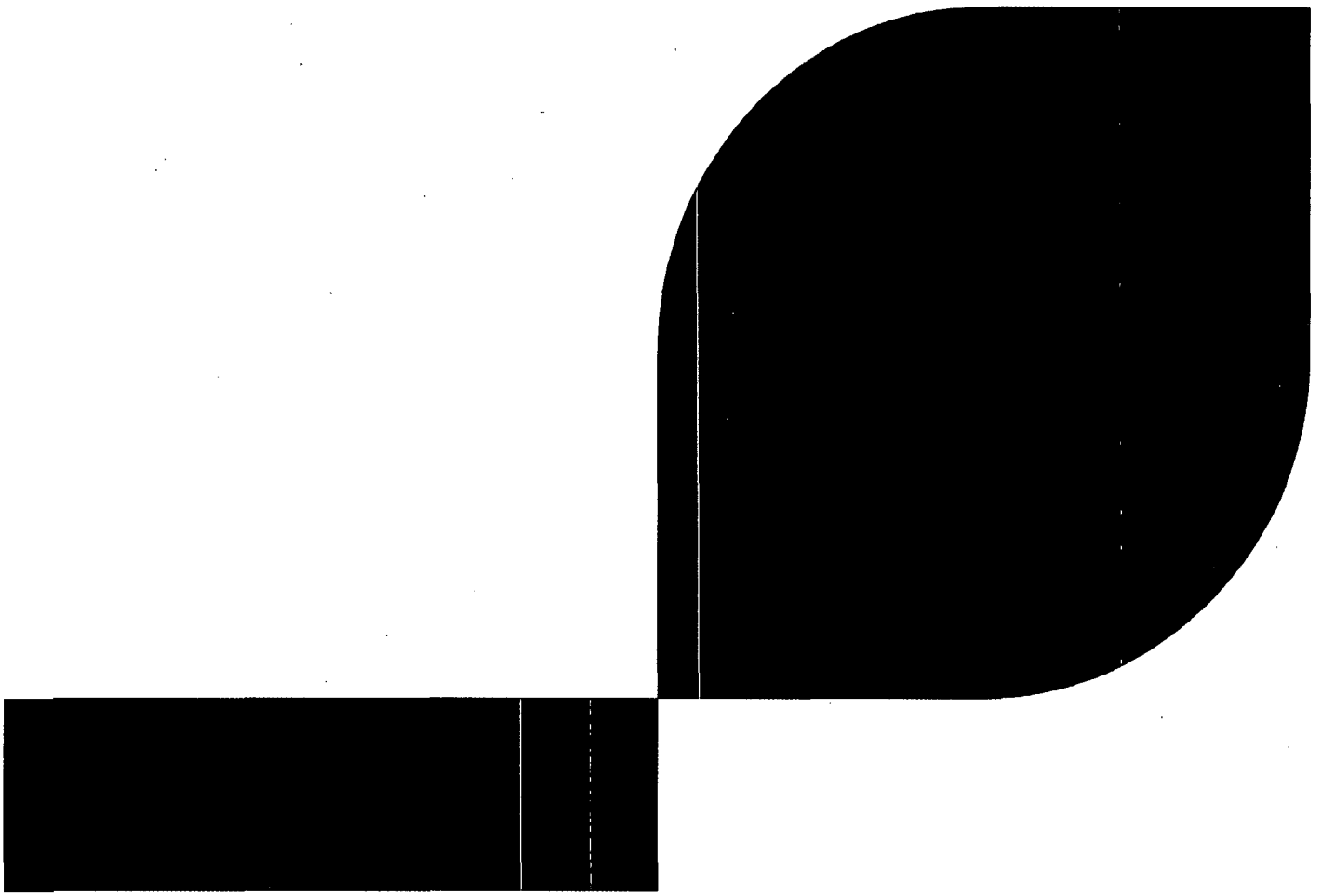
ENCLOSURE 3

Browns Ferry Nuclear Plant Unit 1
Technical Specifications Change TS - 473 - AREVA Fuel Transition

ANP-3035(NP), Revision 0, "AREVA Responses to August 2011 RAIs for Browns Ferry Unit 1 Fuel Transition – LOCA", Non-Proprietary



ANP-3035(NP)
Revision 0

AREVA Responses to August 2011 RAIs for Browns Ferry Unit 1 Fuel Transition - LOCA

September 2011

AREVA NP Inc.

AREVA

AREVA NP Inc.

ANP-3035(NP)
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ANP-3035(NP)
Revision 0

Nature of Changes

Item	Page	Description and Justification
1.	All	This is the initial issue.

Contents

Tables

Figures

1.0 Introduction

Tennessee Valley Authority (TVA) submitted a License Amendment Request (LAR) to change the Browns Ferry Unit 1 Technical Specifications in support of reload fuel transition to AREVA NP. In response to the LAR, the Nuclear Regulatory Commission (NRC) has issued a Request for Additional Information (RAI) (Reference 1) following a July 2011 audit at AREVA's Richland, Washington facilities.

The information provided in the report provides the responses to the RAIs.

2.0 NRC Requests for Additional Information and the AREVA Response

The NRC requests listed below are according to Reference 1.

2.1 *NRC Request 1*

Please provide a revised Emergency Core Cooling System (ECCS) Evaluation Summary that provides a detailed description of the most severe loss-of-coolant accident (LOCA) analysis, along with a description of other break sizes, locations and other properties that were evaluated to support the determination that the most severe postulated LOCA has been calculated.

The new break spectrum report, ANP-3015(P), *Browns Ferry Units 1, 2, and 3, LOCA Break Spectrum Analysis,* provides the requested summary (Reference 2).

2.2 *NRC Request 2*

Please provide a detailed description of the model changes made to address the staff's concern with the evaluation model's application.

The description of the model change to address the staff's concerns [
] is provided in Section 4.4 of ANP-3015(P) (Reference 2).

2.3 *NRC Request 3*

Please provide the results of a sensitivity study demonstrating the effect of the EXEM-BWR 2000 pressure control assumptions on the break spectrum. Please include results for the limiting break size as determined using the modified EXEM-BWR 2000 analyses (0.21 ft^2) and for a smaller break size that would result in a delayed pressurization following a level-driven main streamline isolation.

The following new analyses were performed to address the request:

- SF-BATT|BA, 0.21 ft^2 recirculation discharge pipe break, 102% power/ [ ], top-peaked axial power shape
- SF-BATT|BA, 0.05 ft^2 recirculation discharge pipe break, 102% power/ [ ], top-peaked axial power shape

The 0.05 ft^2 break size was chosen to maximize the delay in pressurization.

Analysis modifications consisted of:

[

]

The PCT was [ ] for both cases using the [ ], as shown in Table 2.3.1. Table 2.3.2 shows event times for the 0.21 ft^2 break. Table 2.3.3 shows event times for the 0.05 ft^2 break. For the 0.21 ft^2 break, more detailed results are provided in Reference 2 Section 6 (Tables 6.1 and 6.2 and Figures 6.1 – 6.19) for the original analysis [ ] and in Appendix A for the [ ] analysis. For the 0.05 ft^2 break, more detailed results are provided in Appendix B for the [ ] analysis and Appendix C for the [ ] analysis. The analyses demonstrate that the EXEM BWR-2000 method for [ ].

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* [

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**Table 2.3.1 Sensitivity Results for
Pressure Control for
102% Power [ ] SF-BATT|BA
Top-Peaked Pump Discharge**

**Table 2.3.2 Event Times for Limiting
TLO Recirculation Line Break
0.21 ft^2 Split Pump Discharge SF-BATT|BA
Top-Peaked Axial 102% Power [ ]**

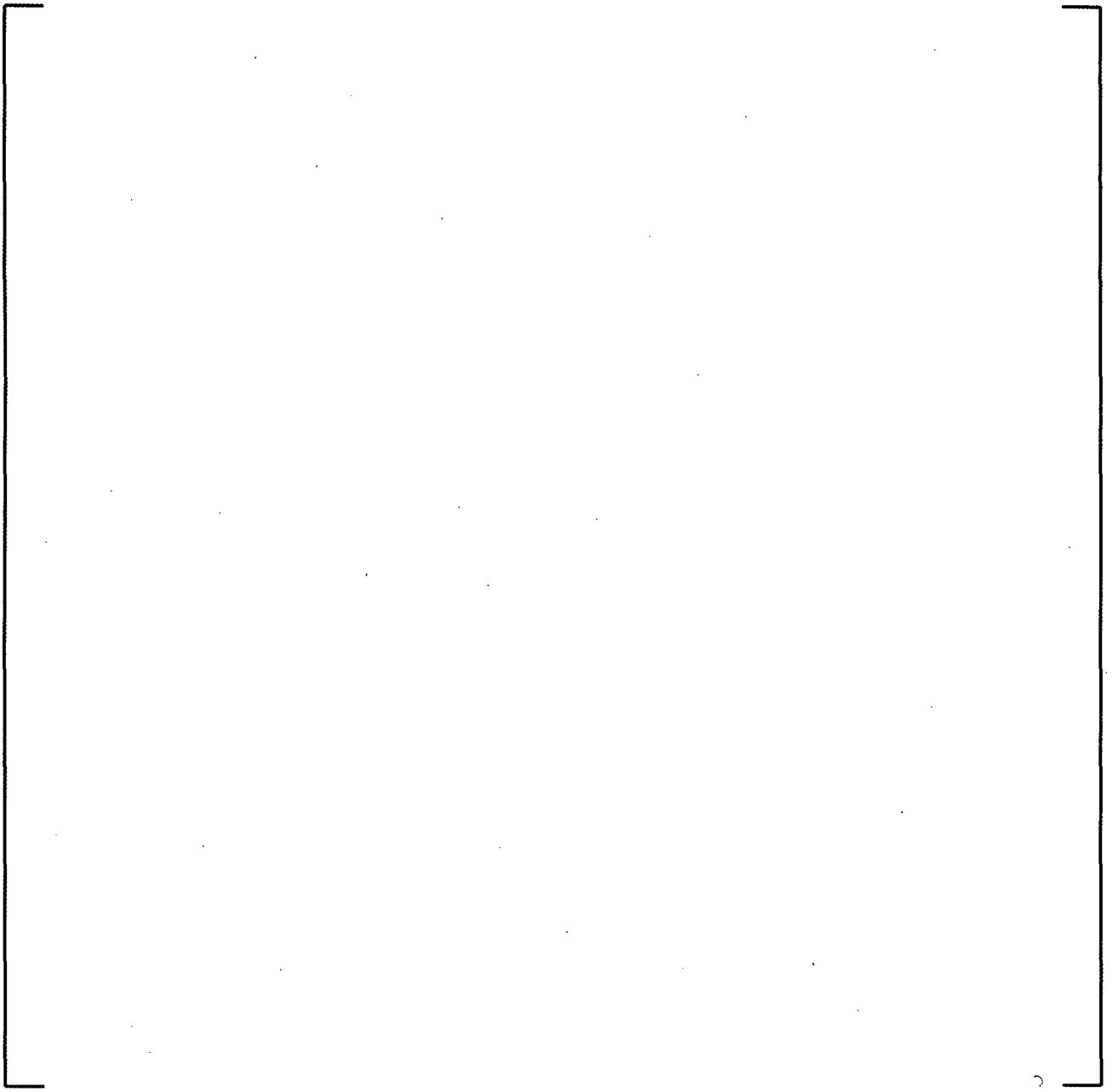


**Table 2.3.3 Event Times for
TLO Recirculation Line Break
0.05 ft^2 Split Pump Discharge SF-BATT|BA
Top-Peaked Axial 102% Power [ ]**

[

]

2.4 *NRC Request 4*

Please provide a summary of the break spectrum results that include sufficient detail to compare the break spectra for each combination of power shape, core flow state point, single failure, and break geometry.

Appendices B, C, and D were added to the break spectrum report (Reference 2) to provide sufficient detail to compare spectra.

2.5 *NRC Request 5*

Please explain why the break spectrum results exhibit slightly discontinuous behavior in the intermediate range of break sizes. Identify the significant model aspects that are causing the behavior and provide an estimate or description of the impact on the evaluation.

Table B.1 of Reference 2 provides the PCTs in question for the intermediate break sizes. The behavior over the range of breaks in question is best described by focusing on the results for the [

] An extensive review was performed to determine the cause of the discontinuous behavior in PCT. Numerically, the solutions were converged since changes to the calculation time steps did not result in a significant change to PCT, nor change the shape of the PCT plot. The review determined that the significant difference between the cases was liquid in the bottom of the average core in the RELAX system analysis. Specifically, the discontinuous behavior was attributed to differences in steam generation and counter current flow limitation (CCFL) at the assembly inlet. [

], the [ ] break has much less liquid mass than the [ ] break, which leads to the higher PCT.

Scoping analyses determined that the CCFL phenomenon was sensitive to [

]

[

]

[

]

[

]

[ ]

Figure 2.5.1 102% Power [ ] SF-BATT|BA Liquid Mass in the Bottom Core Volume
[
]

[ ]

Figure 2.5.2 102% Power [ ] SF-BATT|BA Liquid Mass in the Bottom Core Volume
[
]

[ ]

Figure 2.5.3 102% Power [ ] SF-BATT|BA Cladding Temperatures

[

]

Figure 2.5.4 102% Power [ ] SF-BATT|BA Cladding Temperatures

[

]

2.6 *NRC Request 6*

Please determine the cause of the intermediate temperature transient observable in the plots of peak cladding temperature vs. time for the intermediate break size cases and provide a summary explanation. Justify the validity of the results, given the temperature trends depicted.

For the break sizes in question, the RELAX hot channel analyses shows the temperature of the peak node turning over near the end of the event due to [

] . Analyses discussed in response to RAI 5 are used to demonstrate the timing of events. As shown in Figure 2.6.1, the PCT for the [ ] break just starts to [

] . As shown for the [ ] break, the differences in timing results in a bigger "hump" in the PCT plot. The analyses of Figure 2.6.1 were repeated with the end of blowdown changed to the end time of the analysis; this change eliminates the use of the Appendix K spray heat transfer coefficients. Figure 2.6.2 shows the [

] . The difference in shapes is attributed to the phenomenon discussed in response to RAI 5. As shown in Figure 2.5.4, [

] It is concluded that the PCT plots are valid based on the EXEM BWR-2000 Appendix K methodology which dictates a [

] .

Figure 2.6.1 102% Power [ ] SF-BATT|BA Cladding Temperatures

[

]

Figure 2.6.2 102% Power [ ] SF-BATT|BA Cladding Temperatures

[

]

2.7 ***NRC Request 7***

Title 10 of the Code of Federal Regulations, Section 50.46, requires ECCS cooling performance to be calculated for a number of postulated LOCAs of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated LOCAs are calculated. At the time EXEM-BWR 2000 was approved, ECCS research suggested that the large-break LOCA was generally limiting for boiling-water reactors, and there appears to be little consideration of post-power uprate plant operation.

Since the ECCS research was compiled and documented in NUREG-1230, "Compendium of ECCS Research for Realistic LOCA Analysis," operating experience has shown that the small break scenario can in fact result in a more limiting event. Because the small-break accident is limiting, AREVA Topical Report ANP-2908(P) includes a number of explicitly analyzed ancillary line breaks, since these breaks are smaller in size. The general trend is a liquid blow down at high pressure until the break uncovers, followed by a depressurization of the reactor coolant system caused by steam exiting the break. The analysis results indicate that, absent any emergency core cooling, the steam flow pressure reduction is a dominant mechanism in the event.

Please provide an analysis of the rupture of the bottom head drain line (which would not include the pressure reduction associated with break uncover) to demonstrate that the initial heatup would not contribute to the limiting peak cladding temperature. This analysis should consider the most limiting of the Battery Board B failure and the high-pressure coolant injection failure.

For the Battery Board B failure (SF-BATT|BB), the available ECCS is 4 ADS, HPCI, 1 LPCS, and 2 LPCI. With both HPCI and ADS active, the rupture of the bottom head drain line will result in a very mild event. To demonstrate this, two analyses were performed. One analysis assumed the inventory was lost from the rupture of the bottom head drain line, check valves were assumed to eliminate any inventory loss from the reactor water cleanup line connected to the recirculation suction line. The other analysis assumed no check valves in the cleanup line; therefore, inventory was lost from both the bottom head drain line and cleanup line (see Reference 2, Figure 4.3). **[**

] For both cases, the break was assumed to be the full diameter of the pipe. The core did not uncover and PCT remained below 1000°F for both analyses; therefore, this single failure does not challenge the limiting recirculation line break PCT.

When HPCI is available, a rupture of the bottom head drain line (with or without break flow through the cleanup line) results in a mild event, since HPCI is able to maintain a water level in the vessel.

In terms of available ECCS, a single failure of the HPCI (SF-HPCI) is bound by a single failure of Battery Board A (SF-BATT|BA). SF-HPCI has 6 ADS, 2 LPCS, and 4 LPCI

ECCS systems remaining. SF-BATT|BA has 6 ADS, 1 LPCS, and 2 LPCI ECCS systems remaining. For this scenario, ADS will depressurize the vessel allowing low pressure systems to maintain coolant inventory. The event will experience a mild heatup. As before, one analysis assumed the inventory was lost from the bottom head drain line, the other analysis assumed inventory lost from both the bottom head drain line and the cleanup line. The PCT for the SF-BATT|BA for both analyses was less than 1000°F. Only the analysis where inventory was lost from both the bottom head drain line and the cleanup line showed a mild heatup, which makes it the limiting scenario. The other analysis where inventory was lost only from the bottom head drain line did not have a heatup. Figures for the limiting scenario are presented in Appendix D. This single failure does not challenge the limiting recirculation line break PCT.

In regards to response to RAI 3, the limiting scenario was repeated with [
] . The analysis did not result in a higher PCT.

Based on the results of the analyses presented above, rupturing the bottom head drain line does not result in a limiting PCT.

