

Westinghouse Non-Proprietary Class 3

WCAP-16914-NP  
APP-MY03-T2C-001  
Revision 0

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# **Evaluation of Debris Loading Head Loss Tests for AP1000 Recirculation Screens and In-Containment Refueling Water Storage Tank Screens**



**Westinghouse**

**WCAP-16914-NP**  
**APP-MY03-T2C-001**  
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**Evaluation of Debris Loading Head Loss Tests for  
AP1000 Recirculation Screens and In-Containment  
Refueling Water Storage Tank Screens**

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[

]a.c

[

] <sup>a,c</sup>

I

.....] <sup>a,c</sup>

## EXECUTIVE SUMMARY

This report documents recirculation screen head loss experiments that were conducted for AP1000 as part of the response for the AP1000 design to Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance" (Reference 1) and Generic Letter (GL) 2004-02 (Reference 2).

[

] <sup>a,c</sup>

The data from this test program demonstrated the ability of the Recirculation and the In-Containment Refueling Water Storage Tank Screens to successfully perform their design functions under debris loading conditions expected for the AP1000 following a postulated LOCA. Three head loss tests were performed [ <sup>a,c</sup>. As

] <sup>a,c</sup>

The testing also demonstrates the [ <sup>a,c</sup> screens will perform as expected as Containment Recirculation and the In-Containment Refueling Water Storage Tank Screens under the expected AP1000 debris loading conditions. That is, they will not develop head losses due to debris collection that will challenge either long-term core cooling or maintaining a coolable core geometry.

The testing also demonstrates that the AP1000 design provides for considerable margin in screen performance for [

] <sup>a,c</sup>

## 1 BACKGROUND

In response to Nuclear Regulatory Commission (NRC) Generic Safety Issue (GSI)-191, Westinghouse has performed a set of recirculation screen head loss experiments that were conducted for the AP1000. The purpose of this test program was to quantify the head loss for both the Containment Recirculation Screens and the In-Containment Refueling Water Storage Tank Screens with debris loadings including containment chemical effects applicable to the AP1000.

[

] <sup>a,c</sup>

The performance of the recirculation screens must be confirmed and demonstrated under debris loading conditions (including chemical effects) that include a spectrum of plant specific debris characteristics for a range of LOCAs up to and including a Large Break LBLOCA Design Basis Accident (DBA) in order to satisfy GSI-191. [

] <sup>a,c</sup> These head loss tests were performed under the Westinghouse Quality Management System (QMS) requirements.

## 2 OBJECTIVE

The objective of this project was to perform tests under the Westinghouse QMS program for debris loading on the recirculation screens. These tests were carried out in conformance with the test procedure steps in the approved Test Plan (Appendix A and Reference 6). [

] <sup>a,c</sup>

### 3 APPROACH

[

] <sup>a,c</sup> The test was conservative [

] <sup>a,c</sup> for the AP1000

[

] <sup>a,c</sup>

[

]a,c

## 4 DESCRIPTION OF EXPERIMENTAL APPARATUS

A description of the test flume used in the conduct of the head loss testing is included in Section 2.0 of Appendix B (Reference 7) and will not be repeated here. [

