



**babcock & wilcox nuclear power generation**

• 800 main street • lynchburg, va 24504 • phone 434.522.6800  
• fax 434.522.6837 • www.babcock.com

March 16, 2010

BW-JAH-2010-210

PROJ 776

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852-2738

SUBJECT: B&W *mPower*<sup>™</sup> Reactor March 31, 2010 Presentation Material

The B&W Power Generation Group is planning a meeting with the NRC staff on March 31, 2010 to discuss the B&W *mPower*<sup>™</sup> reactor design and updates in the design since our October 27, 2009 meeting as well as information on ECCS design, and the planned integrated system testing. Because of the Confidential Commercial information planned for discussion during this meeting, B&W believes the meeting should be closed to the public.

Enclosed, please find three sets of slides marked as "B&W Confidential Commercial Information" containing the material planned for presentation during the meeting which should be withheld from public disclosure. The attached affidavit details the reasons the identified information should be withheld. Also enclosed are redacted nonproprietary versions of the slides which may be released to the public without restriction

Questions concerning this submittal may be directed to T.J. Kim at (434) 382-9791 (email" [tjkim@babcock.com](mailto:tjkim@babcock.com)) or to Jeff Halfinger at (434) 316-7507 (email: [jahalfinger@babcock.com](mailto:jahalfinger@babcock.com))

Jeff A. Halfinger

*MTC [unclear] for JAHALFINGER*

Program Director, *mPower*<sup>™</sup>  
Nuclear Power Generation Group  
The Babcock & Wilcox Company

Cc: Joelle L. Starefos, NRC, TWFN-6 E4

4601  
10/19/10

Add: Joelle Starefos  
to FRLOS

AFFIDAVIT OF Richard E. Reimels

STATE OF VIRGINIA

CITY OF LYNCHBURG

I, Richard E. Reimels, being duly sworn, do hereby depose and say:

1. I am a citizen of the United States of America. I am a resident of Lynchburg, Virginia. My birth date is October 16, 1948.
  
2. I am presently employed by the Babcock and Wilcox Company (B&W) in Lynchburg, Virginia. I am the President of the B&W Nuclear Power Generation Group. I have held this position since January 2007. I have personal knowledge of the facts set forth in this affidavit, and if called and sworn as a witness in a deposition or before any court, I could and would testify competently under oath to these facts.
  
3. The Babcock and Wilcox Company requests that NRC withhold from public disclosure, the information marked as "B&W Confidential Commercial Information" regarding the B&W *mPower*<sup>TM</sup> modular reactor design in this letter dated 3/16/2010. These include three sets of presentation slides entitled, "B&W *mPower*<sup>TM</sup> Overview," "Safety Approach for the B&W *mPower*<sup>TM</sup> Plant," and "B&W *mPower*<sup>TM</sup> Integrated Systems Test."
  
4. I have personal knowledge of the criteria and procedures used by B&W in designating confidential commercial or financial information as proprietary and have been delegated the function to review the information to identify proprietary information

and authorized to apply for its withholding. The need for confidentiality is driven by the following:

- a) The information requested to be withheld reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by any of B&W's competitors, without a license from the submitter, would constitute a competitive economic disadvantage to B&W.
- b) Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.
- c) The information requested to be withheld reveals aspects of privately funded development plans or programs of commercial value to B&W.
- d) The information requested to be withheld consists of patentable ideas.

5. Specifically, the information identified in paragraph 3 above, is classified as proprietary because B&W has developed the conceptual and technical approaches regarding details of the B&W *mPower*<sup>TM</sup> modular reactor design features, disclosure of which could adversely affect B&W's competitive position by informing competitors of the degree of maturity and viability of the program, thereby motivating them to increase efforts to develop competing technologies. The information to be withheld identifies certain design characteristics in the B&W *mPower*<sup>TM</sup> reactor or recent evolutionary changes in the design in several areas including the emergency core cooling system design and plans for integrated system testing. These features of the reactor design and the details regarding plans for testing were privately funded by B&W and are of commercial value to B&W because of their nature in providing key elements of the B&W *mPower* modular reactor design and analysis. All or parts of the approach described in the withheld material is patentable.

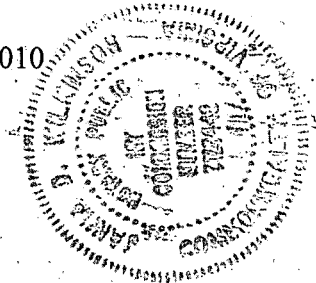
I declare under penalty of perjury under the laws of the United States of America that the foregoing is a true and correct statement of facts.

*Richard E. Reimels*

Richard E. Reimels

Subscribed and sworn to before me this 16th day of March 2010

*Jana A. Auer*  
Notary Public



My commission expires: 8/31/2011

County/City of Lynchburg  
Commonwealth/State of Virginia  
The foregoing instrument was acknowledged  
before me this 16th day of March,  
2010, by  
Richard Reimels  
*Jana A. Auer*  
Notary Public  
My commission expires: 8/31/2011

Redacted Version



nuclear power generation

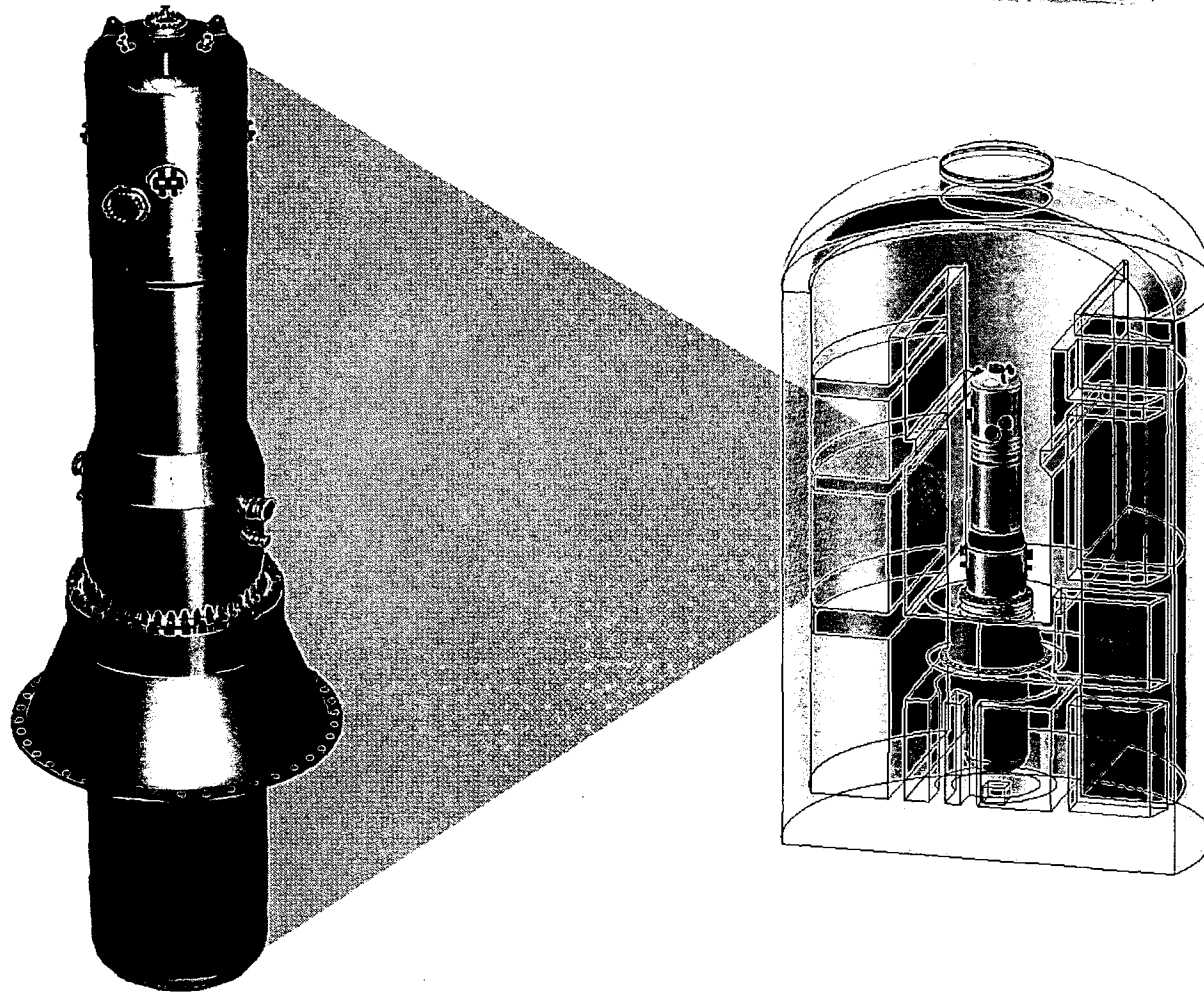
B&W Confidential Commercial  
Information

