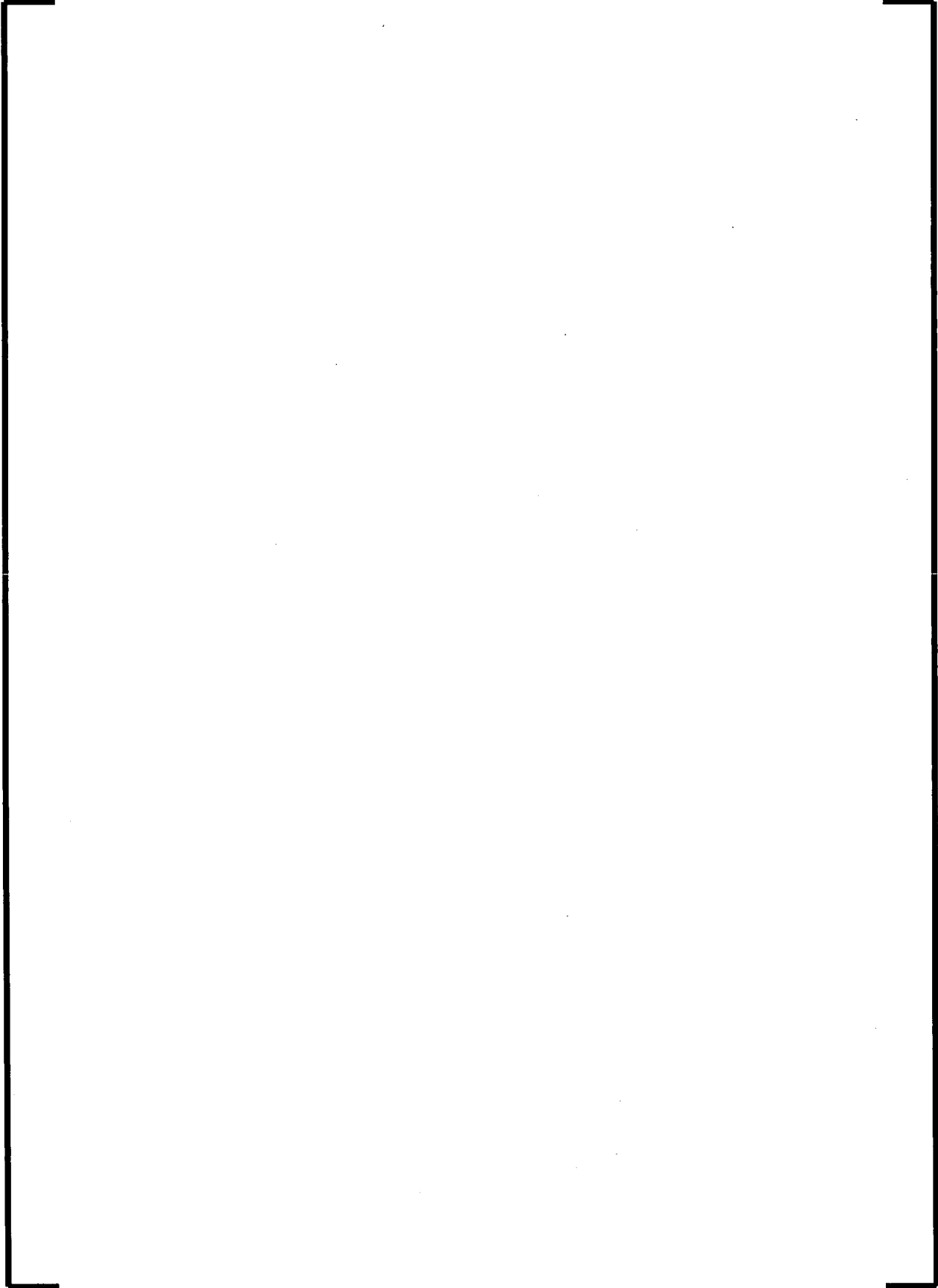
Response to Question 19-312(Part 5):

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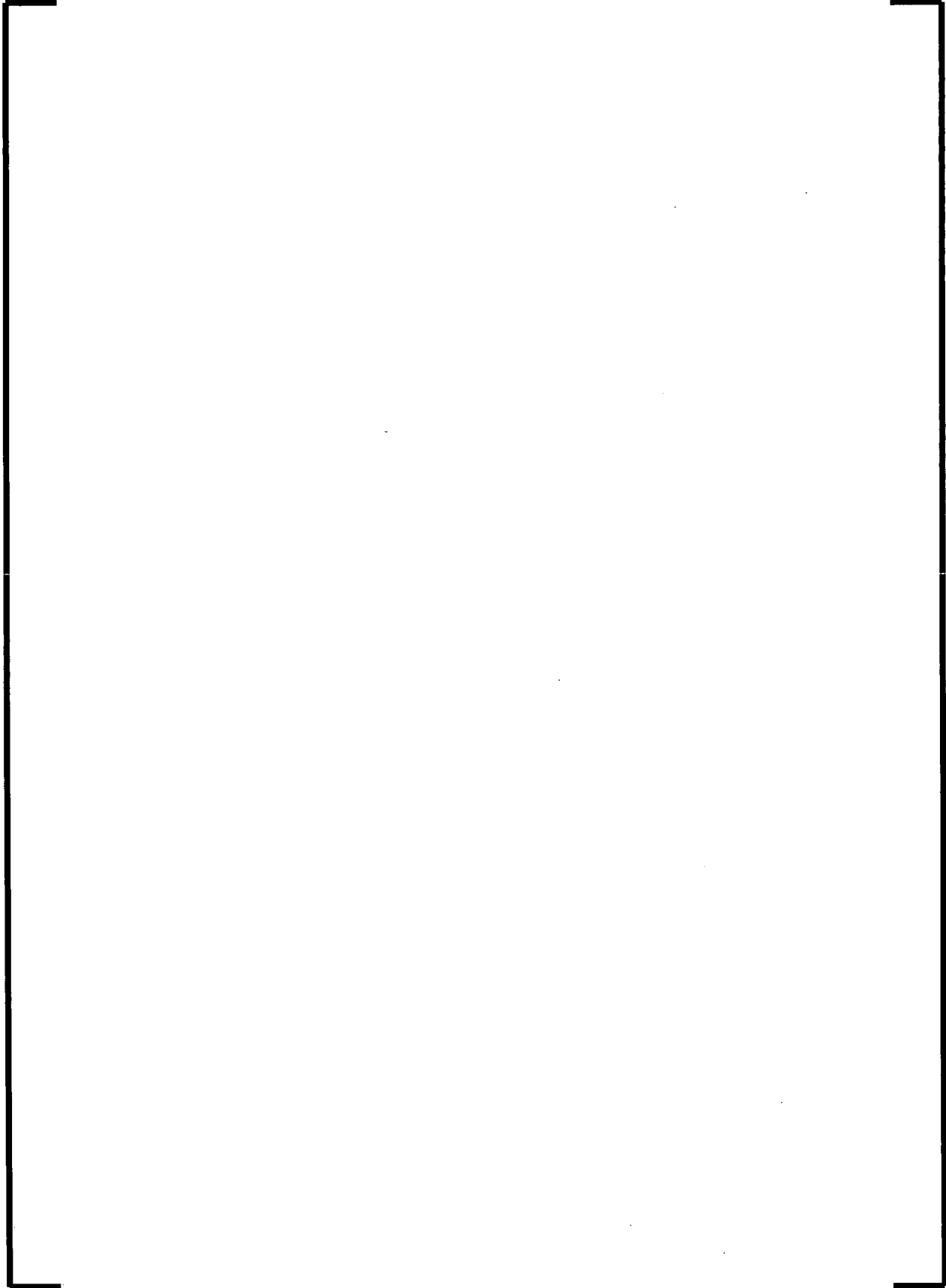




