ENCLOSURE 4

Westinghouse Non-Proprietary Class 3

"AP1000 Shield Building Modifications" Presentation – (Non-Proprietary)

AP1000

Overview of Westinghouse Response

Westinghouse

Shaw™

AP1000

Purpose and Objectives

- For Westinghouse: To provide a clear description of their (Westinghouse) integrated design process and the status of the progress made through this process including design modifications. (Non-Proprietary)
- To provide expectations of the schedule for a submittal from Westinghouse responding to the issues contained in the October 15, 2006 NRC letter. (Non-Proprietary)
- To achieve a full understanding on the part of Westinghouse of the scope and breadth of the technical issues that require resolution. (Proprietary)
- To provide the NRC with the Westinghouse plans for providing the appropriate level of detail, including design modifications, in the shield building deliverable to respond to the issues identified in the October 15, 2009 NRC letter. (Proprietary)
- To achieve a full understanding on the part of NRC of the scope and breadth of testing that will be performed to demonstrate the adequacy of the proposed design features. (Proprietary)

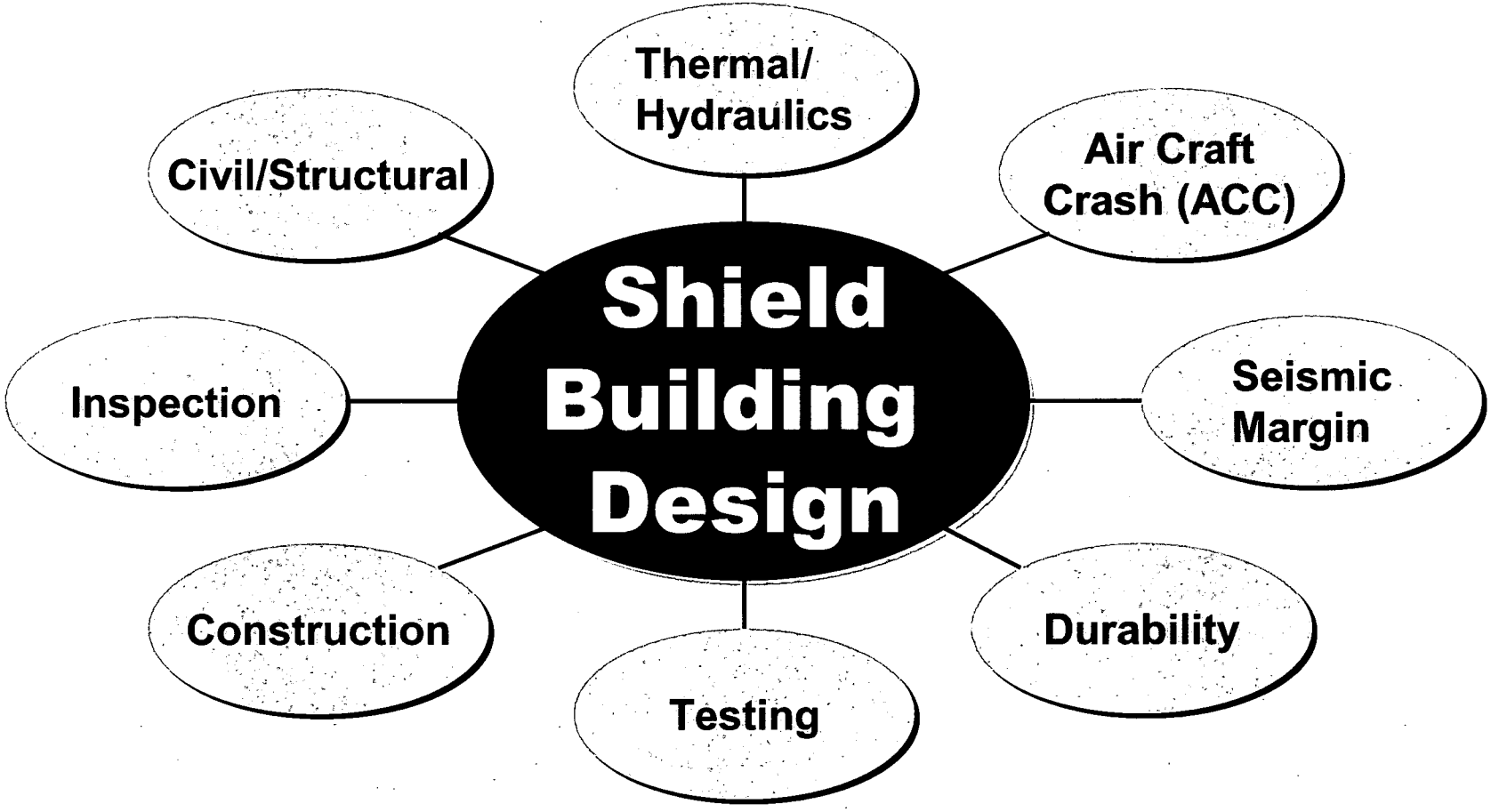
Shield Building Organizational Chart

AP1000

a, c

AP1000

Integrated Design Process



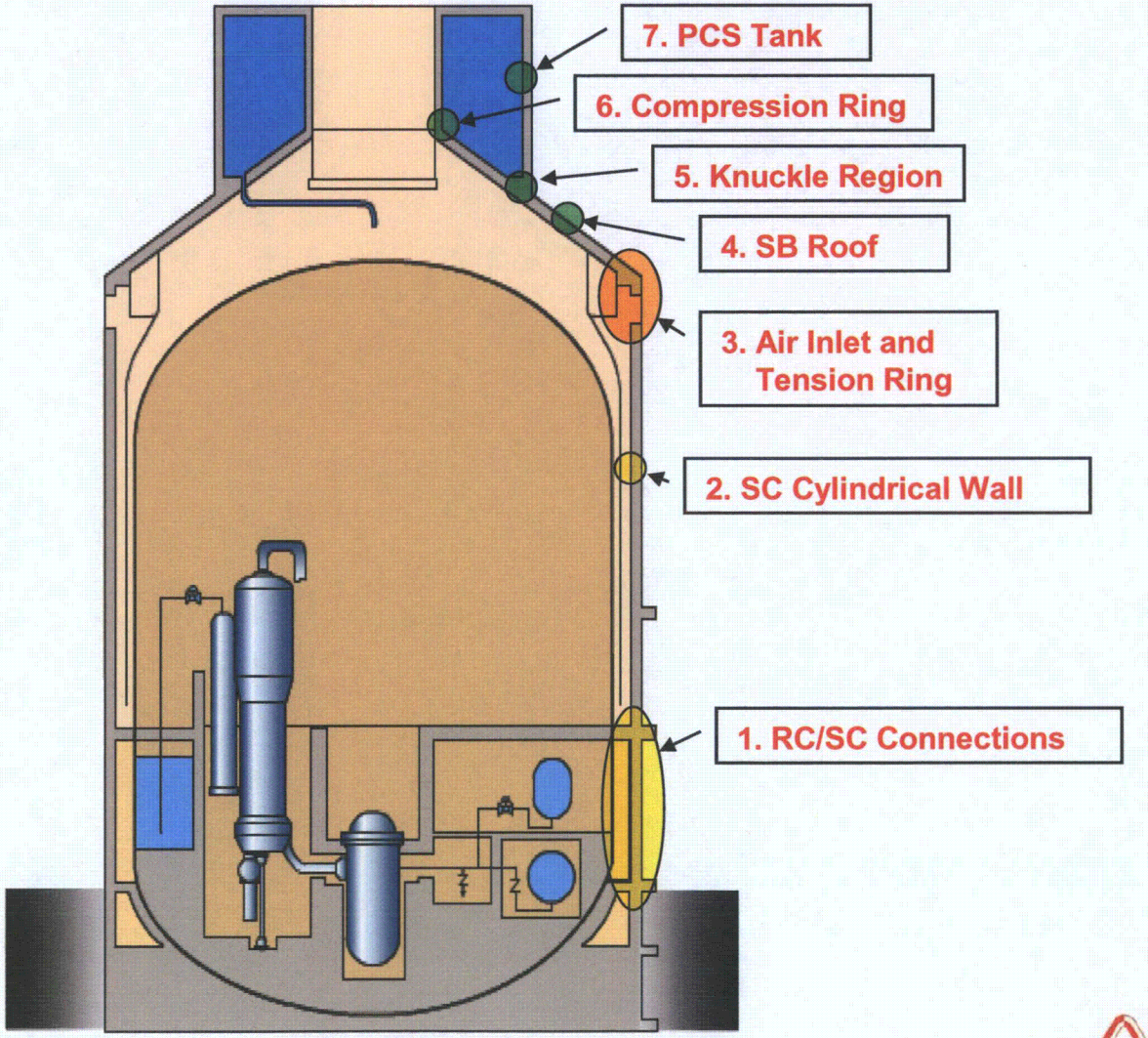
Westinghouse

Shaw™

Shield Building Design Changes

AP1000

- Added Shear Reinforcing Tie Bars that tie the entire SC structure together so that the Shield Building acts as a single unit
- Increased SC plate thickness and changed to a more ductile material to improve its strength, ductility and resistance to buckling
- Simplified air-inlet design to increase its structural integrity and to improve the SC-RC connection to the RC roof design
- Reduced the use of Self-Consolidating Concrete



Westinghouse

Shaw

Comprehensive Test Plan

AP1000

a, c

Summary of Construction & Inspection Issues

AP1000

- Shaw construction is an integrated participant in the design of the AP1000 structures
- Shaw construction is developing an extensive mock-up plan for the Shield Building to ensure that the as-constructed Shield Building meets design requirements - Successful mockups validate placement procedures

a, c

[●

]

- Procedures, workmanship and quality control ensure best available construction practices

a, c

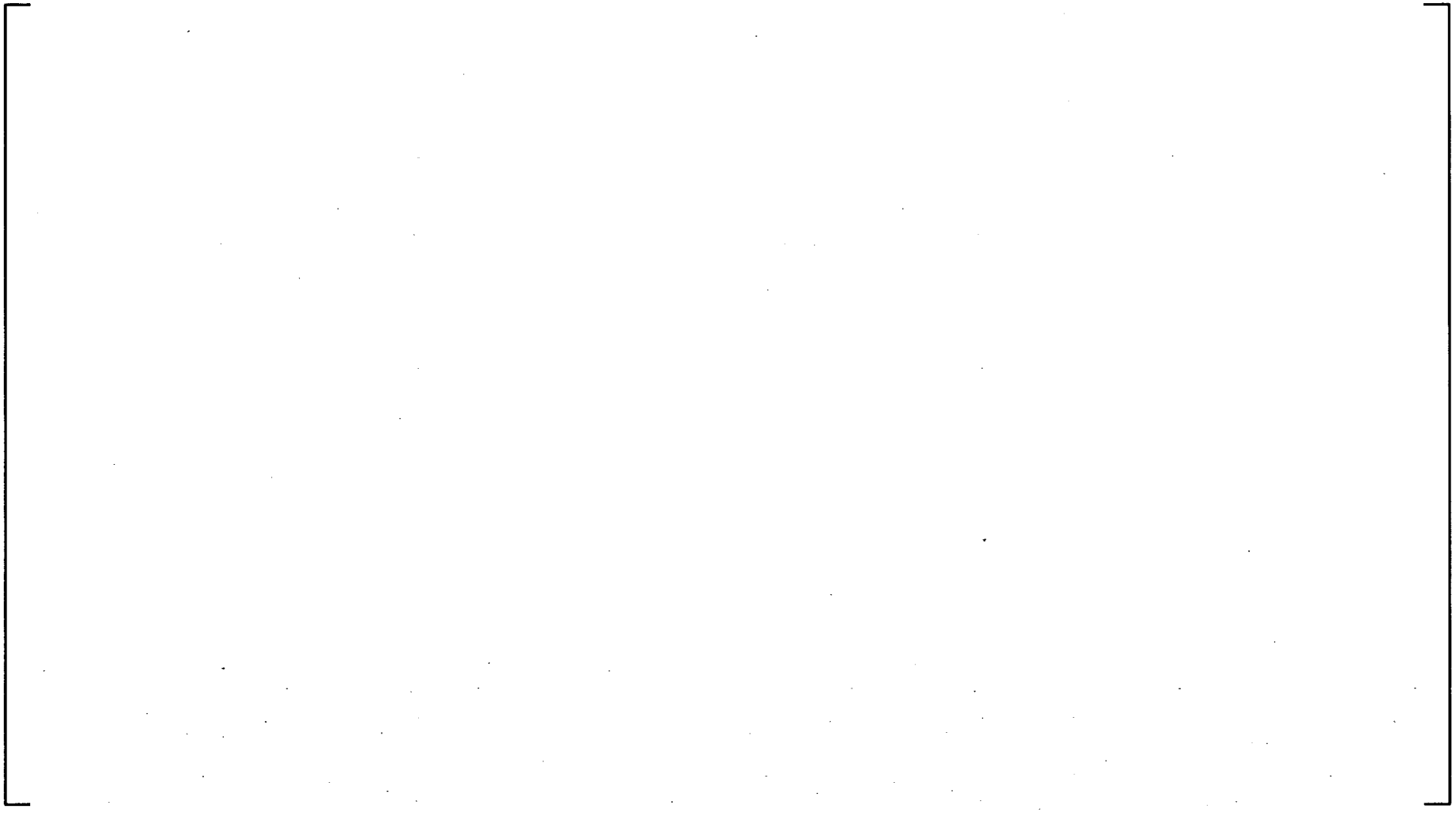
[●

]

Shield Building

AP1000

a, c



Schedule for Westinghouse Submittals

AP1000

• Revised Shield Building Report	January 2010
• Seismic Report	February 2010
• Hard Rock High Frequency Report	February 2010
• Shield Building Chapter 3	February 2010
• Revised DCD Chapter 6	December 2009
• Revised DCD Chapter 19F	January 2010
• Test Summary Report	March 2010

AP1000

Design Process for the AP1000 Shield Building

Design Process

AP1000

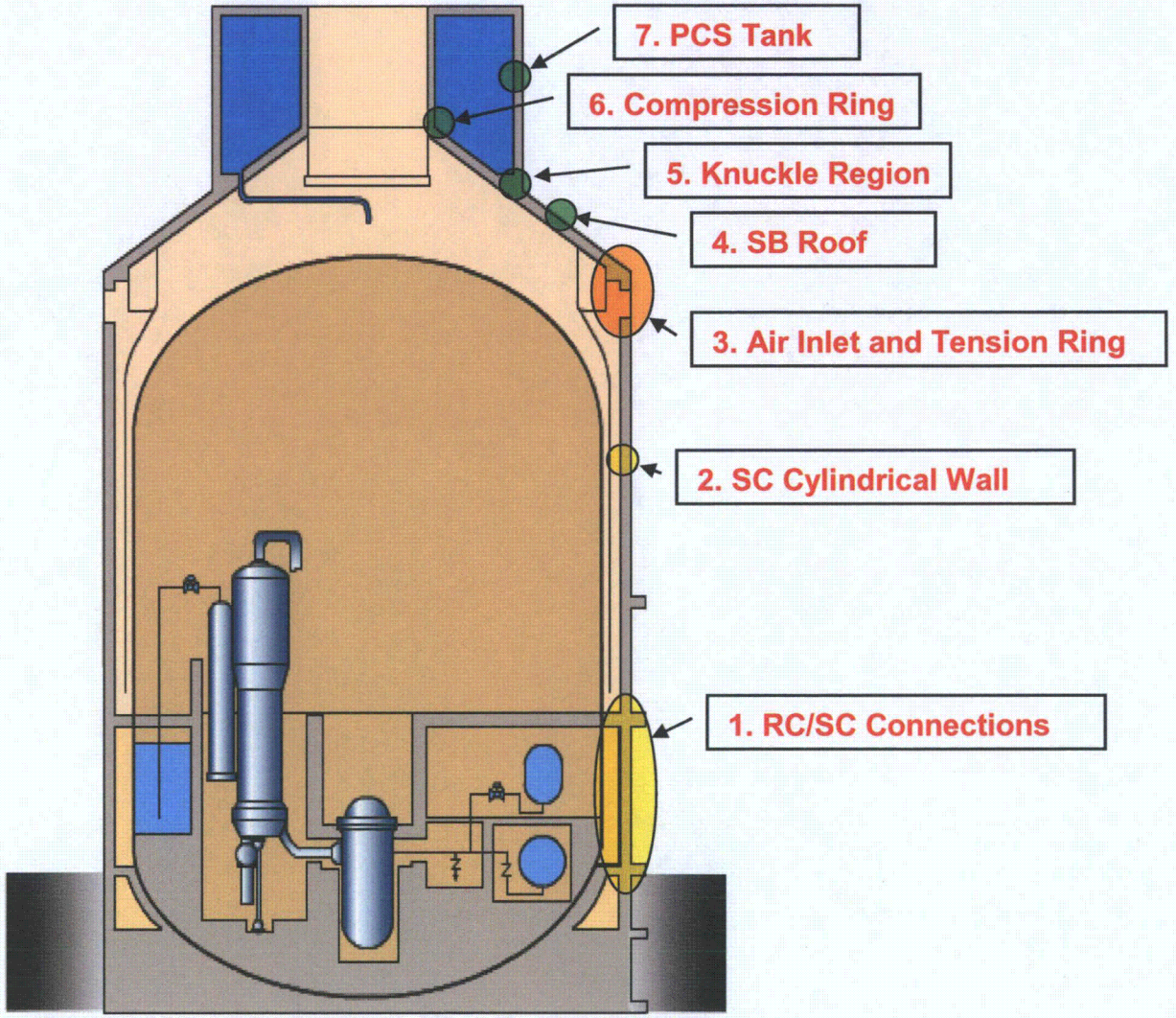
a, c

Shield Building Design Process

AP1000

Functions:

- Radiation shielding
- Missile barrier
- Passive Containment Cooling
- Cylindrical section structurally supports the roof with the PCS water storage tank



Westinghouse

Shaw™

Design Considerations for the Steel Concrete Composite (SC)