# ***B&W mPower™ Overview***

Redacted material marked with square brackets and noted by  
[CCI per Affidavit 4(a)-(d)]

# Agenda

1:00 – 1:10 pm	Introduction & opening remarks	NRC/B&W
1:10 - 1:40 pm	Overview of B&W mPower™ reactor design	B&W
1:40 – 3:00 pm	B&W mPower safety approach	B&W
3:00 – 3:40 pm	Integrated systems test update	B&W
3:40 – 4:00 pm	NRC feedback and next steps	All
4:00 pm	Adjourn	



# Overview of the B&W mPower™ Reactor Design Briefing for the Nuclear Regulatory Commission

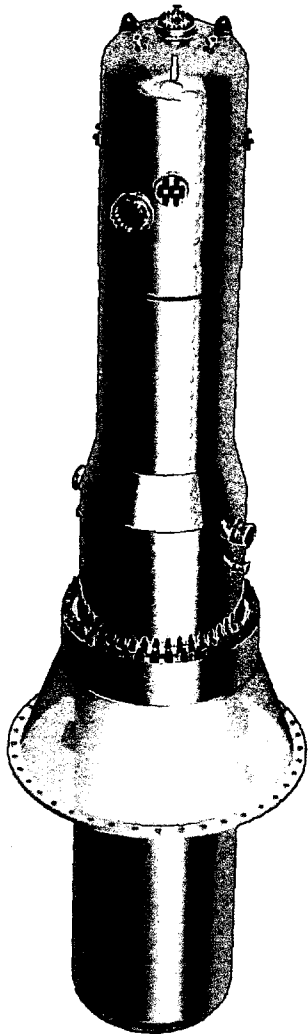
March 31, 2010

## Design Changes Since the Last Briefing

- Plant Arrangement
  - Containment size reduced
  - Spent fuel moved to adjacent, below ground structure
- Design uses a single control rod drive mechanism design, supplemented by emergency boron injection
- ECCS configuration, including replacement of the internal decay heat removal heat exchangers with an external heat exchanger



# Integral Nuclear Steam Supply System



- Integrates core, steam generator, and pressurizer into a single vessel
- Control rod drive mechanisms (CRDMs) and primary coolant pumps inside vessel
- Reactor coolant pressure boundary penetration size and location minimize coolant loss during LOCA
- Rail shippable
- Core remains covered throughout design basis LOCA

***Integral design reduces overall plant complexity and enhances safety***

babcock & wilcox nuclear power generation

[CCI per Affidavit4(a)-(d)]

babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

---

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

---

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

---

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

[CCl per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

---

[CCI per Affidavit 4(a)-(d)]



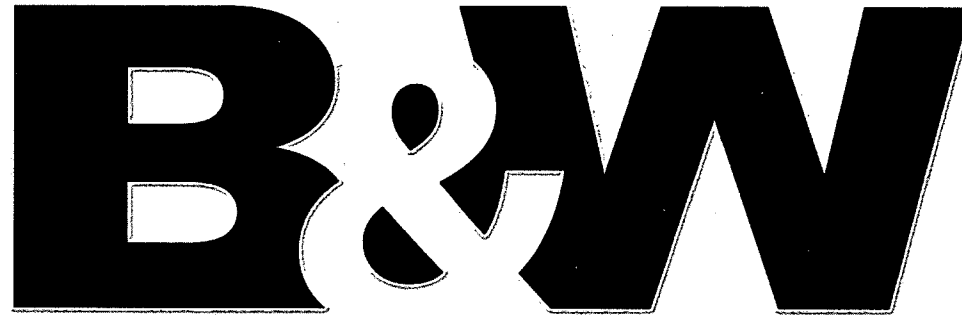
babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

## Summary

- NSSS utilizes an integral PWR design
  - Uses a single integral economizer once through steam generator to produce superheated steam
  - Internal reactor coolant pumps and control rod drive mechanisms
  - Internal pressurizer
- Long operating cycle without soluble boron
- Plant design modified to store spent fuel outside of containment (below ground)
- Multiple reactor plant designs will not share engineered safety features

Redacted Version



nuclear power generation

B&W Confidential Commercial  
Information

***Safety Approach for the  
B&W mPower™ Plant***

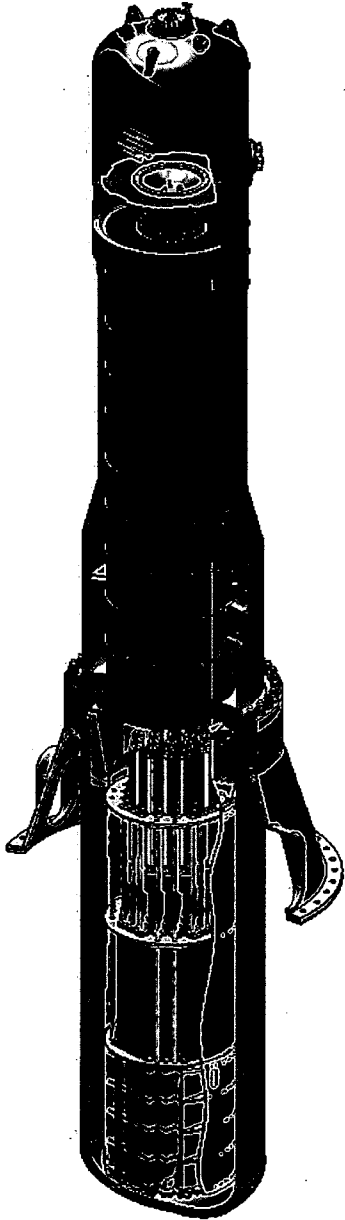
*March 31, 2010*

Redacted material marked with square brackets and noted by  
[CCI per Affidavit 4(a)-(d)]

# **B&W mPower Safety Approach**

- Defense-in-depth
- Inherent safety features of the integral reactor
- Passive engineered safety systems
- Anticipated response to transient and accident conditions

# Inherent Safety Features of the Integral Reactor



- Low power density core
  - Low power density allows lower flow velocities that minimize FIV effects.
  - Low power density reduces fuel and clad temperatures during accidents.
- Large reactor coolant volume
  - Large RCS volume allows more time for safety system response in the event of an accident.
  - More coolant is available during a LOCA providing continuous cooling to protect the core.
- Small penetrations at high elevation
  - Small penetrations reduce rate of energy release to containment resulting in lower containment pressures.
  - High penetration locations increase the amount of coolant left in the vessel after a LOCA.

babcock & wilcox nuclear power generation



# Summary of Safety Features

Design Feature	Benefit	Accidents Affected
Integral layout	No large RCS piping	LOCA
Large, tall NSSS	Increased coolant inventory Increased natural circulation Accommodates internal CRDMs	LOCA, Decrease in heat removal, Loss of RC pumps, Eliminates RCCA ejection
Low core power density	Lower fuel temp	LOCA, Decrease in heat removal, Loss of RC pumps
Once through steam generator	Lower water inventory	Steam line break
Integral pressurizer	Single RCS high point	LOCA, Decrease in heat removal
Multiple RC pumps	Pump redundancy	Locked rotor, Shaft seizure/break
No soluble poison	Large negative reactivity coefficients	LOCA, Decrease in heat removal, Loss of RC pumps, ATWS

---

# Defense-in-Depth



# Reactor Coolant Inventory and Purification System (RCIPS)

babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]



babcock & wilcox nuclear power generation

# Emergency Core Cooling System Overview

babcock & wilcox nuclear power generation

# ECCS High Pressure Decay Heat Removal

babcock & wilcox nuclear power generation

# ECCS Automatic Depressurization

babcock & wilcox nuclear power generation

# **ECCS Low Pressure Passive Injection**

babcock & wilcox nuclear power generation

---

# ECCS RWST Cooling

babcock & wilcox nuclear power generation

---





babcock & wilcox nuclear power generation

# Cavity Flood

# Design Basis Accidents

Accident Category	Examples of Initiating Events
Increase in heat removal from primary system	Inadvertent opening of steam generator relief valves Steam line break Inadvertent operation of HP condenser
Decrease in heat removal from primary system	Loss of normal feedwater Loss of offsite power Feedwater pipe break
Decrease in primary flow	RC pump failure RC pump locked rotor/shaft seizure Loss of all RC pumps
Decrease in RCS inventory	Small break LOCA Steam generator tube rupture