Table 19-312(Part 5)-1—Test Matrix – Stability of ZrO₂ Protective Material against Oxide Melts under MCCI Conditions

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Table 19-312(Part 5)-2 Results of Tests on the Stability of ZrO₂-Protective Material against Oxidic Melts under MCCI Conditions

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Figure 19-312(Part 5)-1—Cross-section of Zirconia Crucible (MgO-stabilized, sintered ceramic) after Interaction with Steel Melt (88 wt% Fe, 5 wt% Cr, 7 wt% Ni) for 6 Hours at 2200°C

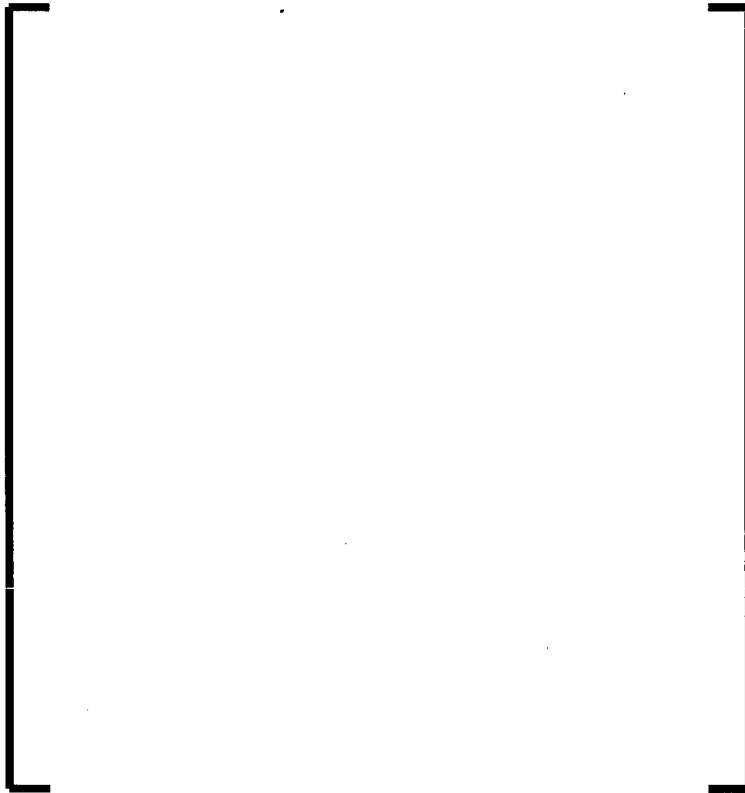