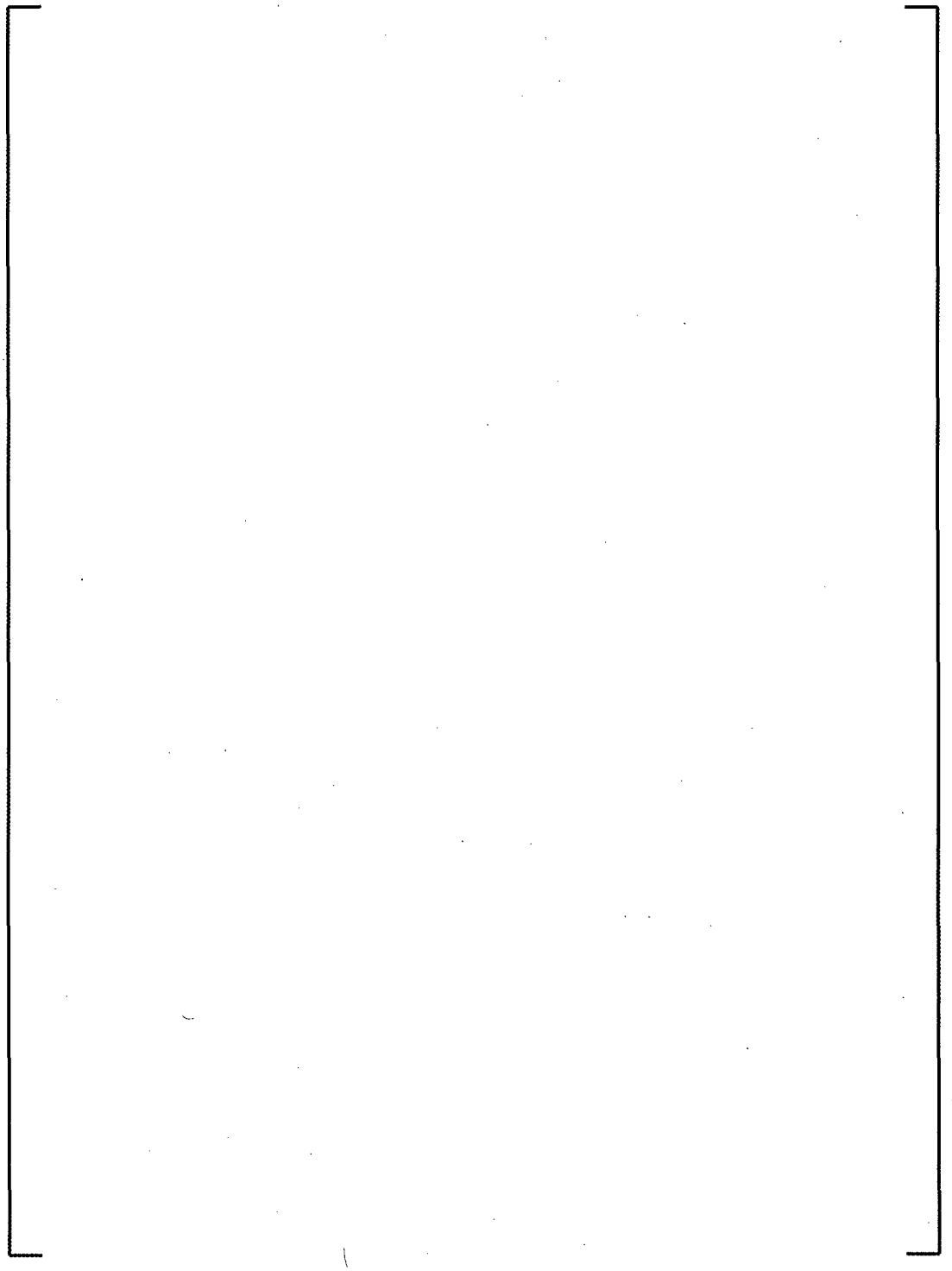
3.0 References

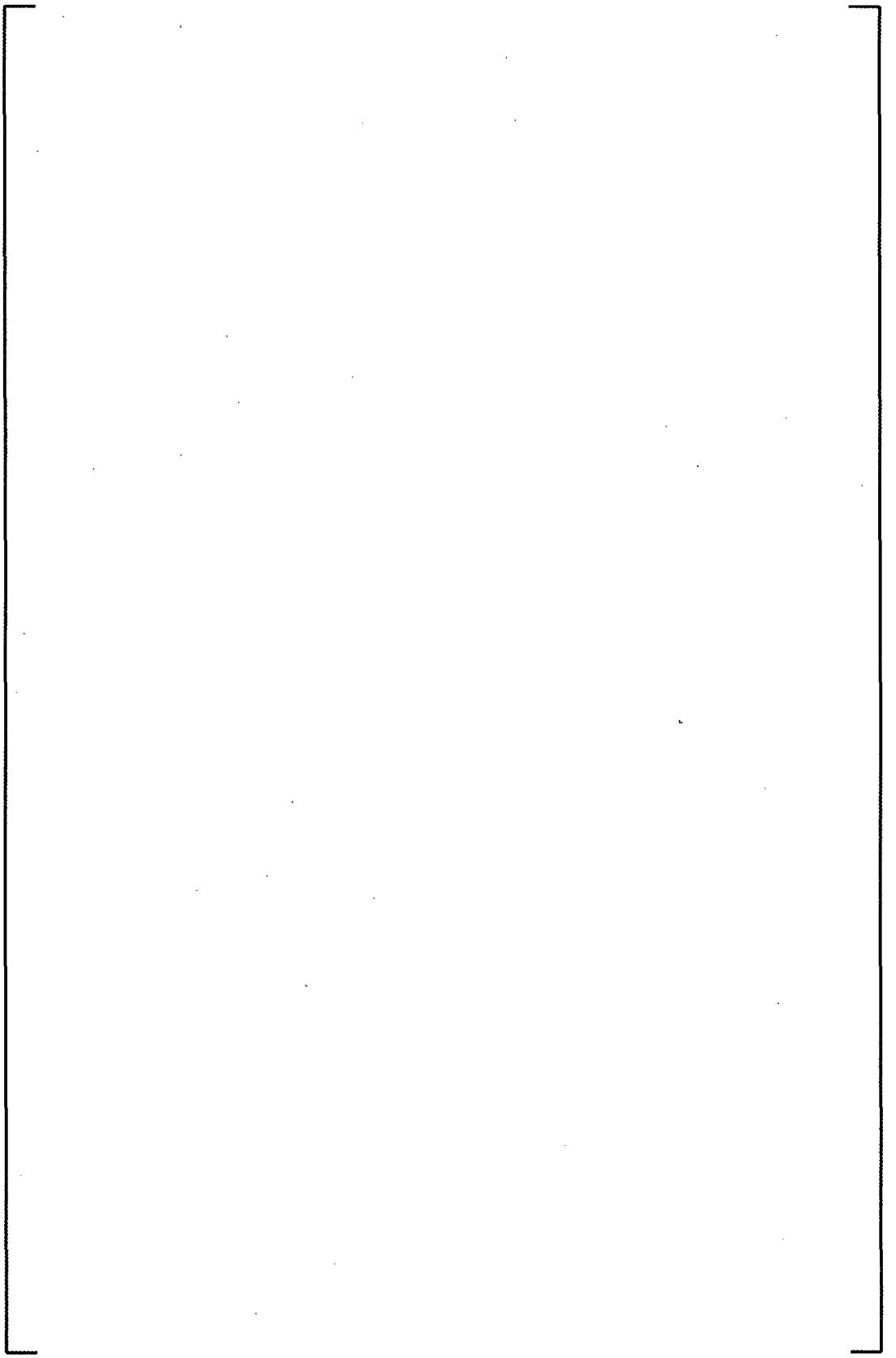
1. Letter, C. Gratton (USNRC) to R.M. Krich (TVA), "Browns Ferry Nuclear Plant, Unit 1 – Request for Additional Information Regarding Technical Specification TS-473, AREVA Fuel Transition (TAC NO. ME3775)," August 23, 2011.

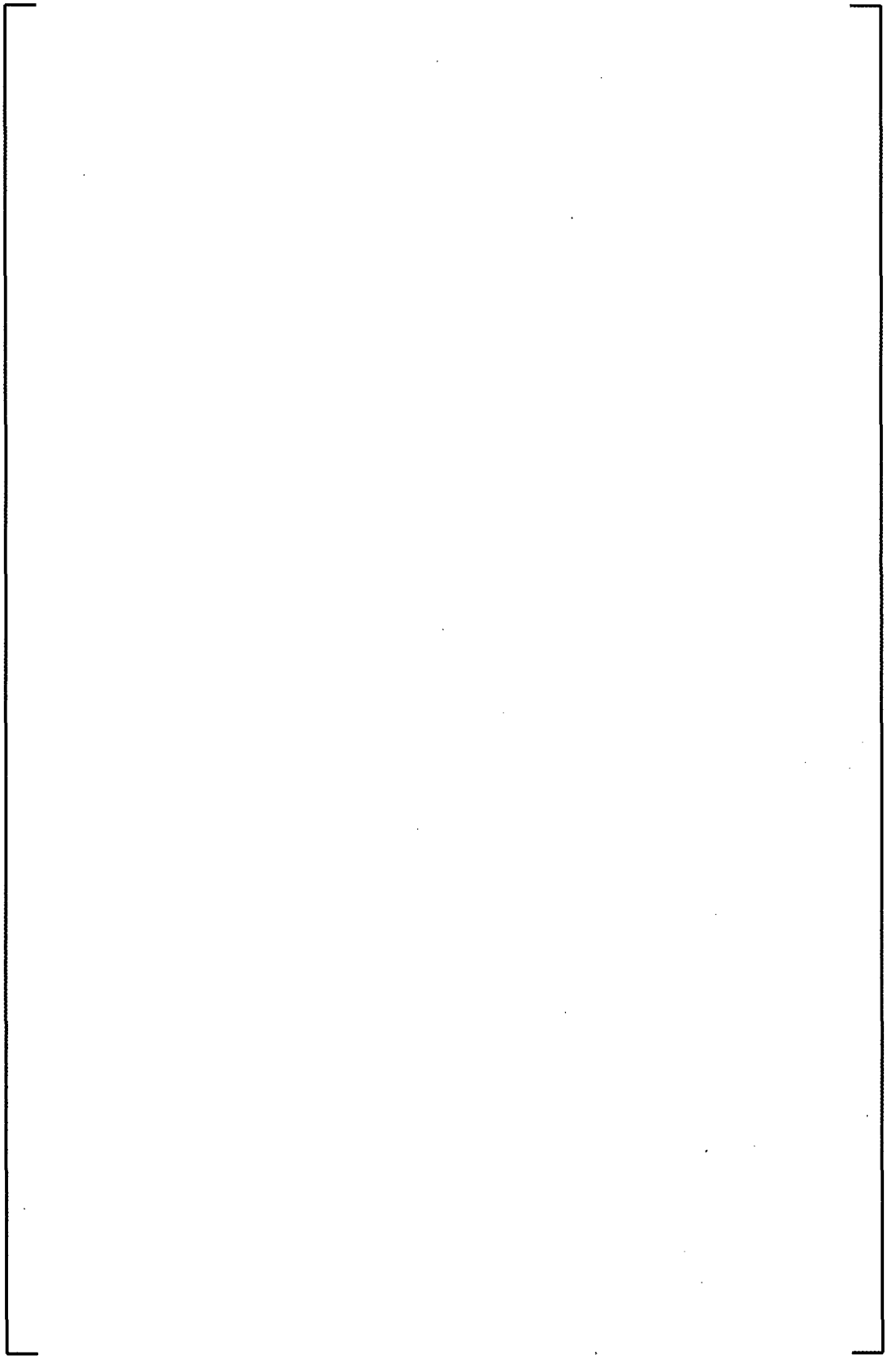
2. ANP-3015(P) Revision 0, *Browns Ferry Units 1, 2, and 3 LOCA Break Spectrum Analysis,* AREVA NP, September 2011.

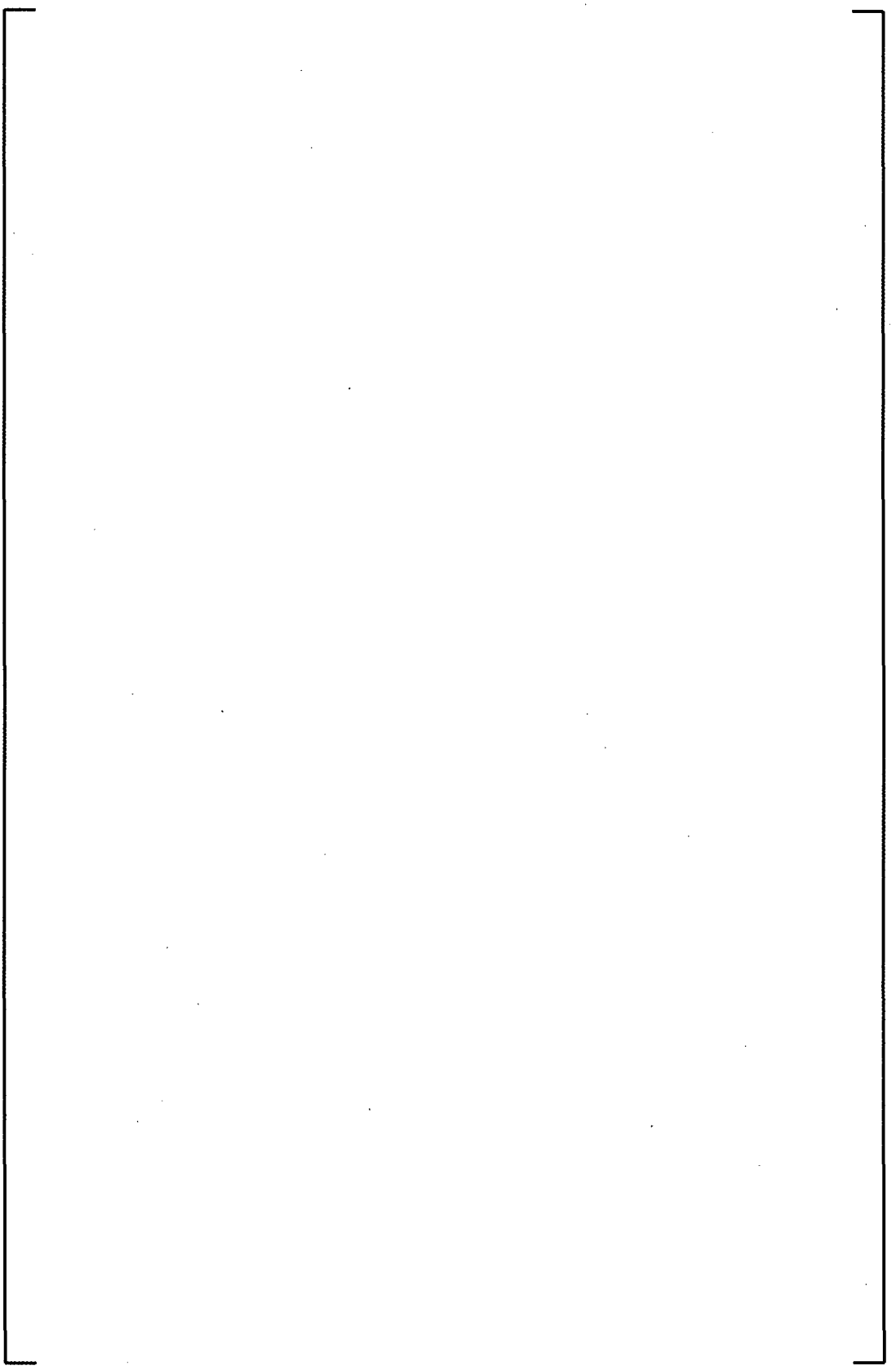
Appendix A TLO Recirculation Line Break With [ ] 0.21 ft^2 Split Supplemental Information

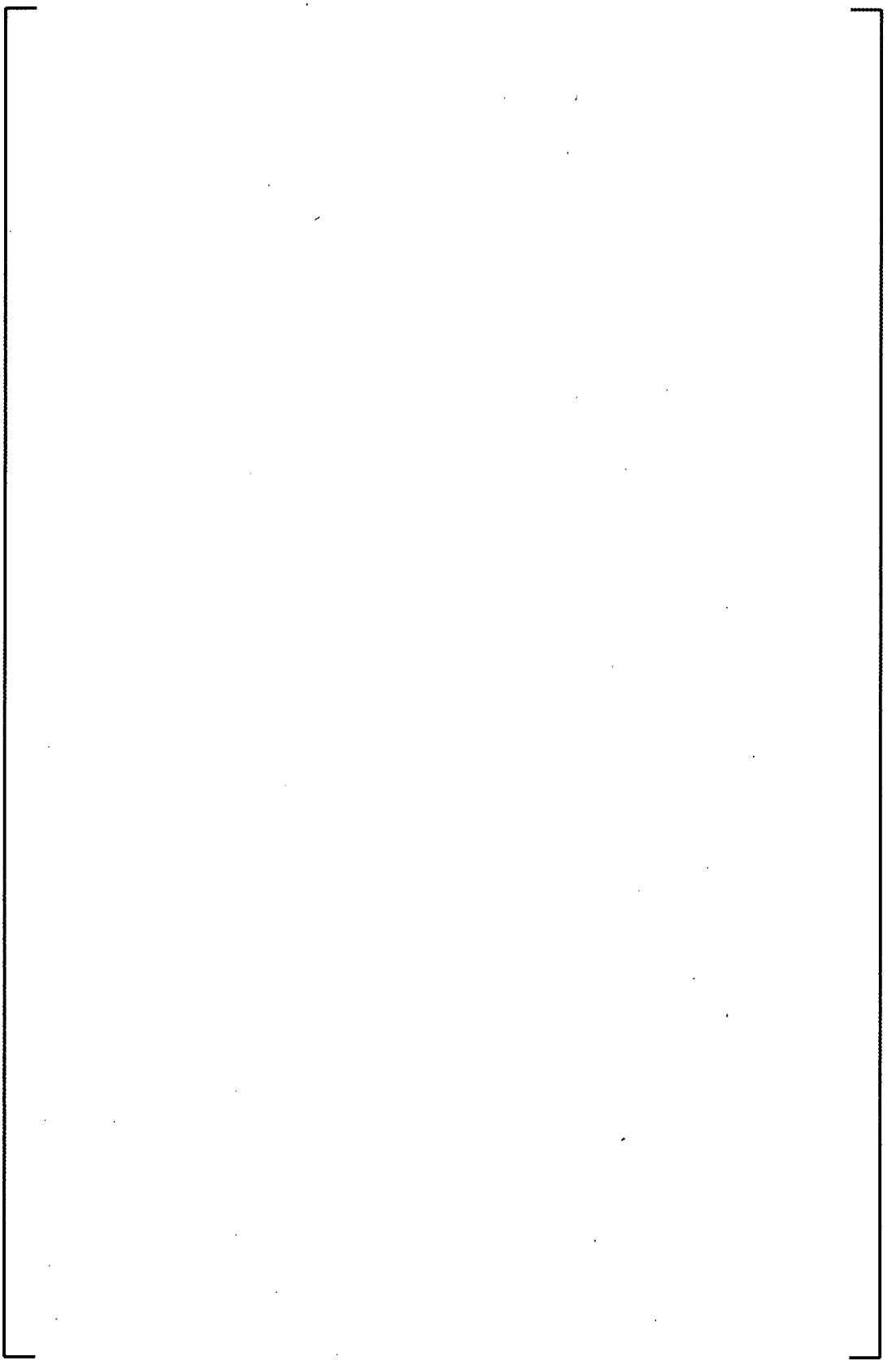
[ ]

