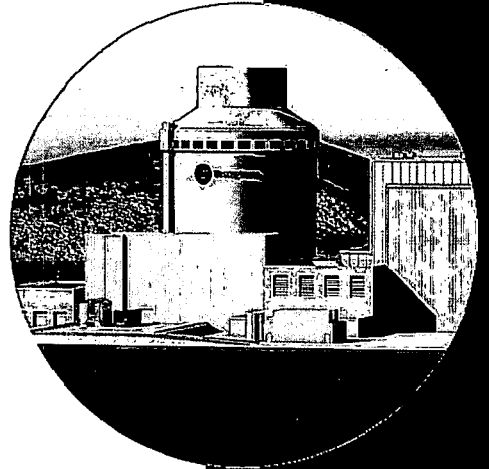


WESTINGHOUSE NON-PROPRIETARY CLASS 3



APP-1200-S3R-003
Revision 1

Design Report for the AP1000 Enhanced Shield Building



March 22, 2010



SECURITY-RELATED INFORMATION – WITHHOLD UNDER 10 CFR 2.390(d)

Westinghouse Non-Proprietary Class 3

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This document contains sensitive unclassified non-safeguards information (SUNSI) related to the physical protection of an AP1000 Nuclear Plant. SUNSI information should be withheld from public disclosure pursuant to 10 CFR 2.390(d).

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ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWS	American Welding Society
CFR	Code of Federal Regulations
CO	carbon monoxide
CV	containment vessel
D2L	deformed bar anchor
DCD	Design Control Document
EEDM	earthquake energy dissipating mechanism
EPRI	Electric Power Research Institute
FME	foreign material exclusion
FFT	fast Fourier transform
FR	Federal Register
GD&T	geometric dimensioning and tolerance
GDC	General Design Criteria
GPR	ground penetrating radar
GRT	gamma radiography
HCLPF	high confidence of low probability of failure
HVAC	heating, ventilating, and air conditioning
IAEA	International Atomic Energy Agency
ICC	International Code Council
ITAAC	Inspections, Tests, Analyses, and Acceptance Criteria
IEM	impact-echo method
IMI	Irving Materials, Inc.
IP	in plane
IR	impulse response
IRT	infrared thermal imaging
JEAG	Japanese Electric Association Nuclear Standards Committee
kN	kilonewton
ksi	kips per square inch
LS-DYNA	Livermore Software- Design Analysis
LVDT	linear variable differential transformer
MN	meganewton
MPa	megapascal
MSIV	main steam isolation valve
MTR	mill test report
NCHRP	National Cooperative Highway Research Program
NDE	nondestructive examination
NDT	nondestructive testing
NRC	U.S. Nuclear Regulatory Commission

ACRONYMS AND ABBREVIATIONS (cont.)

NUREG	Nuclear Regulatory Commission regulation
OC	on center
OOP	out of plane
PCCWST	primary containment cooling water storage tank
PCS	passive containment cooling system
PJP	partial joint penetration
PSI	pounds per square inch
QA	quality assurance
QC	quality control
RAI	request for additional information
RC	reinforced concrete
RLE	review level earthquake
RSA	response spectrum analyses
RT	radiography testing
SAFT	synthetic aperture focusing technique
SB	shield building
SBCEP	Shield Building Construction Execution Plan
SC	steel concrete composite
SCC	self-consolidating concrete
SR	stress range
SRSS	square root of the sum of the squares
SSE	safe shutdown earthquake
USW	ultrasonic surface wave
UT	ultrasonic testing
VT	visual inspection
WEC	Westinghouse Electric Company

1 INTRODUCTION

1.1 BACKGROUND

The original certified AP1000™ Shield Building was a reinforced concrete design. In response to the new regulatory enhanced aircraft impact design requirements (see 74 FR 28112), it was necessary to modify the AP1000 Shield Building design for the portion of the Shield Building that is not protected from external hazards by the Auxiliary Building. Therefore, the unprotected Shield Building structure was changed from a reinforced concrete (RC) structure to an enhanced (strengthened) steel concrete composite (SC) structure.

As a result of this change, Westinghouse submitted its report titled, “Design for the Enhanced Shield Building” (APP-1200-S3R-003), to the NRC staff for review on August 31, 2009. This report provided an integrated presentation of the enhanced Shield Building design methodology, analysis, AP1000 testing, constructability, and inspection. In addition, this report described the loading due to seismic, thermal, dead, live, and weather-related loads, including tornado and tornado missiles.

In response to the report, the NRC provided the following notes on October 15, 2009, to Westinghouse: “The U.S. Nuclear Regulatory Commission (NRC) has completed its review of that report. Based on that report and the body of technical information reviewed to date, the NRC has determined that the proposed design of the shield building will require modifications in some specific areas to ensure its ability to perform its safety function under design basis loading conditions and to support a finding that it will meet applicable regulations (i.e., 10 CFR 50.55a and 10 CFR Part 50, Appendix A [GDC 1 and 2]).”

Specifically, the NRC also indicated that the design of the SC structural module must demonstrate the ability to function as a unit during design basis events; the design of the connection of the SC module to the RC wall sections of the Shield Building must demonstrate the ability to function during design basis events; and the design of the Shield Building tension ring girder, which anchors the Shield Building roof to the wall, must be supported by either a AP1000 test or a validated (or benchmarked) analysis. The NRC staff concluded that the design report (APP-1200-S3R-003) did not provide sufficient information on the Shield Building design with respect to detailing, design, analysis, testing, and construction and inspection to demonstrate that it will perform its intended safety function under design loads.

As a result of the NRC review and findings of the enhanced Shield Building outlined in the October 15, 2009, letter, Westinghouse reassessed the design and its design approach and has developed an integrated design approach to the AP1000 enhanced Shield Building that addresses NRC concerns. This integrated design approach has resulted in revisions to the design, analysis, and testing that Westinghouse will use to demonstrate that the Shield Building structural components are integrated as a complete structure and act as a single unit to perform the intended safety function under design basis loads.

Following the NRC letter, there was a series of meetings with Westinghouse and the NRC. These meetings were held on November 18, 2009, December 21-22, 2009, January 28-29, 2010, and February 23, 2010. The purpose of the meetings was for Westinghouse to describe the integrated design process being implemented to demonstrate that the AP1000 Shield Building enhanced design meets the challenges of safety and durability throughout its design life. In these meetings Westinghouse described

the design modifications incorporated into the Shield Building to address the NRC concerns, including those changes that provide for the building to act as a single unit during a design basis event. The design details of the RC/SC connections also were discussed as to their ductility and strength following design basis and beyond design basis events. The integrated Shield Building structure with the key areas of interest are shown in Figure 1.1-1.

Additionally, a test program was described that would be developed and completed to confirm the behavior of the SC design. A series of nonlinear benchmark analyses were discussed that would be performed to demonstrate the conservatism inherent in the enhanced Shield Building design. Finally, Westinghouse described the construction mockup program for the RC/SC connections and the air intakes to verify the placement procedures and the inspection techniques to confirm proper construction and the long-term safety for the design life of the Shield Building.

In order to implement the revised design effort described to the NRC in the meetings, Westinghouse implemented an integrated design process and supplemented its design team with a peer review team consisting of additional outside industry experts that included members from The Shaw Group, Inc., Purdue University, URS Corporation, Obayashi Corporation, Ansaldo STS, NuStart and their consultant, Twining Laboratories, and Rutgers University Research.

The overall integrated design process (Figure 1.1-2) depicts each of the elements considered and evaluated to establish the confidence that the design modifications made to the enhanced Shield Building meet the regulatory requirements and the structure functions as a complete unit throughout a design basis event.

This submittal of this Revision 1 to the Design Report for the AP1000 Enhanced Shield Building conveys the completed details of the design modifications, the results of the AP1000 testing completed to date, and a description of the construction methods and inspection techniques for the AP1000 Shield Building. In the near term, Westinghouse will provide the analysis approach and completed analysis results in accordance with the commitments made in the Westinghouse/NRC meetings. Upon submittal of Revision 2 of the Design Report, Westinghouse will have completely addressed and conformed to all of the issues identified in the NRC letter of October 15, 2009.

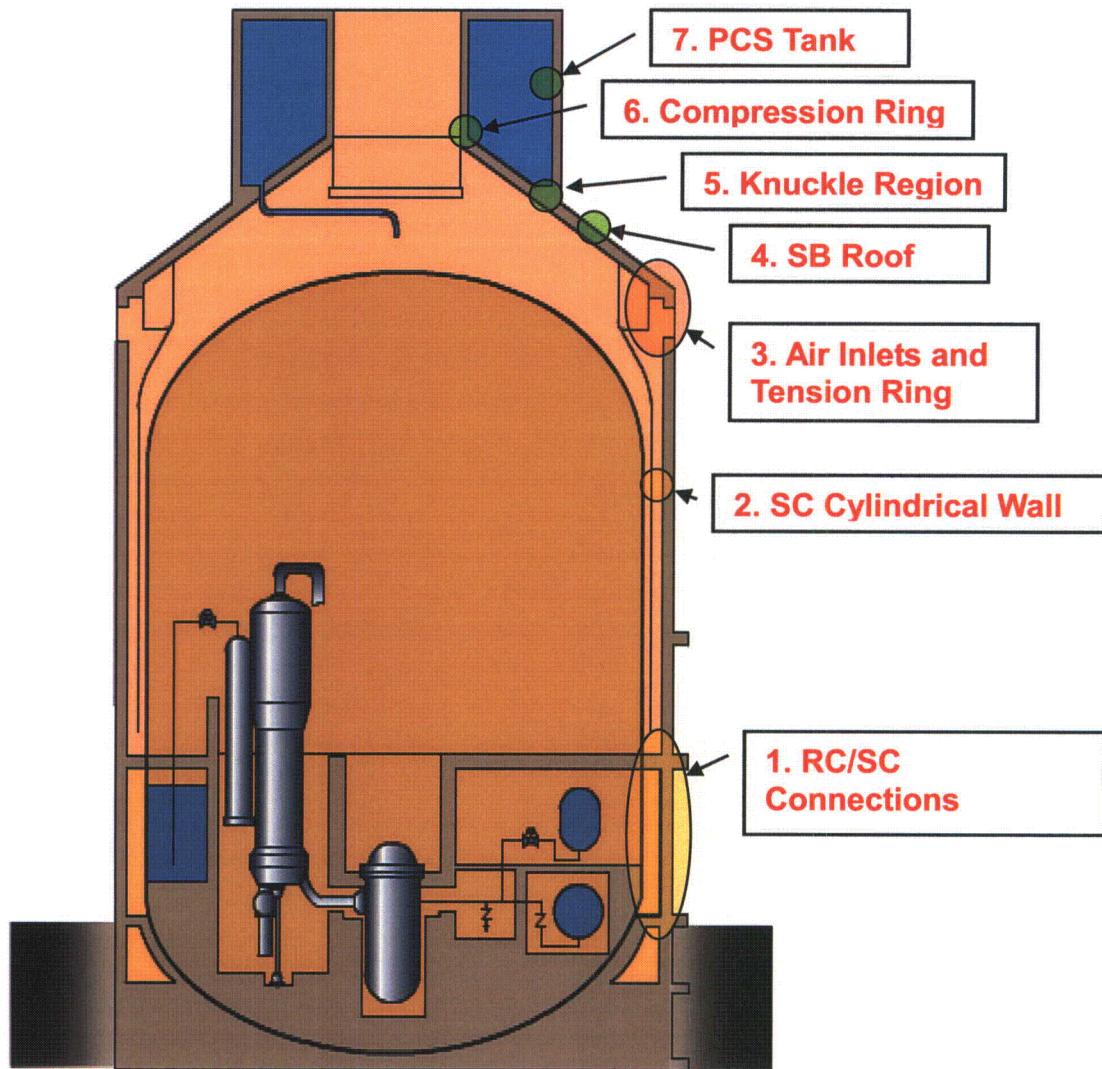


Figure 1.1-1 Shield Building Structure Key Areas

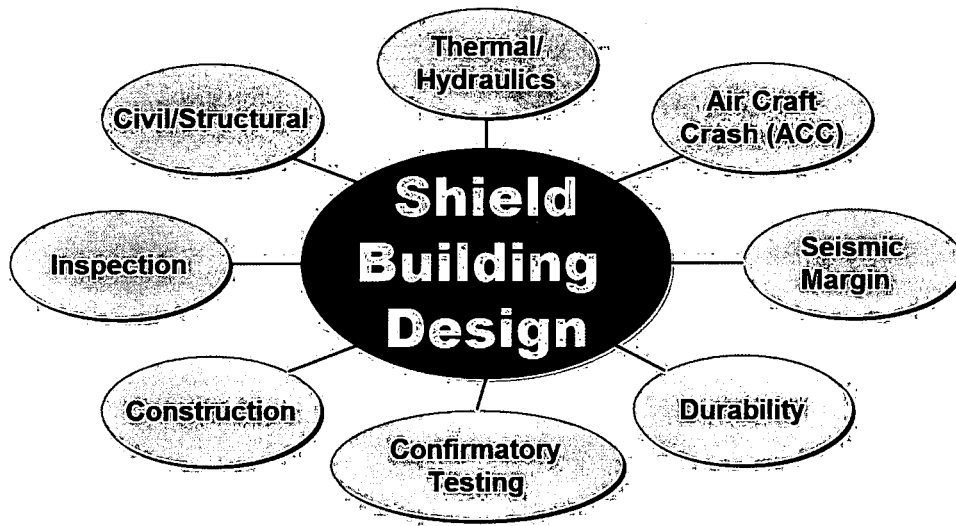
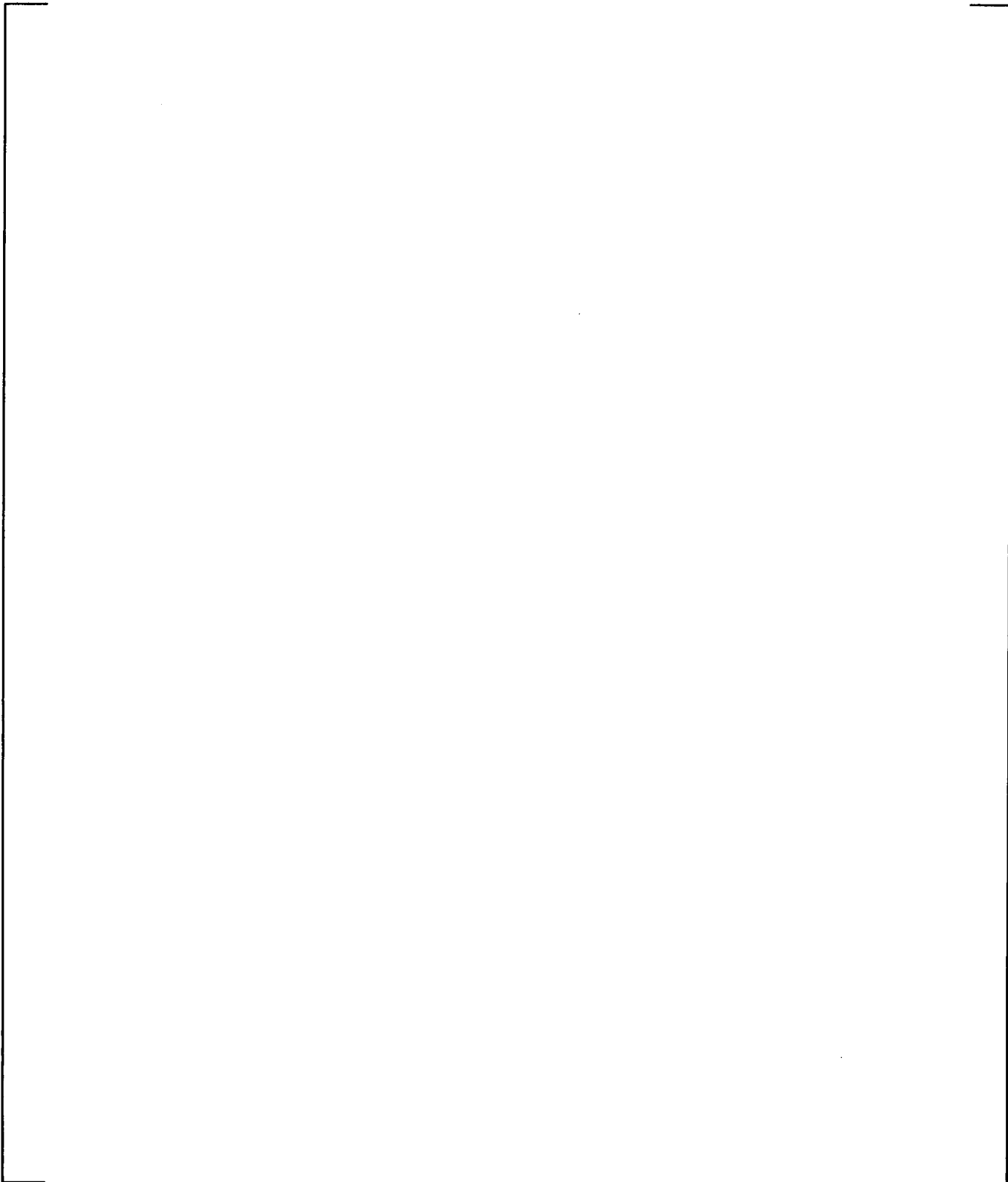
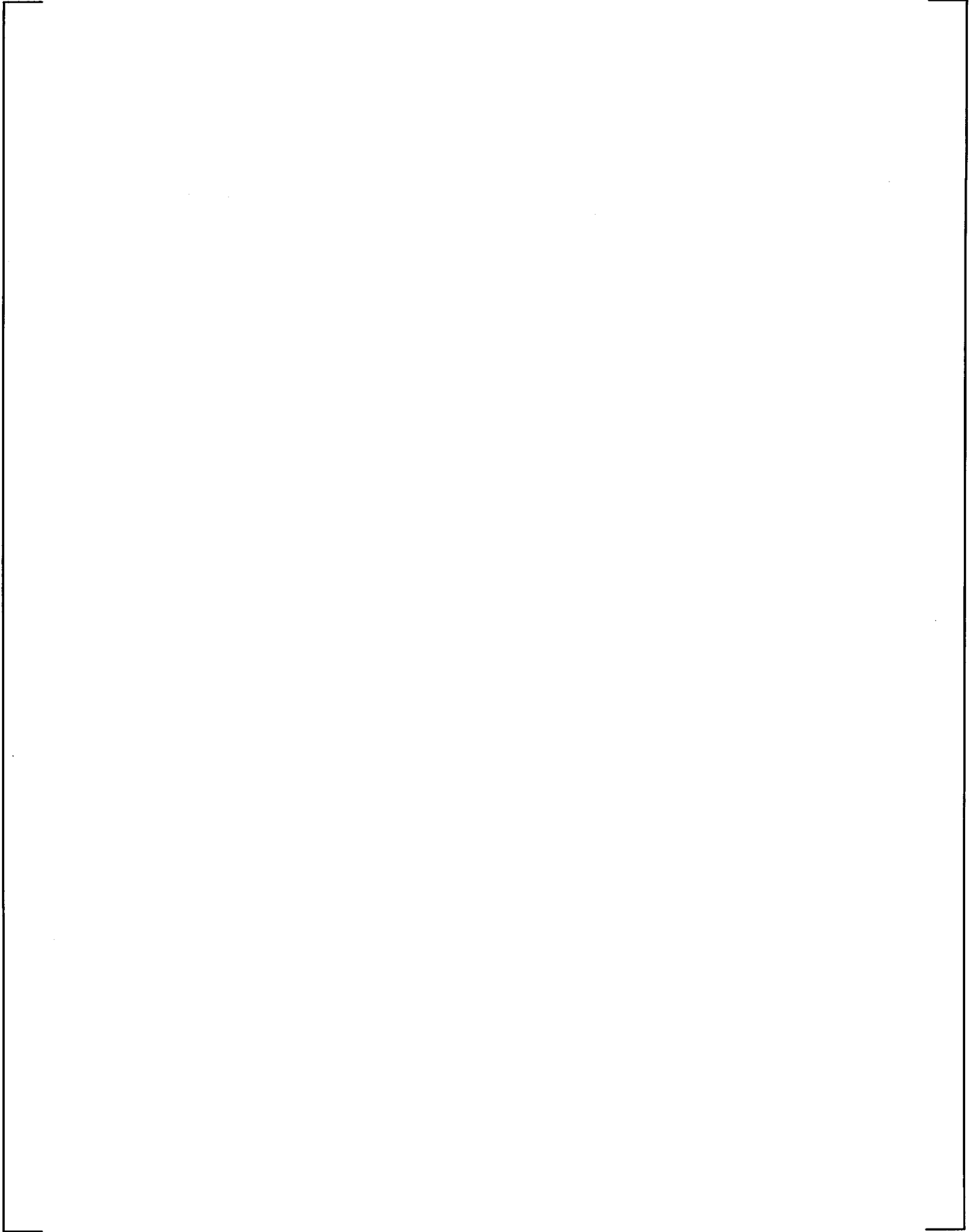


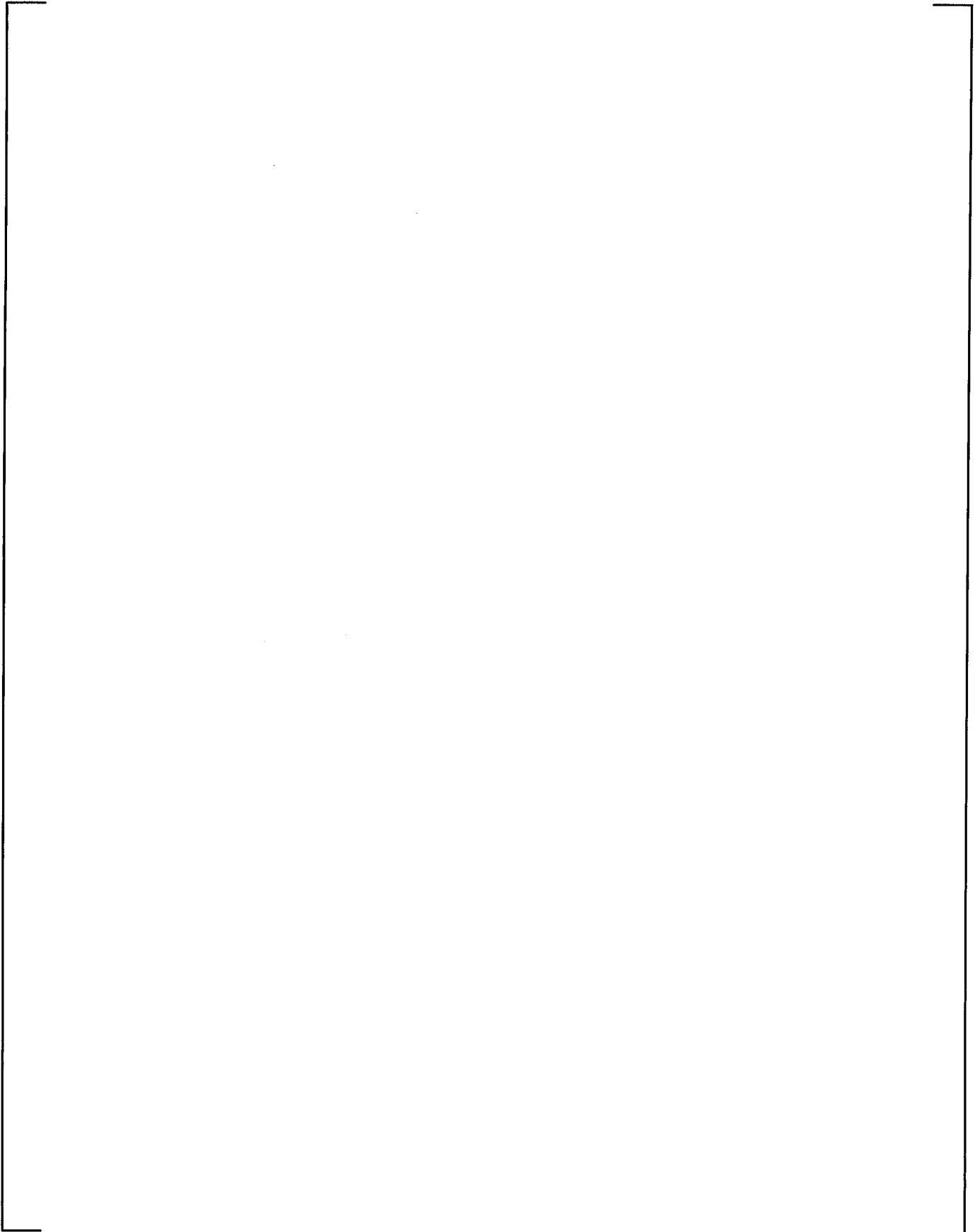
Figure 1.1-2 Shield Building Design Process

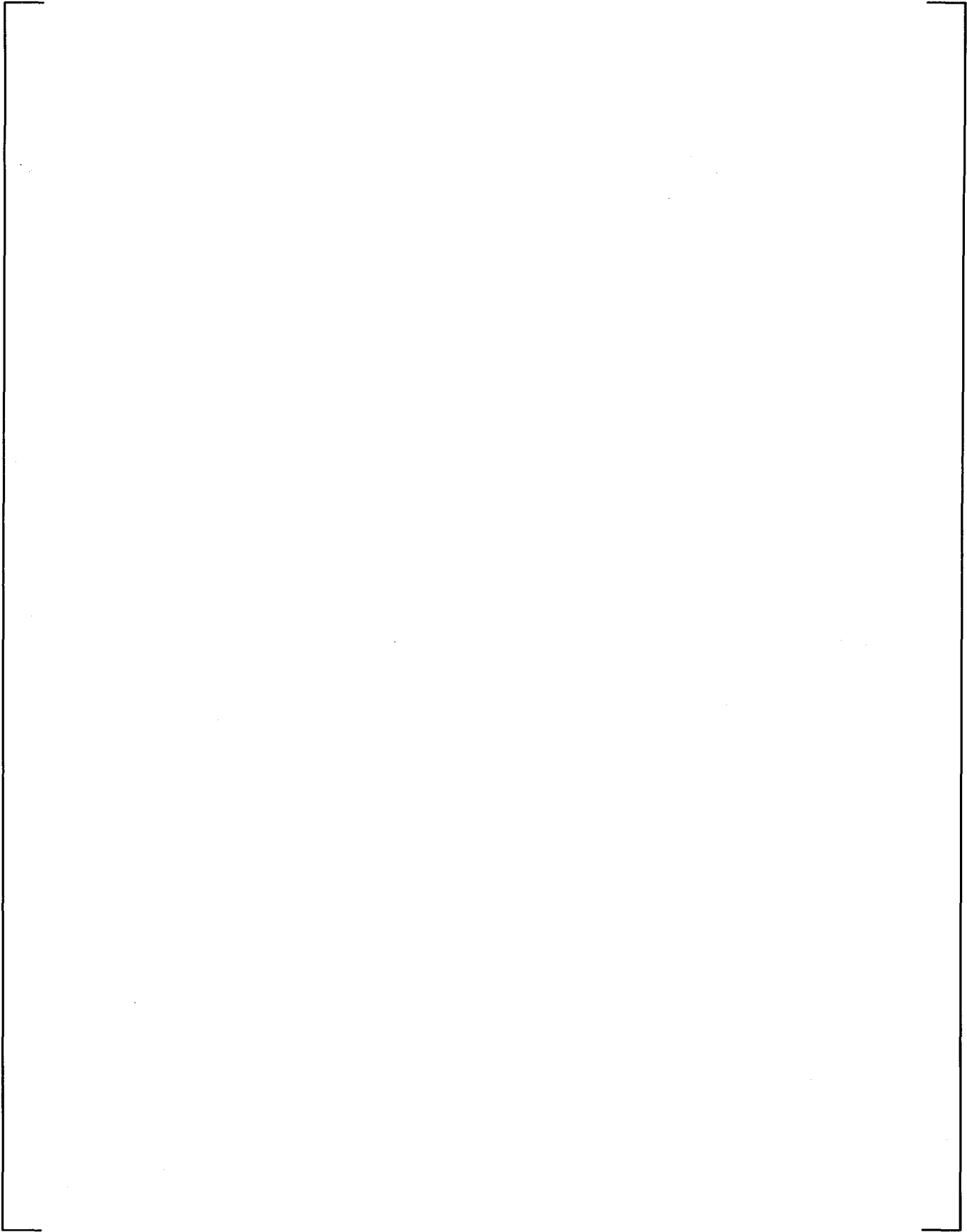
1.2 GENERAL DESCRIPTION OF SHIELD BUILDING

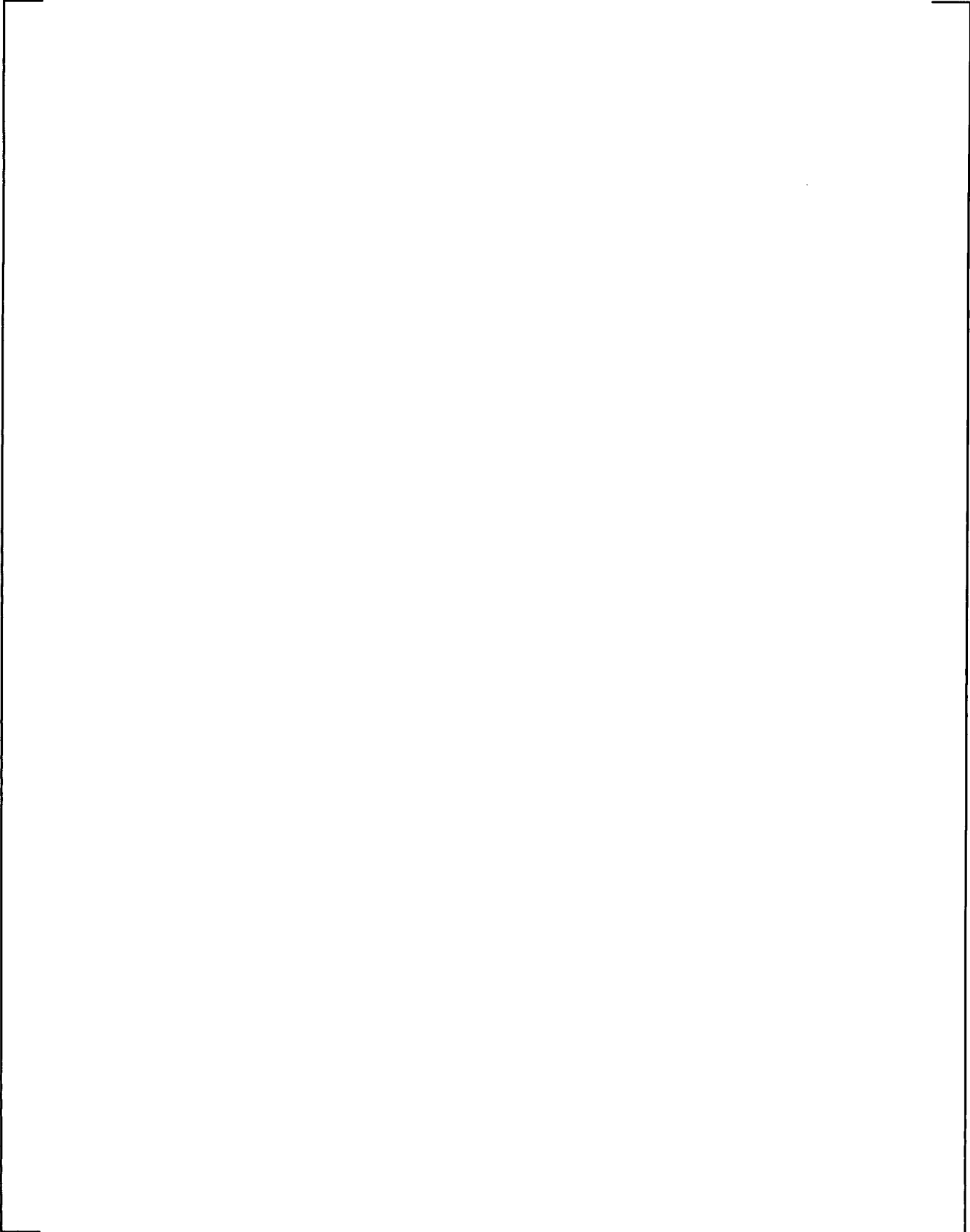
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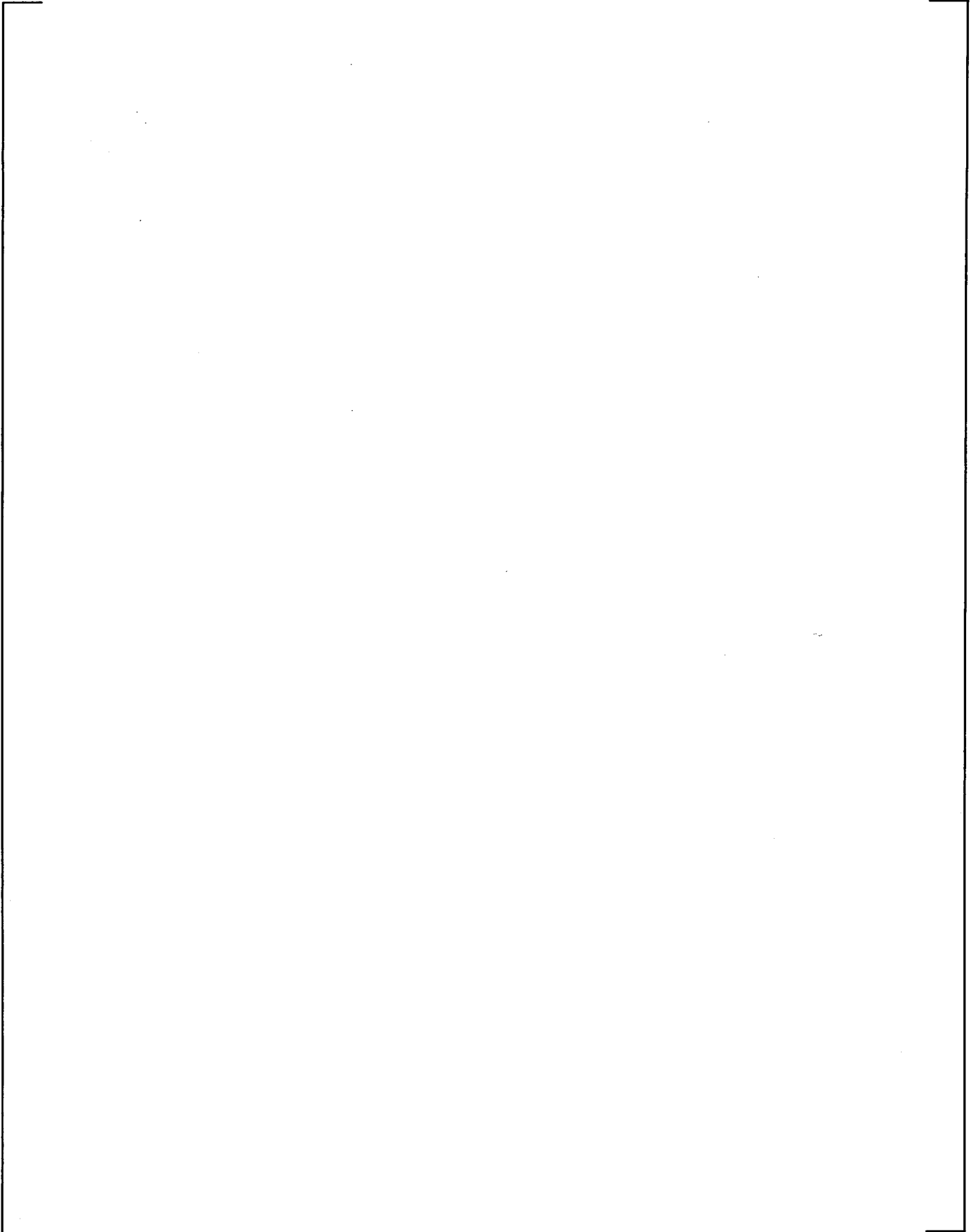


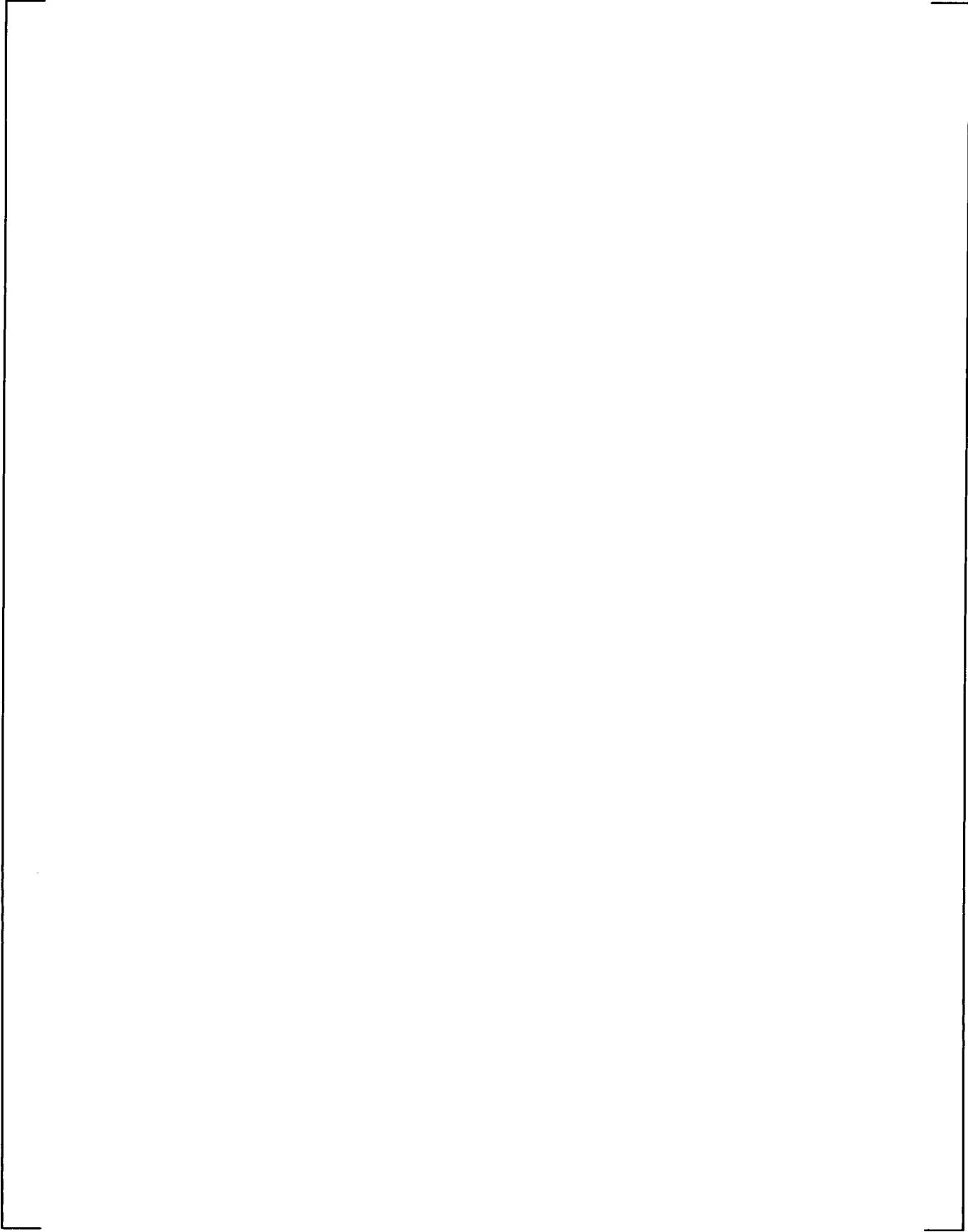


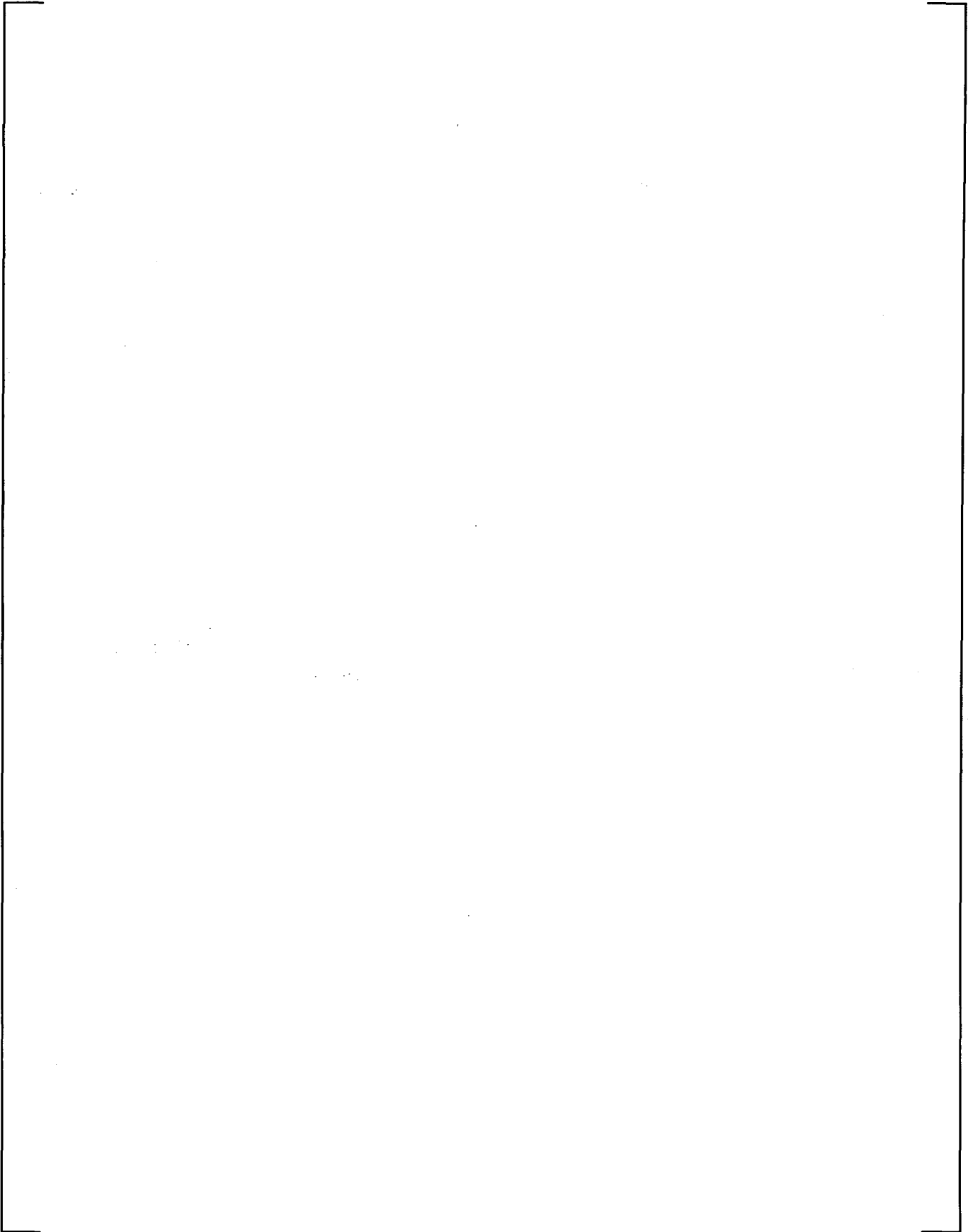


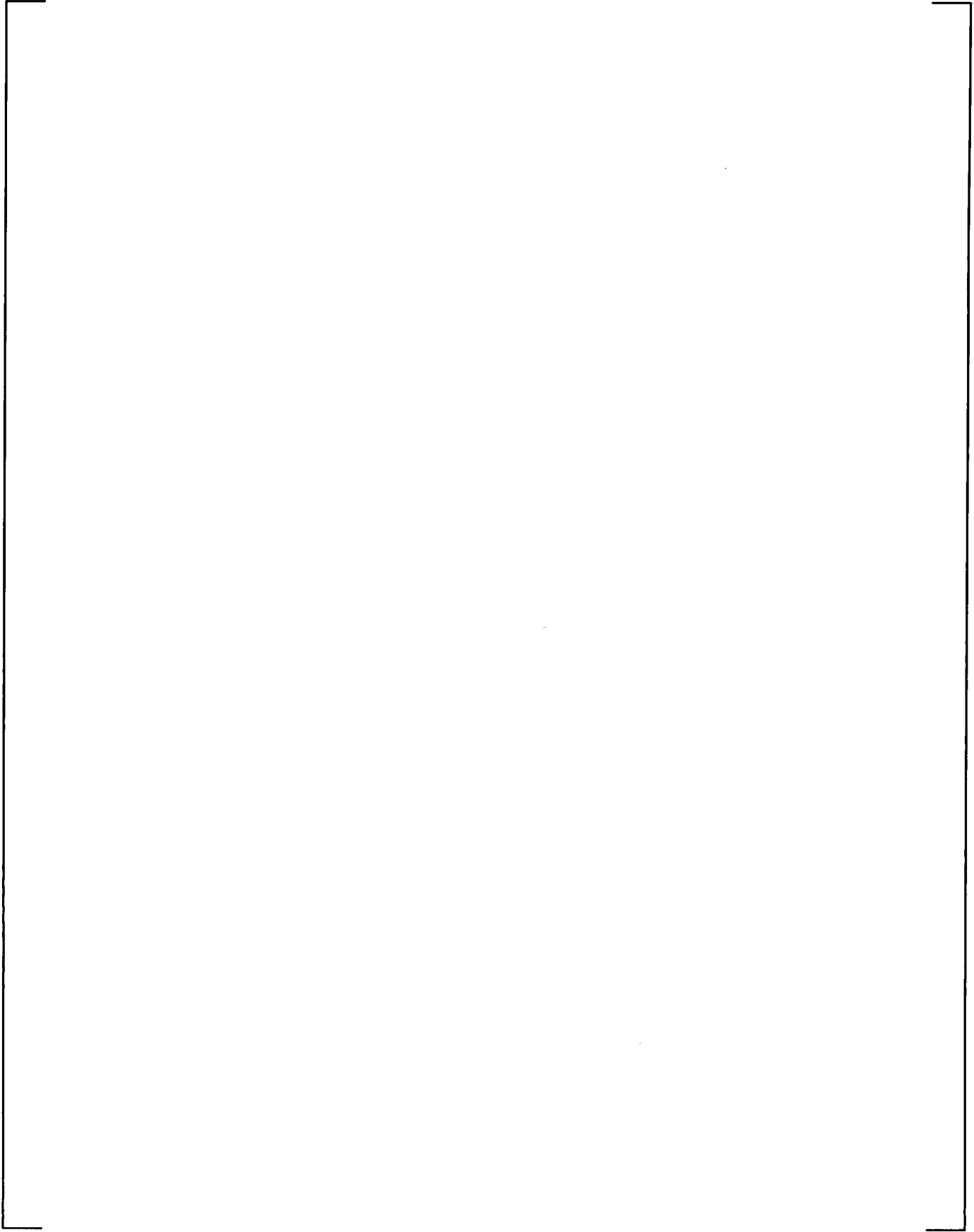


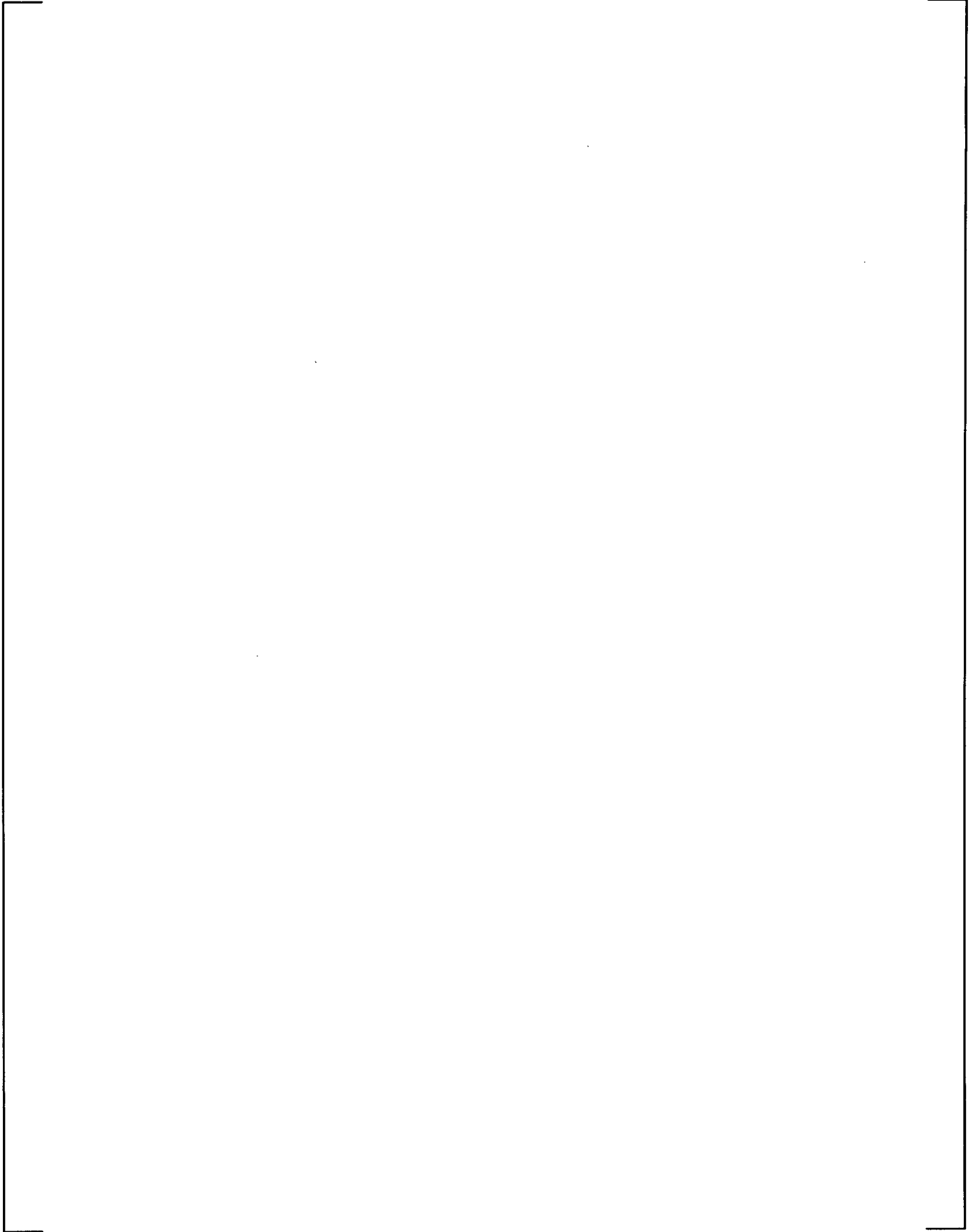


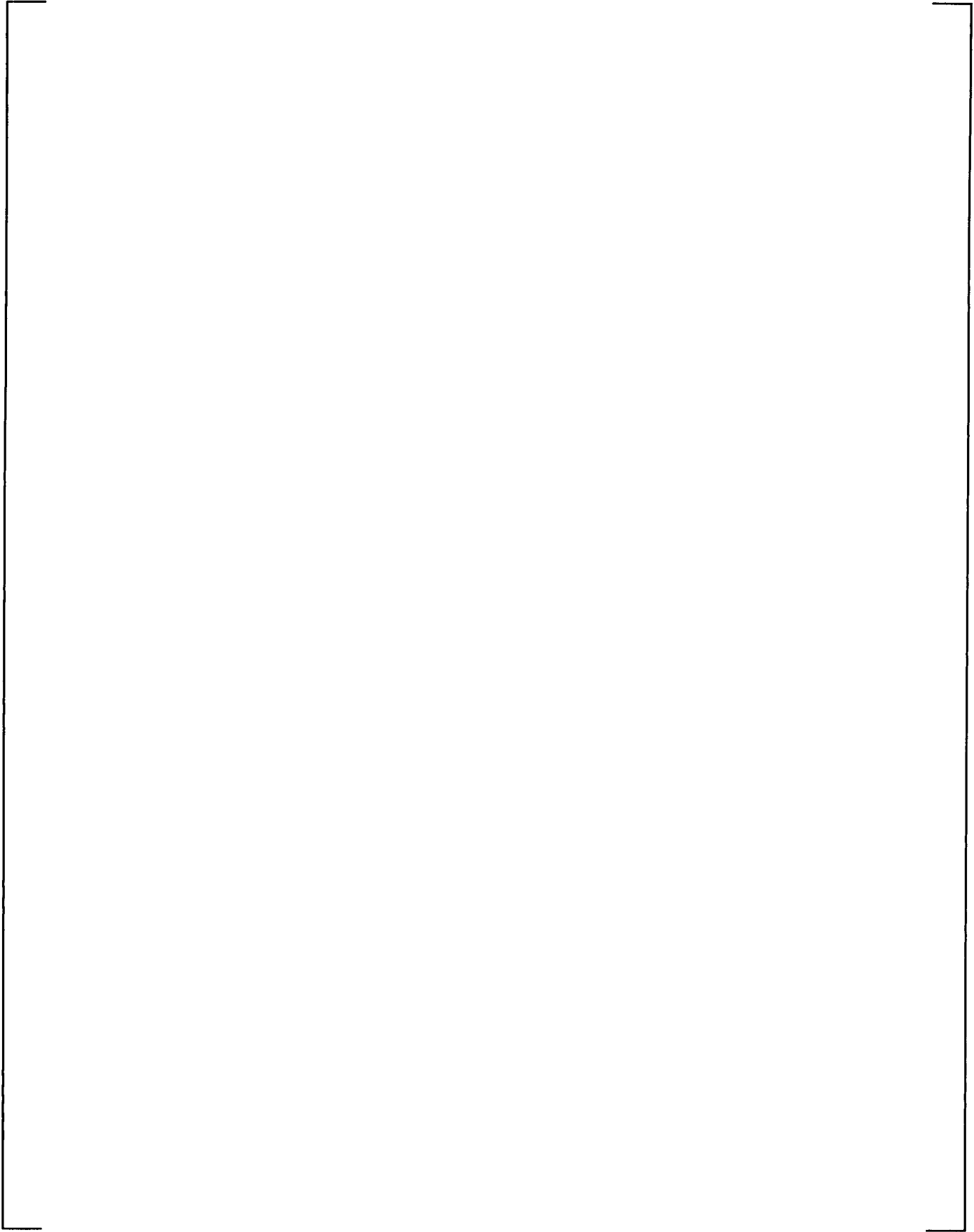


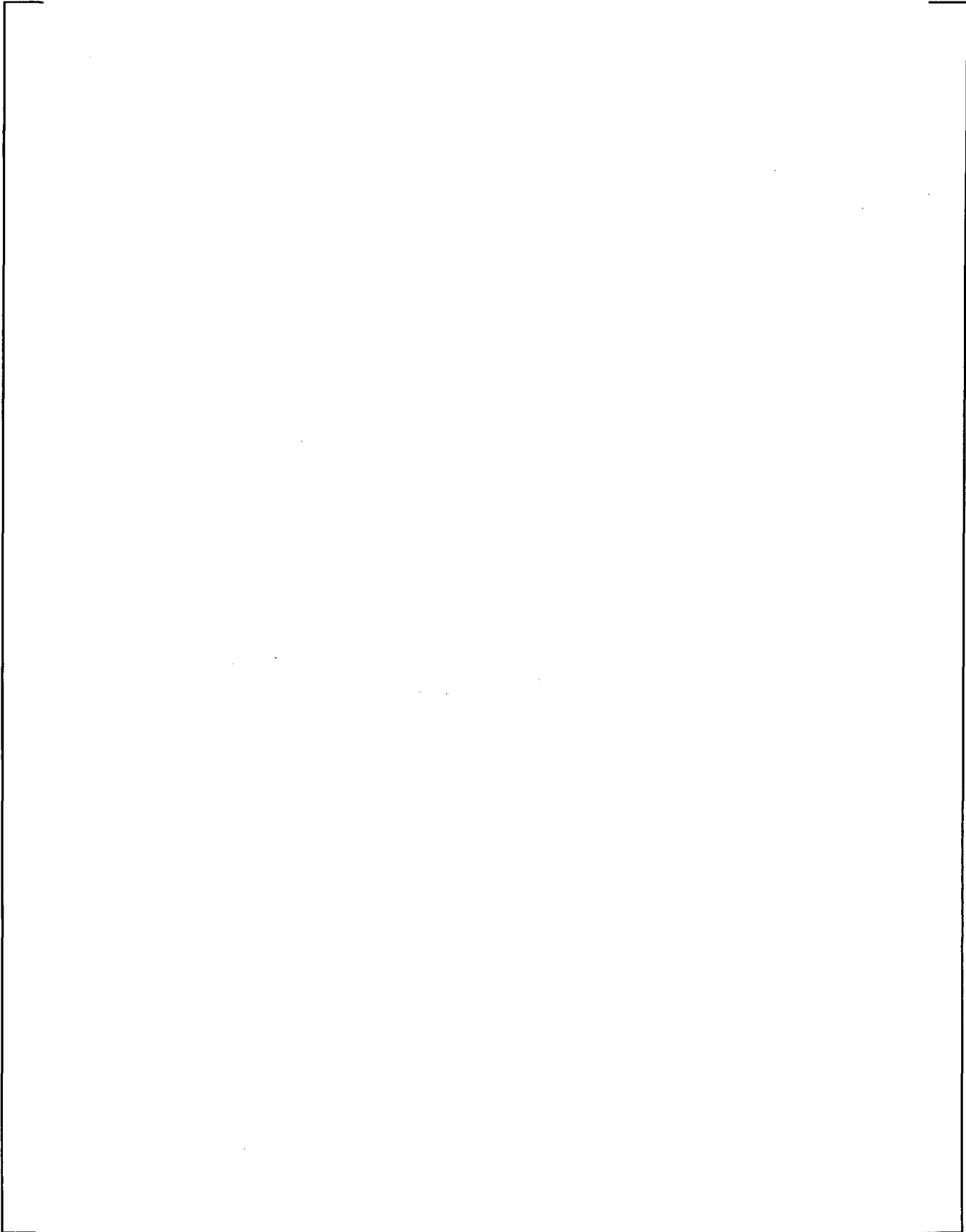








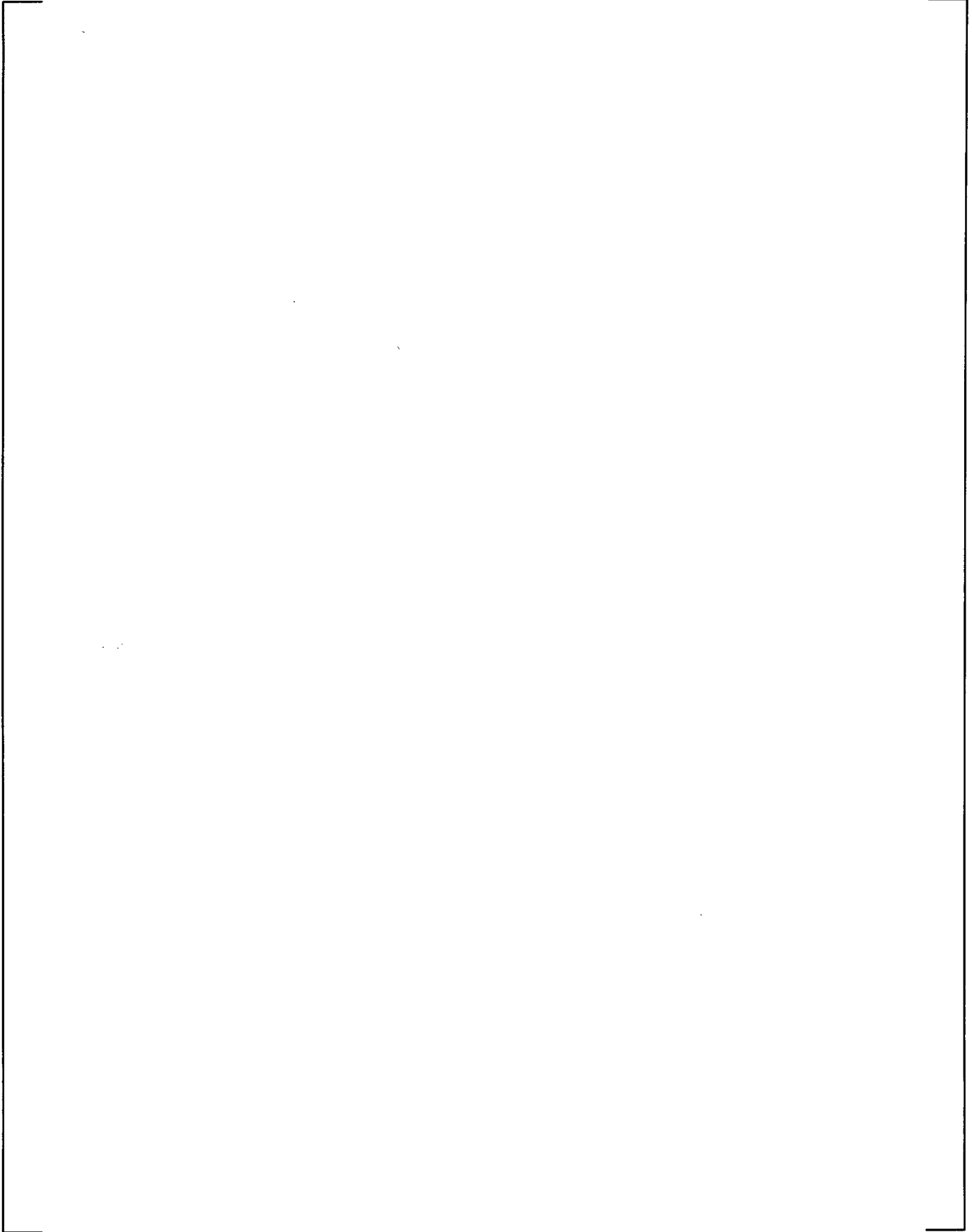


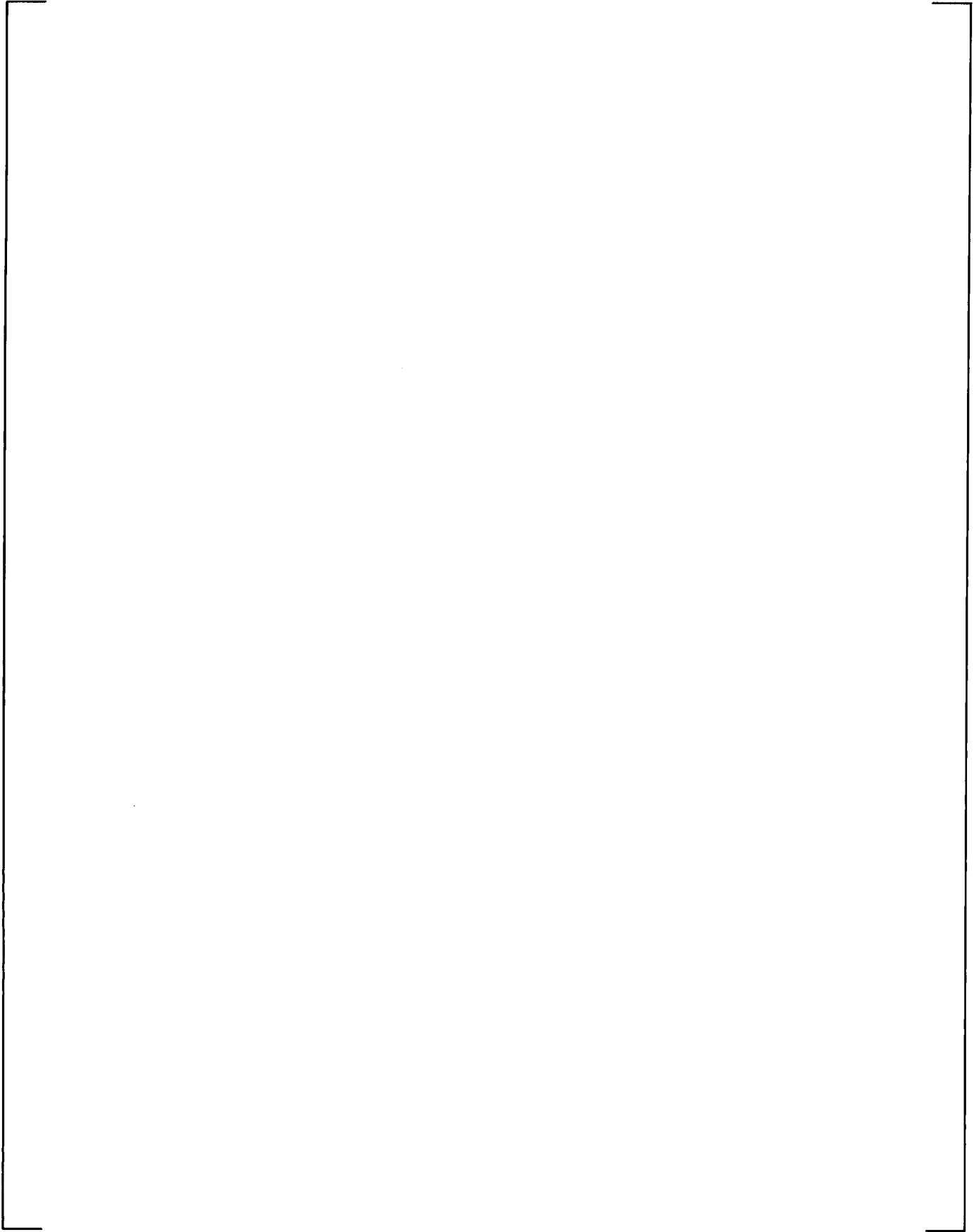


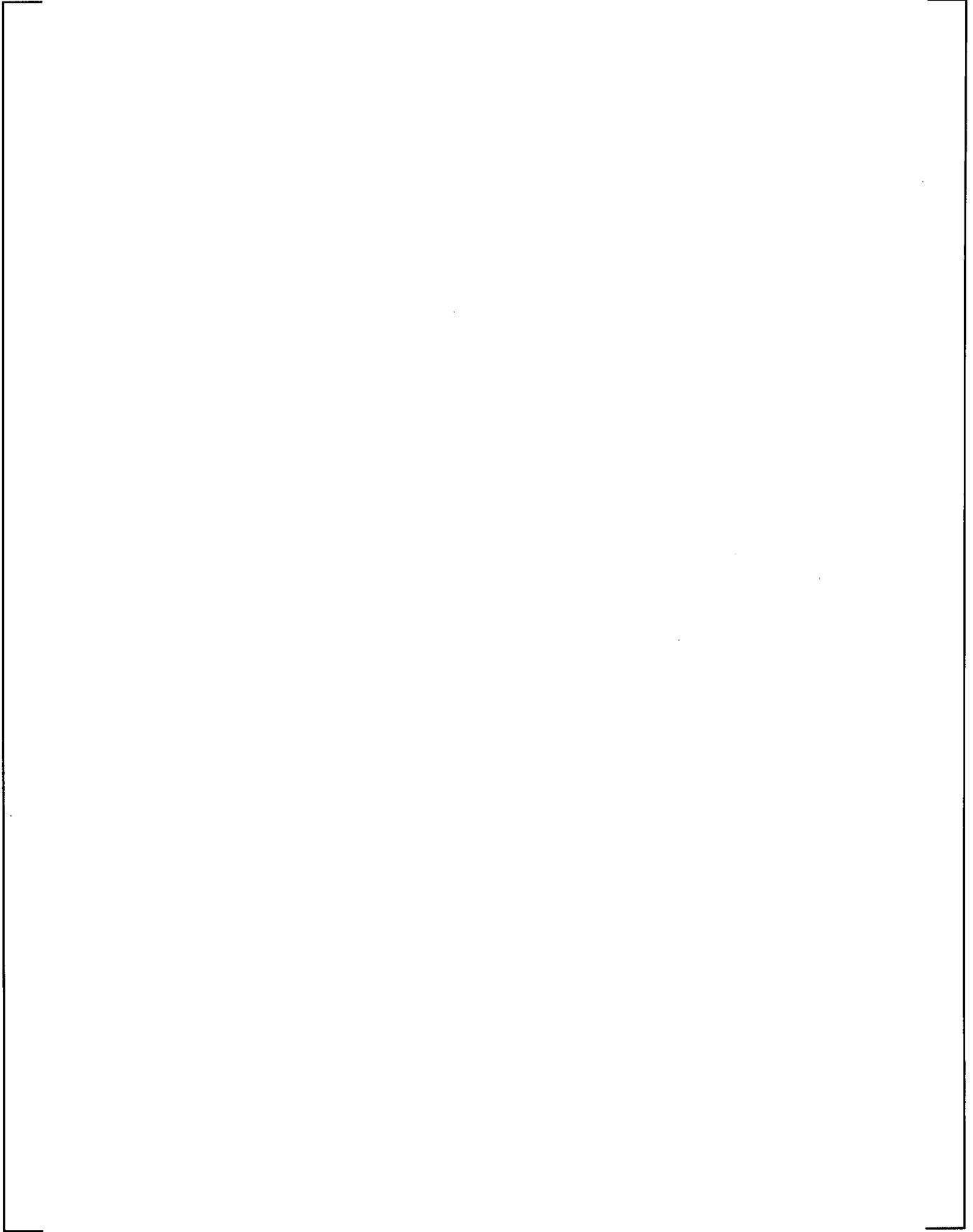
2 SHIELD BUILDING DESIGN ANALYSES

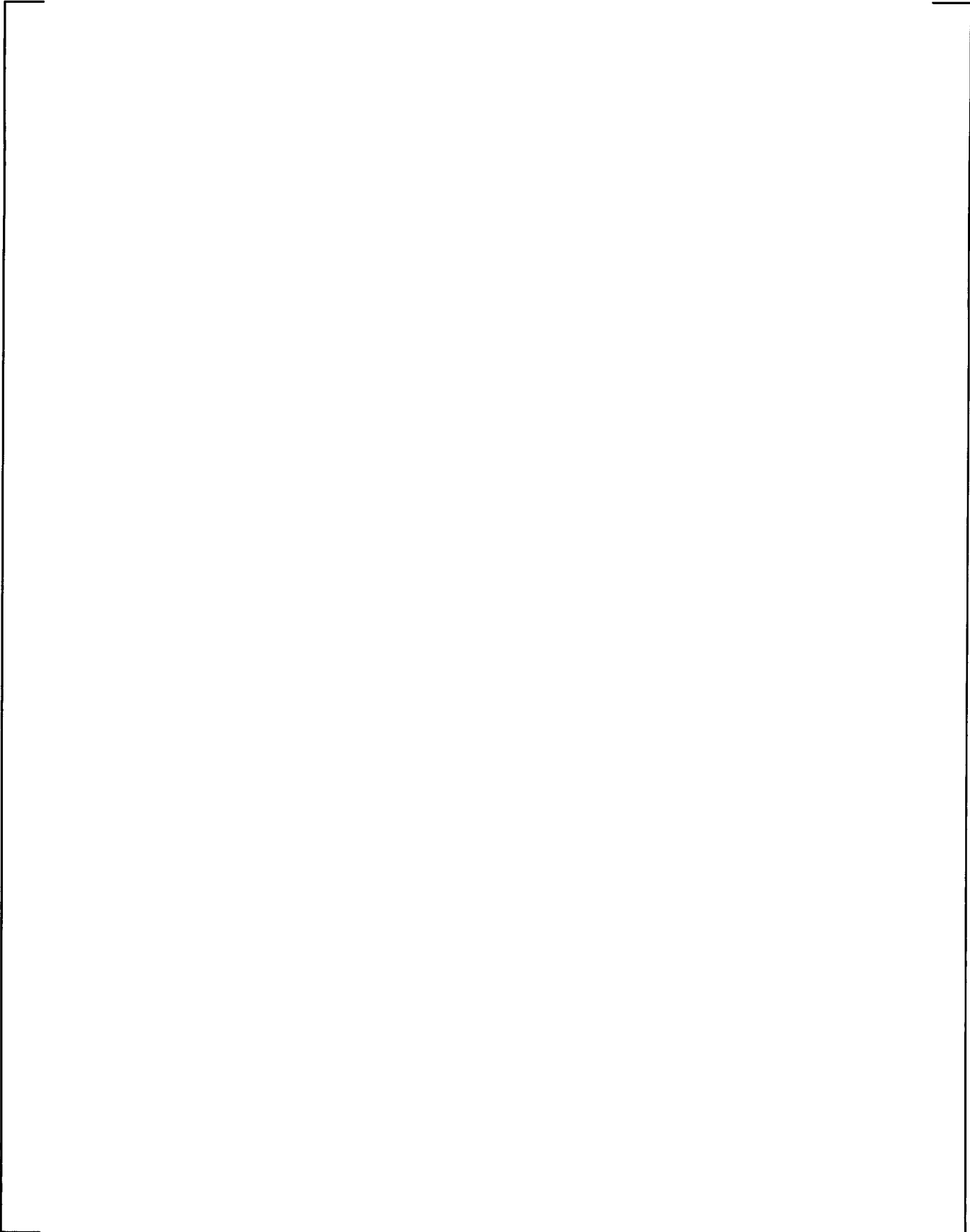
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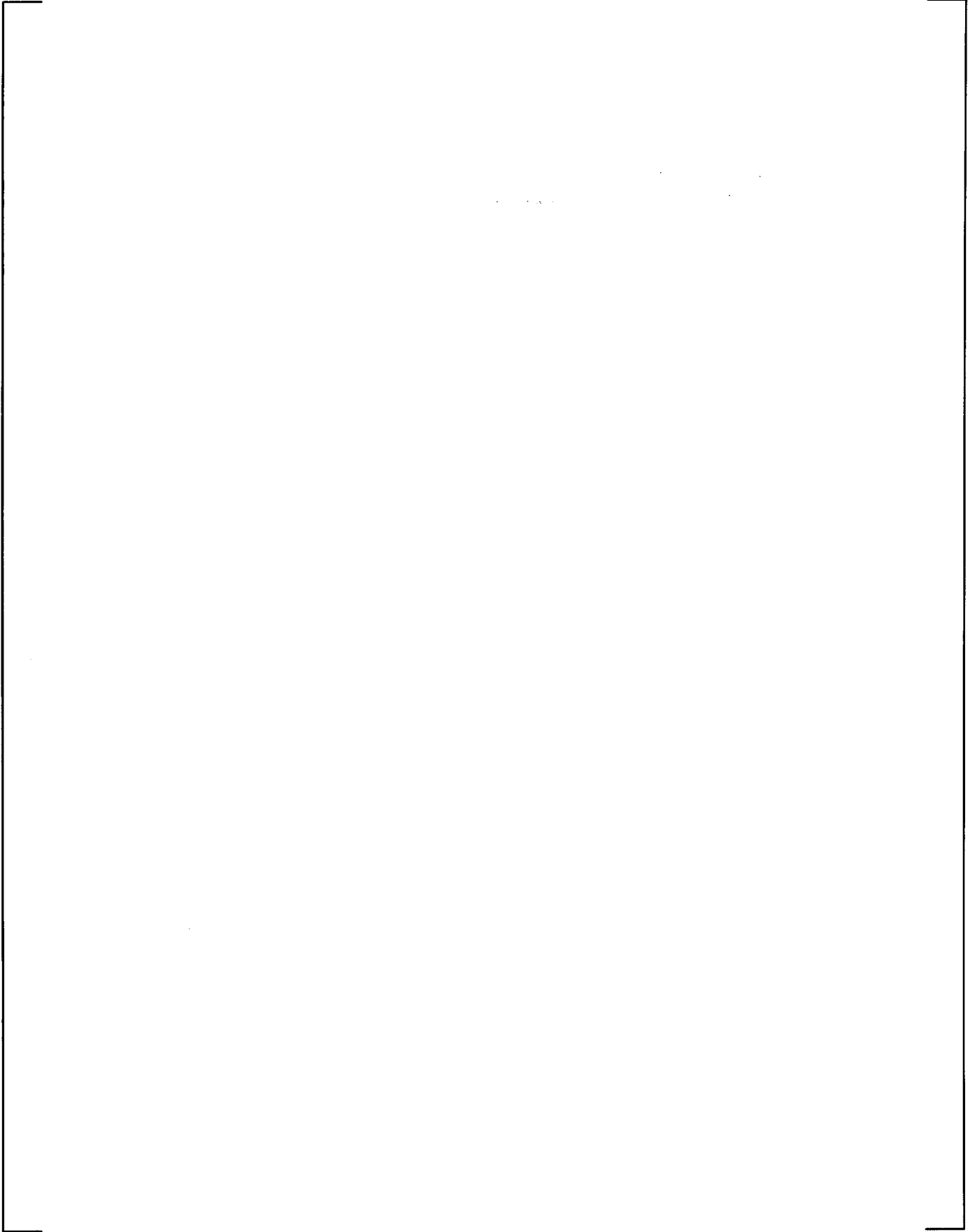






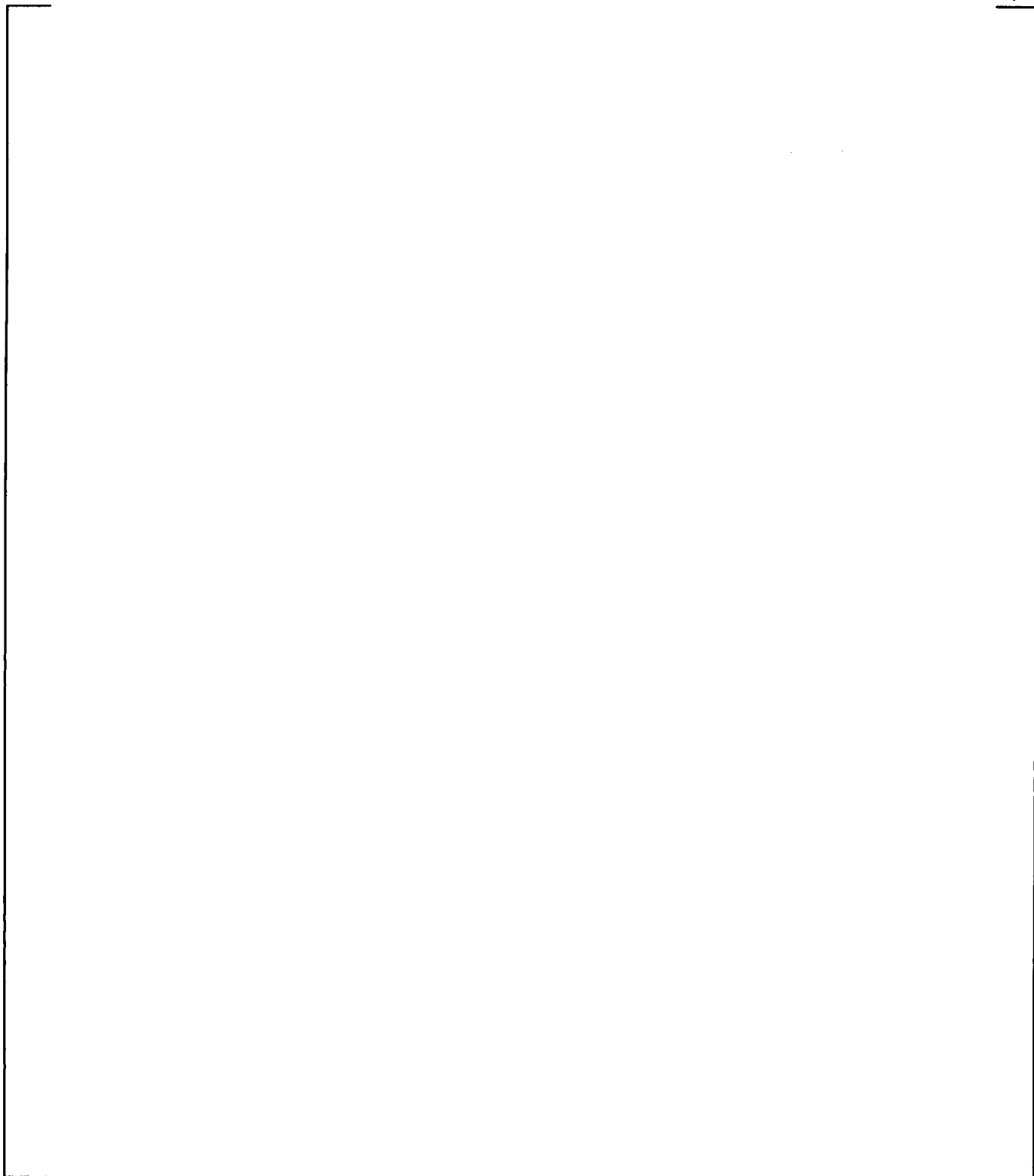


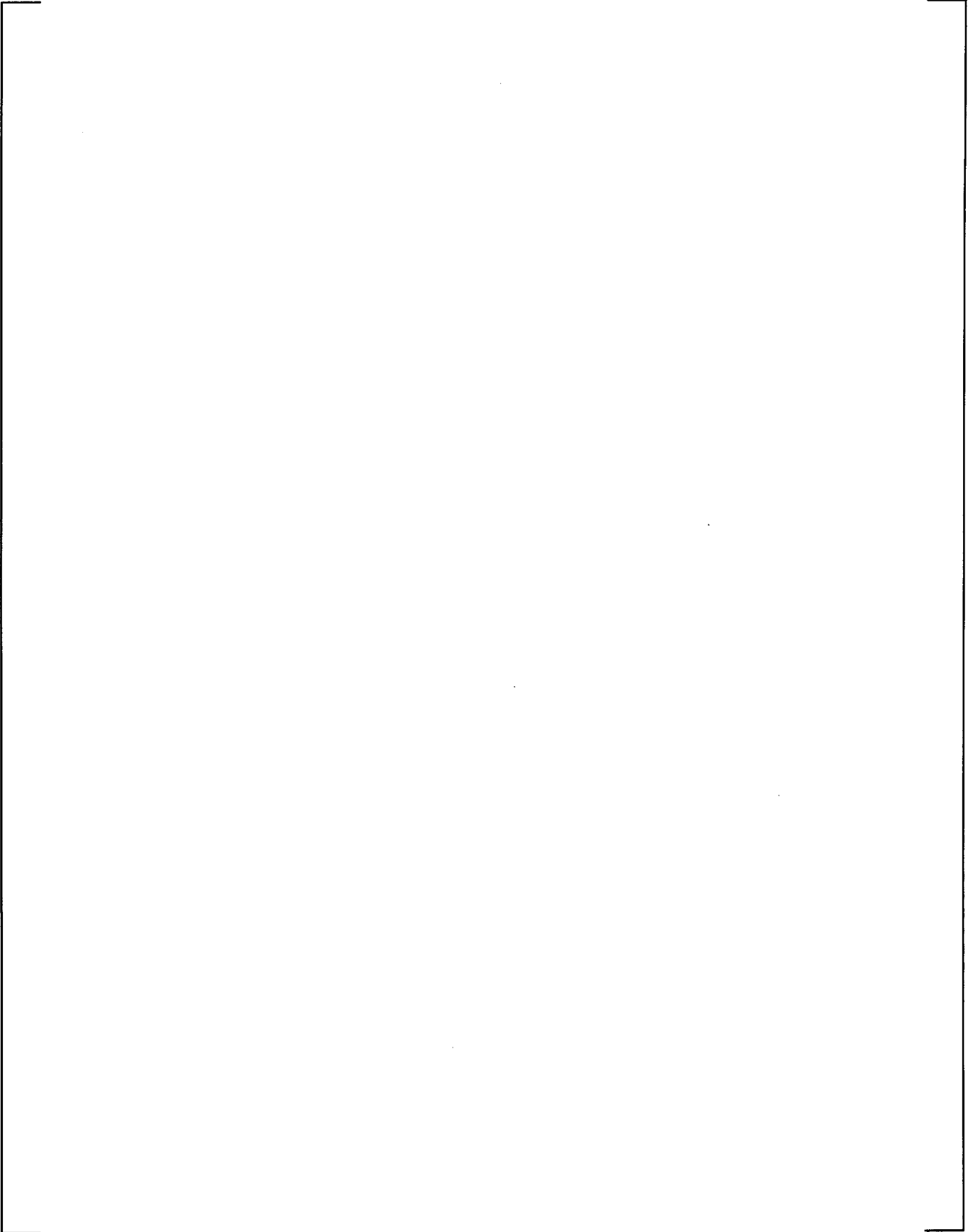


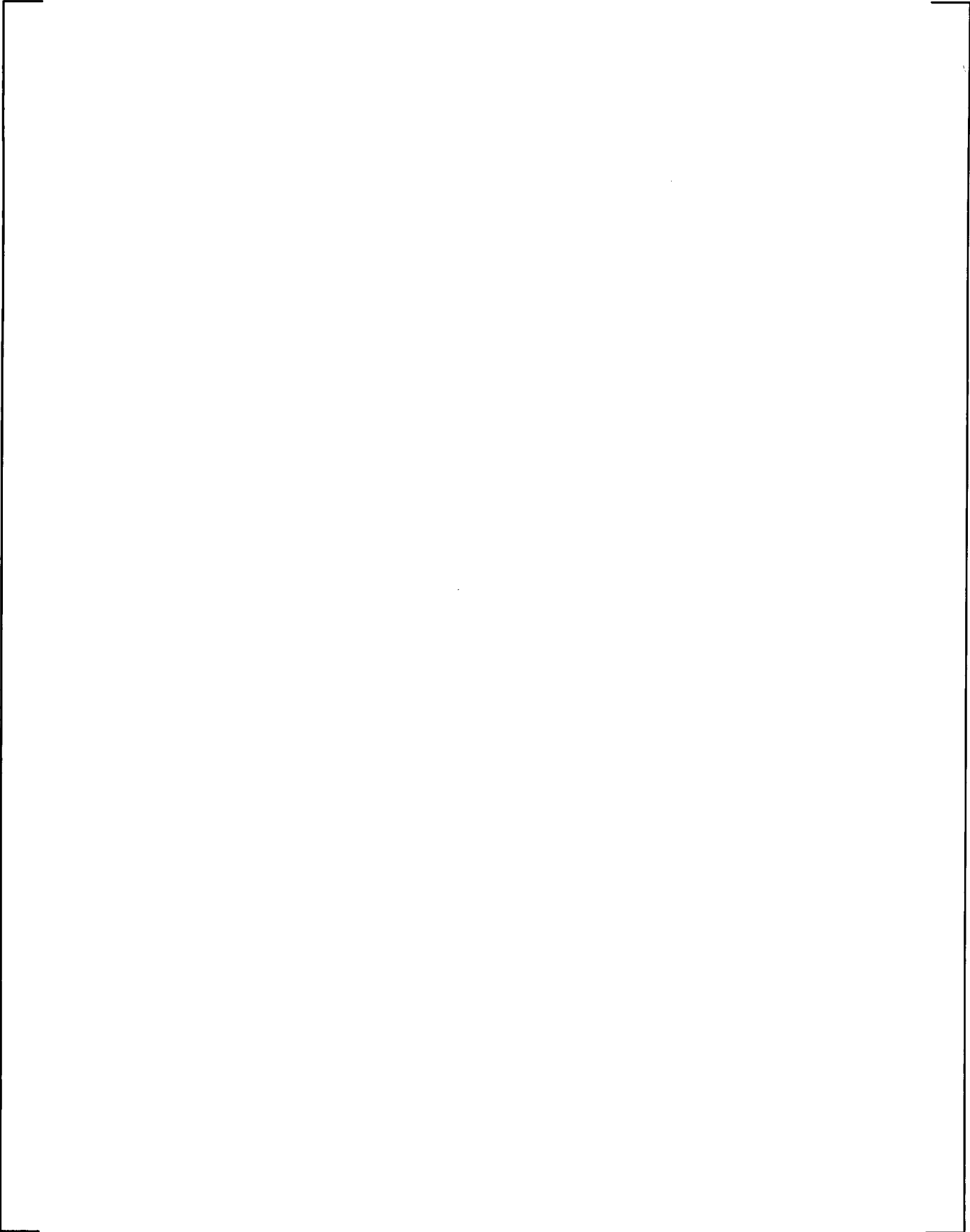


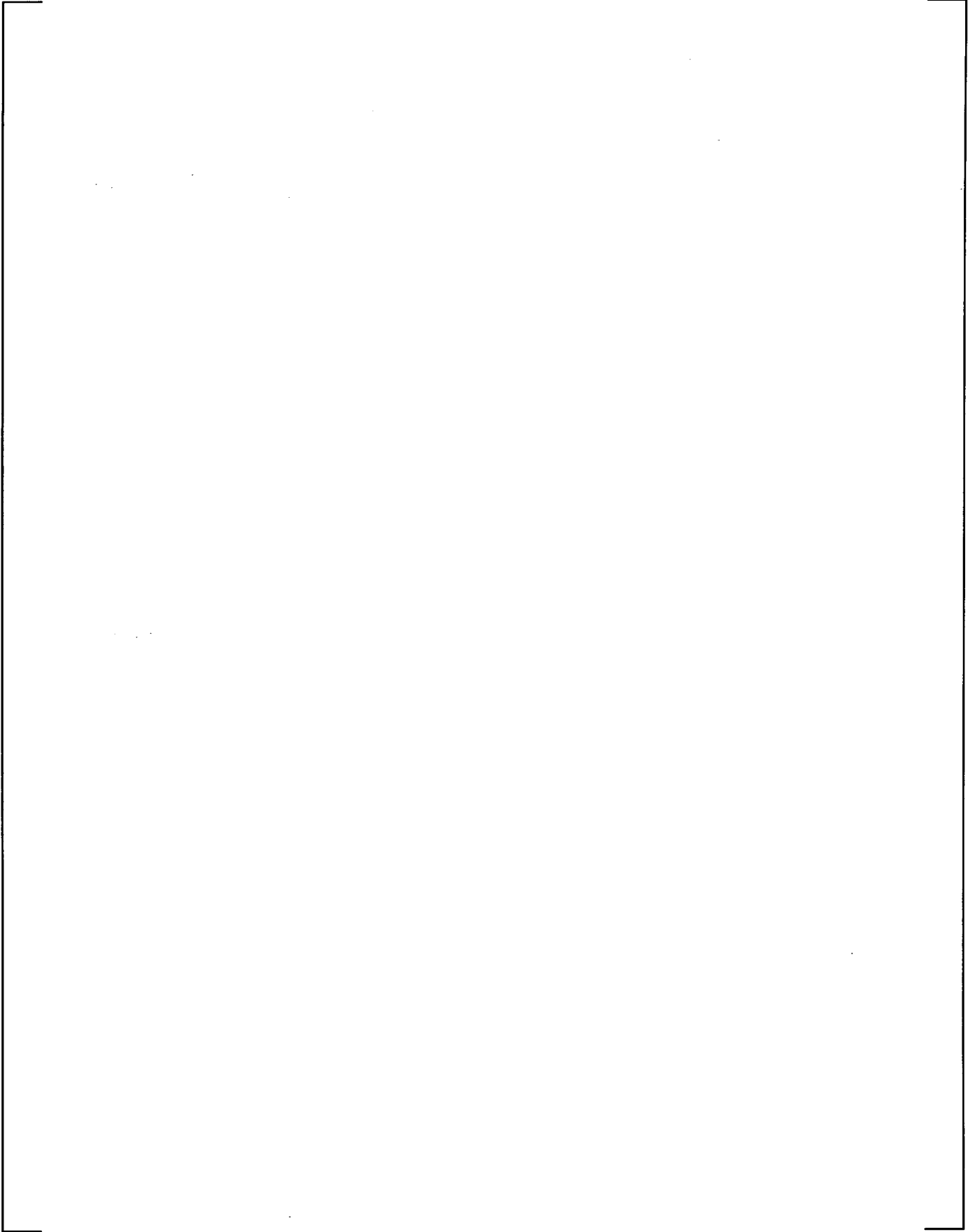
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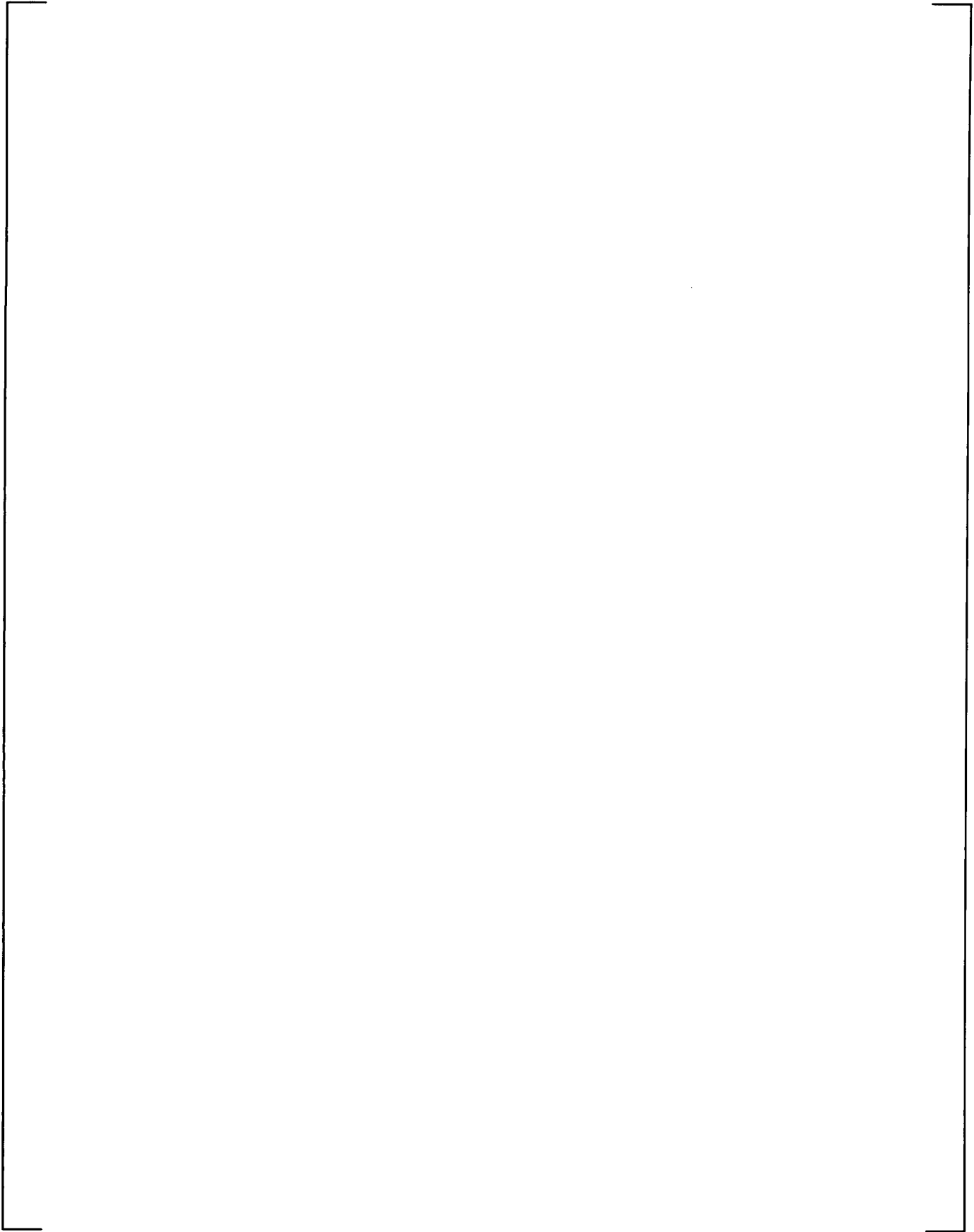
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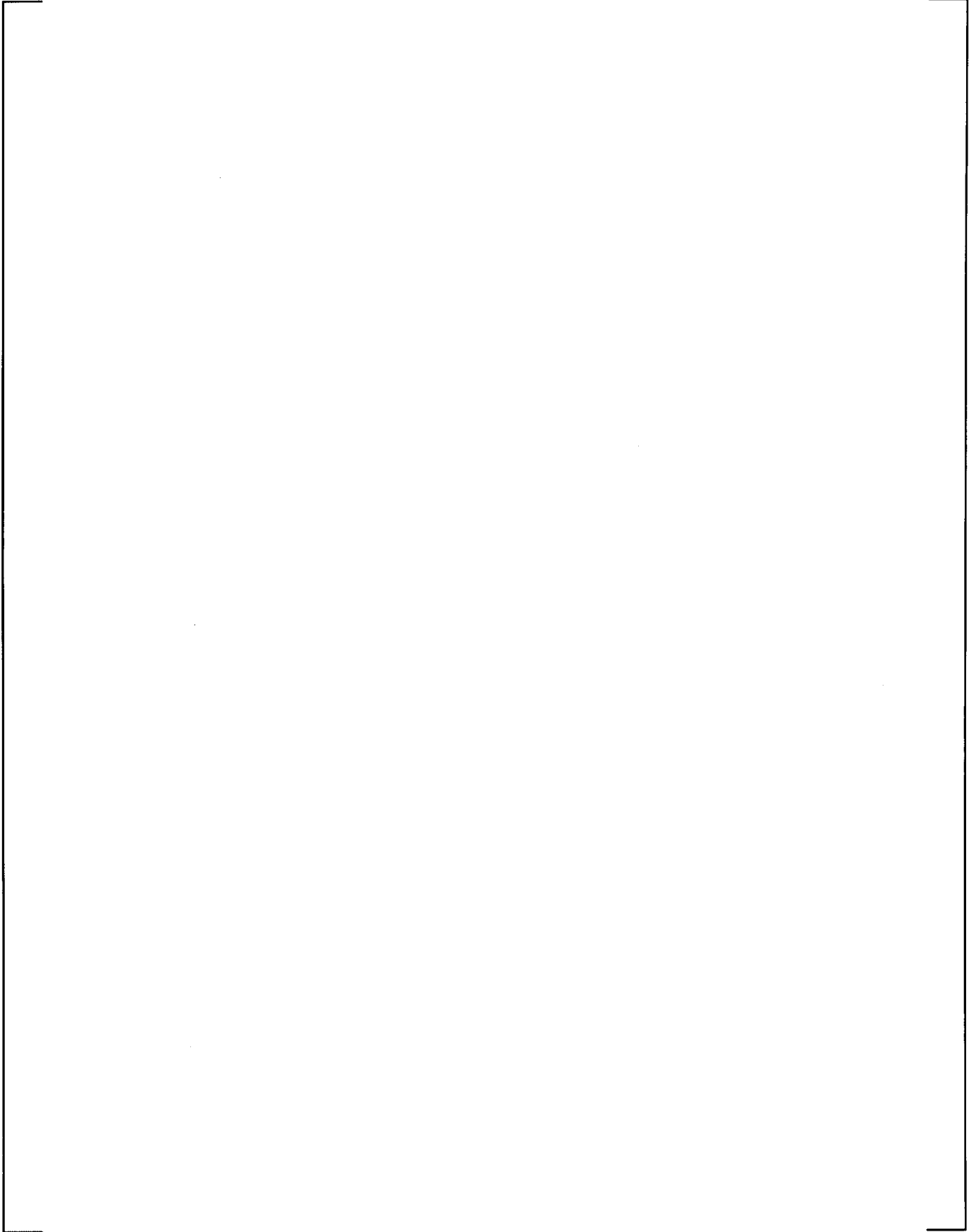