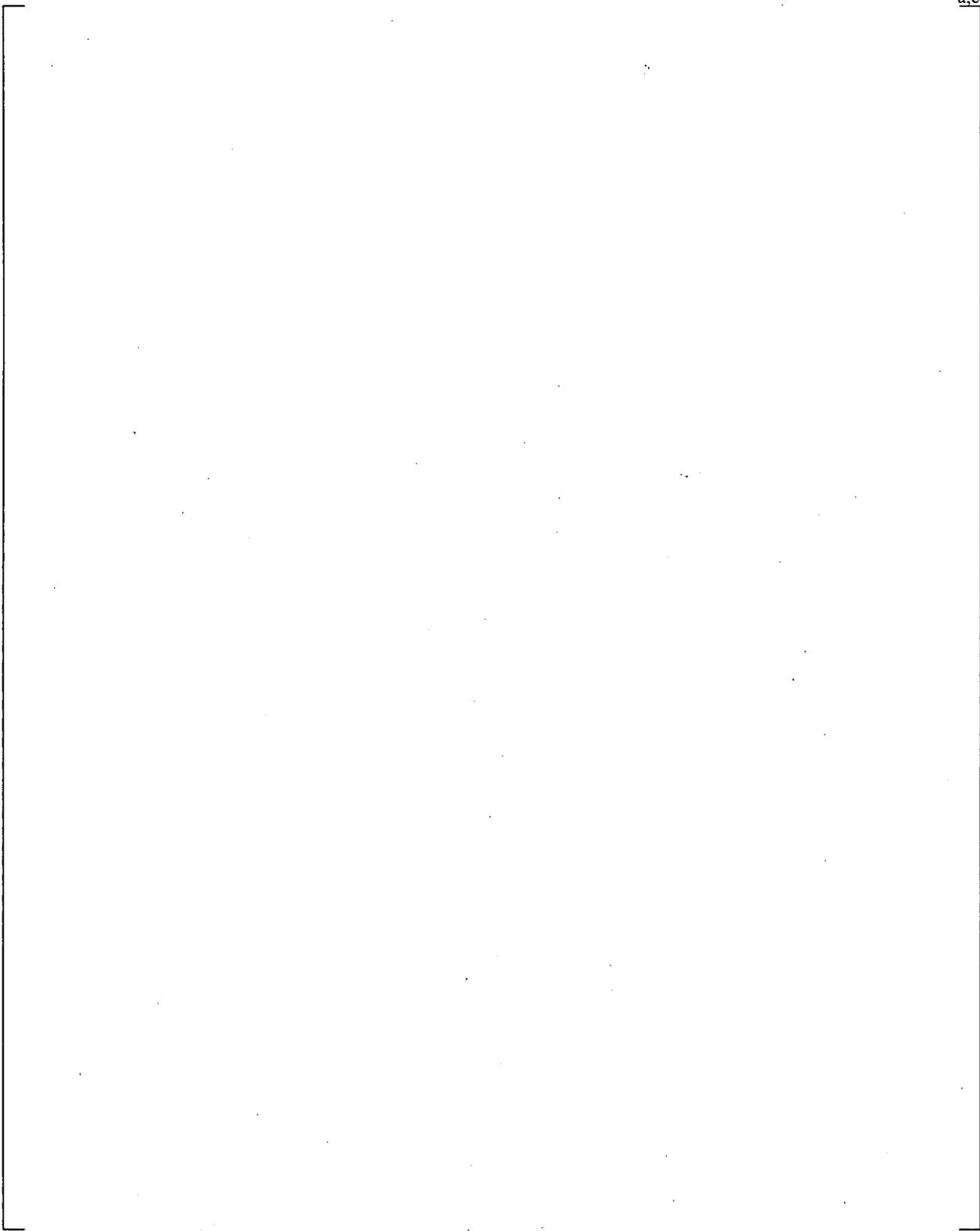
] <sup>a,c</sup>

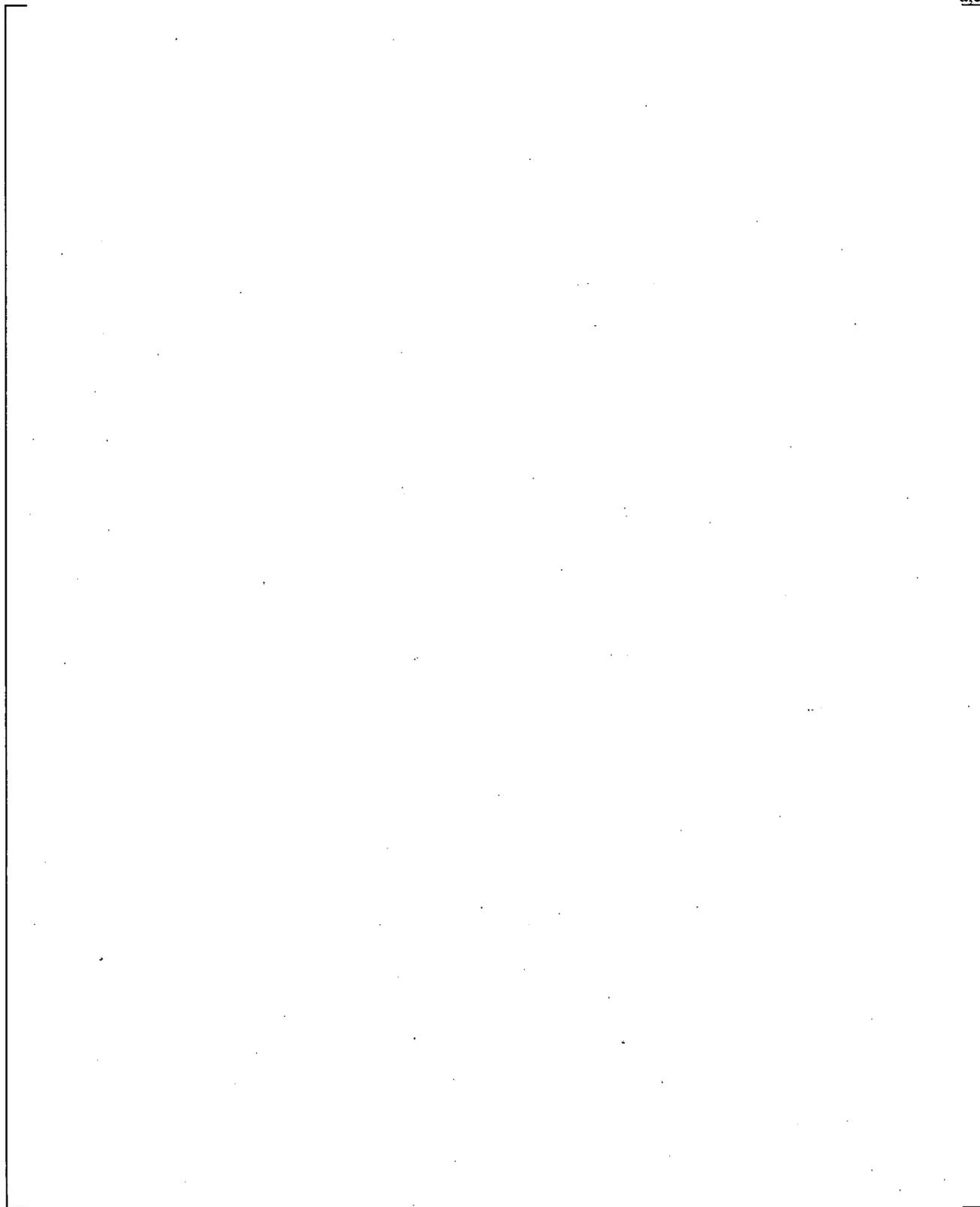
### 4.1 COMPONENTS USED IN HEAD LOSS TESTING

#### 4.1.1 Physical Components

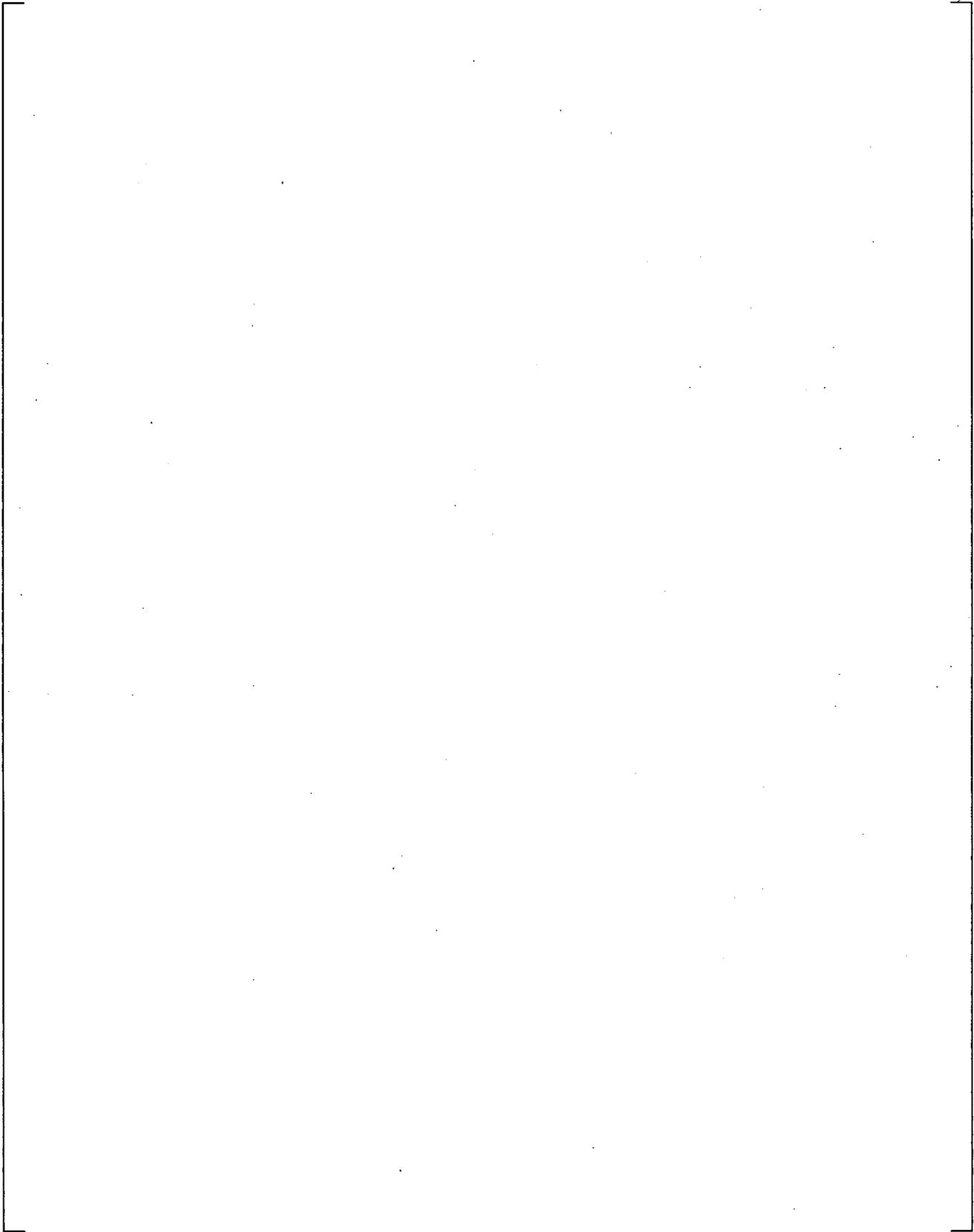
[ <sup>a,c</sup> For additional information on the physical arrangement of the test flume, see Reference 6. [