Figure 19-312(Part 5)-2—Experimental Set-up for Thermal-up Shock Test

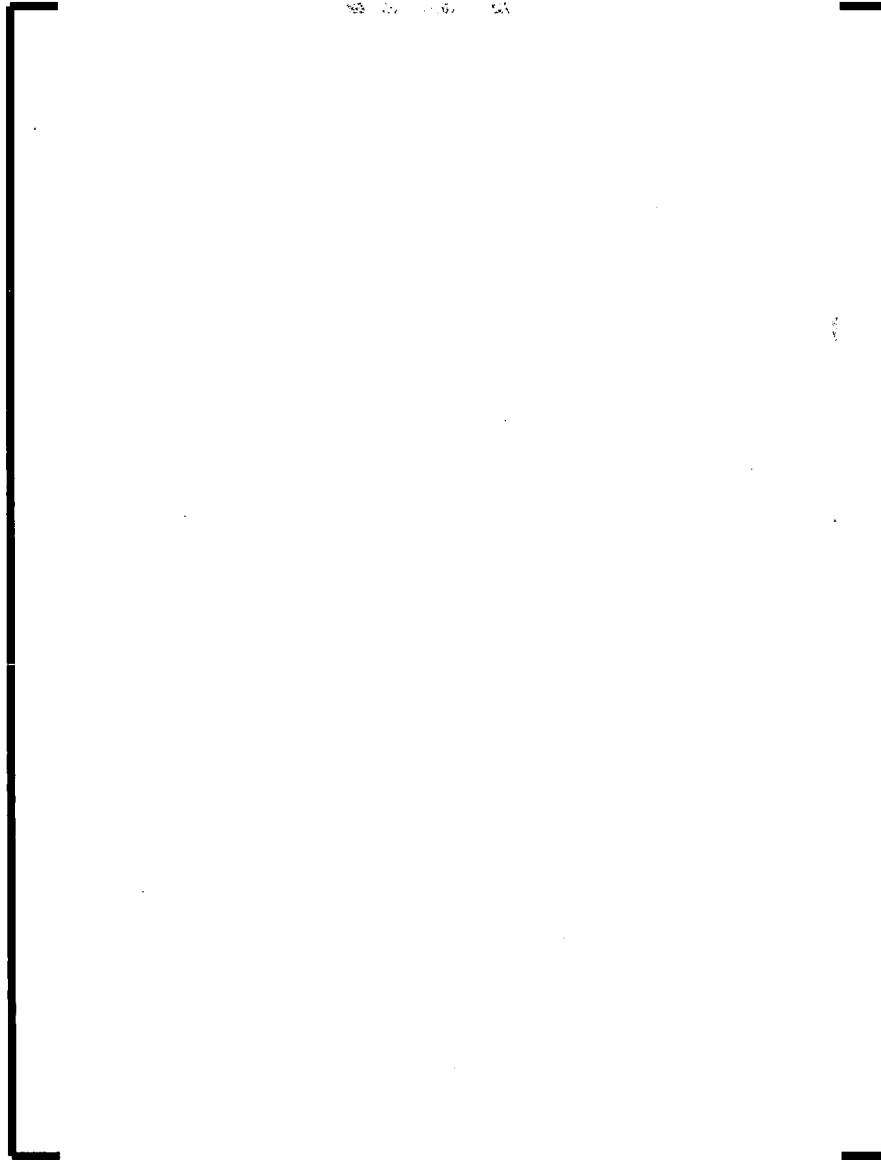


Figure 19-312(Part 5)-3—A surface View of the 3x3 Zettral 95GR Brick Arrangement after Thermal-up Shock Test (melt side)



**Figure 19-312(Part 5)-4—Surface State of the Zettral 95GR Zirconia Brick
No. 5 after Thermal-up Shock**



**Figure 19-312(Part 5)-5 Side Wall (south side; height 100mm, width 76mm)
of Zettral 95GR Zirconia Brick No. 5 after Thermal-up Shock**

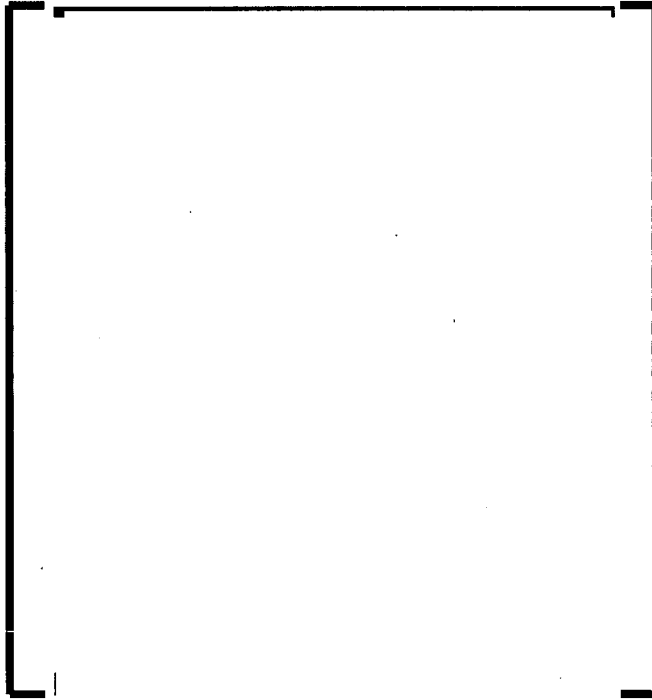
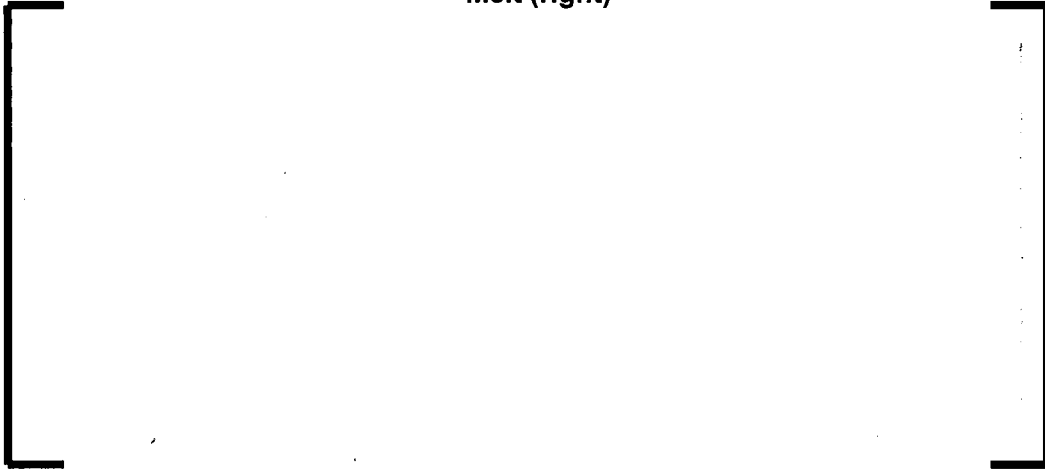
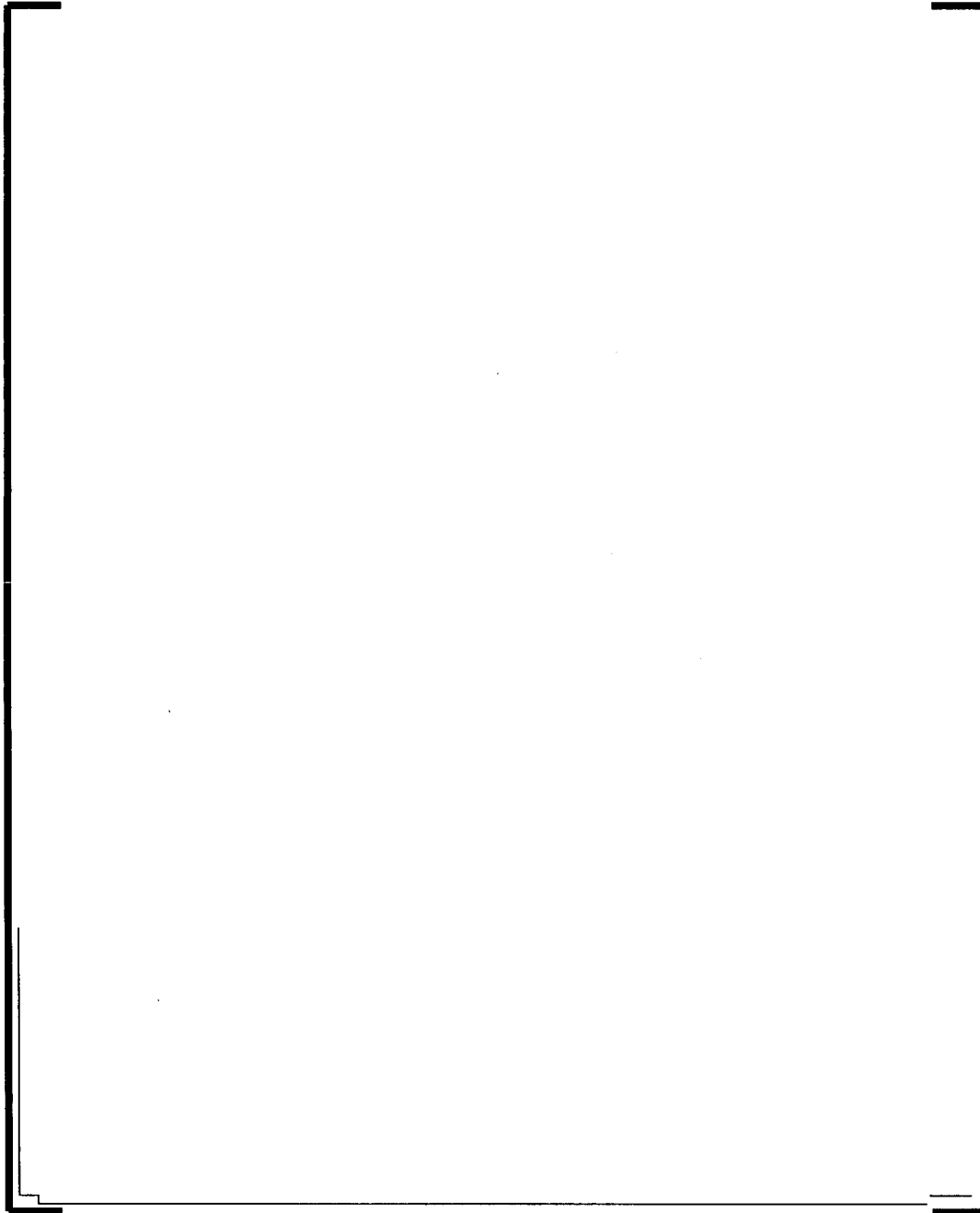