AP1000

a, c

Westinghouse Design Process

AP1000

a, c

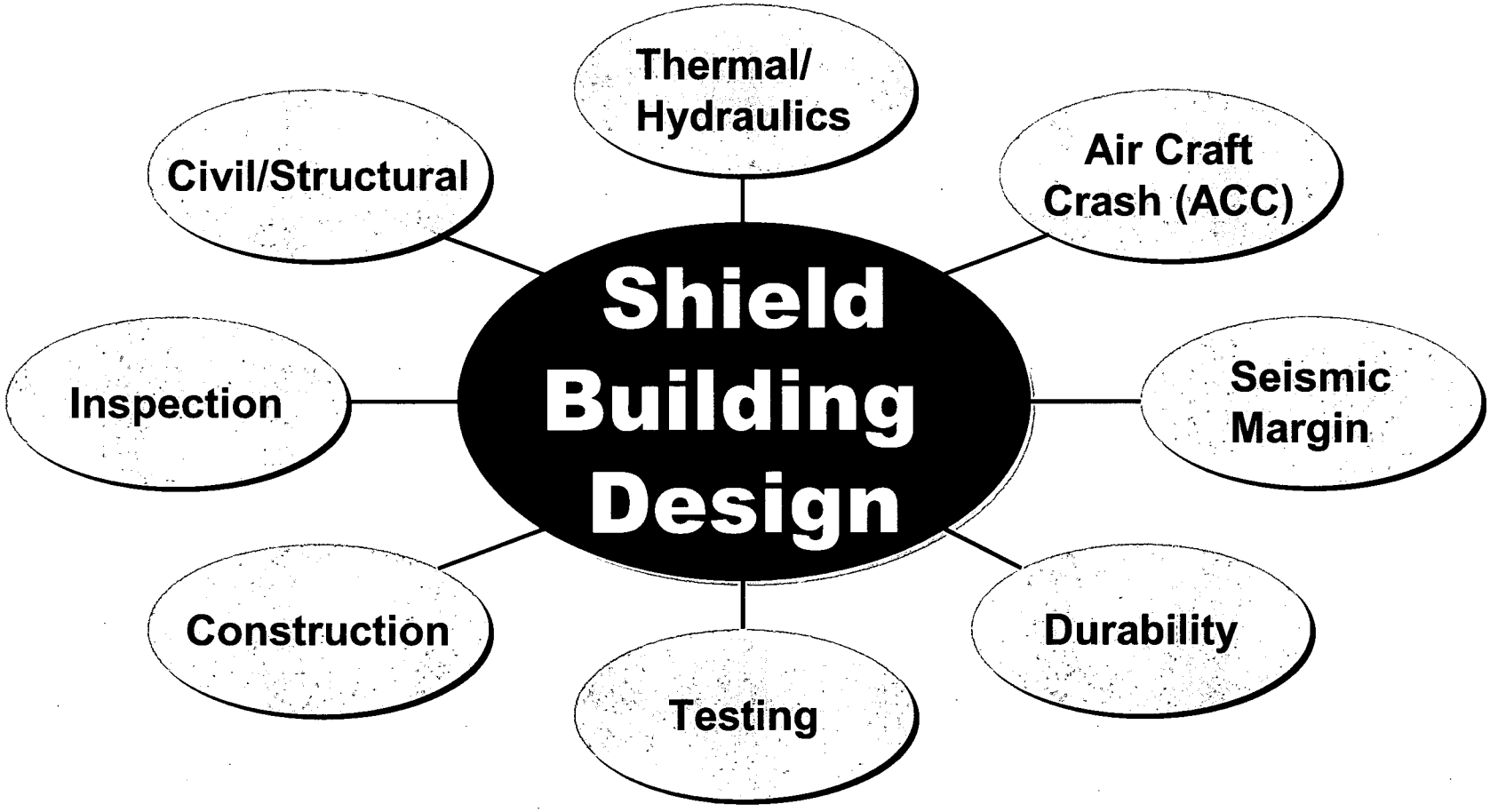
Analysis Methods

AP1000

a, c

Integrated Design Process

AP1000



AP1000

Design Process

- Westinghouse has evaluated all aspects of the Shield Building design process, including:
  - Loading
  - Design
  - Analyses methods
  - Testing
  - Construction and Inspection
- Westinghouse is reviewing detailing aspects of the shield building for compliance with both ACI 349 and ACI 318-08

Detailing

AP1000

a, c

Design Process Conservatisms

AP1000

a, c

AP1000

Design Process

- Westinghouse will include a section in the revised SB report on design margins

[–] a, c

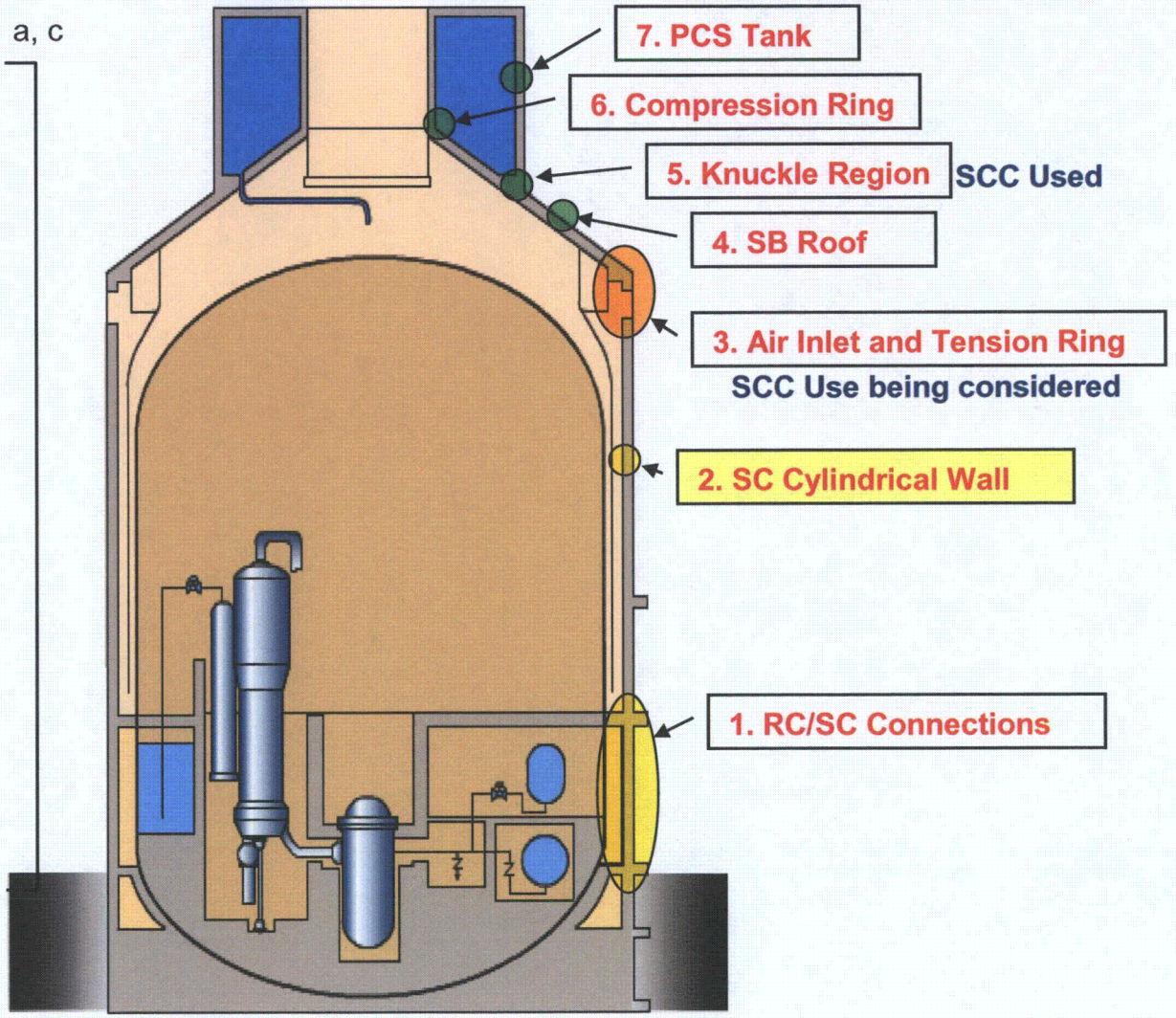
- Nonlinear analyses of the Shield Building will:

[– – –] a, c

Design Features

AP1000

a, c



Westinghouse

Shaw

Shield Building Wall

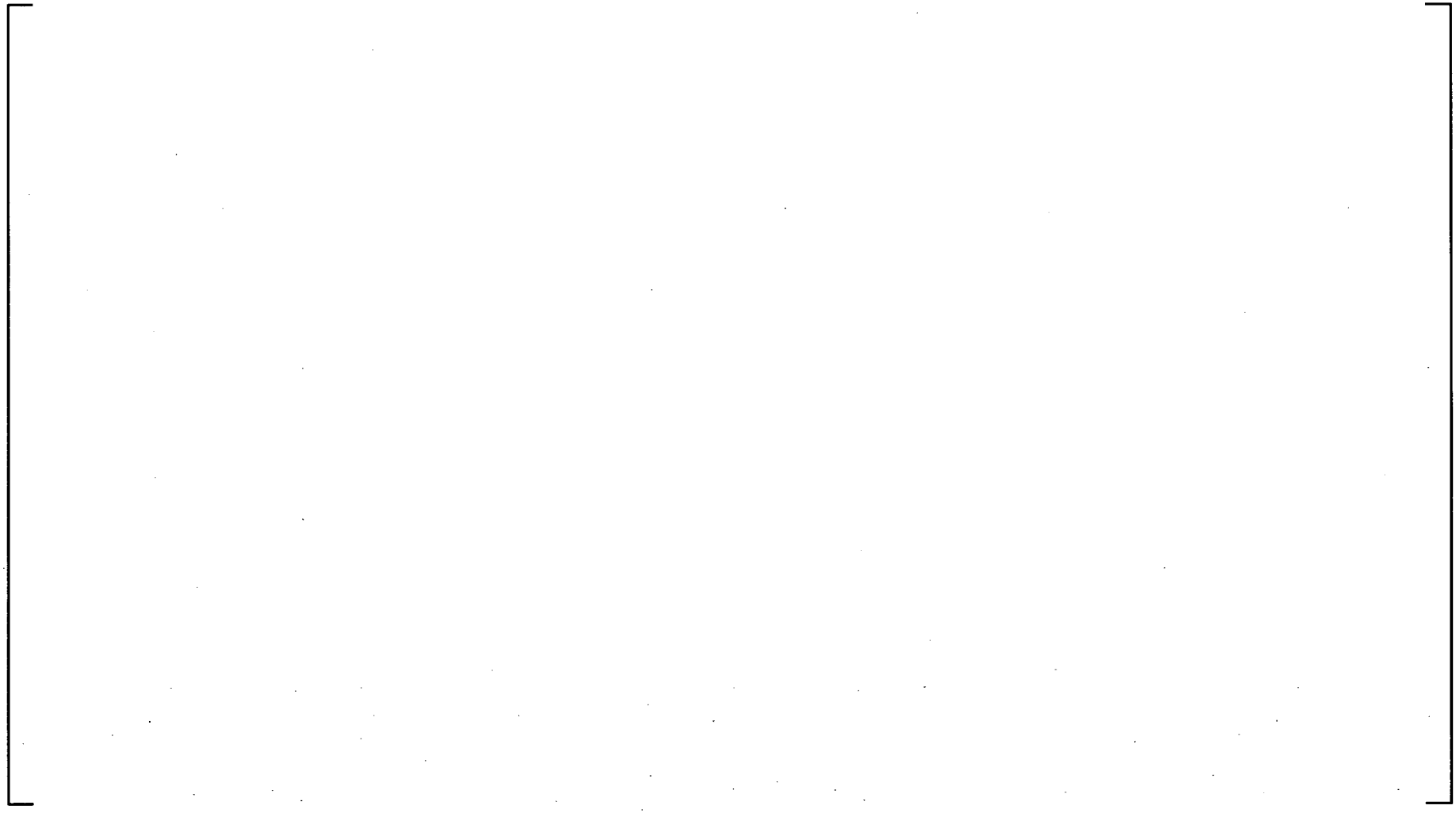
AP1000

a, c

Shield Building Cylindrical Wall

AP1000

a, c



Shield Building Wall Design Modifications

AP1000

a, c

Enhanced Shield Building Wall Panel Layout

AP1000

a, c

Shear Reinforcement Detail

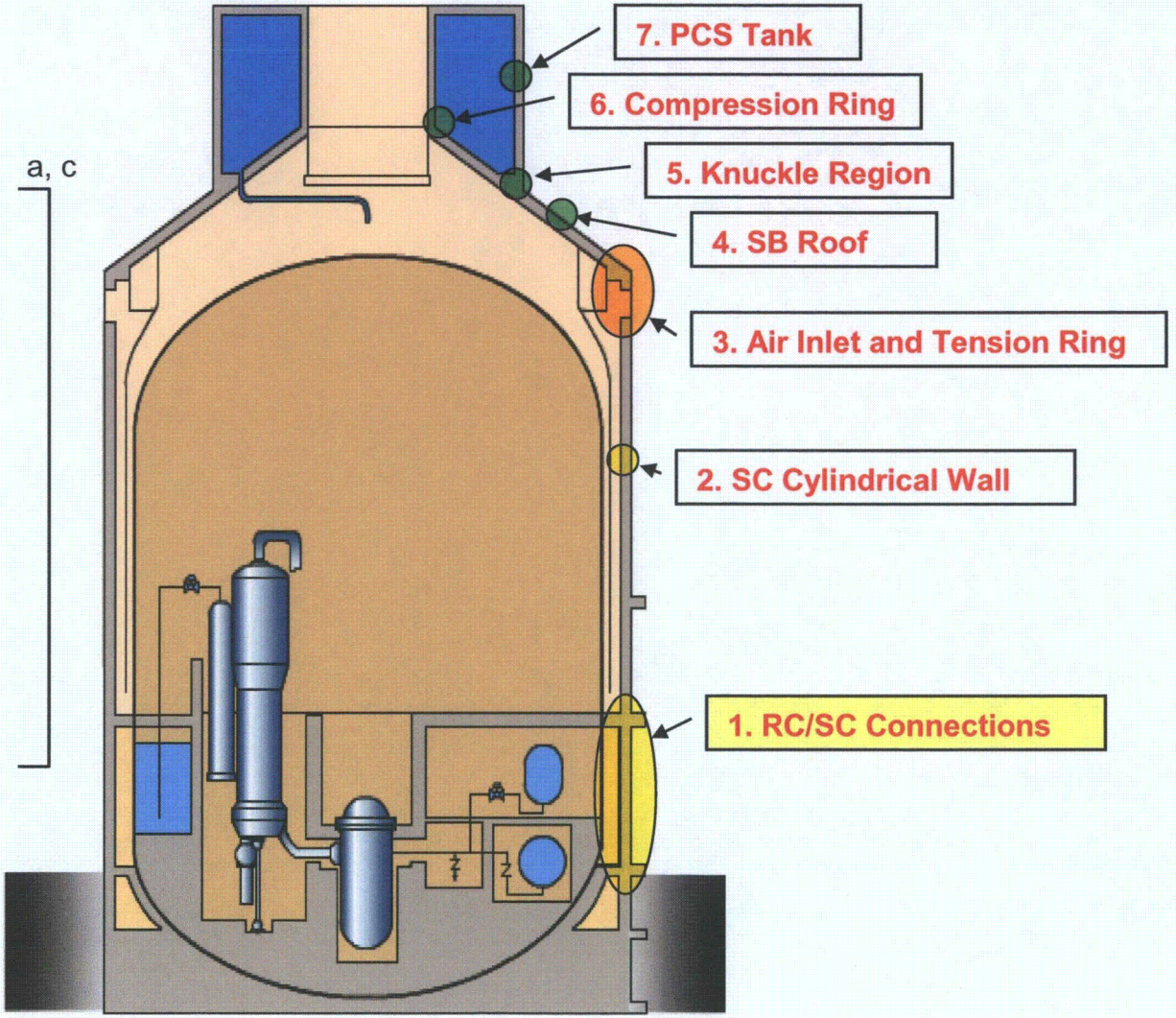
AP1000

a, c

Design Features

AP1000

a, c



Westinghouse

Shaw

West Wall Connection at Elevation 100

AP1000

a, c

AP1000

Plan View EL. 100' – Connection with Lower Shield Wall

a, c

Rebar Details Below EL. 100'

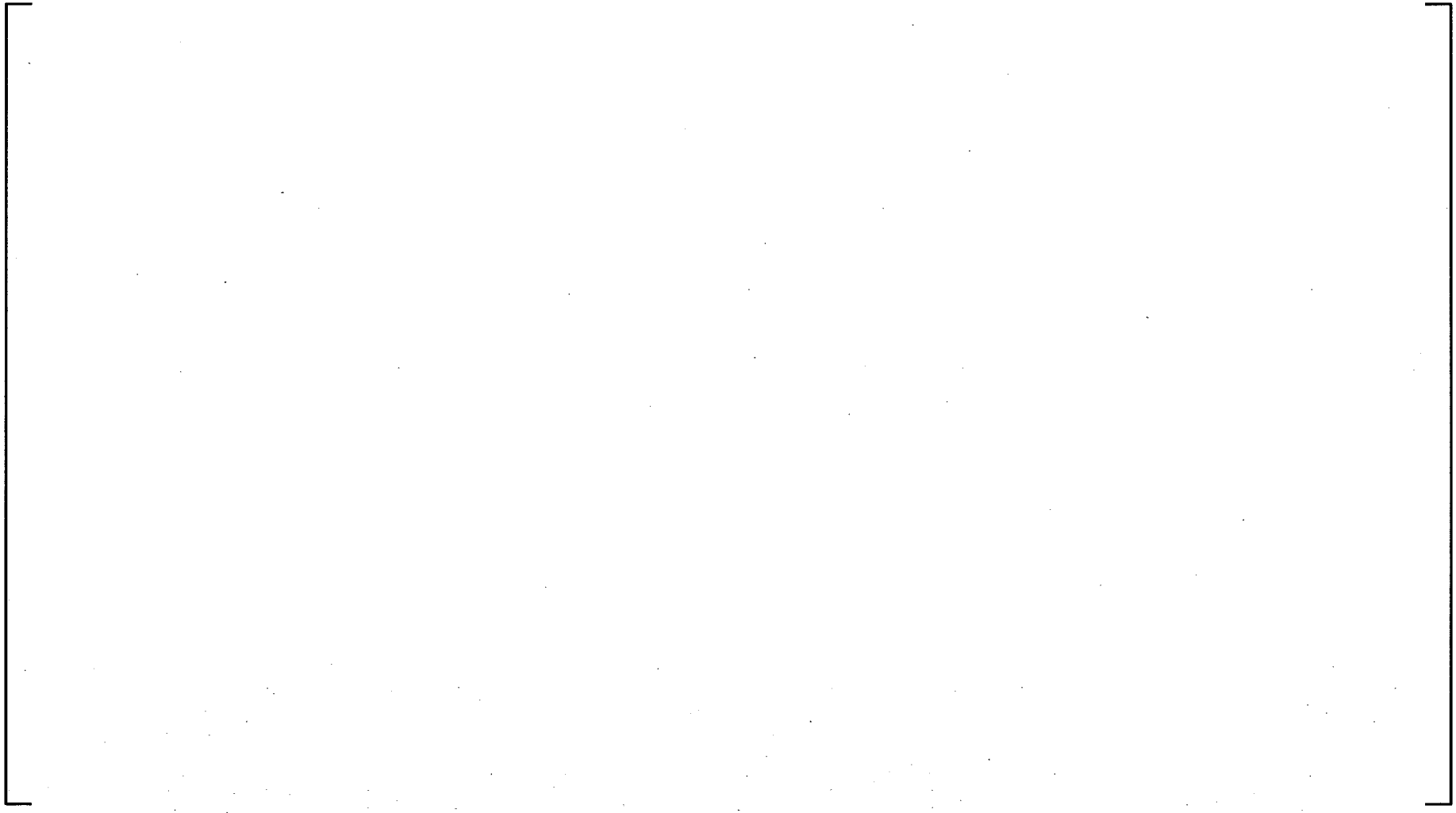
AP1000

a, c

Corner Connection Detail

AP1000

a, c



Shield Building Wall – Corner Detail Wall N/Q, EL. 100'