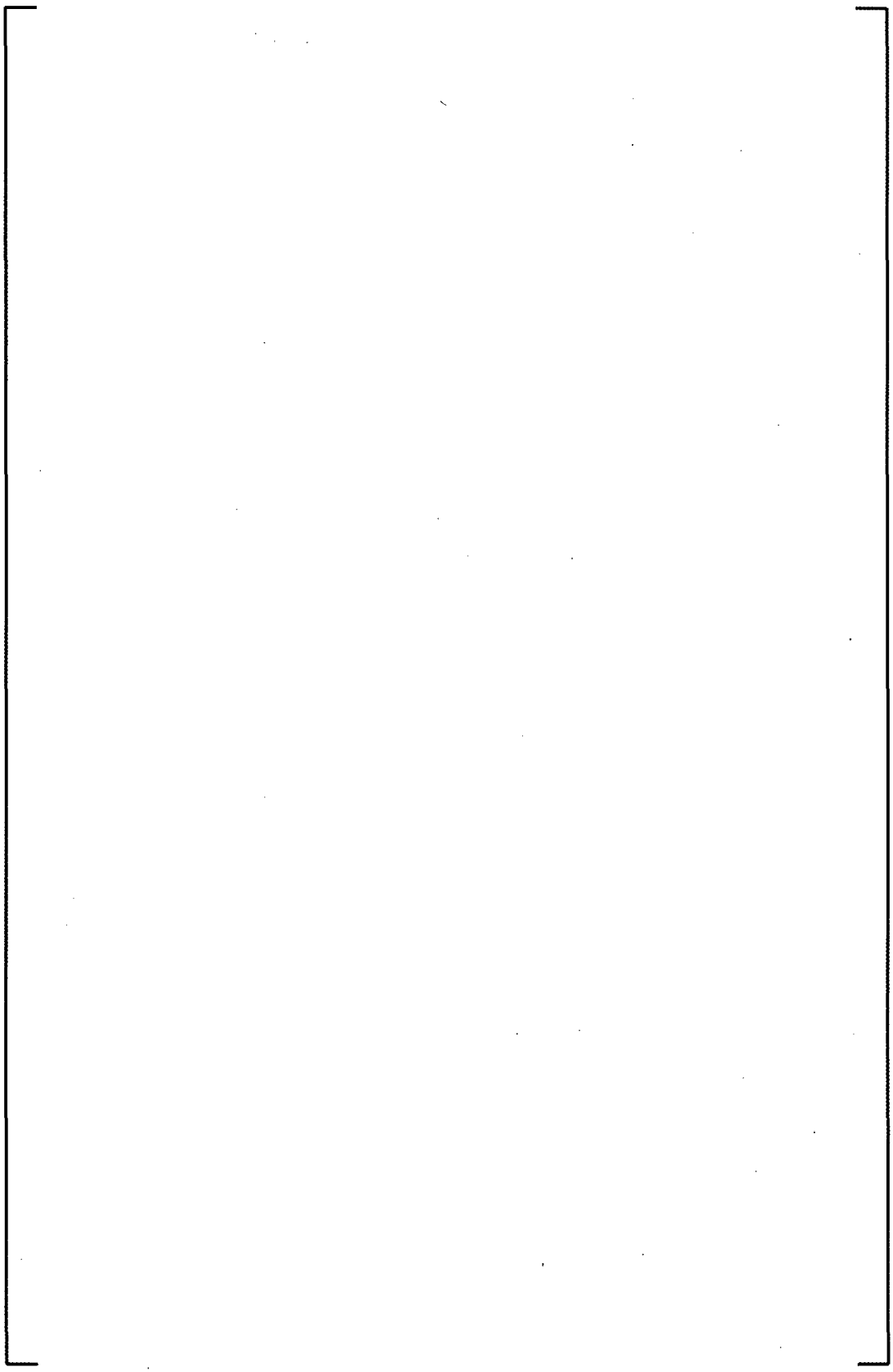


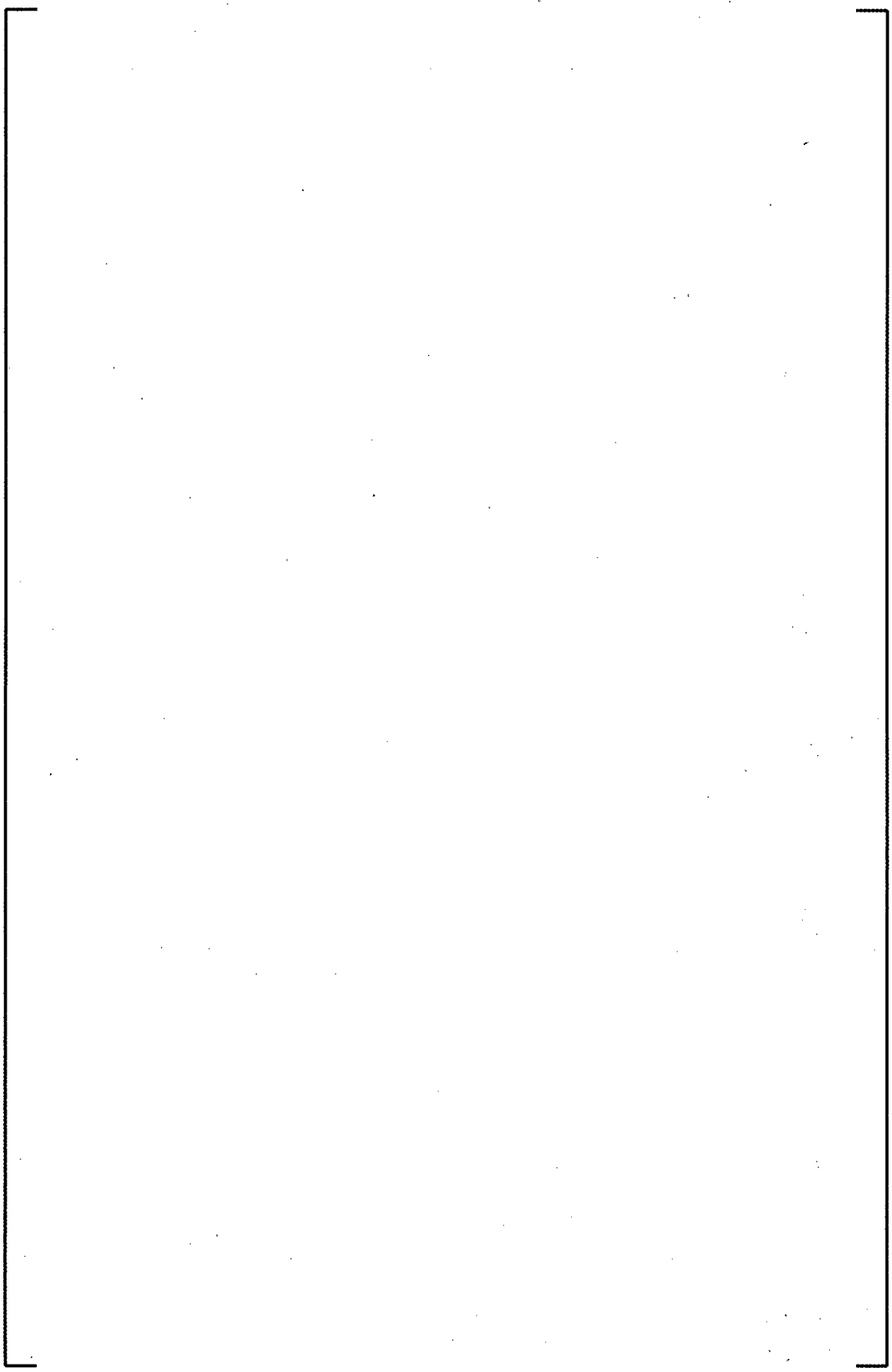


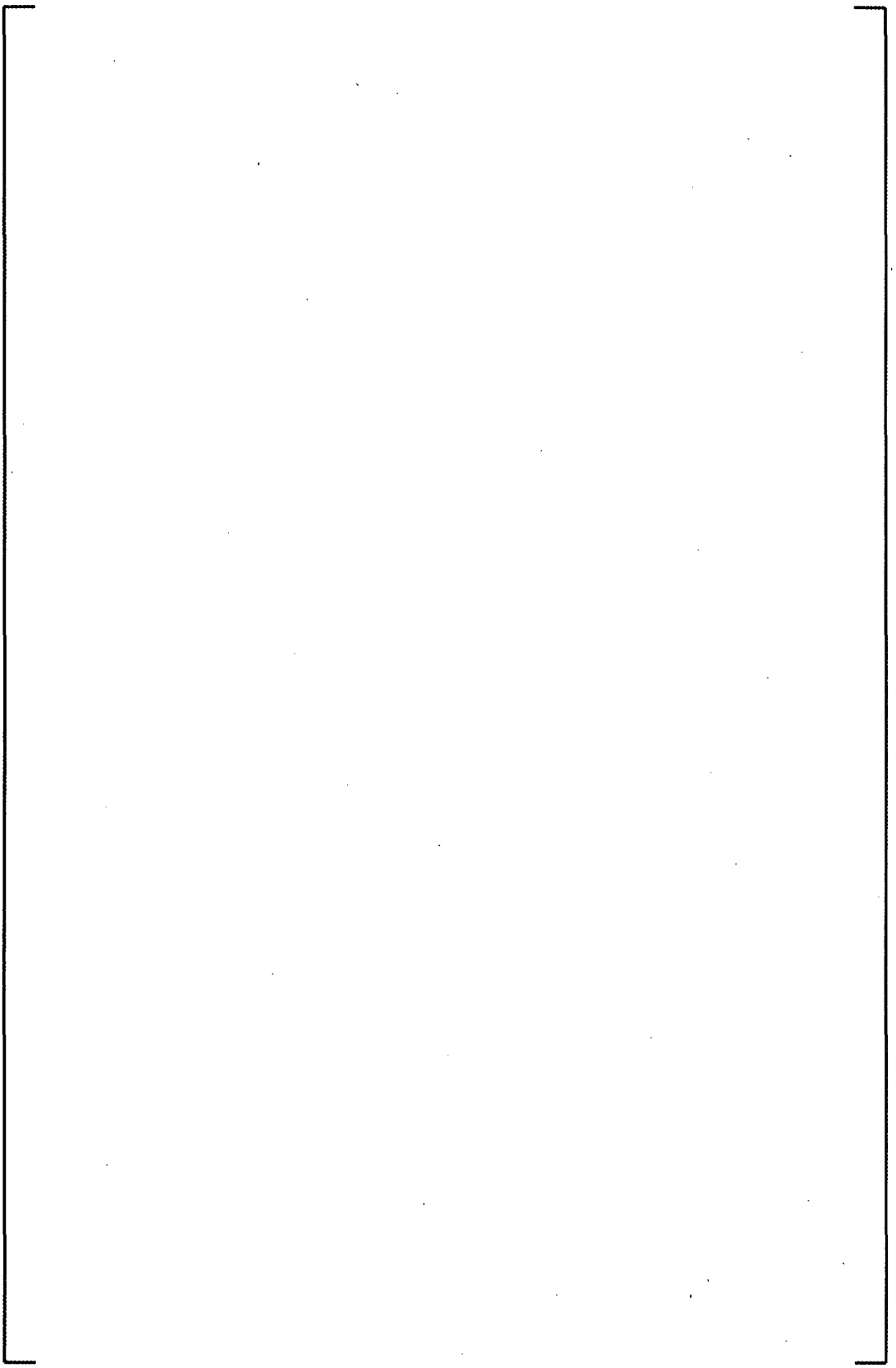


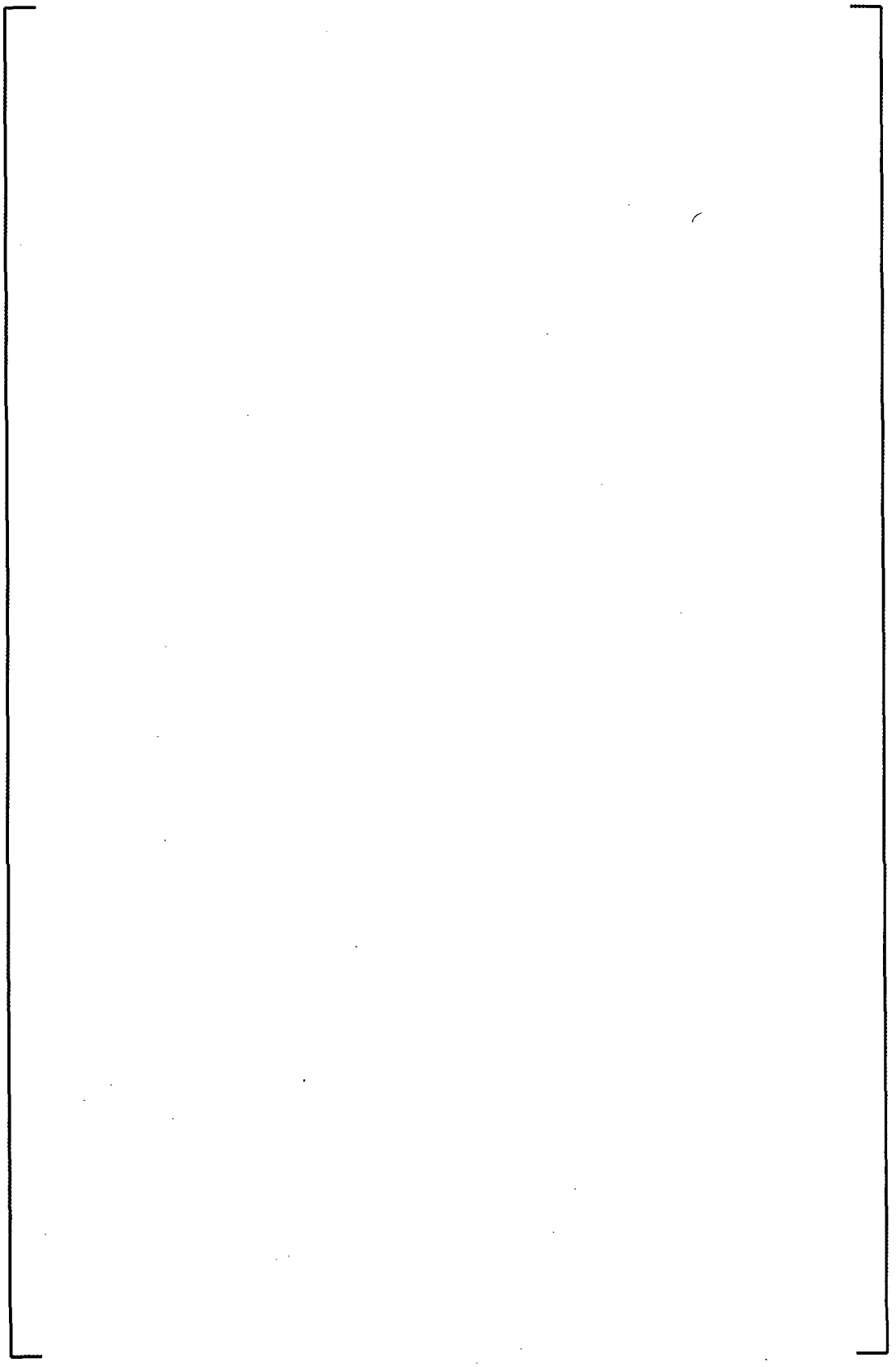


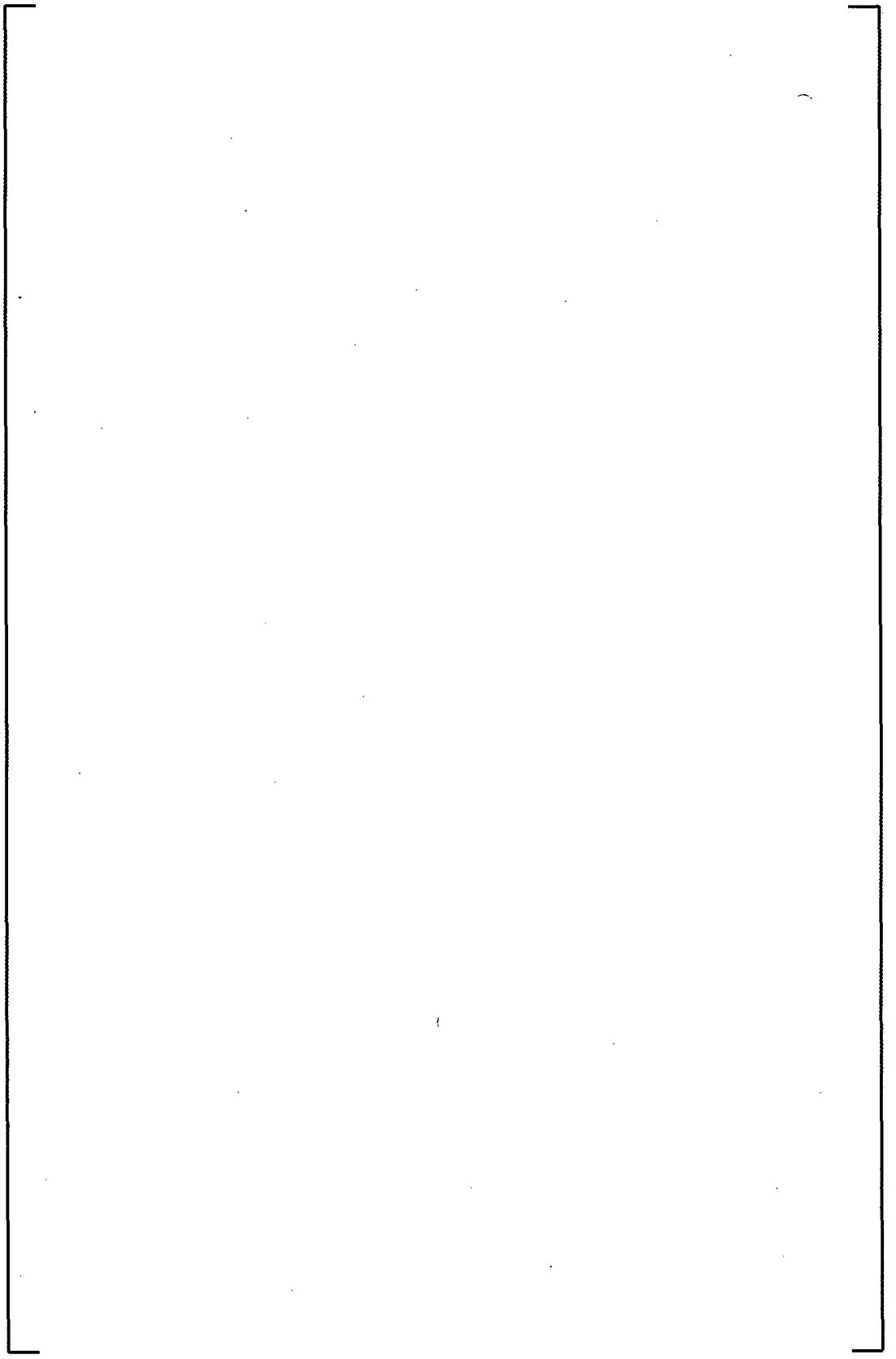












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Appendix B TLO Recirculation Line Break With [ ] 0.05 ft^2 Split Supplemental Information

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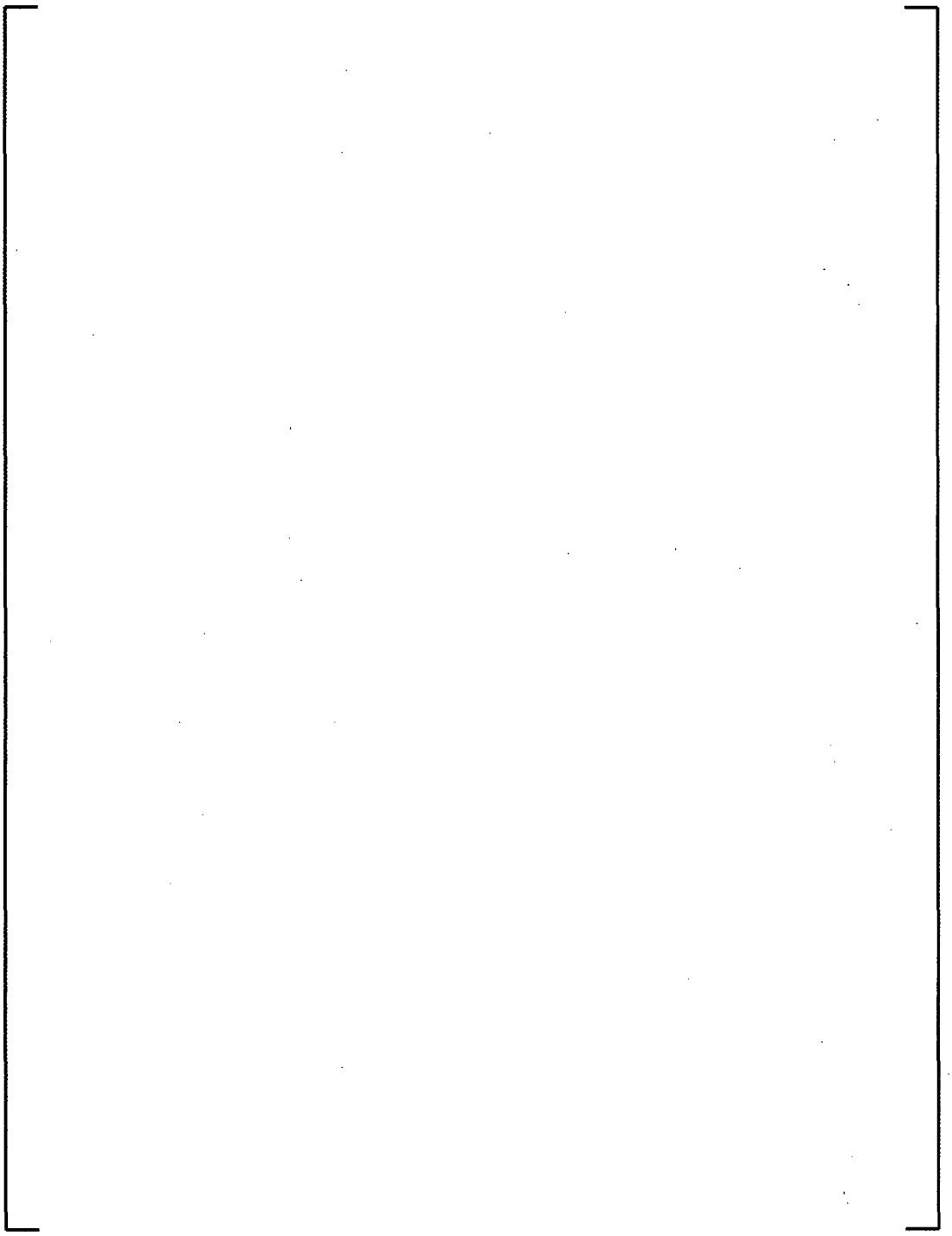