Figure 19-312(Part 5)-6—Test No. 1 (A12) - Arrangement for ZrO₂ under MCCI Conditions (left) and Cross-section of ZrO₂ after Test with Solidified Melt (right)



**Figure 19-312(Part 5)-7—Test No. 1 (A12) - Scanning Electron Micrograph of
the Contact Zone Melt/Zirconia**



**Figure 19-312(Part 5)-8—Test No. 2 (A16) – Cross-section of Concrete with Zirconia Samples in Solidified Melt (left: Z95GR, right: composition #3004).
Small picture: orthogonal 90 degree cut**



Figure 19-312(Part 5)-9—Test No. 3 (A17) – Cross-section of Concrete with Zirconia Samples in Solidified Melt (left: Z95GR/RHI, right: composition #3004/ZIRCOA)

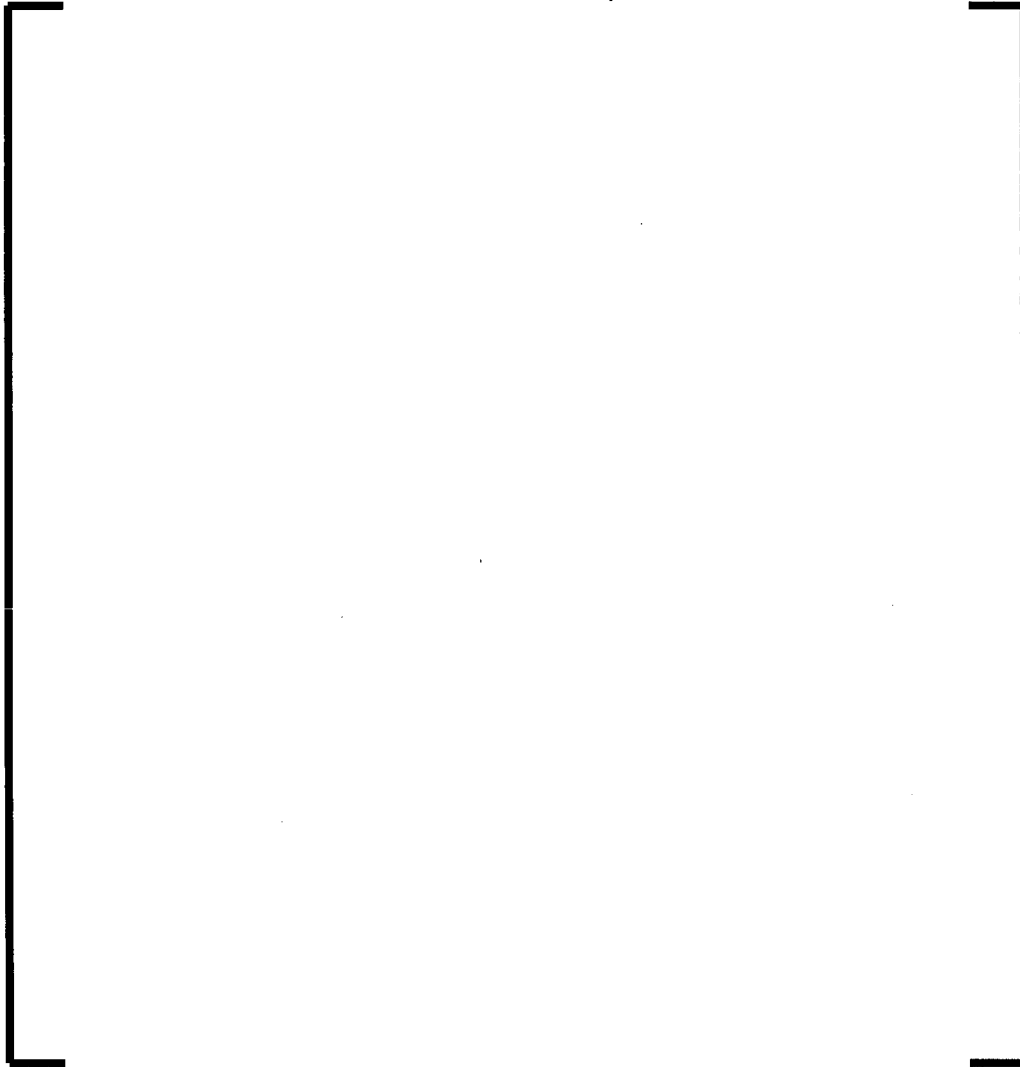


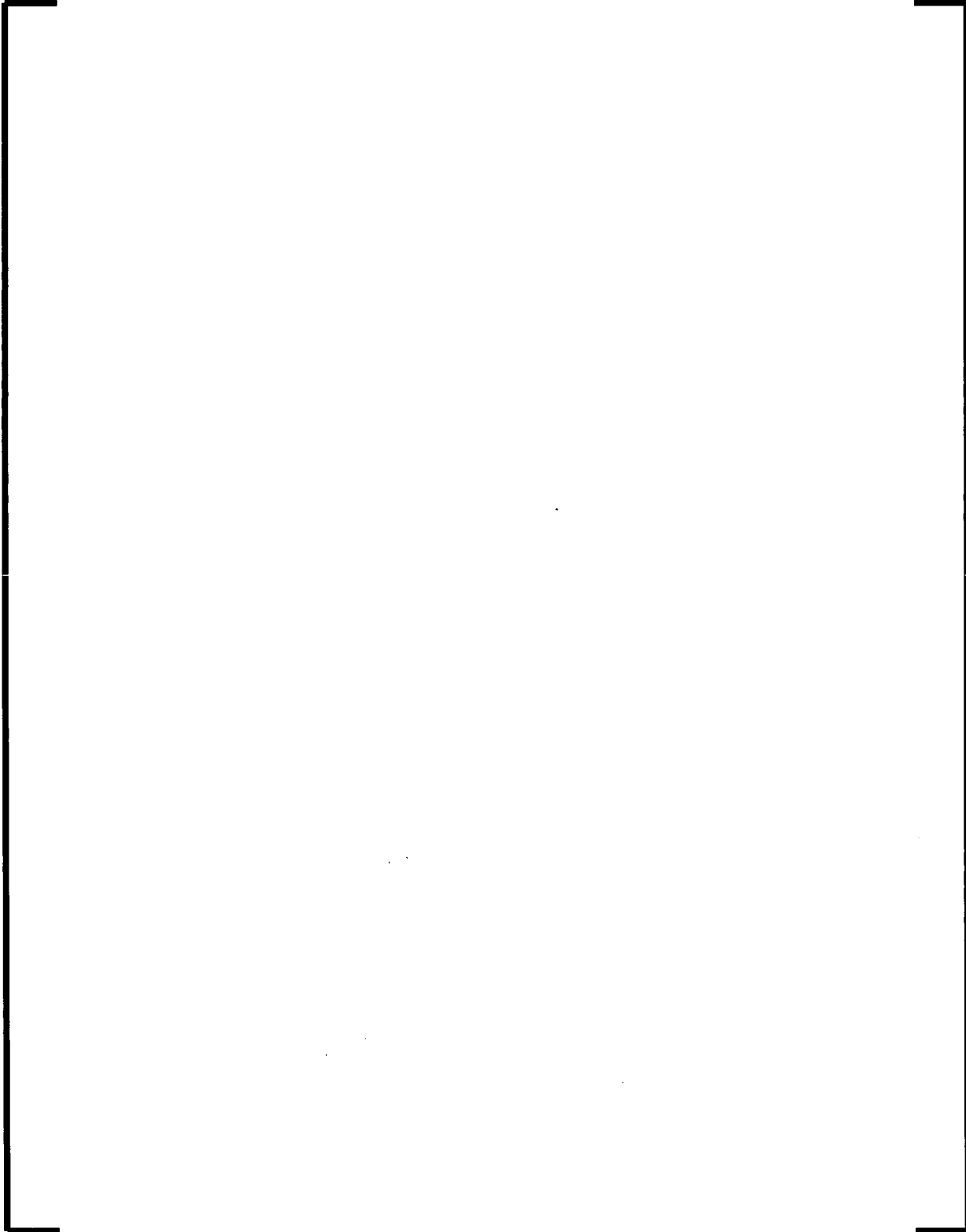
Figure 19-312(Part 5)-10—Test No. 4 (A18) – Cross-section of Concrete with Zirconia Samples #3004/ZIRCOA (left) and Z95GR/RHI (right) in Solidified Melt