AP1000

a, c

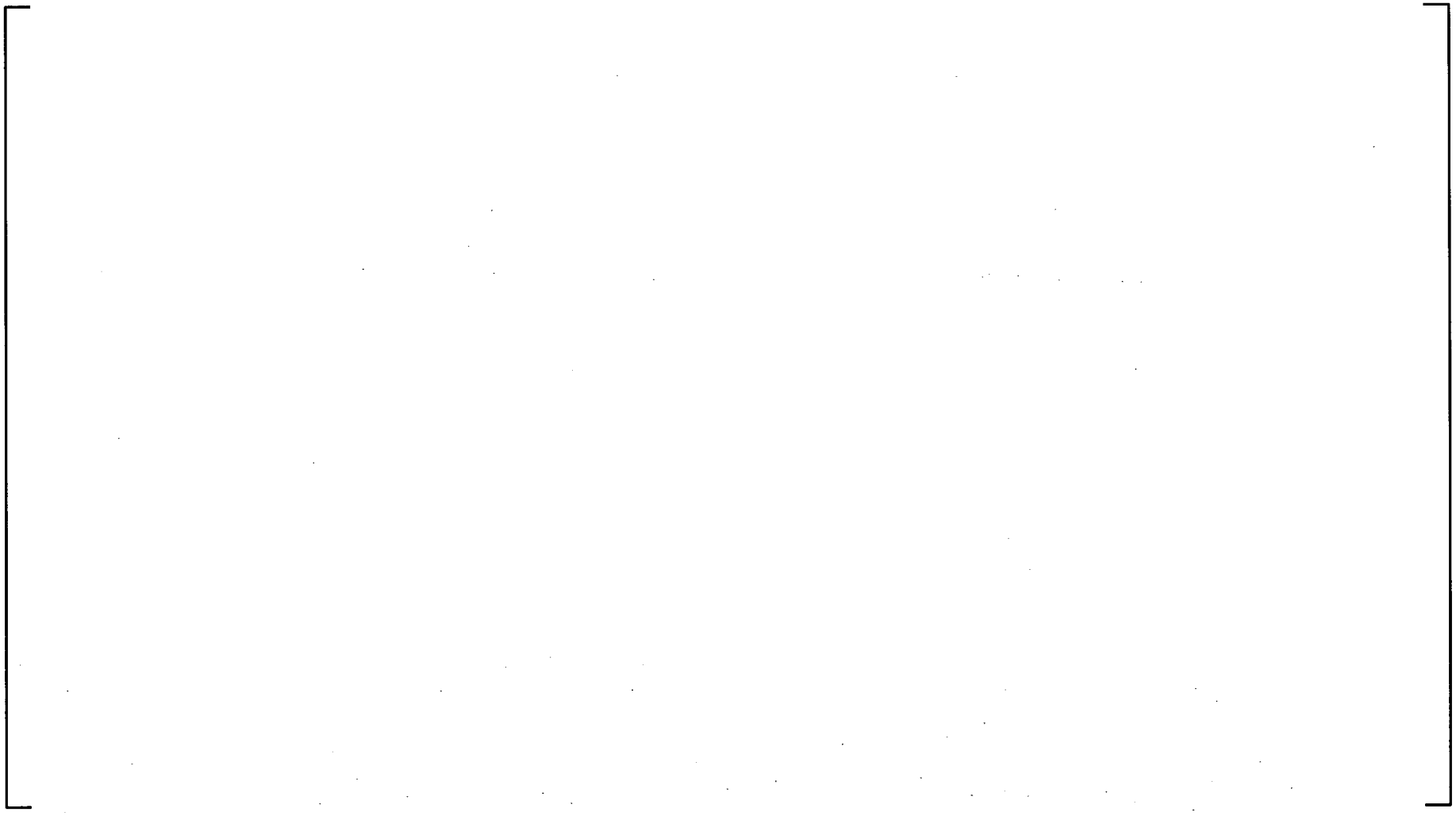
Shield Building Wall – Corner Detail Wall N/Q, EL. 100'