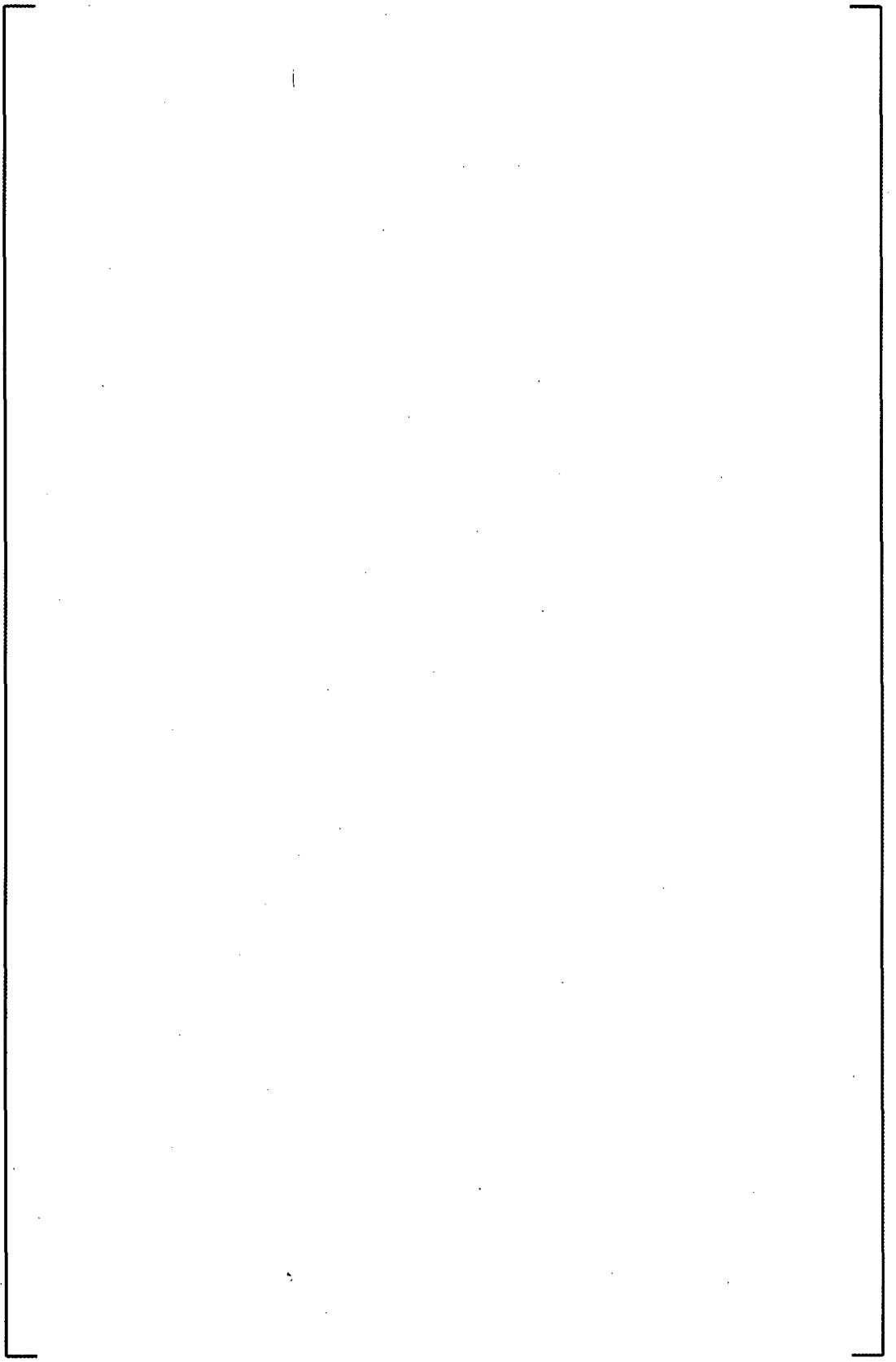

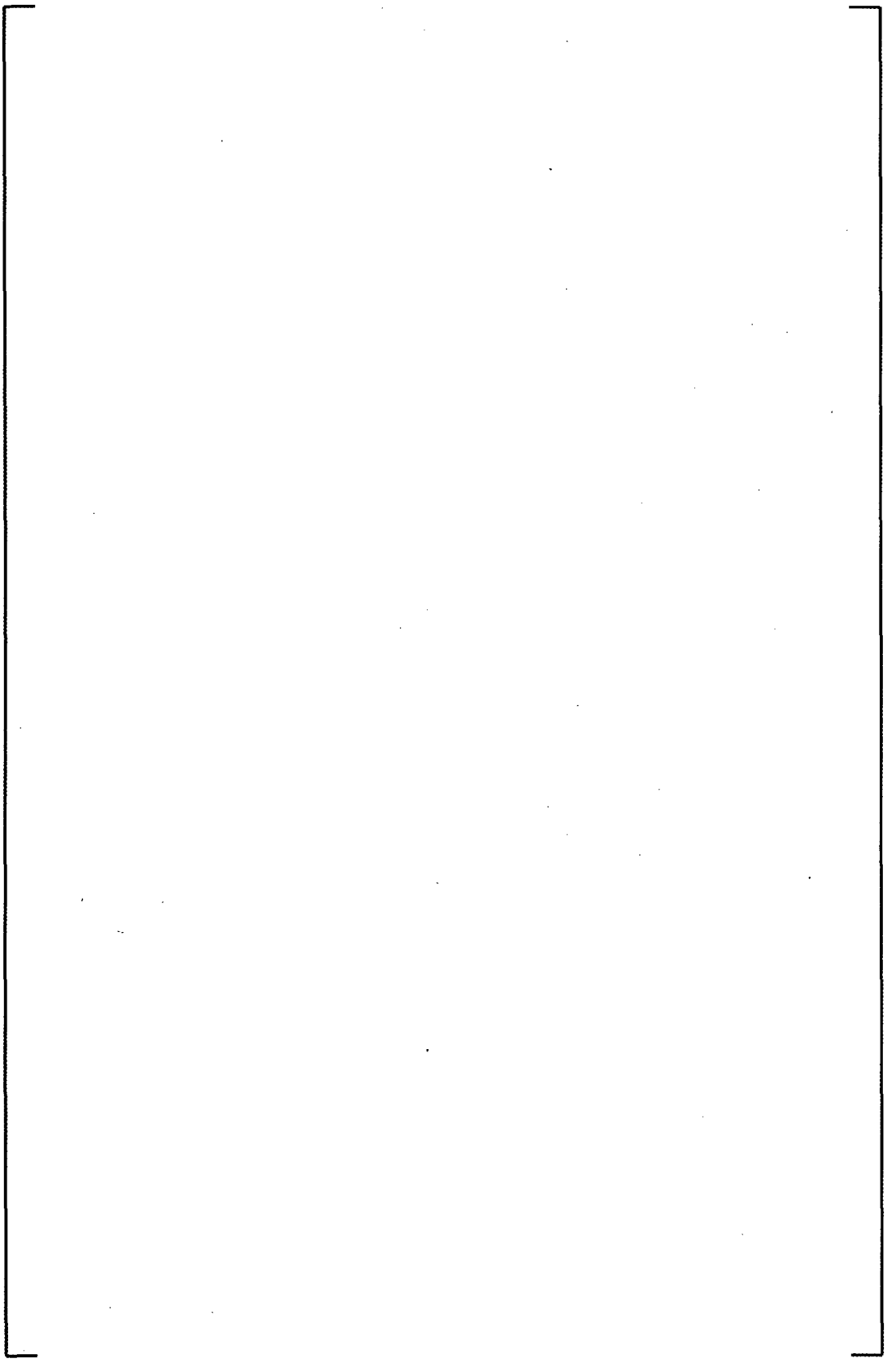

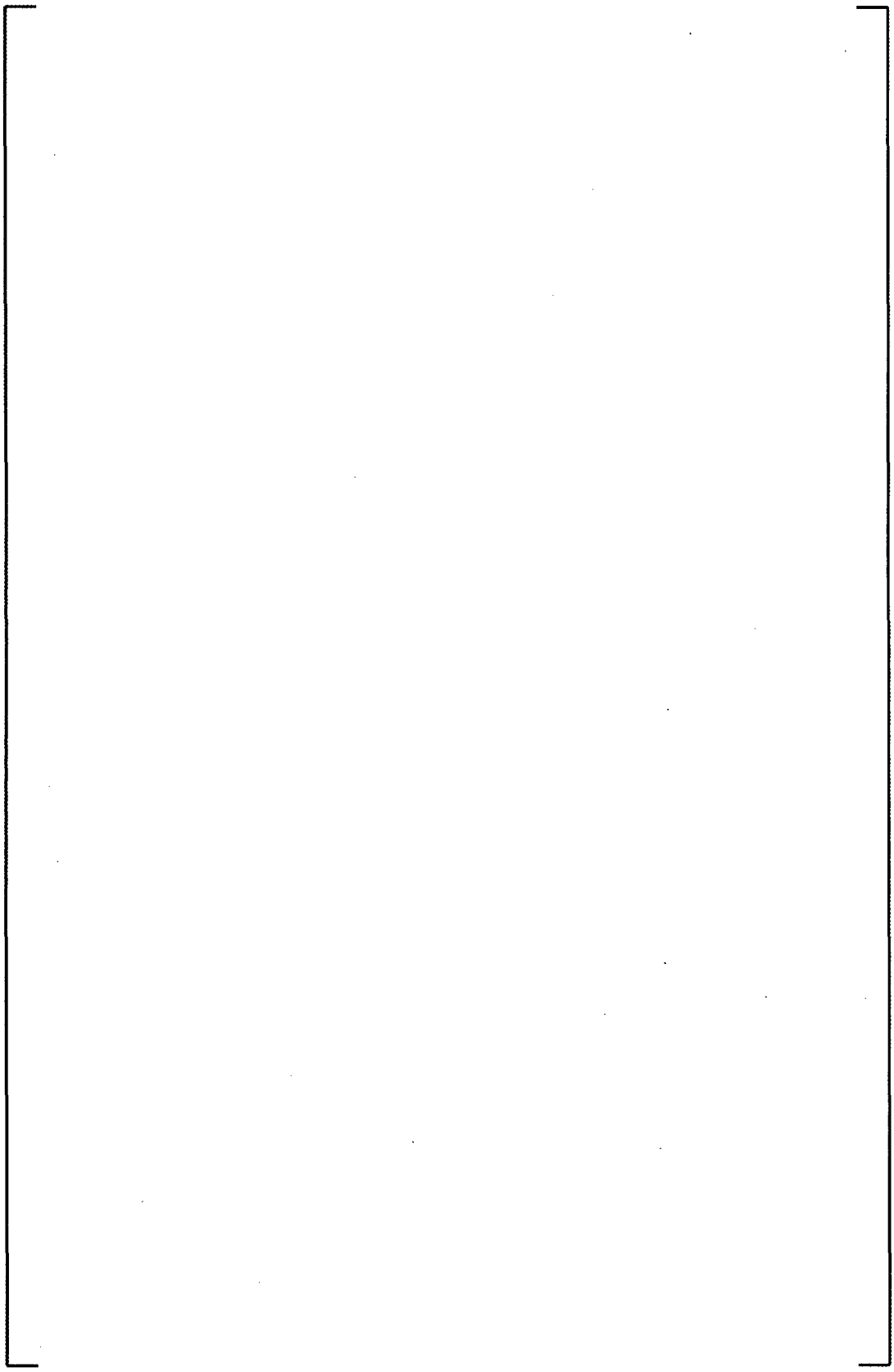

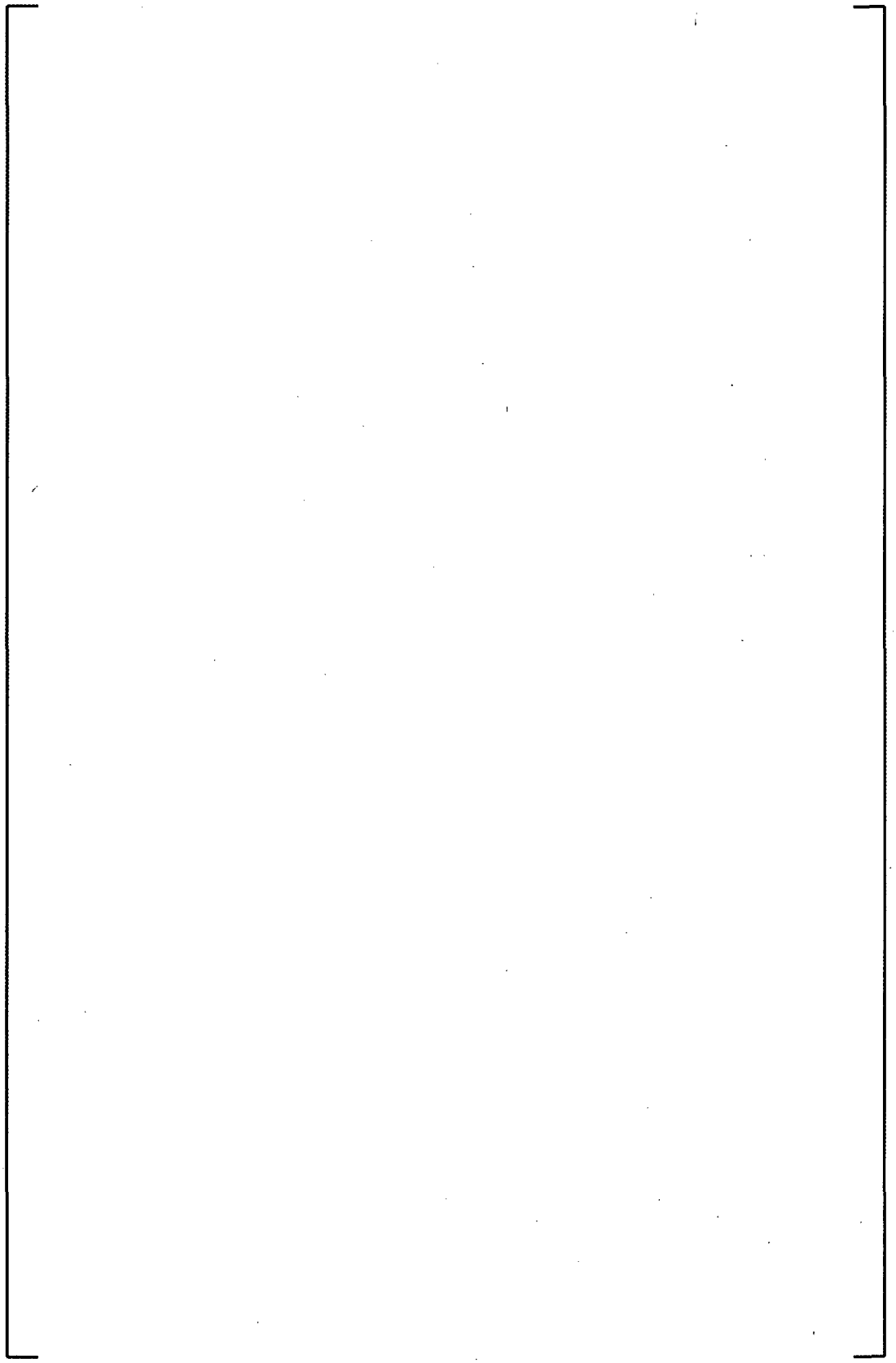

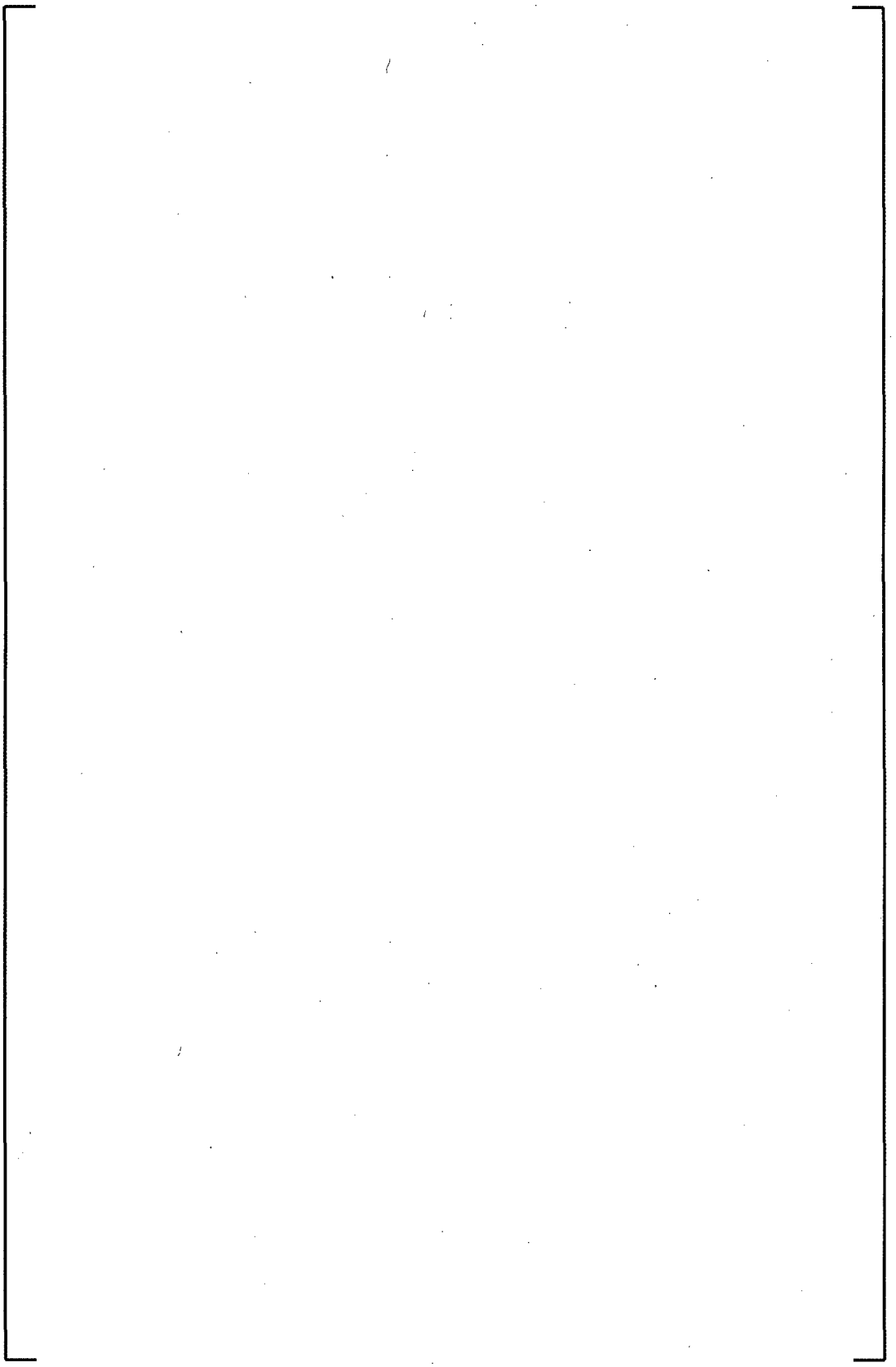

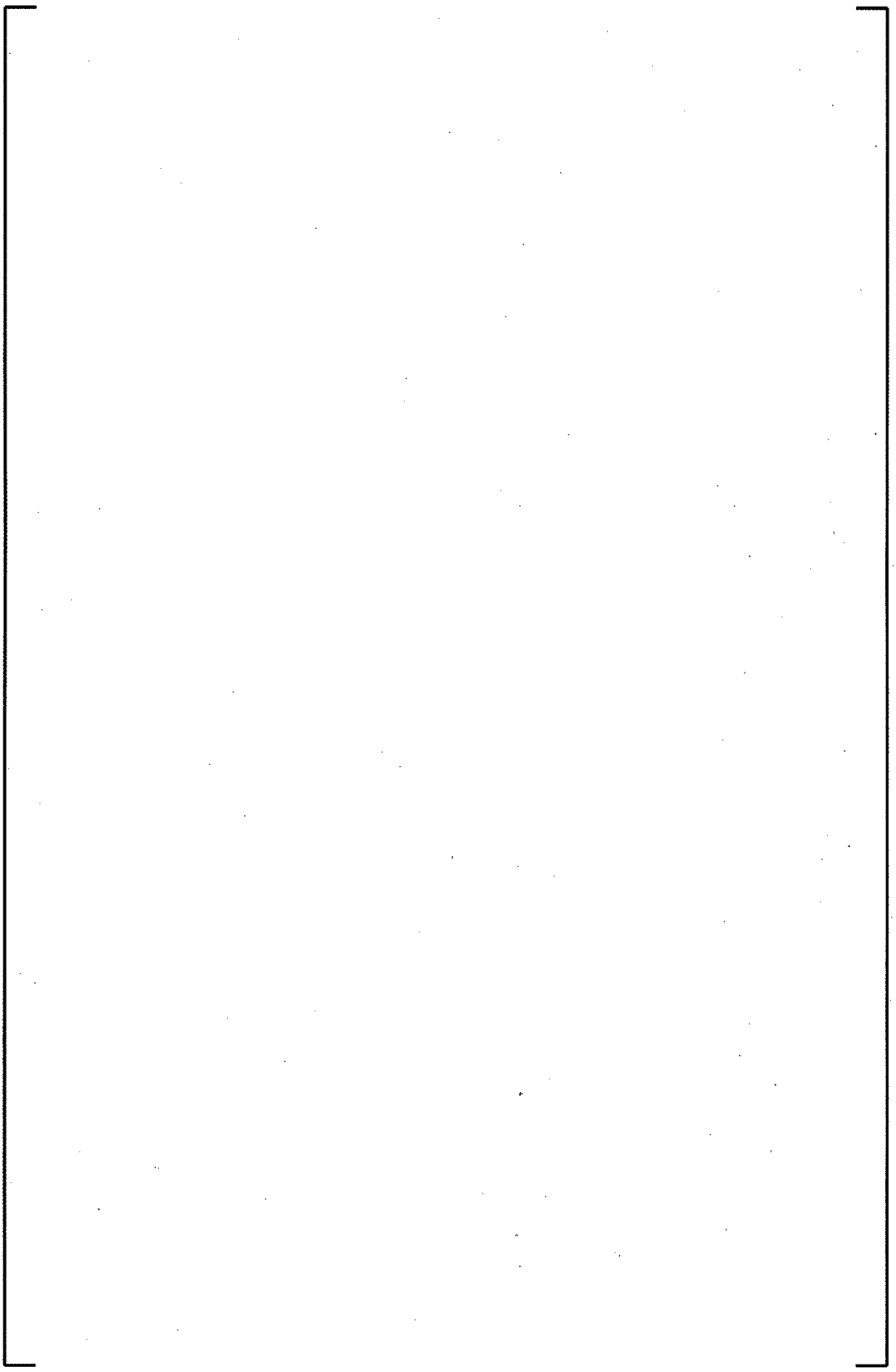

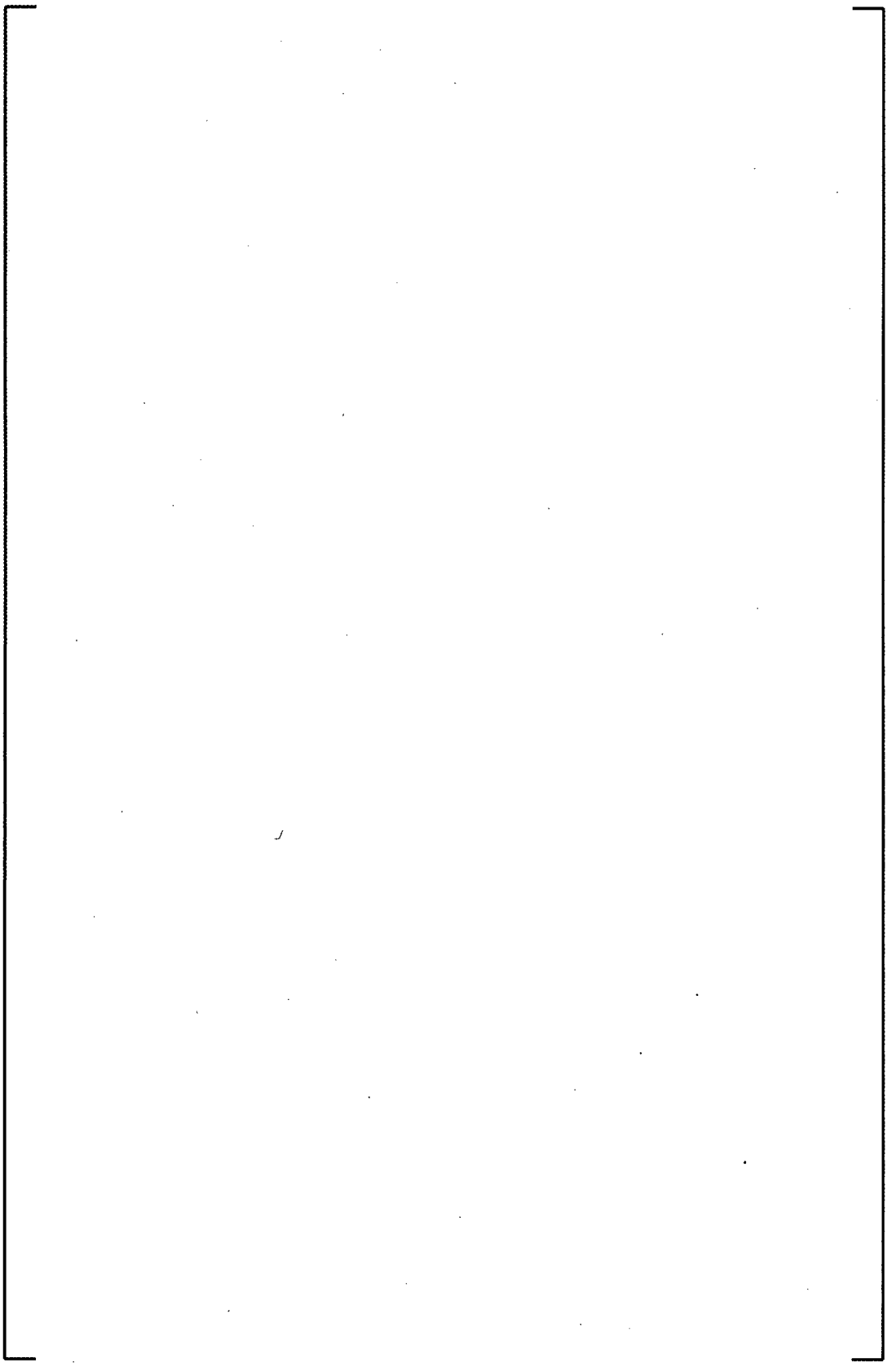

