Attachment 6

WEC non-proprietary document EQ-QR-68-WBT-NP, "Qualification Summary Report for Post-Accident Monitoring System (PAMS)," Revision 0
(Letter Item 4, SSER 23 Appendix HH Item Number 108)

Westinghouse

Westinghouse Non-Proprietary Class 3

Nuclear Automation
Watts Bar Unit 2 NSSS Completion Program
I&C Projects

Qualification Summary Report for Post-Accident Monitoring System (PAMS)

EQ-QR-68-WBT-NP,
Rev. 0

February 2011

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WESTINGHOUSE NON-PROPRIETARY CLASS 3

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0	Jenna L. Tyger Technical Editor, Technical Communications

REVISION HISTORY

RECORD OF CHANGES

Revision	Author	Description	Completed
0	Natalie R. Jurcevich	Proprietary markings added to EQ-QR-68-WBT, Rev. 0-B. This document includes comments received by Tennessee Valley Authority (TVA) in project letter WBT-TVA-1630 (Reference 55) and WBT-TVA-1665 (Reference 56).	See EDMS

DOCUMENT TRACEABILITY & COMPLIANCE

Created to Support the Following Document(s)	Document Number	Revision
N/A		

OPEN ITEMS

Item	Description	Status
None.		

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ACRONYMS AND TRADEMARKS

Acronyms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 45), or included below to ensure unambiguous understanding of their use within this document.

Acronym	Definition
AC160	Advant® Controller
AIR	Auxiliary Instrument Room
DBE	Design Basis Event
EDMS	Electronic Document Management System
EFT/B	Electrically Fast Transient Bursts
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EPRI	Electric Power Research Institute
EQLR	Equipment Qualification Lab Report
FRS	Floor Response Spectra
FPDS	Flat Panel Display System
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IEC	International Electrotechnical Commission
MIL	Military Standard
MCB	Main Control Board
MCR	Main Control Room
OBE	Operating Basis Earthquake
OM	Operator's Module
PAMS	Post-Accident Monitoring System
PE	Protective Earth
P/N	Part Number
RFI	Radio Frequency Interference
RG	Regulatory Guide
RH	Relative Humidity
RRS	Required Response Spectra
RTD	Resistance Temperature Detector
SER	Safety Evaluation Report
SSE	Safe Shutdown Earthquake
TR	Topical Report
TRS	Test Response Spectra
TVA	Tennessee Valley Authority
U.S. NRC	United States Nuclear Regulatory Commission
WBT	Watts Bar Unit 2
WLL	Washington Laboratories, LTD

ACRONYMS AND TRADEMARKS (cont.)

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GLOSSARY OF TERMS

Standard terms used in the document are defined in WNA-PS-00016-GEN, "Standard Acronyms and Definitions" (Reference 45), or included below to ensure unambiguous understanding of their use within this document.

Term	Definition
Class 1E	The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal or are otherwise essential in preventing significant release of radioactive material to the environment.
Electromagnetic Compatibility (EMC)	The ability of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.
Electromagnetic Interference (EMI)	Electromagnetic disturbance which manifests itself in performance degradation, malfunction or failure of electrical or electronic equipment.
Mild Environment	An environment expected as a result of normal service conditions and extremes (abnormal) in service conditions where seismic is the only Design Basis Event (DBE) of consequence.
Operating Basis Earthquake (OBE)	An earthquake that could reasonably be expected to occur at the plant during the operating life of the plant considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that produces the vibratory ground motion for which those features of the nuclear power plant, necessary for continued operation without undue risk to the health and safety of the public, are designed to remain functional.
Qualification	The generation and maintenance of evidence to ensure that the equipment will operate on demand to meet the system performance requirements.
Radio Frequency Interference (RFI)	Used interchangeably with EMI. EMI includes the entire electromagnetic spectrum; RFI is more restricted to the radio-frequency band, generally considered to be between 10 kHz and 10 GHz.
Required Response Spectra (RRS)	The response spectrum issued by the user or agent as part of the equipment specification for seismic qualification purposes. The RRS is a plot of the acceleration versus frequency describing the energy content of the earthquake time history. The RRS constitutes the requirement to be met during qualification activities.

GLOSSARY OF TERMS (cont.)

Term	Definition
Response Spectrum	A plot of the maximum response, as a function of oscillator frequency, of any array of single-degree-of-freedom damped oscillators subjected to the same base excitation.
Safe Shutdown Earthquake (SSE)	An earthquake that is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristic of local subsurface material. It is the earthquake that produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional. These structures, systems, and components are those necessary to ensure the integrity of the reactor coolant pressure boundary; the capability to shut down the reactor and maintain it in a safe shutdown condition; and the capability to prevent or mitigate the consequences of accidents that could result in potential off-site exposures comparable to the 10 CFR Part 100 guidelines.
Safety-Related	Equipment that is relied upon to remain functional during and following a DBE to ensure the integrity of the reactor coolant pressure boundary; the capability to shut down the reactor and maintain it in a safe condition; and the capability to prevent or mitigate consequences of accidents that could result in potential off-site exposures comparable to the 10 CFR Part 100 guidelines.
Seismic Category I	A classification of structures, systems and components that shall be designed to withstand the effects of an SSE and maintain the specified design function and integrity.
Test Response Spectrum (TRS)	The response spectrum that is developed from the actual time history of the motion of the shake table.
Zero Period Acceleration (ZPA)	The acceleration level of the high frequency, non-amplified portion of the response spectrum. This acceleration corresponds to the maximum peak acceleration of the time history used to derive the spectrum.

REFERENCES

Following is a list of references used throughout this document.

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2. 10047E63, Rev. 4, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Cabinet Assembly," Westinghouse Electric Company LLC.

3. 10004D82, Rev. 2, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Display Operators Module (OM) Assy," Westinghouse Electric Company LLC.

4. 10000A193, Rev. 4, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Cabinet Assembly Bill of Materials," Westinghouse Electric Company LLC.

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23. 00000-ICE-37764, Rev. 03, "Summary Qualification Report of Hardware Testing for Common Q Applications," Westinghouse Electric Company LLC.

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39. CN-EQT-10-55, Rev. 0, "EMC Qualification of Watts Bar Unit 2 Post-Accident Monitoring System Equipment," Westinghouse Electric Company LLC.

40. CN-EQT-10-53, Rev. 1, "Seismic Evaluation for the Post-Accident Monitoring System (PAMS) for Watts Bar Unit 2," Westinghouse Electric Company LLC.

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SECTION 1
INTRODUCTION

The objective of this report is to document the seismic, environmental, and electromagnetic compatibility (EMC) qualification of the Post-Accident Monitoring System (PAMS) equipment for the Watts Bar Unit 2 (WBT) application.

PAMS is a Class 1E safety-related alarm and display system. The WBT PAMS consists of two independent trains of equipment (Trains A and B) which acquire and process two trains of inputs. The trains are physically separated and electrically isolated from each other. Each train of the WBT PAMS comprises two Advant® Controller 160 (AC160) racks, a primary rack and an extension rack, located in one standard 7721 seismic safety cabinet. For each train, the Primary AC160 rack contains a processor module that processes the Common Q PAMS algorithms and a communication interface module for communicating data on the AF100 bus. The processor performs input processing and algorithms, and sends the outputs to its output cards and over the AF100 to the operator's module (OM). The OM is used to provide various display pages to the operator. The OM uses the Flat Panel Display System (FPDS), which consists of a PC node box, an FPD with touch screen capability, and a standard AF100 communication interface for communication to the processor module.

Per WBT-D-0088, "Transmittal of Westinghouse Comments on TVA Specification EDCR52351," (Reference 1), the WBT PAMS cabinets are located in the Auxiliary Instrument Room (AIR) and the OM is located in the main control room (MCR); both the AIR and MCR are mild environment locations.

The basic objectives for qualification of safety-related electrical equipment are:

- To reduce the potential for common mode failures due to environmental effects.
- To demonstrate that safety-related electrical equipment is capable of performing its designated safety-related functions during and after a design basis event (DBE).

The objectives were met by monitoring the performance during testing and subsequent evaluations to demonstrate the AC160 safety system platform hardware supplied for the WBT PAMS is qualified to WBT plant-specific seismic, environmental, and EMC requirements.

The AC160 safety system platform hardware used in the WBT PAMS application has been previously qualified. Evaluations were performed to demonstrate that the existing seismic, environmental, and EMC qualification records satisfy the plant-specific requirements for WBT. The evaluations are summarized within this report.

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SECTION 2
EQUIPMENT IDENTIFICATION AND QUALIFICATION SUMMARY

2.1 EQUIPMENT IDENTIFICATION

The WBT PAMS equipment is installed in two cabinets and on the main control board (MCB), as a part of the OM. The standard 7721 seismic safety cabinet is used as the system cabinet, which is typically used for installing AC160 safety system platform equipment. The WBT PAMS cabinet and OM assemblies are defined in Drawings 10047E63, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Cabinet Assembly" (Reference 2) and 10004D82, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Display Operations Module (OM) Assy" (Reference 3).

Table 2.1-1 lists the components housed in the WBT PAMS cabinets. Table 2.1-2 lists the components installed on the MCB as the OM assembly.

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

a,c

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet (cont.)

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

a,c

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet (cont.)

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

a,c

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet (cont.)

a,c

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet (cont.)

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

a,c

Table 2.1-1. List of Internal Components Housed in the WBT PAMS Cabinet (cont.)

[

Item No.	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)

] a,c

Table 2.1-2. List of WBT PAMS OM Components

Item No.	Part Name	Description	WBT PAMS Part Number per 10004D82 (Reference 3)

a,c

2.2 QUALIFICATION METHOD

The method used to qualify the equipment identified in Table 2.1-1 and Table 2.1-2 was a combination of type test and analysis.

There have been various EMC, environmental, and seismic type test programs to qualify AC160/Common Q hardware on a generic basis, not specifically for the WBT plant application of the AC160/Common Q hardware. Each type test (EMC, environmental, and seismic) was performed to demonstrate that the EUT were capable of performing the specified safety function(s) within the specified performance criteria.

Per the Safety Evaluation Report (SER) contained in WCAP-16097-P-A, "Common Qualified Platform Topical Report" (Reference 5), the U.S. Nuclear Regulatory Commission (NRC) requires a plant-specific evaluation of the generic qualifications to be performed for the plant-specific application of the Common Q equipment; this requirement is captured as Plant Specific Action Item 6.4. The plant-specific evaluation is to demonstrate that the WBT PAMS AC160/Common Q hardware is qualified based on component or equipment similarity to the previously qualified AC160/Common Q hardware and that the AC160/Common Q hardware is qualified for the WBT plant-specific requirements.

2.3 SUMMARY OF QUALIFIED EQUIPMENT

In summary, the WBT PAMS cabinet equipment, as identified in Drawing 10047E63 (Reference 2), is EMC, environmentally, and seismically qualified to the WBT EMC, environmental, and seismic qualification requirements specified in WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Requirements Specification" (Reference 6). The WBT PAMS OM equipment, as identified in Drawing 10004D82 (Reference 3), is EMC and environmentally qualified to the WBT EMC and environmental qualification requirements specified in WNA-DS-01617-WBT-P (Reference 6). The OM equipment qualified seismic levels are contained within this report along with the qualified mounting configurations of each OM component. Westinghouse was not responsible for the installation of the OM equipment. Therefore, determining if the OM equipment is seismically qualified to the WBT seismic qualification requirements for the OM equipment locations is not in the scope of this report.

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SECTION 3
EQUIPMENT PERFORMANCE SPECIFICATION

3.1 SAFETY FUNCTION

[

]^{a,c}

3.2 PERFORMANCE REQUIREMENTS

The PAMS cabinets, the equipment mounted within, and the OM components must demonstrate:

[

]^{a,c}

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SECTION 4
EQUIPMENT QUALIFICATION REQUIREMENTS

4.1 EMC

The WBT PAMS EMC qualification requirements are specified in WNA-DS-01617-WBT-P, "Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System – System Requirements Specification" (Reference 6), which identifies WCAP-16097-P-A (Reference 5); Regulatory Guide (RG) 1.180, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems" (Reference 7); and Electric Power Research Institute (EPRI) Topical Report (TR)-102323, "Guidelines for Electromagnetic Interference Testing in Power Plants" (Reference 8) as acceptable resources for obtaining the requirements, test levels, and acceptance criteria for EMC qualification of WBT PAMS equipment, as clarified by Section 7.4 of WCAP-16097-P, "Common Qualified Platform Topical Report" (Reference 9), which states:

"The baseline Common Q equipment will be qualified in accordance with MIL Std 461D, MIL Std 462D, and as augmented by EPRI TR-102323."

"The basis for selecting the specific tests, test methods, test levels and susceptibility criterion for the baseline equipment will be based on the EPRI TR-102323 guidelines."

"Any new additions to the baseline equipment, whether they are new modules/devices or enhancements to existing modules/devices will be tested consistent with the requirements of RG 1.180, Rev. 01. No regression EMI testing will be performed; rather the requirements as defined in RG 1.180, Rev. 01 will be followed."

Table 4.1-1 and Table 4.1-2 summarize the emissions, susceptibility, and surge withstand requirements defined by EPRI TR-102323 (Reference 8) and RG 1.180 (Reference 7), respectively. The WBT EMC test specifications, test levels, and acceptance criteria for emissions and susceptibility, including surge withstand, are to meet the requirements of RG 1.180 (Reference 7) and/or EPRI TR-102323 (Reference 8).

Table 4.1-1. Basic Type Test Requirements of EPRI TR-102323 (Reference 8)

EMC Type Test	MIL-STD method	Or	IEC Method	Additional Remarks
Emissions Tests				
Low-Frequency, Conducted	461D CE101	or	None specified	EPRI TR-102323 (Reference 8) endorses MIL-STD methods only for emissions.
High-Frequency, Conducted	461D CE102	or	None specified	
Low-Frequency, Radiated	461D RE101	or	None specified	
High-Frequency, Radiated	461D RE102	or	None specified	
Susceptibility Tests (including Surge Withstand Capability)				
Low-Frequency, Conducted	461D CS101	or	801-6	IEC 61000-4-16 is current IEC equivalent for this specific test range.
High-Frequency, Conducted	461D CS114	or	801-6	IEC 61000-4-6 is current IEC equivalent.
Low-Frequency, Radiated	461D RS101	or	None	Test may be omitted altogether if certain usage criteria are met.
High-Frequency, Radiated	461D RS103	or	801-3	IEC 61000-4-3 is current IEC equivalent.
Surge	461D CS116	or	801-5 draft	IEC 61000-4-5 is current IEC equivalent.
Electrically Fast Transient Bursts (EFT/B)	461D CS115	or	801-4	IEC 61000-4-4 is current IEC equivalent.
Electrostatic Discharge (ESD)	None specified	or	801-2	IEC 61000-4-2 is current IEC equivalent. By definition this test is declared "optional" for safety systems based upon assumptions regarding operator interaction during normal operation. However, for equipment that has direct human interaction, it is directed that this test must be applied extensively.

Table 4.1-2. Basic EMC Type Test Requirements of RG 1.180 (Reference 7)

Category	MIL-STD-461E Methods		IEC/EN 61000 Methods
Emissions	CE101: Conducted emissions, low-frequency, 30 Hz to 10 kHz CE102: Conducted emissions, high-frequency, 10 kHz to 2 MHz RE101: Radiated emissions, magnetic field, 30 Hz to 100 kHz RE102: Radiated emissions, electric field, 2 MHz to 1 GHz[1]	or	No standard endorsed for: Conducted emissions, low frequency, 30 Hz to 10 kHz 61000-6-4 (EN 55011/CISPR 11): Conducted emissions, high frequency, 150 kHz to 30 MHz No standard endorsed for: Radiated emissions, magnetic field, 30 Hz to 100 kHz 61000-6-4 (EN 55011/CISPR 11): Radiated emissions, electric field, 30 MHz to 1 GHz[1]
Susceptibility	CS101: Conducted susceptibility, low frequency, 30 Hz to 150 kHz CS114: Conducted susceptibility, high frequency, 10 kHz to 30 MHz CS115: Conducted susceptibility, bulk cable injection, impulse excitation CS116: Conducted susceptibility, damped sinusoidal transients, 10 kHz to 100 MHz RS101: Radiated susceptibility, magnetic field, 30 Hz to 100 kHz RS103: Radiated susceptibility, electric field, 30 MHz to 1 GHz[1]	or	61000-4-13: Conducted susceptibility, low frequency, 16 Hz to 2.4 kHz 61000-4-16: Conducted susceptibility, low frequency, 15 Hz to 150 kHz 61000-4-6: Conducted susceptibility, disturbances induced by radio-frequency fields 61000-4-4: Conducted susceptibility, electrically fast transients/bursts 61000-4-5: Conducted susceptibility, surges 61000-4-12: Conducted susceptibility, 100 kHz ring wave 61000-4-8: Radiated susceptibility, magnetic field, 50 Hz and 60 Hz 61000-4-9: Radiated susceptibility, magnetic field, 50/60 Hz to 50 kHz 61000-4-10: Radiated susceptibility, magnetic field, 100 kHz and 1 MHz 61000-4-3: Radiated susceptibility, electric field, 26 MHz to 1 GHz[1]

Table 4.1-2. Basic EMC Type Test Requirements of RG 1.180 (Reference 7) (cont.)

Category	IEEE C62.41 Methods		IEC/EN 61000 Methods
Surge Withstand Capability	EFT Combination Wave Ring Wave	or	61000-4-4 as described above 61000-4-5 as described above 61000-4-12 as described above

Note:
1. The baseline requirements specified for these tests are up to 1 GHz, but contextual extension of the range up to 10 GHz is recommended.

4.2 ENVIRONMENTAL

The WBT PAMS environmental qualification requirements are specified in WNA-DS-01617-WBT-P (Reference 6), which identifies that the WBT PAMS cabinet equipment and OM equipment shall be qualified to the environmental qualification requirements described in Appendix 1 of WCAP-16097-P-A (Reference 5). Per Appendix 1 of WCAP-16097-P-A (Reference 5), the environmental qualification shall be performed in accordance with IEEE Standard 323-1983, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" (Reference 10). WCAP-16097-P-A (Reference 5) also identifies the expected room abnormal temperature and humidity parameters, where the Common Q cabinets will be installed; these are shown in Table 4.2-1. The environmental qualification test conditions for Common Q equipment installed in a cabinet are shown in Table 4.2-2.

Per WNA-DS-01617-WBT-P (Reference 6), the WBT PAMS cabinets and the equipment therein, and the WBT PAMS OM equipment shall be qualified for the WBT plant-specific environment conditions defined in Table 4.2-3 and Table 4.2-4, respectively. Table 4.2-3 and Table 4.2-4 provide the abnormal environmental conditions for the AIR and MCR at WBT.

For the equipment installed inside an enclosure, the heat rise inside that enclosure needs to be considered in the environmental conditions. Therefore, the WBT PAMS equipment that is housed inside the PAMS cabinet will be exposed to the environmental conditions defined in Table 4.2-3. However, the temperature conditions would be increased by the heat rise inside the WBT PAMS cabinet. Per WNA-TR-02383-WBT, "Post Accident Monitoring System Cabinet Hardware Test Report" (Reference 11), the WBT PAMS cabinet heat rise temperature observed during the cabinet hardware test was [ ]^{a,c}. For the environmental qualification of the WBT PAMS cabinet equipment, a cabinet heat rise of [ ]^{a,c} was conservatively assumed.

The generic abnormal environmental qualification test parameters in Table 4.2-2 envelop the WBT environmental conditions shown in Table 4.2-3 (including the conditions inside the cabinet) and Table 4.2-4. Thus demonstrating that the WBT PAMS equipment is qualified to the required conditions specified in Table 4.2-2; it also demonstrates the qualification for the plant-specific environmental conditions (Table 4.2-3 and Table 4.2-4) at WBT.

Table 4.2-1. Common Q Hardware Expected Room Abnormal Environmental Requirements

Abnormal Environmental Parameter	Minimum	Maximum	Duration

a,c

Table 4.2-2. Common Q Hardware Generic Qualification Environmental Requirements

Time Cycle	Minimum Time (Hours)	Temperature (°F)	Relative Humidity (%)	Supply Voltage (VAC)	Frequency (Hz)

a,c

Table 4.2-3. AIR Environmental Conditions

Parameter	Design Range	Duration
Temperature(1)	40-120°F	Continuous
Humidity(2)	20-95% RH	Continuous
Pressure	Atmospheric	Continuous
Radiation (40-year Total Integrated Dose)	Background <1 x 10^3 Rads	N/A

Notes:
1. Applies to the ambient environment outside the PAMS cabinet. The PAMS equipment mounted within the PAMS cabinet will be exposed to the heat rise conditions inside the cabinet; per WNA-TR-02383-WBT (Reference 11), the cabinet heat rise inside the PAMS cabinet was measured to be [ ]^{a,c}.
2. Non-condensing.

Table 4.2-4. MCR Environmental Conditions

Parameter	Design Range	Duration
Temperature(1)	60-104°F	Continuous
Humidity(2)	20-95% RH	Continuous
Pressure	Atmospheric	Continuous
Radiation (40-year Total Integrated Dose)	Background <1 x 10^3 Rads	N/A

Notes:
1. Applies to the ambient environment.
2. Non-condensing.

4.3 SEISMIC

The WBT PAMS seismic qualification requirements are specified in WNA-DS-01617-WBT-P (Reference 6), which identifies that the WBT PAMS cabinet equipment and OM equipment shall be seismically qualified in accordance with the requirements of Appendix 1 of WCAP-16097-P-A (Reference 5). Per Appendix 1 of WCAP-16097-P-A (Reference 5), the seismic qualification shall be performed in accordance with IEEE Standard 344-1987, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations" (Reference 12). However, per WNA-DS-01617-WBT-P (Reference 6), the WBT PAMS equipment shall be qualified in accordance with IEEE Standard 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations" (Reference 13).

In accordance with IEEE Standard 344-1975 (Reference 13), the seismic qualification of Class 1E equipment should demonstrate an equipment's ability to perform its required function during and after the

time it is subjected to the accelerations resulting from one SSE test run. In addition, the equipment must withstand the effects of five OBE test runs, prior to the application of an SSE test run.

Tennessee Valley Authority (TVA) Specification EDCR 52351, "Post Accident Core Monitoring System" (Reference 14) provides the OBE and SSE required Floor Response Spectra (FRS) for the WBT Auxiliary Control Building elevation 711.50 feet (applicable to the PAMS cabinet in the AIR at elevation 708 feet) and elevation 755.50 feet (applicable to the OM in the MCR at elevation 755 feet). The OBE and SSE FRS are provided in Figure 4.3-1 through Figure 4.3-3 and Figure 4.3-4 through Figure 4.3-6 for the 711.50 foot elevation, respectively. Figure 4.3-7 through Figure 4.3-9 and Figure 4.3-10 through Figure 4.3-12 provide the OBE and SSE FRS for the 755.50 foot elevation, respectively.

Figure 4.3-1 through Figure 4.3-12 each contain hand drawn markups, with corresponding hand notated revision bars; these markings were on these figures in the source document, EDCR 52351 (Reference 14).

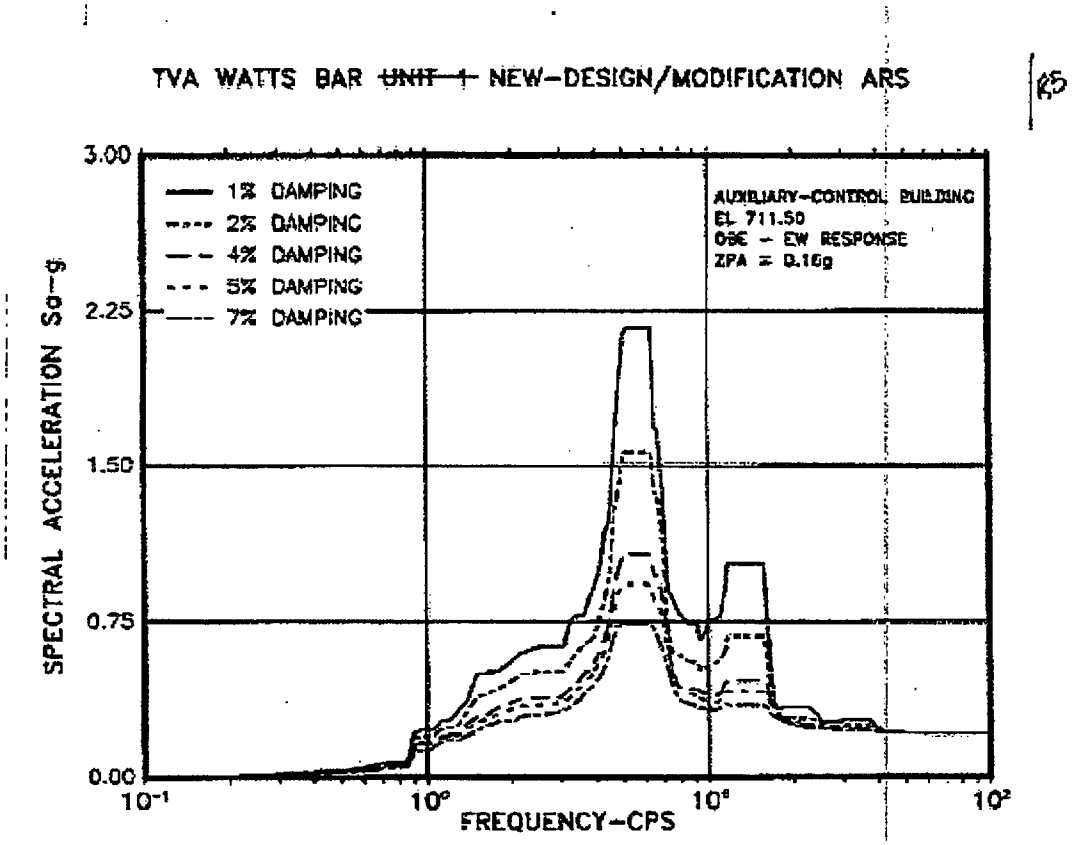

Figure 4.3-1. OBE East to West FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 feet from Reference 14

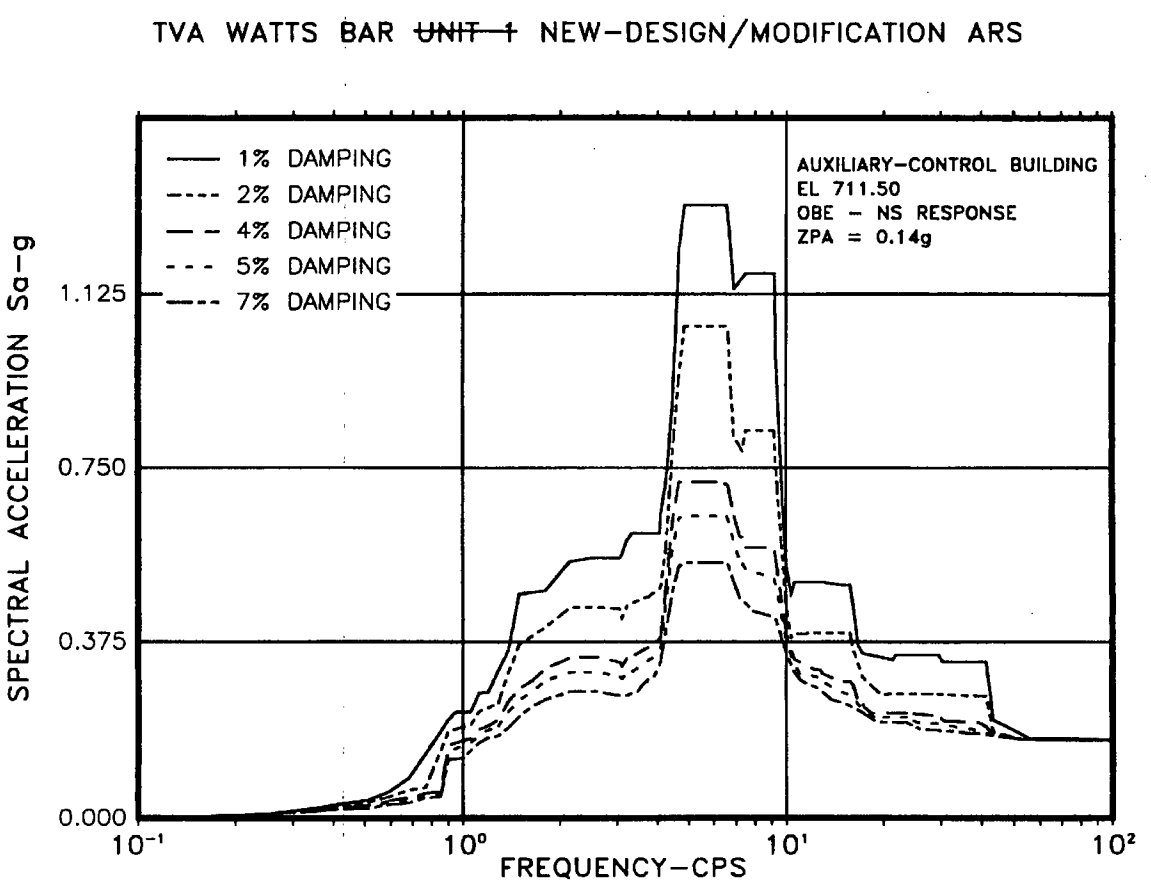

Figure 4.3-2. OBE North to South FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 feet from Reference 14

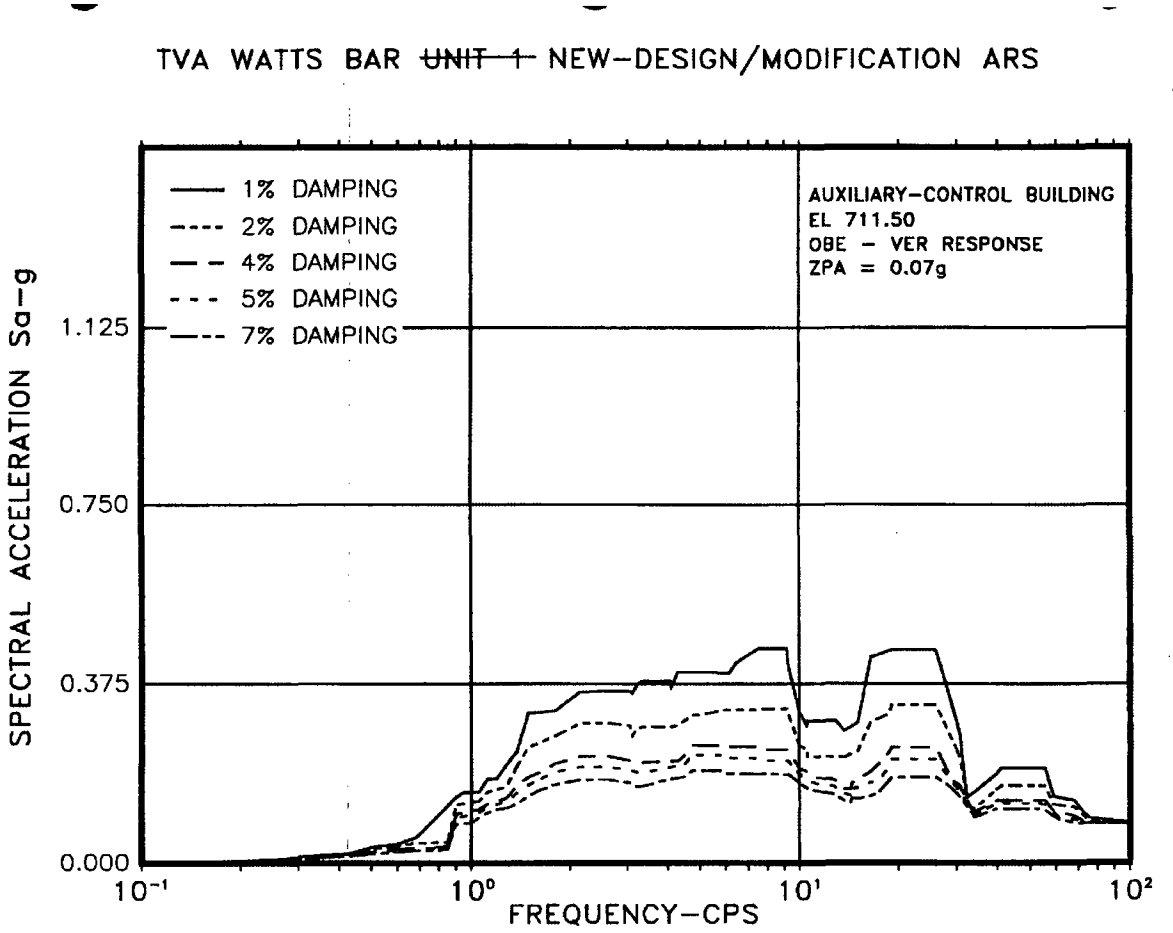

Figure 4.3-3. OBE Vertical FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 feet from Reference 14

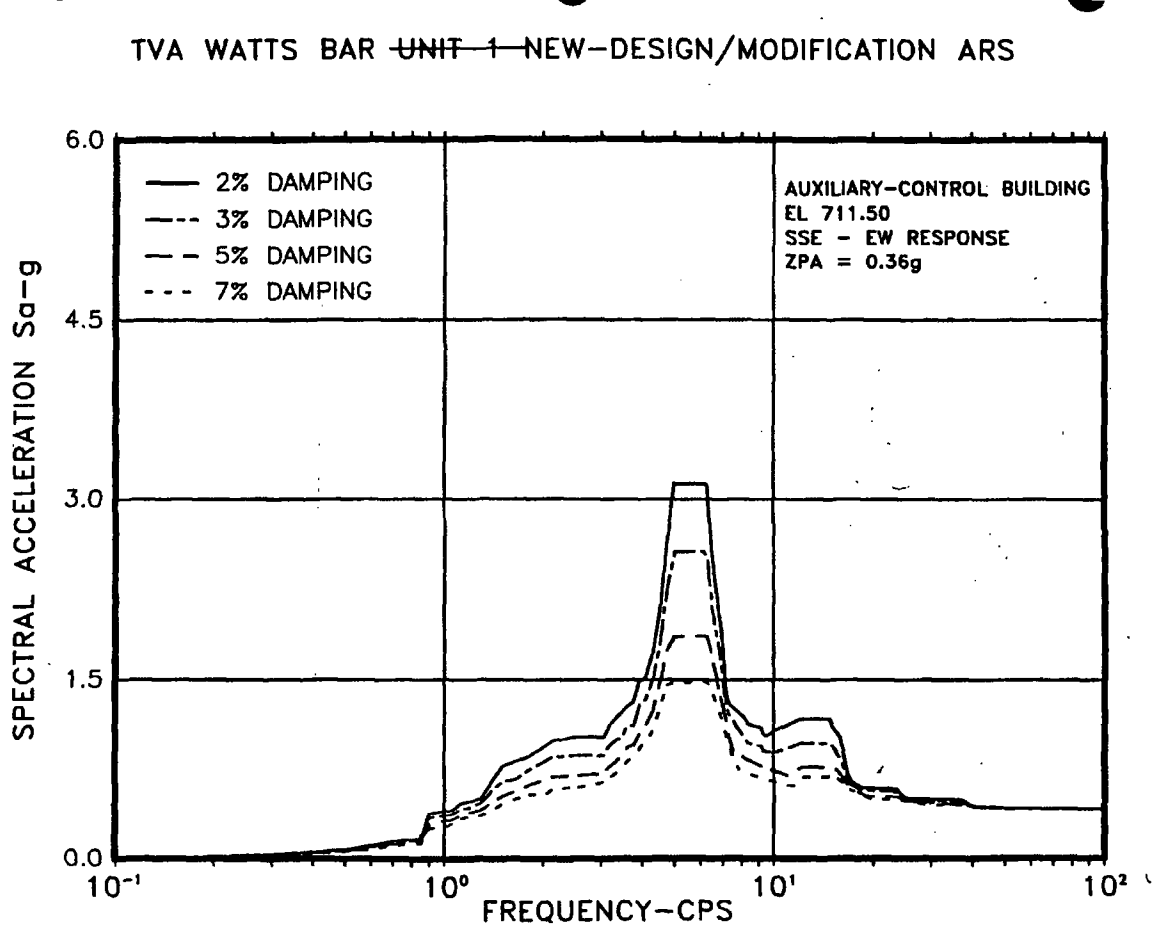

Figure 4.3-4. SSE East to West FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 feet from Reference 14

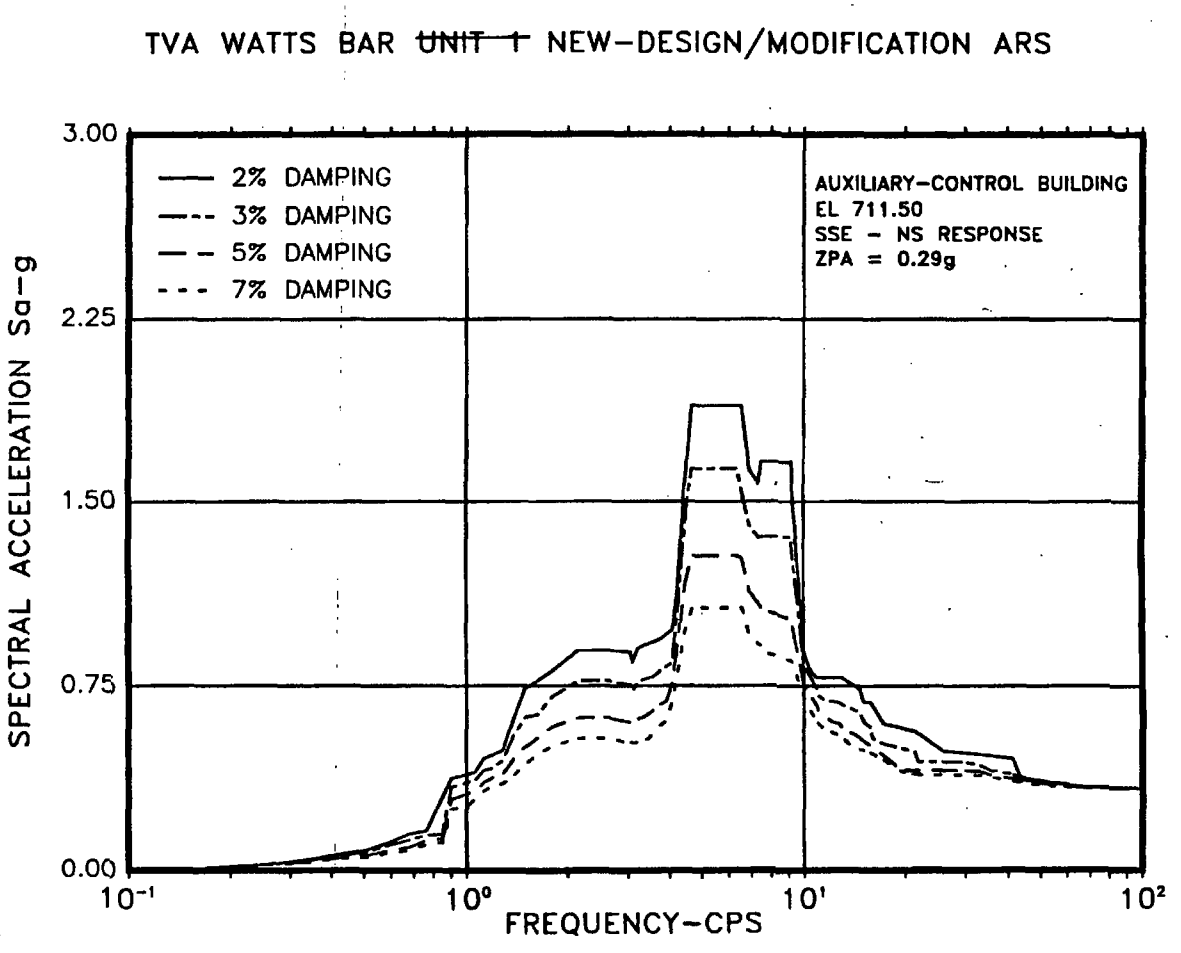

Figure 4.3-5. SSE North to South FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 feet from Reference 14

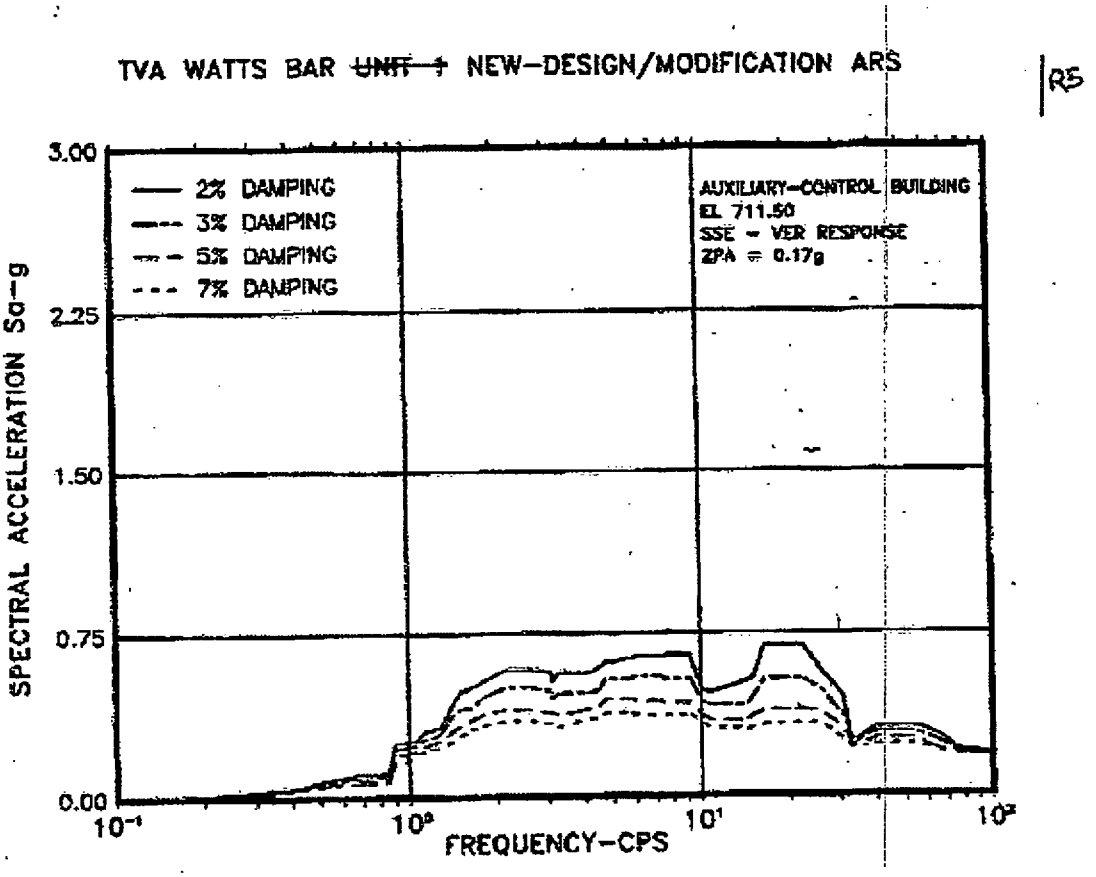

Figure 4.3-6. SSE Vertical FRS for Watts Bar Auxiliary Control Building at Elevation 711.50 Feet from Reference 14

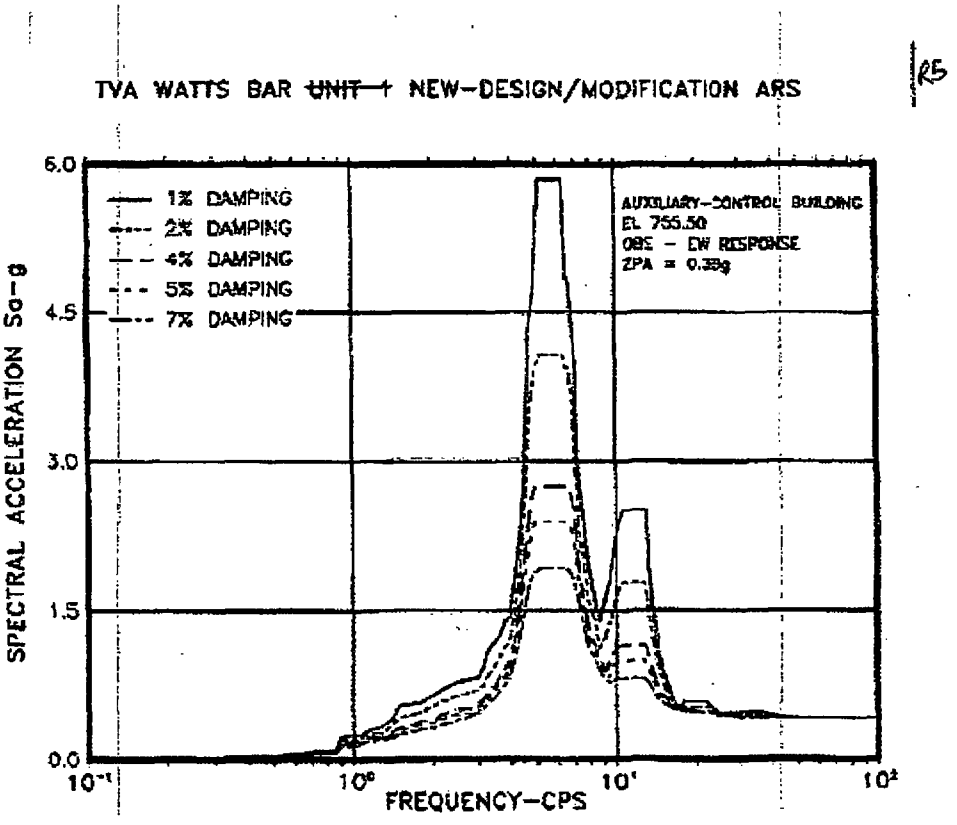

Figure 4.3-7. OBE East to West FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

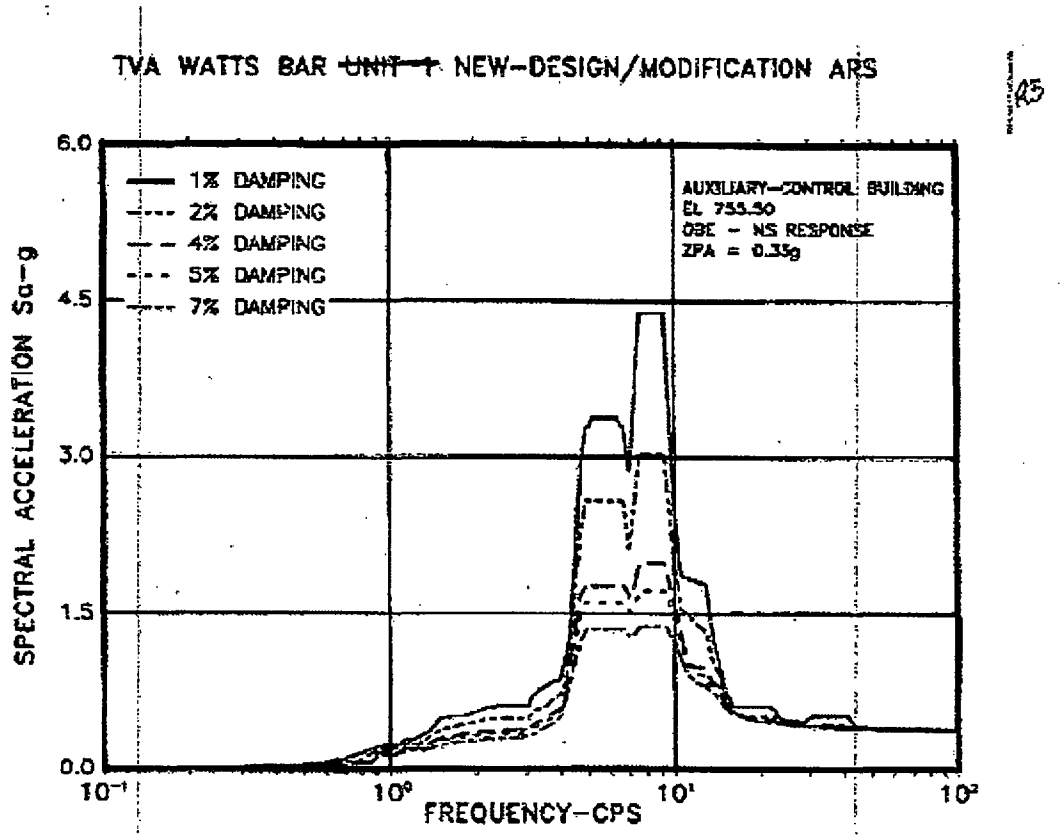

Figure 4.3-8. OBE North to South FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

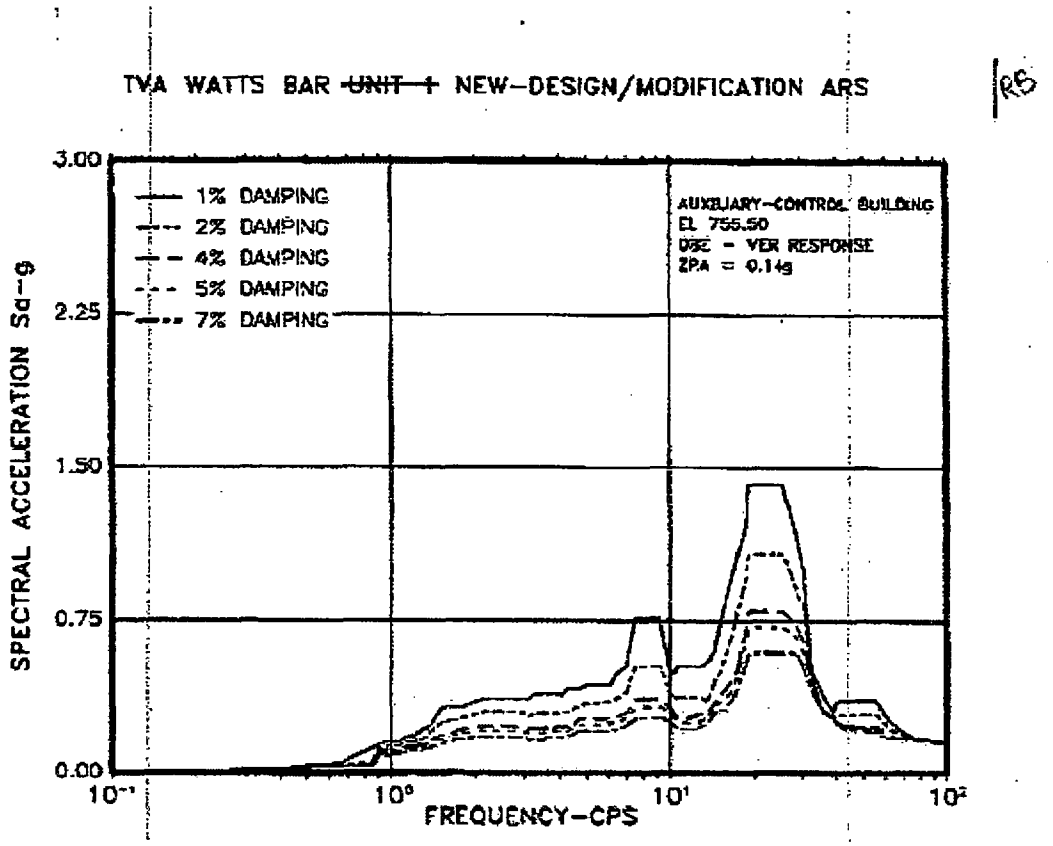

Figure 4.3-9. OBE Vertical FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