a, c

RC Wall Rebar Details

AP1000

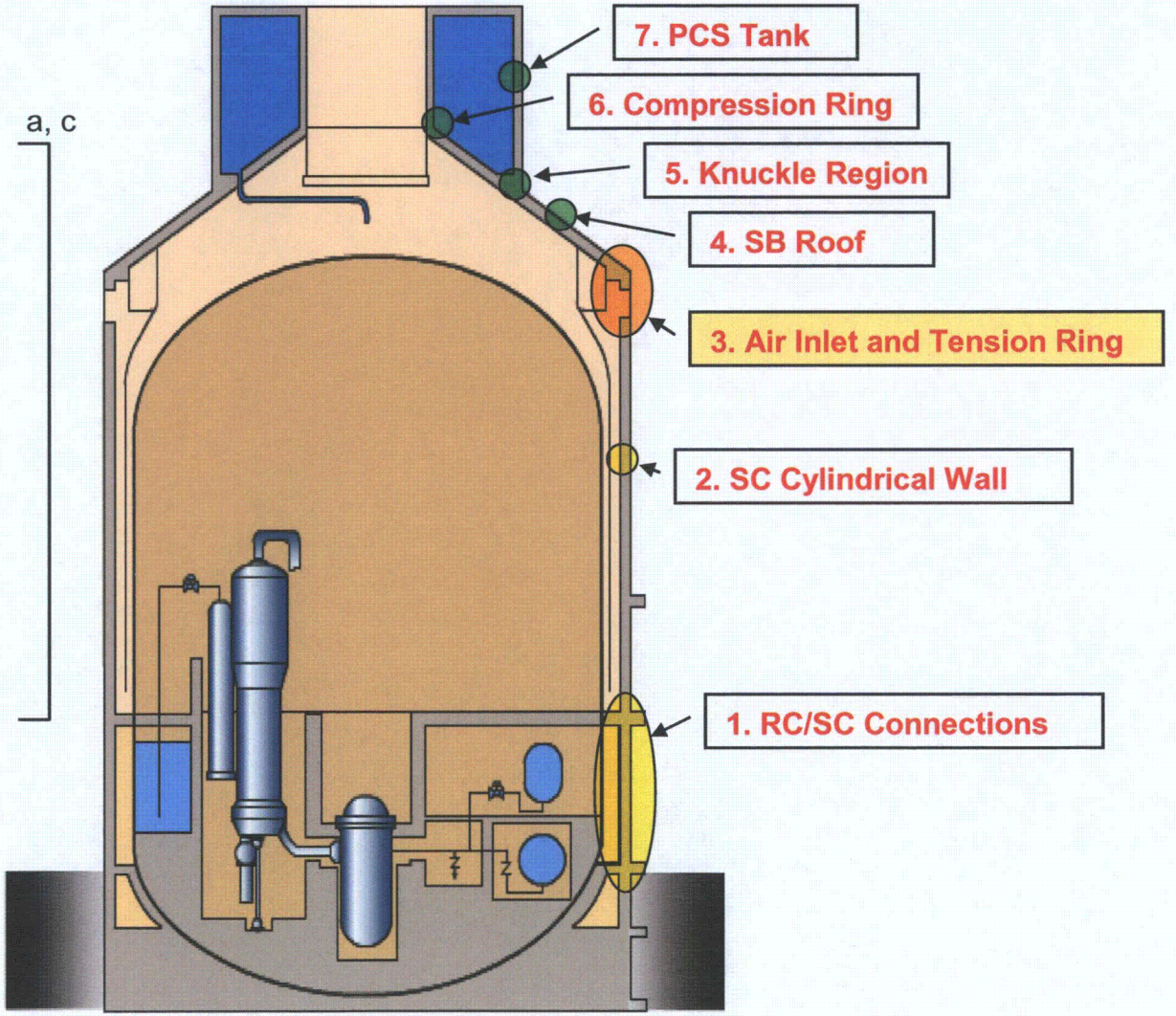
a, c



Design Features

AP1000

a, c



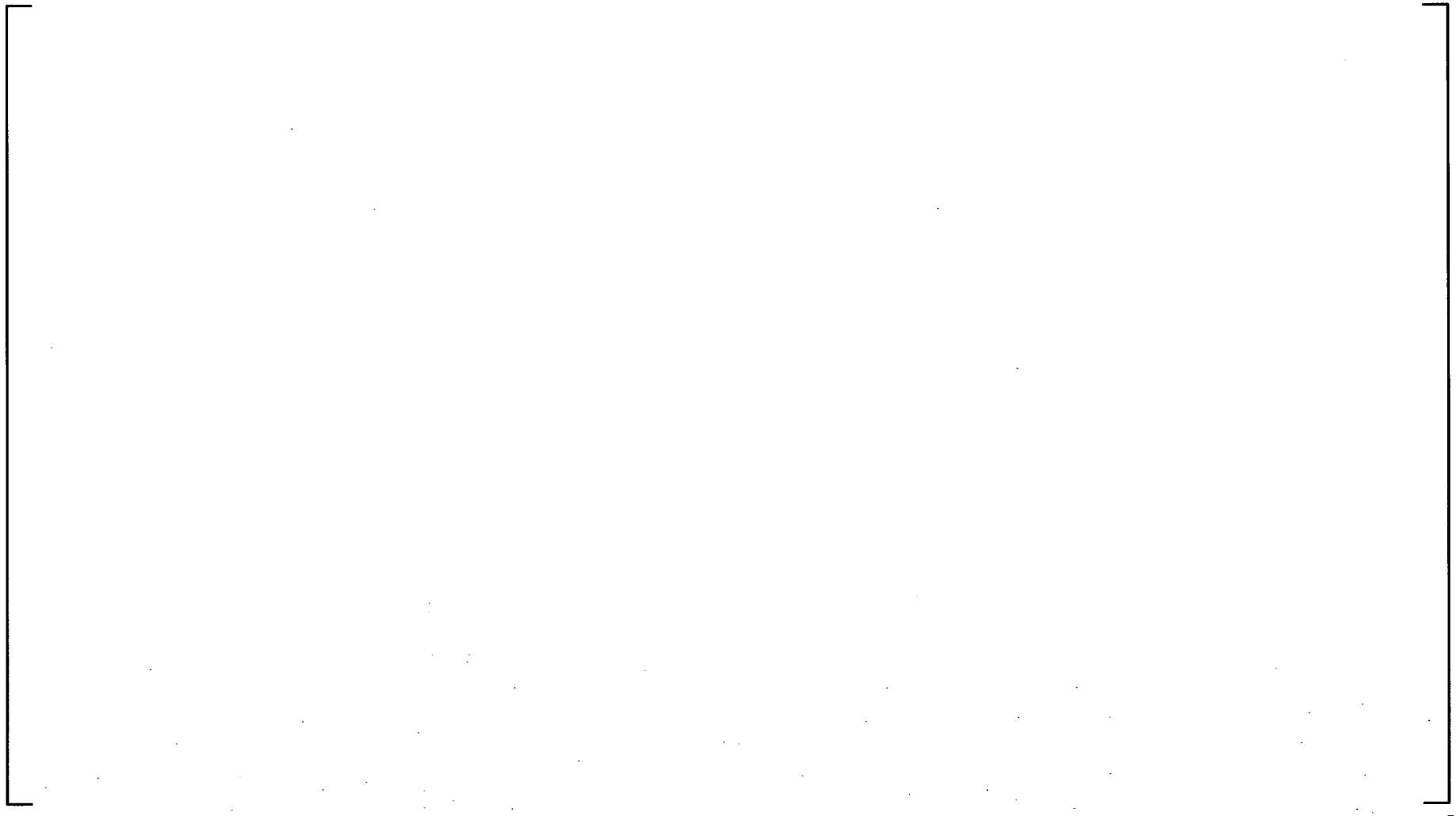
Westinghouse

Shaw™

Air Inlet Design Modifications

AP1000

a, c



Air Inlet Design Modifications

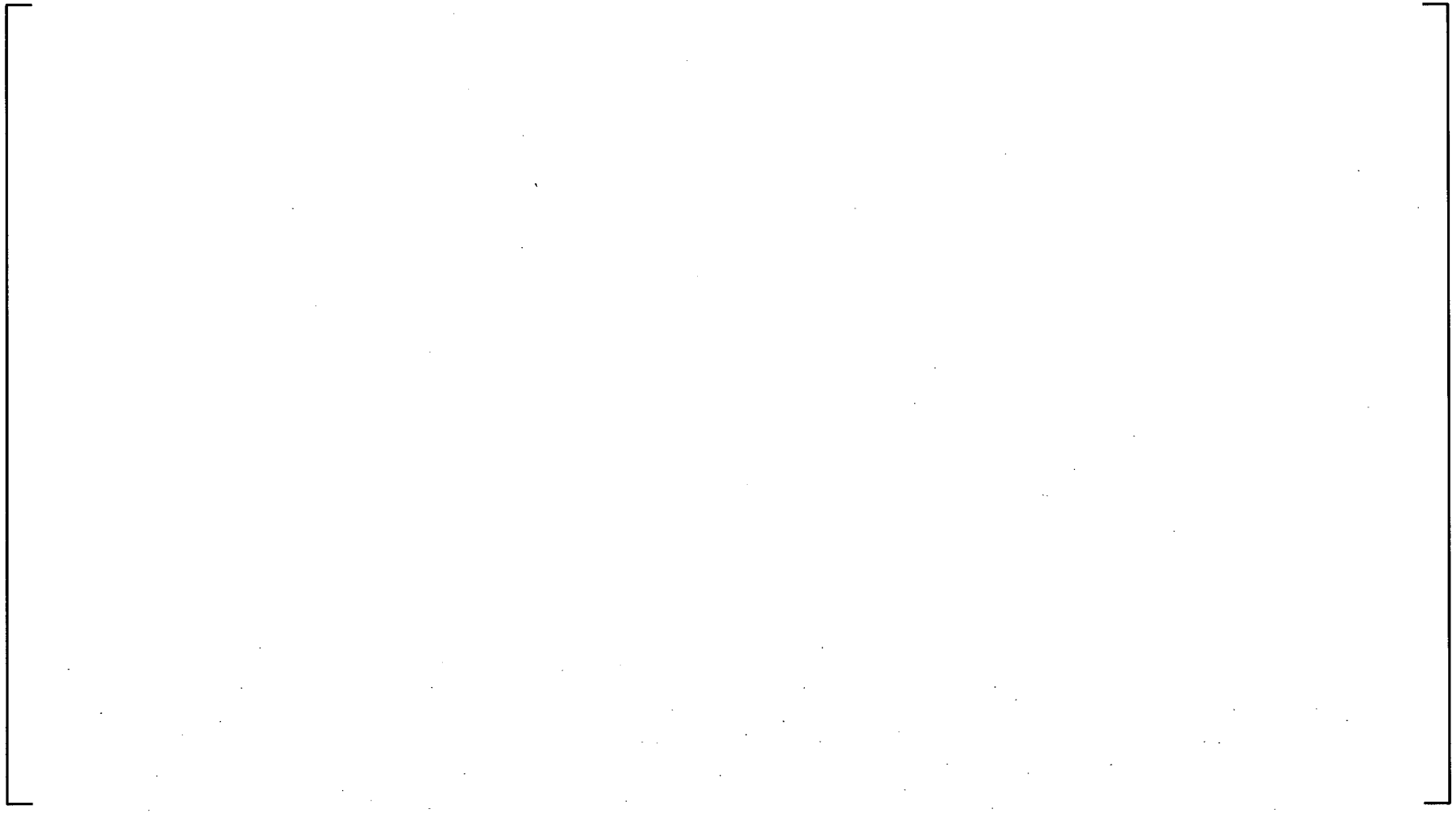
AP1000

a, c

Air Inlet Design Modifications

AP1000

a, c



Tension Ring and Air Inlets

AP1000

a, c

Beam Seats

AP1000

a, c

Design Features Summary

AP1000

a, c

AP1000

Analysis Plan

Analysis Plan

AP1000

a, c

Seismic Analysis

AP1000

a, c

Linear Elastic Analyses

AP1000

a, c

Buckling, Creep & Shrinkage Effects

AP1000

a, c

Daily and Seasonal Thermal Cycling

AP1000

a, c

Daily and Seasonal Thermal Cycling

AP1000

a, c

Concrete Placement FE Studies

AP1000

a, c

Benchmarking FE Analyses

AP1000

a, c

Tension Ring and Air Inlet

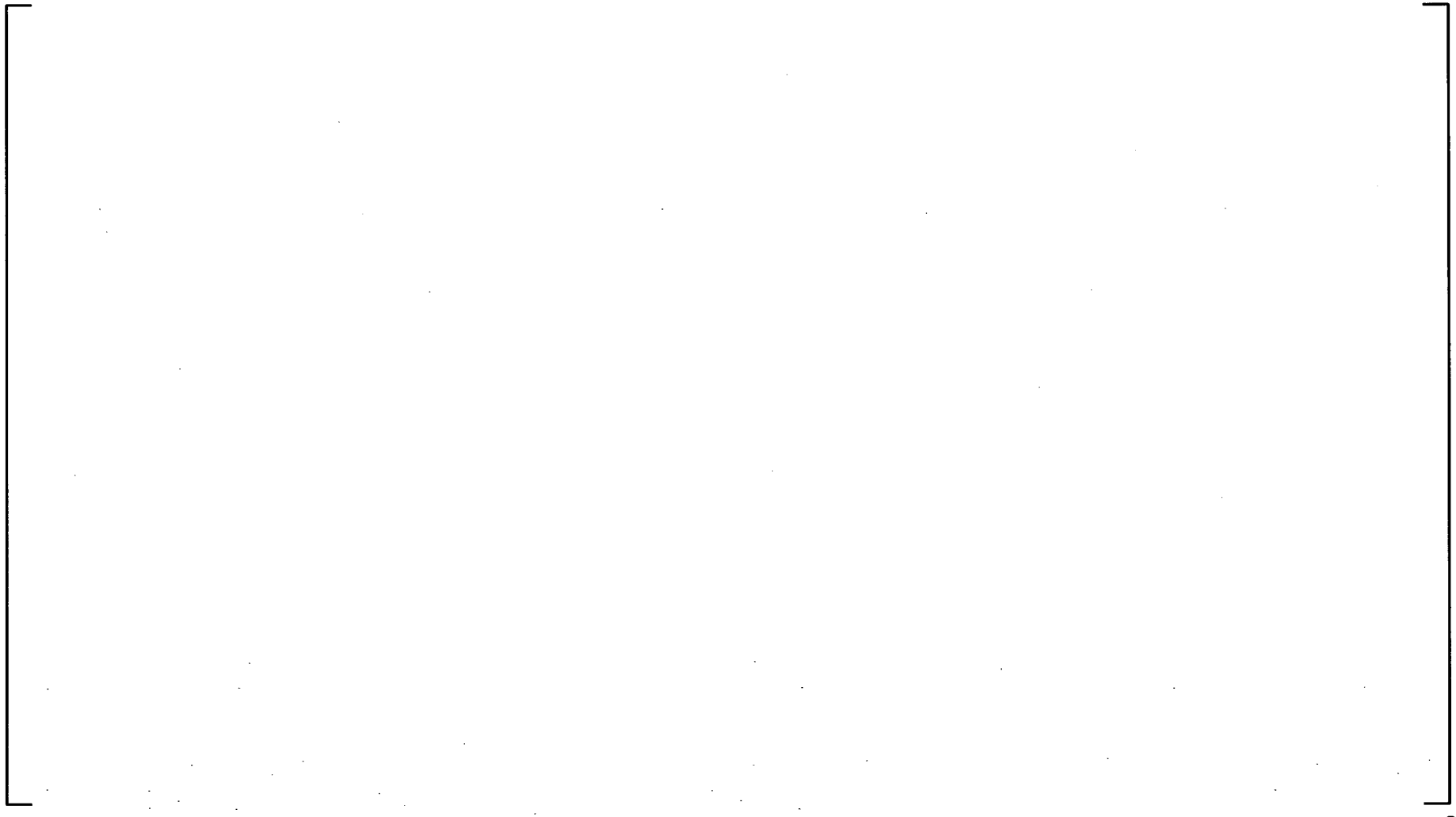
AP1000

a, c

Conclusions on SB Air Inlet and Tension Ring

AP1000

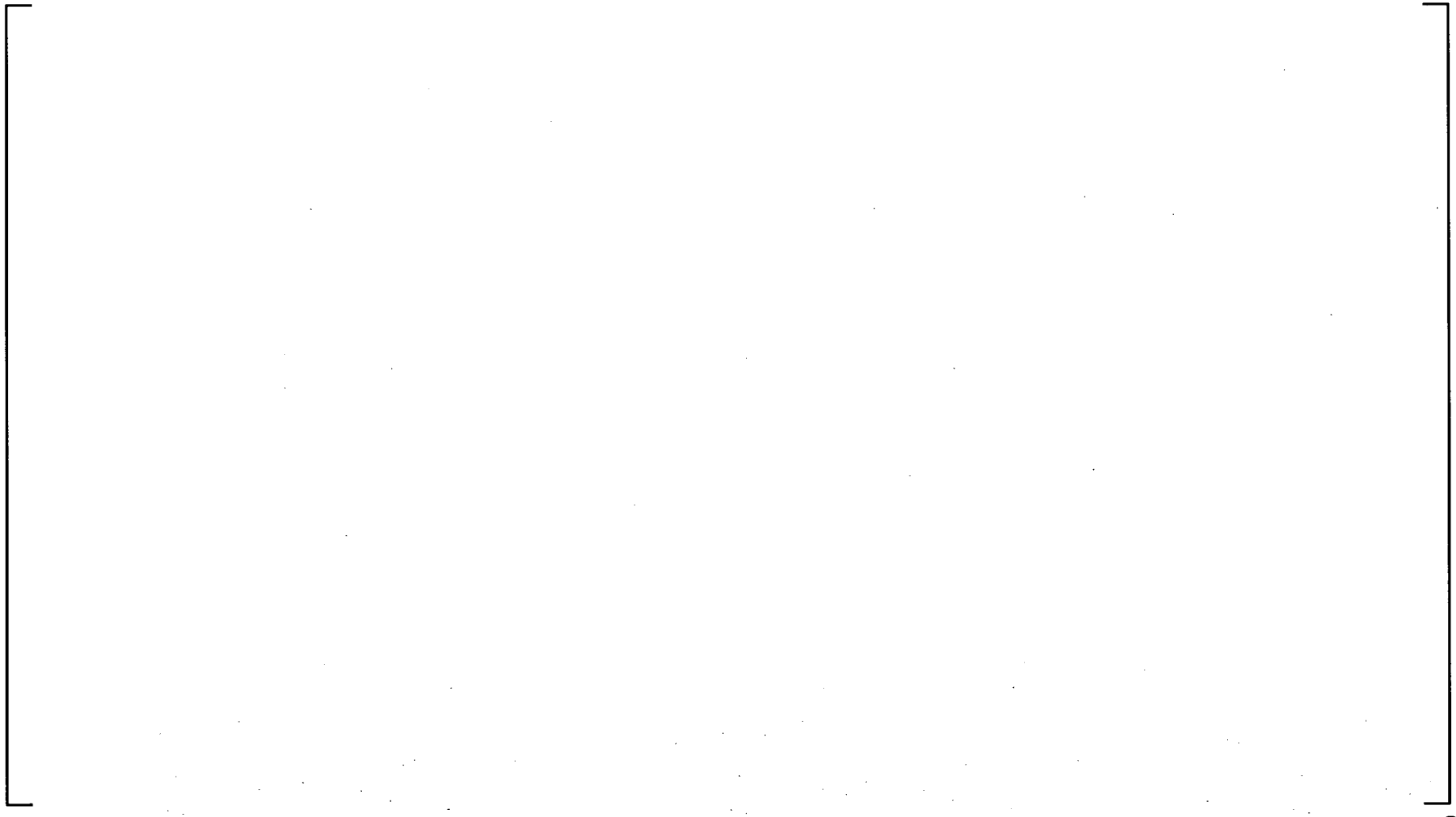
a, c



Overall FE Model and Loading

AP1000

a, c



Seismic Margin Analysis – Load Case 1 – Displacements (in)

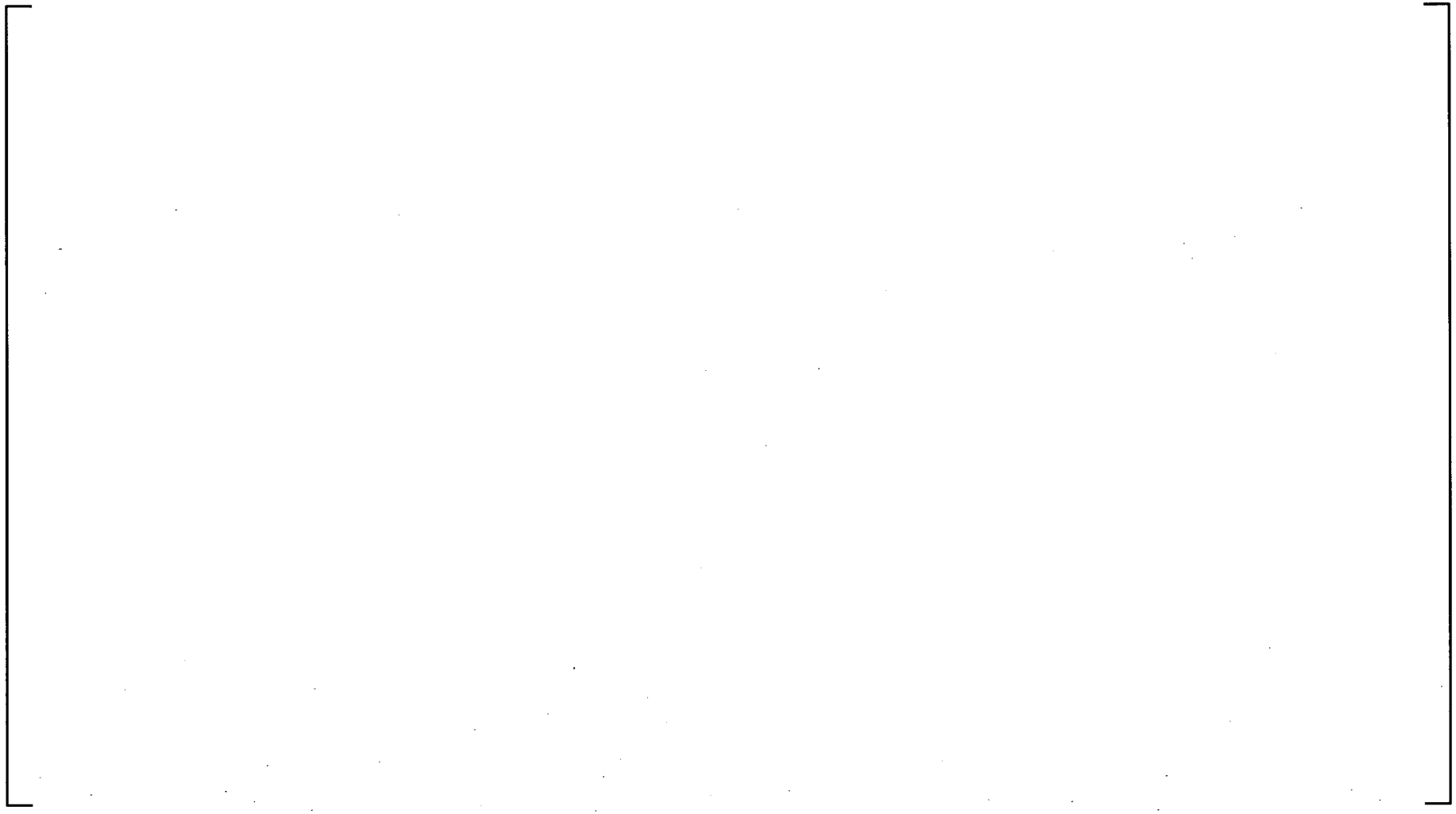
AP1000

a, c

Seismic Margin Analysis – Load Case 1

AP1000

a, c



Summary of Analysis Plan

AP1000

a, c

AP1000

AP1000 TESTING

Amit H. Varma

Purdue University

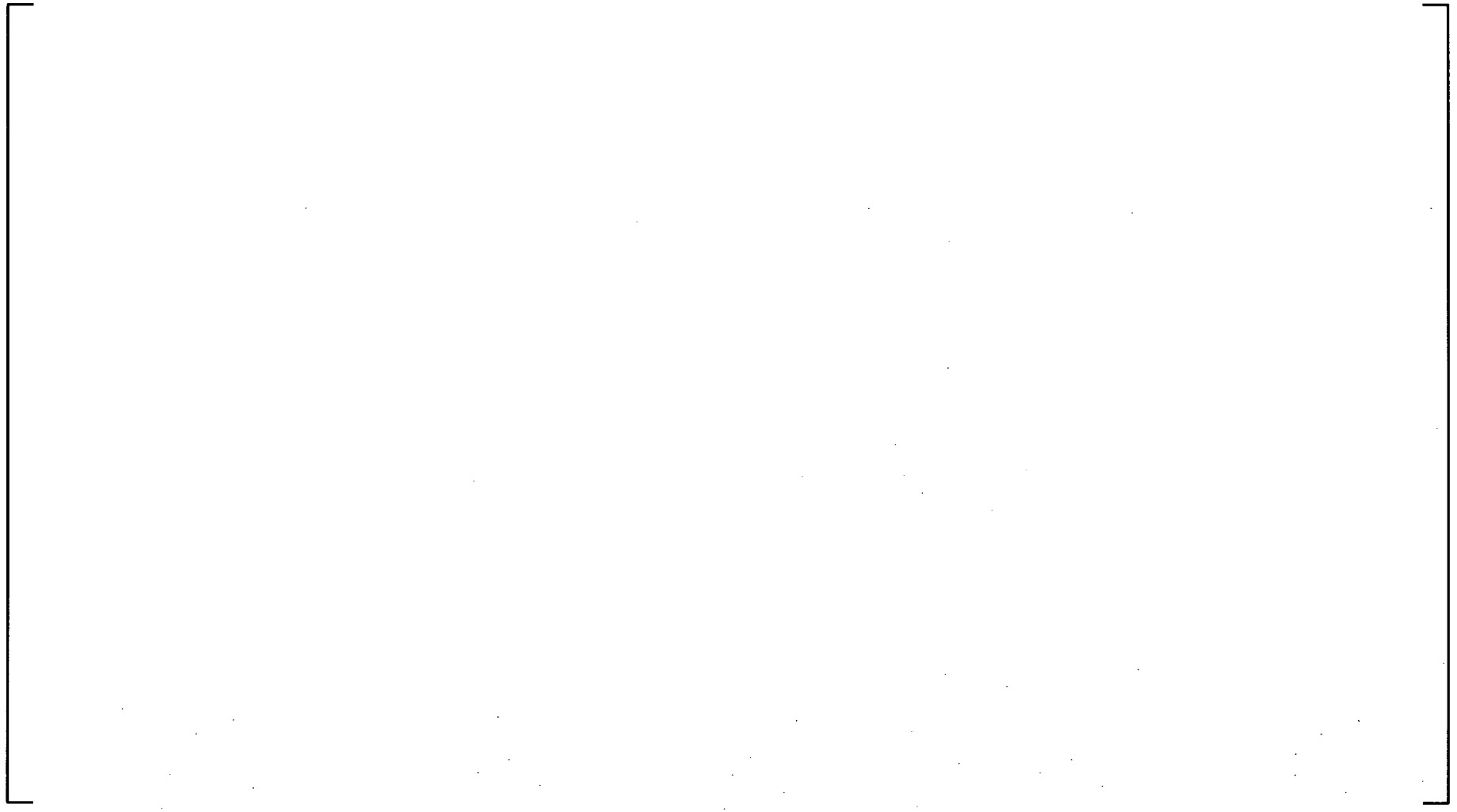
Westinghouse

Shaw™

Goal and Objectives

AP1000

a, b, c



Proposed Testing

AP1000

a, b, c

Comprehensive Test Plan

AP1000

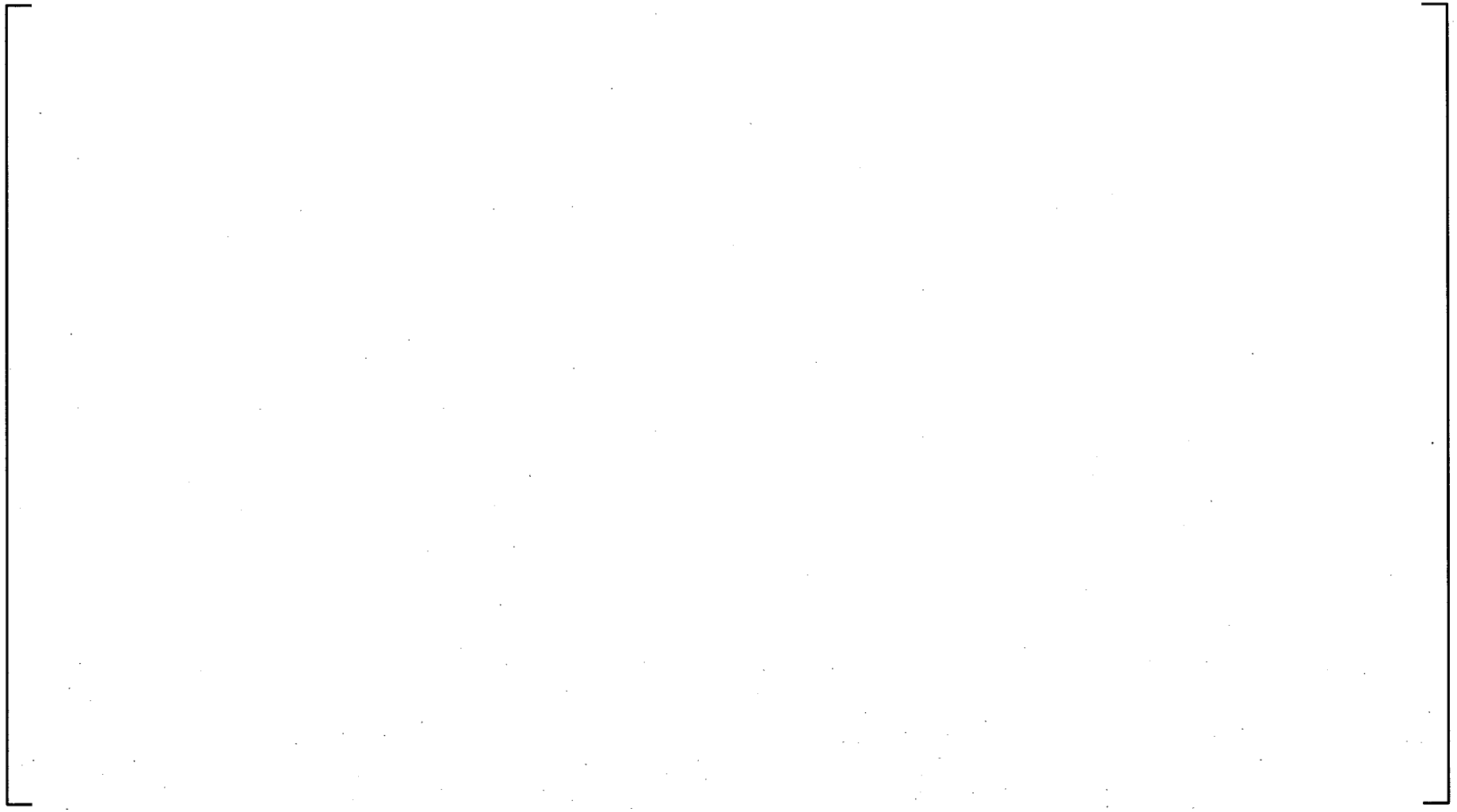
a, c

[redacted]