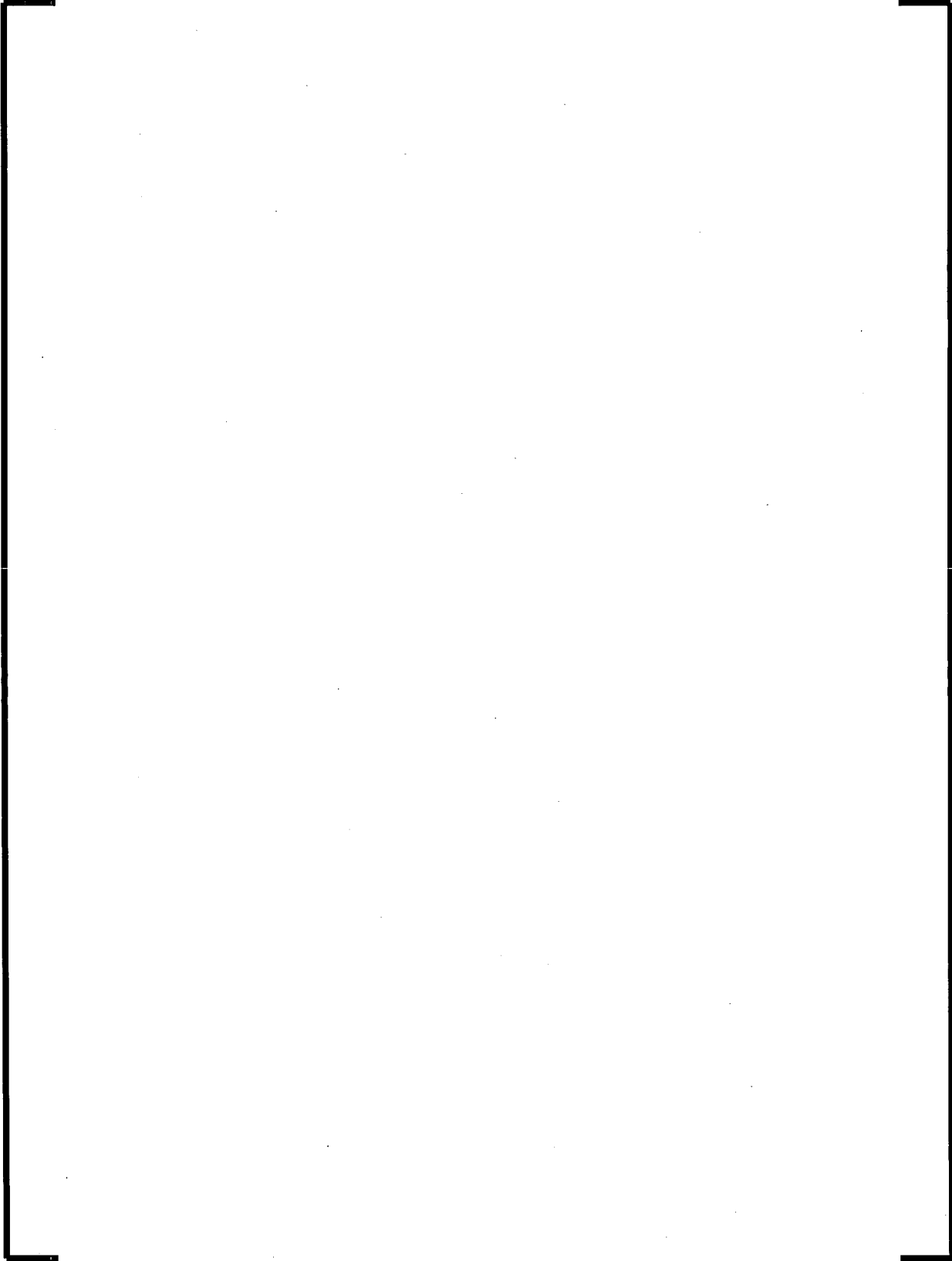


Response to Question 19-312(Part 6):

AREVA NP has assessed the behavior of zirconia bricks