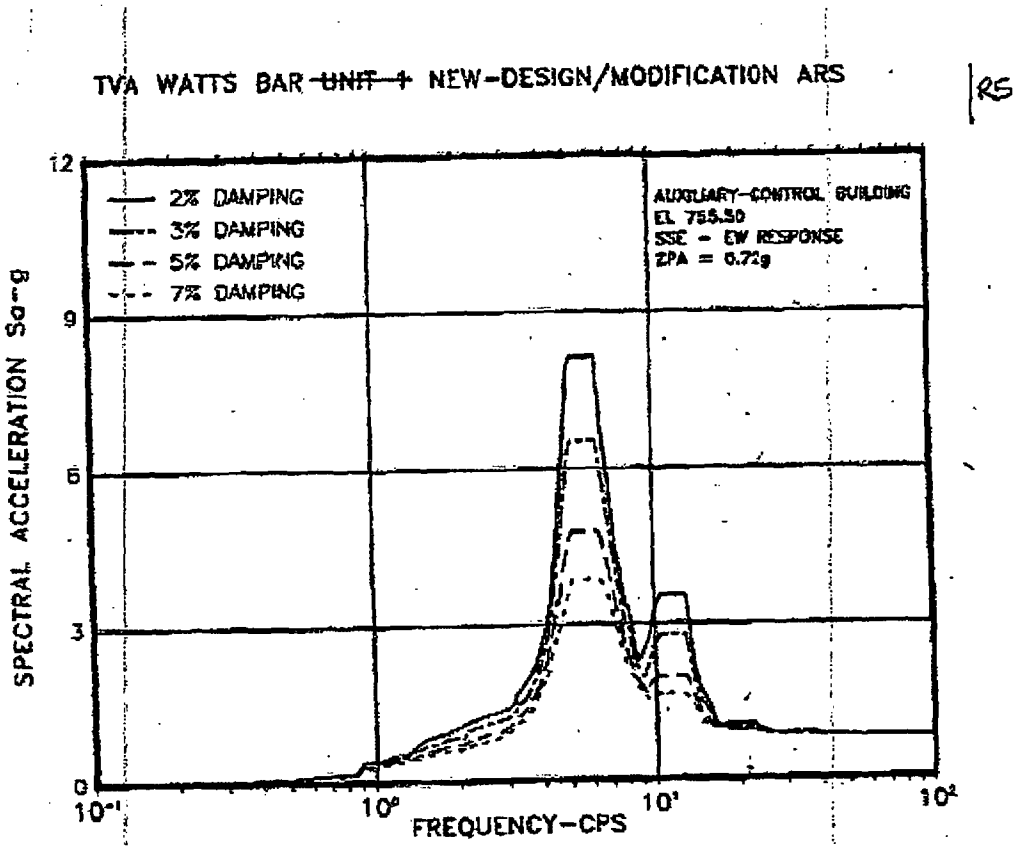

Figure 4.3-10. SSE East to West FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

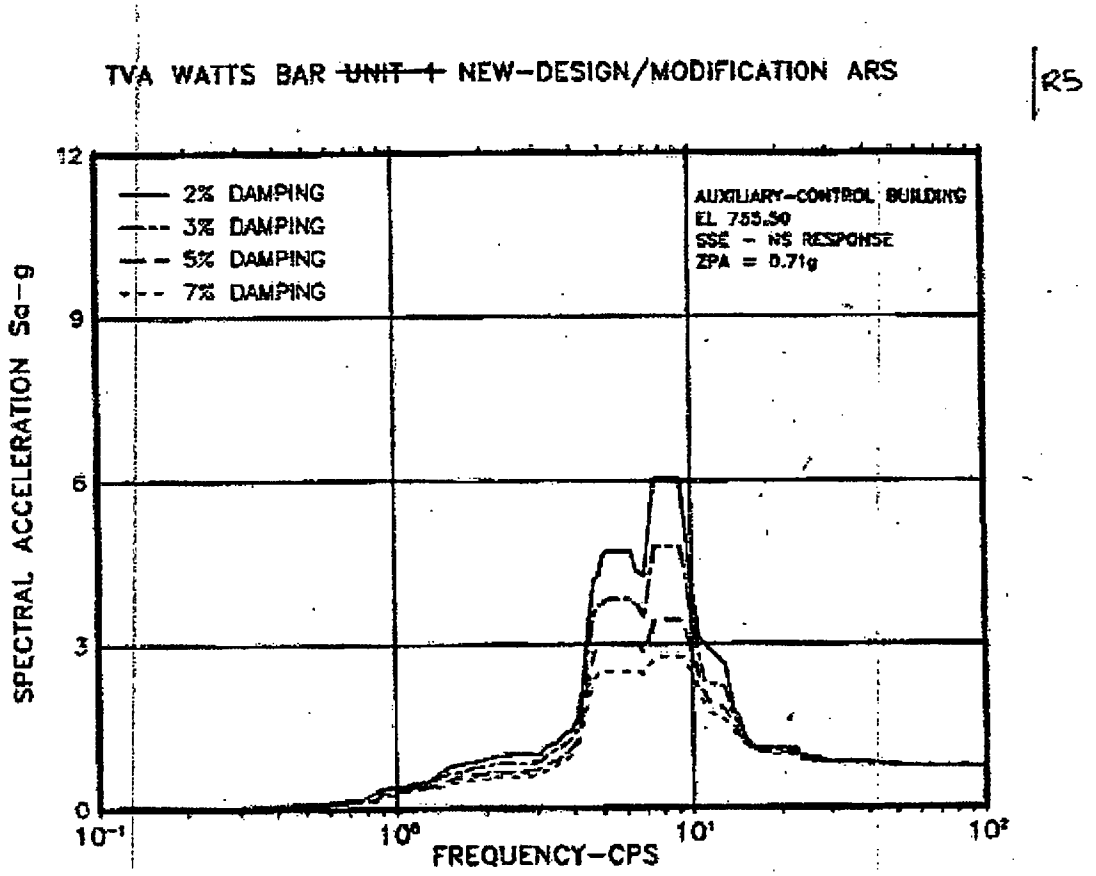

Figure 4.3-11. SSE North to South FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

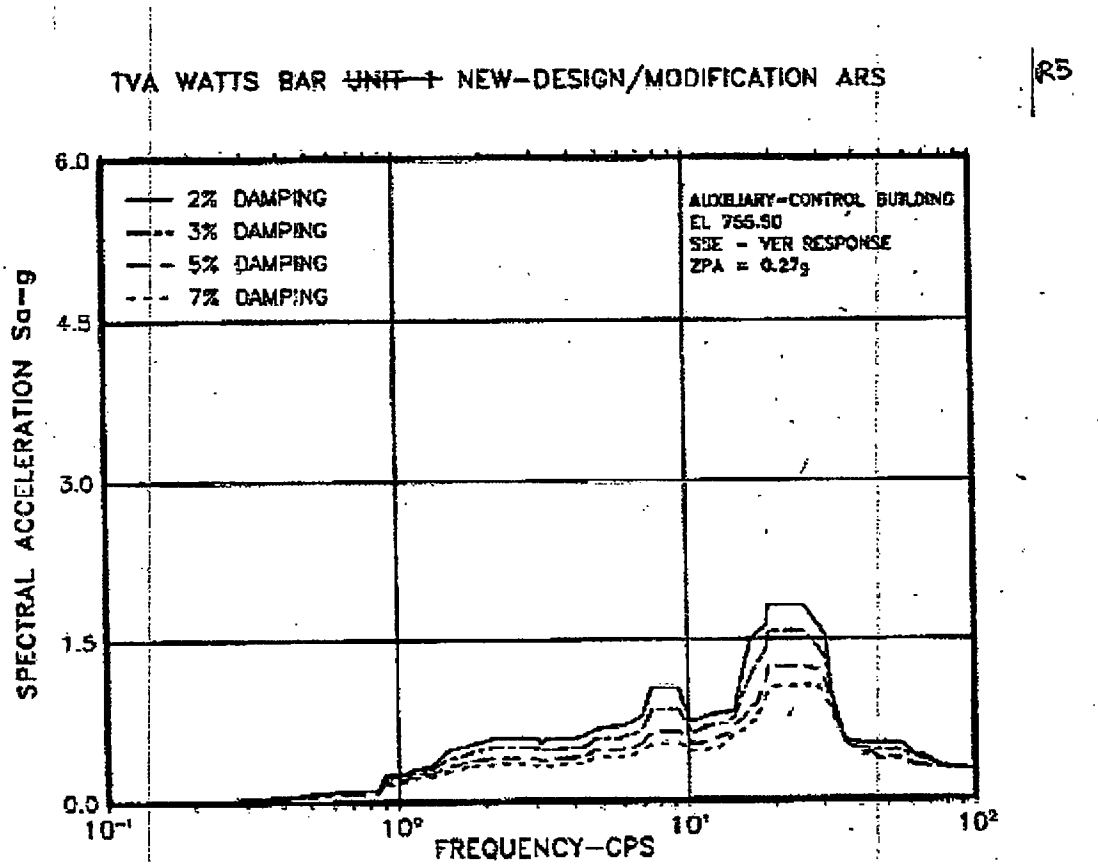

Figure 4.3-12. SSE Vertical FRS for Watts Bar Auxiliary Control Building at Elevation 755.50 Feet from Reference 14

(Last Page of Section 4)

SECTION 5
TYPE TESTING PERFORMED

5.1 GENERAL

The AC160 Safety System Platform equipment, which includes the Standard Seismic 7721 safety cabinet and associated components and Common Q Platform hardware, was qualified based on testing and evaluation. The AC160/Common Q hardware was originally qualified for seismic, environmental, and EMC, as part of the base Common Q qualification program, which is documented in 00000-ICE-37764, "Summary Qualification Report of Hardware Testing for Common Q Applications" (Reference 23). Qualification tests have been performed on components that have been changed since completion of this base program due to product evolution, improvement, and/or obsolescence.

The qualification of the WBT PAMS AC160/Common Q equipment is based on the test programs identified in Table 5.1-1. The test programs that are identified were not performed specific for the WBT application of the AC160/Common Q hardware. Section 6 provides a plant-specific evaluation to demonstrate that the WBT PAMS AC160/Common Q hardware is qualified based on similarity to the qualified AC160/Common Q hardware and that the AC160/Common Q hardware is qualified for the WBT plant-specific requirements; this plant-specific evaluation addresses Plant Specific Action Item 6.4 as required by the NRC's SER contained in WCAP-16097-P-A (Reference 5).

Table 5.1-1. Qualification Testing Performed for AC160/Common Q

Test Report	Equipment Qualified	Testing Performed

a,c

Table 5.1-1. Qualification Testing Performed for AC160/Common Q (cont.)

a,c

Test Report	Equipment Qualified	Testing Performed

5.2 EMC TESTING

The AC160/Common Q equipment was subjected to EMC testing as documented in the various references cited in Table 5.1-1. The various EMC test programs were performed by Washington Laboratories, LTD (WLL) at the Westinghouse Electric Company LLC facility located in New Stanton, PA and at the WLL facility in Gaithersburg, MD, WYLE Laboratories in Huntsville, Alabama, and Retlif Testing Laboratories in Ronkonkoma, New York.

Table 5.2-1 identifies the EMC test standard(s) that were satisfied for each EMC qualification program.

Table 5.2-1. EMC Qualification Requirement Basis for the AC160/Common Q Hardware

Qualification Reference Document Number	EMC Test Standard		Notes
	RG 1.180, Rev. 1 (Reference 7)	EPRI TR-102323, Rev. 1 (Reference 8)	
WNA-DC-00173-GEN (References 16, 17, 18, 19)	X	N/A	
WCAP-16166-P, Supplement 1-E06 (Reference 21)	X	N/A	
00000-ICE-37764 (Reference 23)	N/A	X	
EQ-QR-64-GEN (Reference 28)	X	N/A	
LTR-EMPE-03-26 (Reference 27)	See Comments	See Comments	
WCAP-16166-P, Supplement 1-E05 (Reference 22)	X	X	
EQ-QR-40 (Reference 29)	X	X	

a,c

5.3 ENVIRONMENTAL TESTING

The AC160/Common Q equipment was subjected to environmental testing as documented in the applicable references cited in Table 5.1-1. The environmental testing documented in EL:6680 (Reference 15) was performed by Clark Dynamic Testing Laboratory, LLC. The other various environmental test programs were performed by Westinghouse Electric Company LLC at the Westinghouse facility located in New Stanton, PA and WYLE Laboratories in Huntsville, Alabama.

Table 5.3-1 provides the tested environmental conditions from the various test programs. As discussed in Section 4.2, the required environmental test conditions in Table 4.2-2 satisfy the WBT plant-specific environmental requirements in Table 4.2-3 and Table 4.2-4; this includes a [ ]^{a,c} heat rise inside the PAMS cabinet as discussed in Section 4.2.

As shown in Table 5.3-1, the tested conditions from the various test programs envelop the required environmental test conditions in Table 4.2-2. [

]^{a,c}

Table 5.3-1. Environmental Test Condition Summary

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

a,c

Table 5.3-1. Environmental Test Condition Summary (cont.)

a,c

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

Table 5.3-1. Environmental Test Condition Summary (cont.)

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

a,c

Table 5.3-1. Environmental Test Condition Summary (cont.)

a,c

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

Table 5.3-1. Environmental Test Condition Summary (cont.)

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

a,c

Table 5.3-1. Environmental Test Condition Summary (cont.)

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

a,c

Table 5.3-1. Environmental Test Condition Summary (cont.)

a,c

Test Cycle	Qualification Reference	Temperature (°F)	Humidity (% RH)	Duration (hr)	Supply Voltage (VAC)	Frequency (Hz)

5.4 SEISMIC TESTING

The AC160/Common Q equipment was subjected to seismic testing as documented in the applicable references cited in Table 5.1-1. The seismic testing documented in EL:6681 (Reference 36) was performed at Clark Dynamic Testing Laboratory, LLC. The seismic testing documented in 00000-ICE-37764 (Reference 23), and 00000-ICE-37773 (Reference 34) was performed at WYLE Laboratories, LLC. The other various seismic test programs were performed by Westinghouse Electric Company LLC at the Westinghouse facility located in New Stanton, PA.

Note that the seismic qualification testing of the AC160/Common Q equipment was performed to both IEEE Stds 344-1975 and 344-1987 (References 13 and 12, respectively), however, as noted in WNA-DS-01617-WBT-P (Reference 6), WBT PAMS shall be seismically qualified to IEEE Std 344-1975 (Reference 13). The seismic testing on the AC160/Common Q equipment that was performed in accordance with IEEE Std 344-1987 (Reference 12) bounds the requirements specified in IEEE Std 344-1975 (Reference 13). Therefore, it is concluded that all of the AC160/Common Q seismic qualification testing was performed in accordance with IEEE Std 344-1975 (Reference 13).

(Last Page of Section 5)

SECTION 6
ANALYSIS PERFORMED AND BASIS FOR QUALIFICATION

6.1 GENERAL

This section documents evaluation performed to:

- Demonstrate EMC qualification of WBT PAMS cabinets and associated hardware, and OM assembly based on similarity to the qualified AC160 Safety System platform hardware. The WBT applicable EMC requirements are described in Section 4.1.

- Demonstrate environmental qualification of WBT PAMS cabinets and associated hardware based on similarity to the qualified AC160 Safety System platform hardware. The WBT applicable environmental requirements are described in Section 4.2.

- Demonstrate seismic qualification of the WBT PAMS cabinets and associated hardware based on similarity to qualified AC160 Safety System platform hardware. The WBT applicable seismic requirements as detailed in Section 4.3.

A list of equipment supplied for the WBT PAMS application is provided in Table 6.1-1 and Table 6.1-2, for the cabinet configurations and OM assembly, respectively. These tables also identify the qualification basis for each component, and qualification justification, where applicable.

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

a,c

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

EQ-QR-68-WBT-NP, Rev. 0

Westinghouse Non-Proprietary Class 3

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-1. Qualification Records for the WBT PAMS Cabinet Trains A and B Components (cont.)

a,c

Item No	Part Name	Description	WBT PAMS Part Number for Train A and Train B Components per 10000A193 (Reference 4)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

Table 6.1-2. Qualification Records for the WBT PAMS OM Components

Item No	Part Name	Description	WBT PAMS Part Number for OM Components per 10004D82 (Reference 3)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

a,c

Table 6.1-2. Qualification Records for the WBT PAMS OM Components (cont.)

Item No	Part Name	Description	WBT PAMS Part Number for OM Components per 10004D82 (Reference 3)	Environmental Qualification Reference	EMC Qualification Reference	Seismic Qualification Reference	Remarks

a,c

6.2 EMC

The requirements for EMC qualification are specified in Section 4.1.

Table 6.1-1 and Table 6.1-2 identify the EMC qualification basis for components used in the PAMS cabinet and OM, respectively. The components used in PAMS are either identical or similar to the qualified component. If the component is similar to a tested component, similarity justification for qualification is provided by the evaluations contained in CN-EQT-10-55 (Reference 39).

As shown in Table 5.2-1, the AC160/Common Q hardware was type tested in the various test programs and satisfied the requirements of EPRI TR-102323 (Reference 8) and RG 1.180 (Reference 7), as applicable.

Based on the EMC type testing and similarity evaluations performed, it is concluded that the qualified AC160/Common Q hardware EMC conditions envelops the WBT PAMS EMC requirements stated in Section 4.1, when installed as detailed in Section 7.

The plant-specific evaluation of the WBT PAMS equipment EMC qualification is documented in CN-EQT-10-55 (Reference 39).

6.3 ENVIRONMENTAL

Table 6.1-1 and Table 6.1-2 identify the environmental qualification basis for components used in the PAMS cabinet and OM, respectively. The components used in PAMS are either identical or similar to the qualified component. If the component is similar to a tested component, similarity justification for qualification is provided by the evaluations contained in CN-EQT-10-49 (Reference 38).

The AC160/Common Q hardware was exposed to the environmental conditions shown in Table 5.3-1. The voltage and frequency of the power supplies were also varied during these test programs, as shown in Table 5.3-1. The AC160/Common Q hardware qualified environmental conditions envelop the WBT PAMS environmental requirements as defined in Section 4.2 (Table 4.2-2).

Based on the qualification testing and similarity evaluations performed, it is concluded that the AC160/Common Q hardware is qualified for the WBT PAMS application.

The plant-specific evaluation of the WBT PAMS equipment environmental qualification is documented in CN-EQT-10-49 (Reference 38).

6.4 SEISMIC

6.4.1 WBT PAMS Cabinet Dynamic Similarity Analysis

[

]^{a,c}

The dynamic similarity analysis is documented in CN-EQT-10-44 (Reference 42). [

]^{a,c} The summary results of this dynamic similarity analysis are listed in Table 6.4-1.

Table 6.4-1. Summary Results of the Dynamic Similarity Analysis

a,c

[

]

[

]^{a,c}

6.4.2 Comparison of the Qualified Seismic Levels of the WBT PAMS Cabinet and Equipment Housed within to the WBT Requirements

Table 6.1-1 identifies the seismic qualification basis for the PAMS cabinet; it is based on the AC160 cabinet test documented in EL:6681 (Reference 36). As stated in subsection 6.4.1, the WBT PAMS cabinet was shown to be dynamically similar to the AC160 cabinet tested in EL:6681 (Reference 36).

Table 6.1-1 identifies various seismic test programs that provide the seismic qualification basis for the equipment housed within the PAMS cabinet; these programs are documented in 00000-ICE-37764 (Reference 23), EQLR-171 (Reference 25), LTR-EMPE-03-26 (Reference 27), EQLR-169A (Reference 30), EQLR-159 (Reference 31), EQLR-168 (Reference 32), EQLR-178 (Reference 33), 00000-ICE-37773 (Reference 34), EQLR-182 (Reference 35), EL:6681 (Reference 36), EQ-EV-62-WBT (Reference 49), EQLR-130 (Reference 50), and EQLR-124 (Reference 51).

To demonstrate that the resulting qualified levels from these various seismic test programs apply to WBT, the qualifying OBE and SSE levels must envelope the WBT OBE and SSE amplified RRS for the WBT PAMS cabinet.

6.4.2.1 Development of WBT OBE and SSE Amplified RRS

[

]^{a,c}

The WBT OBE and SSE amplified RRS have been compared to the qualified levels from the various seismic test programs identified in Table 6.1-1; these comparisons are provided in Subsections 6.4.2.2 through 6.4.2.14. Note that TVA drawing 48N1319, "Miscellaneous Steel Instrument Rm Emb.Pl's" (Reference 48), identifies that the North to South direction of the plant is the cabinet Side to Side orientation. [

]^{a,c}

6.4.2.2 EL:6681

6.4.2.2.1 Qualification of the Tested Cabinet

Figures 6.4-1 through 6.4-3 provide the comparison of the WBT OBE FRS to the qualified OBE levels for the tested cabinet from EL:6681 (Reference 36) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-4 through 6.4-6 provide the comparison of the WBT SSE FRS to the qualified SSE levels for the components in the tested cabinet from EL:6681 (Reference 36) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-1 through 6.4-6, the qualified OBE and SSE levels envelop the WBT OBE and SSE FRS in each principal direction.

a,c

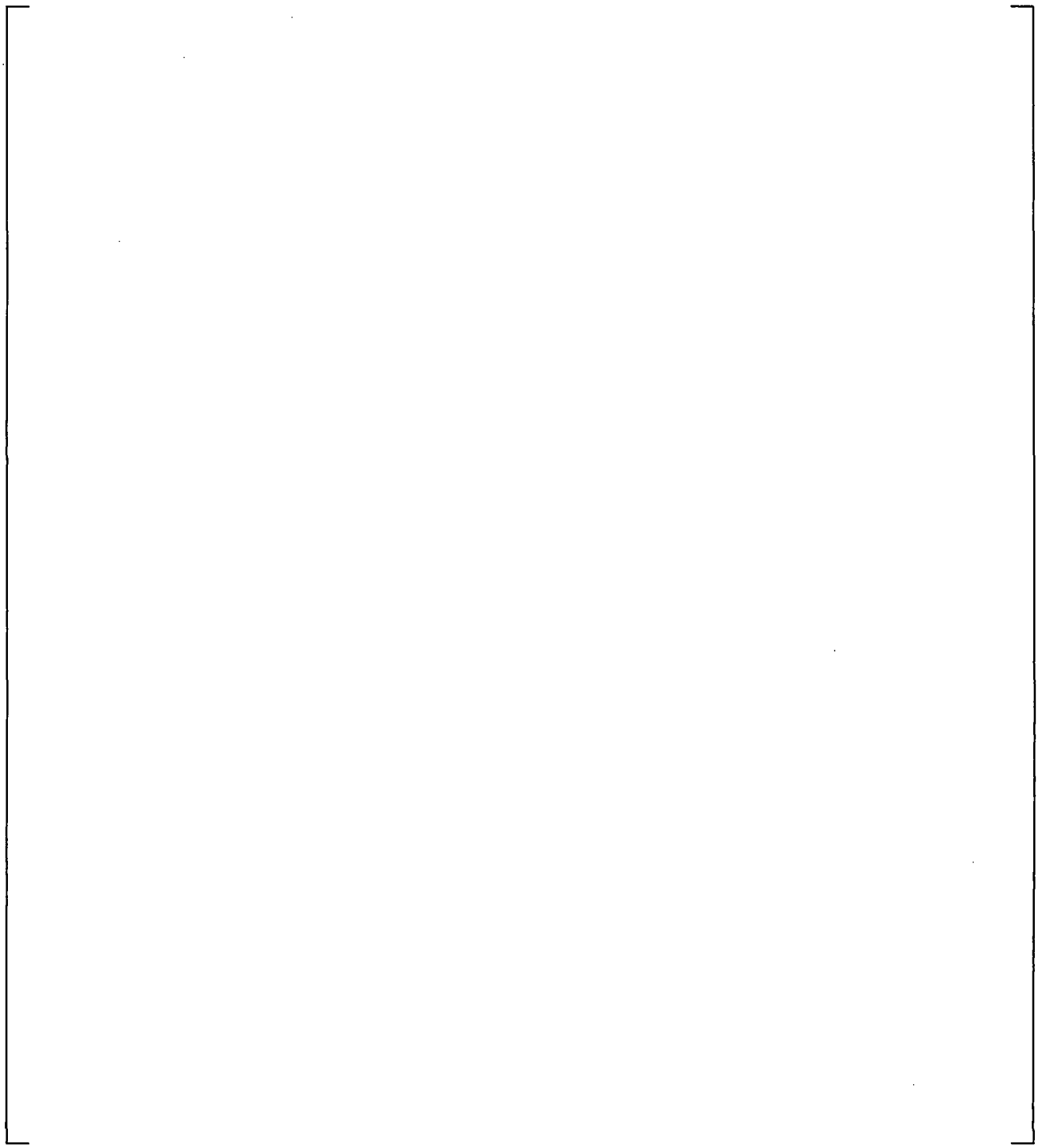

Figure 6.4-1. [

]a,c

a,c

[

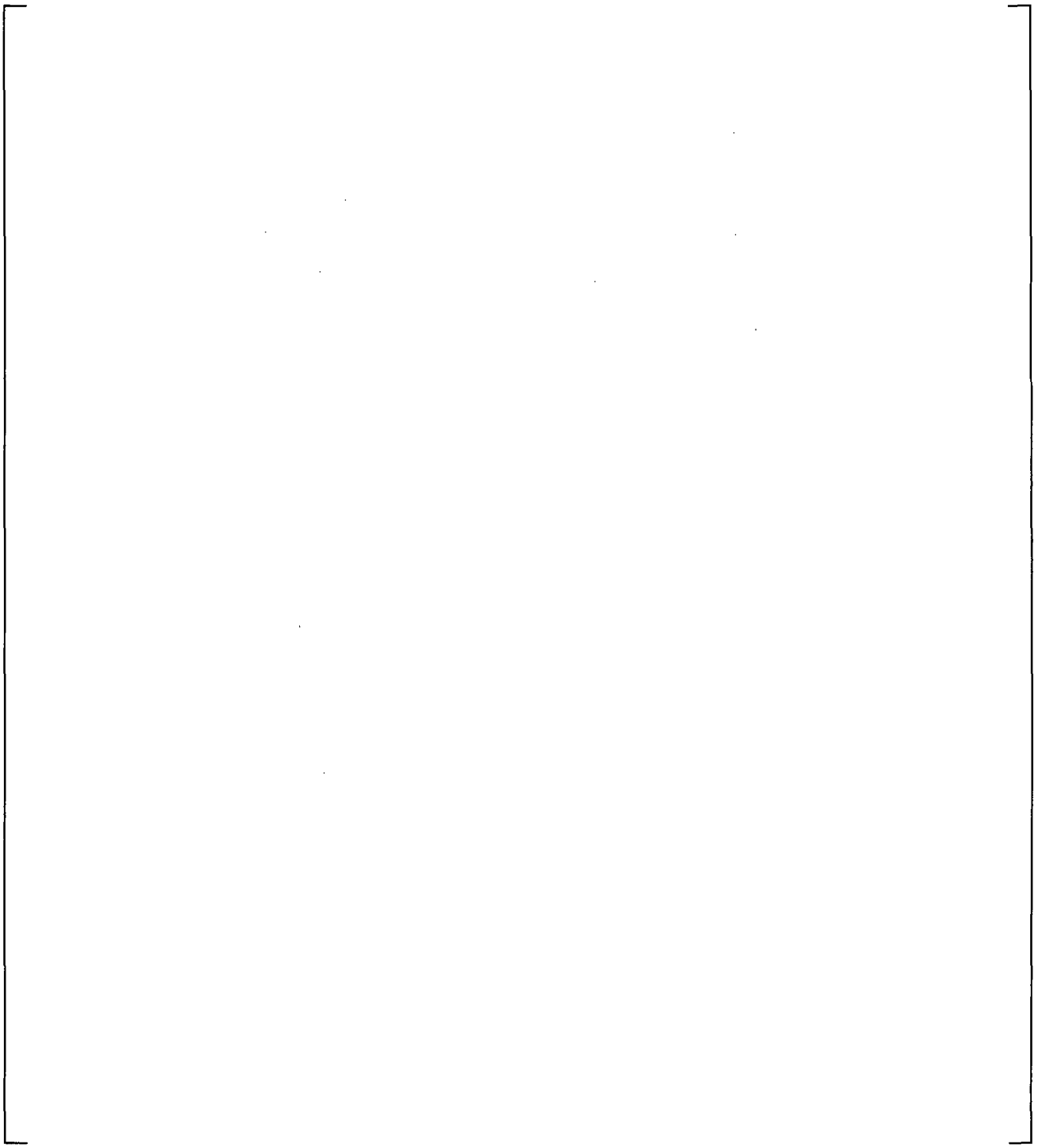

Figure 6.4-2. [

]a,c

a,c

[

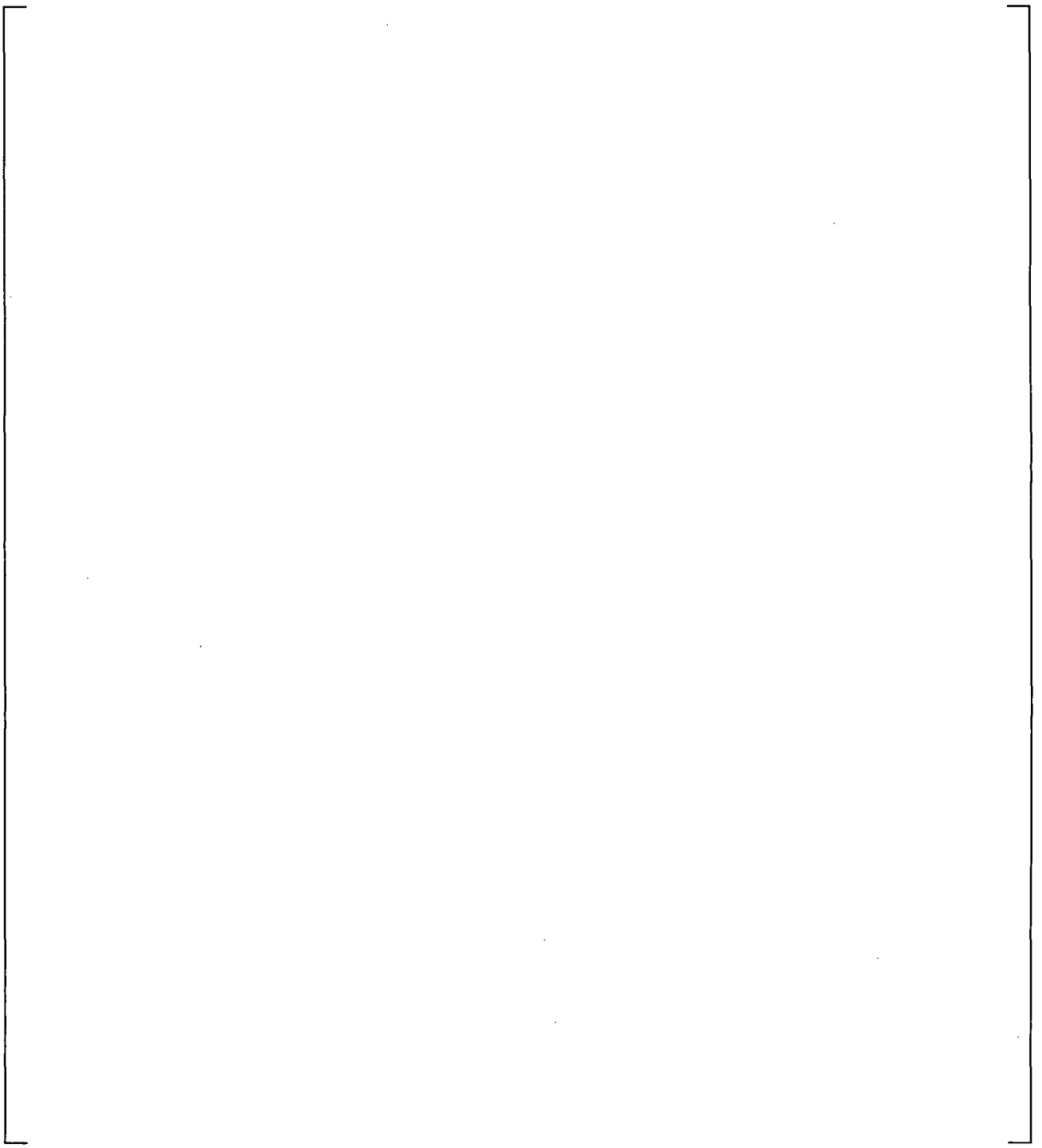

Figure 6.4-3. [

]^{a,c}

a,c

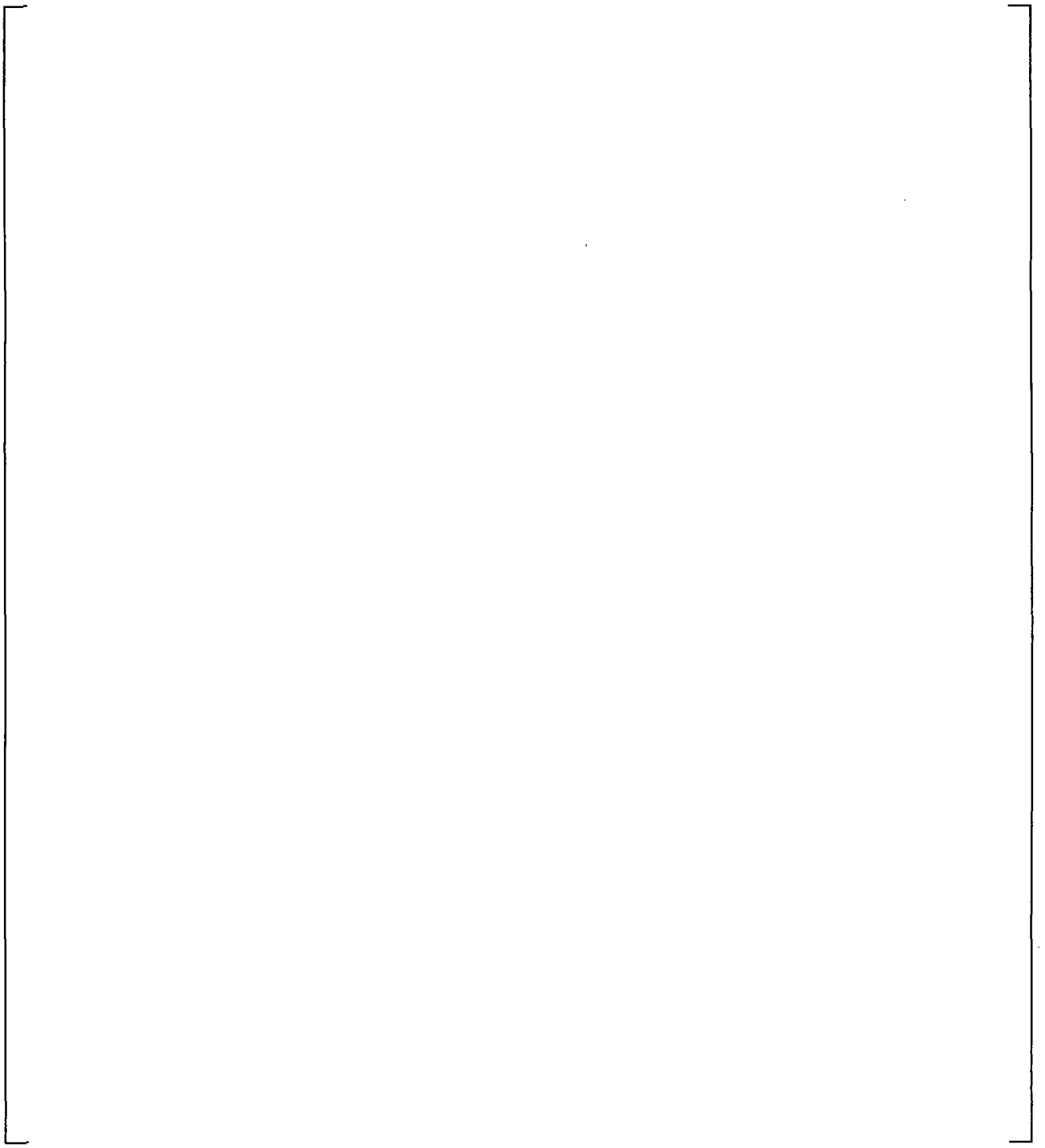

Figure 6.4-4. [

][a,c]

a,c

[

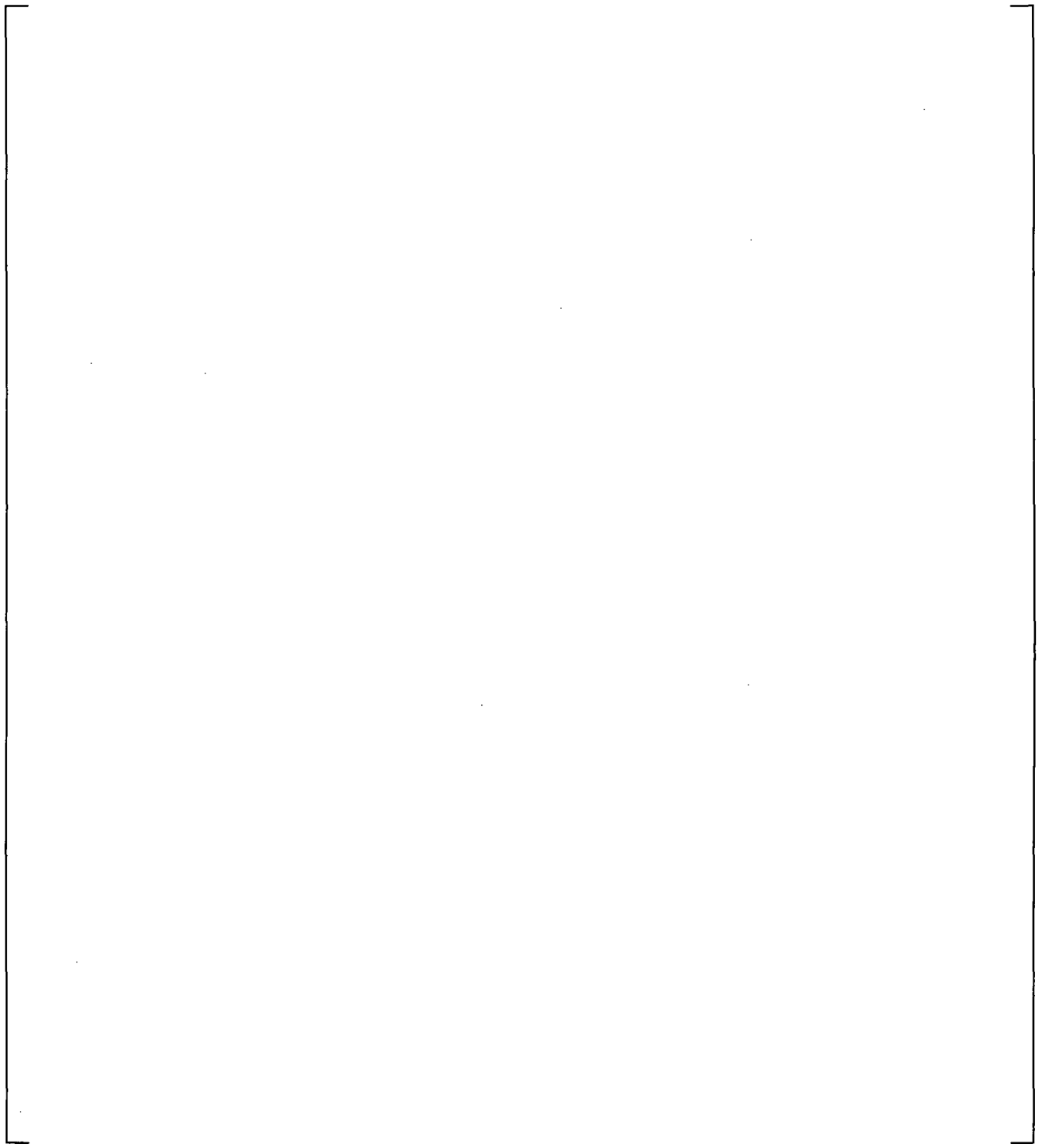

Figure 6.4-5. [

]^{a,c}

a,c

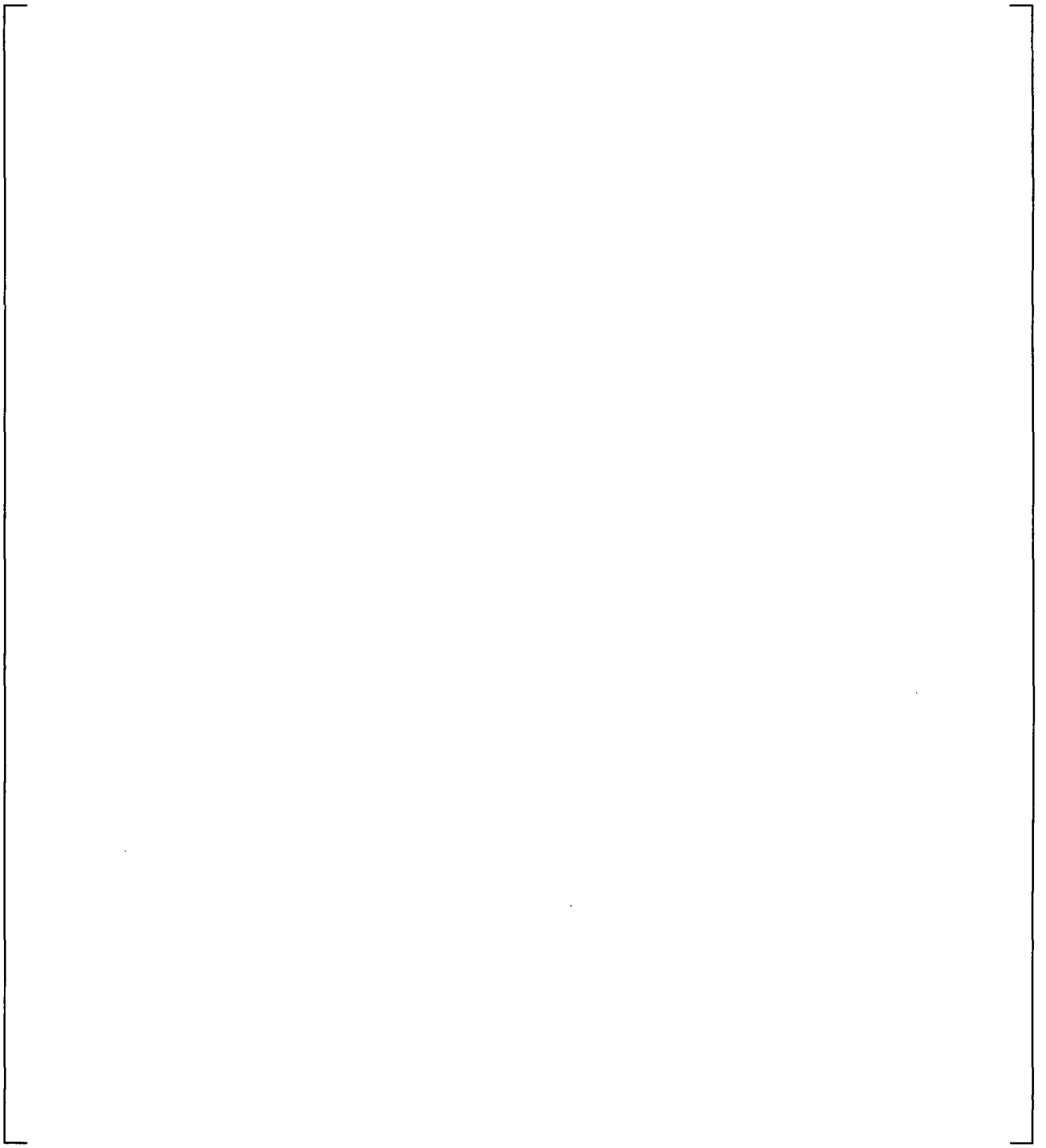

Figure 6.4-6. [

]a,c

6.4.2.2.2 Qualification of the Components Mounted within the Tested Cabinet

Figures 6.4-7 through 6.4-9 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels for the components mounted within the tested cabinet from EL:6681 (Reference 36) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-10 through 6.4-12 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EL:6681 (Reference 36) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-7 through 6.4-12, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