Proposed Testing Program In-Plane (Panel) Setup

AP1000

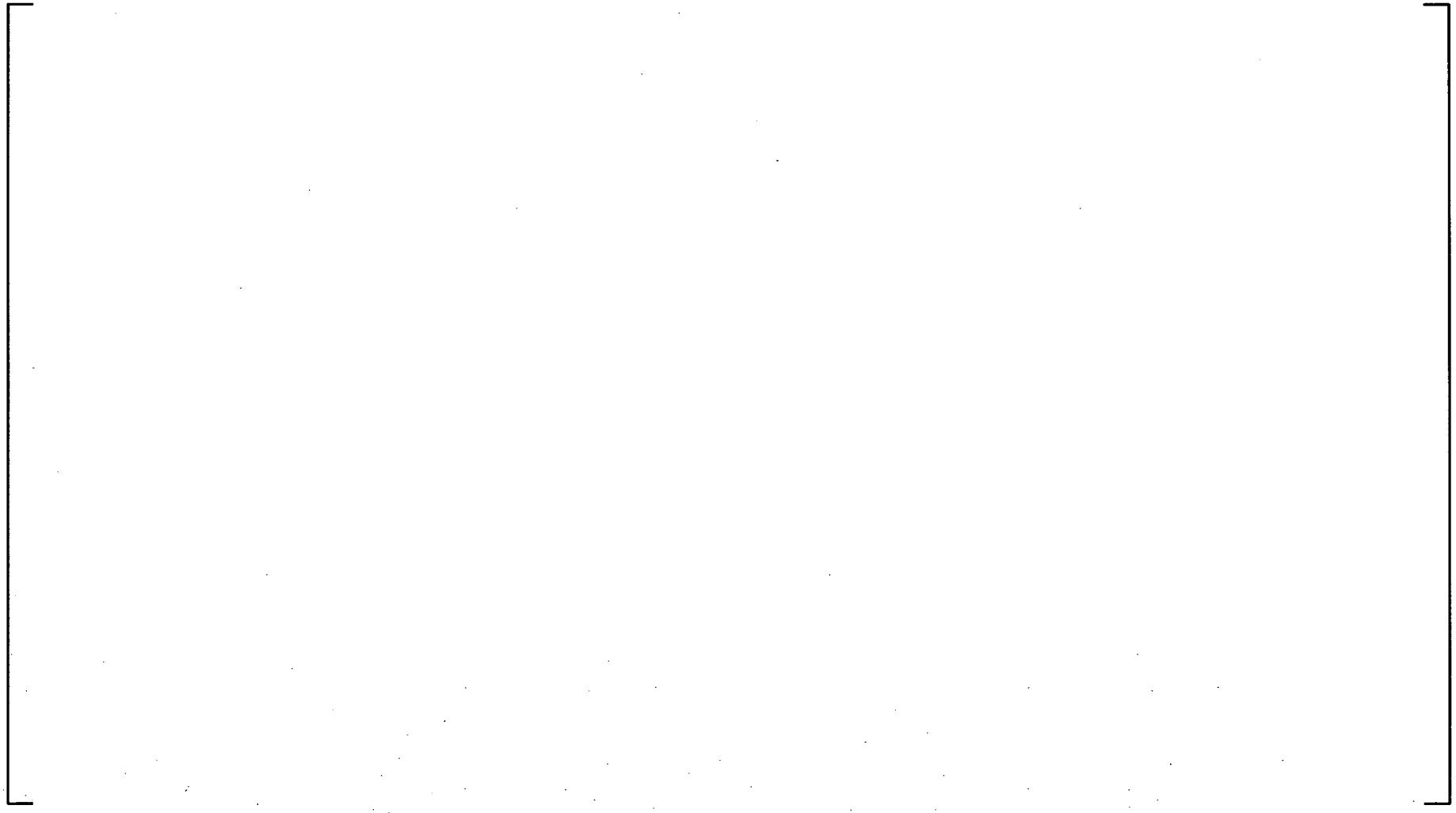
a, b, c



In-Plane Behavior Hypothesis For In-Plane Shear and Tension

AP1000

a, b, c



Proposed Testing Program In-Plane (Panel) Setup 1/3 Scale Specimen

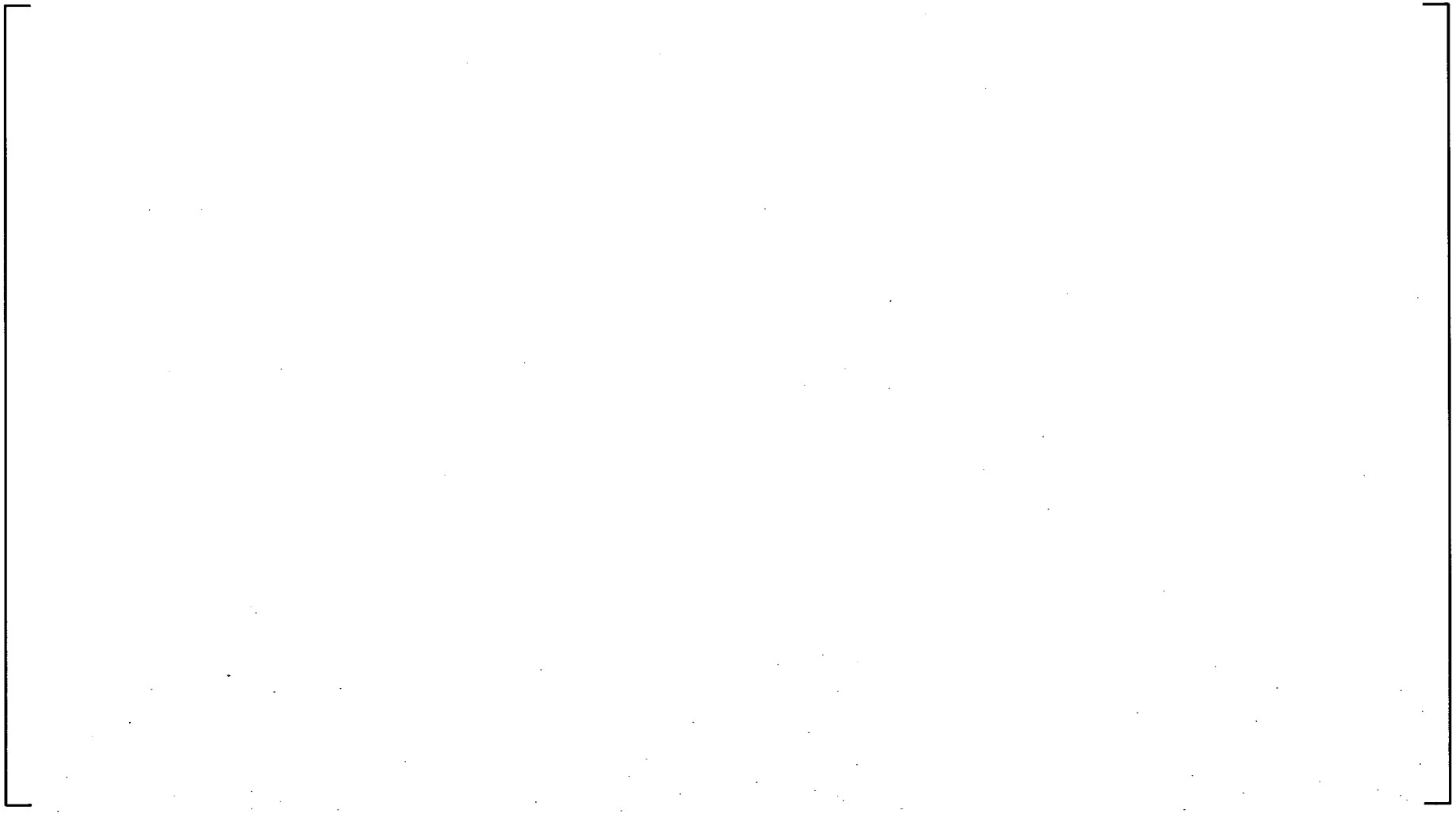
AP1000

a, b, c

Specimen Design

AP1000

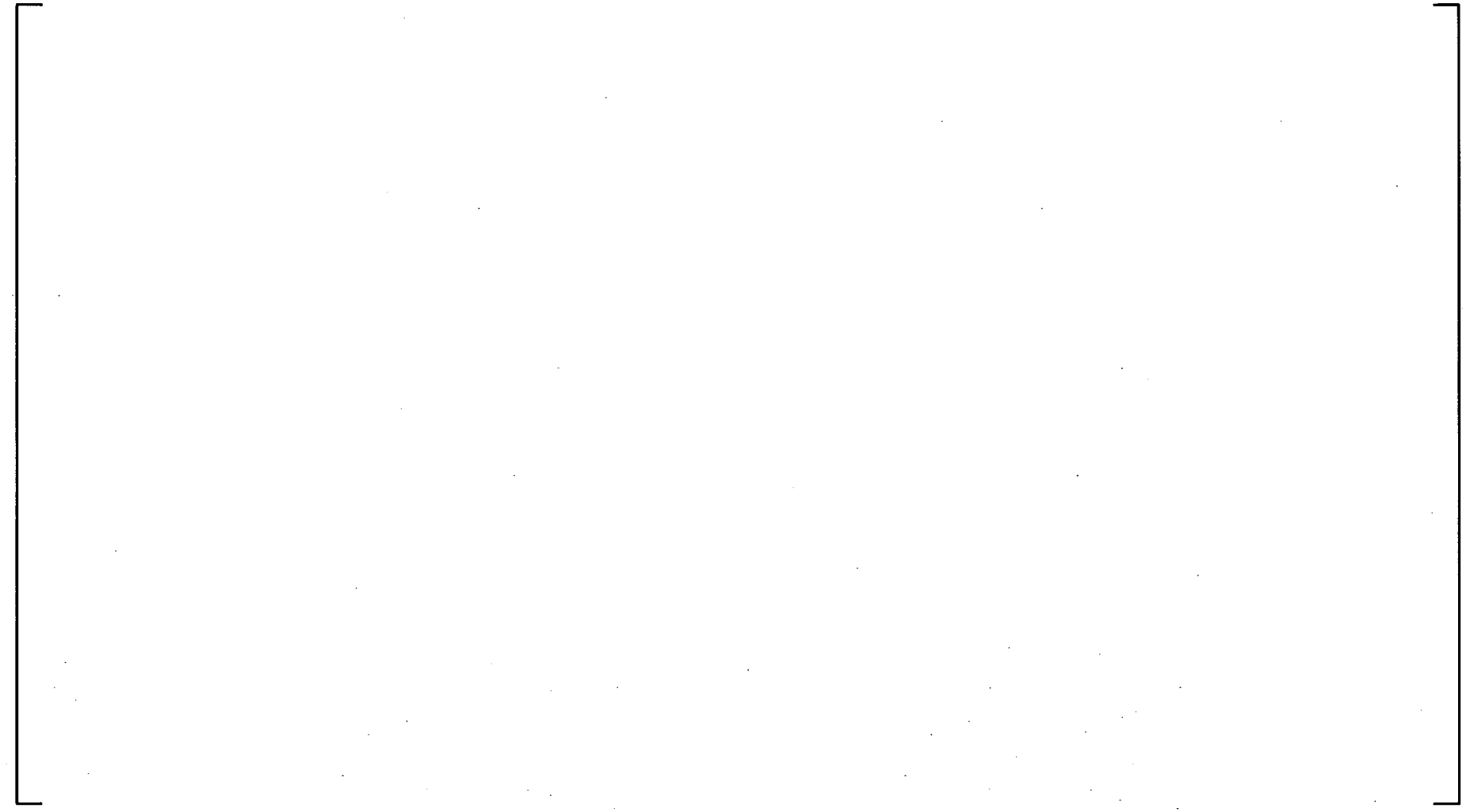
a, b, c



Test Setup

AP1000

a, b, c



Test Setup

AP1000

a, b, c

Test Setup

AP1000

a, b, c

Test Setup

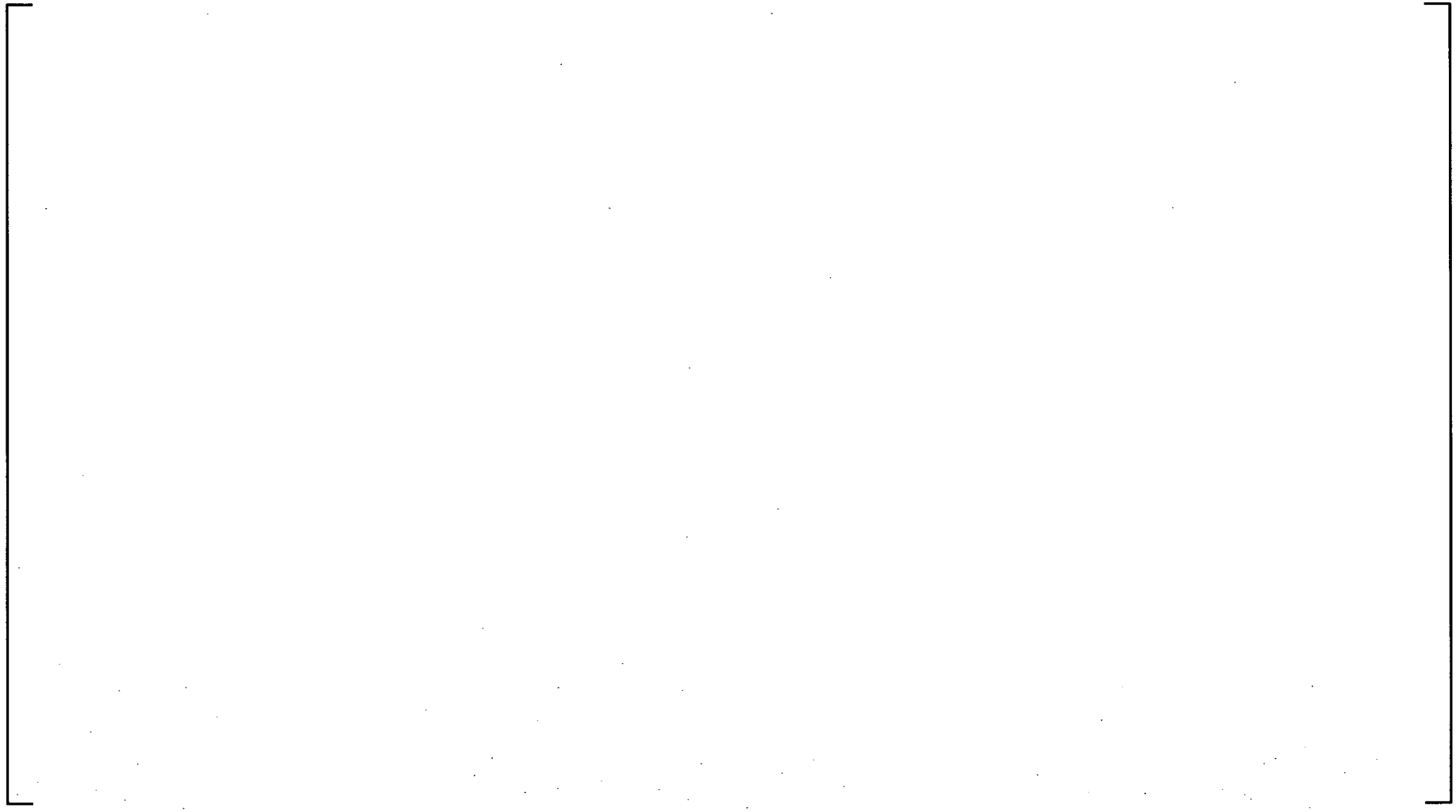
AP1000

a, b, c

In-Plane Behavior

AP1000

a, b, c



In-Plane Behavior Proposed Tests

AP1000

a, b, c

In-Plane Behavior Proposed Tests

AP1000

a, b, c

Proposed Testing Program SC-to-RC Connection

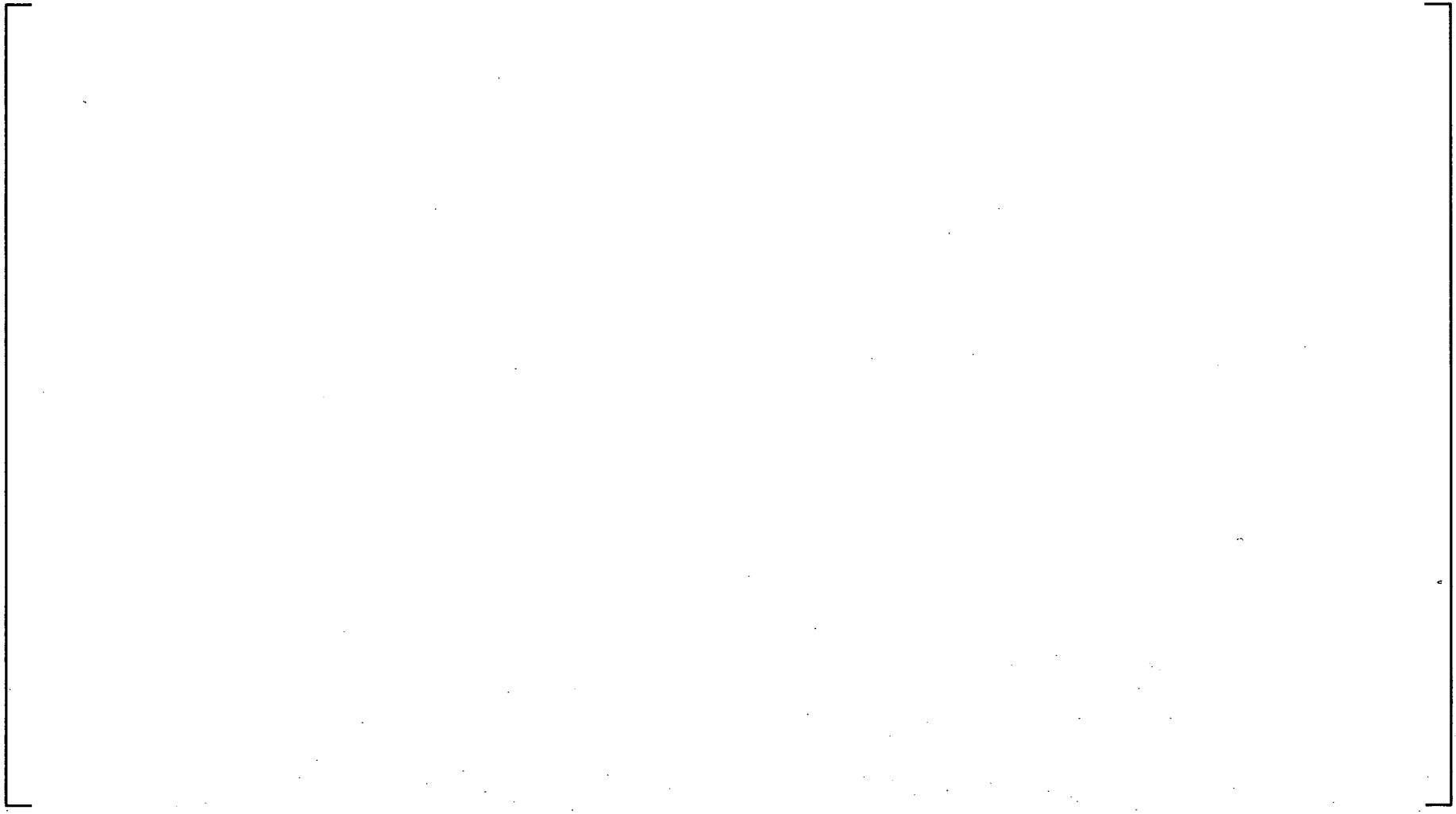
AP1000