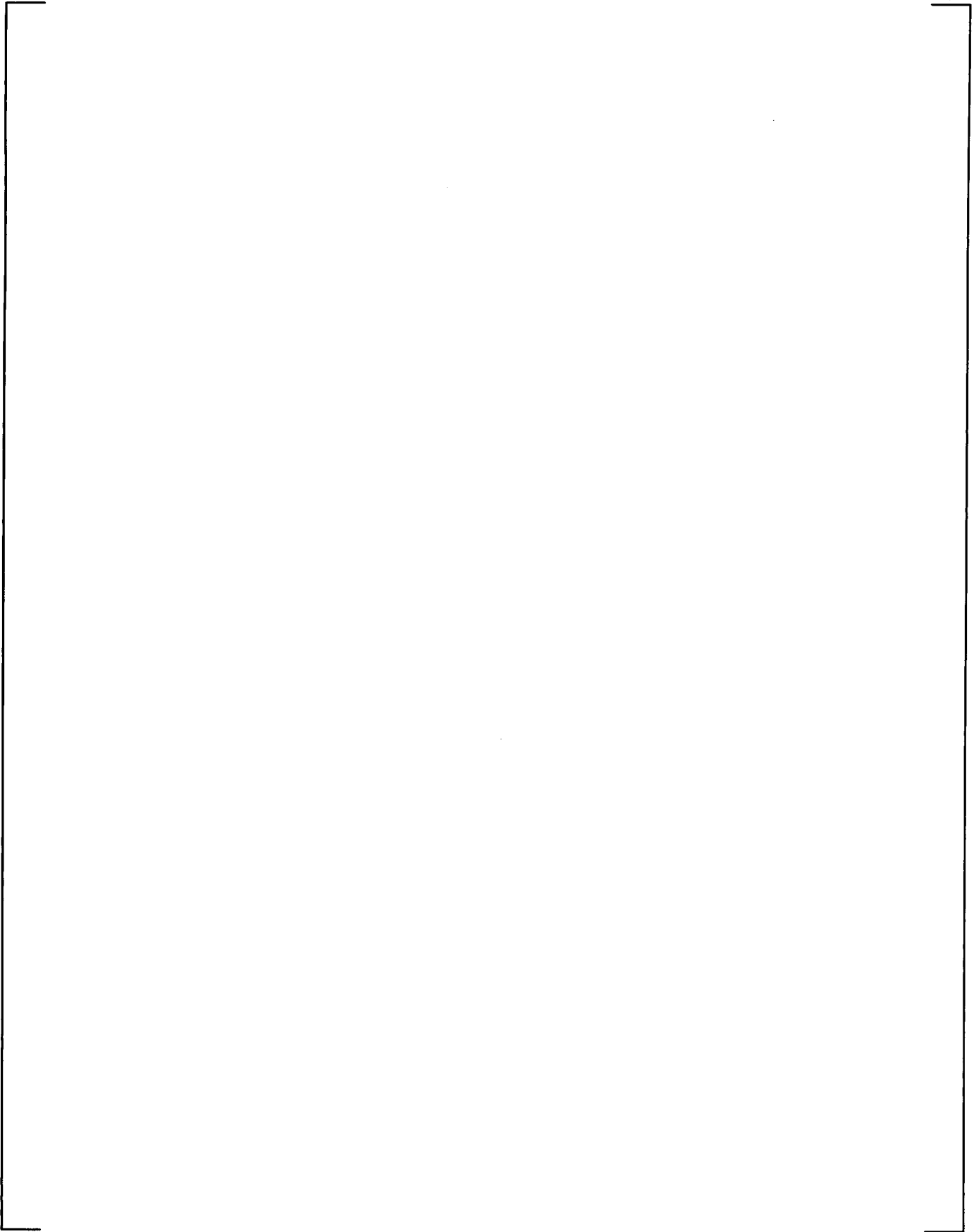


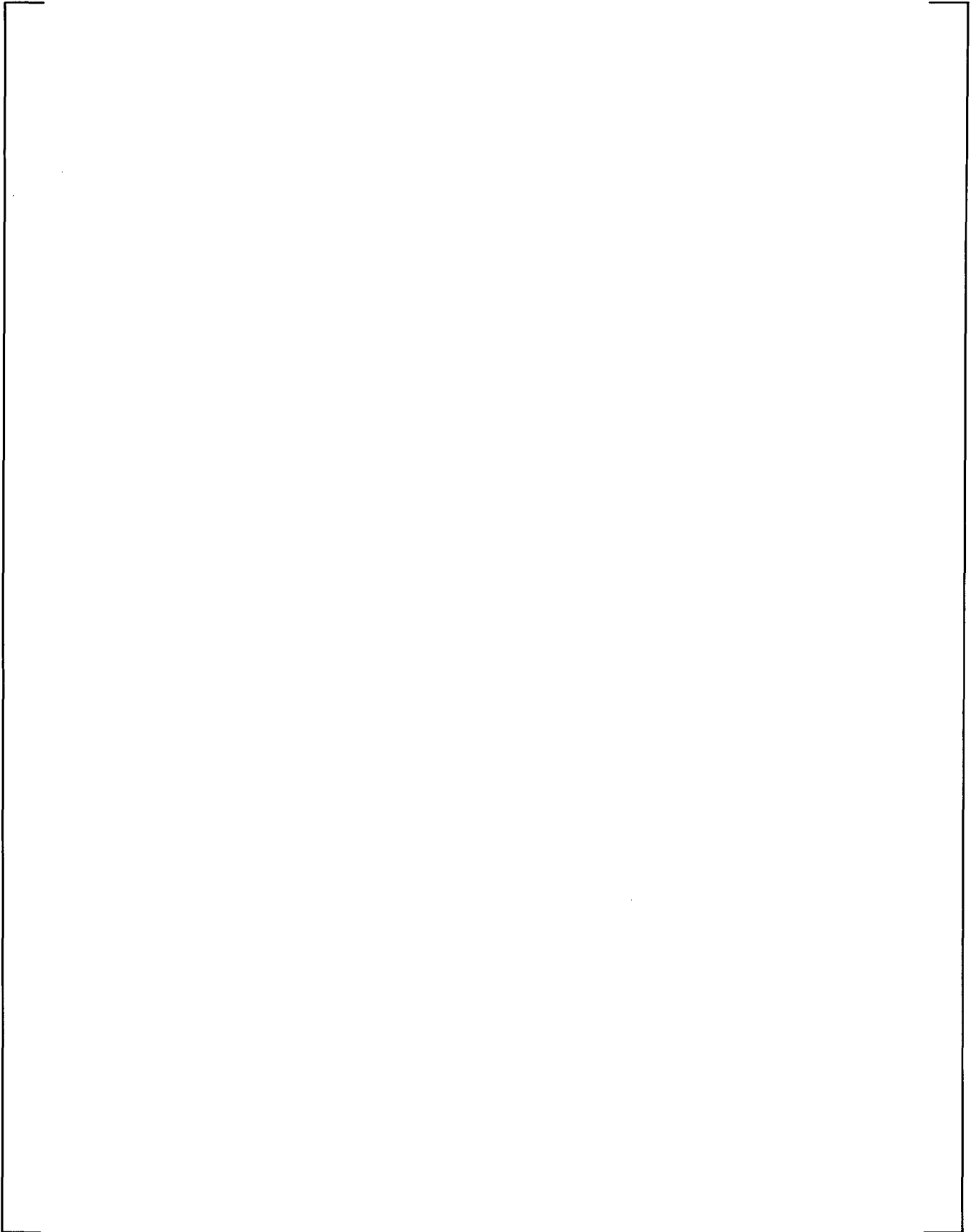


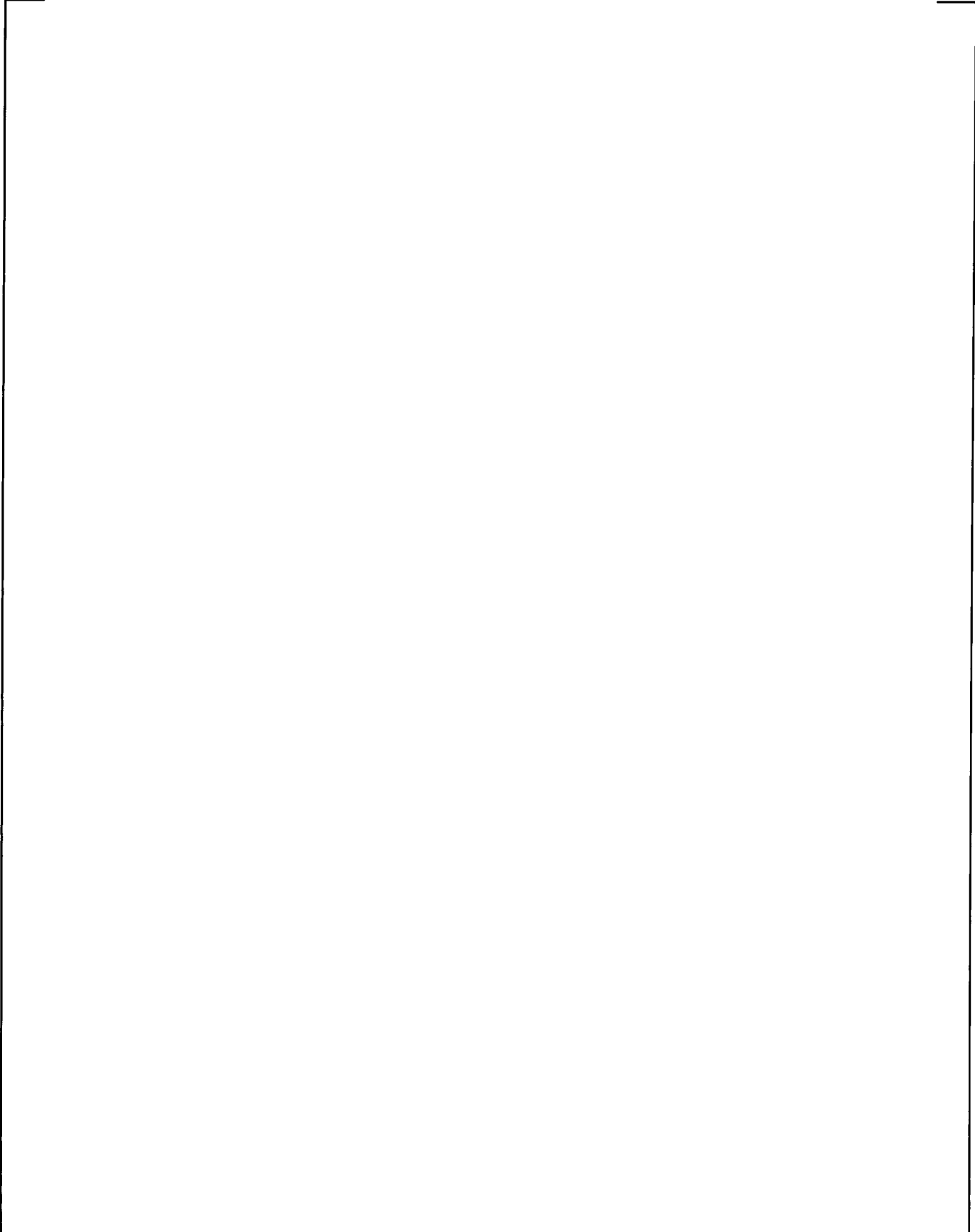


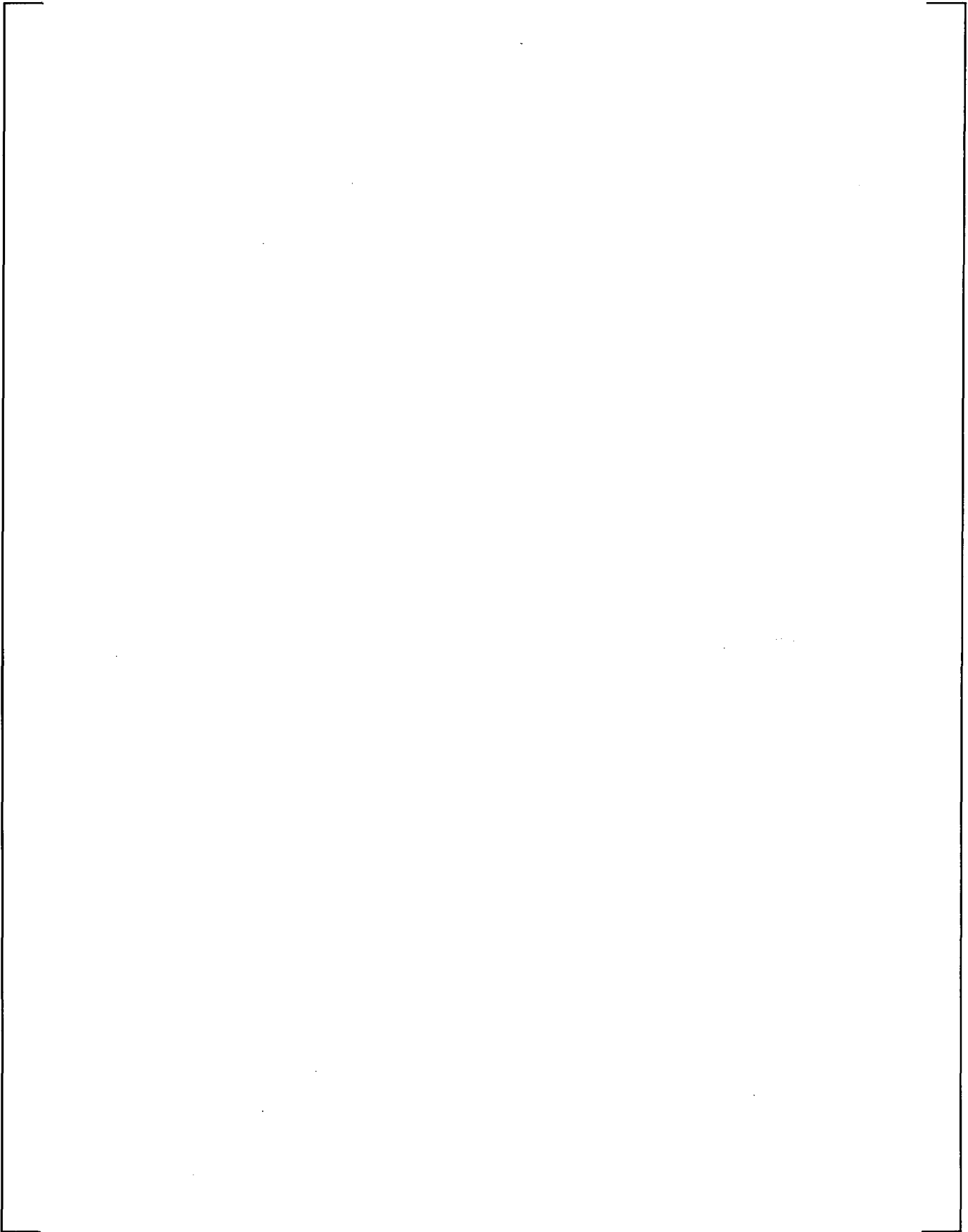






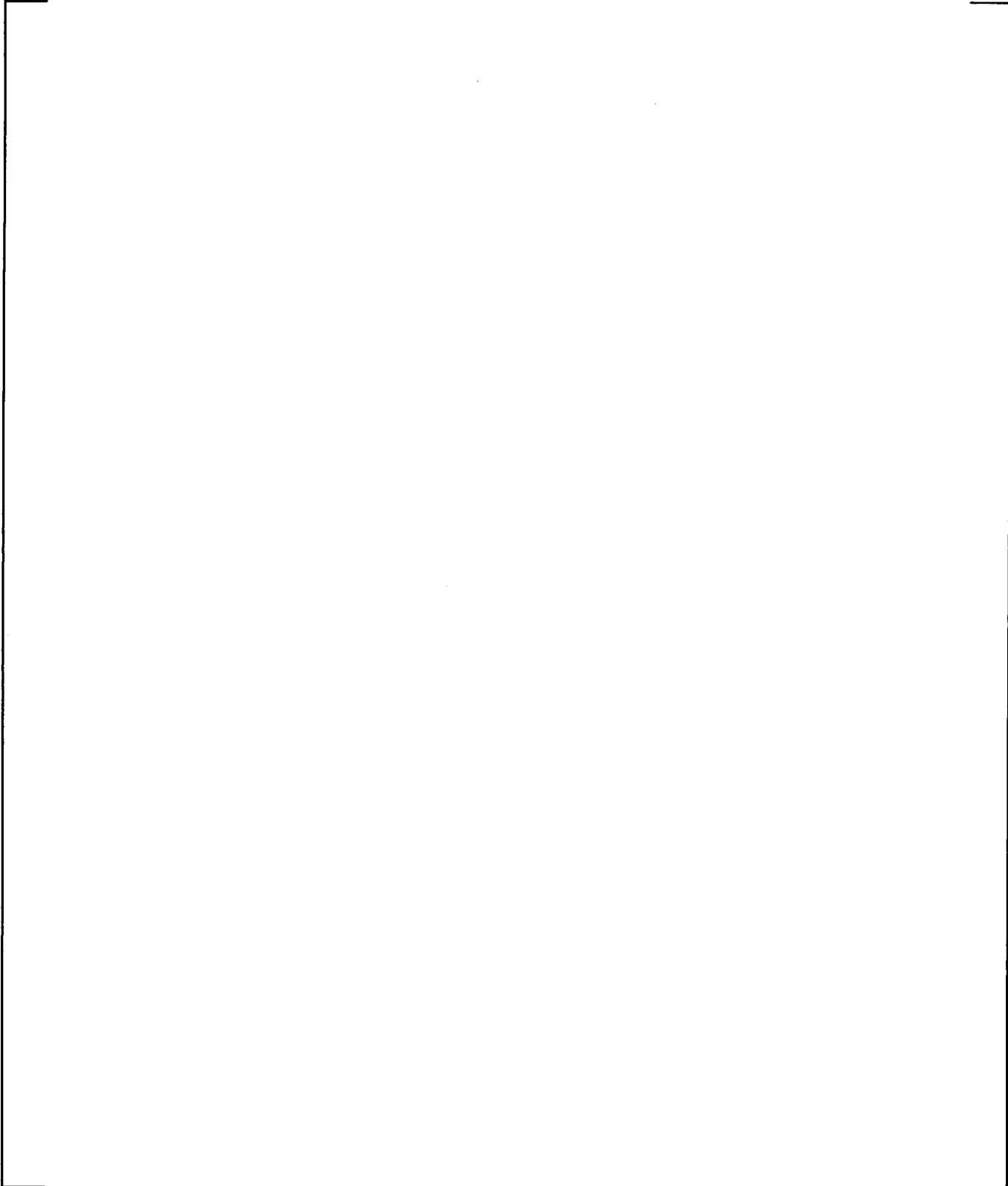


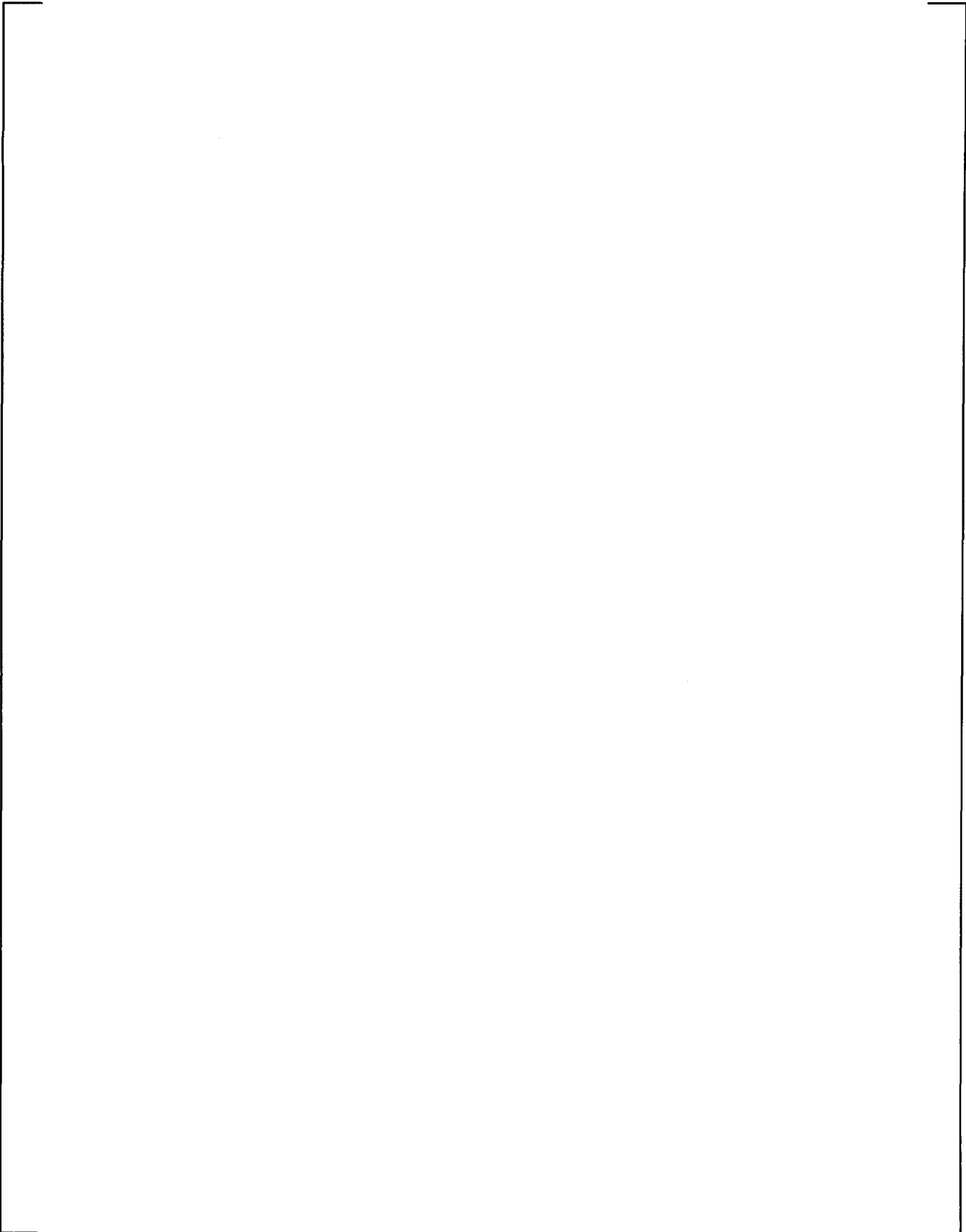


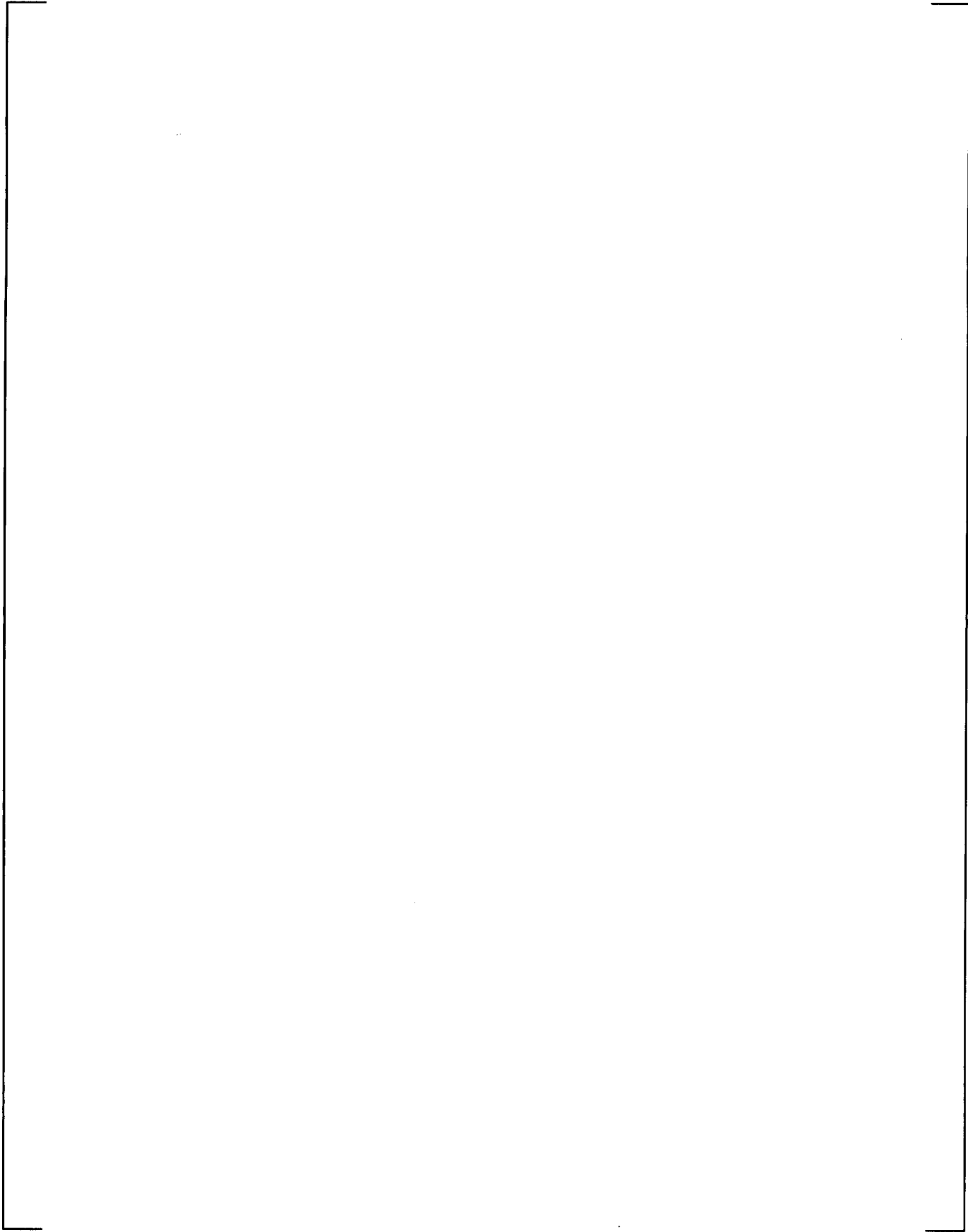


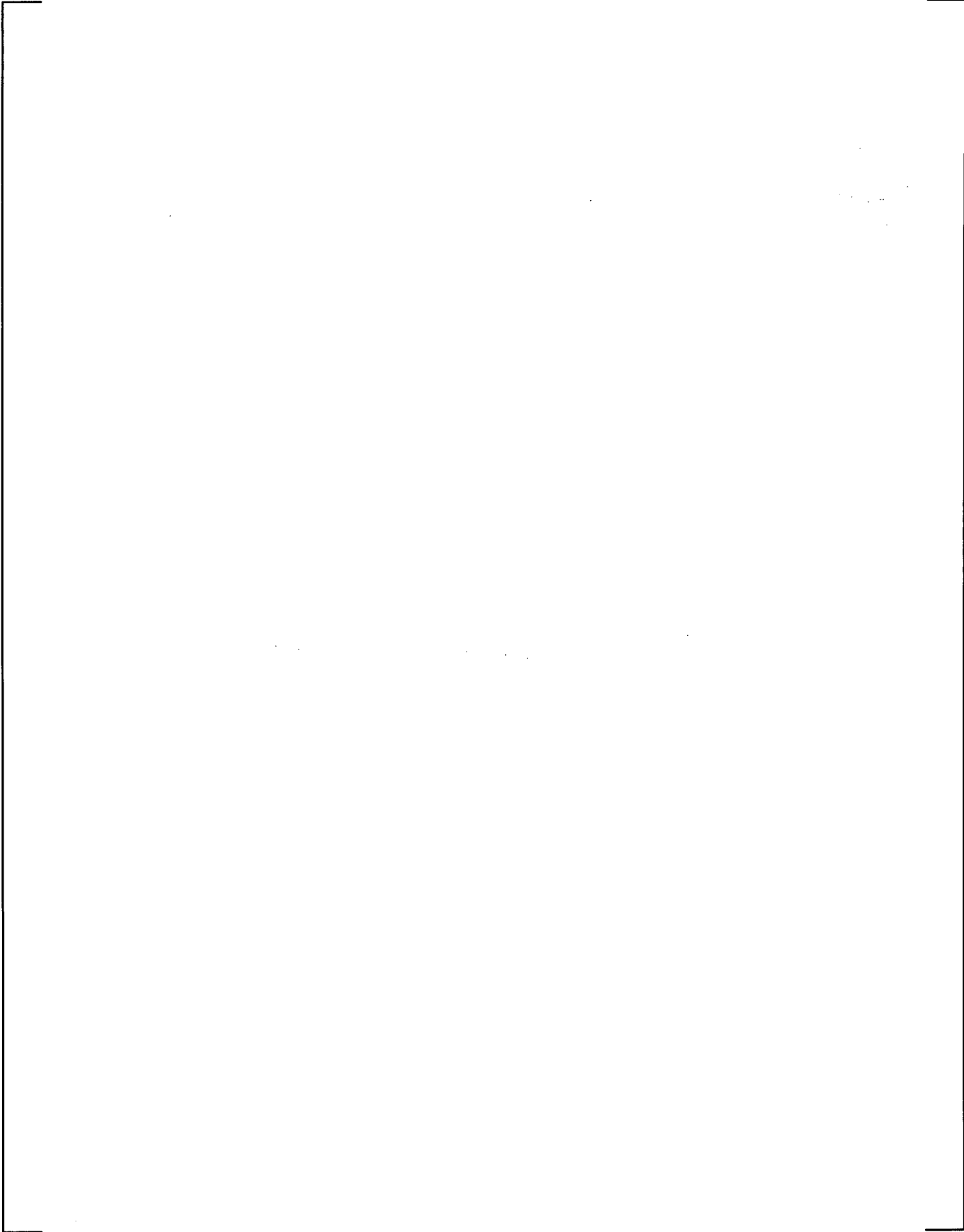
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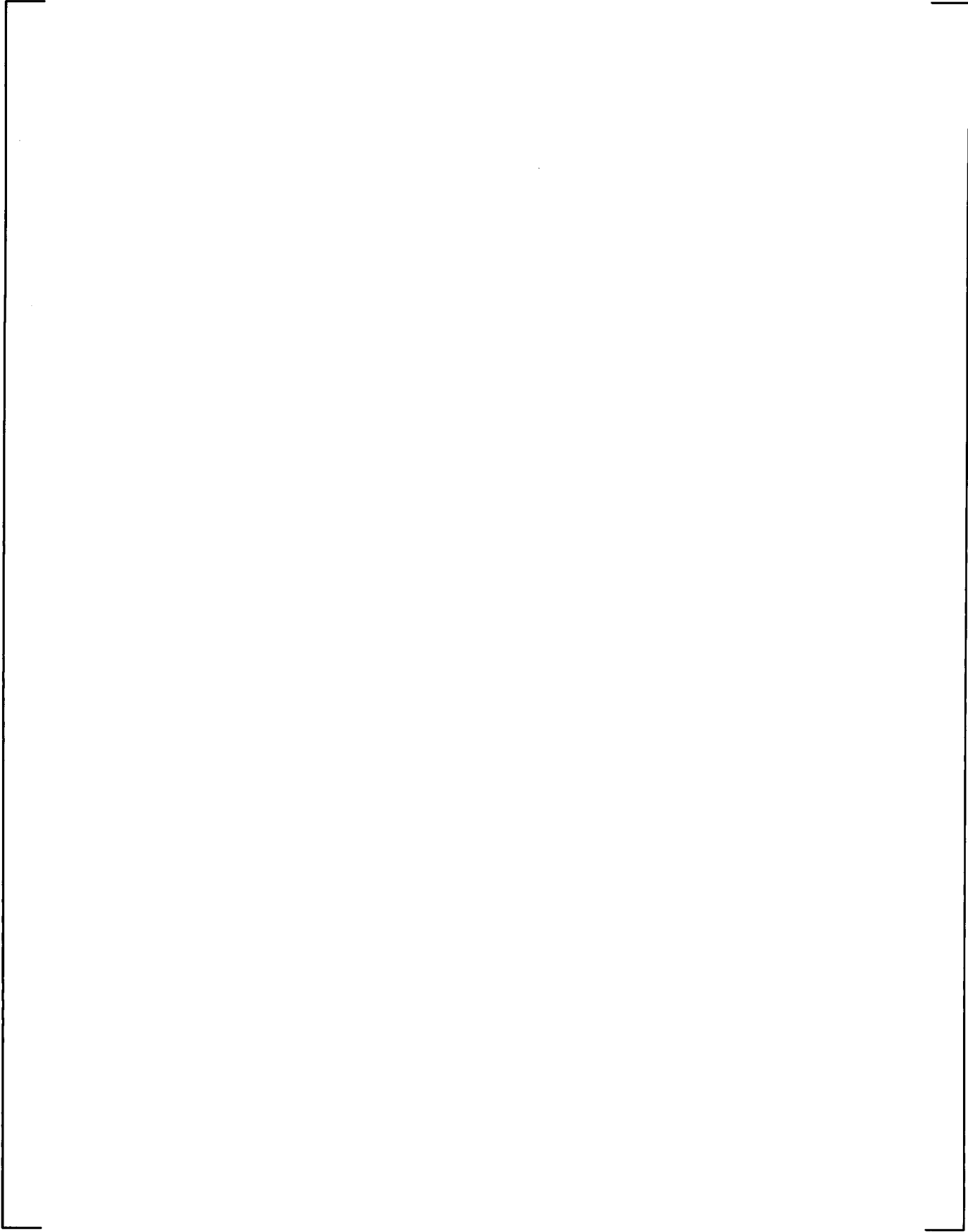
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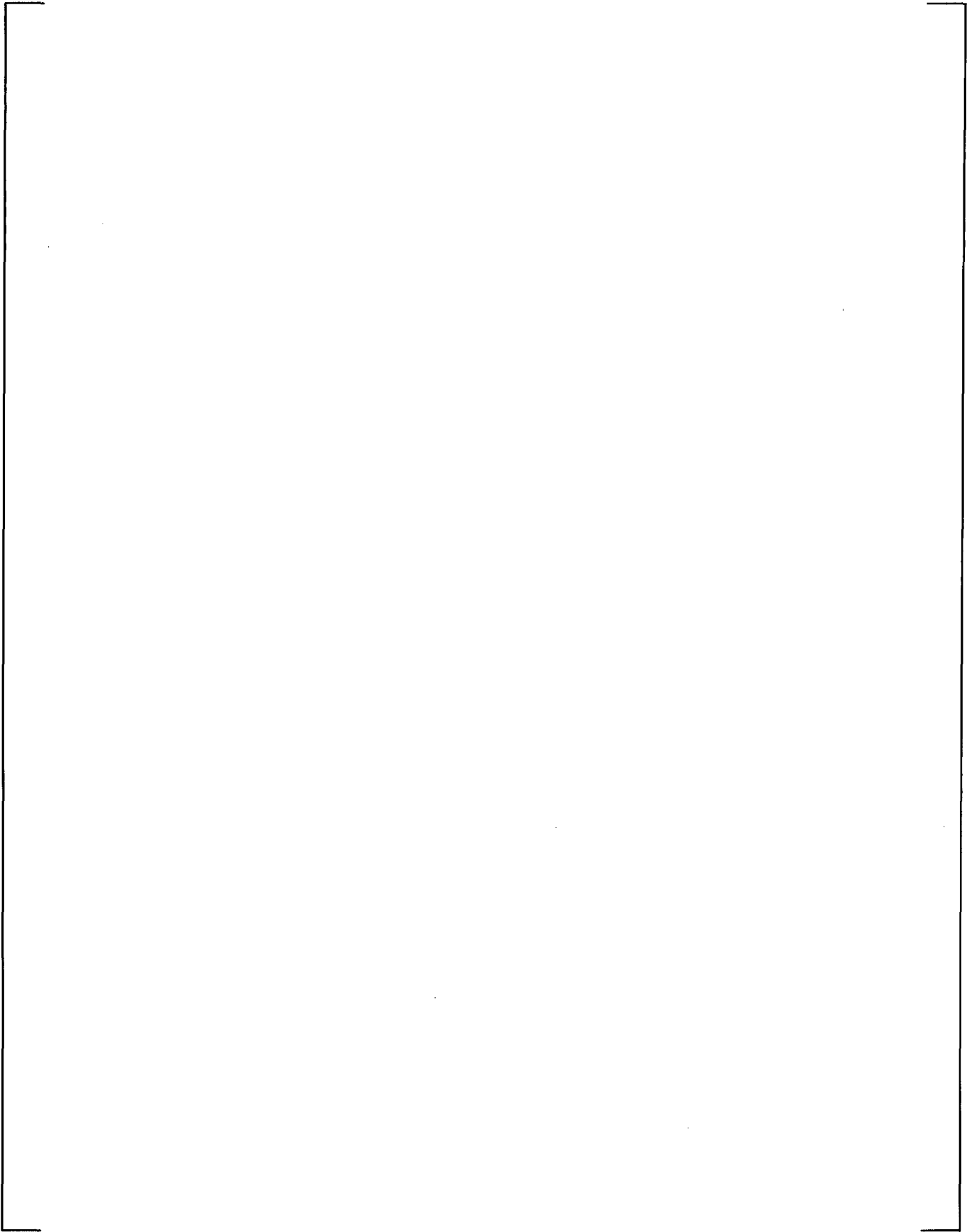




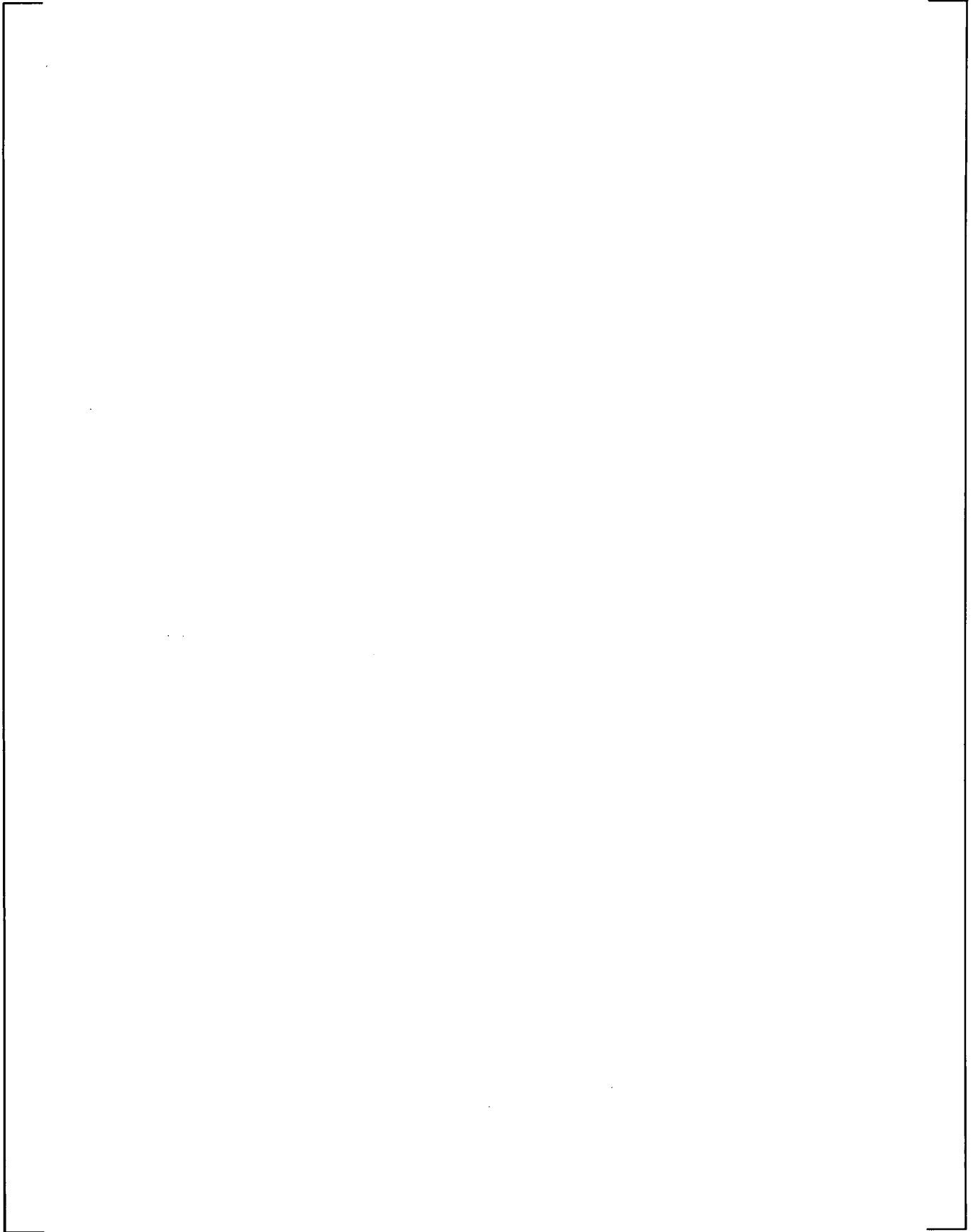


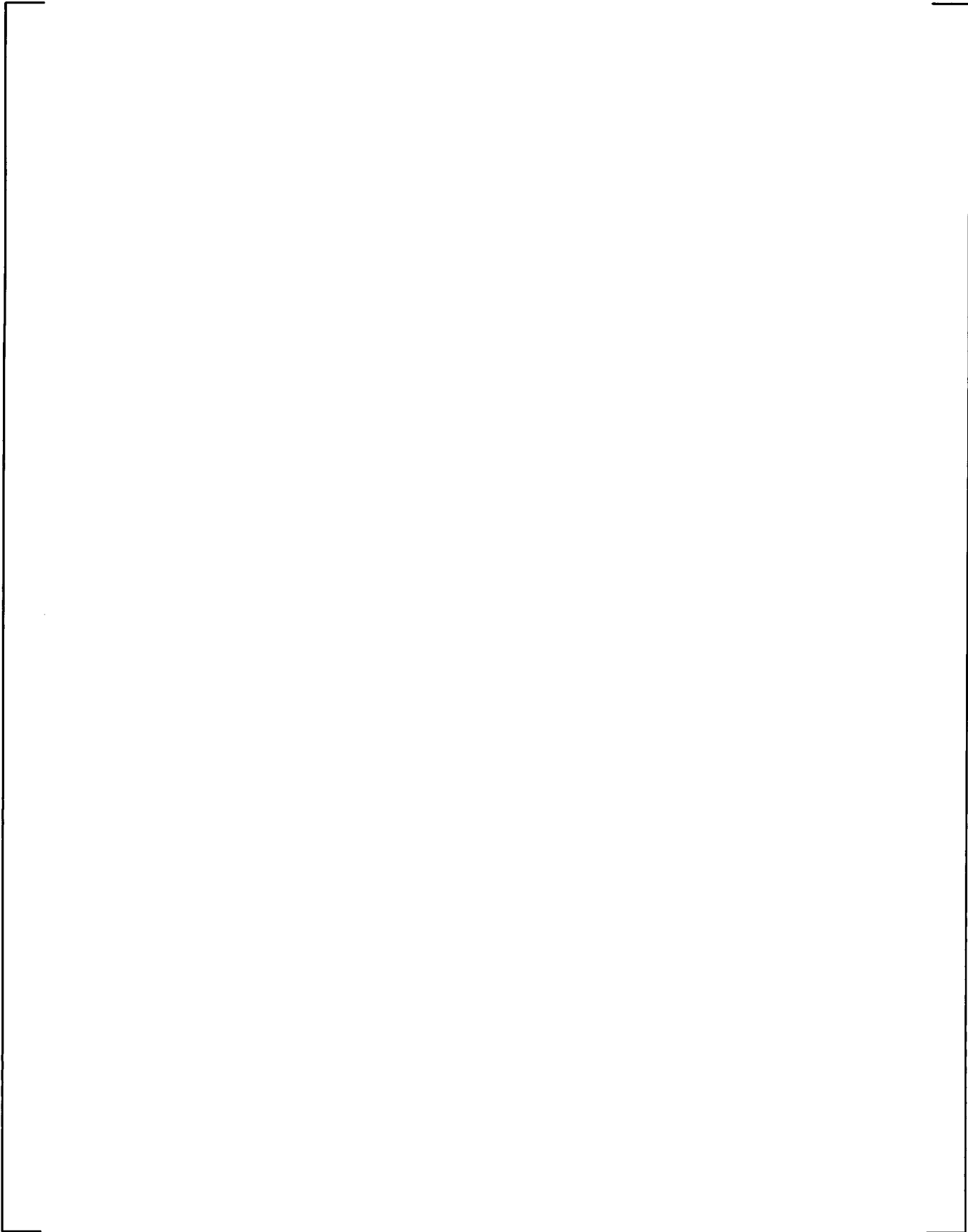


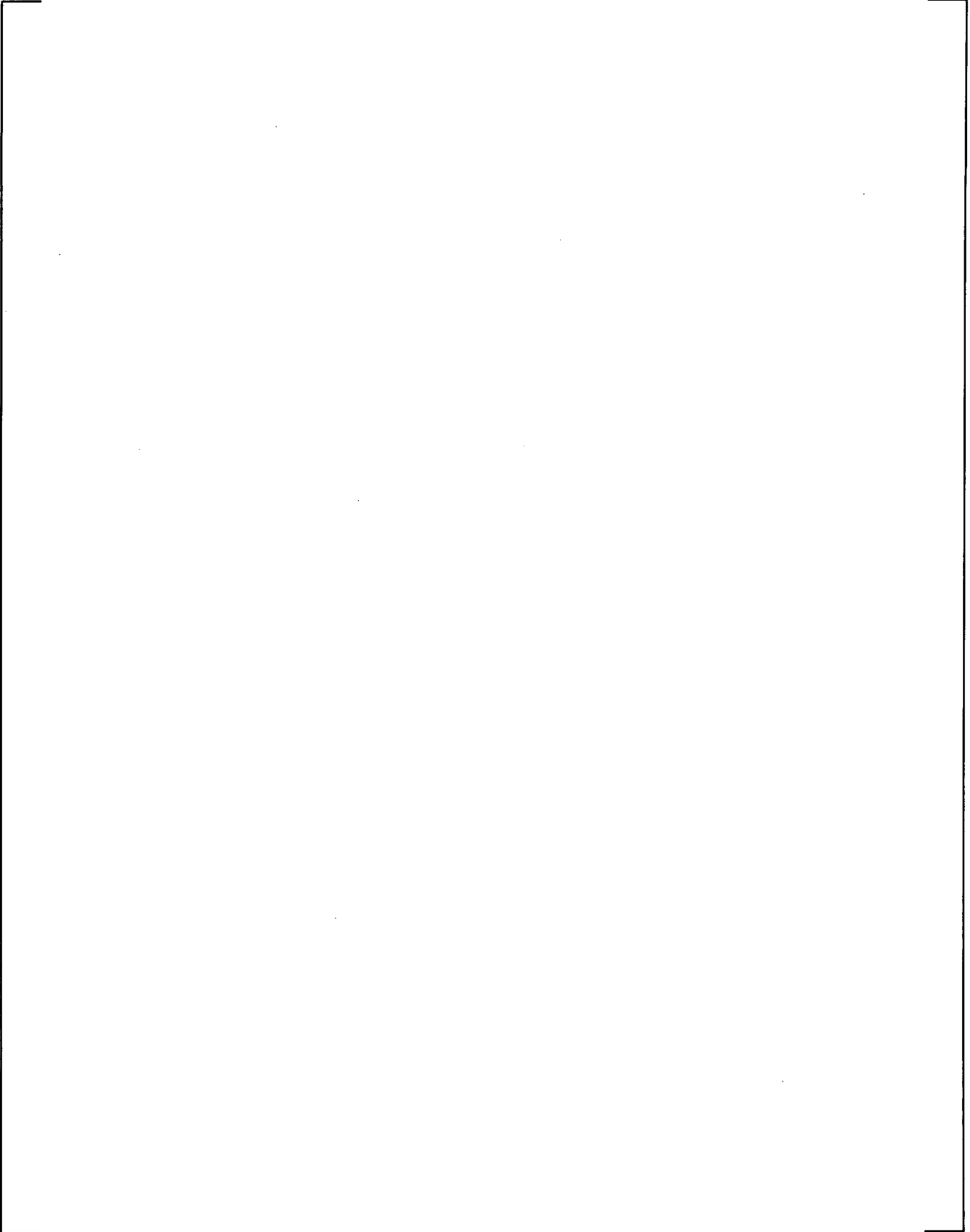


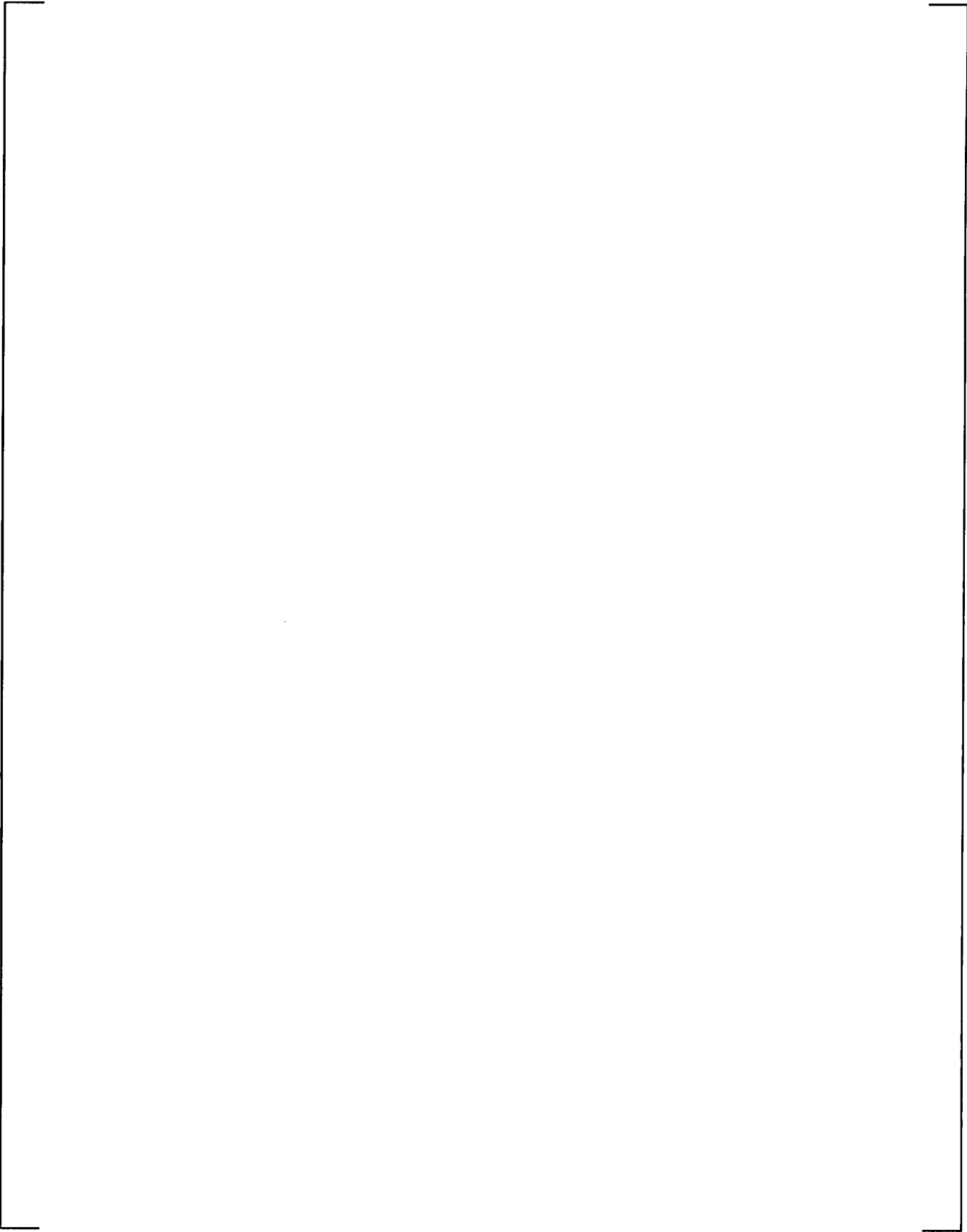


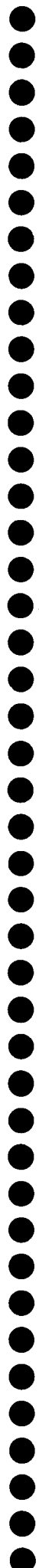
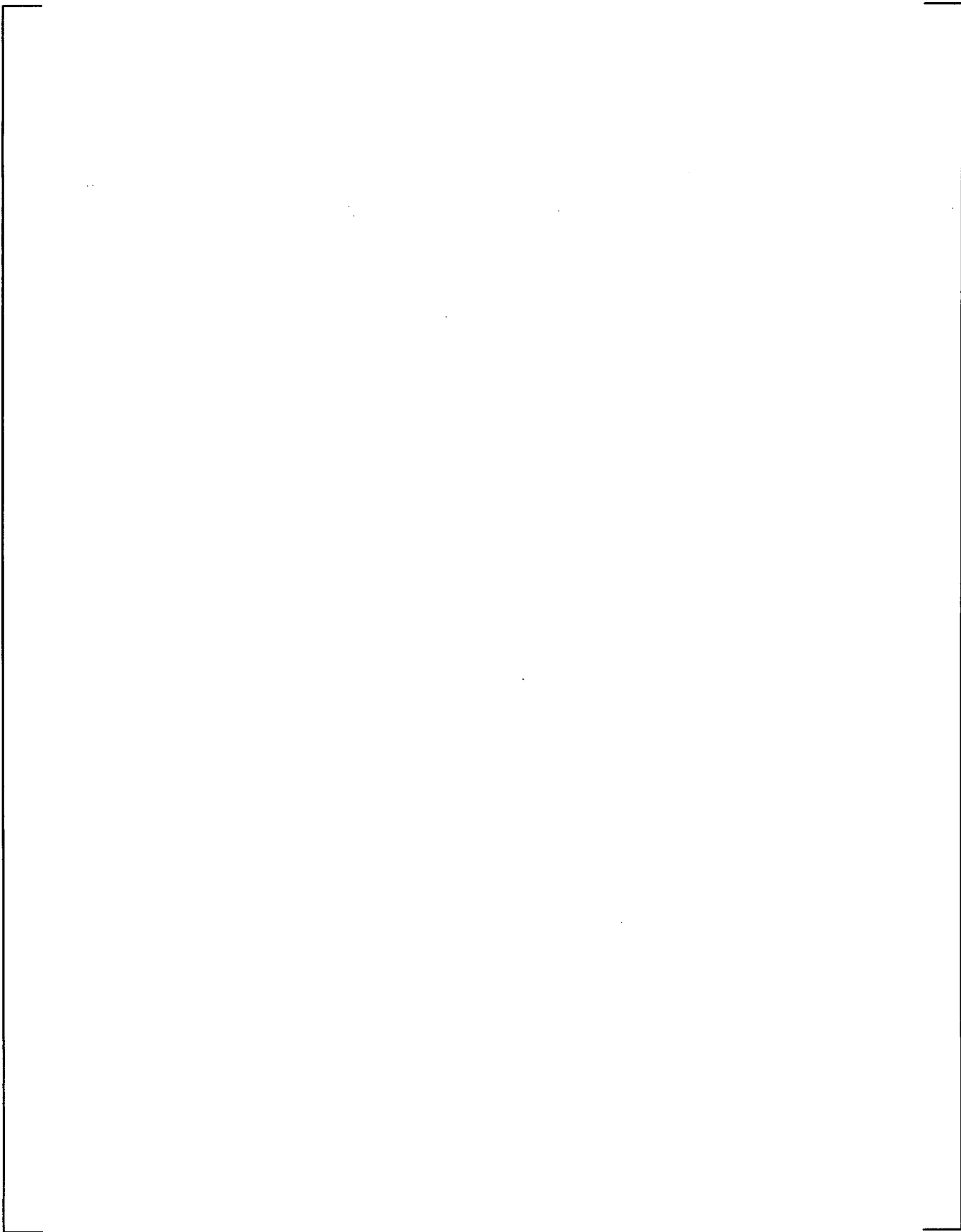


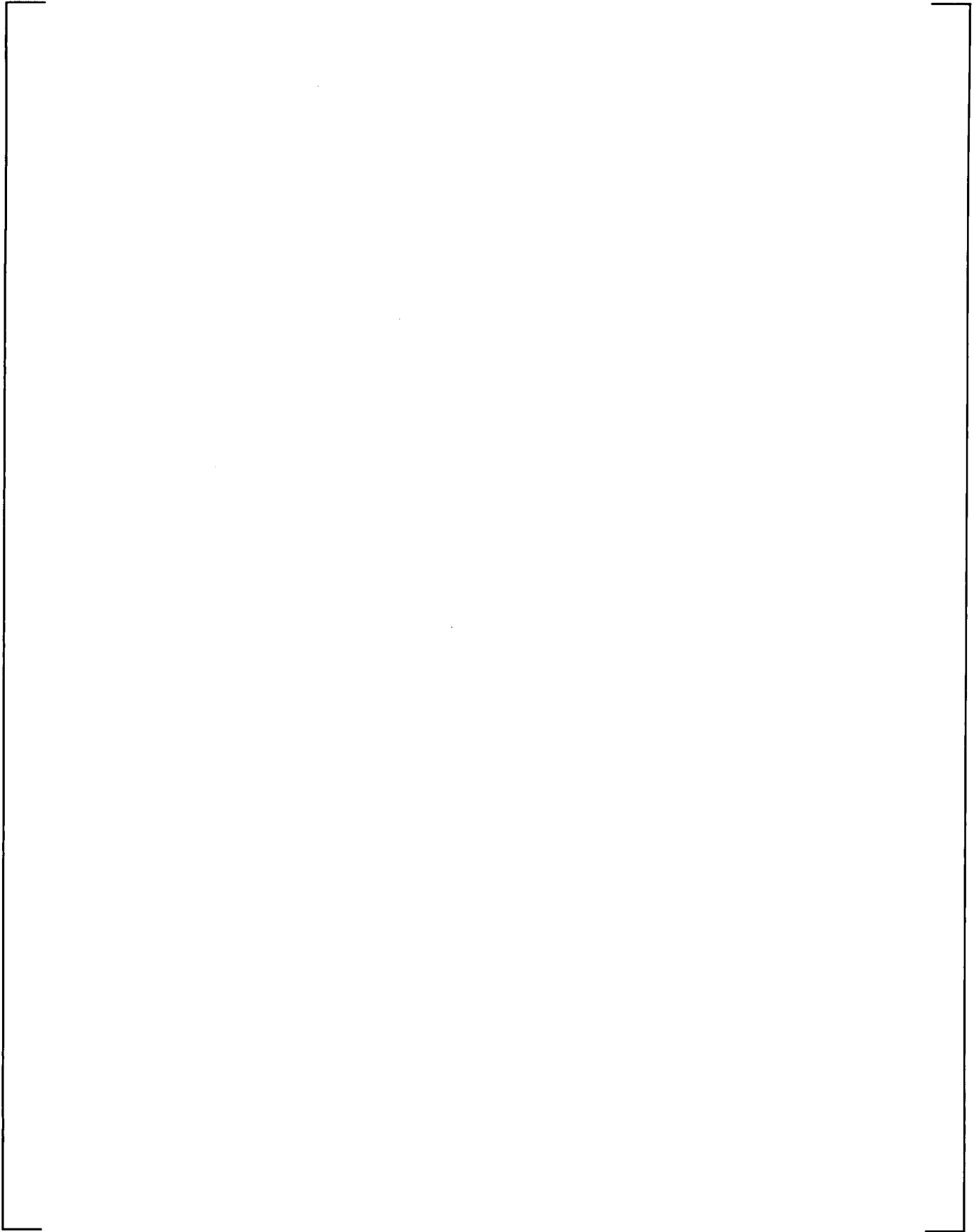


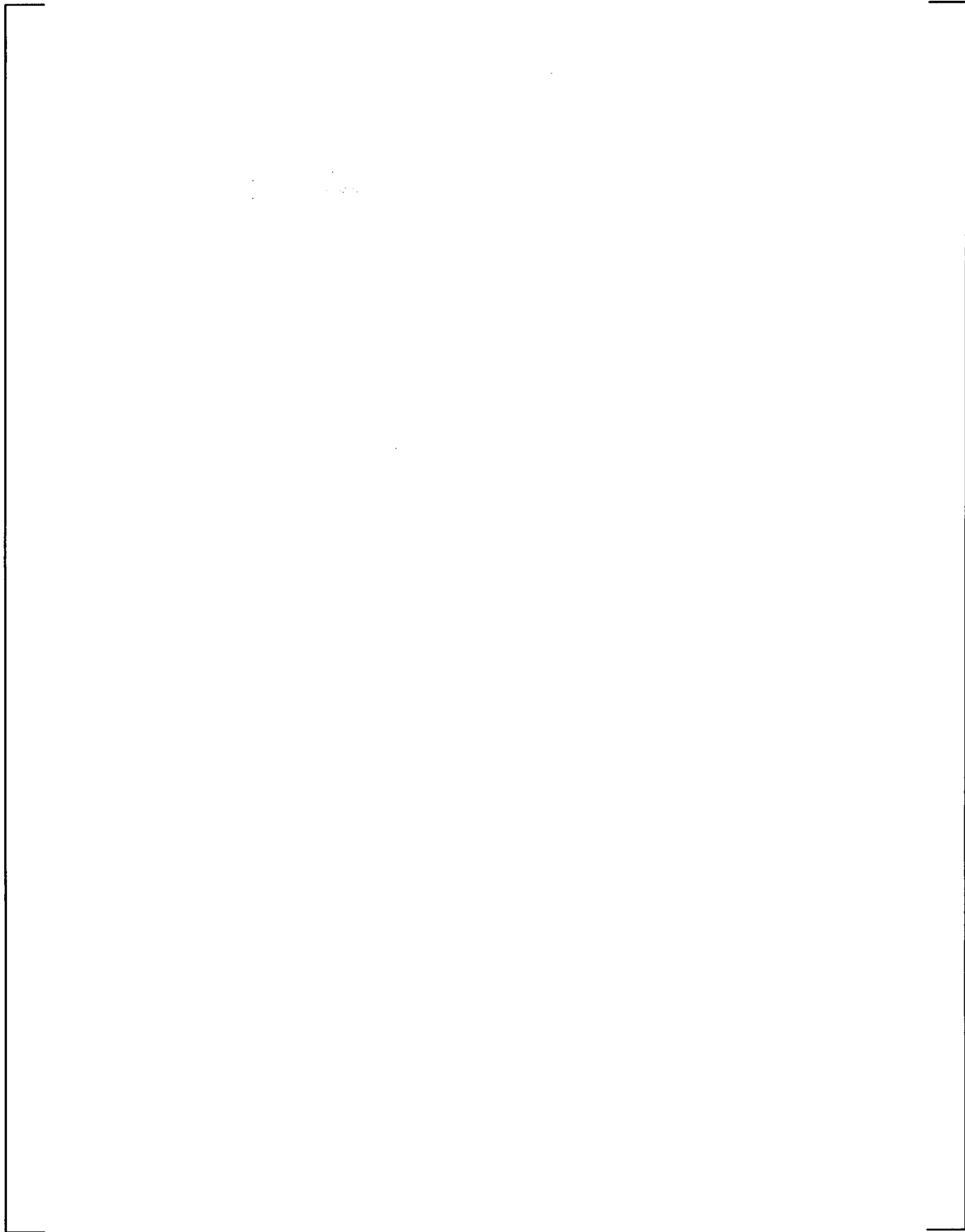






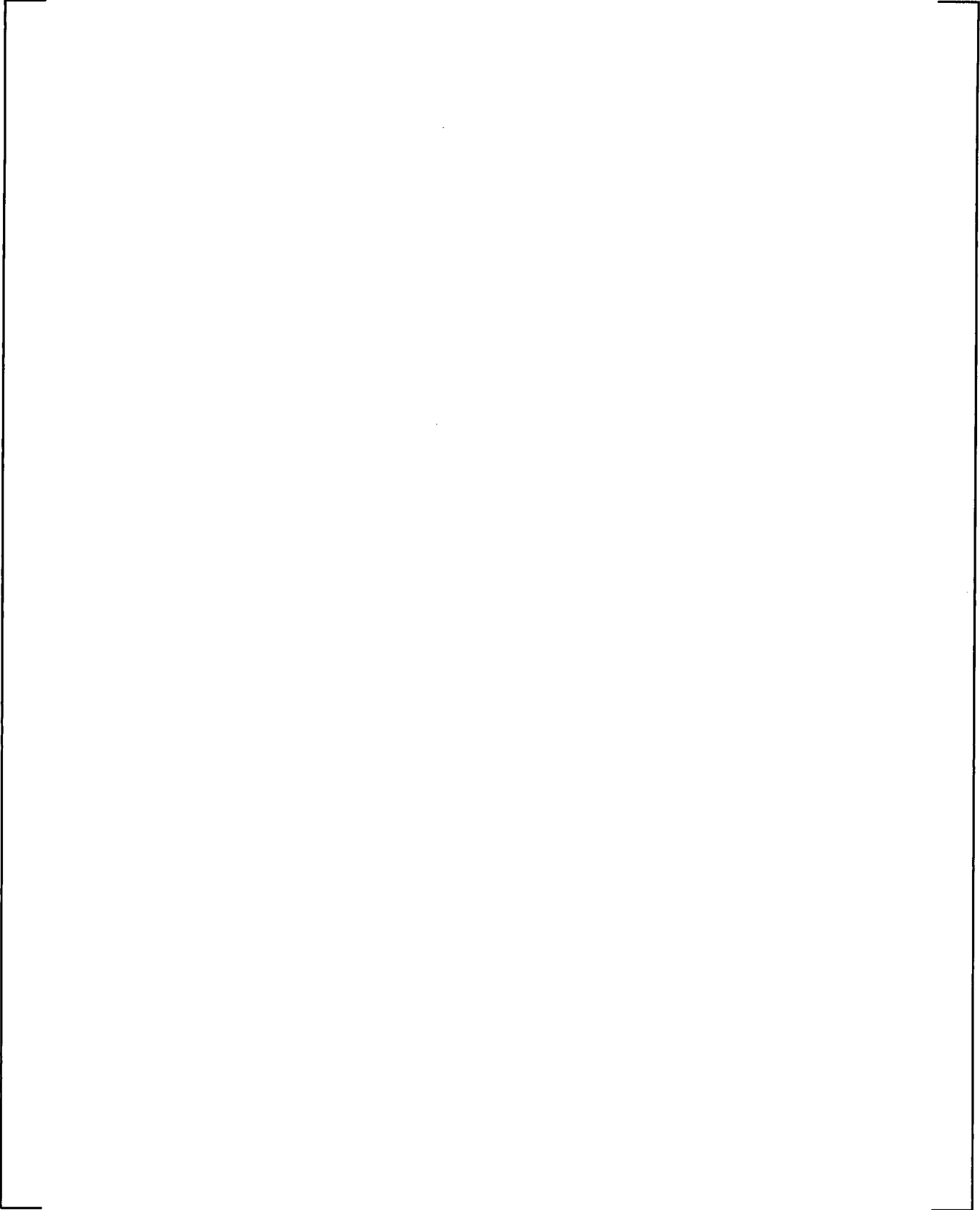


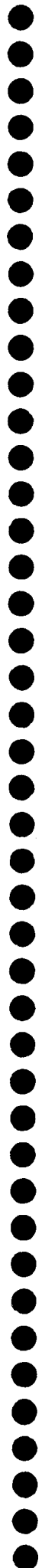
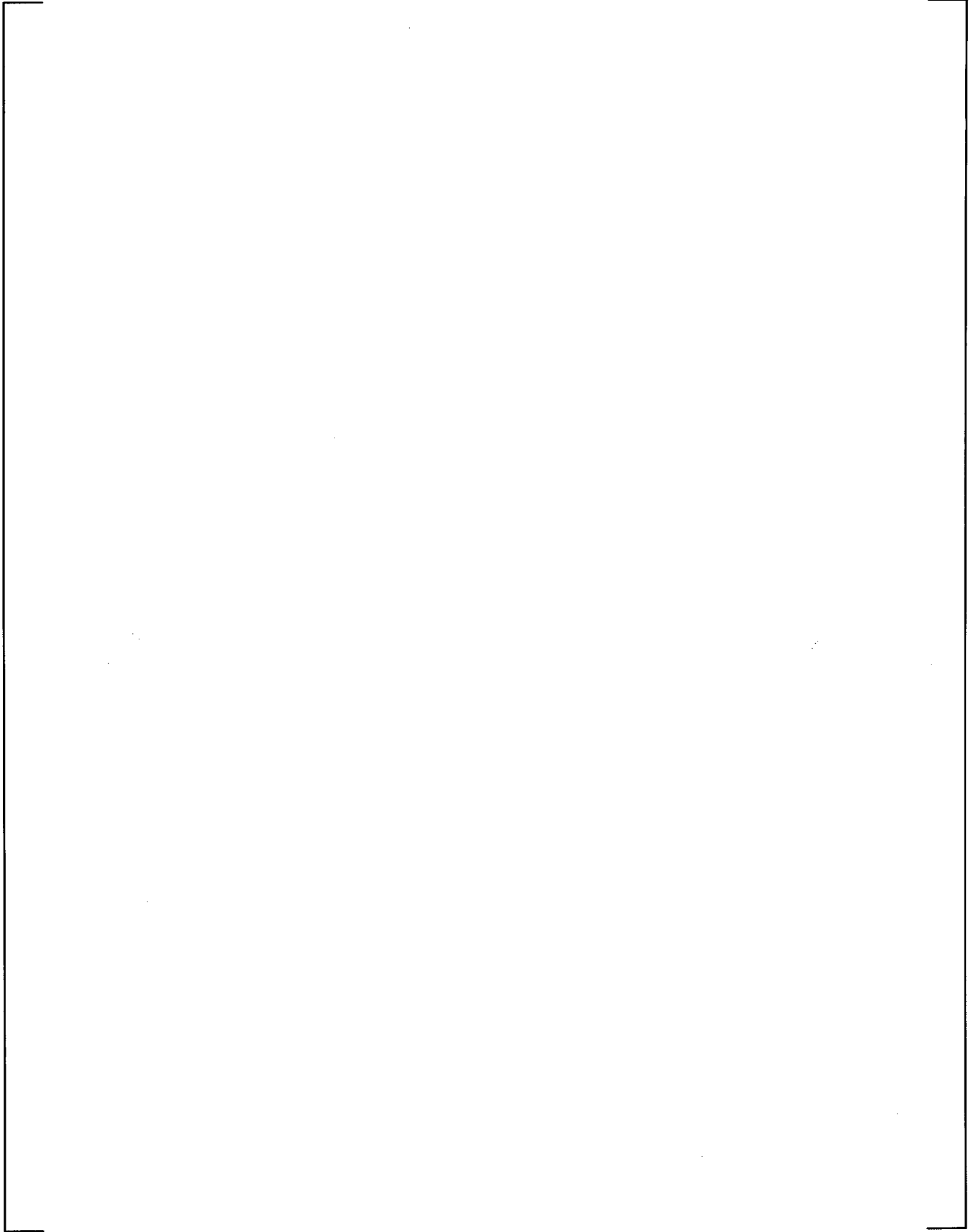


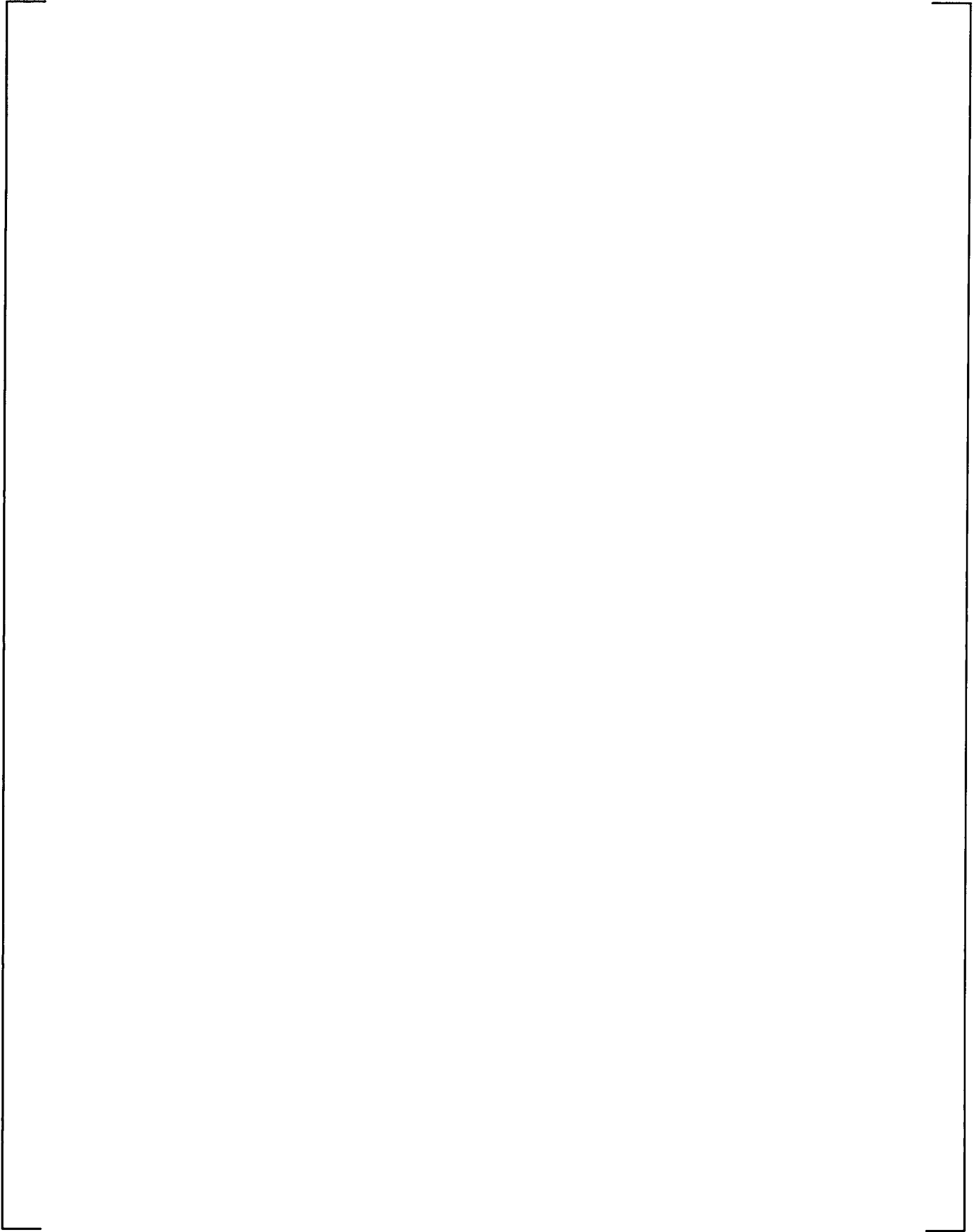


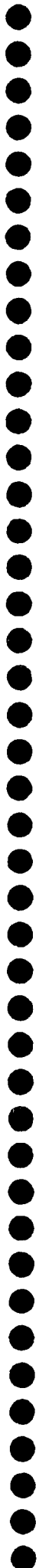
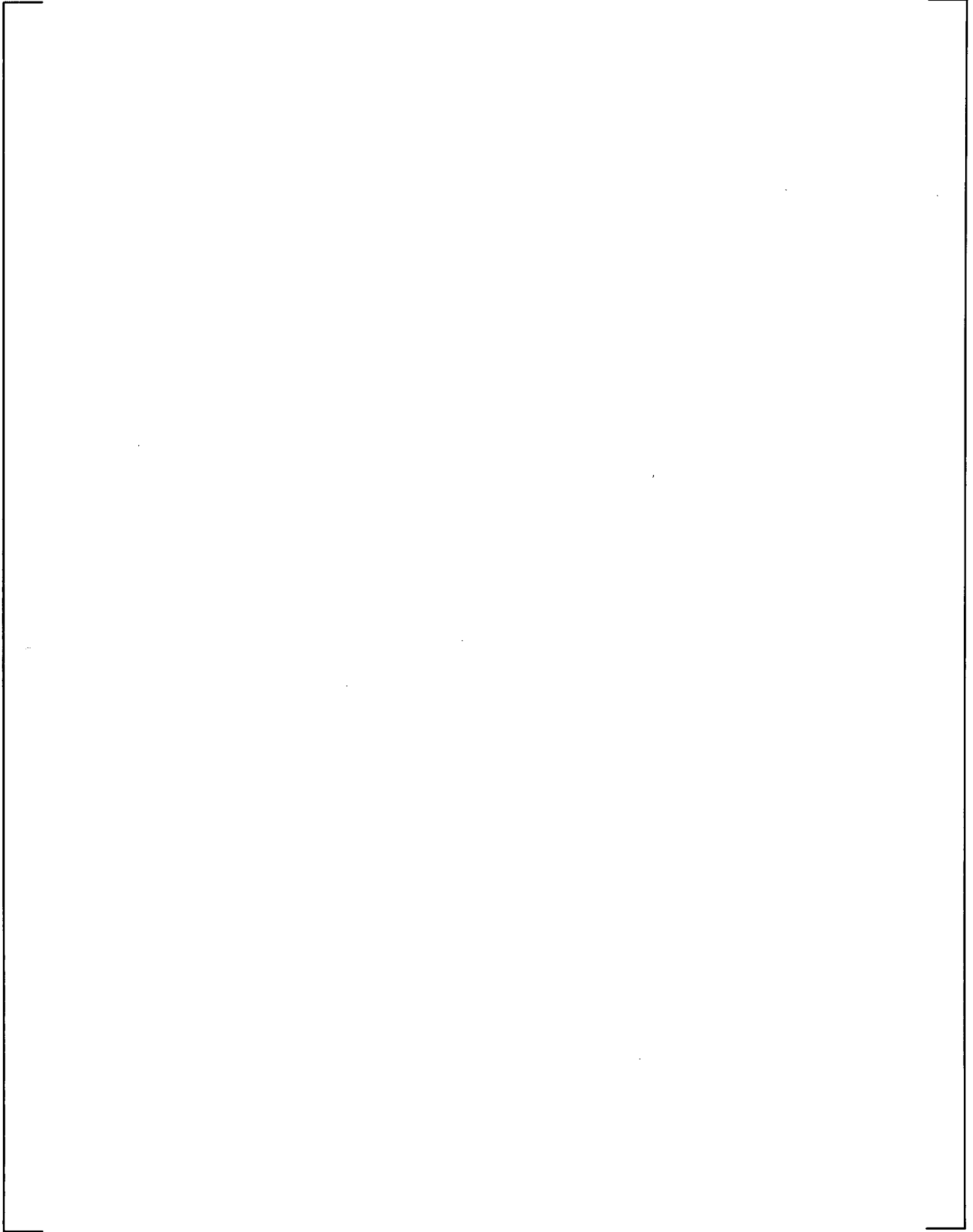
5 DESIGN OF THE AIR INLETS AND THE TENSION RING

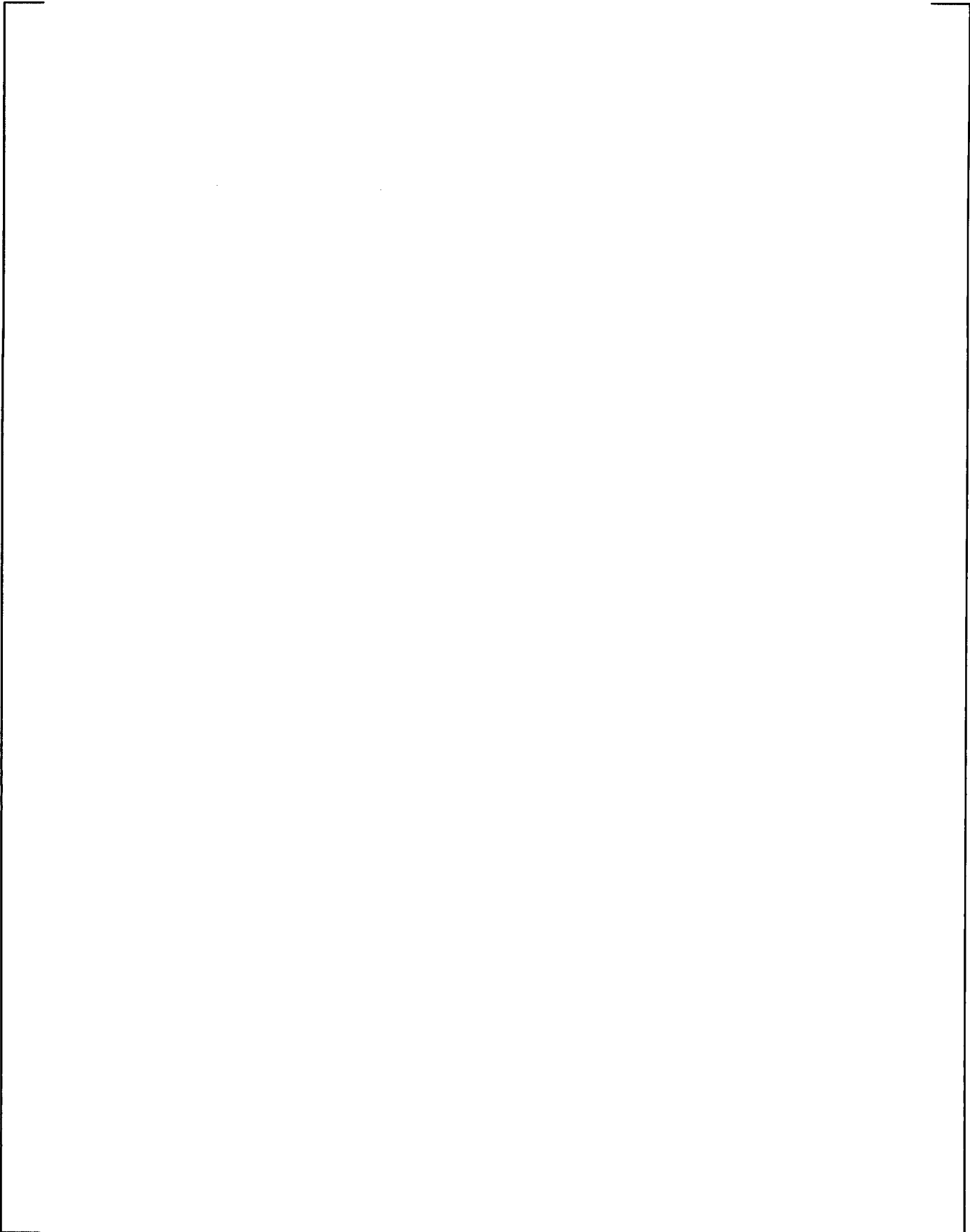
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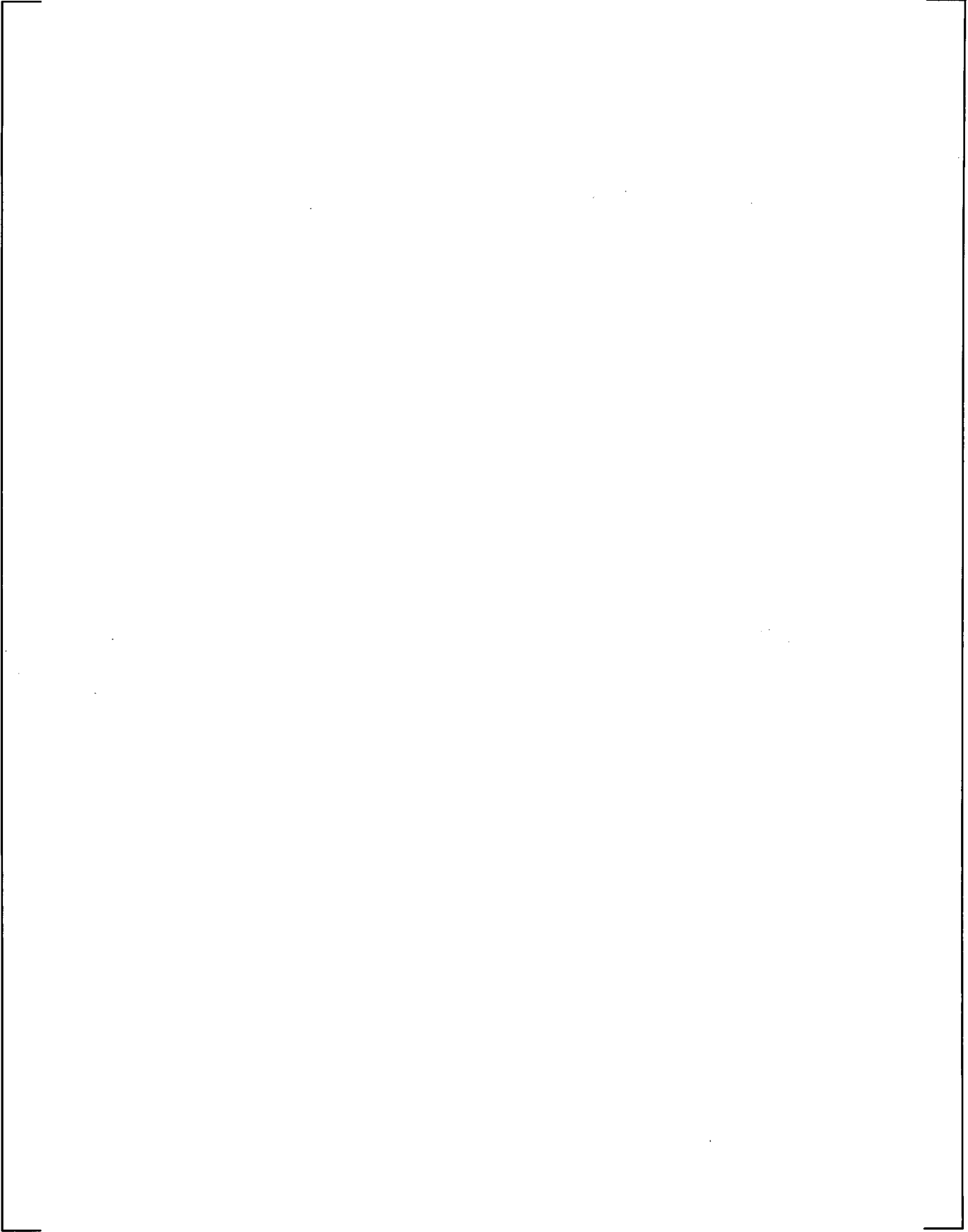


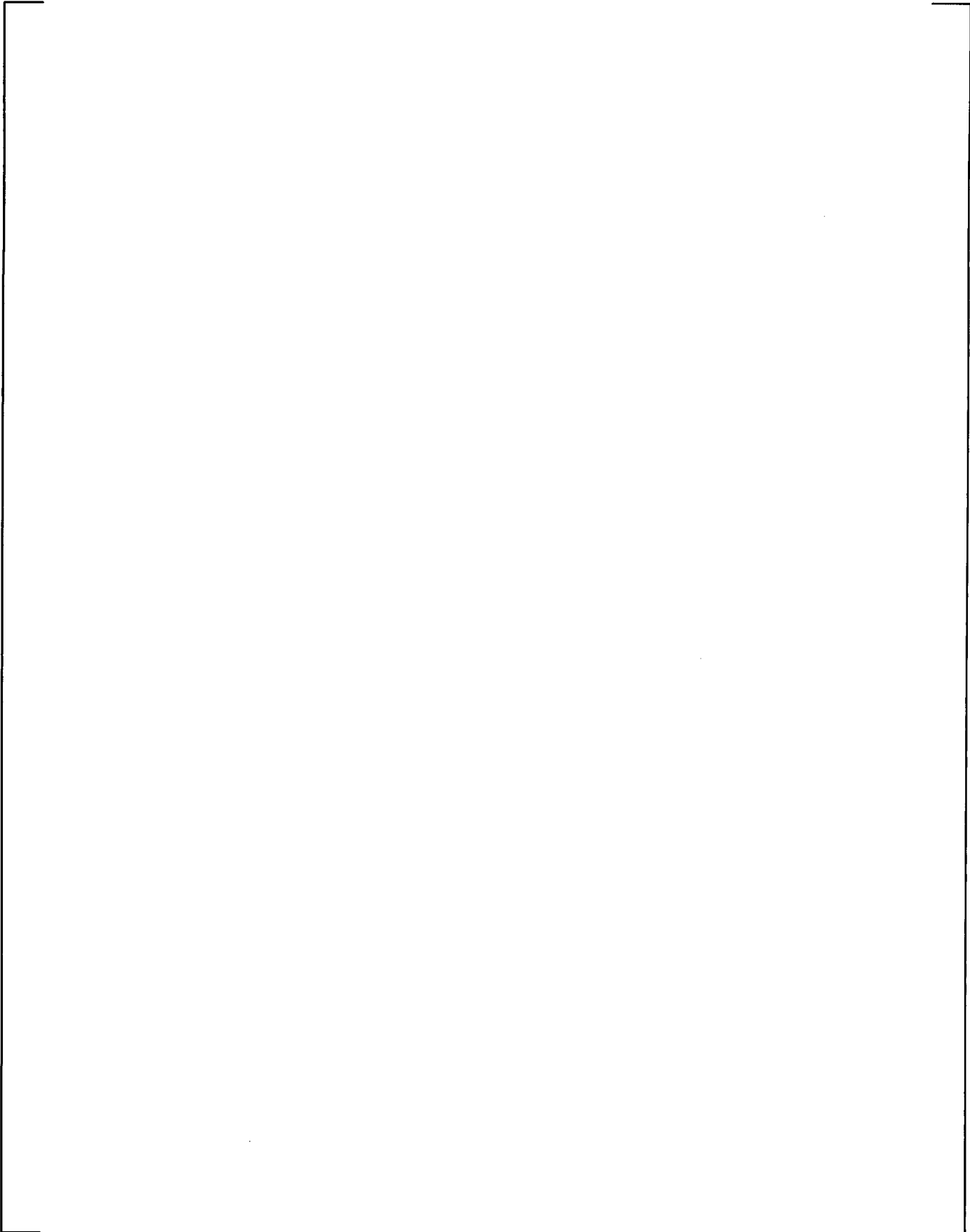


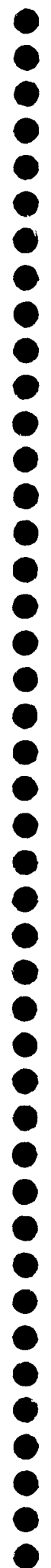
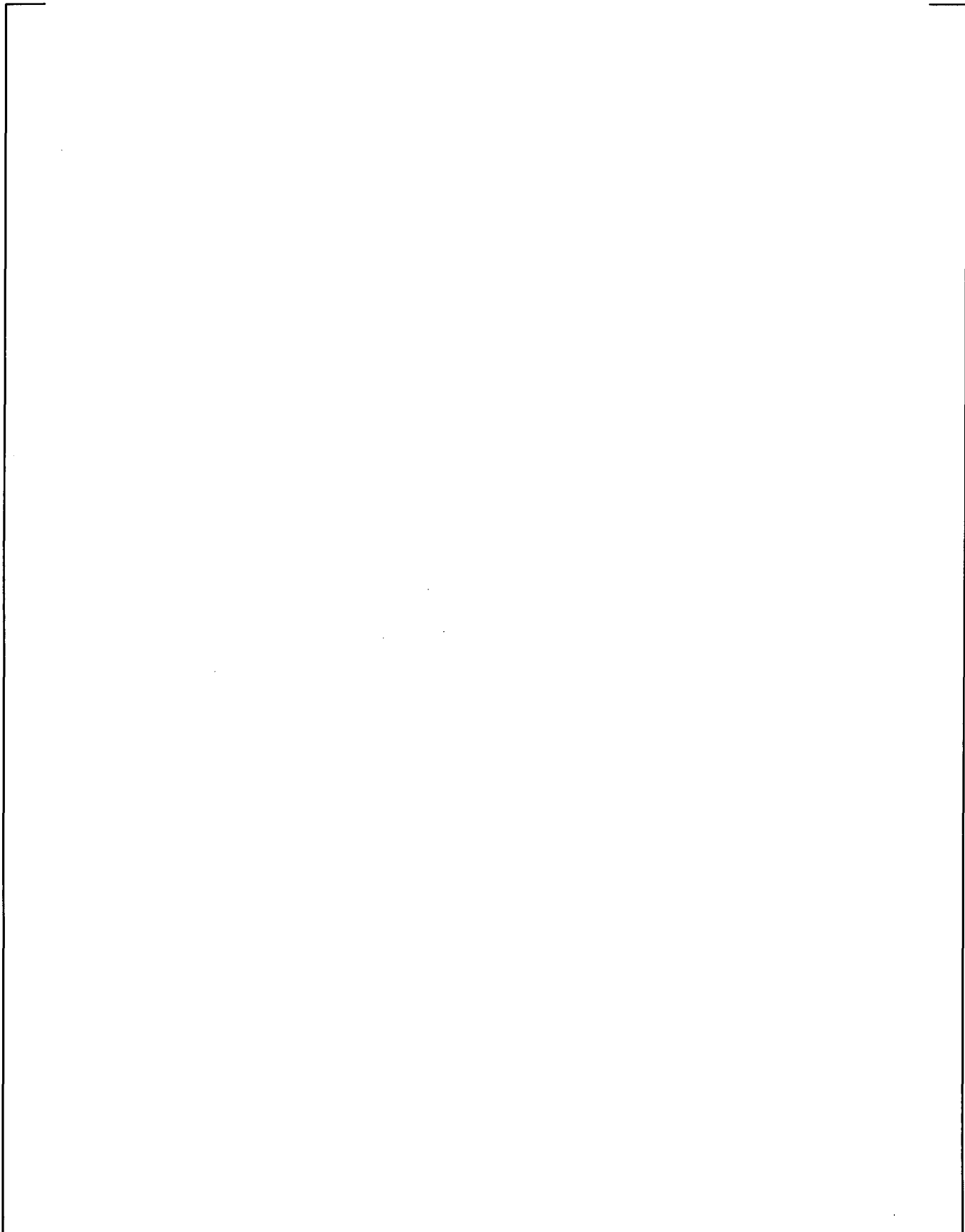


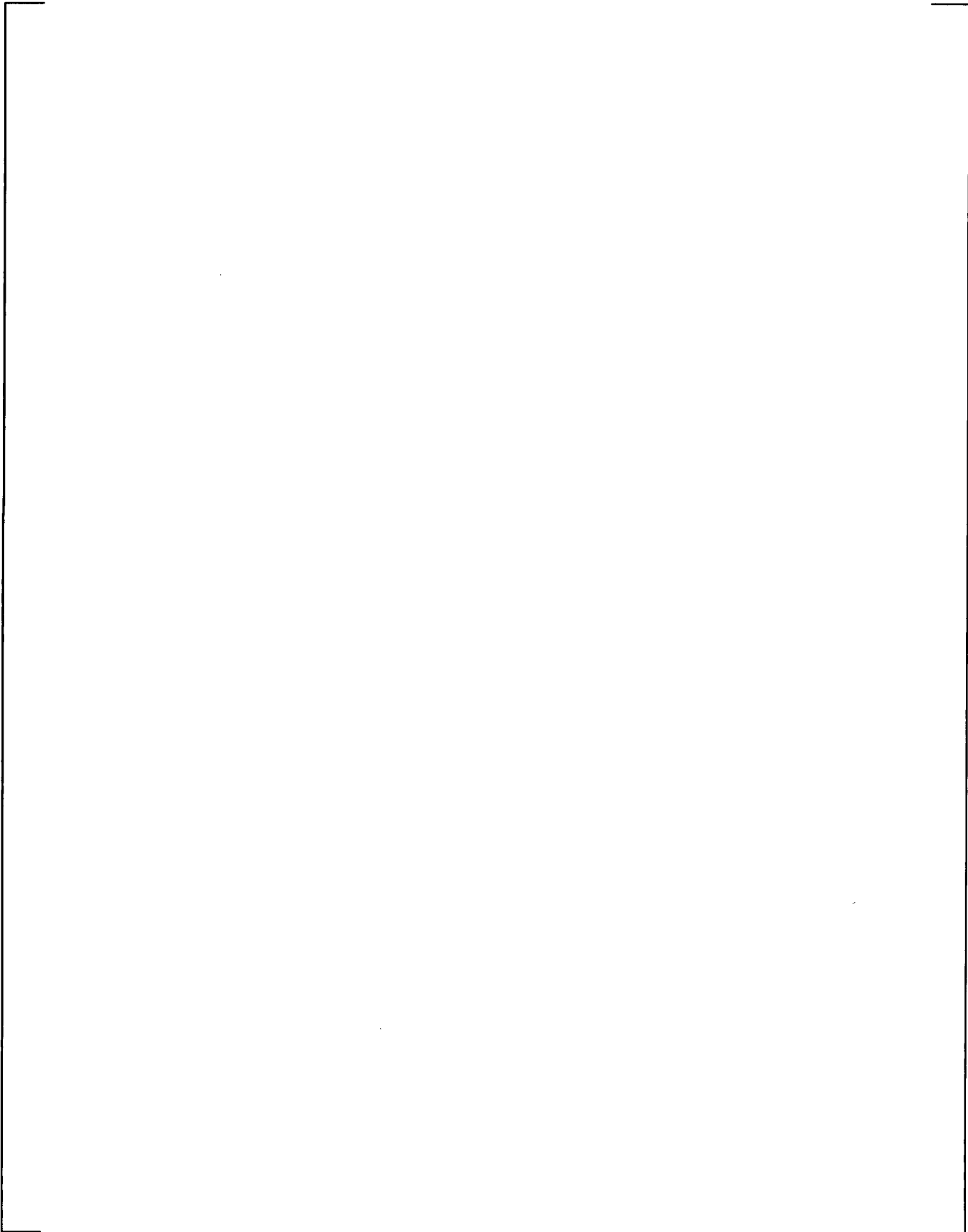


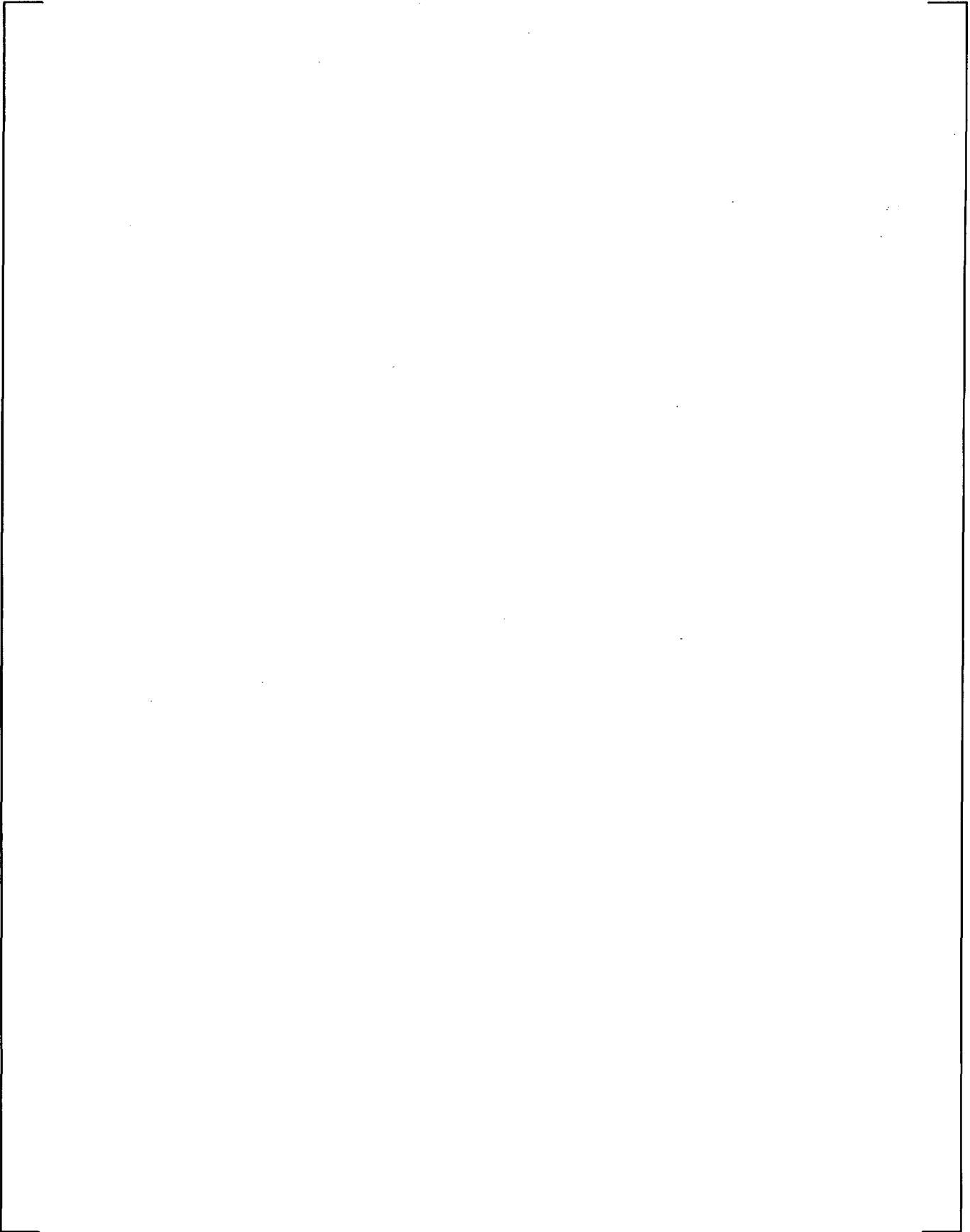






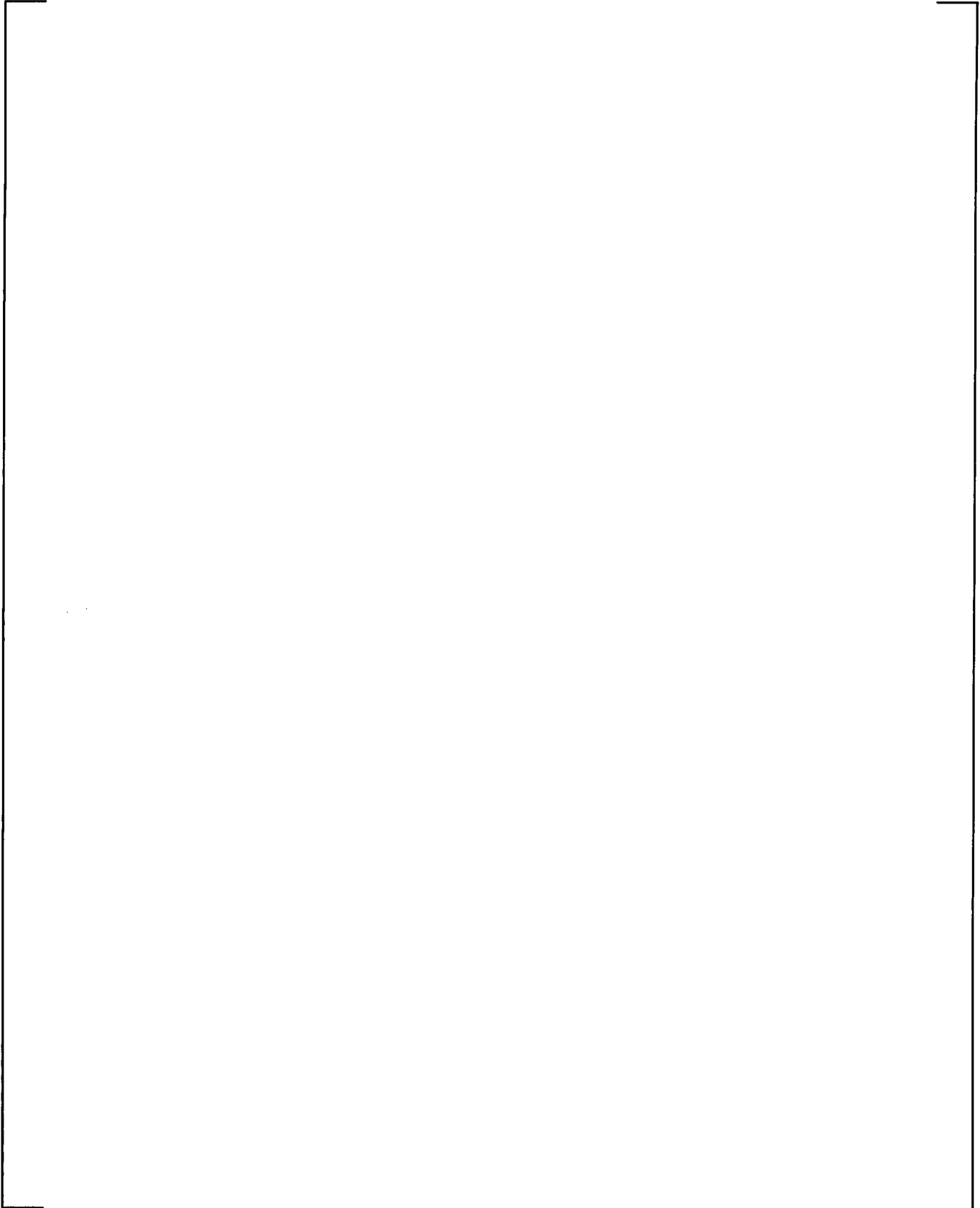


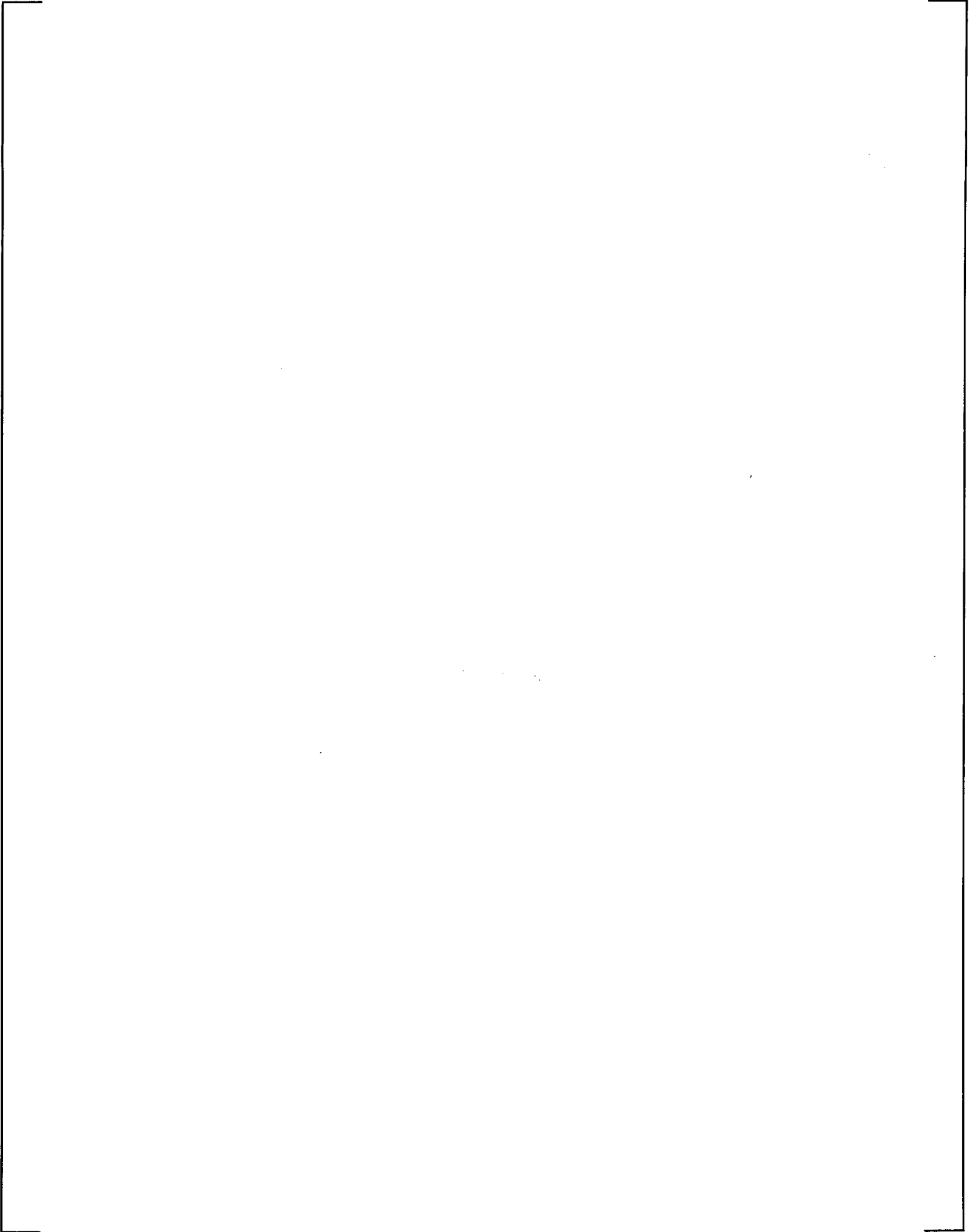


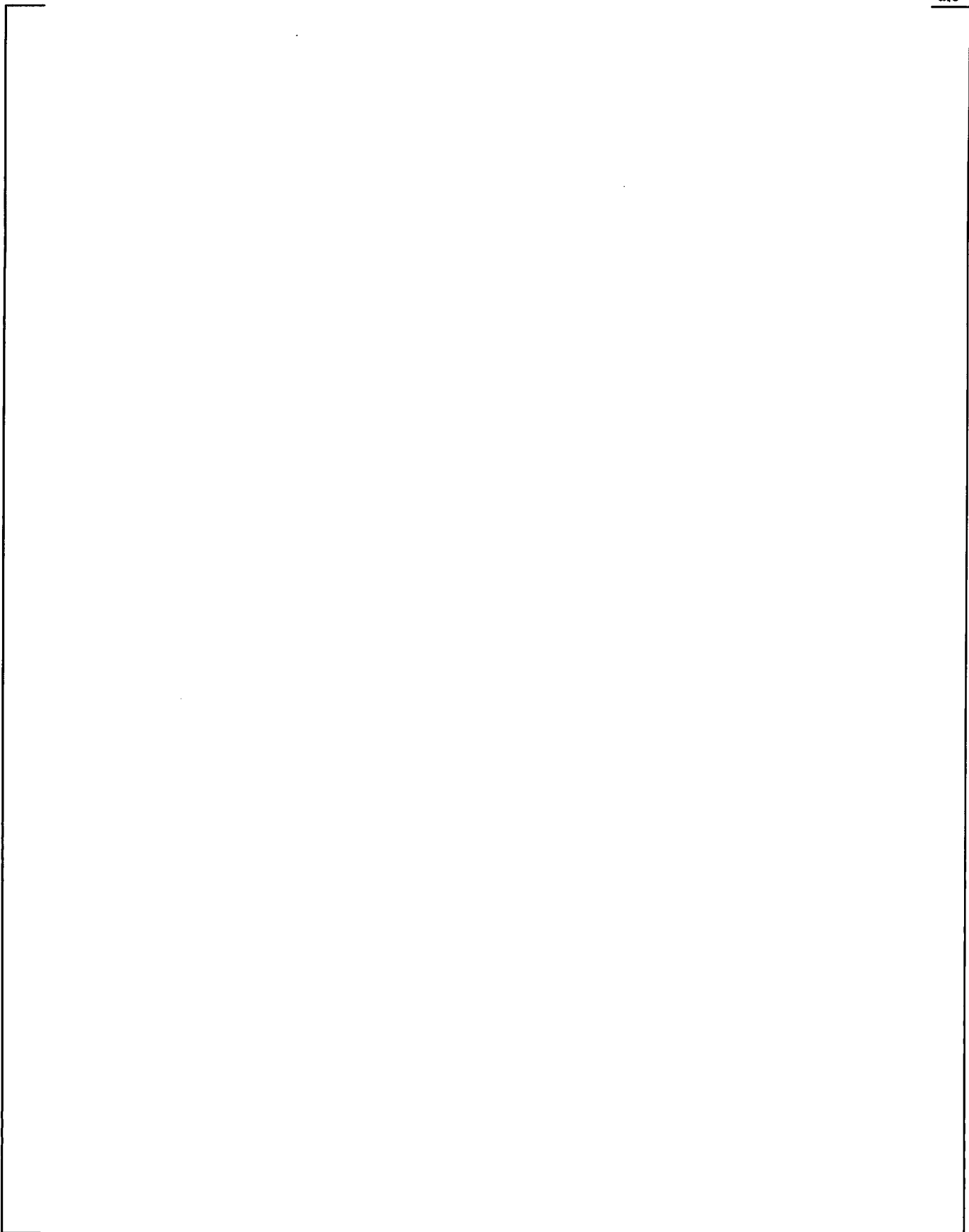


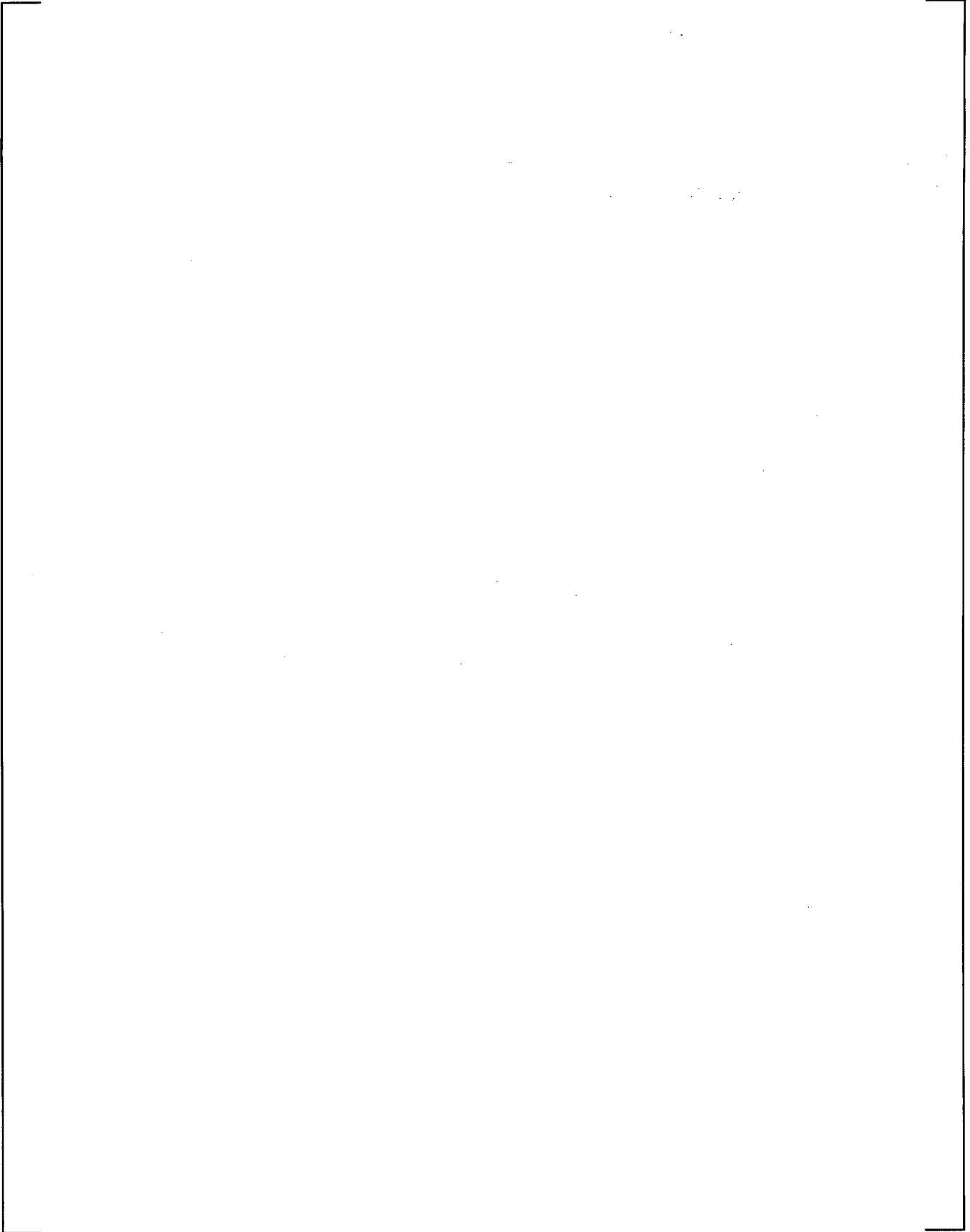
6 REINFORCED CONCRETE REGIONS OF THE SHIELD BUILDING

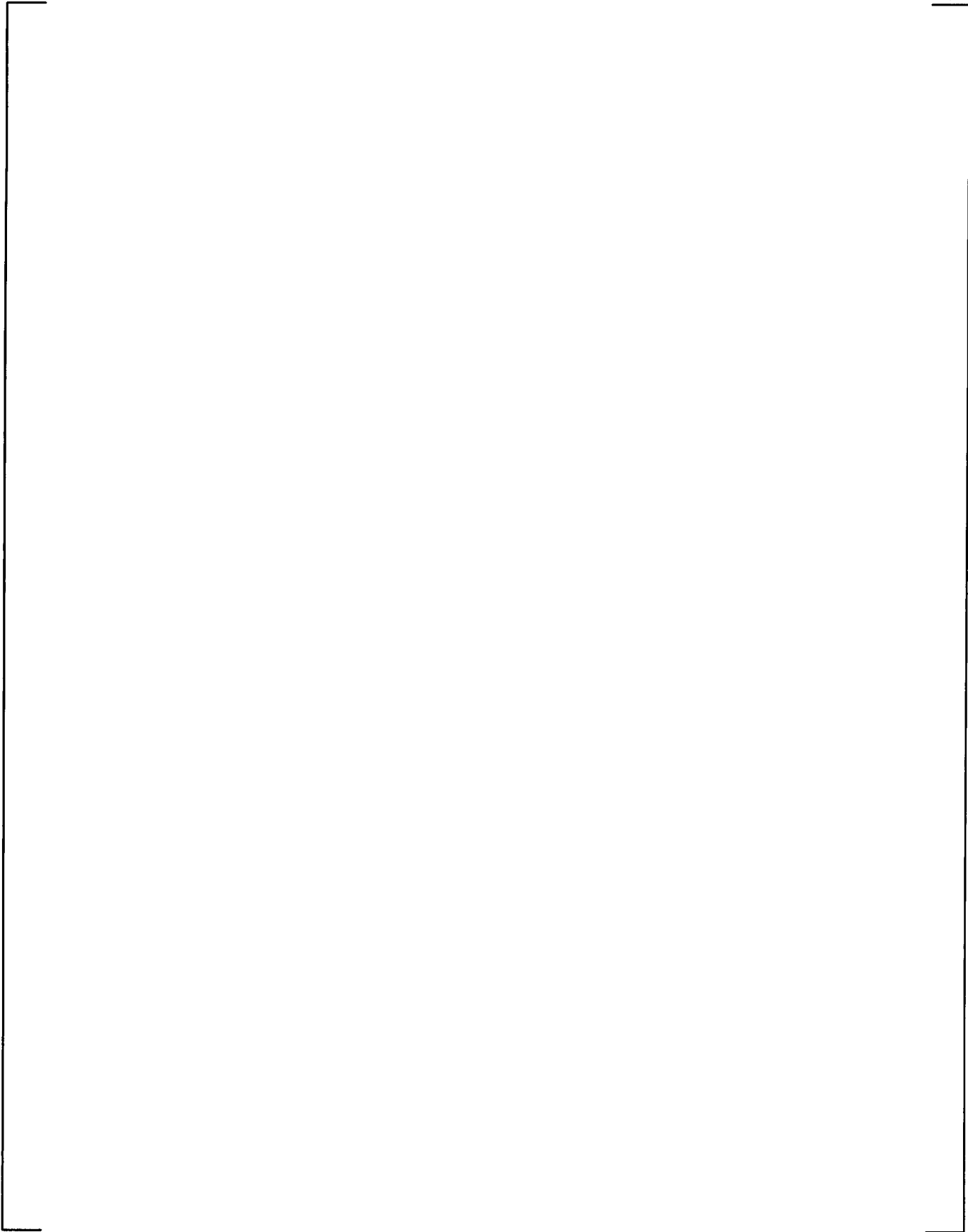
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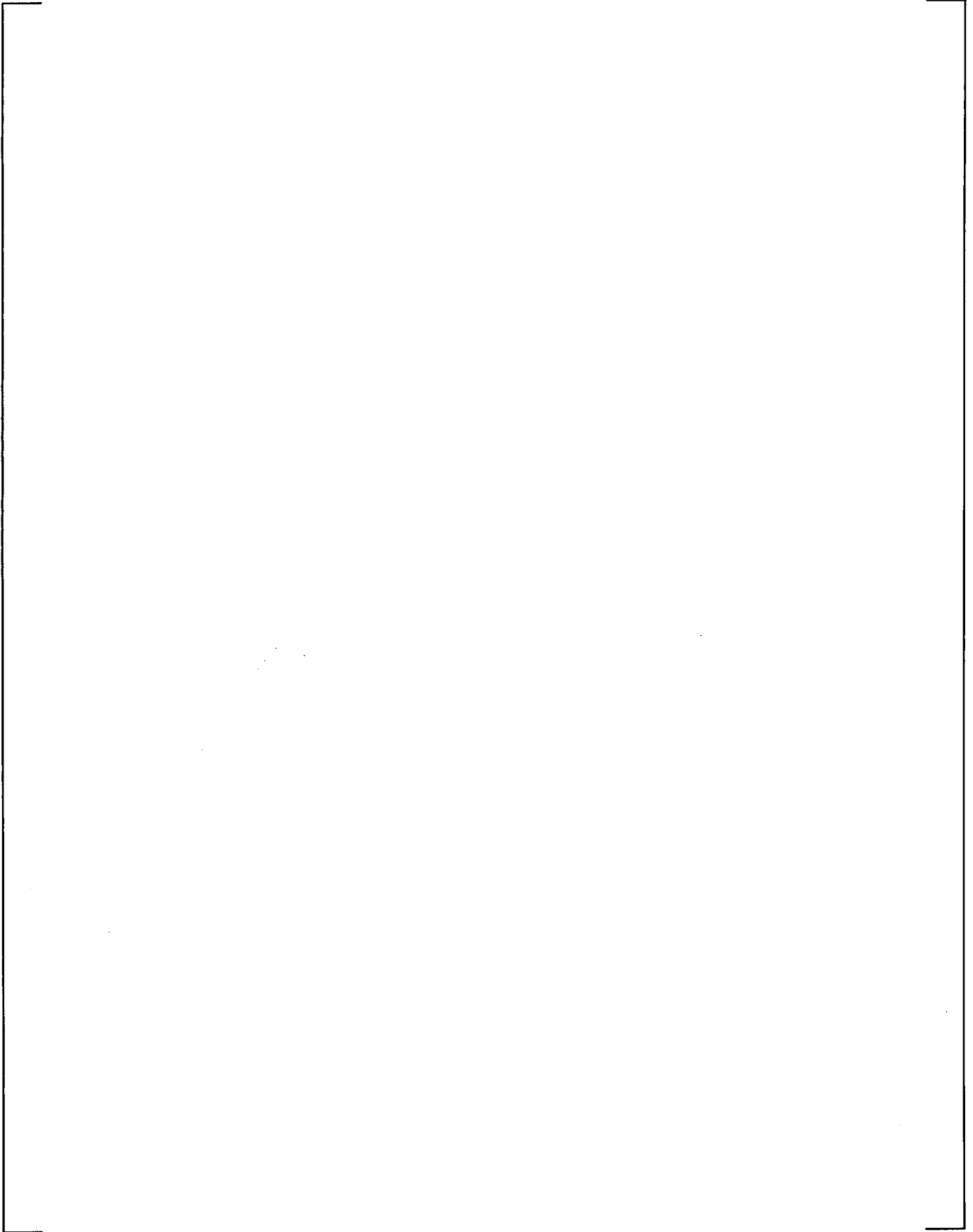