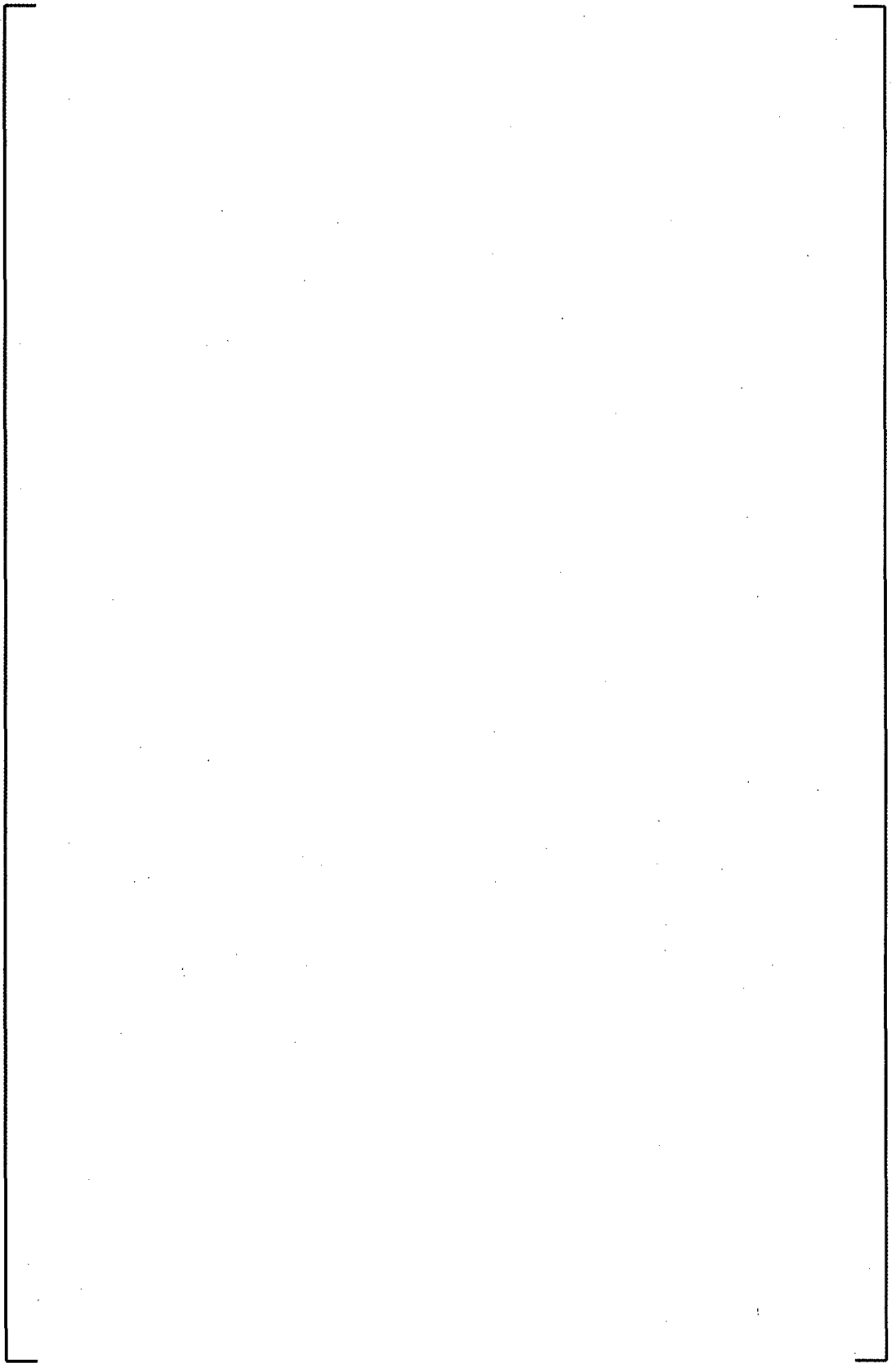

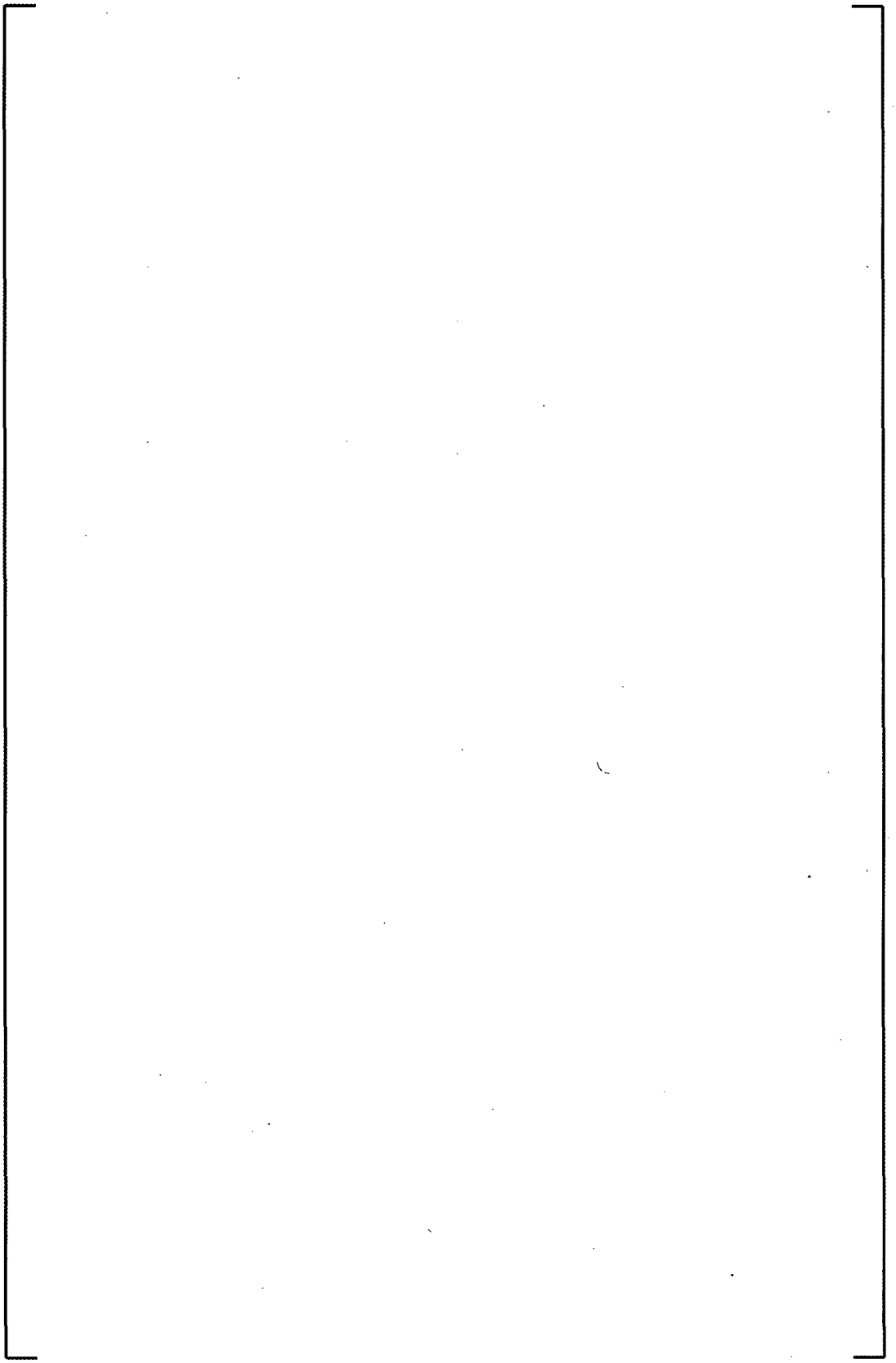

Appendix C TLO Recirculation Line Break With [ ] 0.05 ft^2 Split Supplemental Information

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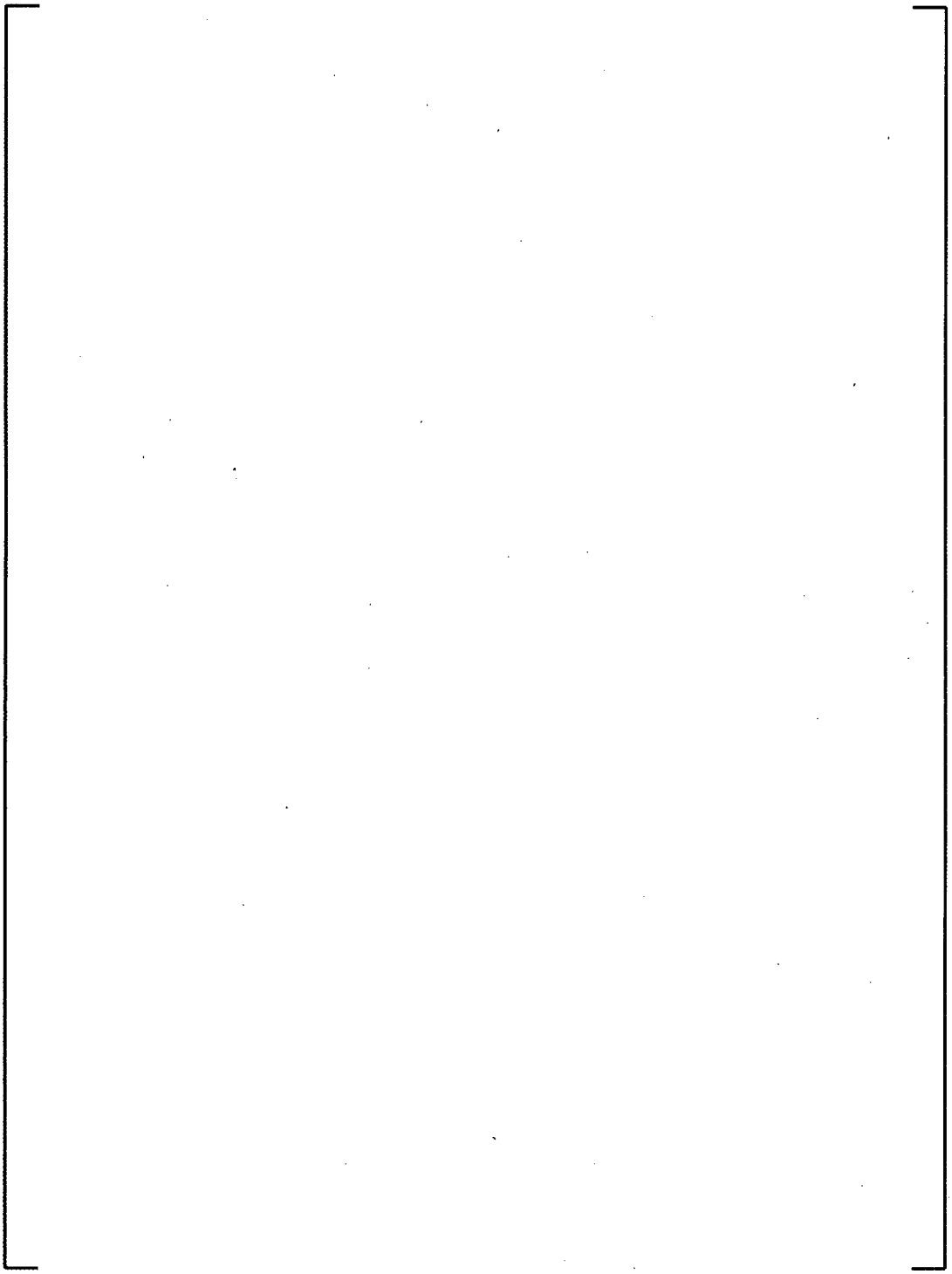