under U.S. EPR specific conditions:









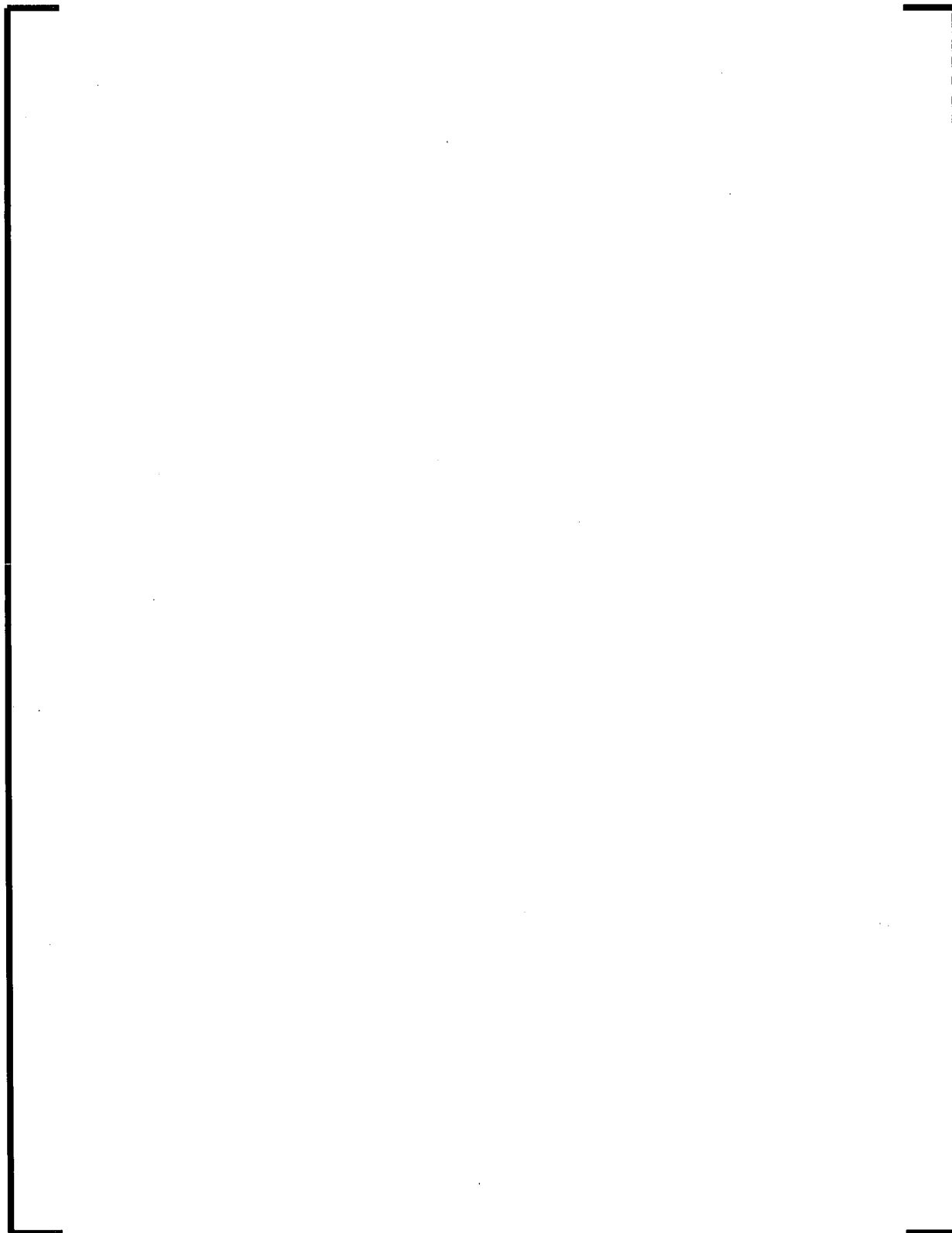
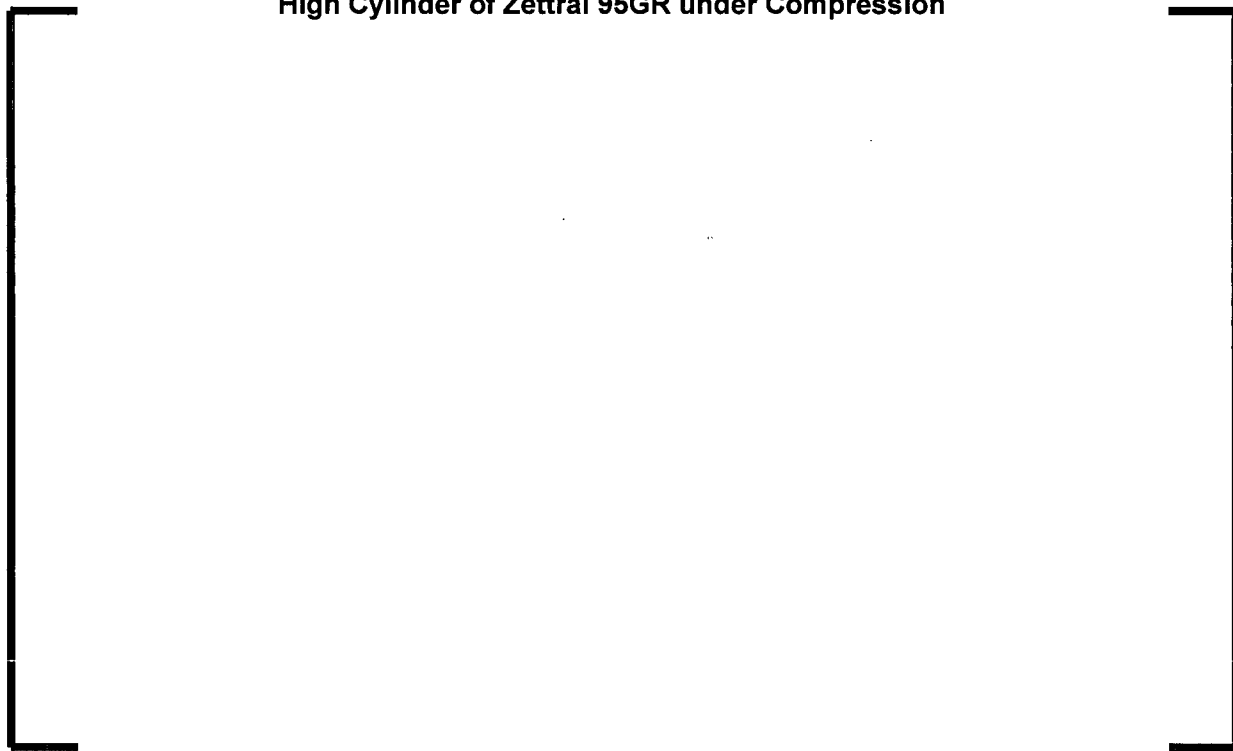