a, b, c

Proposed Testing Program SC-to-RC Connection

AP1000

a, b, c



Proposed Testing Program SC-to-RC Connection

AP1000

a, b, c

Proposed Testing Program SC-to-RC Connection

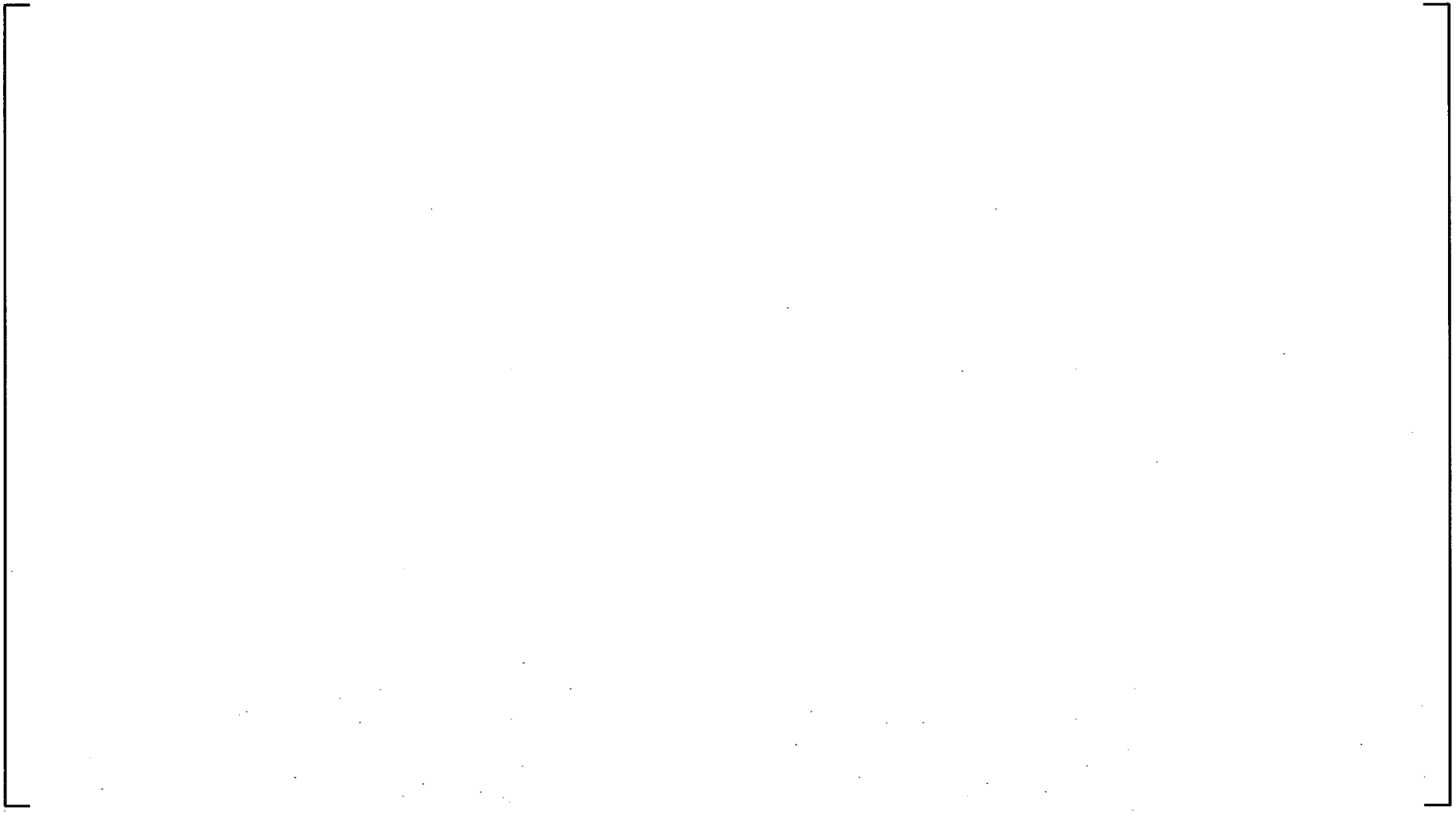
AP1000

a, b, c

Proposed Testing Program SC-to-RC Connection

AP1000

a, b, c



Proposed Testing Program SC-to-RC Connection

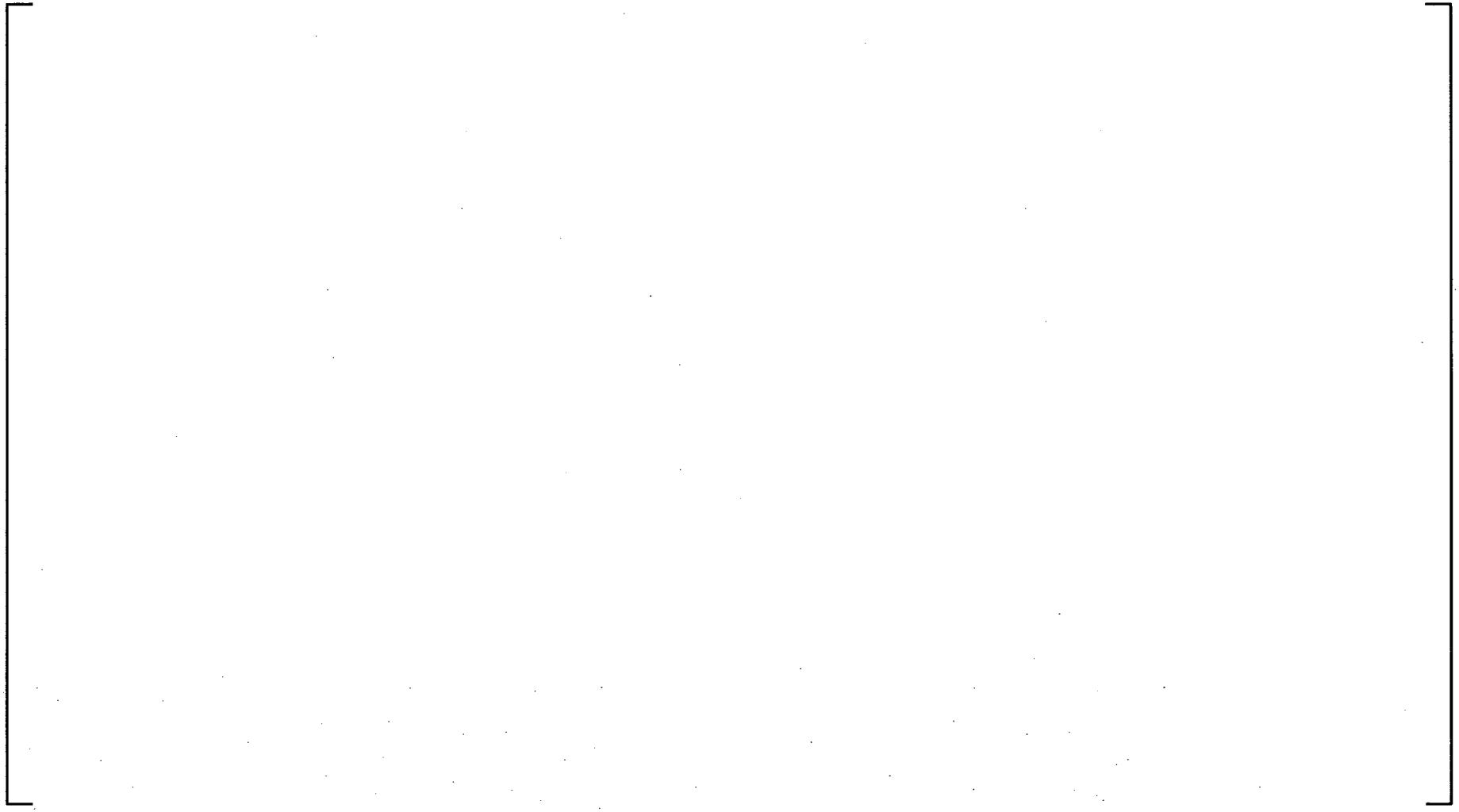
AP1000

a, b, c

Proposed Testing Program SC-to-RC Connection

AP1000

a, b, c



a, b, c

Proposed Testing Program SC-to-RC Connection

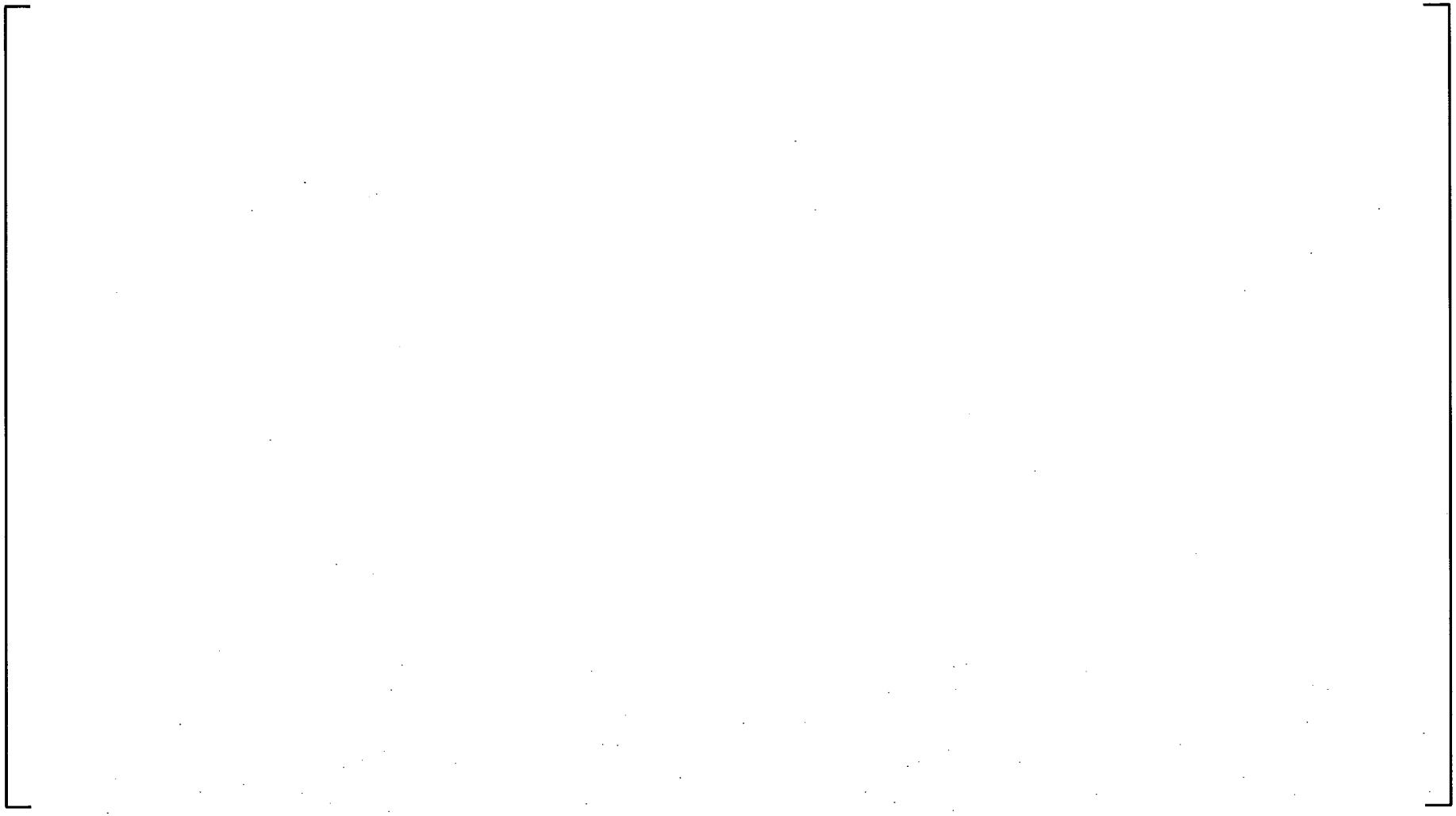
AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c



Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

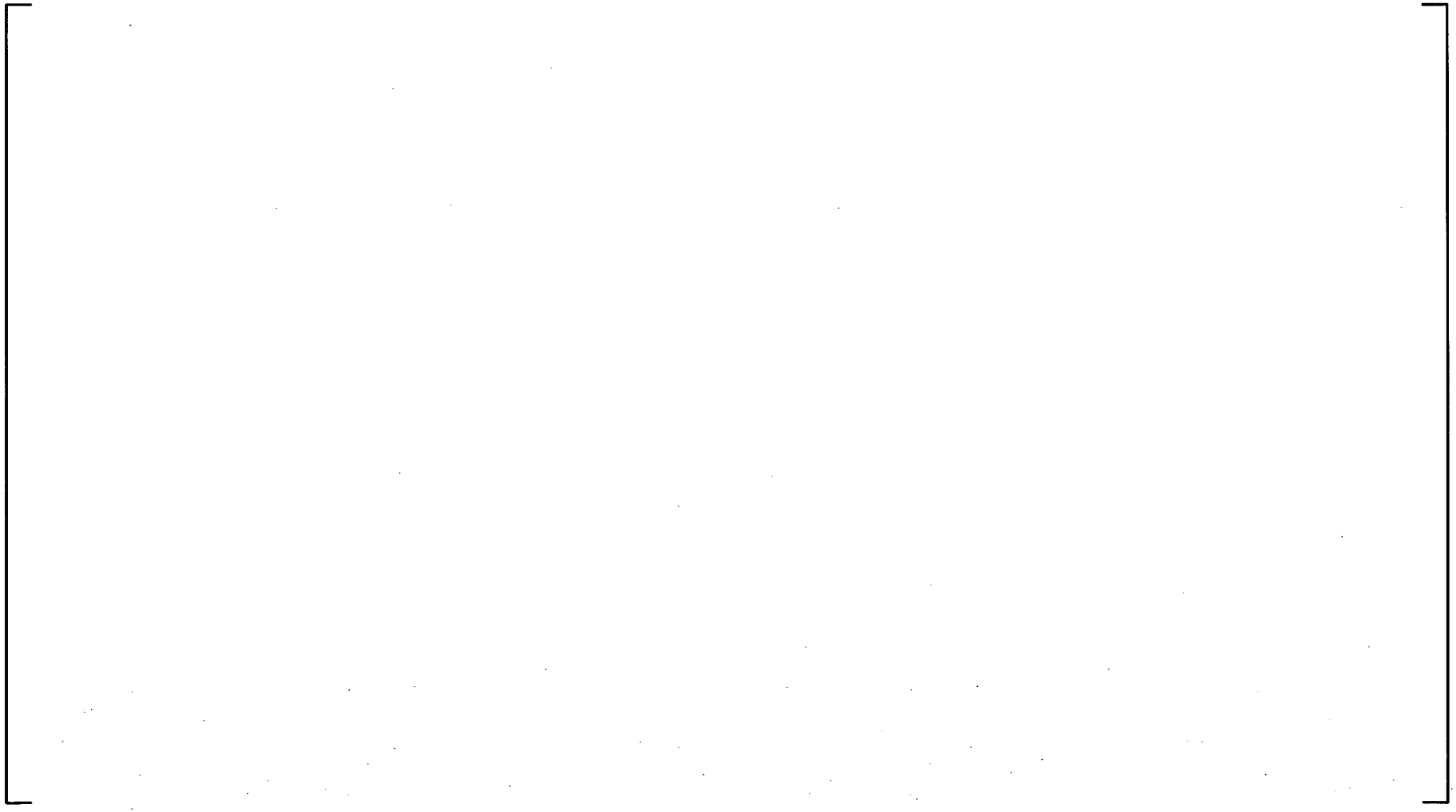
AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