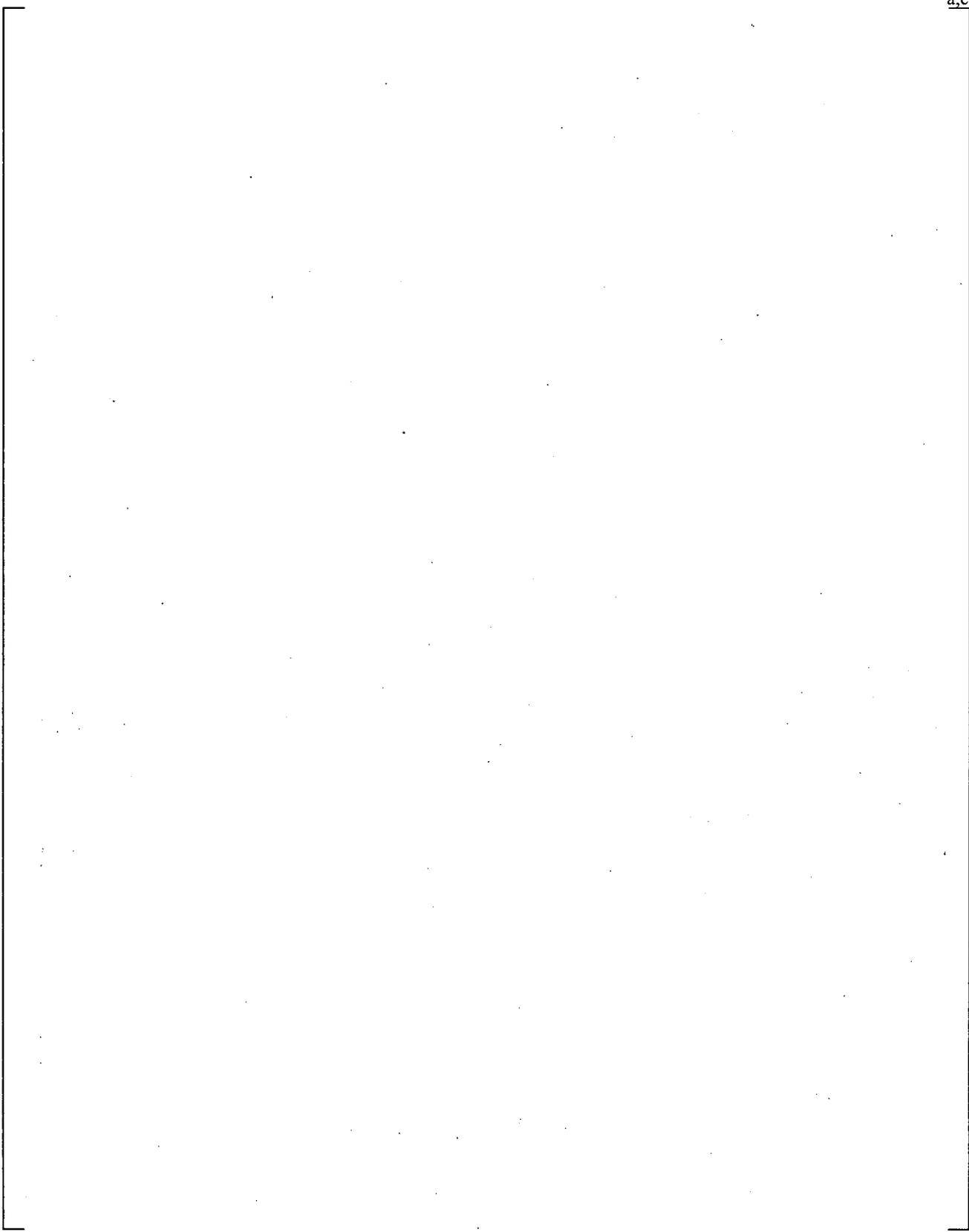
] <sup>a,c</sup>





a.c





### 4.1.2 Instrumentation

[

### 4.2 SCALING CONSIDERATIONS

[

]a,c

]a,c

---

## 5 INITIAL CONDITIONS AND TEST MATRIX

The initial conditions and test matrix of the head loss testing, including the design basis test and the two sensitivity tests, are thoroughly covered in Section 6.0 of Appendix B (Reference 7) [

] <sup>a,c</sup>

a.c



The test matrix included several clean screen test performed over a range of flow rates to bound the velocities that can be seen in the Containment Recirculation and in the IRWST Screens. Three head loss tests were performed [

]a,c

## **6 TEST RESULTS**

### **6.1 SUMMARY OF TEST RUNS, DEBRIS LOADINGS AND TEST VELOCITIES**

The Test Report included as Appendix B (Reference 7) provides a detailed summary of test runs, debris loading and test velocities. [