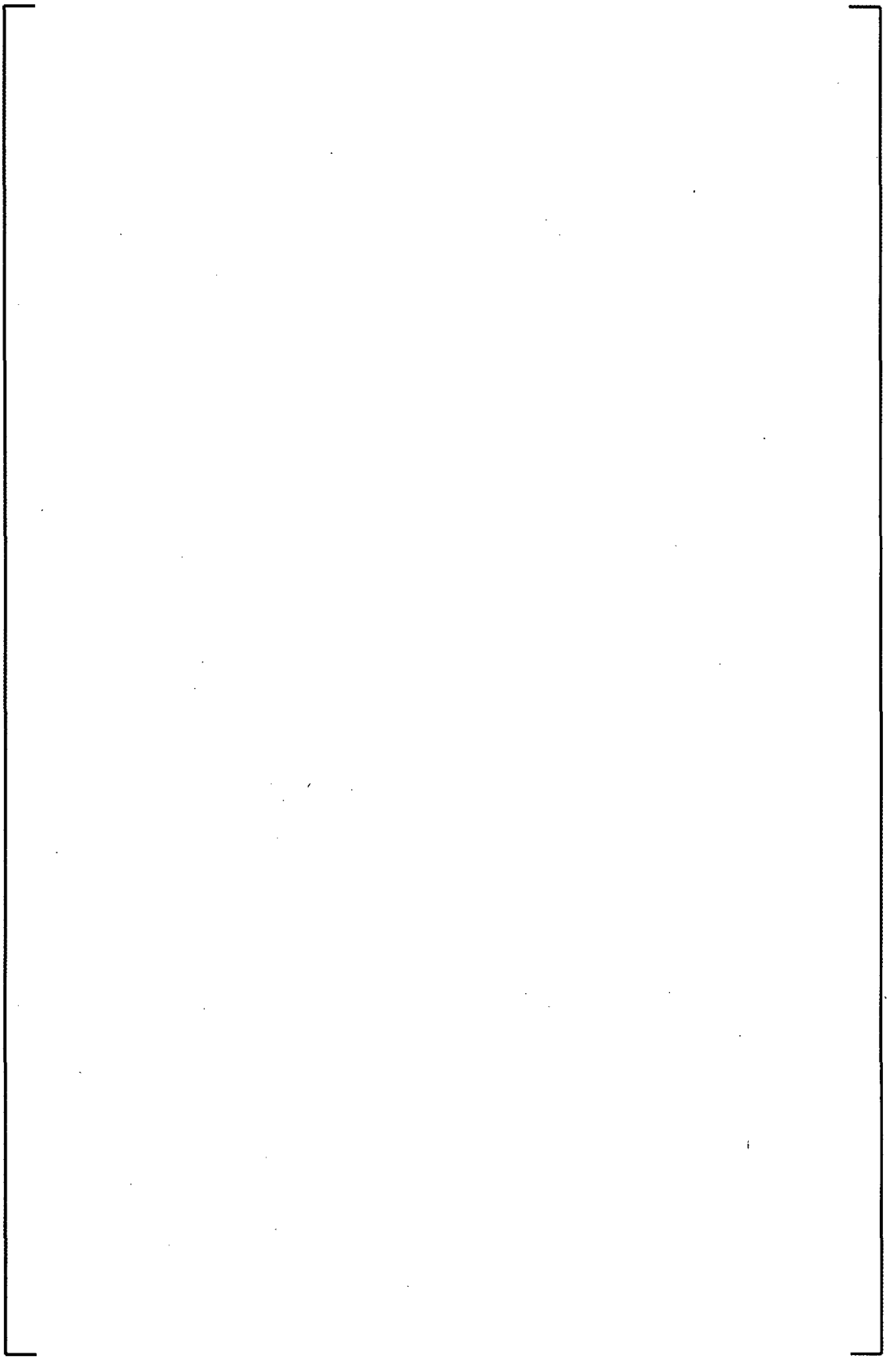

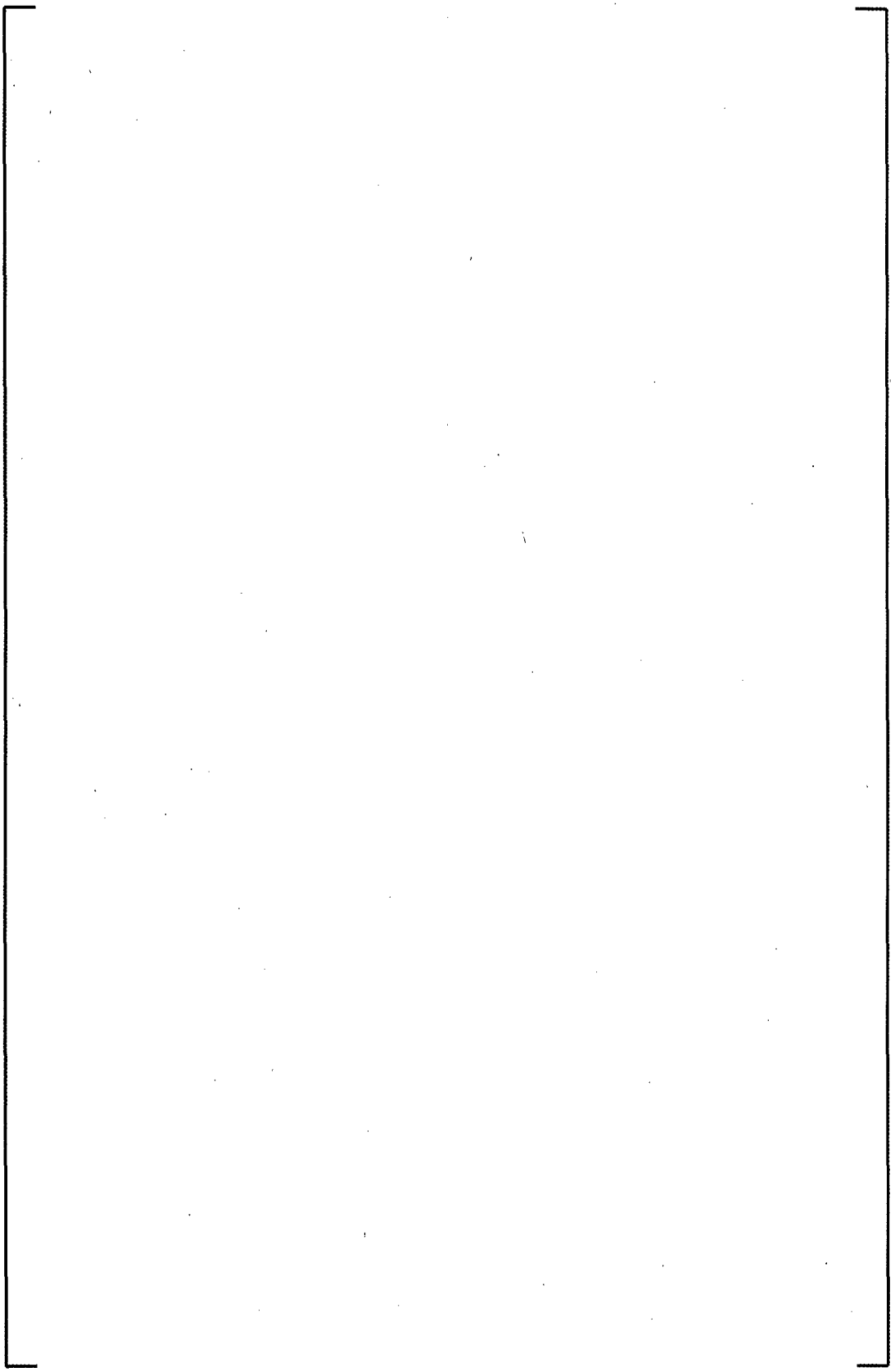

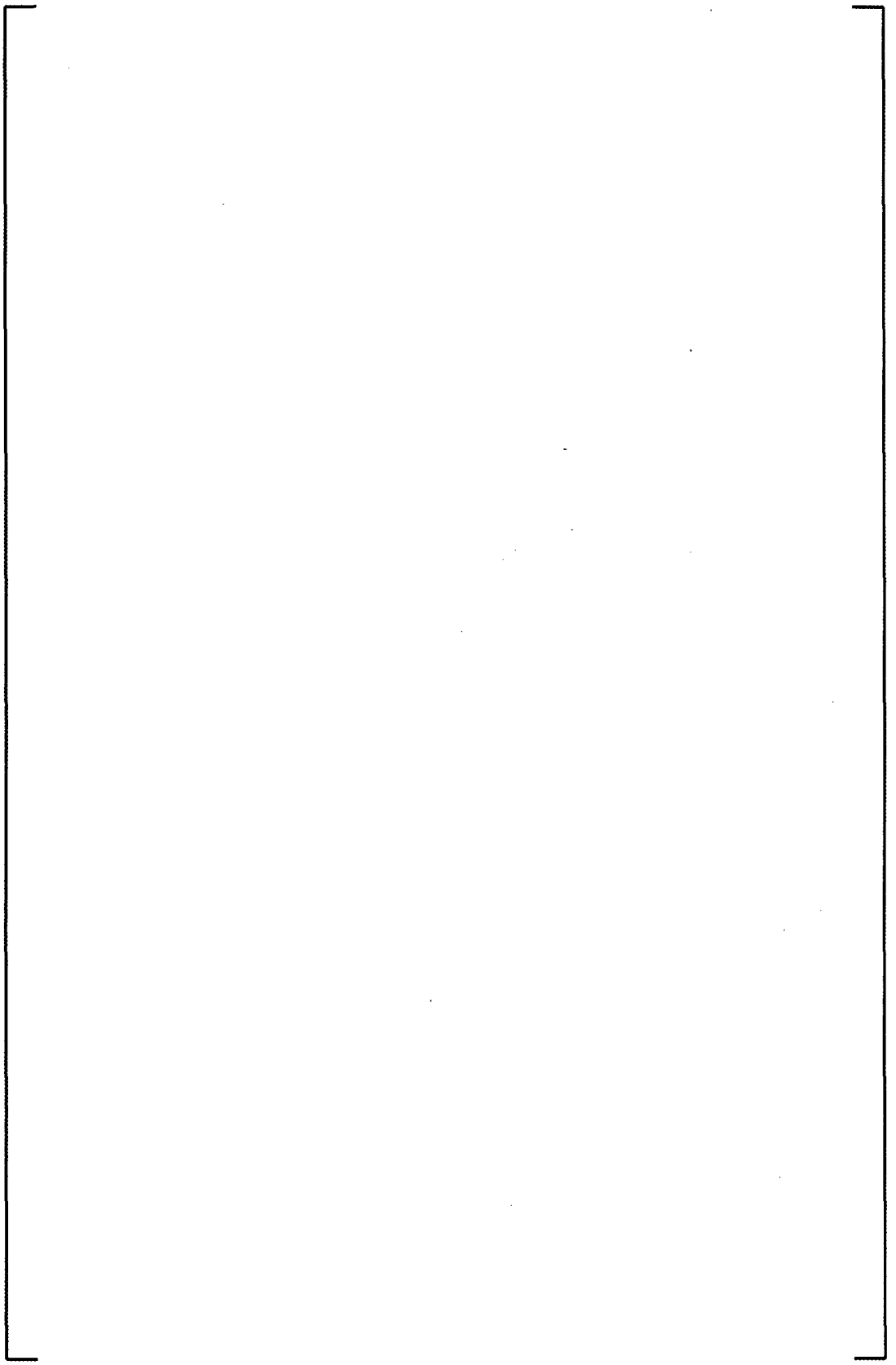

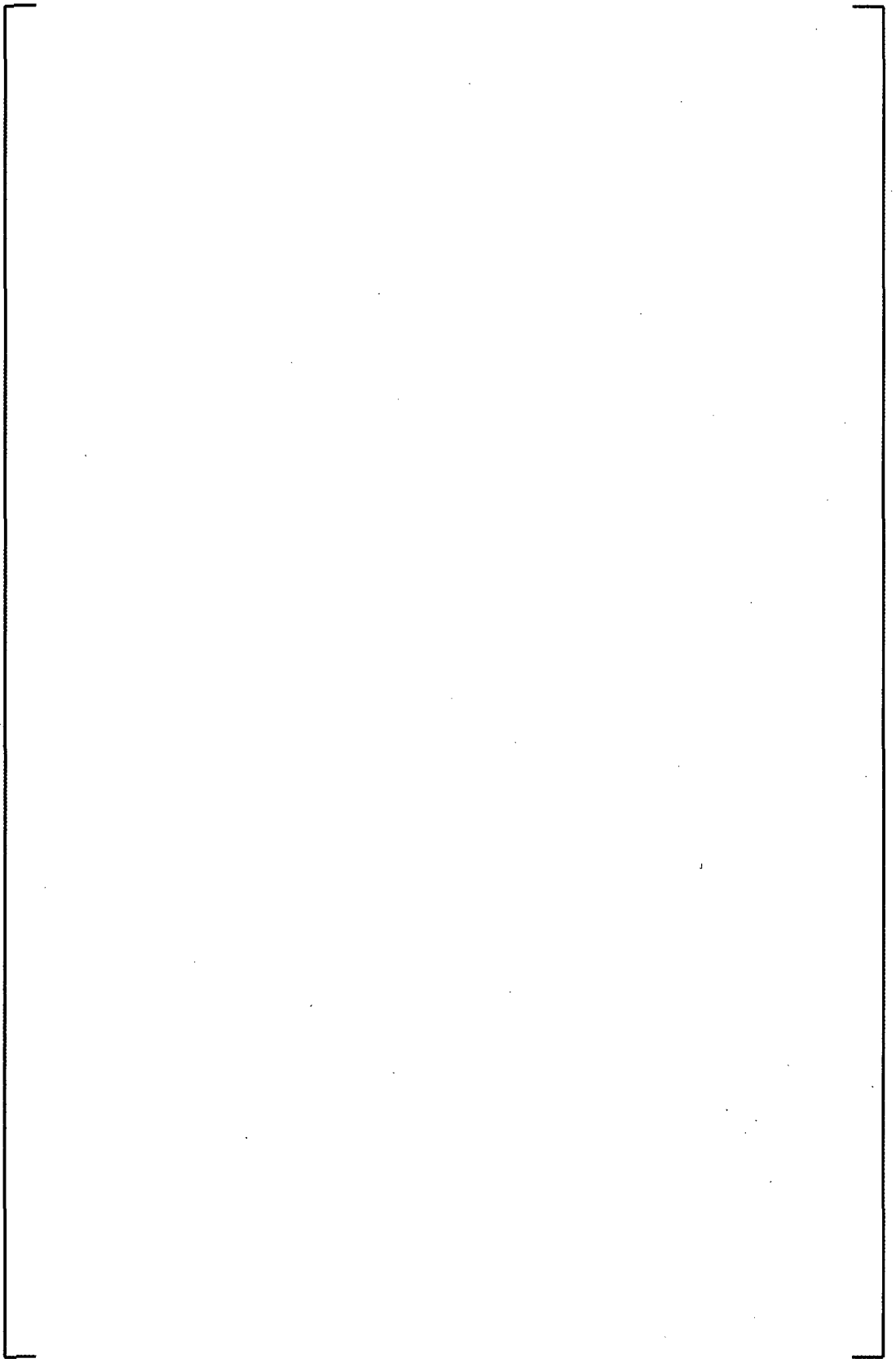

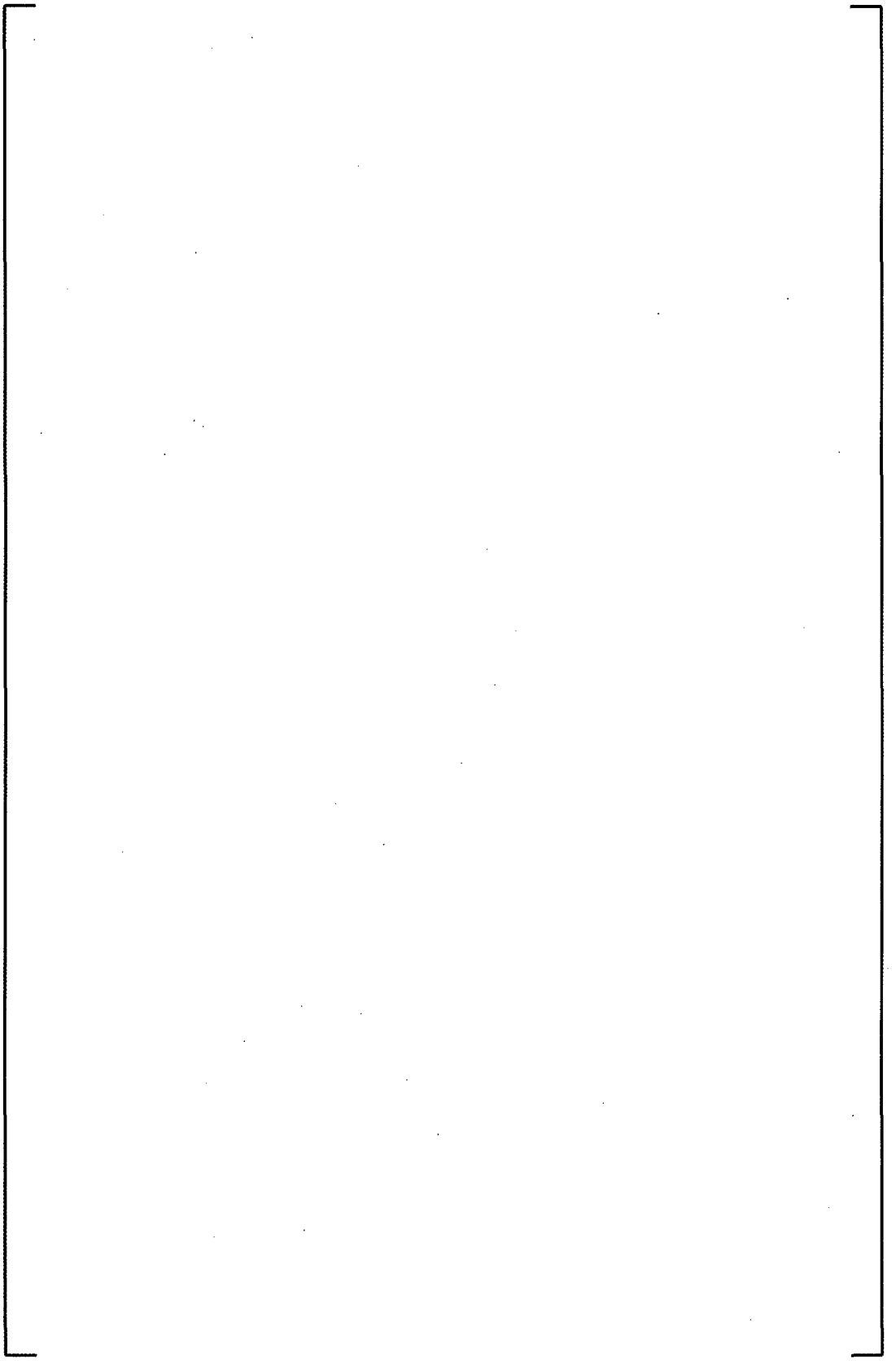

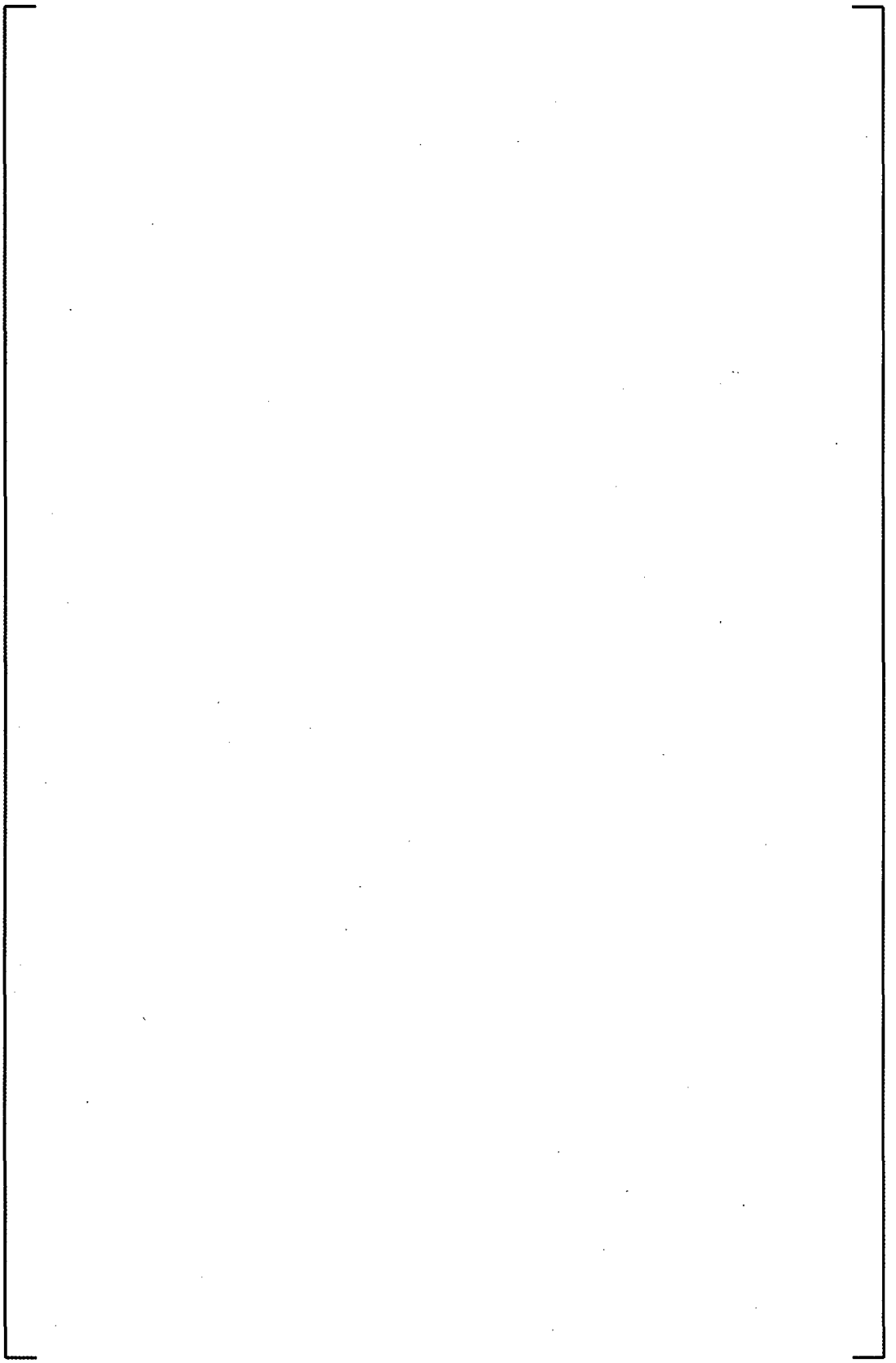

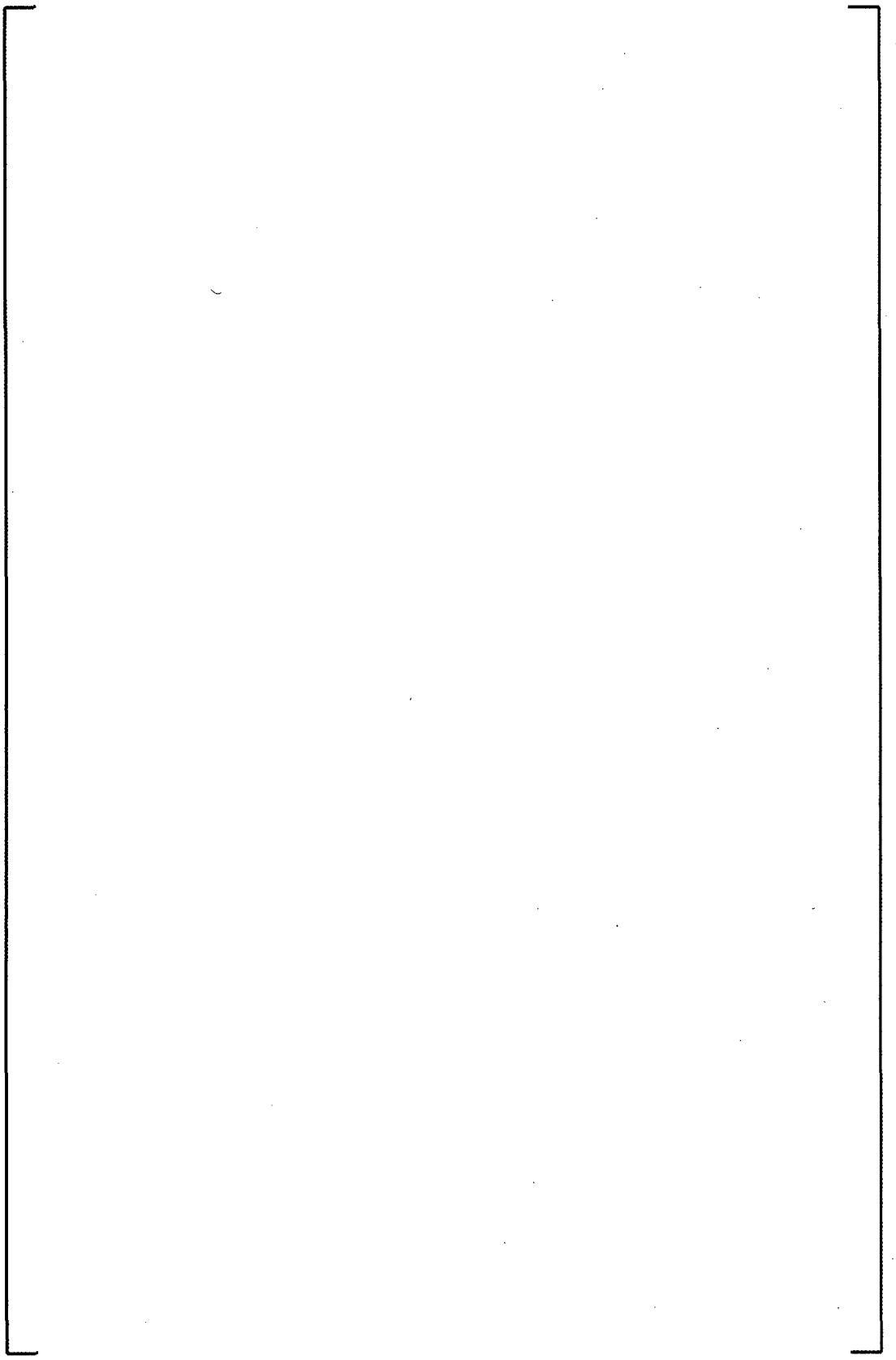

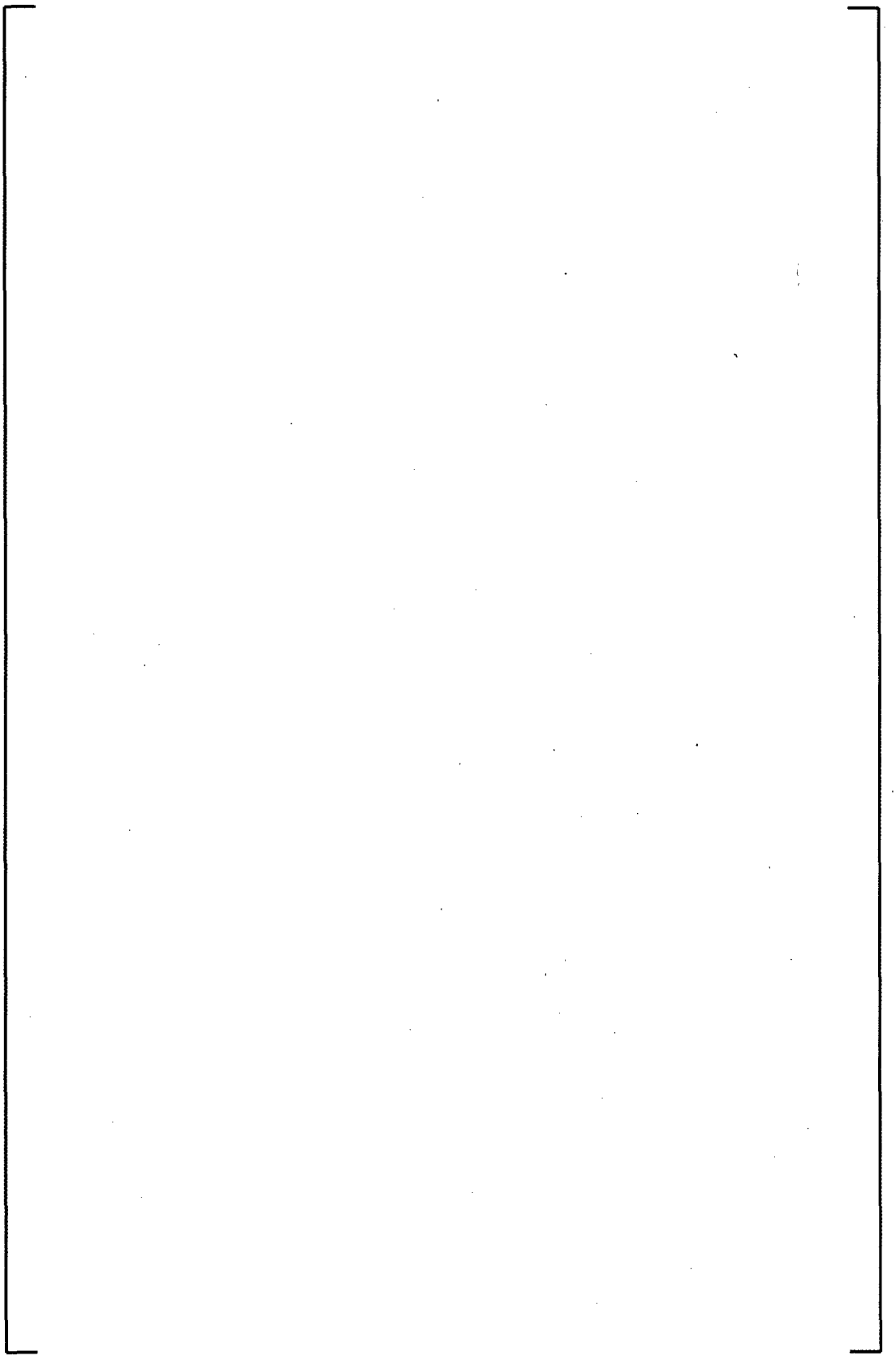

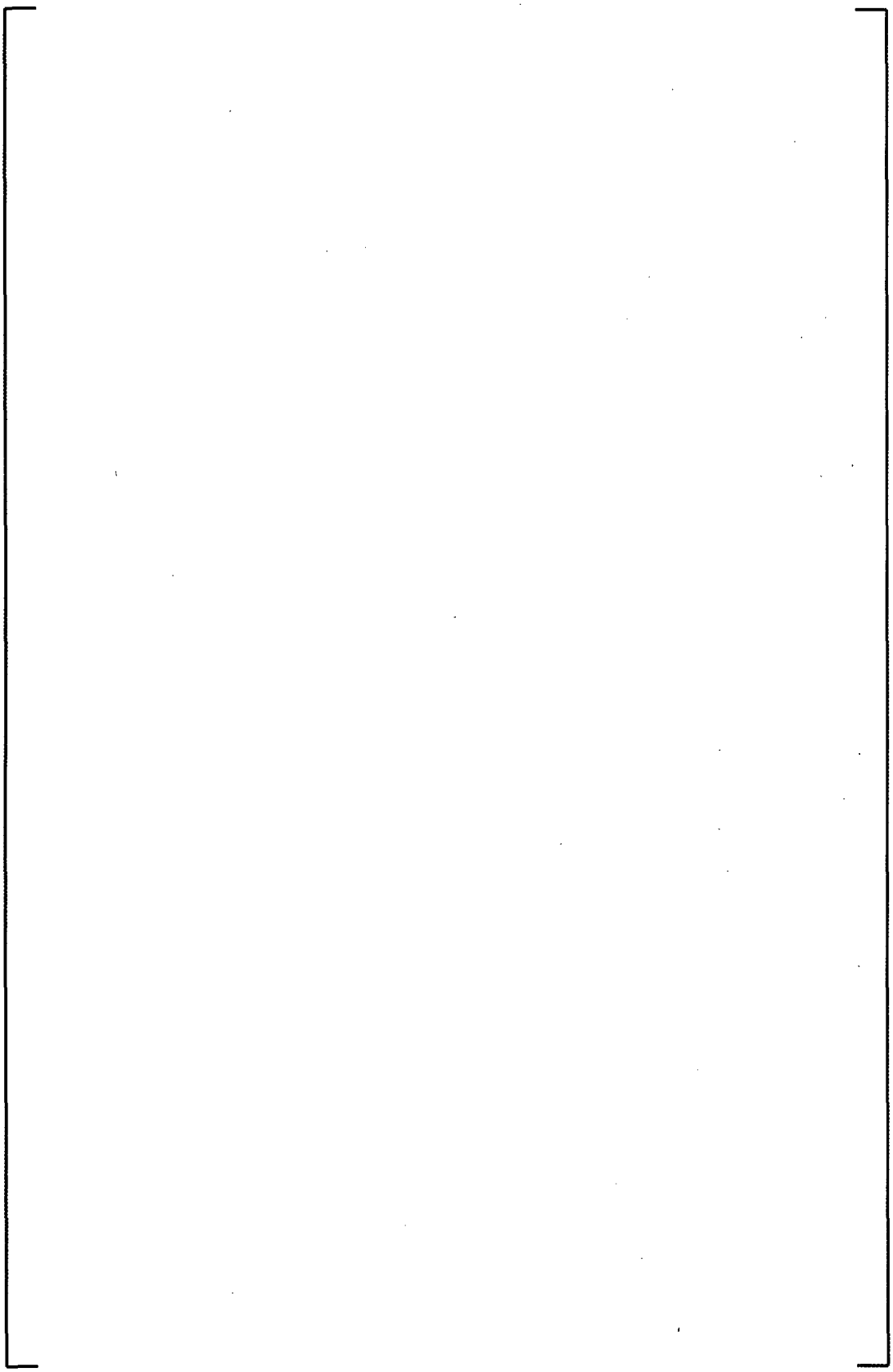