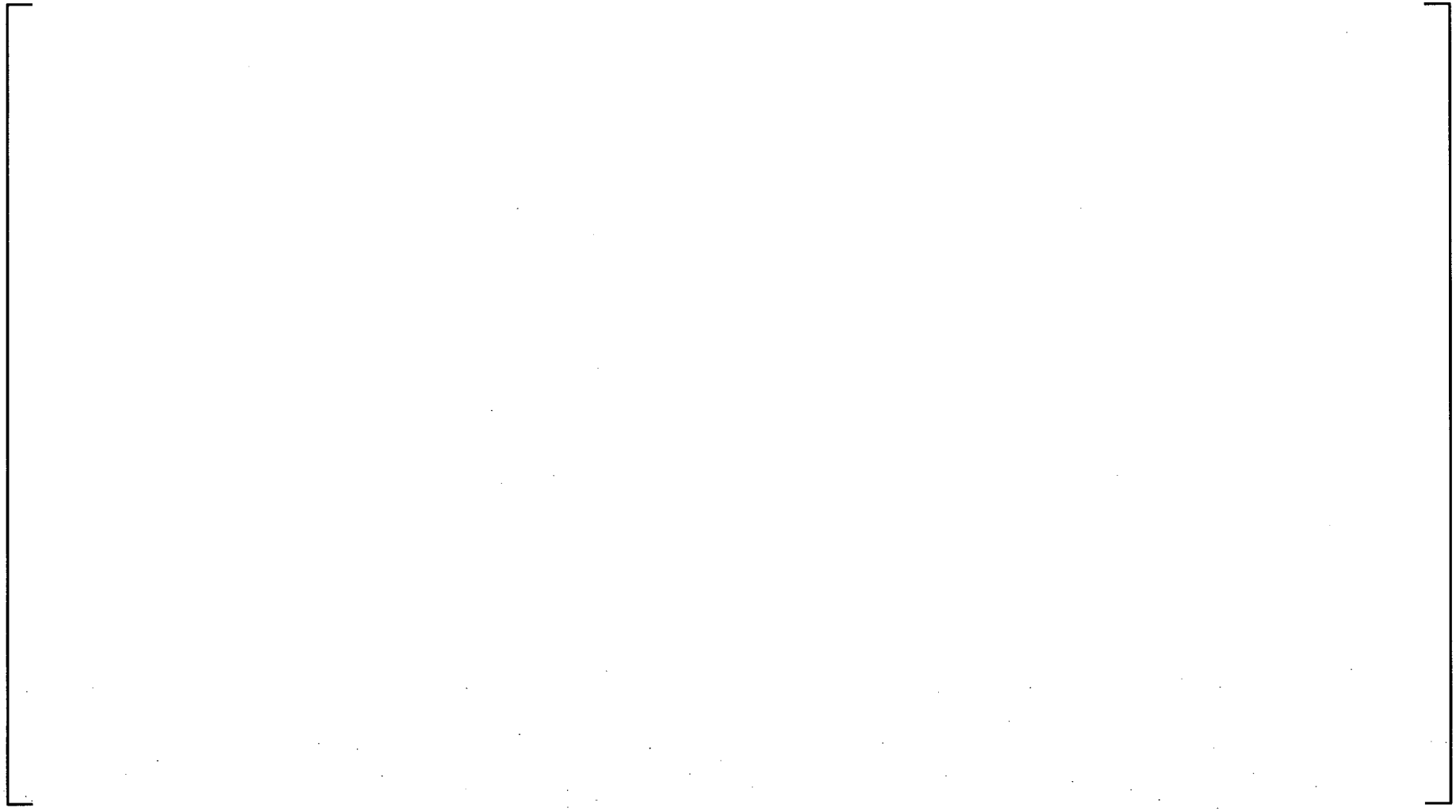
a, b, c



Proposed Testing Program Out-of-Plane Shear and Bending

AP1000

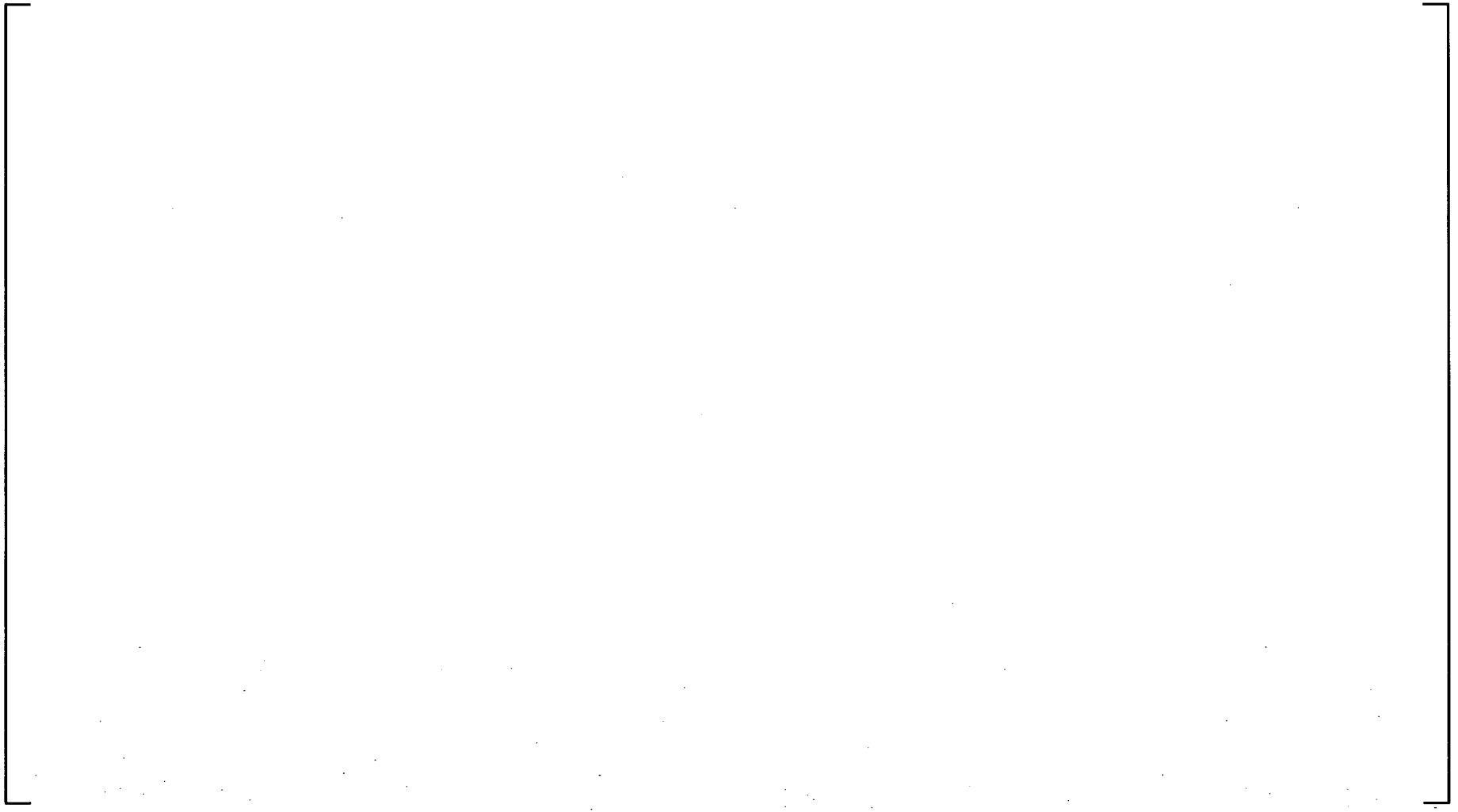
a, b, c



Proposed Testing Program Out-of-Plane Shear and Tension

AP1000

a, b, c



Proposed Testing Program Out-of-Plane Shear and Tension

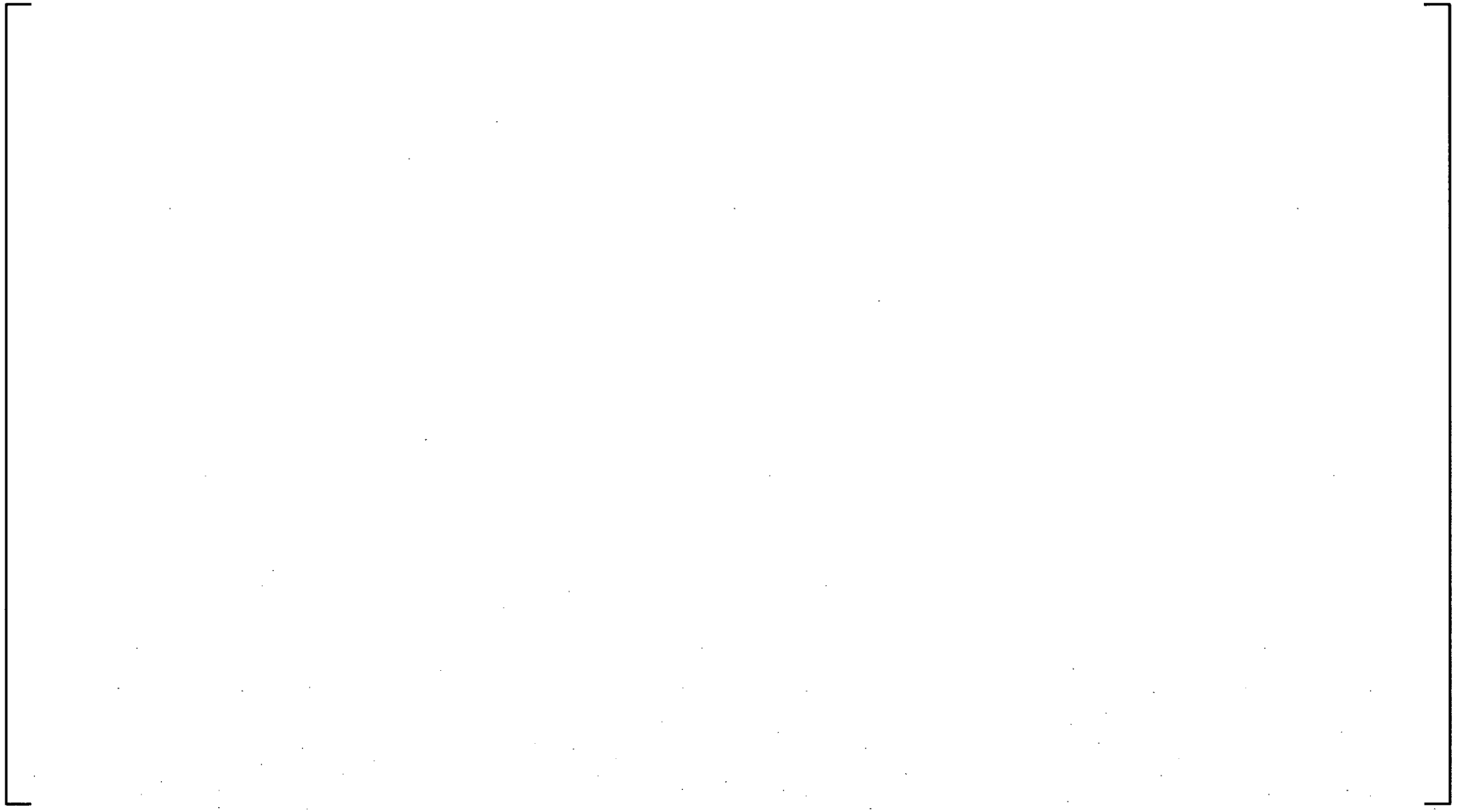
AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Tension