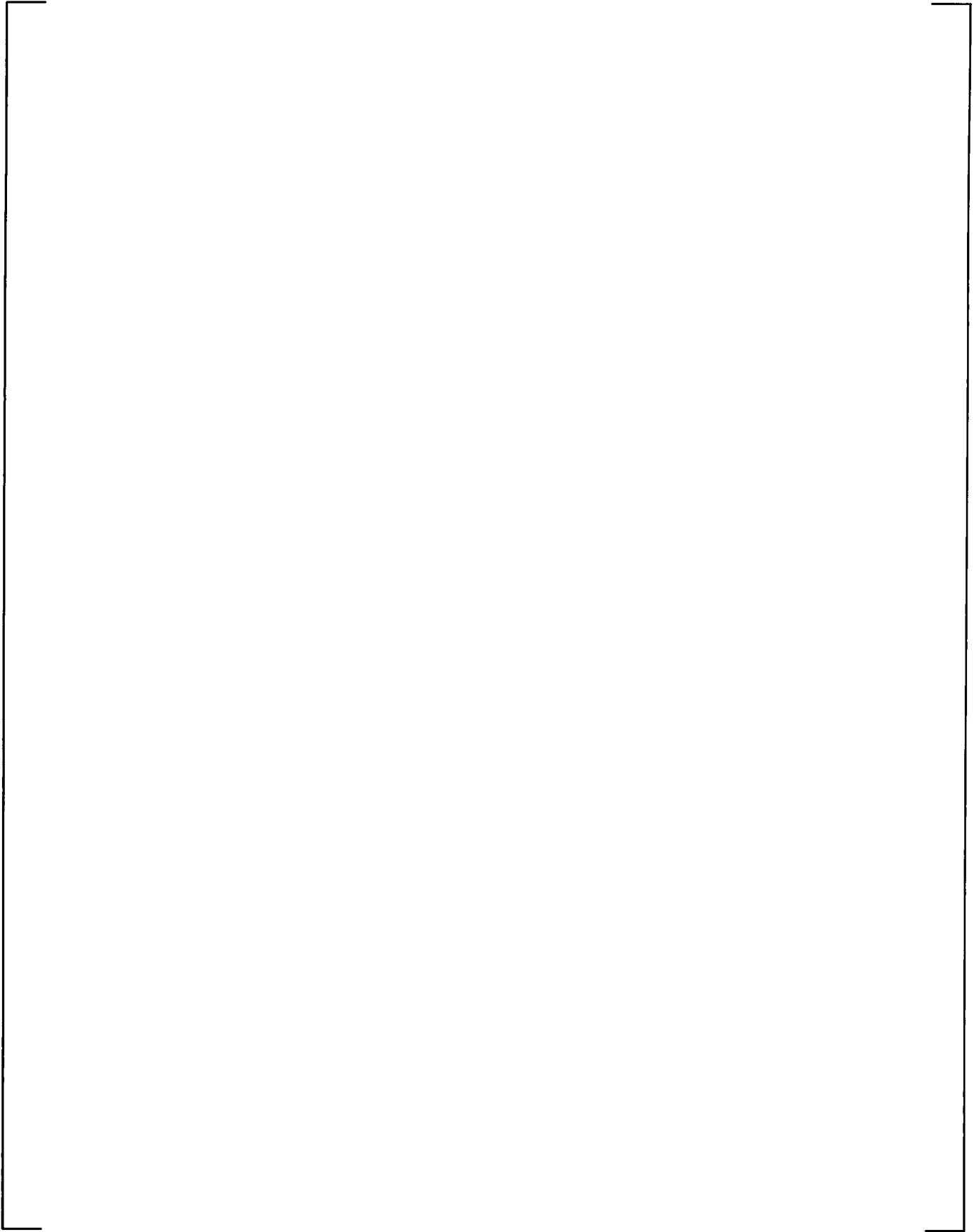


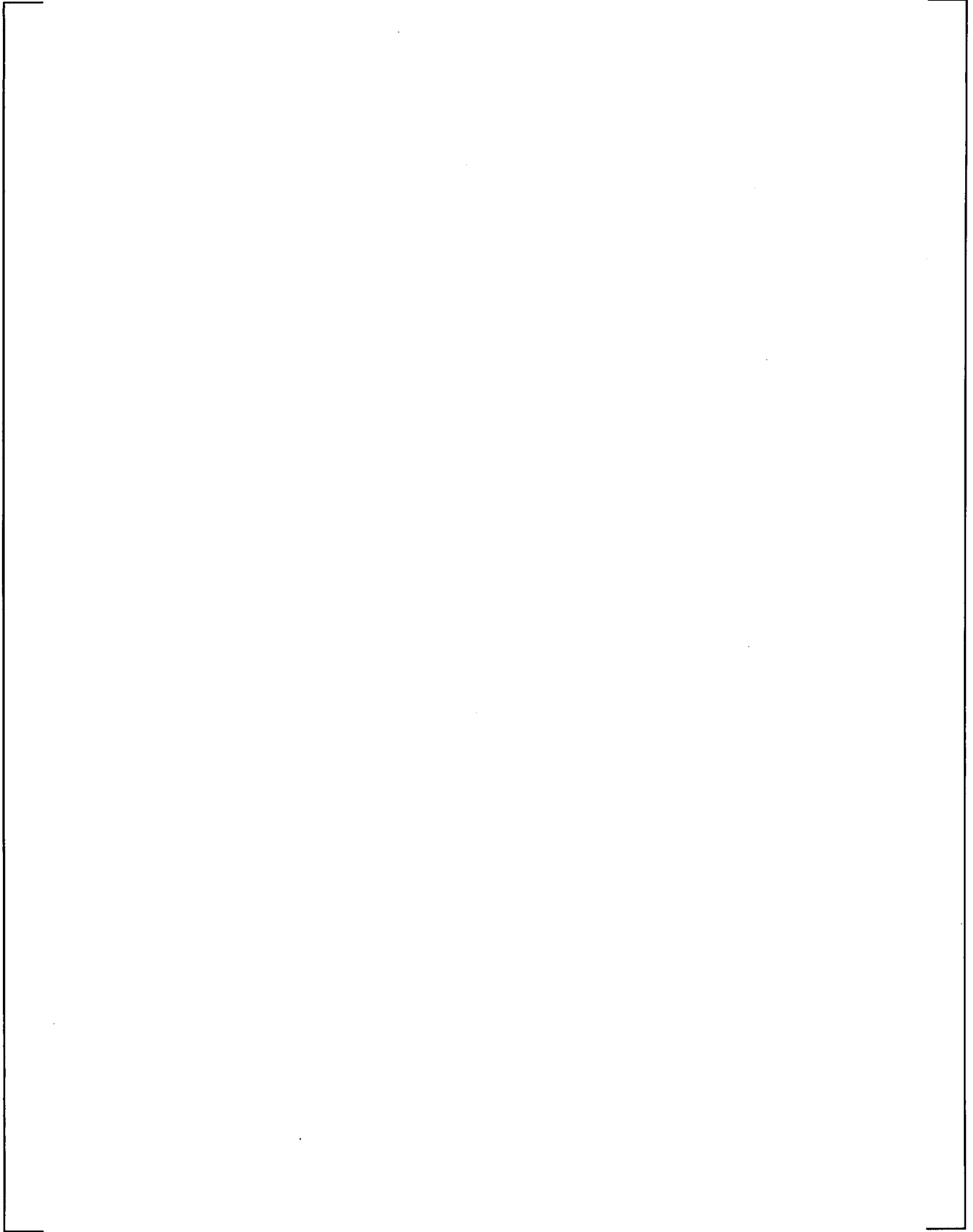






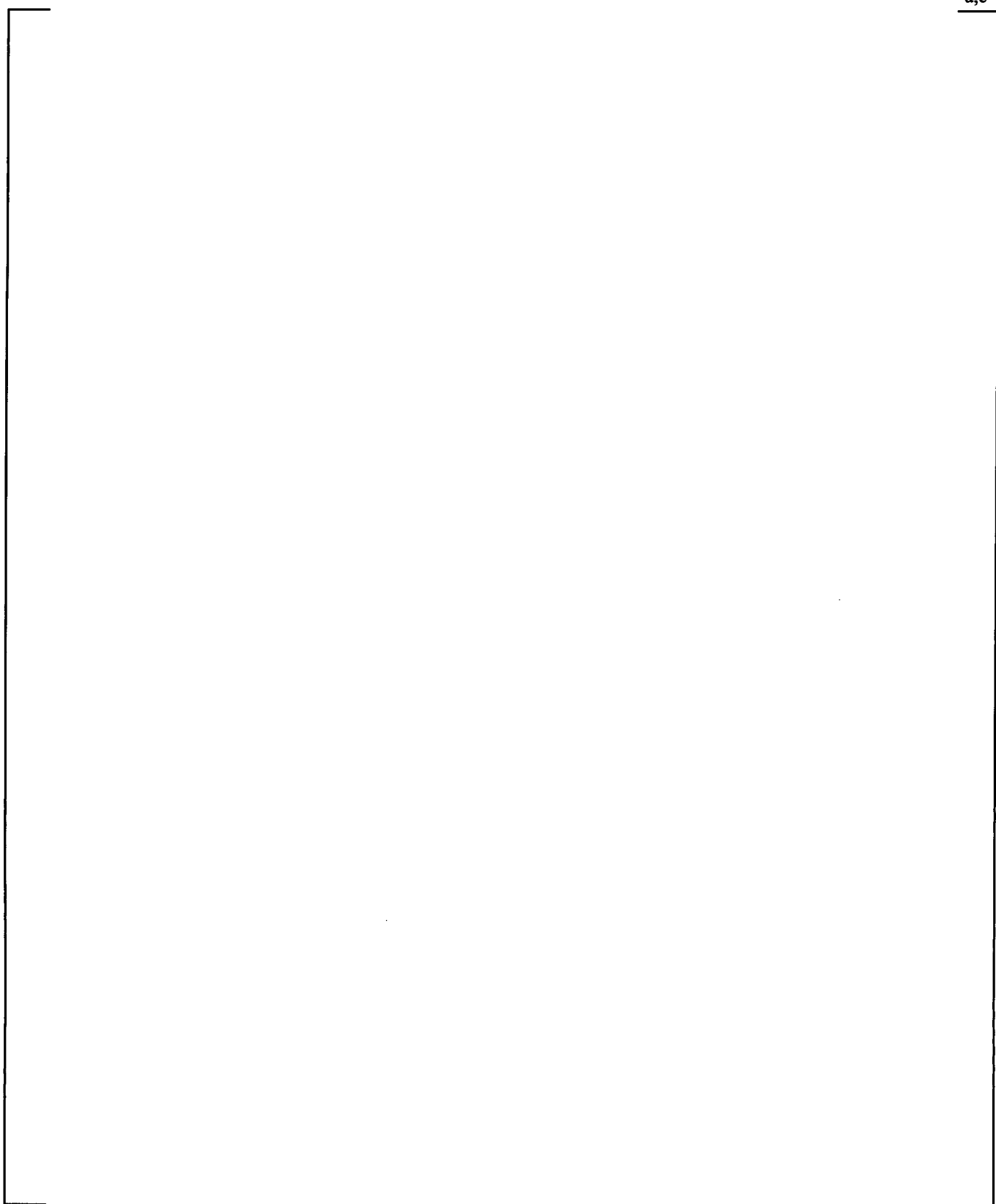


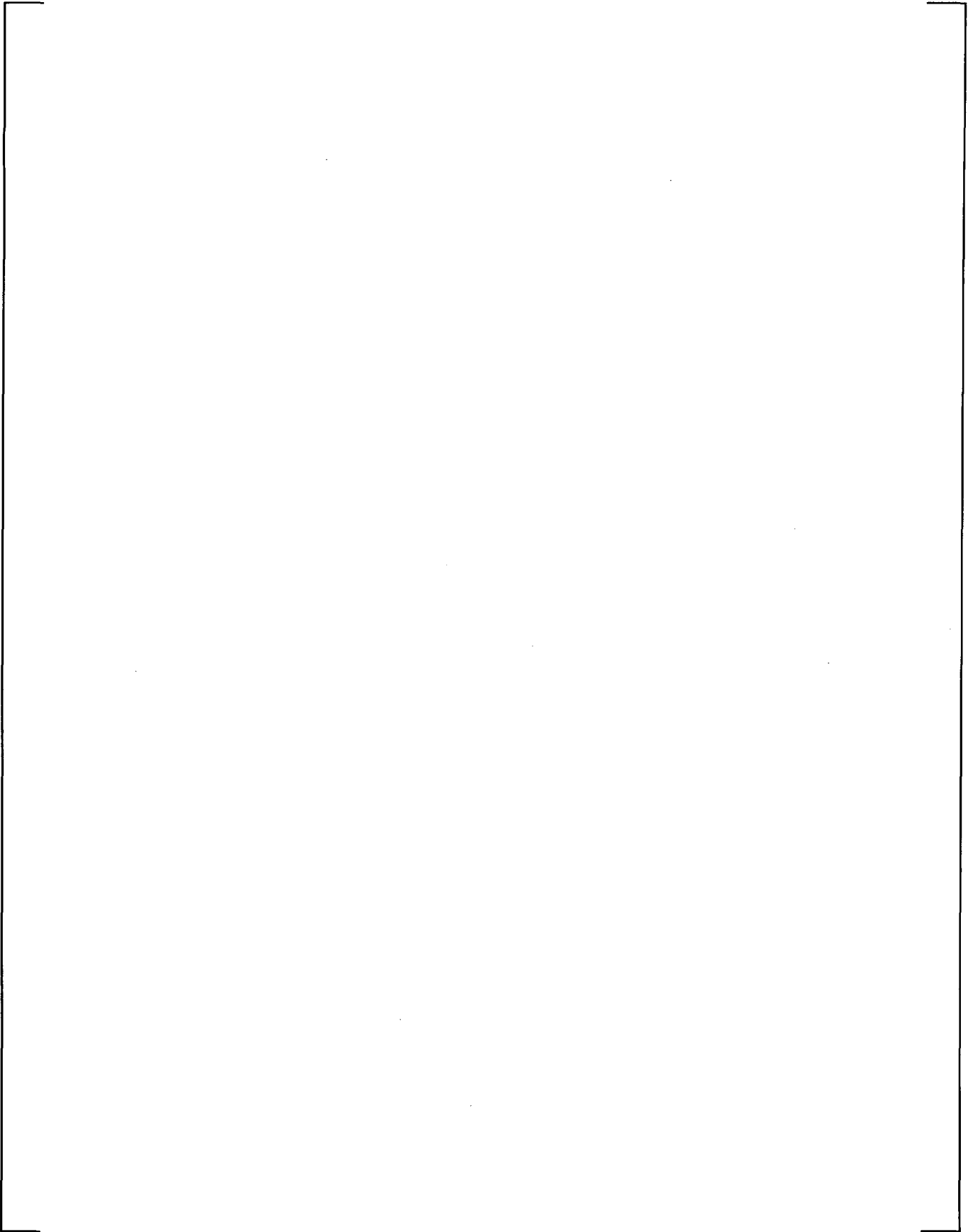


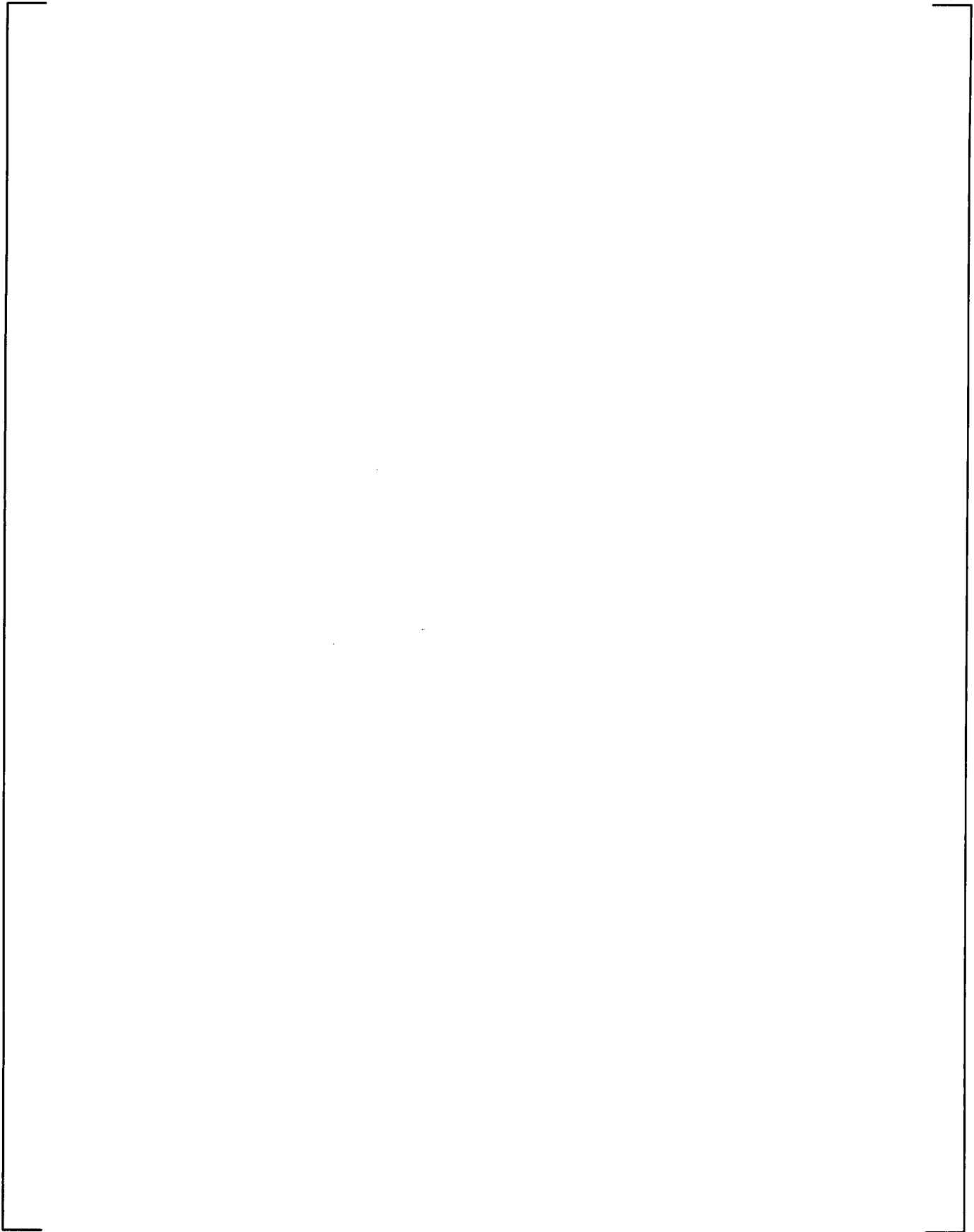


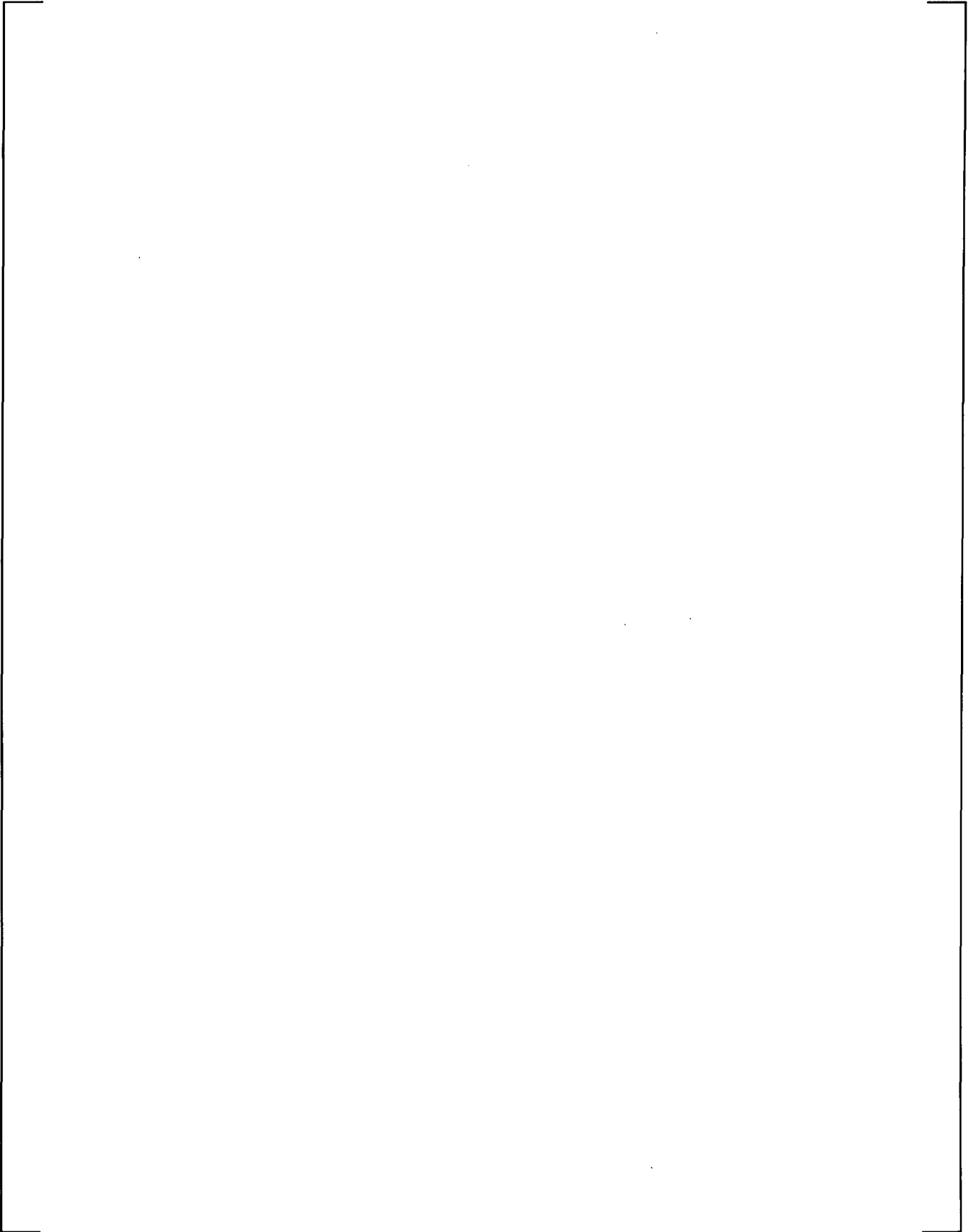
7 SHIELD BUILDING TEST PROGRAM

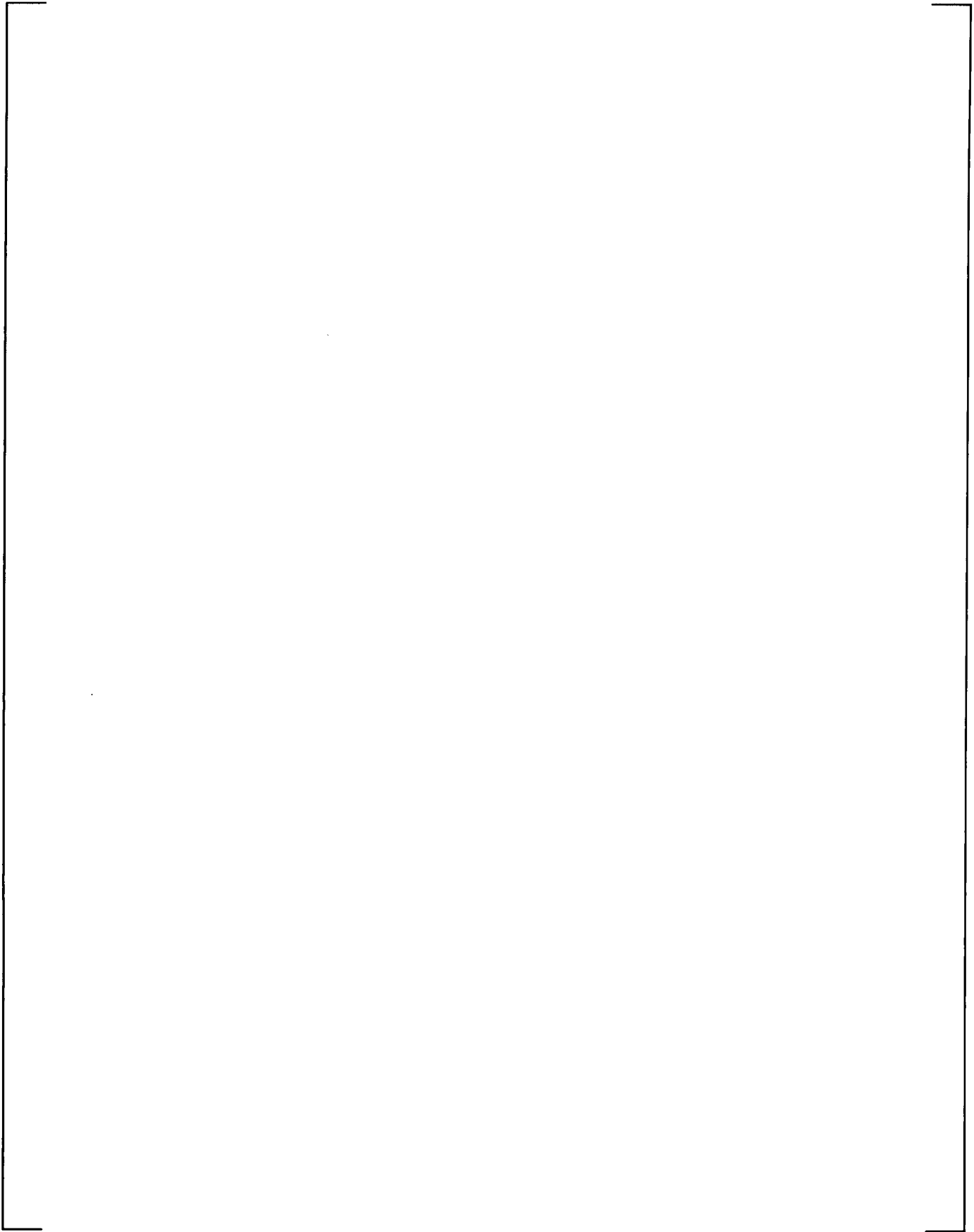
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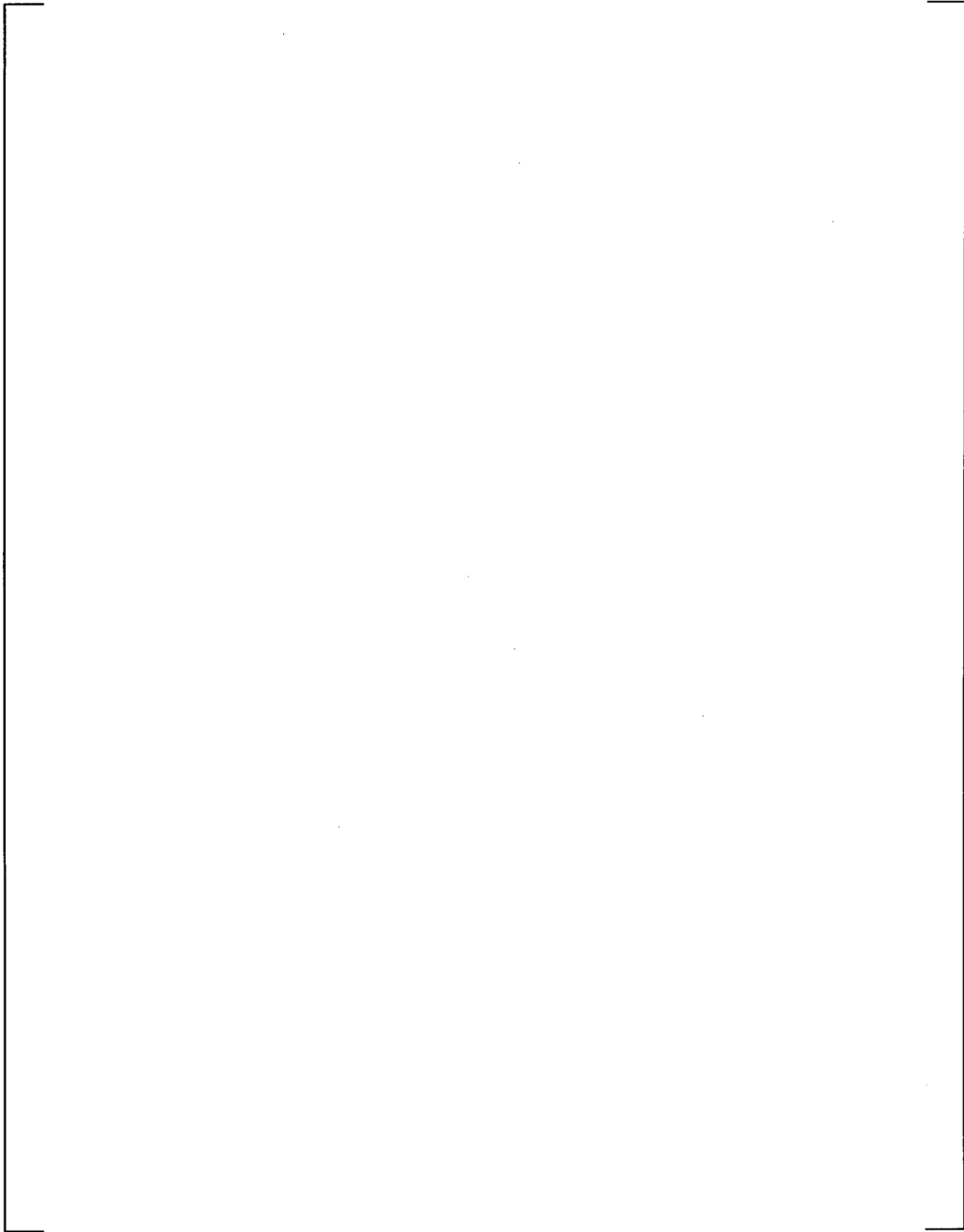


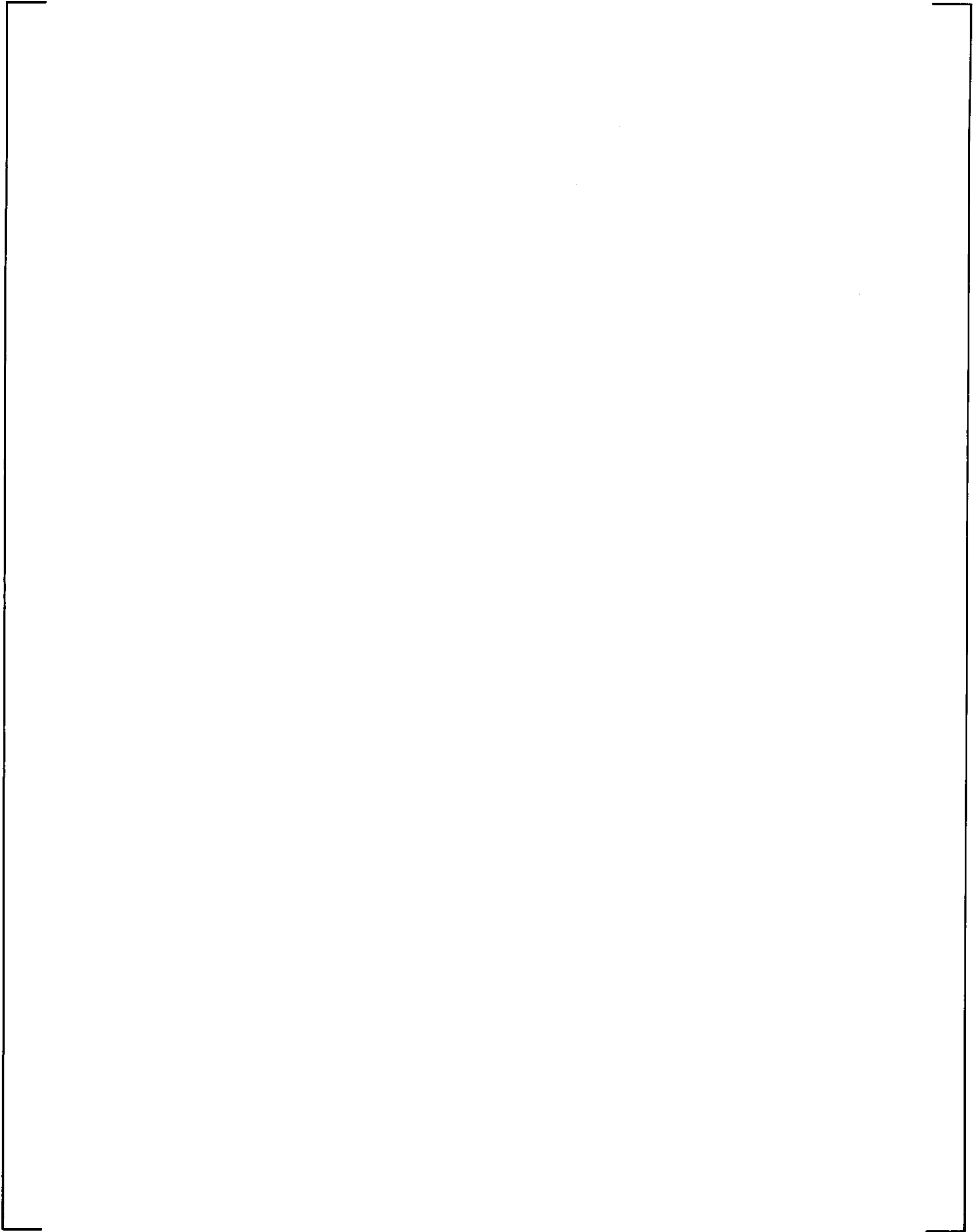


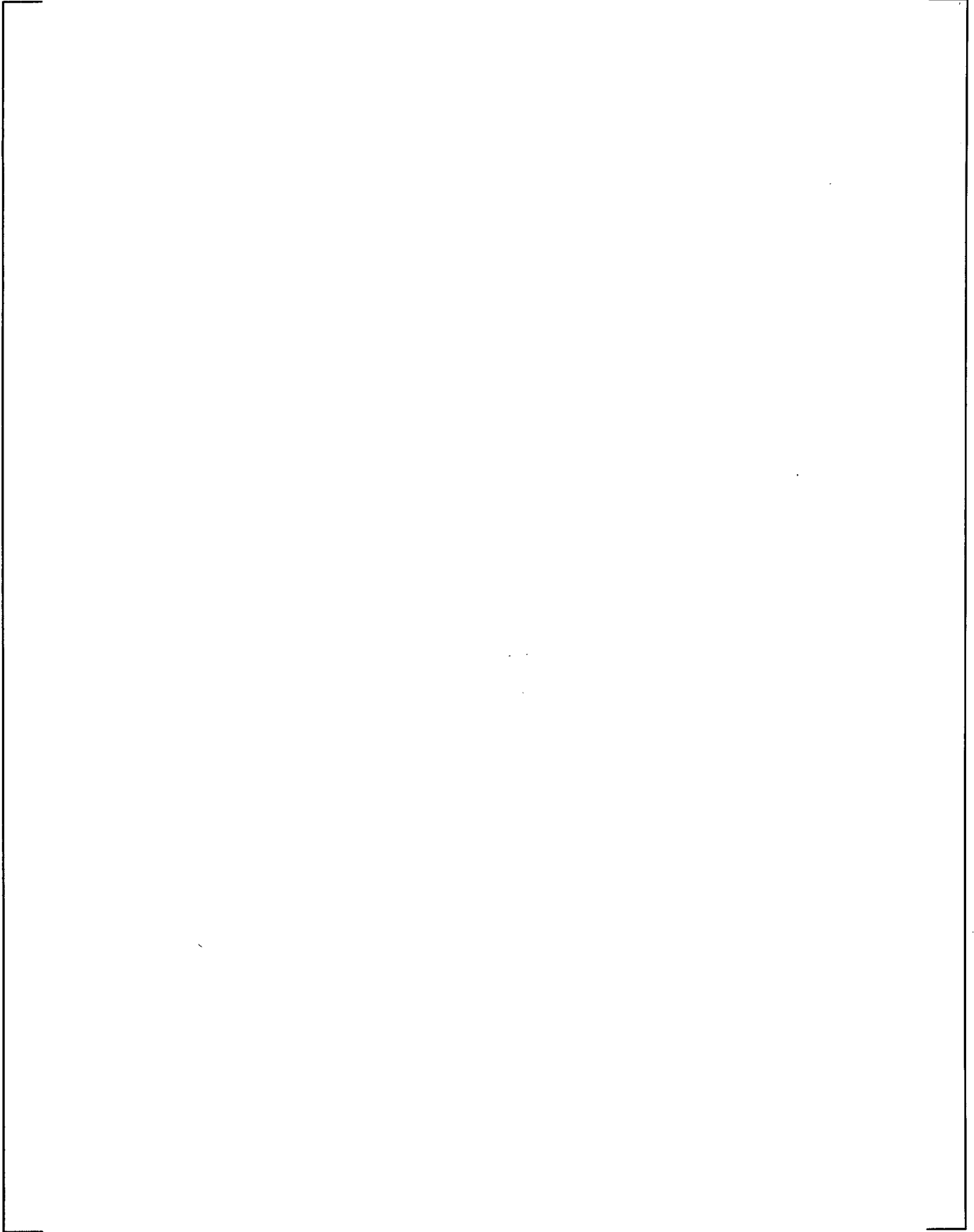


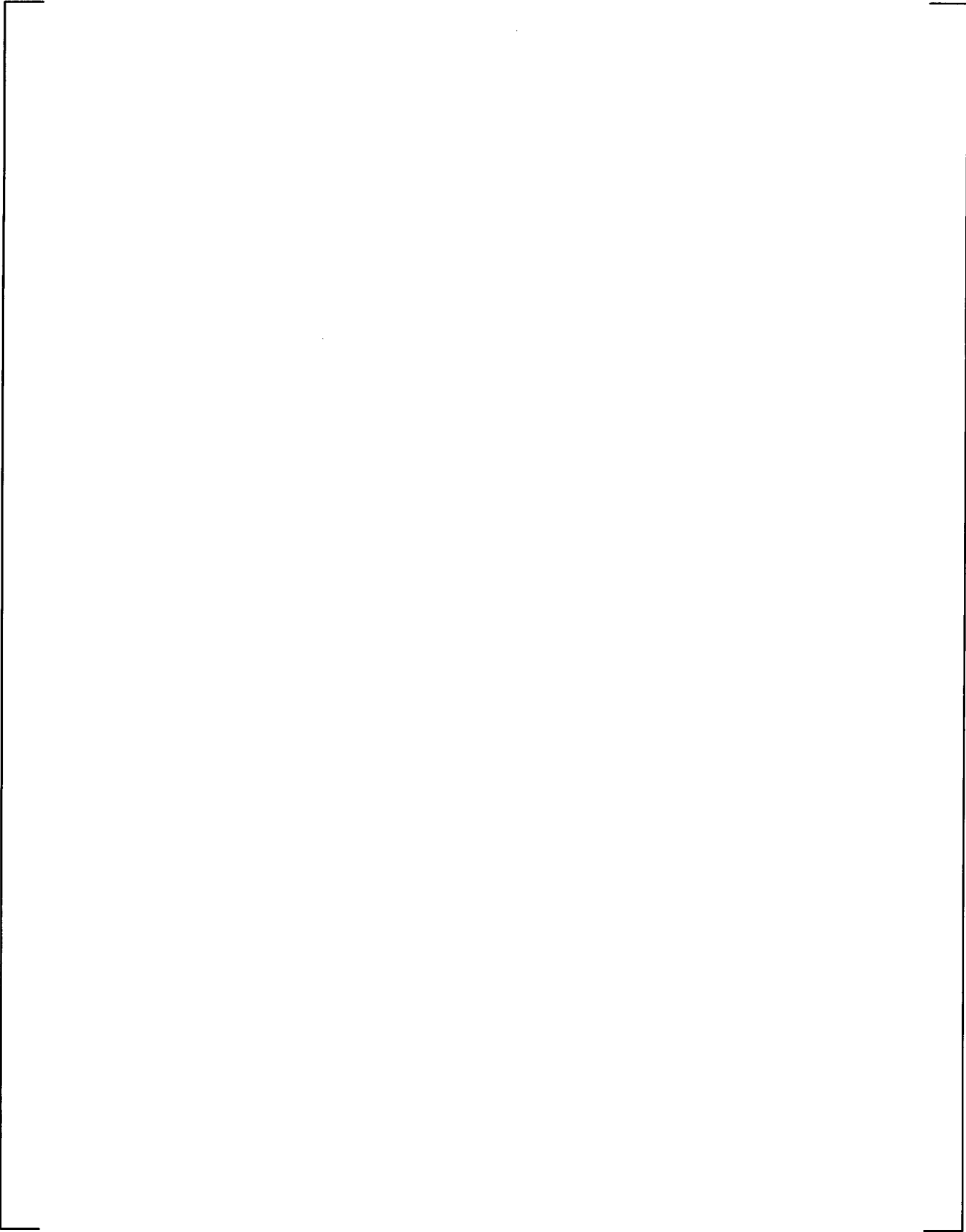


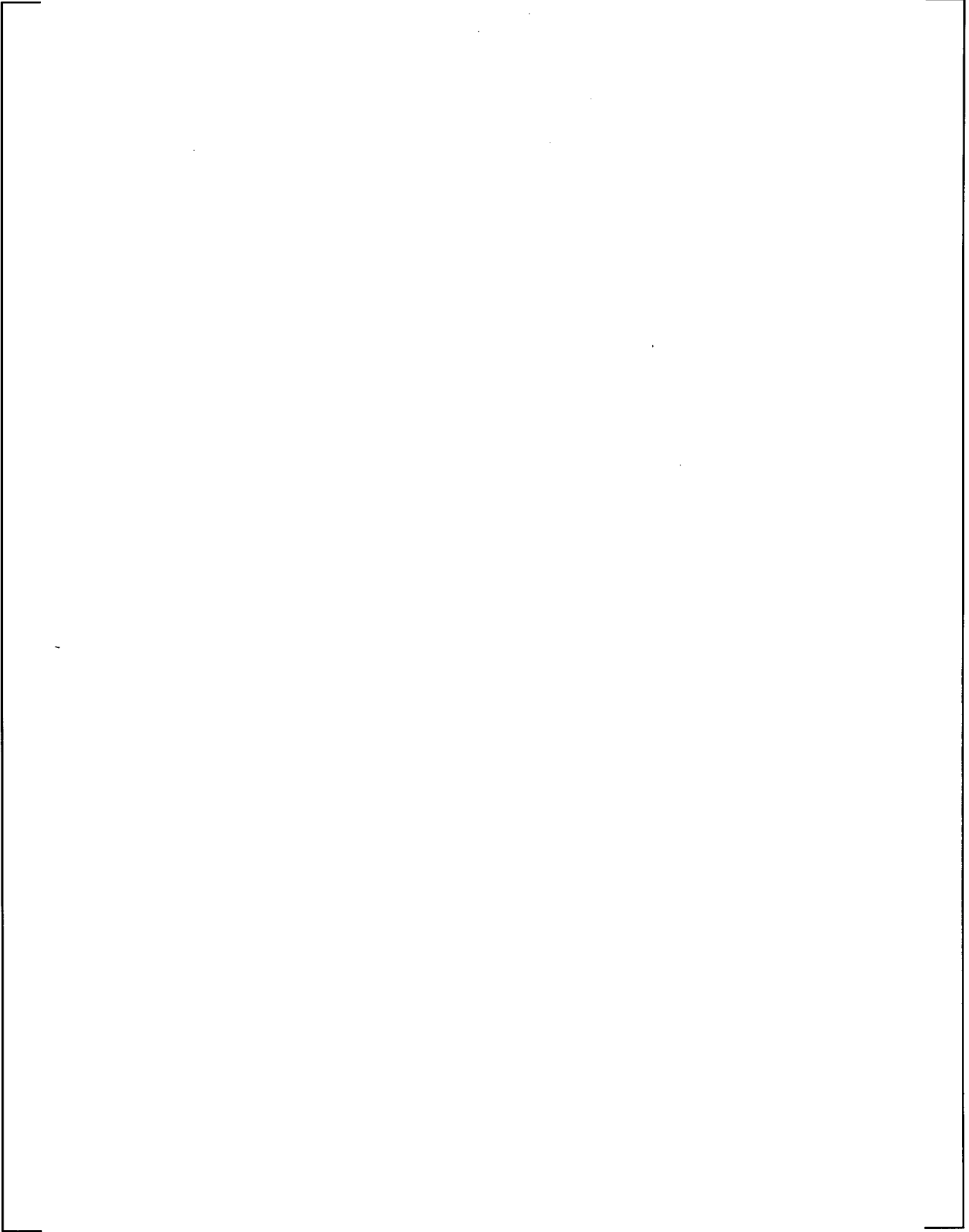


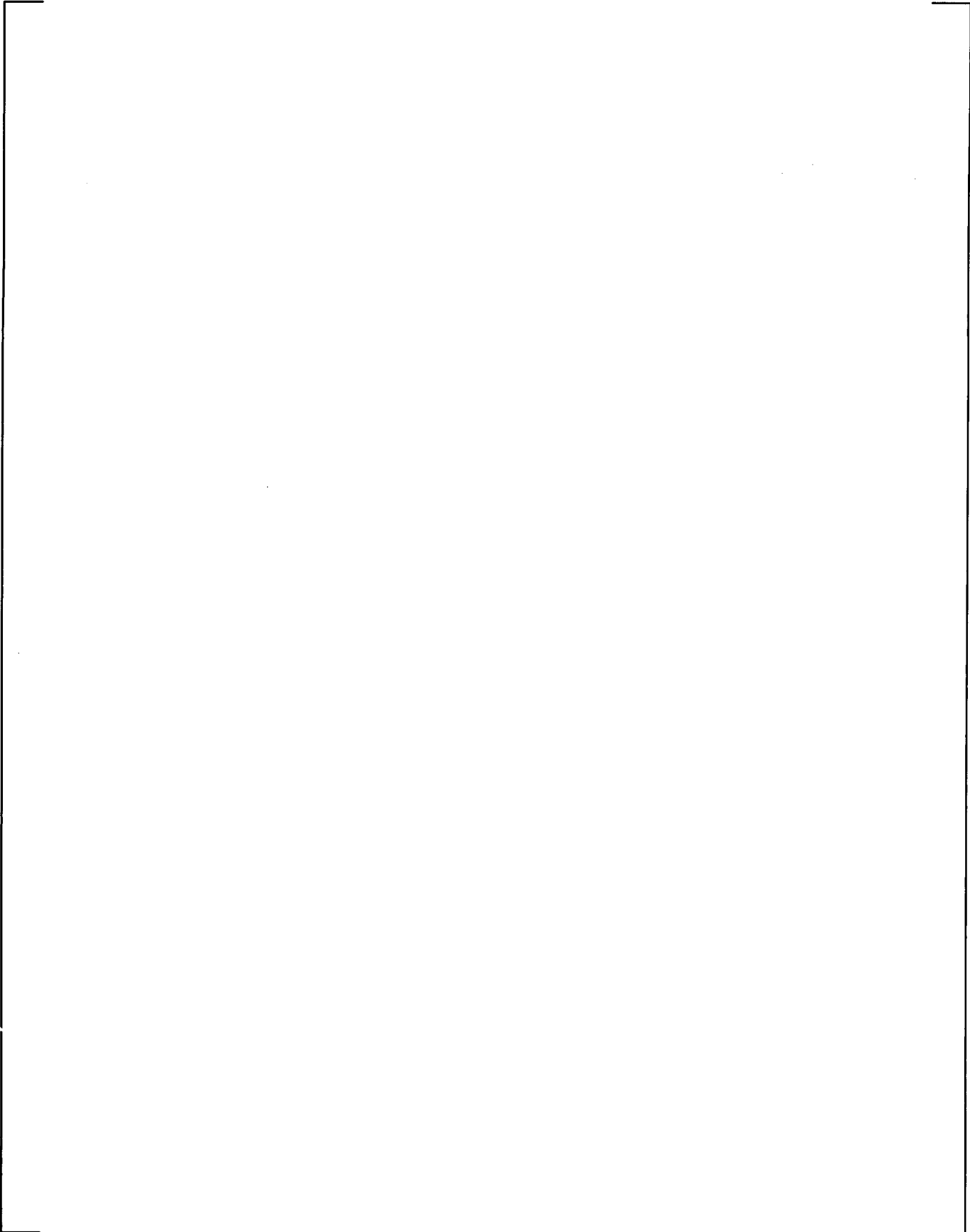


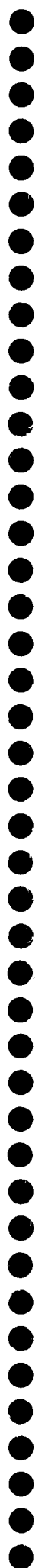
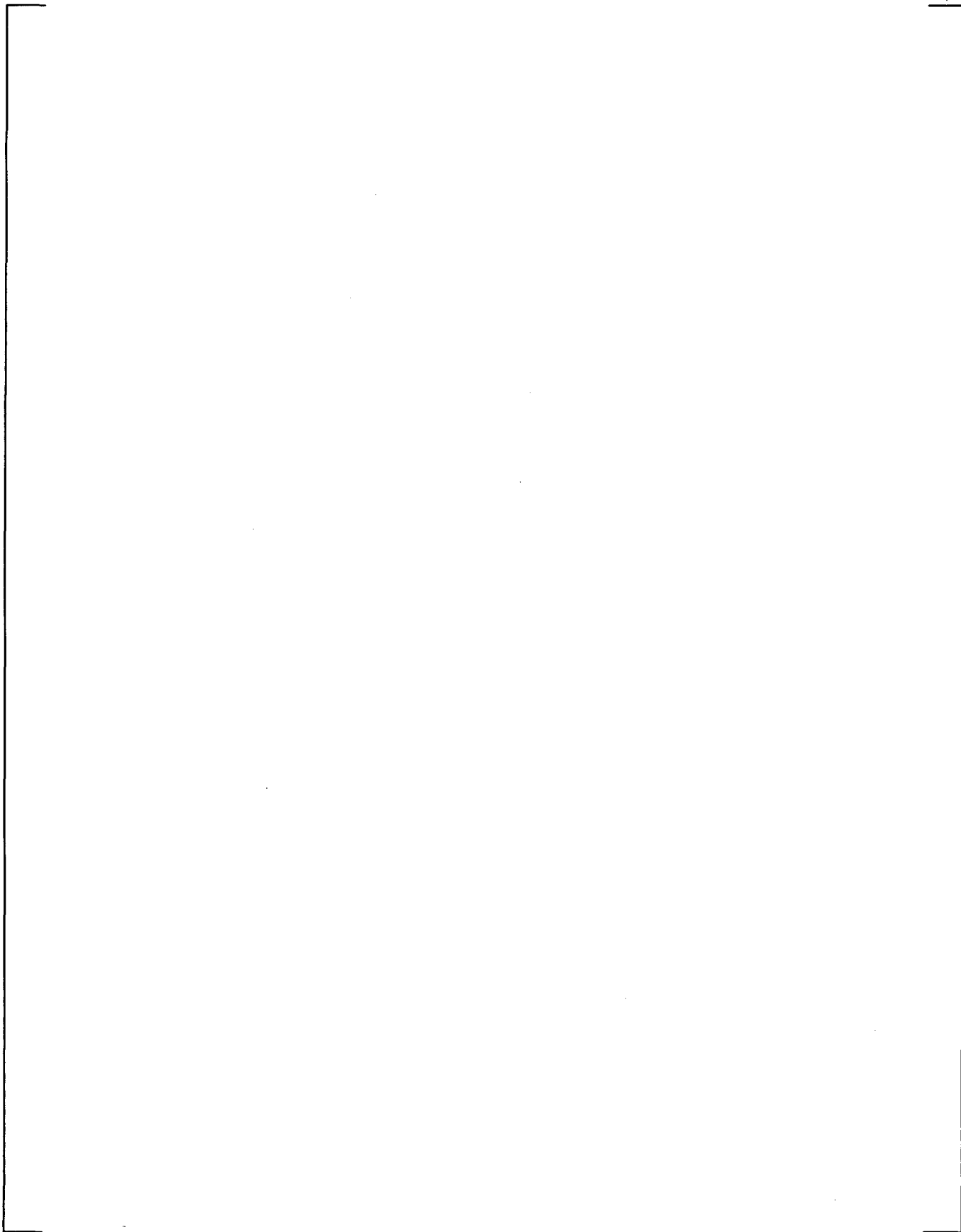


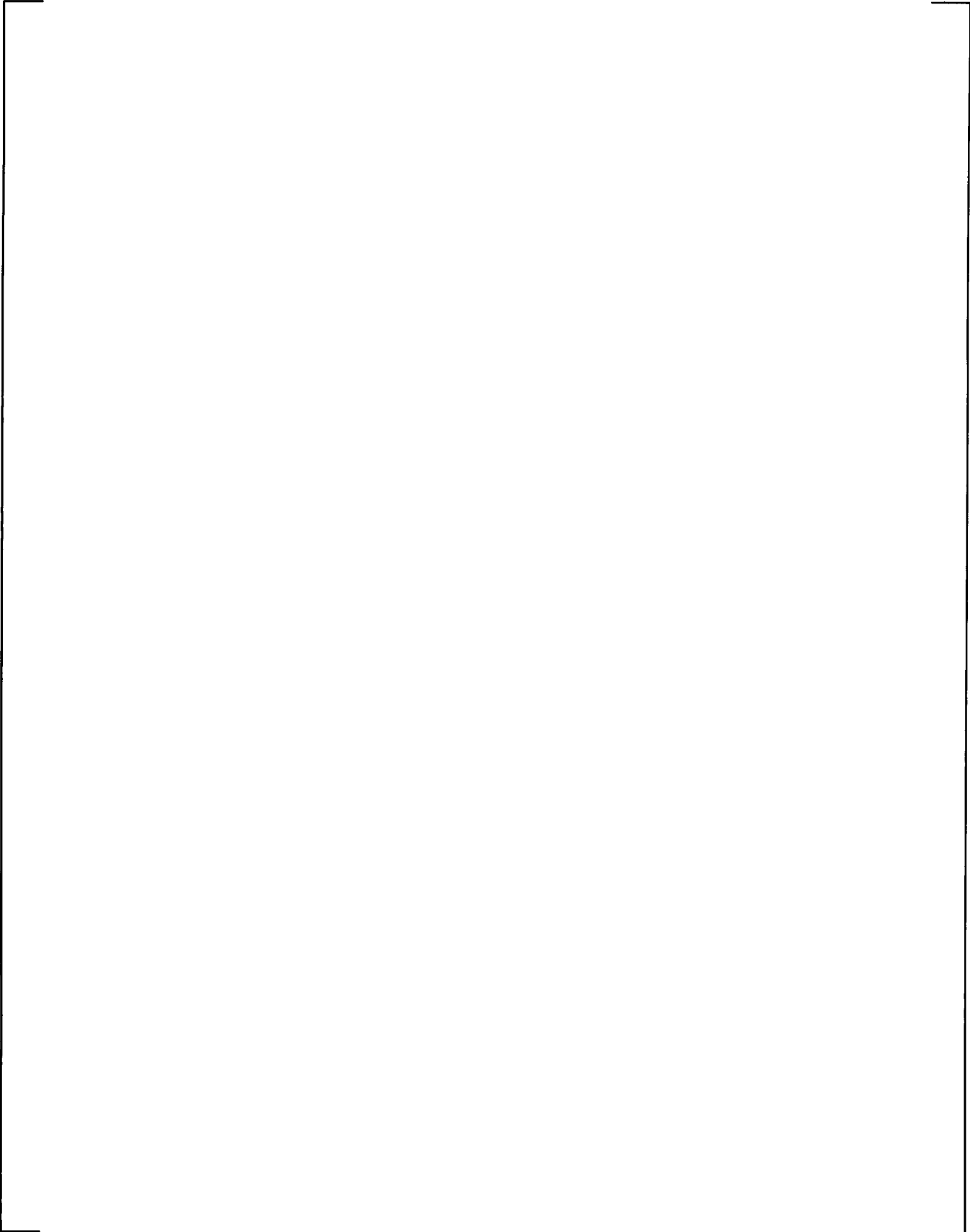


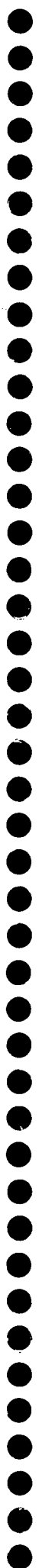
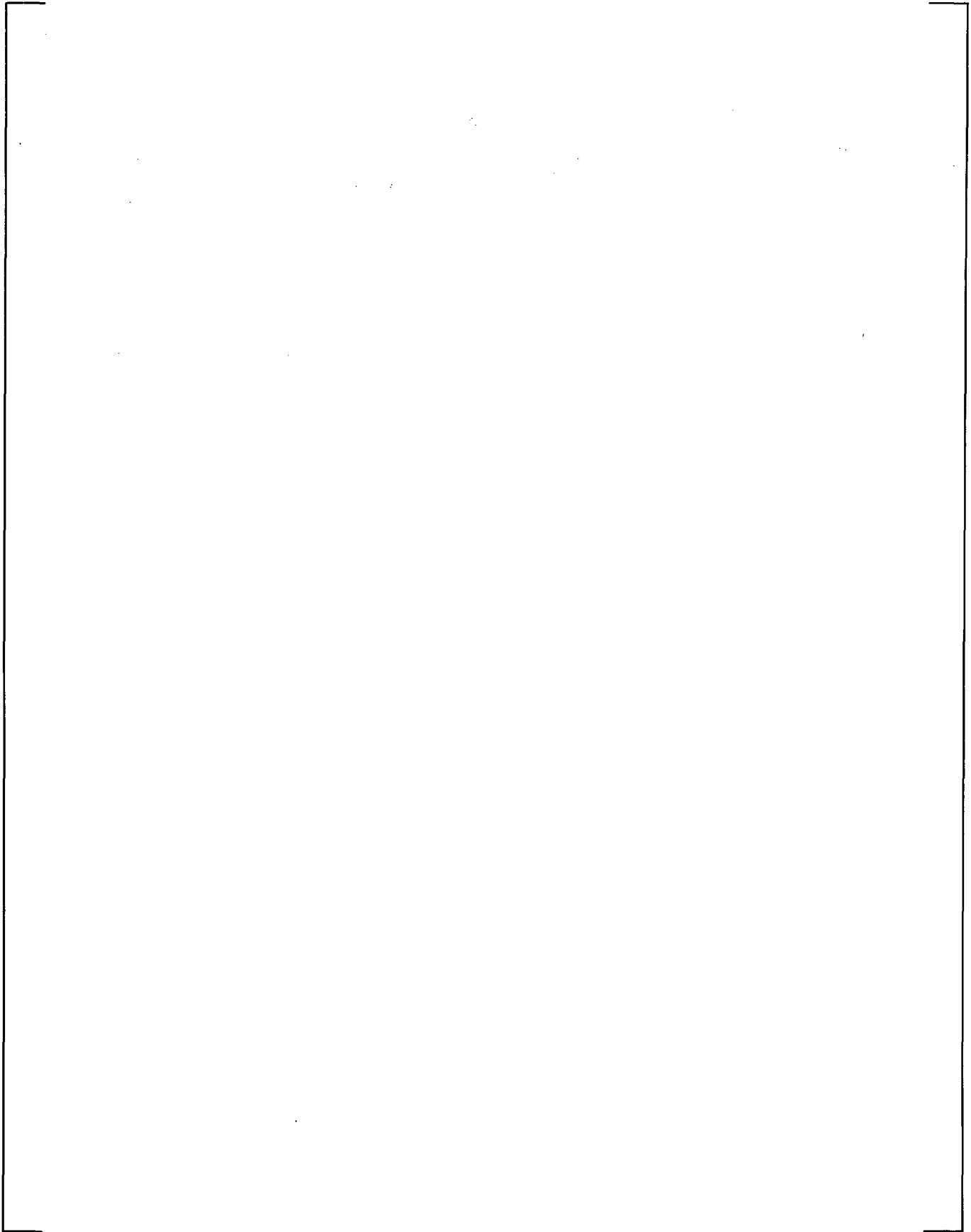


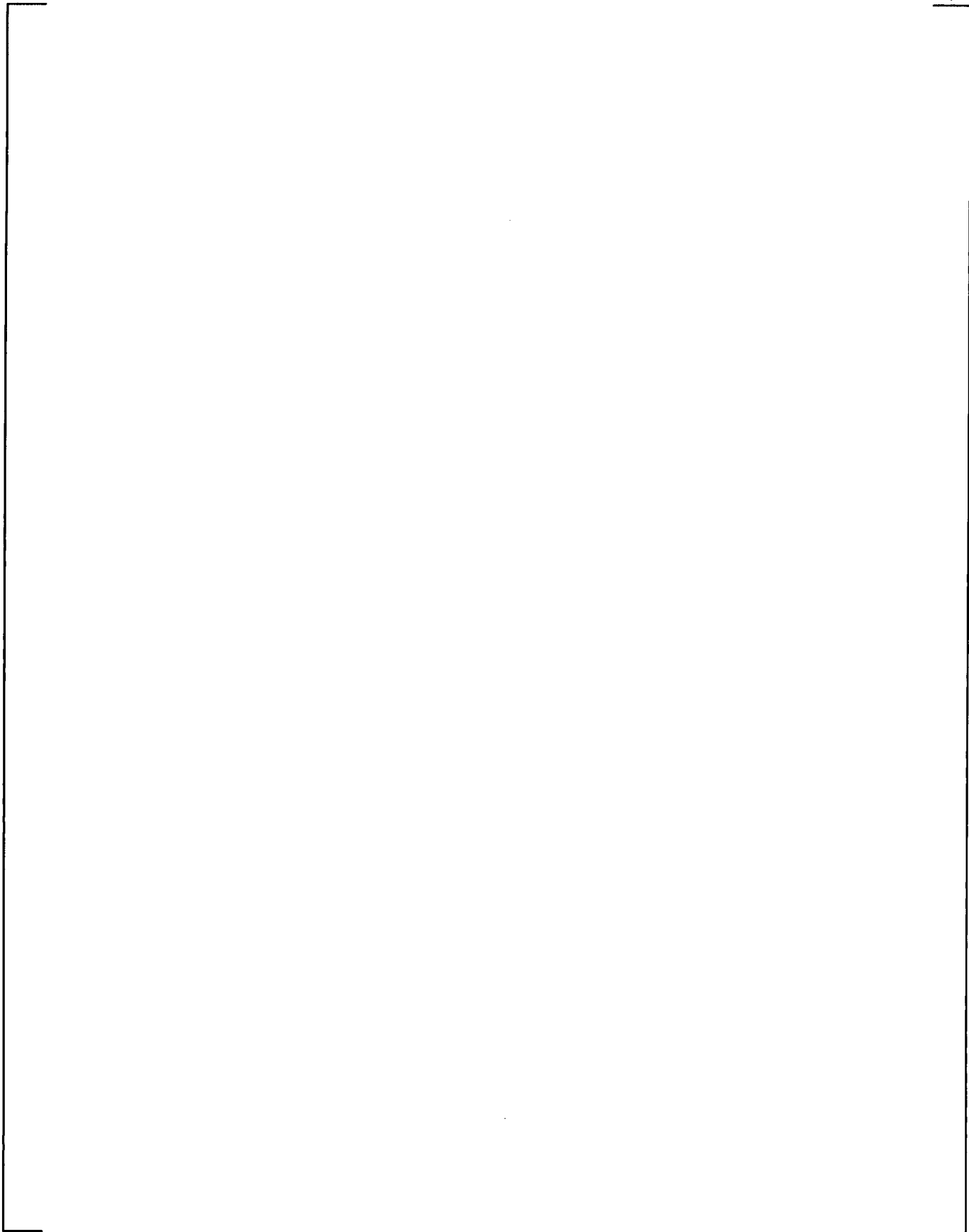


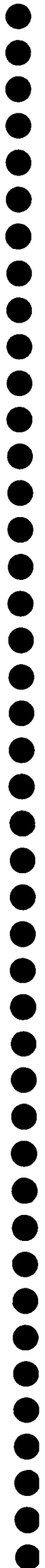
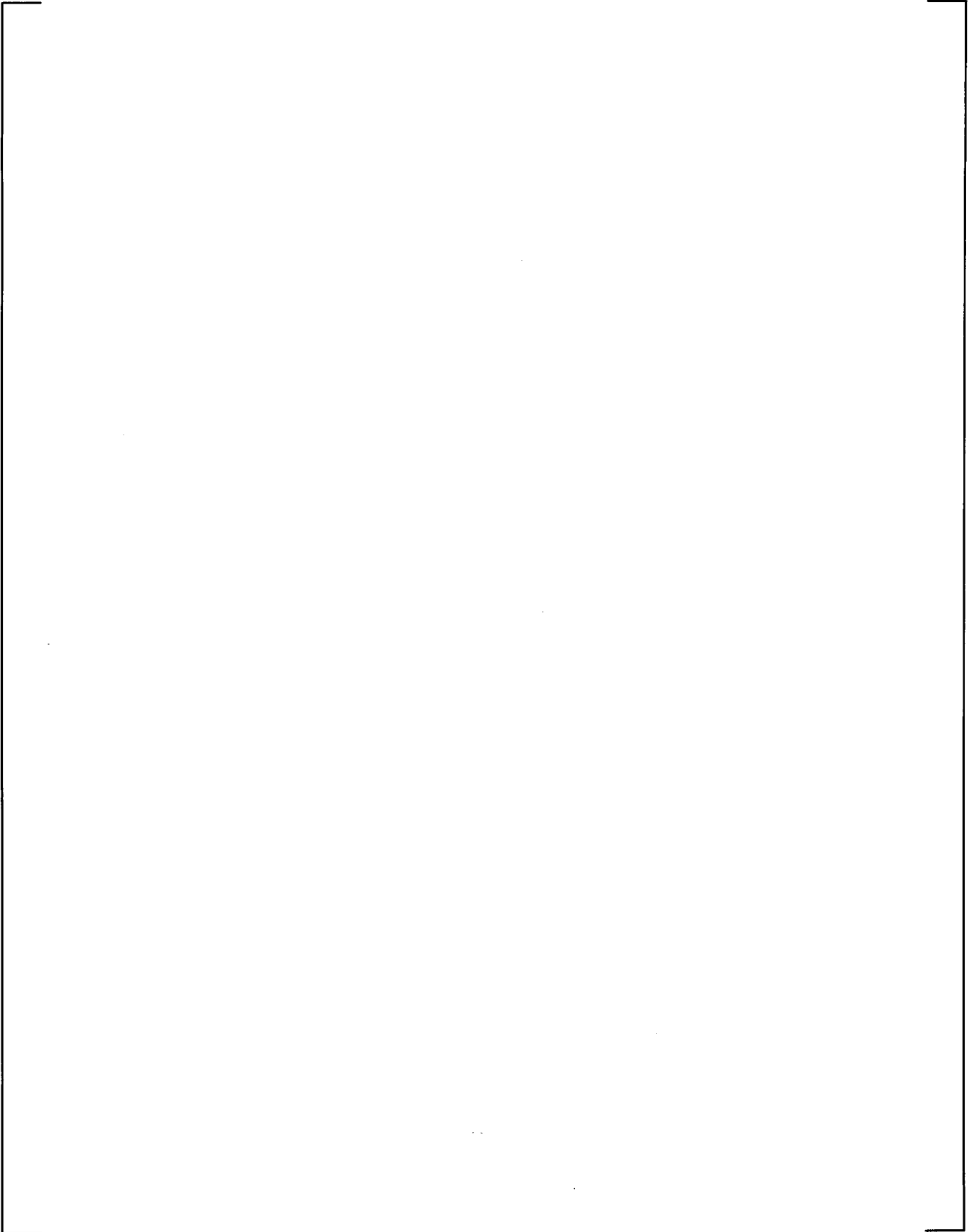


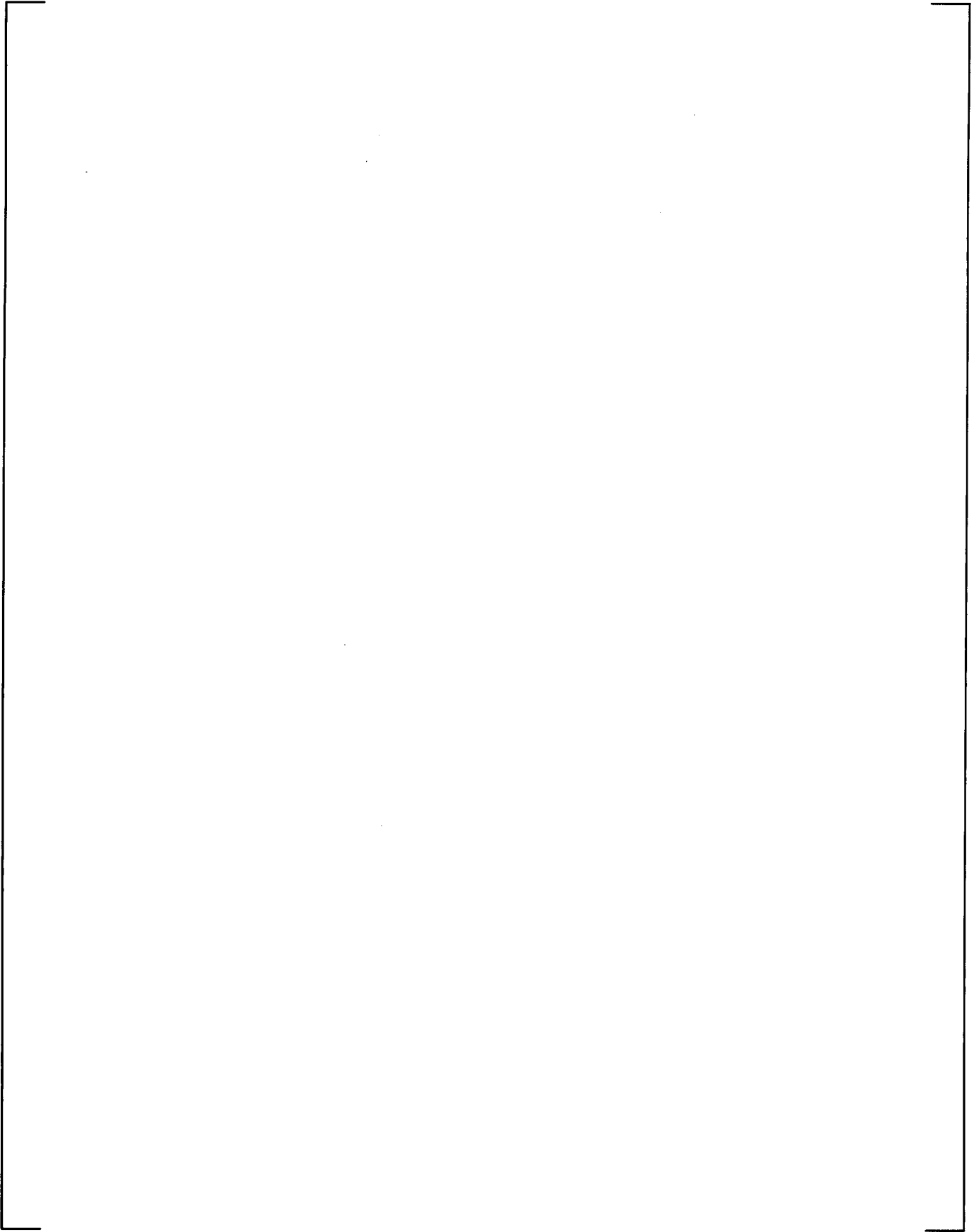


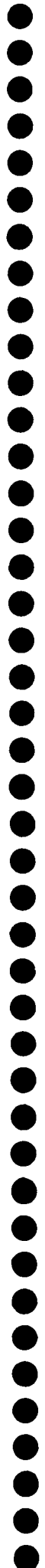
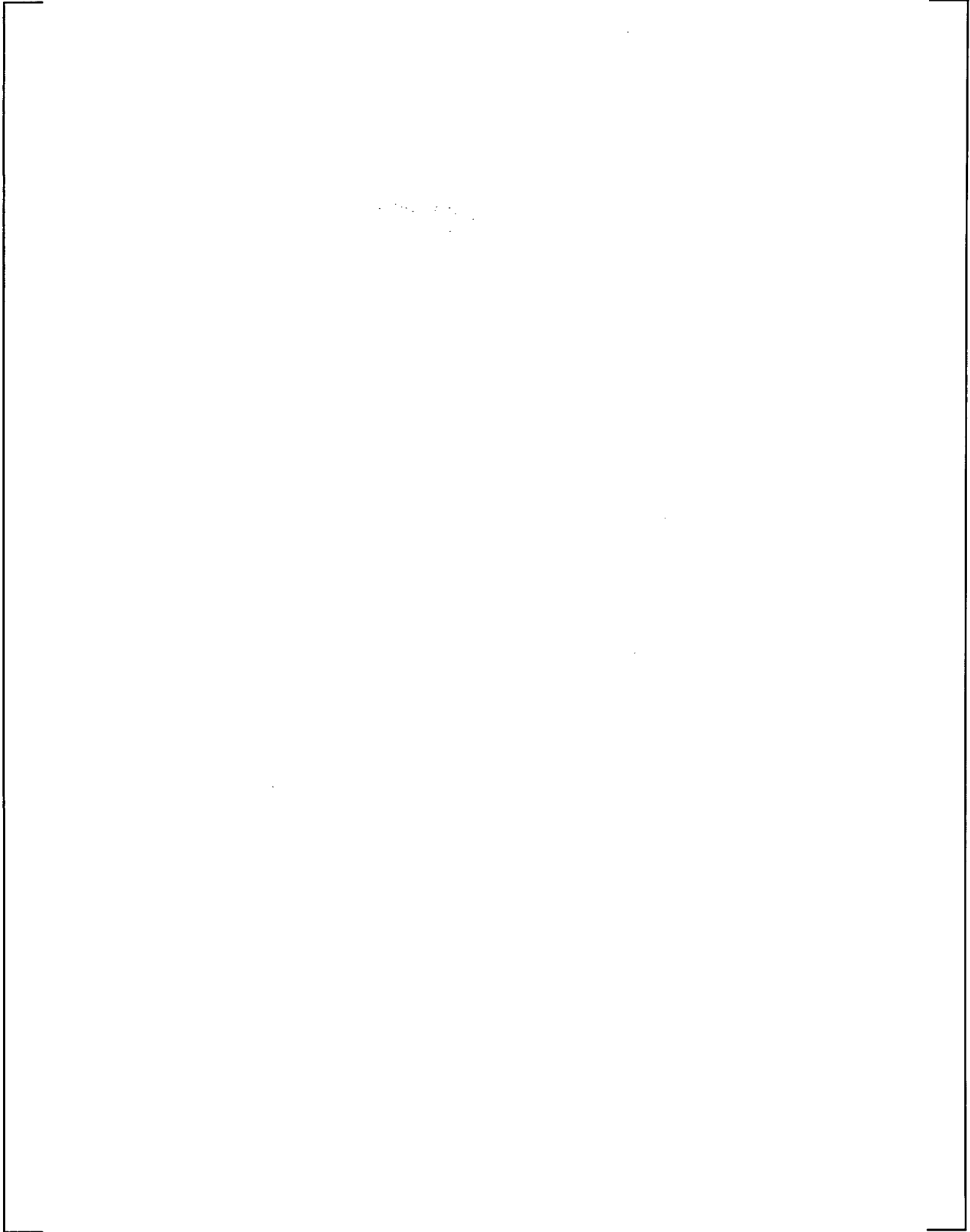