] <sup>a,c</sup>

a.c

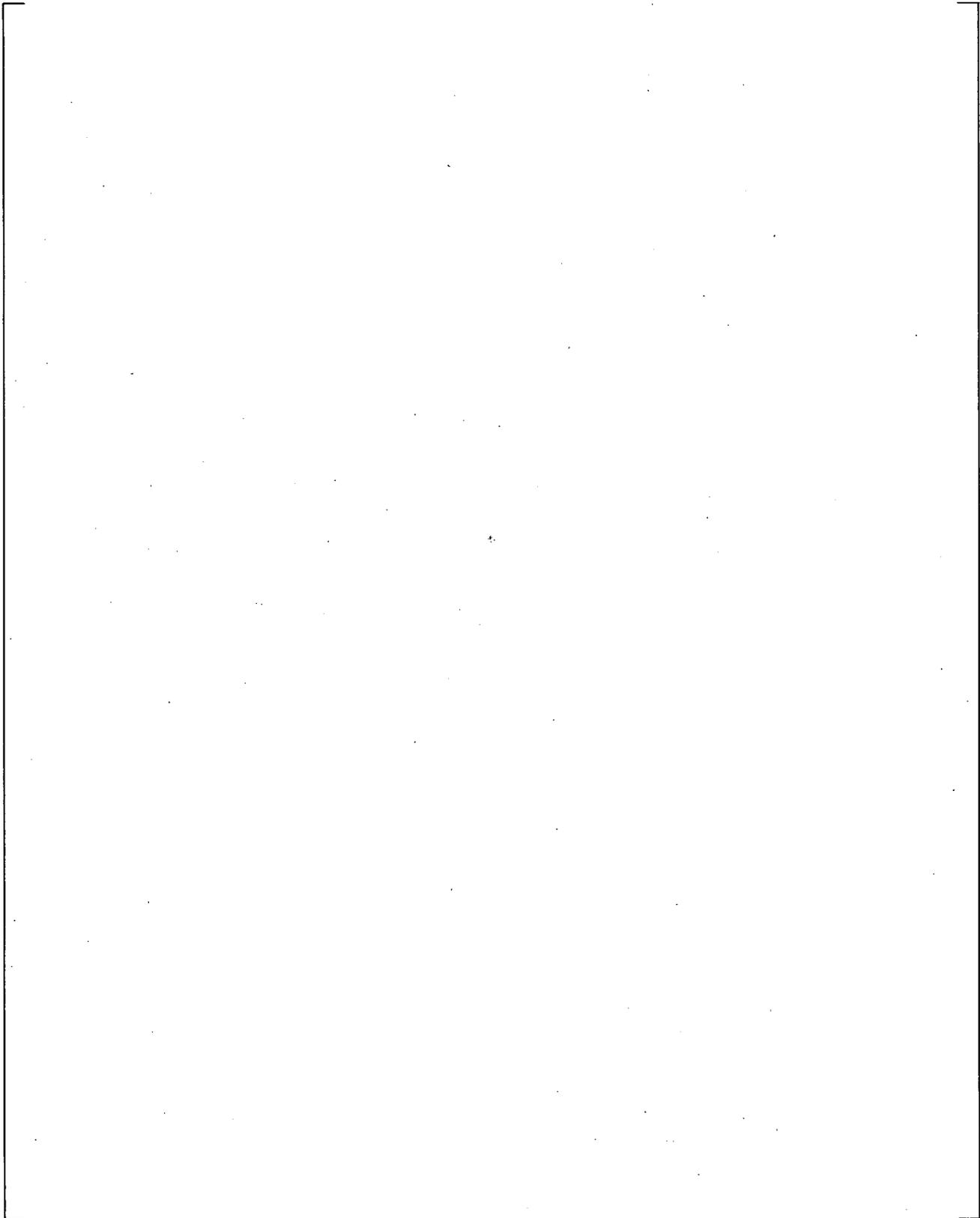




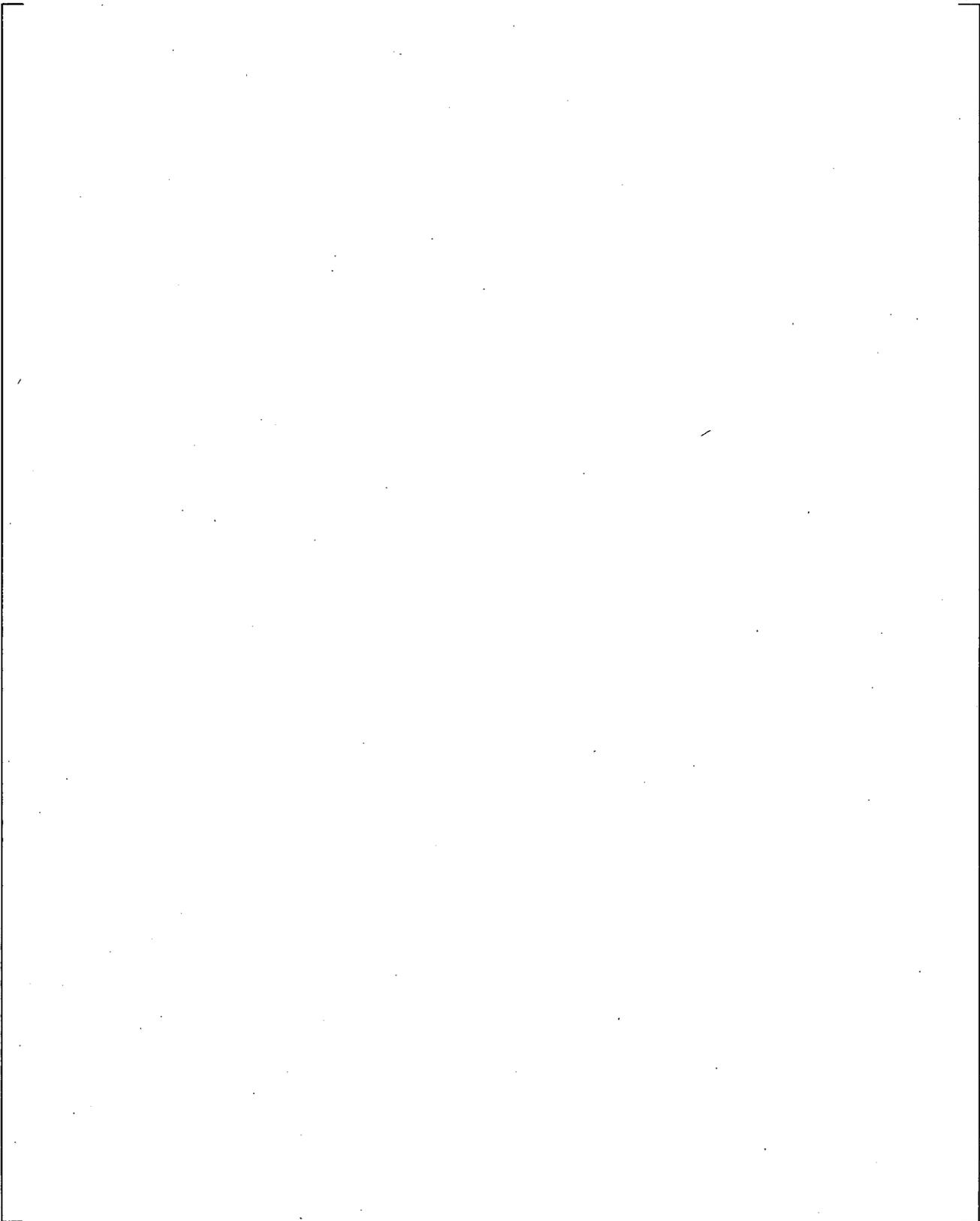
**6.2 DESIGN BASIS TEST [ ]<sup>a,c</sup>**