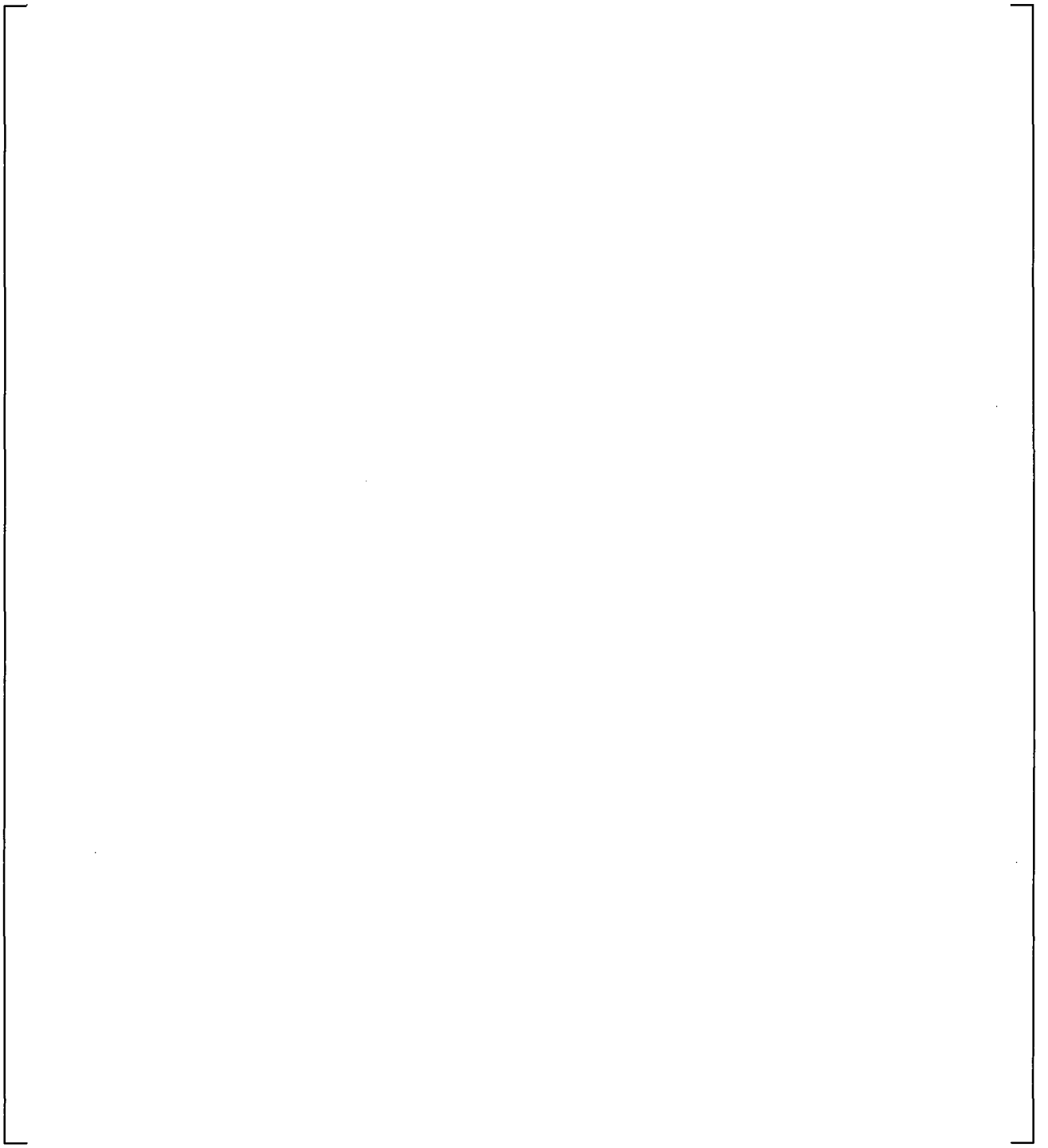

Figure 6.4-7. [

]a,c

a,c

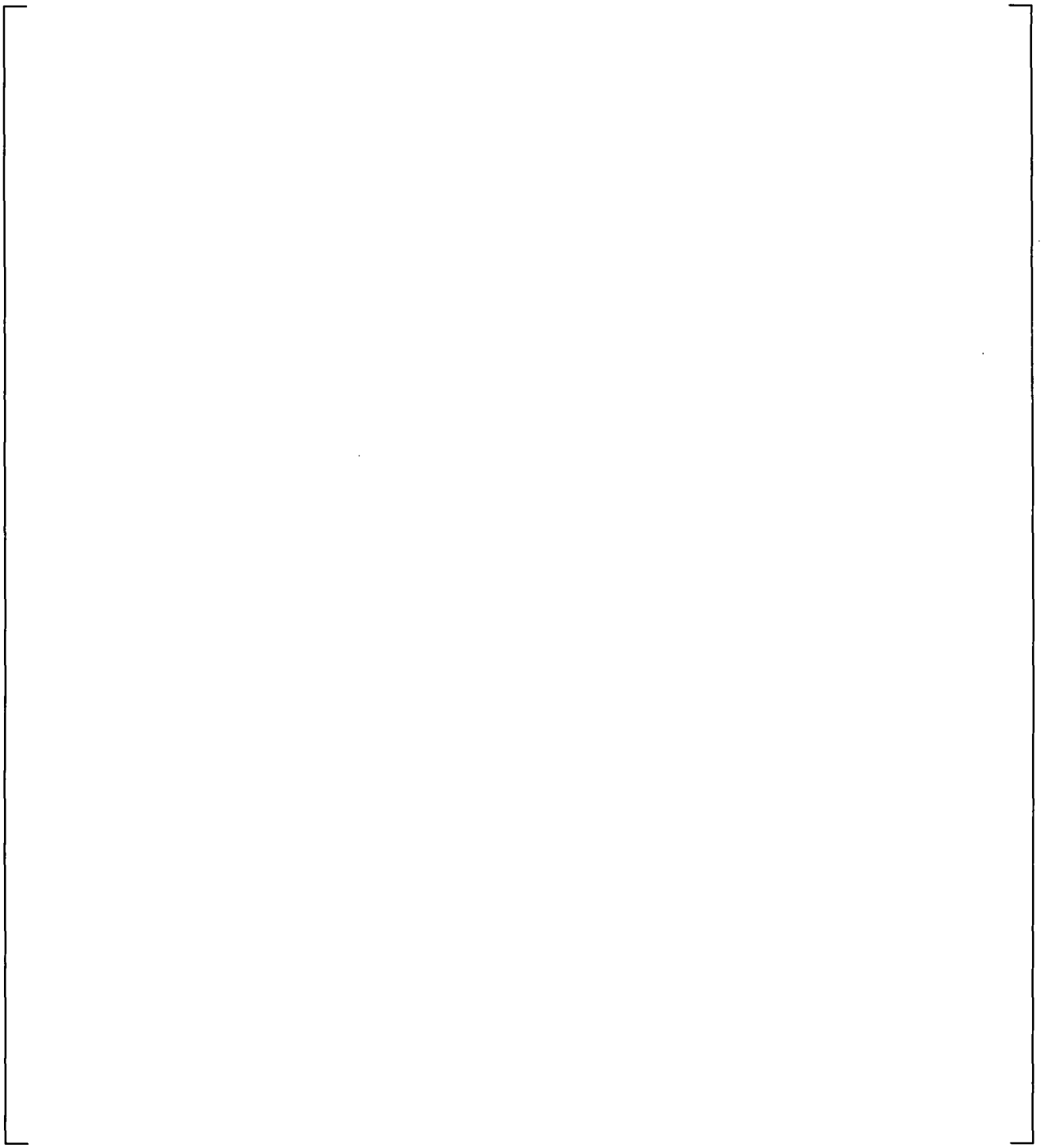

Figure 6.4-8. [

][a,c]

a,c

[

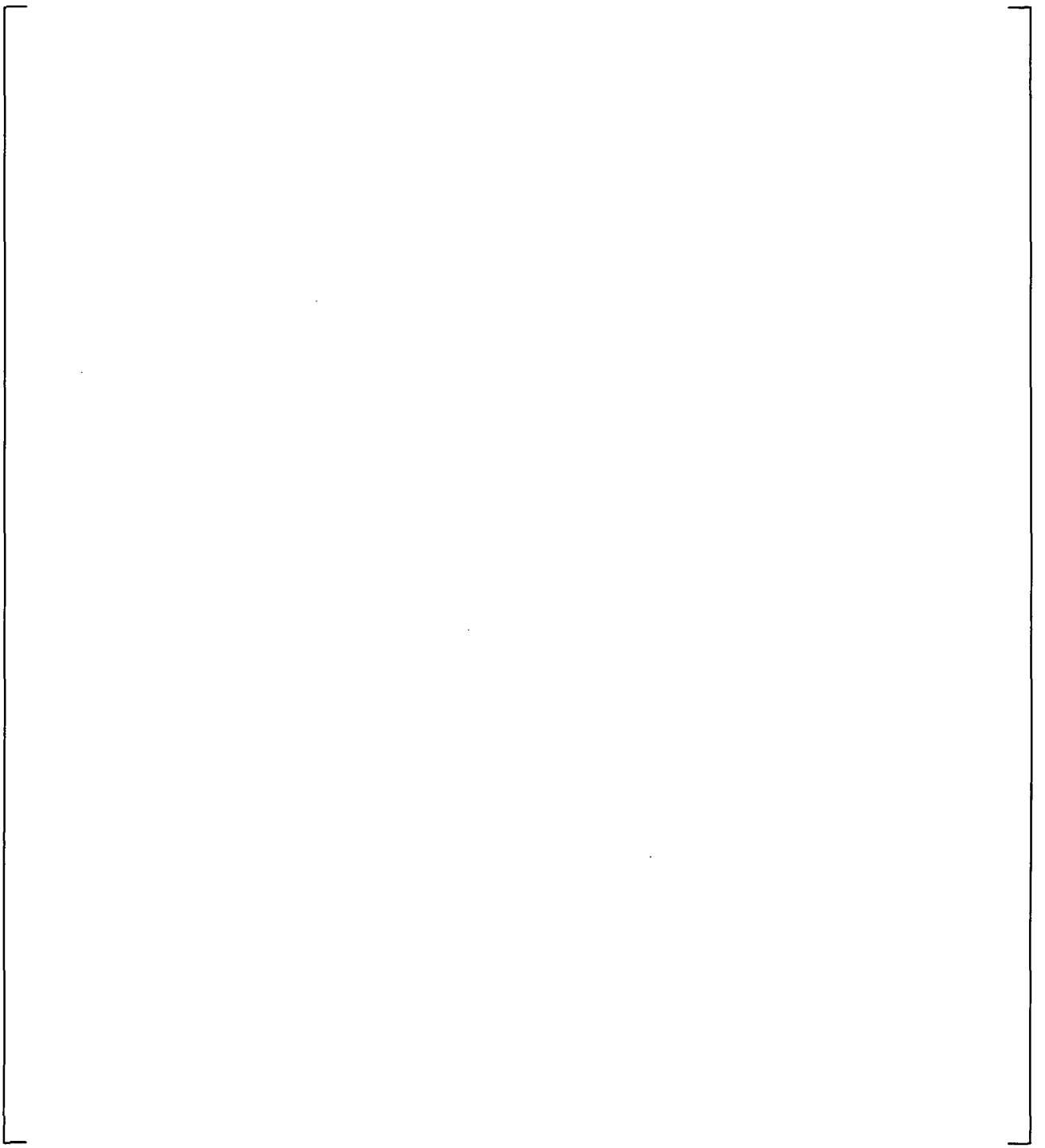

Figure 6.4-9. [

]^{a,c}

a,c

[

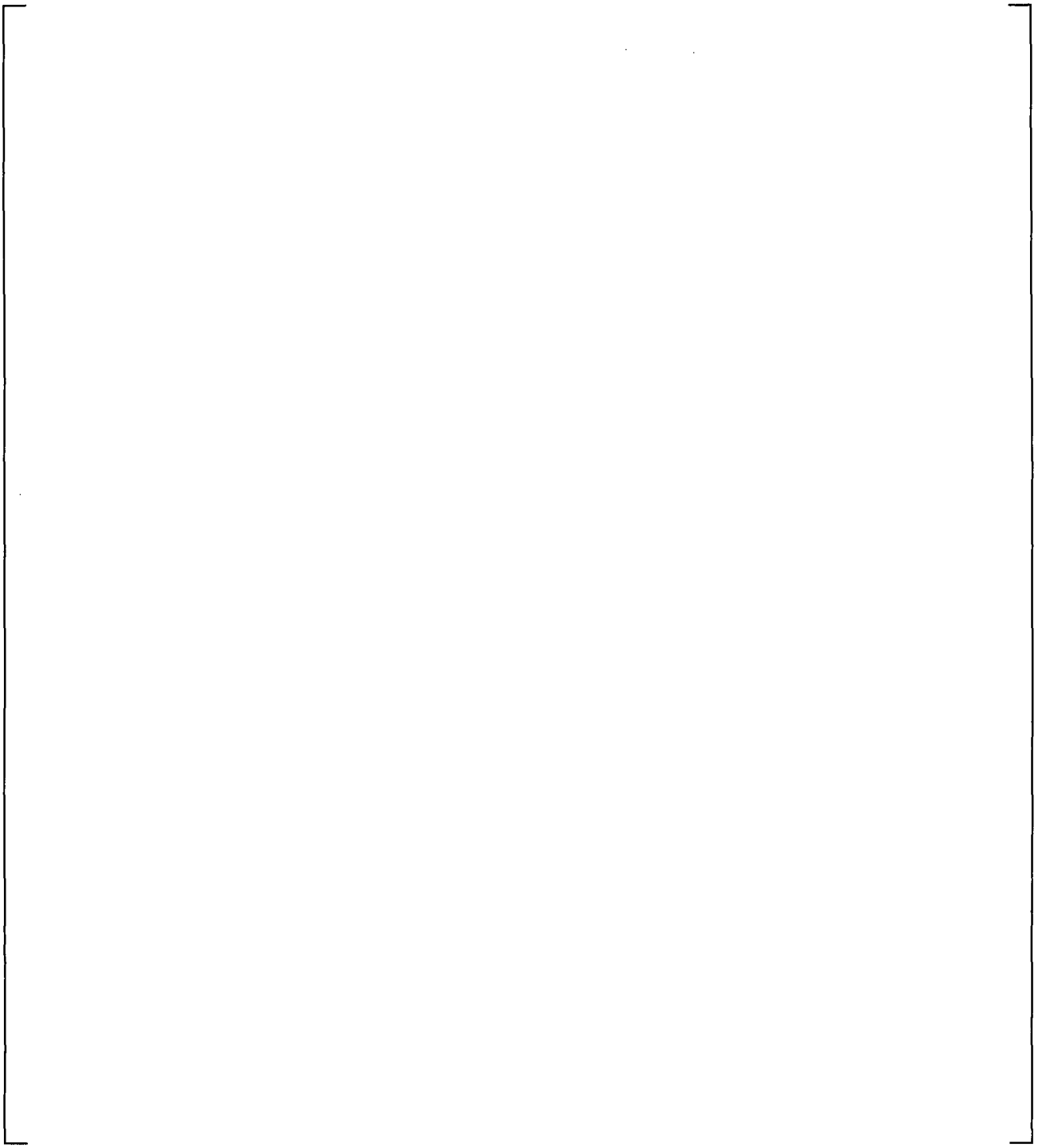

Figure 6.4-10. [

]^{a,c}

a,c

[

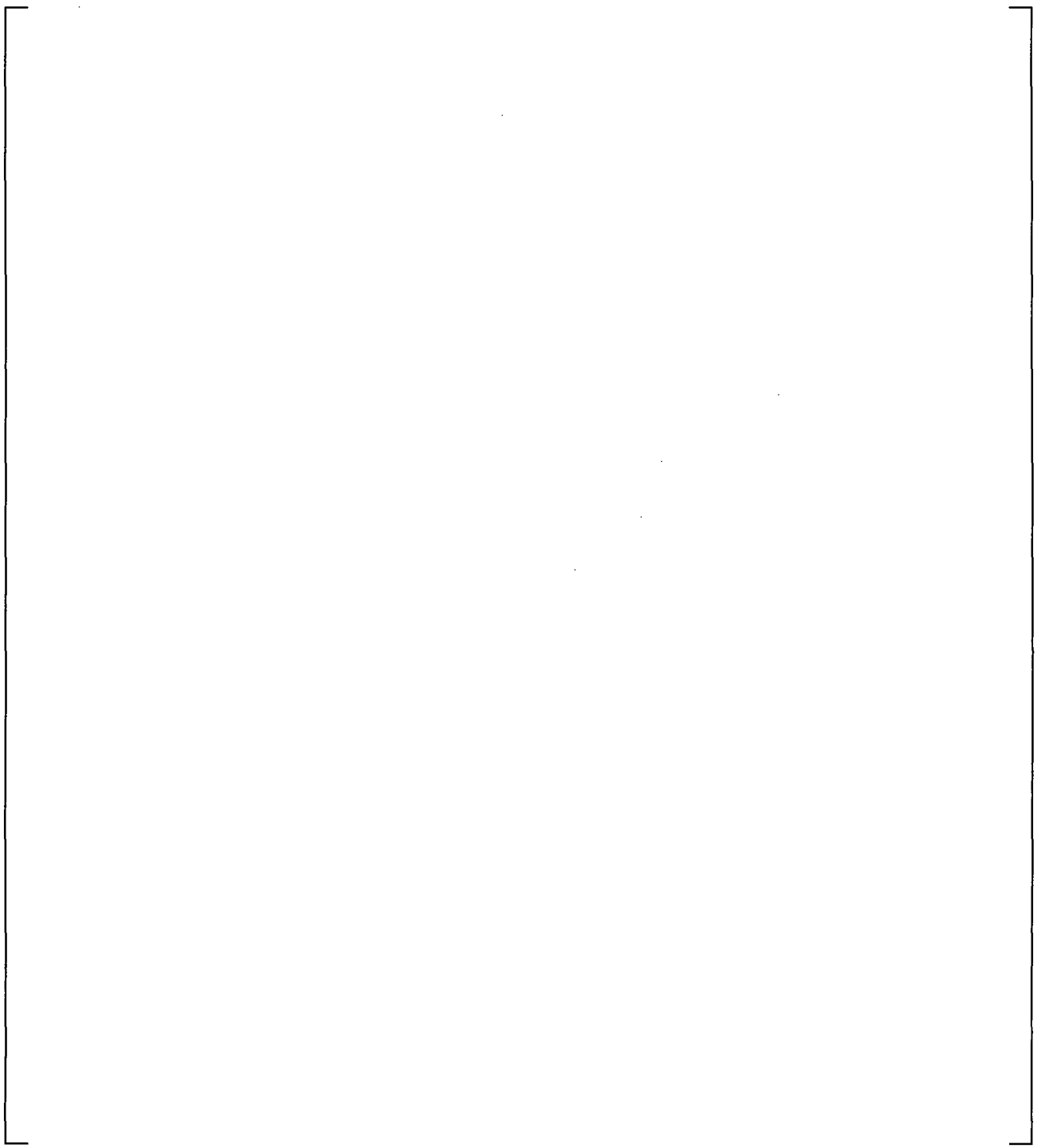

Figure 6.4-11. [

]a,c

a,c

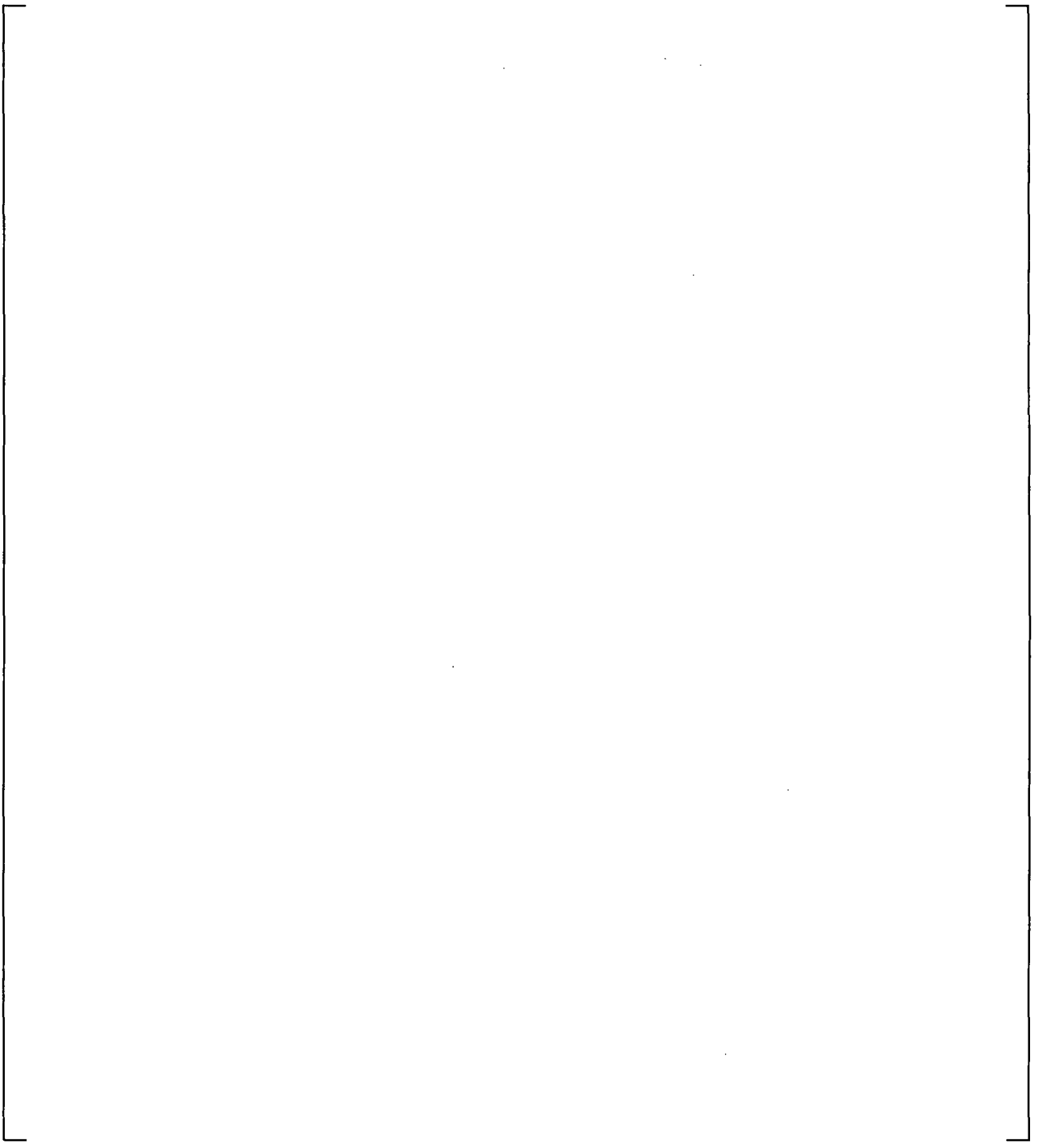

Figure 6.4-12. [

][a,c]

6.4.2.3 EQLR-171

Figures 6.4-13 through 6.4-15 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-171 (Reference 25) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-16 through 6.4-18 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-171 (Reference 25) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-13 through 6.4-18, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

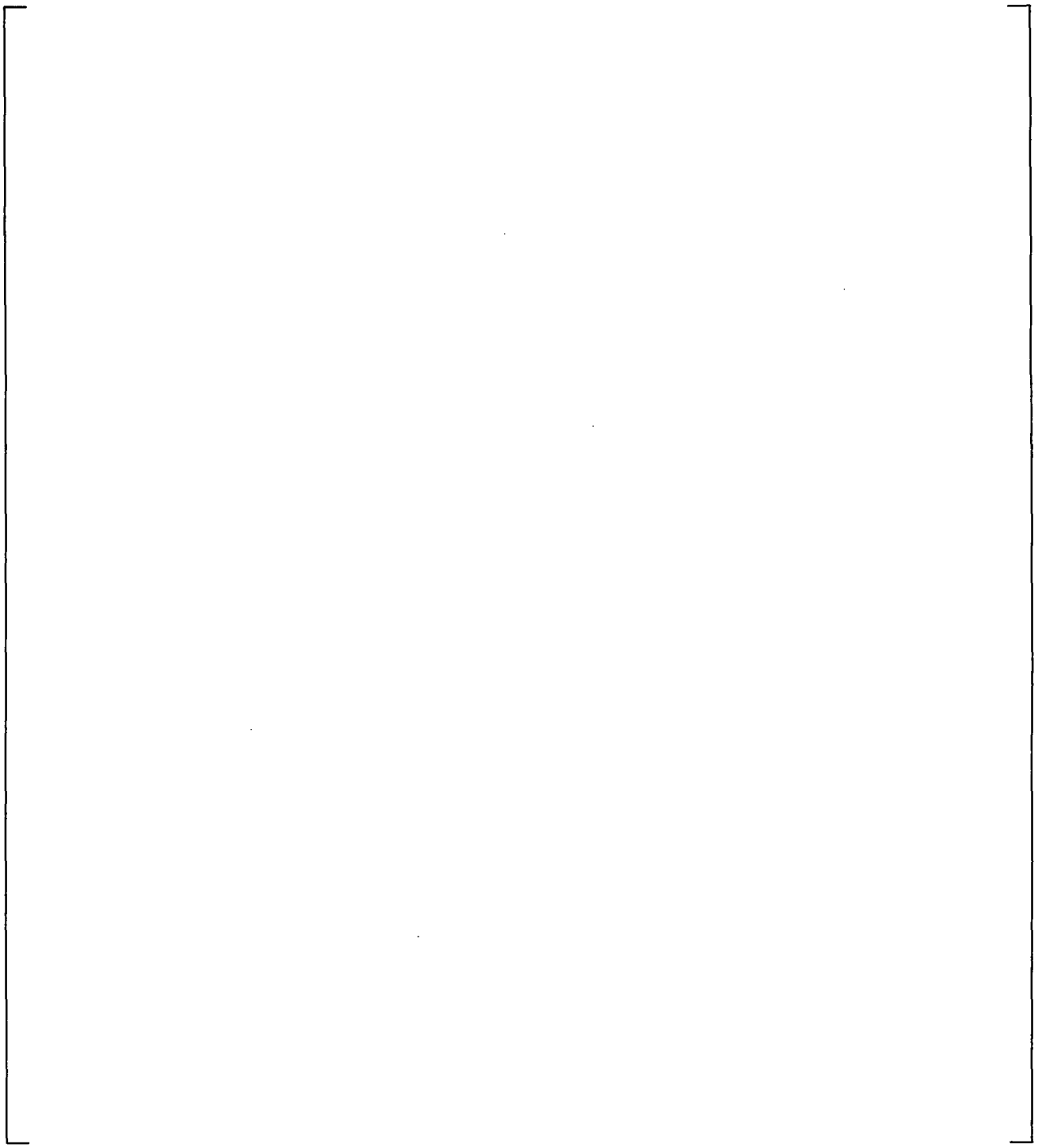

Figure 6.4-13. [

]^{a,c}

a,c

[

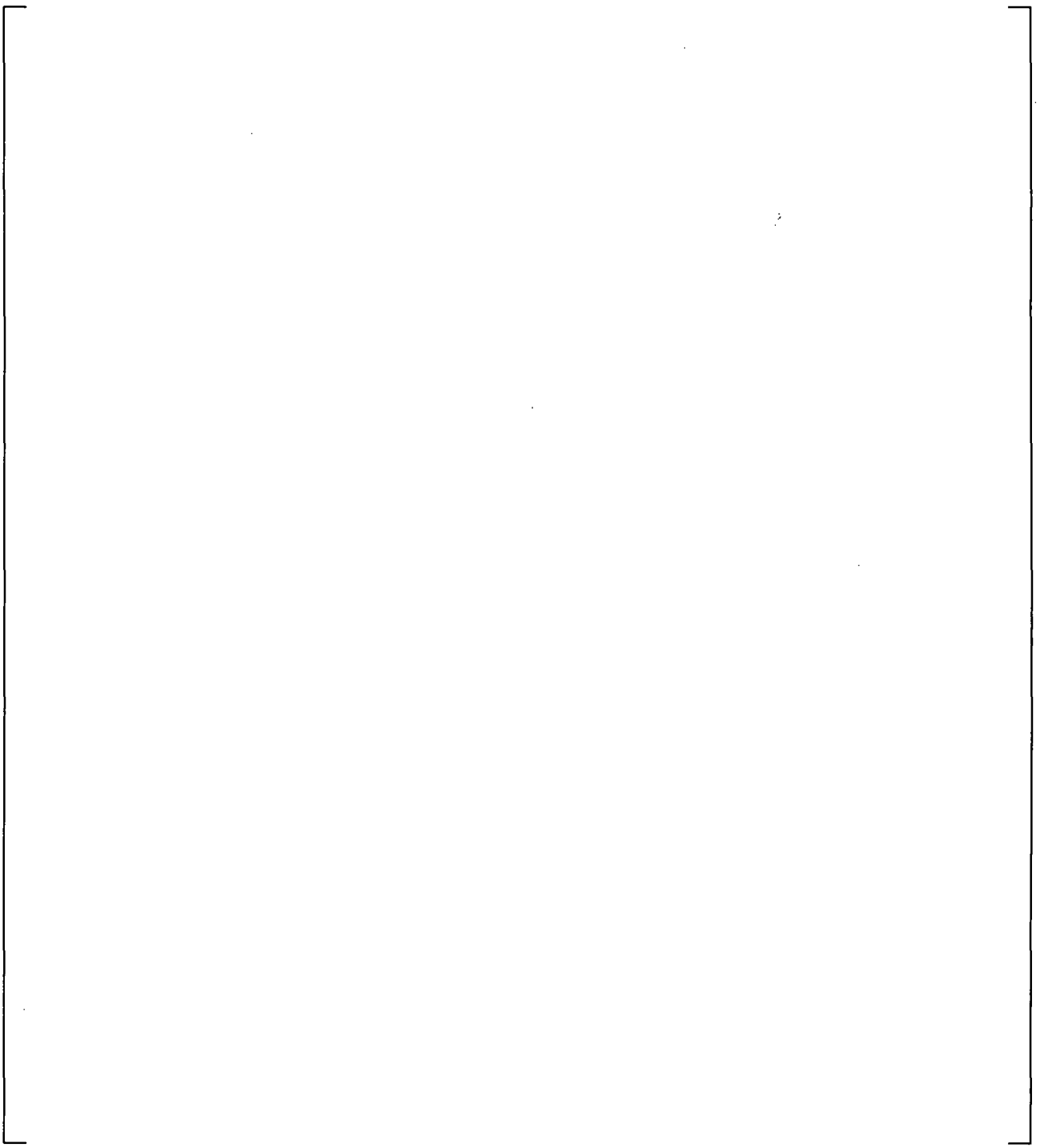

Figure 6.4-14. [

]a,c

a,c

[

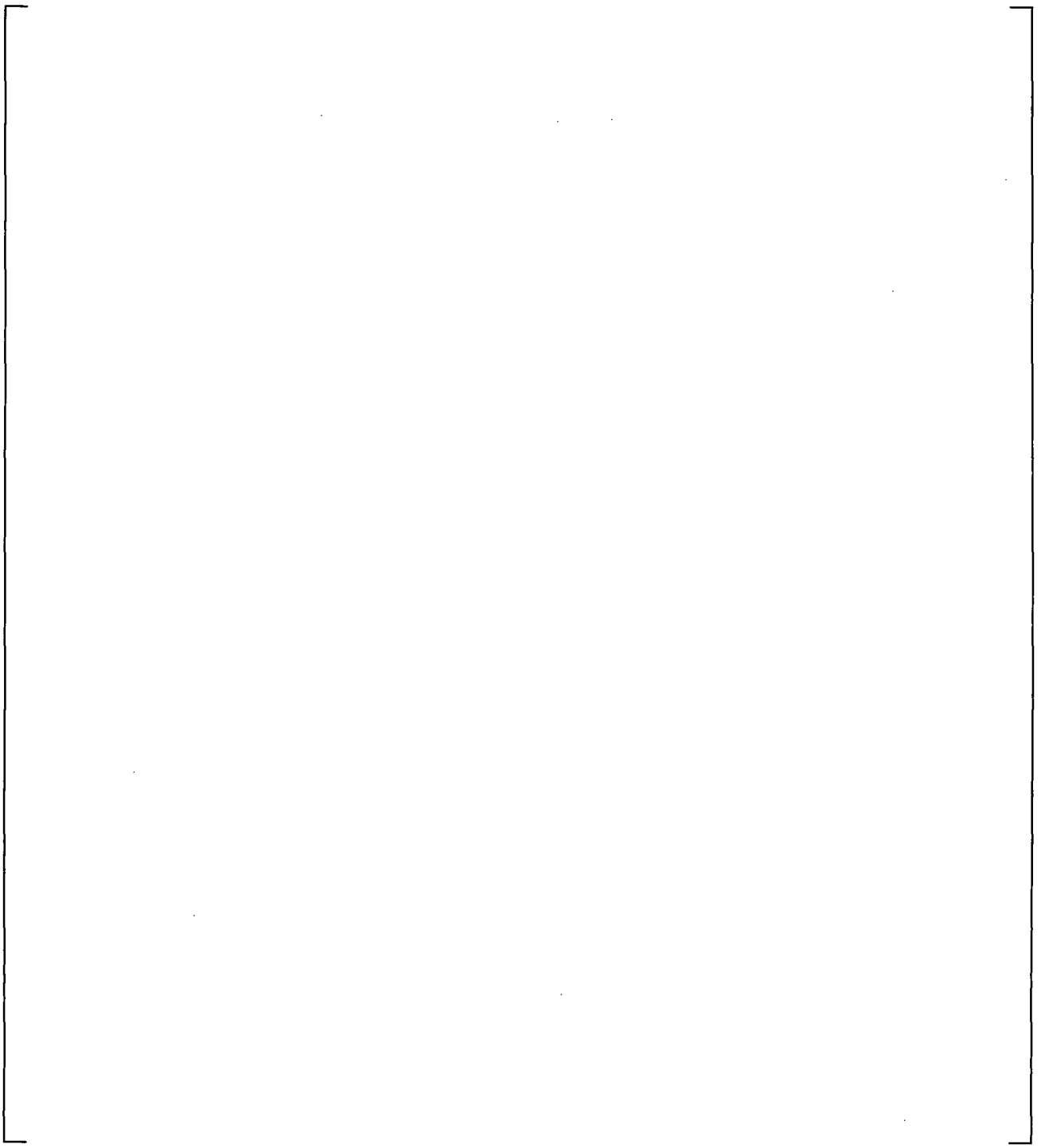

Figure 6.4-15. [

]a,c

a,c

[

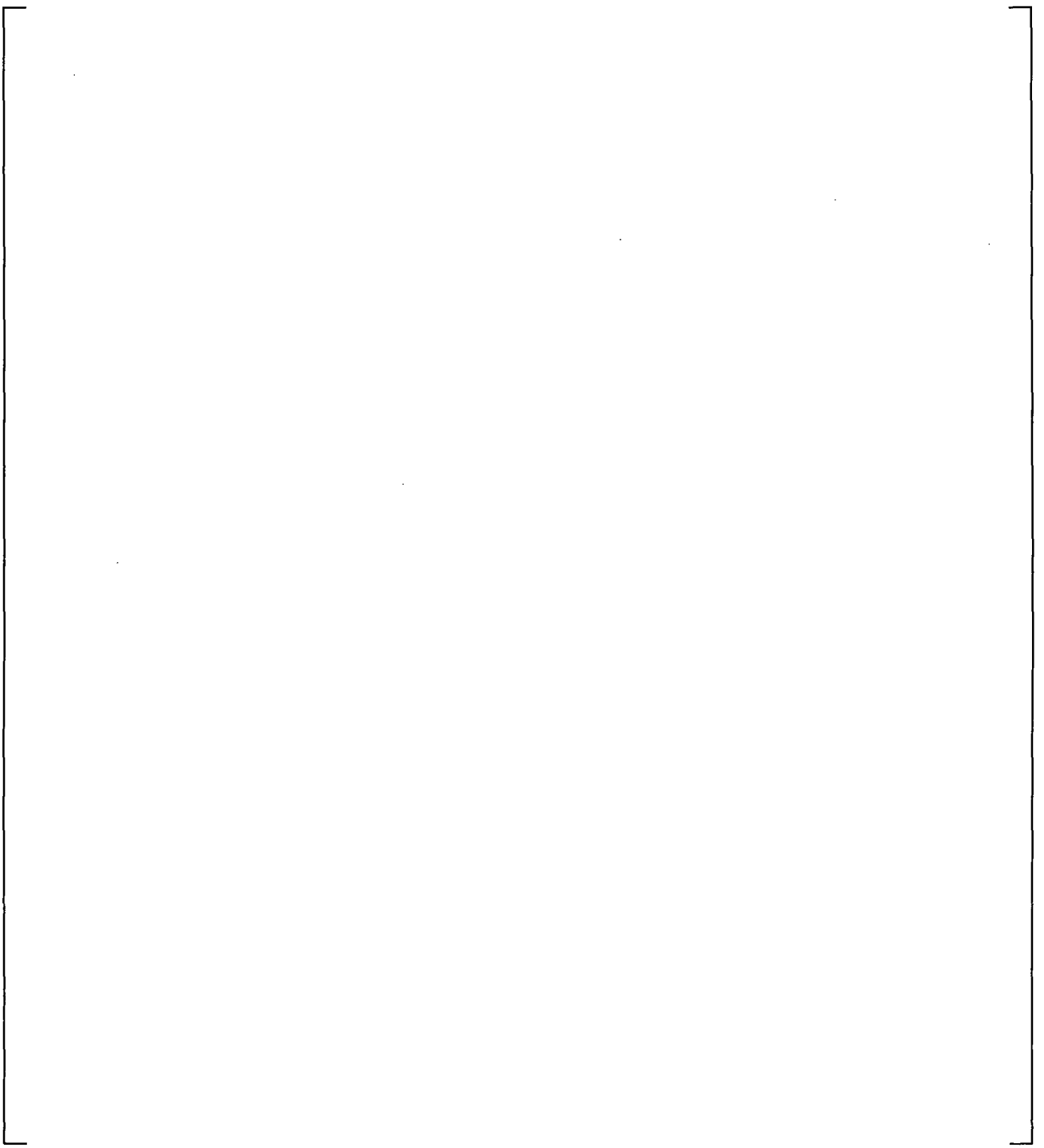

Figure 6.4-16. [

]^{a,c}

a,c

[

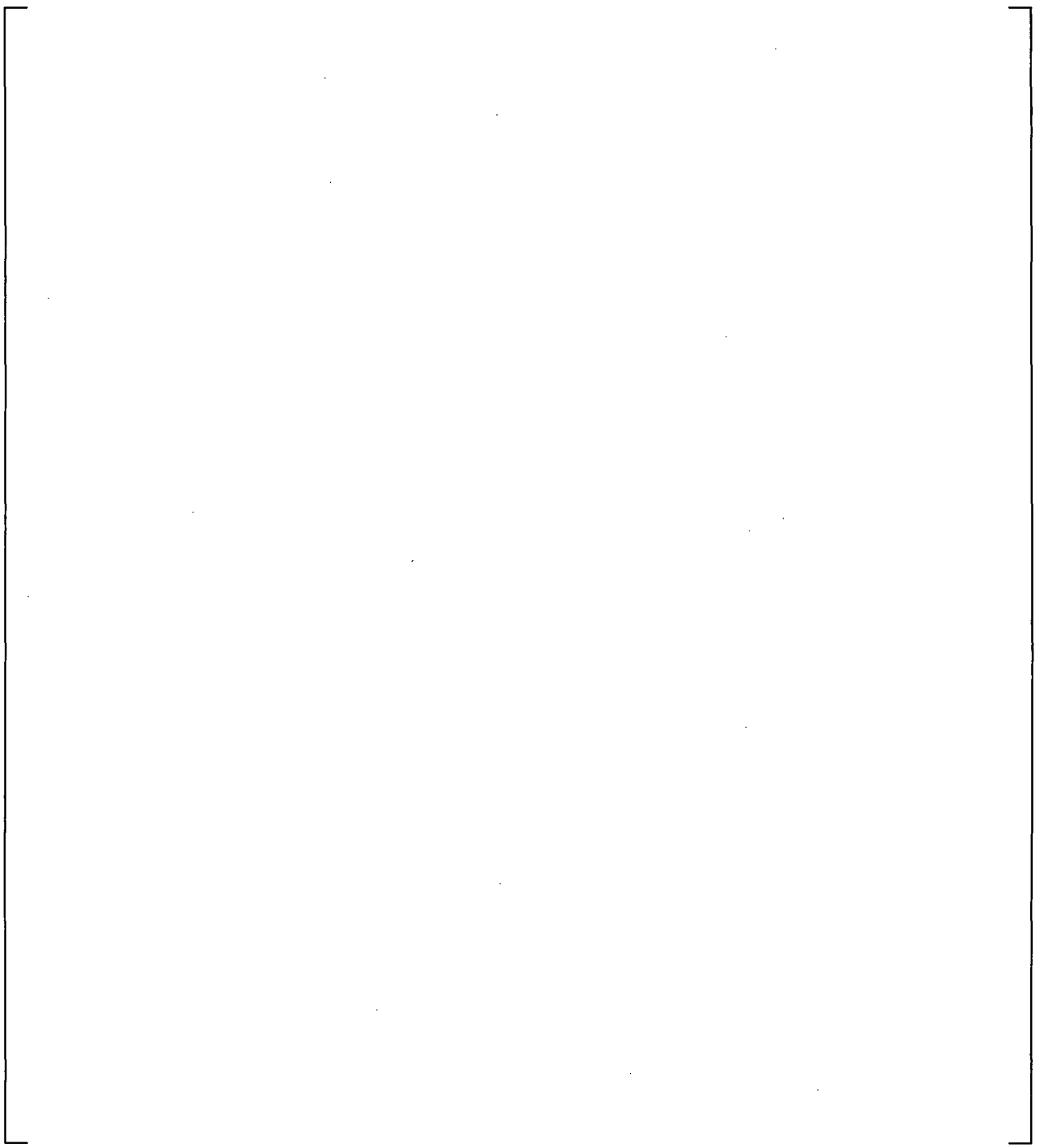

Figure 6.4-17. [

]^{a,c}

a,c

[

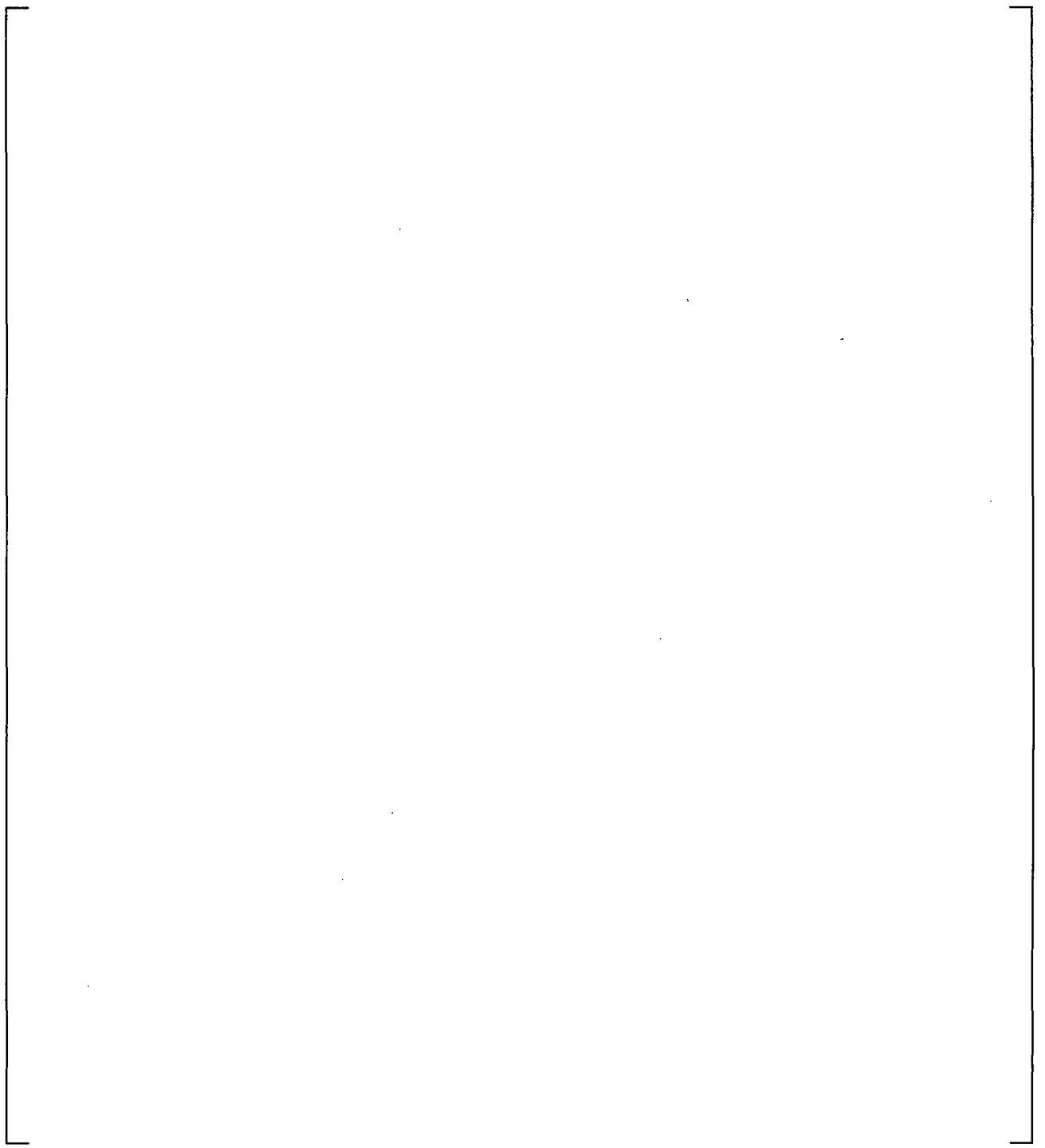

Figure 6.4-18. [

]^{a,c}

6.4.2.4 EQLR-169A

Figures 6.4-19 through 6.4-21 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-169A (Reference 30) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-22 through 6.4-24 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-169A (Reference 30) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-19 through 6.4-24, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