# Increase in Heat Removal from the Primary System

babcock & wilcox nuclear power generation

# Decrease in Heat Removal by the Secondary System



babcock & wilcox nuclear power generation

# Decrease in Reactor Coolant Flow Rate

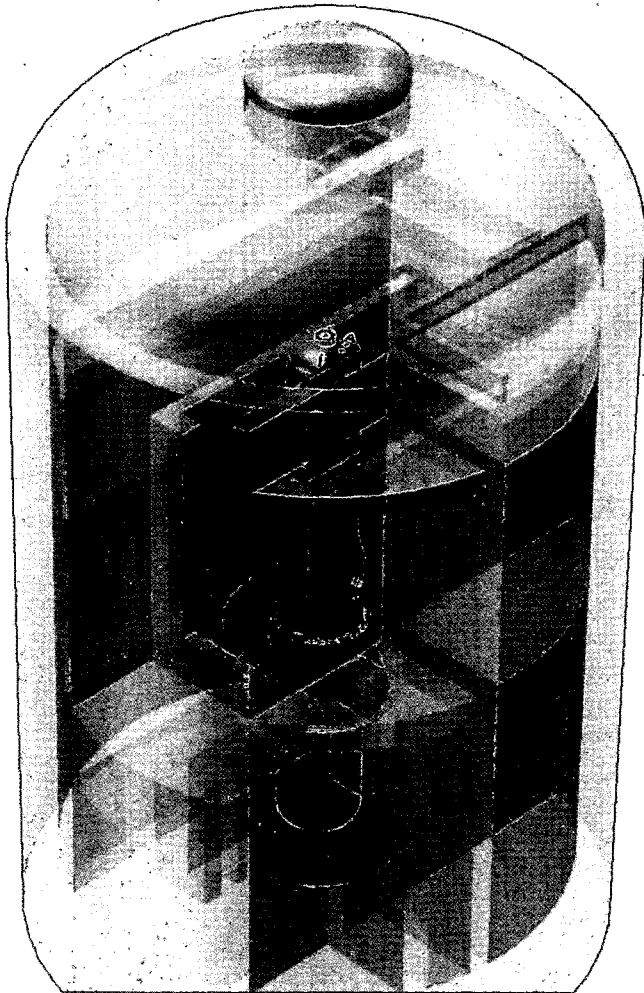
X

# Decrease in Reactor Inventory – SG Tube Rupture



# Decrease in Reactor Inventory - LOCA

# Containment Cooling



- Energy release in steam line break limited
  - Relatively small secondary inventory inside the steam generator
  - Feedwater isolation valves minimize additional leakage into containment
- Energy release during LOCA is relatively large, but over a long period of time
- Containment structures will store released energy without excessive pressures or temperatures

**No active, safety-grade, containment cooling systems required**



# B&W mPower Safety Approach Summary

- **Defense-in-depth**
  - Traditional to prevent barriers to fission product release
  - Diverse mechanisms for core heat removal
  - Utilize reliable non-safety systems to minimize challenges to passive safety systems
- **Inherent safety features of the integral reactor**
  - Low power density core
  - Large reactor coolant volume
  - Small penetrations well above the core
- **Passive engineered safety systems**
  - Use passive features to keep the plant safe for a minimum of 72 hours without operator action
    - One time alignment of valves
    - Natural circulation flow
    - Very large coolant inventories

Redacted Version



nuclear power generation

B&W Confidential Commercial  
Information



***B&W mPower<sup>TM</sup>  
Integrated Systems Test***

*March 31<sup>st</sup>, 2010*

**Redacted material marked with square brackets and noted by  
[CCI per Affidavit 4(a)-(d)]**

**Doug Lee**  
*Manager of Manufacturing,  
Development, Testing, and IP*

# Objectives

- Scaled Integrated Systems Tests
- Steam generator and other component performance
- Computer code/model verification
- Licensing support
- Control and protection systems verification
- Design enhancements
- Simulator development/verification
- Operating procedures and training
- Demonstration to potential customers

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

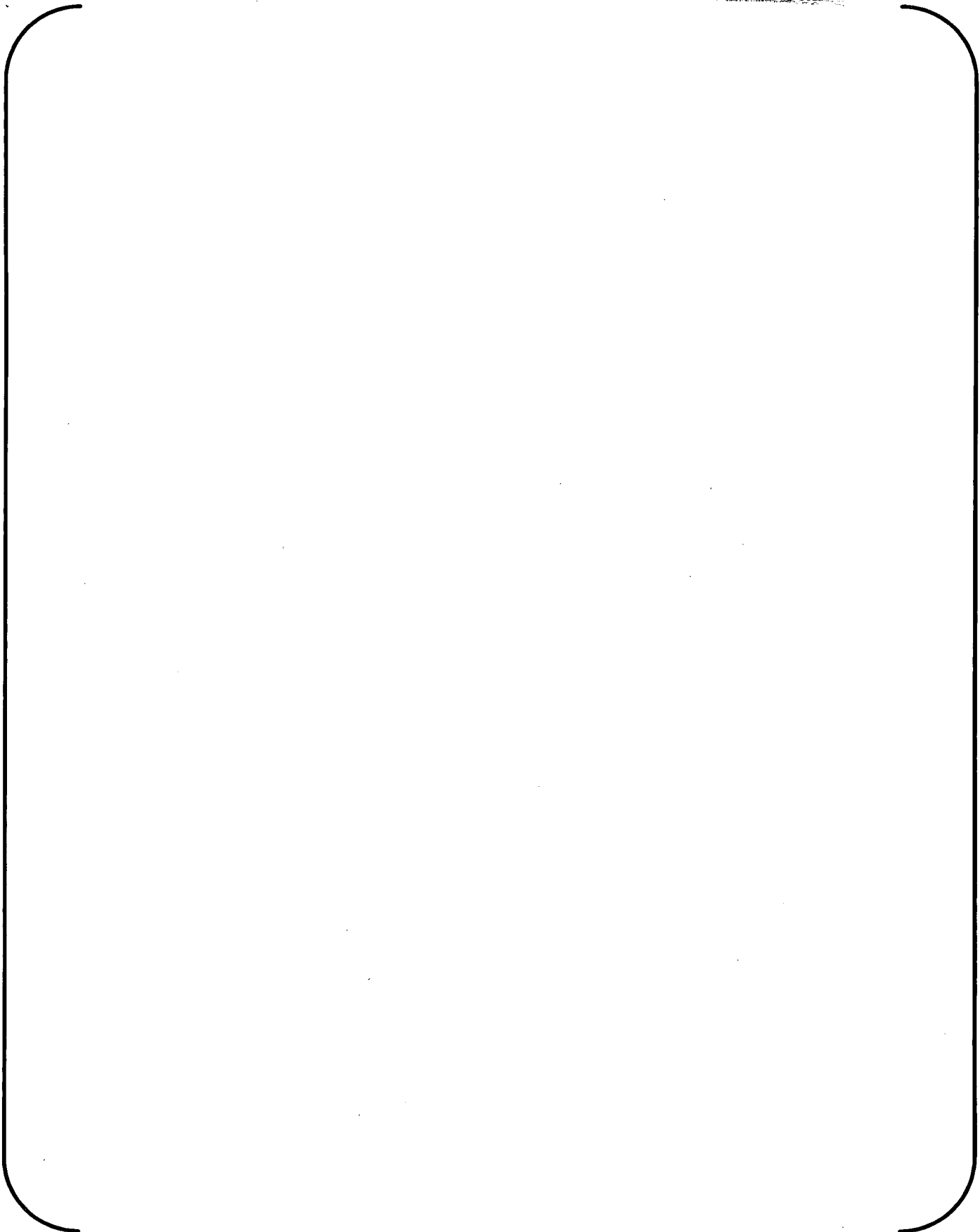
[CCI per Affidavit 4(a)-(d)]



babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

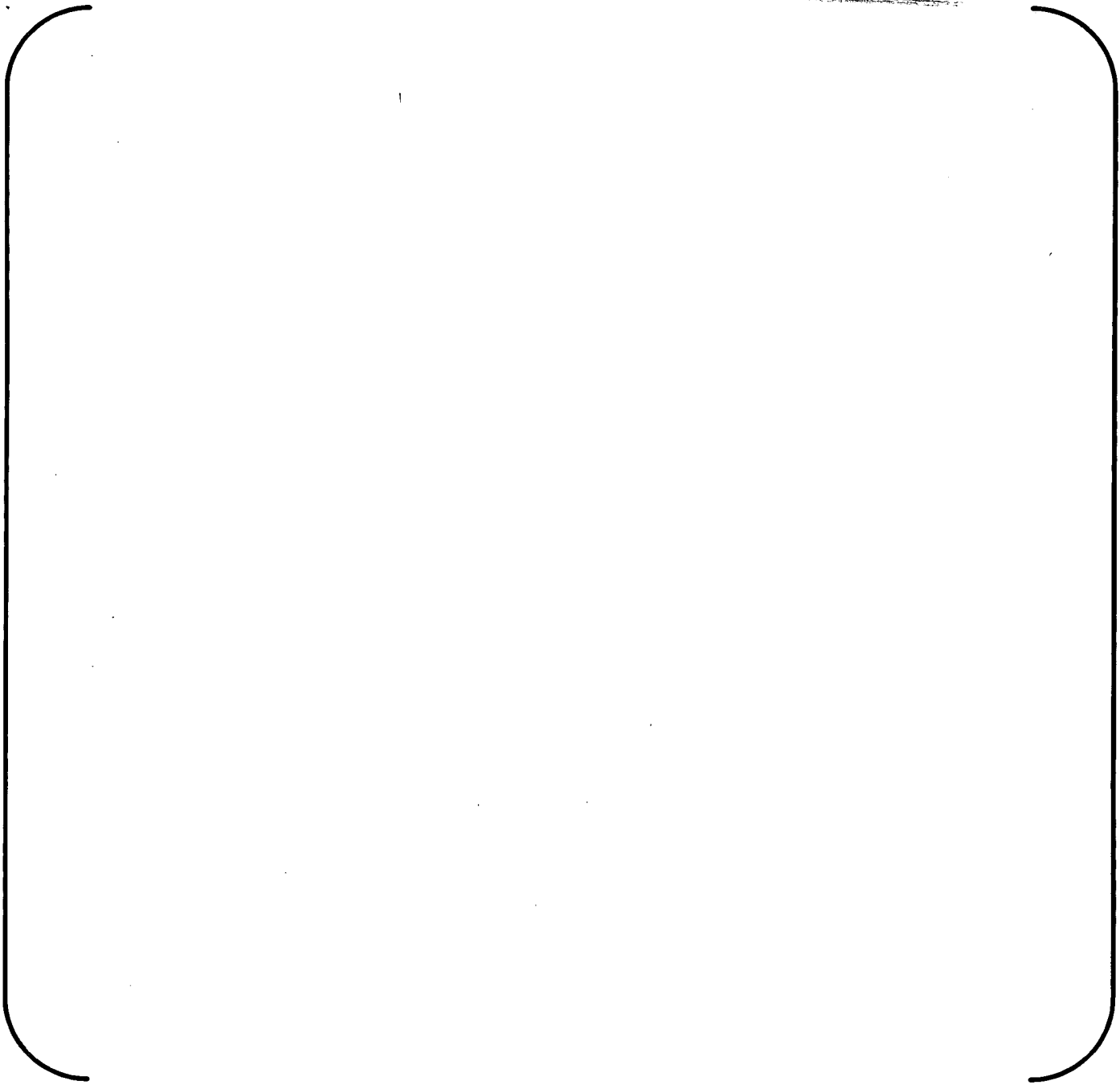
babcock & wilcox nuclear power generation



babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

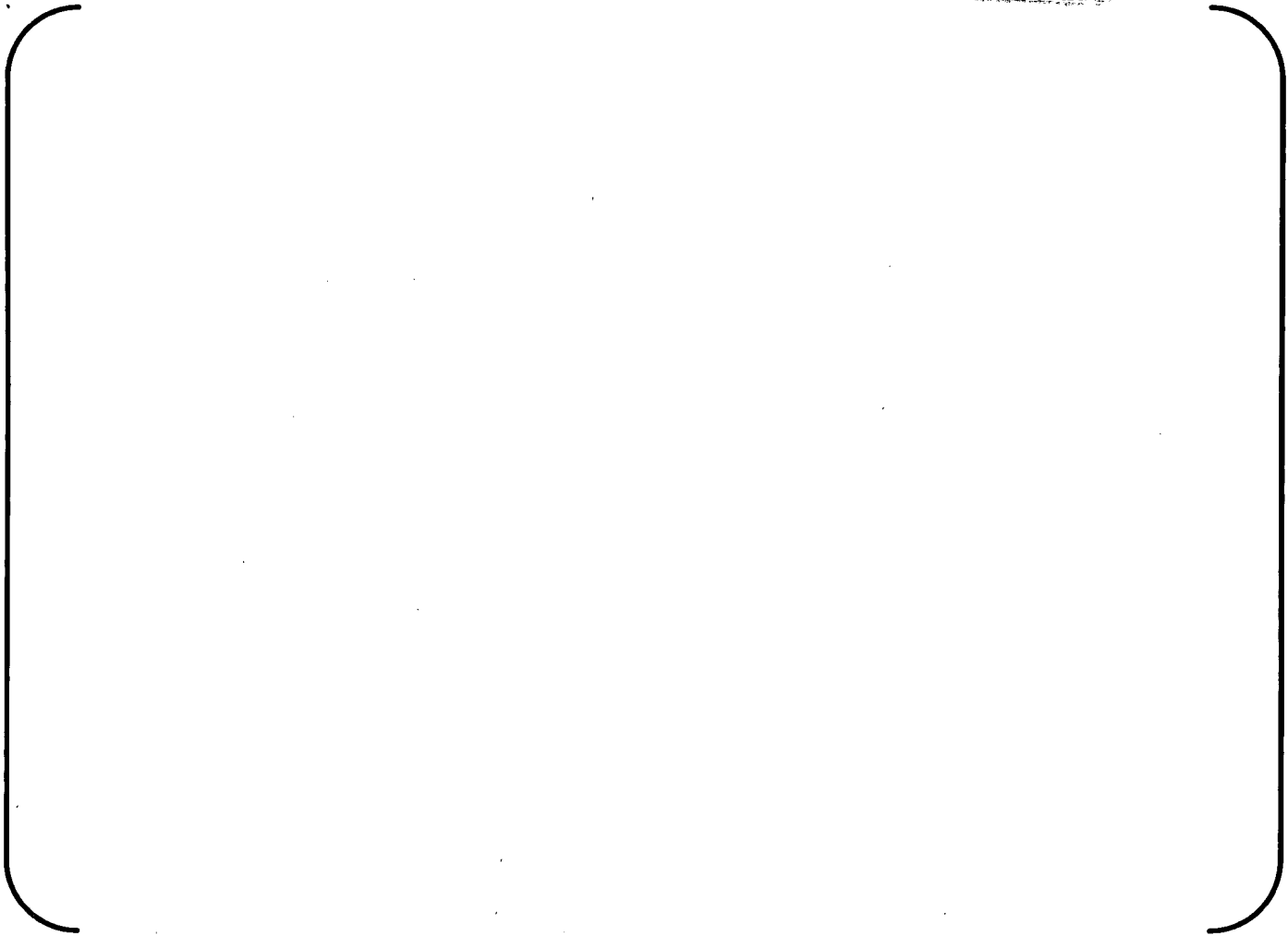
babcock & wilcox nuclear power generation



[CCI per Affidavit 4(a)-(d)]