Figure 19-312(Part 6)-1—Stress-Deformation Diagram of a 50 Millimeter High Cylinder of Zettral 95GR under Compression



**Figure 19-312(Part 6)-2—Stress Displacement Curves of the Wedge
Splitting test of Zettral 95GR at Different Temperatures**



Figure 19-312(Part 6)-3—Zones of Expected Mechanical Properties



Figure 19-312(Part 6)-4—Normalized Stresses During Time in a Linear Elastic Calculation

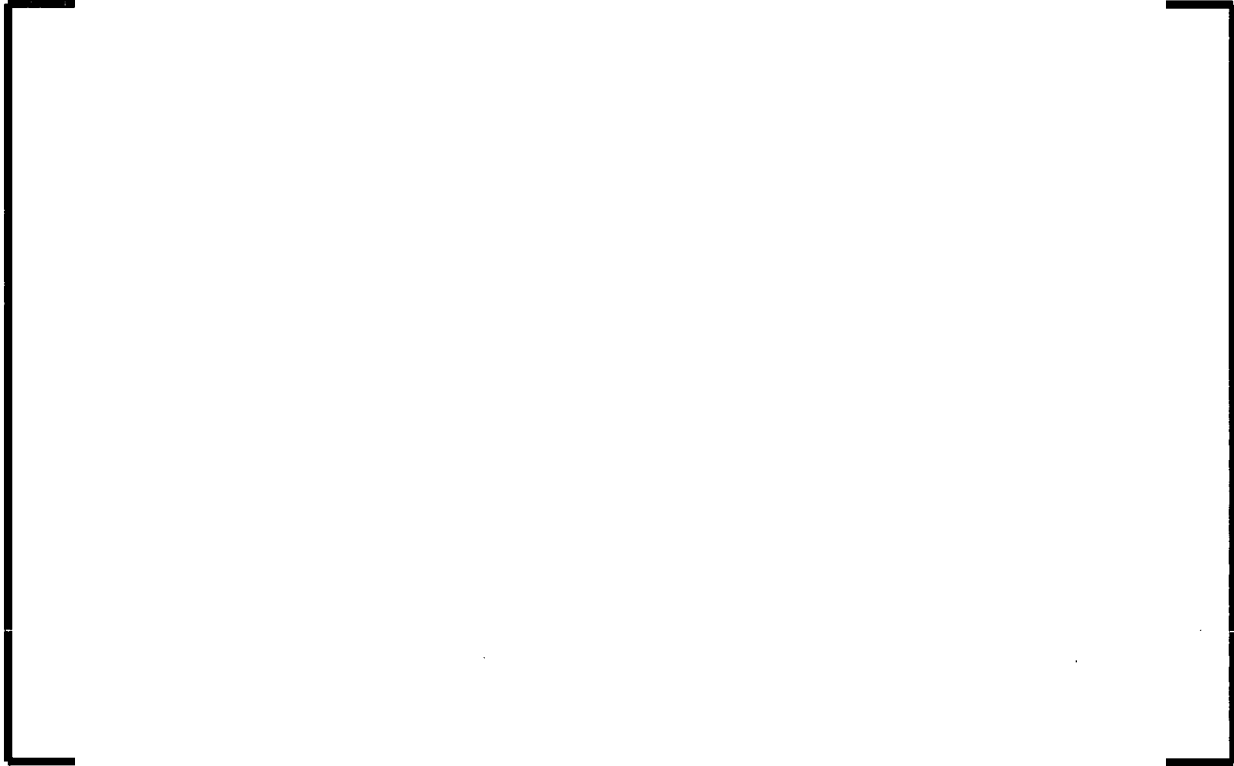


Figure 19-312(Part 6)-5—Non-linear Finite Element Analysis: Crack Strain in the Direction Normal to the Hot Face