Appendix D Bottom Head Drain Line Break Supplemental Information

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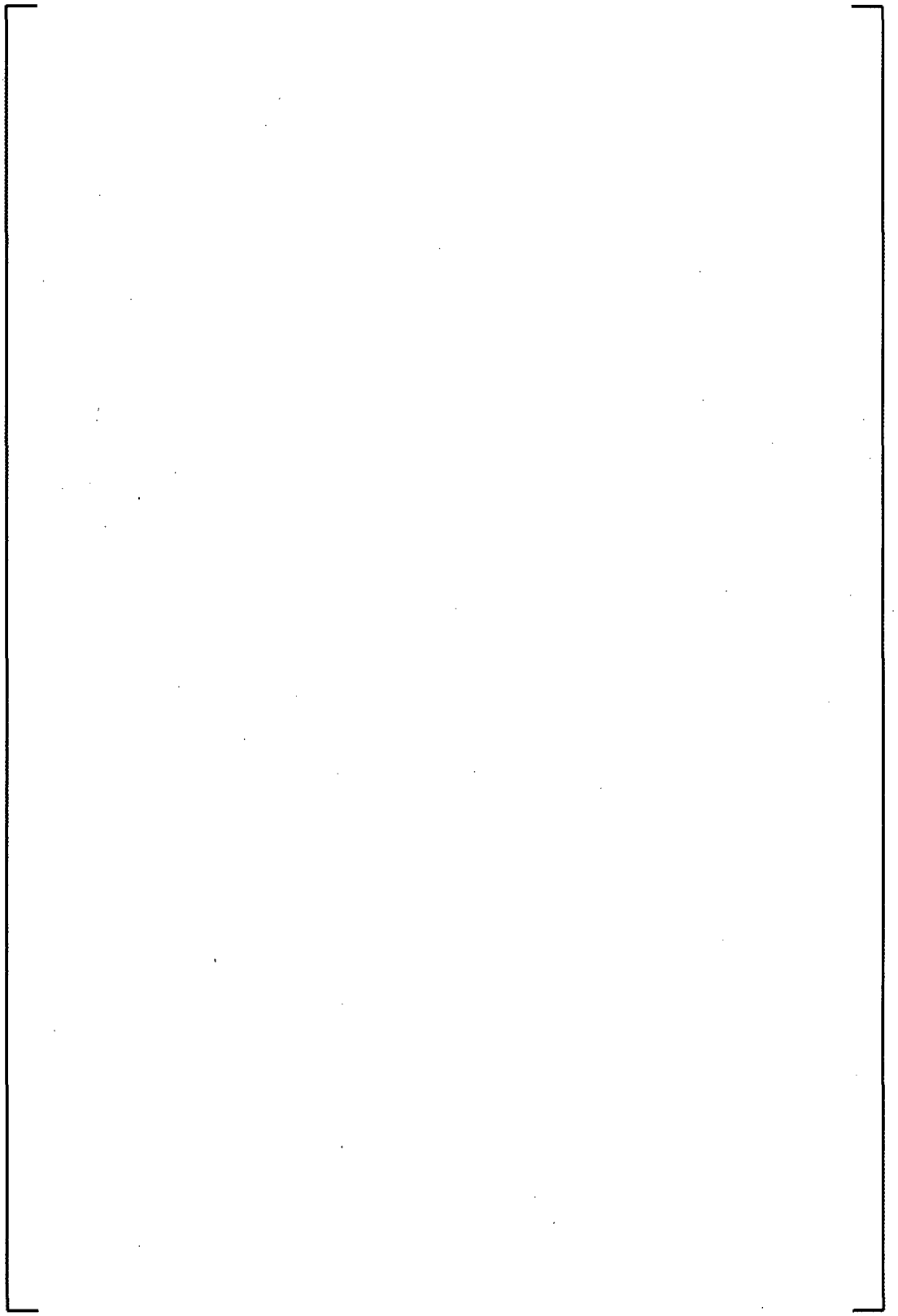
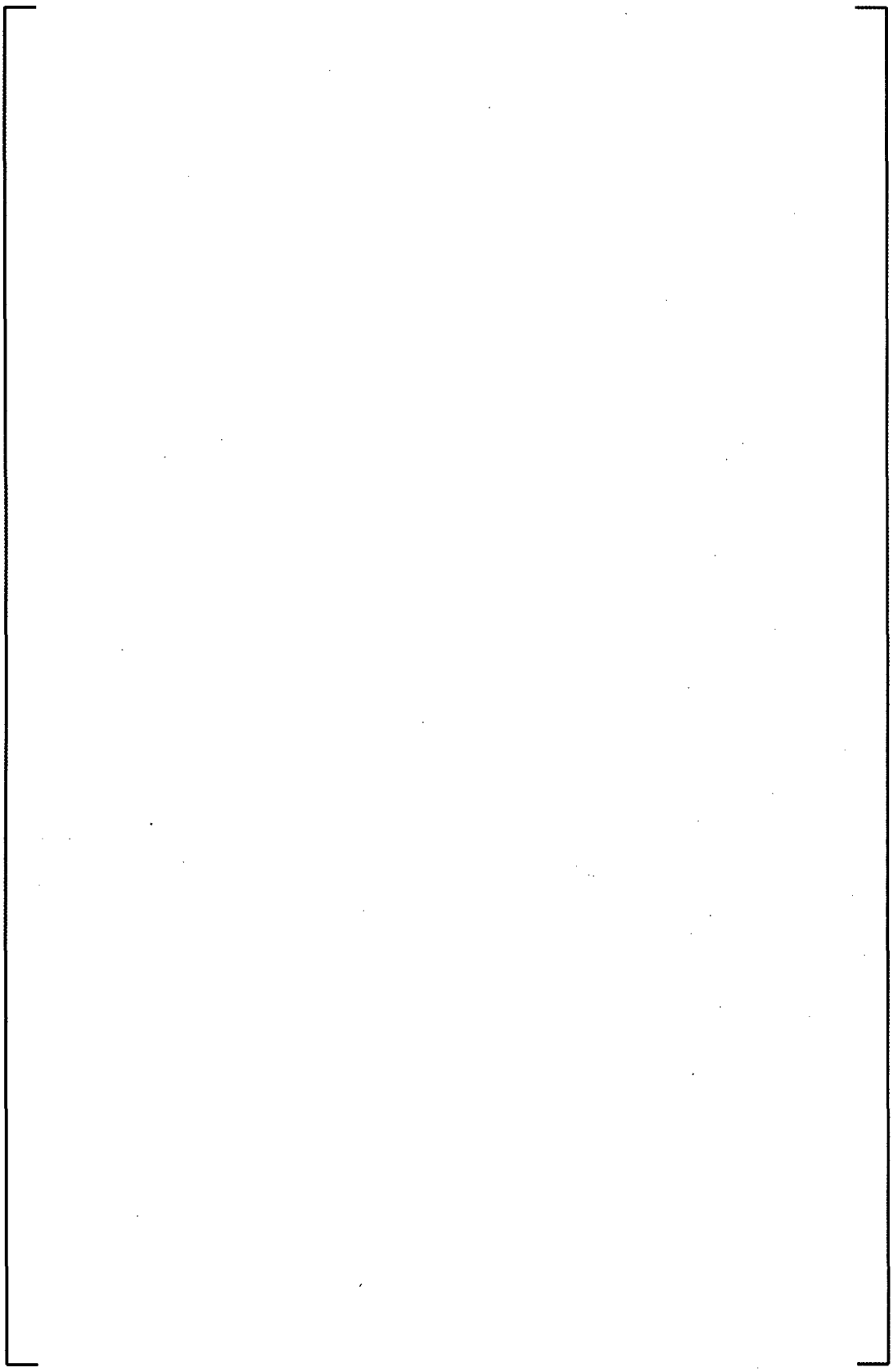
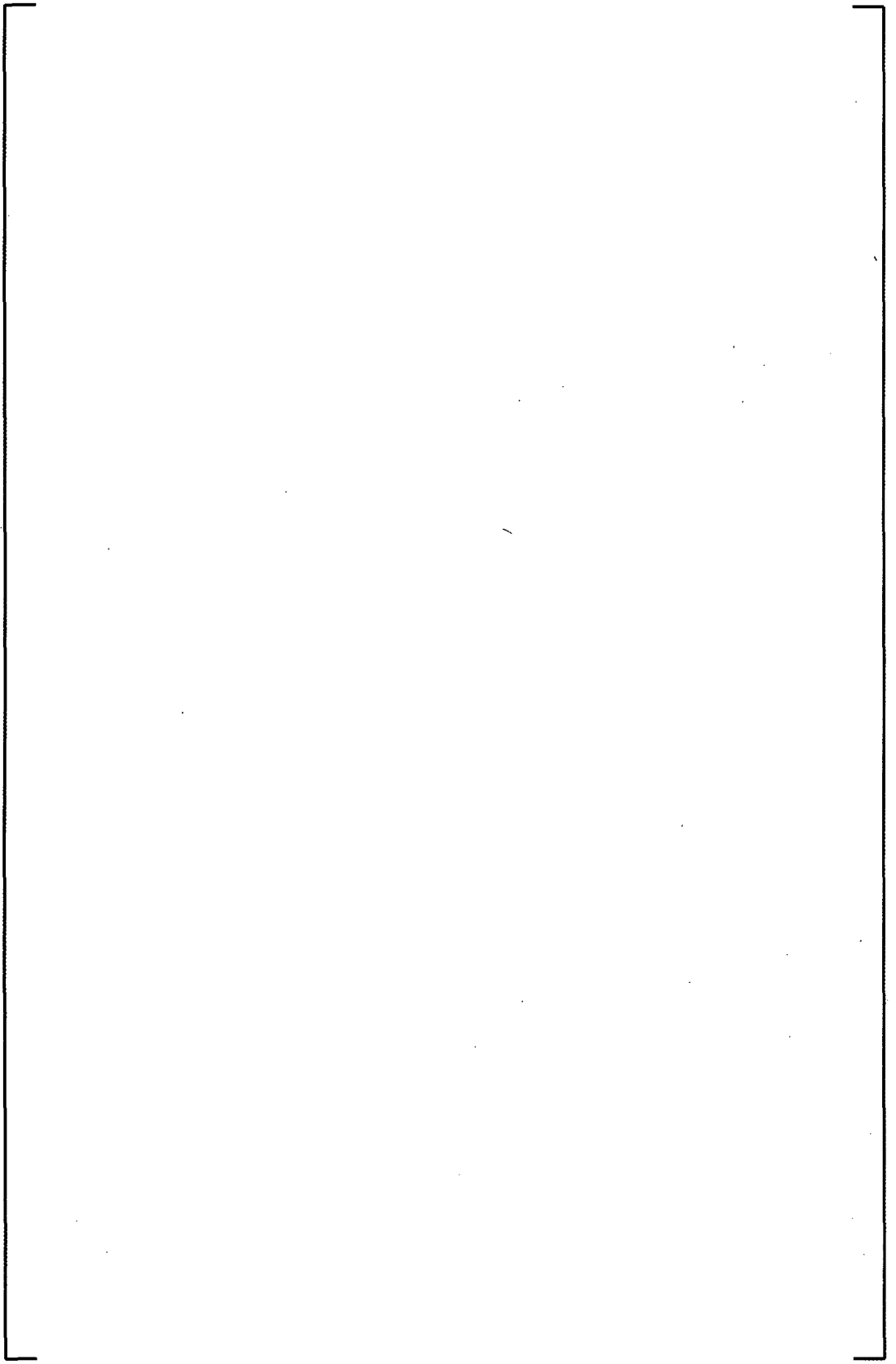
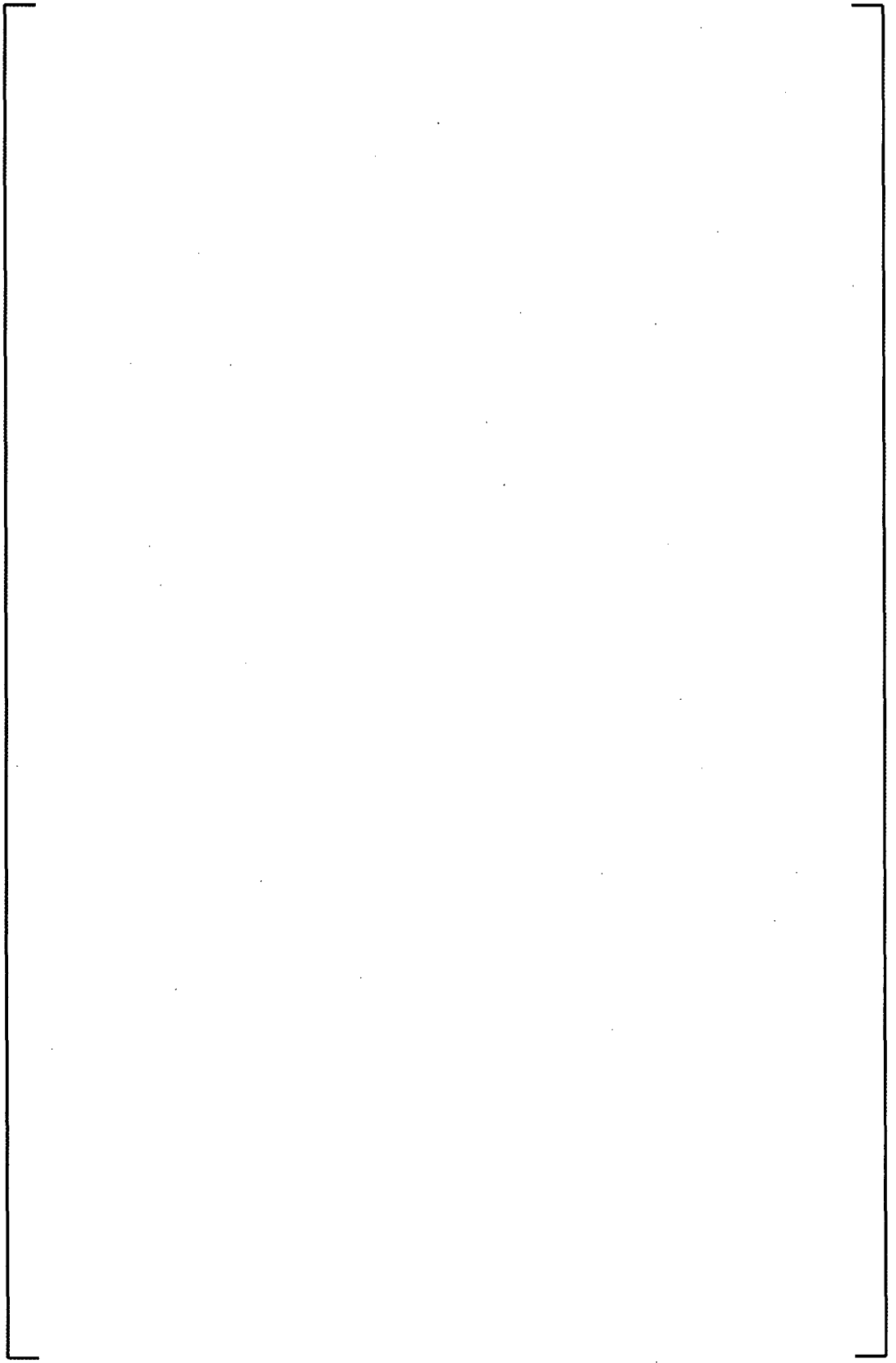
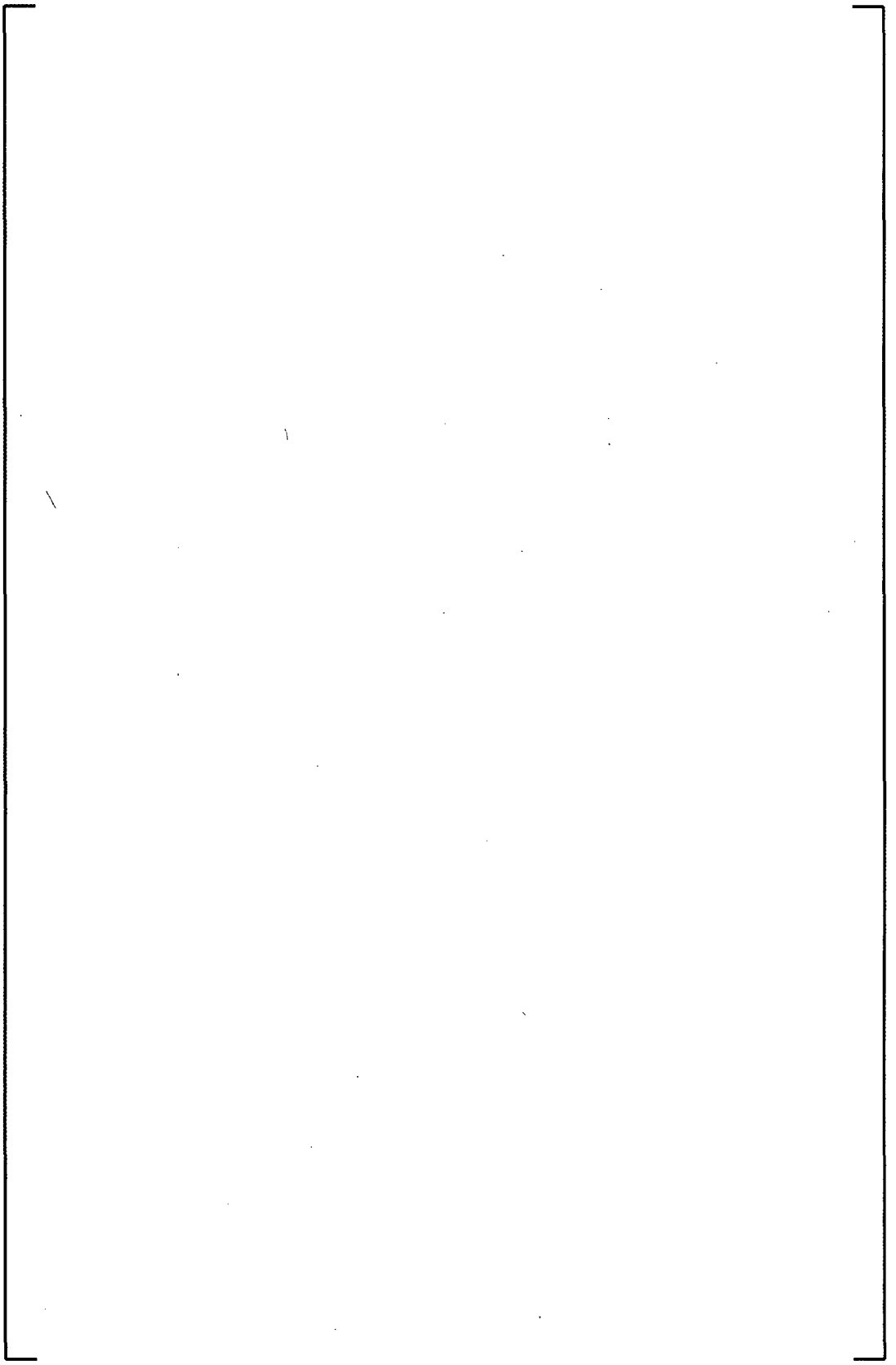
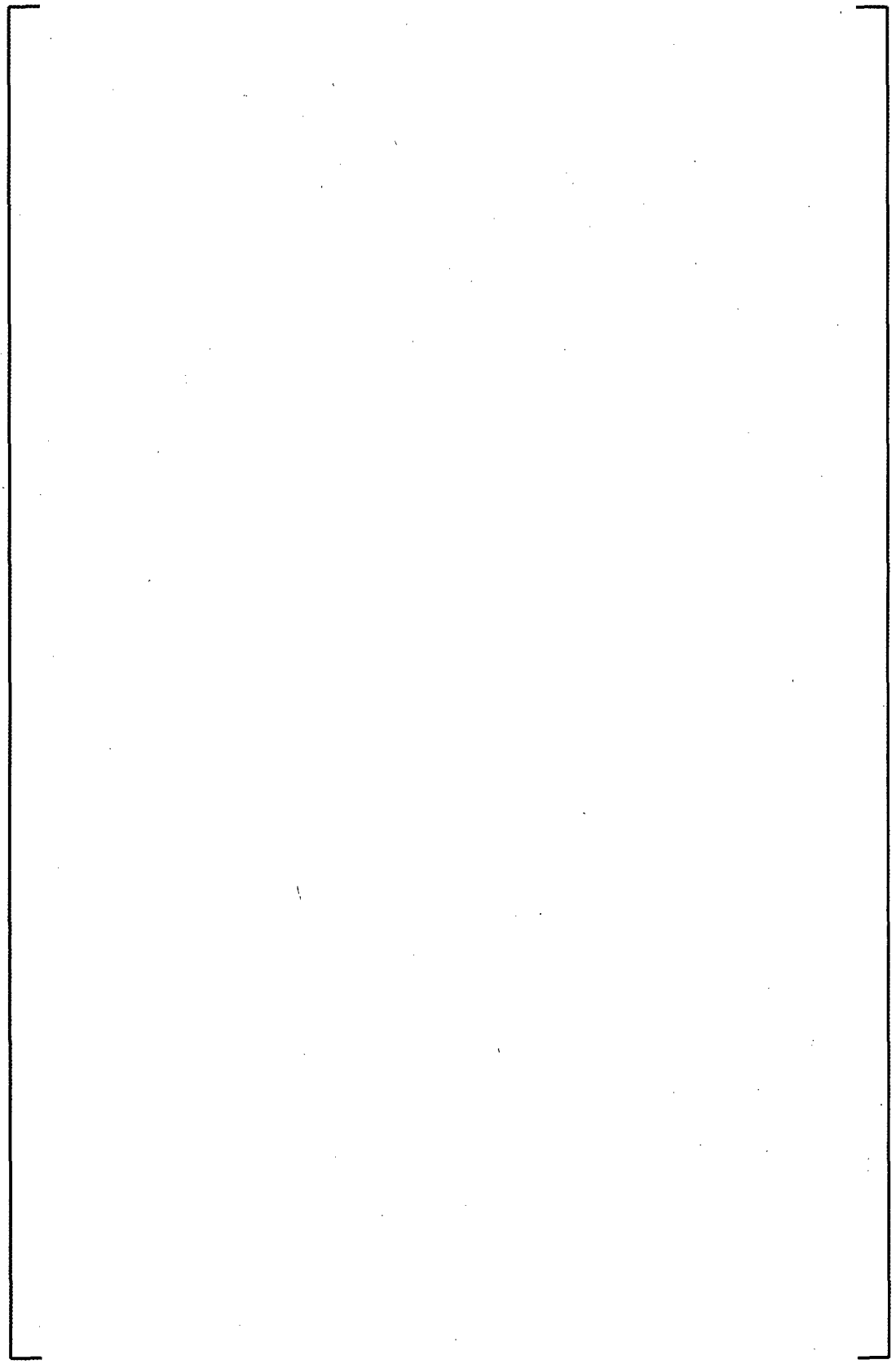