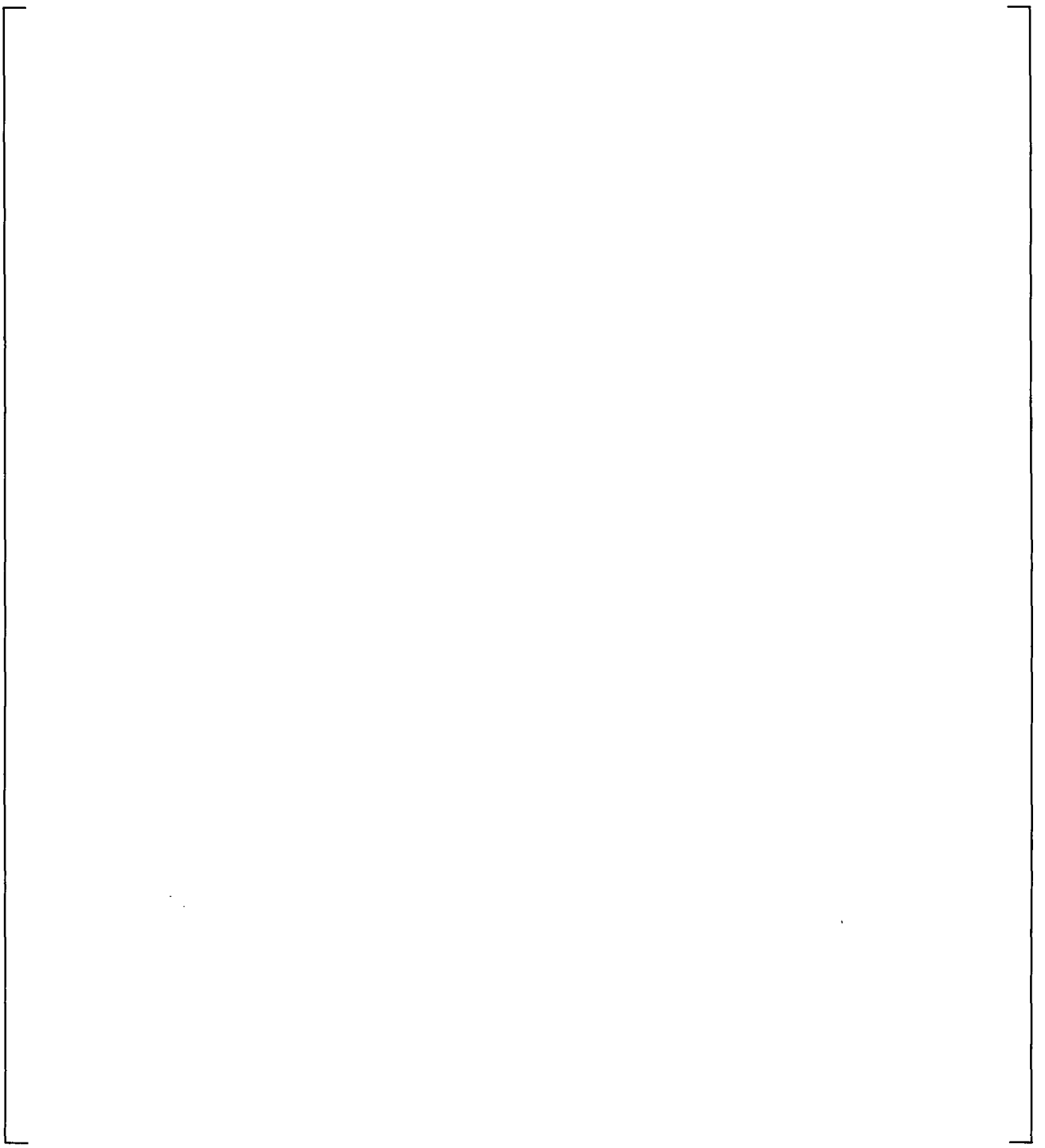

Figure 6.4-19. [

]^{a,c}

a,c

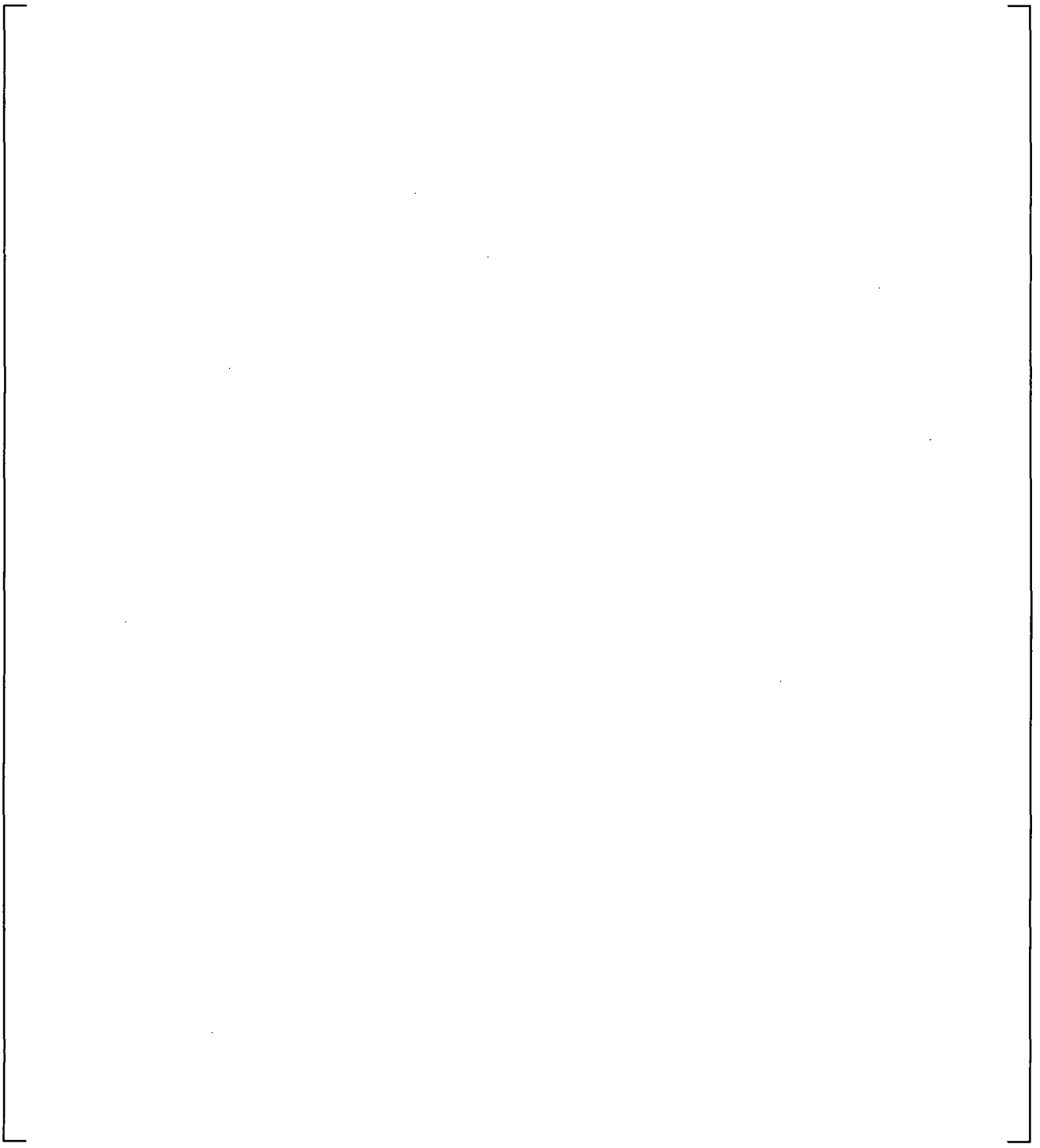

Figure 6.4-20. [

]a,c

a,c

[

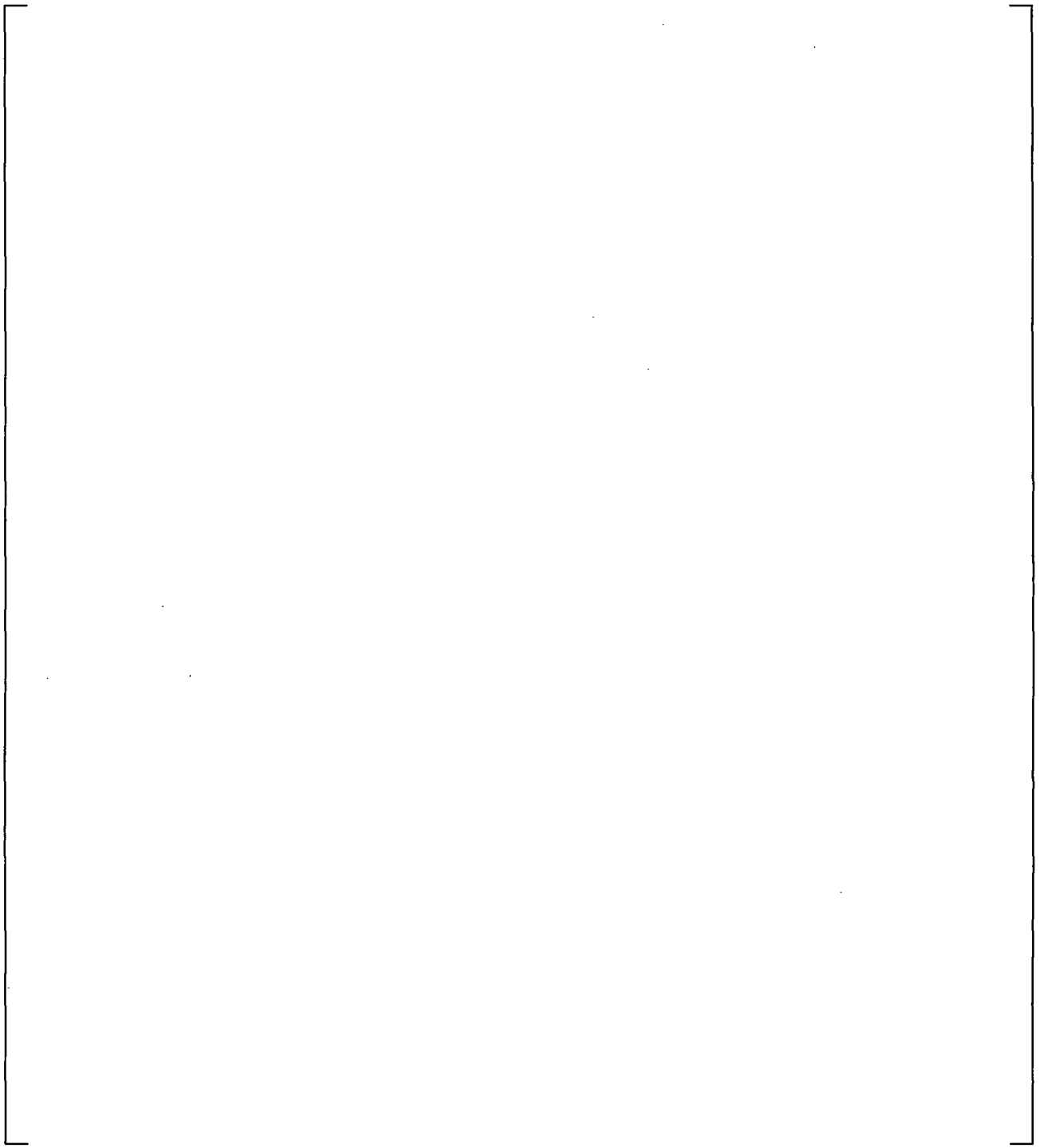

Figure 6.4-21. [

]^{a,c}

a,c

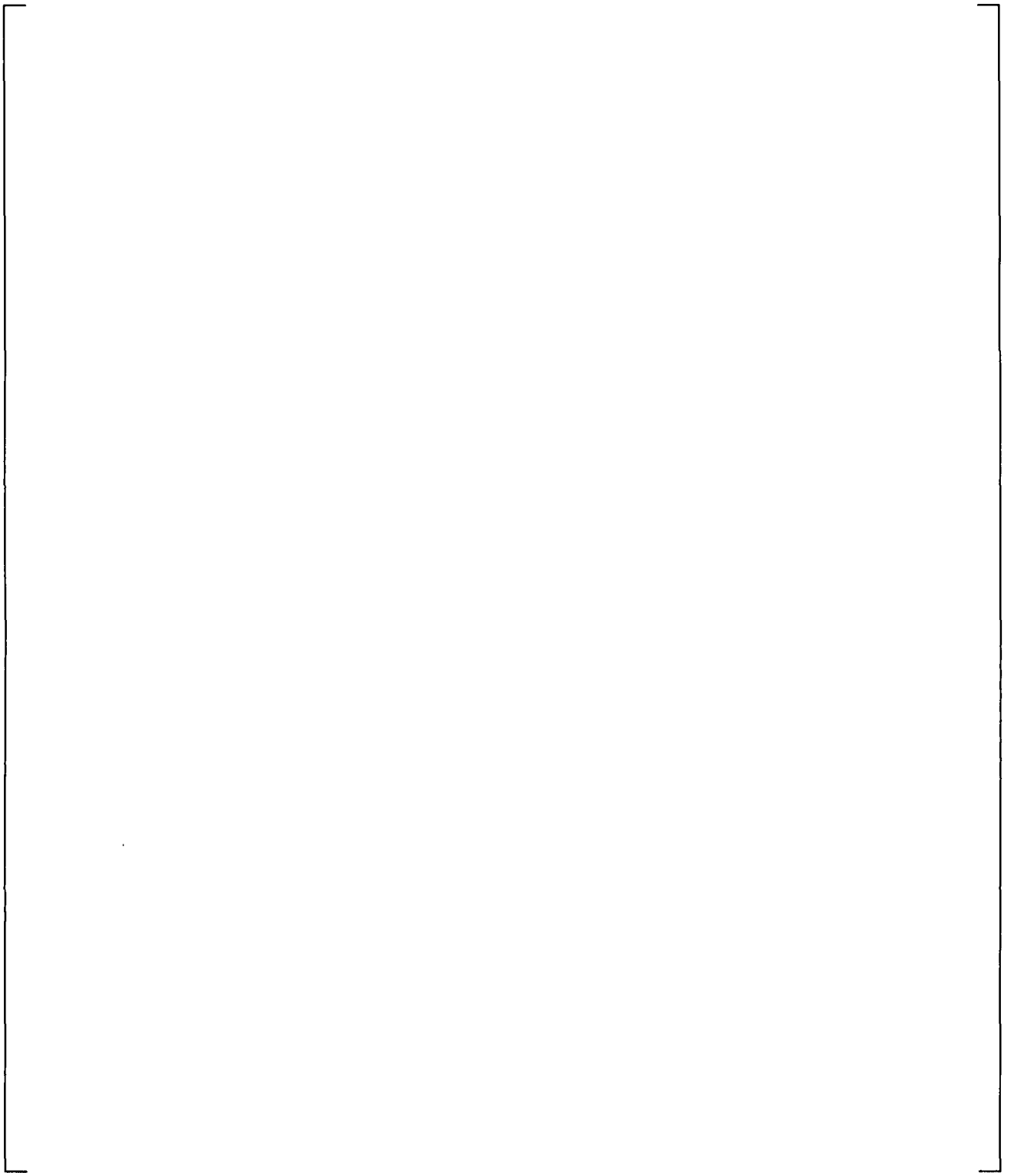

Figure 6.4-22. [

]a,c

a,c

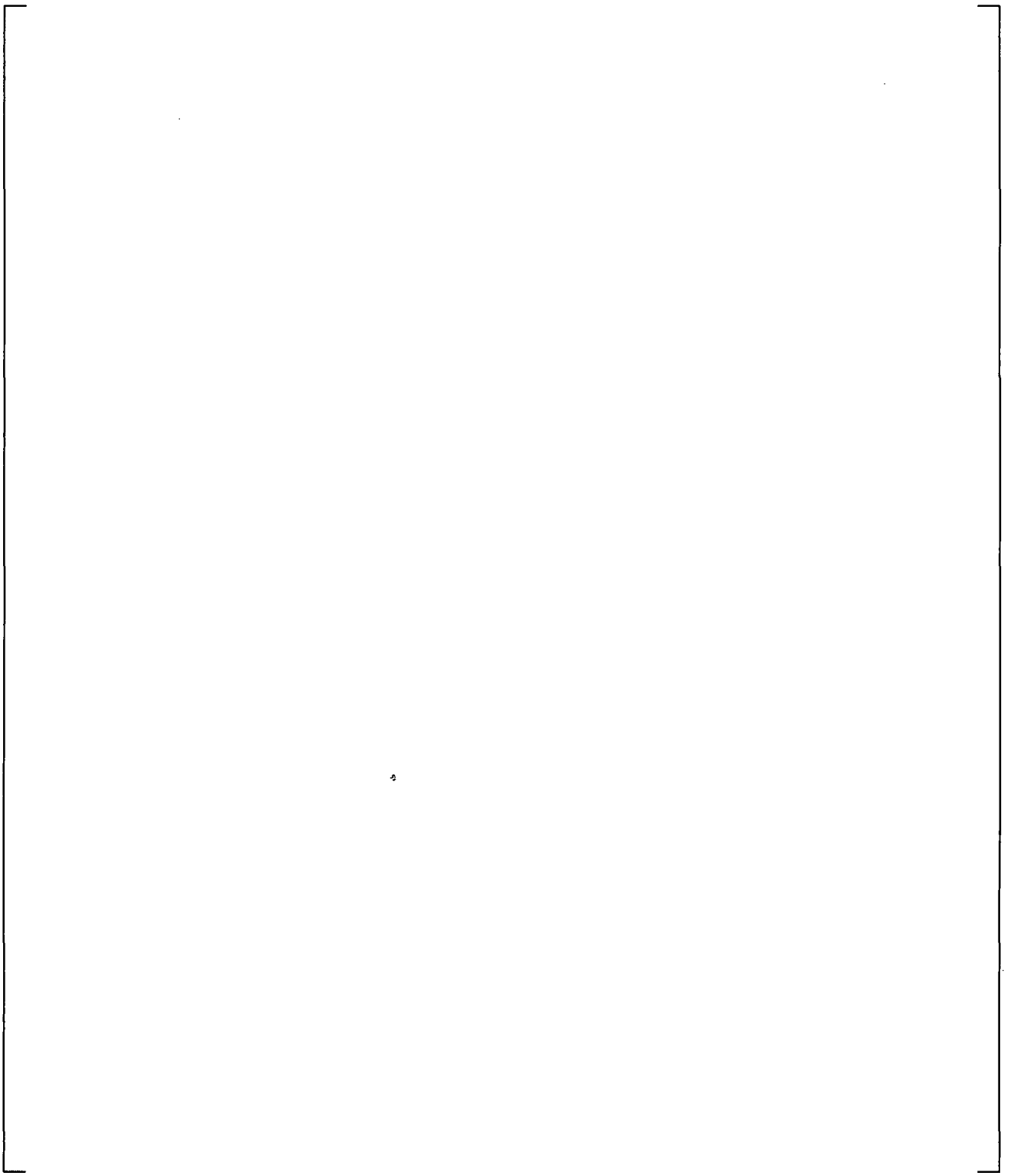

Figure 6.4-23. [

][a,c]

a,c

[

]

Figure 6.4-24. [

]a,c

6.4.2.5 EQLR-178

Figures 6.4-25 through 6.4-27 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-178 (Reference 33) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-28 through 6.4-30 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-178 (Reference 33) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figure 6.4-25 through Figure 6.4-30, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

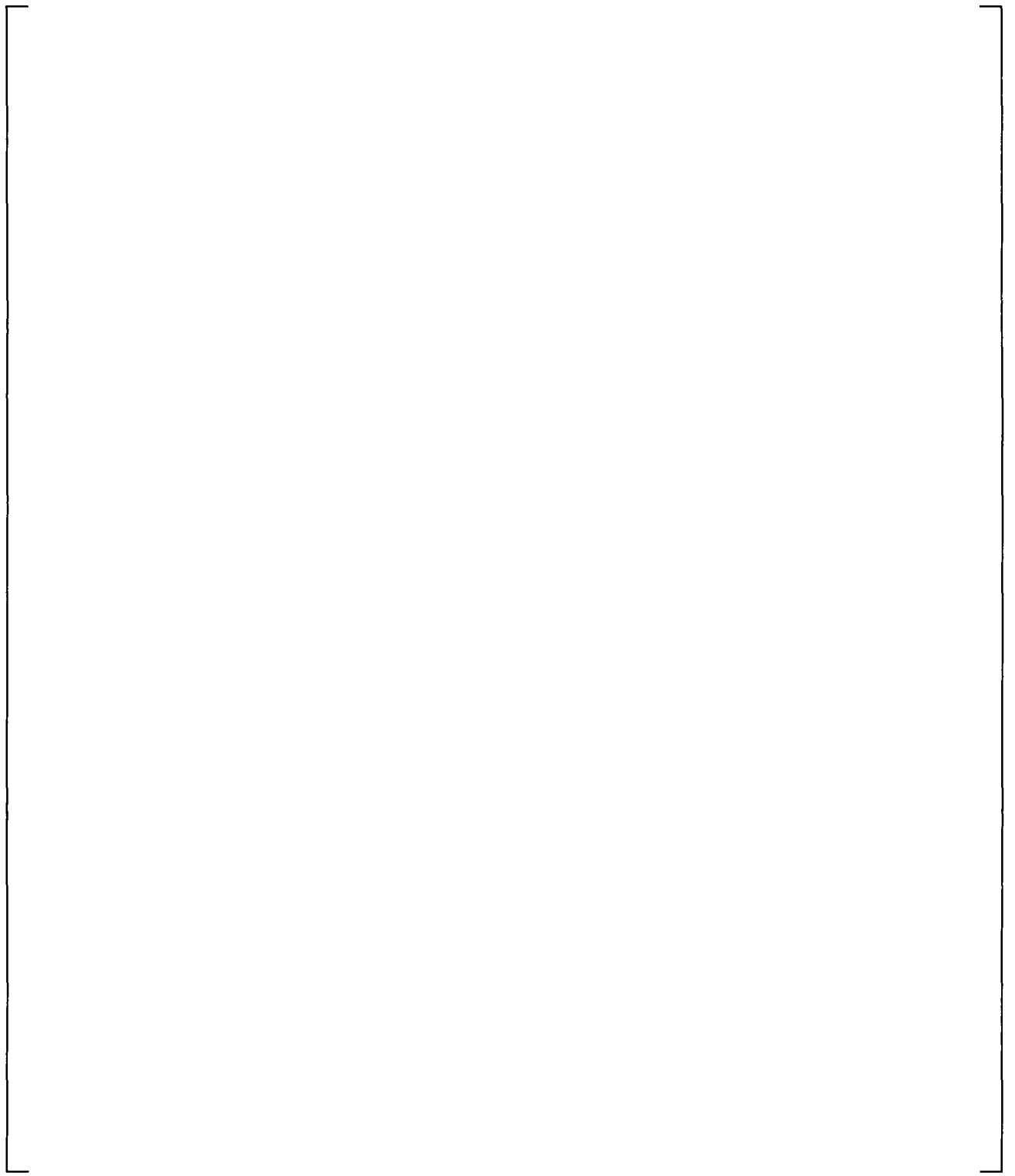

Figure 6.4-25. [

]a,c

a,c

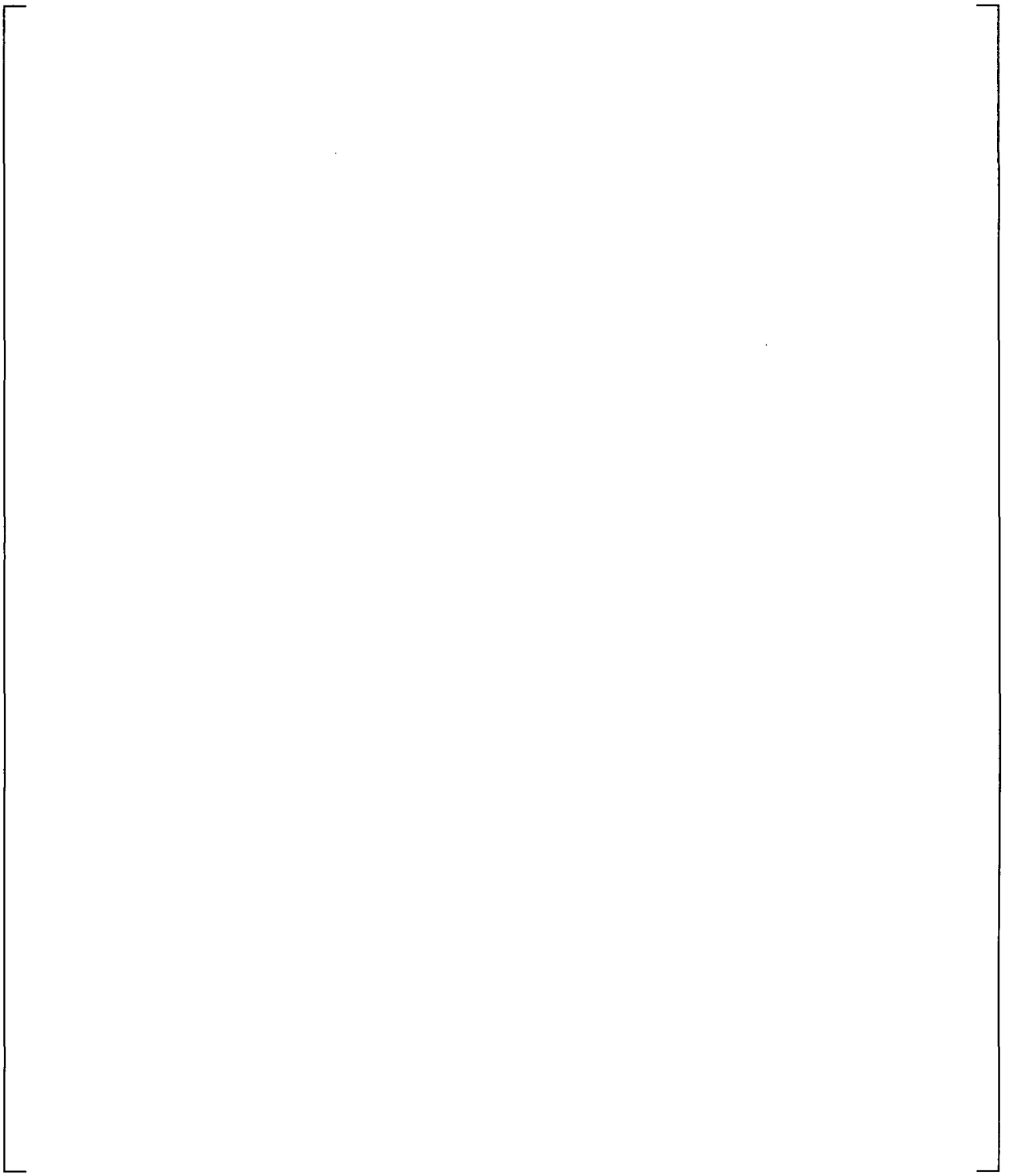

Figure 6.4-26. [

]a,c

a,c

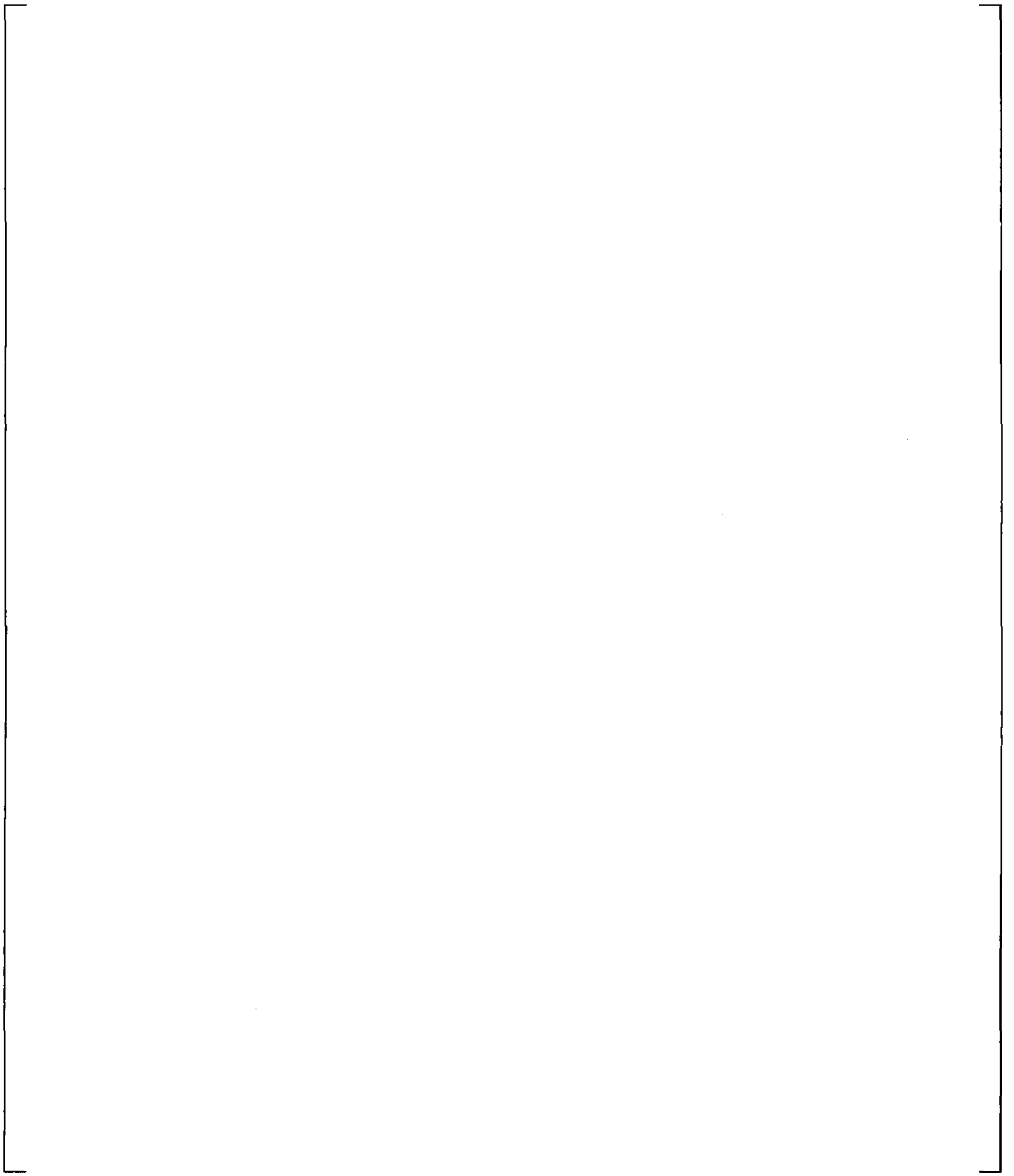

Figure 6.4-27. [

]a,c

a,c

[

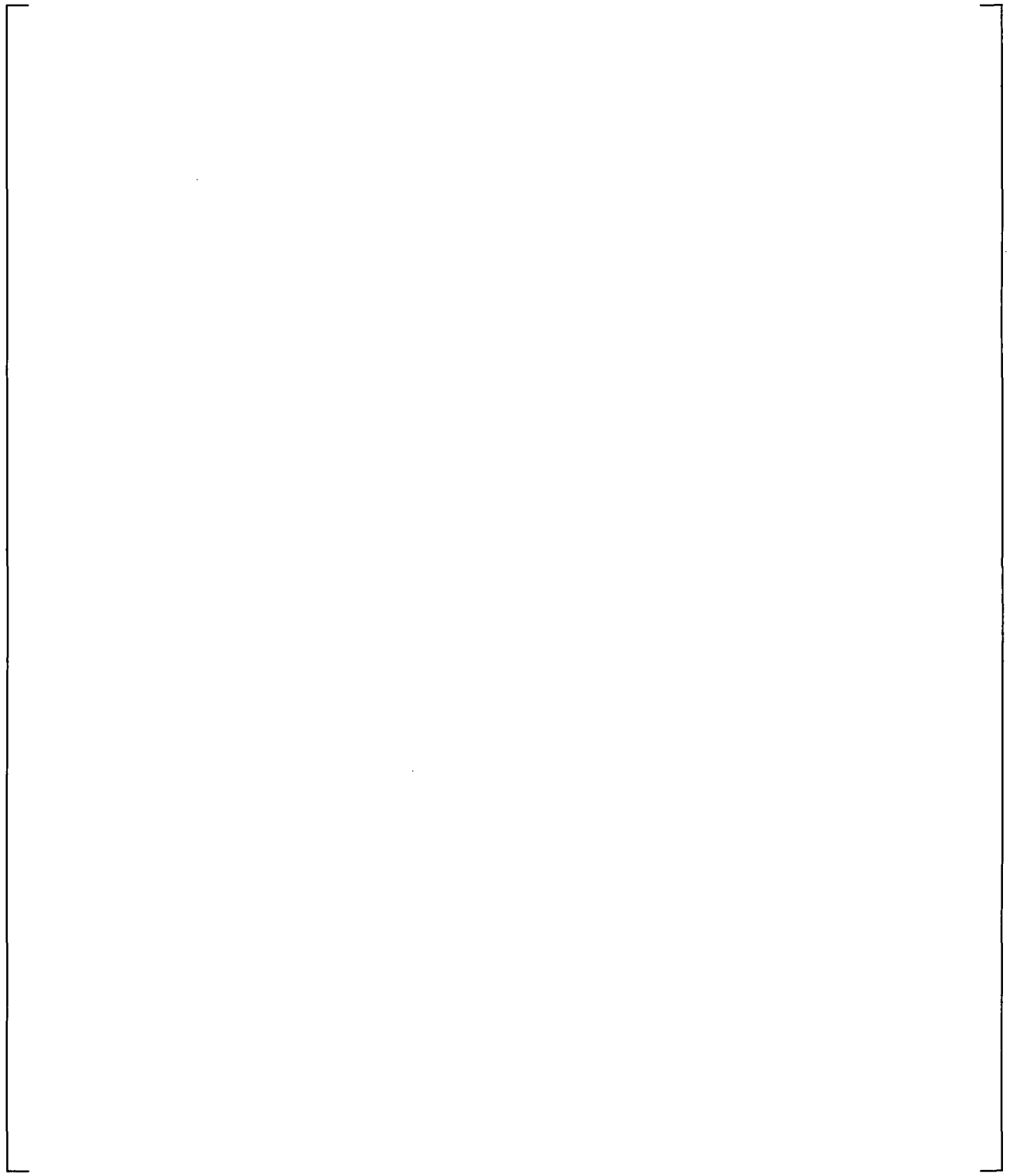

Figure 6.4-28. [

]a,c

a,c

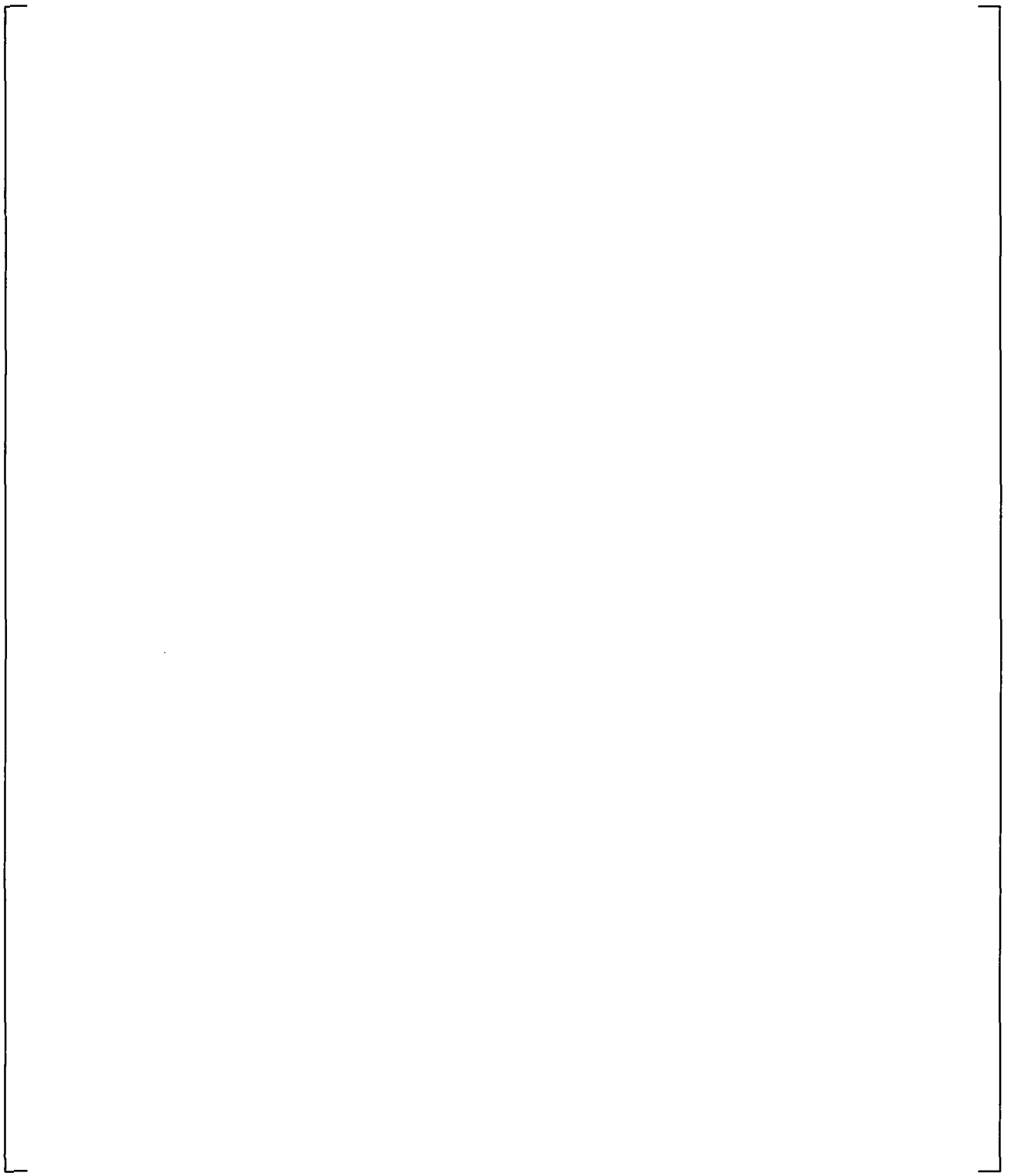

Figure 6.4-29. [

]a,c

a,c

[

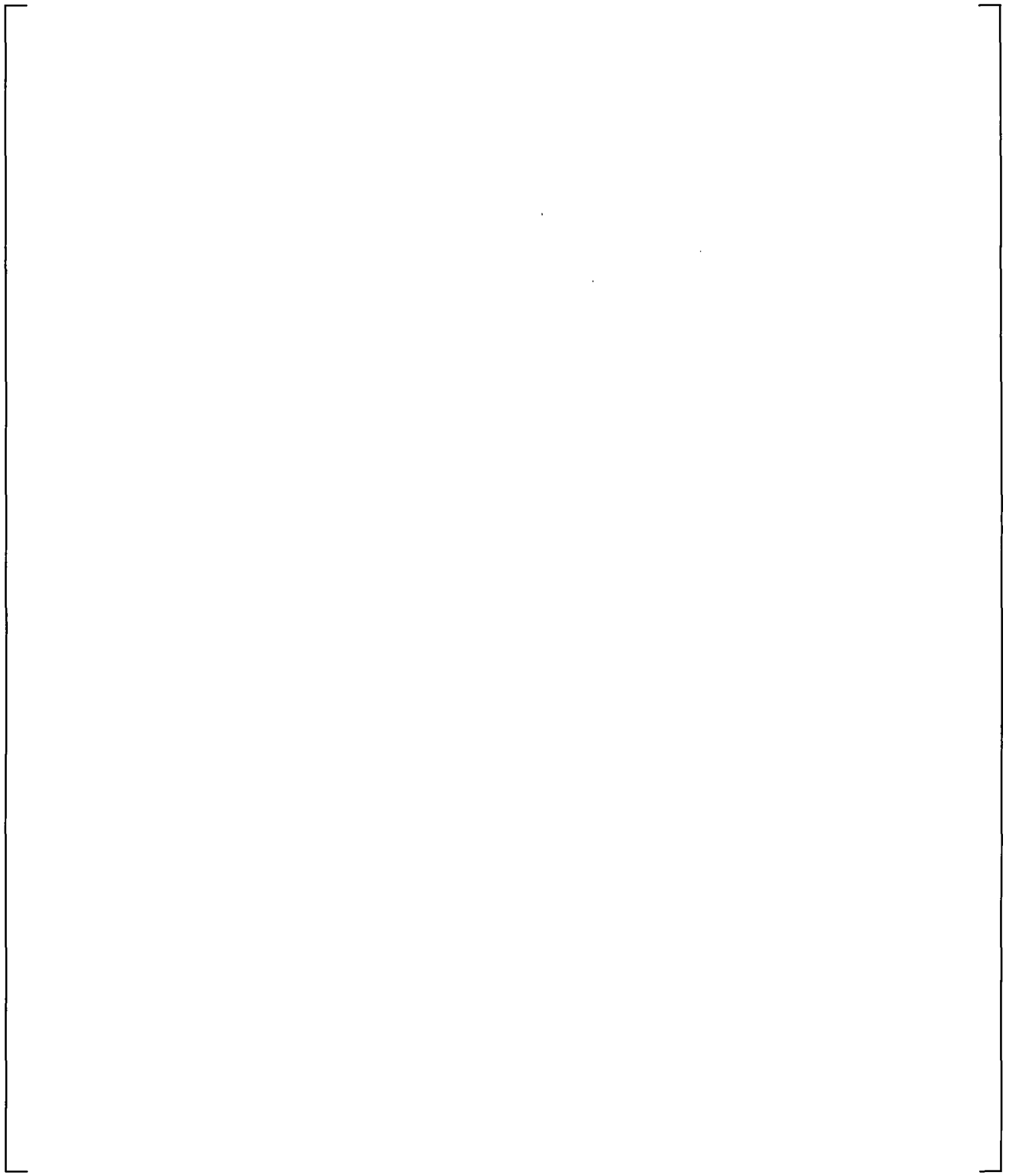

Figure 6.4-30. [

]a,c

6.4.2.6 EQLR-168

Figures 6.4-31 through 6.4-33 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-168 (Reference 32) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures6.4-34 through 6.4-36 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-168 (Reference 32) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-31 through 6.4-36, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

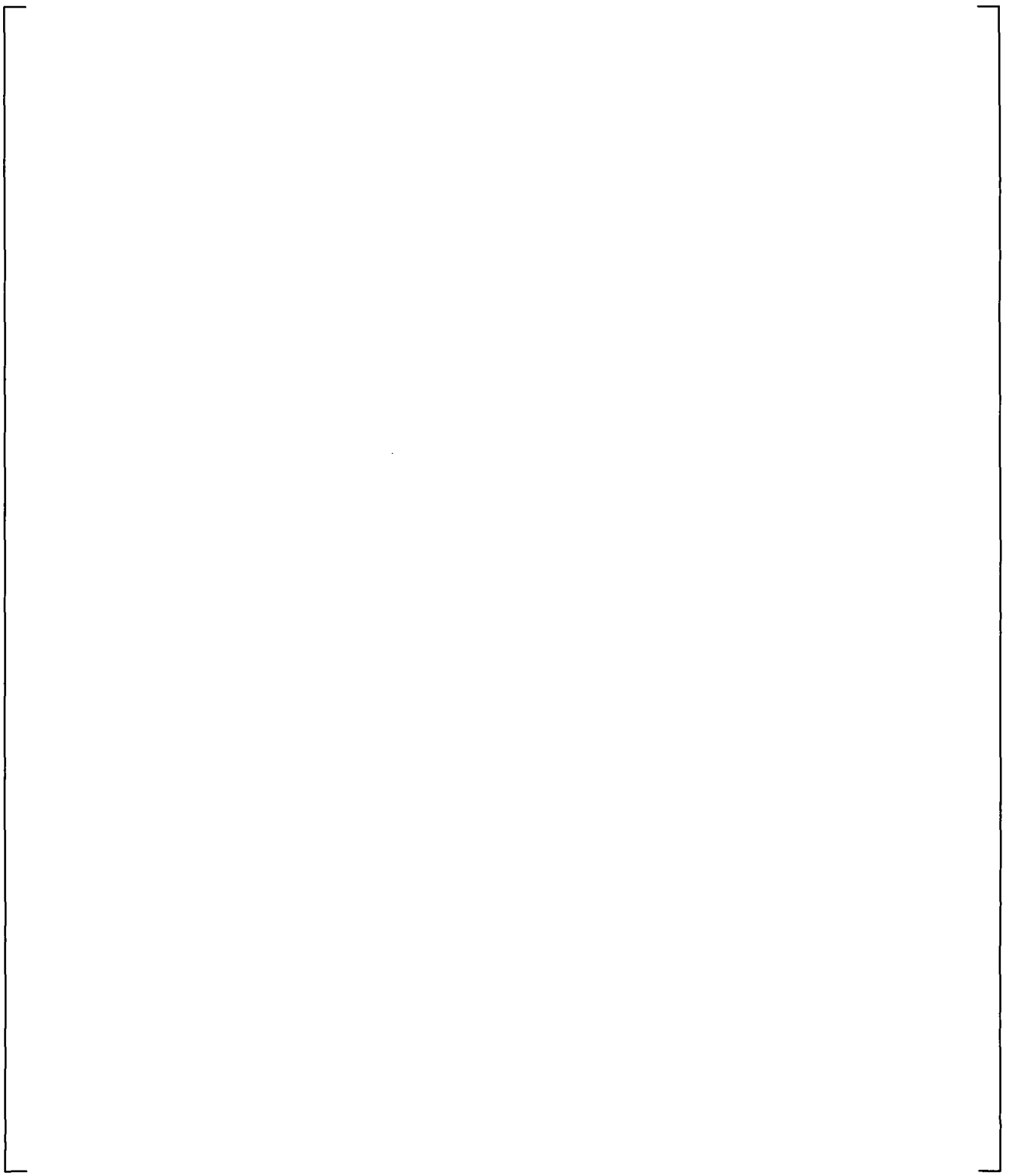

Figure 6.4-31. [

]a,c

a,c

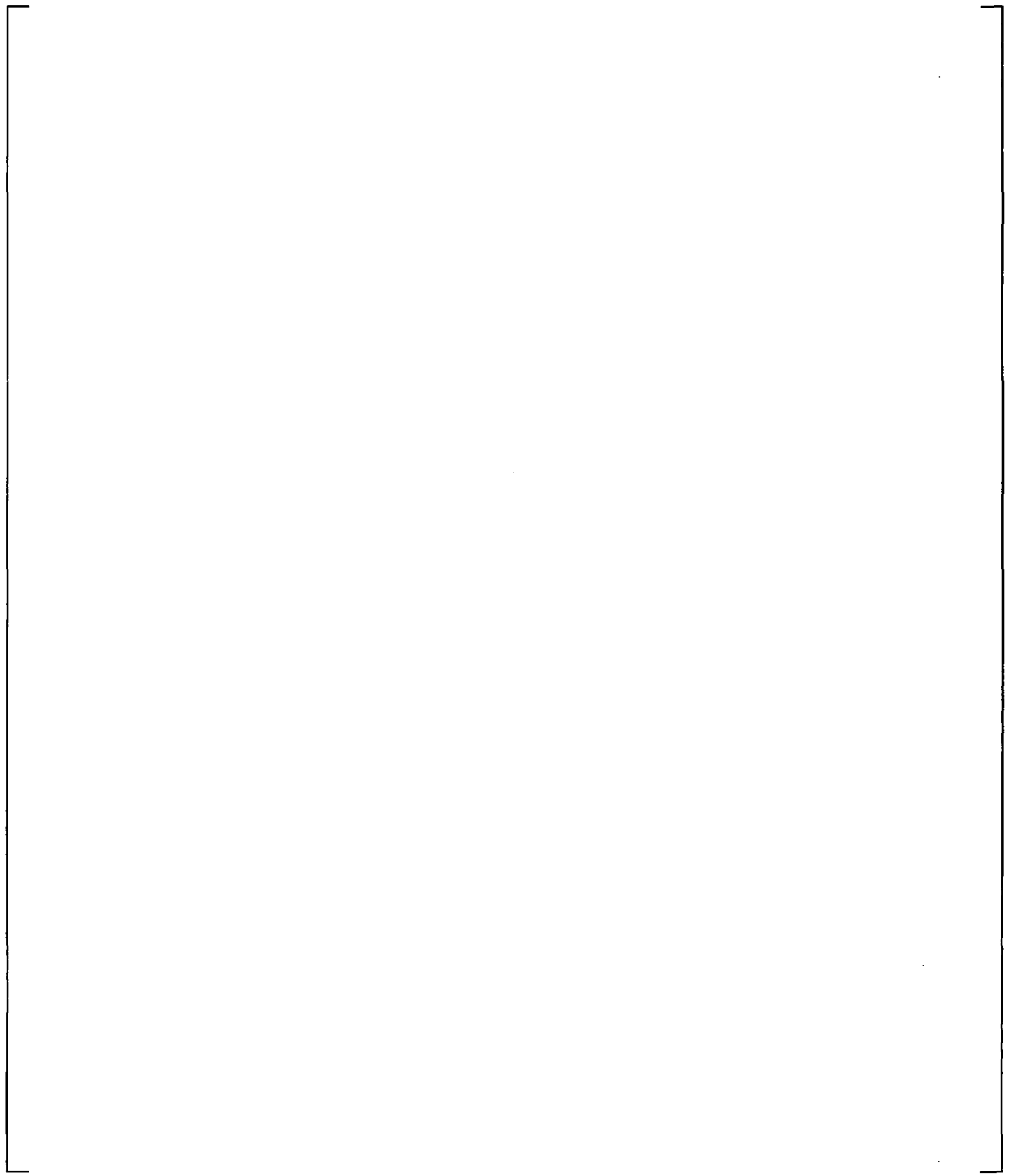

Figure 6.4-32. [

]a,c

a,c

[

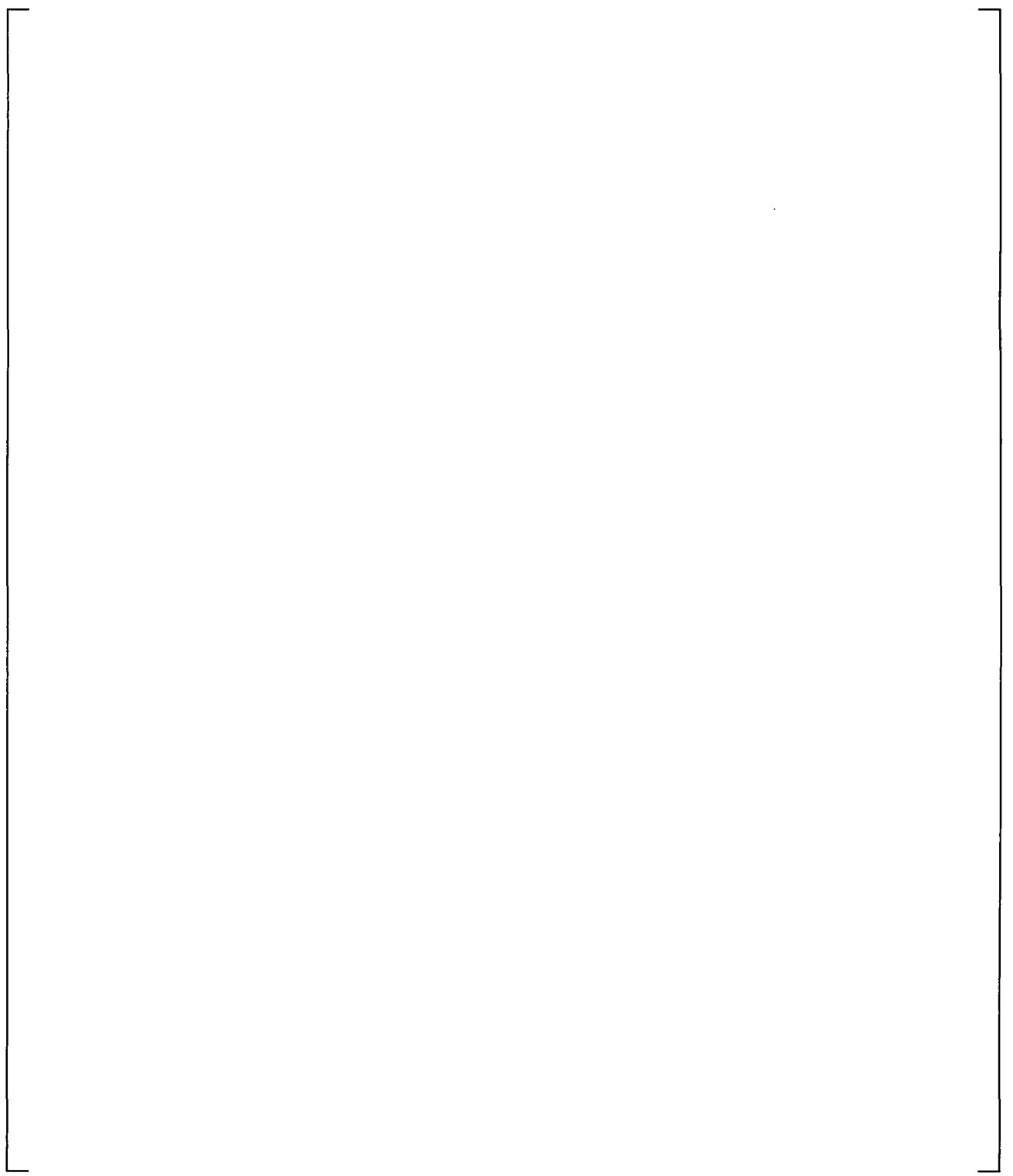

Figure 6.4-33. [

]a,c

a,c

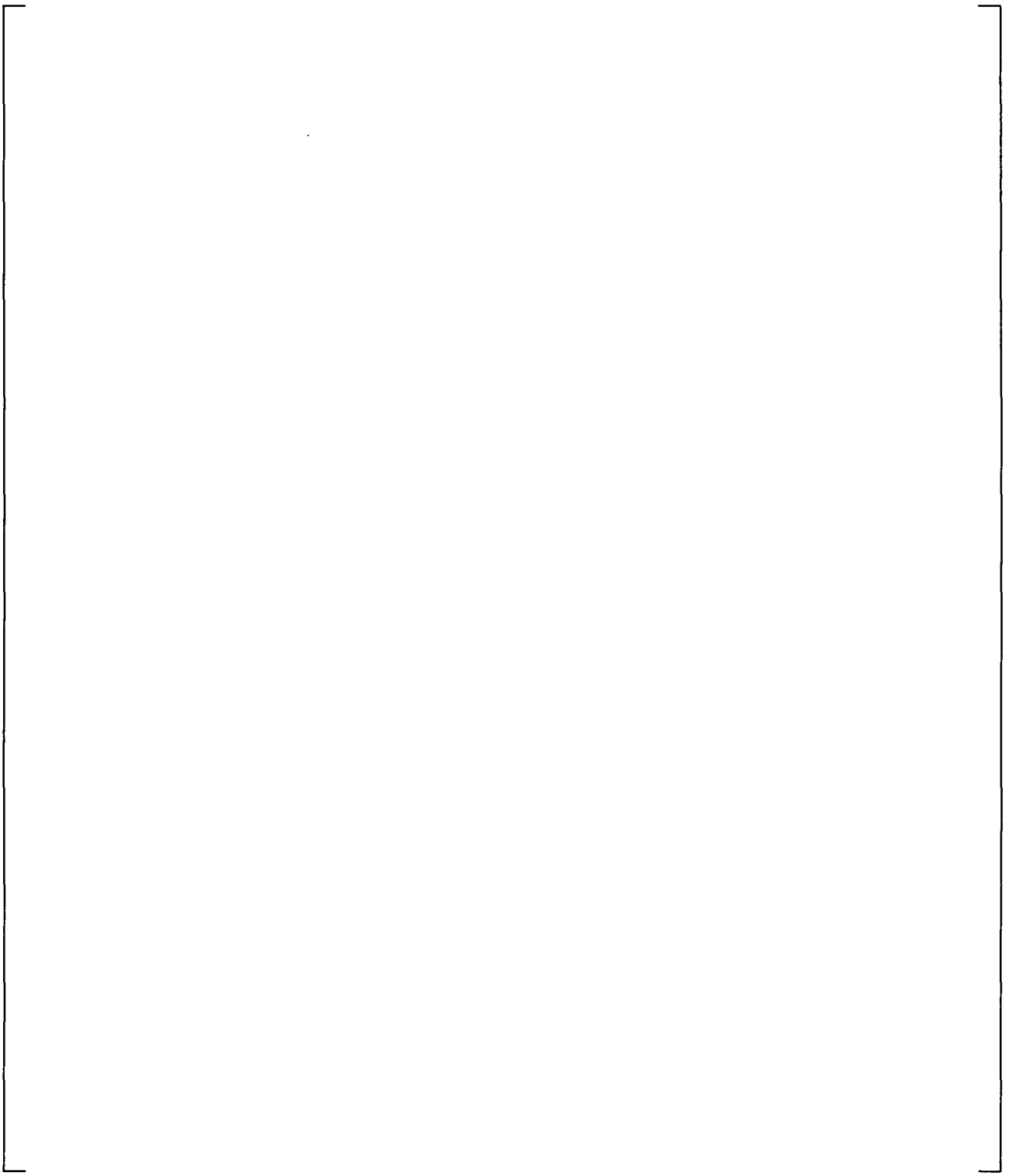

Figure 6.4-34. [

]a,c

a,c

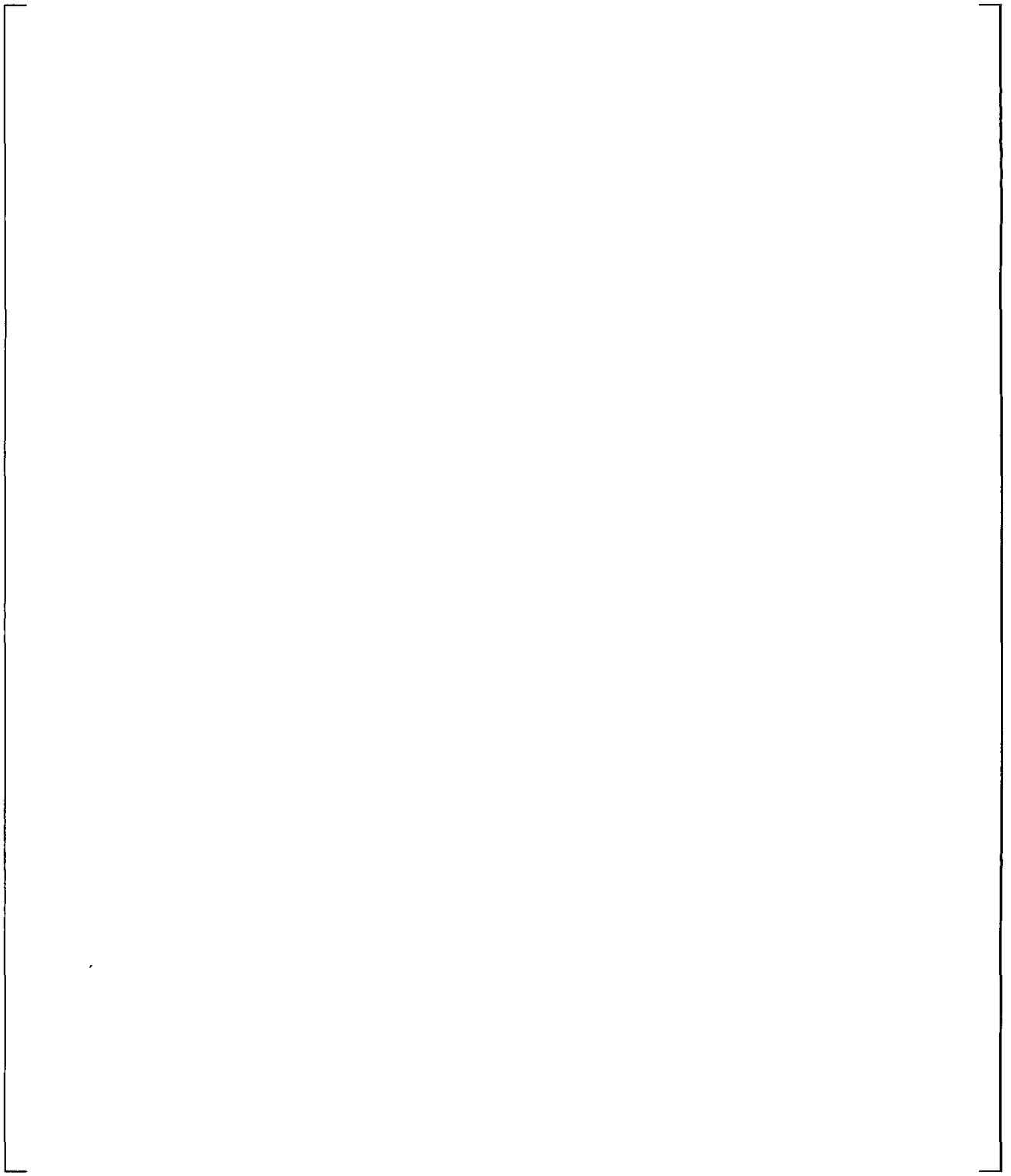

Figure 6.4-35. [

]a,c

a,c

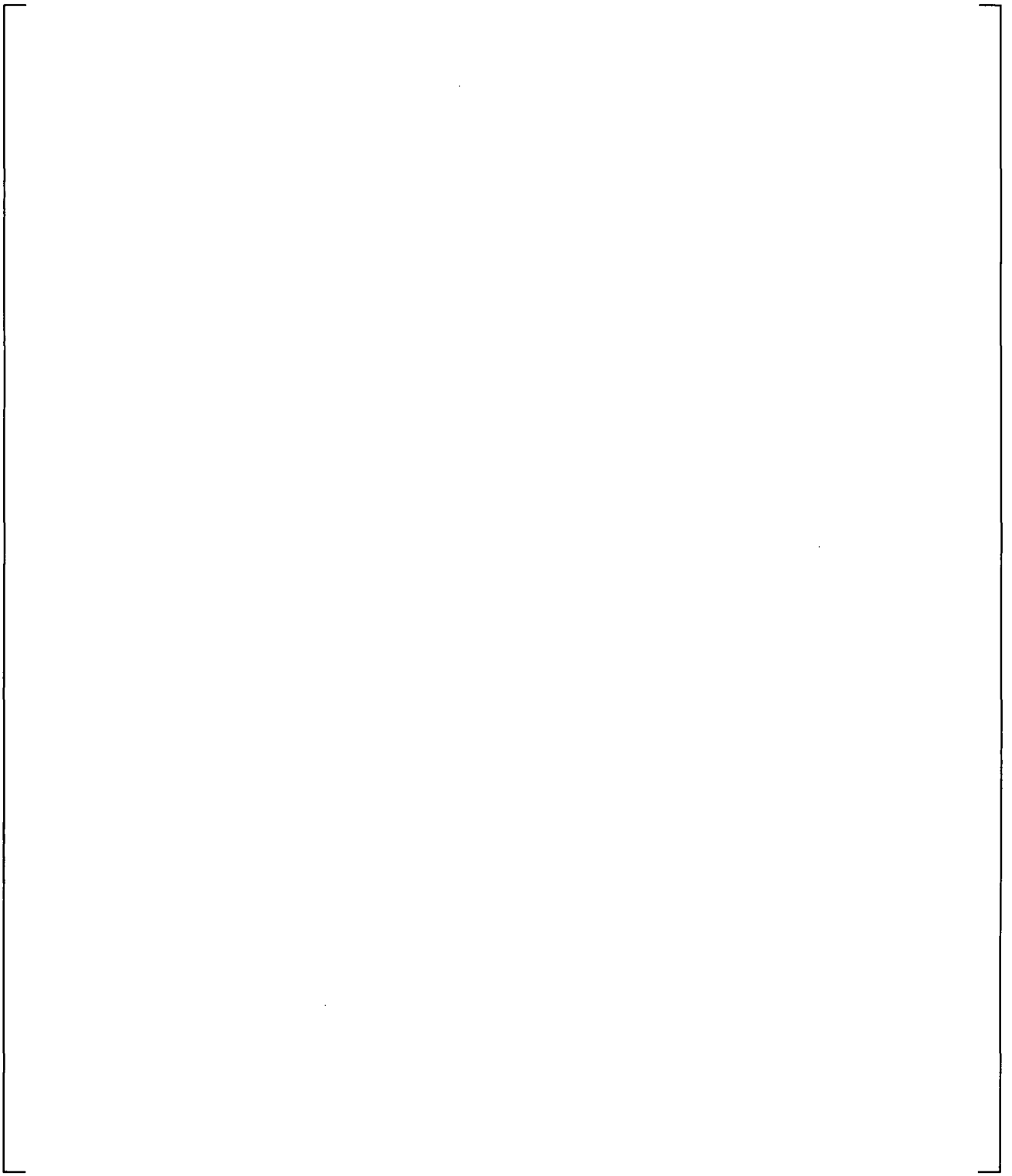

Figure 6.4-36. [

]a,c

6.4.2.7 EQLR-159

Figures 6.4-37 through 6.4-39 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-159 (Reference 31) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-40 through 6.4-42 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-159 (Reference 31) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figure 6.4-37 through Figure 6.4-42, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