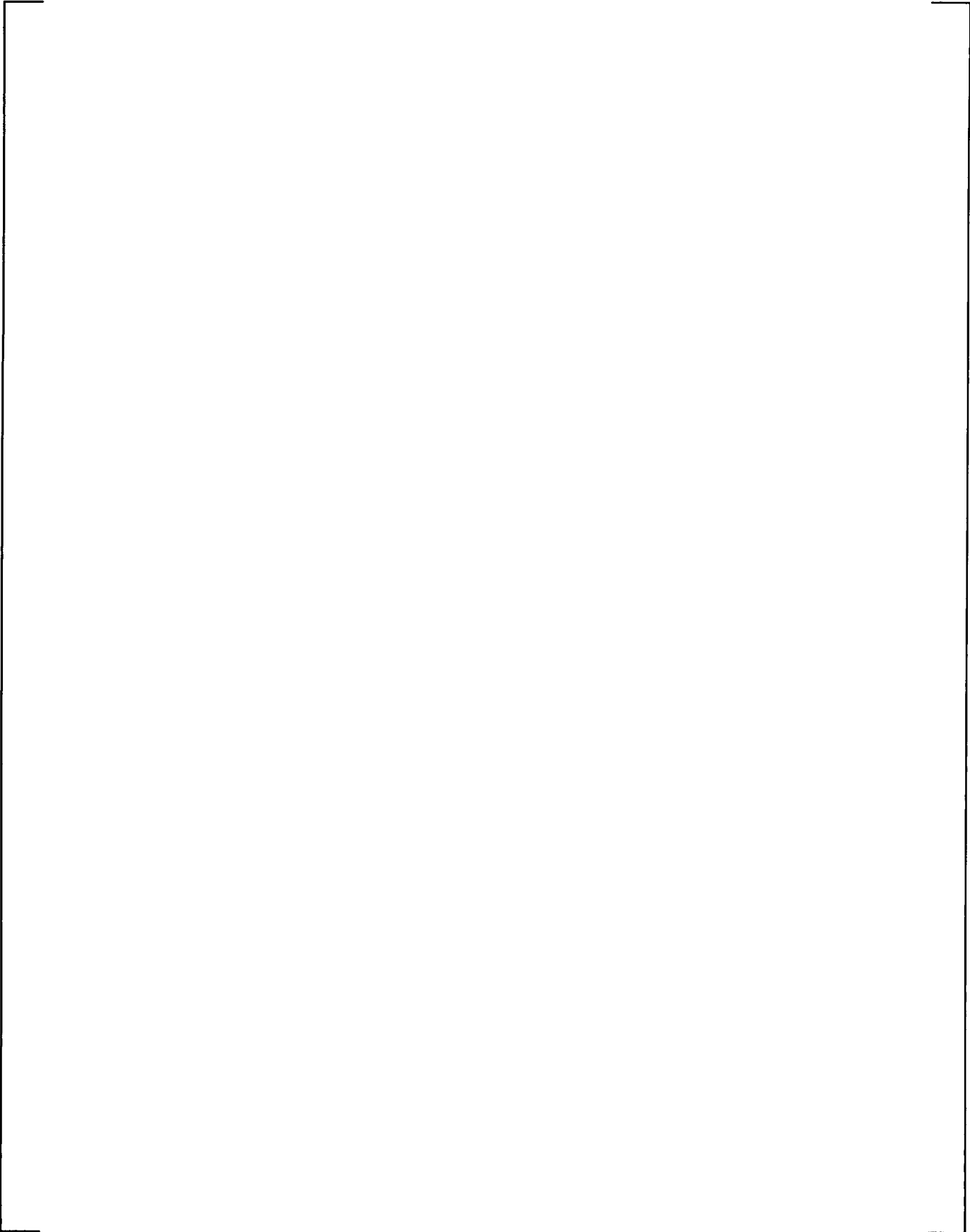


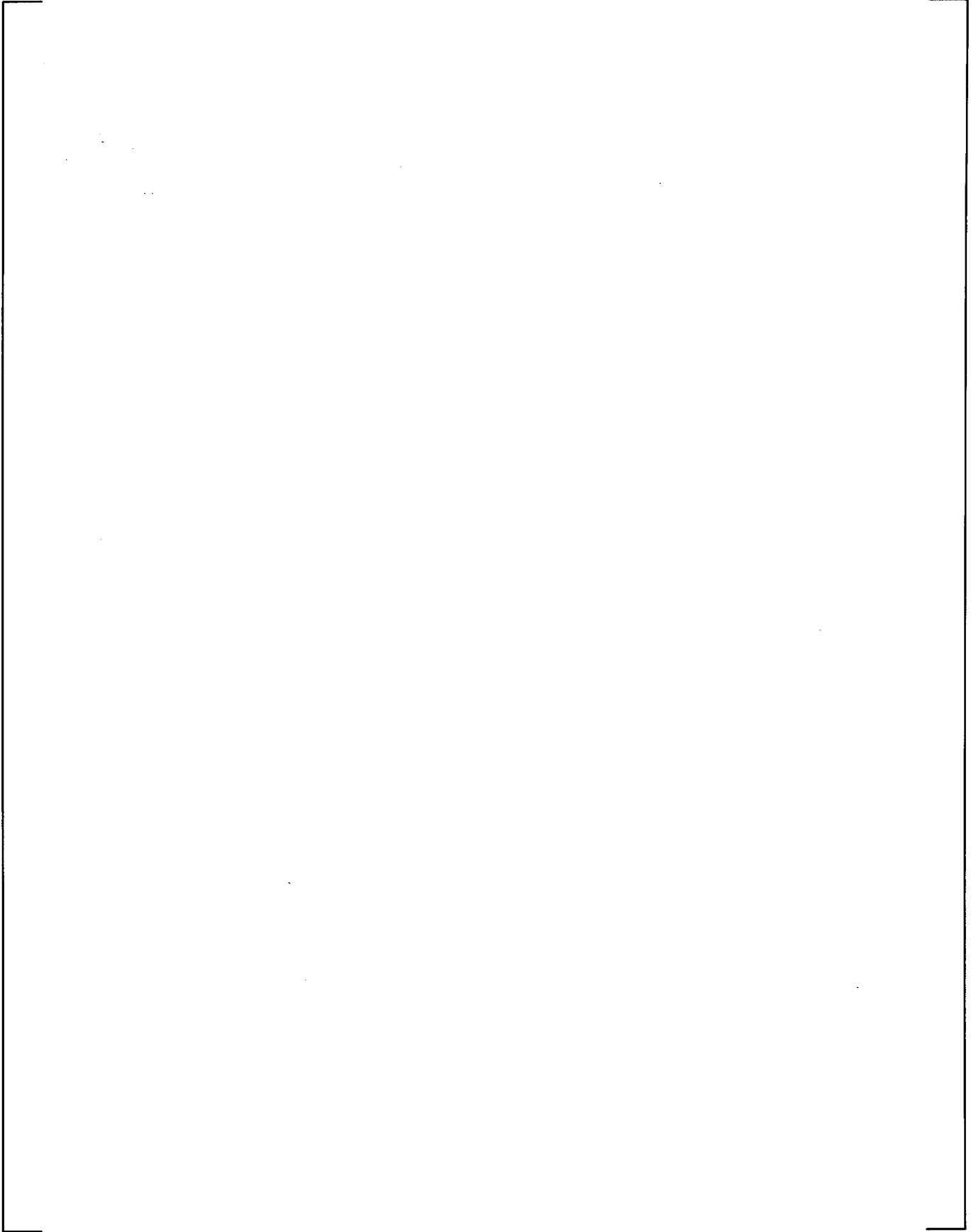


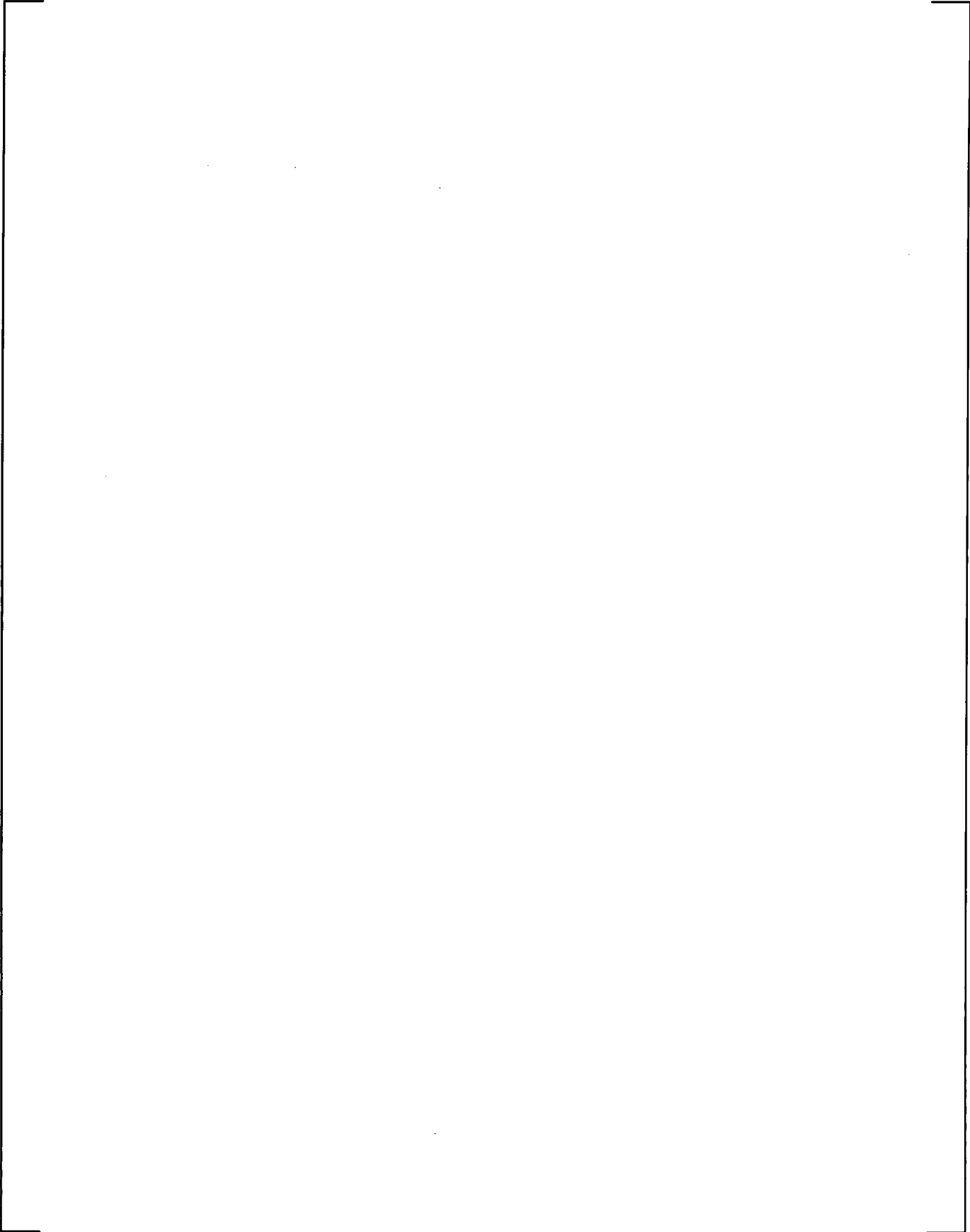


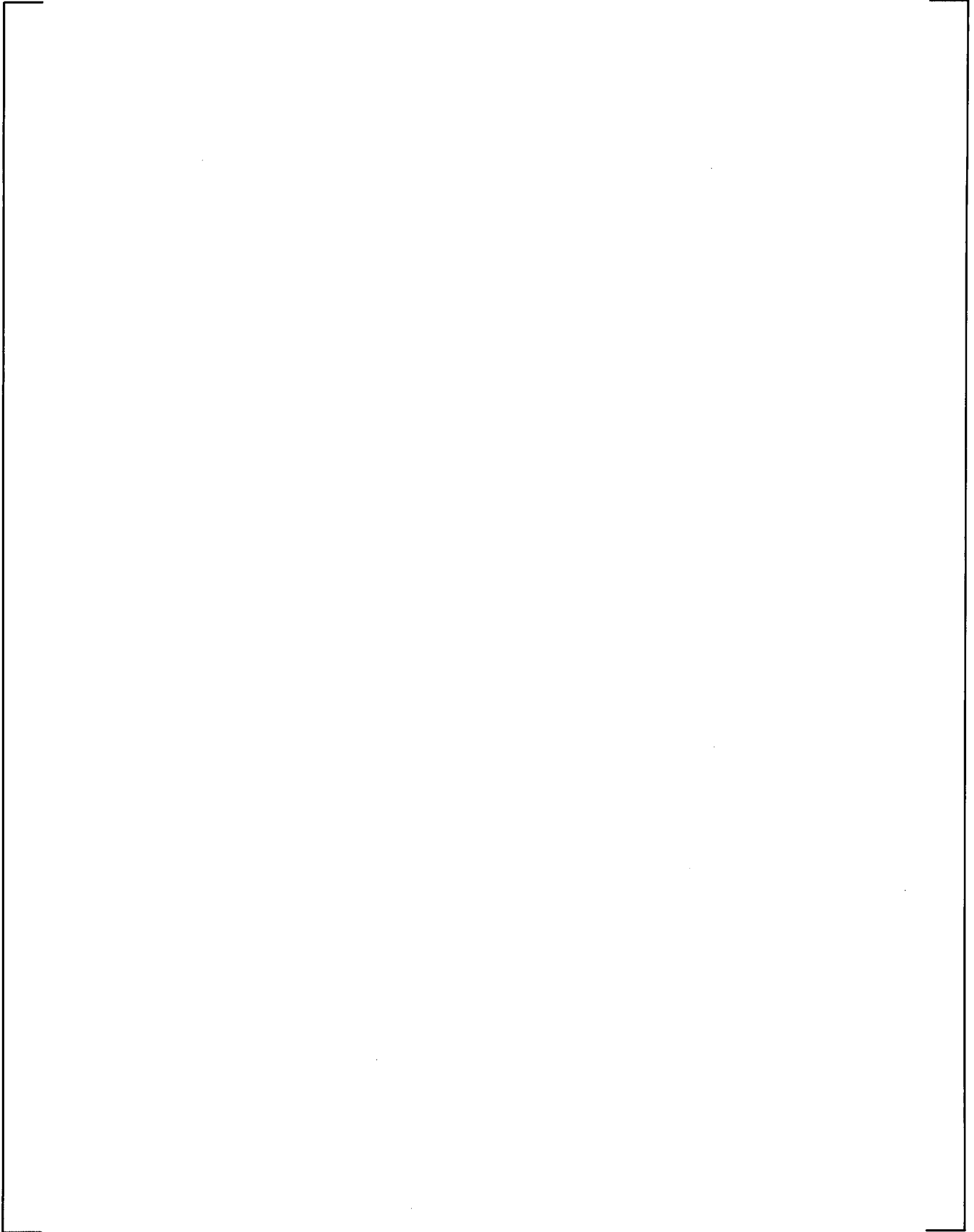


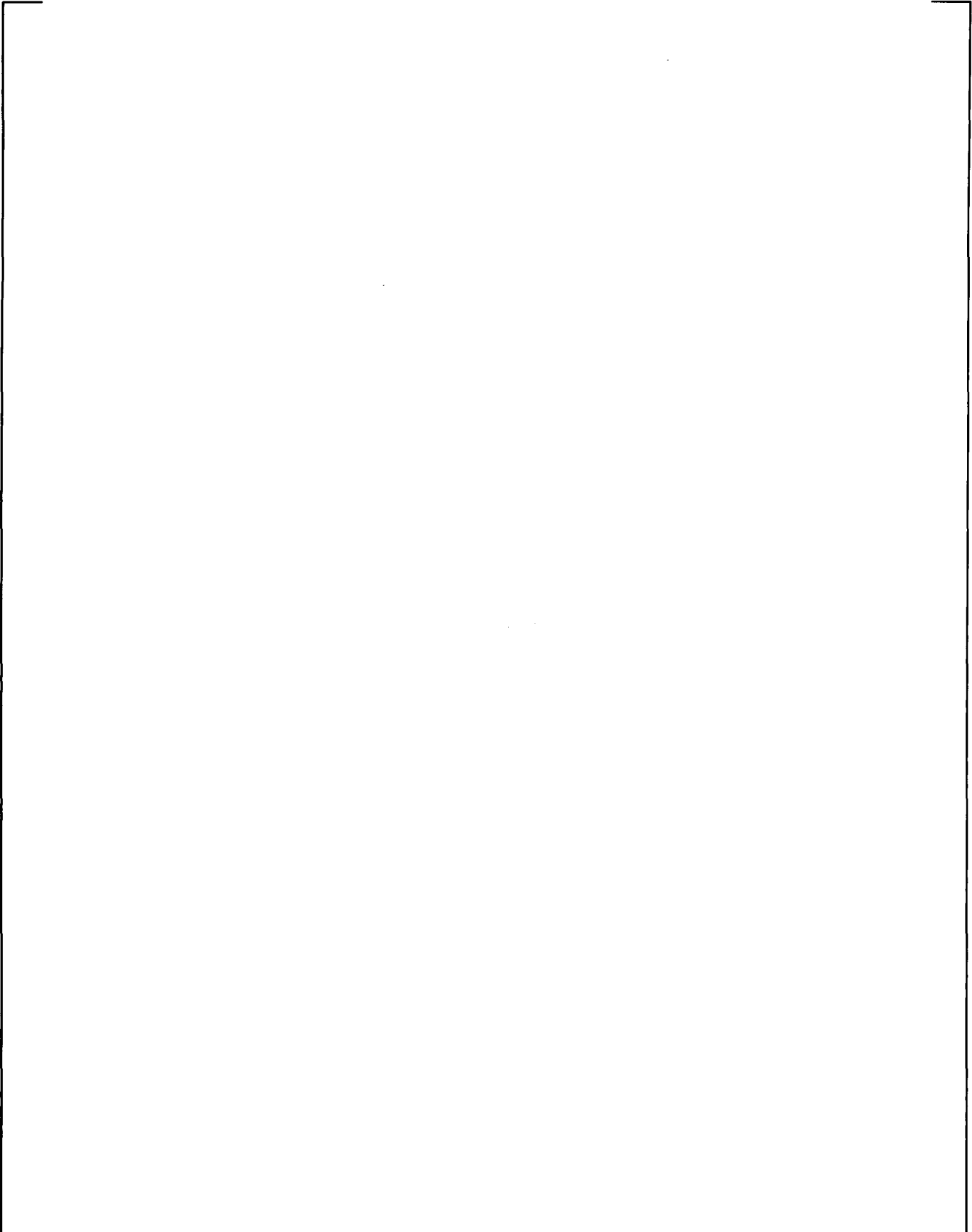


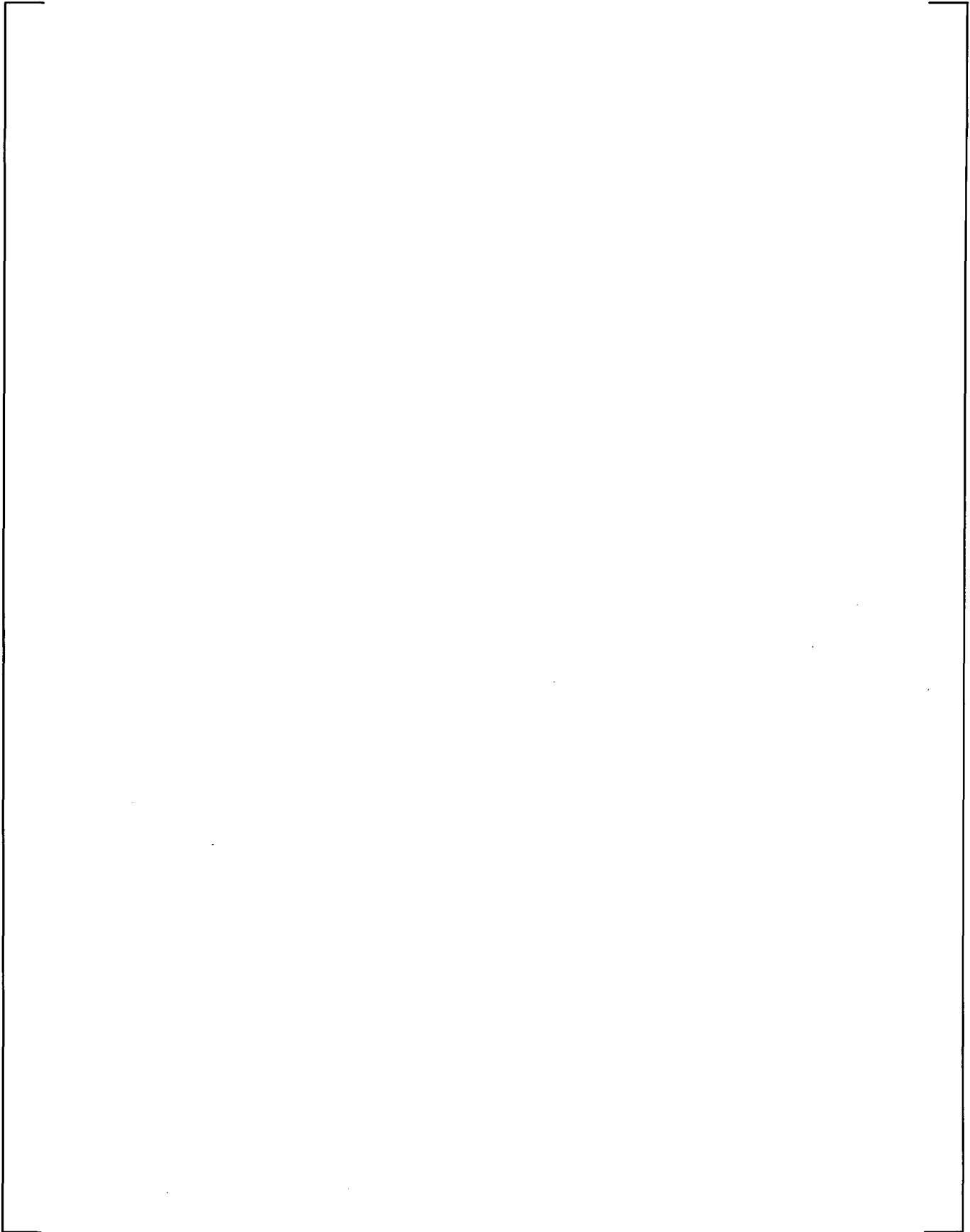


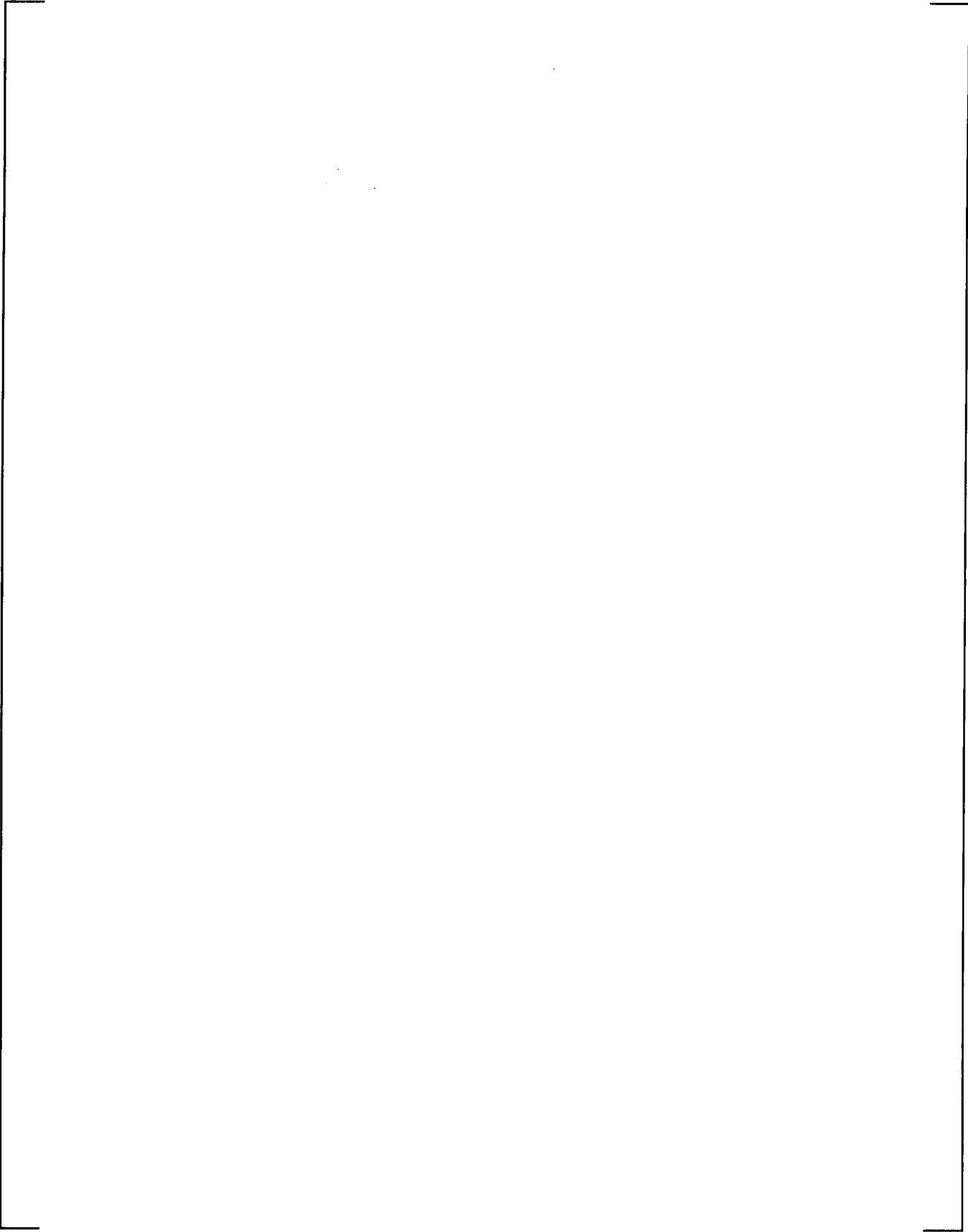


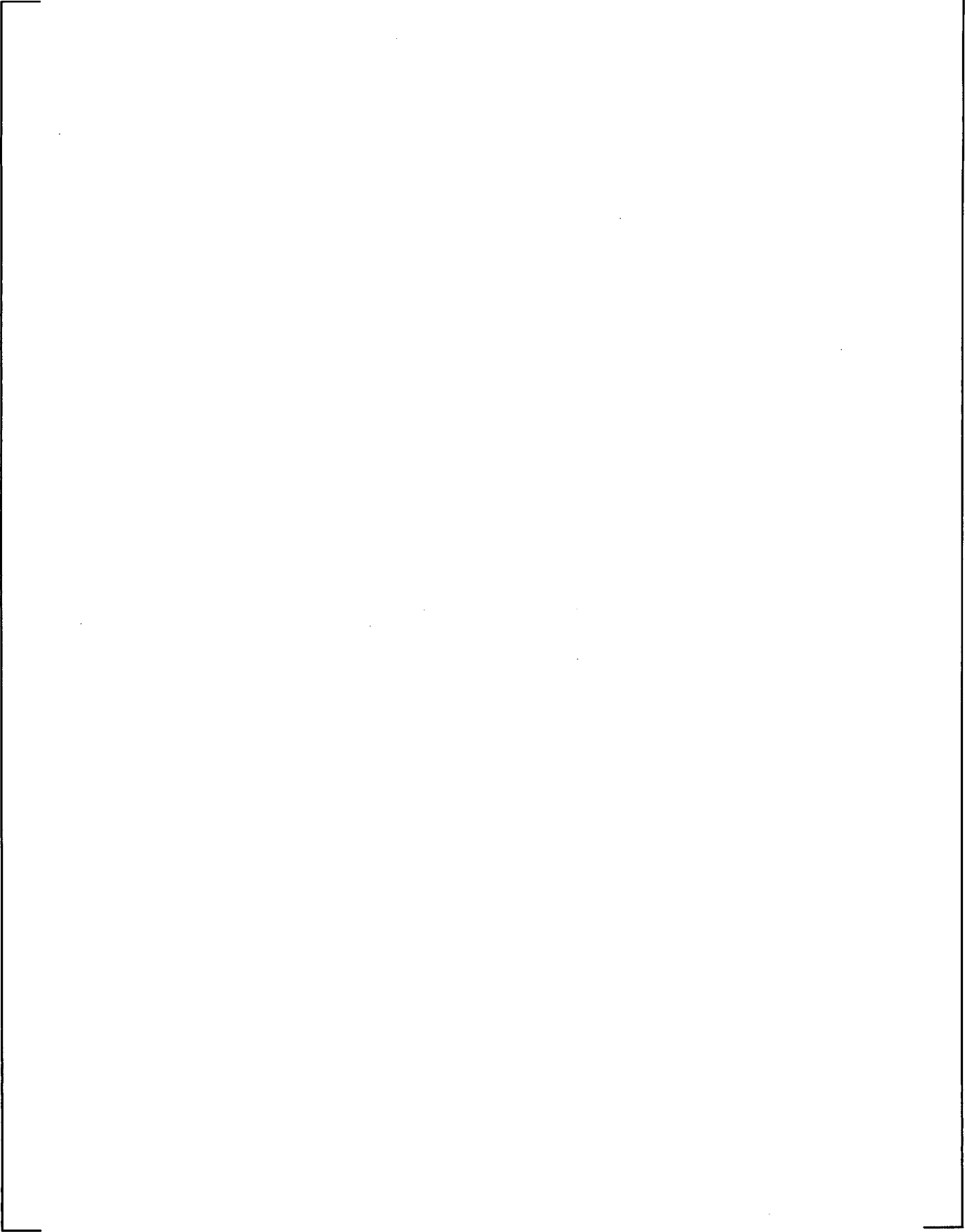


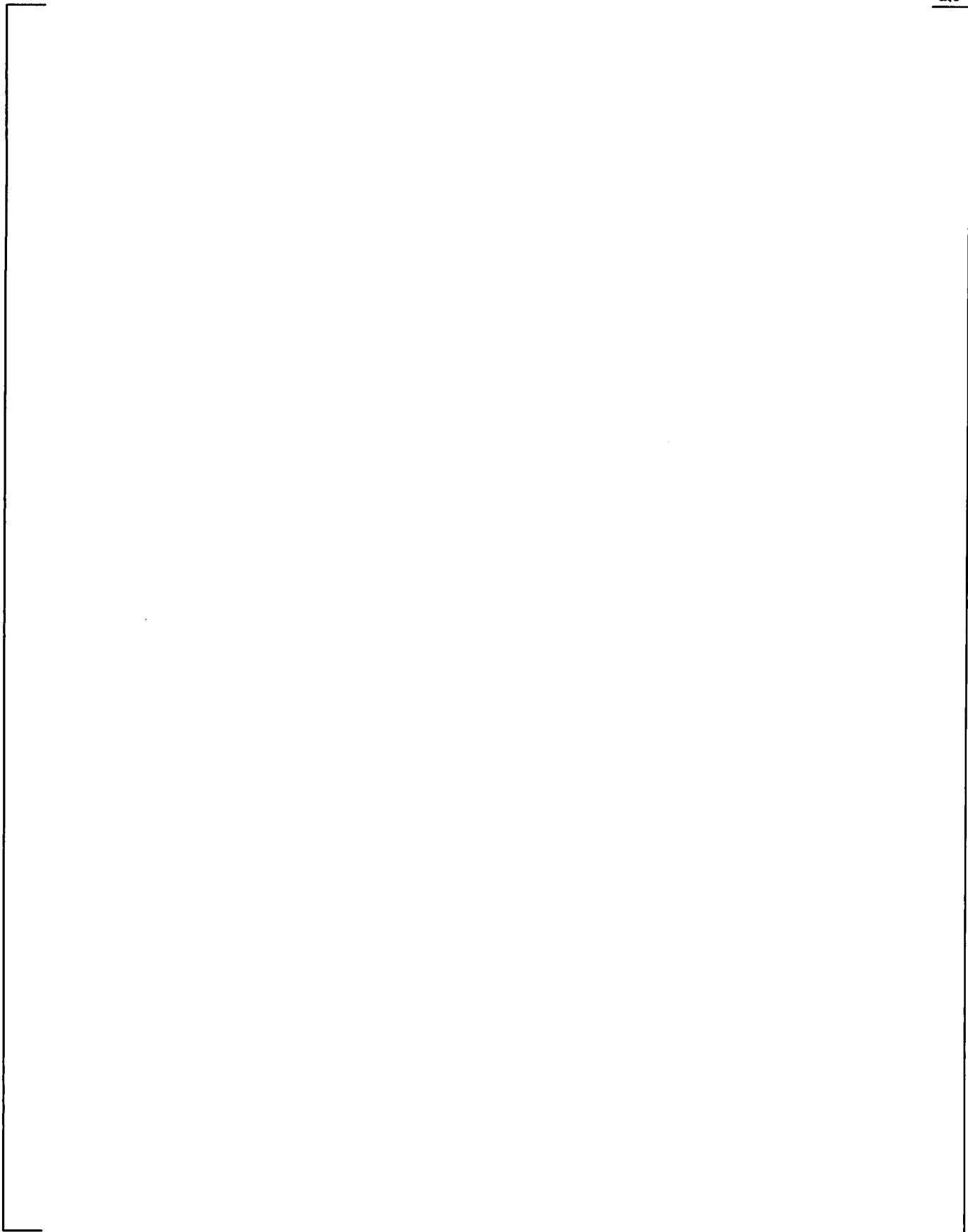


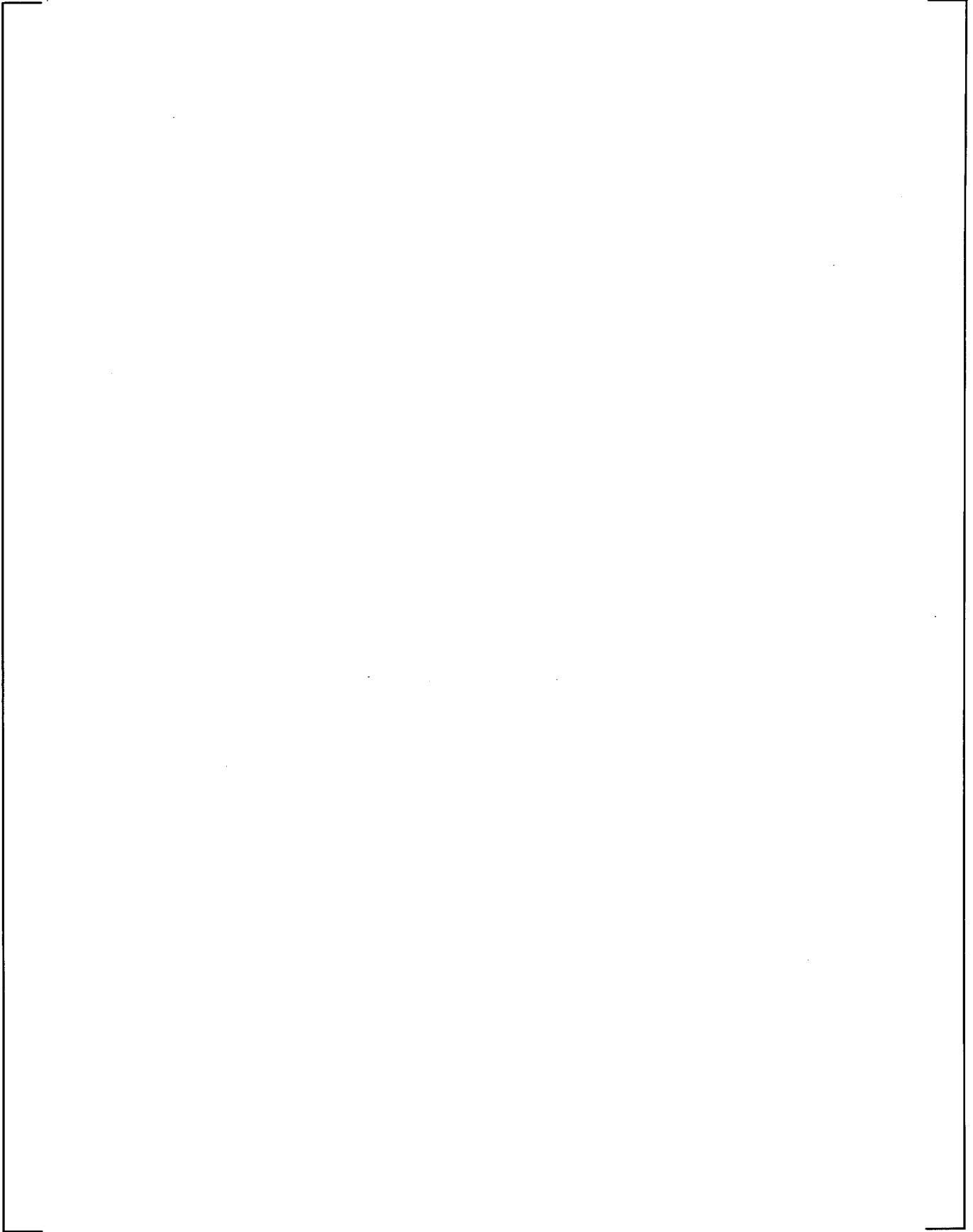


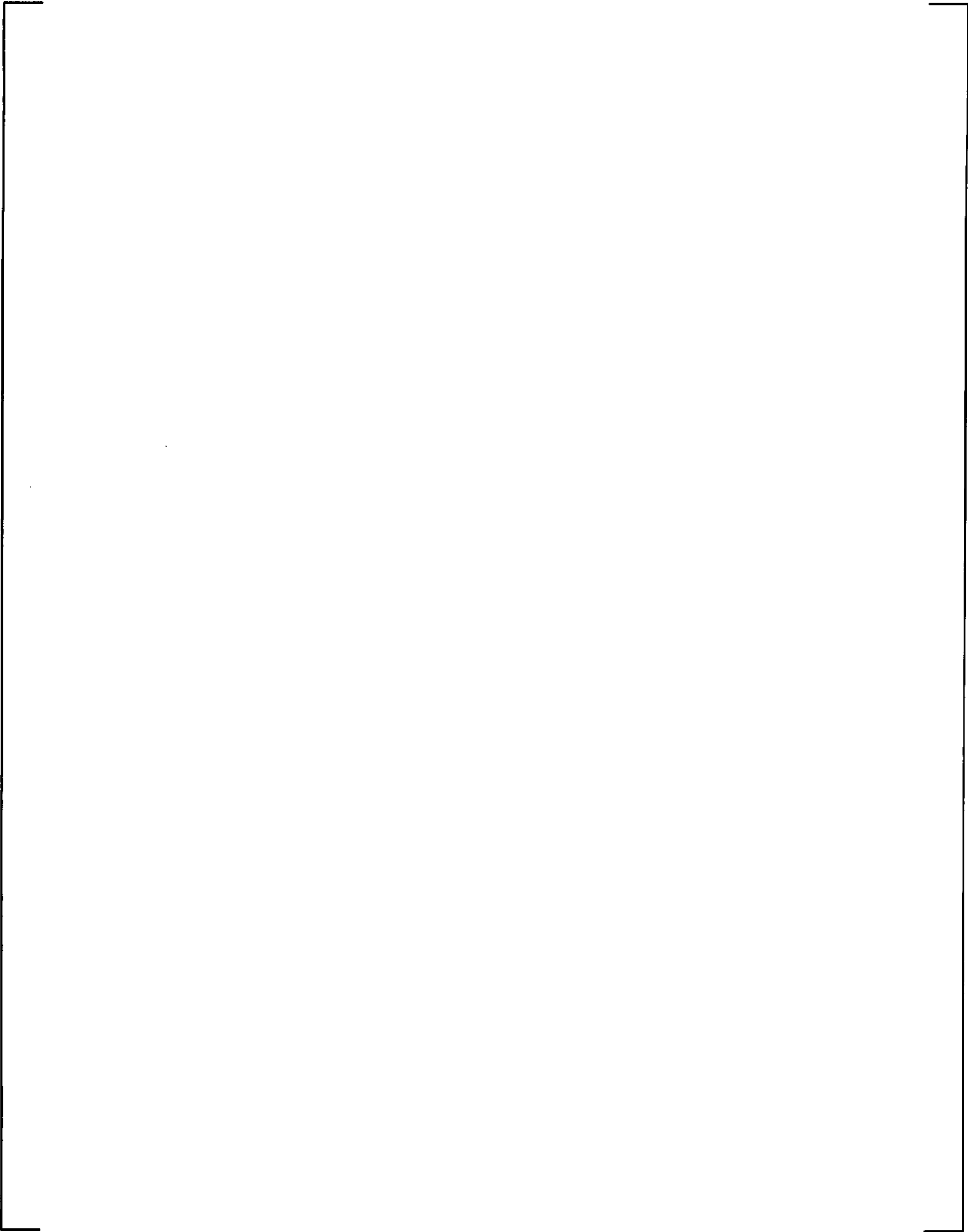


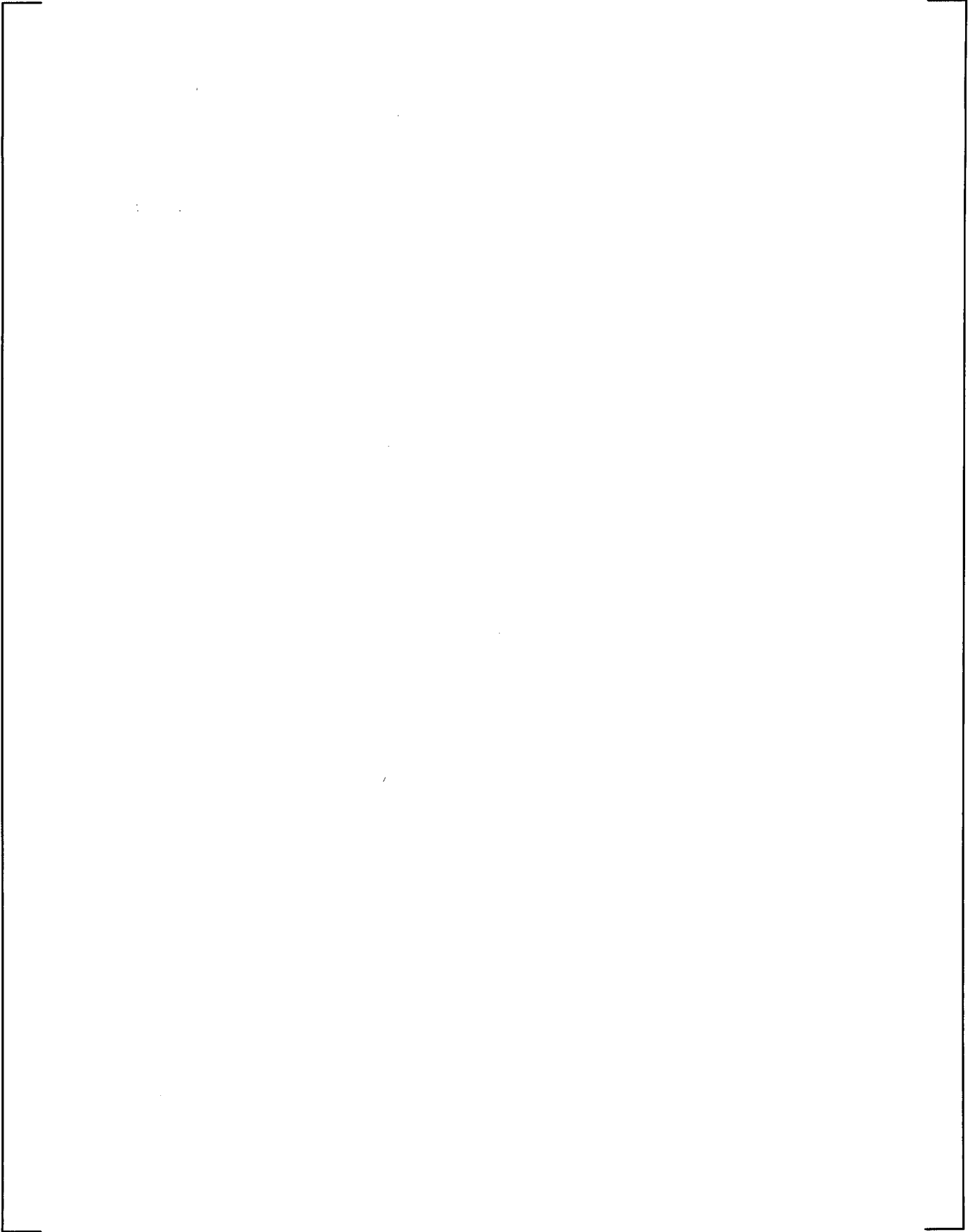


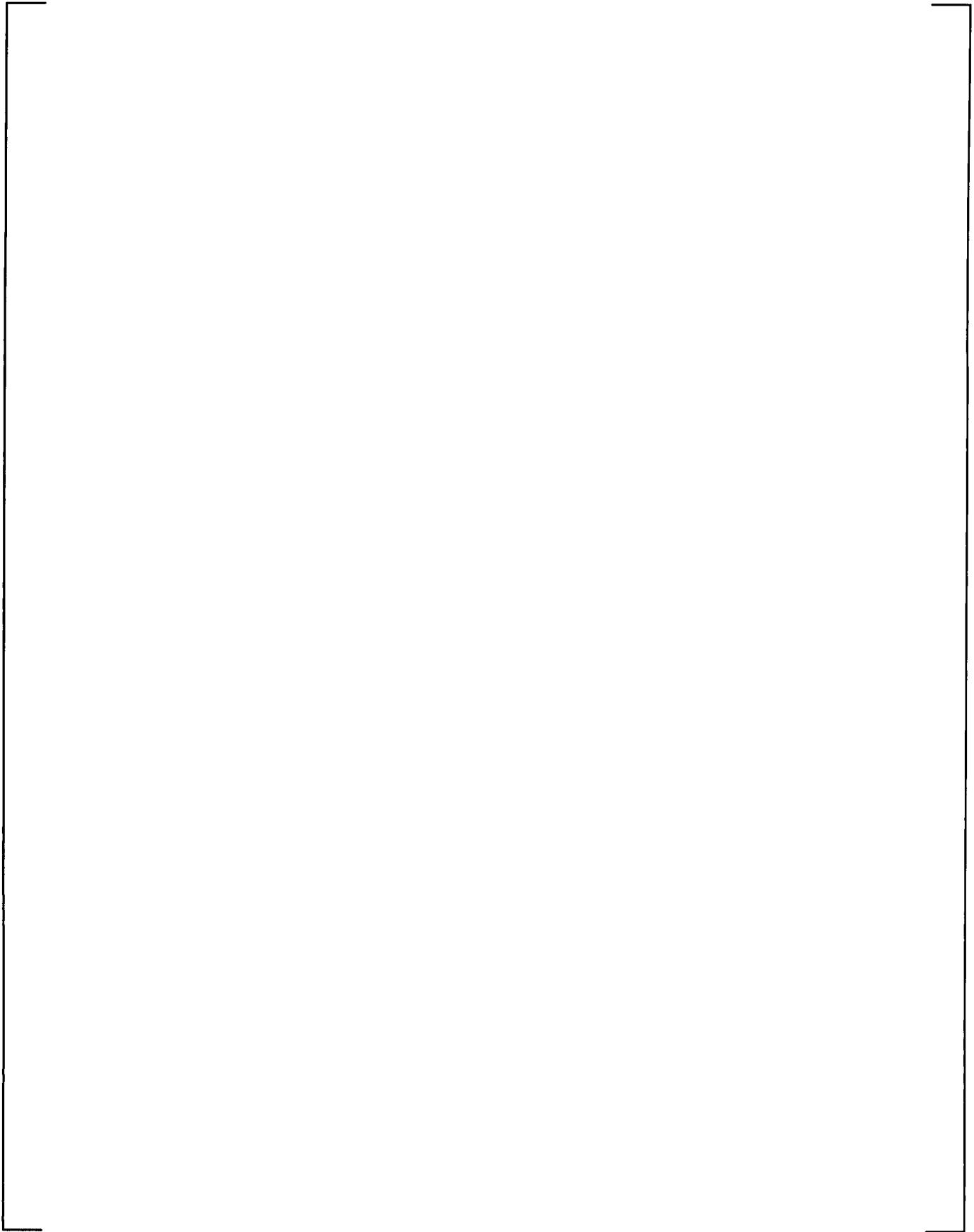


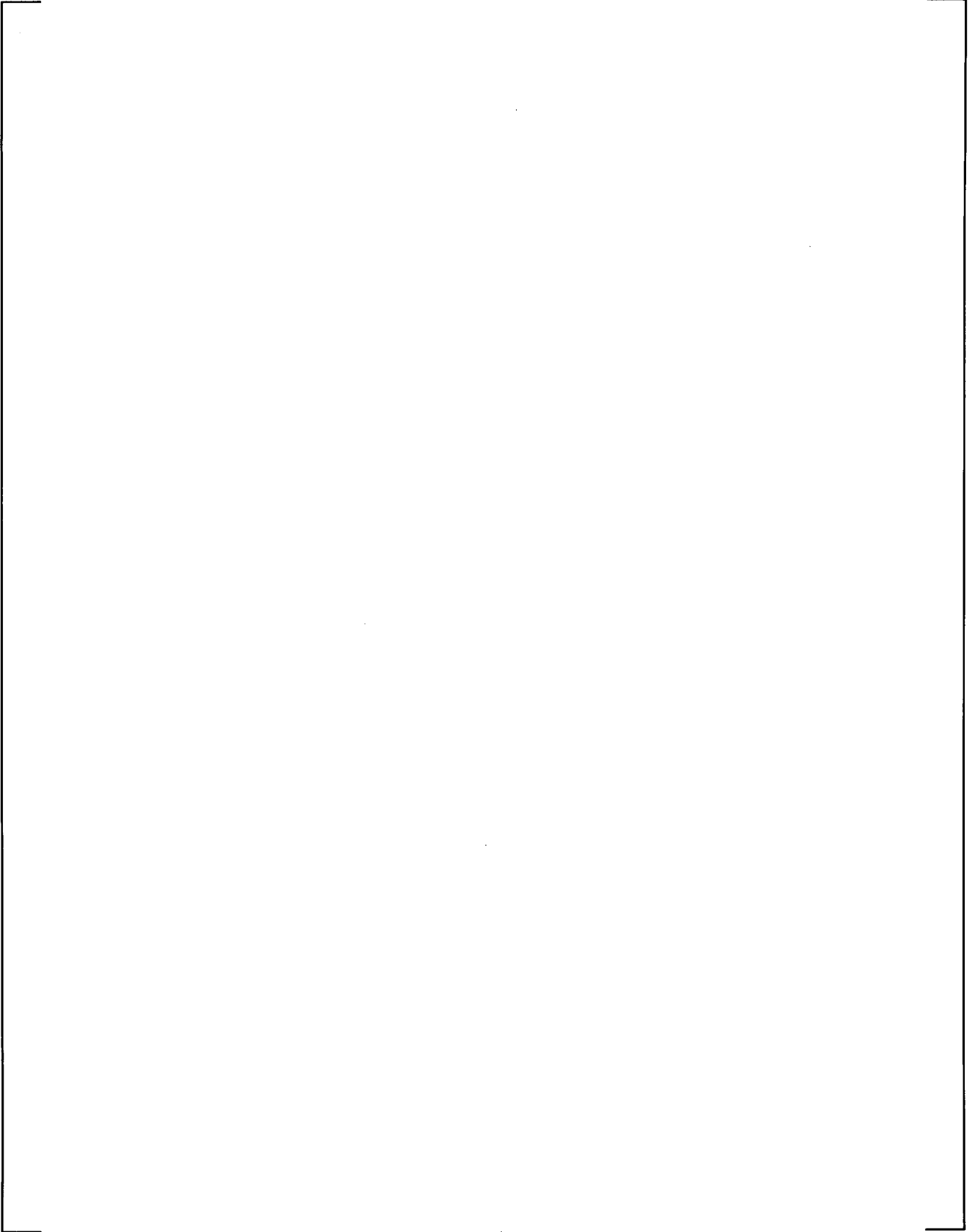


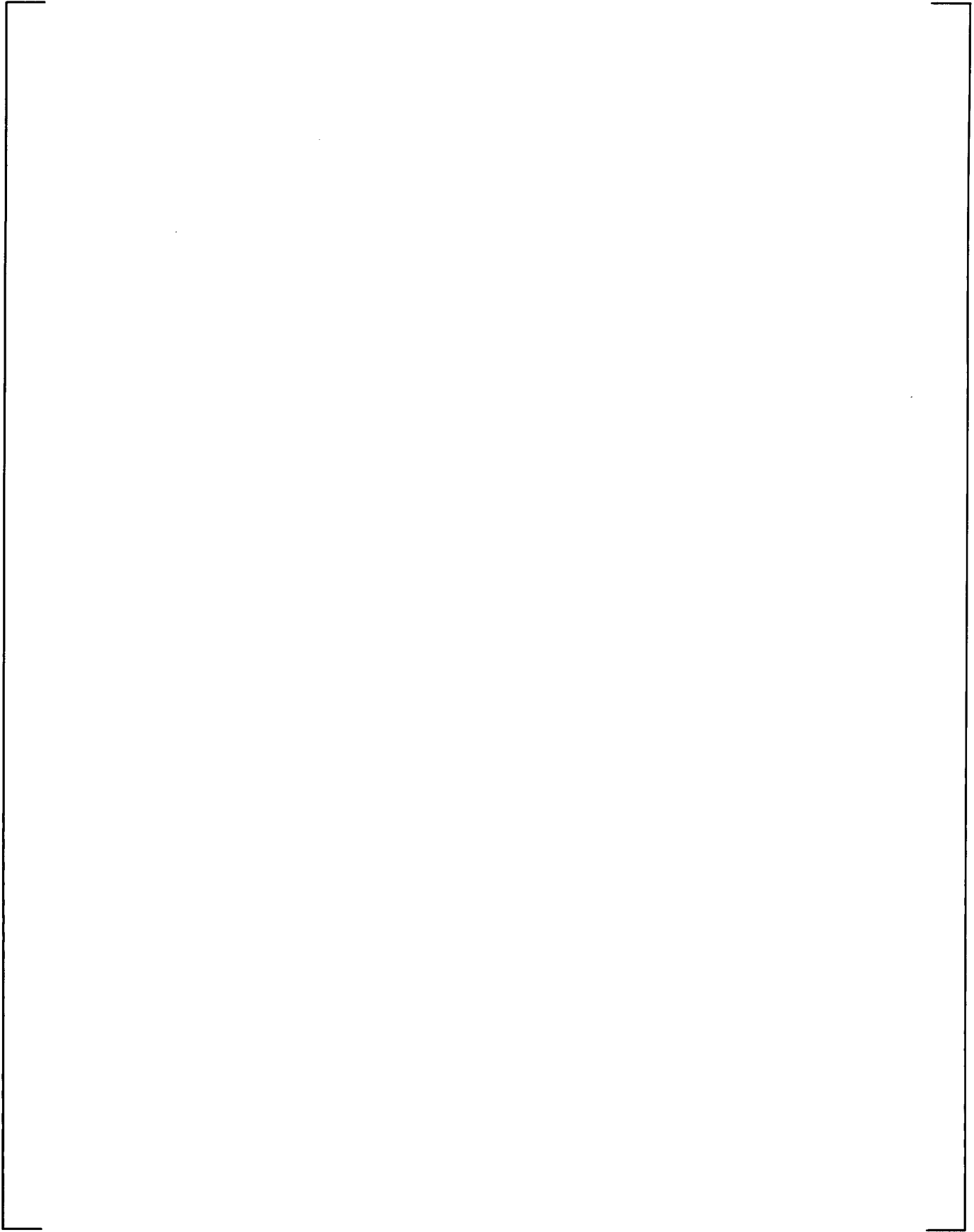


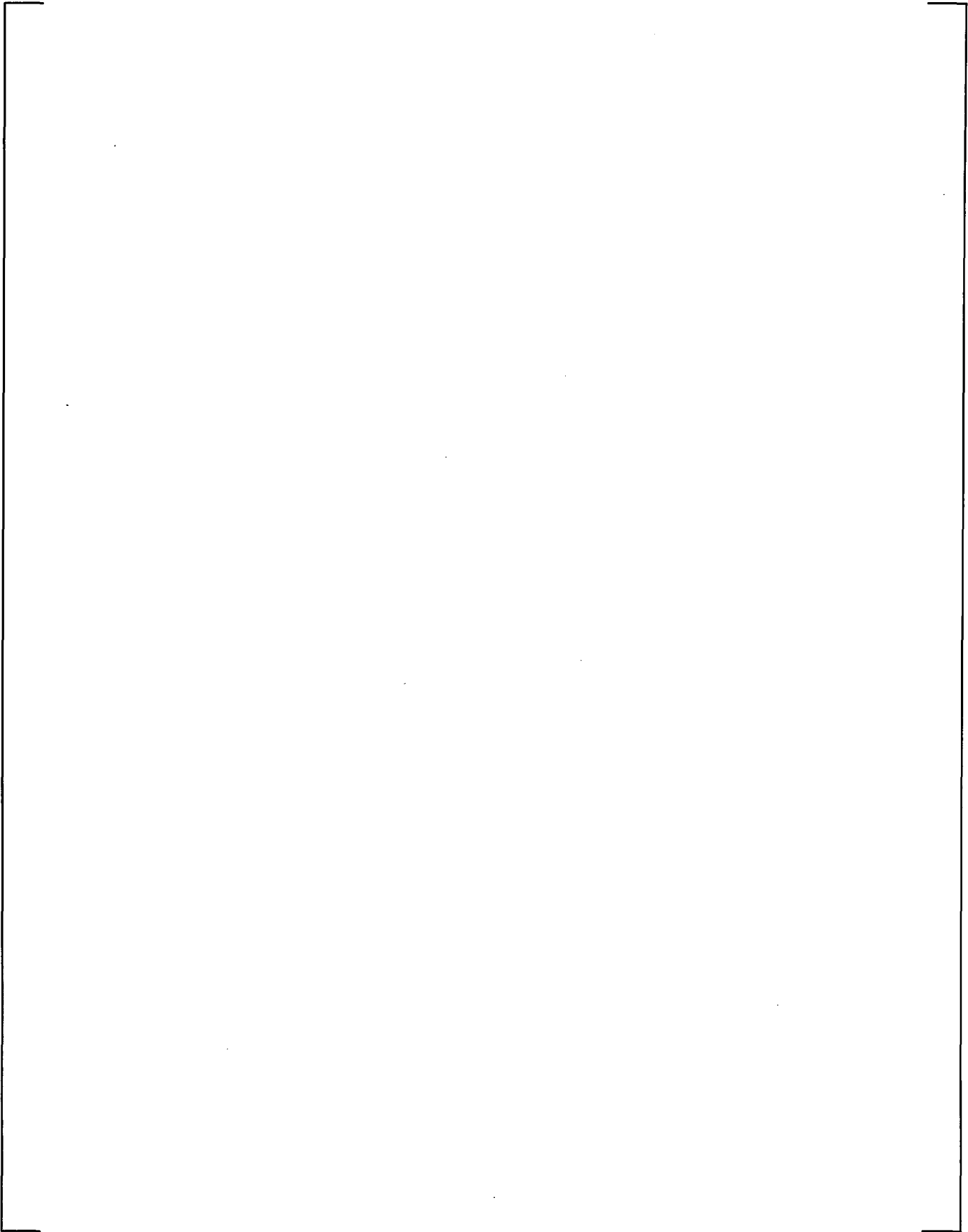


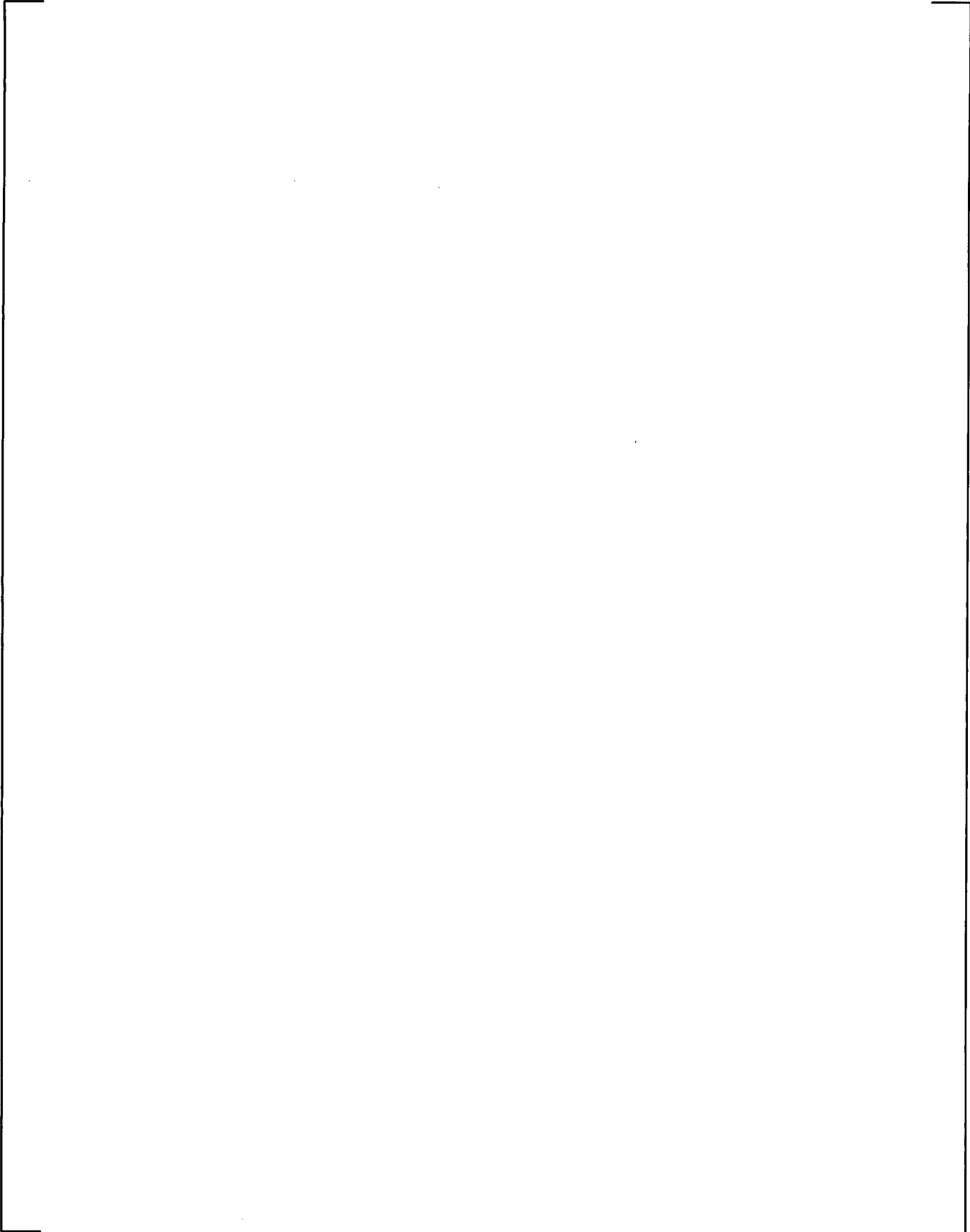


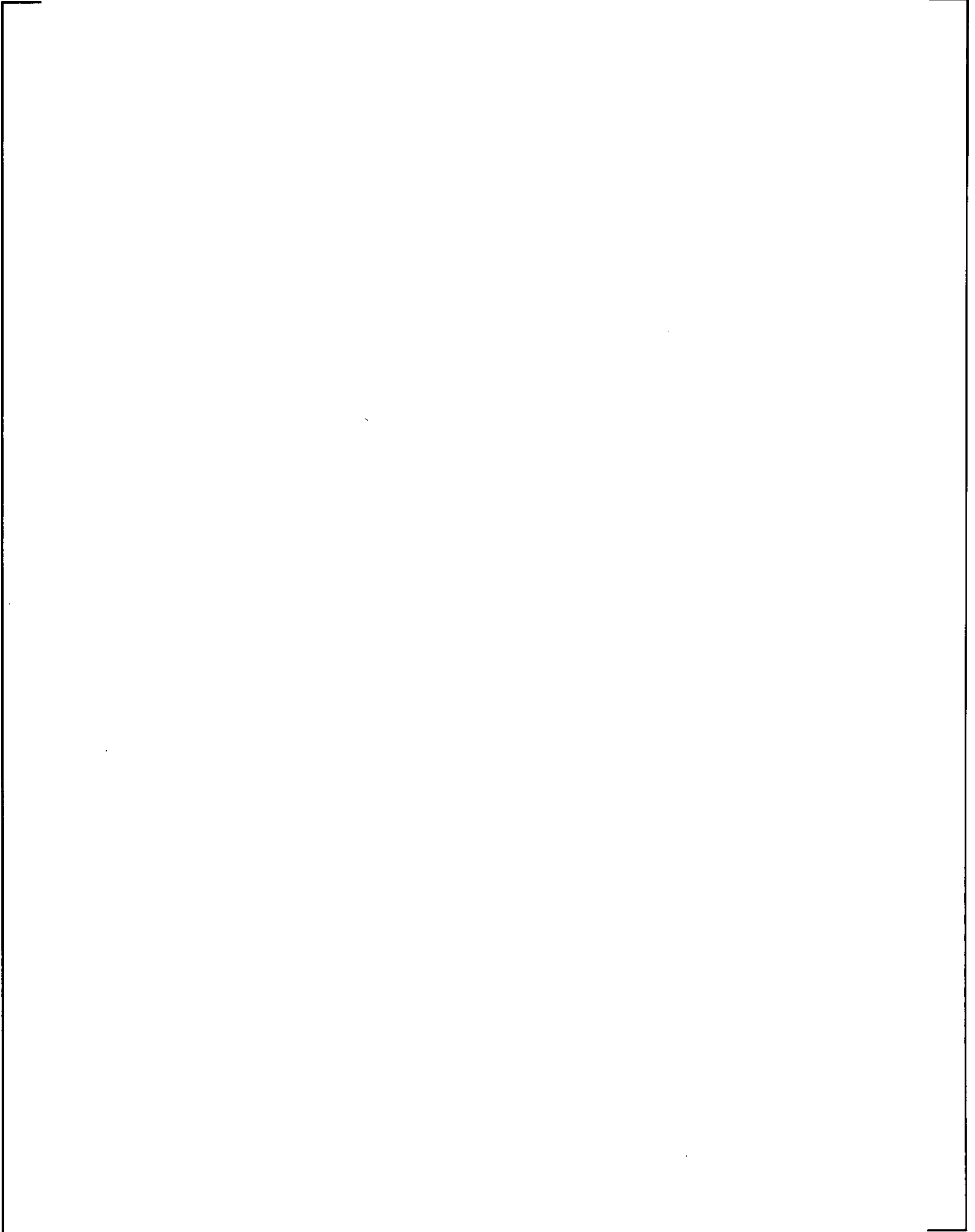


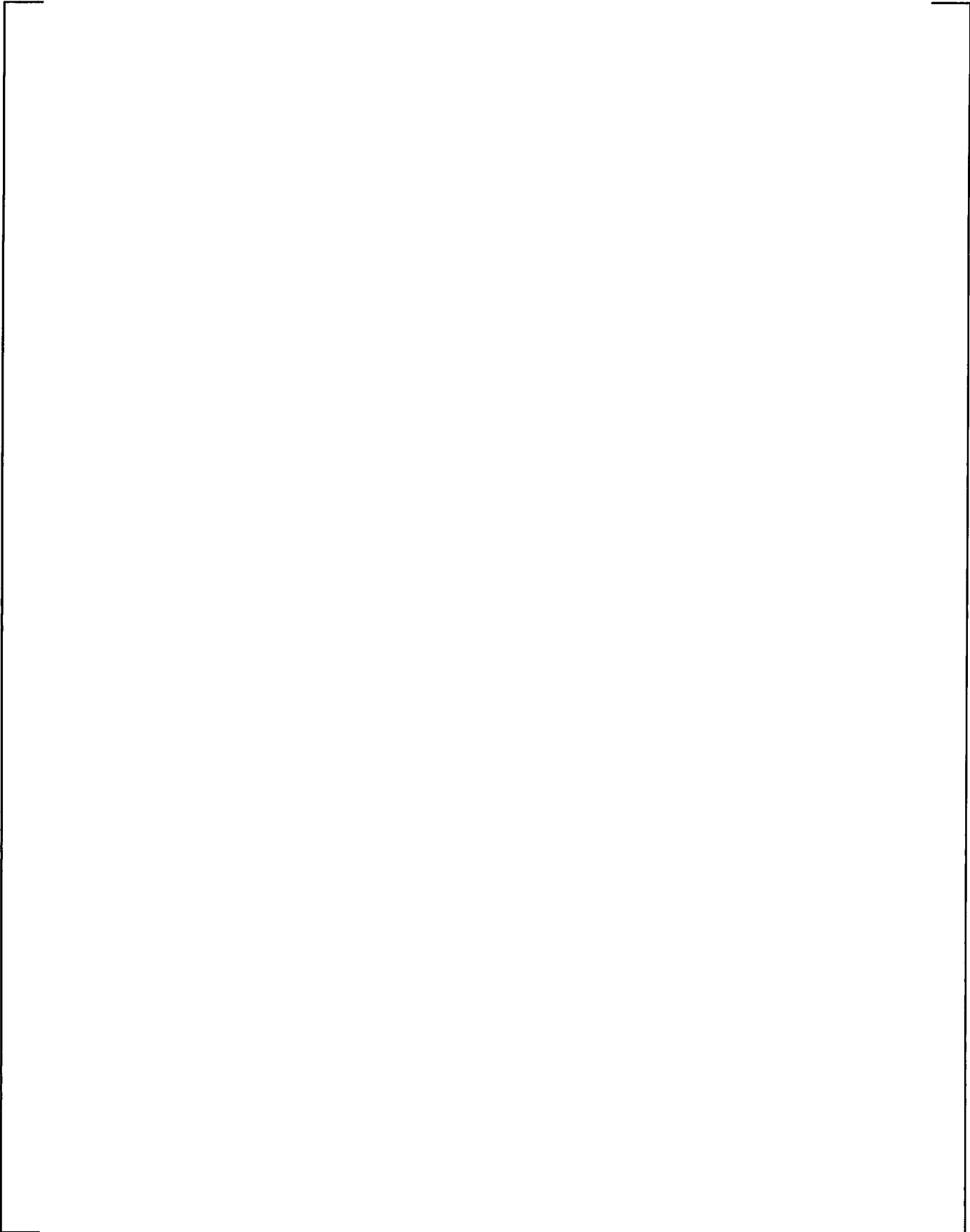


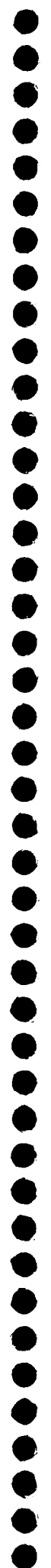
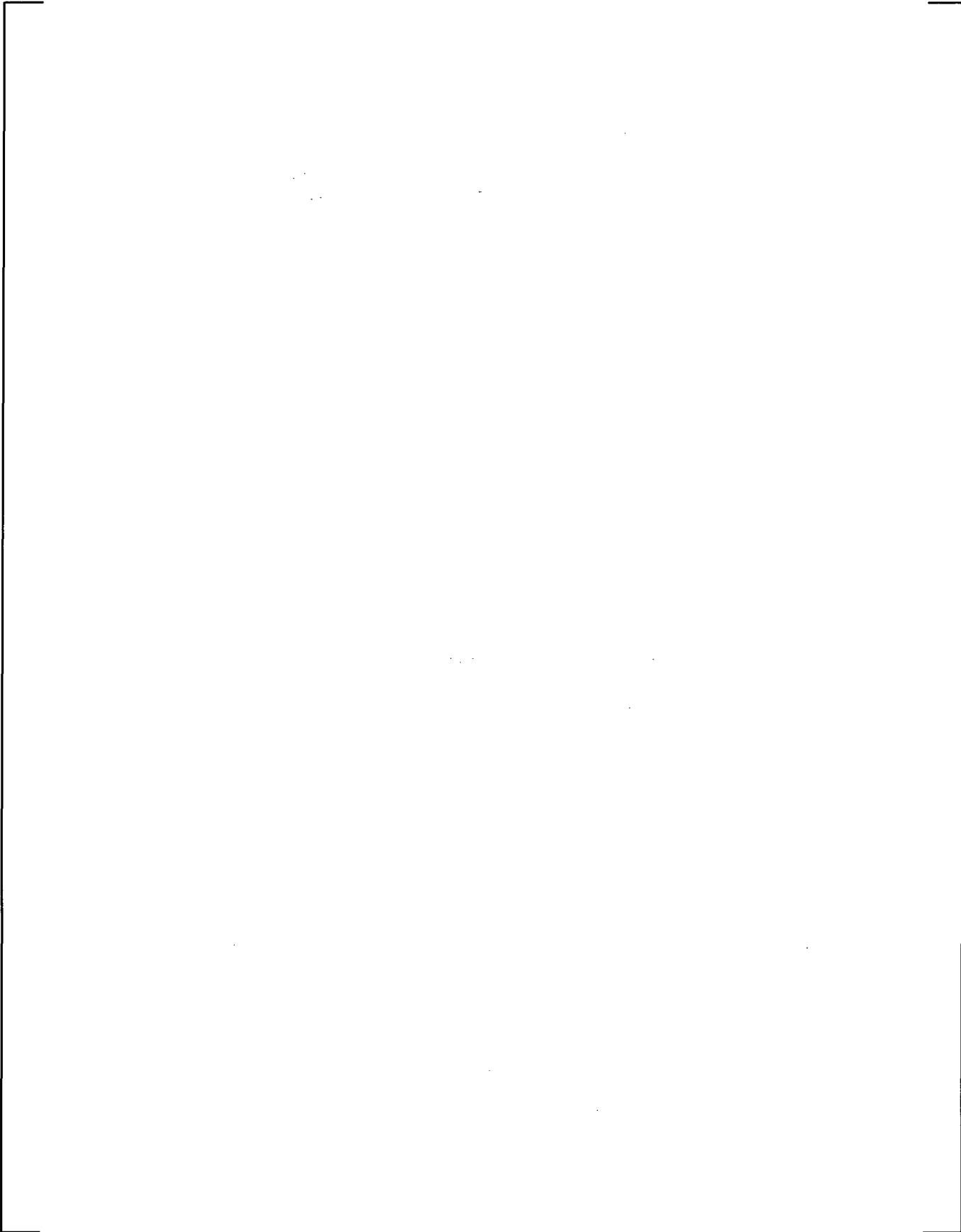