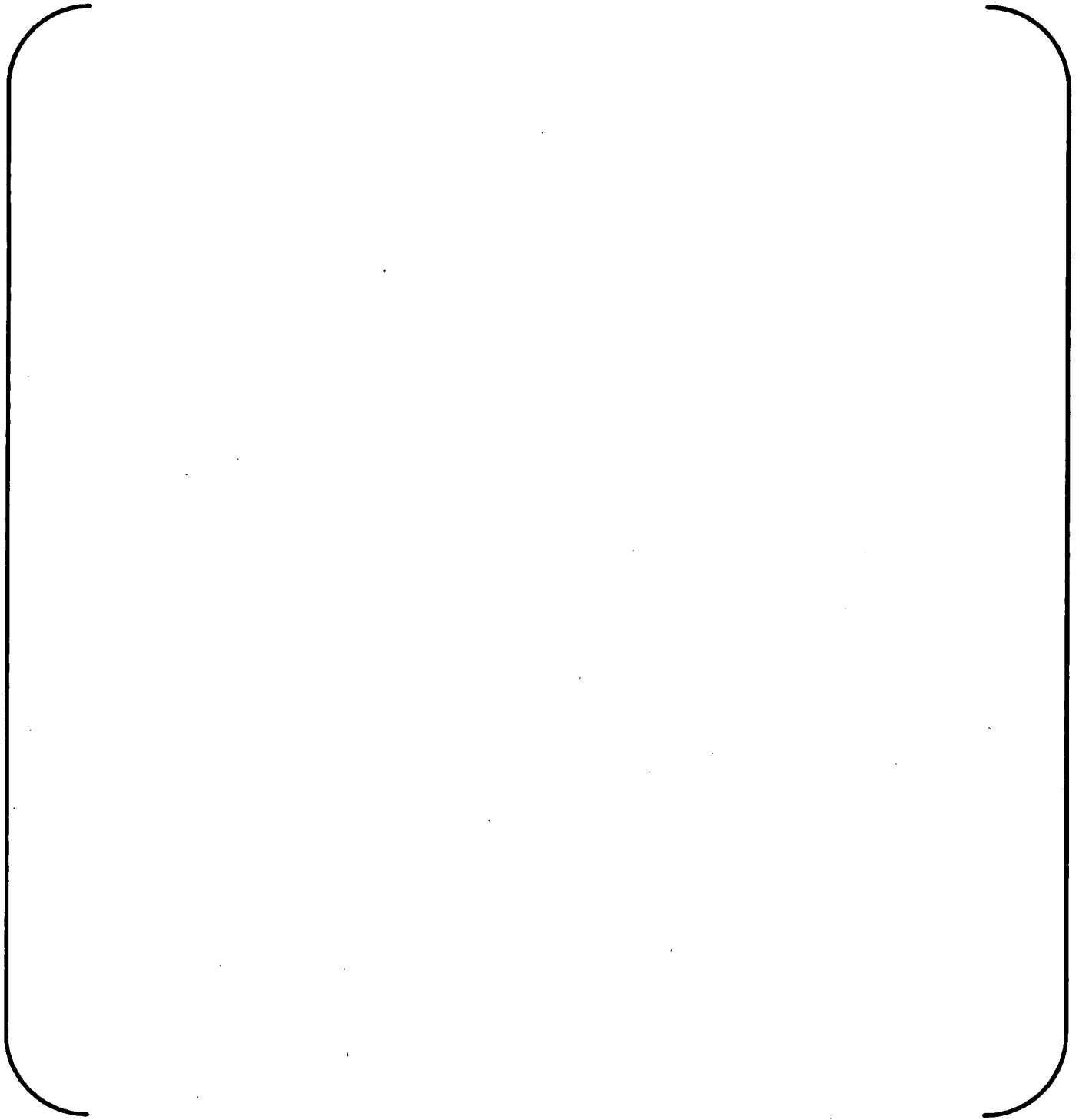
babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]



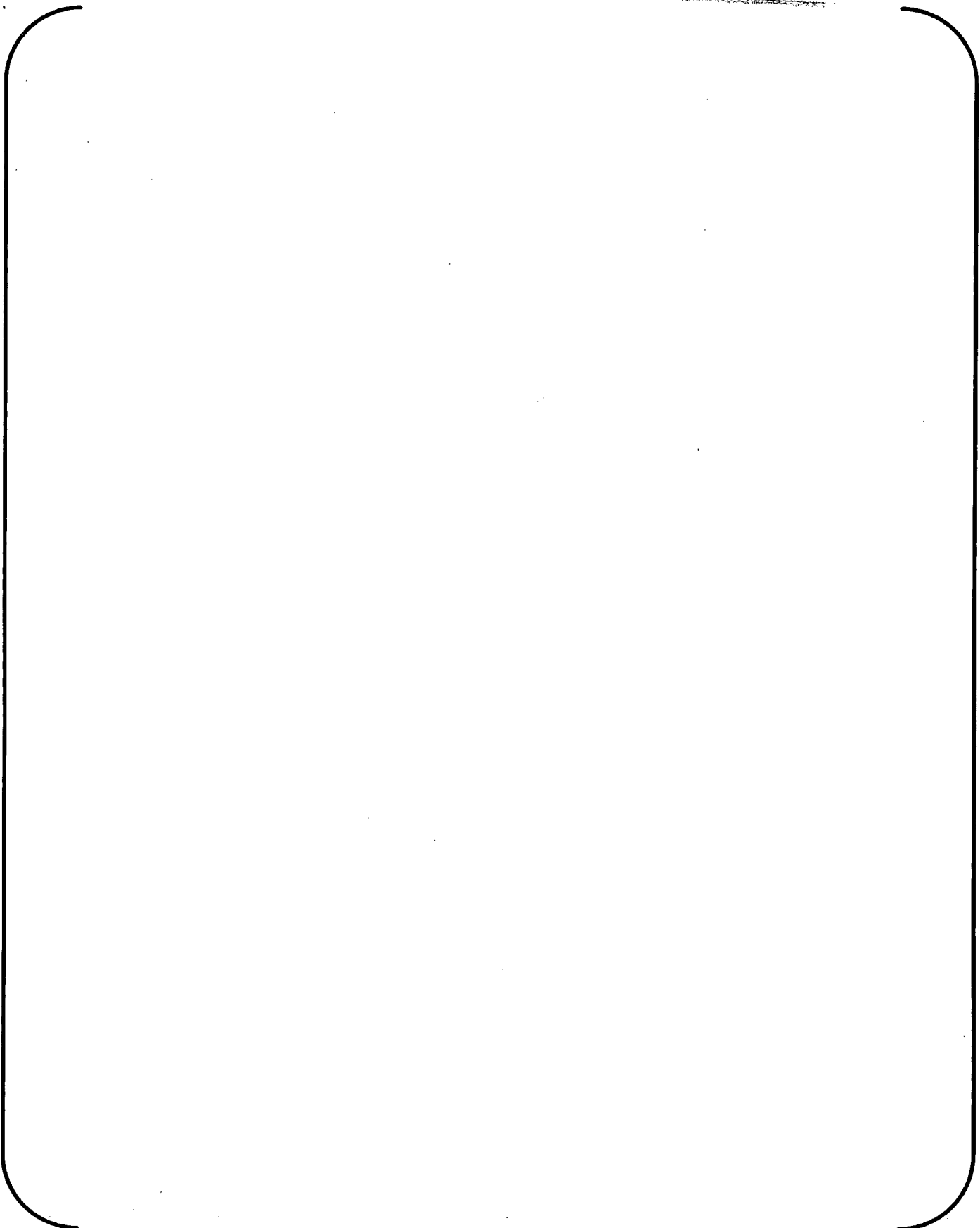
[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation



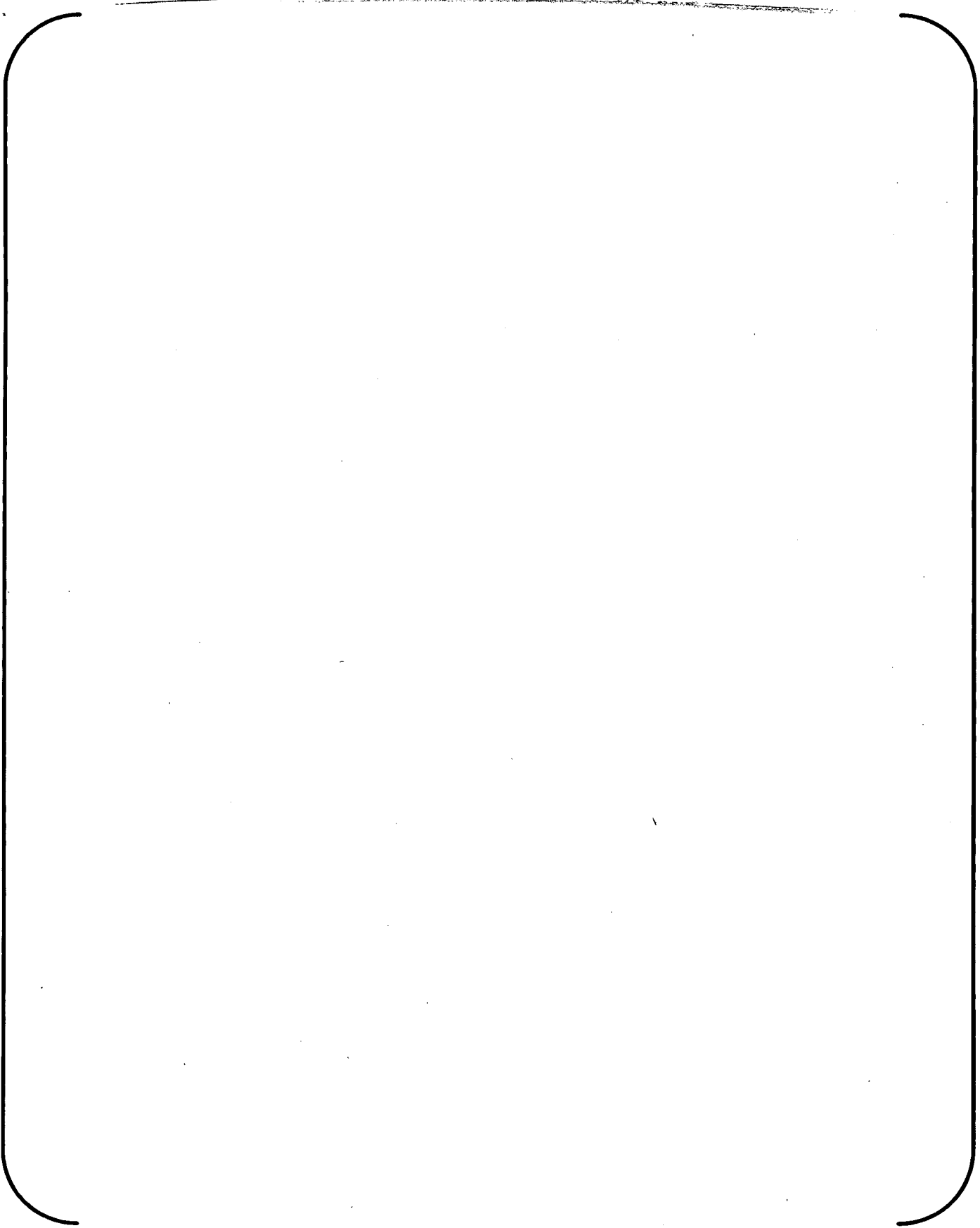
[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation

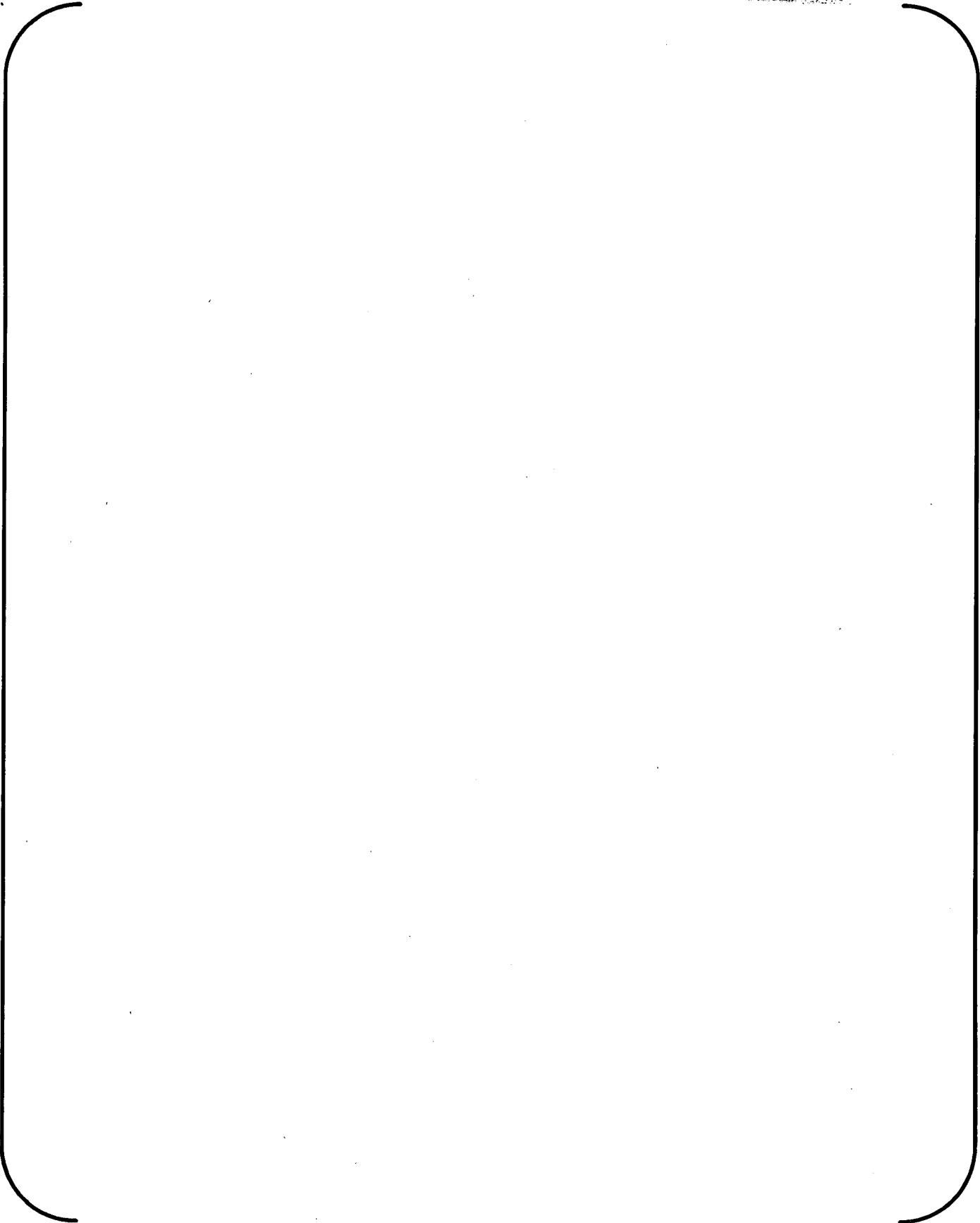




babcock & wilcox nuclear power generation



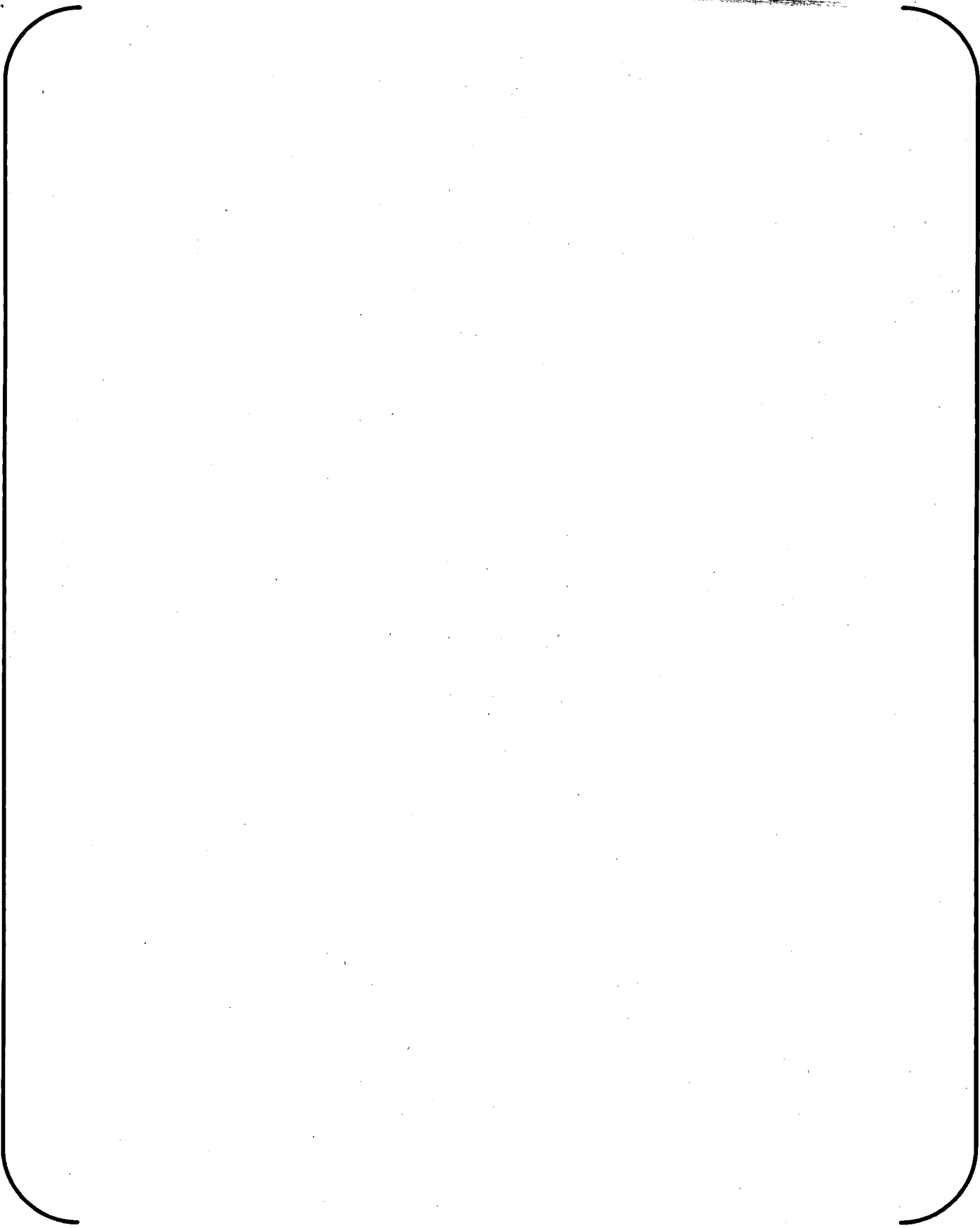
babcock & wilcox nuclear power generation