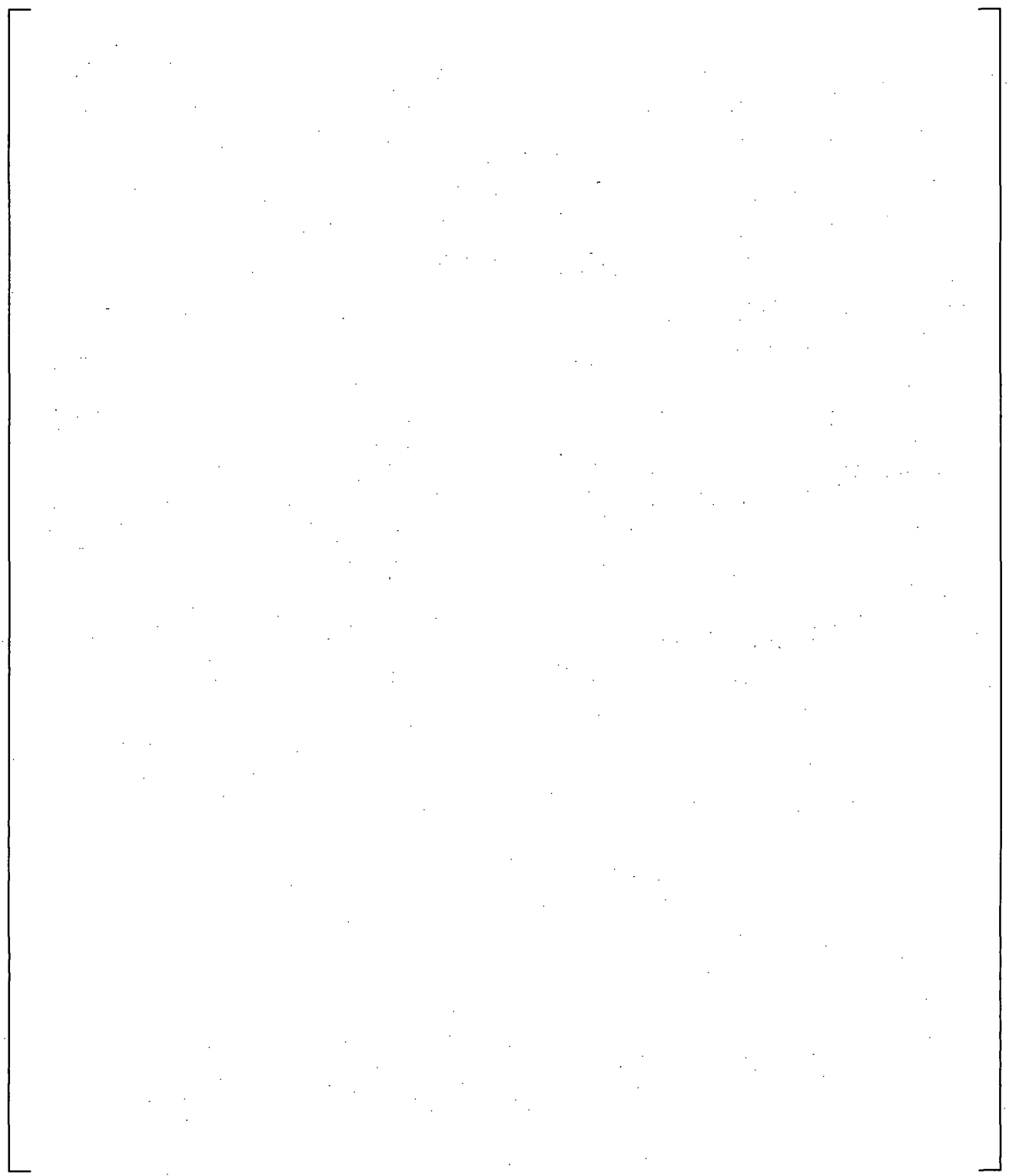

Figure 6.4-37. [

]a,c

a,c

[

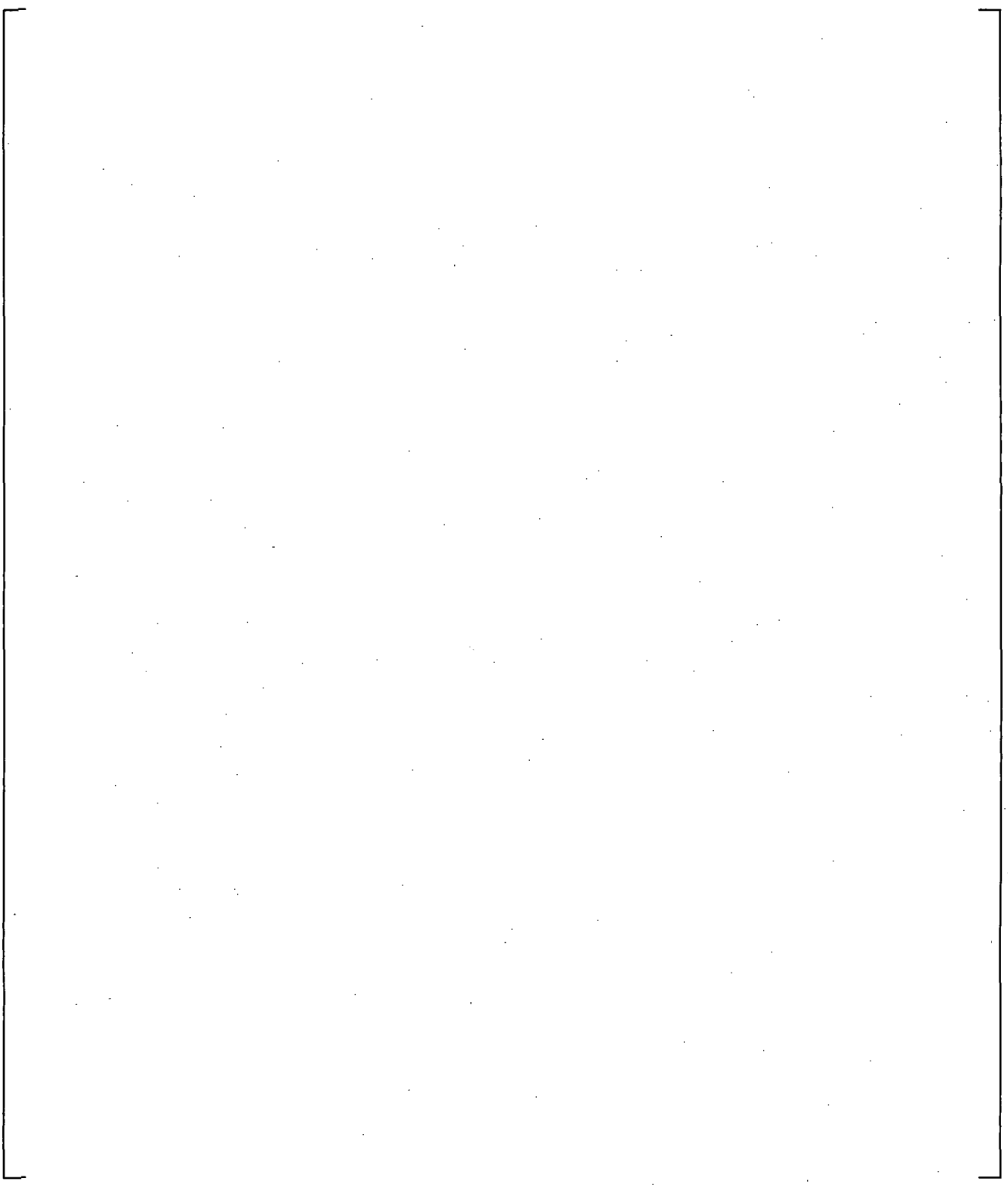

Figure 6.4-38. [

]a,c

a,c

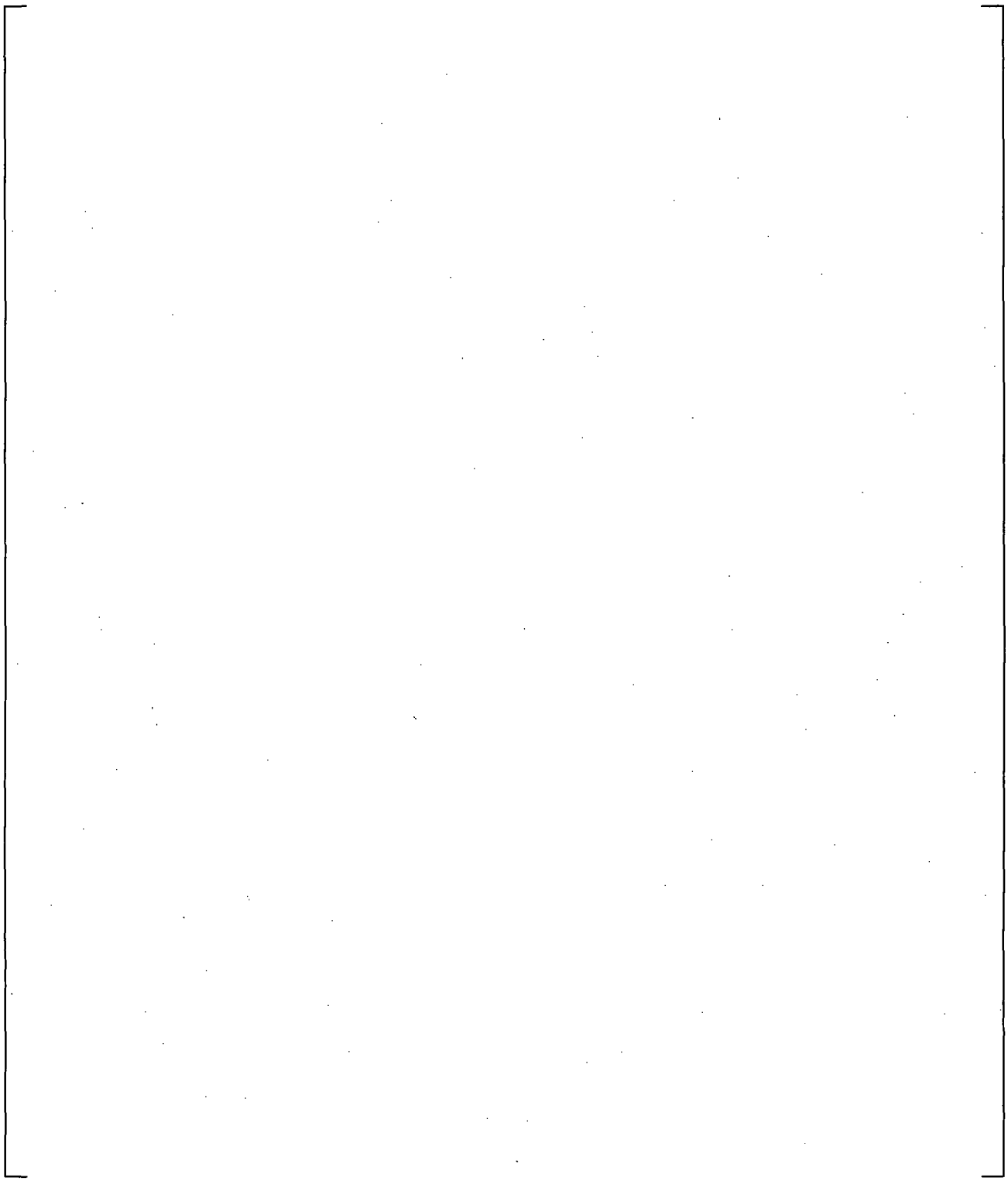

Figure 6.4-39. [

]a,c

a,c

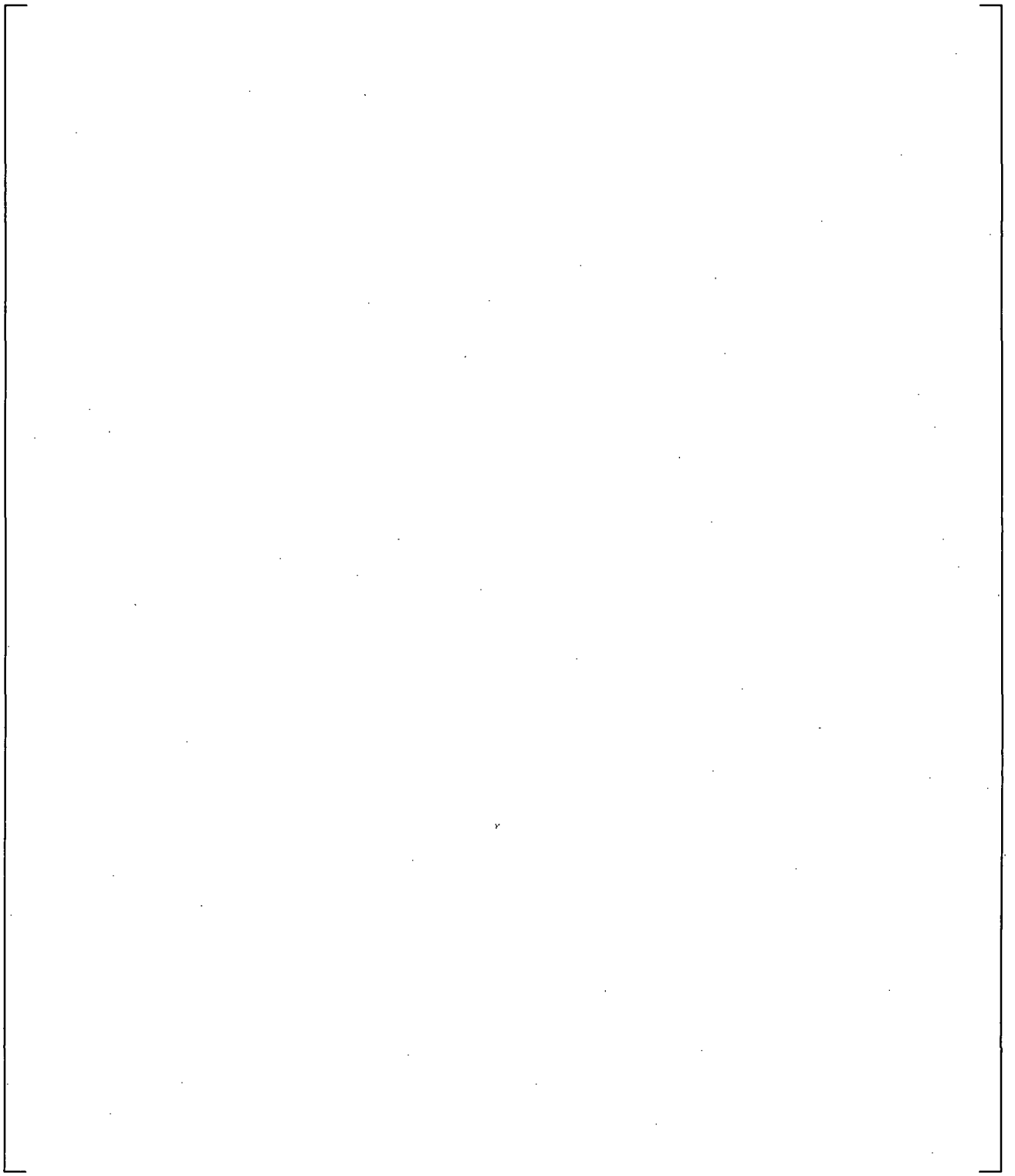

Figure 6.4-40. [

]a,c

a,c

[

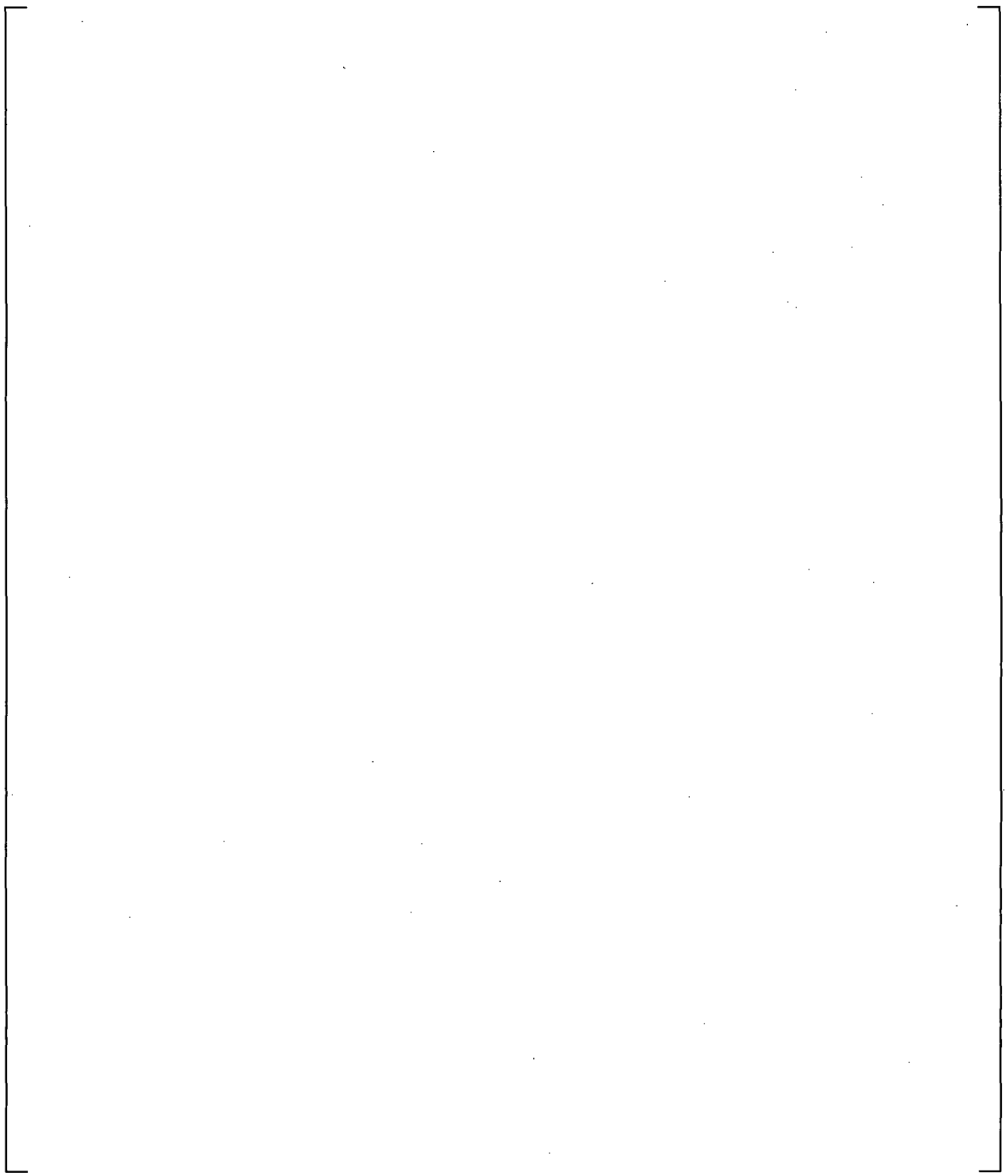

Figure 6.4-41. [

]a,c

a,c

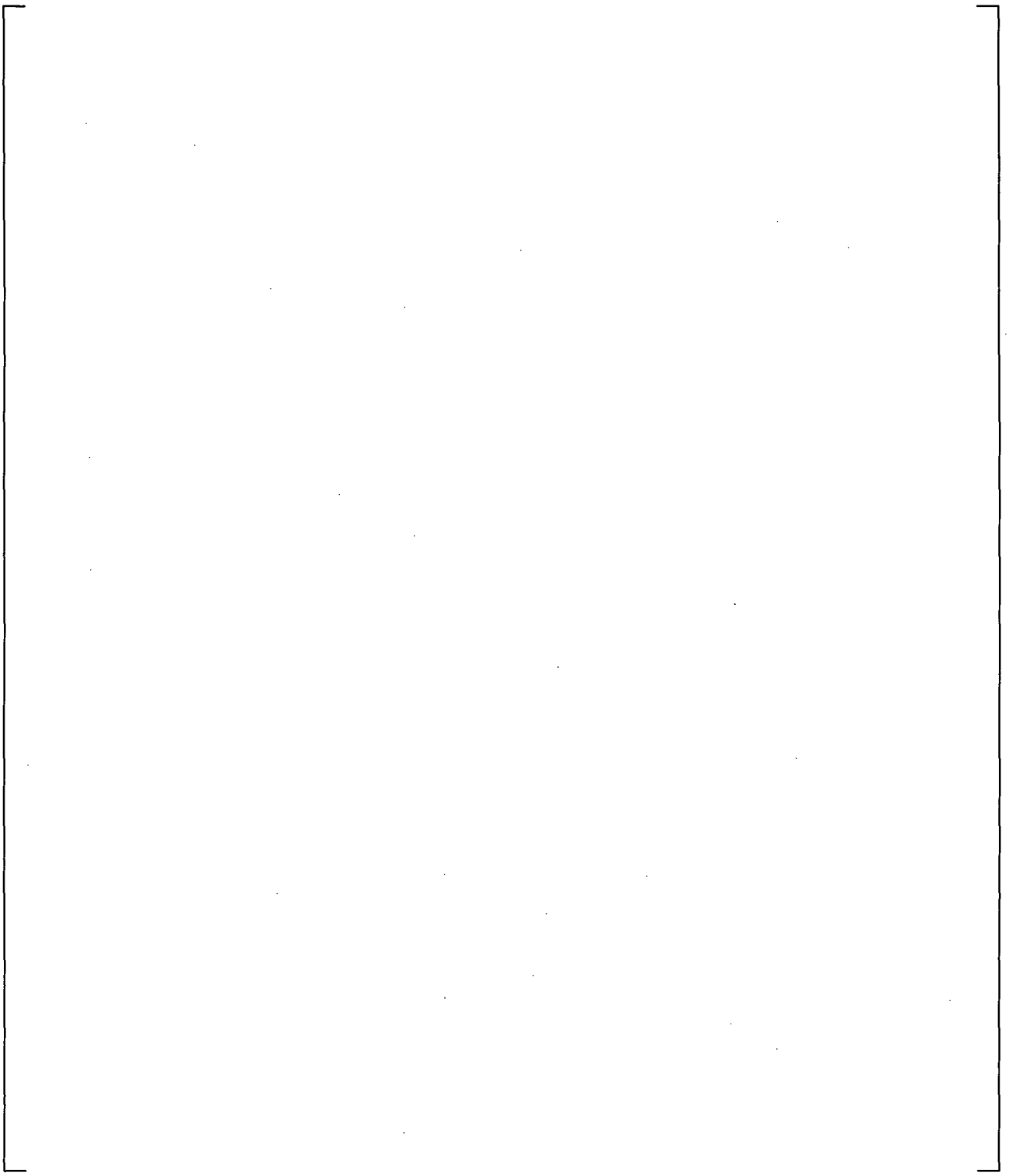

Figure 6.4-42. [

]a,c

6.4.2.8 00000-ICE-37773

Figures 6.4-43 through 6.4-45 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from 00000-ICE-37773 (Reference 34) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively). [

]^{a,c}

Figures 6.4-46 through 6.4-48 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from 00000-ICE-37773 (Reference 34) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-43 through 6.4-48, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

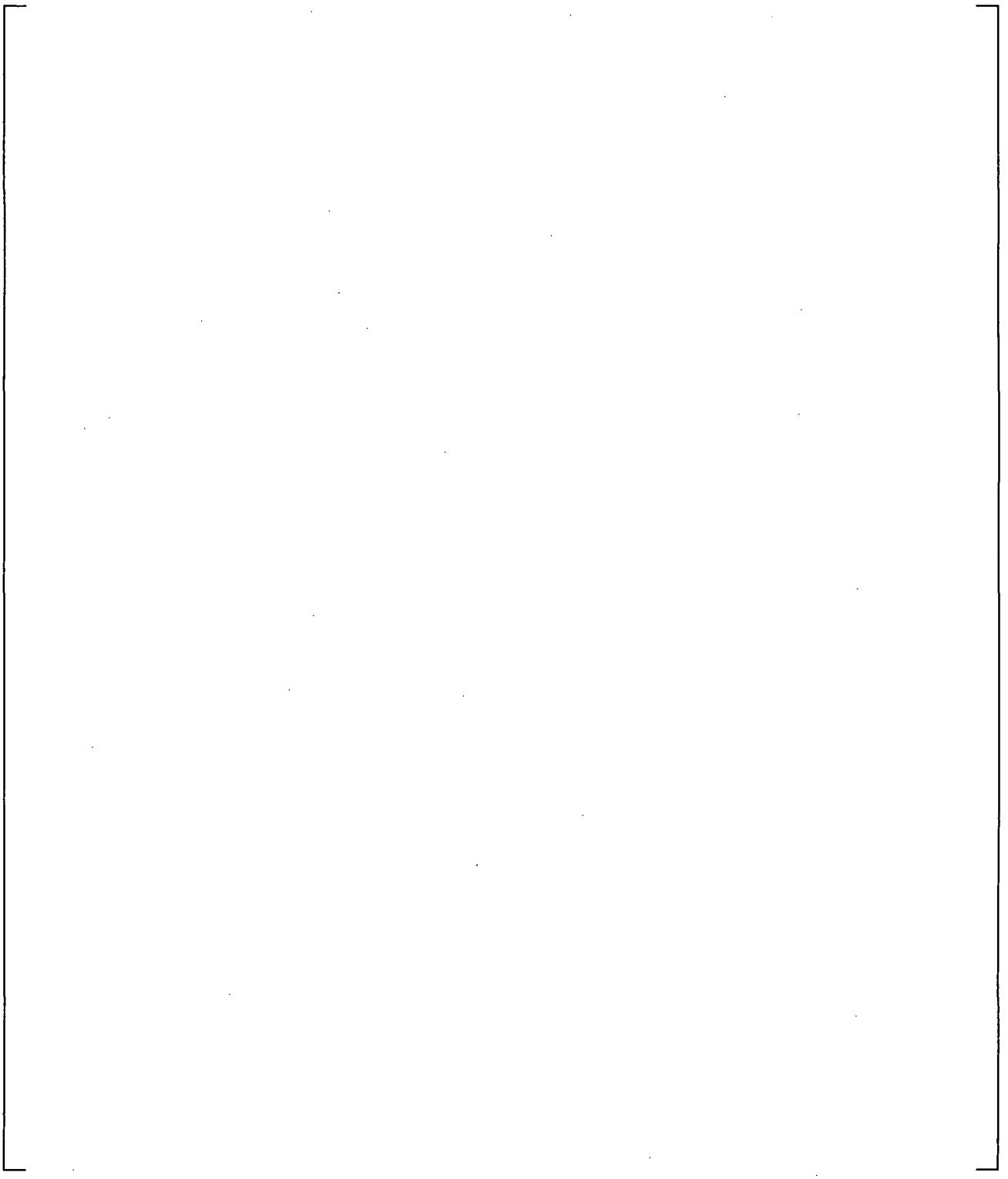

Figure 6.4-43. [

]a,c

a,c

[

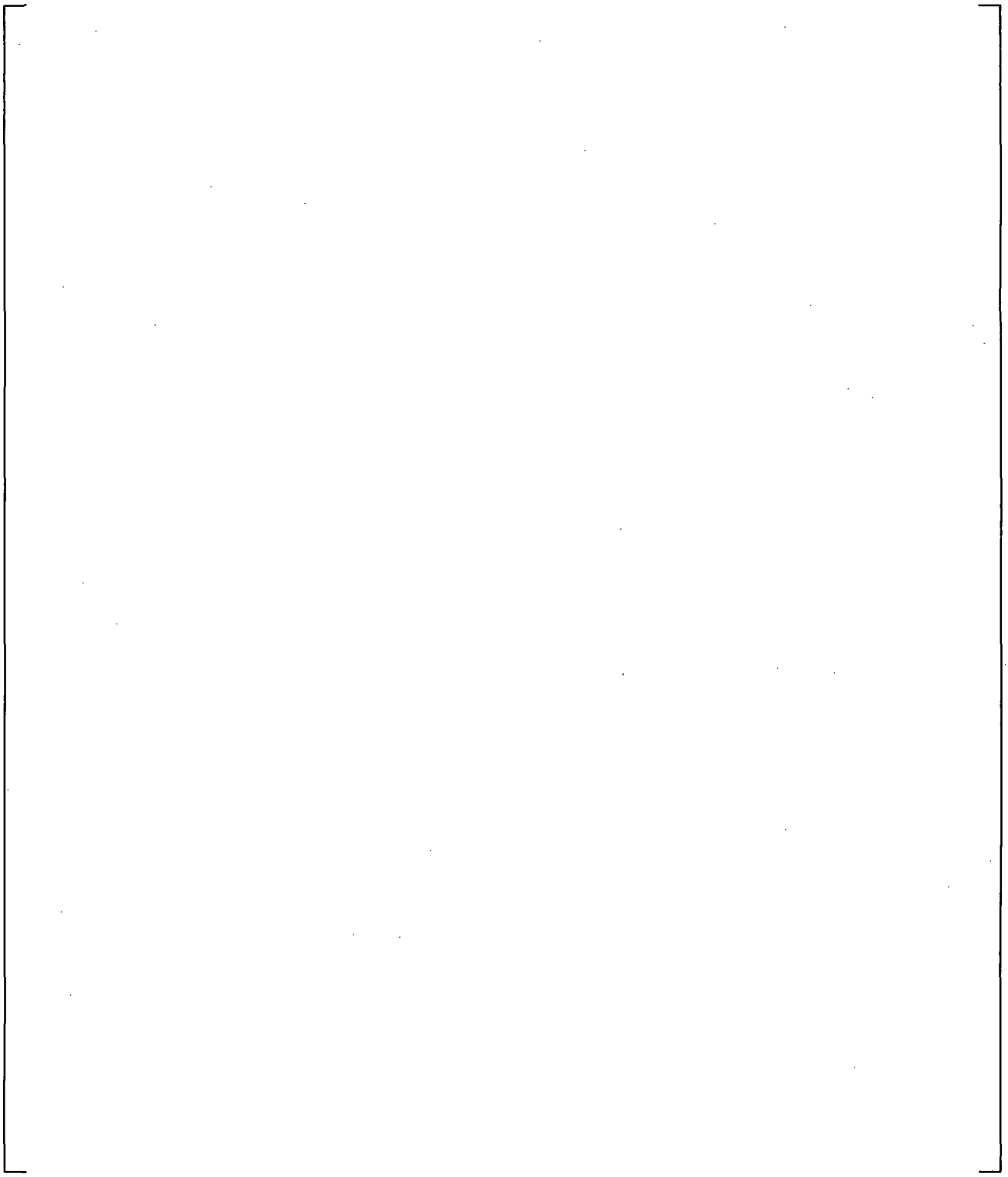

Figure 6.4-44. [

]a,c

a,c

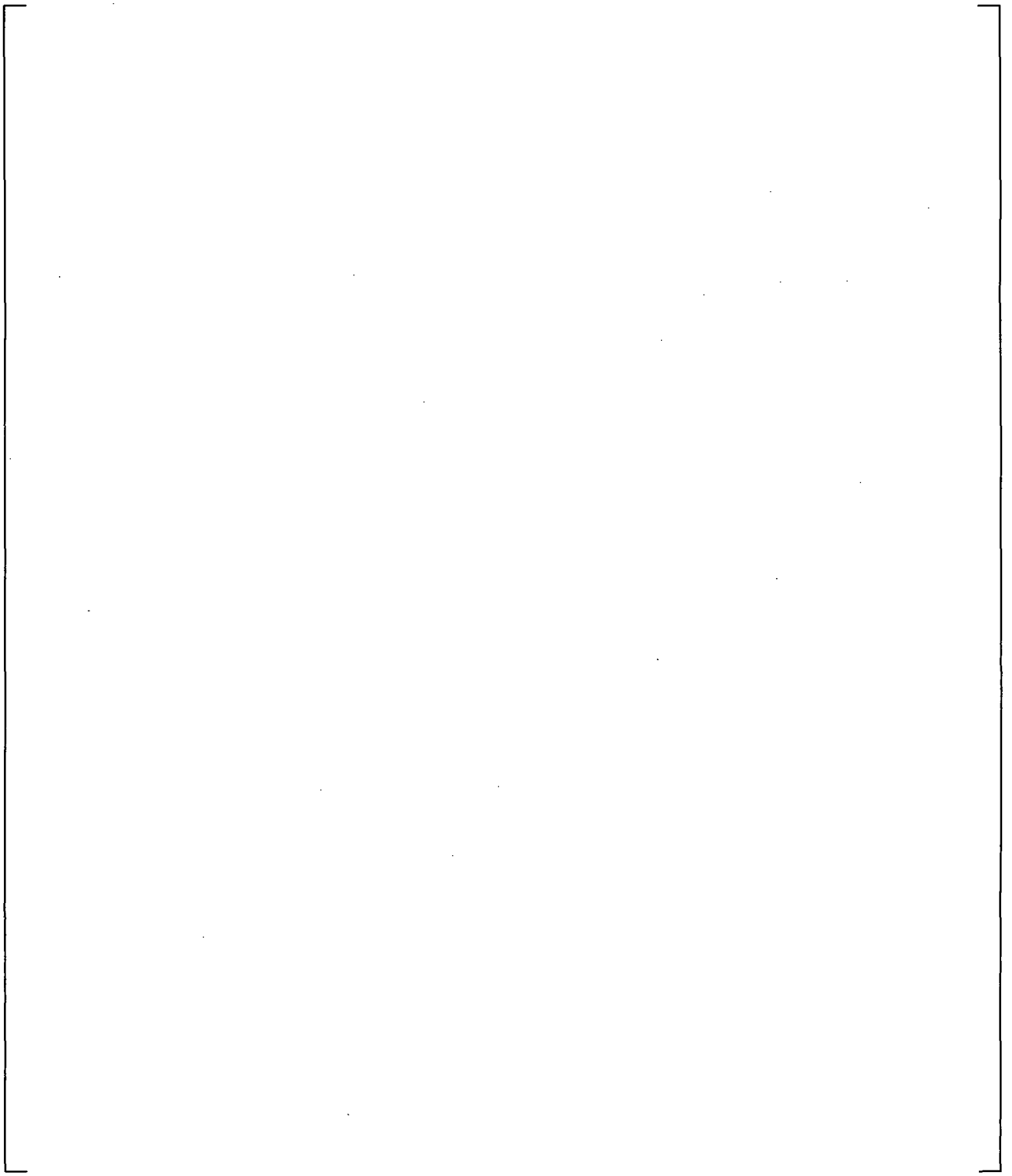

Figure 6.4-45. [ ]a,c

a,c

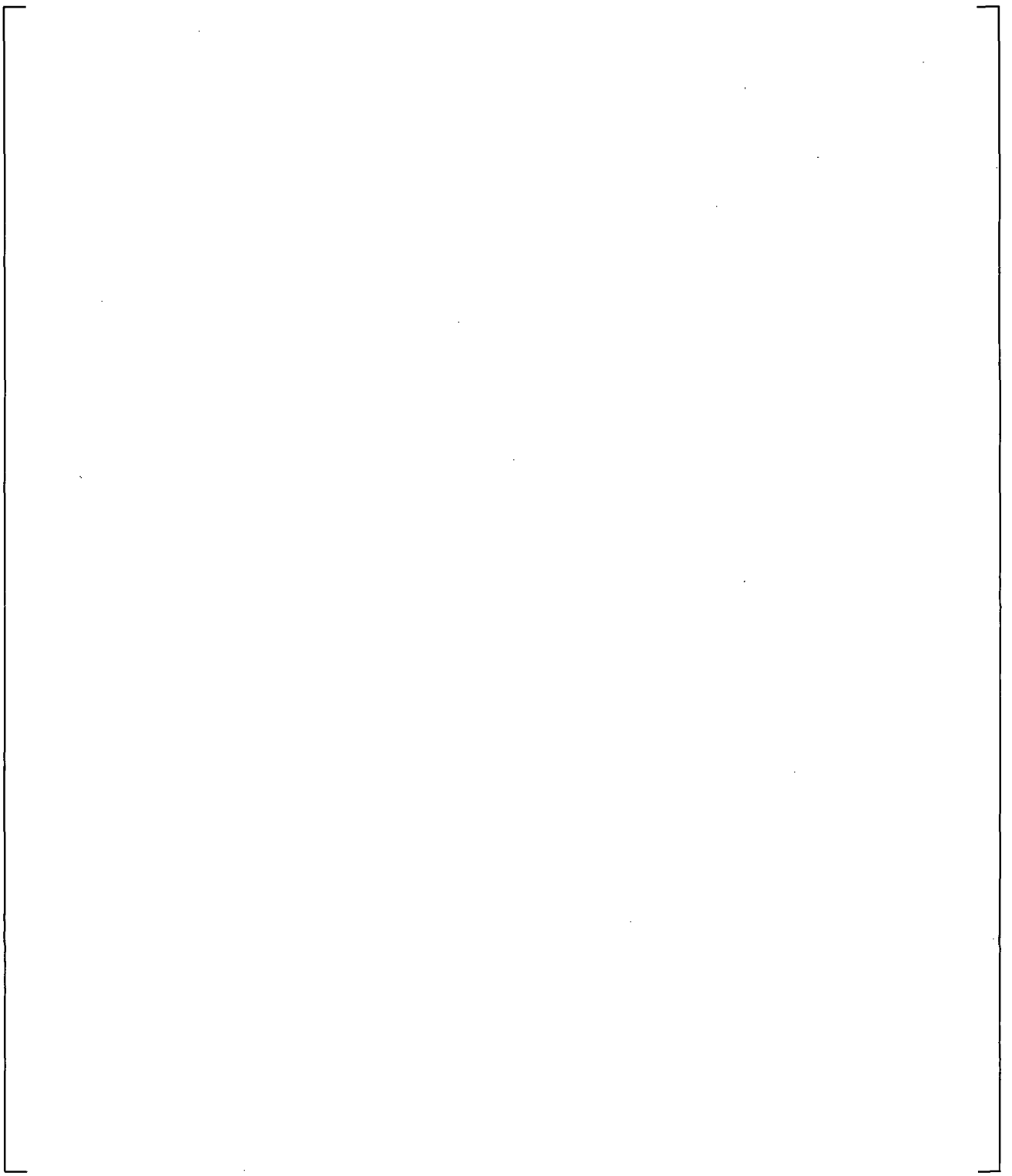

Figure 6.4-46. [

]a,c

a,c

[

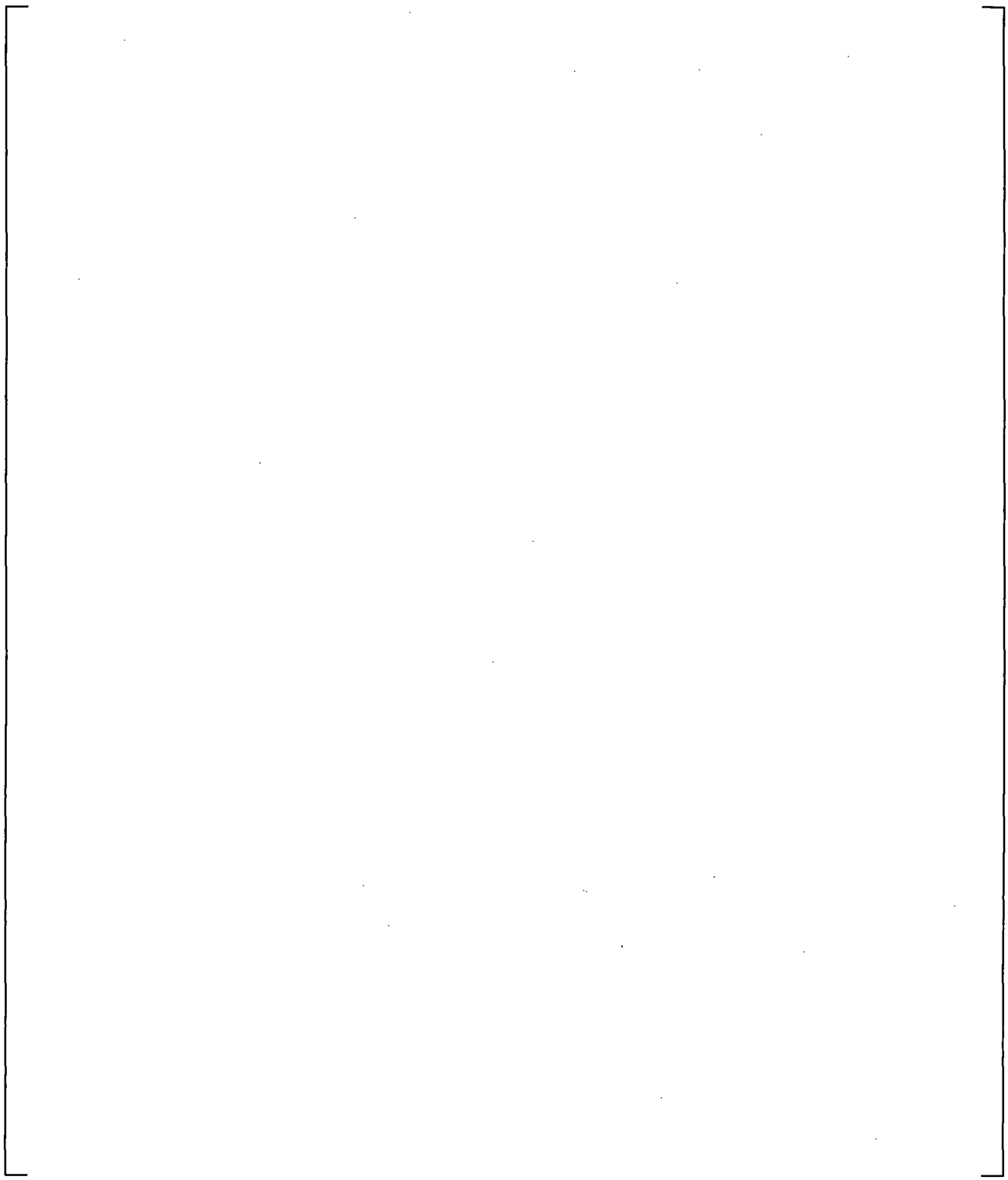

Figure 6.4-47. [

]^{a,c}

a,c

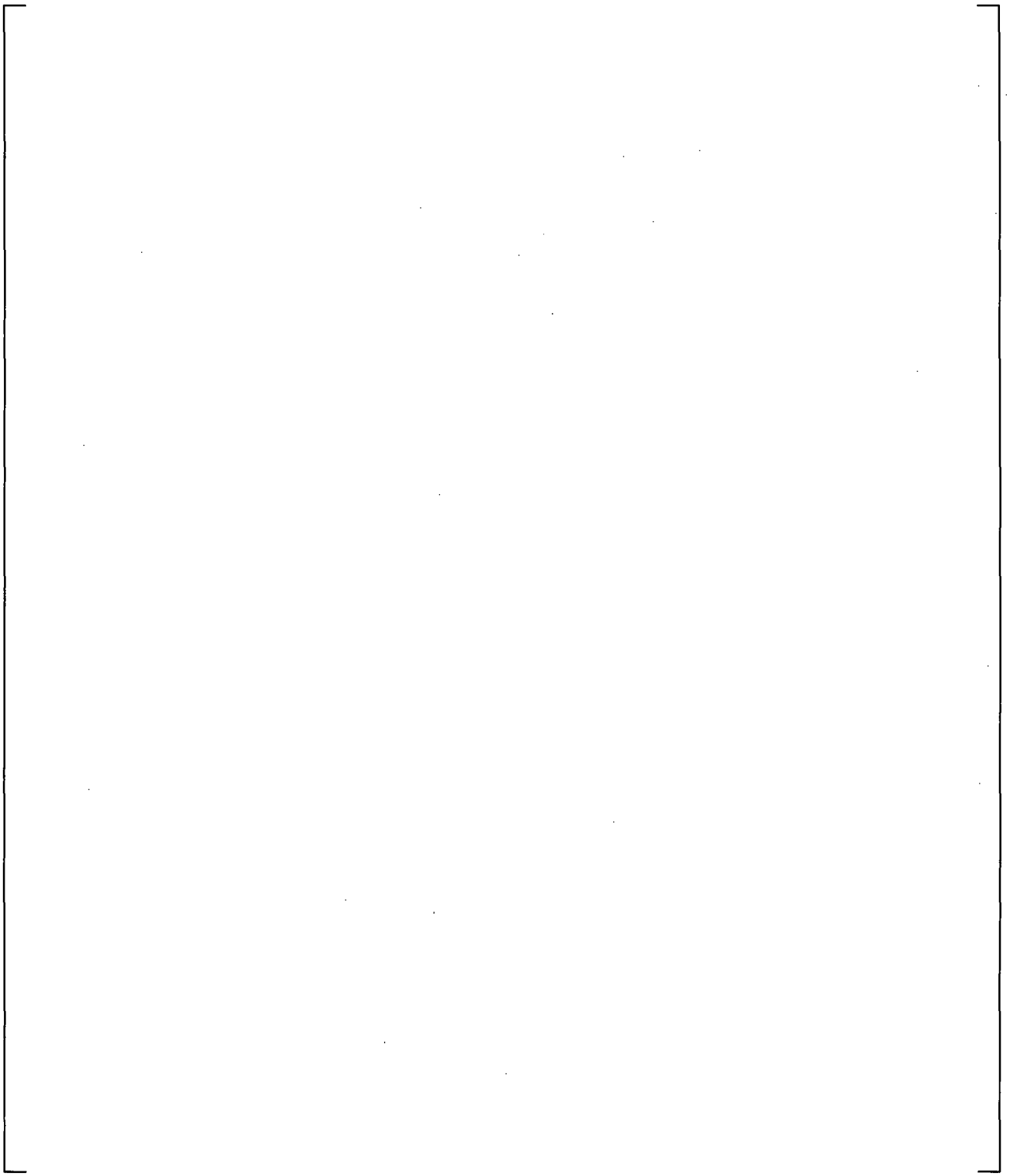

Figure 6.4-48. [

]a,c

6.4.2.9 LTR-EMPE-03-26

Figures 6.4-49 through 6.4-51 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from LTR-EMPE-03-26 (Reference 27) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively). [