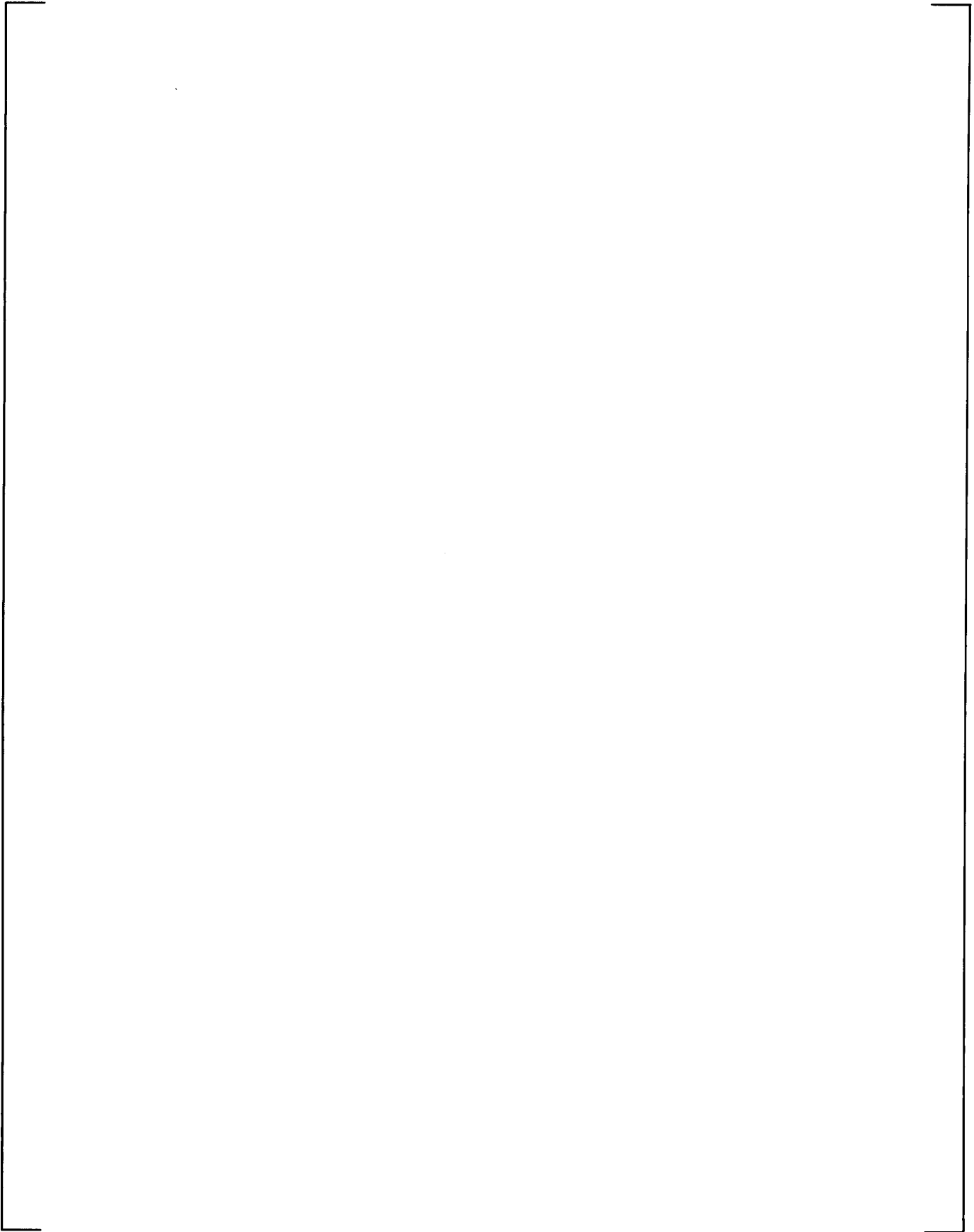


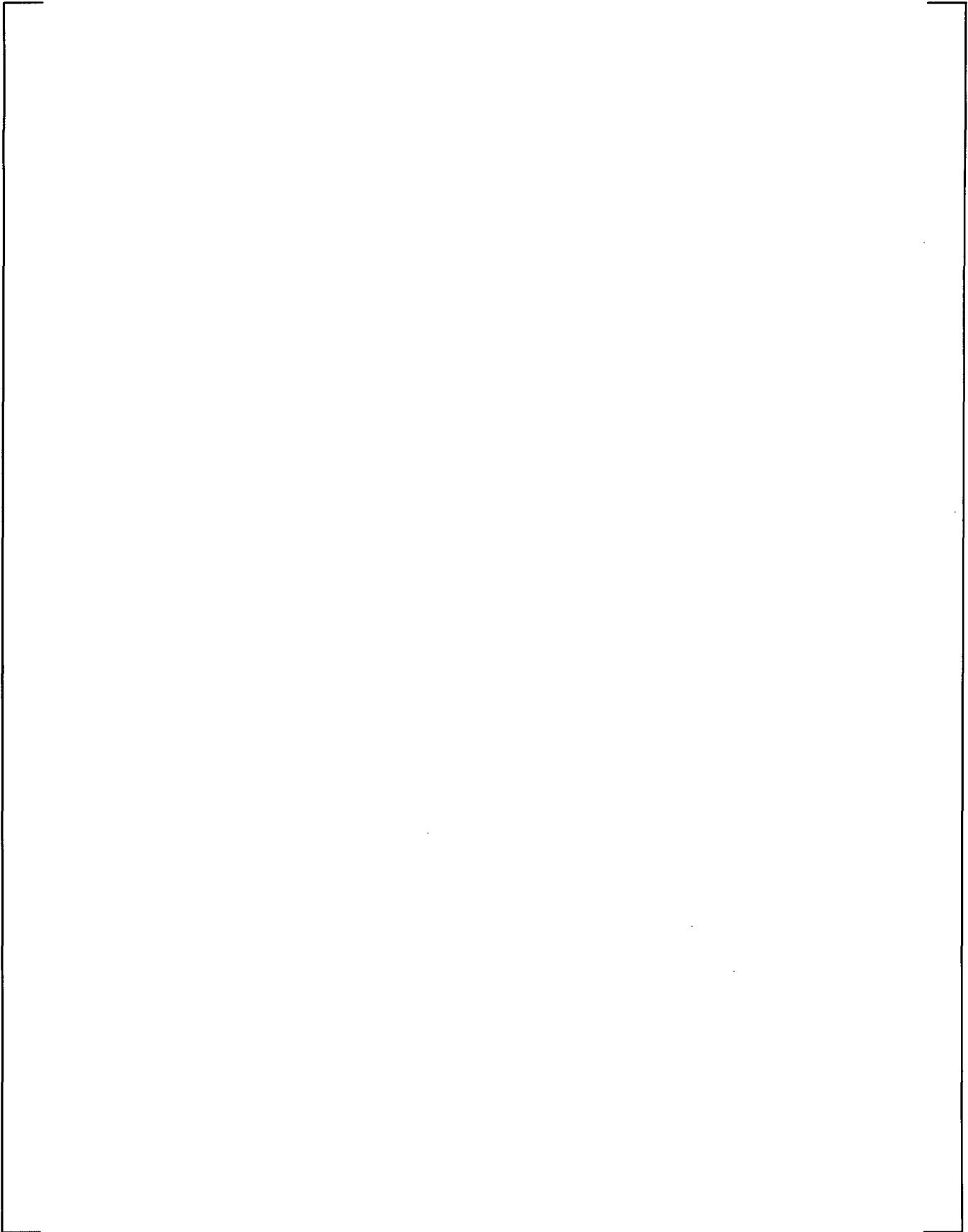


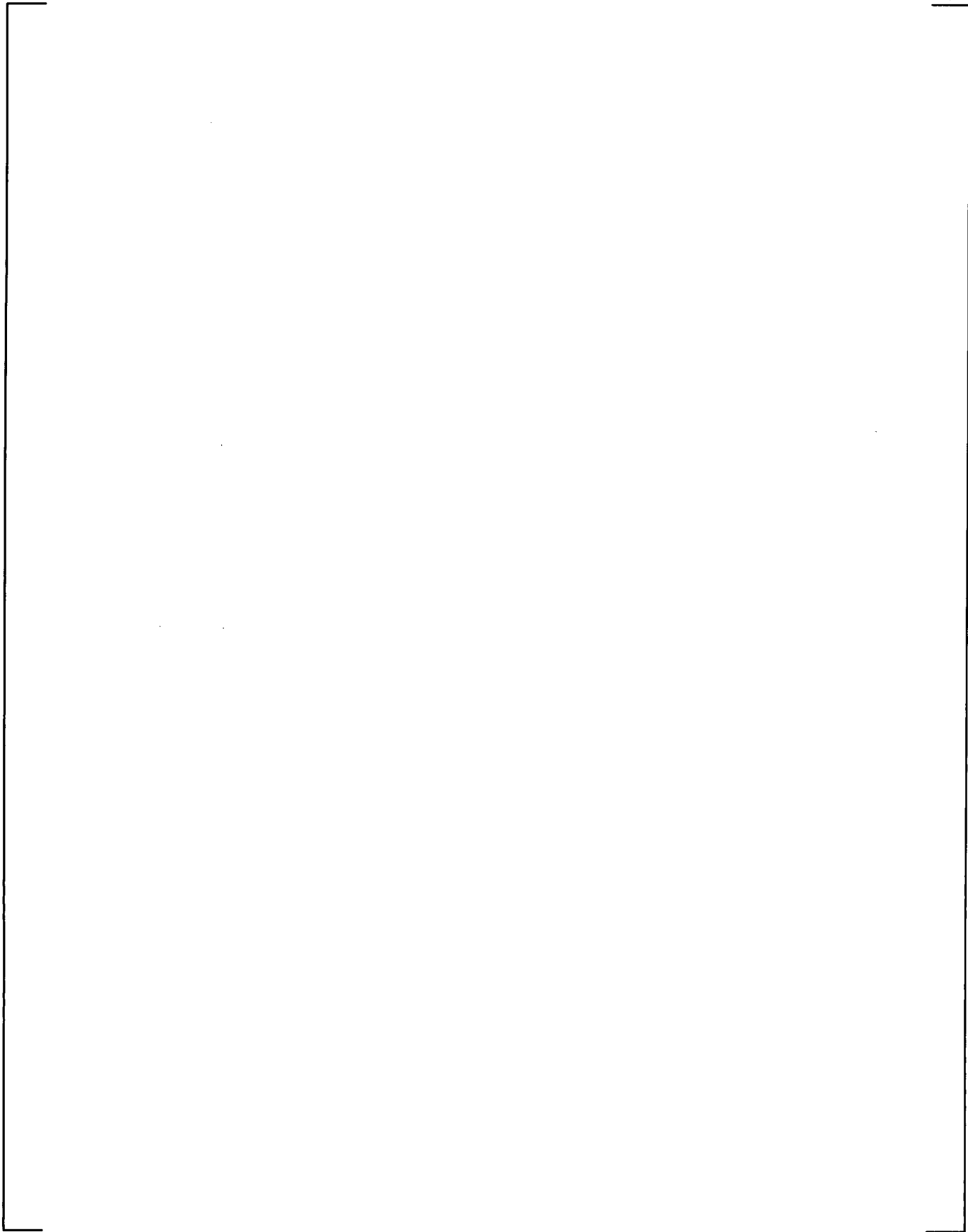


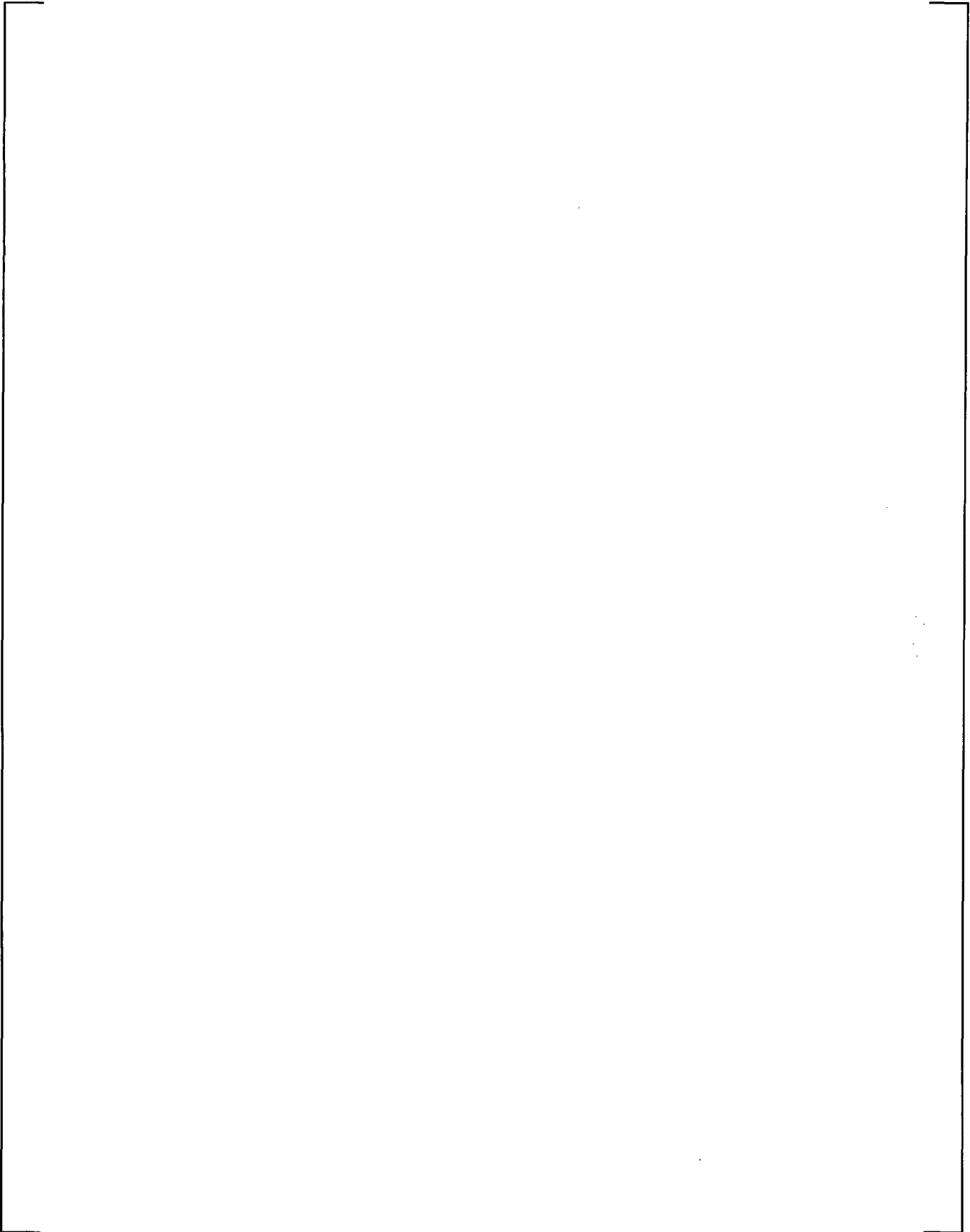


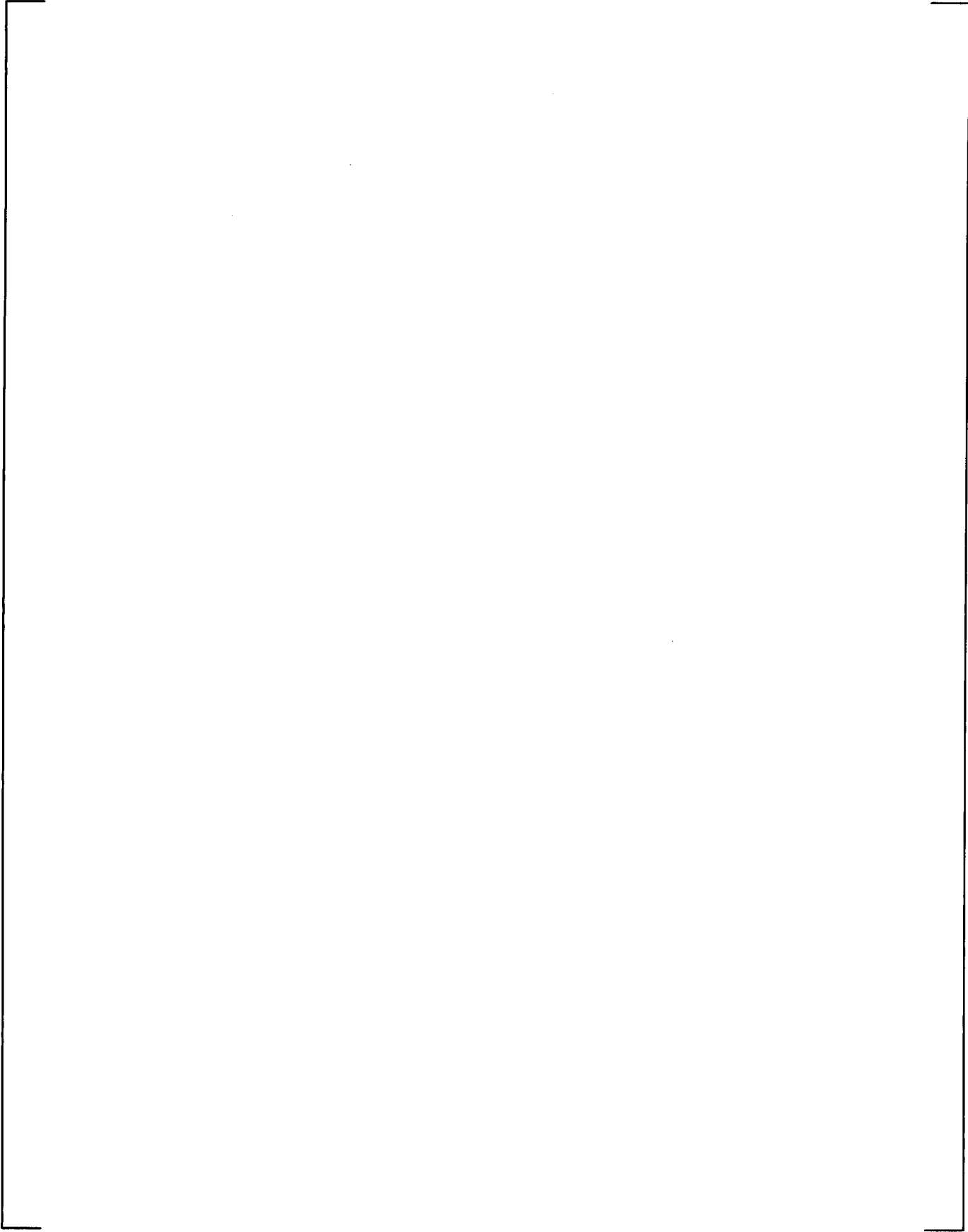


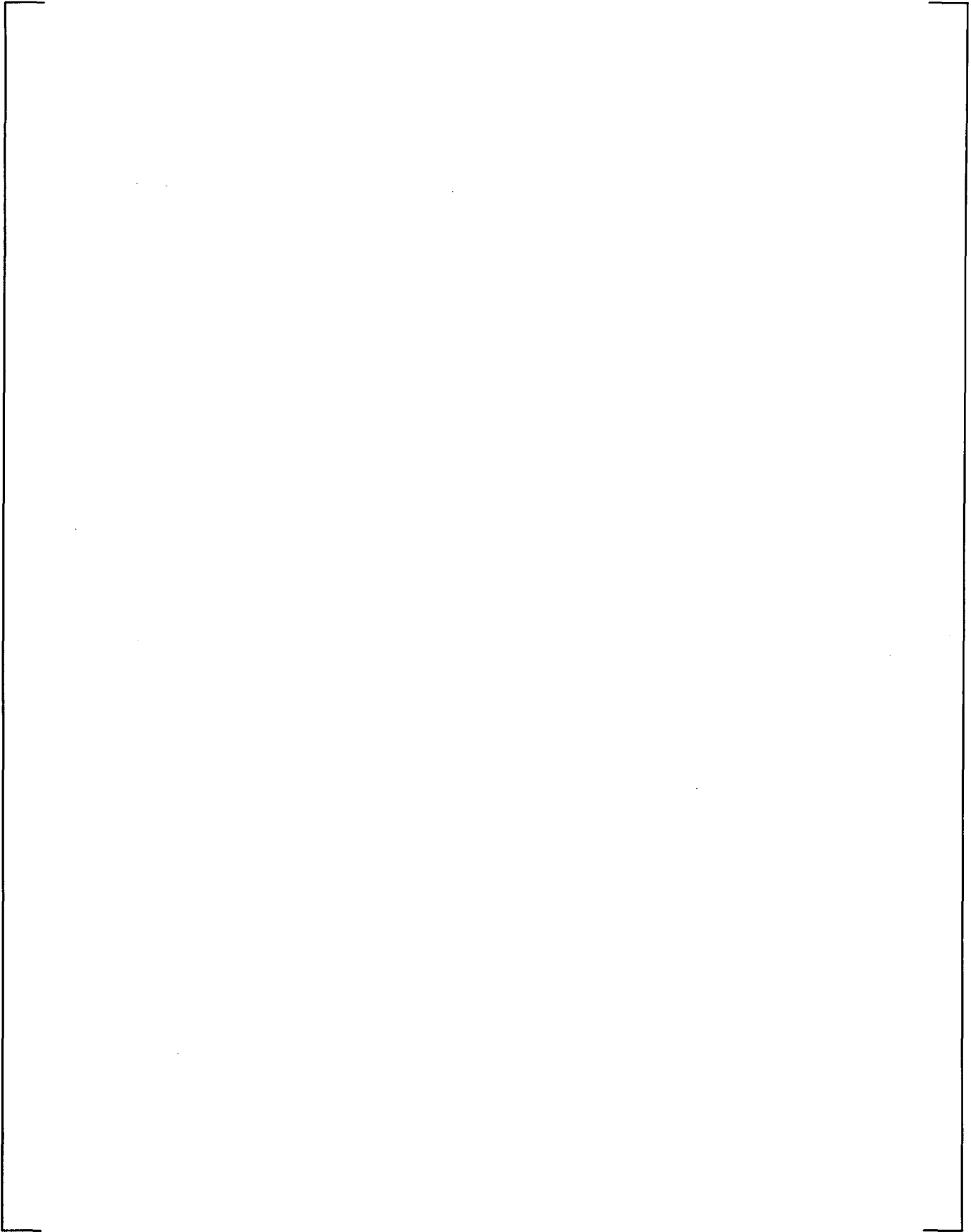


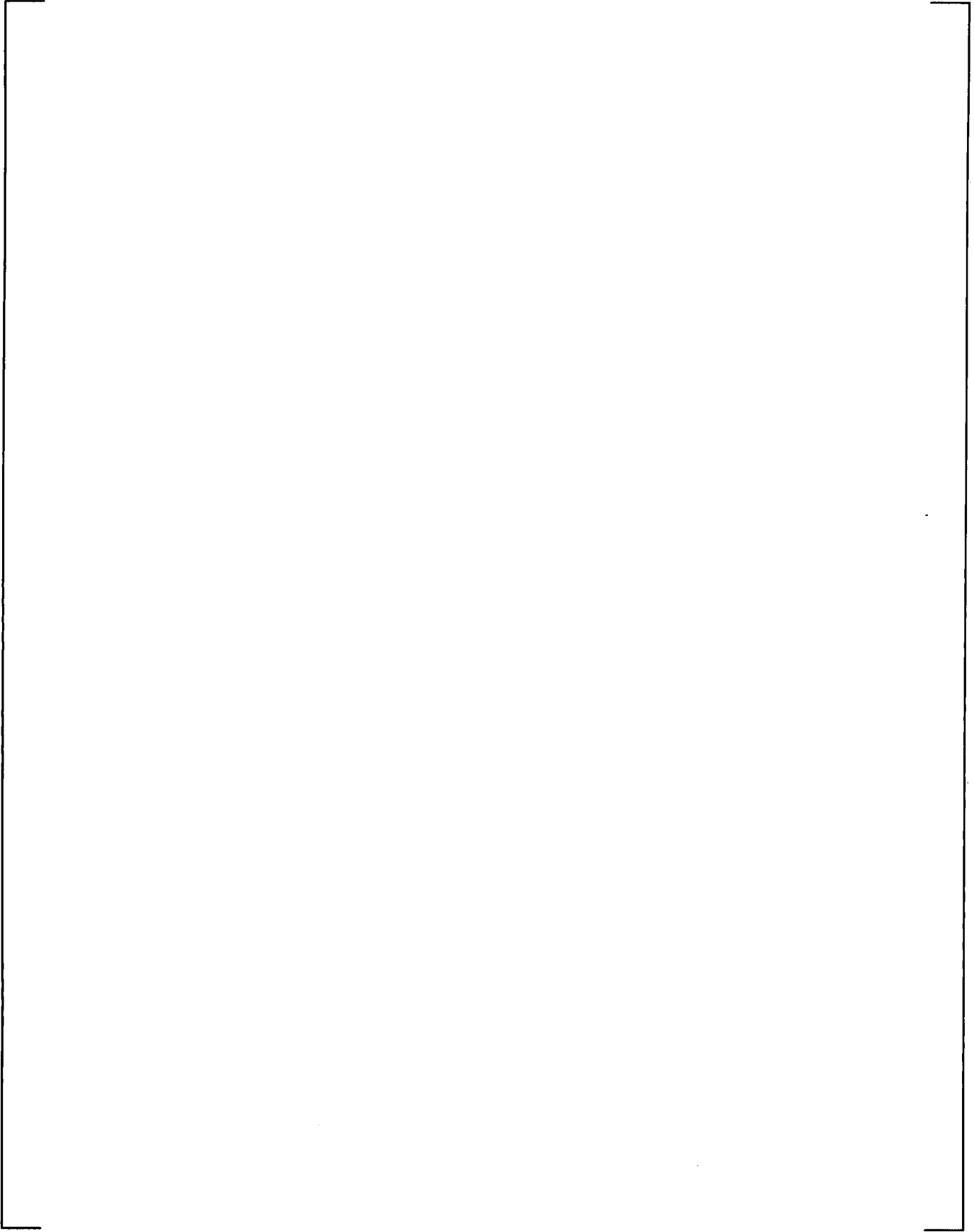


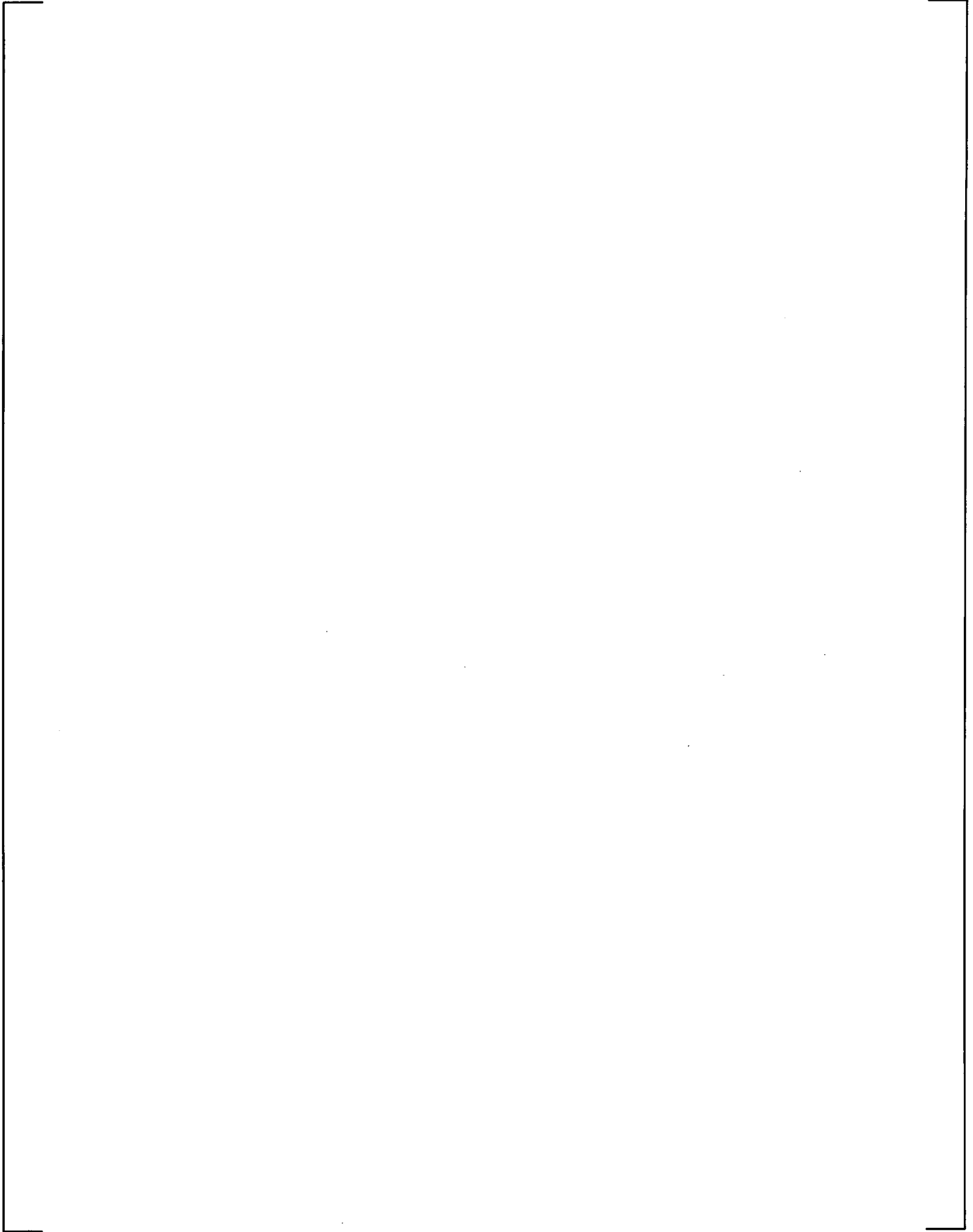


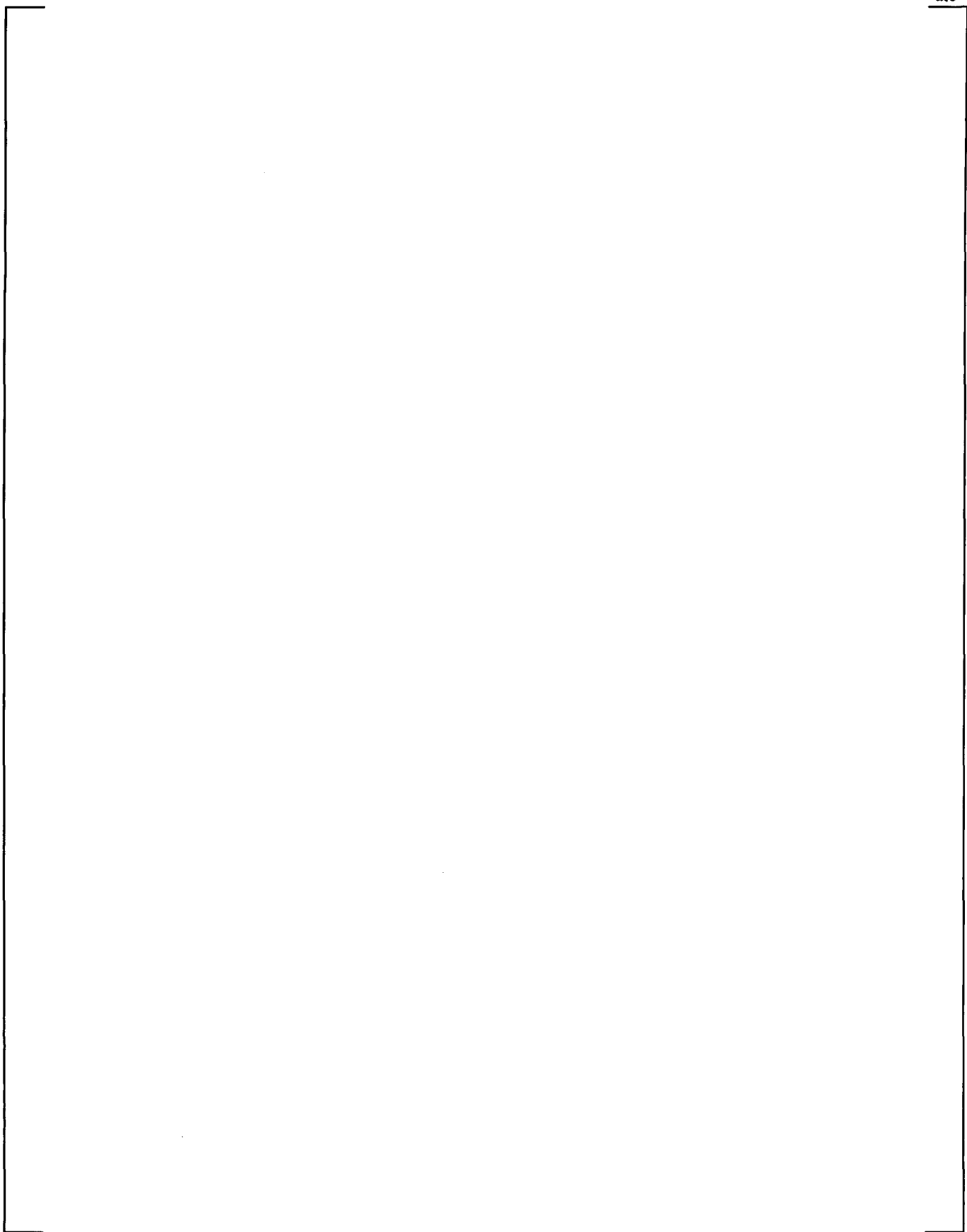


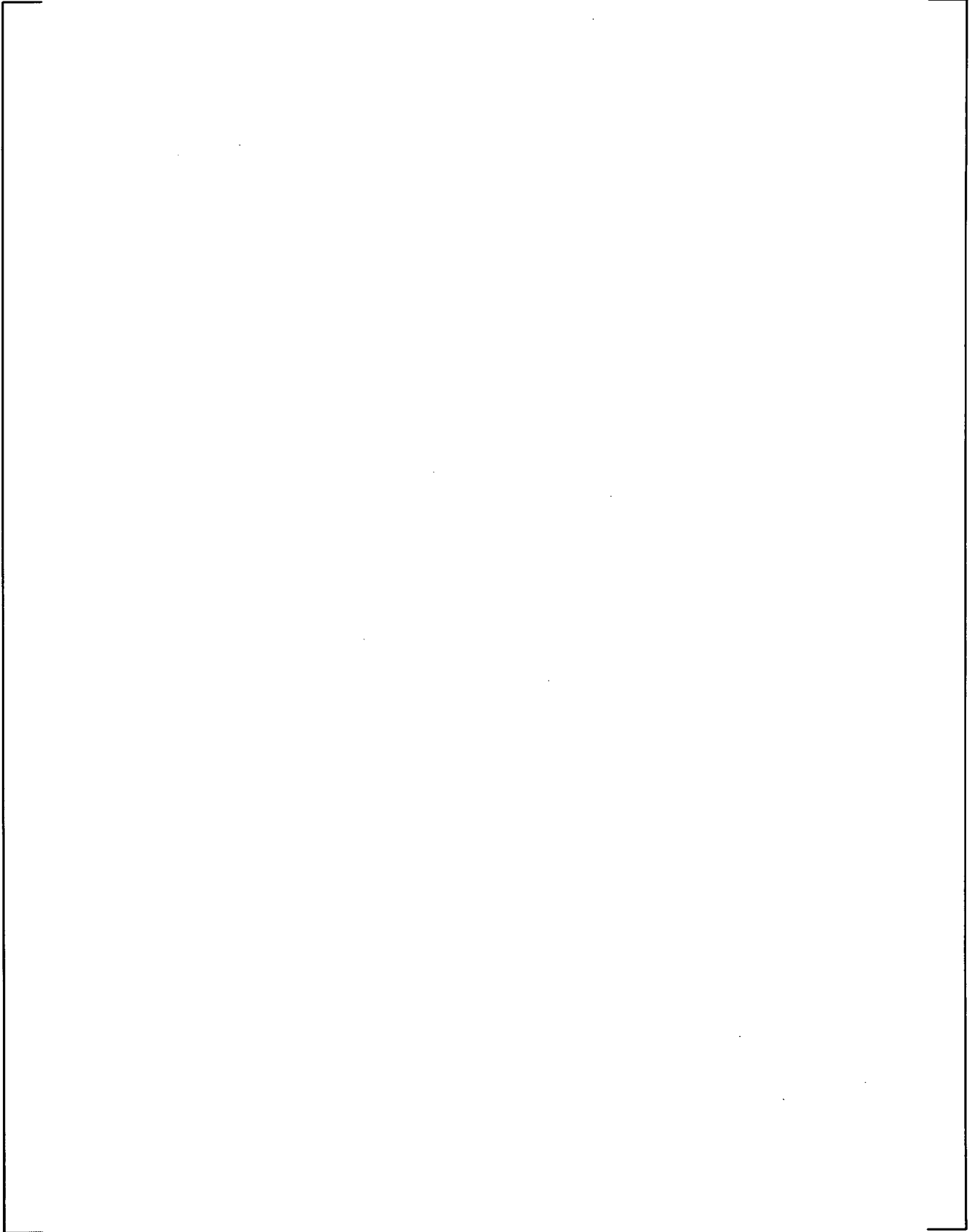


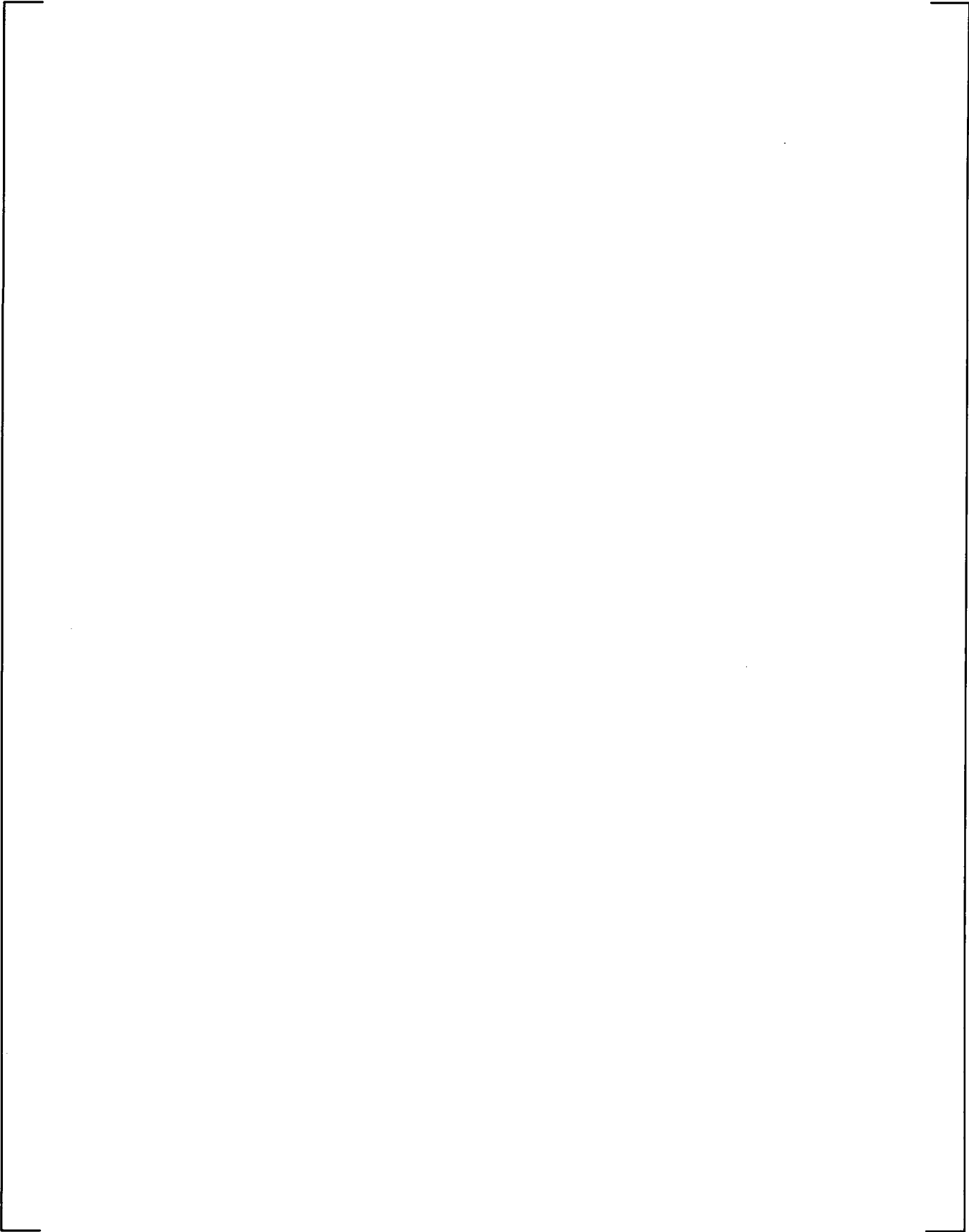


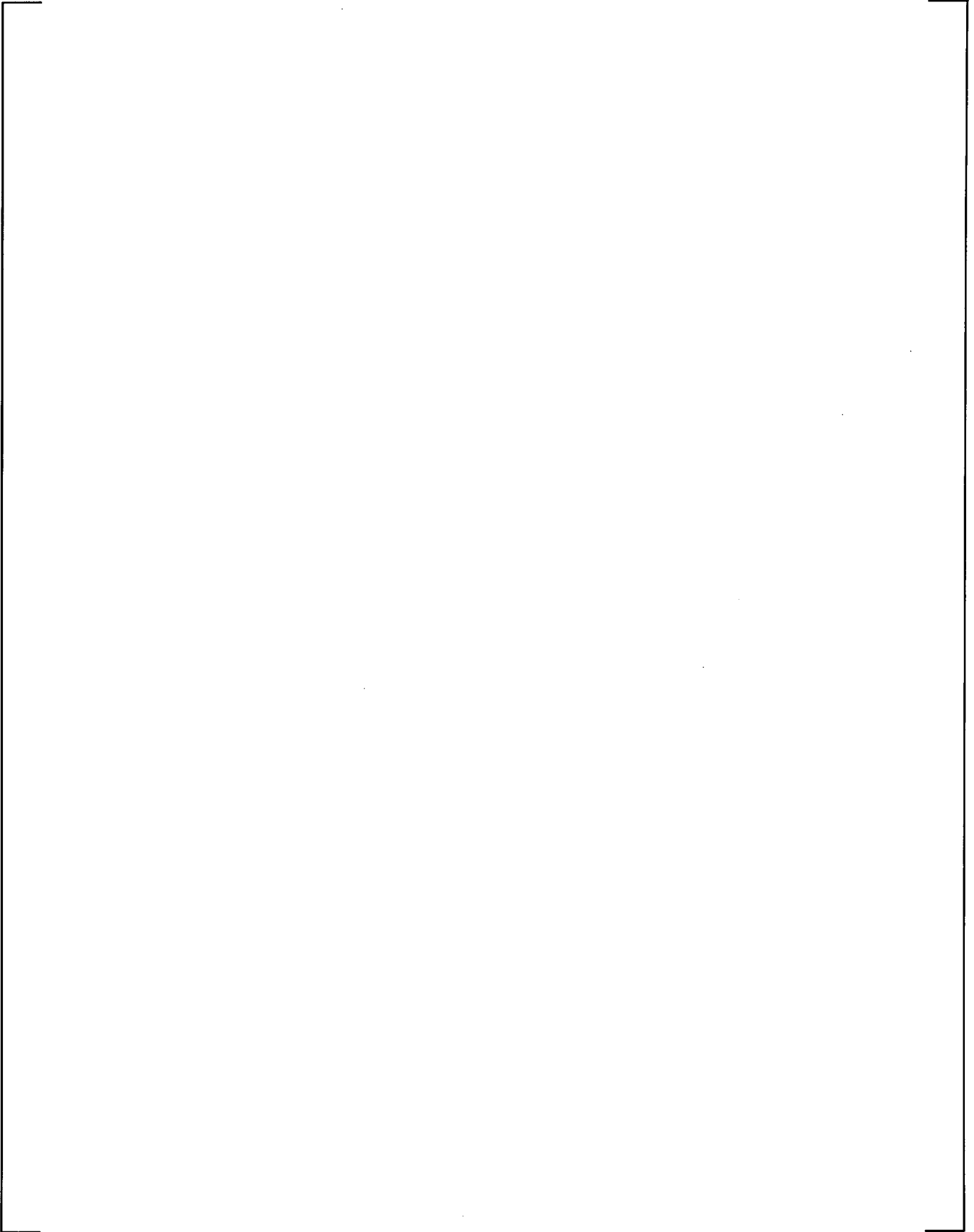


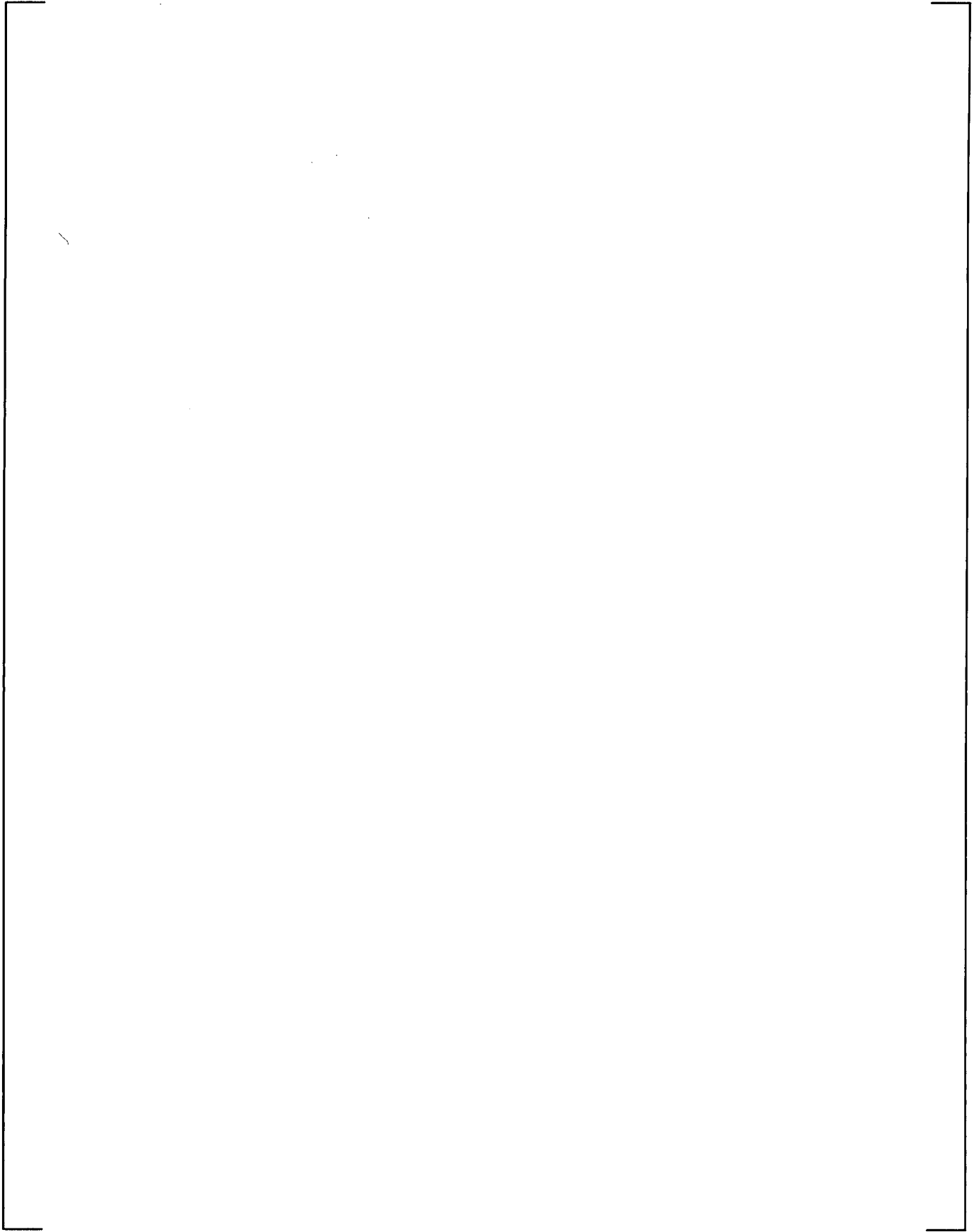


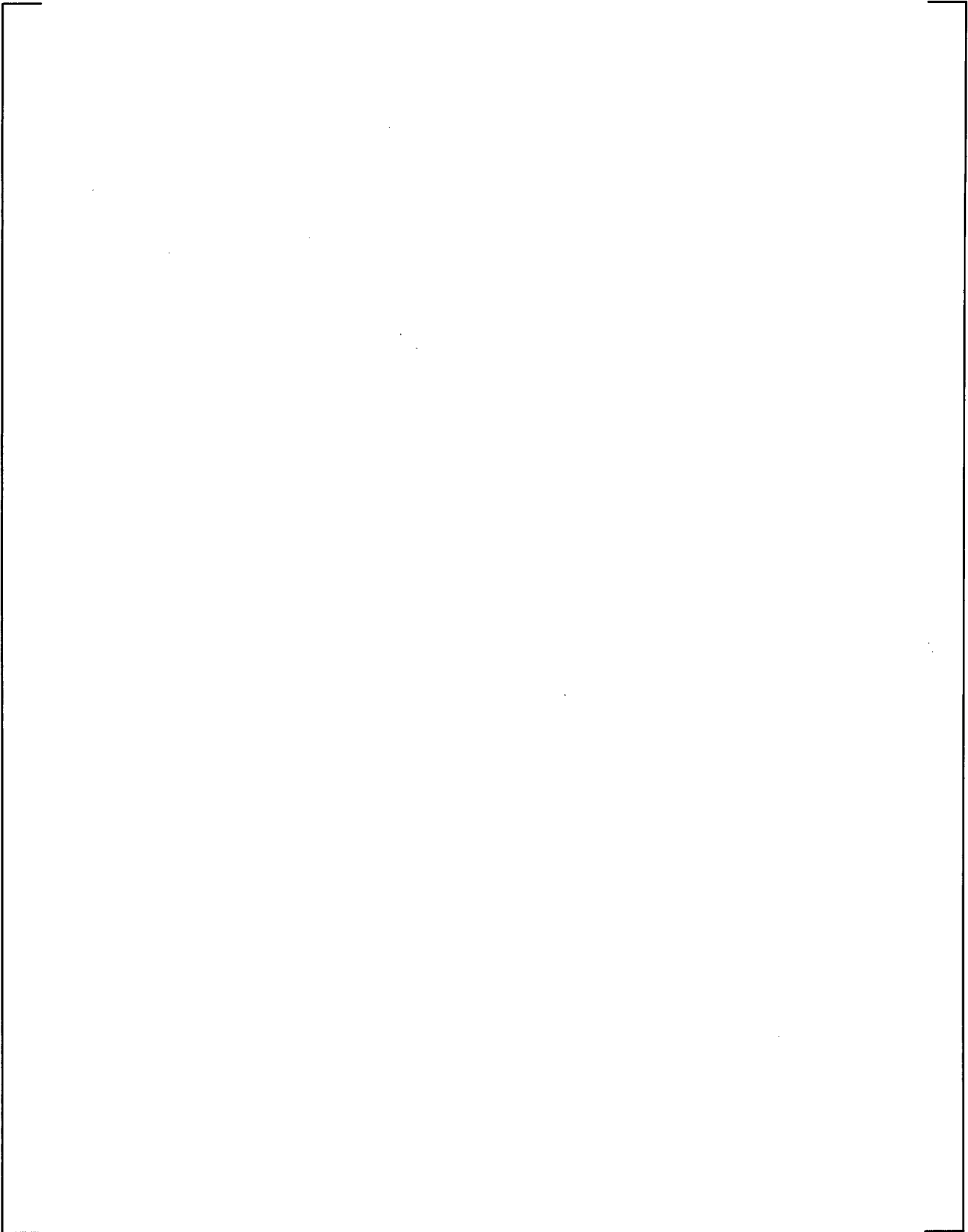


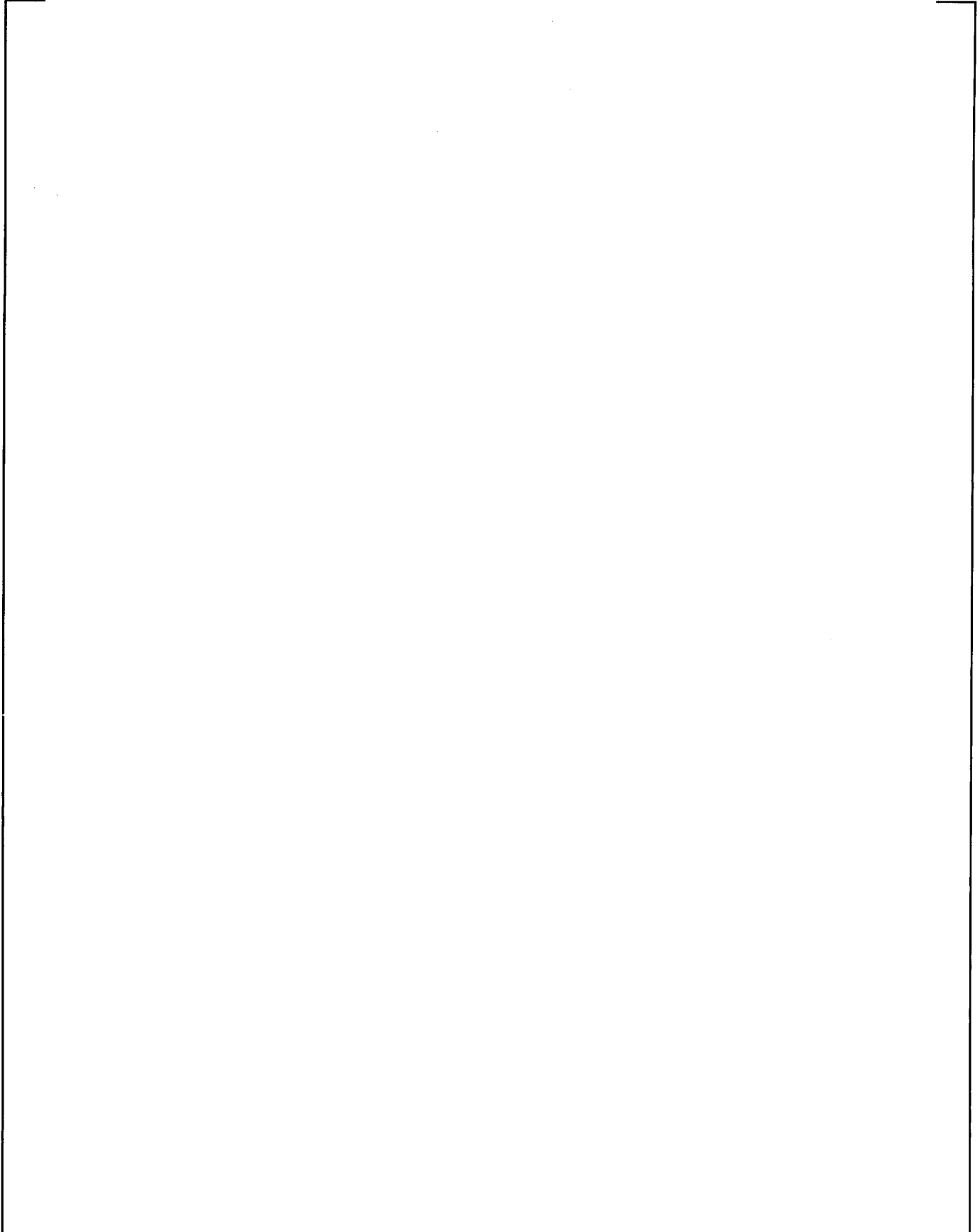


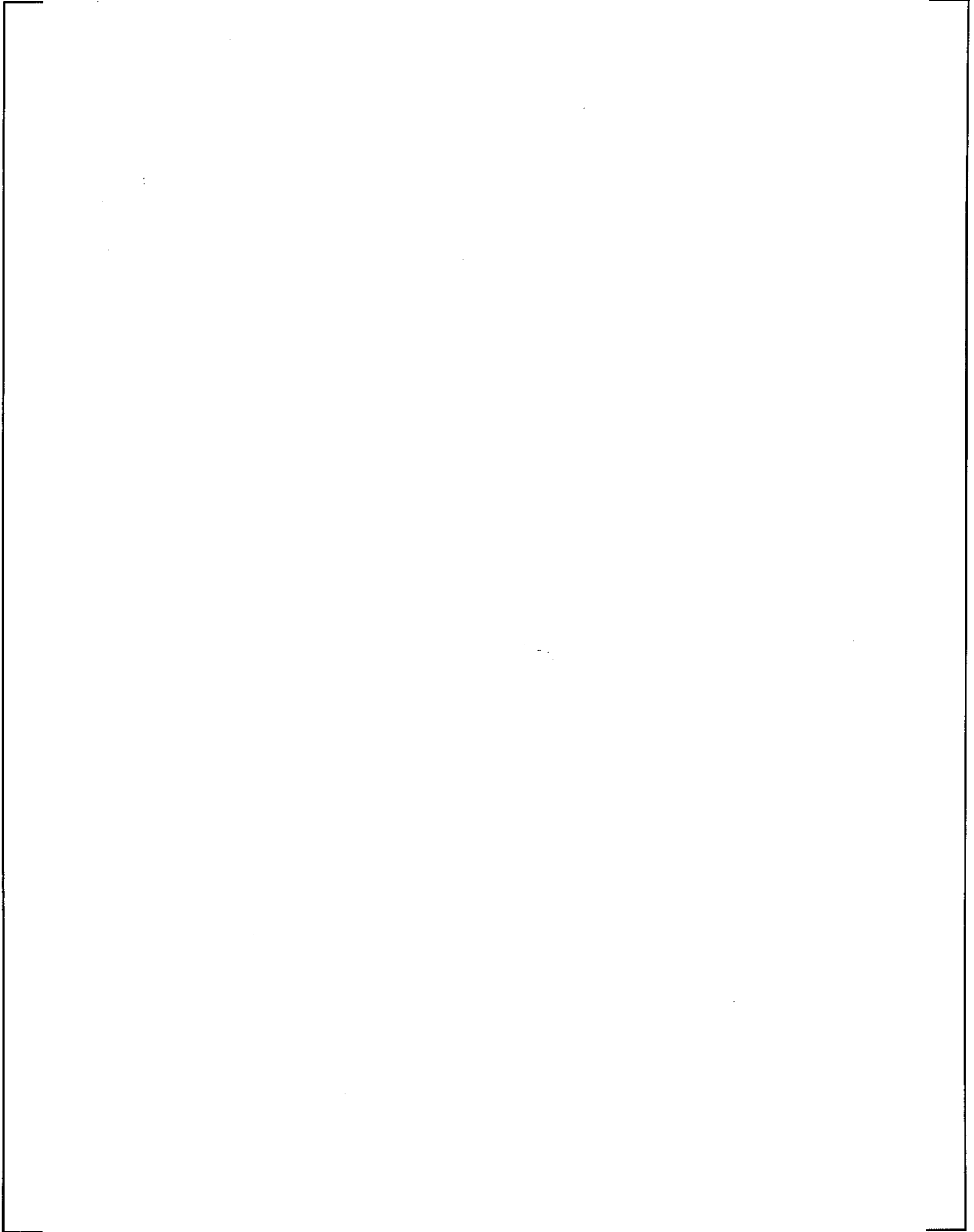


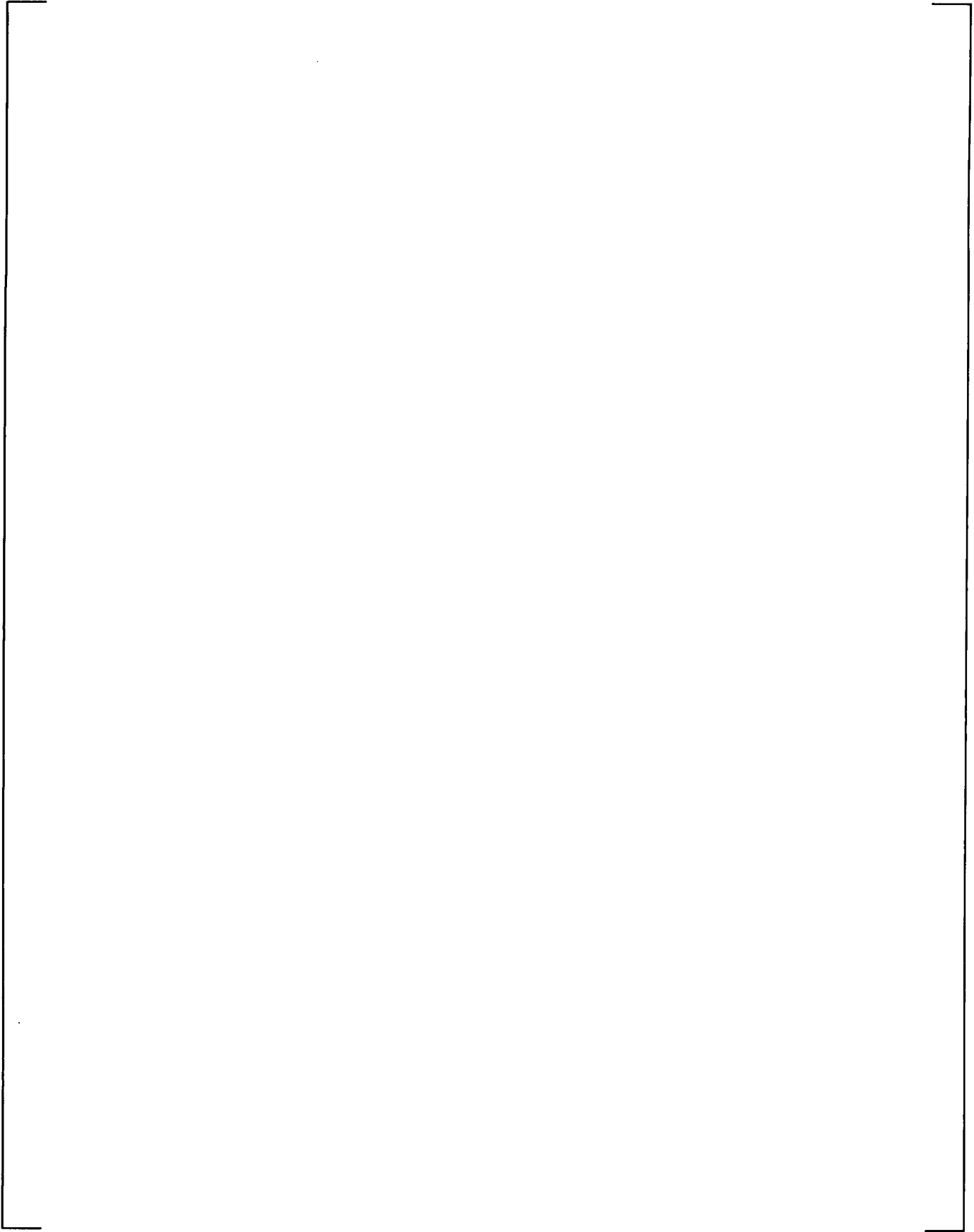


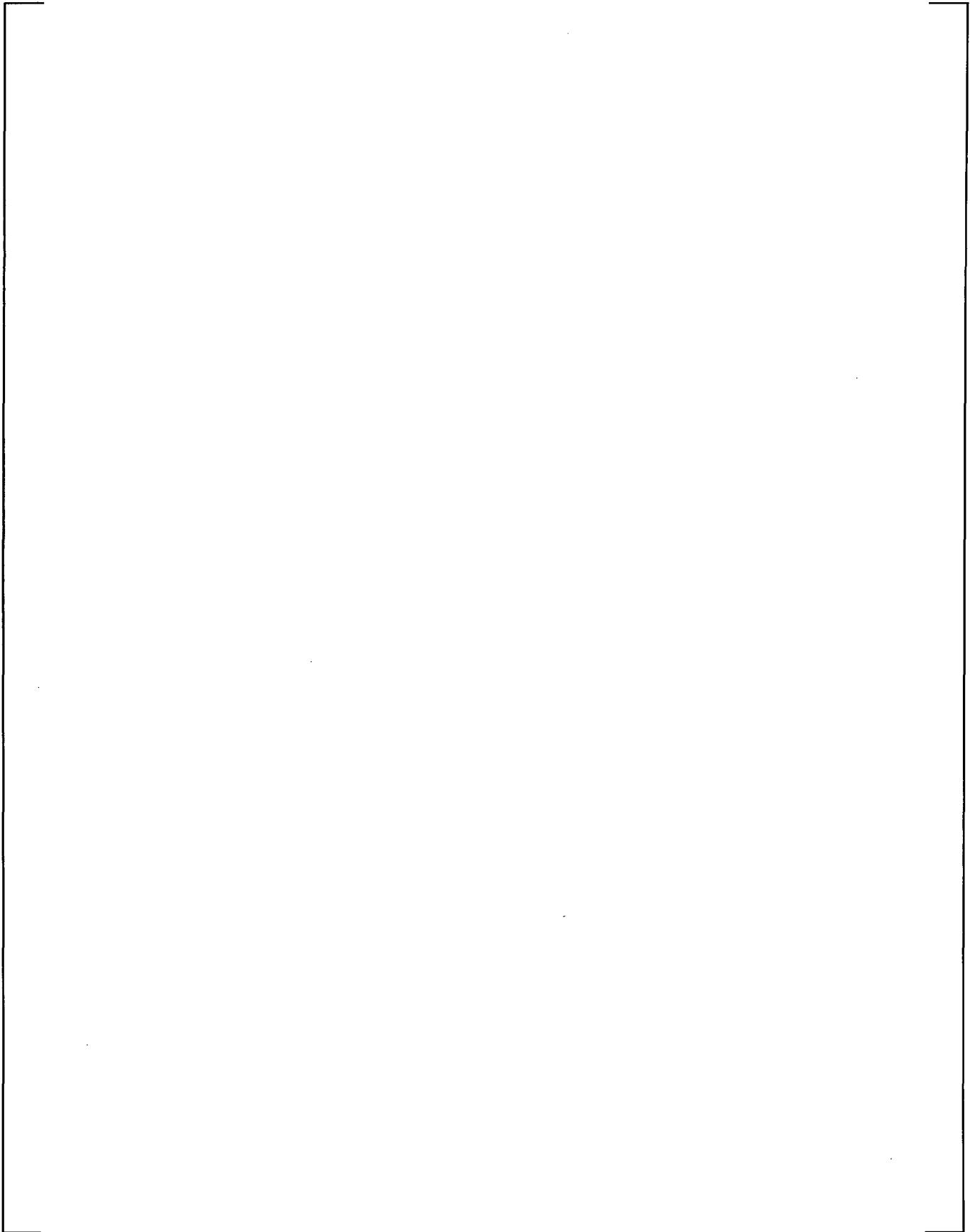


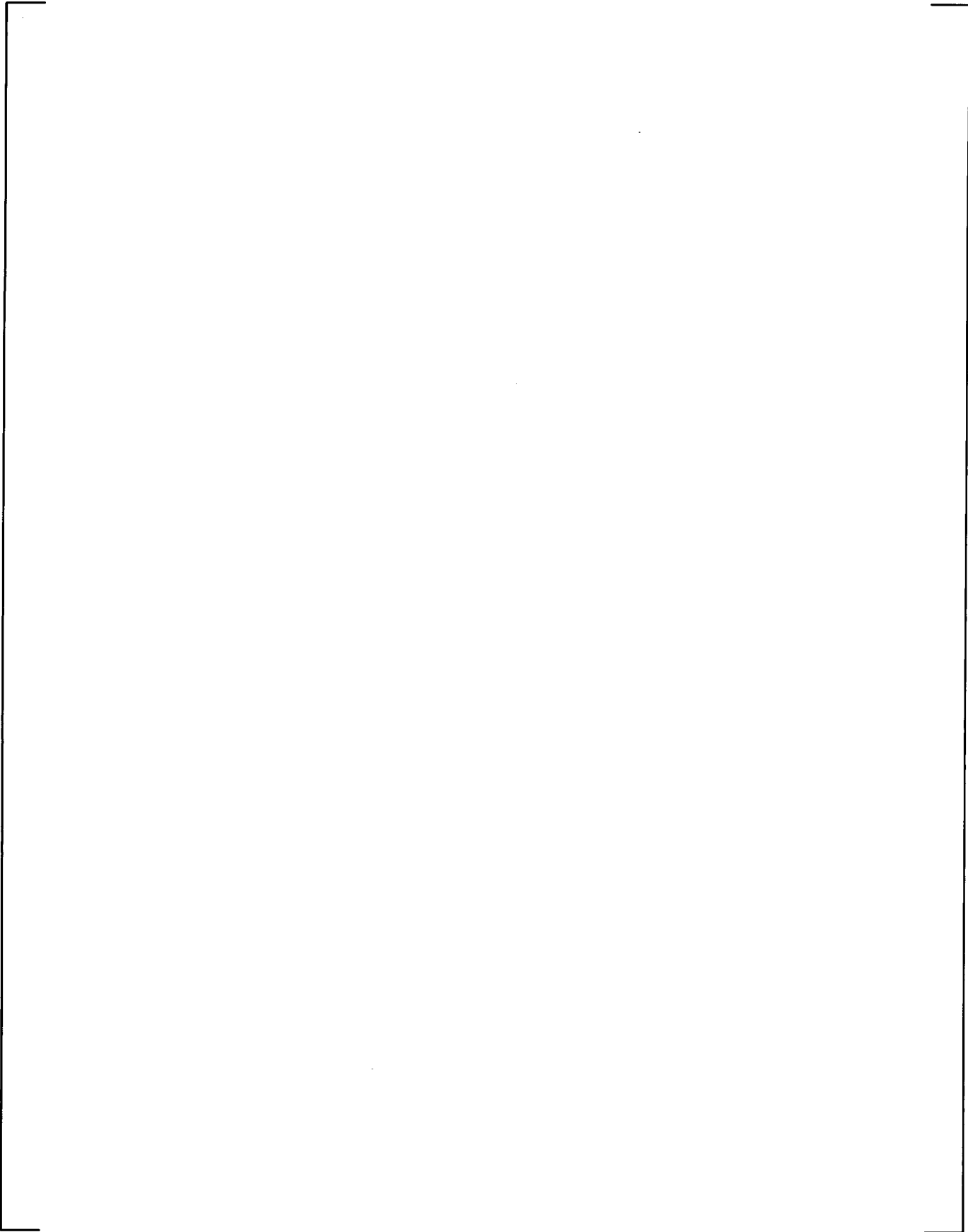


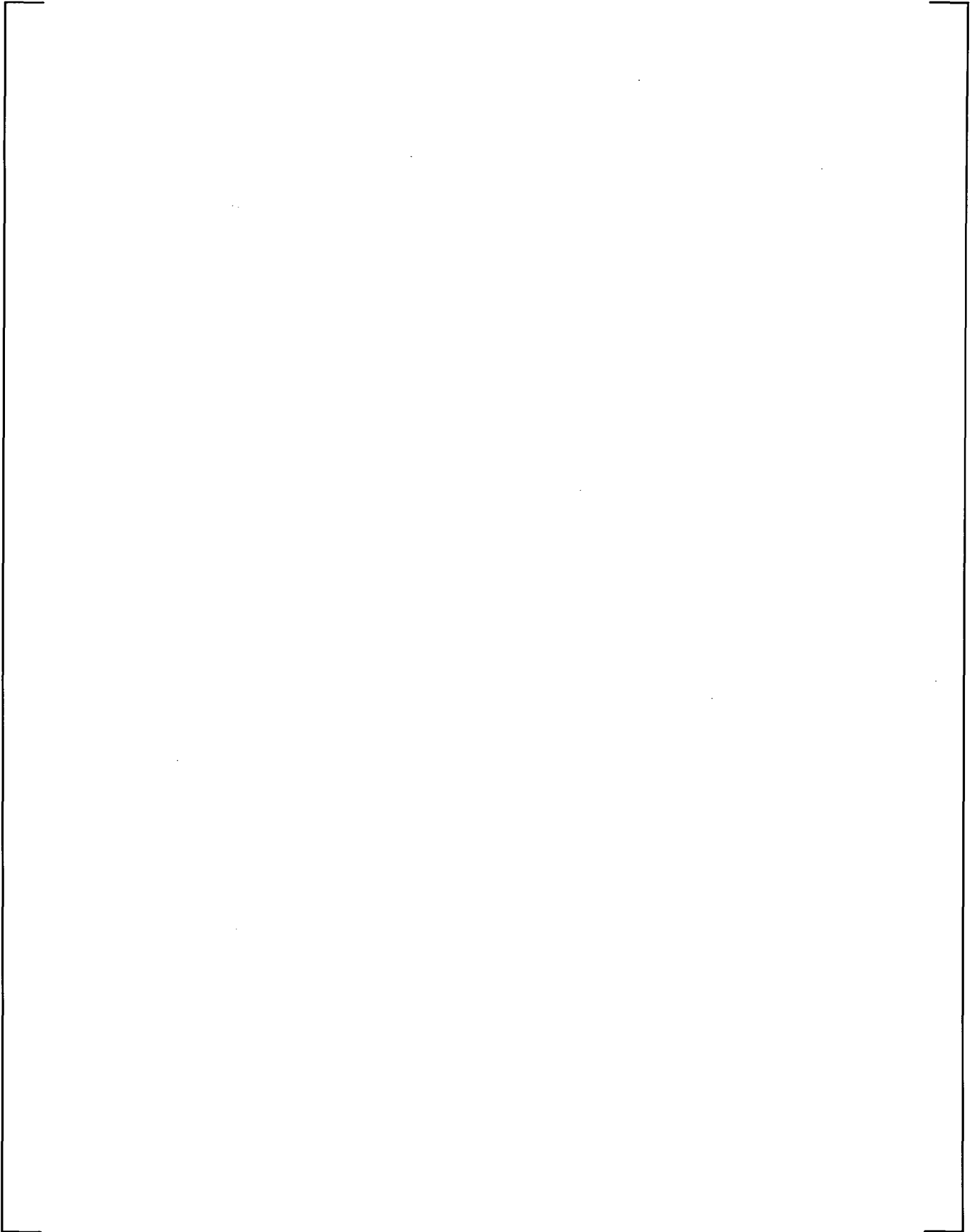


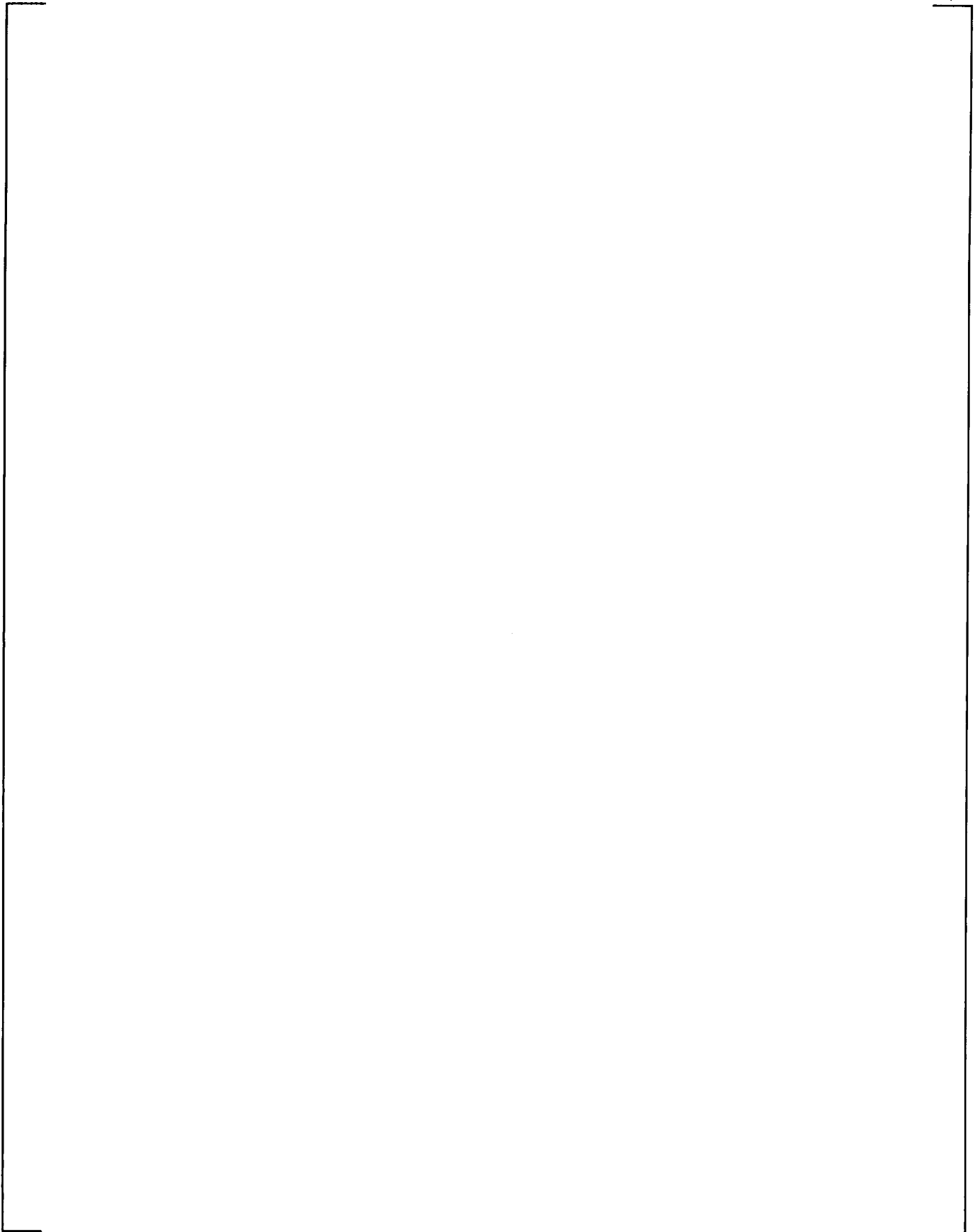


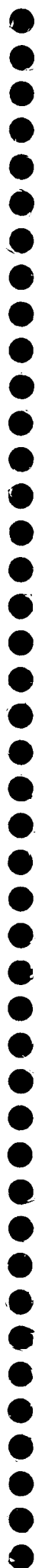
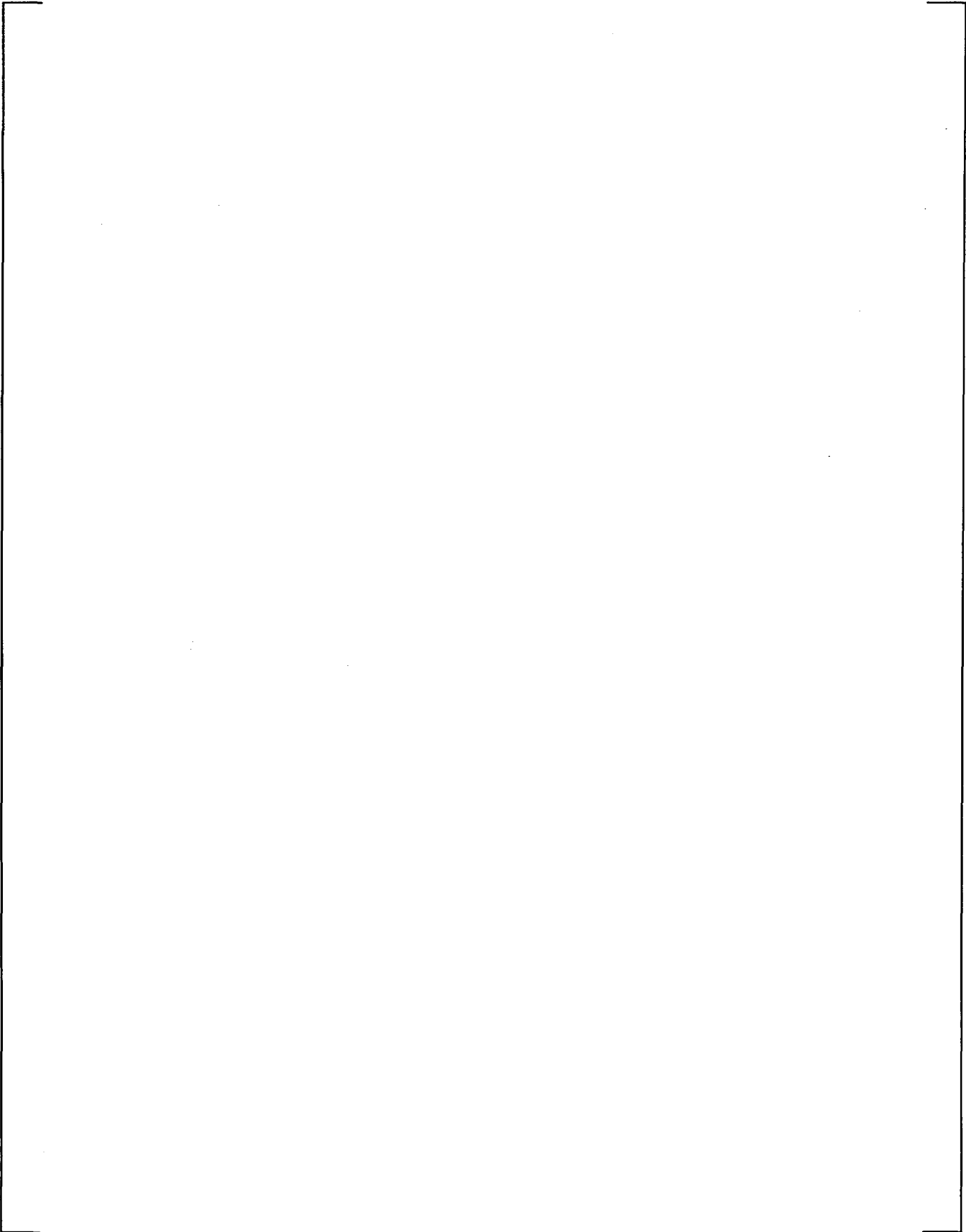