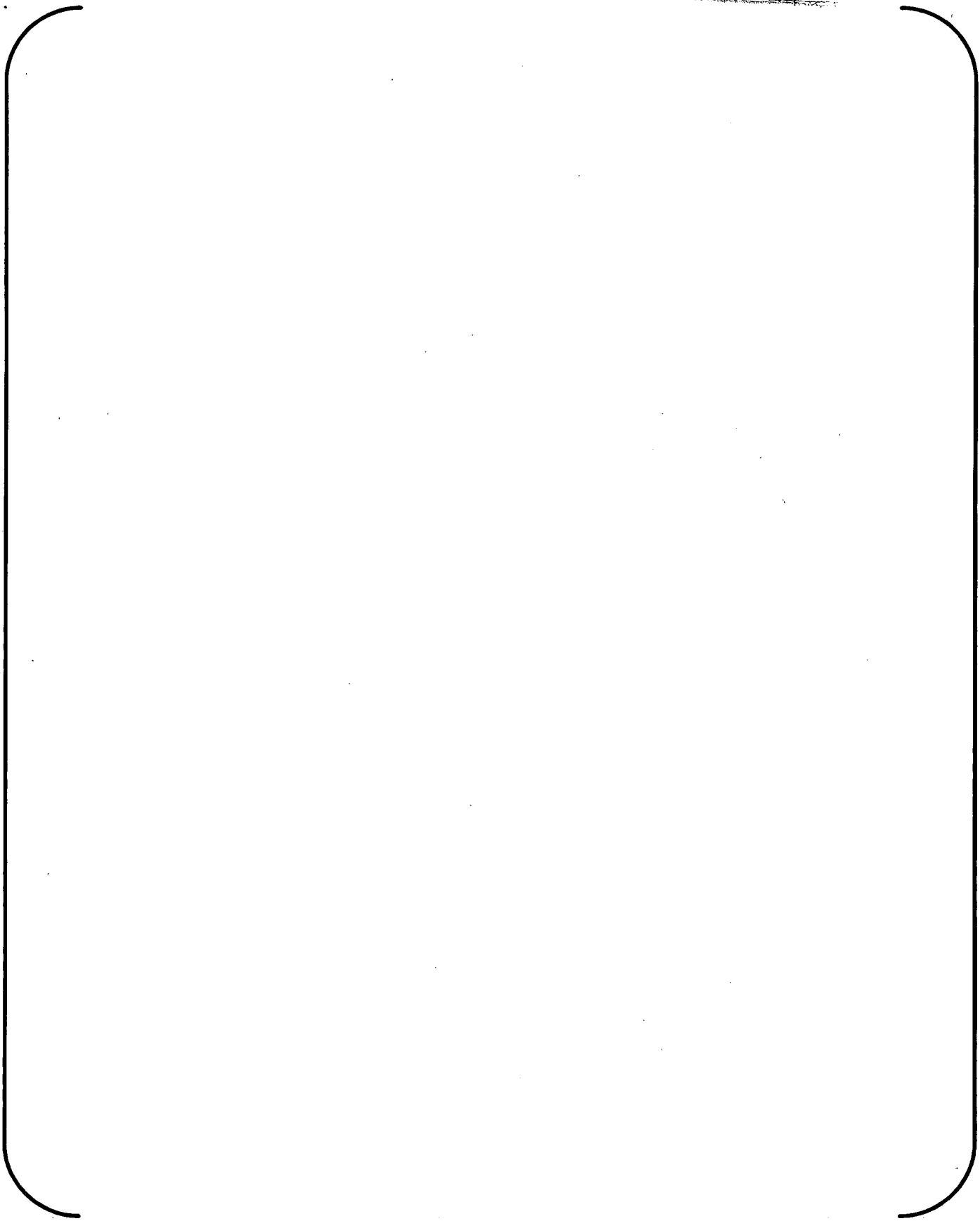
babcock & wilcox nuclear power generation

[CCI per Affidavit 4(a)-(d)]

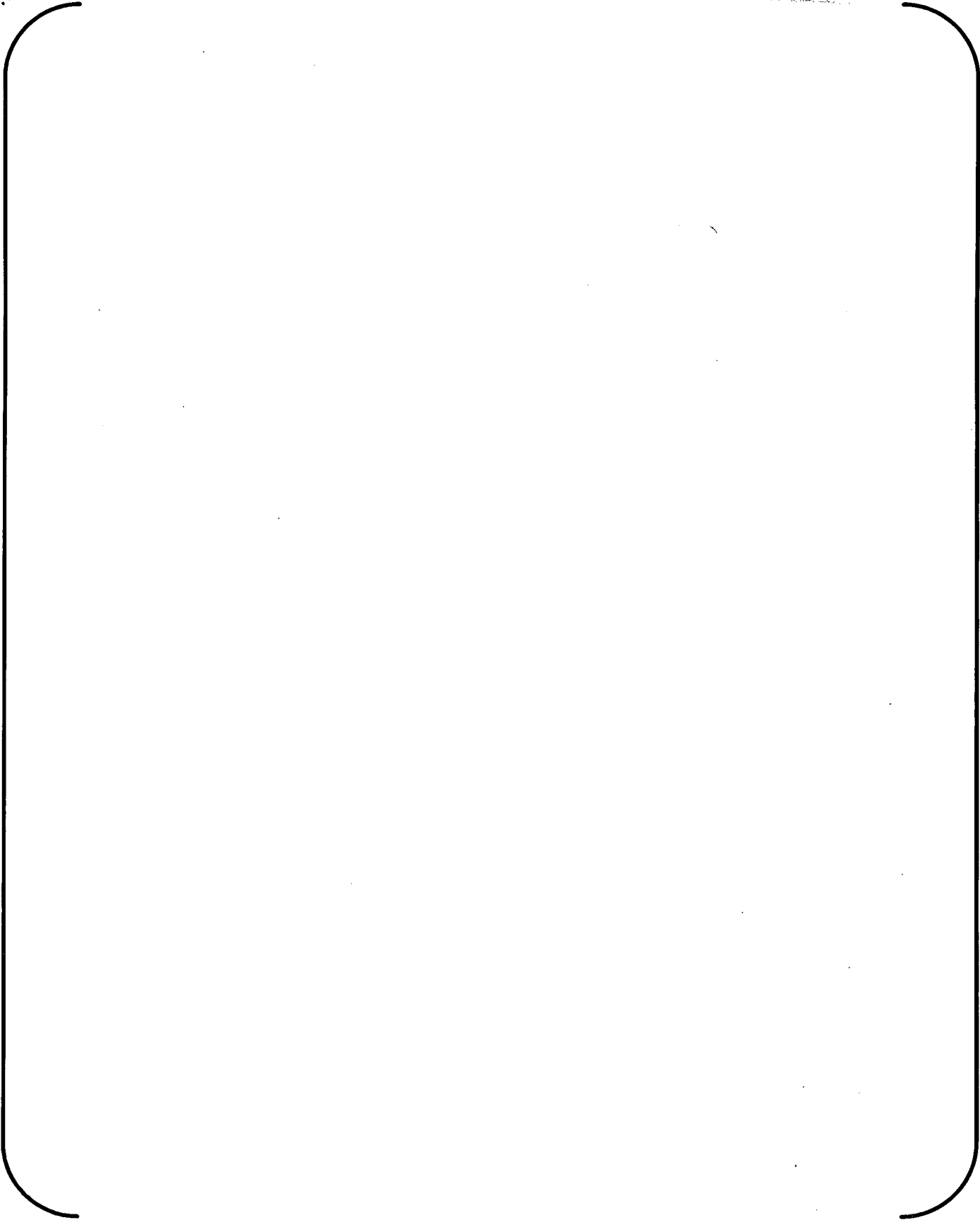
babcock & wilcox nuclear power generation