]^{a,c}

Figures 6.4-52 through 6.4-54 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from LTR-EMPE-03-26 (Reference 27) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-49 through 6.4-54, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

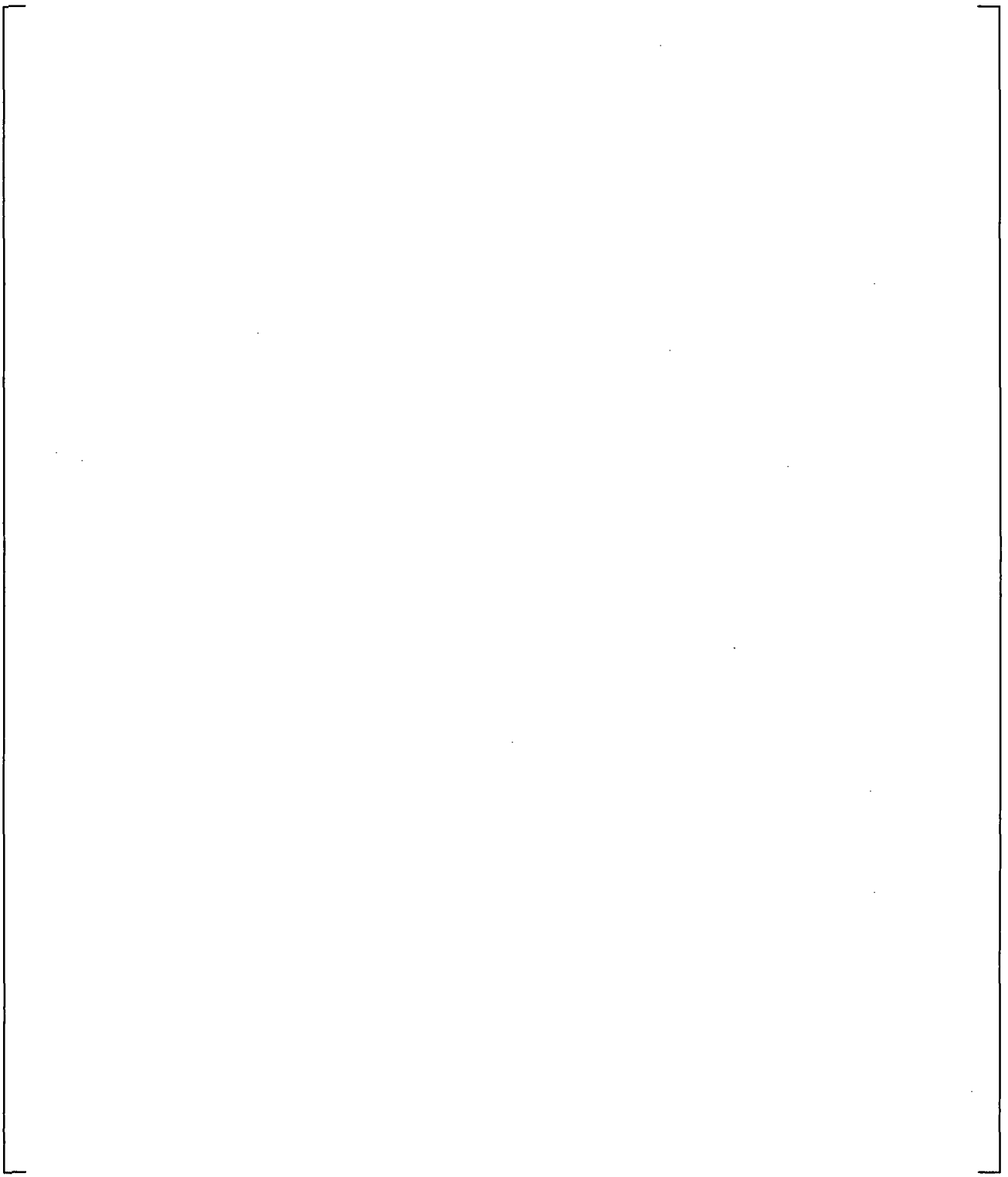

Figure 6.4-49. [

]a,c

a,c

[

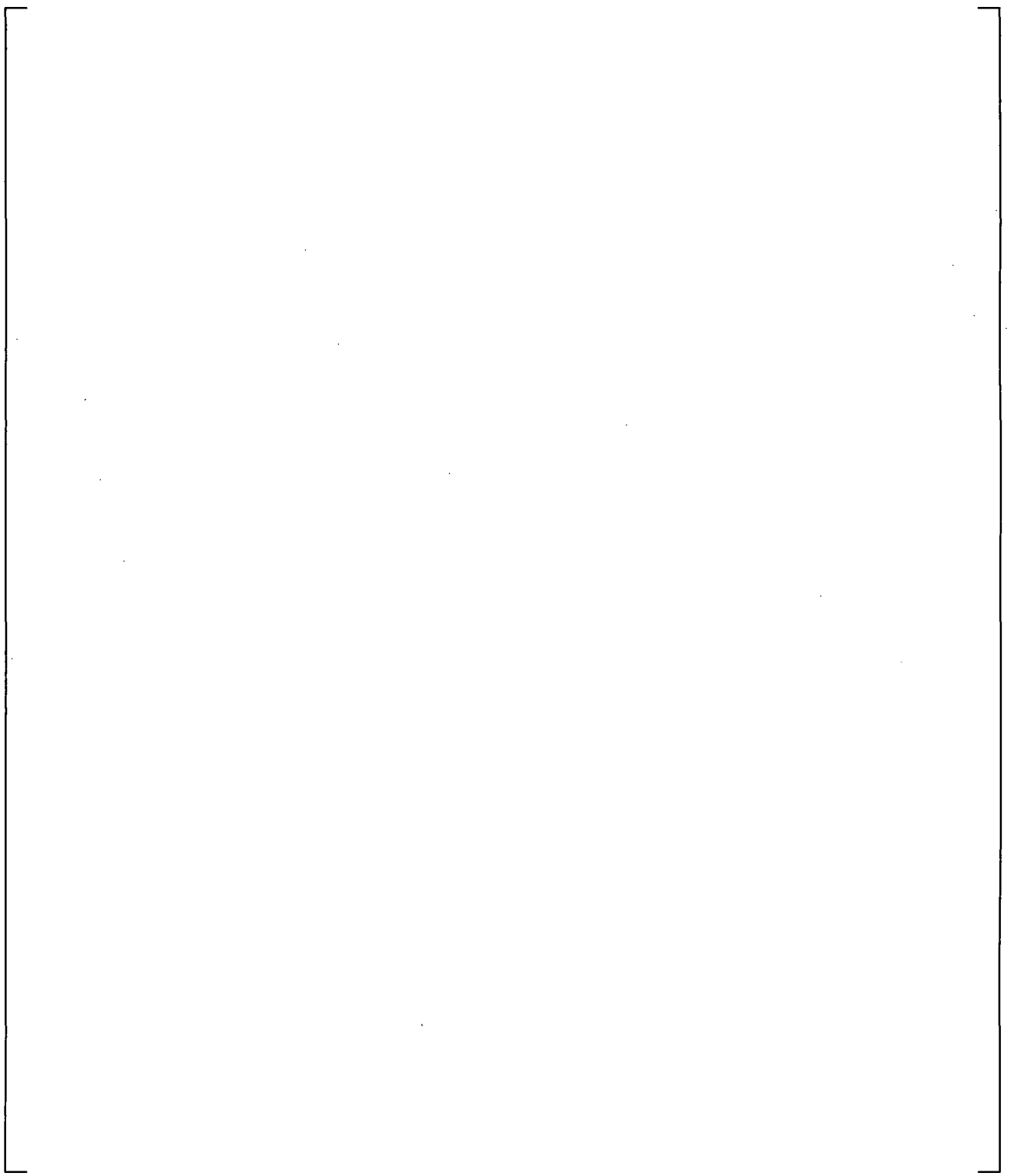

Figure 6.4-50. [

]a,c

a,c

[

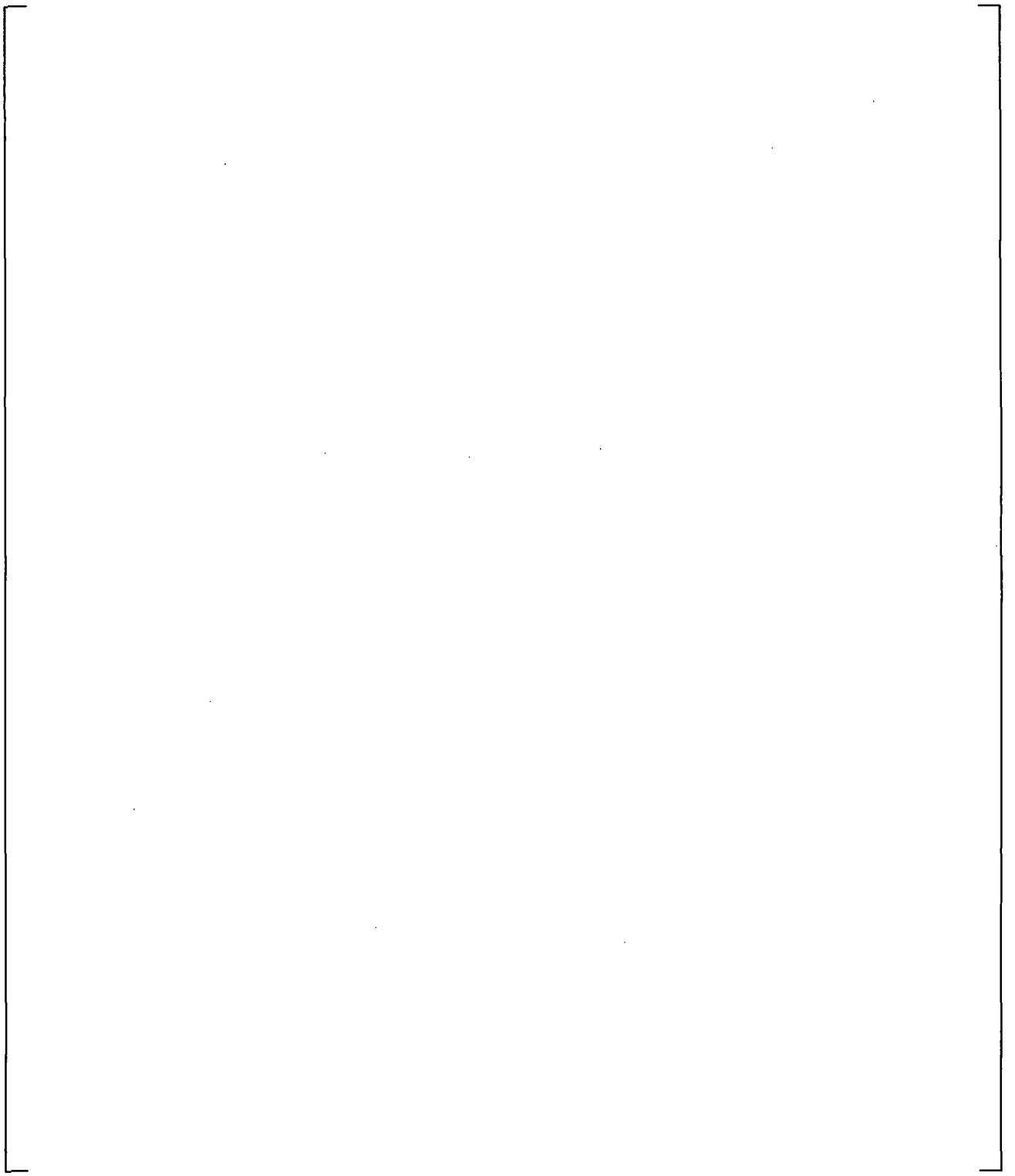

Figure 6.4-51. [

]a,c

a,c

[

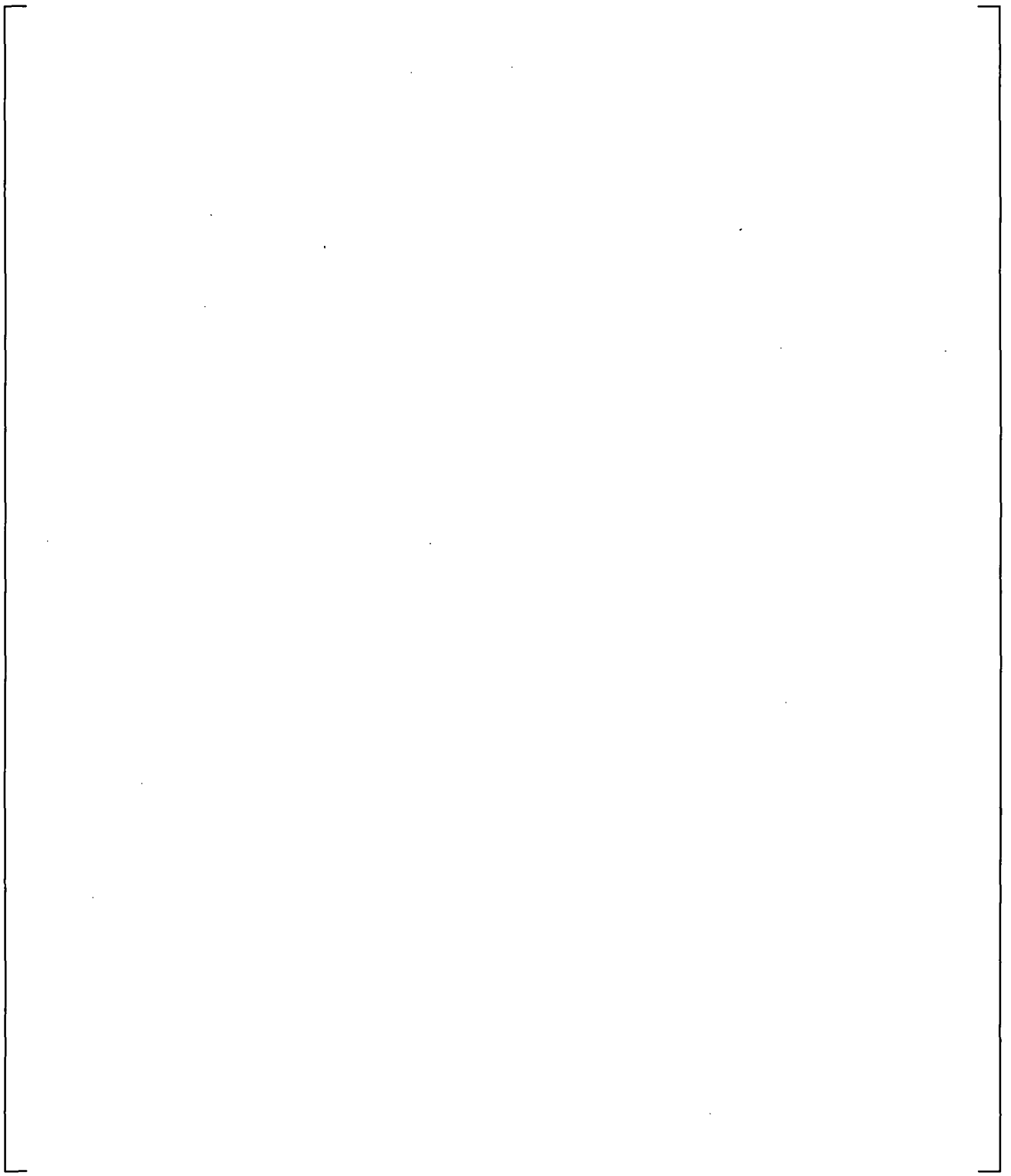

Figure 6.4-52. [

]a,c

a,c

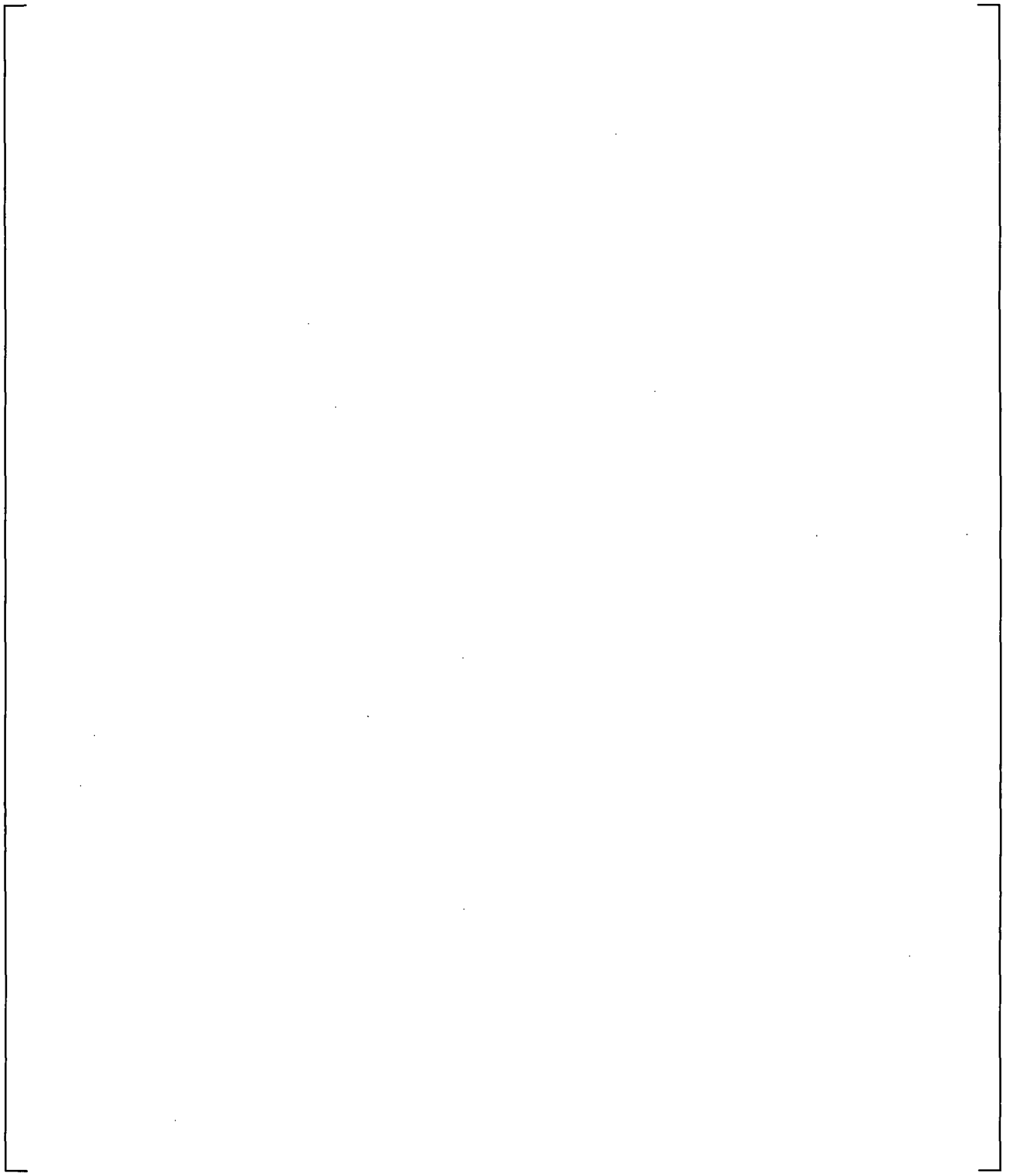

Figure 6.4-53. [

]a,c

a,c

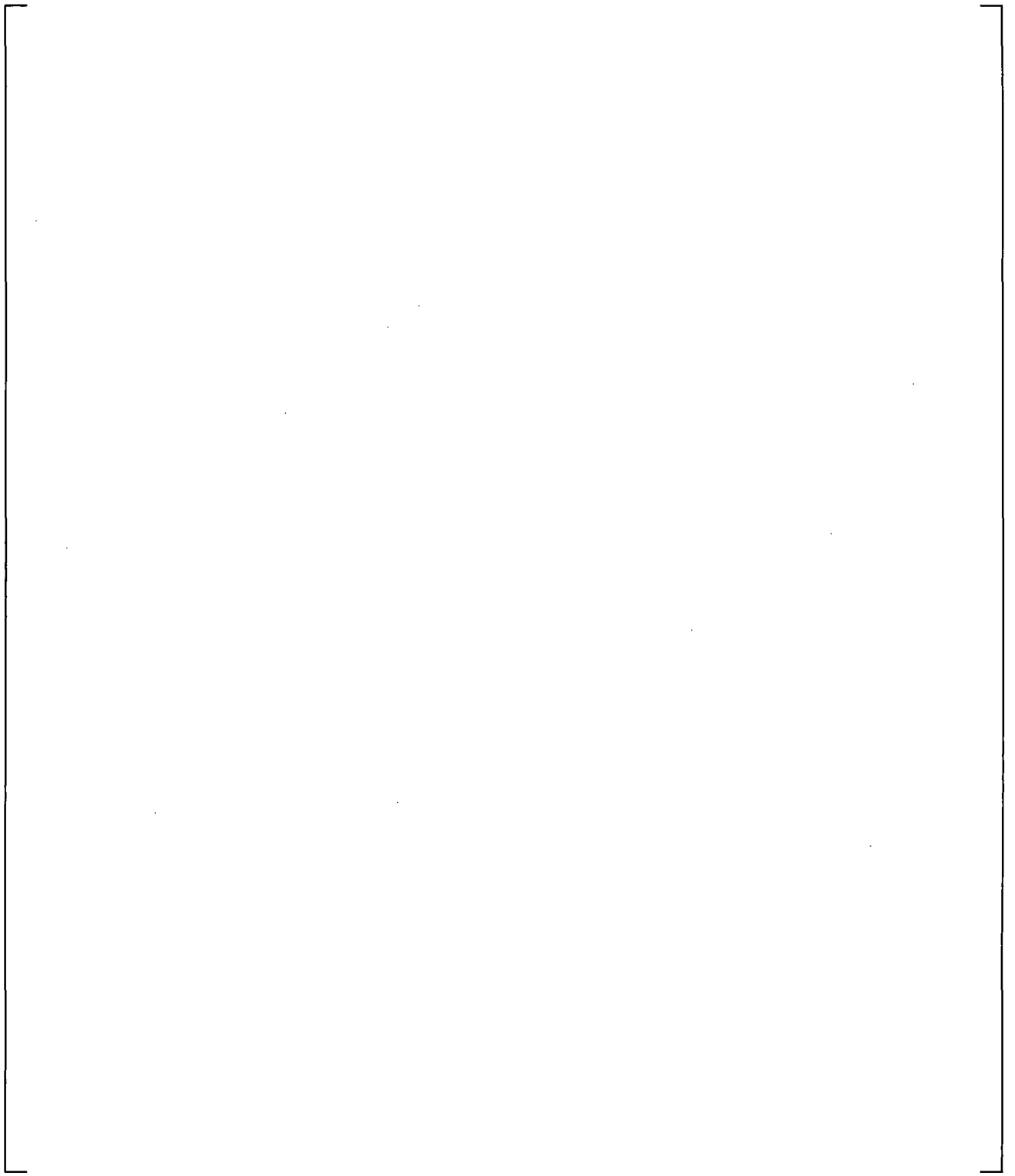

Figure 6.4-54. [

]a,c

6.4.2.10 00000-ICE-37764

Figures 6.4-55 through 6.4-57 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from 00000-ICE-37764 (Reference 23) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-58 through 6.4-60 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from 00000-ICE-37764 (Reference 23) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

[

]^{a,c}

As shown in Figures 6.4-55 through 6.4-60, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

]

Figure 6.4-55. [

]a,c

a,c

[

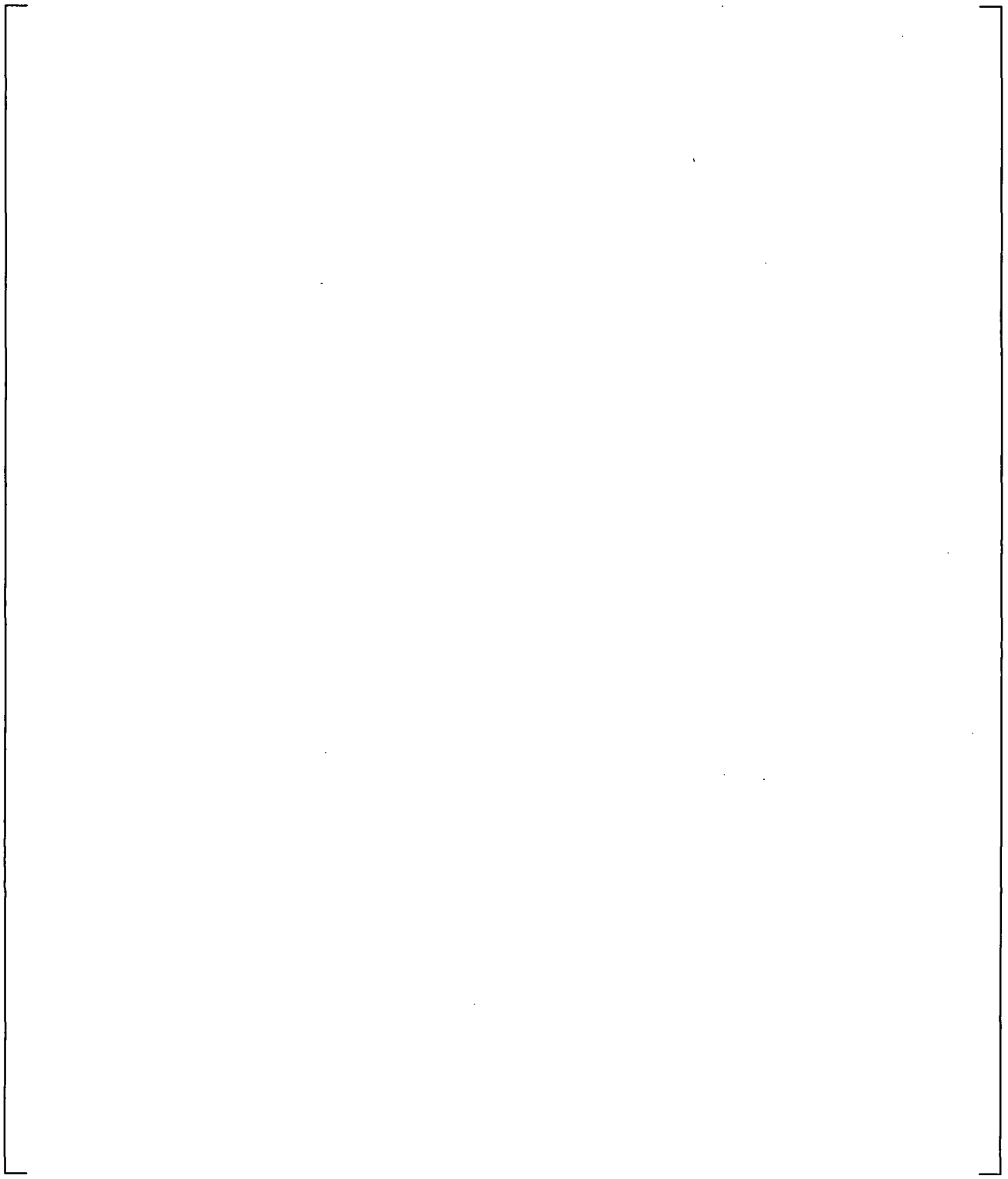

Figure 6.4-56. [

]a,c

a,c

[

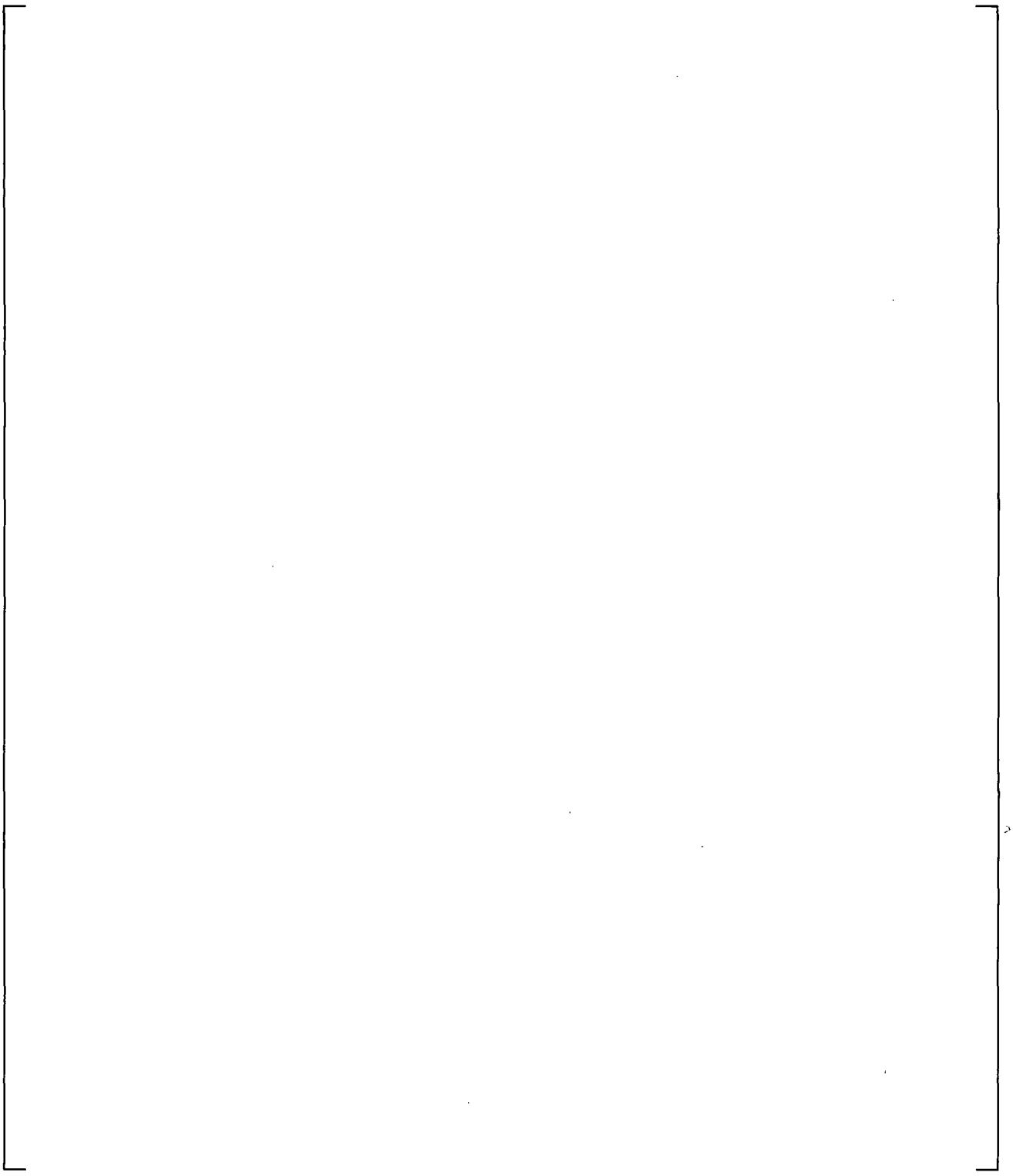

Figure 6.4-57. [

]a,c

a,c

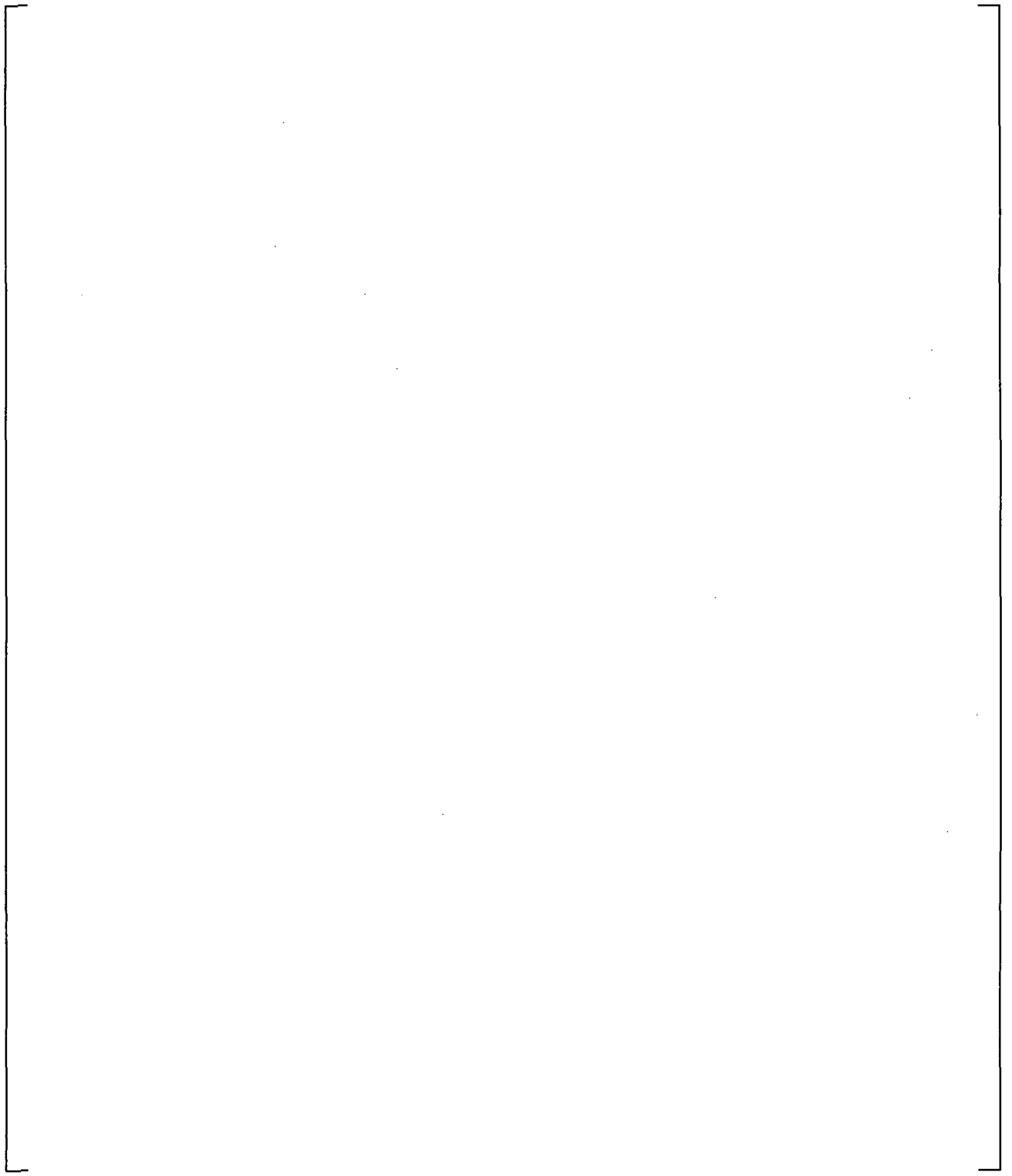

Figure 6.4-58. [

]a,c

a,c

[

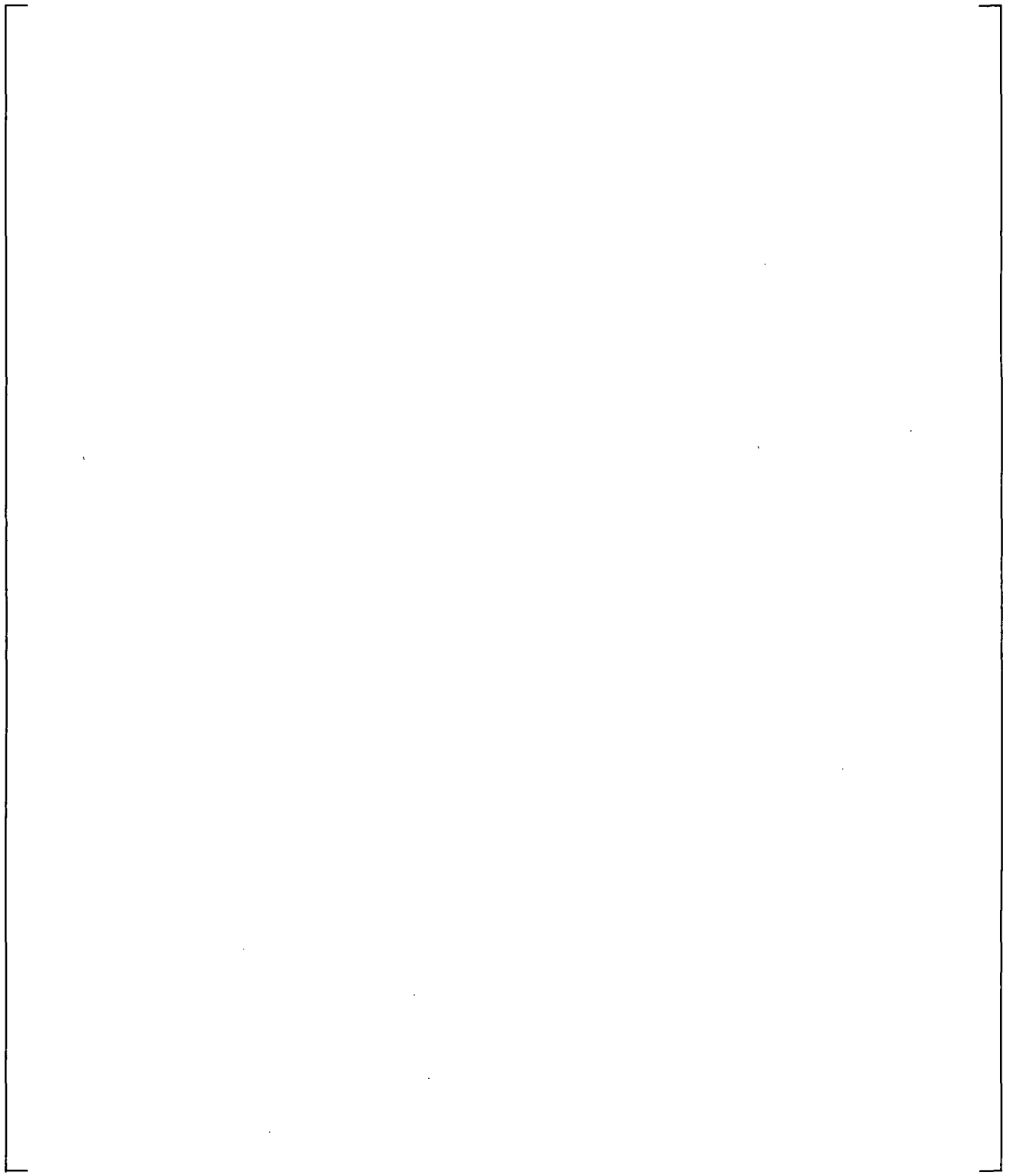

Figure 6.4-59. [

]a,c

a,c

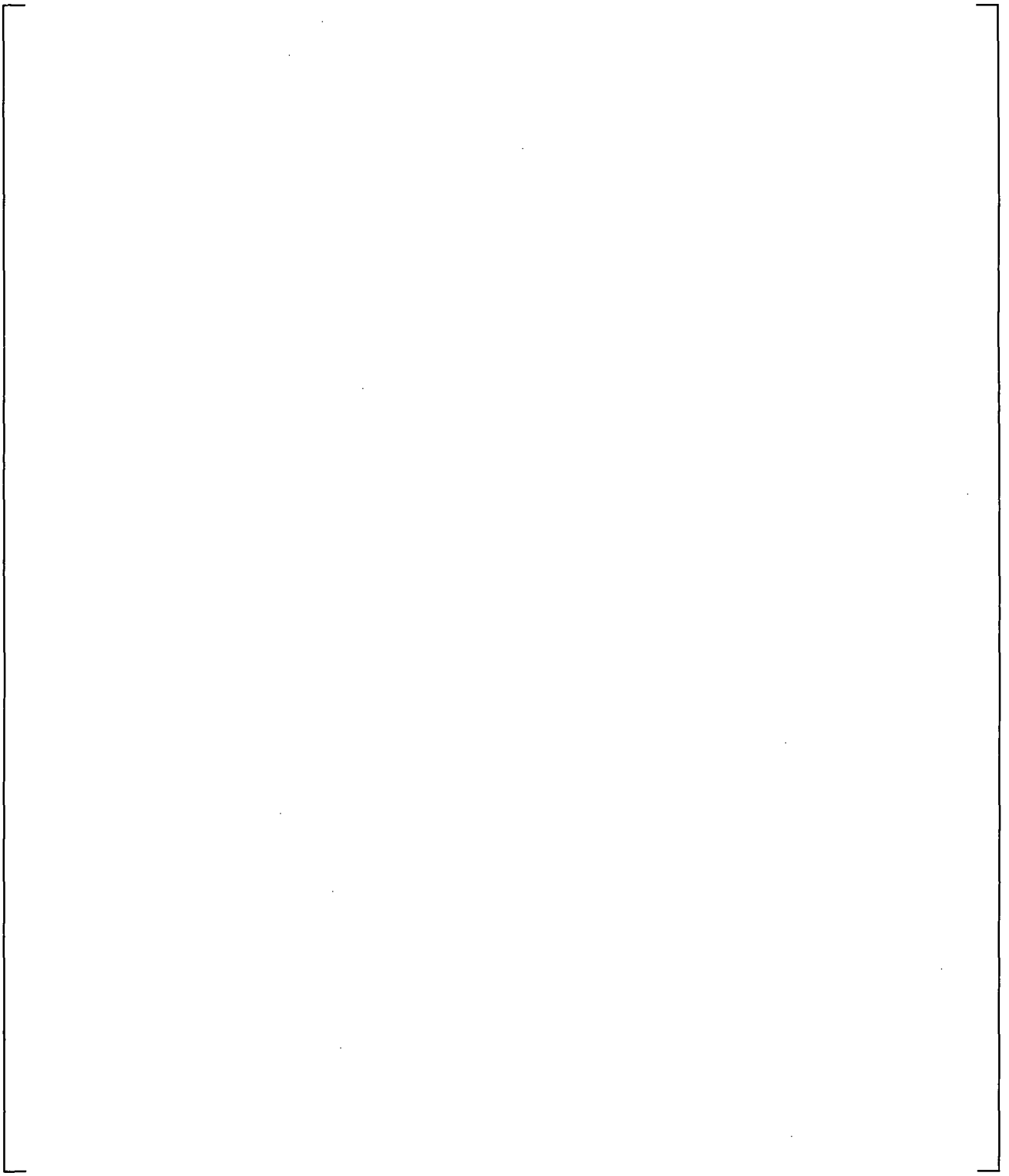

Figure 6.4-60. [

]a,c

6.4.2.11 EQLR-182

Figures 6.4-61 through 6.4-63 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-182 (Reference 35) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-64 through 6.4-66 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-182 (Reference 35) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-61 through 6.4-66, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

]