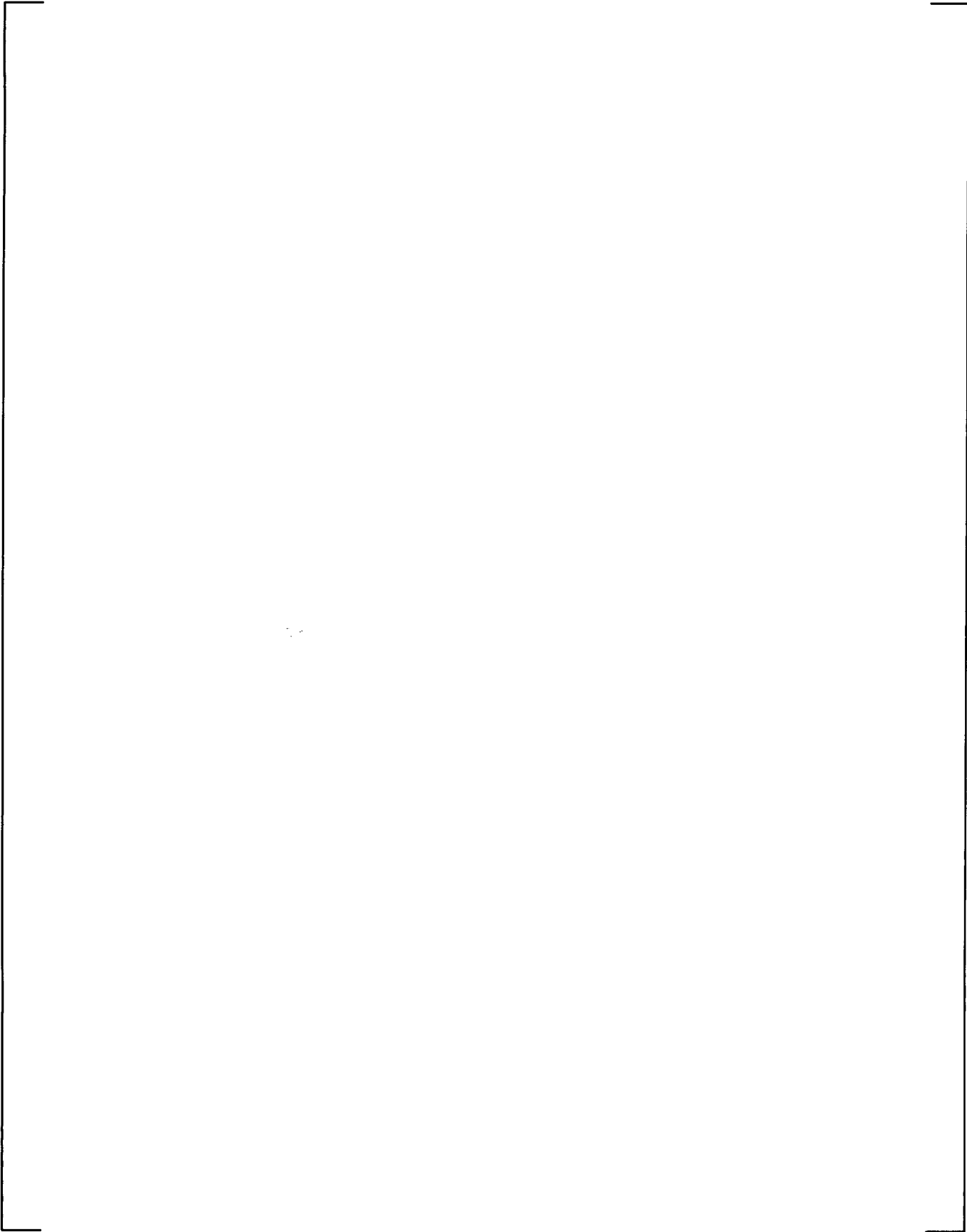


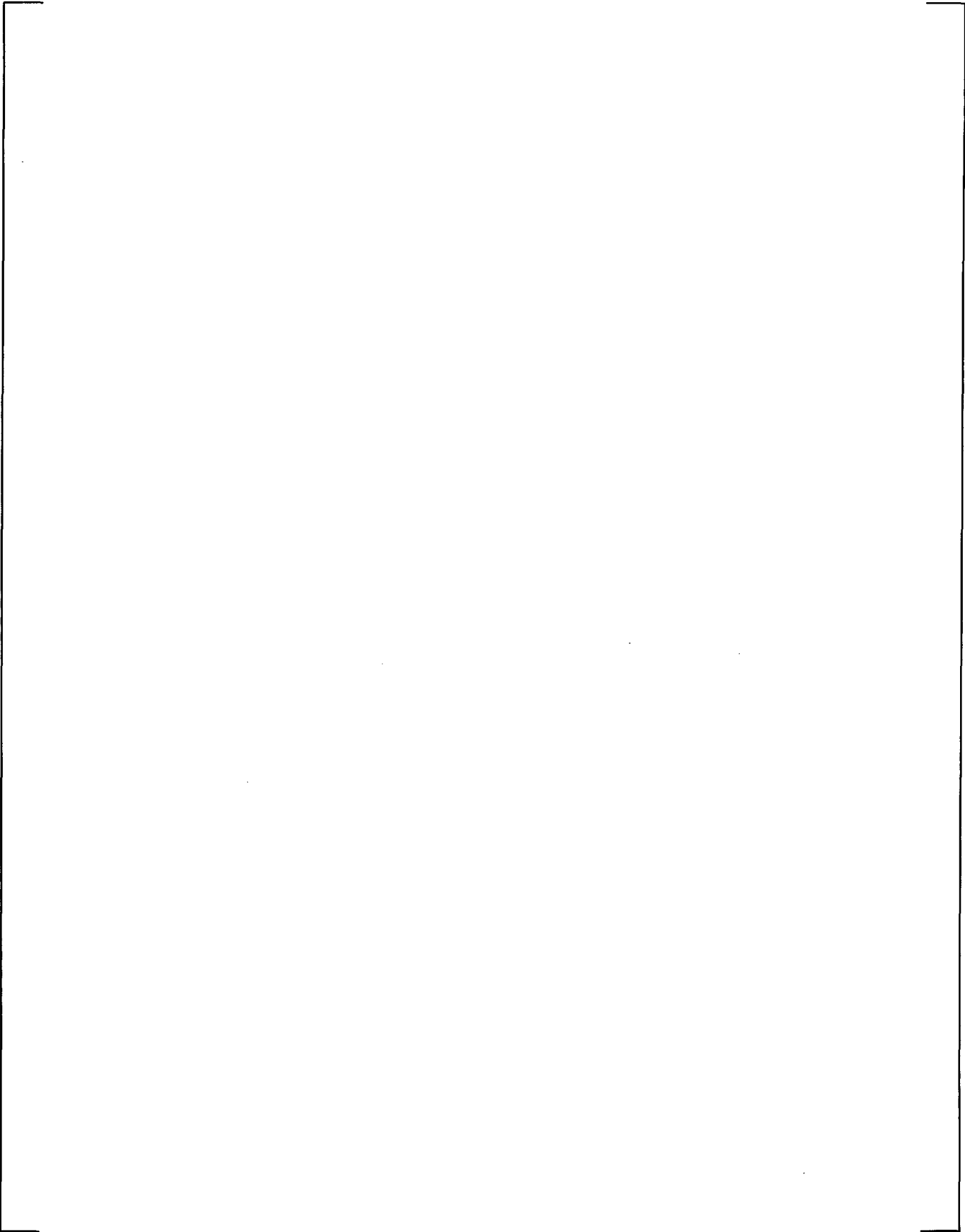


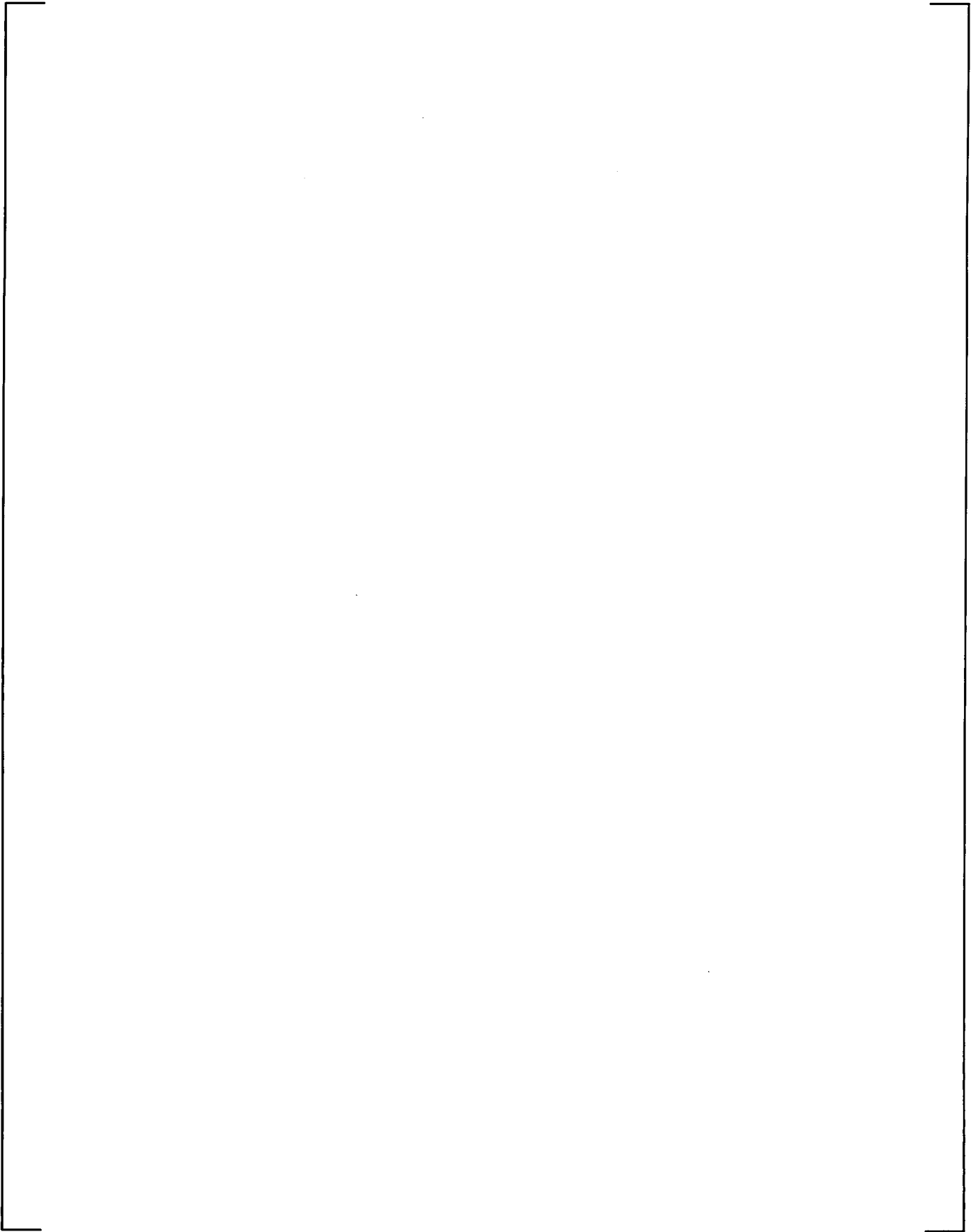


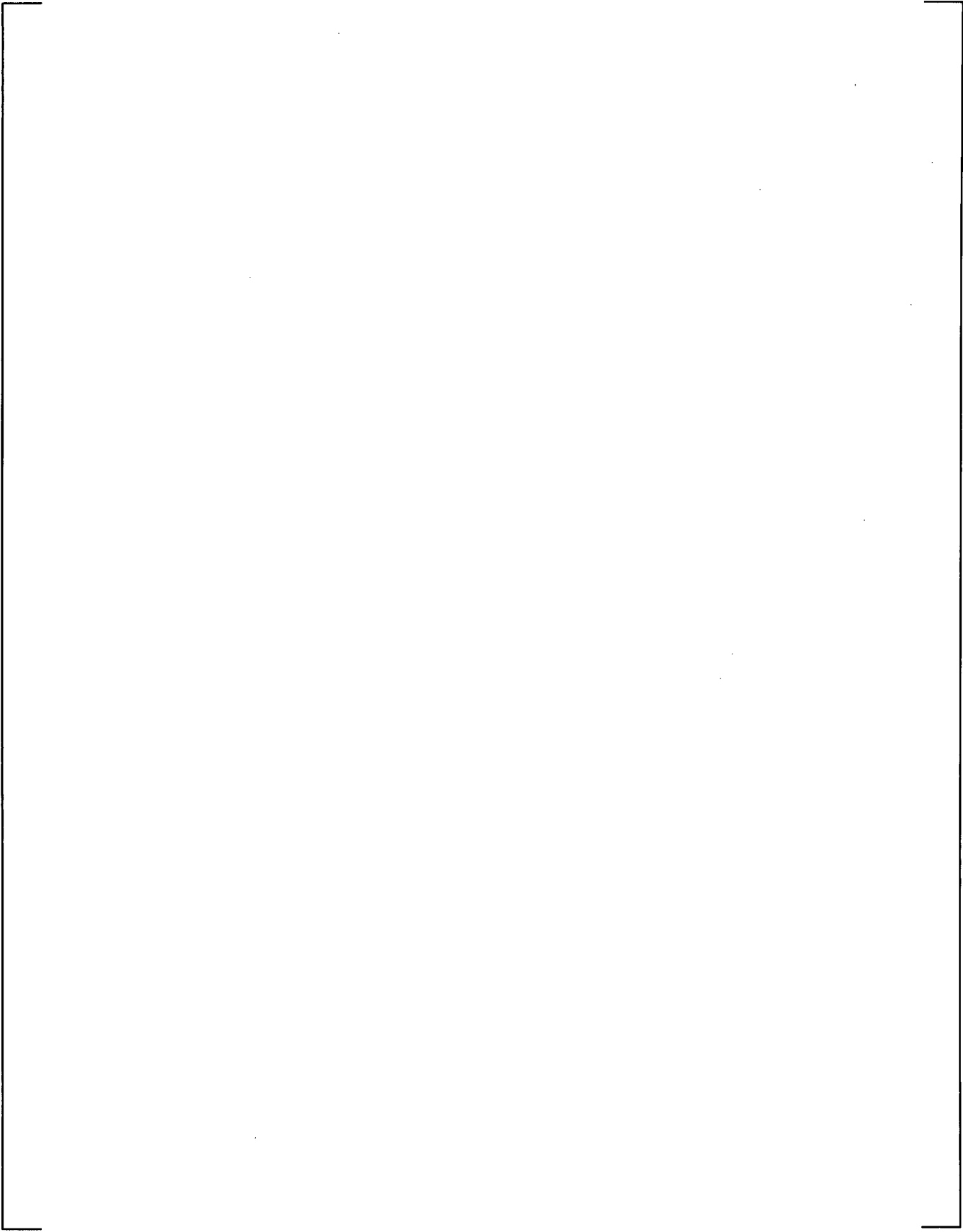


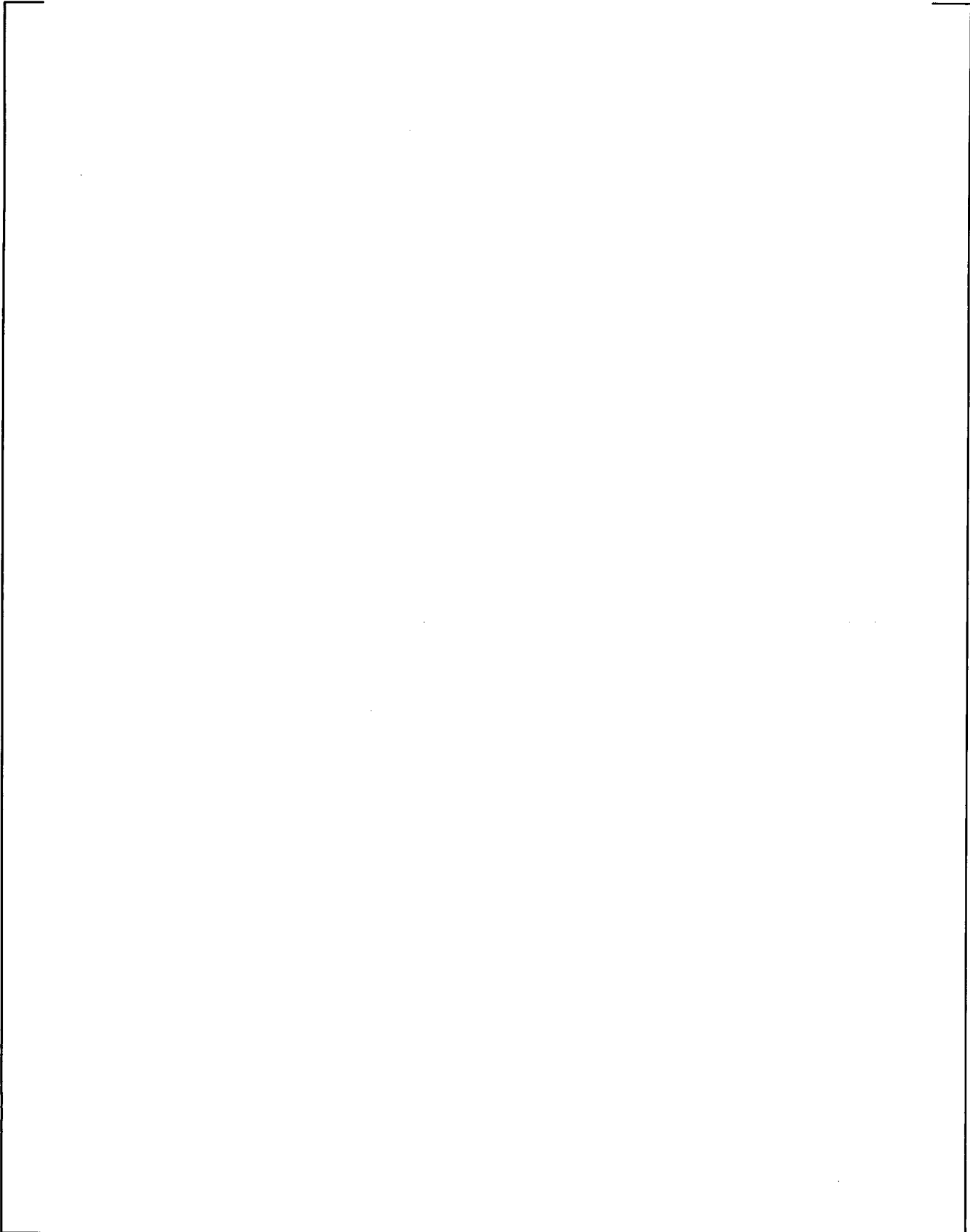


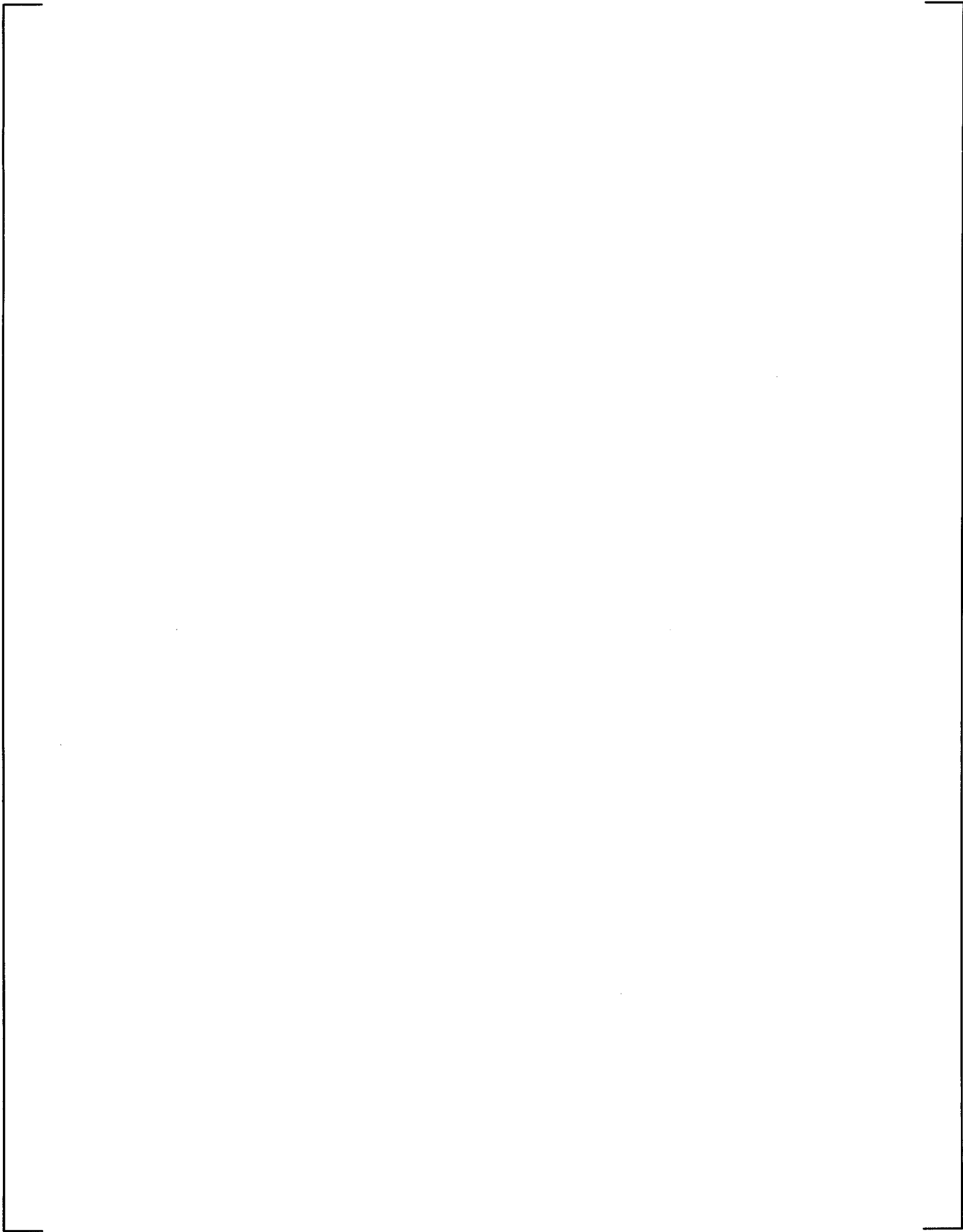


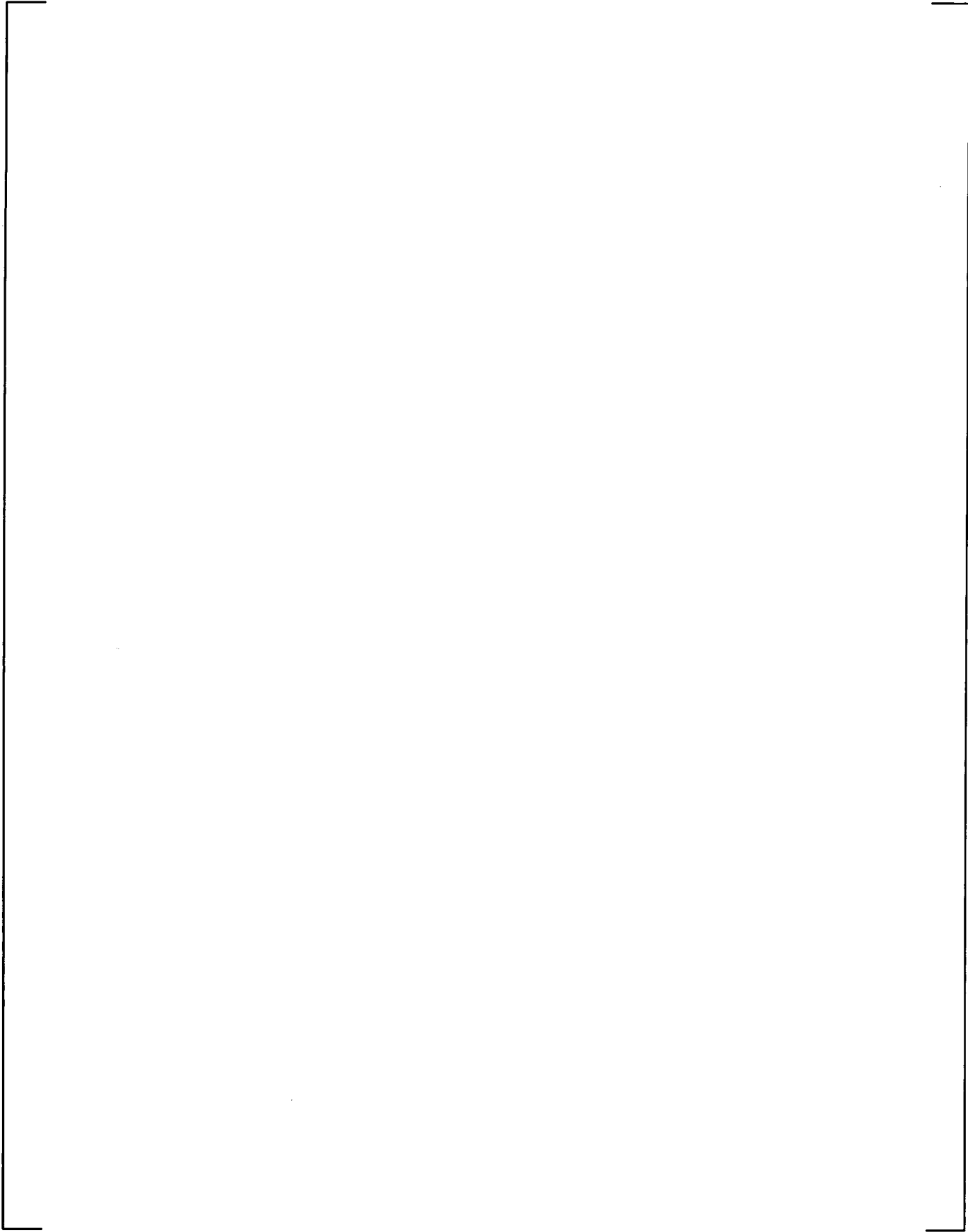


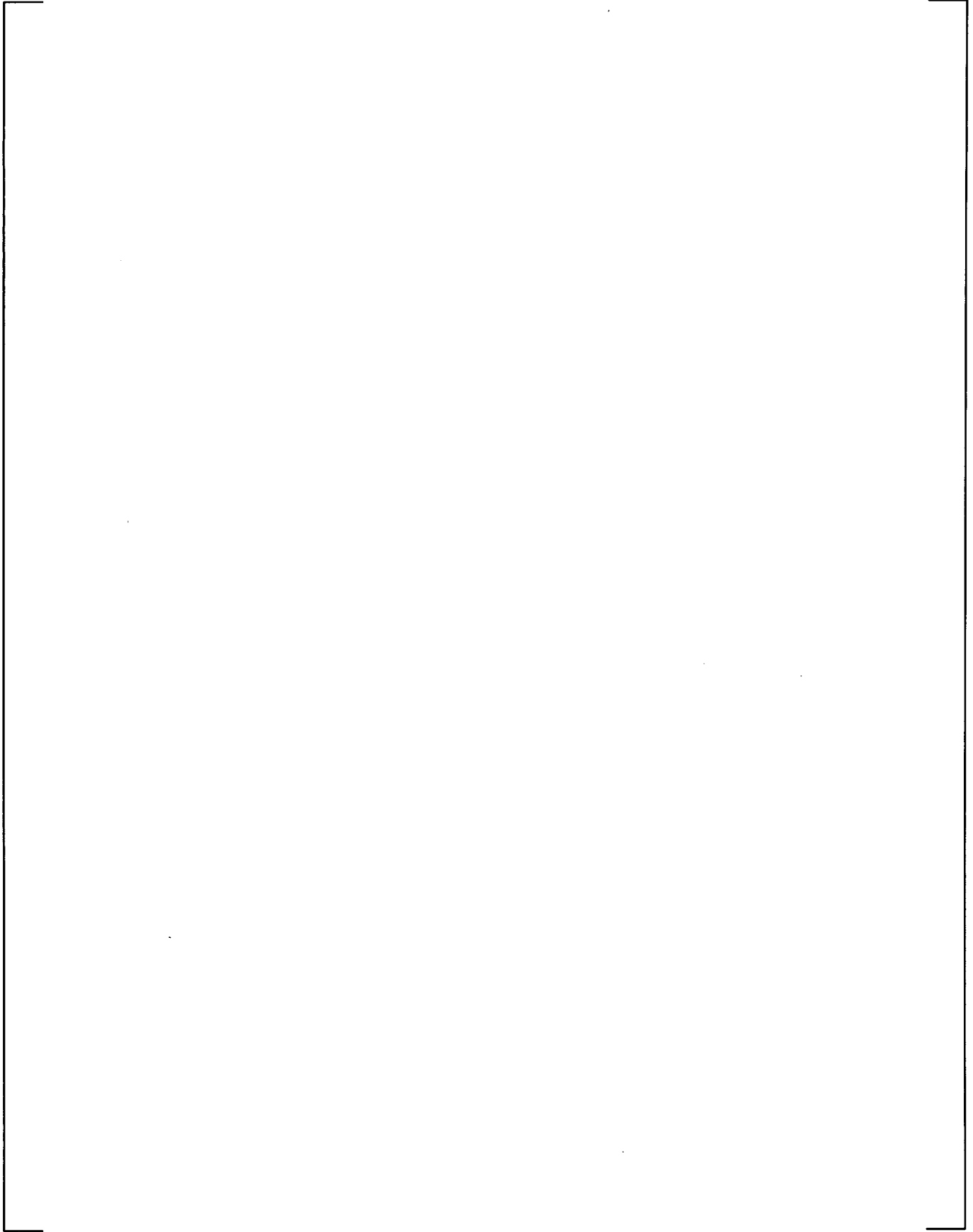


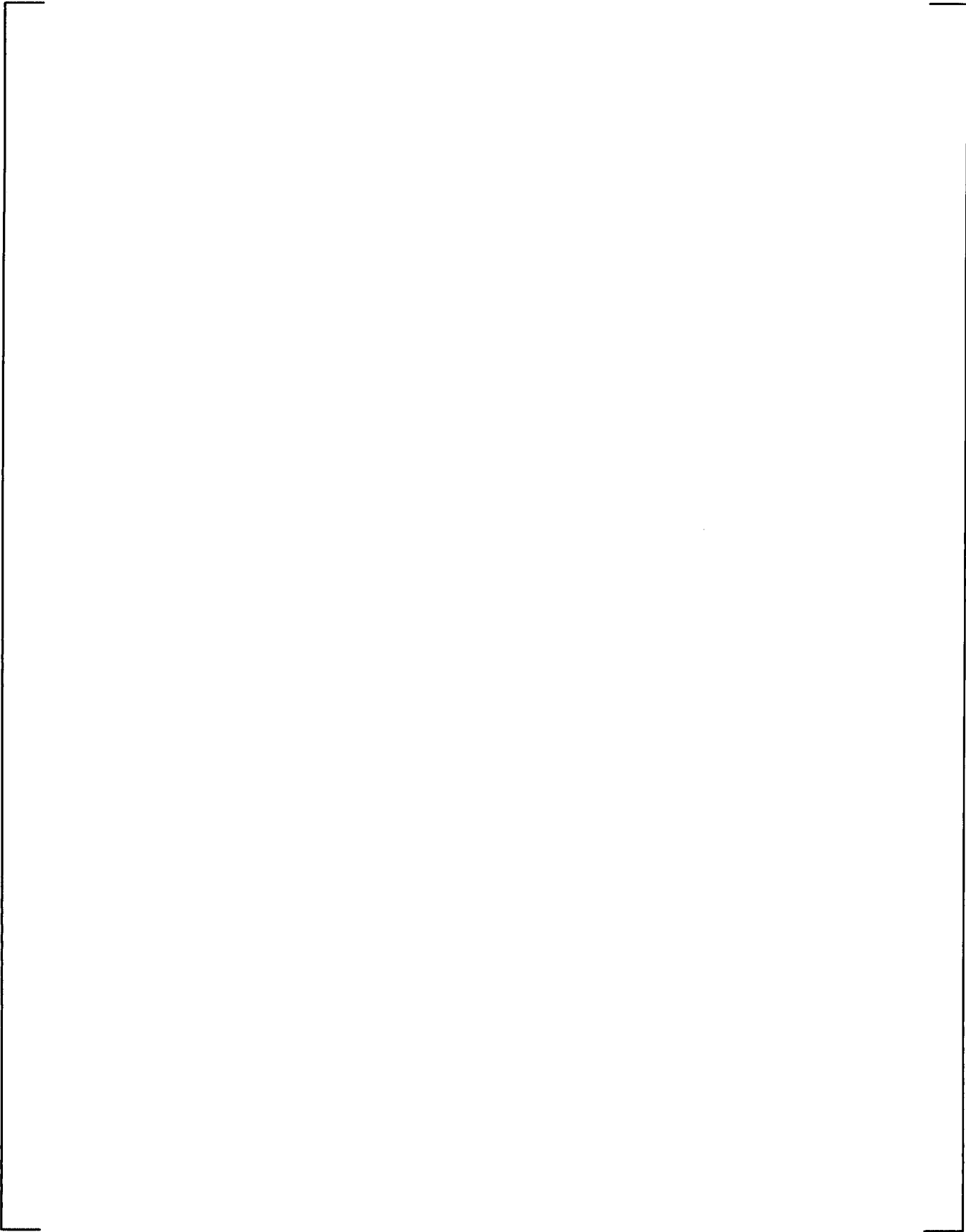


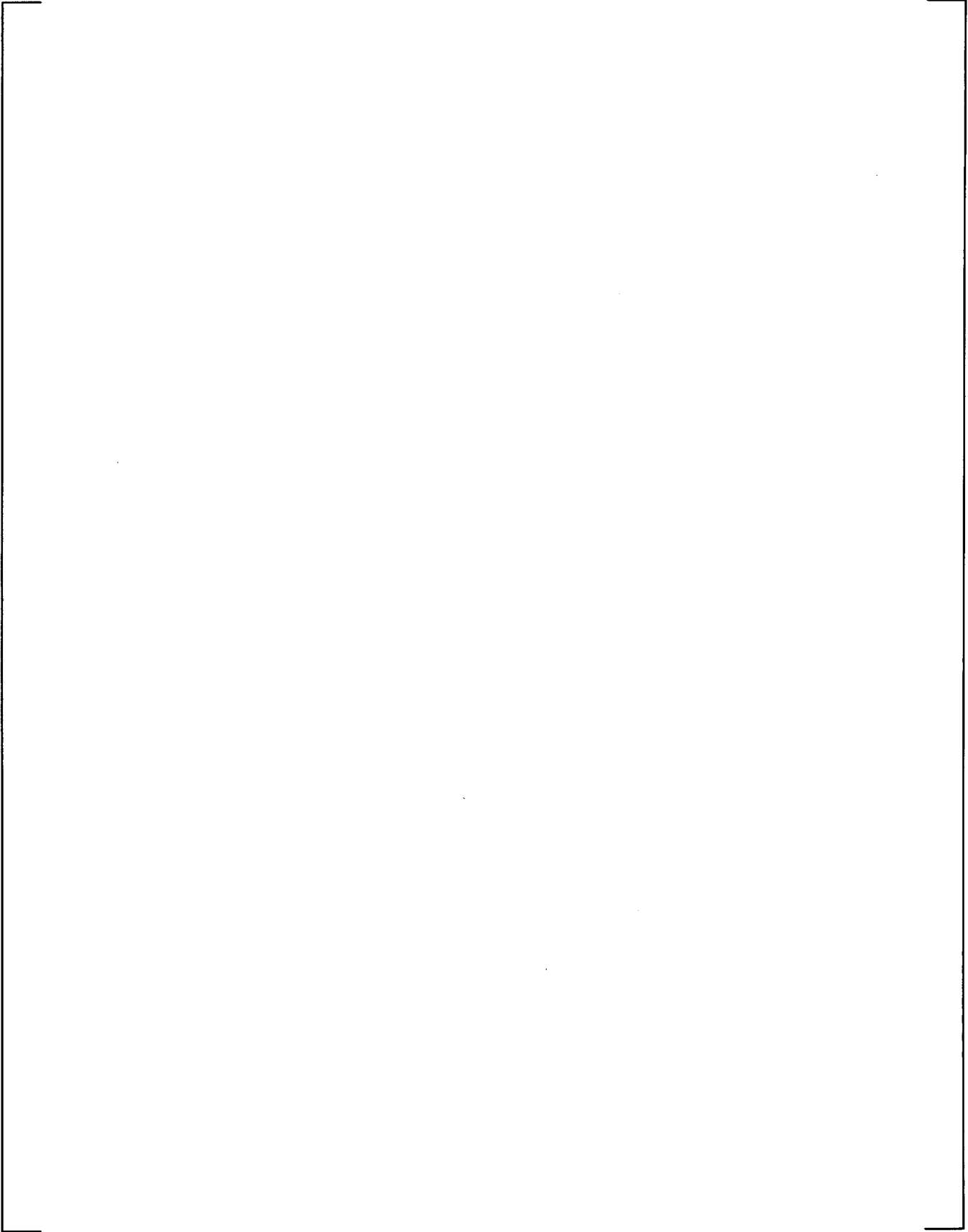


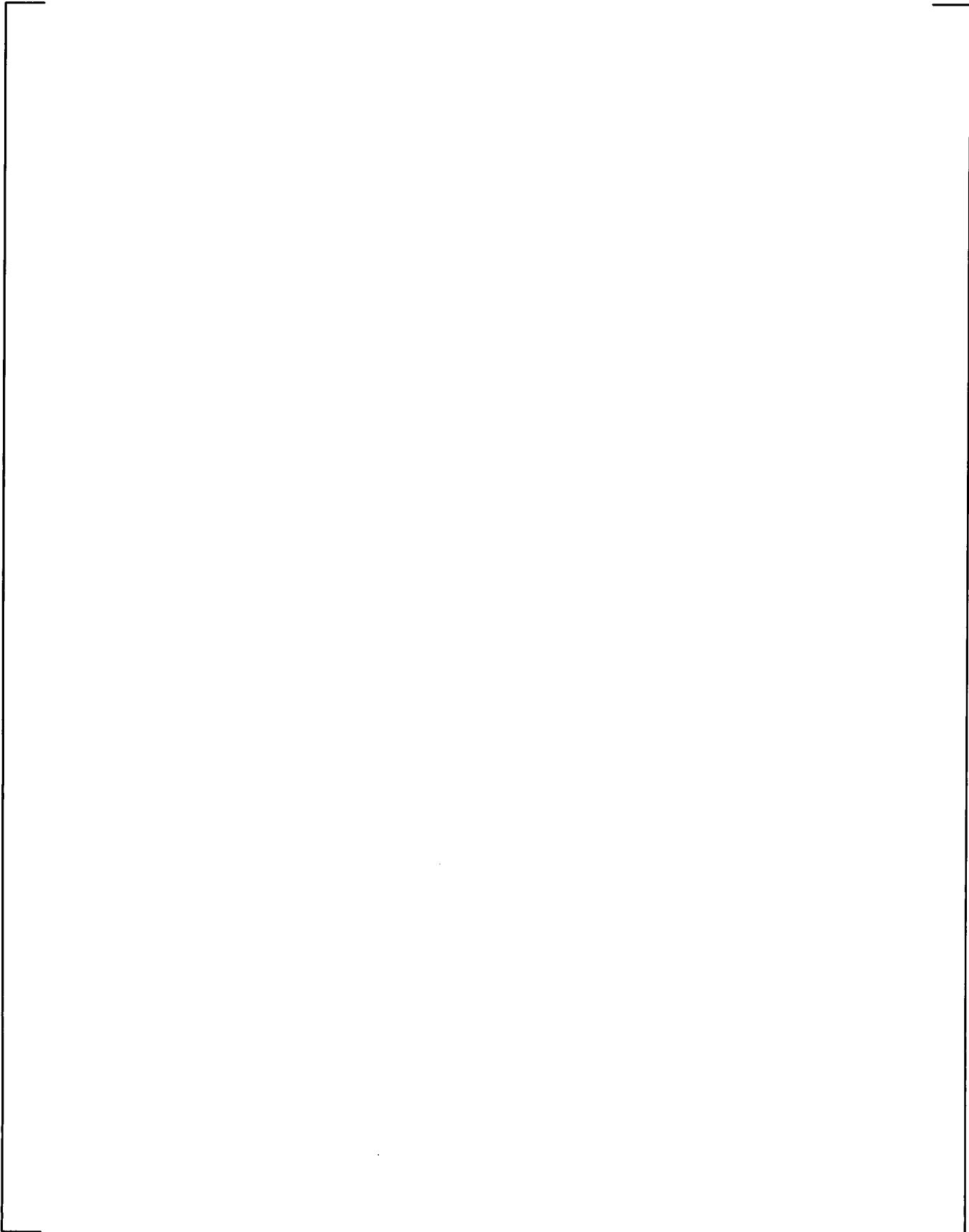


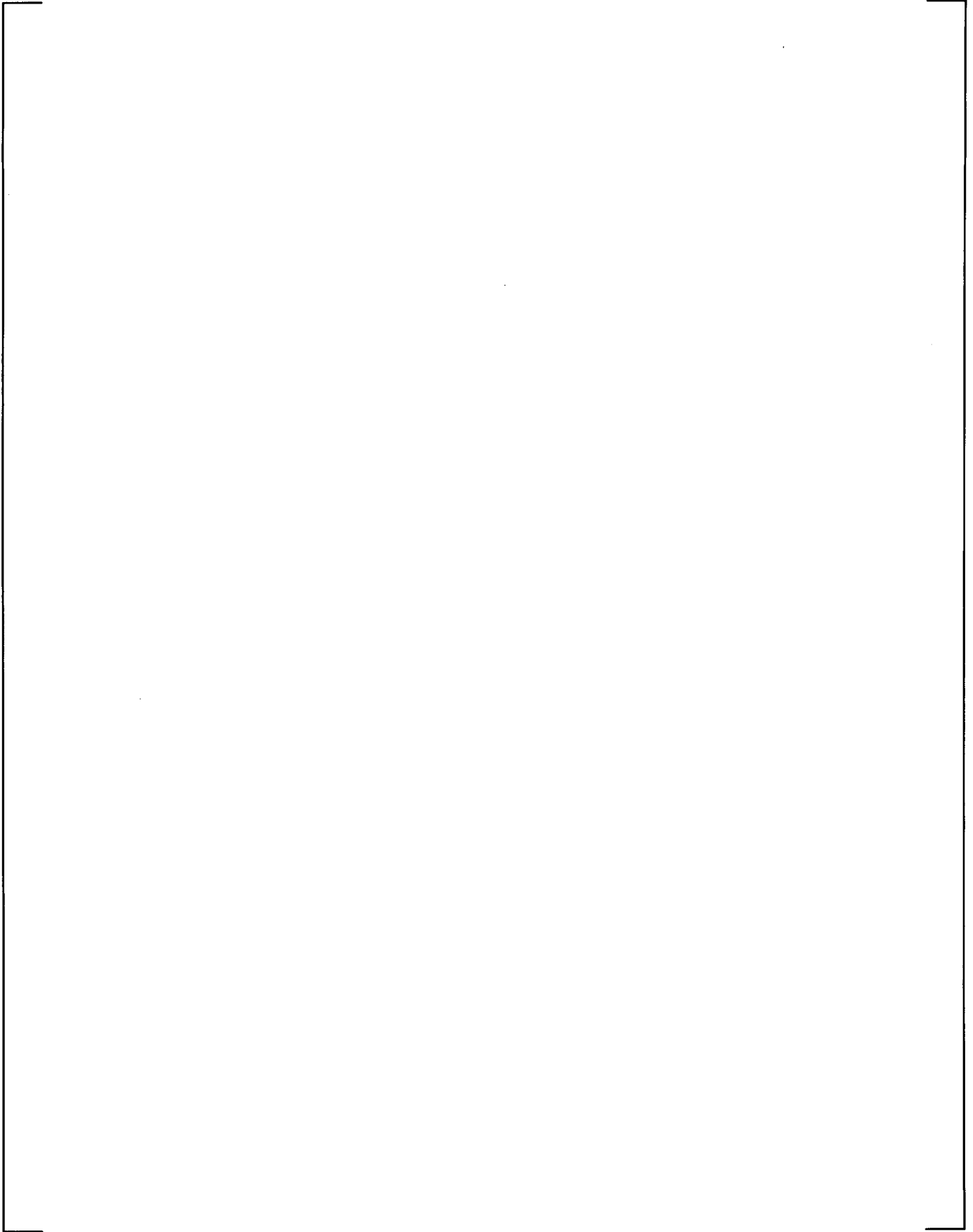


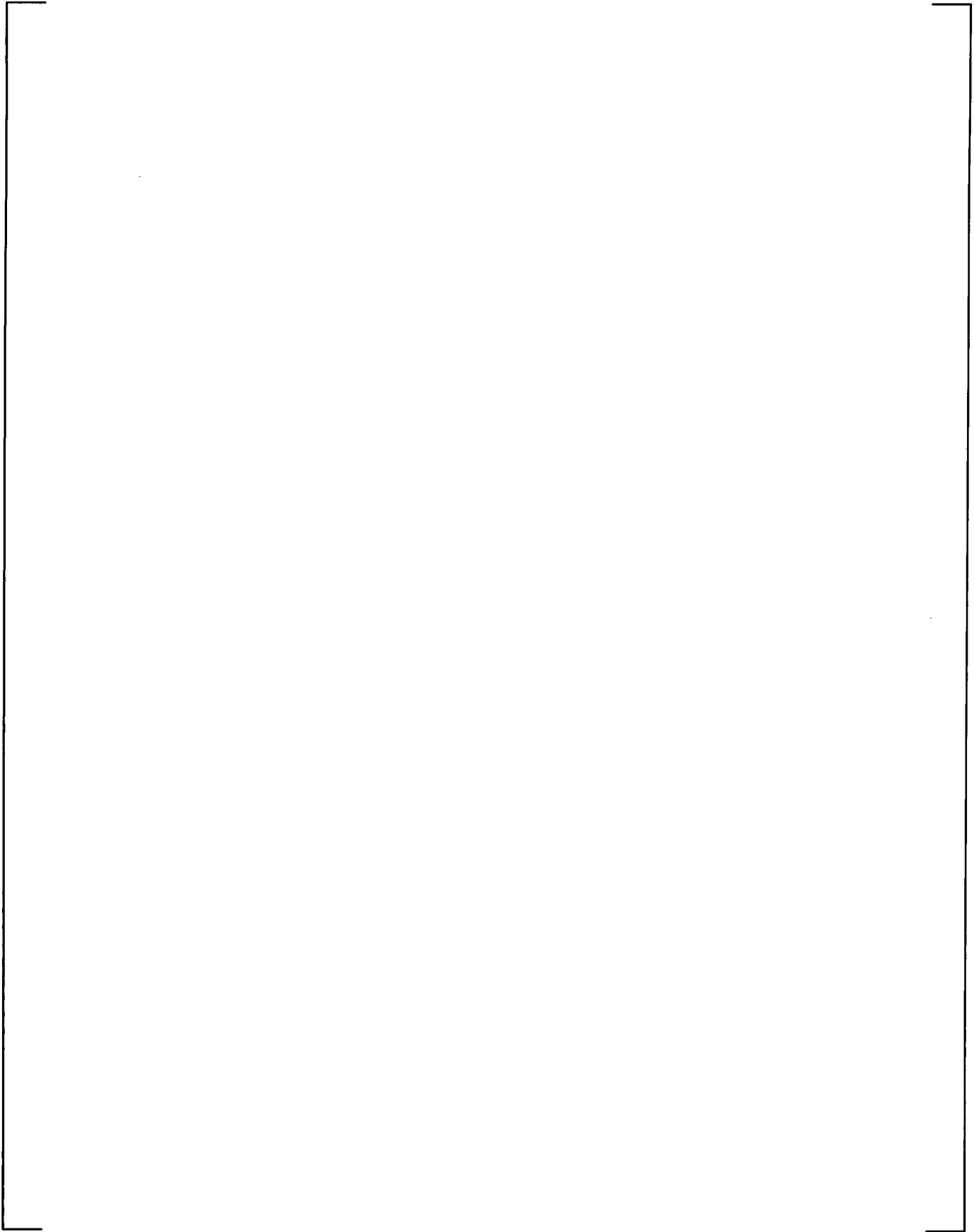


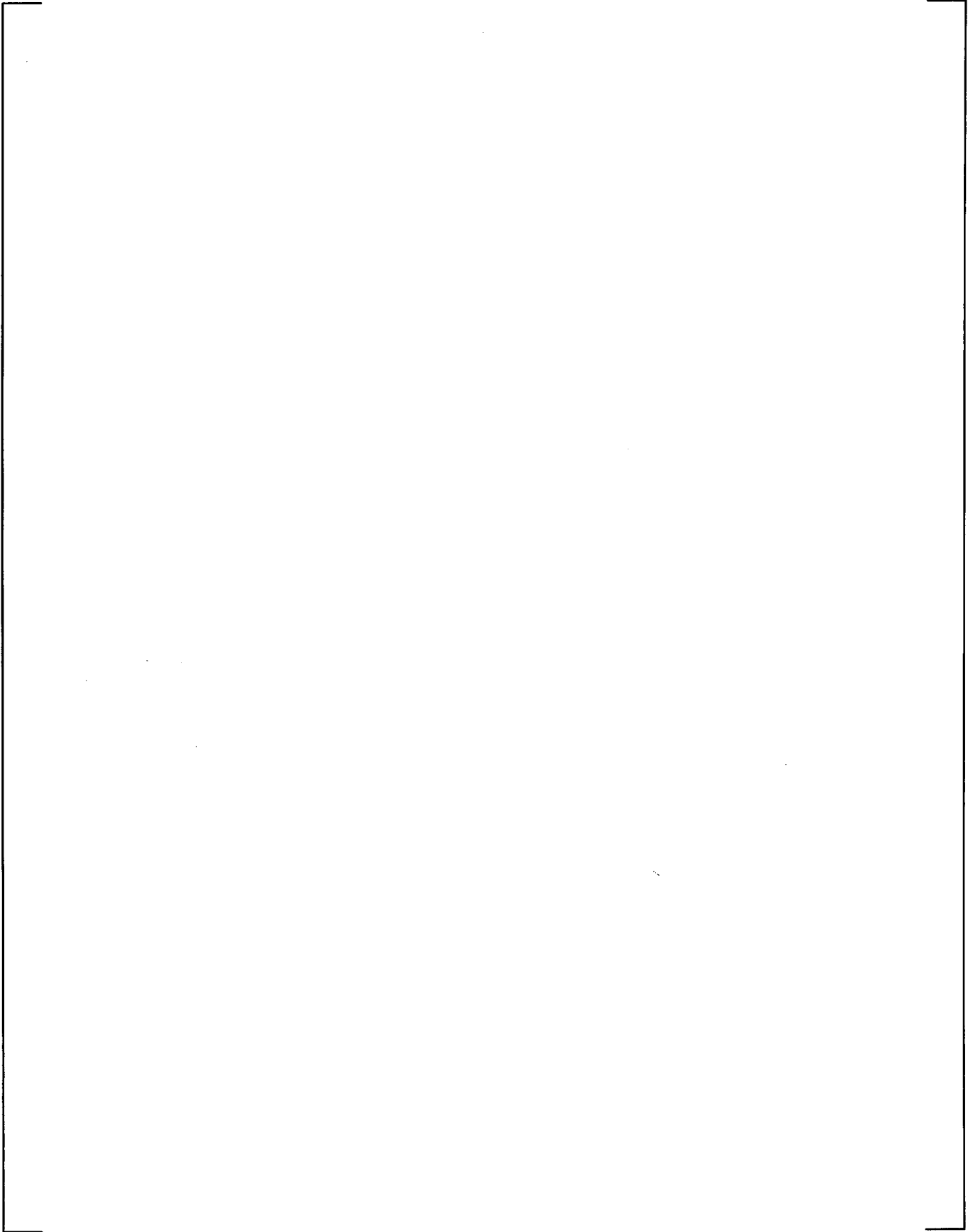


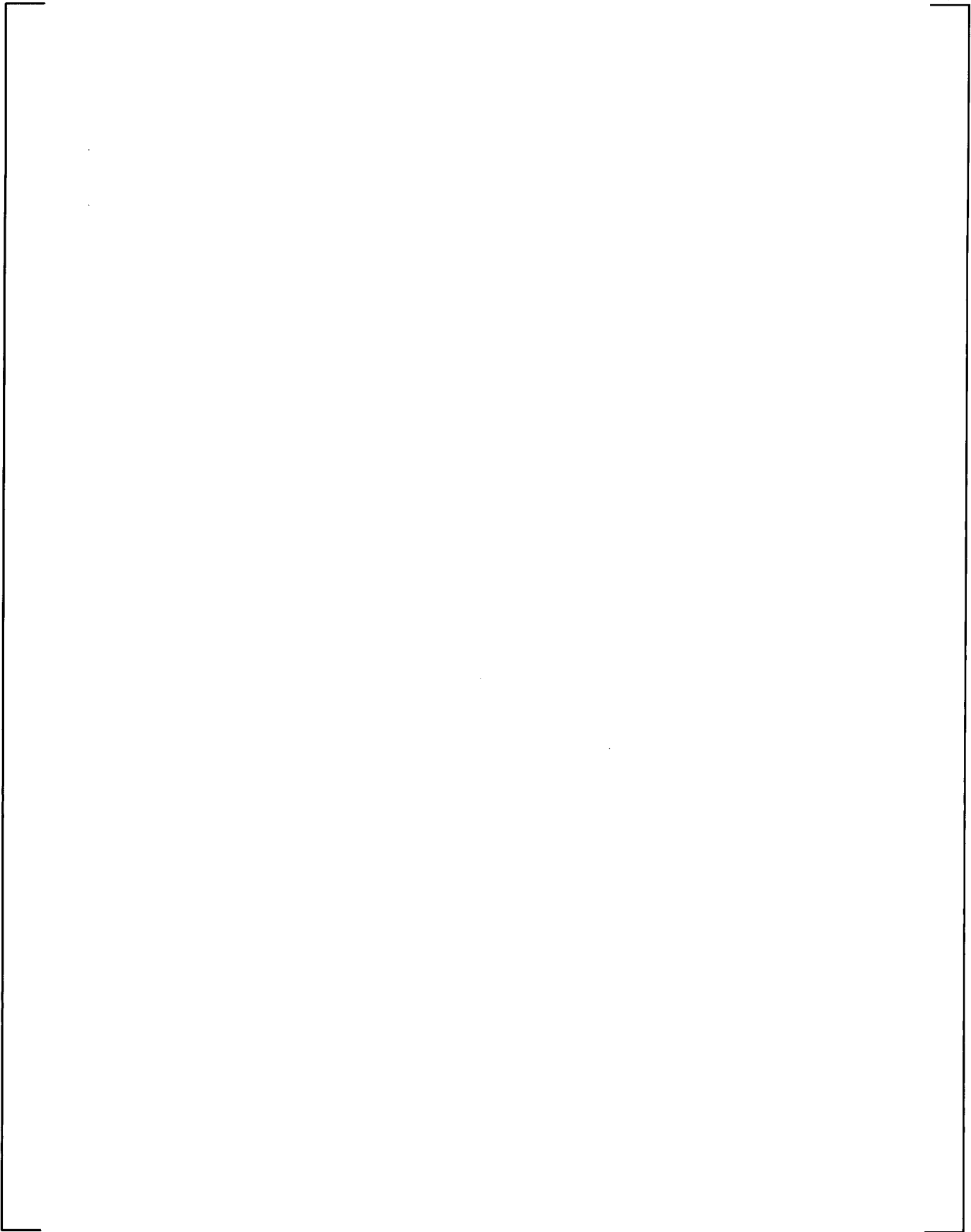


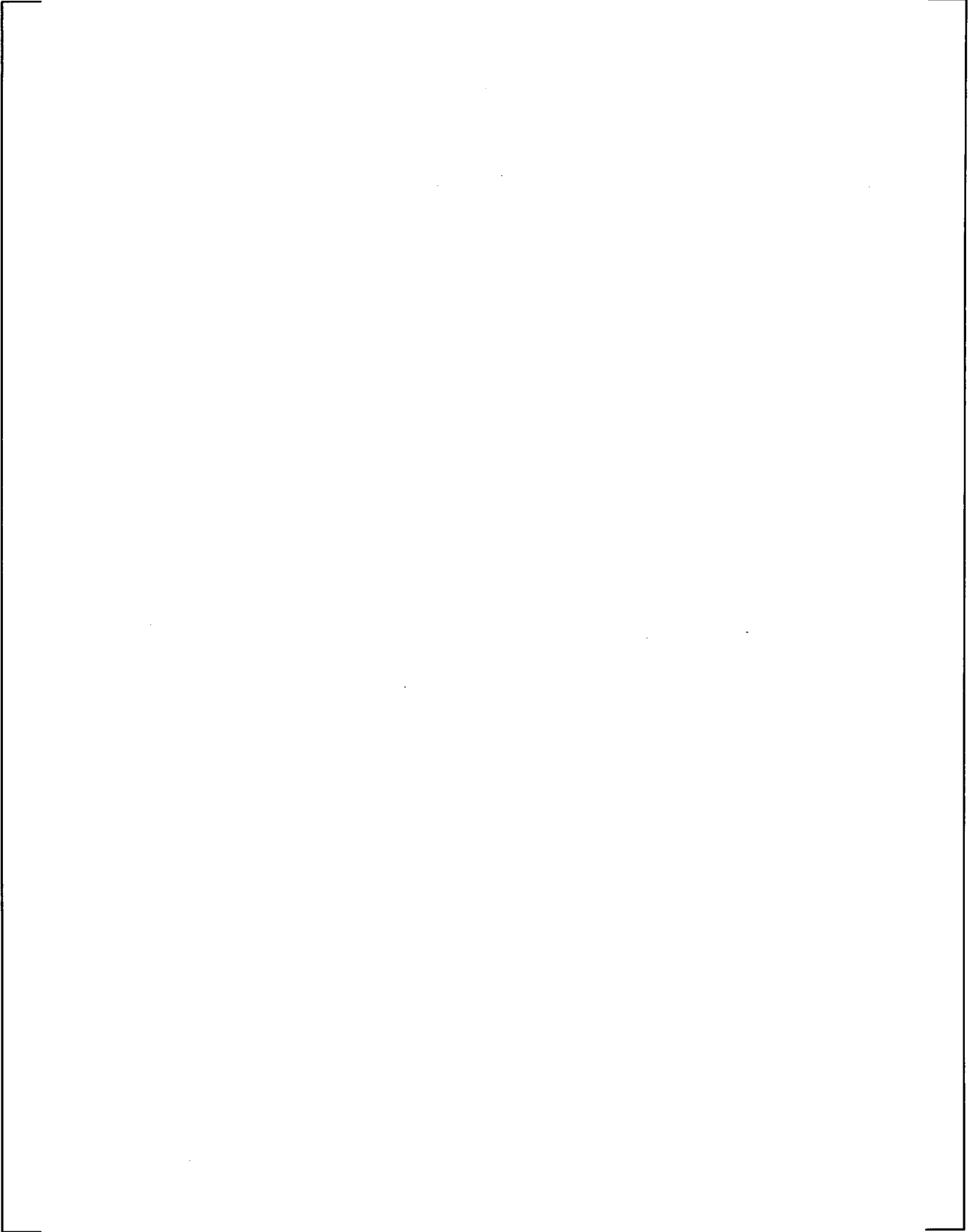


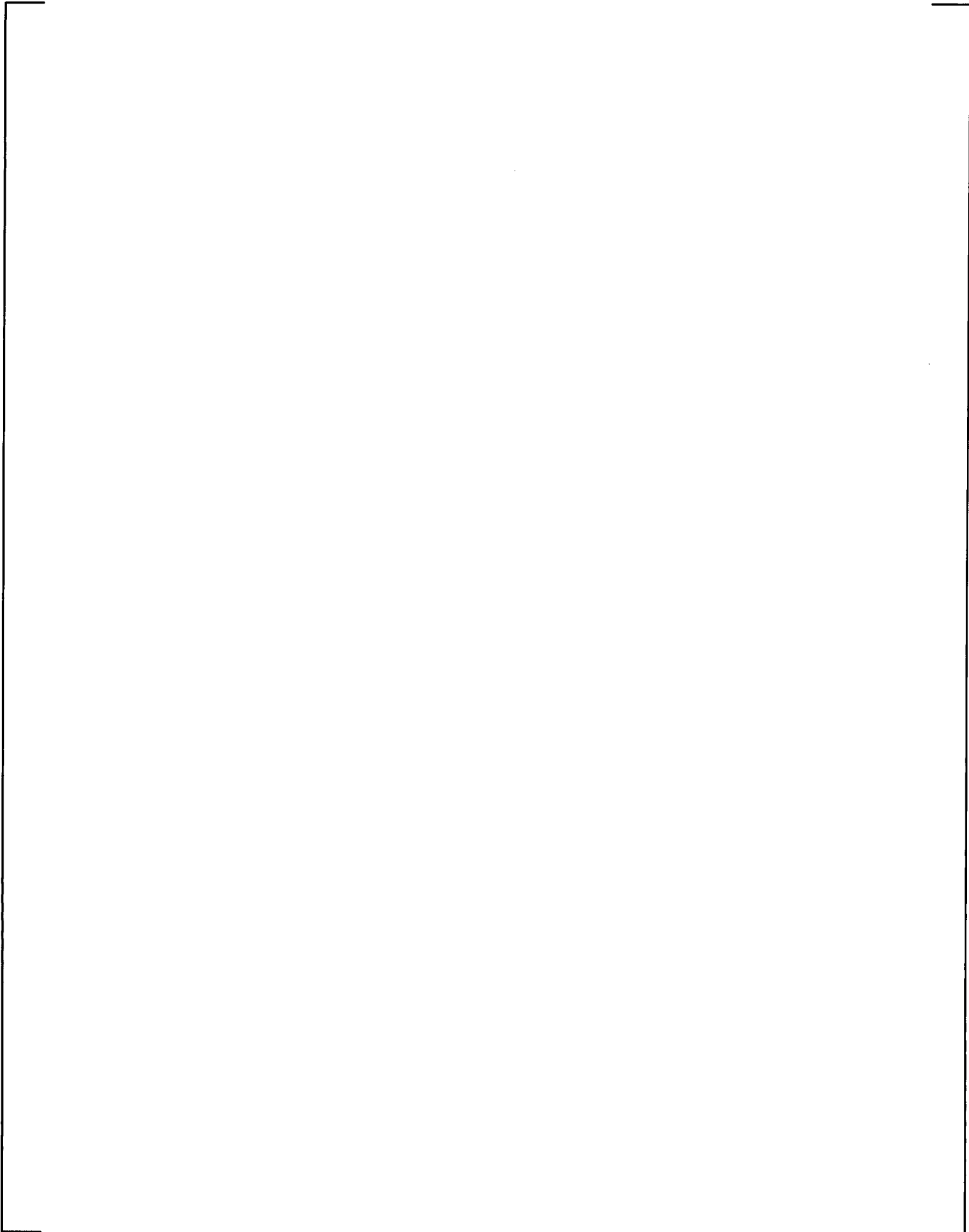


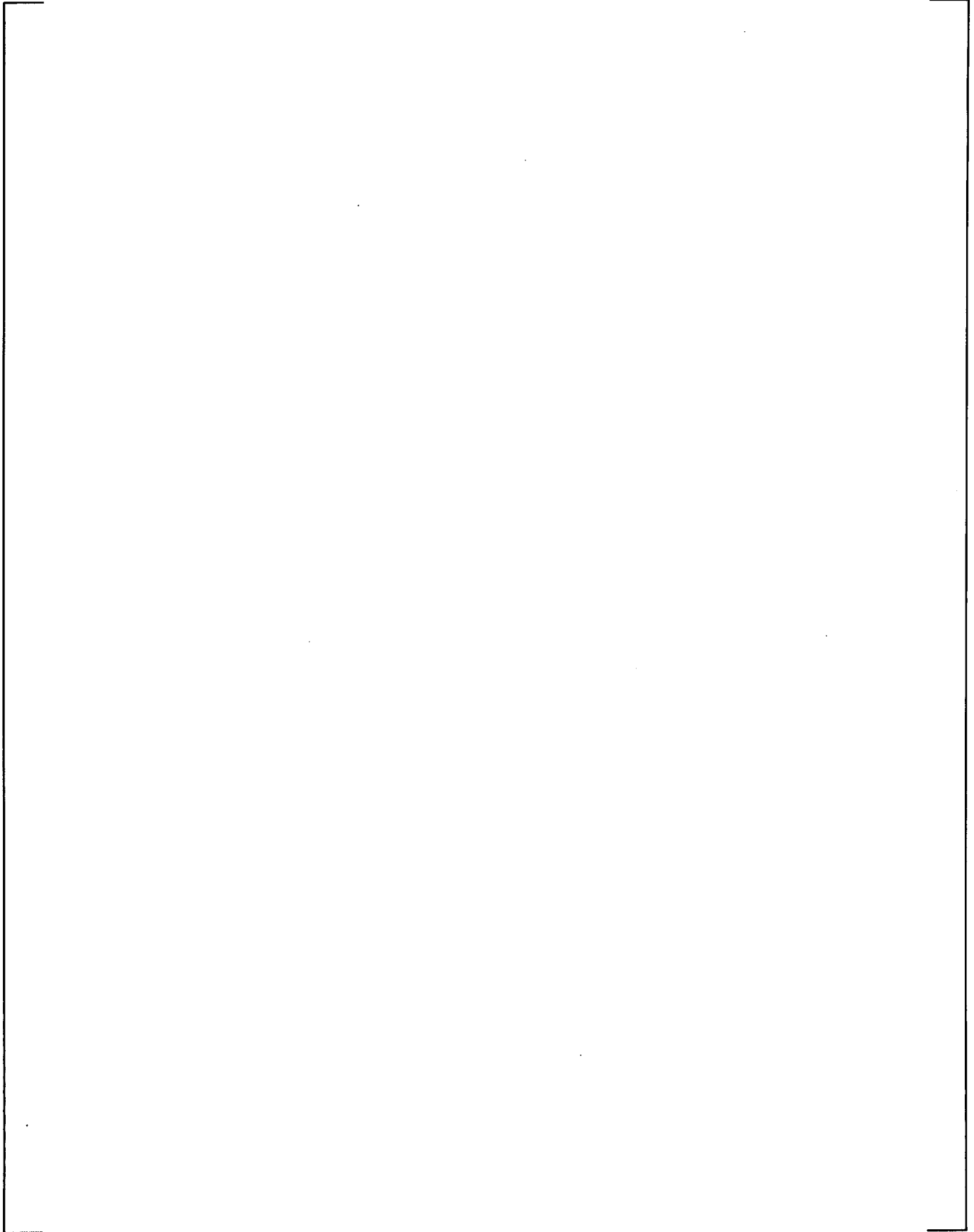


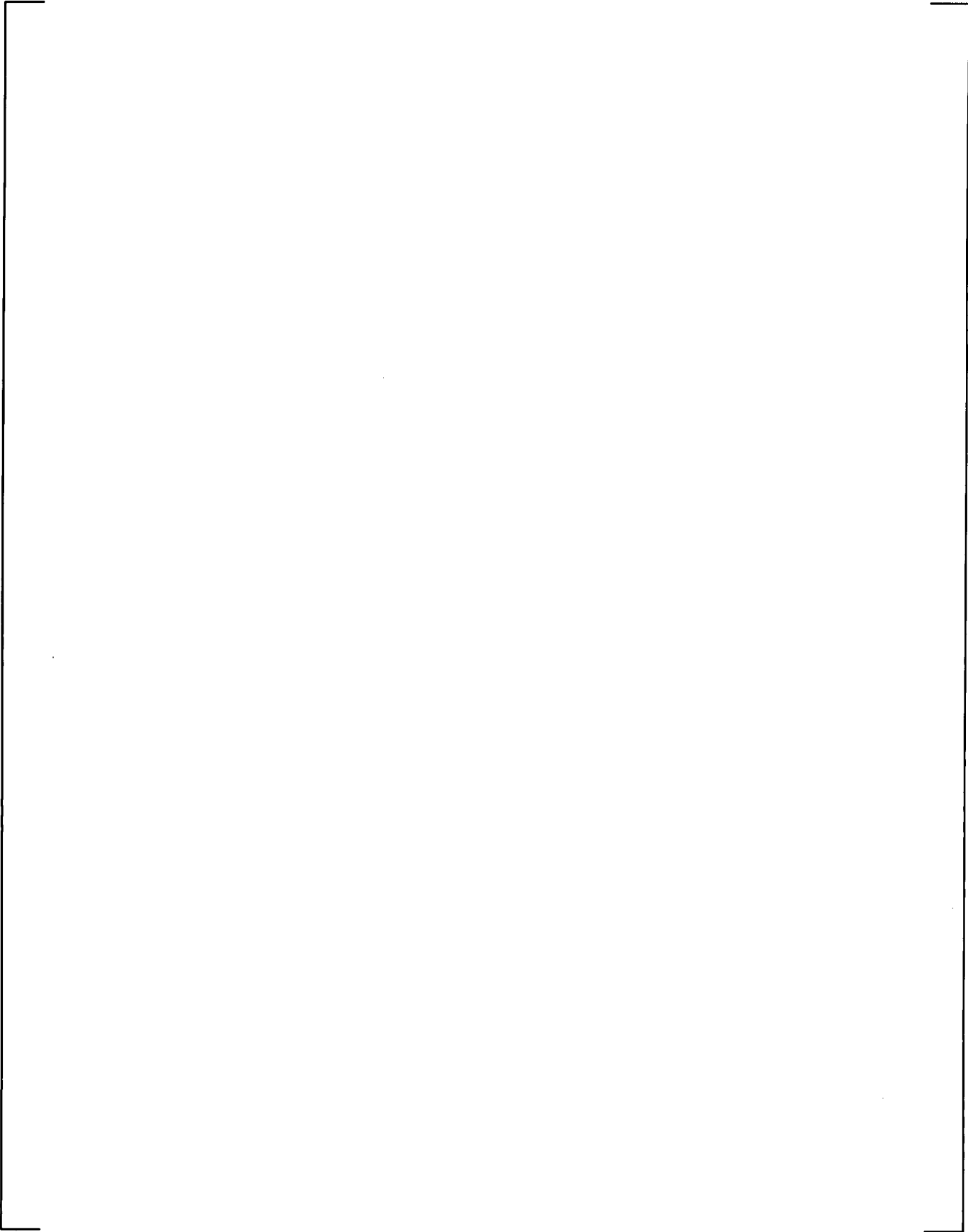


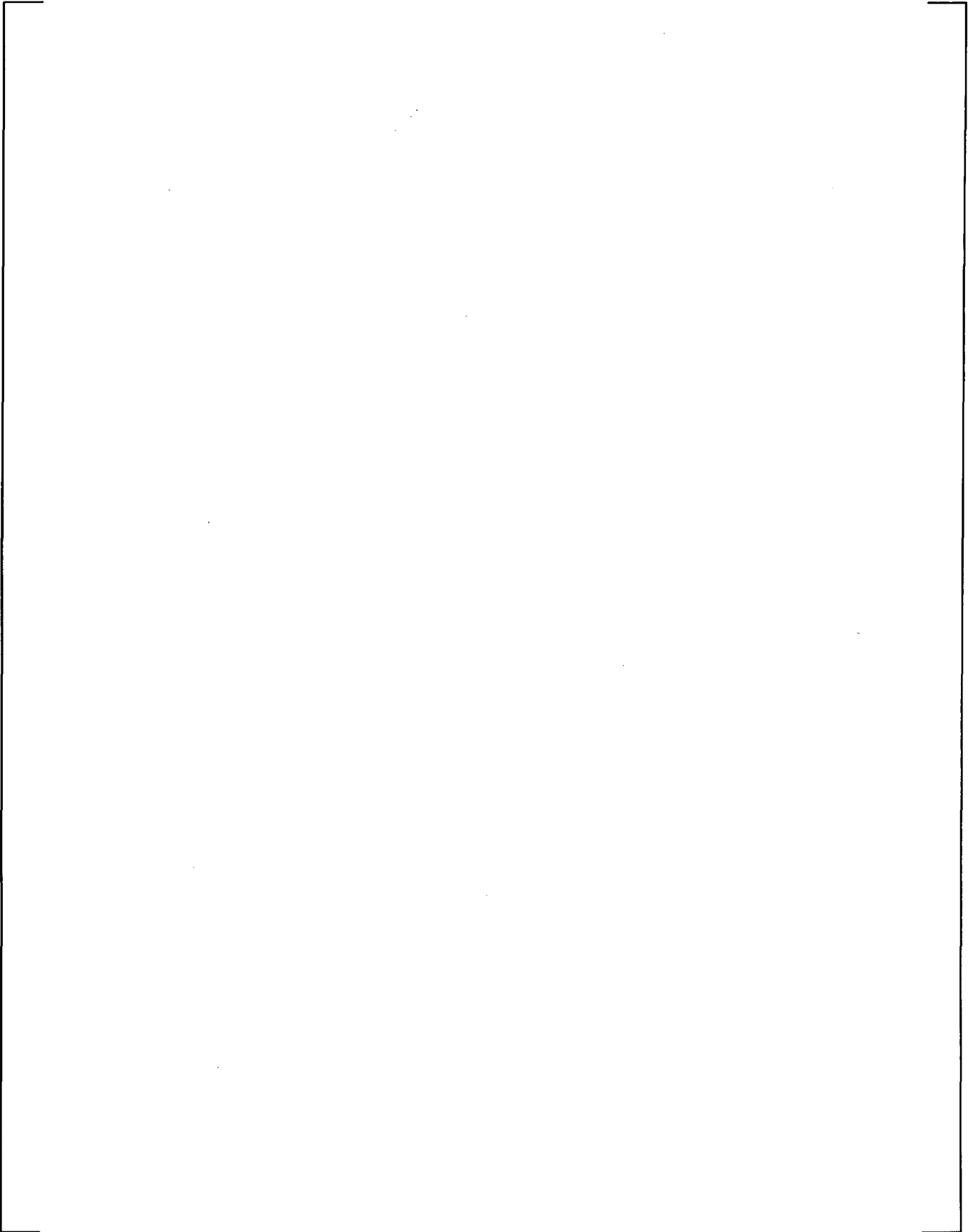


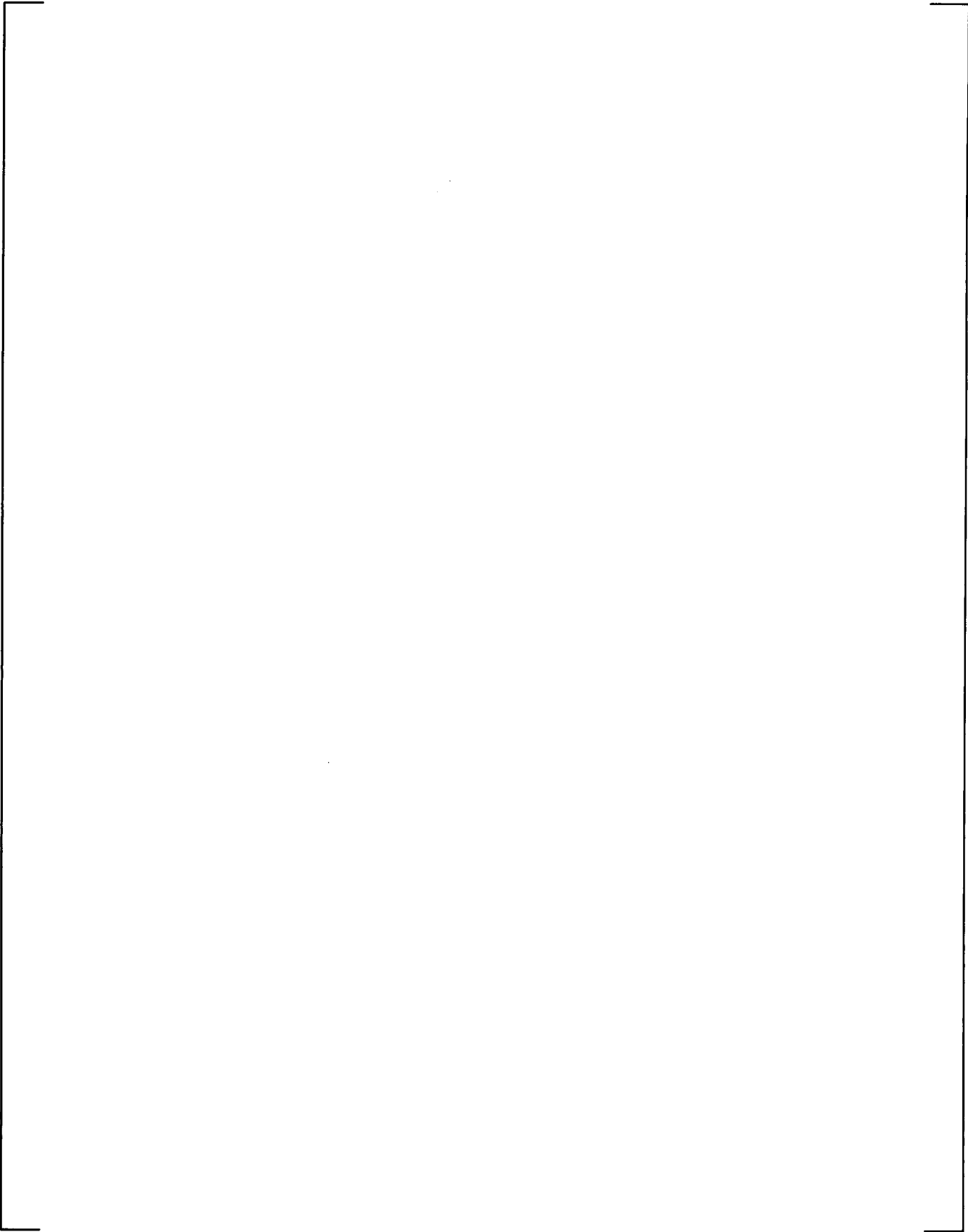


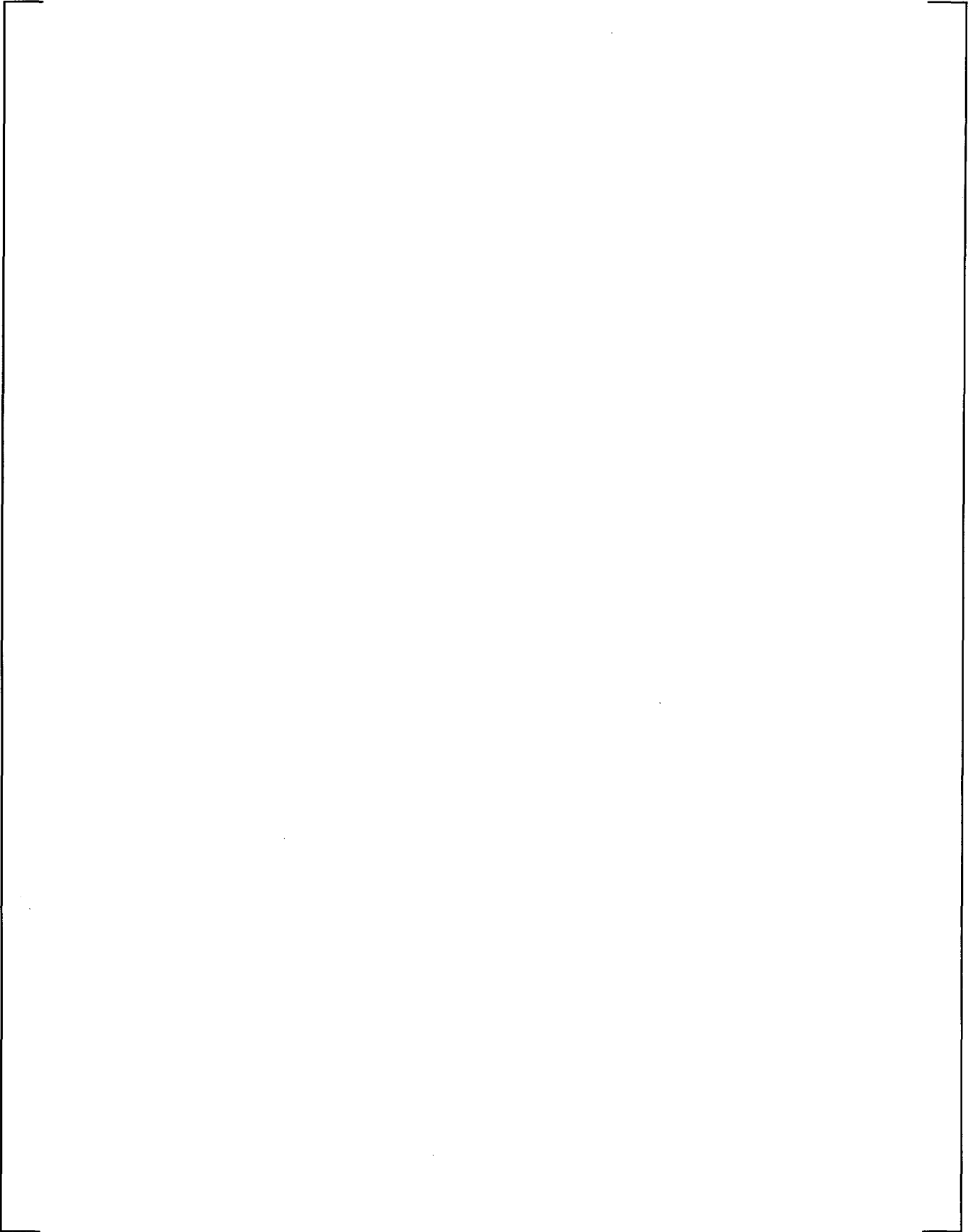


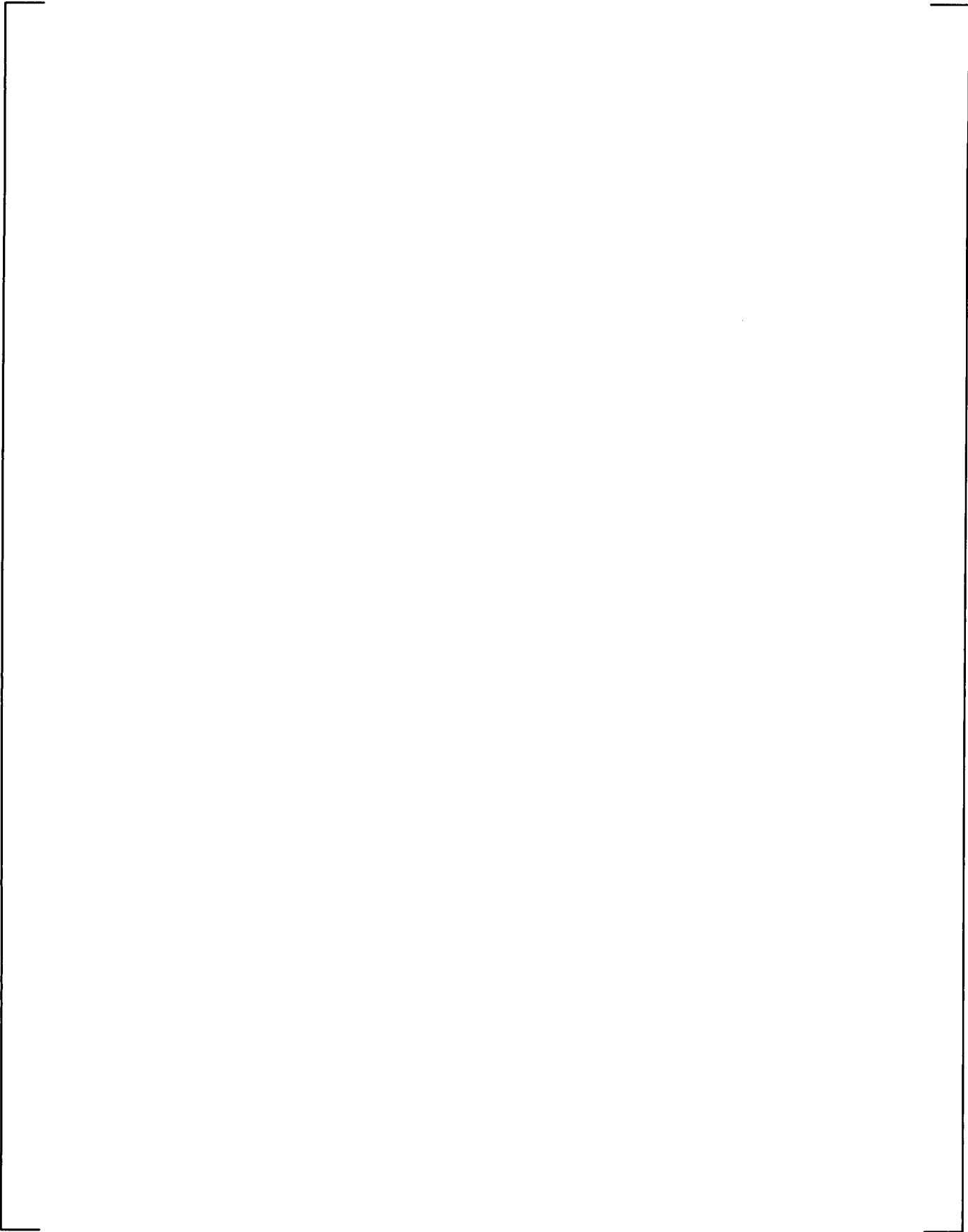


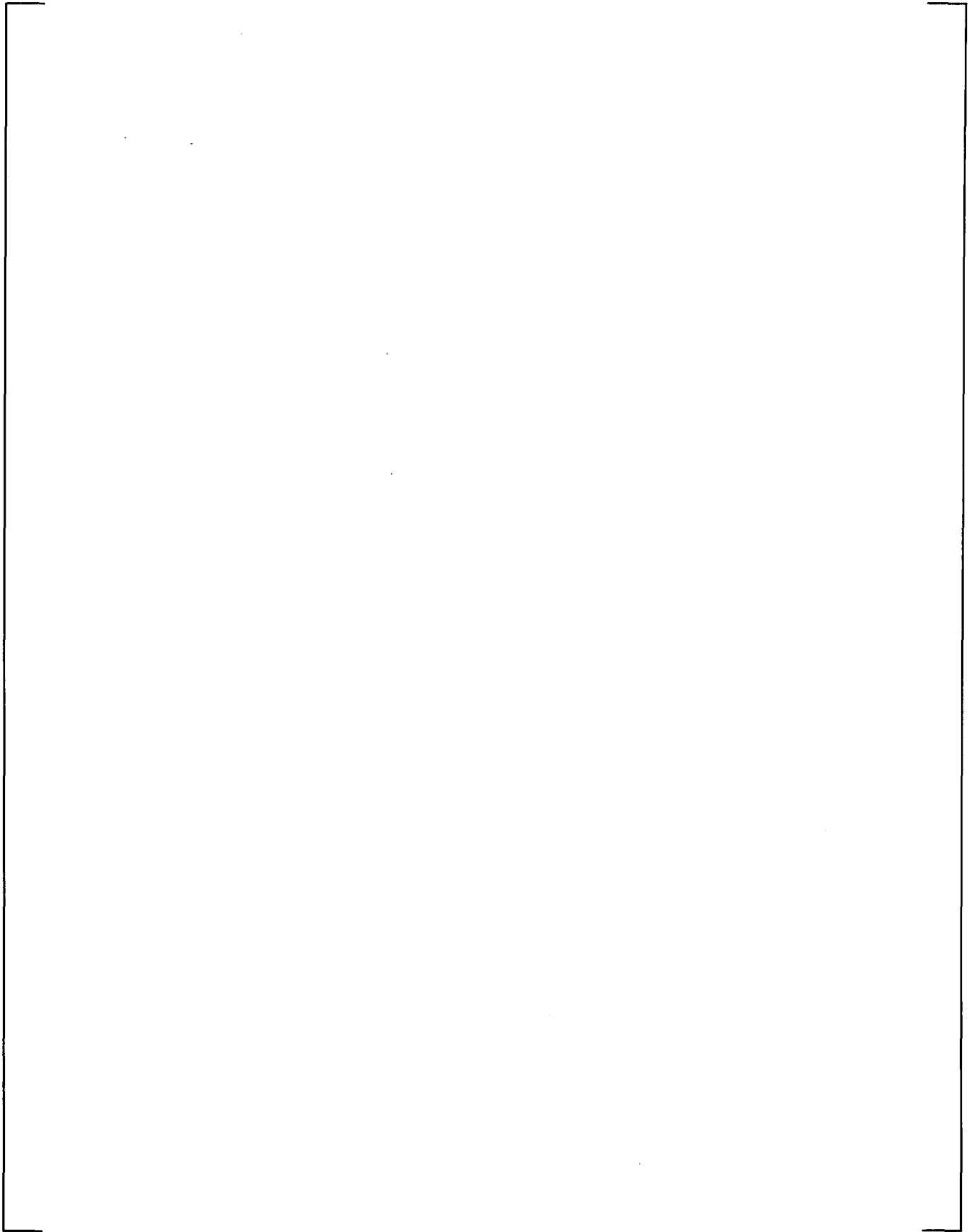


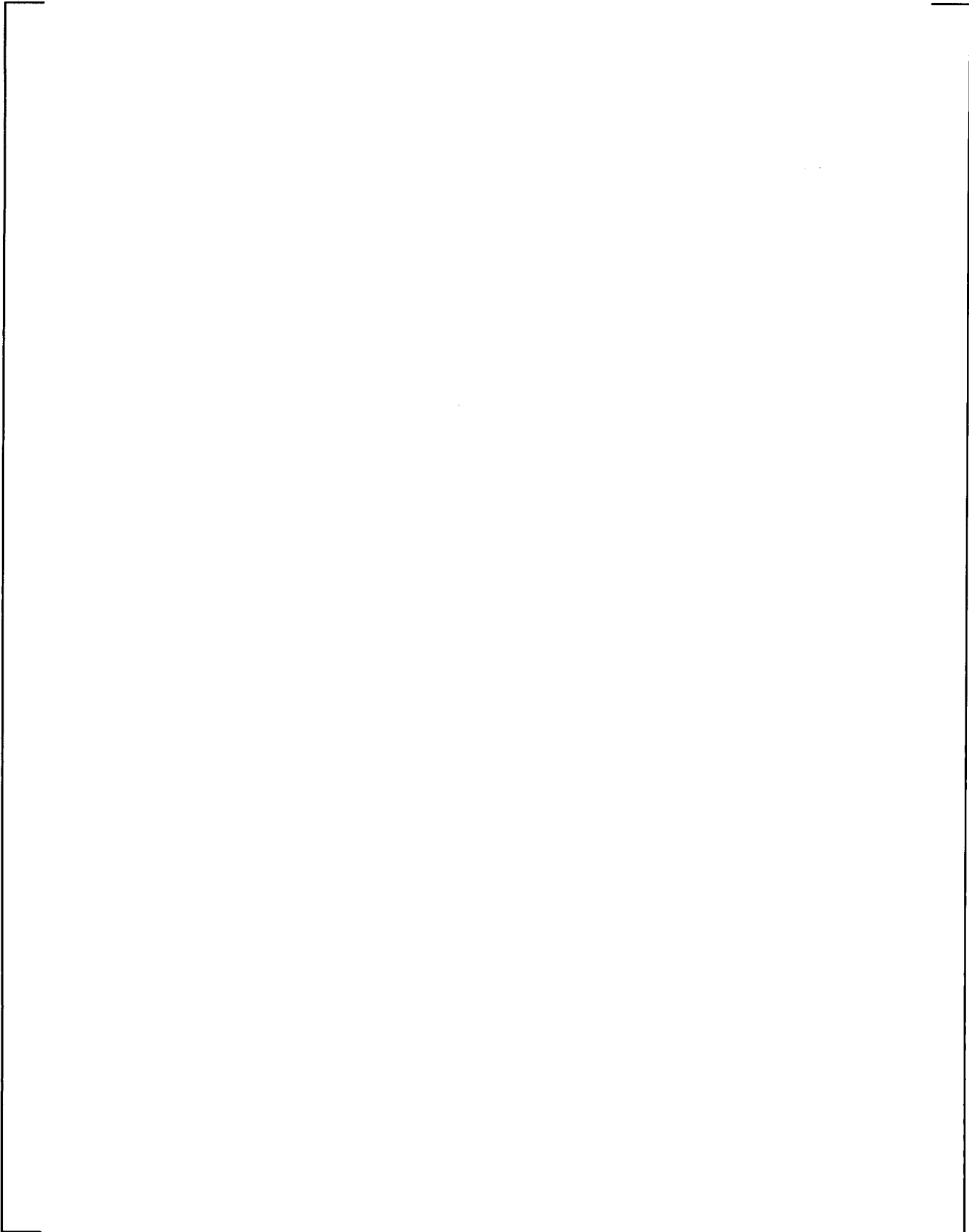


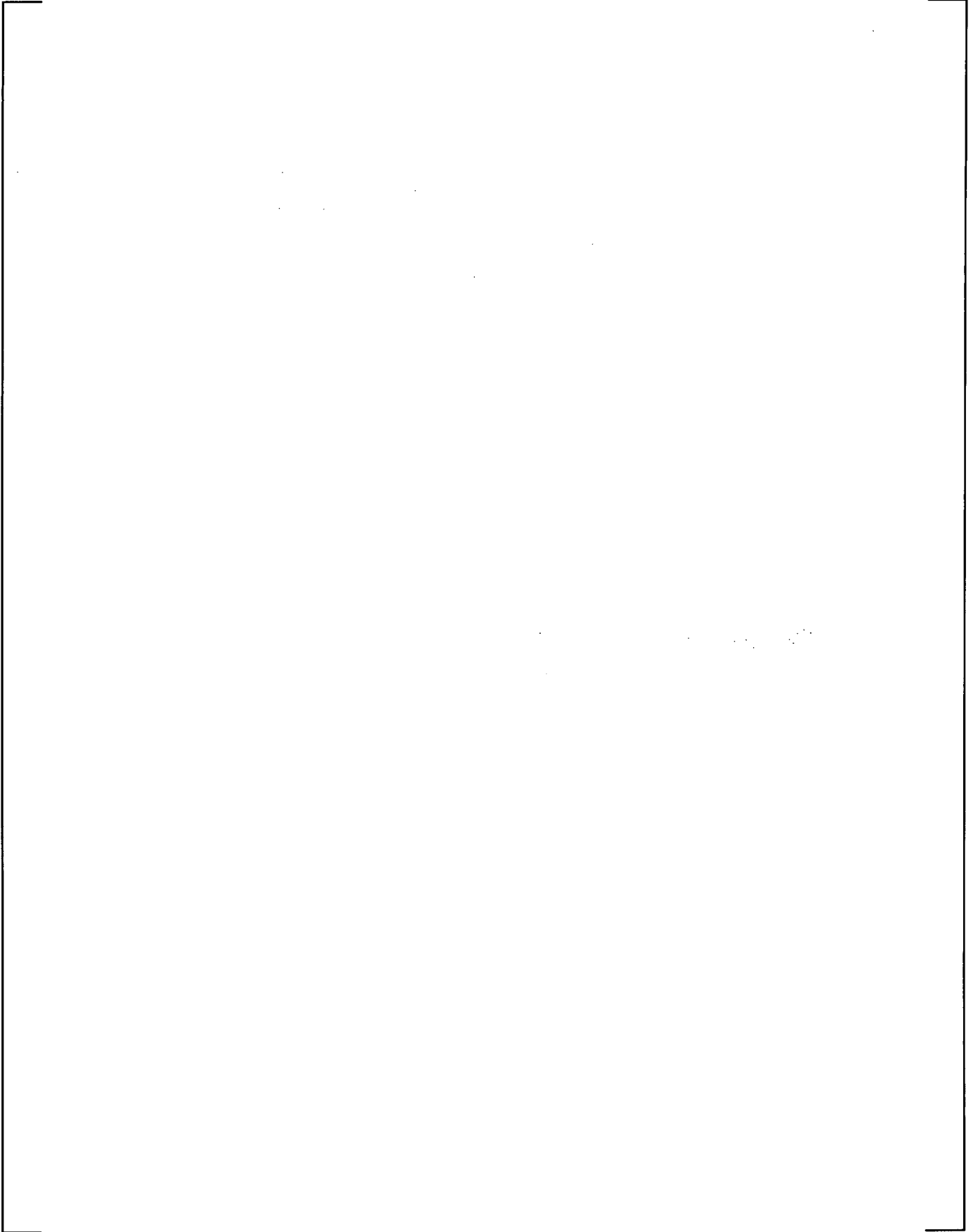


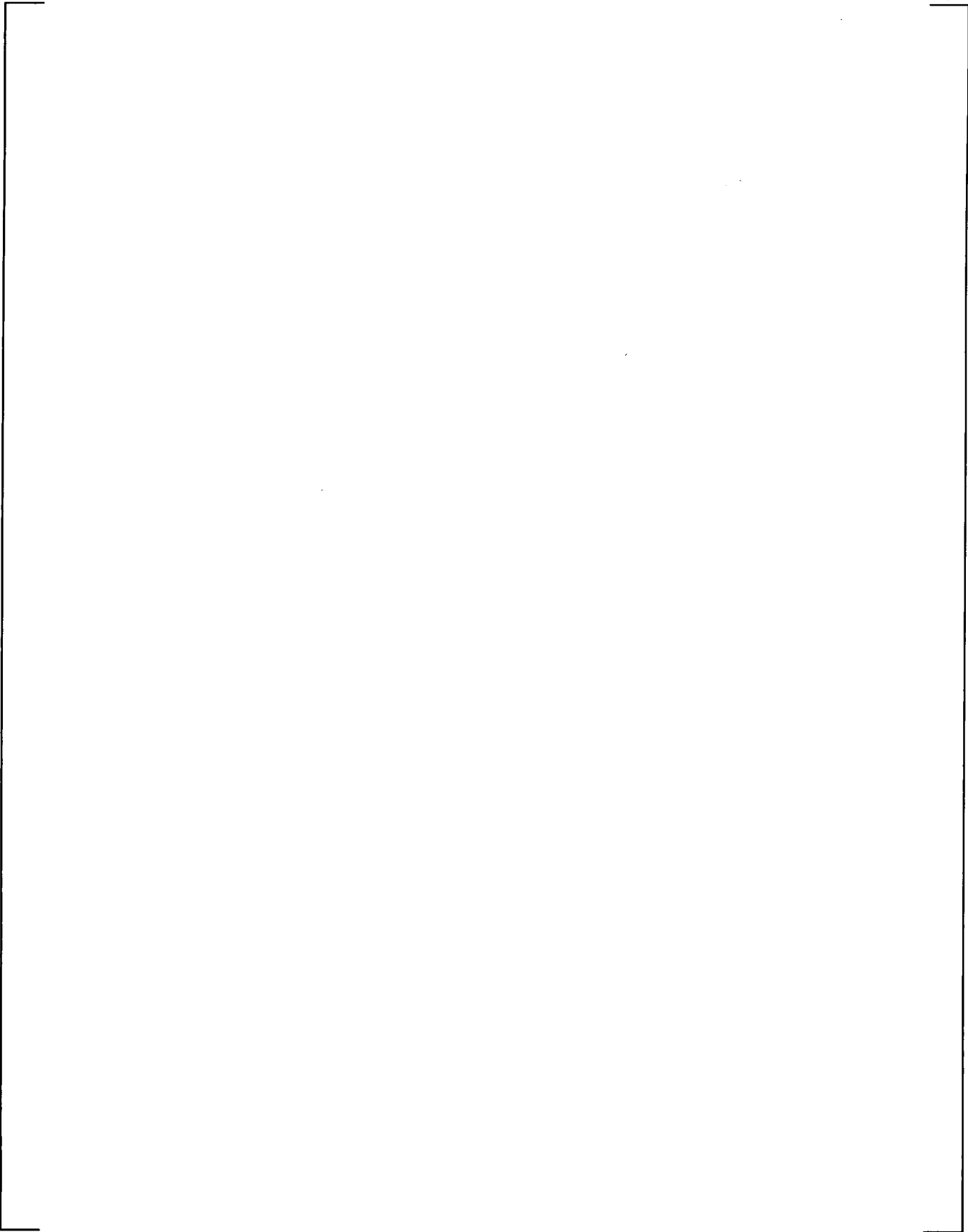


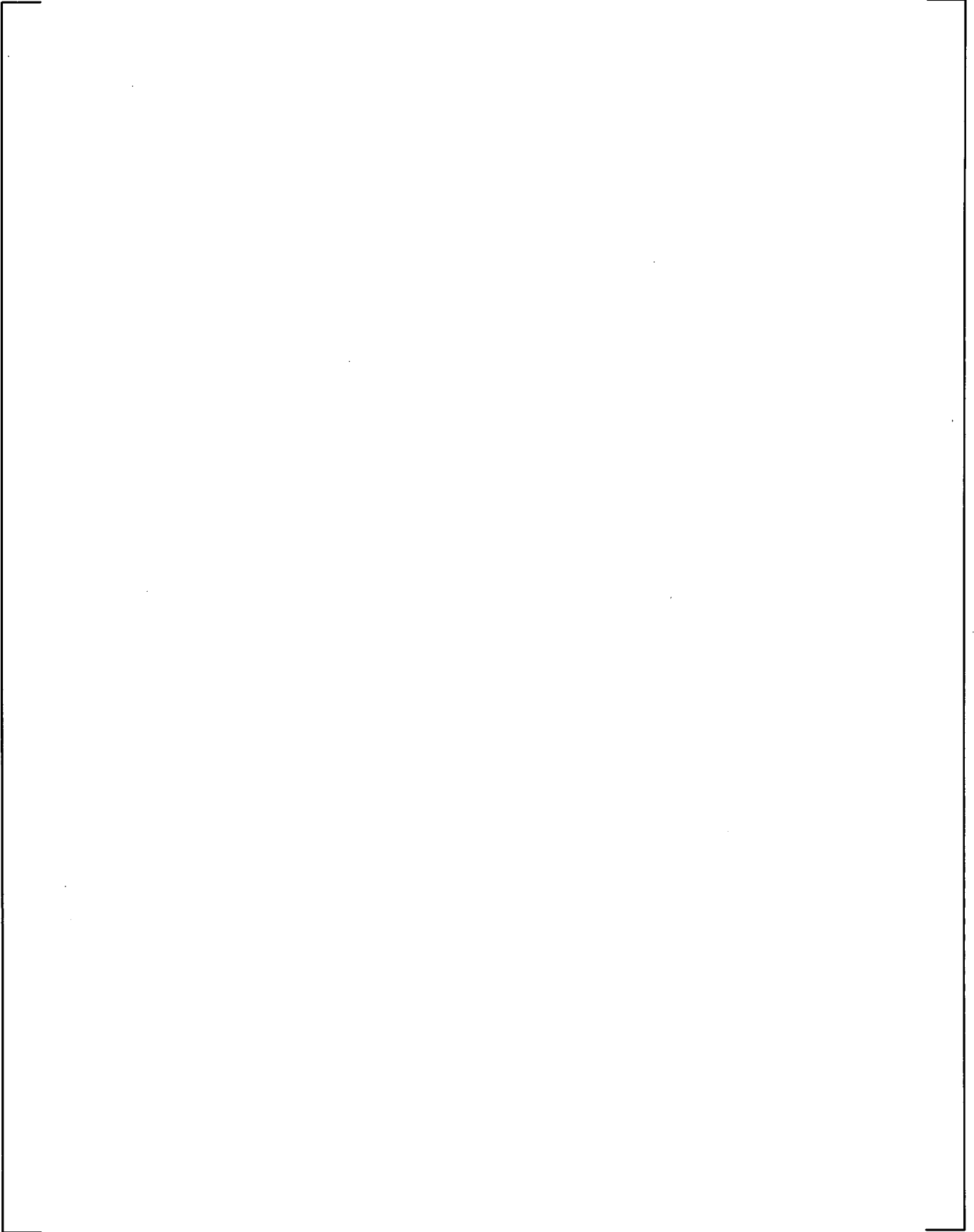


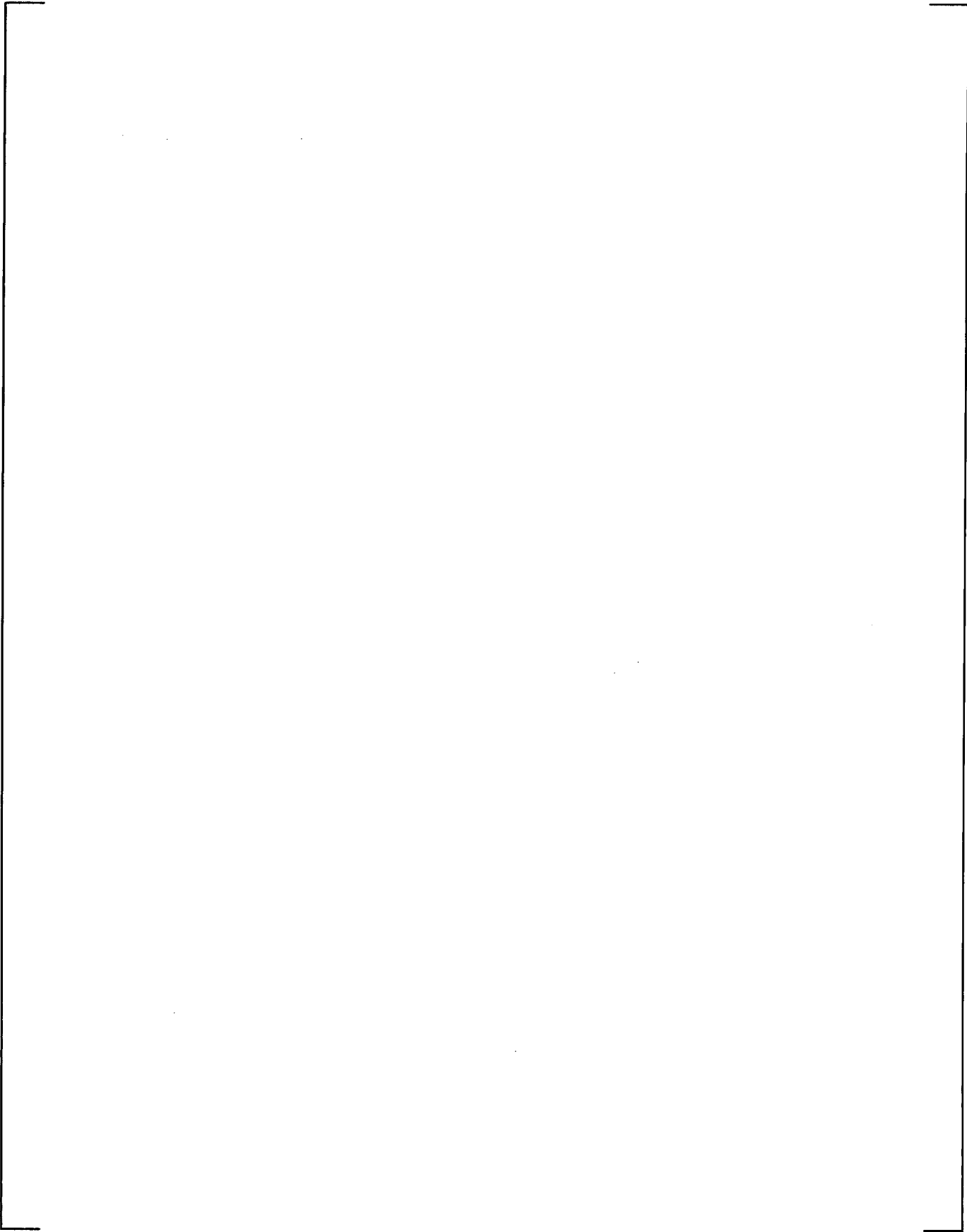


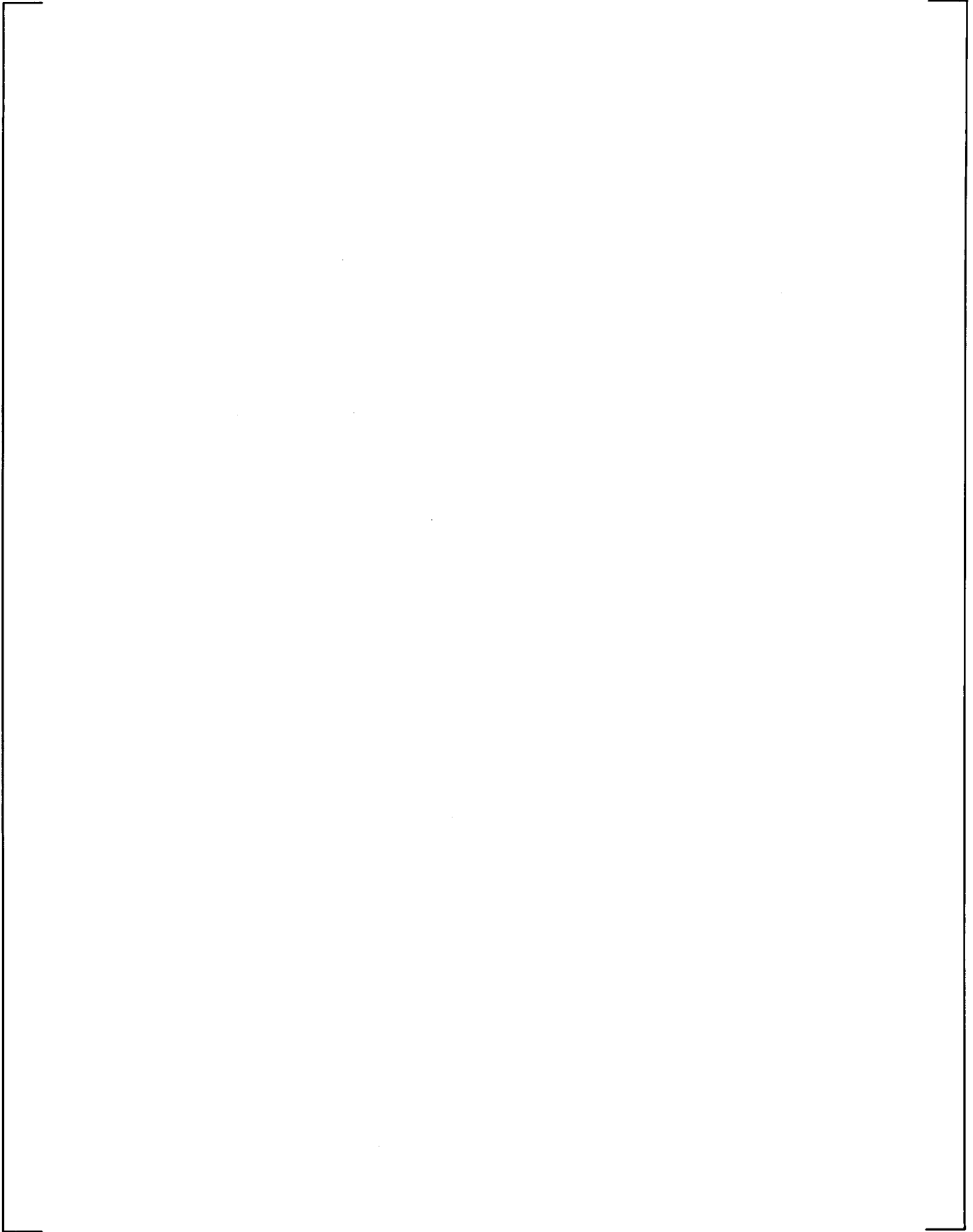


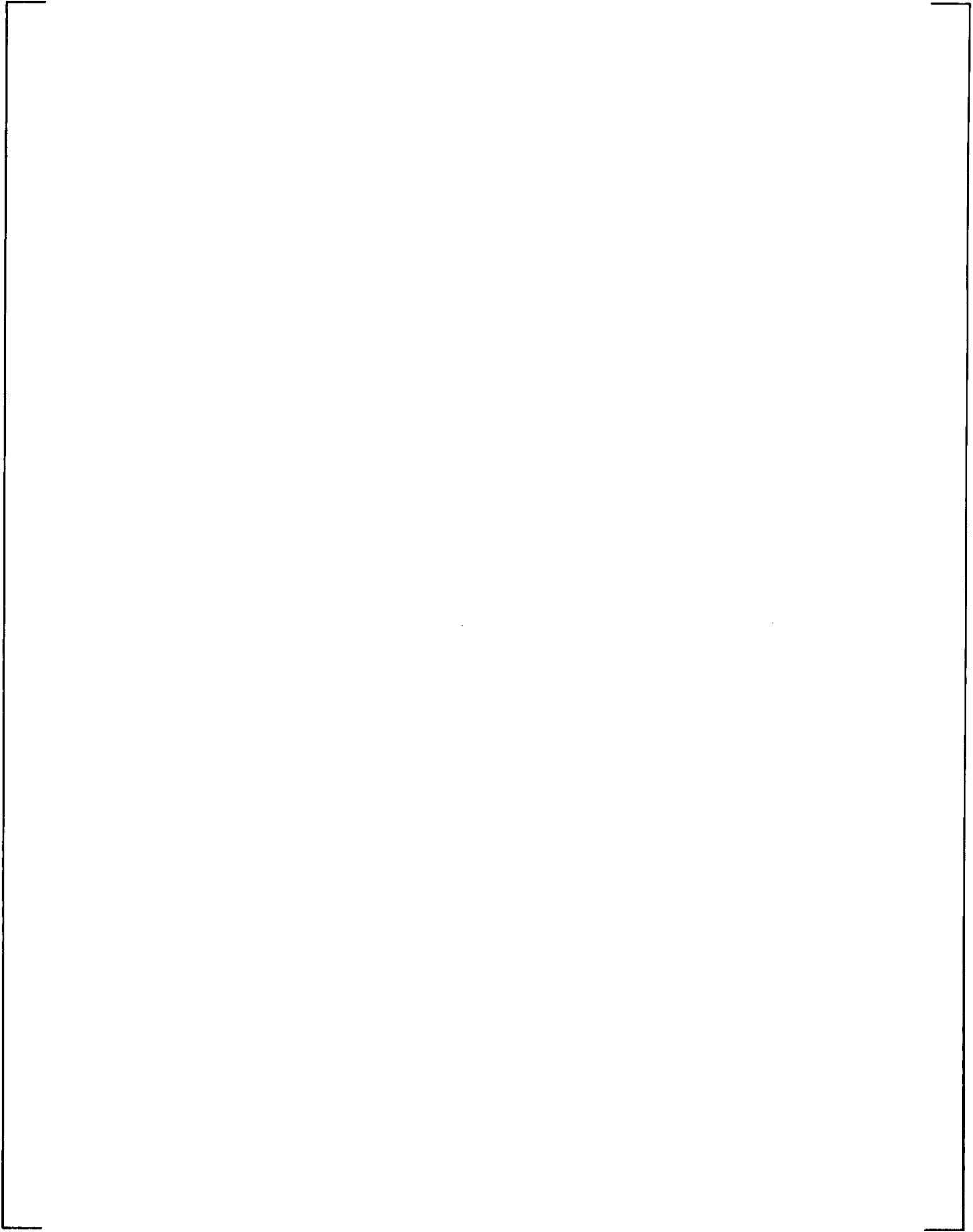


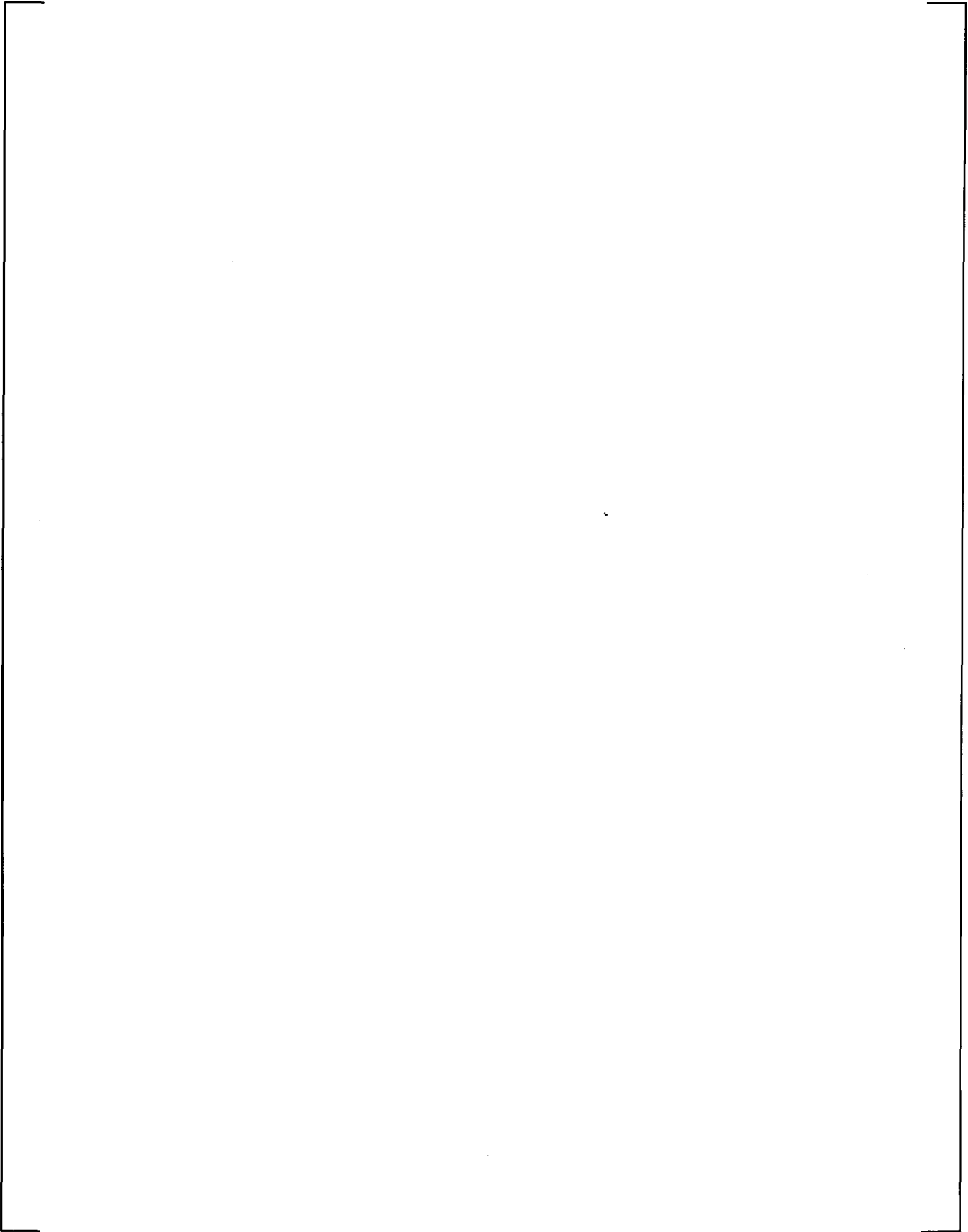


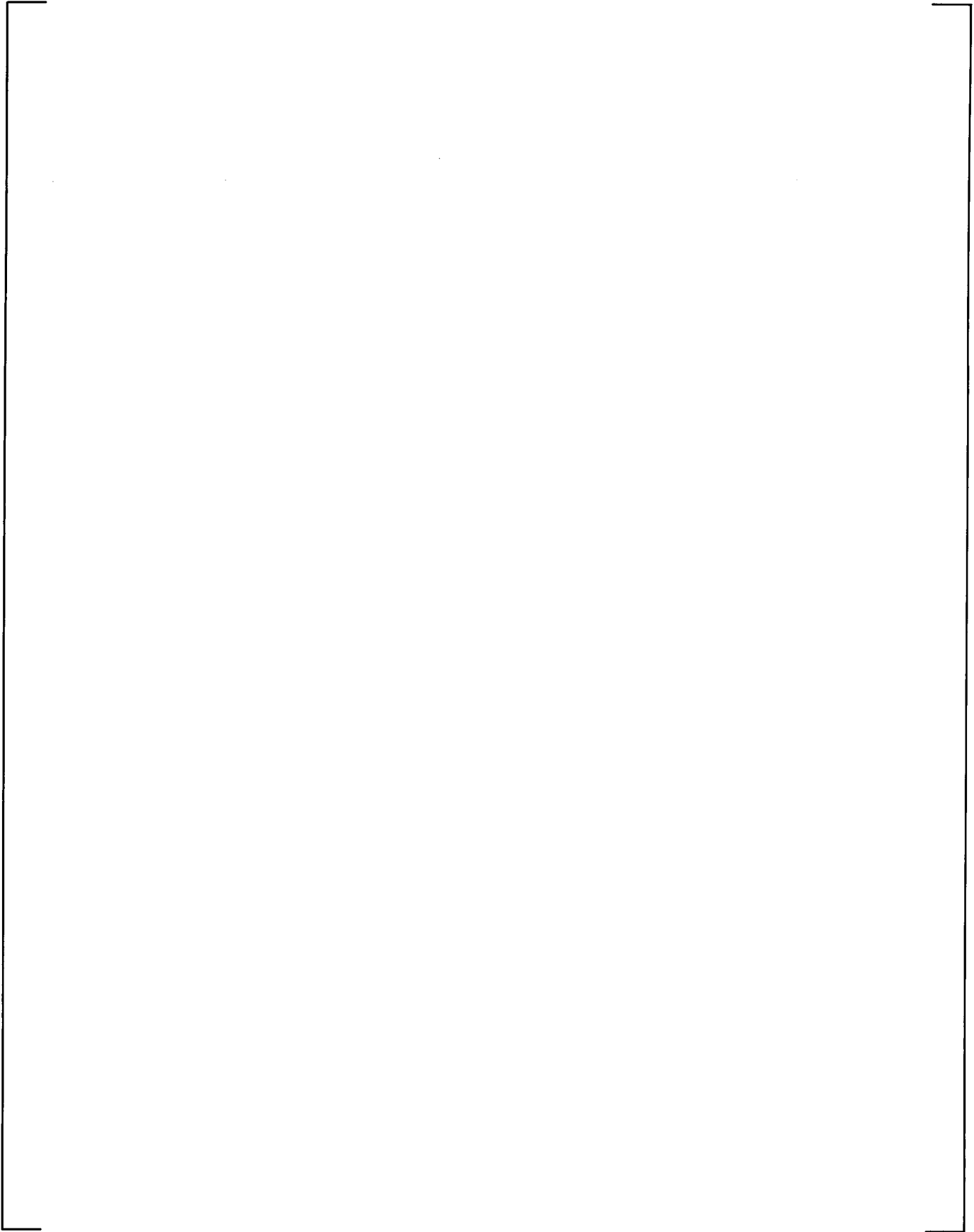


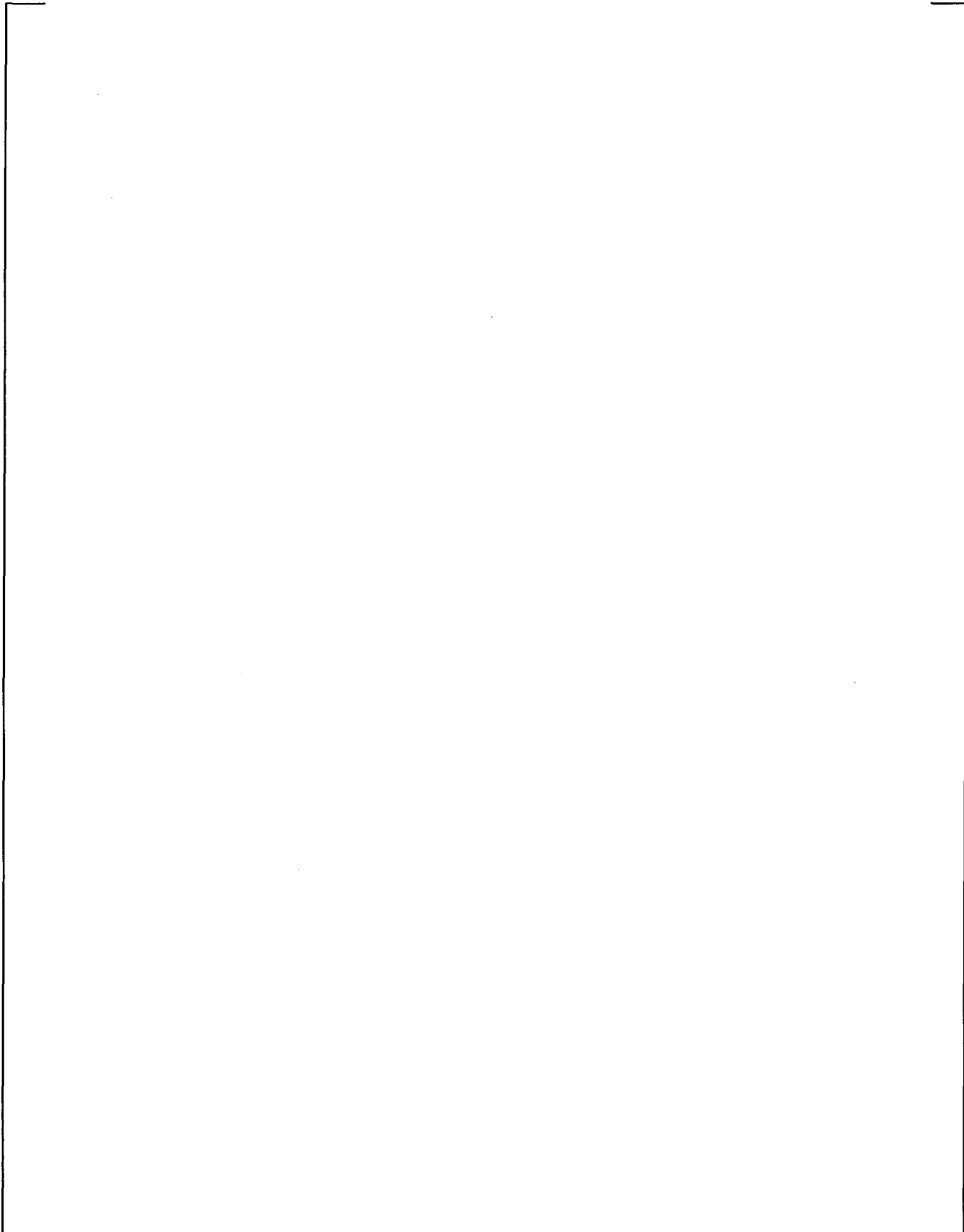


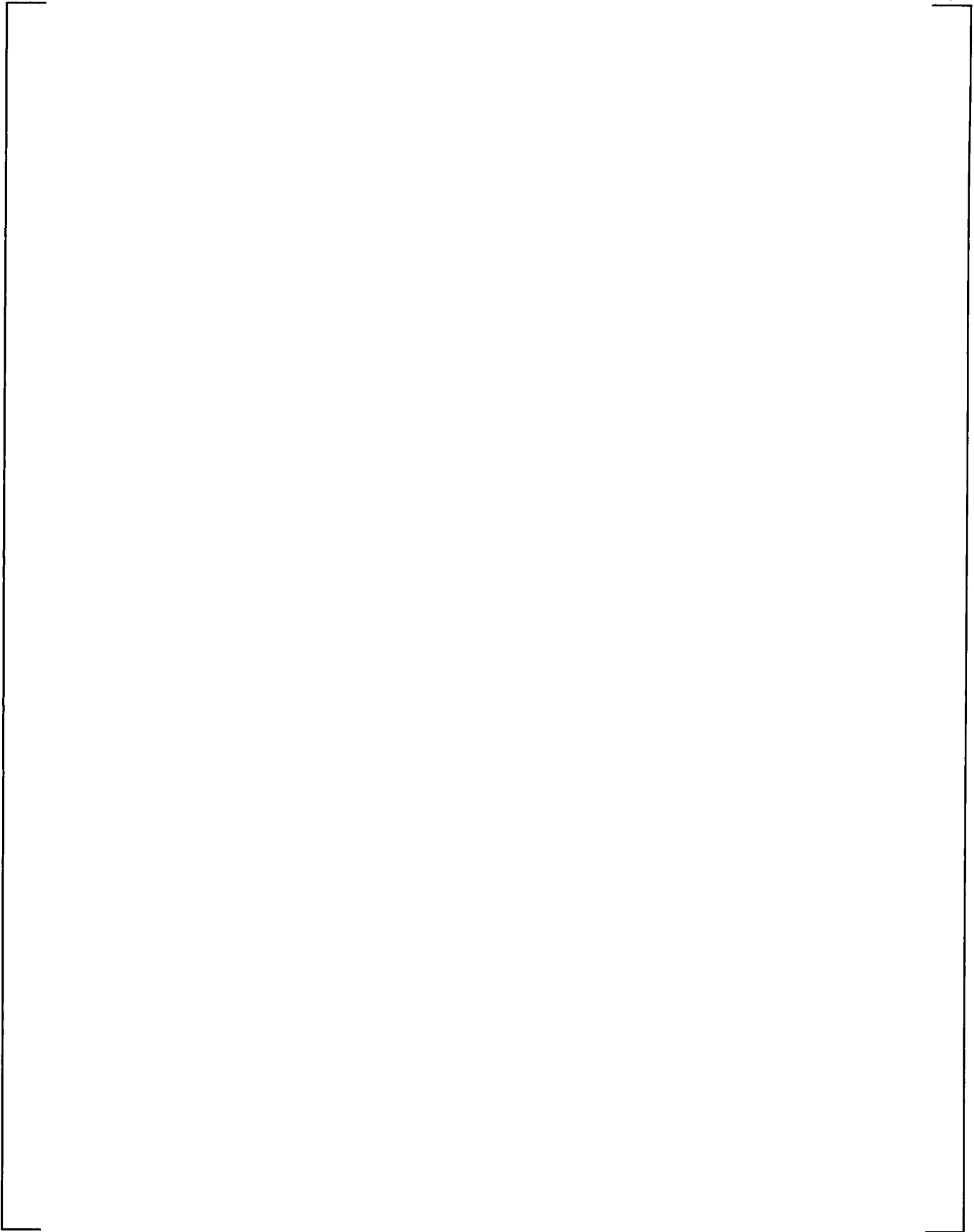


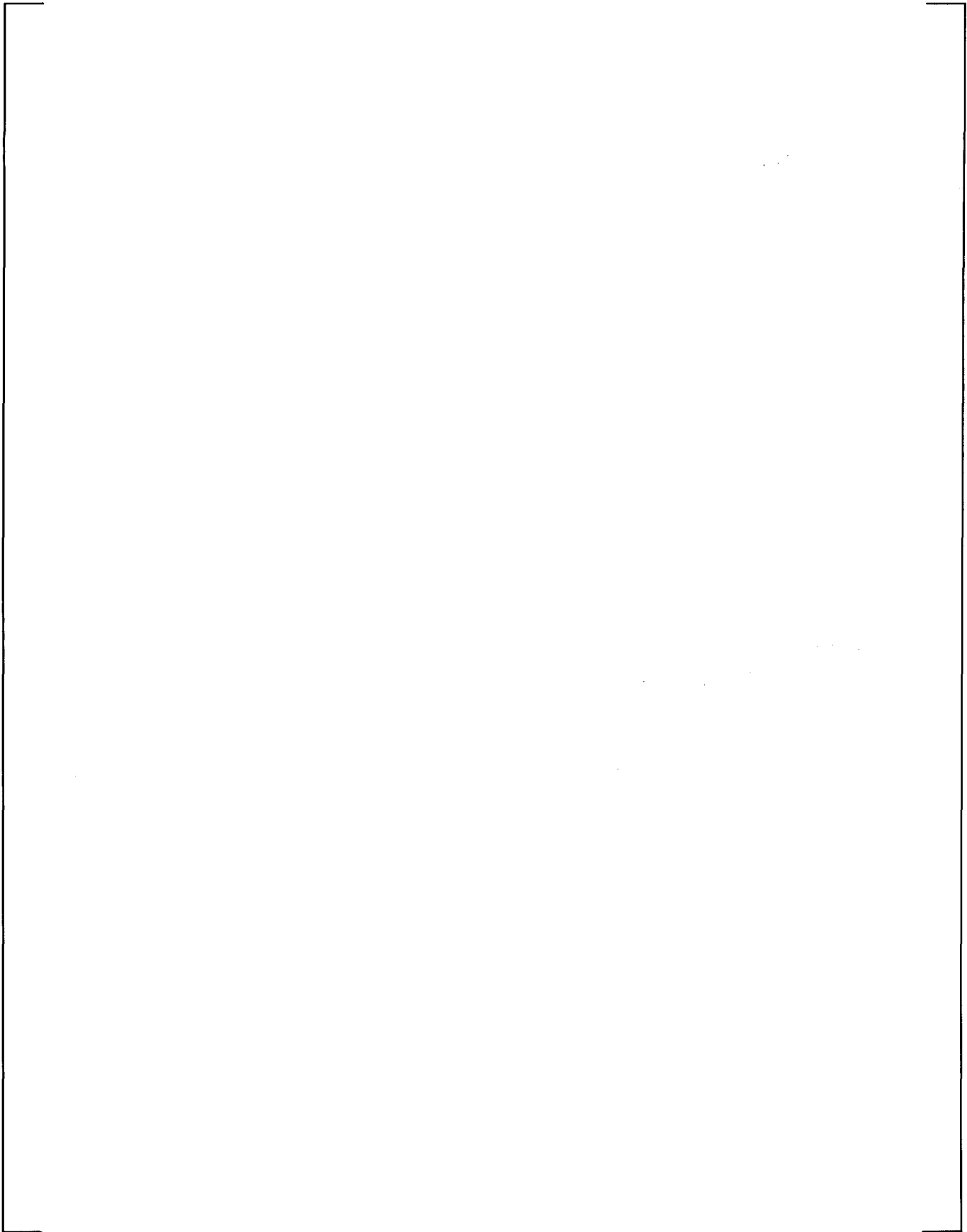


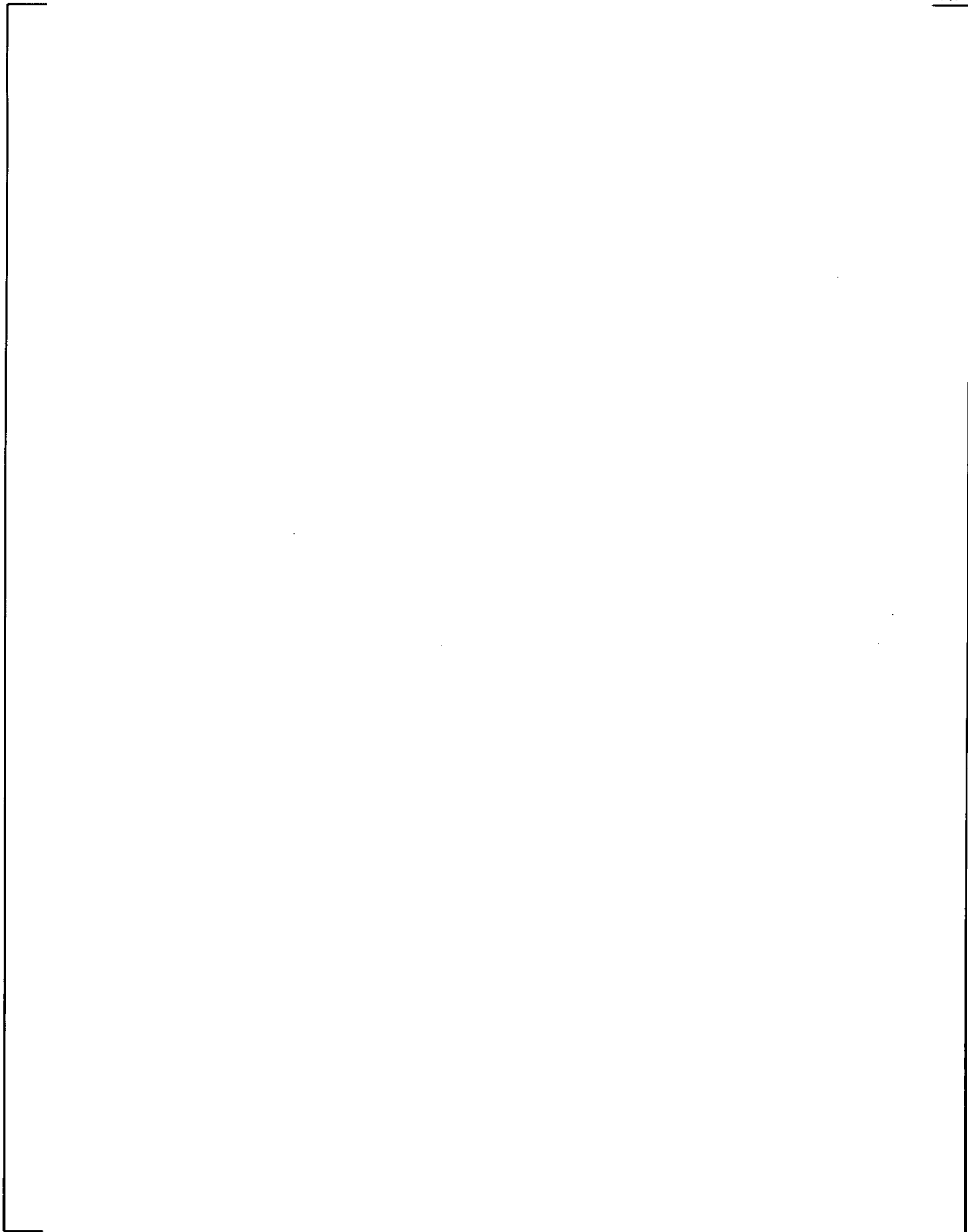


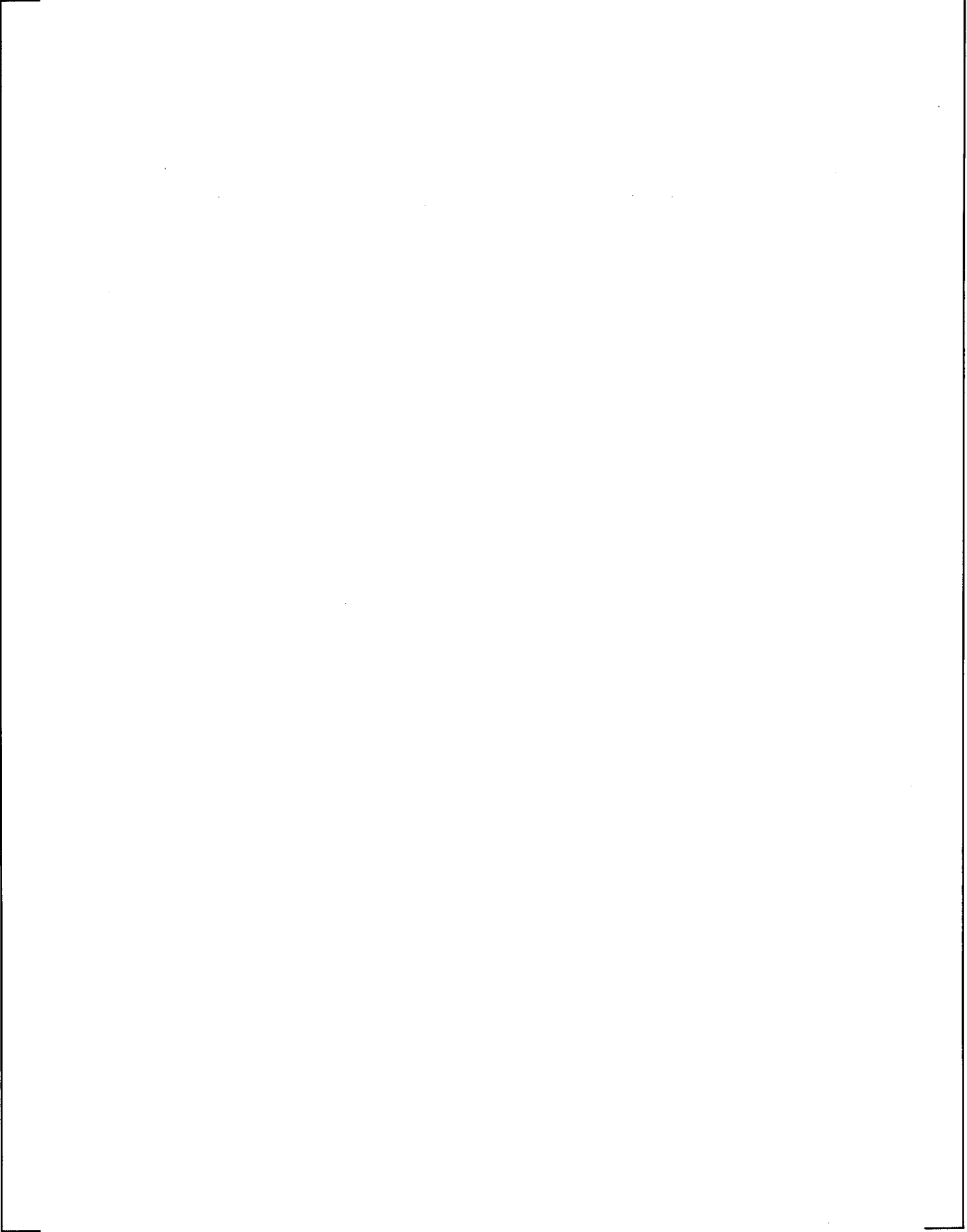


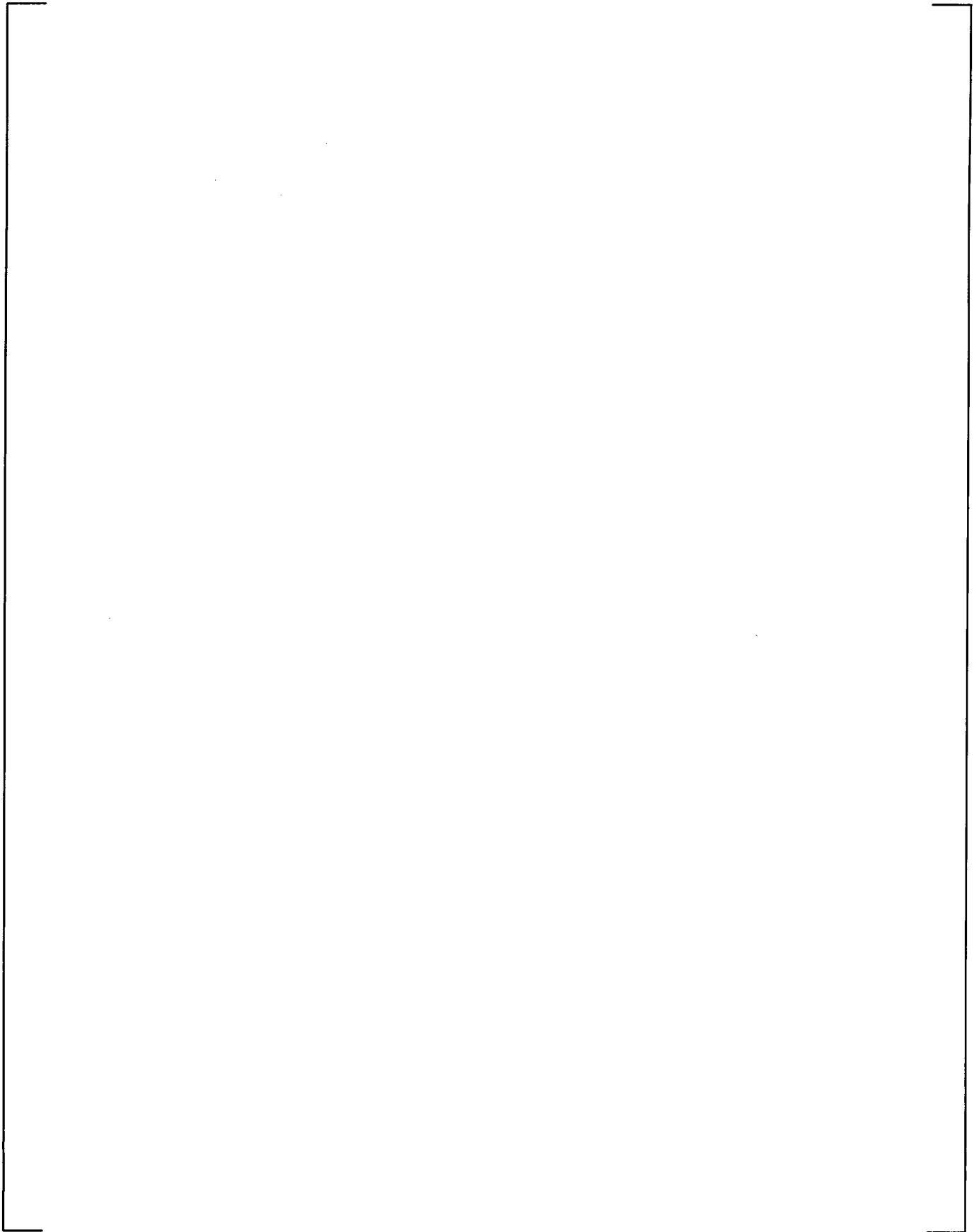


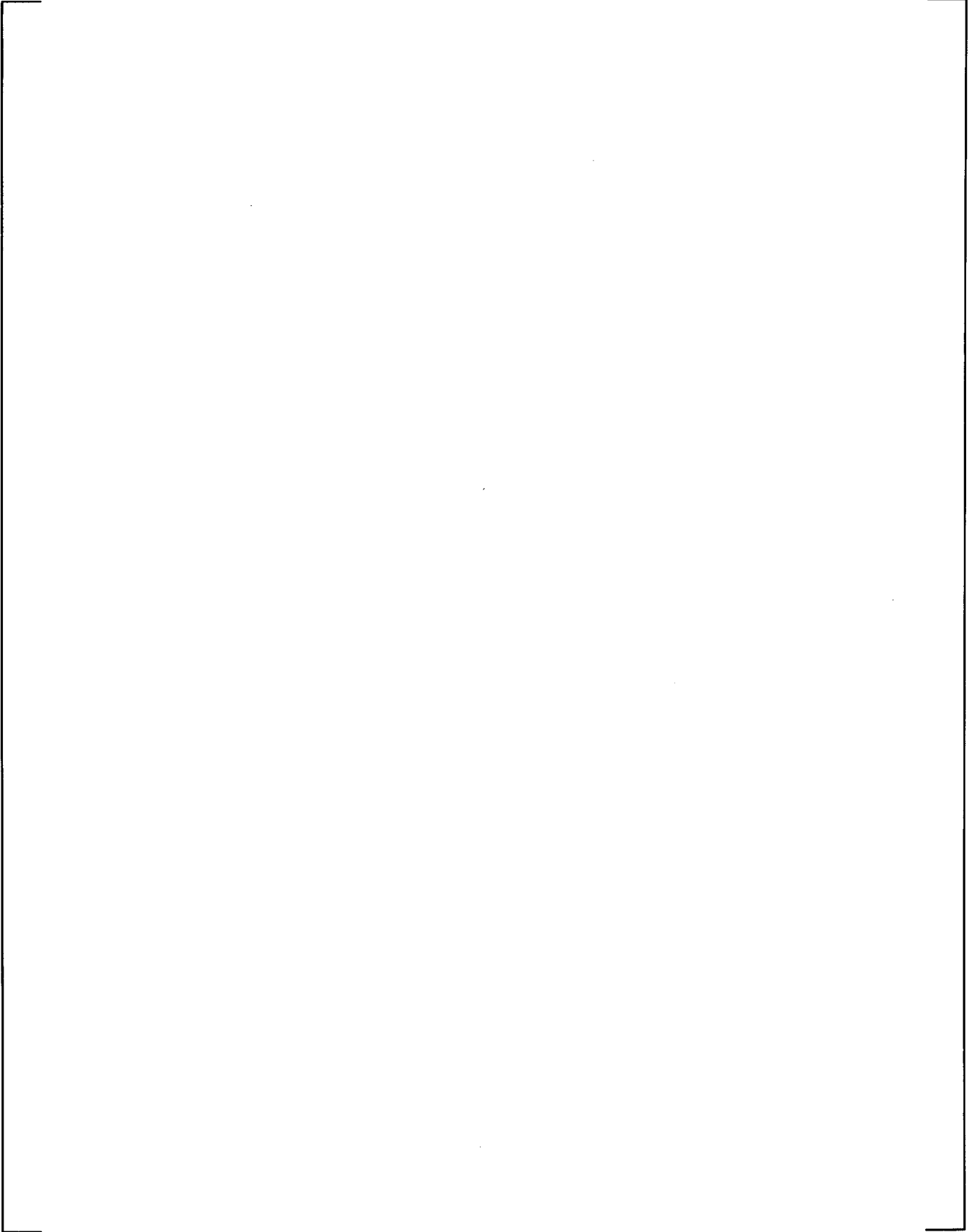


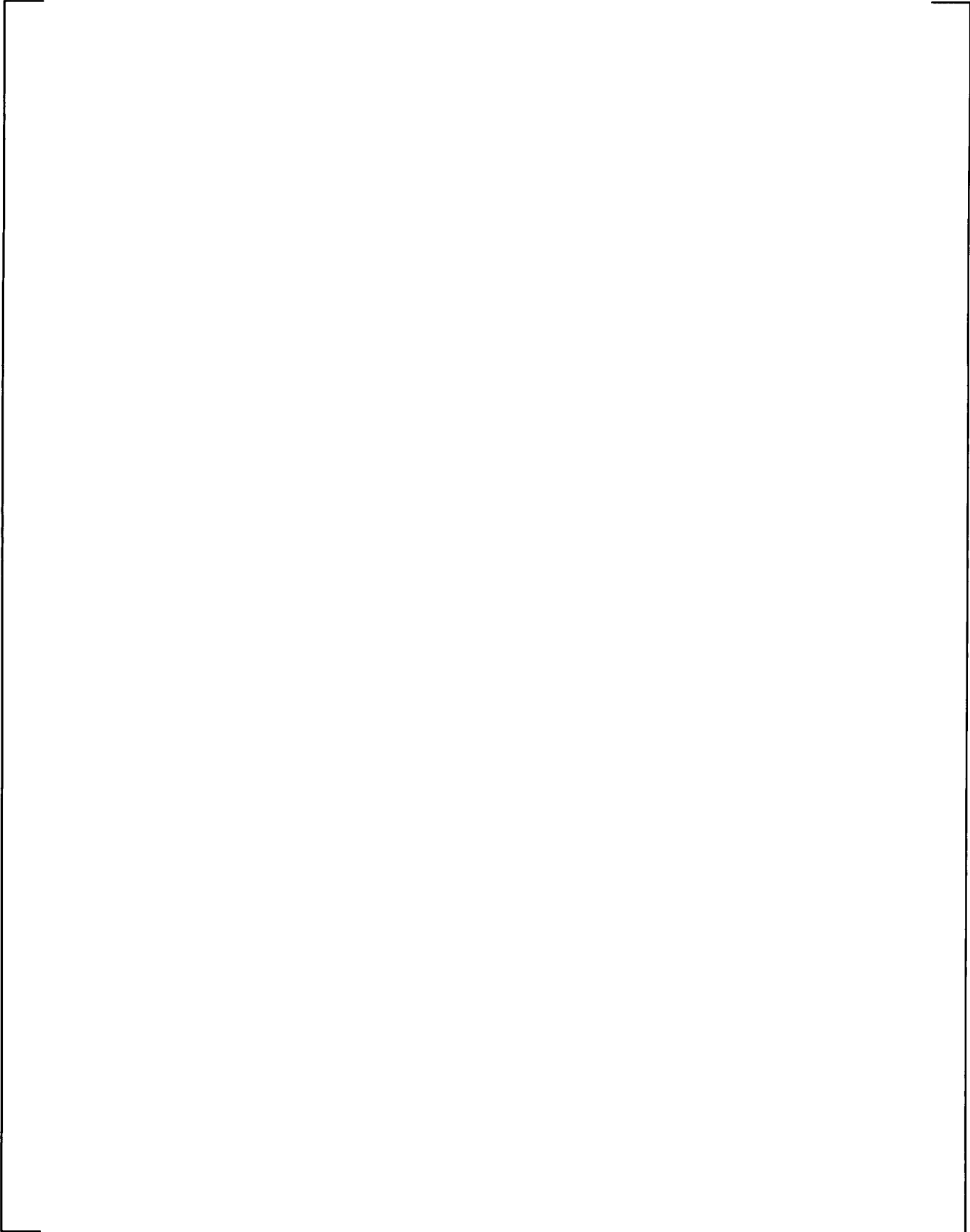


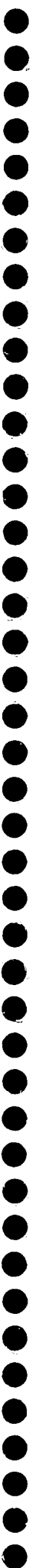
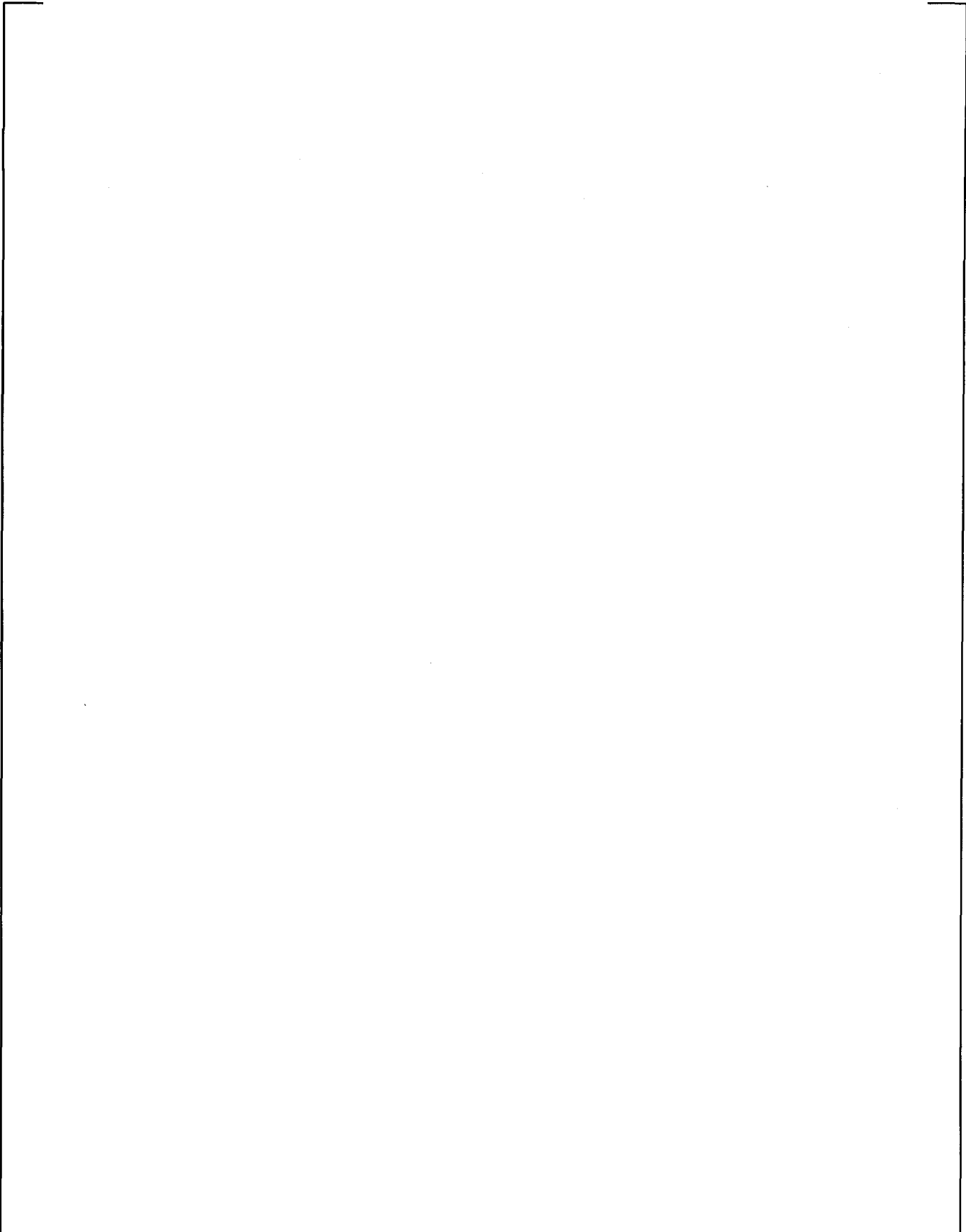