[

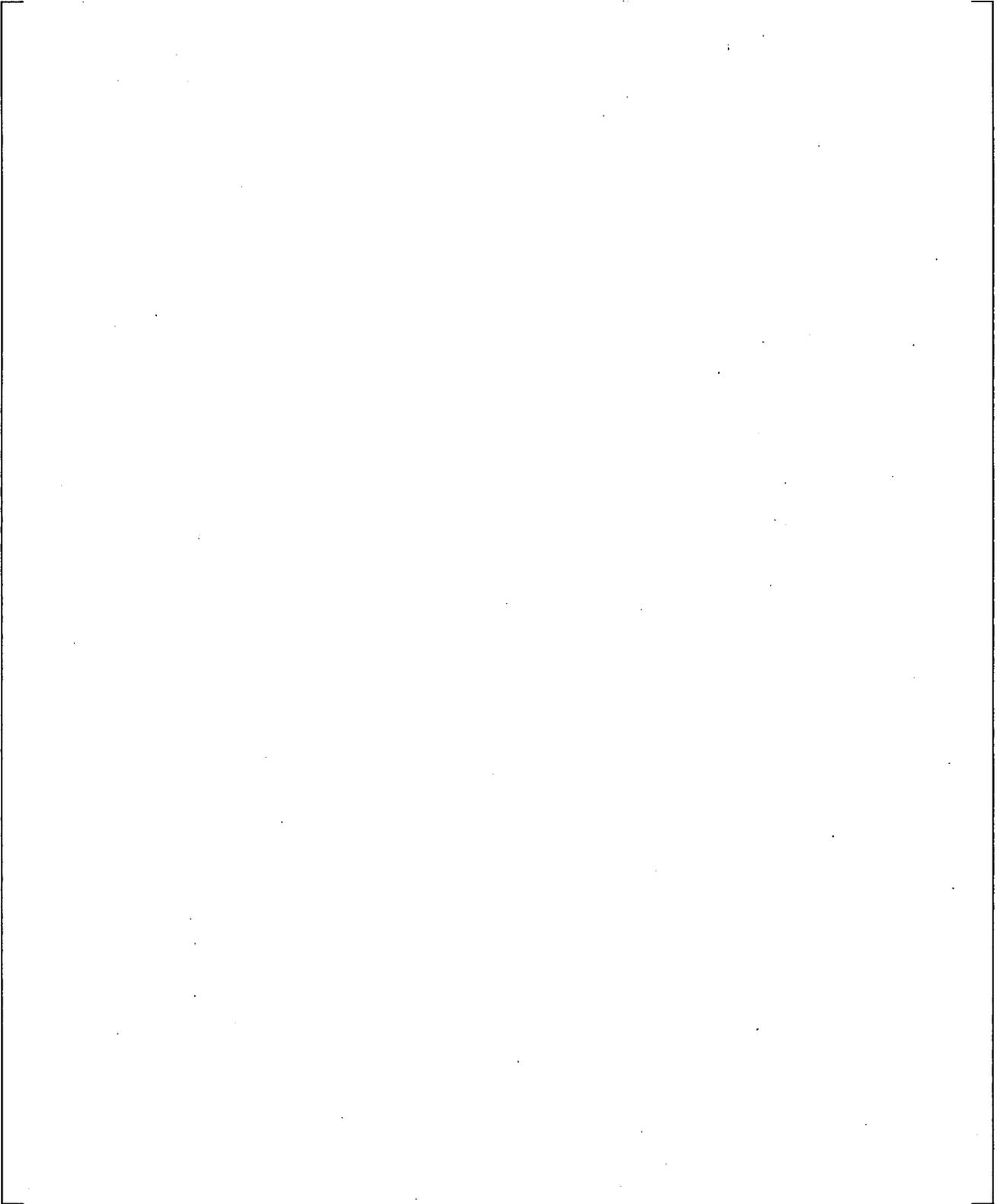
]<sup>a,c</sup>



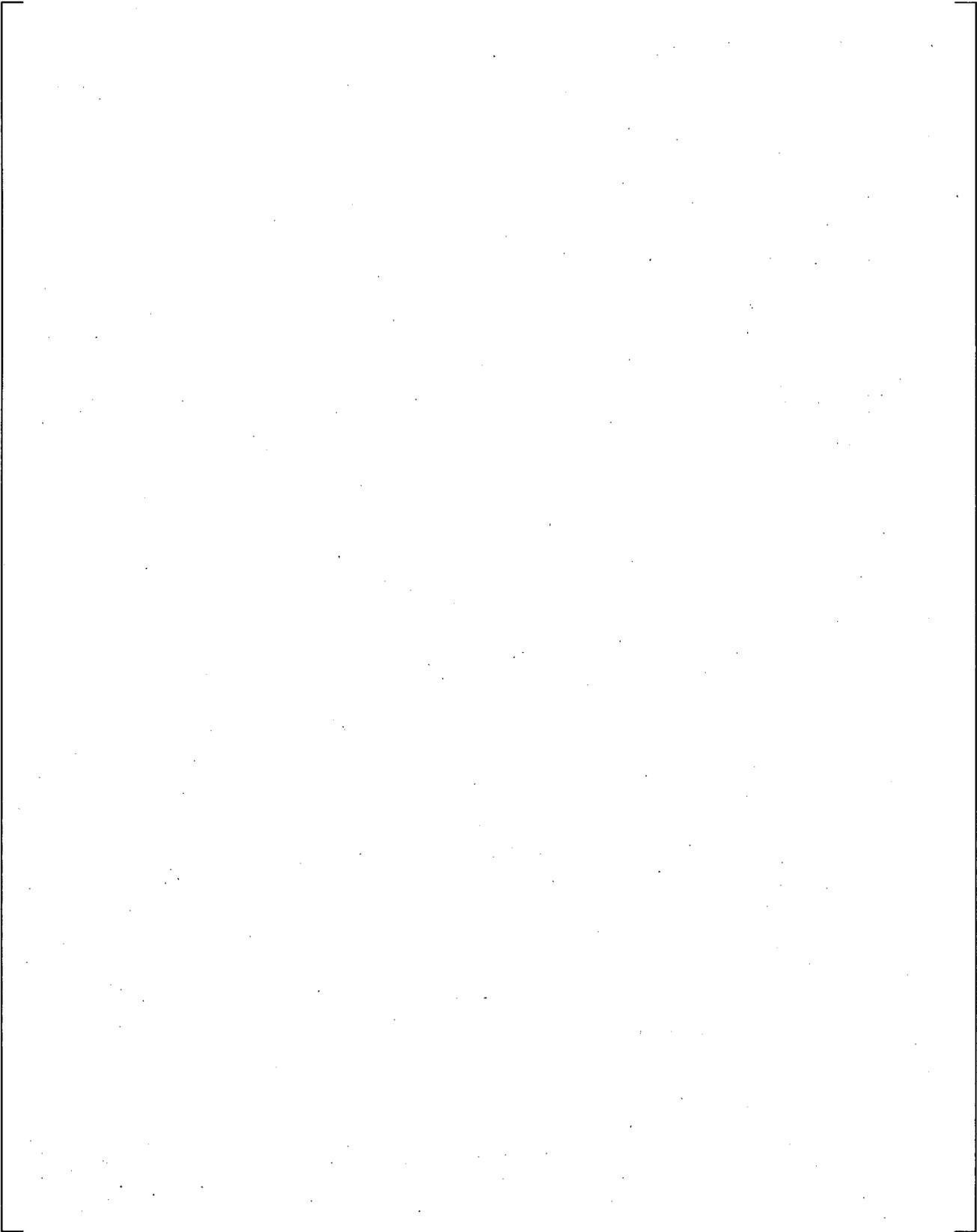
a,c

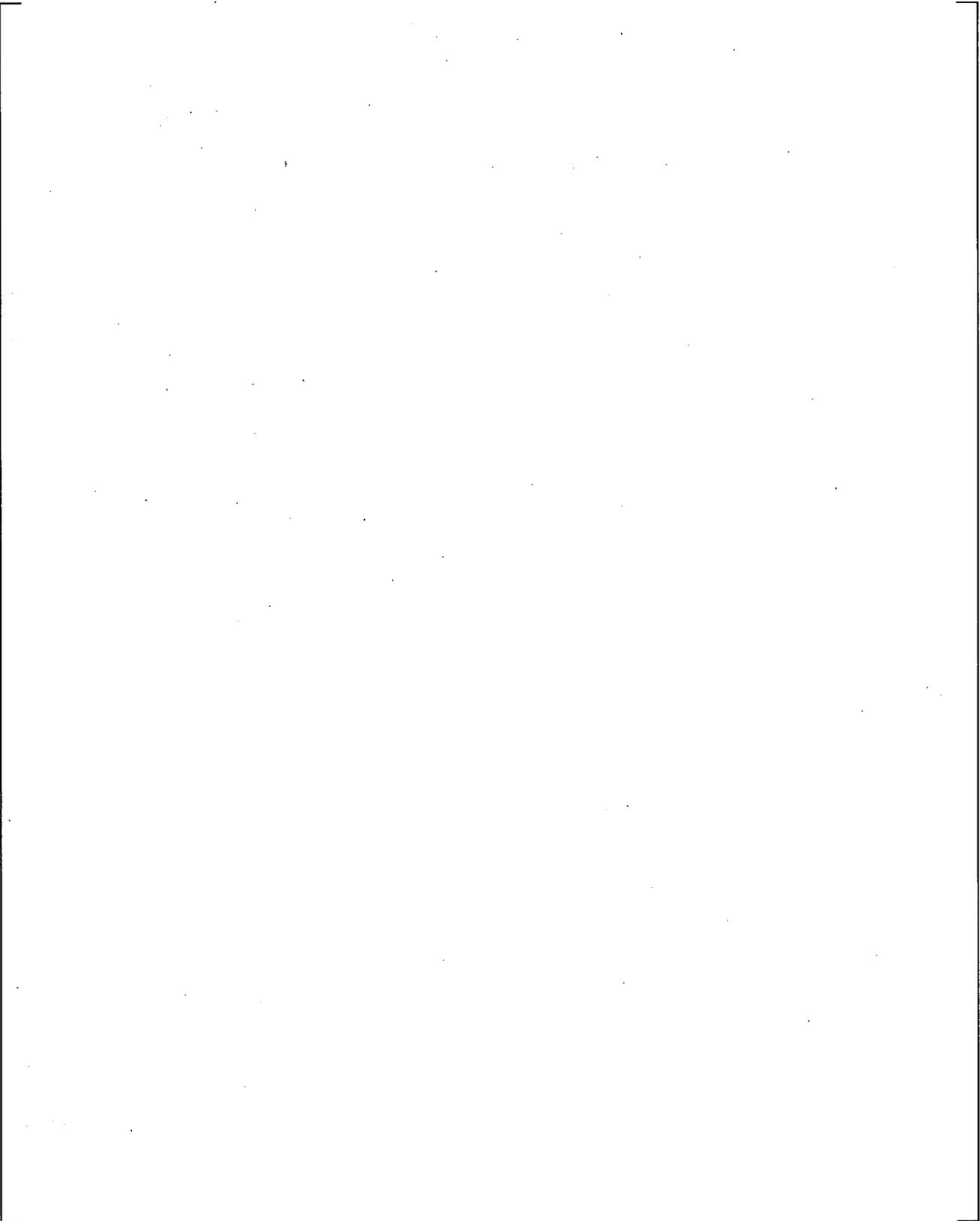


a,c



a,c





**6.3 SENSITIVITY TEST #1 [**

**] <sup>a,c</sup>**

[

<sup>a,c</sup> Nearly

identical observations were noted throughout the test [

<sup>a,c</sup>

a,c

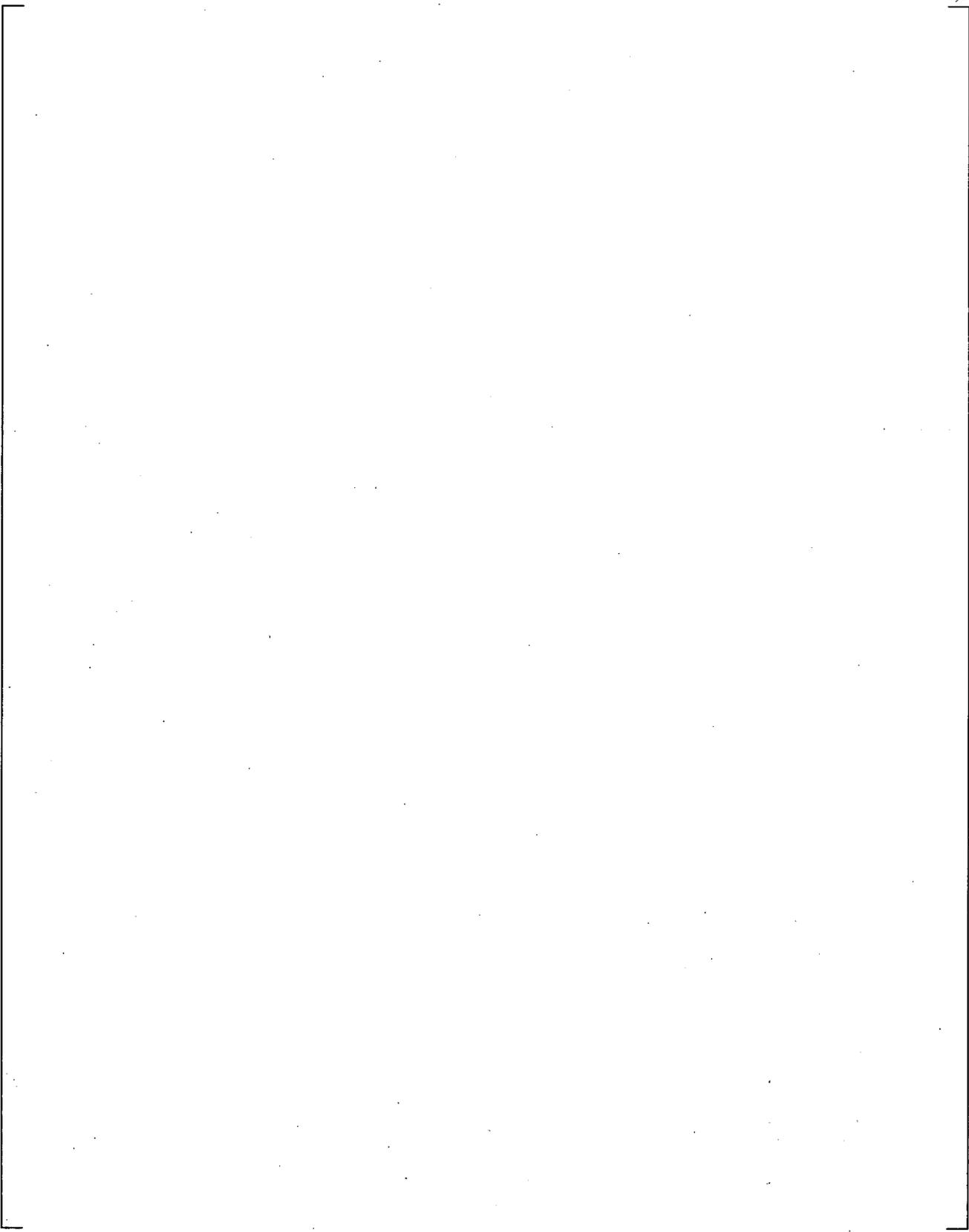
a,c

**6.4 SENSITIVITY TEST #2 [**

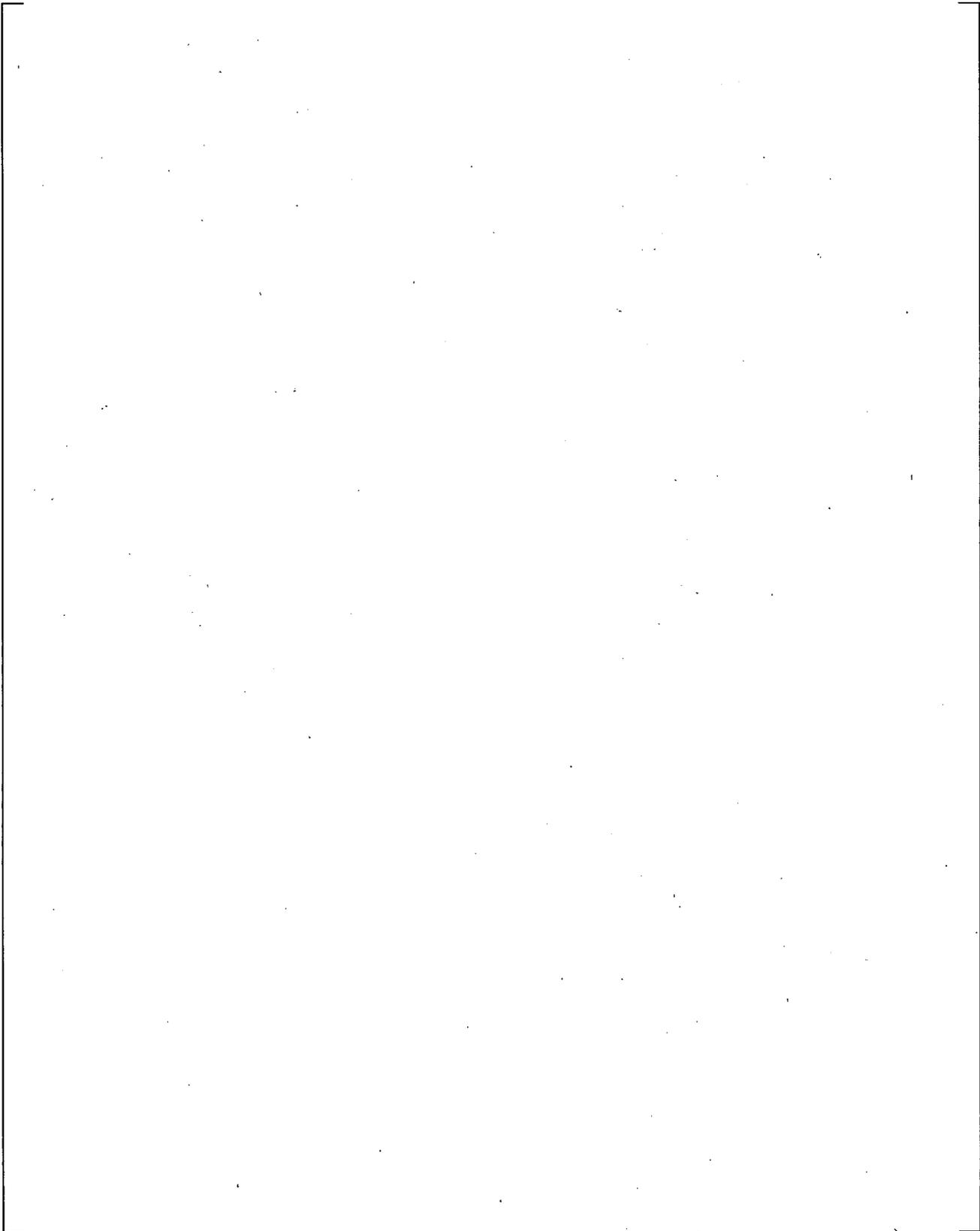
**]<sup>a,c</sup>**

[

<sup>a,c</sup>



a,c



## 7 CONCLUSIONS

### 7.1 TEST DATA SUMMARY

A total of eight head loss tests were performed, [ ]<sup>a,c</sup>. All eight tests showed very small head loss, [ ]<sup>a,c</sup>. Overall, the debris that was introduced into the flume had a minute affect on increasing the head loss through the screen. [ ]