Figure 6.4-61. [

]a,c

a,c

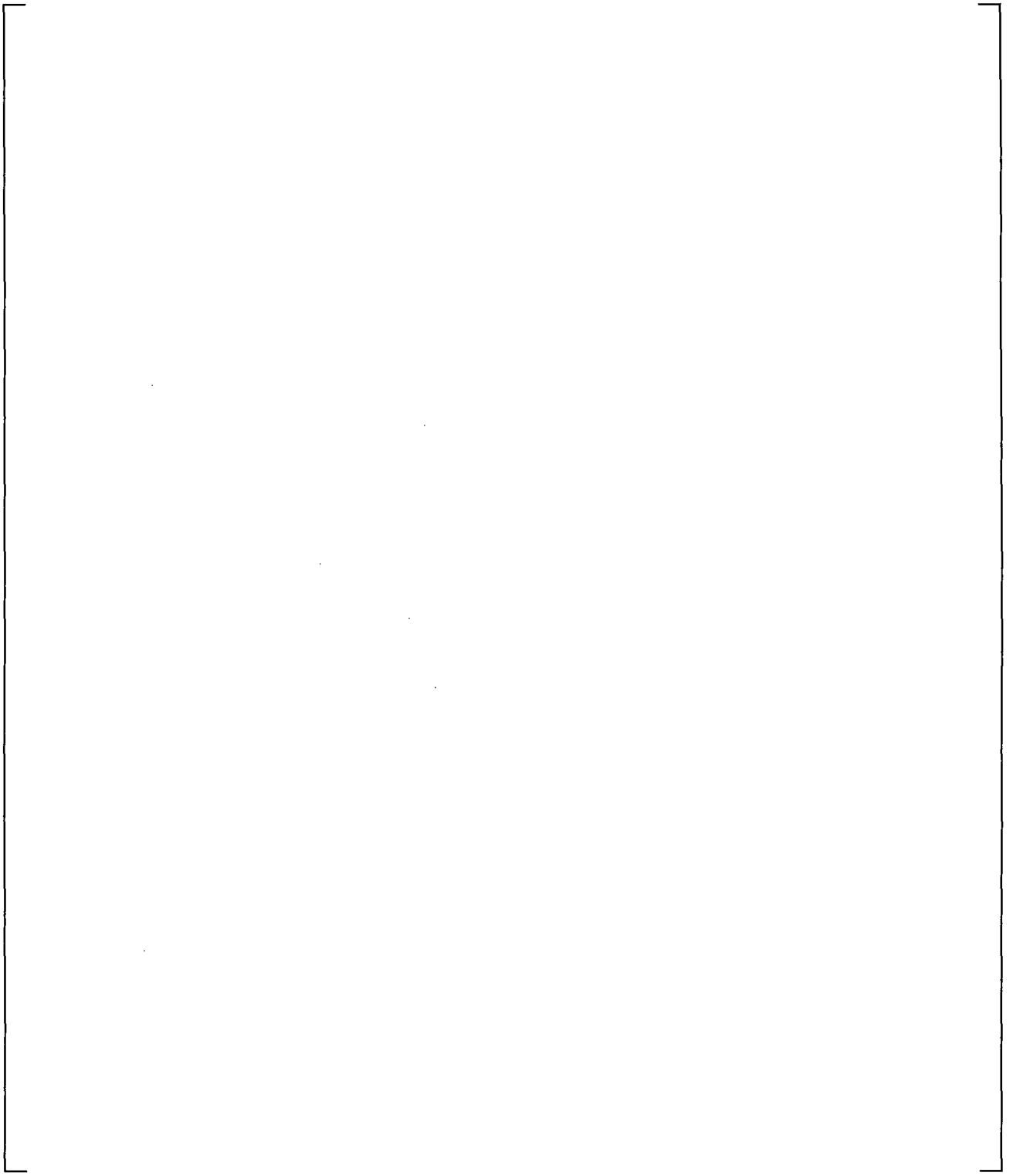

Figure 6.4-62. [

]a,c

a,c

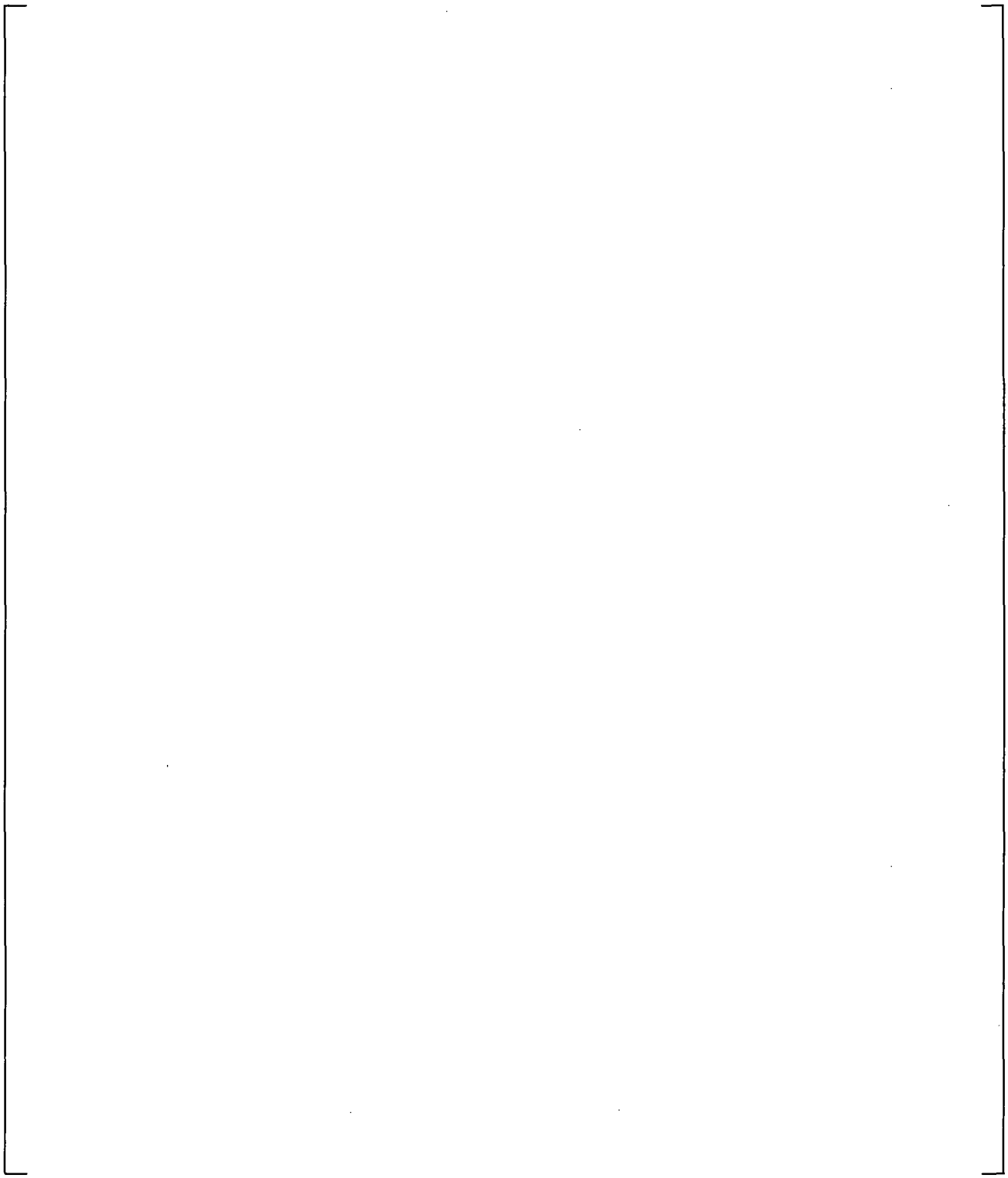

Figure 6.4-63. [

]a,c

a,c

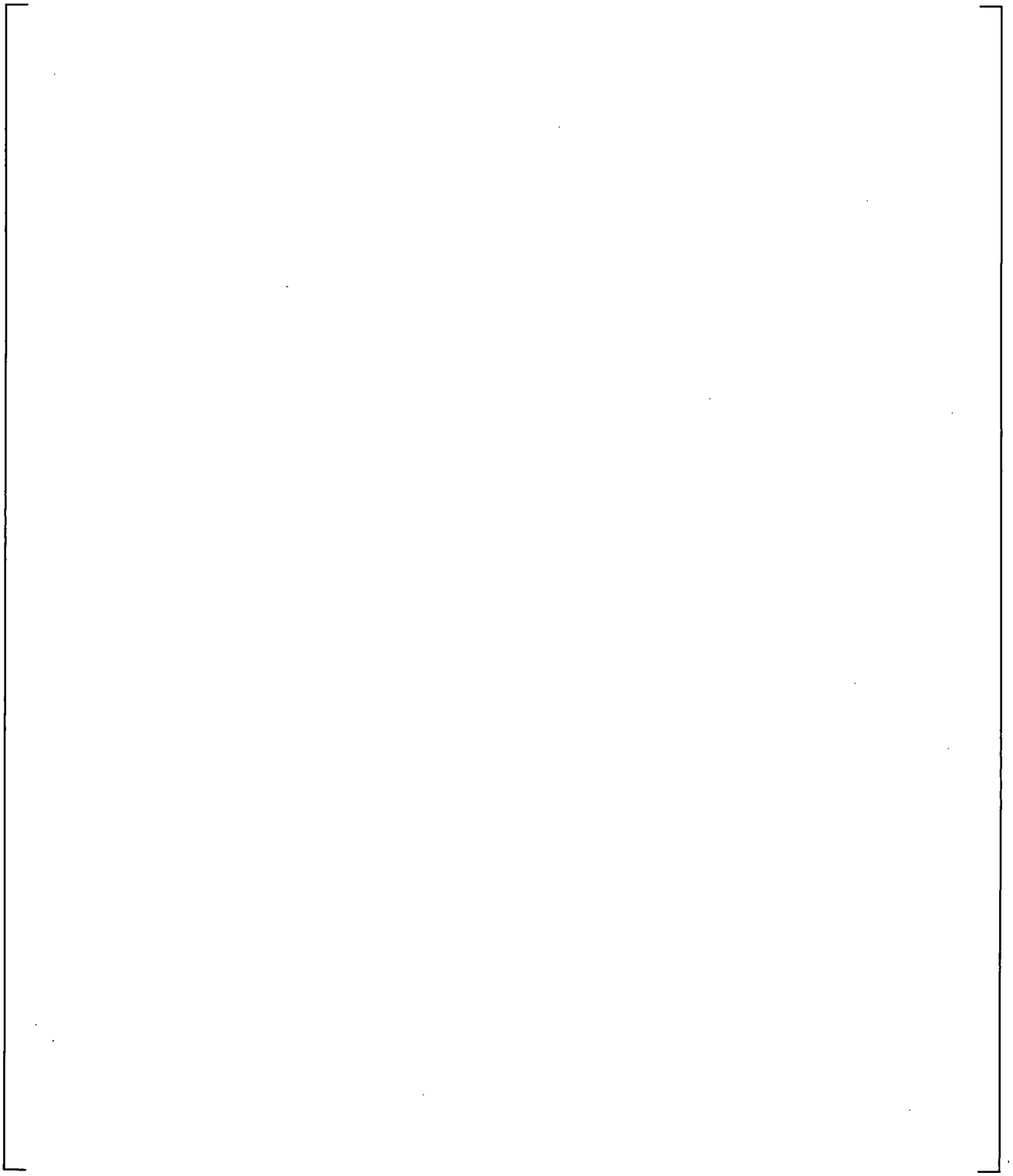

Figure 6.4-64. [

]a,c

a,c

[

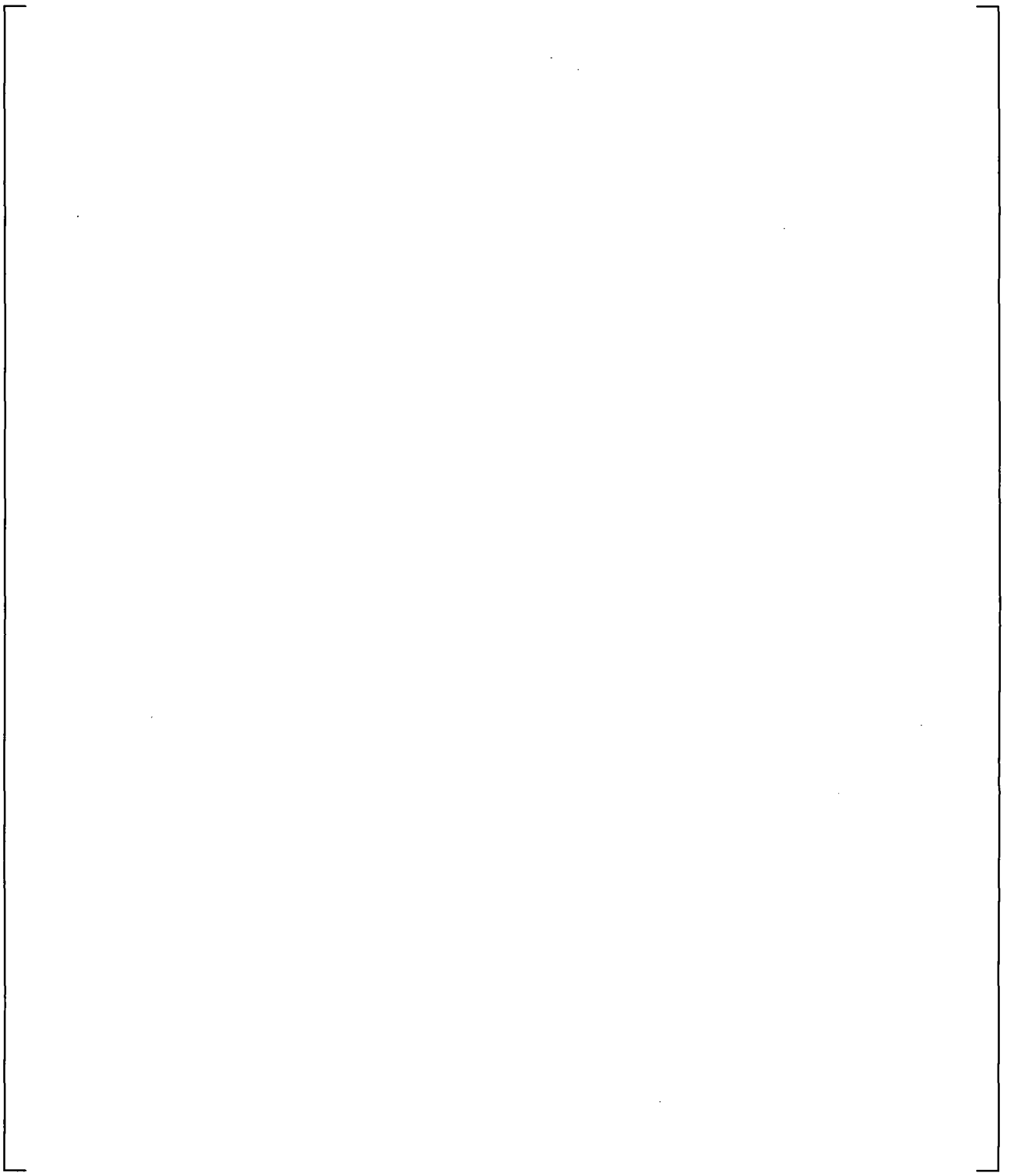

Figure 6.4-65. [

]a,c

a,c

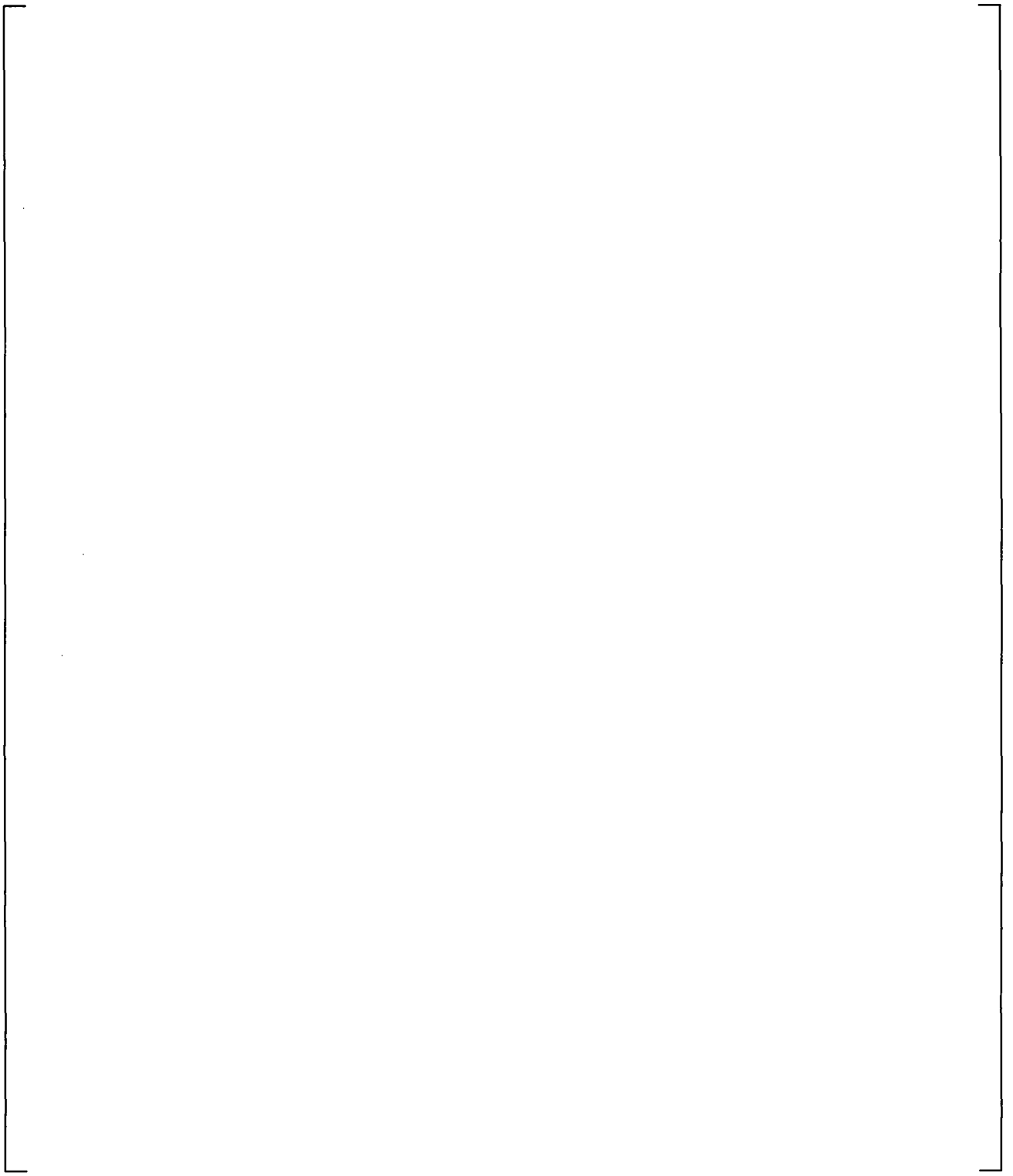

Figure 6.4-66. [

]a,c

6.4.2.12 EQ-EV-62-WBT

Figures 6.4-67 through 6.4-69 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQ-EV-62-WBT (Reference 49) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-70 through 6.4-72 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQ-EV-62-WBT (Reference 49) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-67 through 6.4-72, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

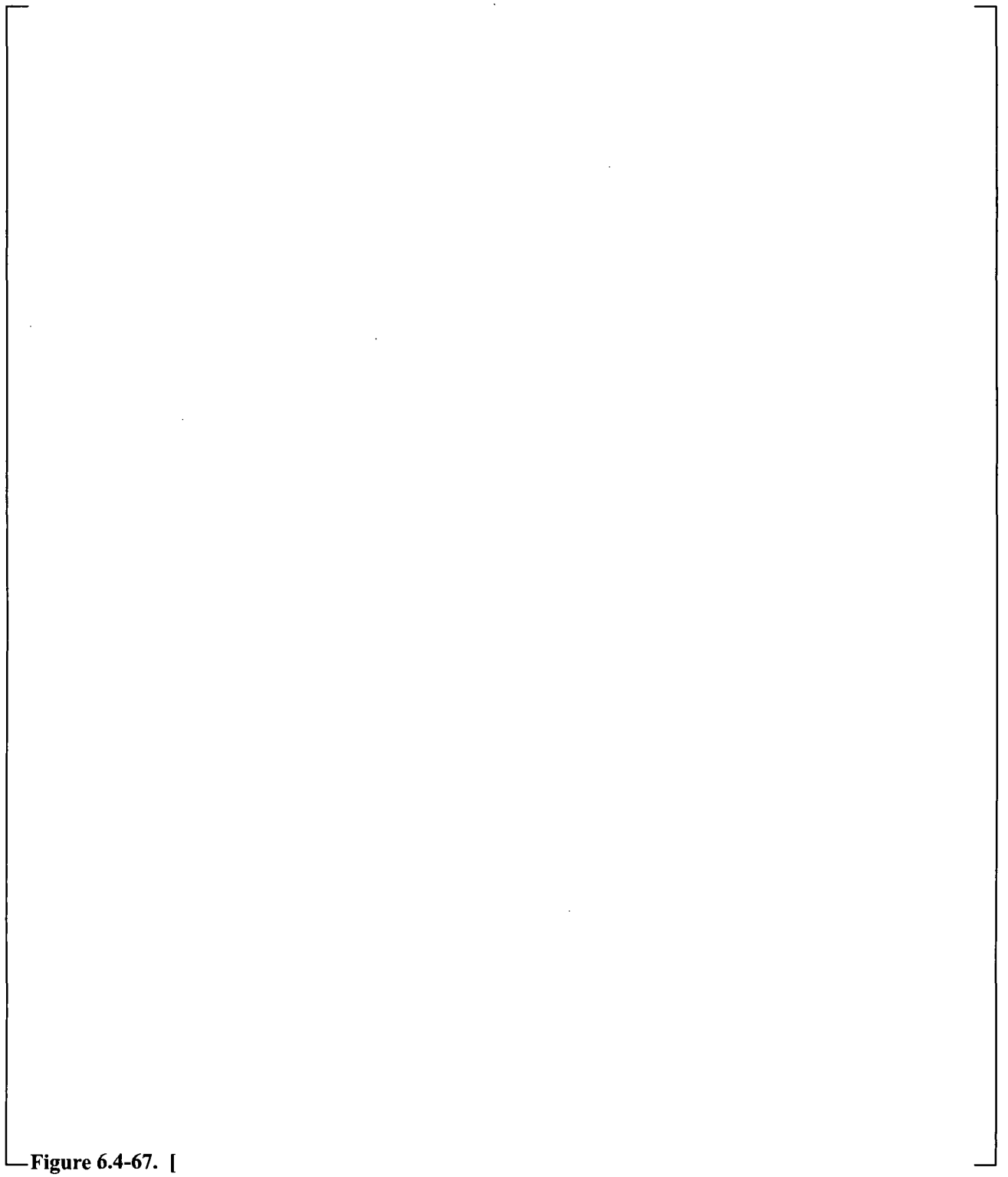

Figure 6.4-67. [

]a,c

a,c

[

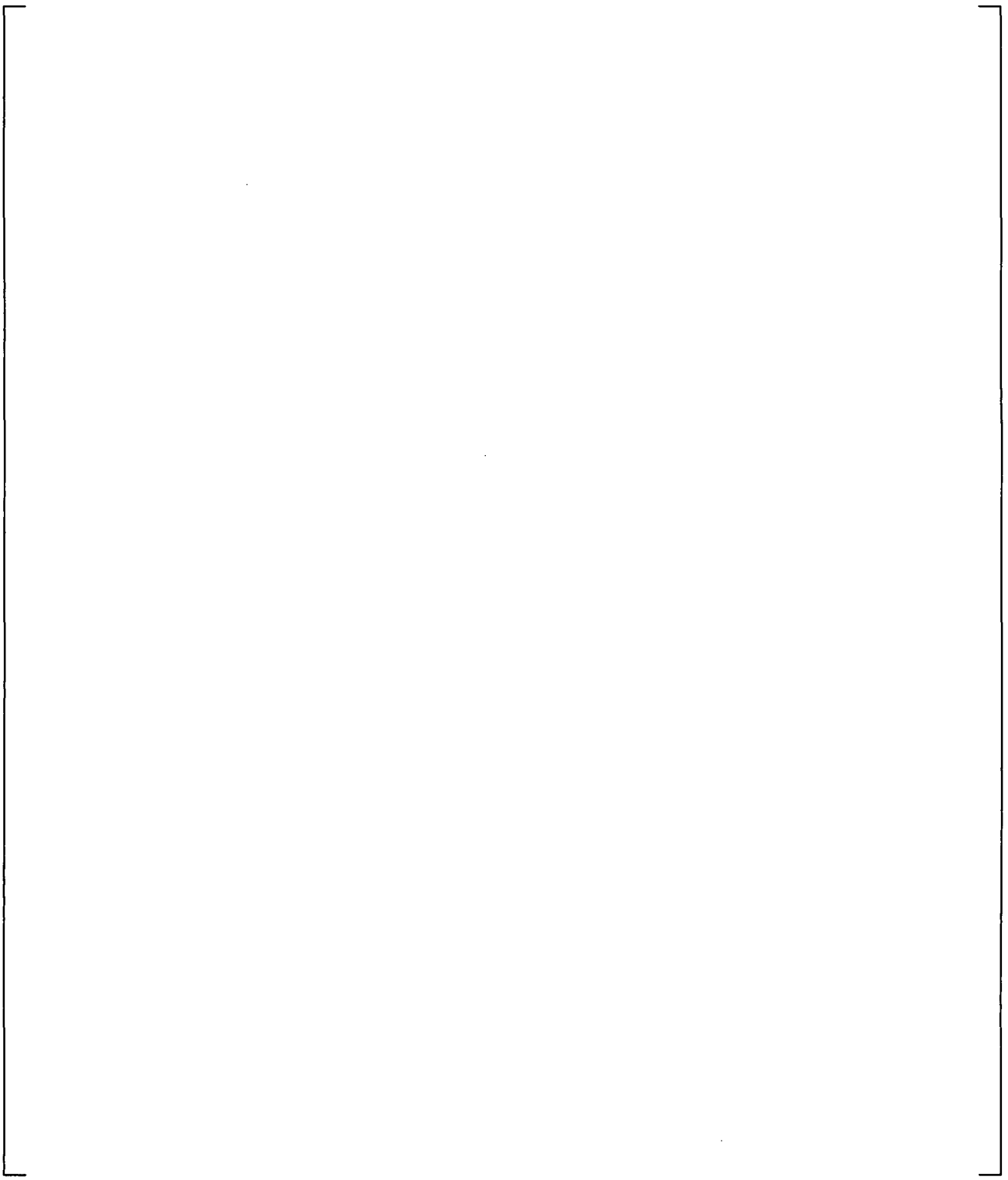

Figure 6.4-68. [

]a,c

a,c

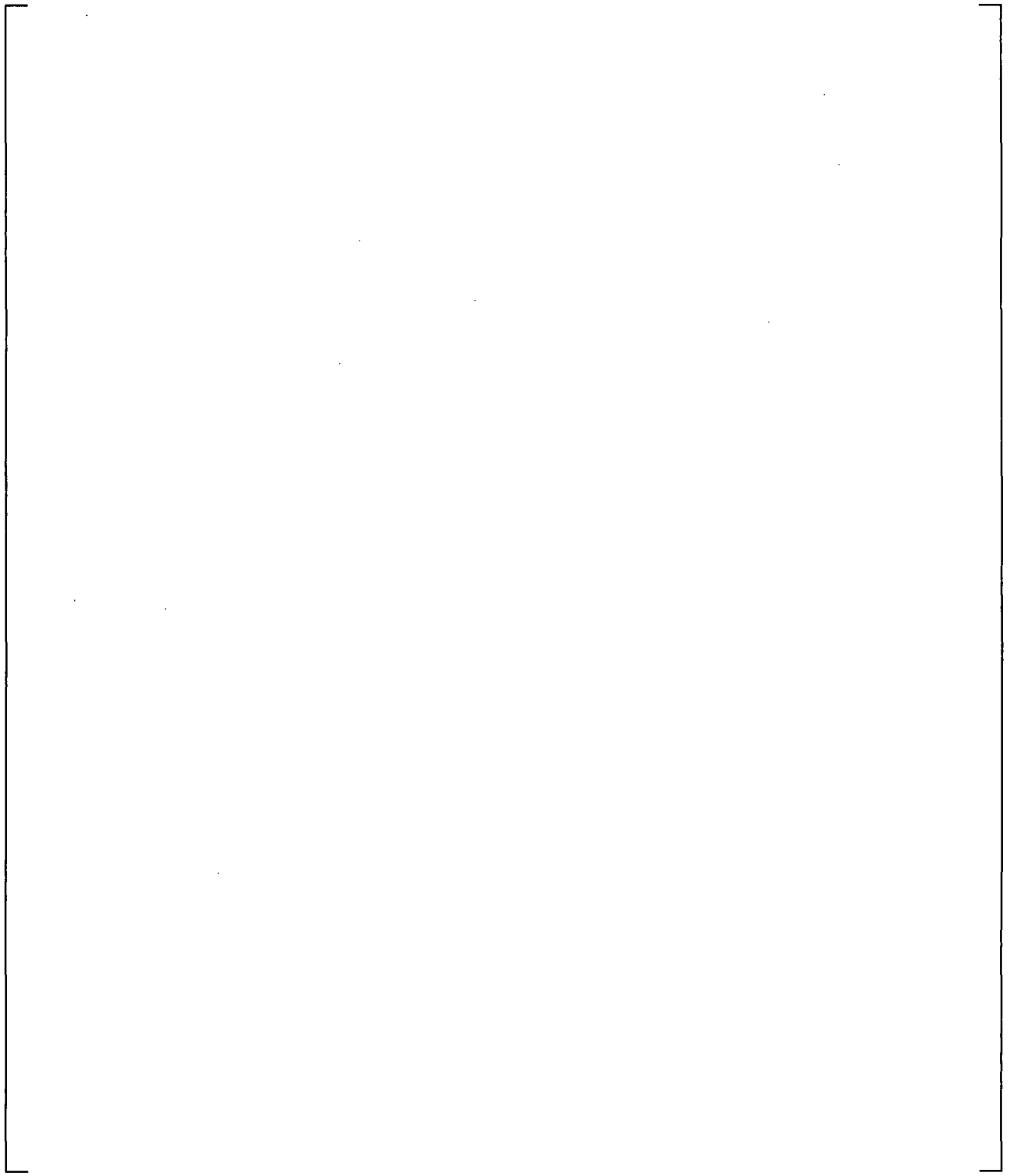

Figure 6.4-69. [

]a,c

a,c

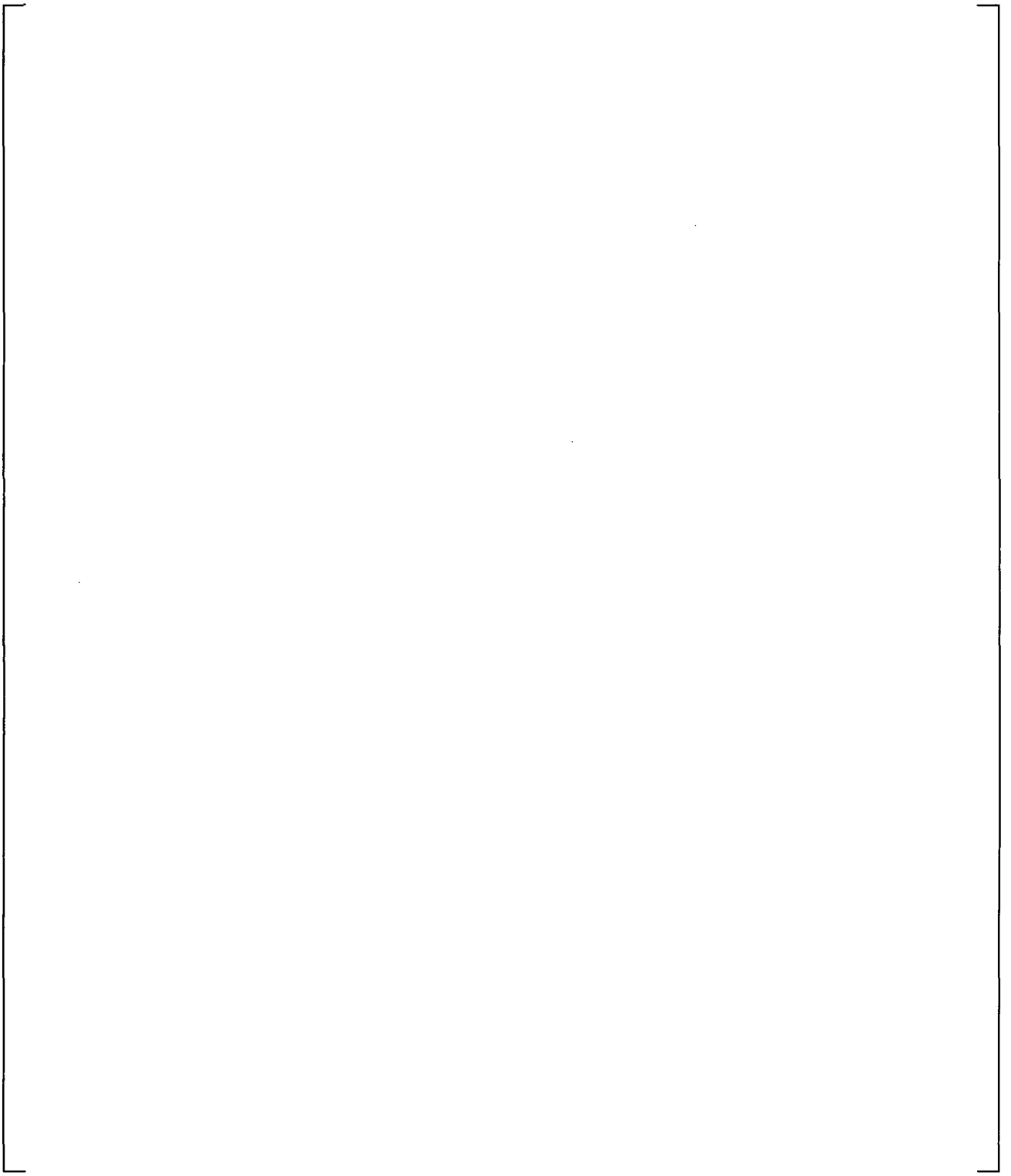

Figure 6.4-70. [

]a,c

a,c

[

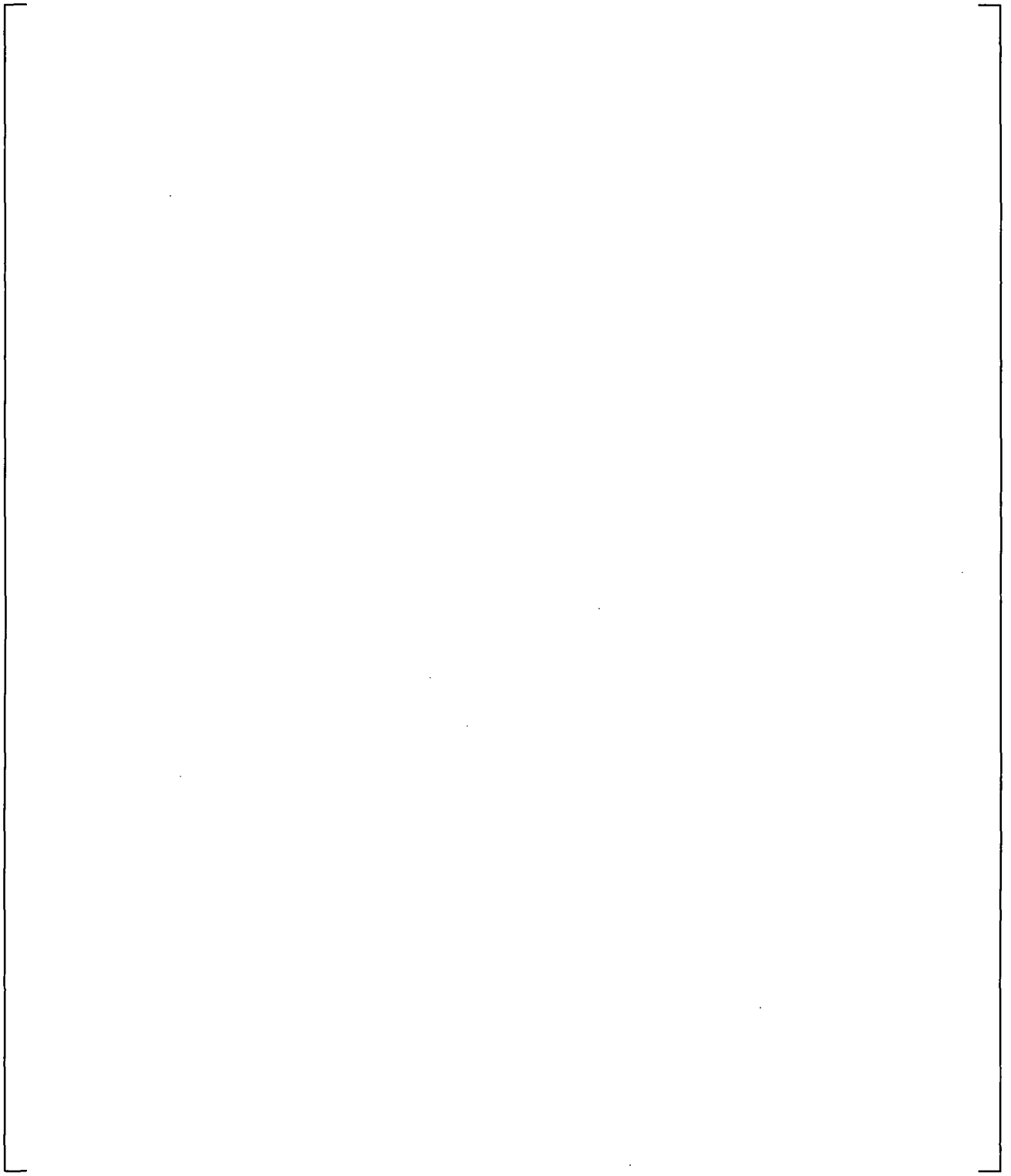

Figure 6.4-71. [

]a,c

a,c

[

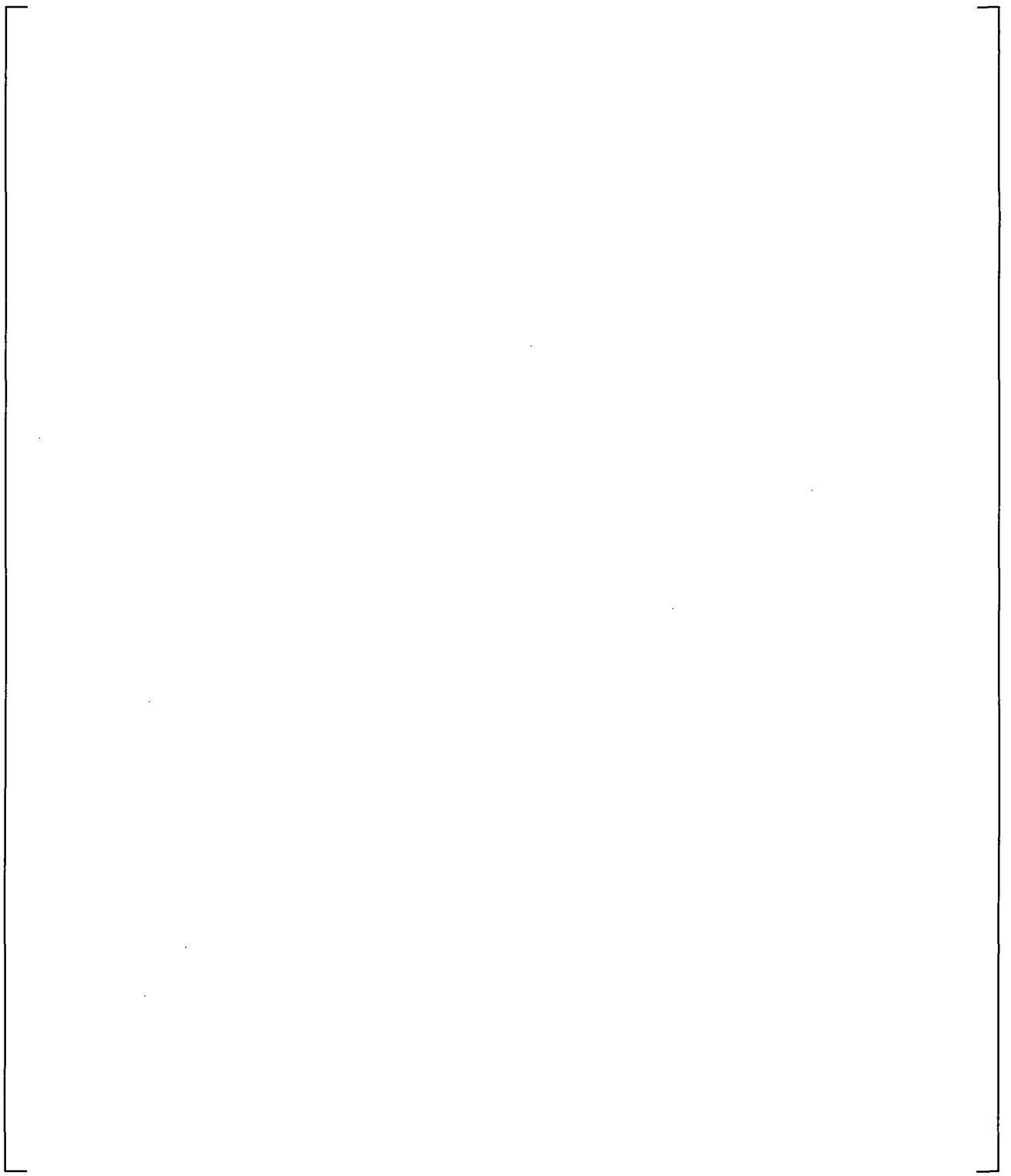

Figure 6.4-72. [

]a,c

6.4.2.13 EQLR-130

Figures 6.4-73 through 6.4-75 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-130 (Reference 50) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-76 through 6.4-78 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-130 (Reference 50) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-73 through 6.4-78, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

[

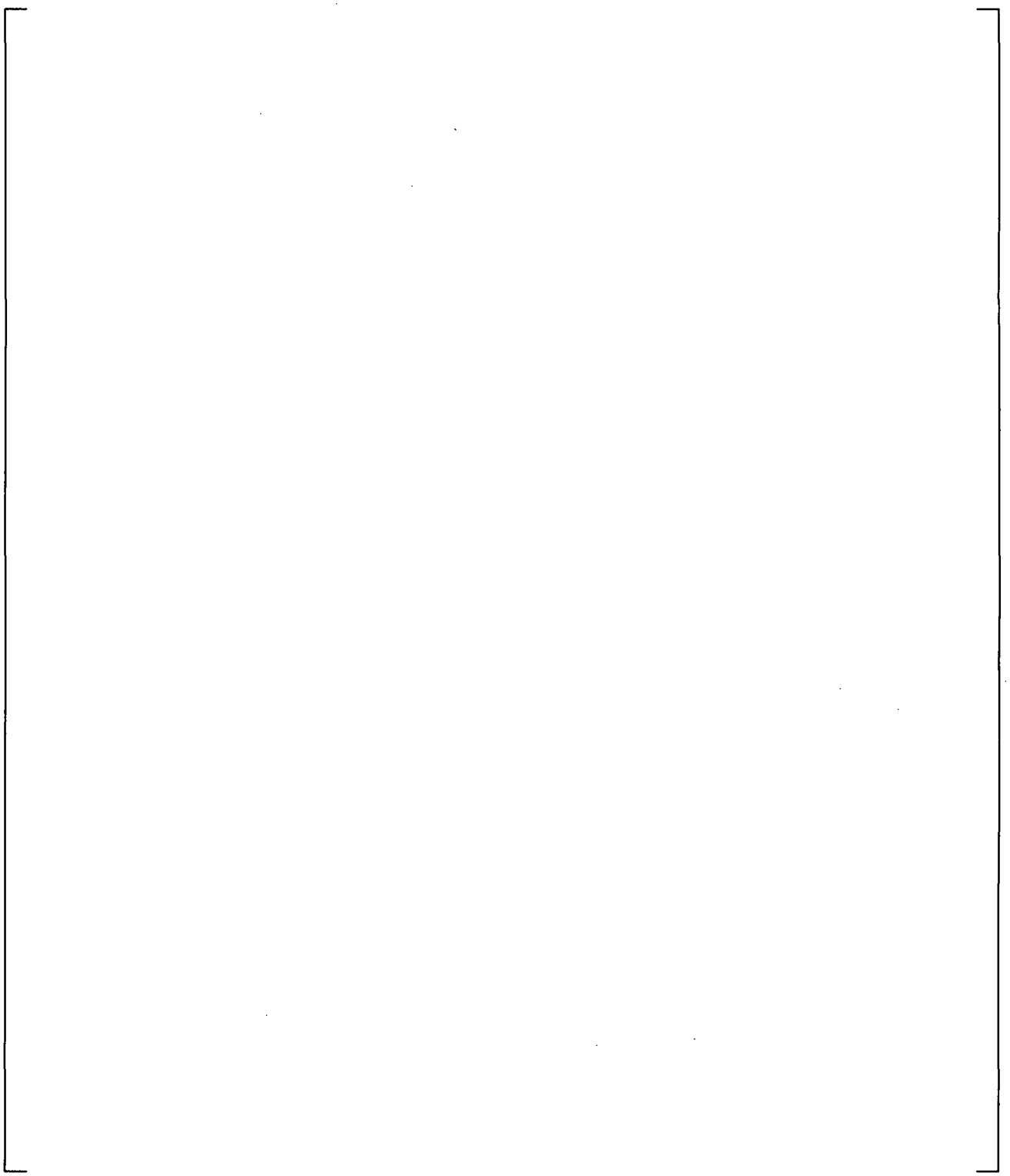

Figure 6.4-73. [

]a,c

a,c

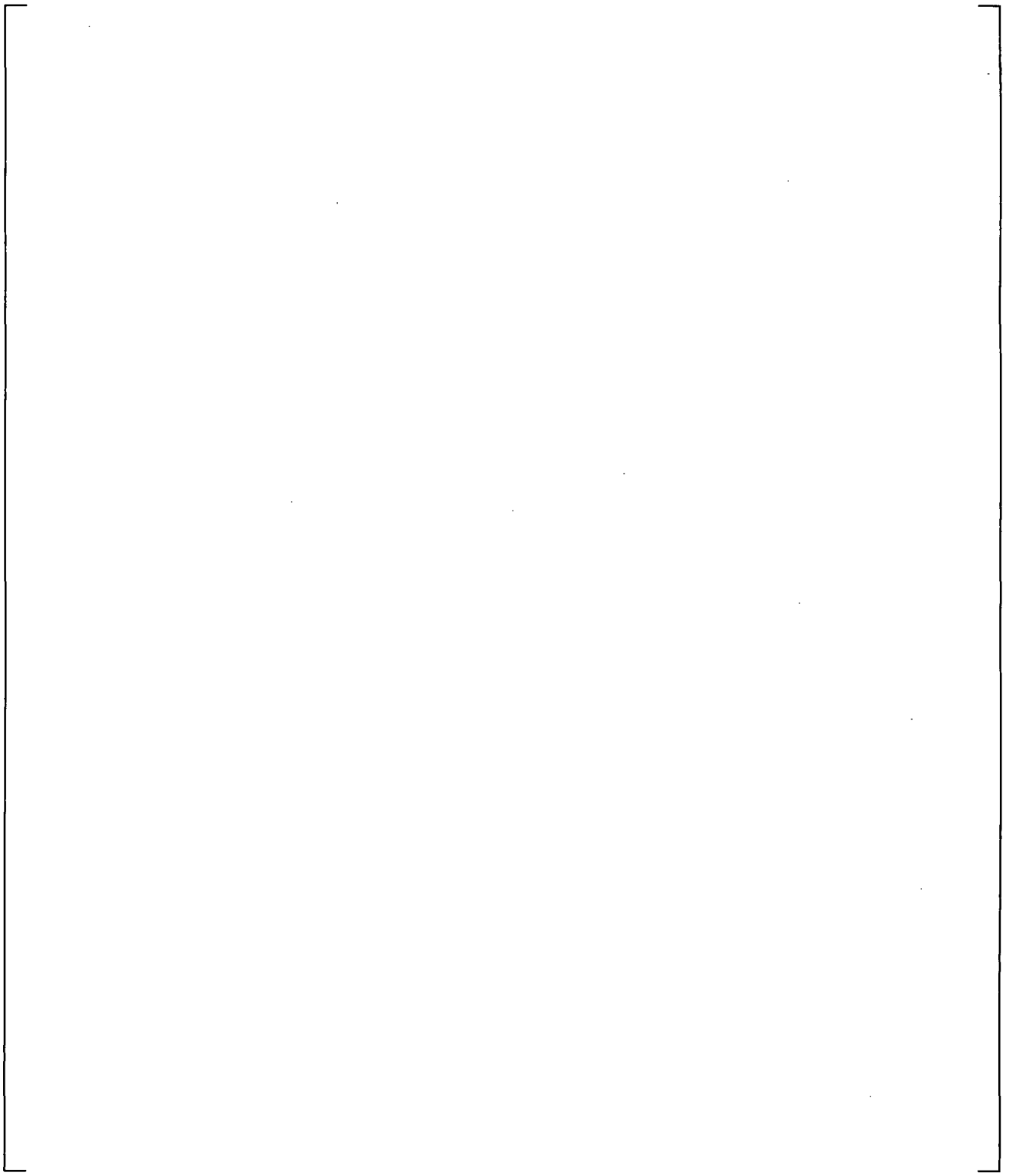

Figure 6.4-74. [

]a,c

a,c

[

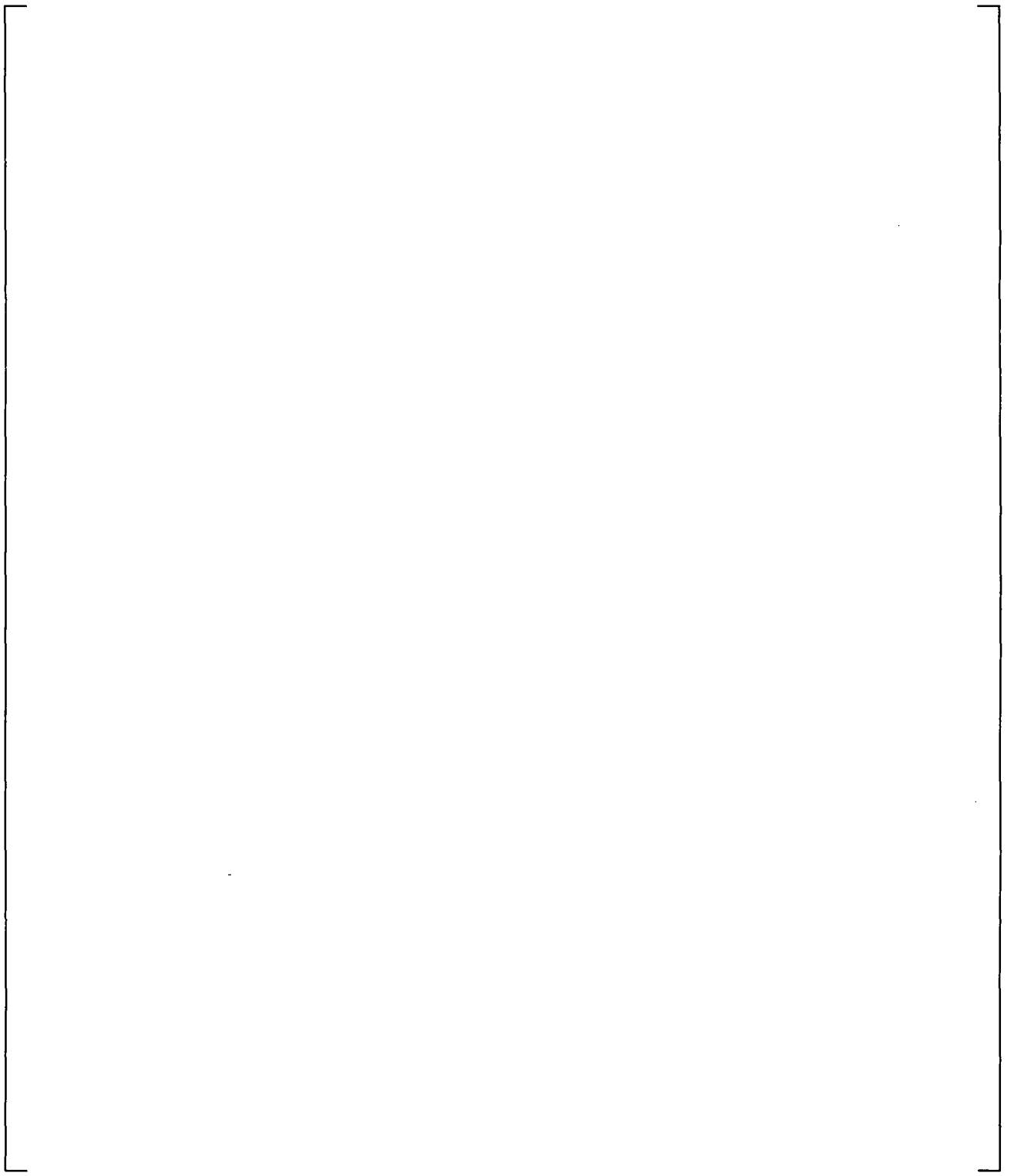

Figure 6.4-75. [

]a,c

a,c

[

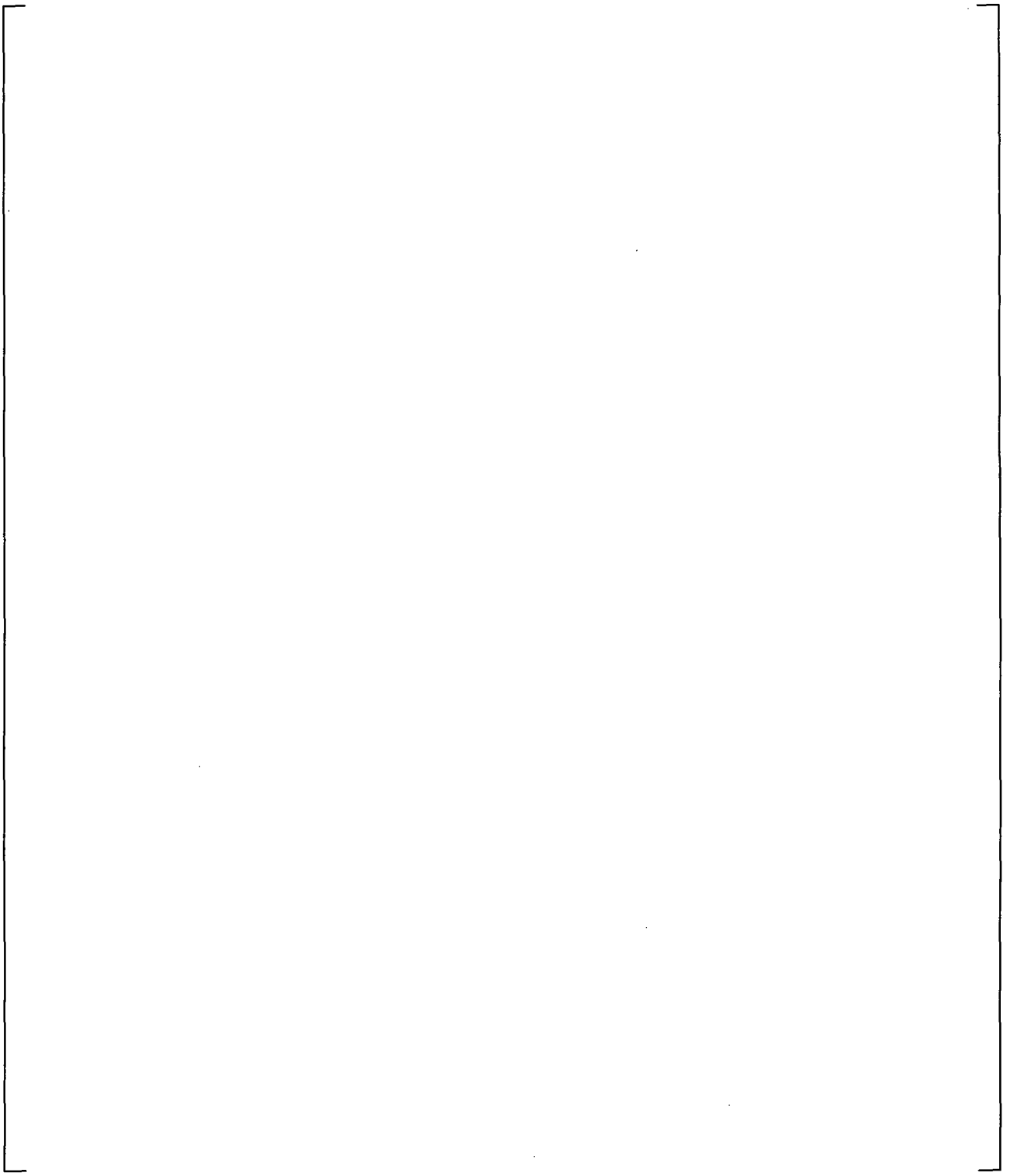

Figure 6.4-76. [

]a,c

a,c

[

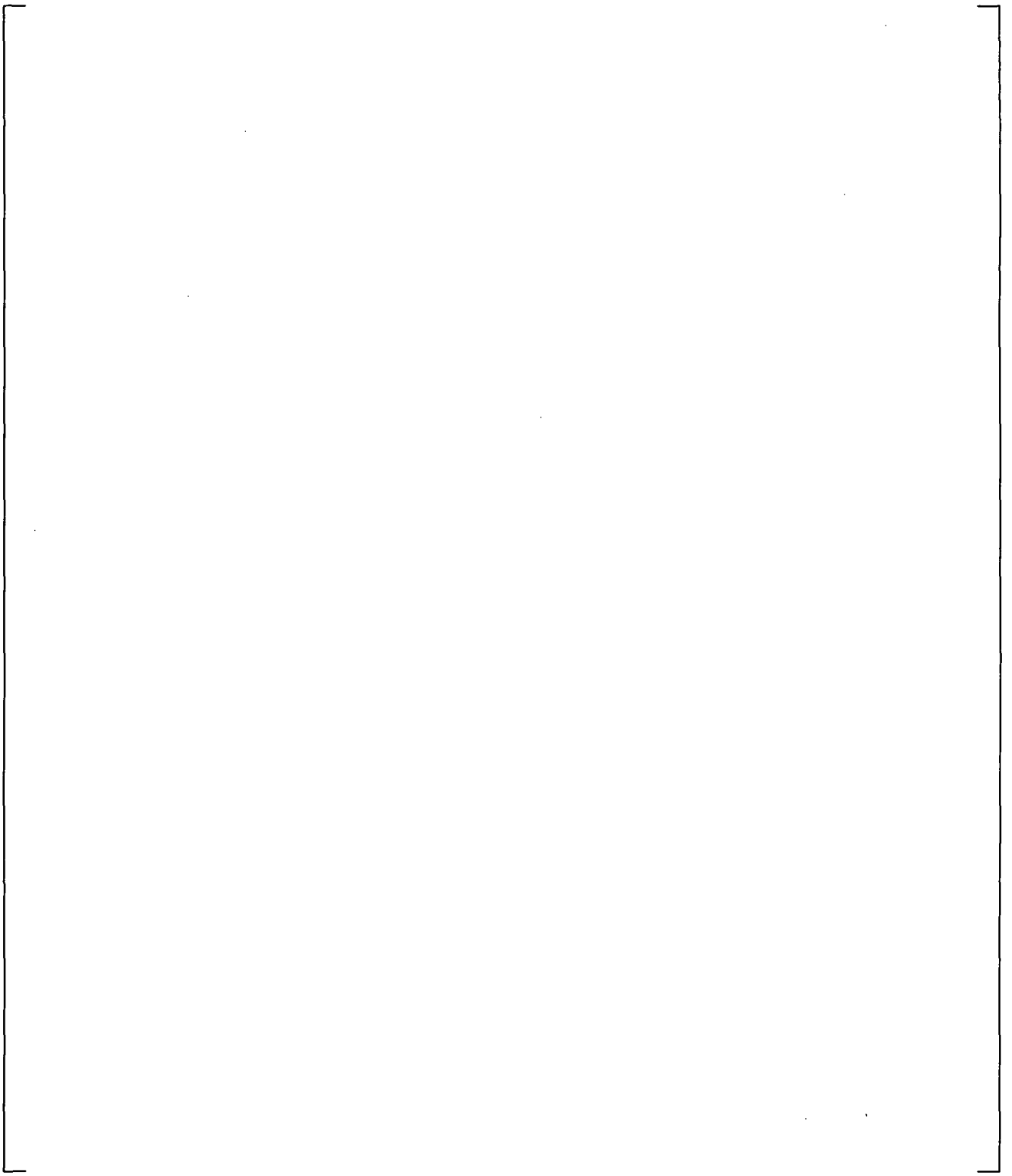

Figure 6.4-77. [

]a,c

a,c

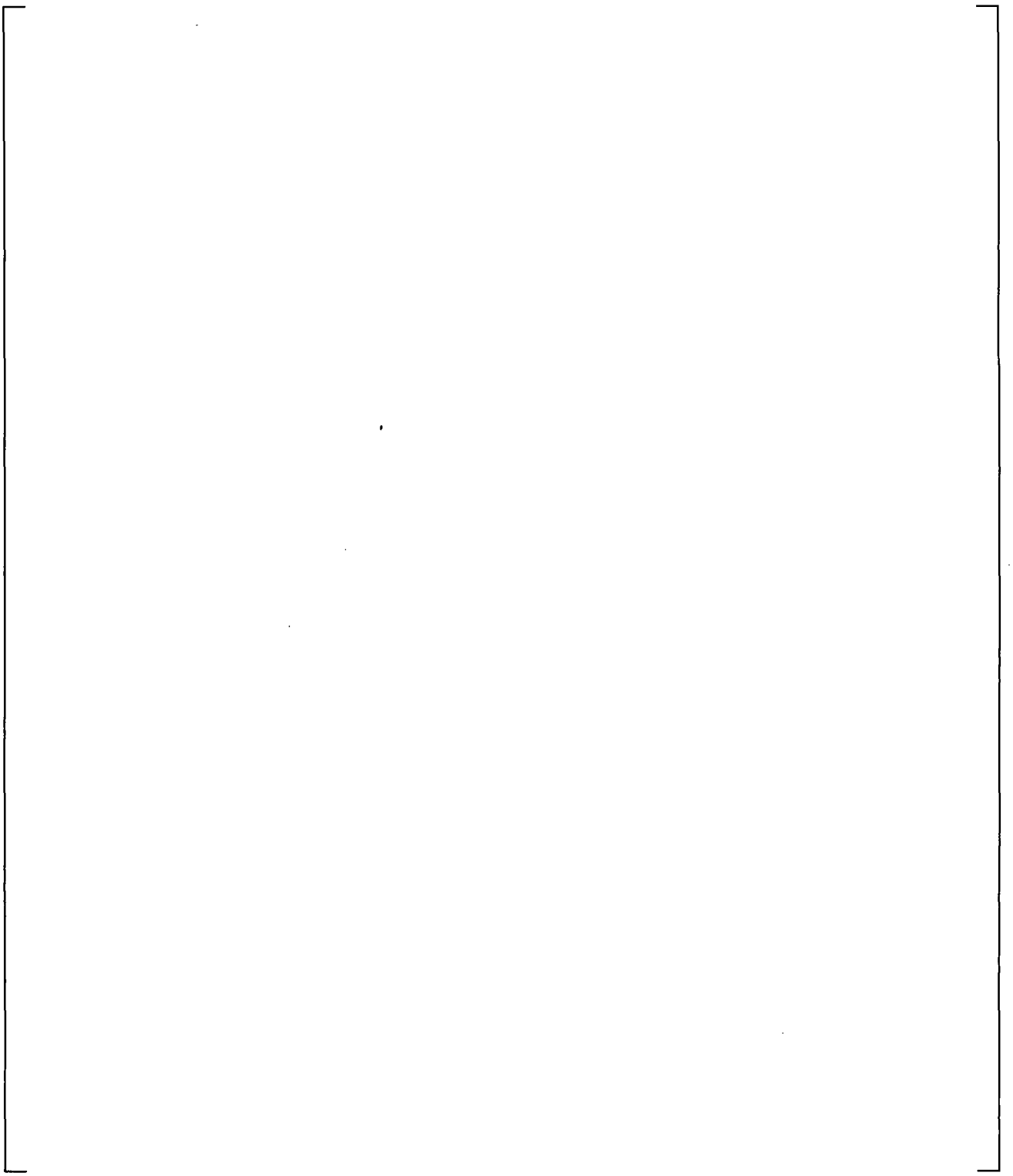

Figure 6.4-78. [ ]a,c

6.4.2.14 EQLR-124

Figures 6.4-79 through 6.4-81 provide the comparison of the WBT OBE amplified RRS to the qualified OBE levels from EQLR-124 (Reference 51) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