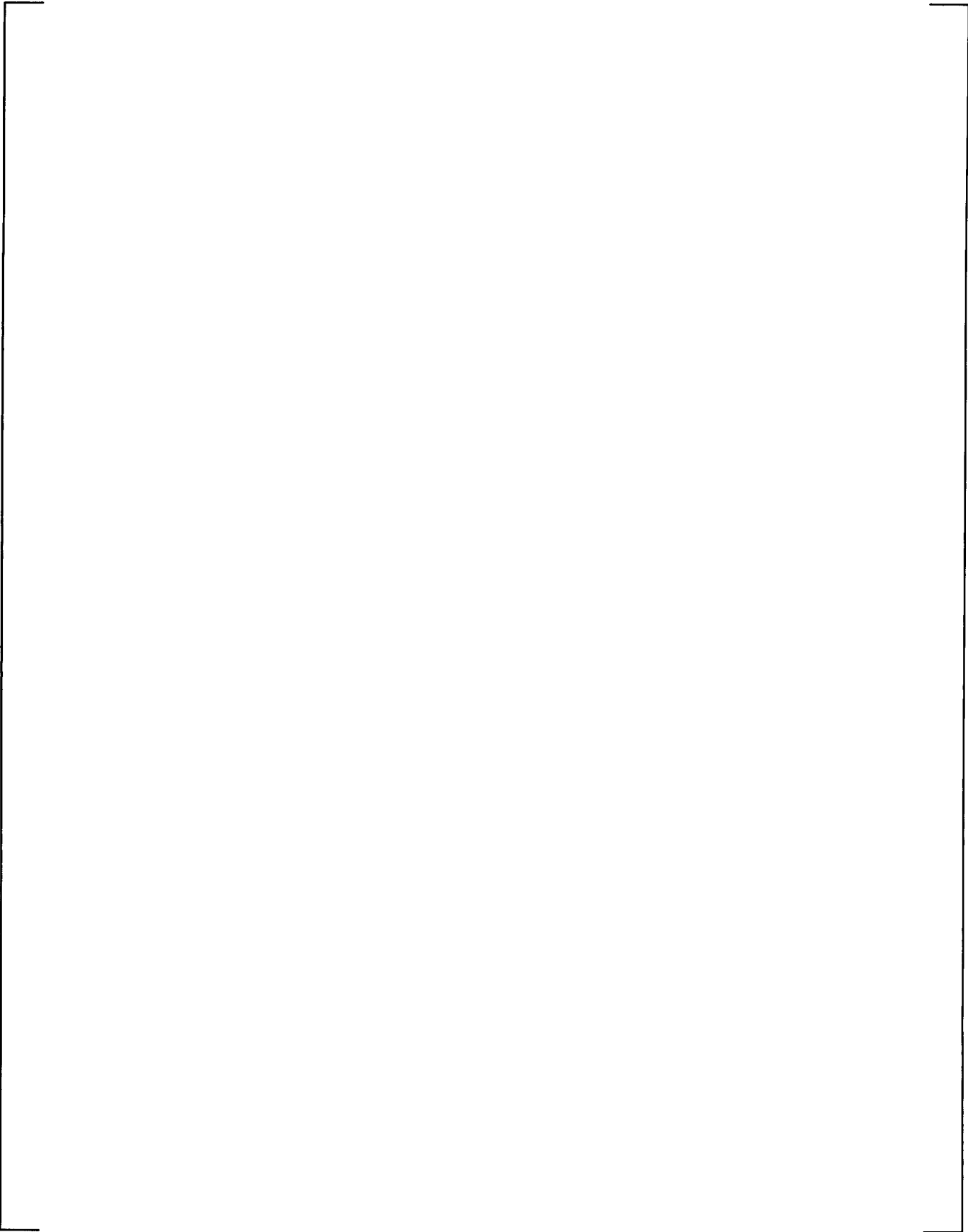


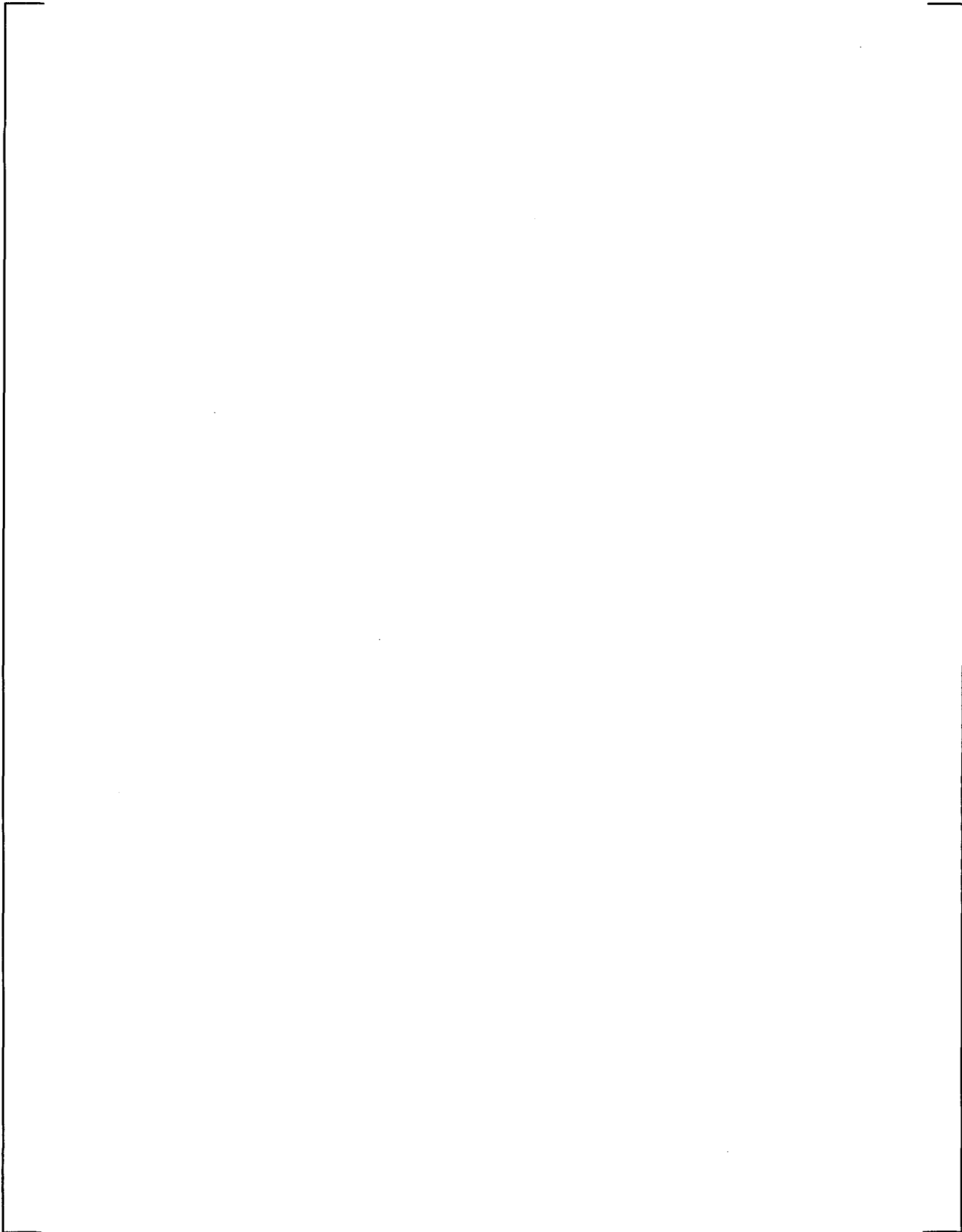


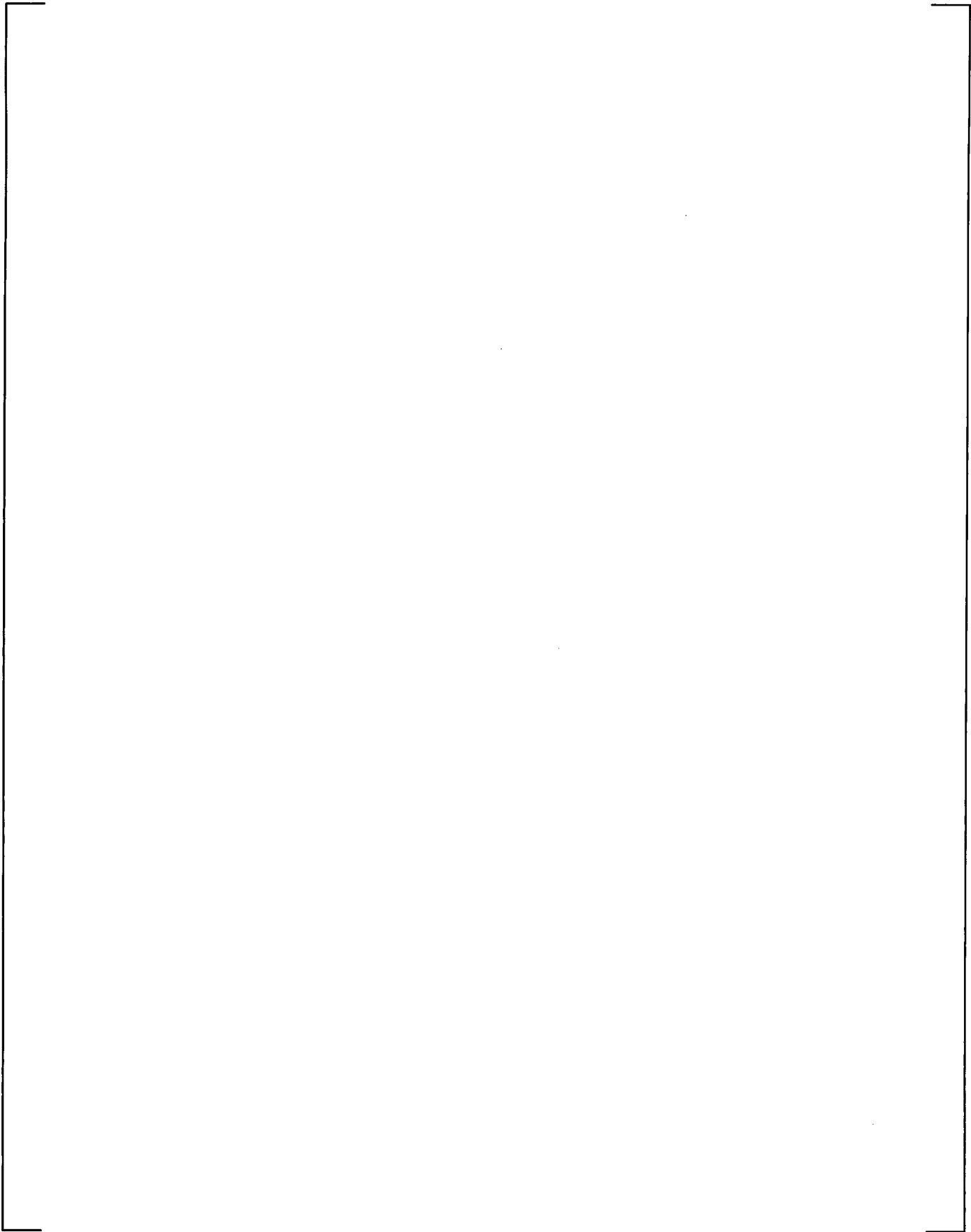


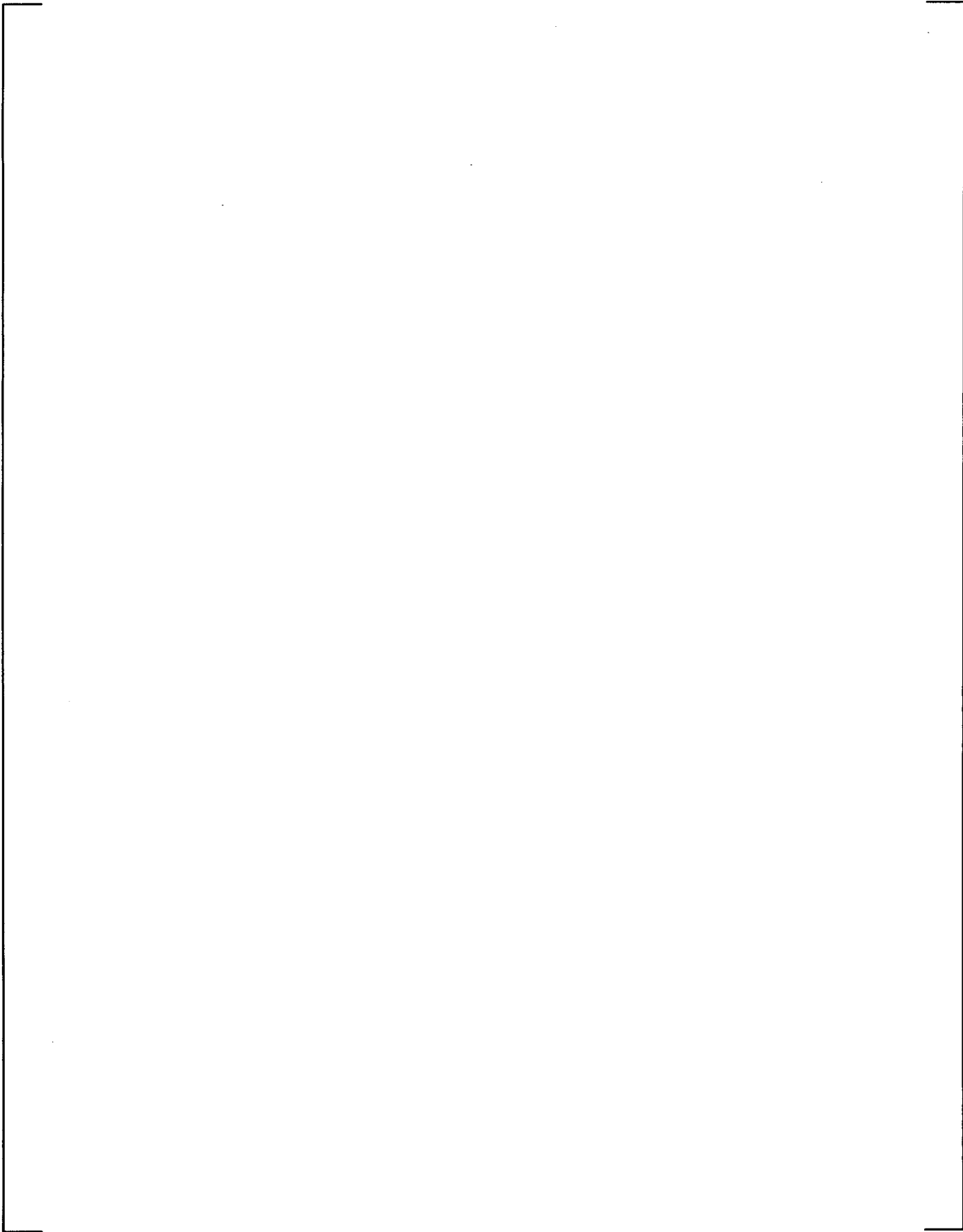


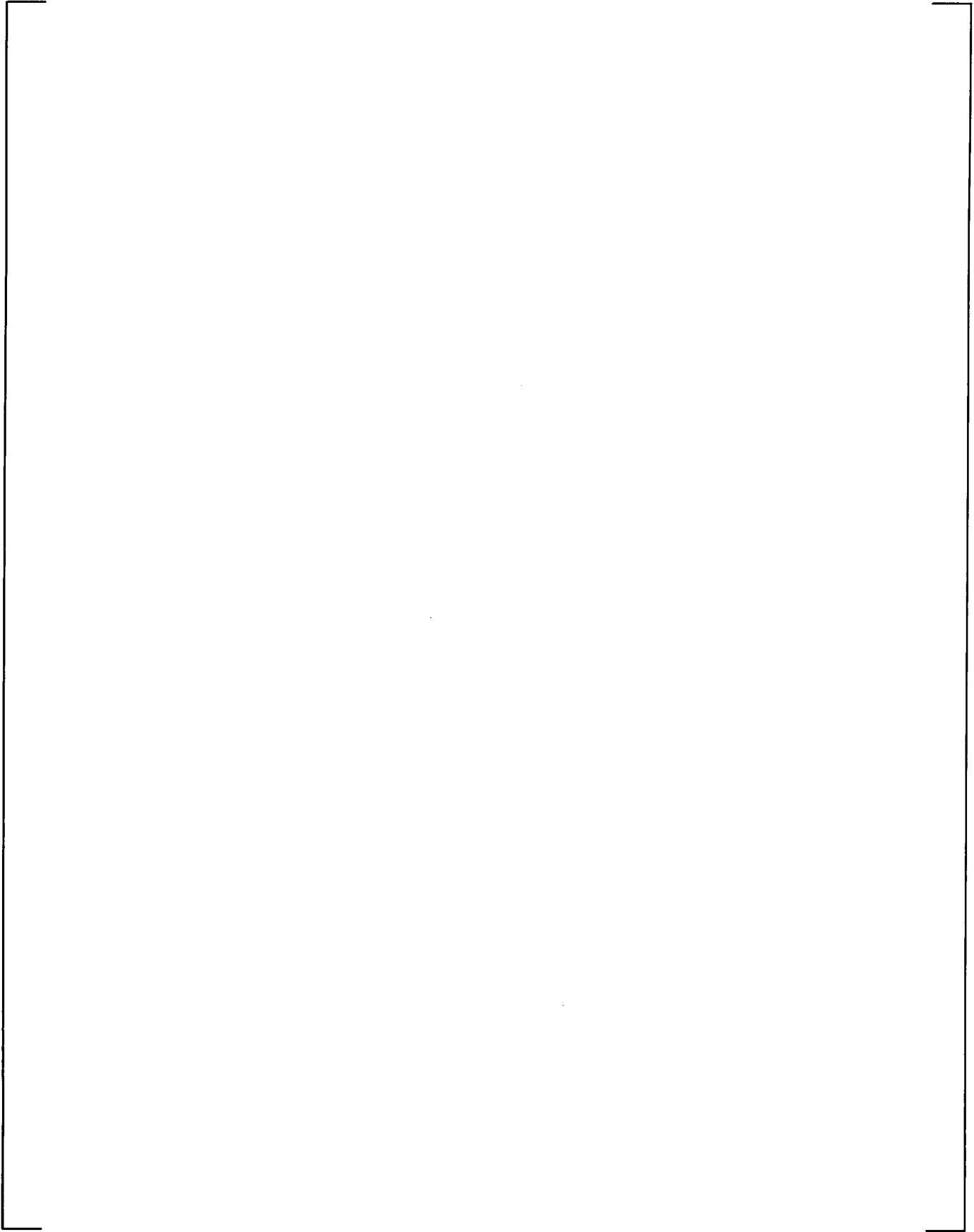


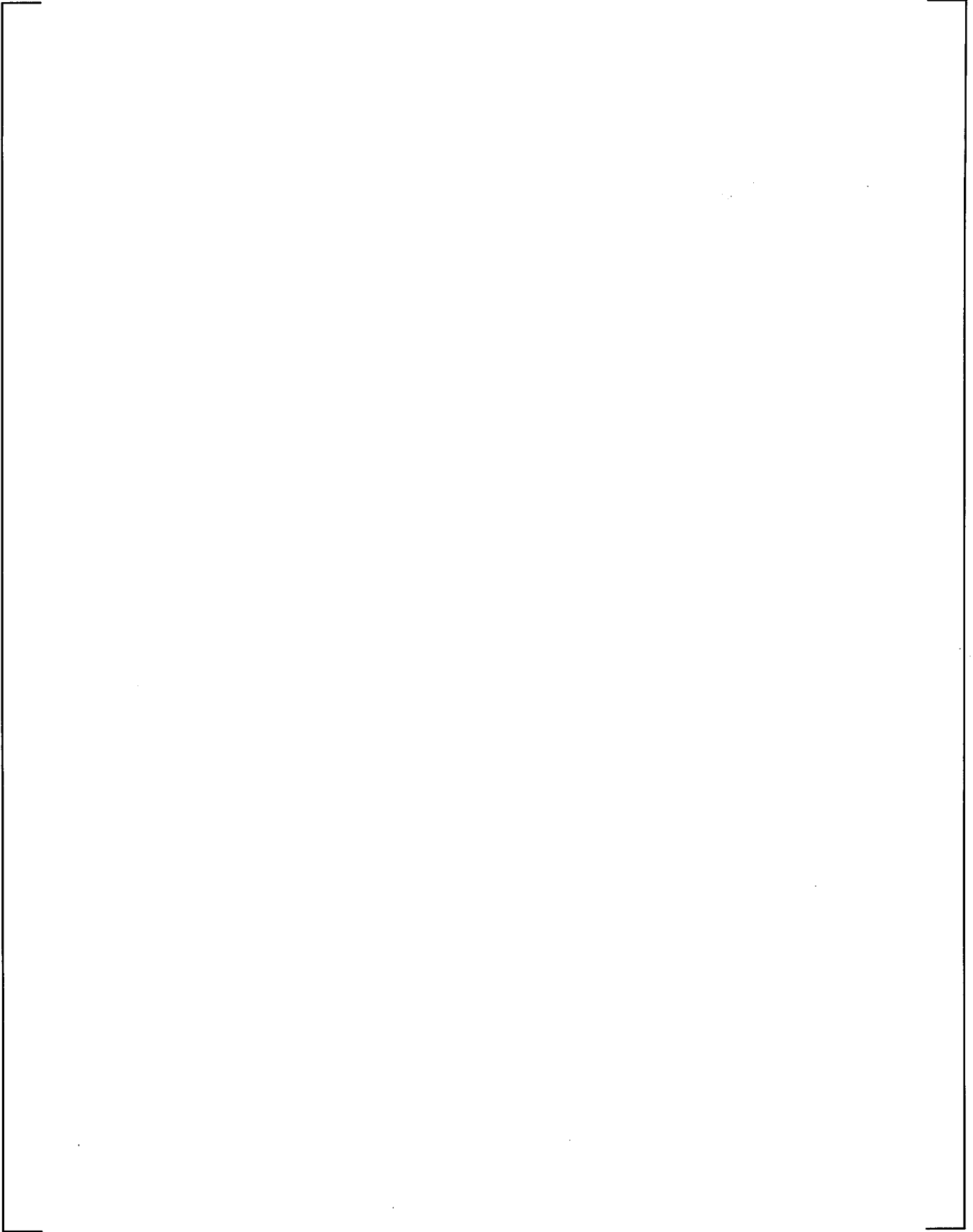


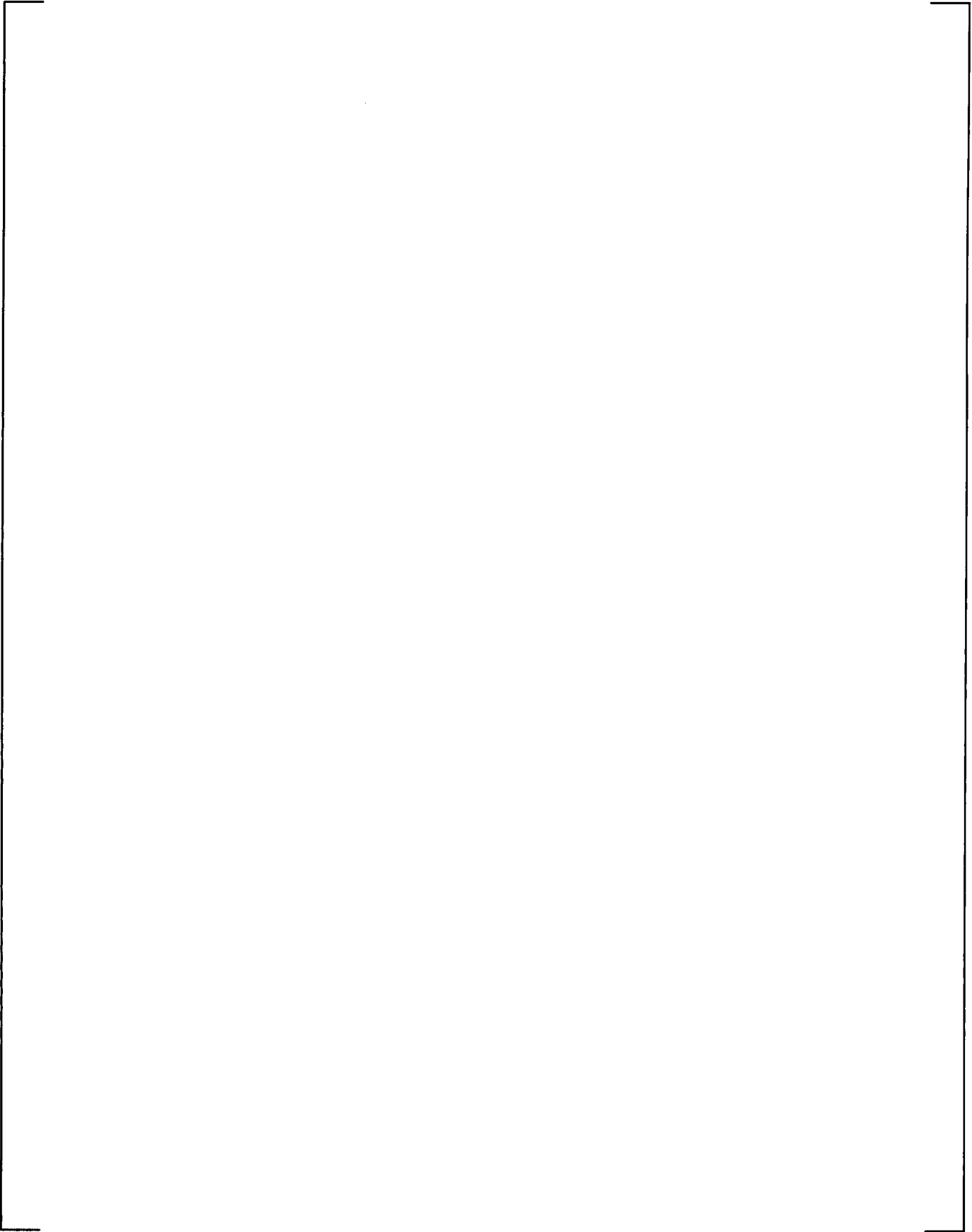


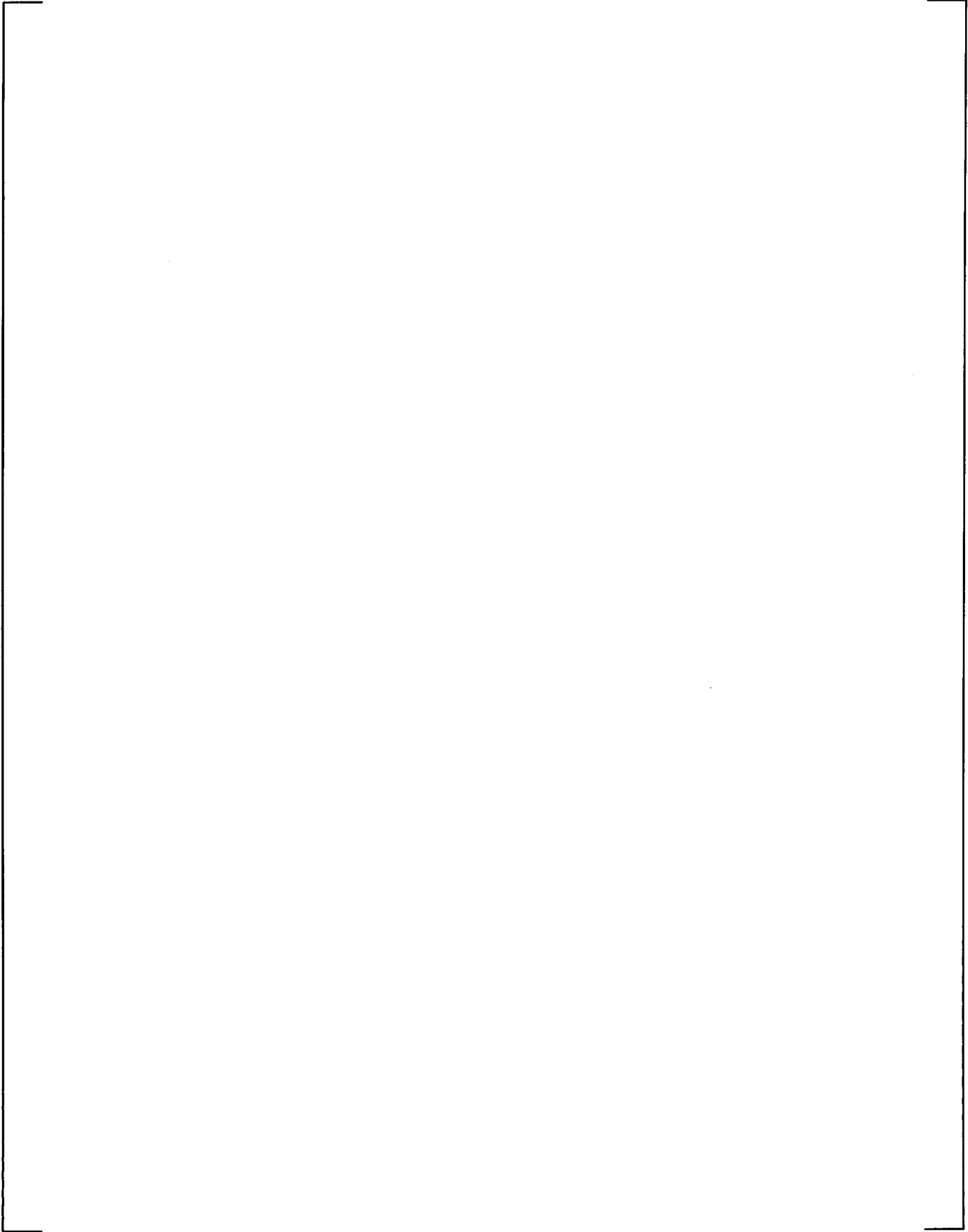


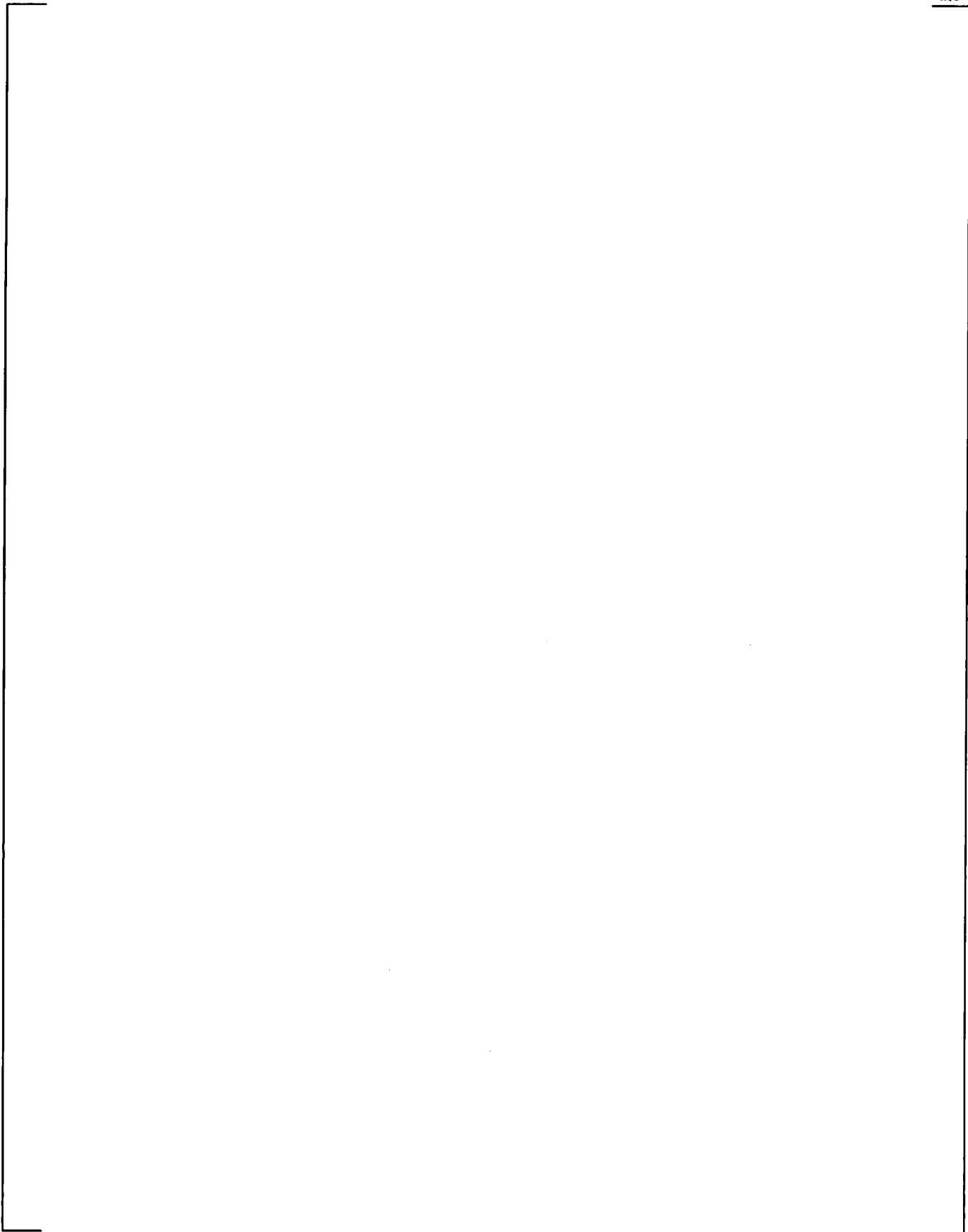


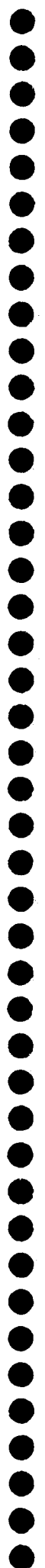
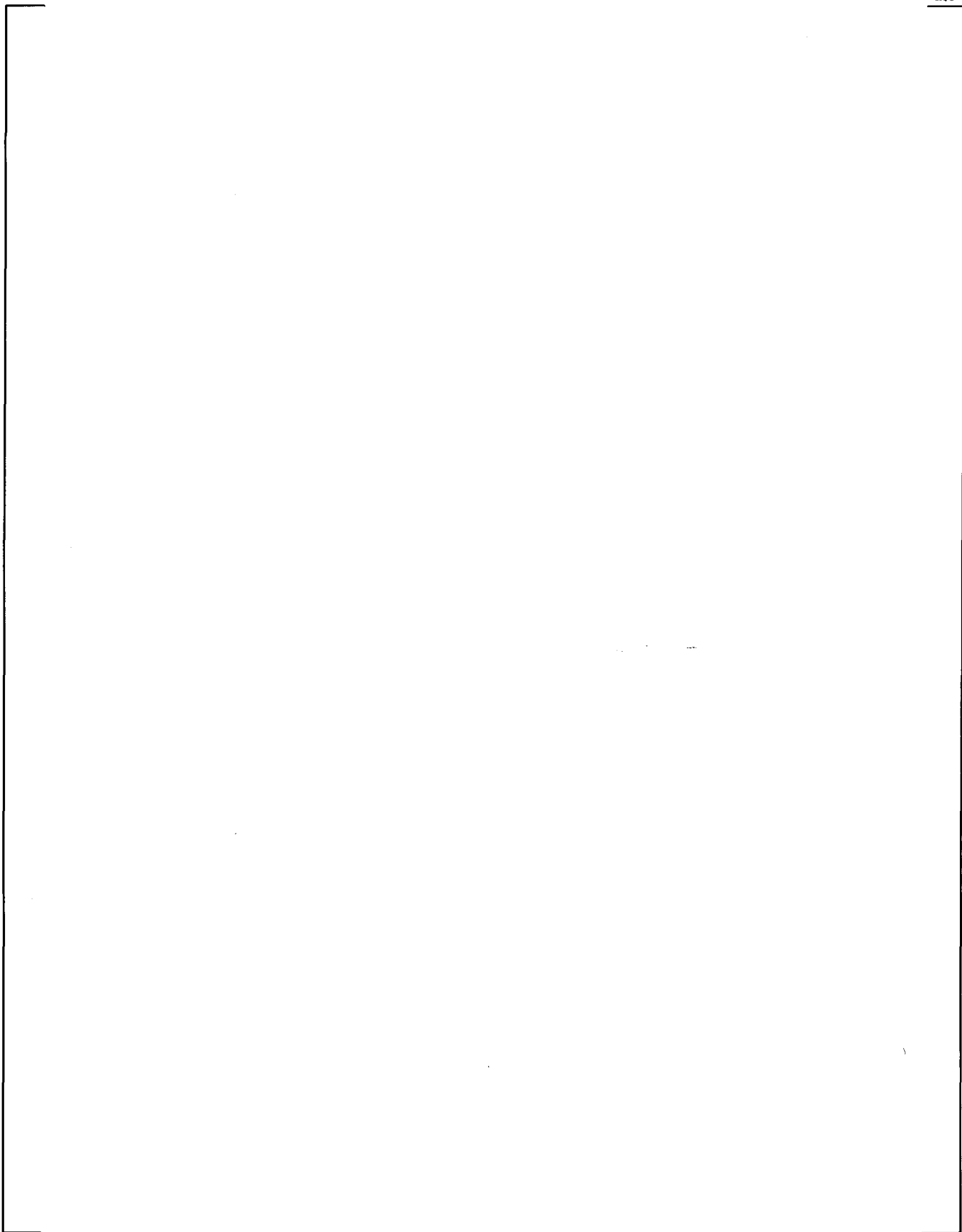


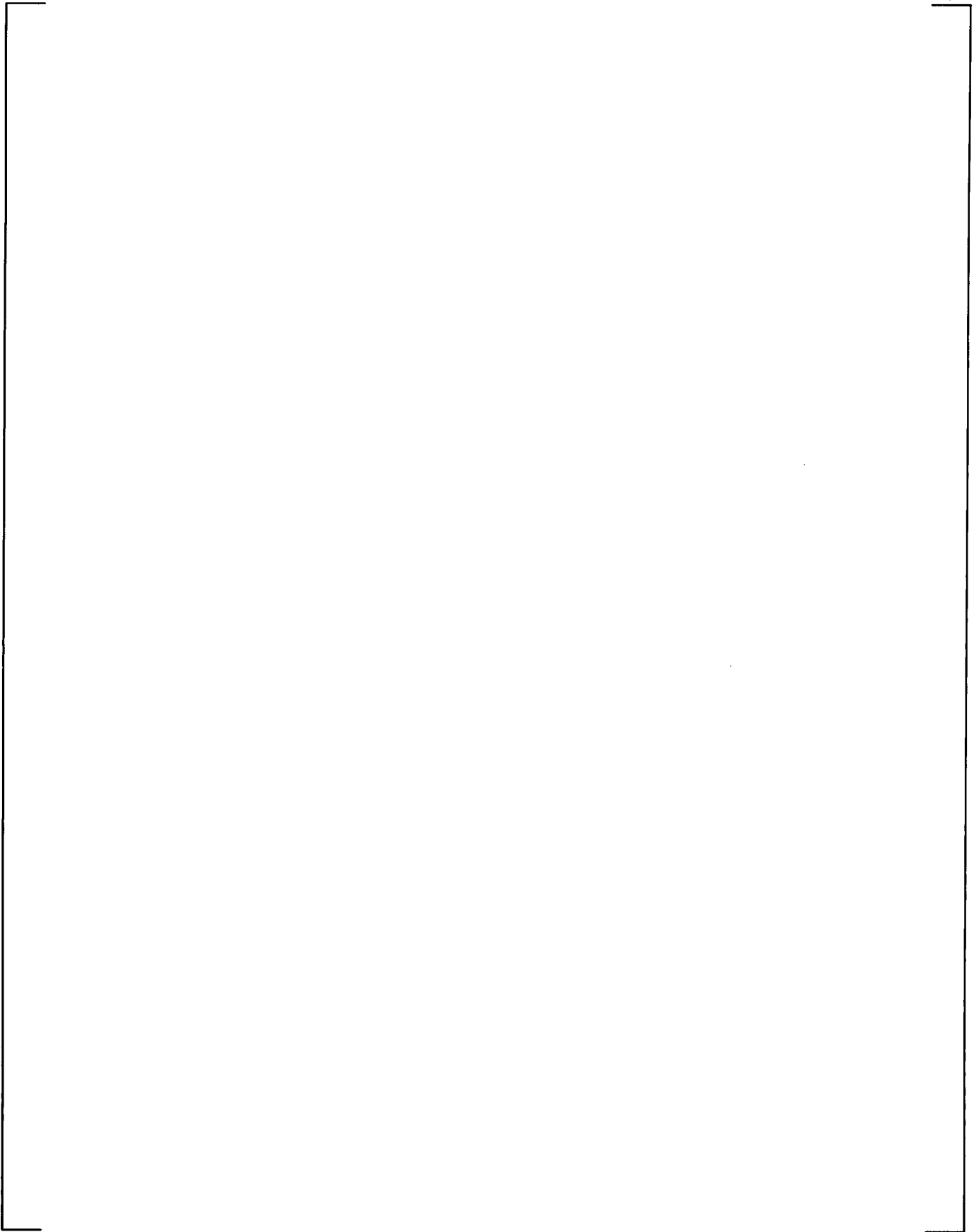


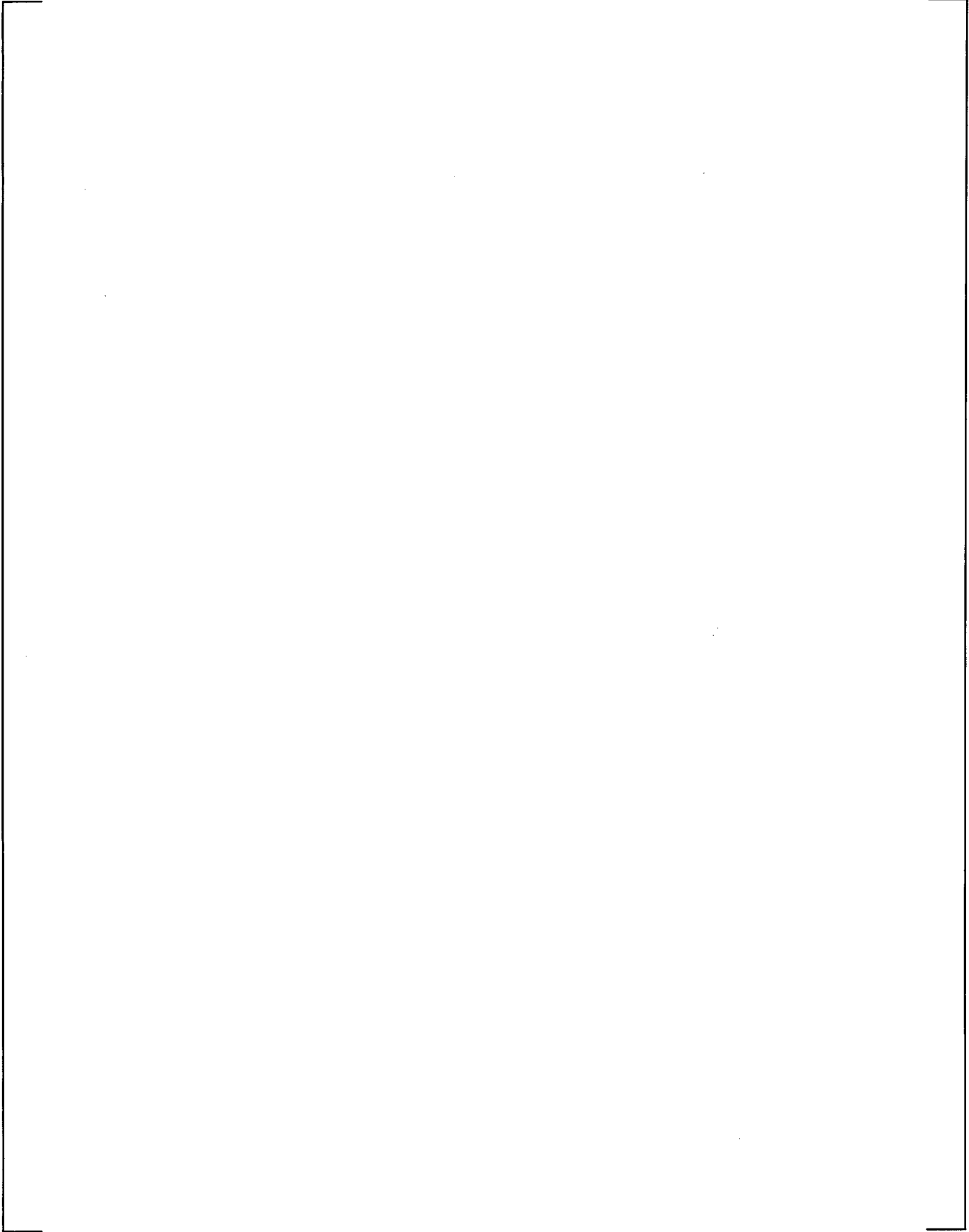


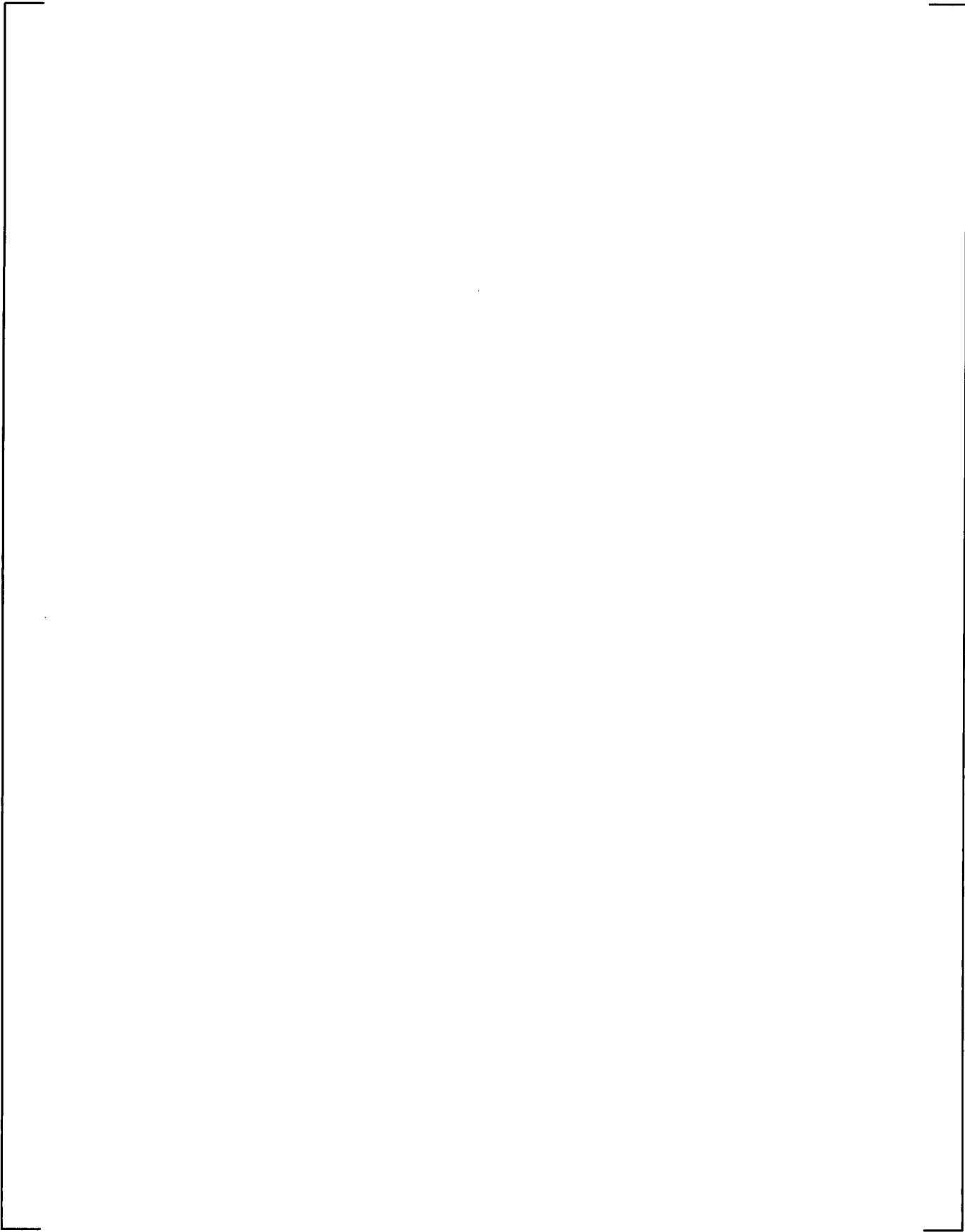


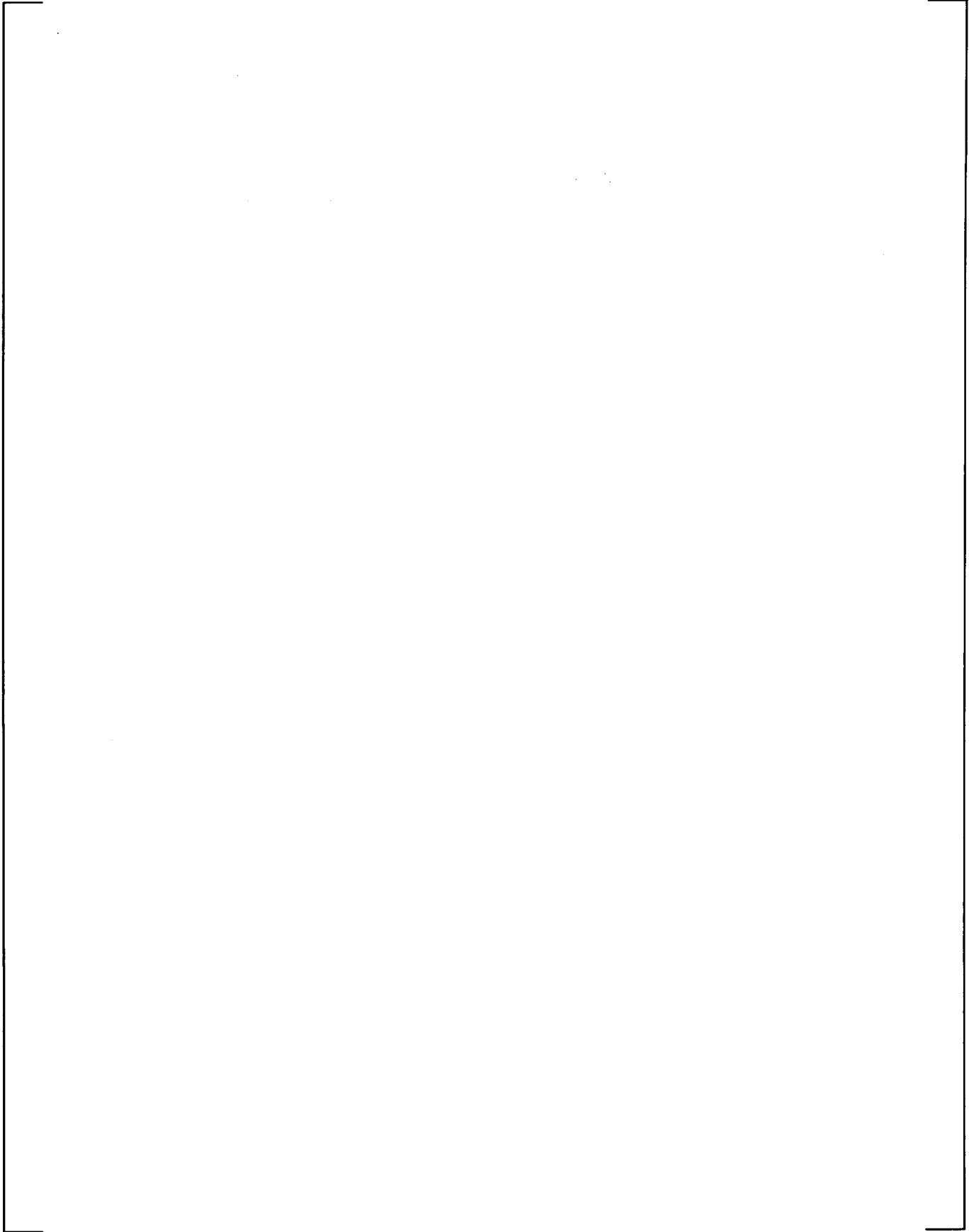


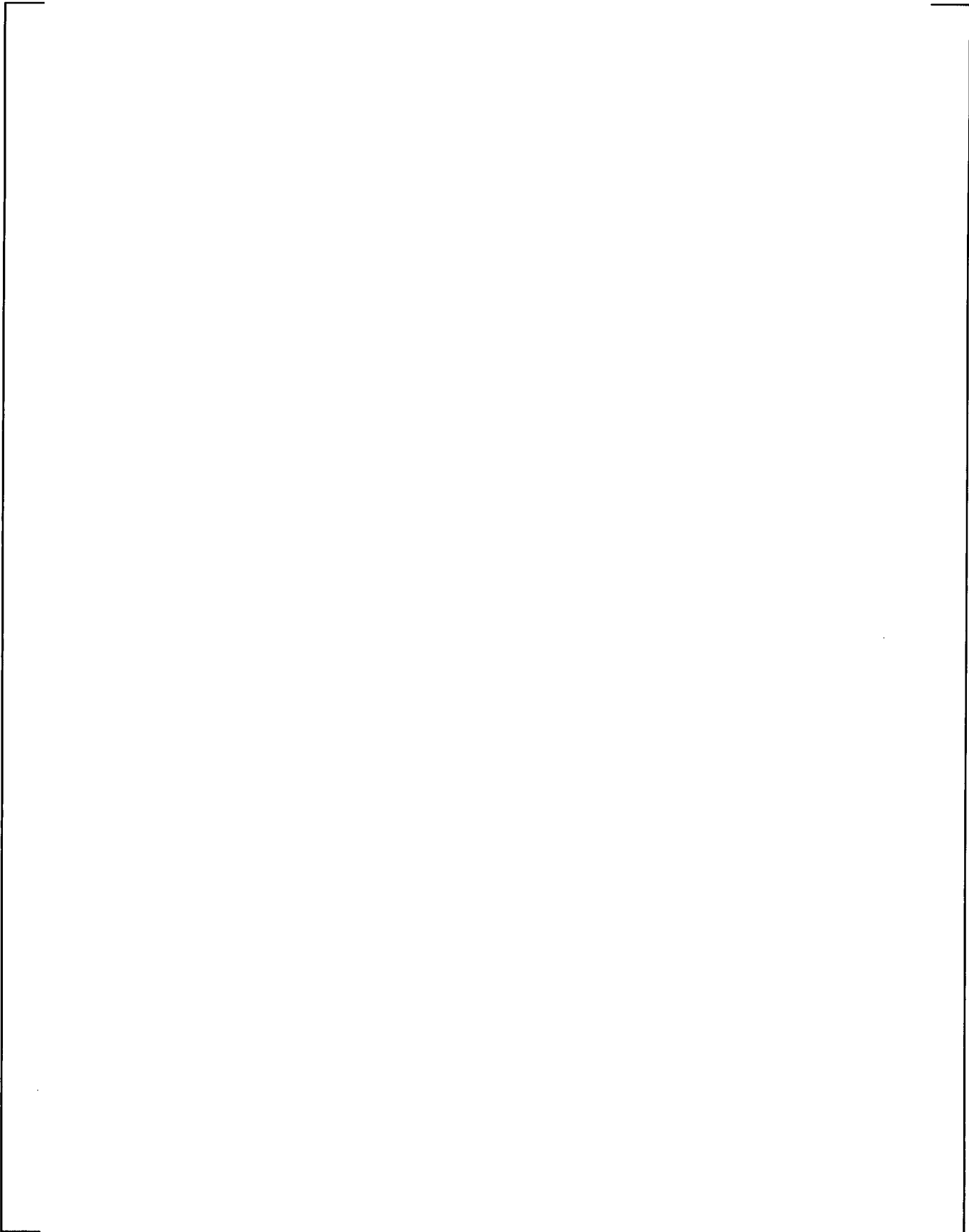


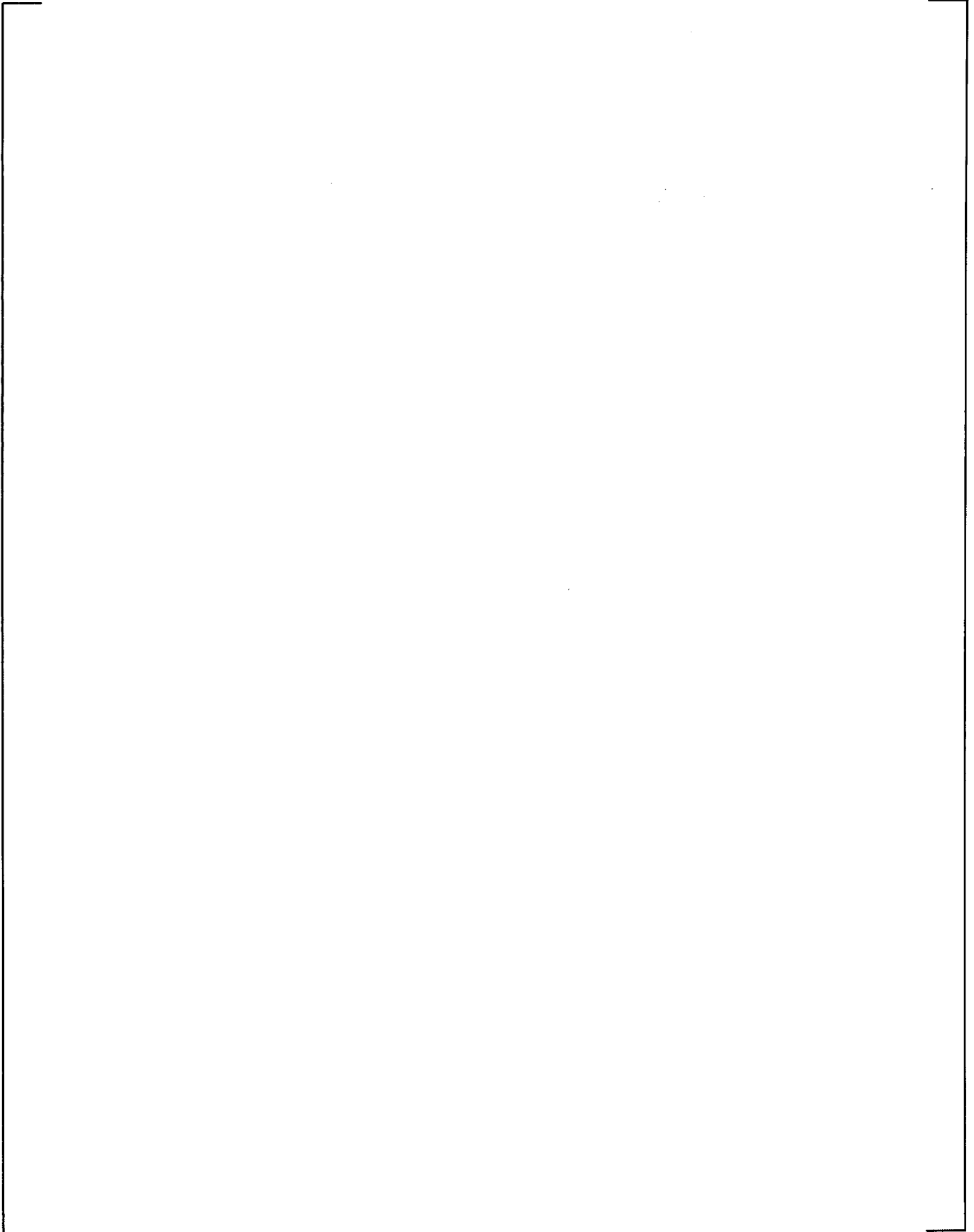


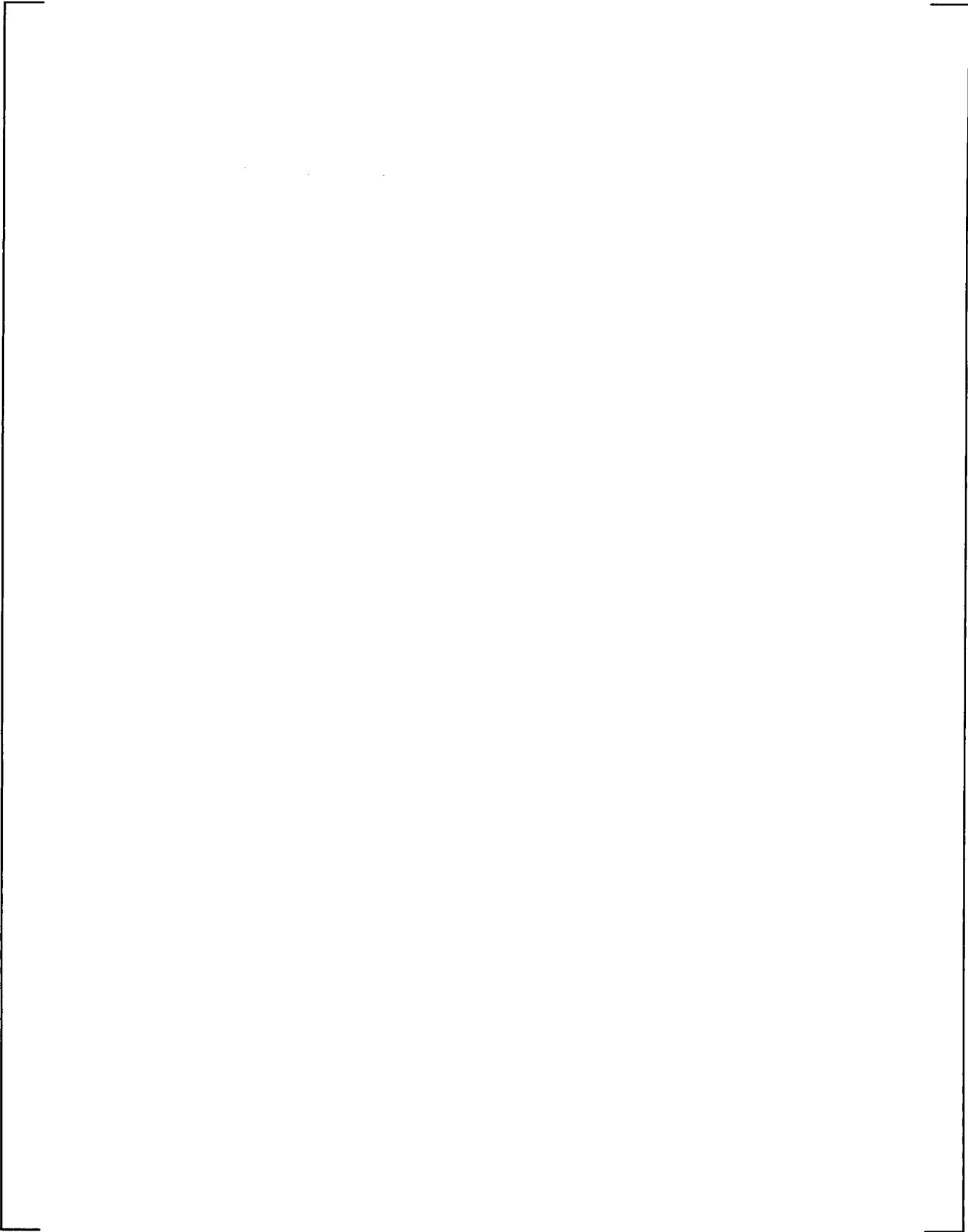


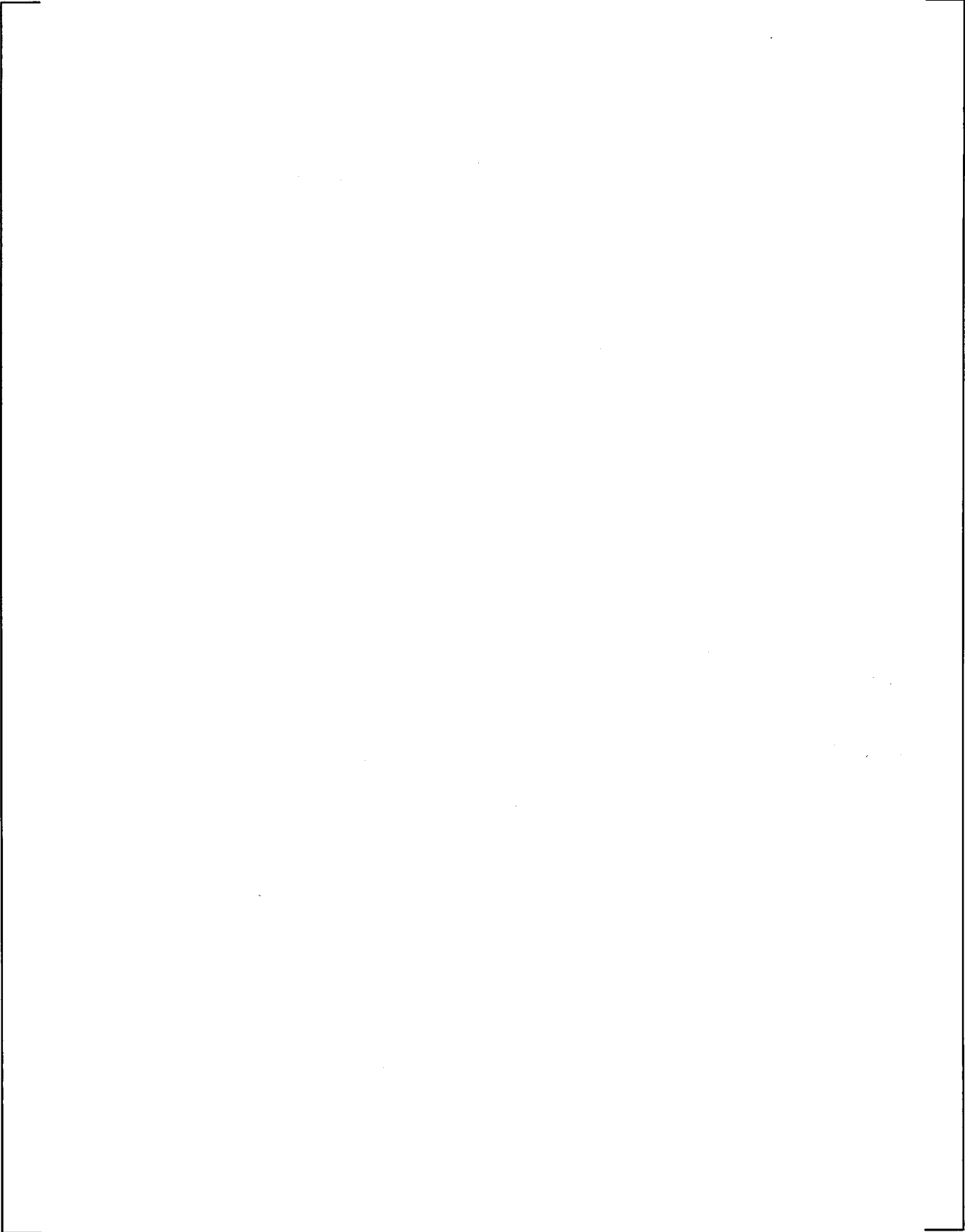


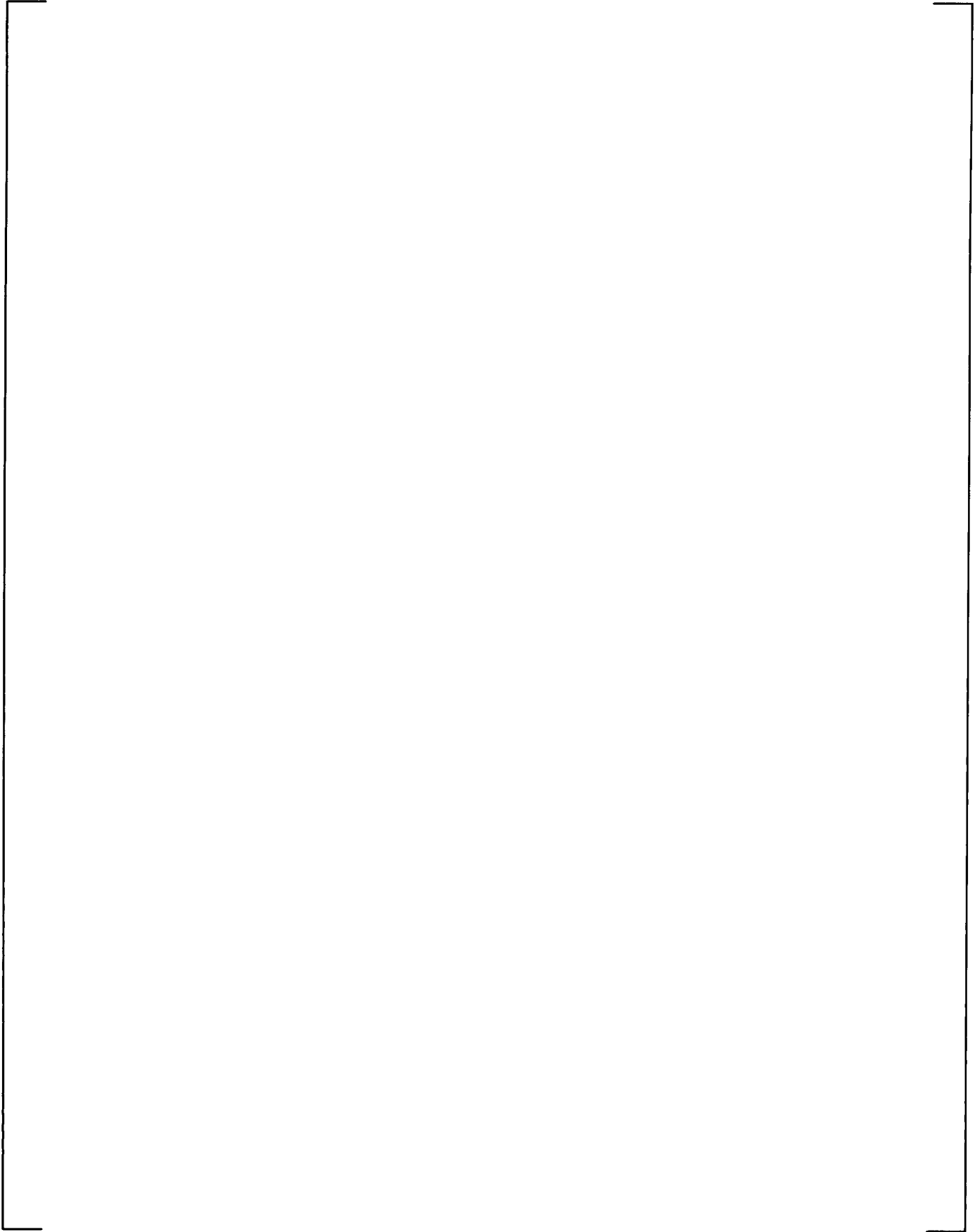


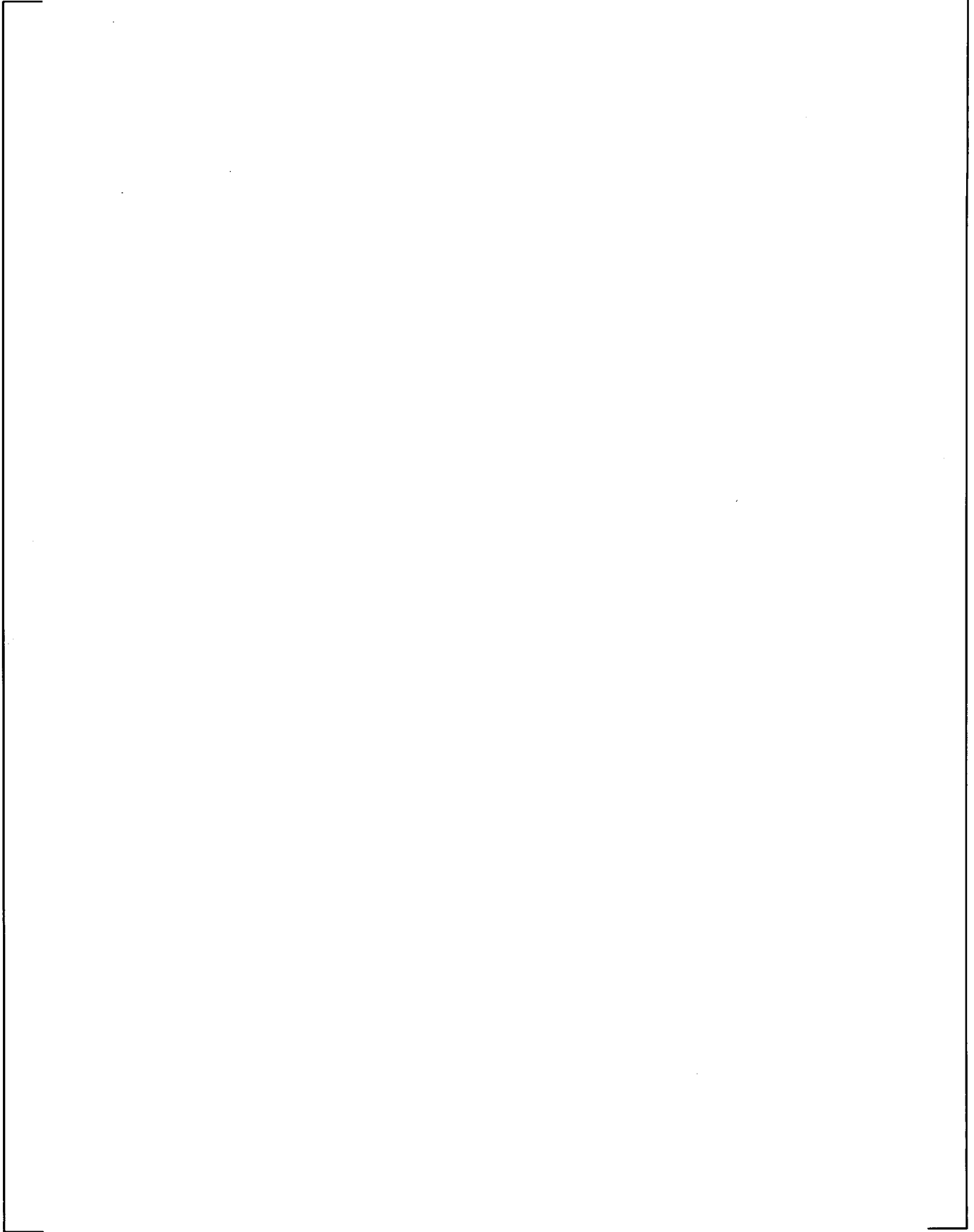


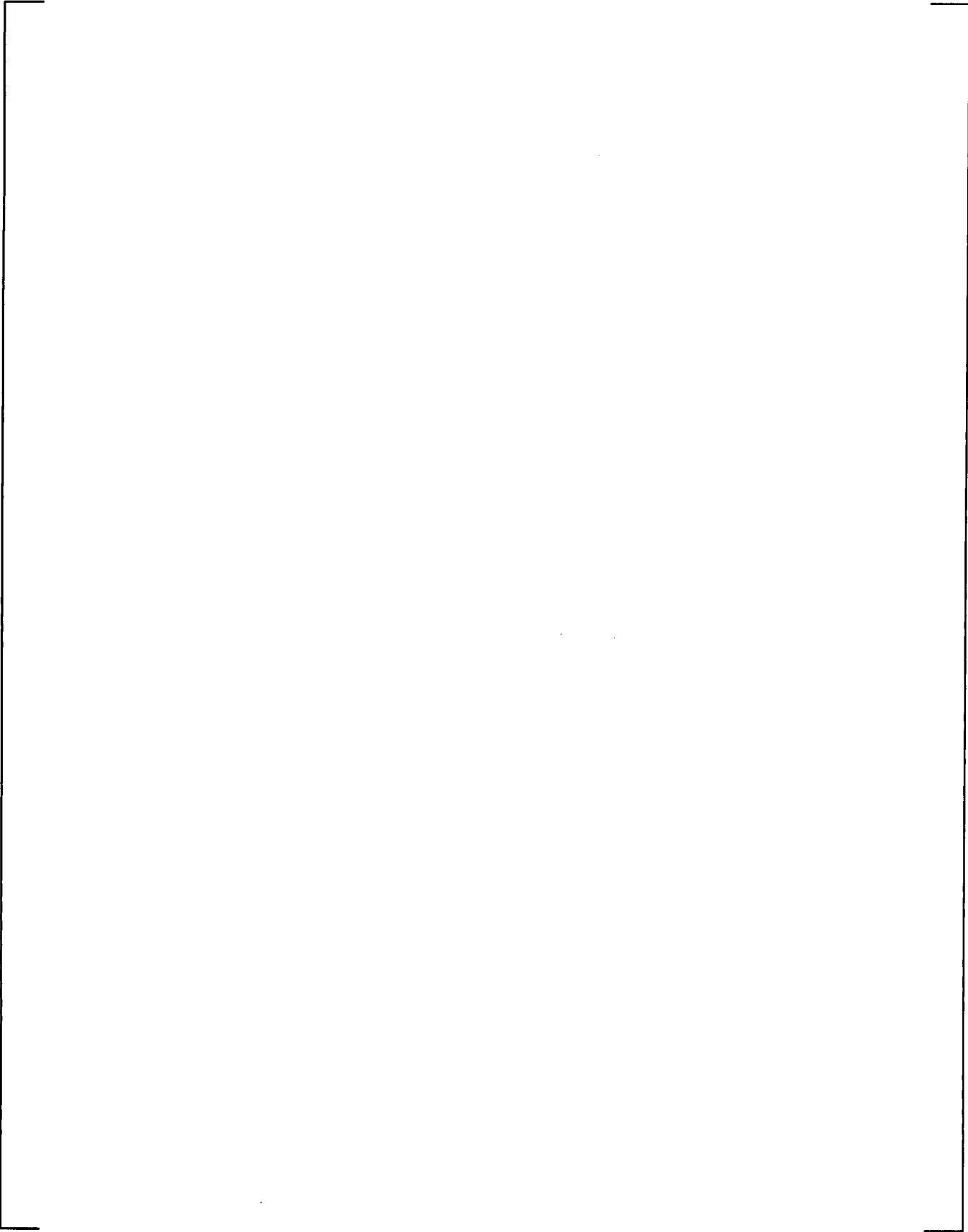


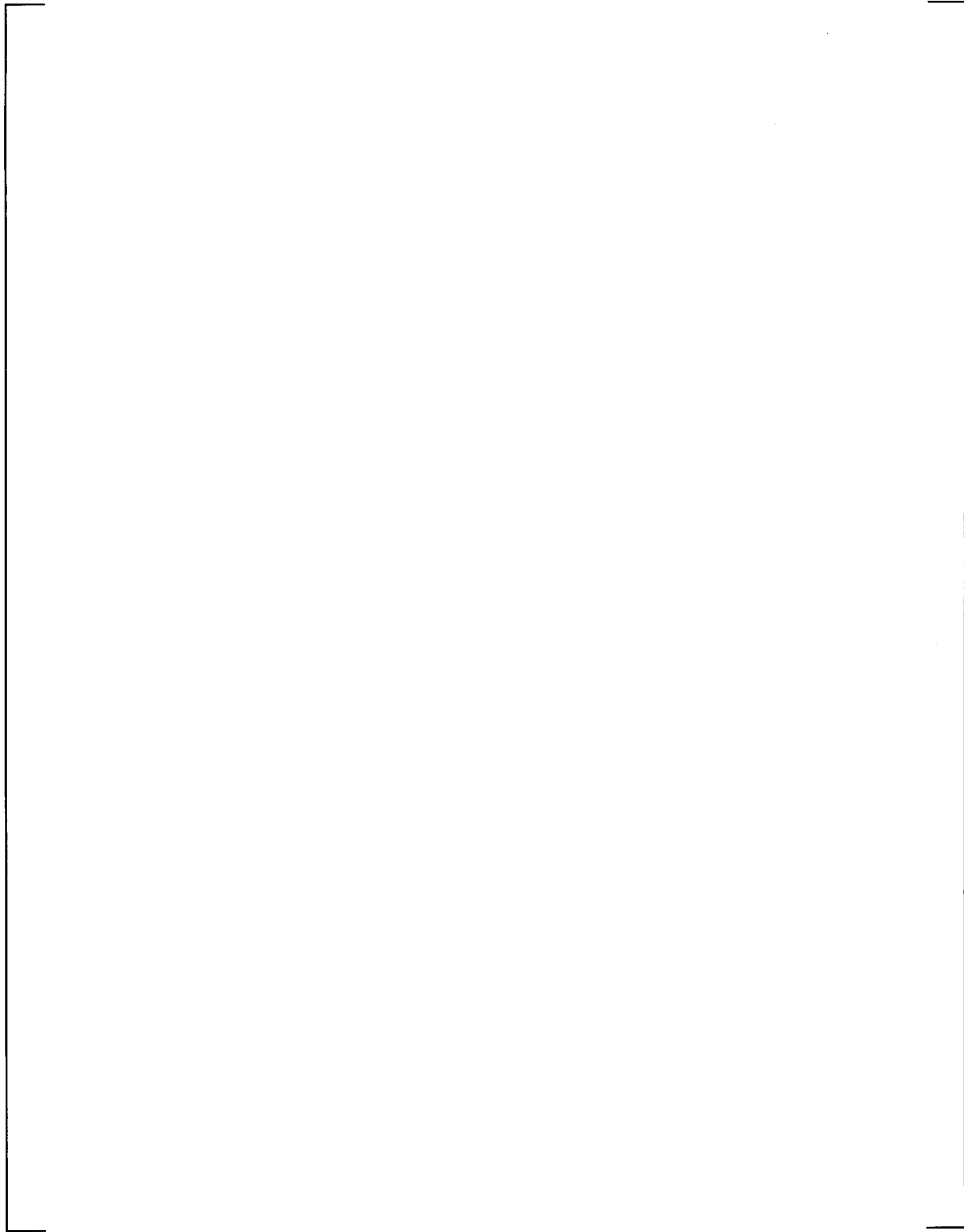


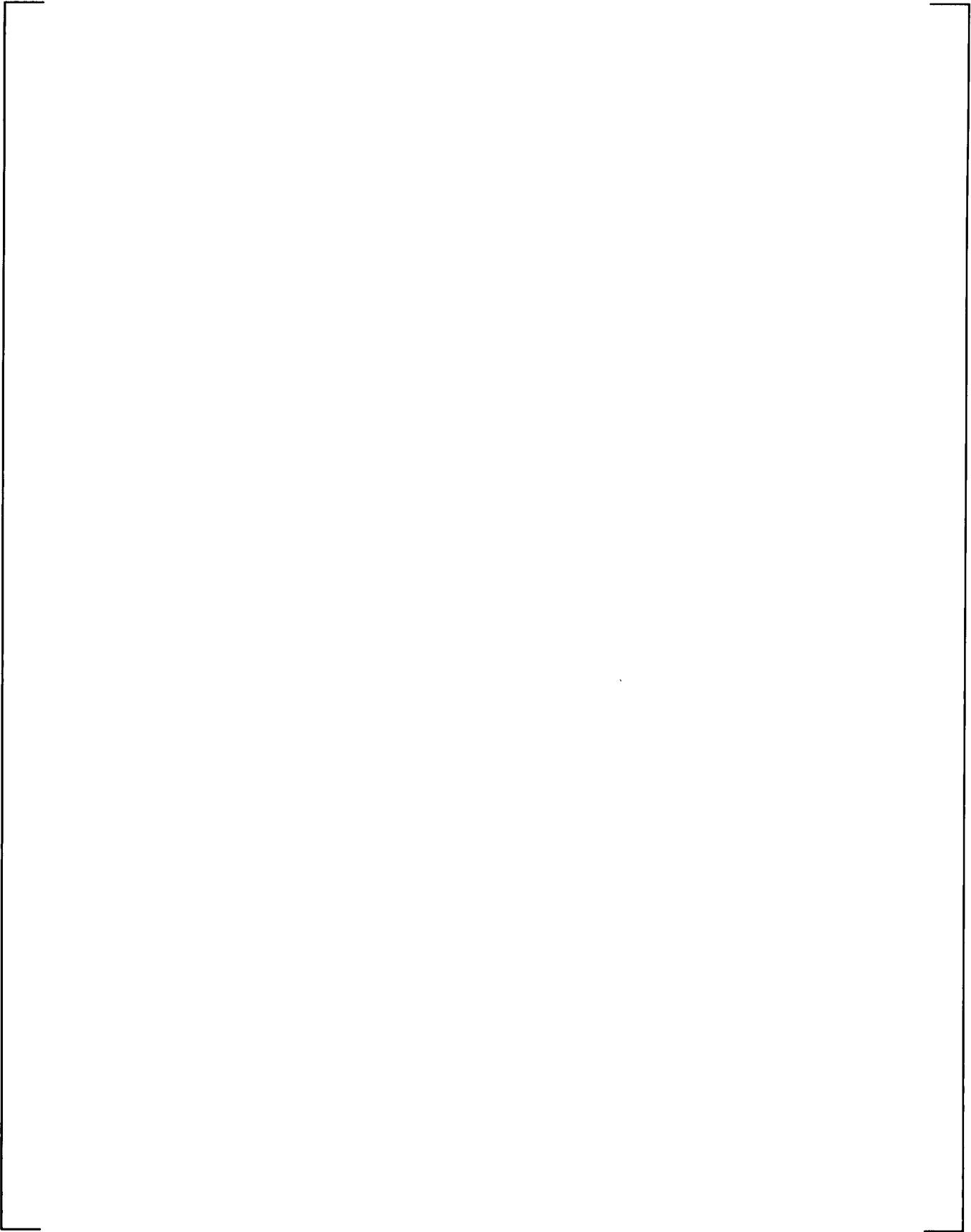






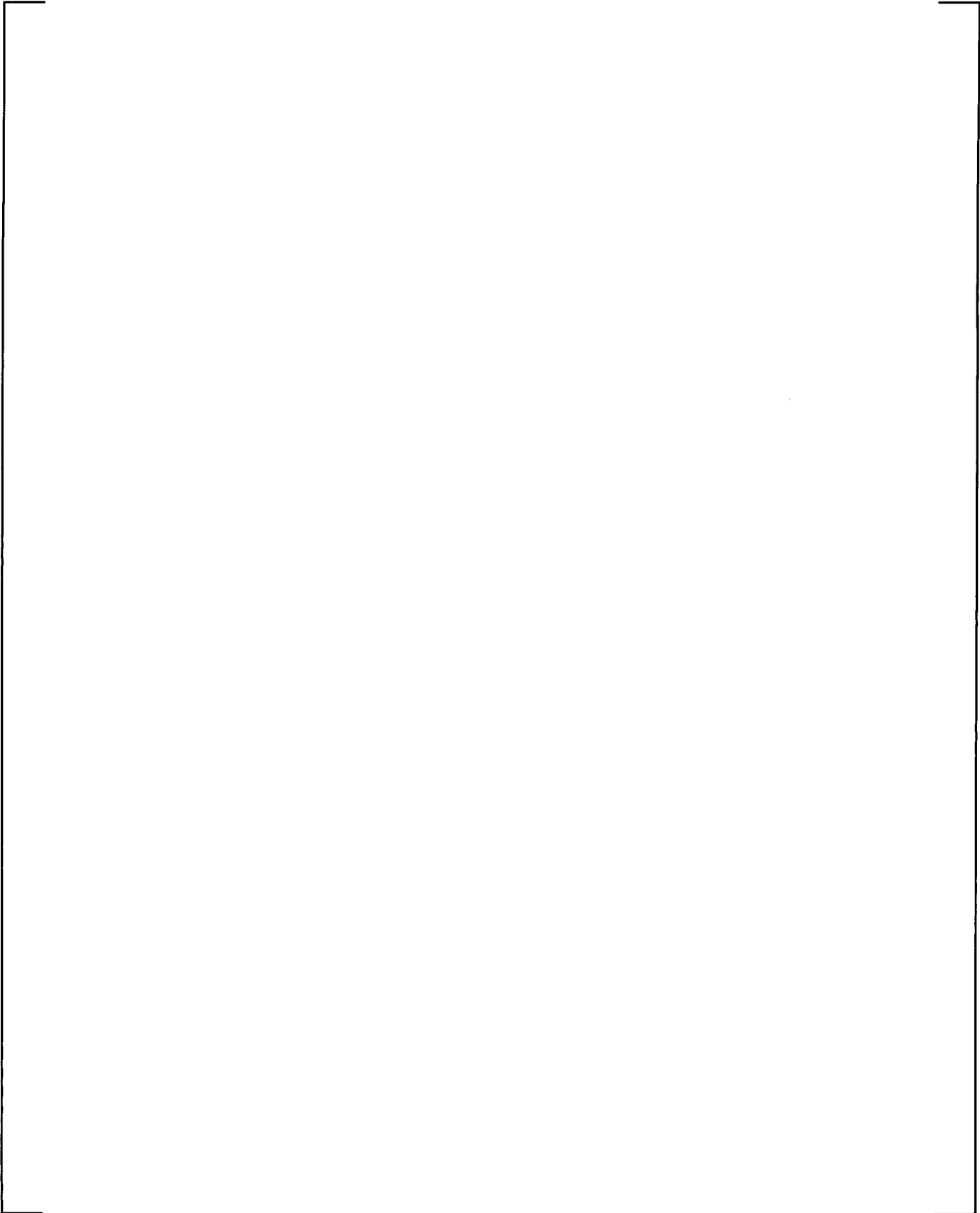


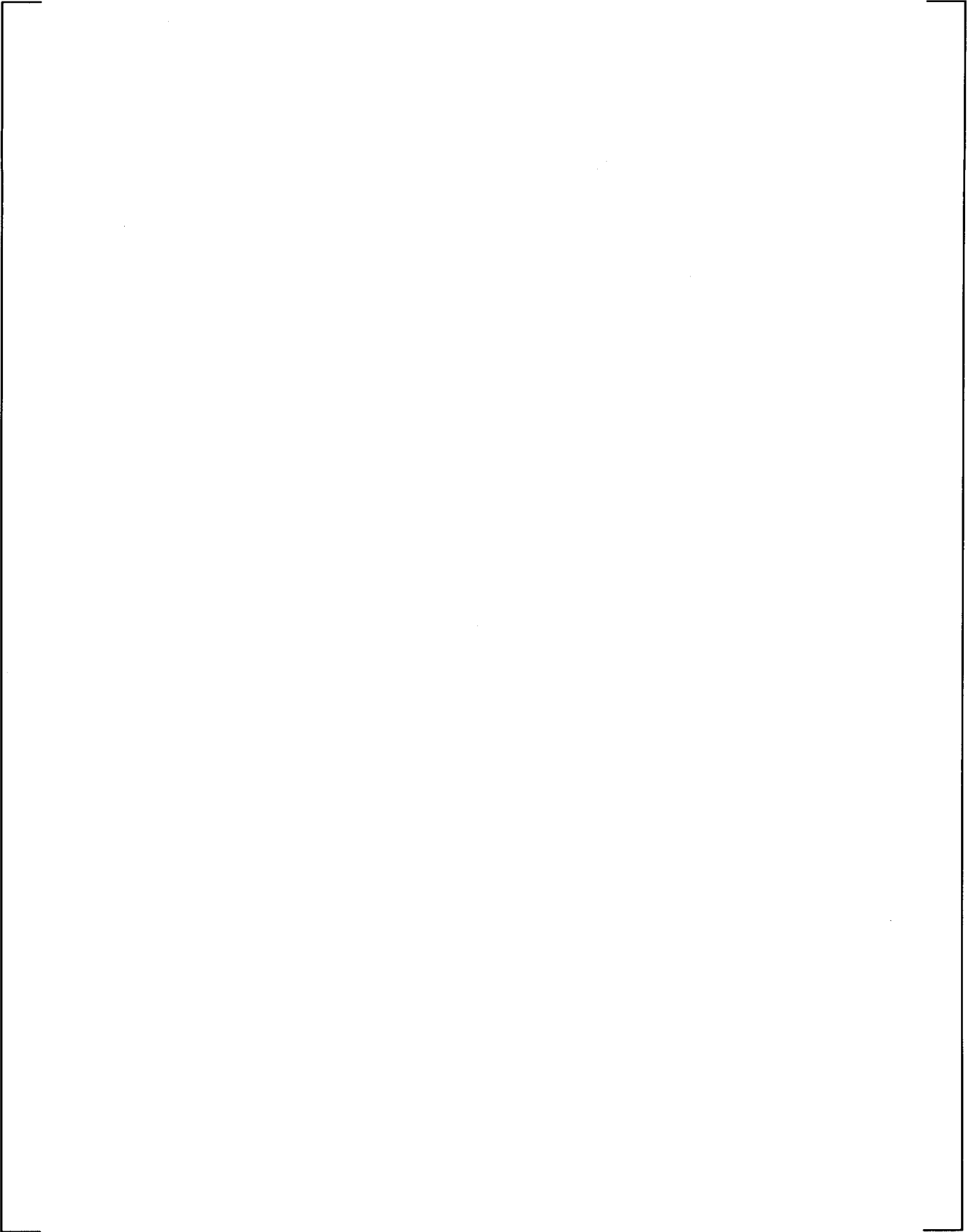


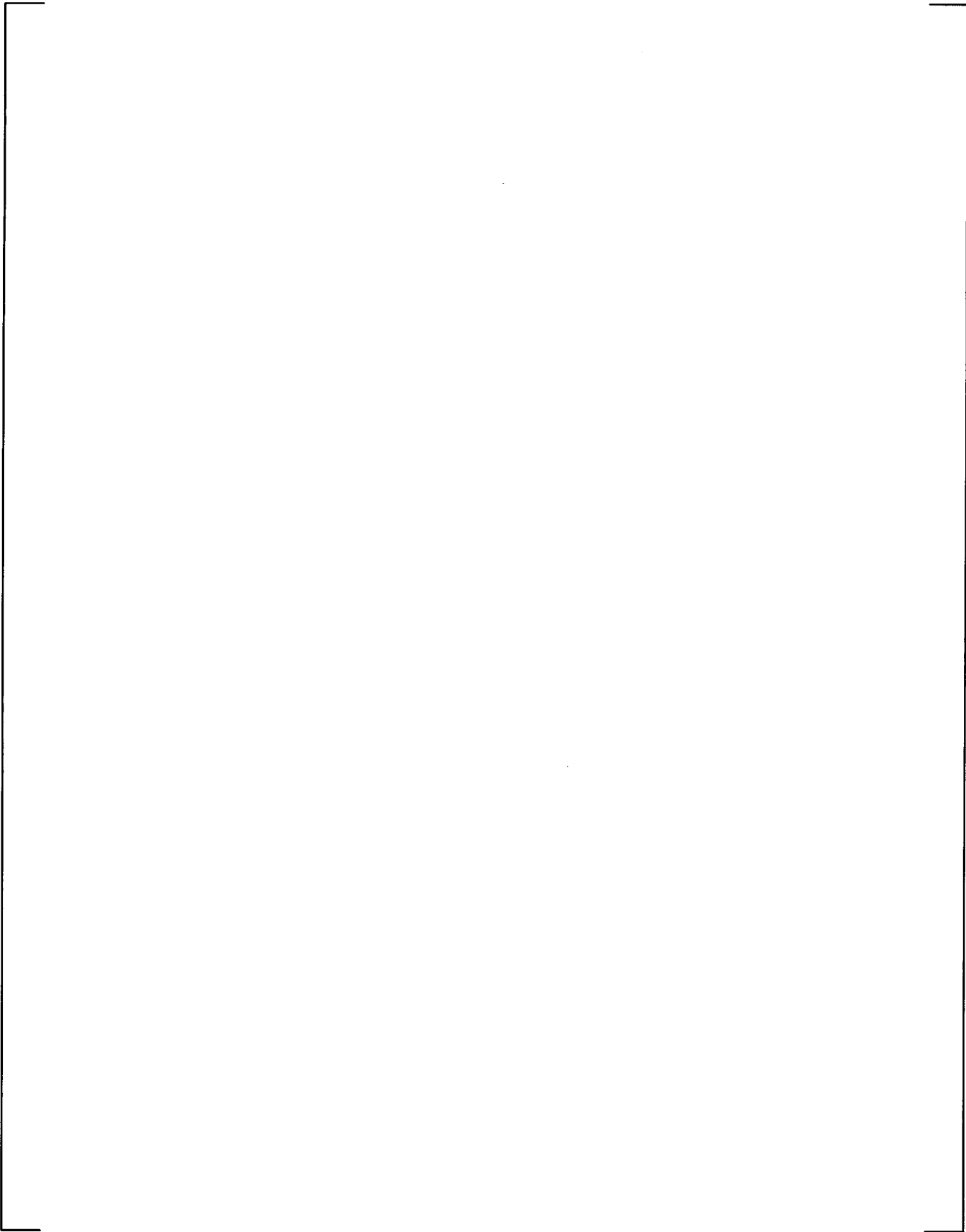


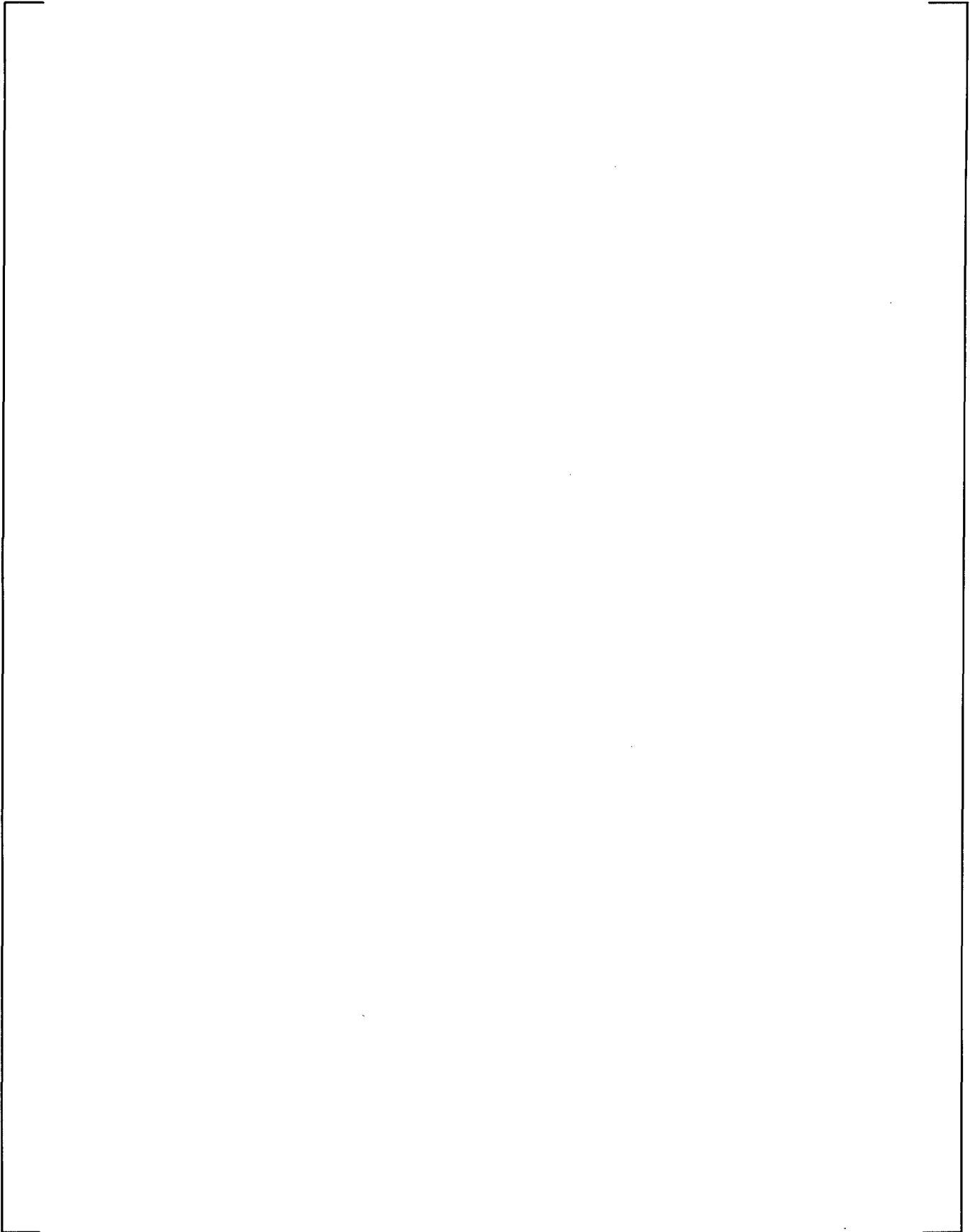
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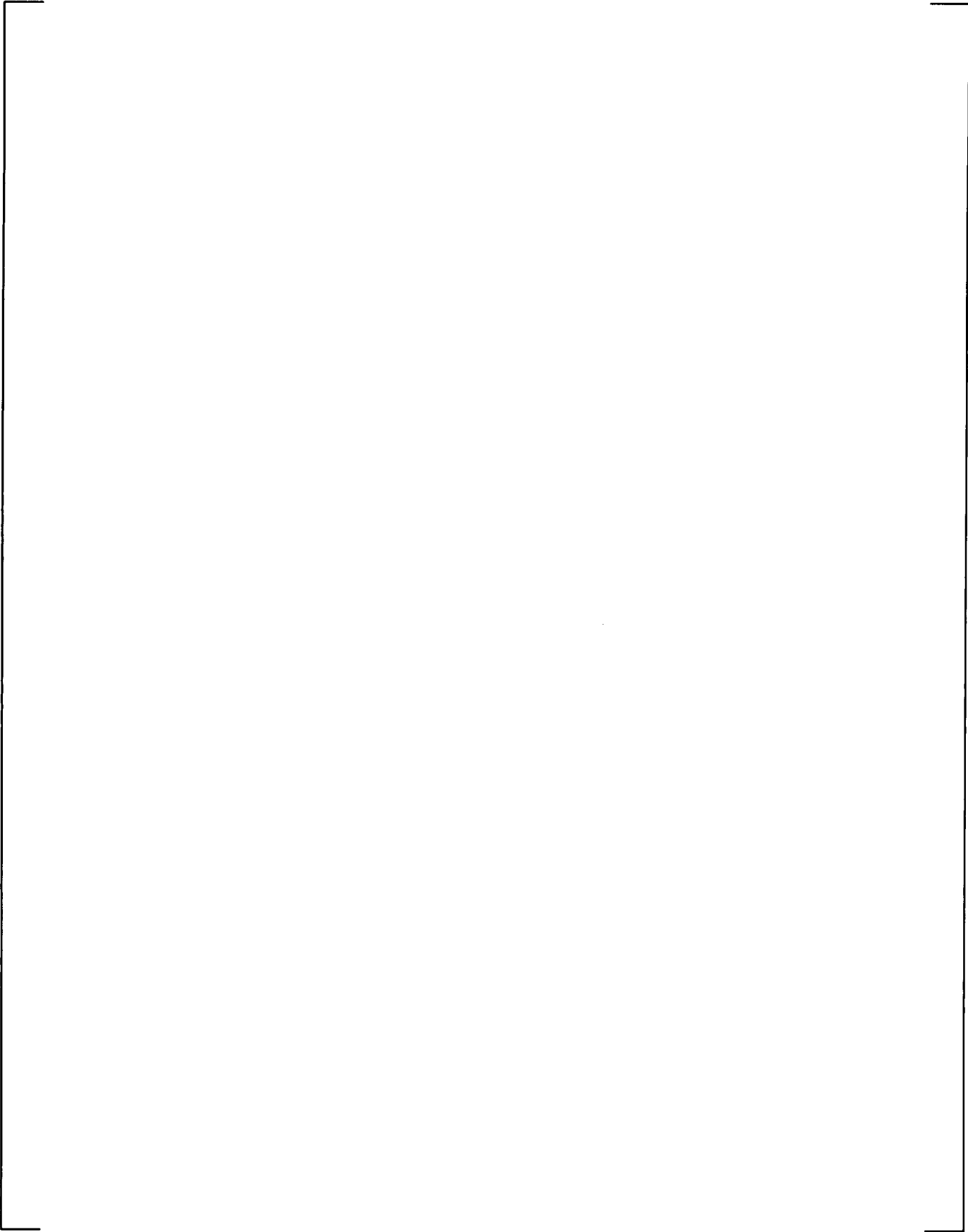
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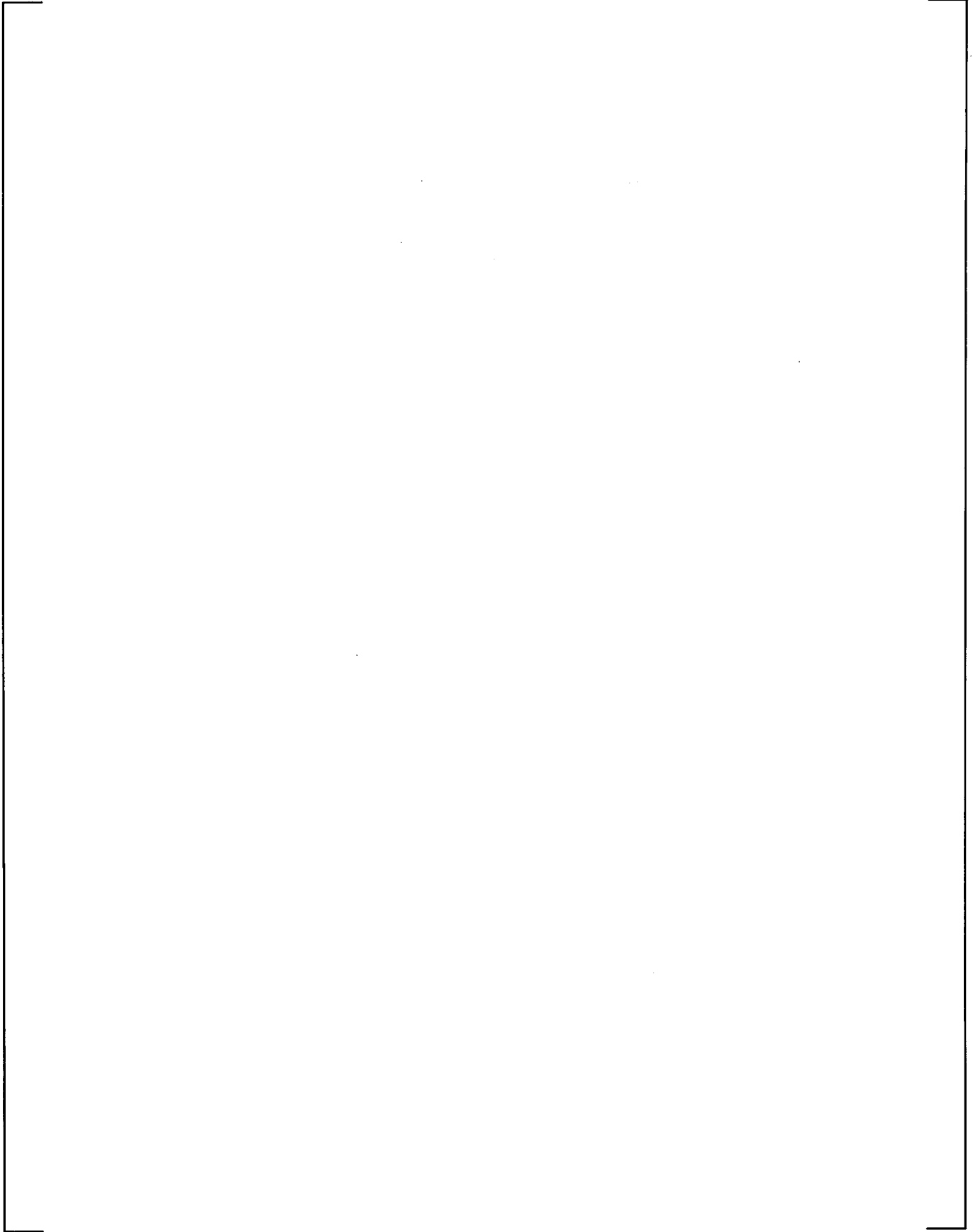