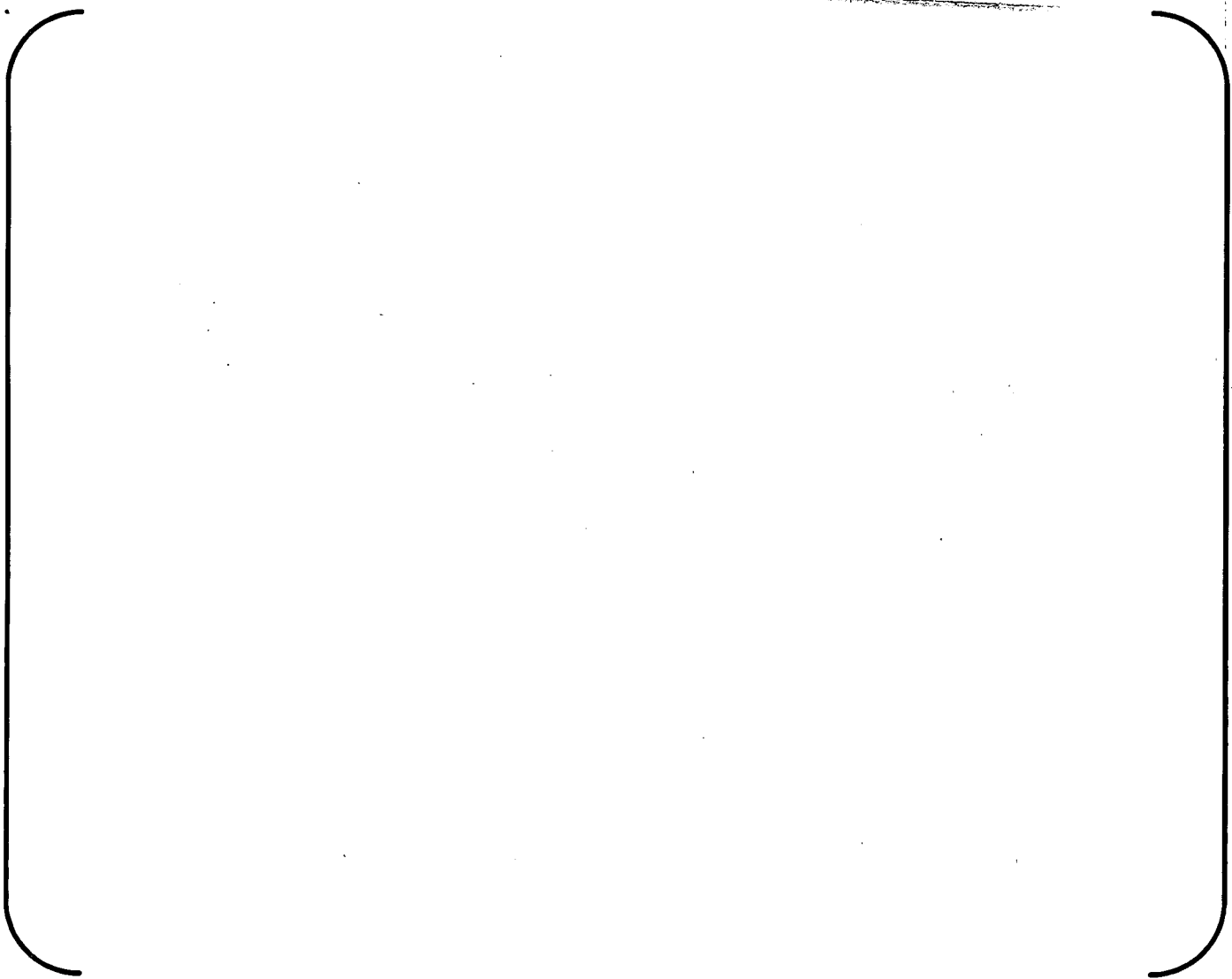
babcock & wilcox nuclear power generation



babcock & wilcox nuclear power generation

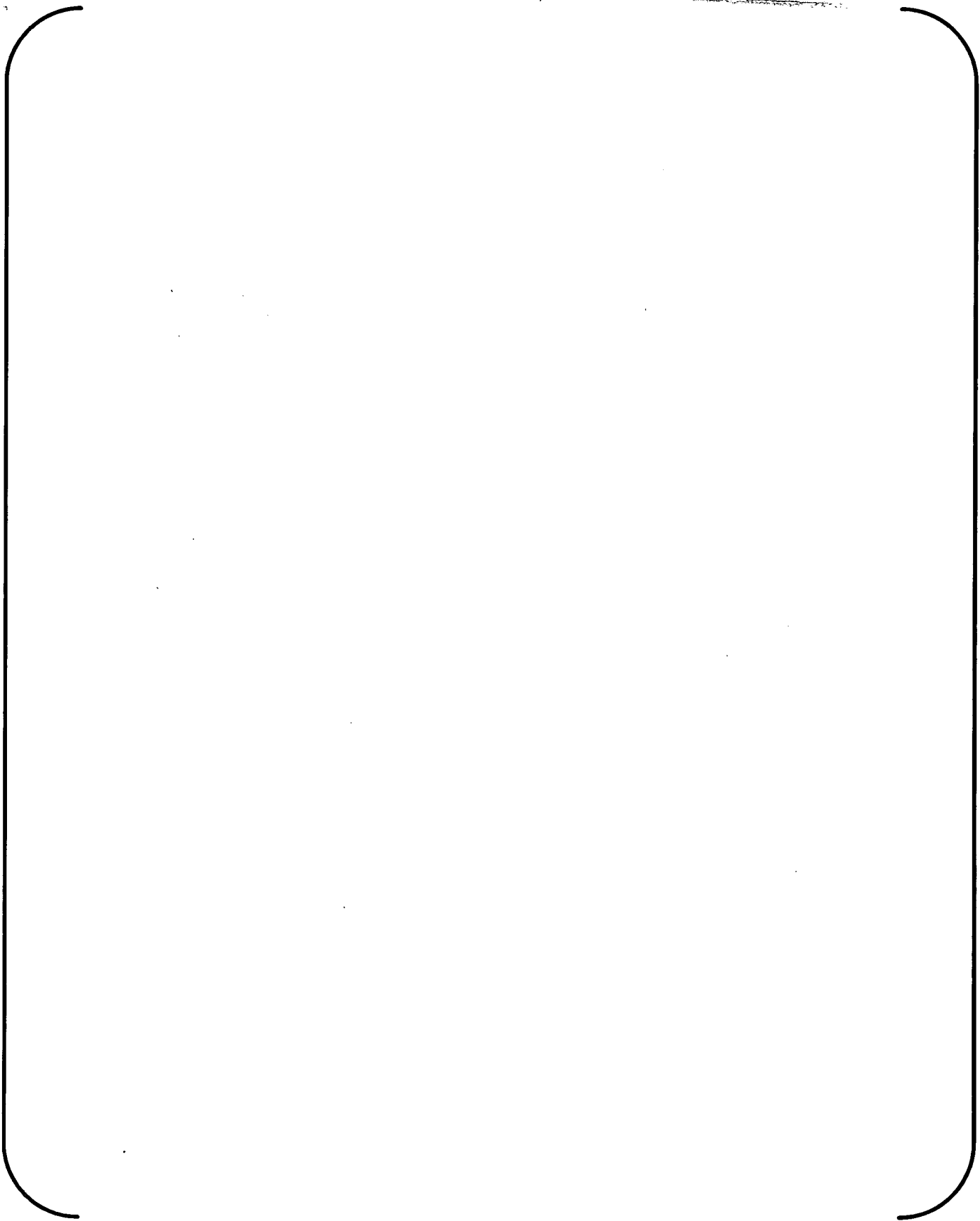


babcock & wilcox nuclear power generation



[CCI per Affidavit 4(a)-(d)]

babcock & wilcox nuclear power generation





# IST Technical Report

- Summary
- Function and Design Requirements
- System Design Description
  - Core Simulator
  - Steam Generator
  - Pressurizer
  - Pump Simulator
  - Pipe Sections
- Engineered Safety Features
- BOP Simulation
- Instrumentation for Control and Protection Systems
- IST Strong Back
- System and Component Testing Requirements
- References

# Status/Conclusions

- IST Technical Report scheduled for submission to NRC in June 2010

[CCI per Affidavit 4(a)-(d)]