Figures 6.4-82 through 6.4-84 provide the comparison of the WBT SSE amplified RRS to the qualified SSE levels from EQLR-124 (Reference 50) in each principal direction (Side to Side vs. North to South, Front to Back vs. East to West, and Vertical vs. Vertical, respectively).

As shown in Figures 6.4-79 through 6.4-84, the qualified OBE and SSE levels envelop the WBT OBE and SSE North to South and East to West amplified RRS and the Vertical RRS.

a,c

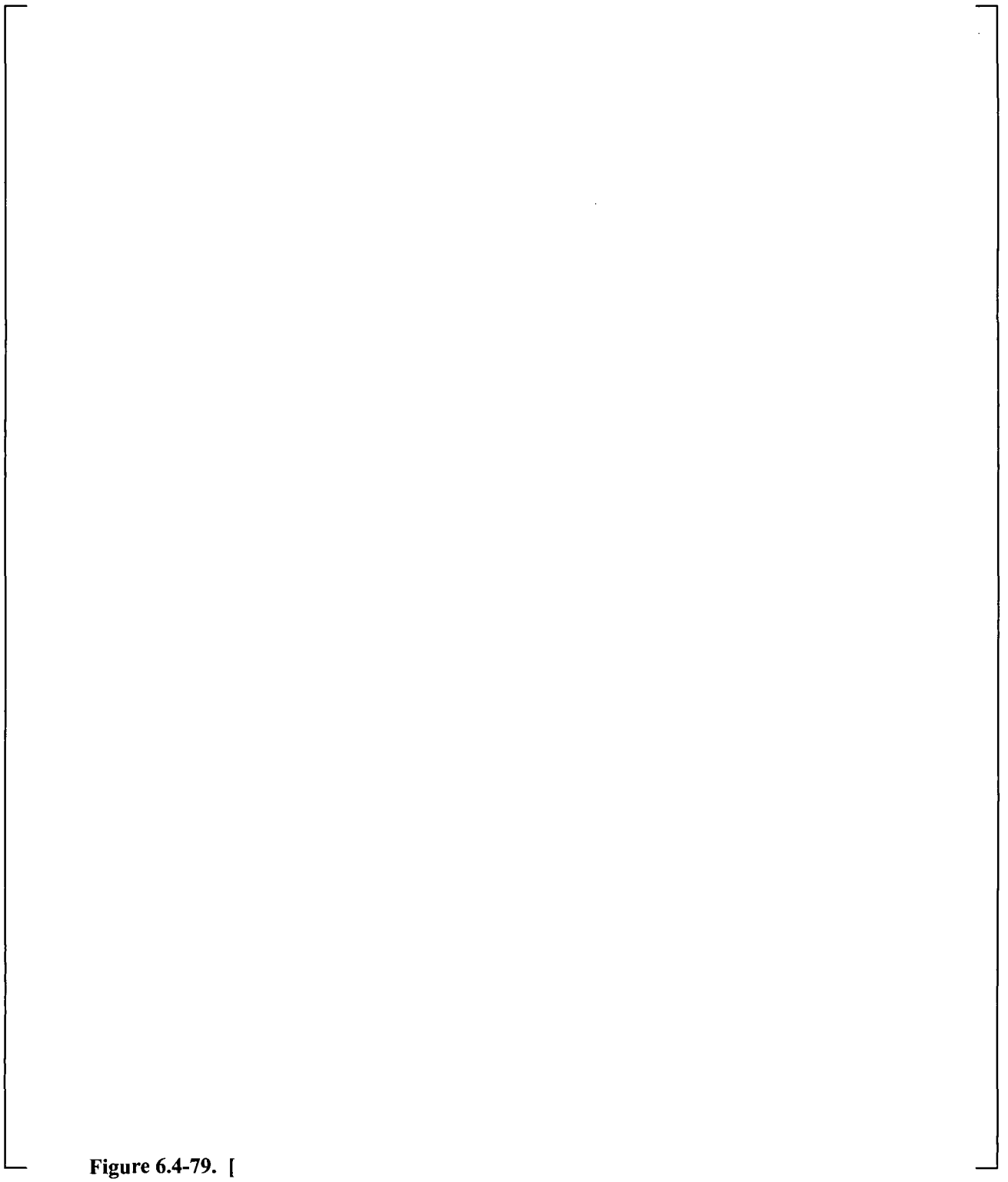

Figure 6.4-79. [

]a,c

a,c

[

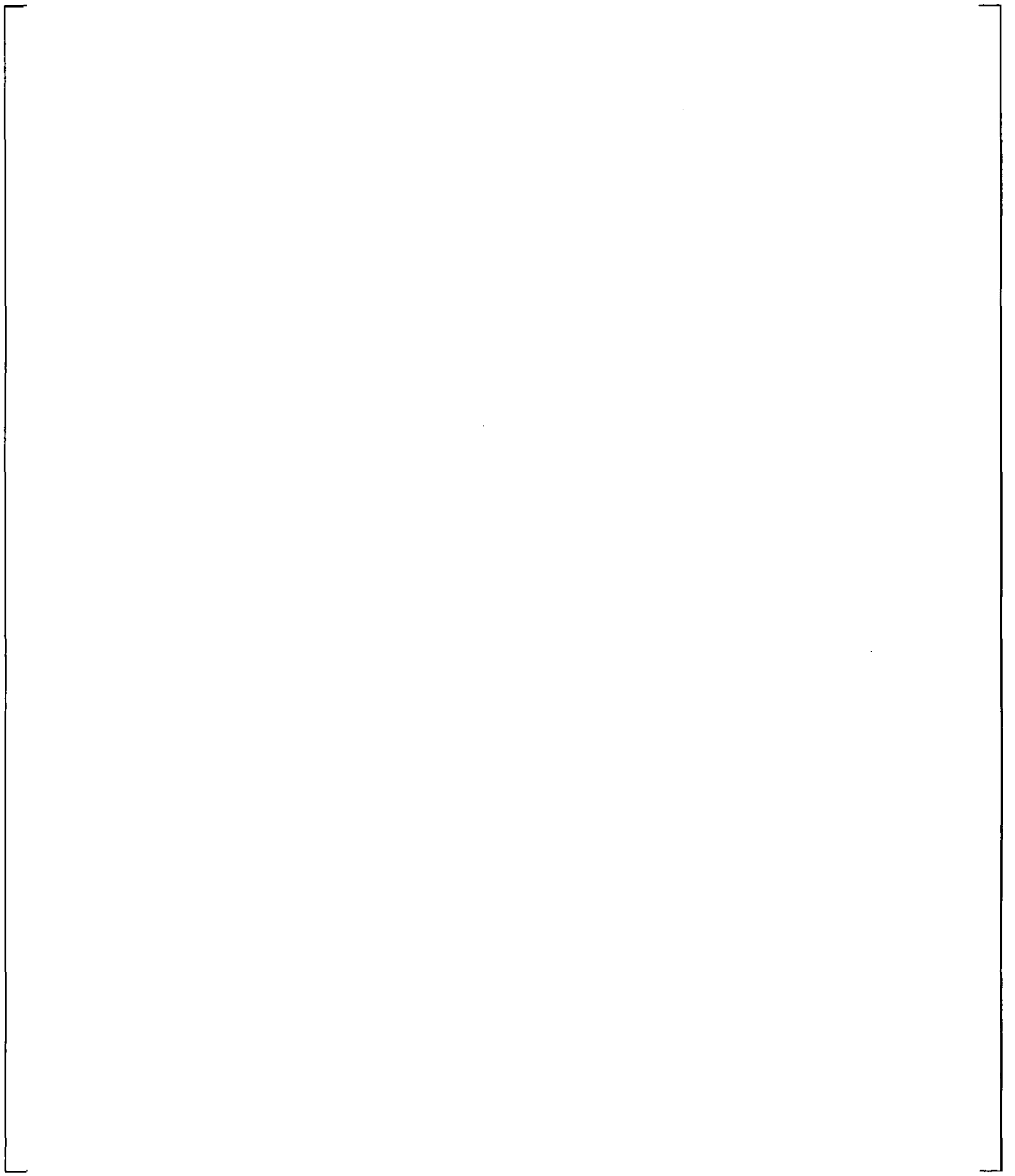

Figure 6.4-80. [

]a,c

a,c

[

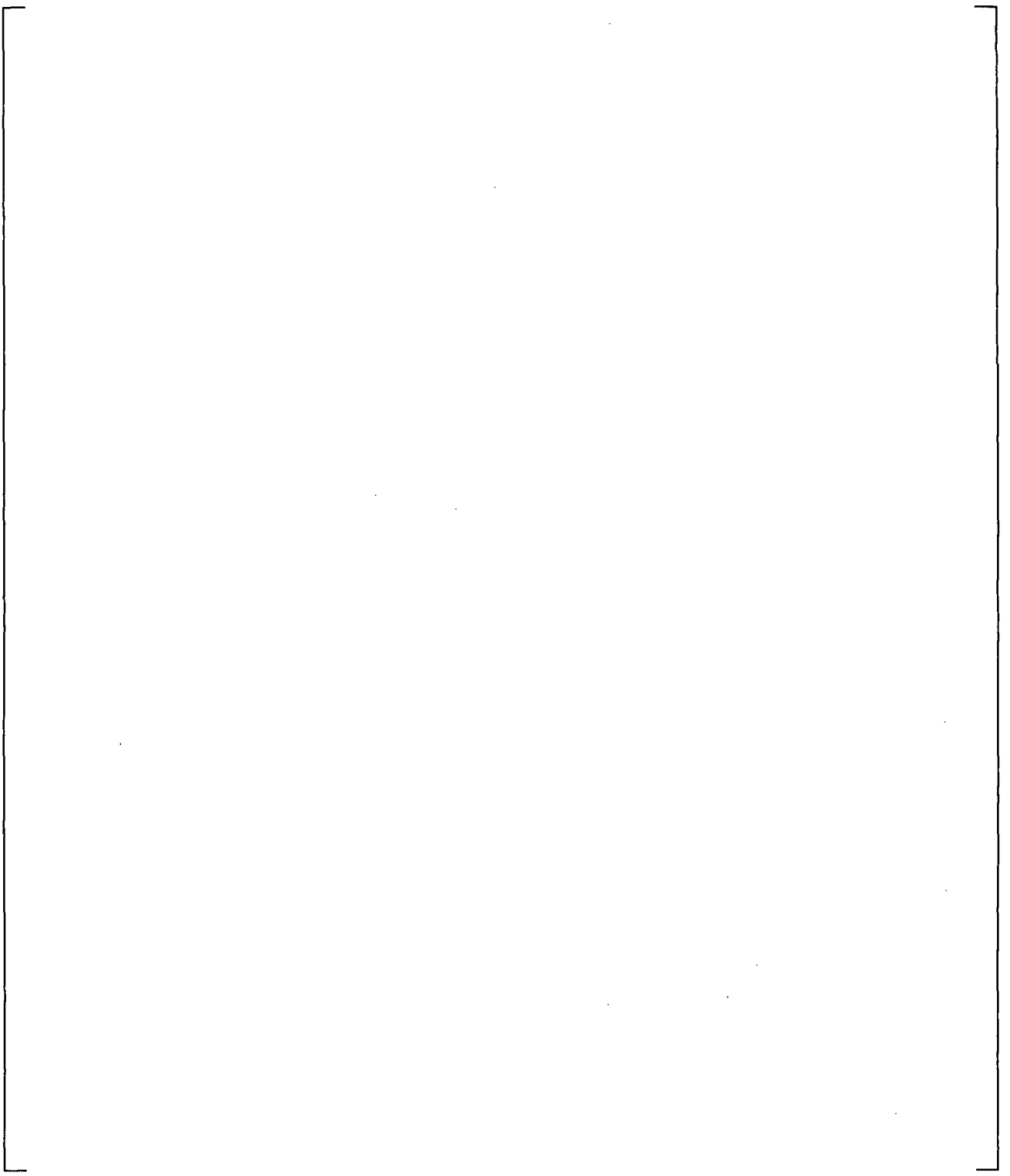

Figure 6.4-81. [

]a,c

a,c

[

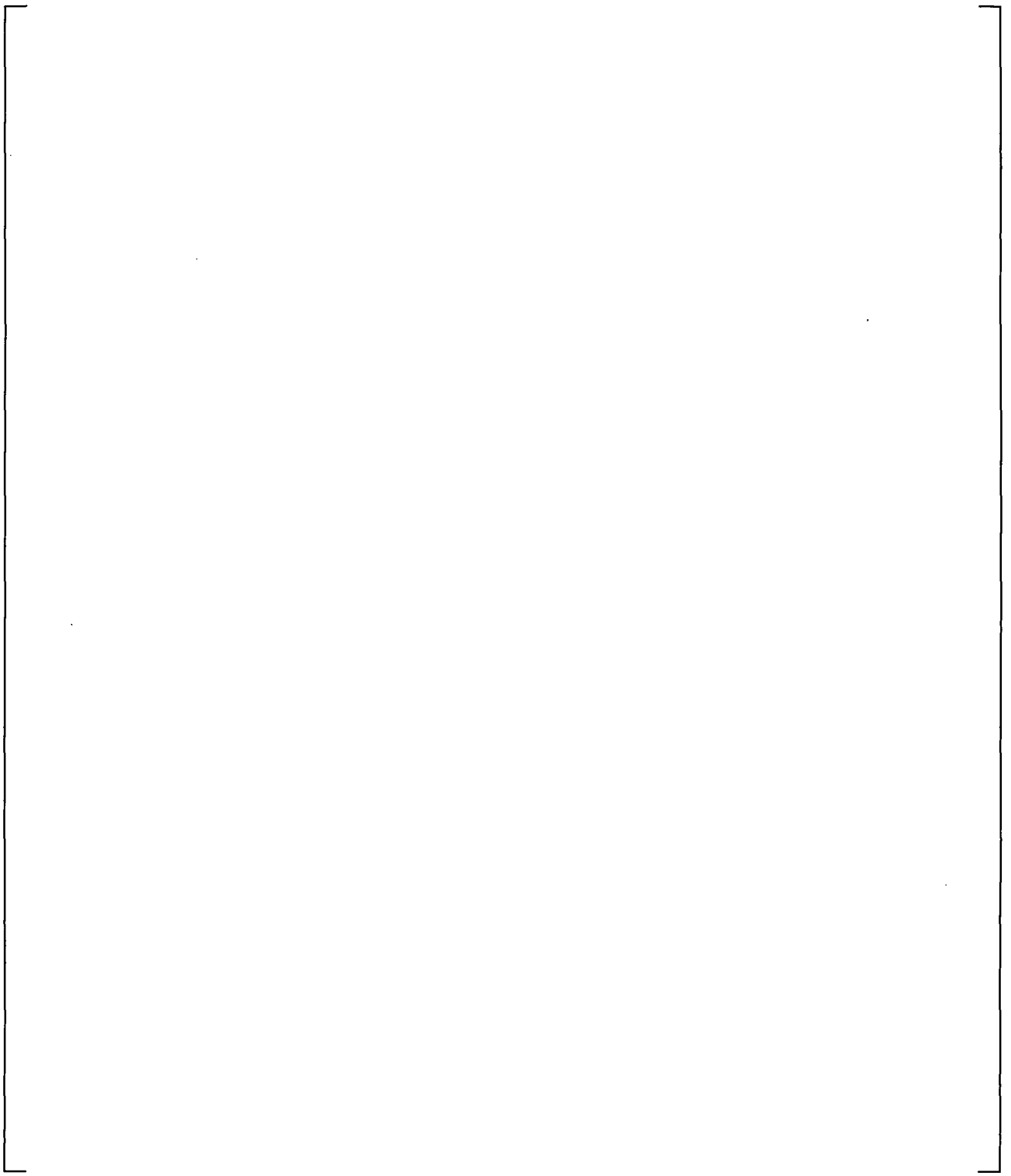

Figure 6.4-82. [

]a,c

a,c

[

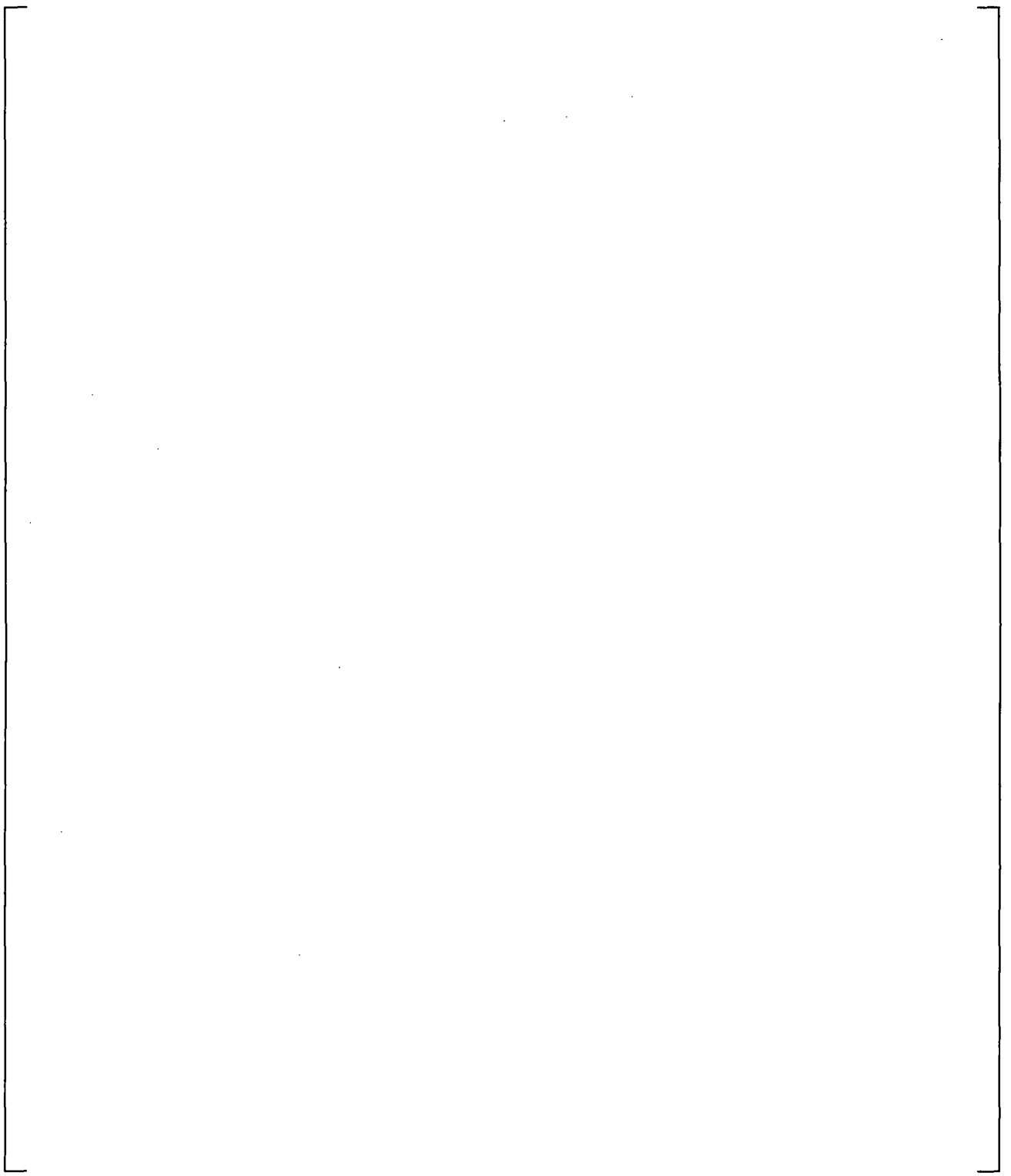

Figure 6.4-83. [

]a,c

a,c

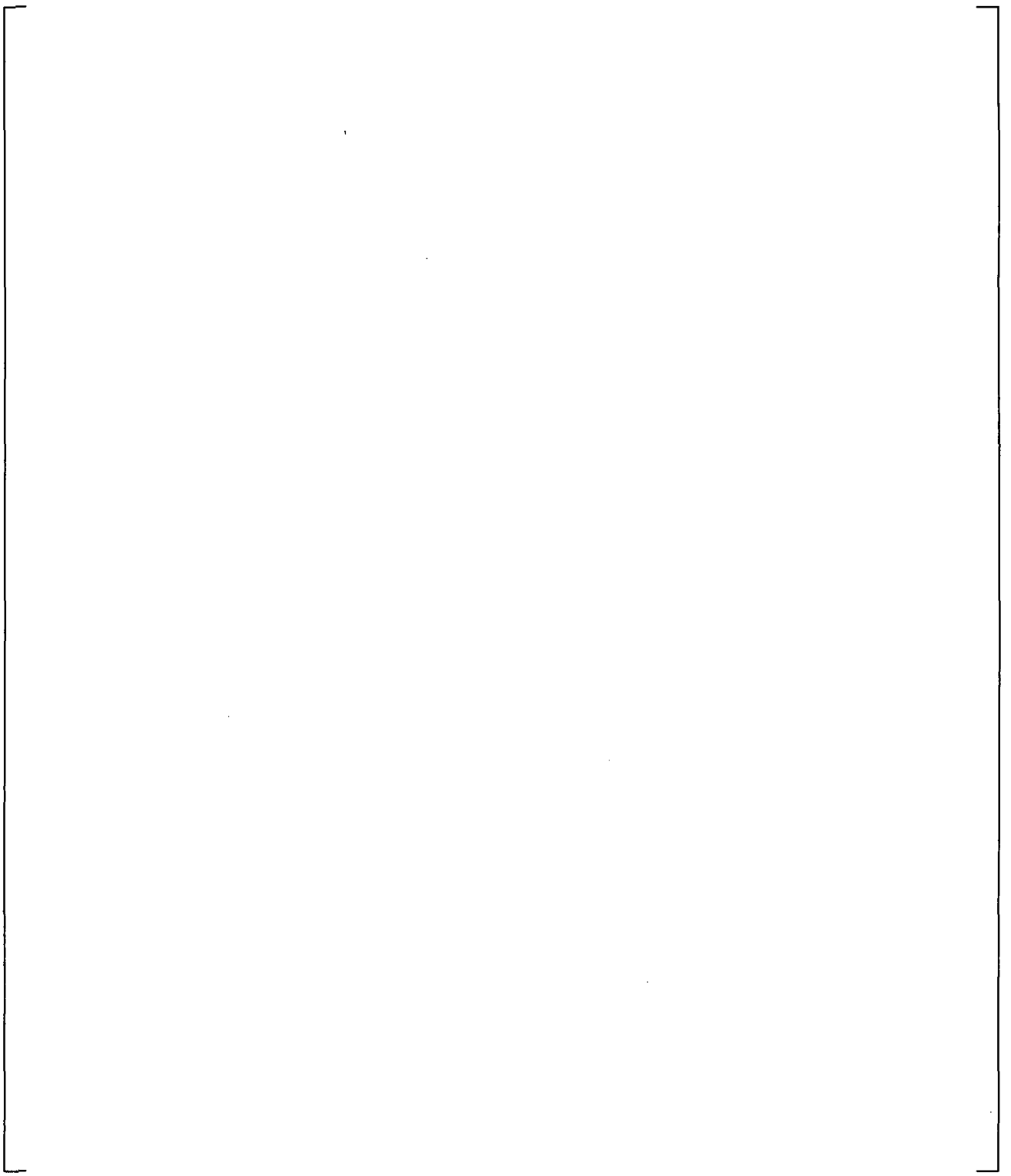

Figure 6.4-84. [

]a,c

6.4.3 Mounting Evaluation of the Equipment Housed in the WBT PAMS Cabinet

To demonstrate the equipment housed within the WBT PAMS cabinet maintains structural integrity in accordance with the requirements of IEEE Std 344-1975 (Reference 13), the mounting of WBT PAMS cabinet components were compared to the as-tested component mounting configurations.

[

]^{a,c}

The mounting of the WBT PAMS cabinet components maintain structural integrity in accordance with the requirements of IEEE Standard 344-1975 (Reference 13) when subjected to the maximum amplified acceleration of the WBT PAMS cabinet. [

]^{a,c}

6.4.4 Mounting Evaluation of WBT PAMS Cabinet Base

As per drawing 10044E60, "Watts Bar Unit 2 Post Accident Monitoring System (PAMS) Cabinet Outline and Installation" (Reference 43) which details the WBT PAMS cabinet installation options, the cabinet base can be welded to the floor embedment (supplied by the customer) which will be secured to the concrete floor with appropriate hardware (also supplied by the customer), or bolted to the floor embedment. The welding and bolting patterns identified in 10044E60 (Reference 43) are identical to those found in the standard 7721 cabinet outline and assembly drawing 3D91662, "Standard 7721 Seismic Cabinet Outline & Installation" (Reference 44). Both patterns were evaluated as documented in the following subsections.

6.4.4.1 Evaluation of WBT PAMS Cabinet Base Welding Pattern

[

]^{a,c}

[

]a,c

Therefore, mounting of the WBT PAMS cabinet base according to the welding pattern defined in 10044E60 (Reference 43) is seismically qualified.

6.4.4.2 Evaluation of WBT PAMS Cabinet Base Bolting Pattern

[

]a,c

Therefore, mounting of the WBT PAMS cabinet base according to the bolting pattern defined in 10044E60 (Reference 43) is seismically qualified.

6.4.5 Qualified Seismic Levels of the WBT PAMS OM Assembly Components

Table 6.1-2 identifies various seismic test programs that provide the seismic qualification basis for the OM components; these programs are documented in LTR-EMPE-03-26 (Reference 27), EQLR-159 (Reference 31), EQLR-168 (Reference 32), and EL:6681 (Reference 36).

The qualified OBE and SSE levels for the OM are shown in Figures 6.4-85 through 6.4-88. Westinghouse is not responsible for the installation of the OM equipment to the MCB. Therefore, the comparison of the OM qualified OBE and SSE levels to the WBT OBE and SSE FRS for the Watts Bar Control Building at Elevation 755.00 feet, which are presented in Section 4.3, or an amplified RRS that would represent the location at which the OM is mounted to the MCB is out of the scope of this report. However, the qualified mounting configuration(s) of each OM component is provided in Section 7.1.

a,c

[

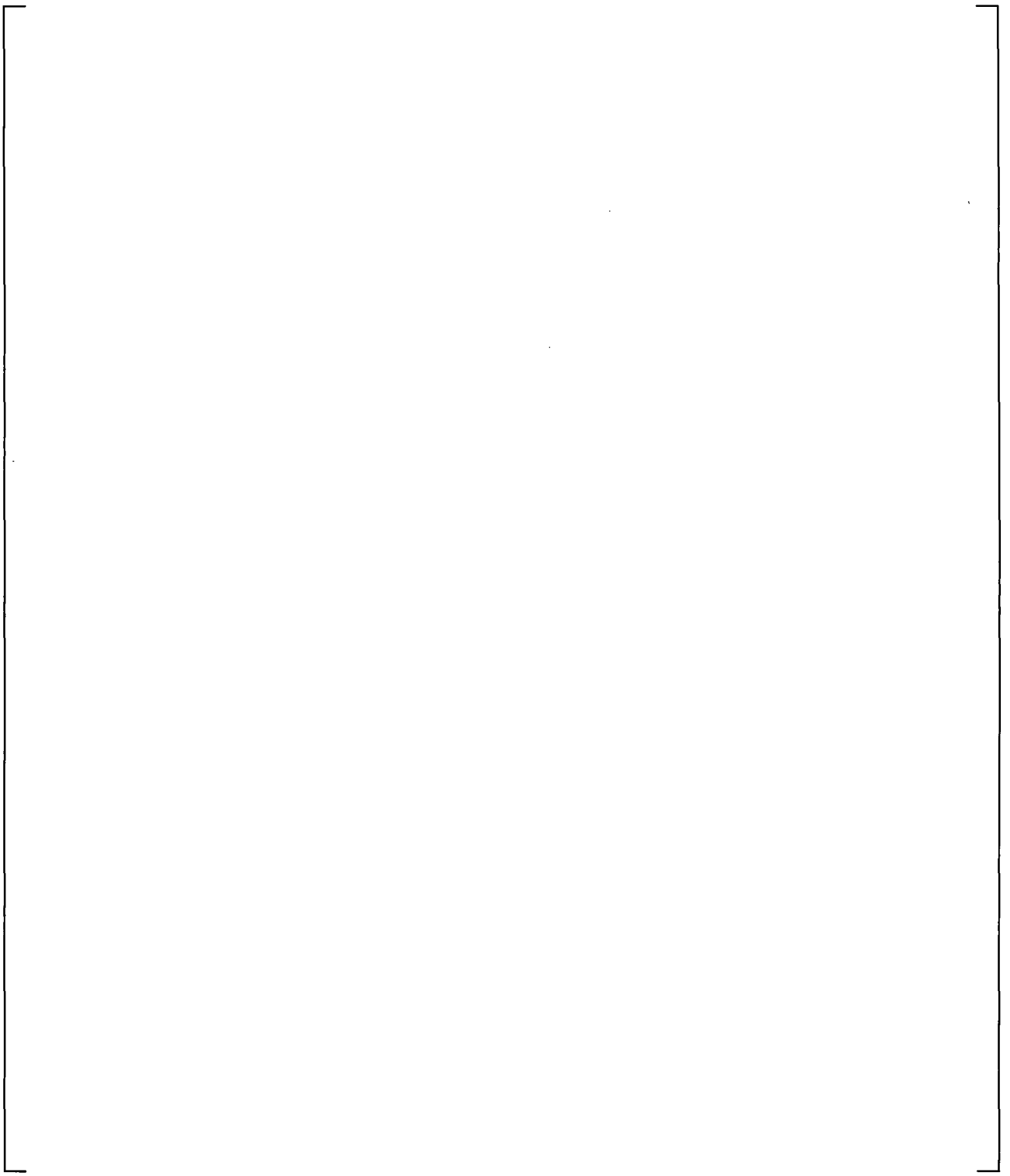

Figure 6.4-85. [ ]^a,c

a,c

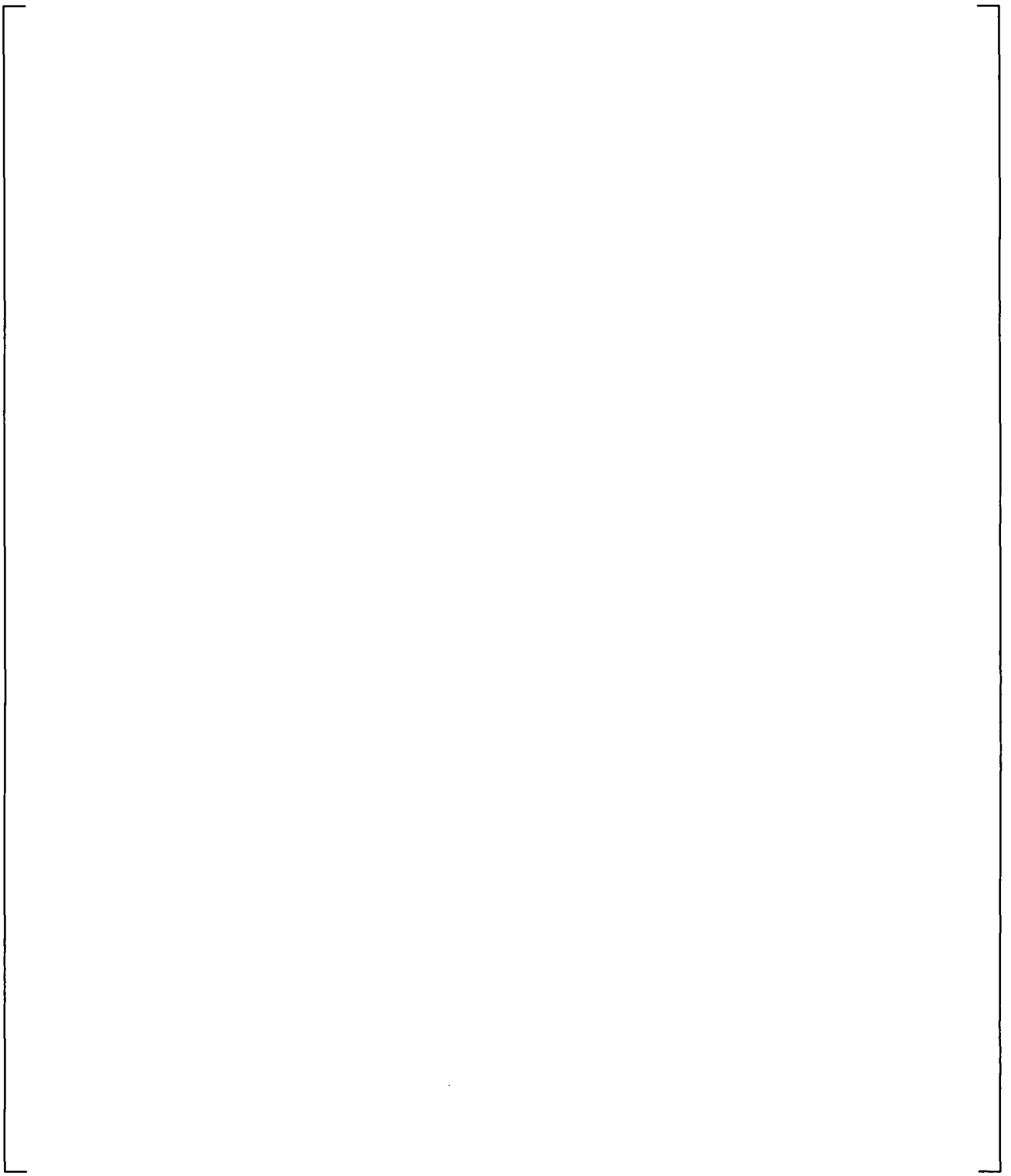

Figure 6.4-86. [ ]a,c

a,c

[

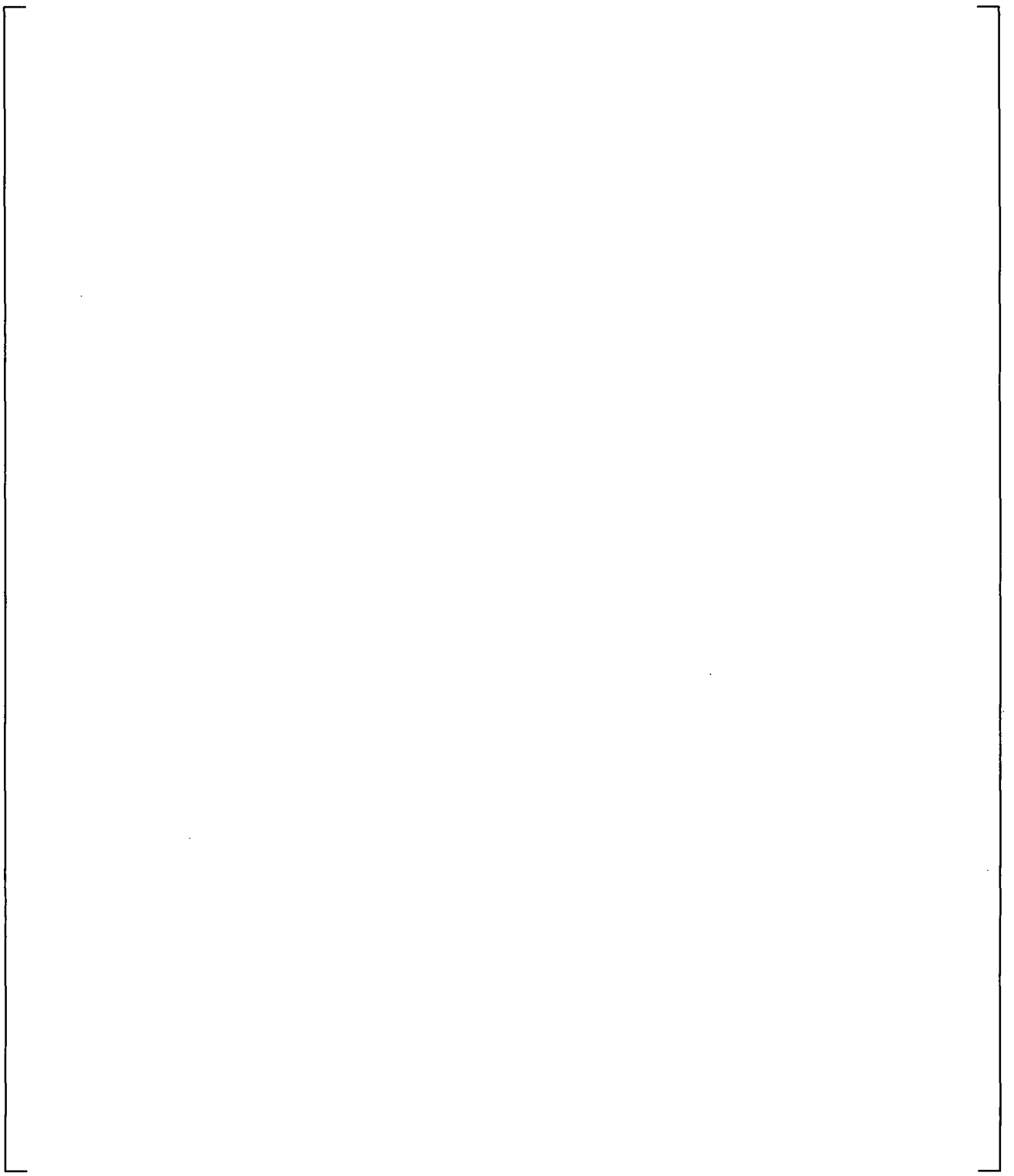

Figure 6.4-87. [ ]^{a,c}

a,c

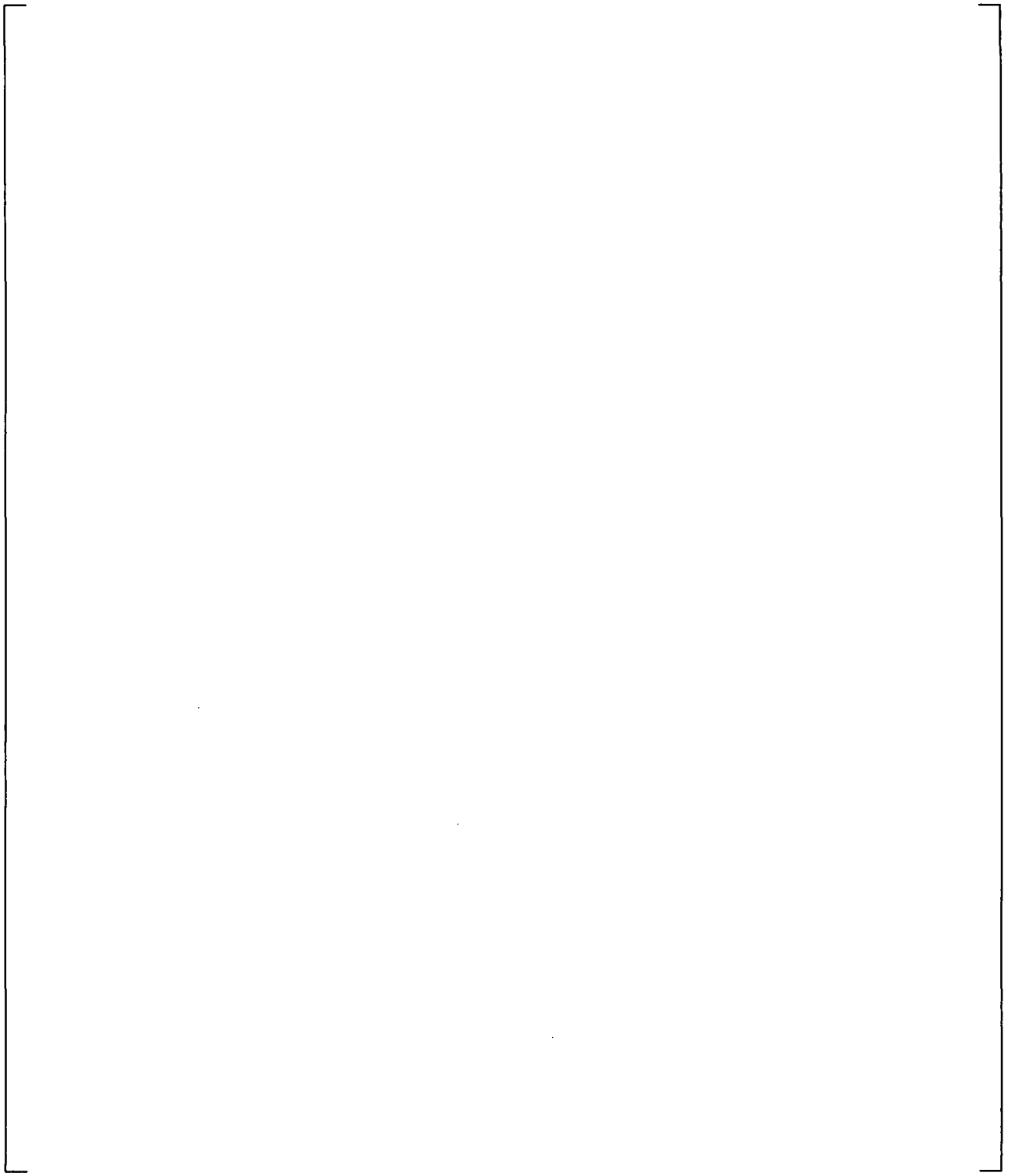

Figure 6.4-88. [**]**[a,c]**

(Last Page of Section 6)

SECTION 7
INSTALLATION REQUIREMENTS AND MAINTENANCE, SURVEILLANCE, AND REPLACEMENT PROGRAM

7.1 EQUIPMENT INTERFACE/BOUNDARY CONDITIONS

The equipment interface/boundary condition requirements for the WBT PAMS cabinet is based on the outline and installation Drawing 10044E60 (Reference 43).

The equipment interface/boundary condition requirements for the WBT PAMS OM equipment are based on the testing and analysis herein and are provided below:

[

]^{a,c}

[

]a,c

All other mounting configurations must be analyzed prior to use.

7.2 INSTALLATION LIMITATIONS

The following limitations and restrictions must be followed for the qualified use of the equipment on the basis of the test program recorded in this document:

[

]a,c

[

]a,c

7.3 MAINTENANCE, SURVEILLANCE, AND REPLACEMENT PROGRAM

There are no maintenance, surveillance, or replacement requirements defined as a result of the equipment qualification program.

(Last Page of Section 7)

SECTION 8
SUMMARY AND CONCLUSIONS

The qualification testing performed on the AC160/Common Q hardware demonstrates that the WBT PAMS equipment is EMC, environmentally and seismically qualified for the WBT Class 1E application per the guidance contained in IEEE Standards 323-1983 and 344-1975 (References 10 and 13, respectively). The equipment has also demonstrated EMI/EMC compatibility for safety application in nuclear power plants according to the guidance provided in U.S. NRC Regulatory Guide 1.180, Rev. 1 (Reference 7) for emissions and susceptibility. The equipment has also demonstrated the ESD susceptibility requirements of EPRI TR-102323 (Reference 8).

Note that Westinghouse was not responsible for the installation of the OM equipment. Therefore, determining if the OM equipment is seismically qualified to the WBT seismic qualification requirements for the OM equipment locations is not in the scope of this report. However, this report does contain the seismic levels that the OM equipment is qualified to and the mounting configurations that the qualification is based upon.

(Last Page of Section 8)