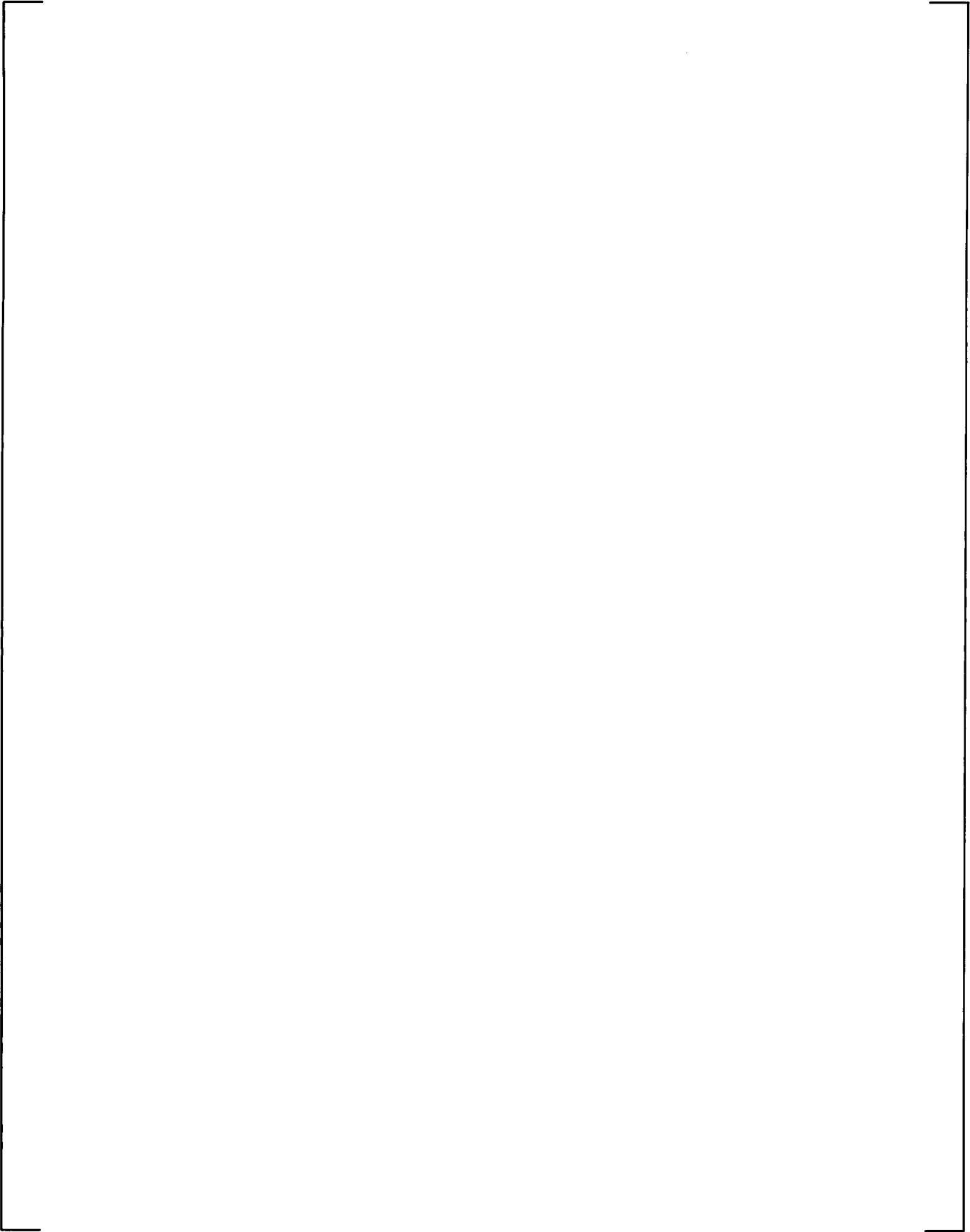


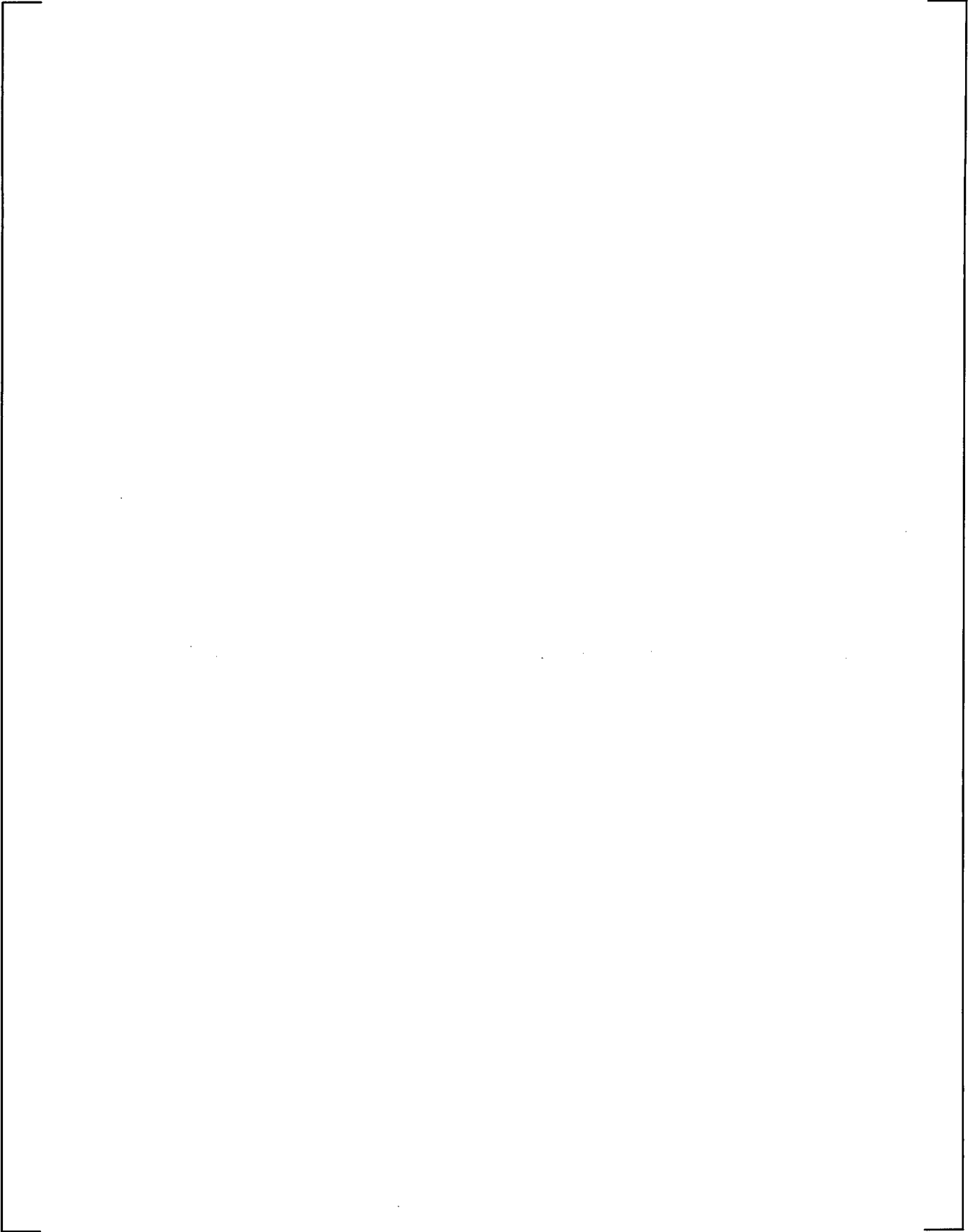


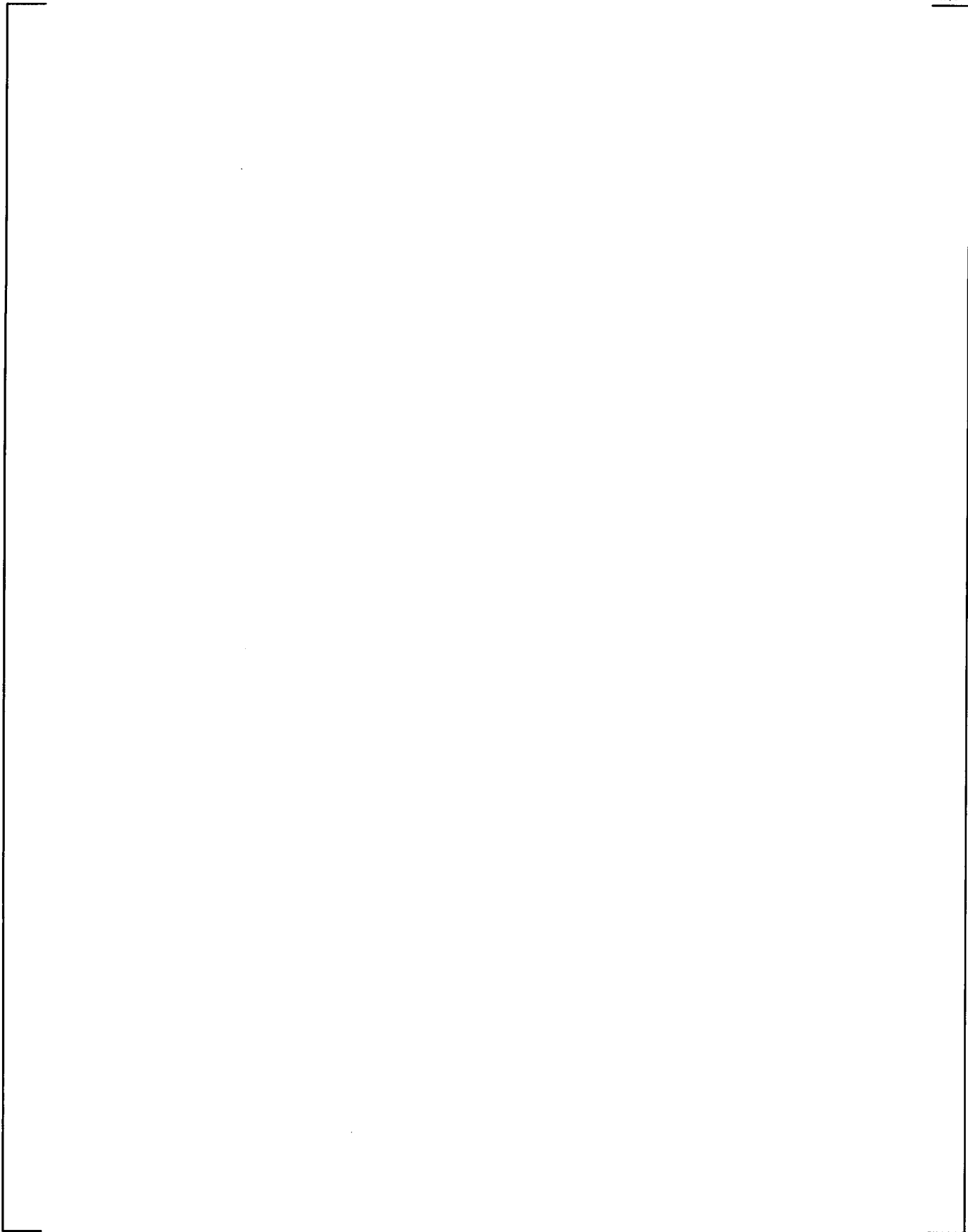


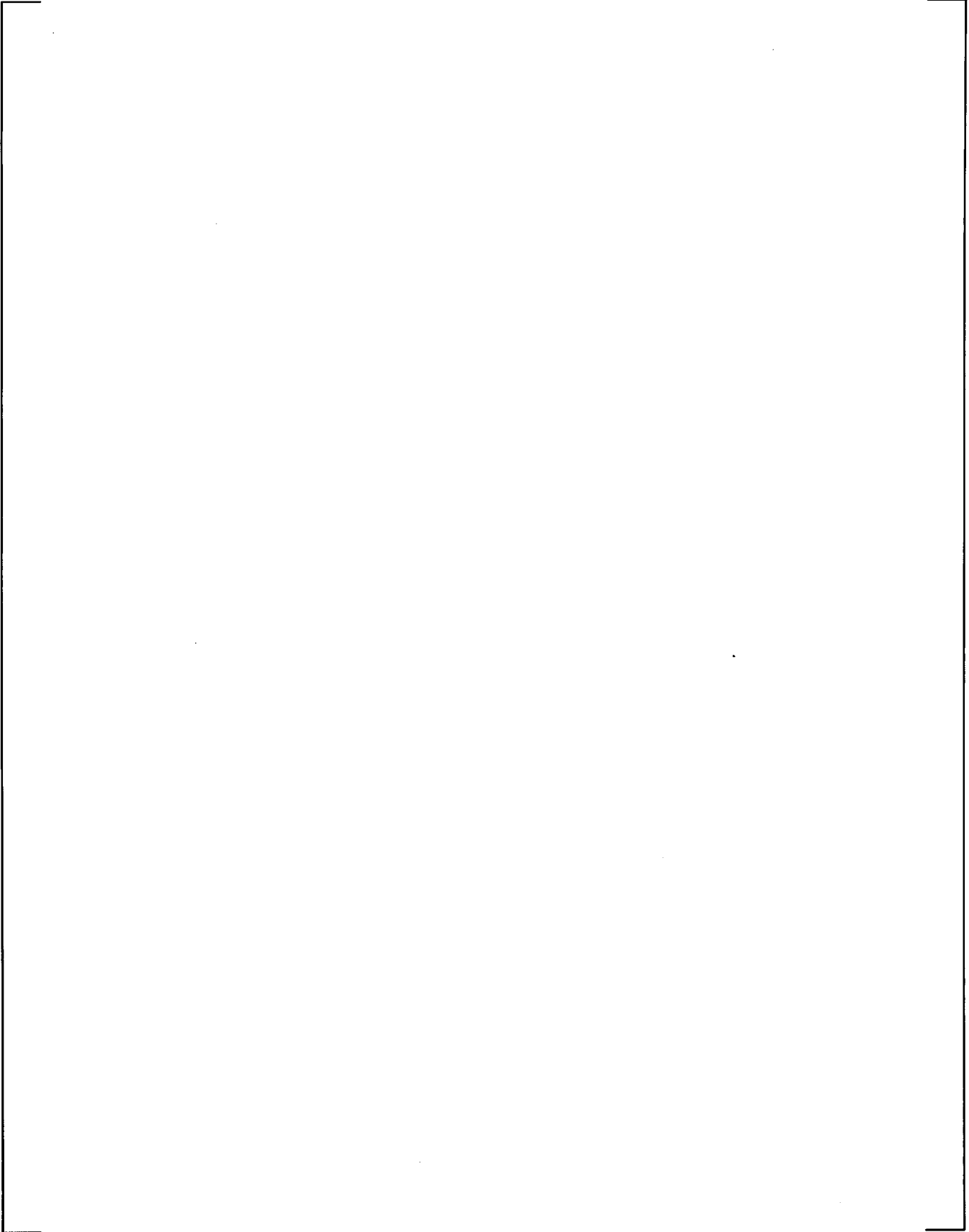


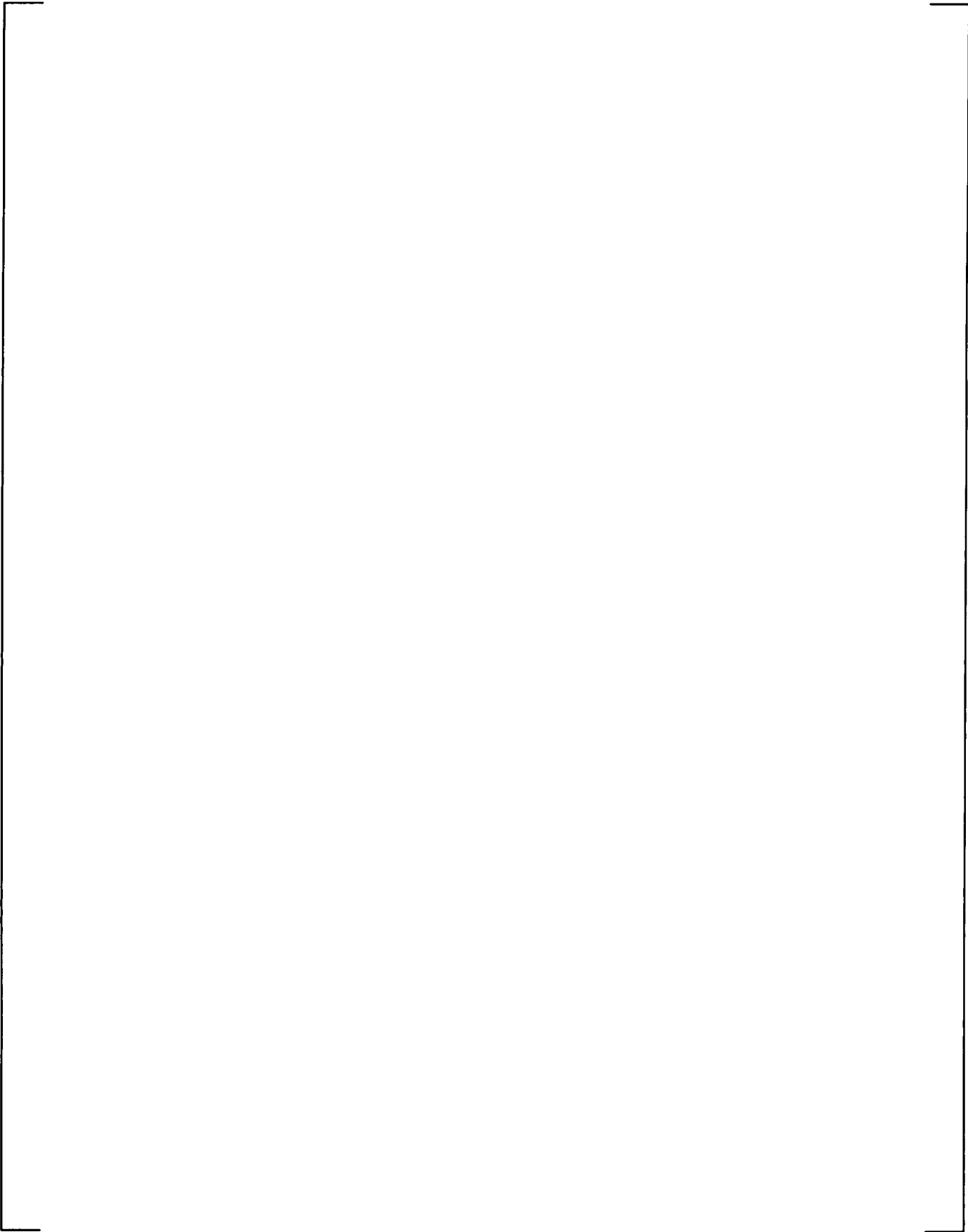


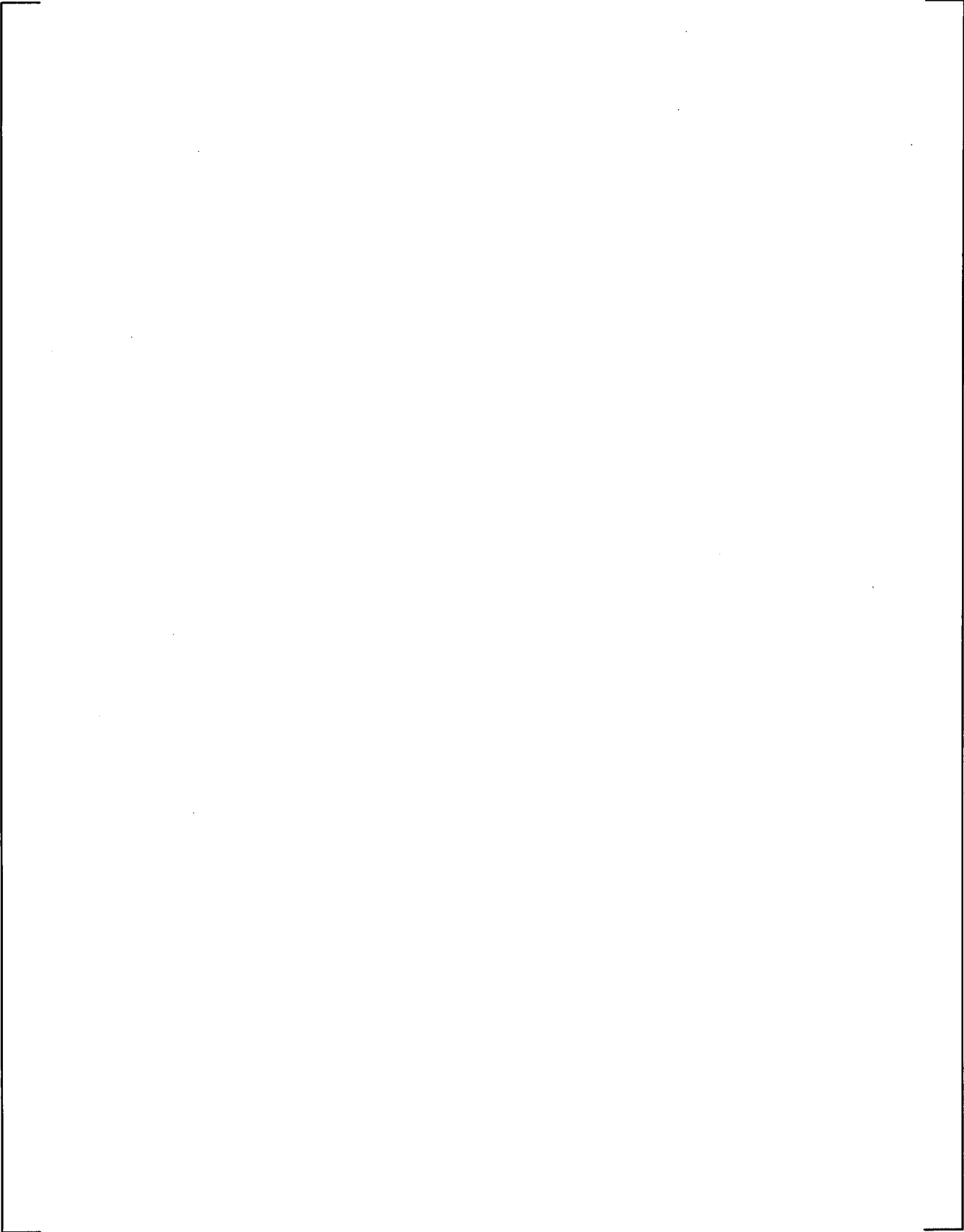


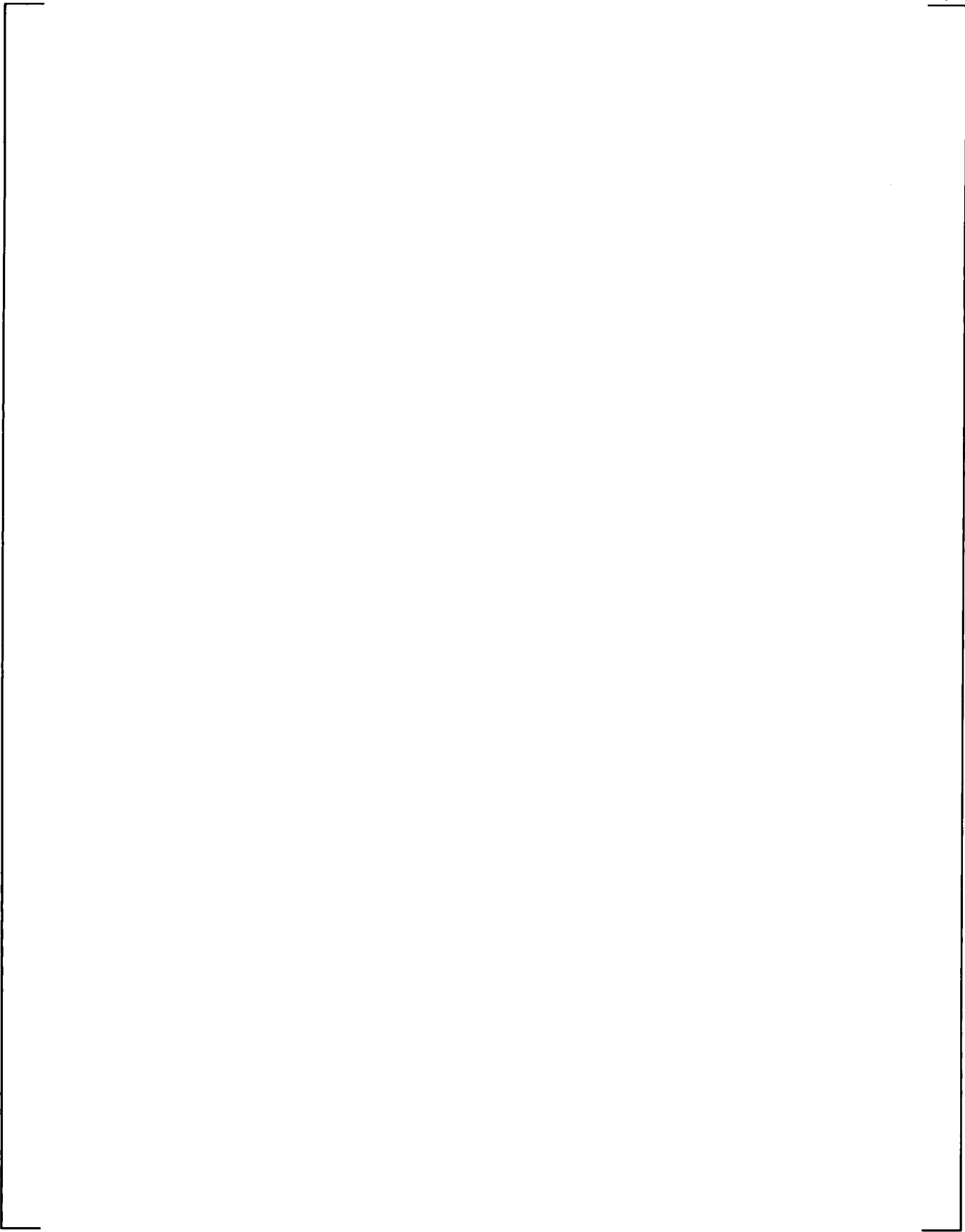


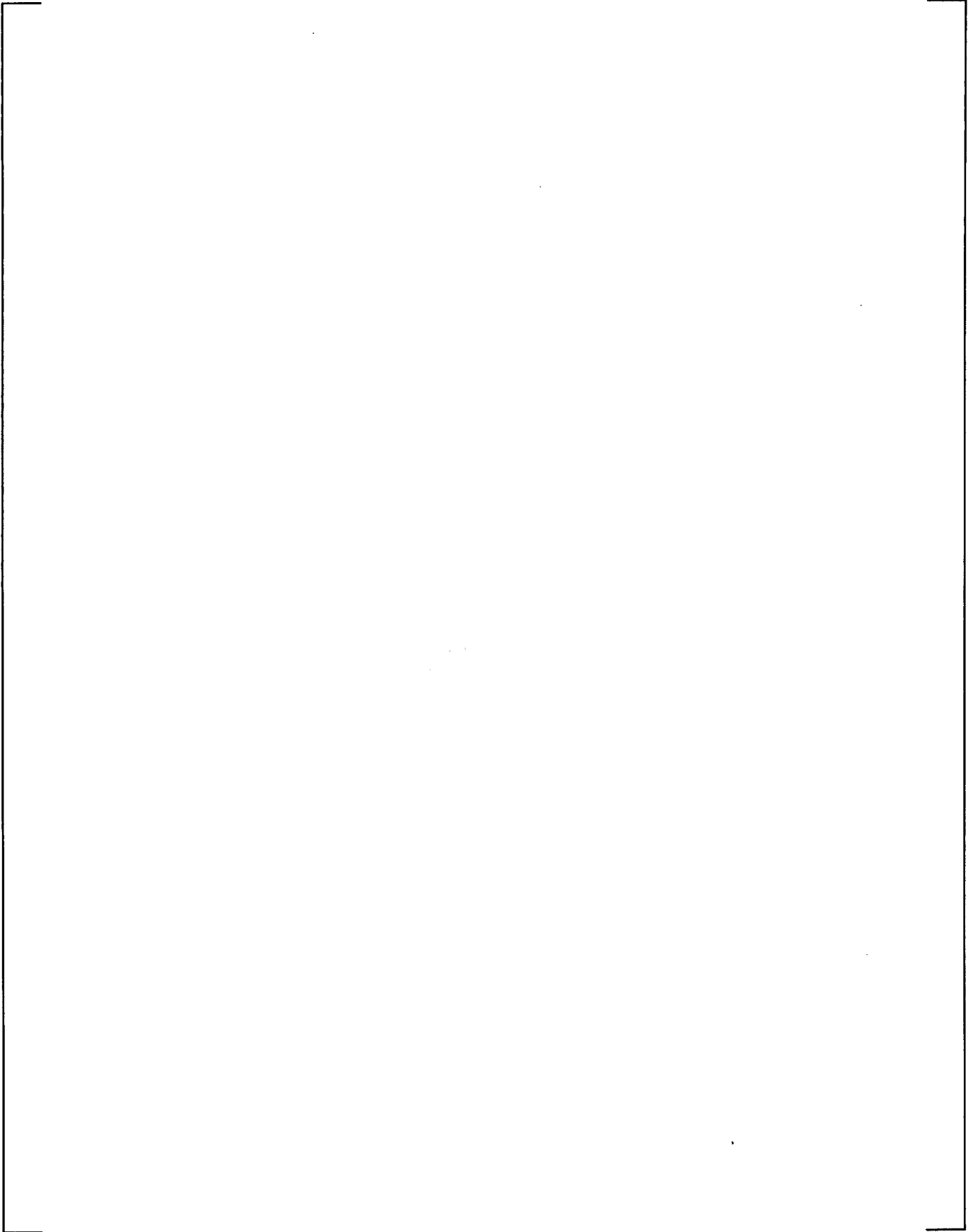


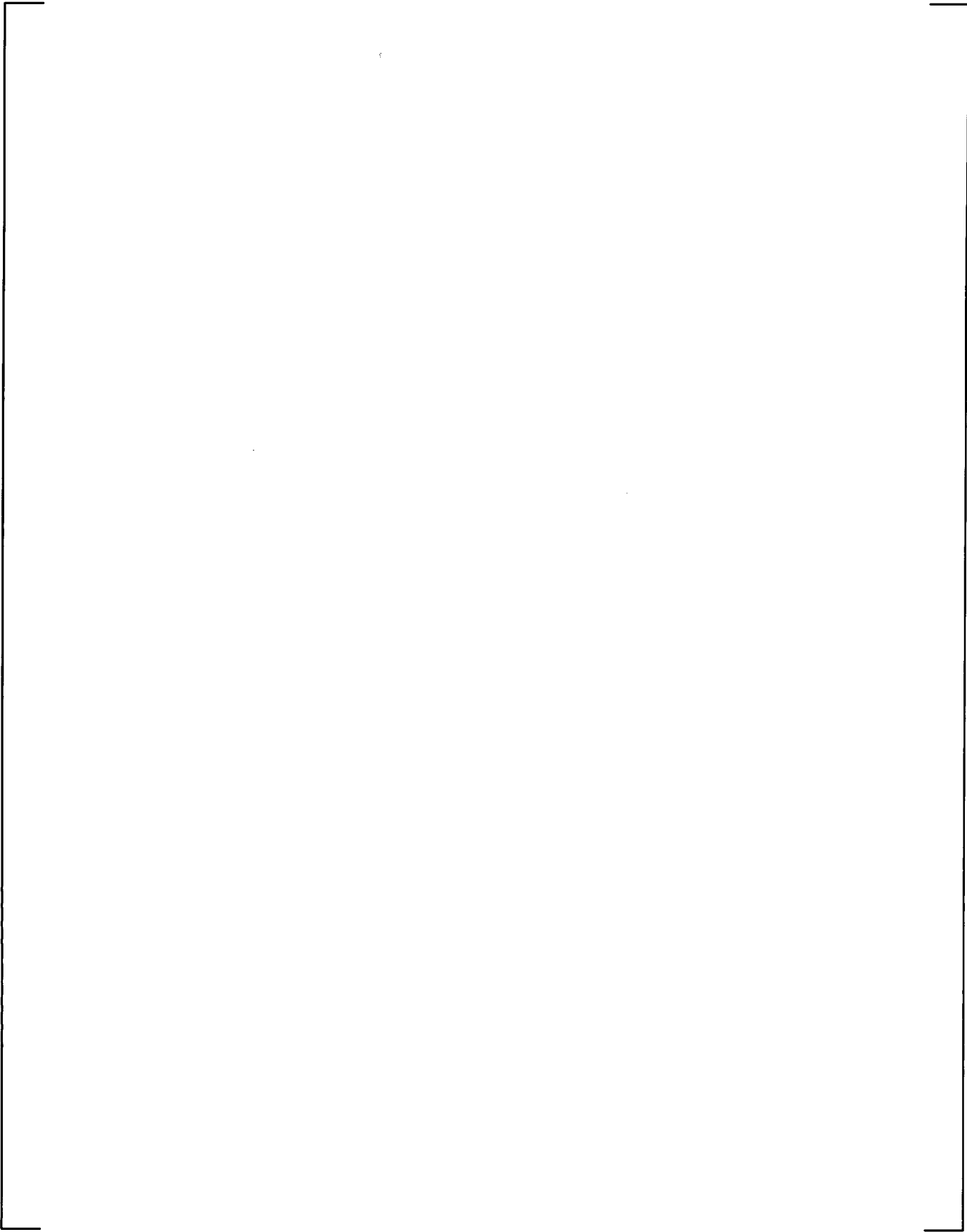


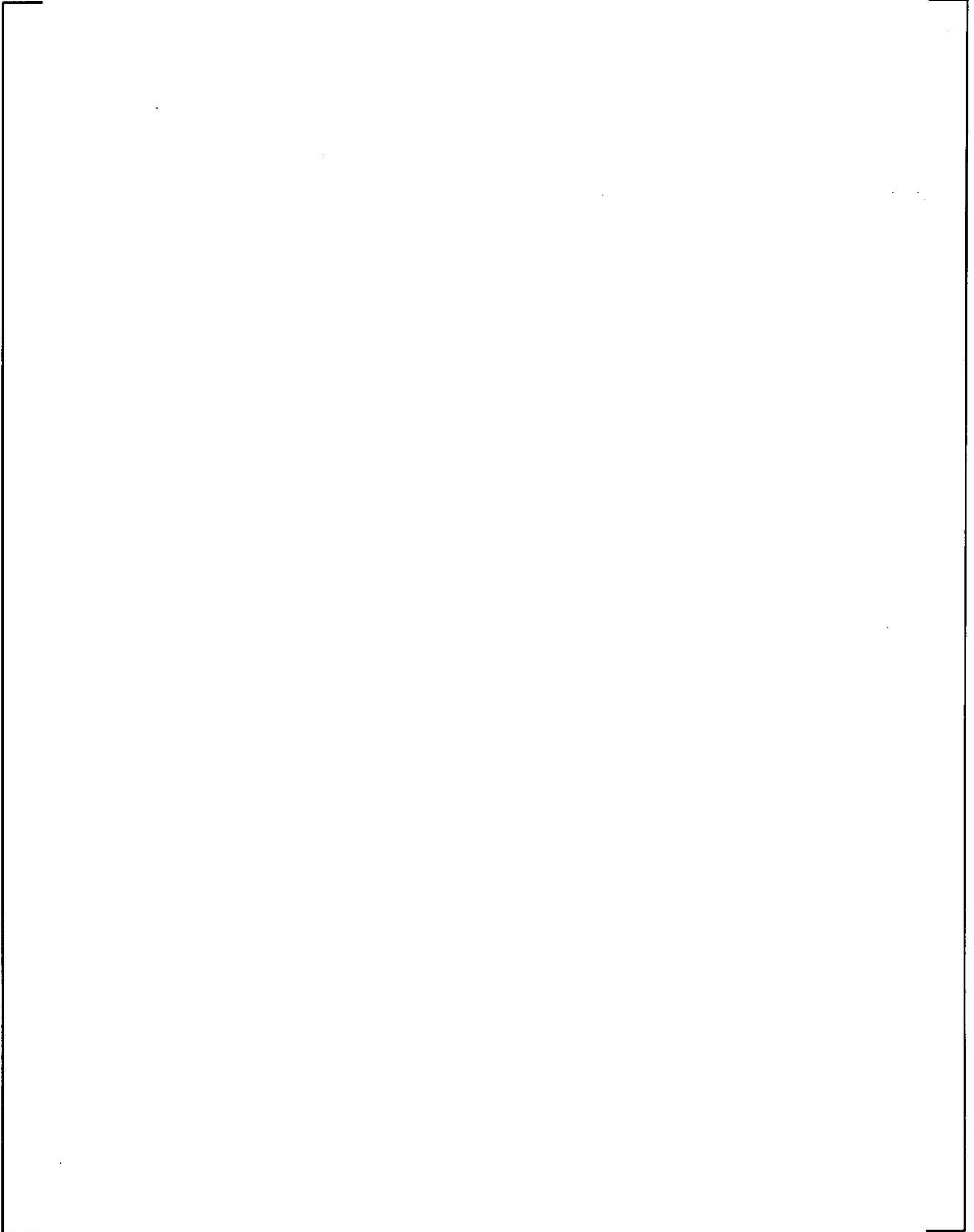


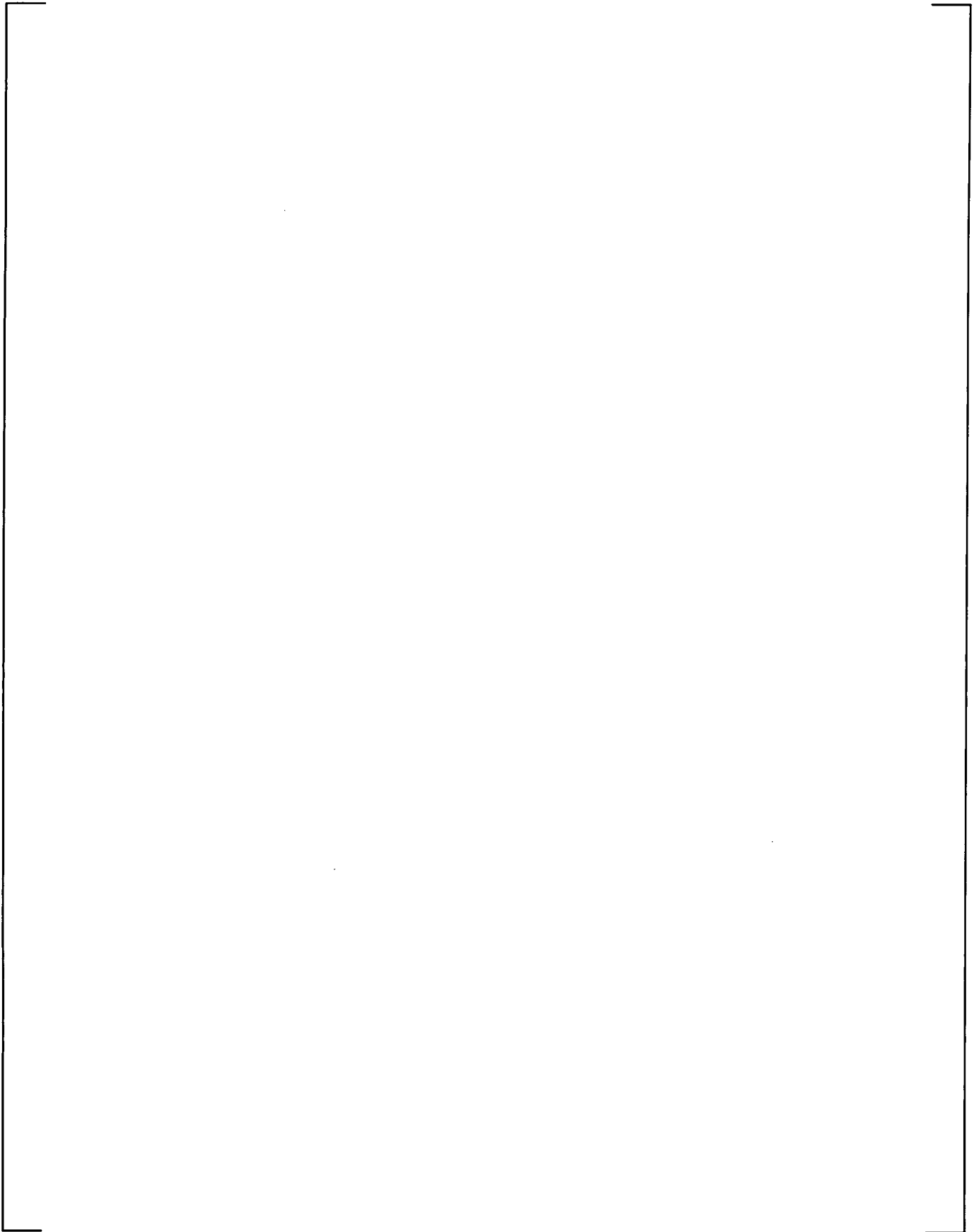


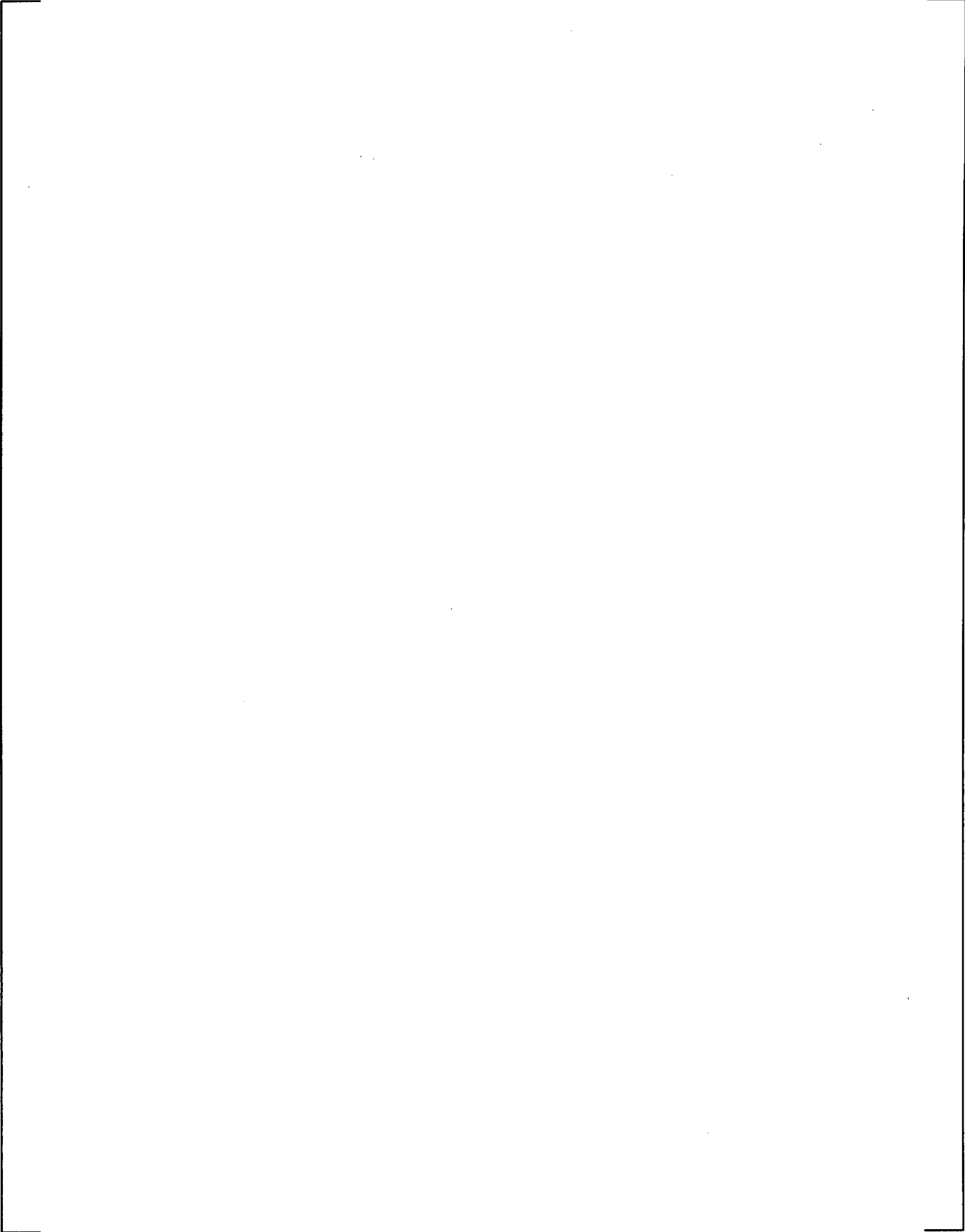


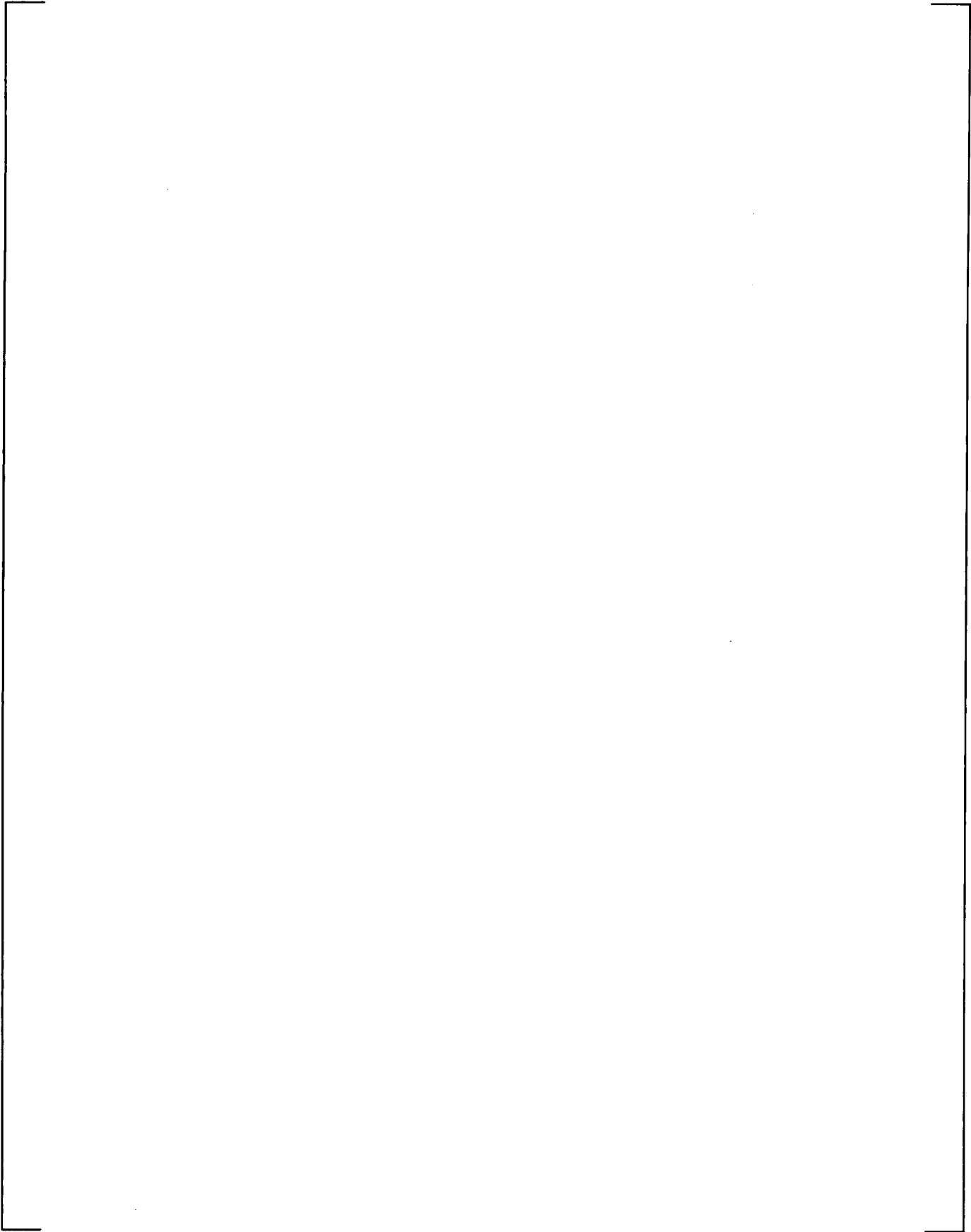


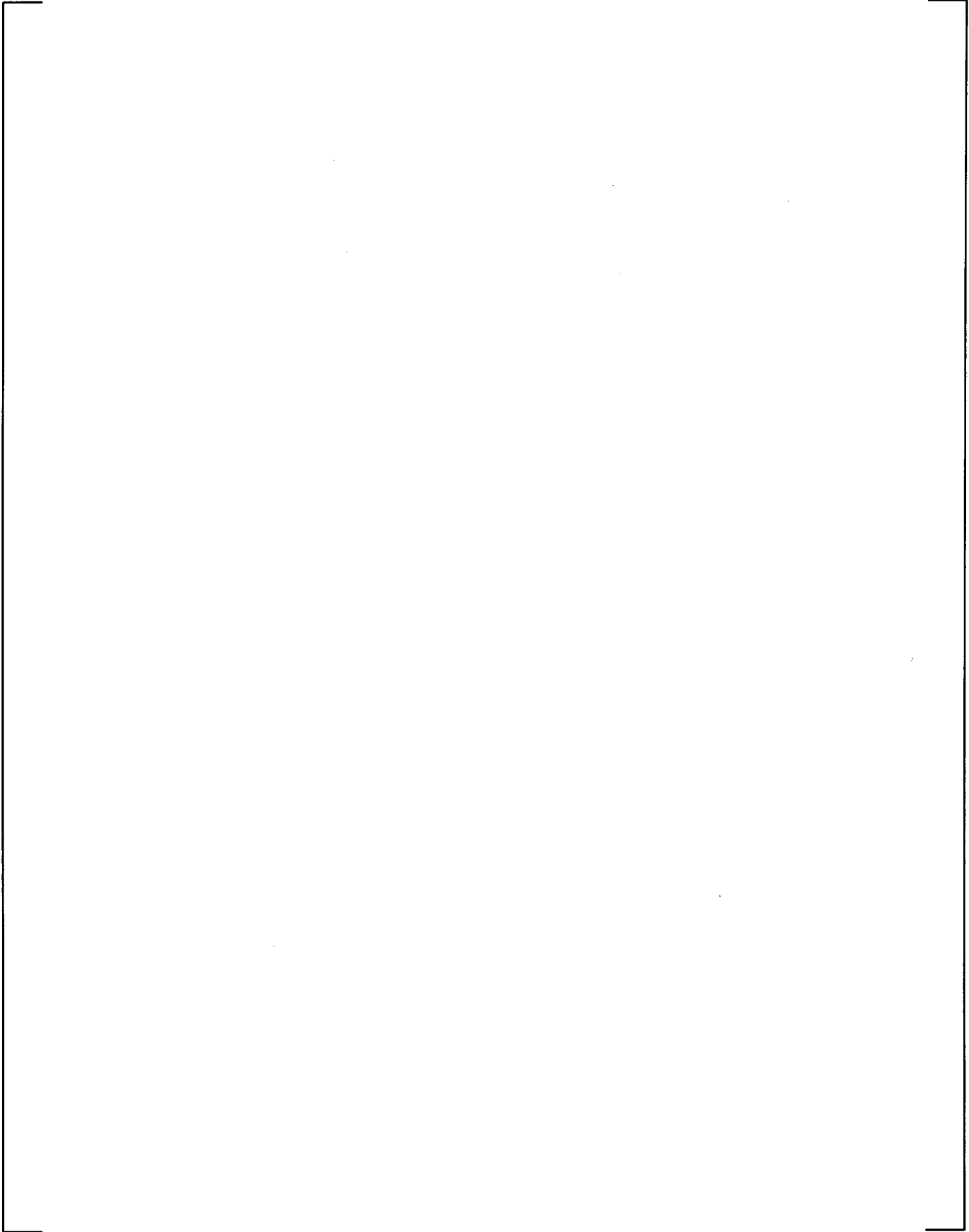


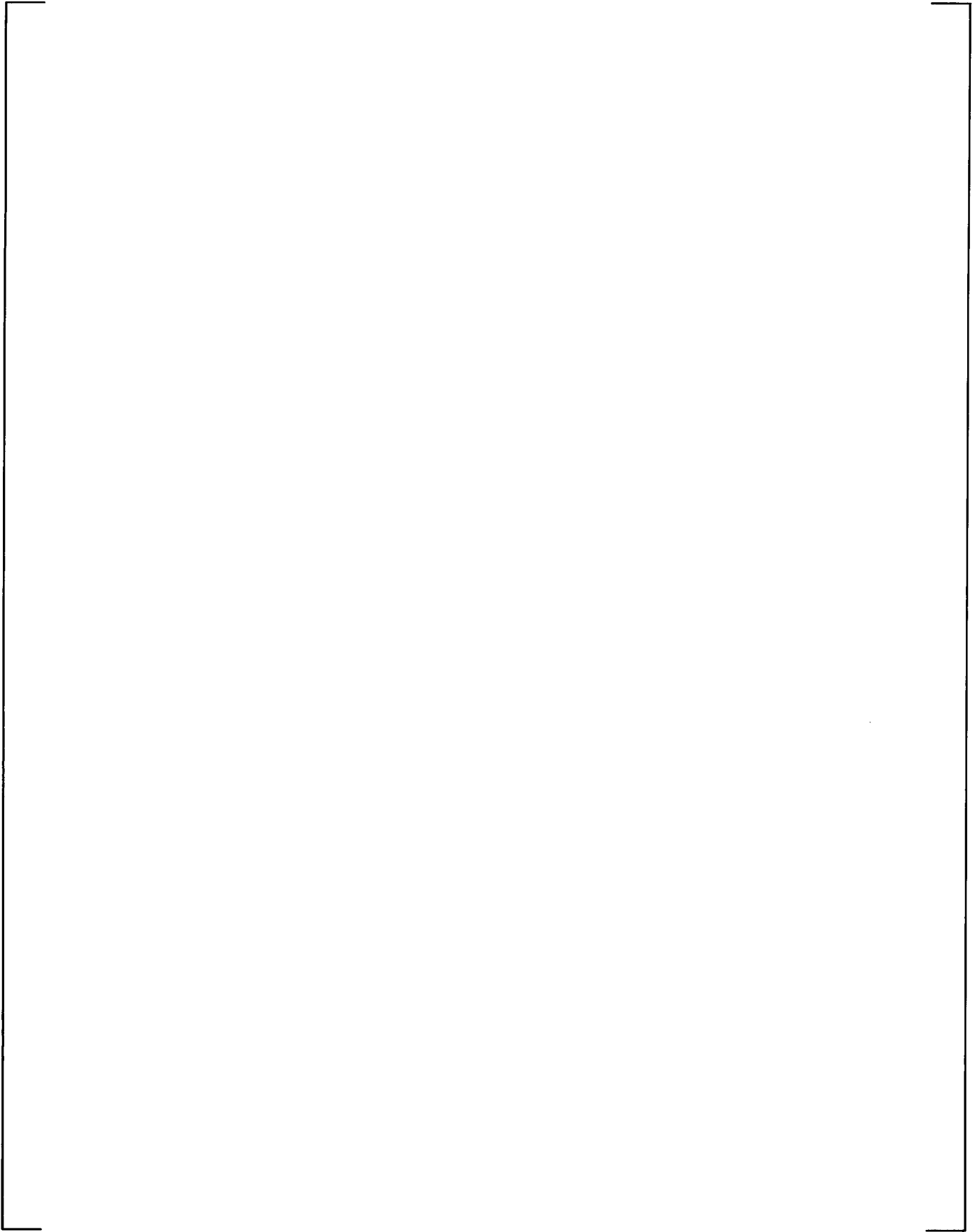


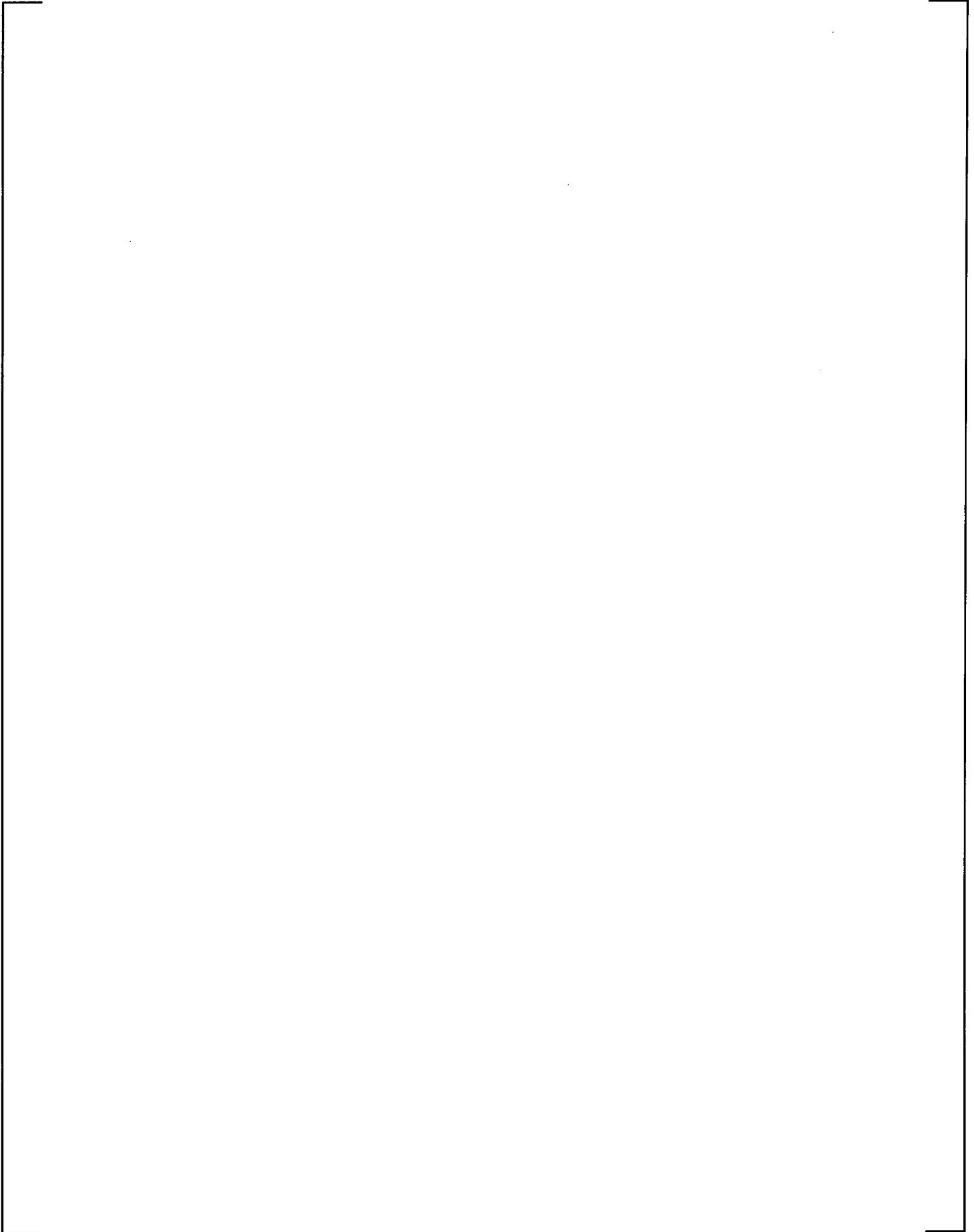


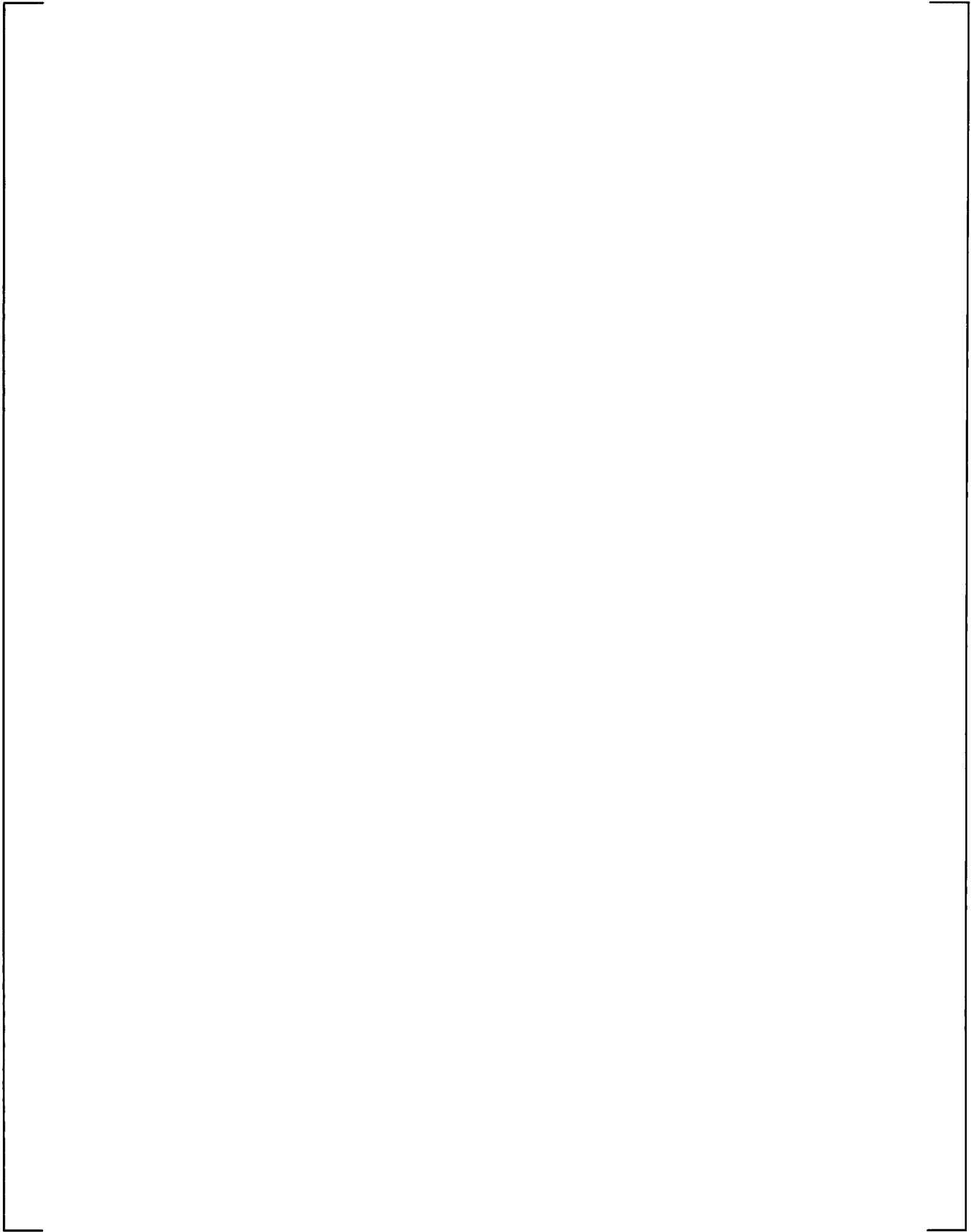


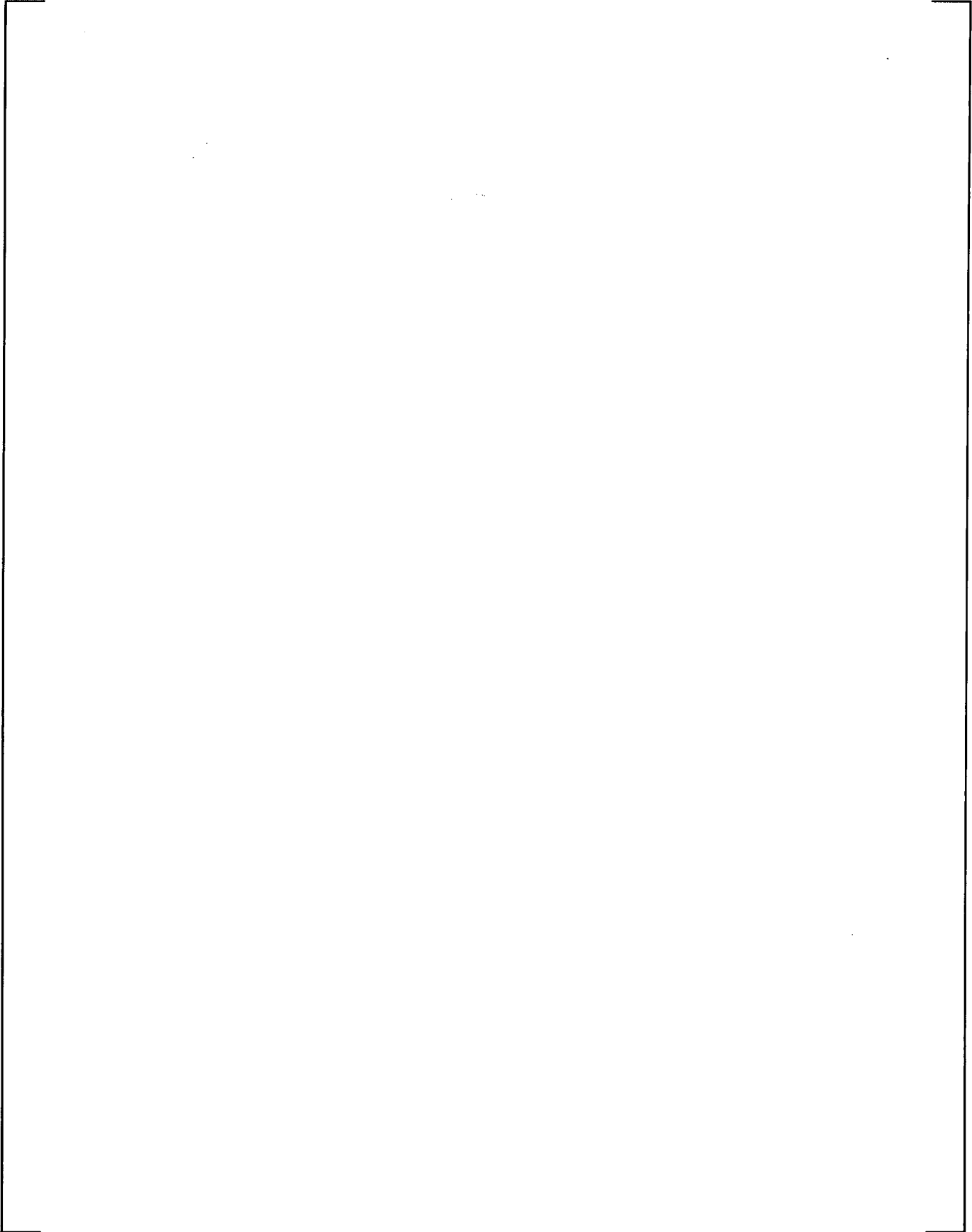


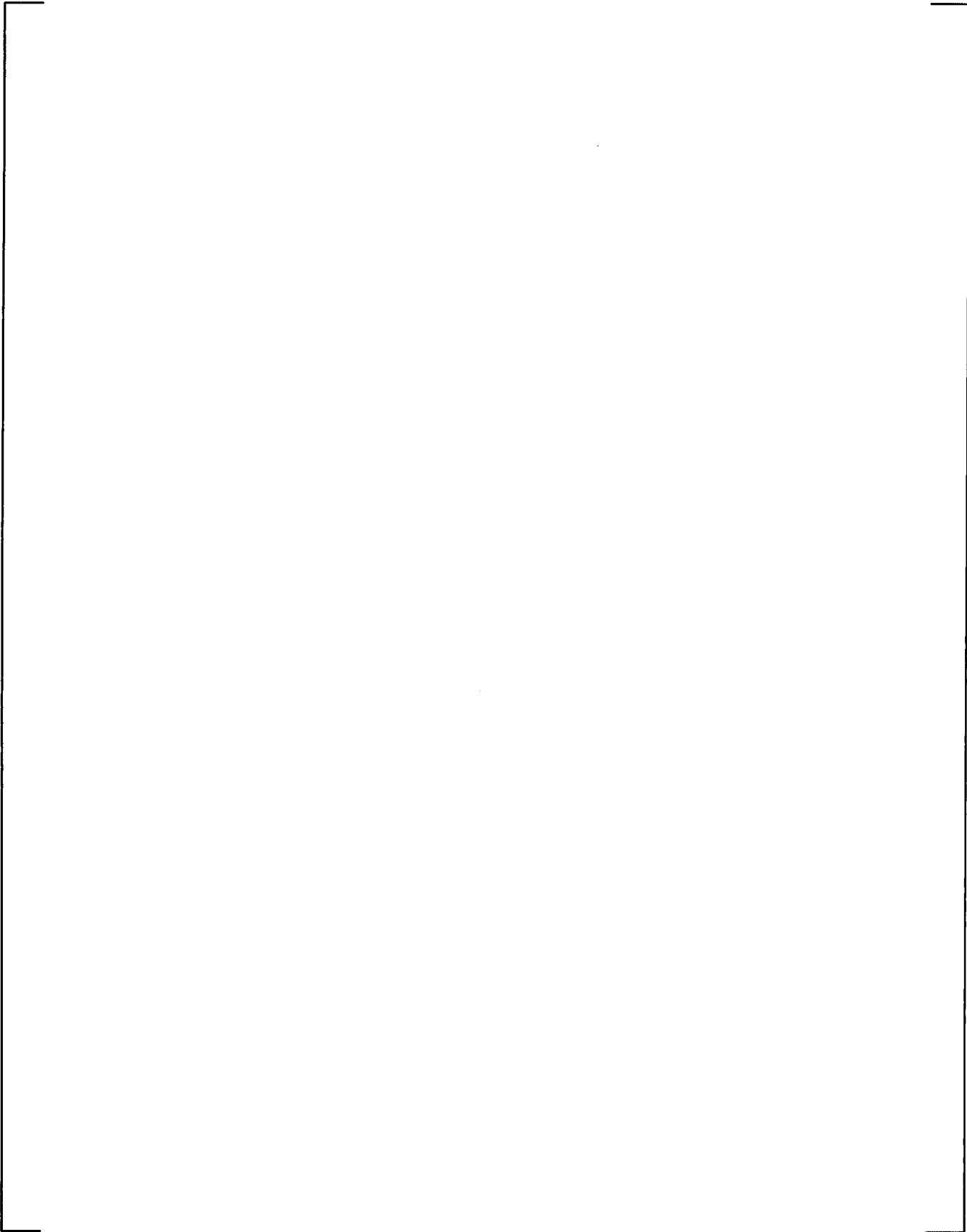


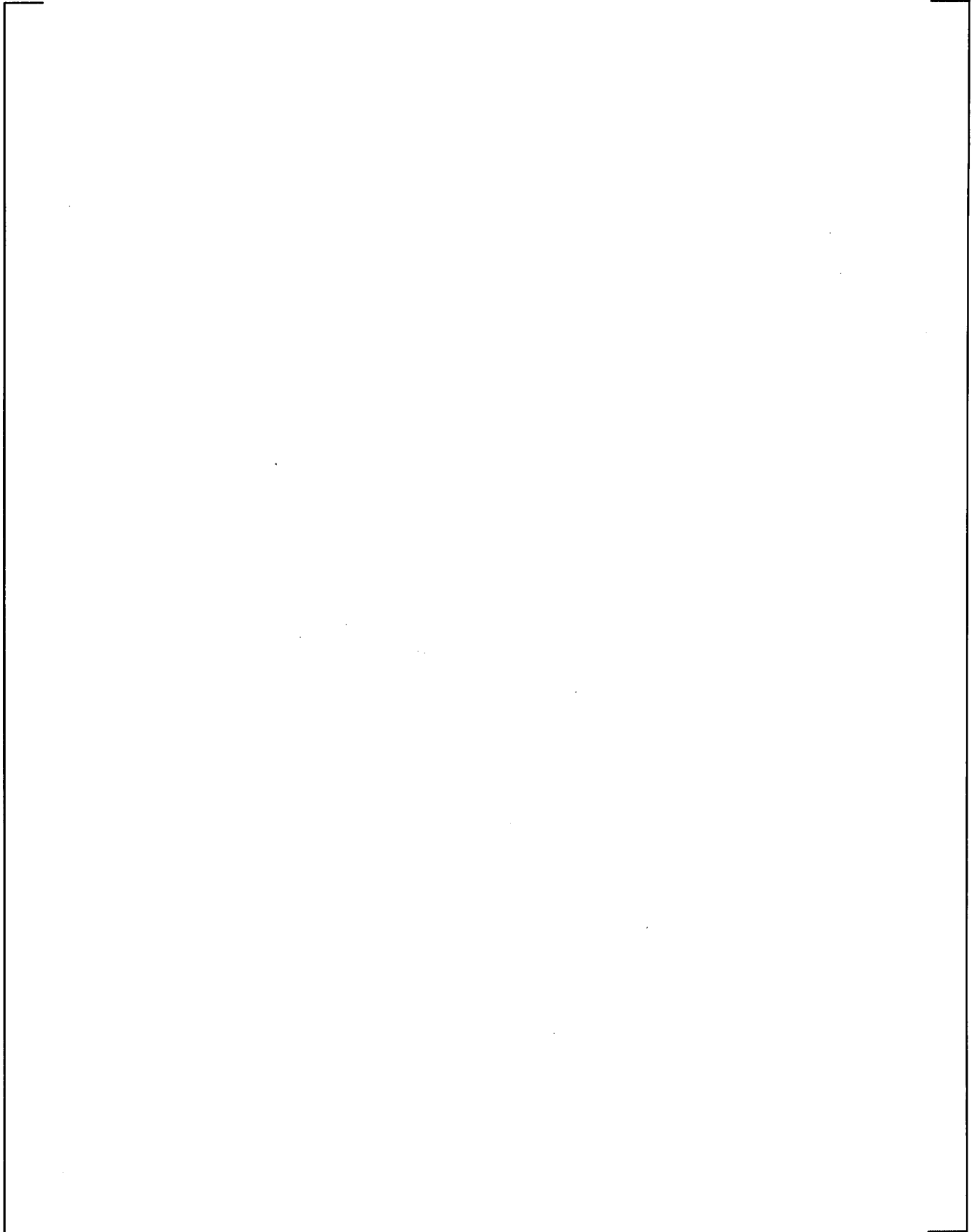


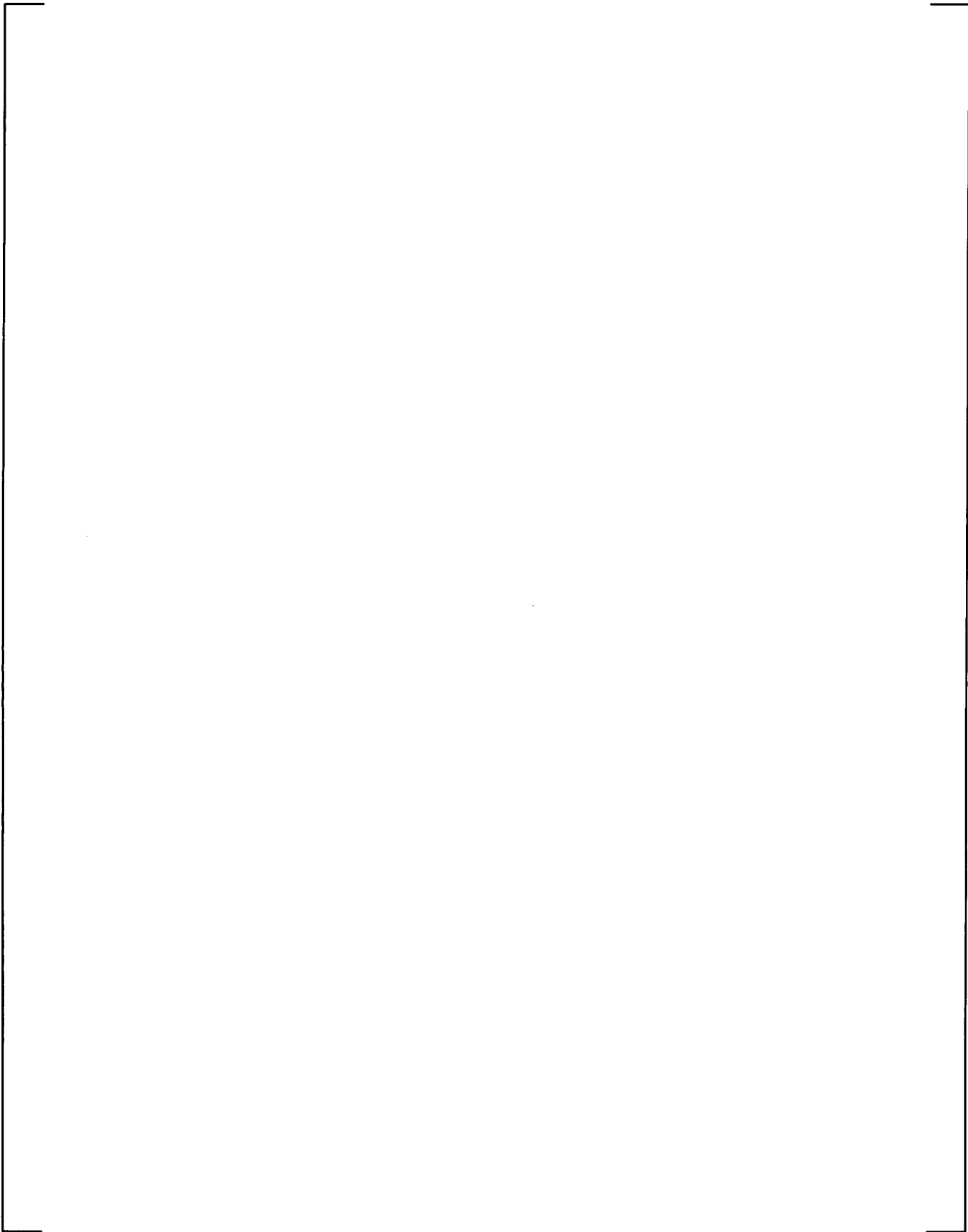


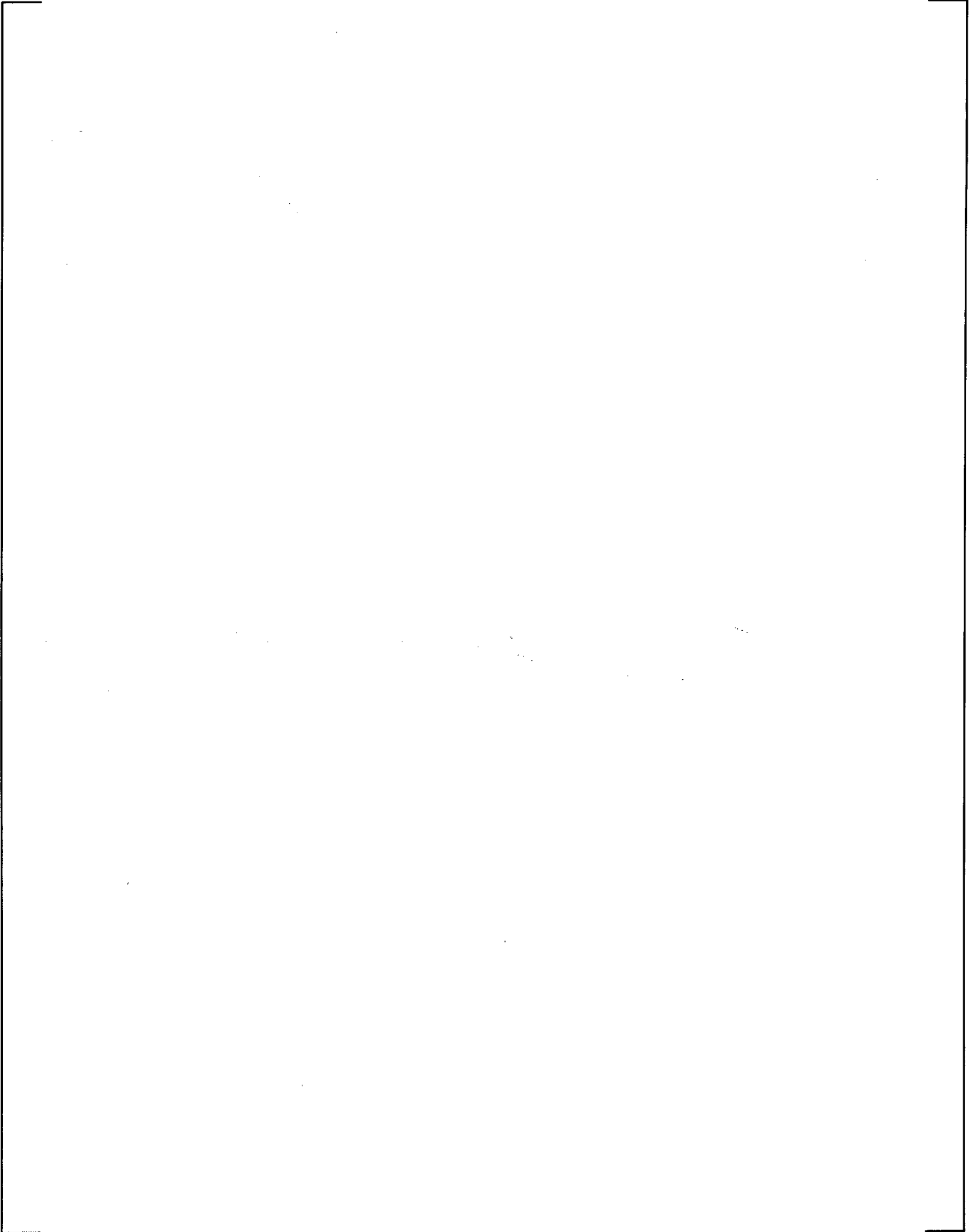


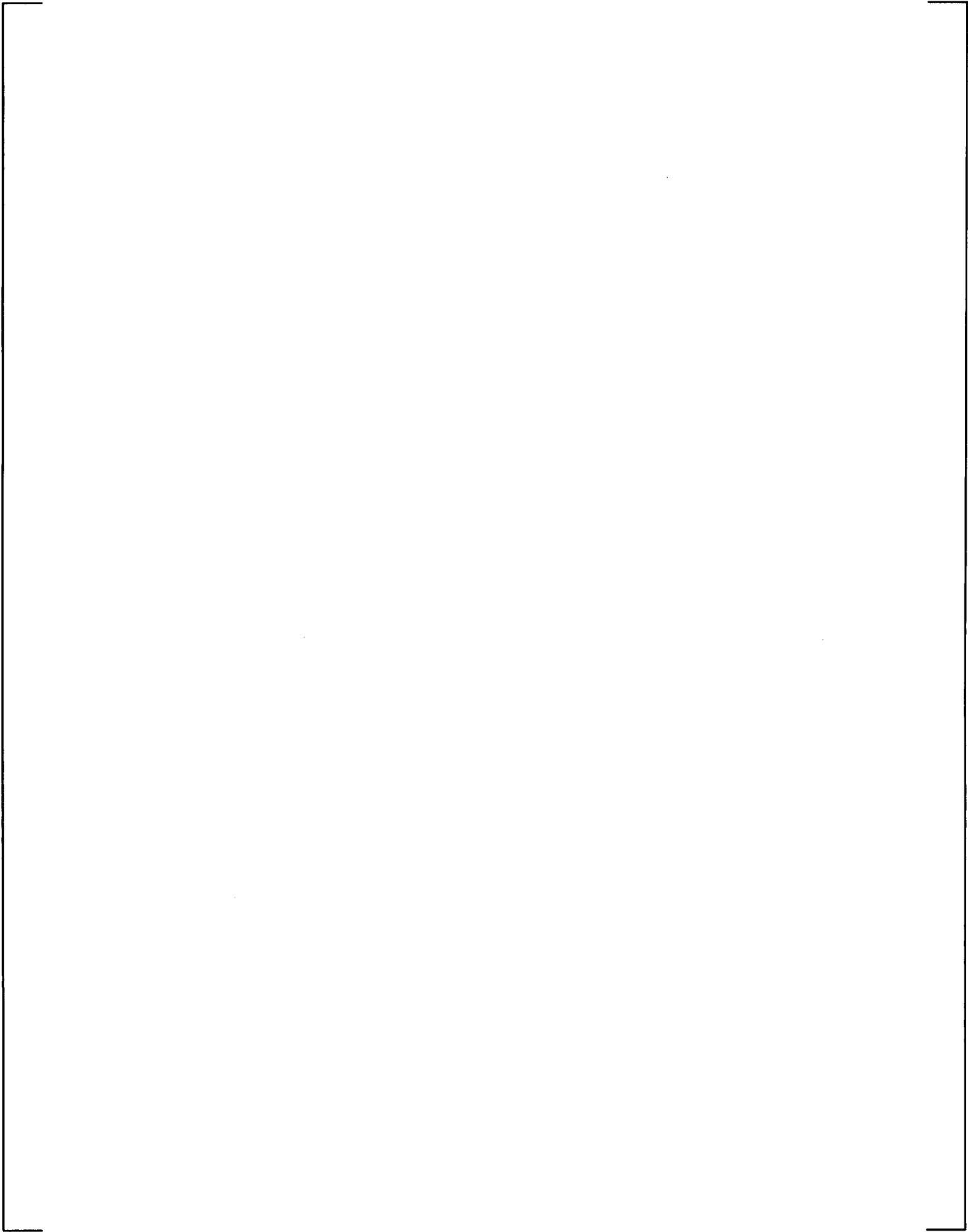


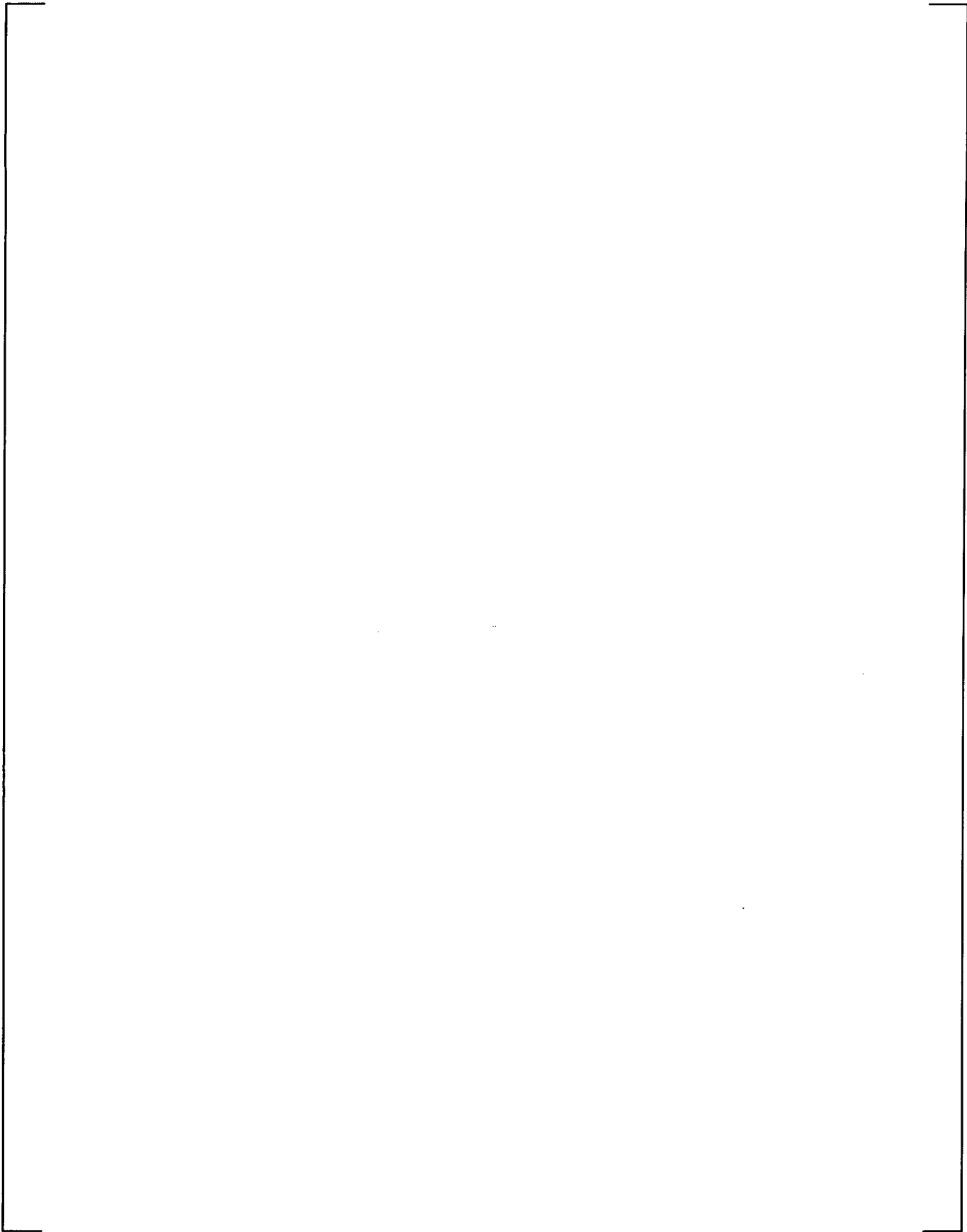


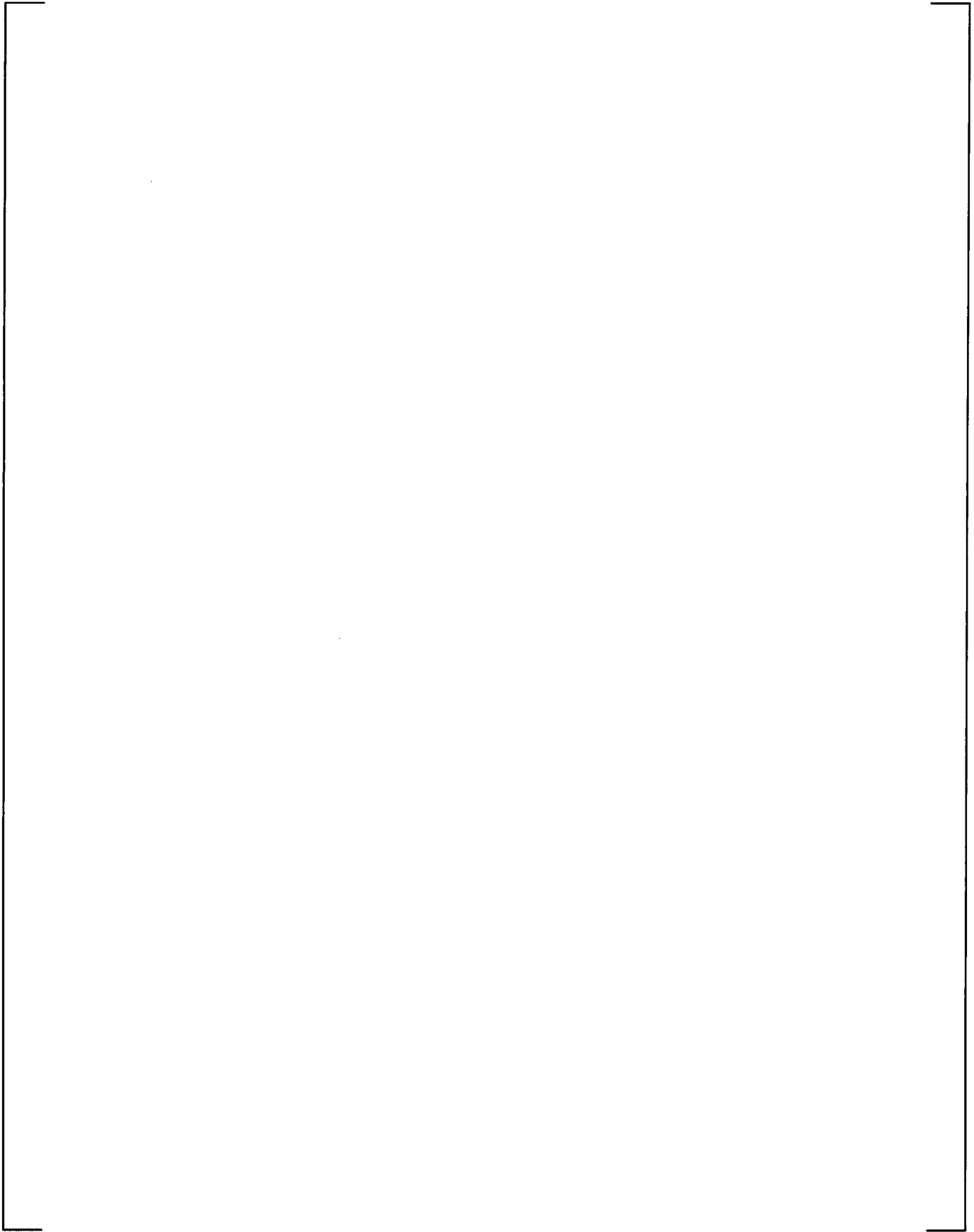


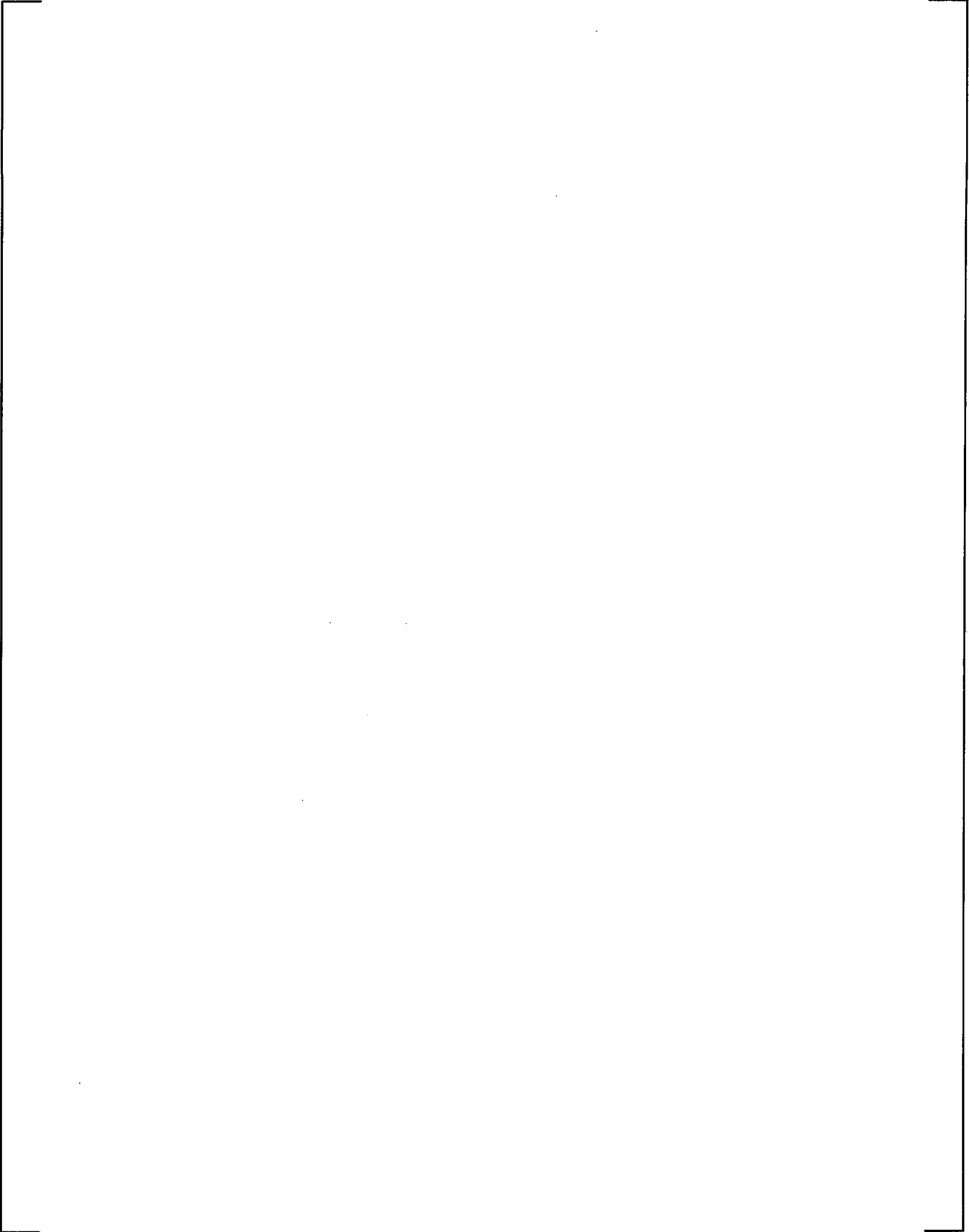


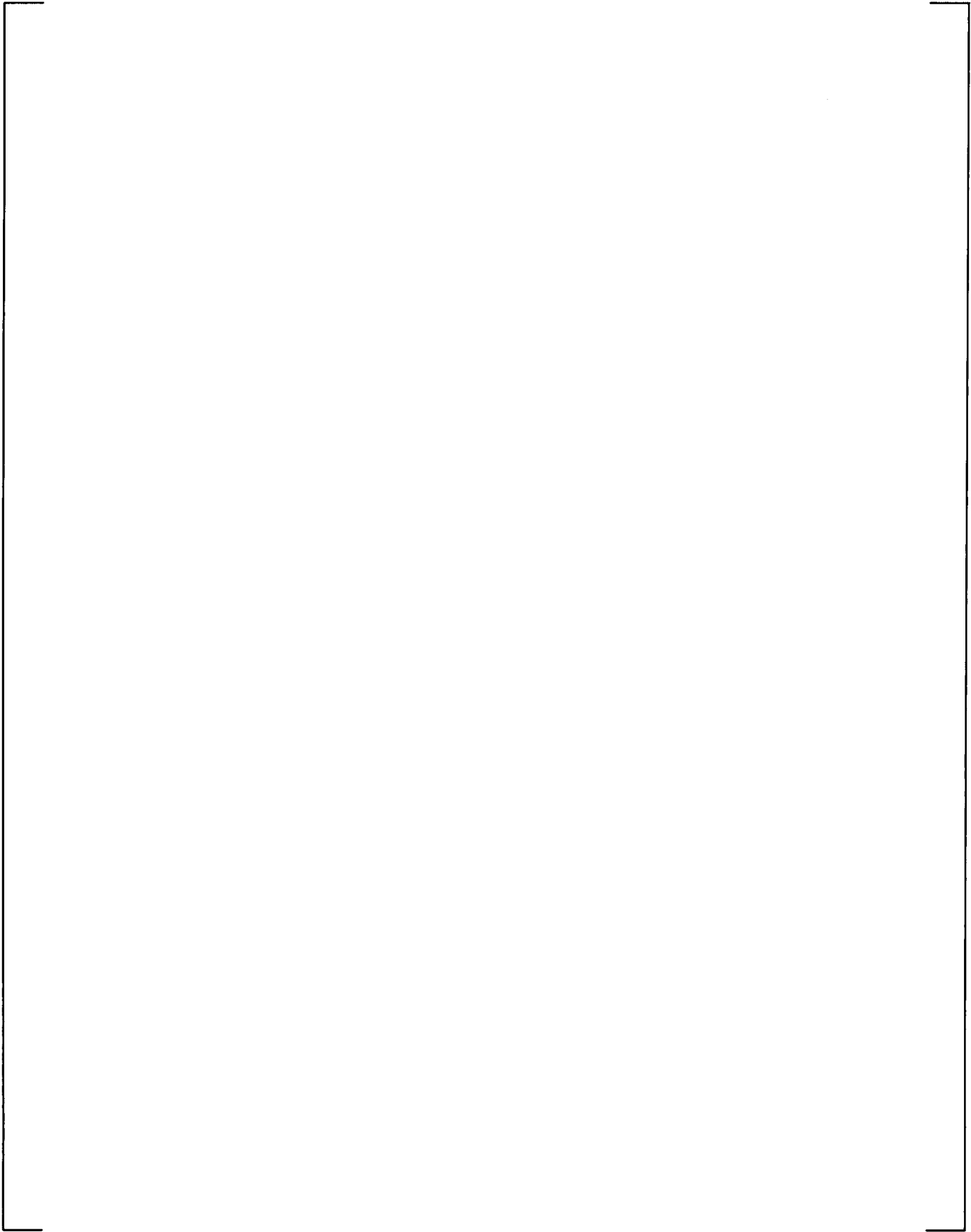


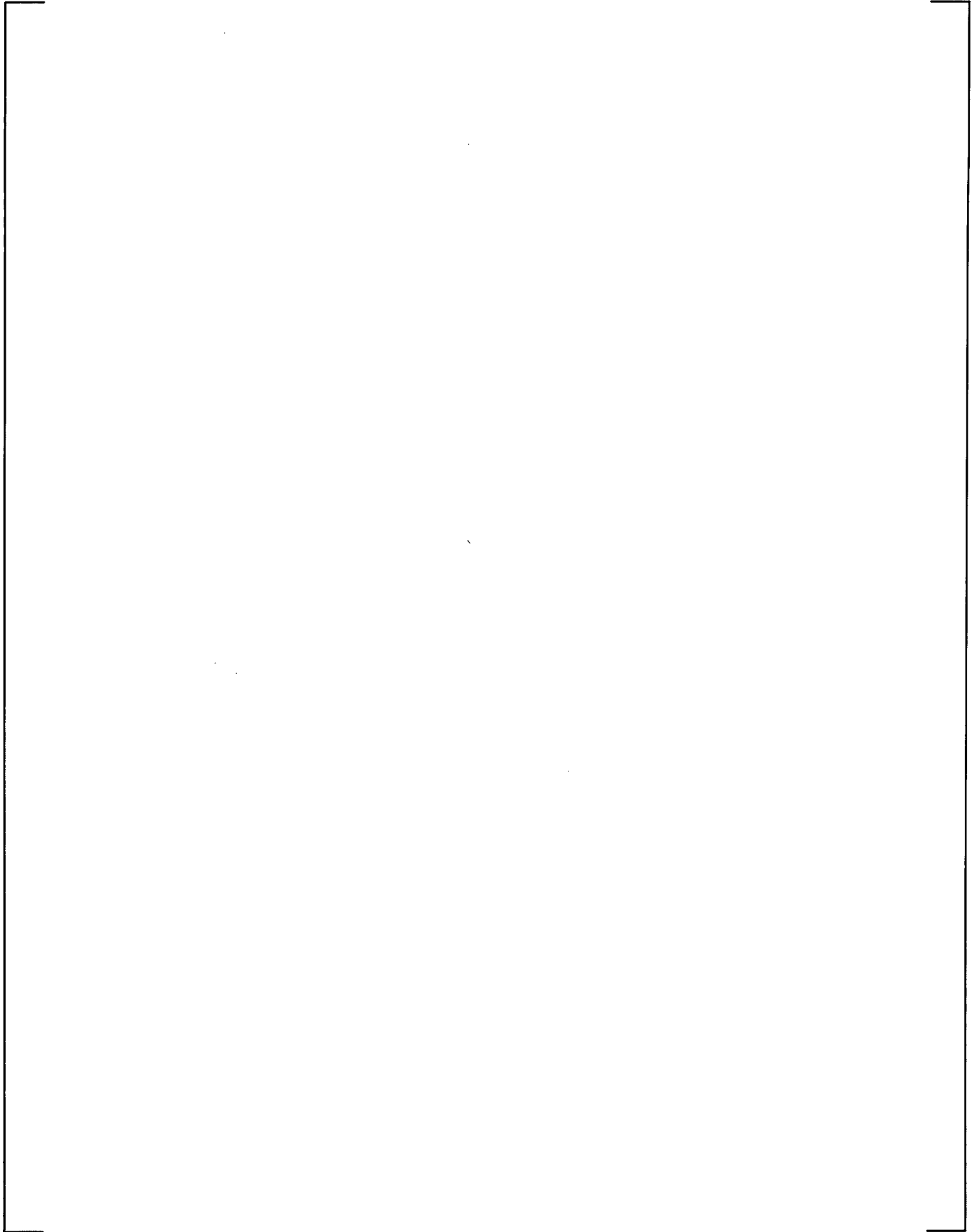


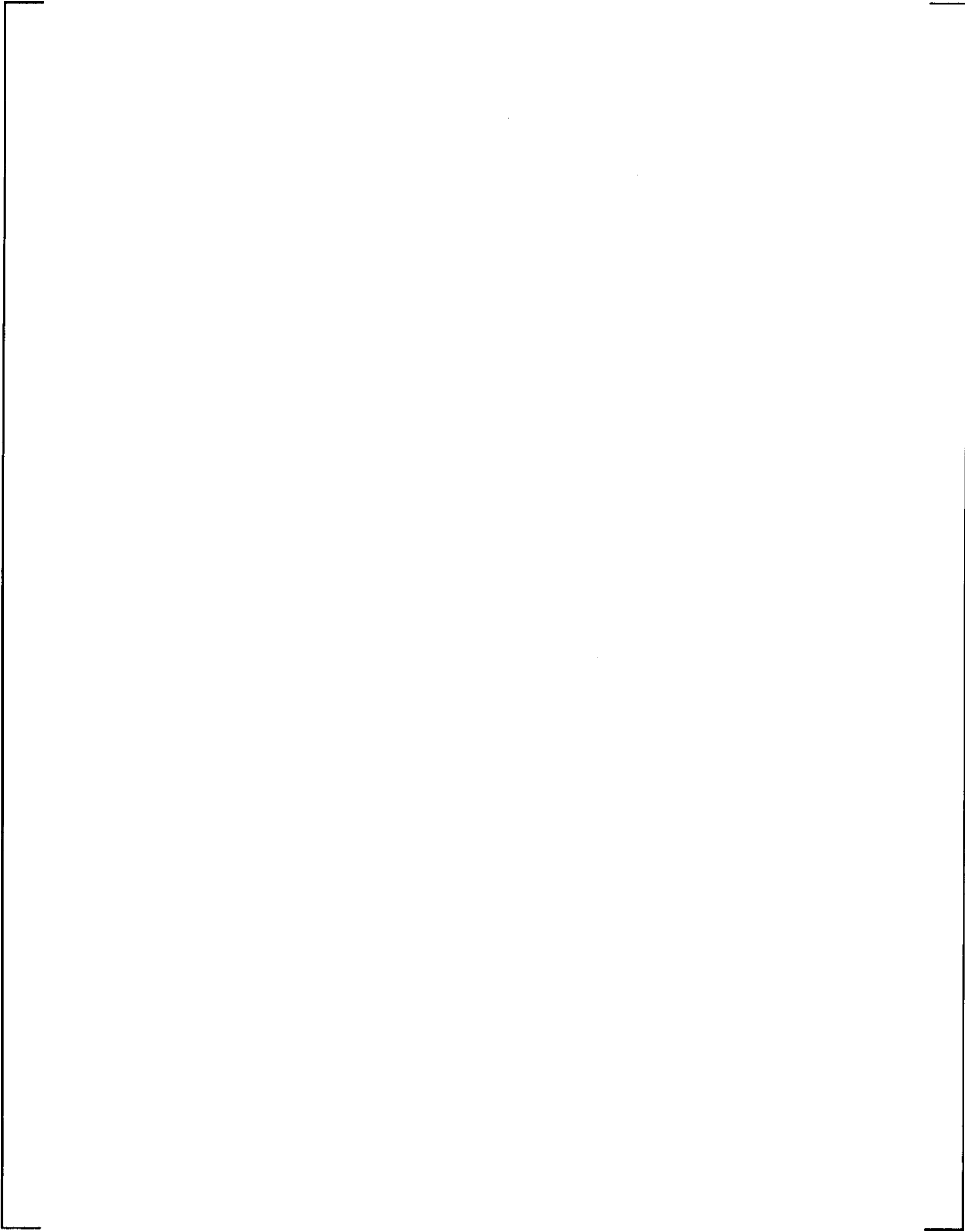


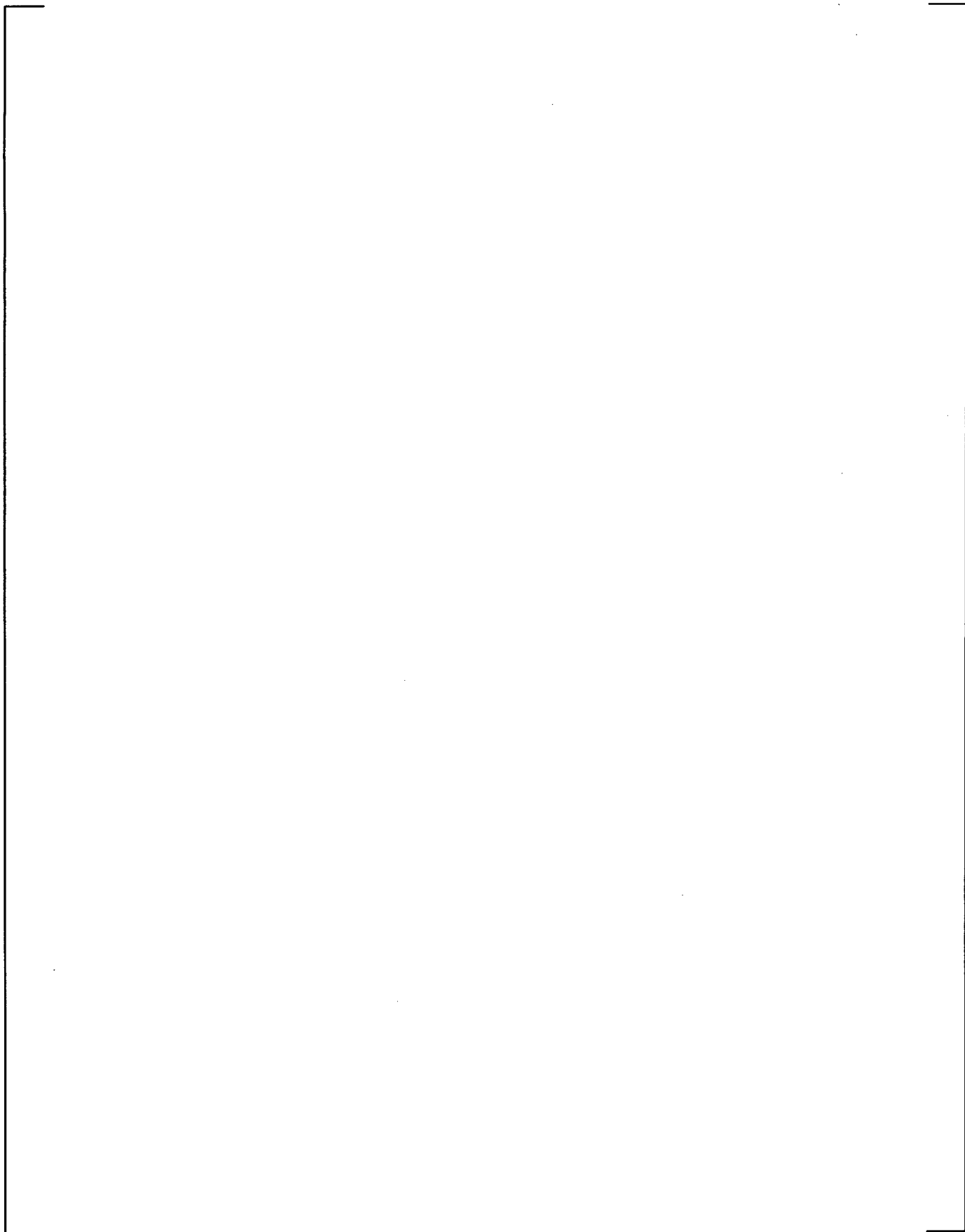


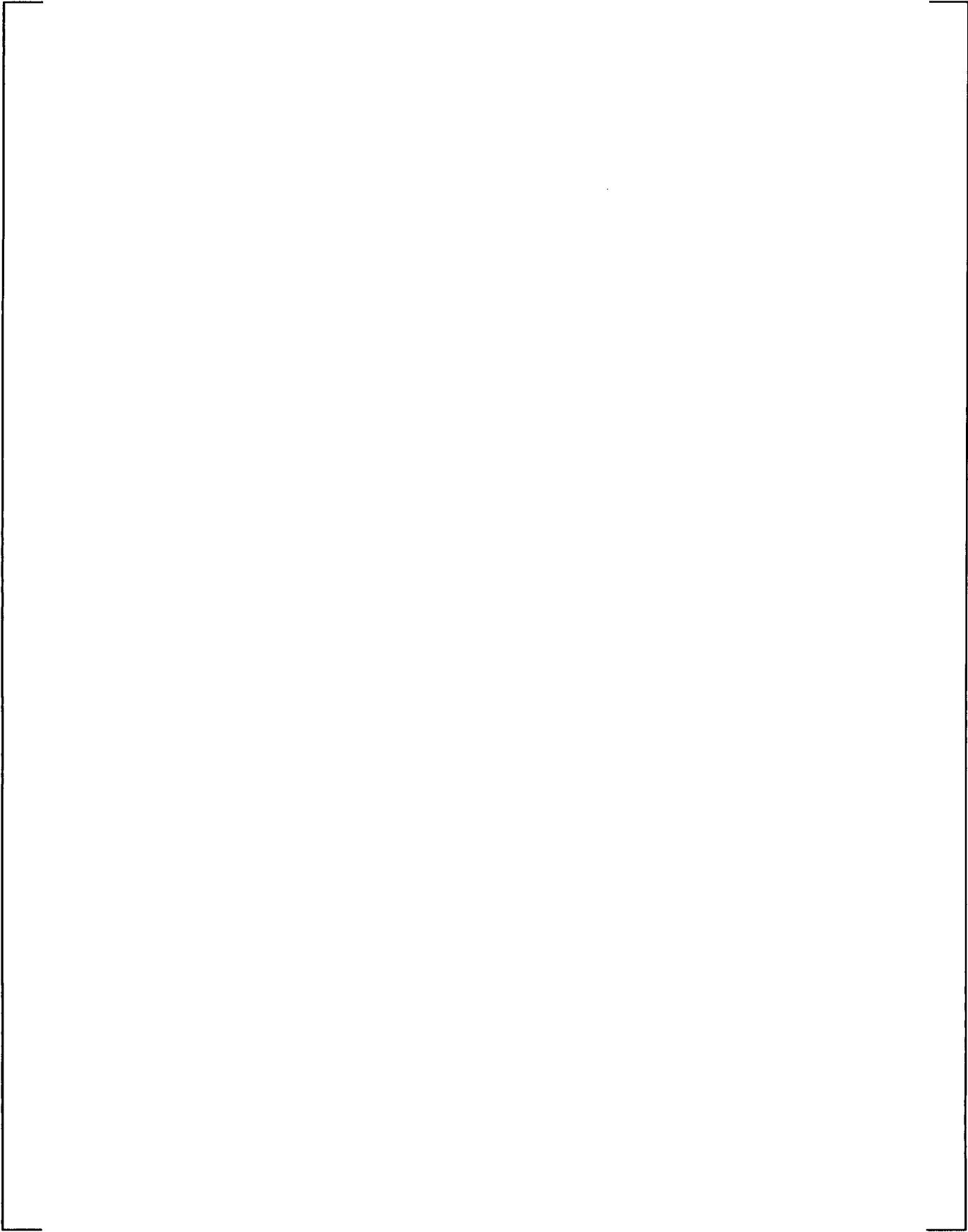












**APPENDIX D
DESIGN SKETCHES**

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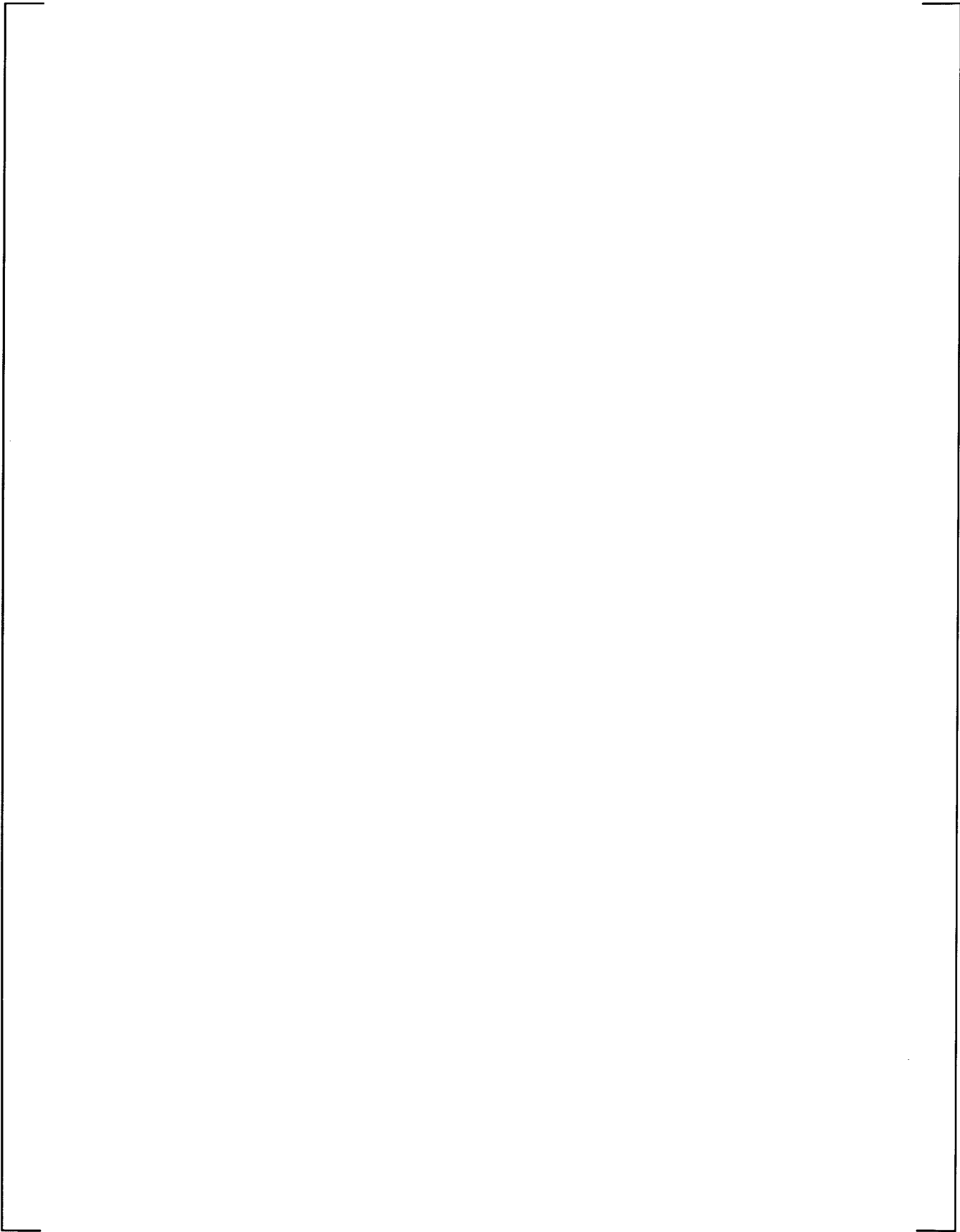
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**APPENDIX H
AP1000 NRC COMPLIANCE MATRIX**

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