By a comparison of the design basis testing and sensitivities testing against the expected debris loading for the AP1000, the testing performed [ ]<sup>a,c</sup> both the Containment Recirculation Screens and the In-Containment Refueling Water Storage Tank Screens.

### 7.2 APPLICABILITY OF TESTING TO AP1000 DESIGN

[ ]

[ ]<sup>a,c</sup>

[

]a.c

As [ ]<sup>a,c</sup> bounded the conditions for both the Containment Recirculation and the In-Containment Refueling Water Storage Tank Screens, the data collected from this program is applicable to both screens. Therefore, the data from this test program is directly applicable to the AP1000 [ ]<sup>a,c</sup>.

## 8 SUMMARY

Head loss experiments were conducted for AP1000 as part of the response for the AP1000 design to Generic Safety Issue (GSI)-191. The performance of the recirculation screens was demonstrated under debris loading conditions (including chemical effects) that include a spectrum of AP1000 specific debris loadings. [

] <sup>a,c</sup>

[

] <sup>a,c</sup> The applicability of the test data to the AP1000 has been demonstrated in section 8.2 of this report.

Three head loss tests were performed [

loss values are obtained for the [

] <sup>a,c</sup>. Test results demonstrate that acceptable head  
] <sup>a,c</sup> conditions tested. [

] <sup>a,c</sup> As expected, these sensitivity runs showed that the AP1000 design has extensive margin with respect to the Containment Recirculation Screen performance under the spectrum of Design Basis Accident (DBA) conditions considered.