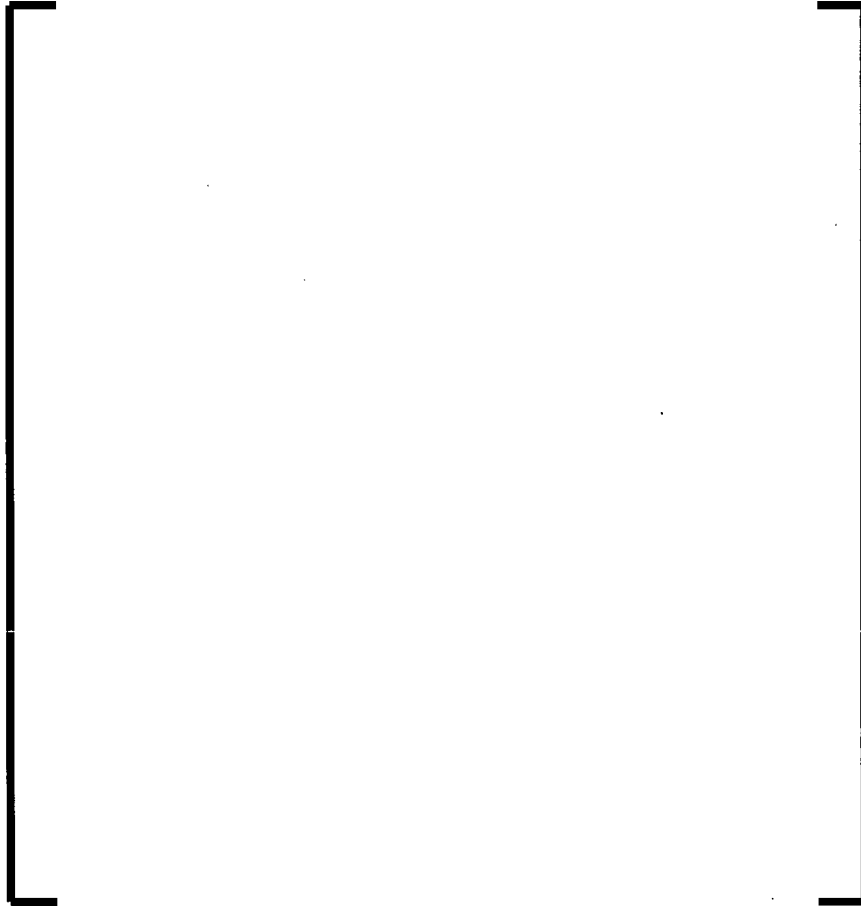
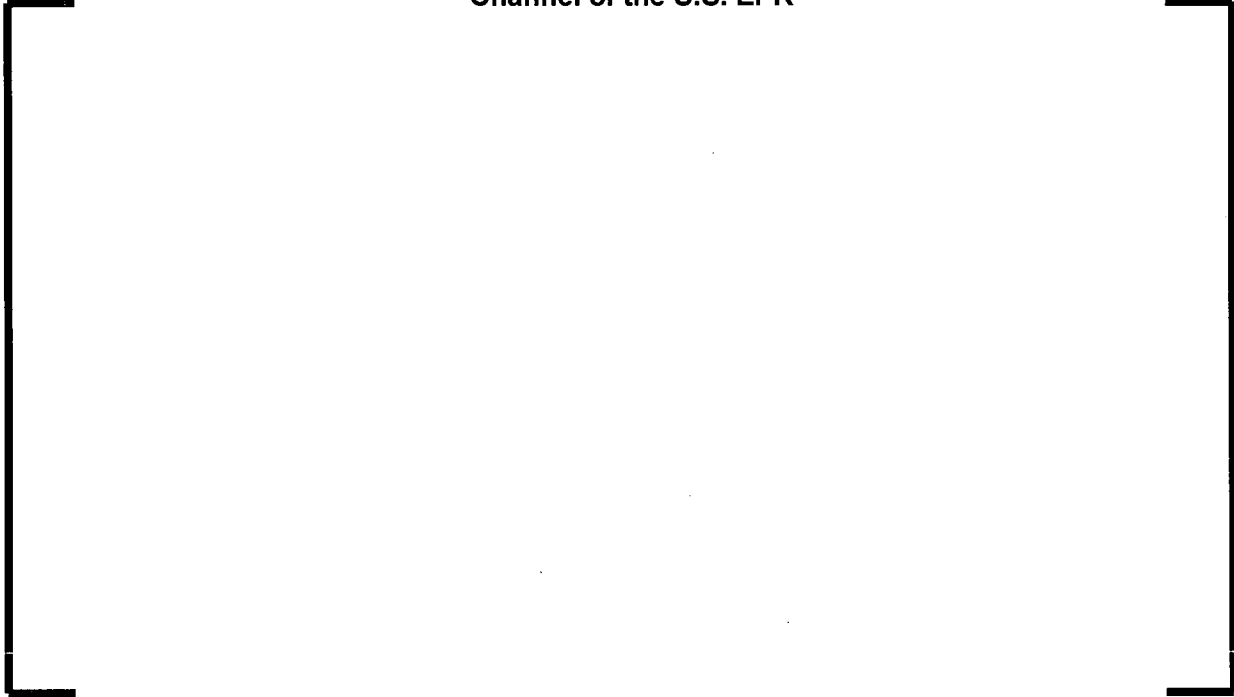


Figure 19-312(Part 6)-6—Sketch of the Lower Pit, Melt Plug and Transfer Channel of the U.S. EPR



References

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15. M.T. Farmer, et al., 'MACE Test M4, Data Report', MACE-TR-D16; Argonne Nat. Lab., Aug. 1999.
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18. W. Steinwarz, et al. 'Investigations on the Phenomenology of Ex-vessel Core Melt Behaviour' Final report, EU 4th FWP, EXV-COMAS(99)-D27, October 1999.

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FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.