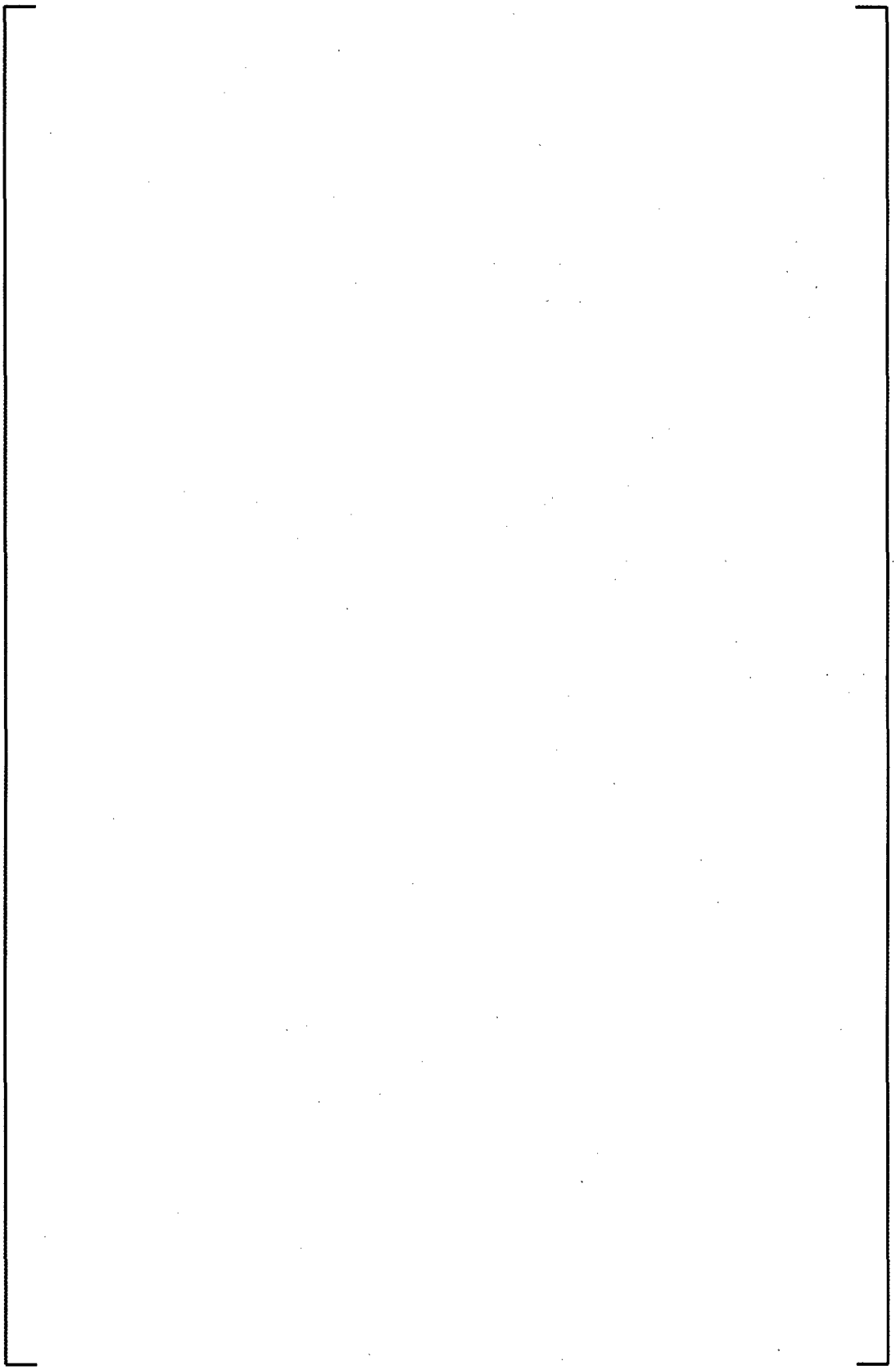


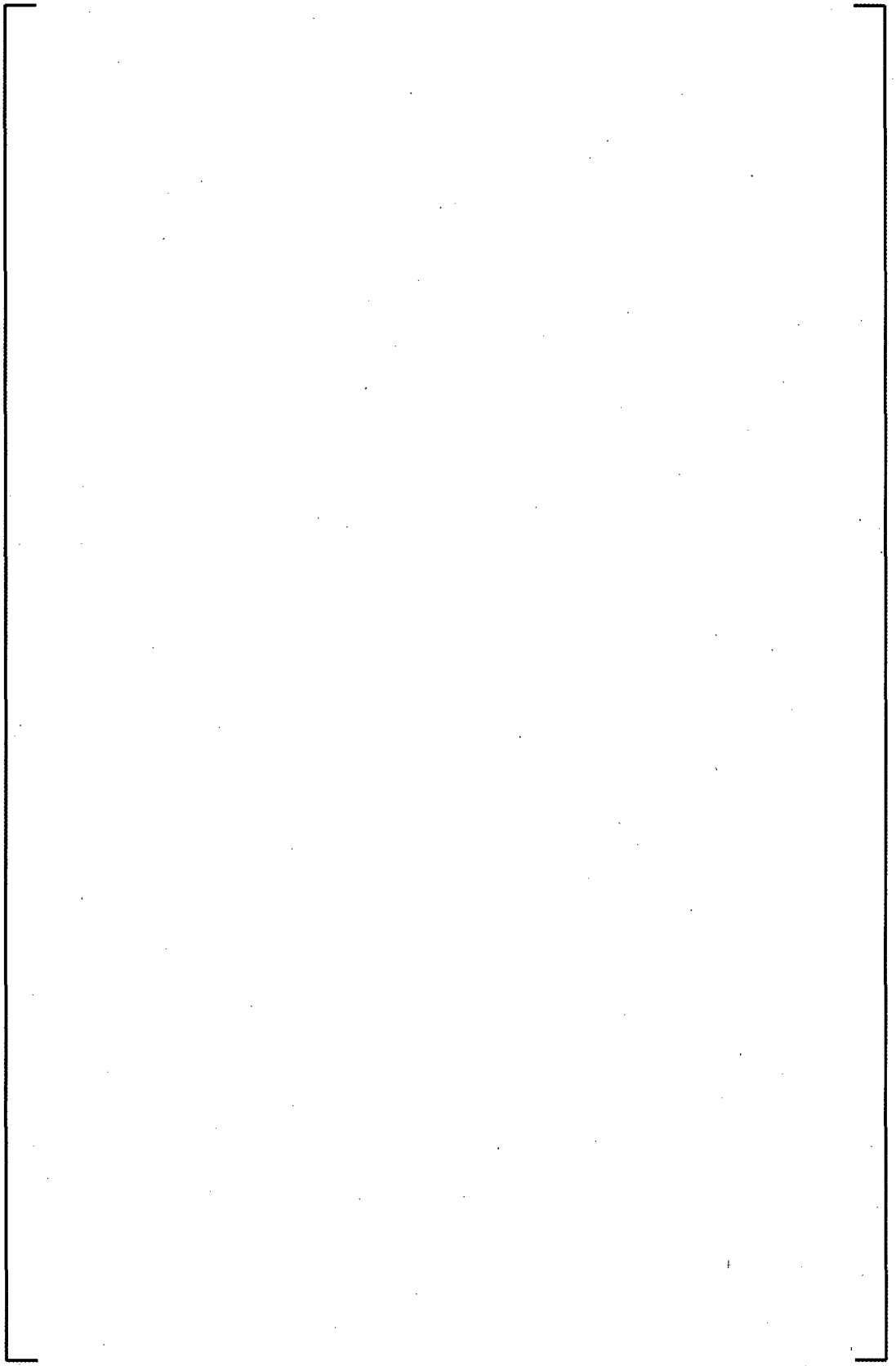


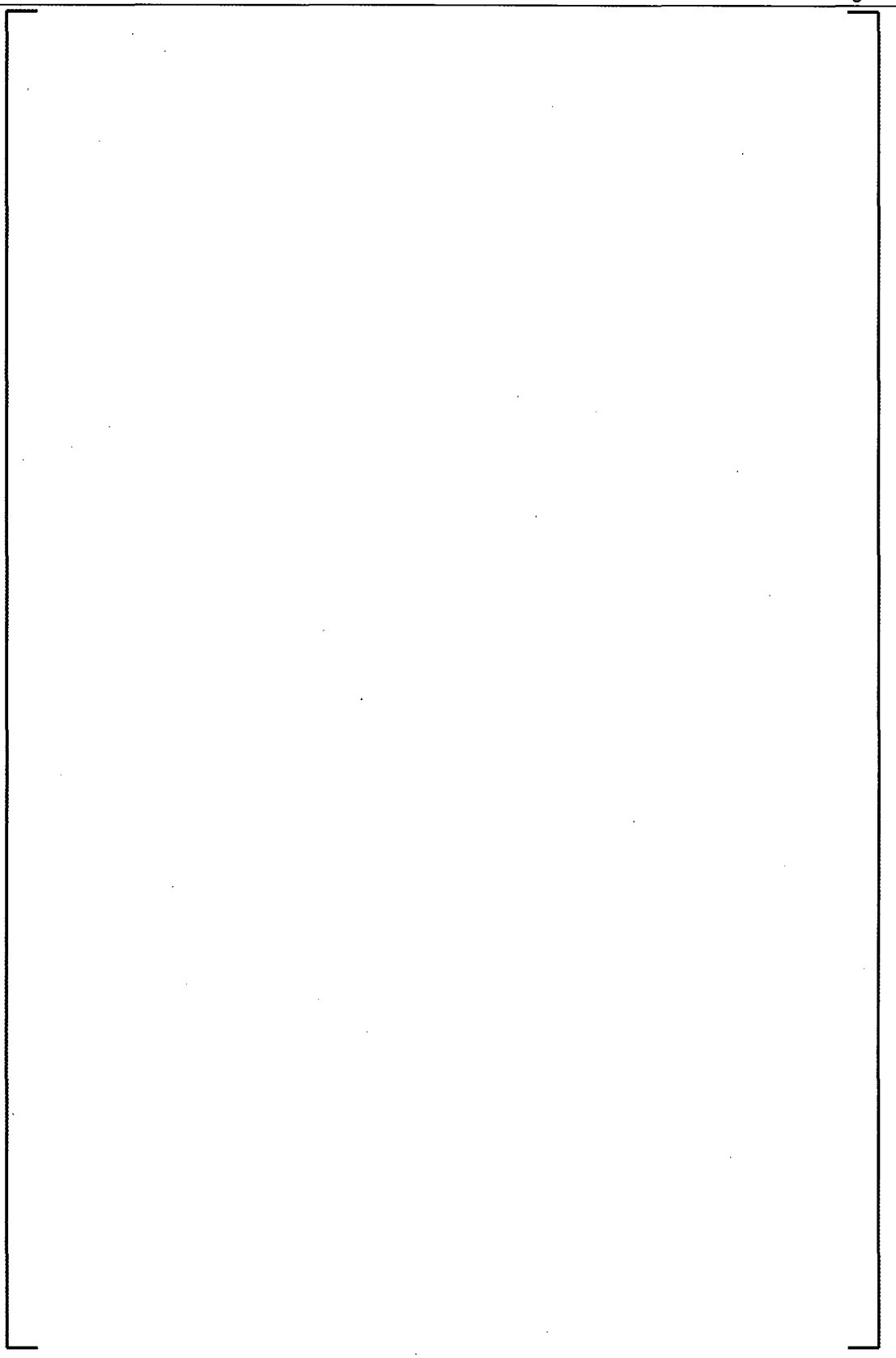


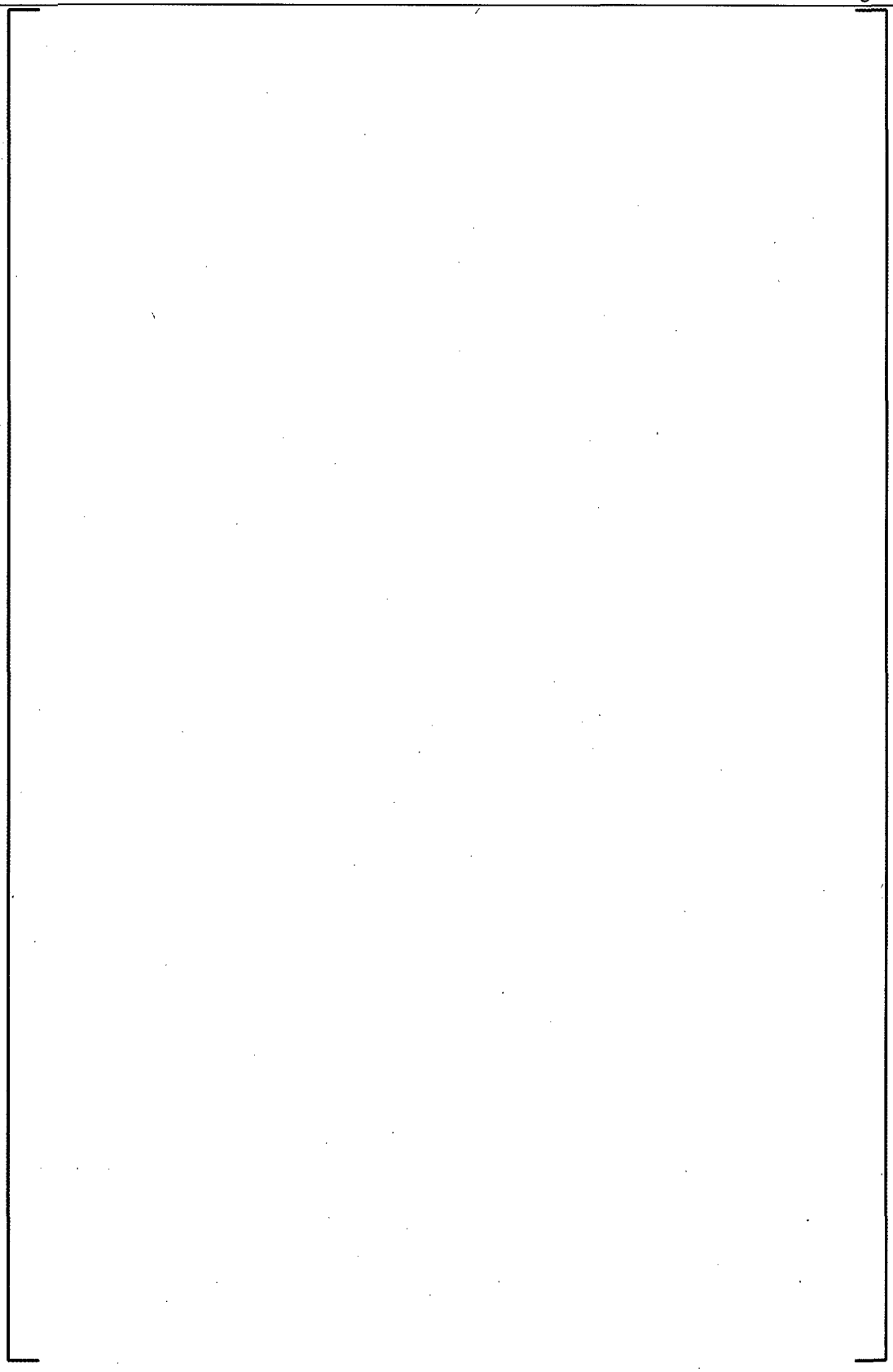












ENCLOSURE 4

Browns Ferry Nuclear Plant Unit 1
Technical Specifications Change TS - 473 - AREVA Fuel Transition

Affidavit for ANP-3035(P), Revision 0, "AREVA Responses to August 2011 RAIs for Browns Ferry Unit 1 Fuel Transition – LOCA", Proprietary

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for AREVA NP Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA NP to determine whether certain AREVA NP information is proprietary. I am familiar with the policies established by AREVA NP to ensure the proper application of these criteria.

3. I am familiar with the AREVA NP information contained in the report ANP-3035(P) Revision 0, entitled, "AREVA Responses to August 2011 RAIs for Browns Ferry Unit 1 Fuel Transition - LOCA," dated September 2011 and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA NP and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

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.

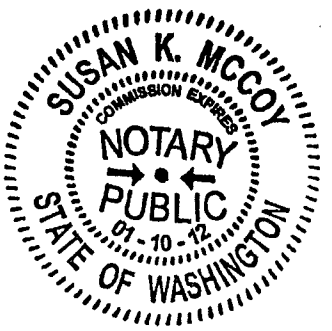
The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document have 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.

SUBSCRIBED before me this 30th day of September, 2011.



Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/10/12

ENCLOSURE 7

Browns Ferry Nuclear Plant Unit 1
Technical Specifications Change TS - 473 - AREVA Fuel Transition

Affidavit for ANP-3015(P), Revision 0, "Browns Ferry Units 1, 2, and 3, LOCA Break Spectrum Analysis", Proprietary

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

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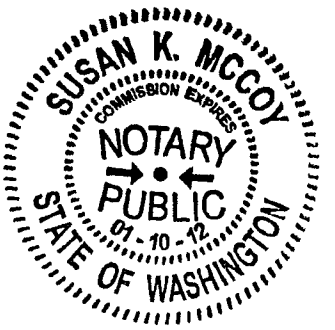

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/10/12