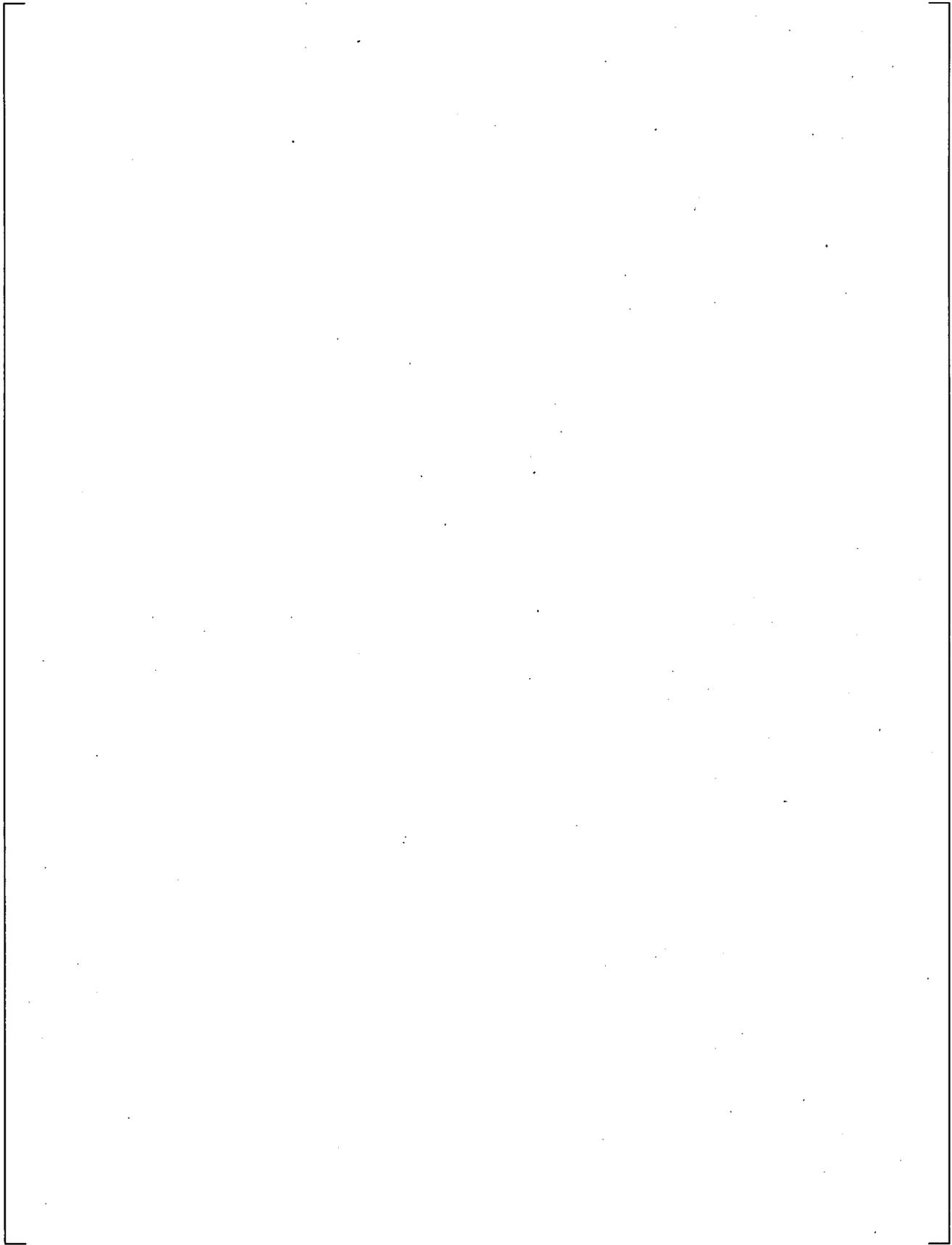
The testing performed conservatively bounds [ ] <sup>a,c</sup> conditions expected to be experienced by both the Containment Recirculation Screens and the In-Containment Refueling Water Storage Tank Screens. The data from this test program demonstrated the ability of the Recirculation Screen and the In-Containment Refueling Water Storage Tank Screen to successfully perform its design function under debris loading conditions expected for the AP1000 following a postulated LOCA.

Furthermore, as the test conditions bound [ ] <sup>a,c</sup> conditions that both the Recirculation and the In-Containment Refueling Water Storage Tank screens would experience in the recirculation mode following a postulated LOCA. The data applies to both of those screens.

## 9 REFERENCES

[

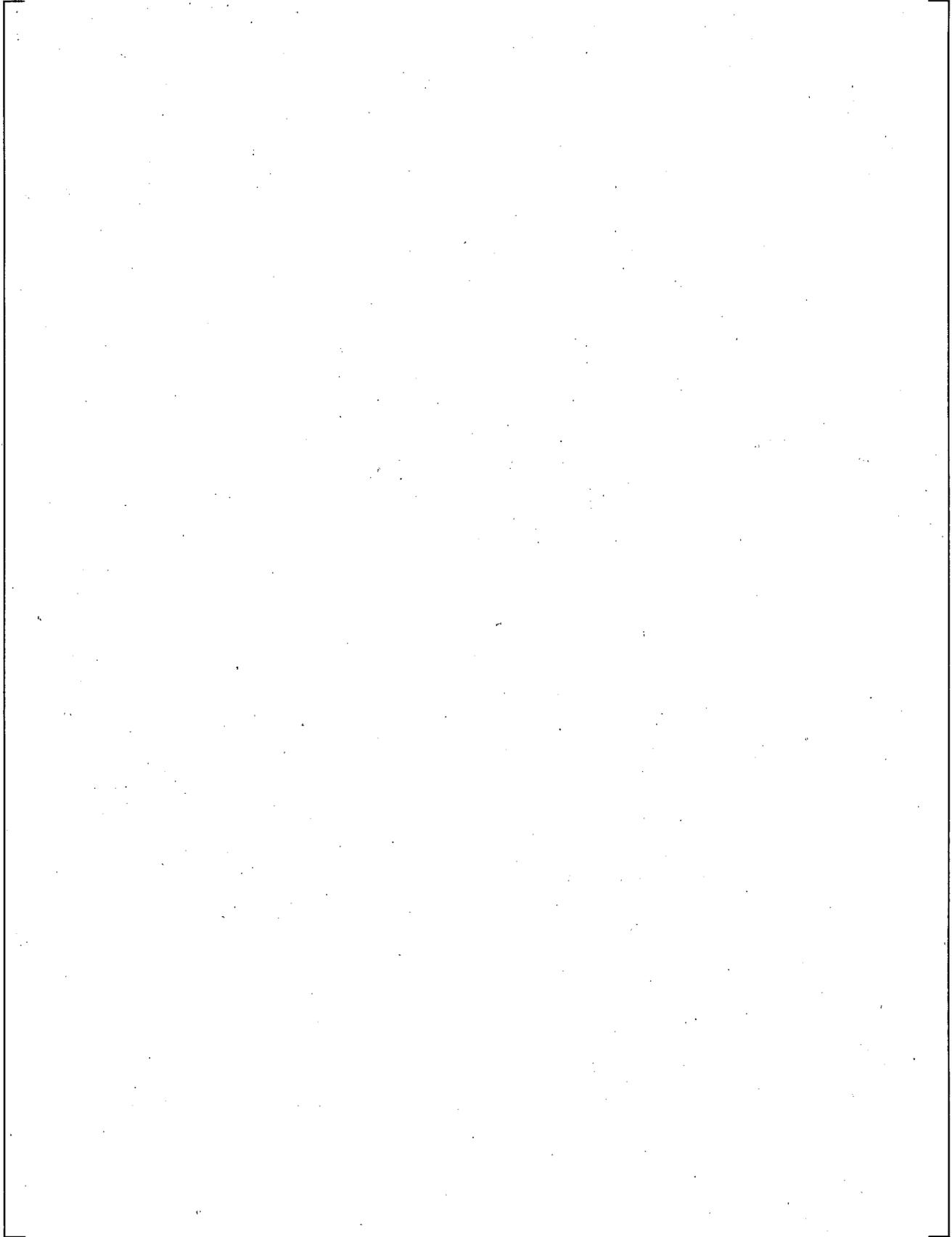
] <sup>a,c</sup>



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## **APPENDIX A TEST PLAN**

Appendix A has been deleted for the Non-Proprietary Version.



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**APPENDIX B  
TEST REPORT**

Appendix B has been deleted for the Non-Proprietary Version.