AP1000

a, b, c



Proposed Testing Program Out-of-Plane Shear and Tension

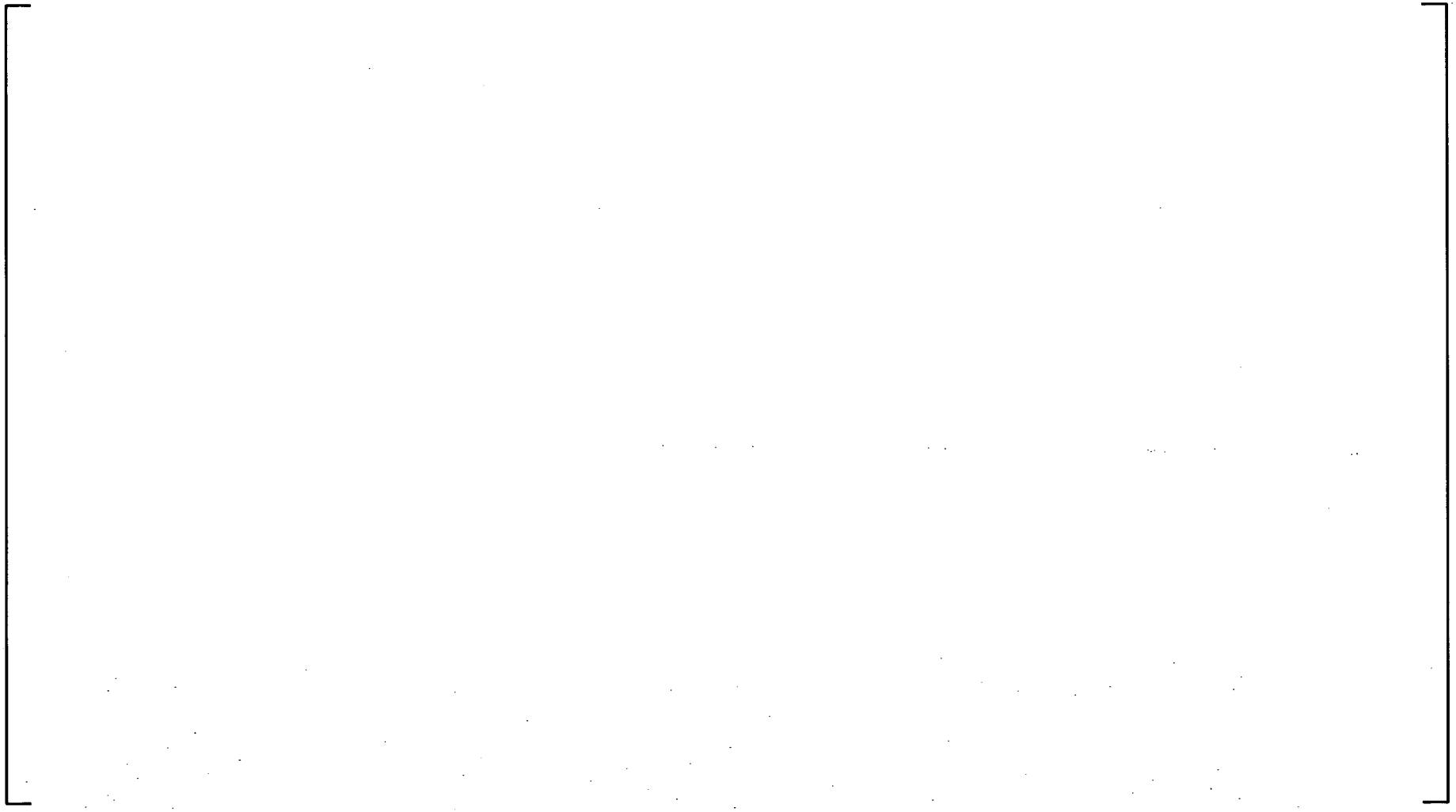
AP1000

a, b, c

Proposed Testing Program Out-of-Plane Shear and Tension

AP1000

a, b, c



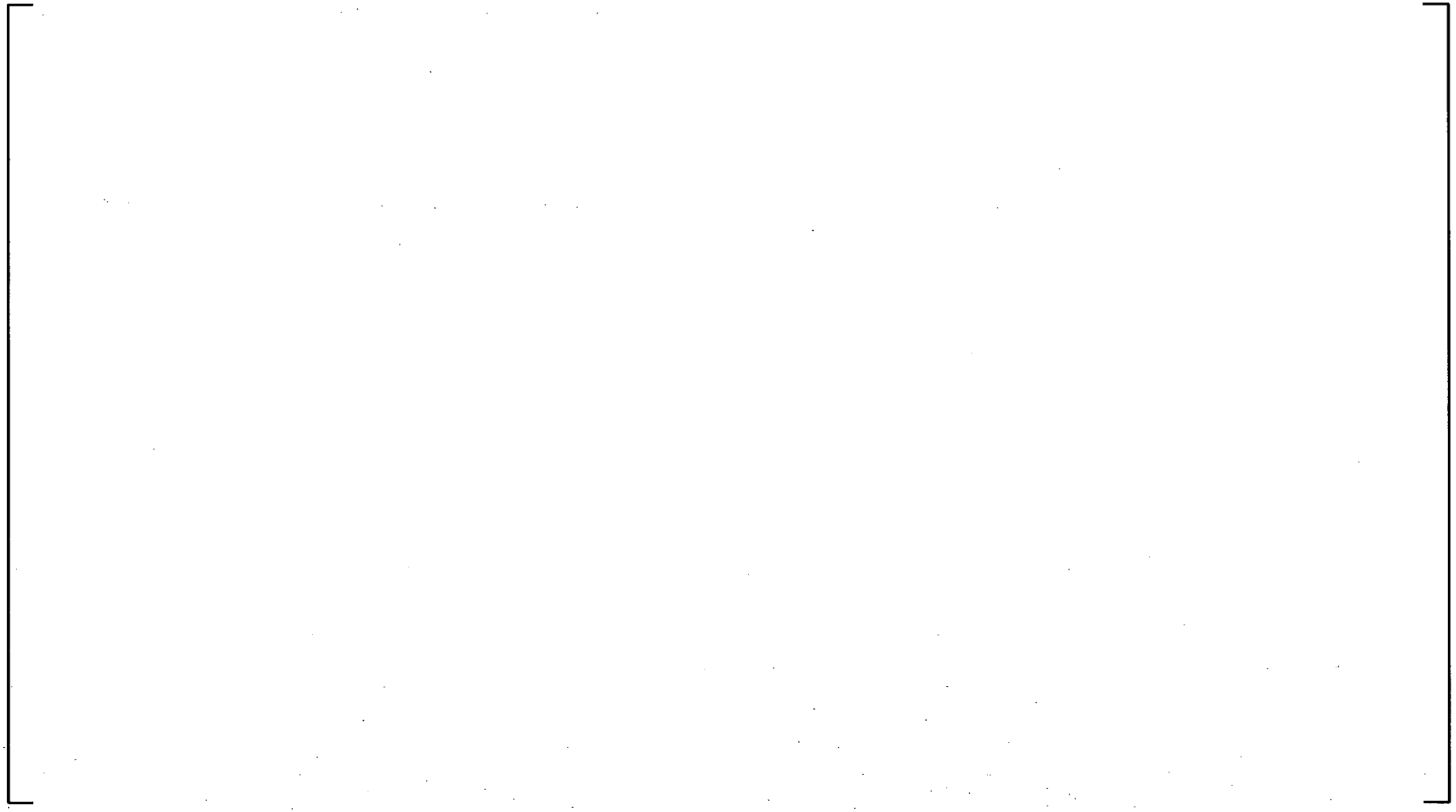
AP1000

Benchmarking Analysis

Benchmarking Analysis

AP1000

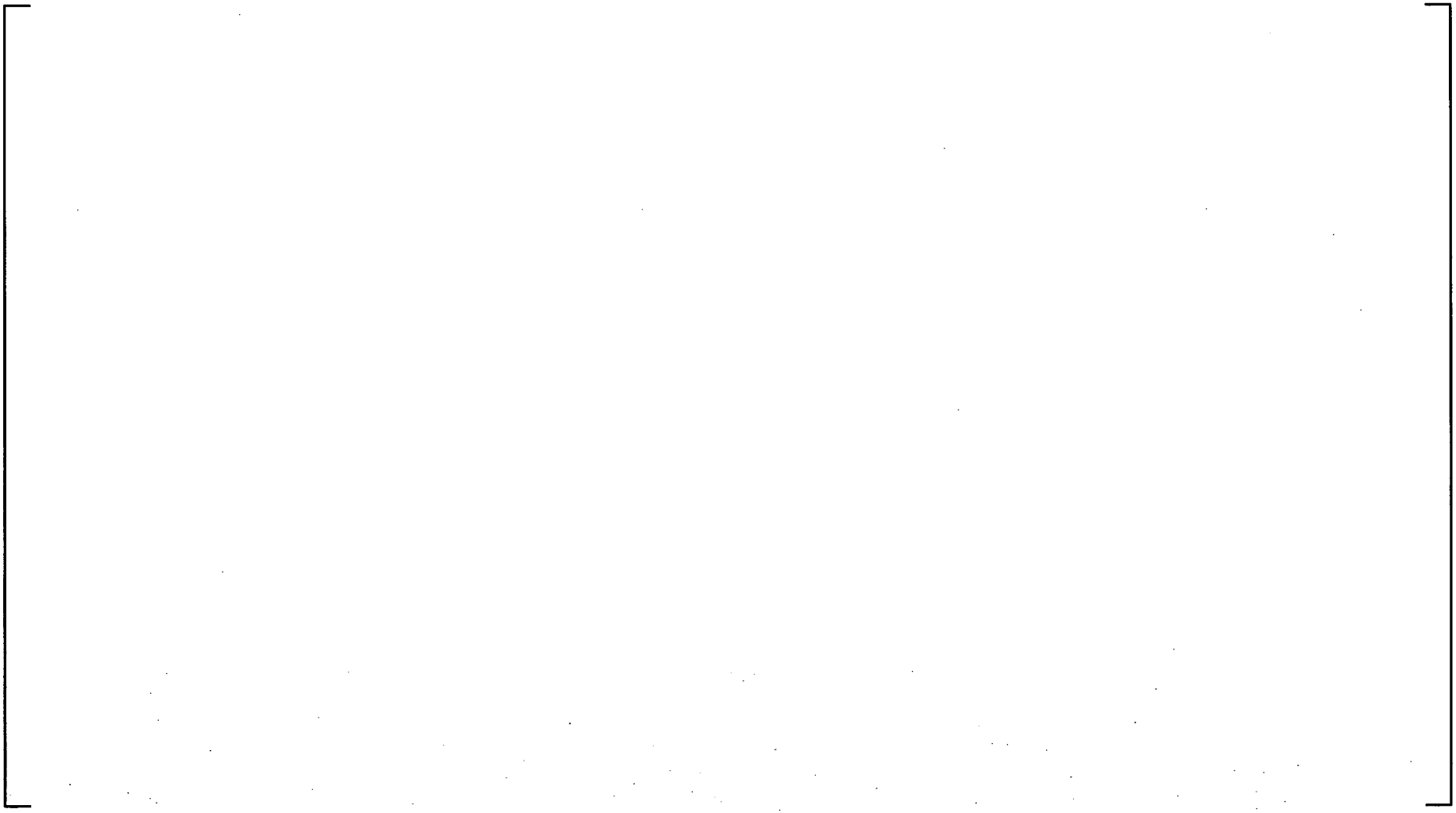
a, b, c



Benchmarking Analysis

AP1000

a, b, c



Example of Models for Tested Specimens

AP1000

a, b, c

Model Details

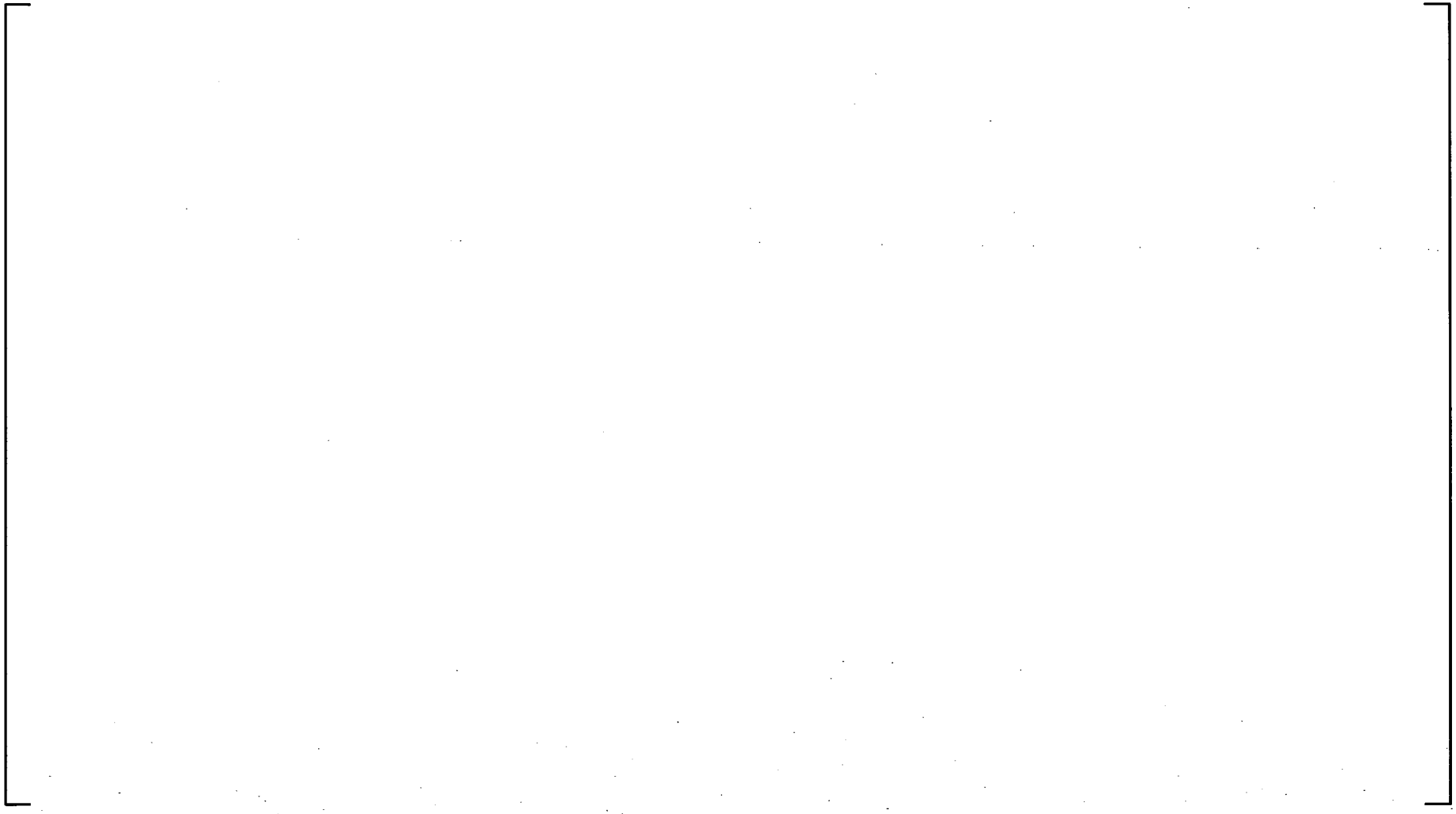
AP1000

a, b, c

Model Details

AP1000

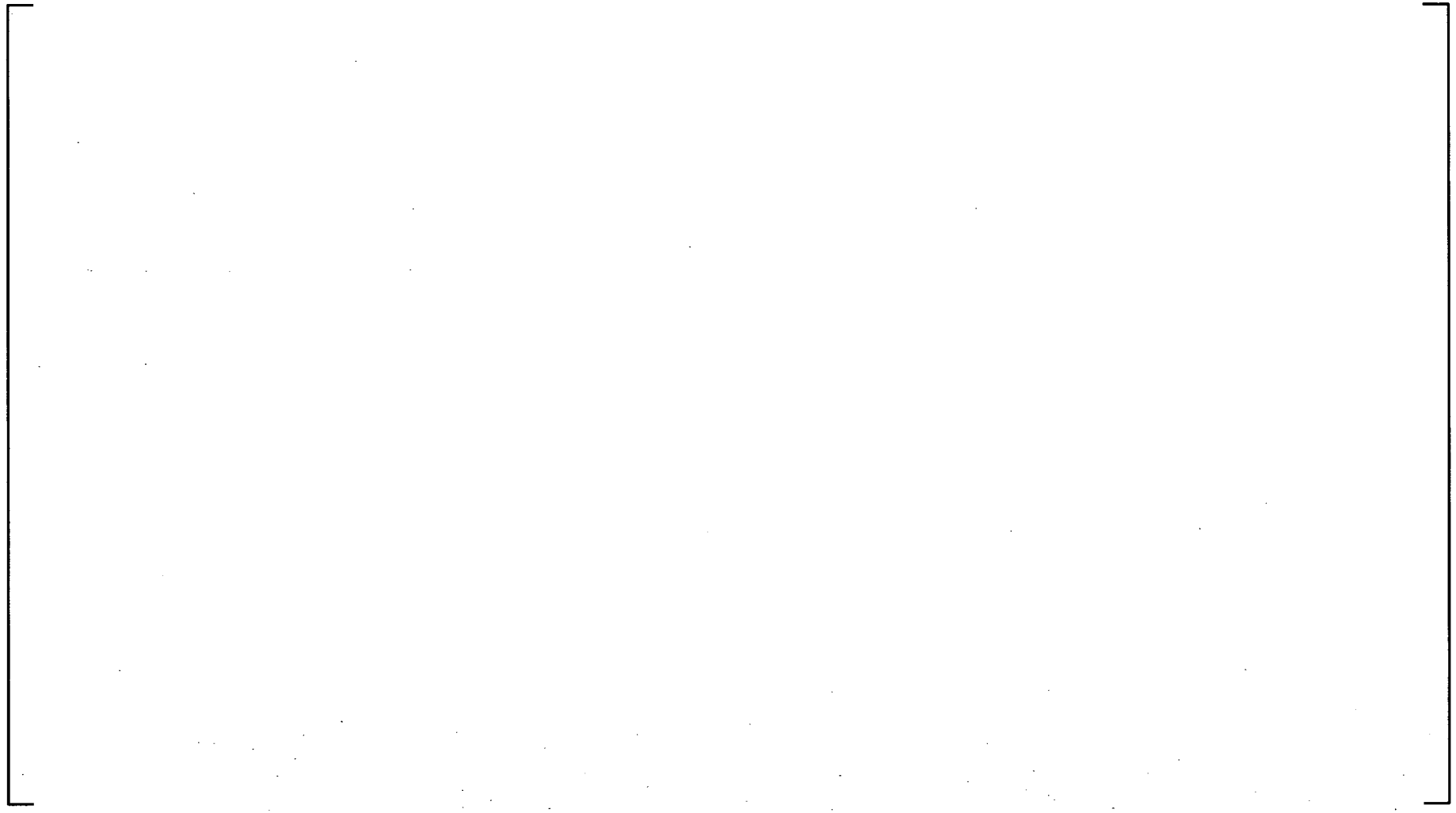
a, b, c



Model Details

AP1000

a, b, c



State At Load Level Corresponding to Steel Plate Yielding (1500 Kips)

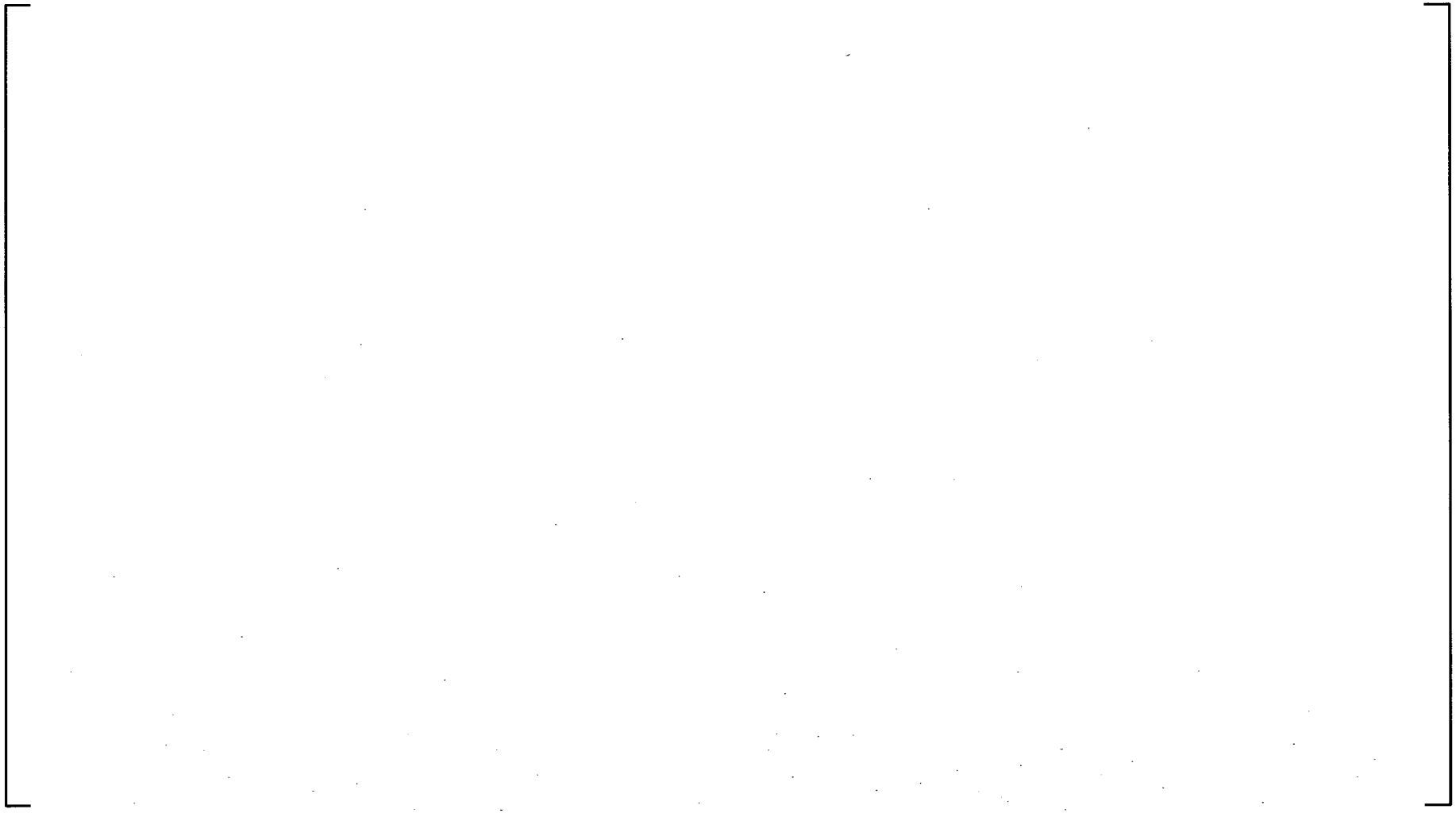
AP1000

a, b, c

State At Load Level Corresponding to Steel Plate Yielding (1500 Kips)

AP1000

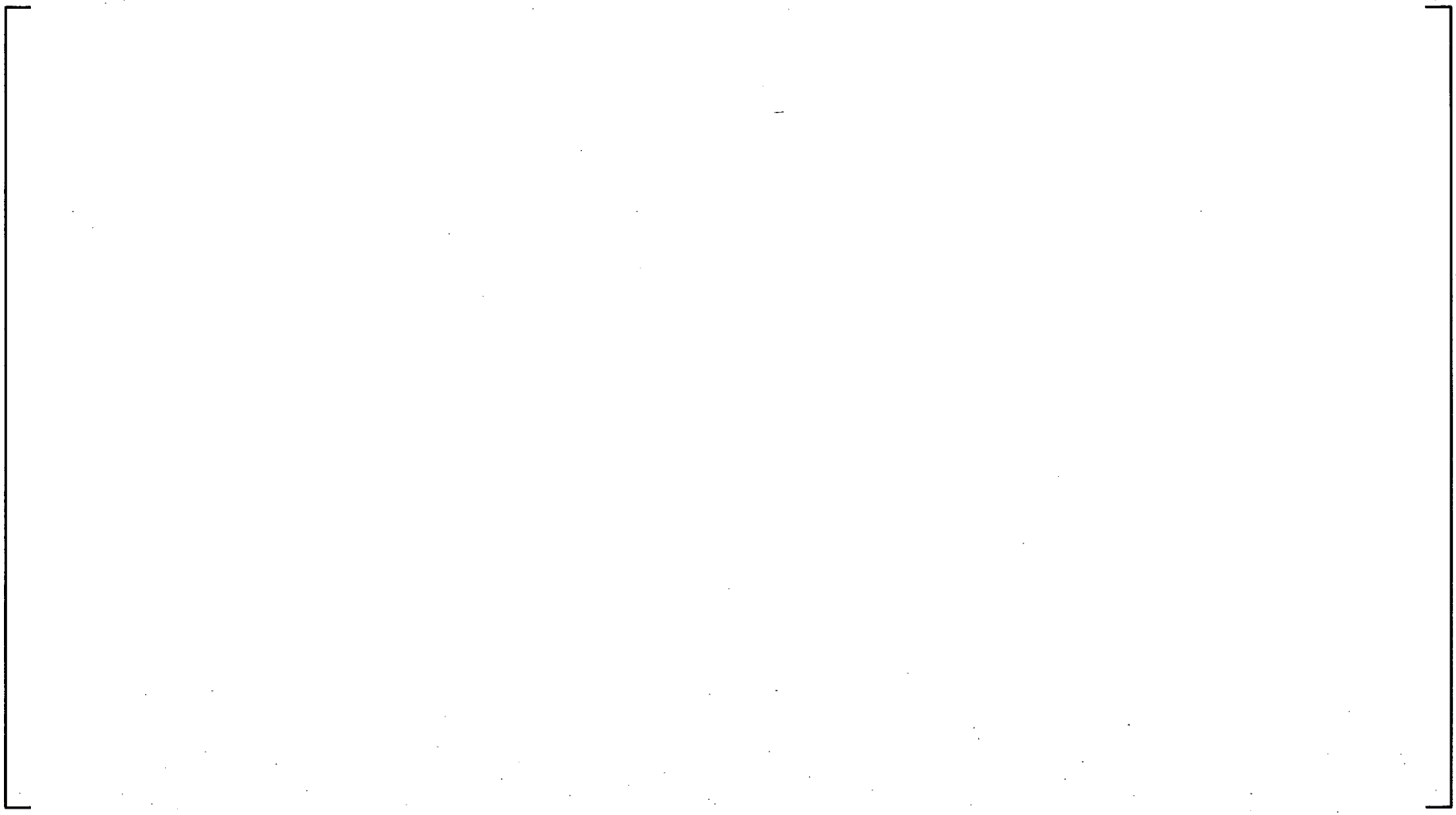
a, b, c



State At Load Level Corresponding to Steel Plate Yielding (1500 Kips)

AP1000

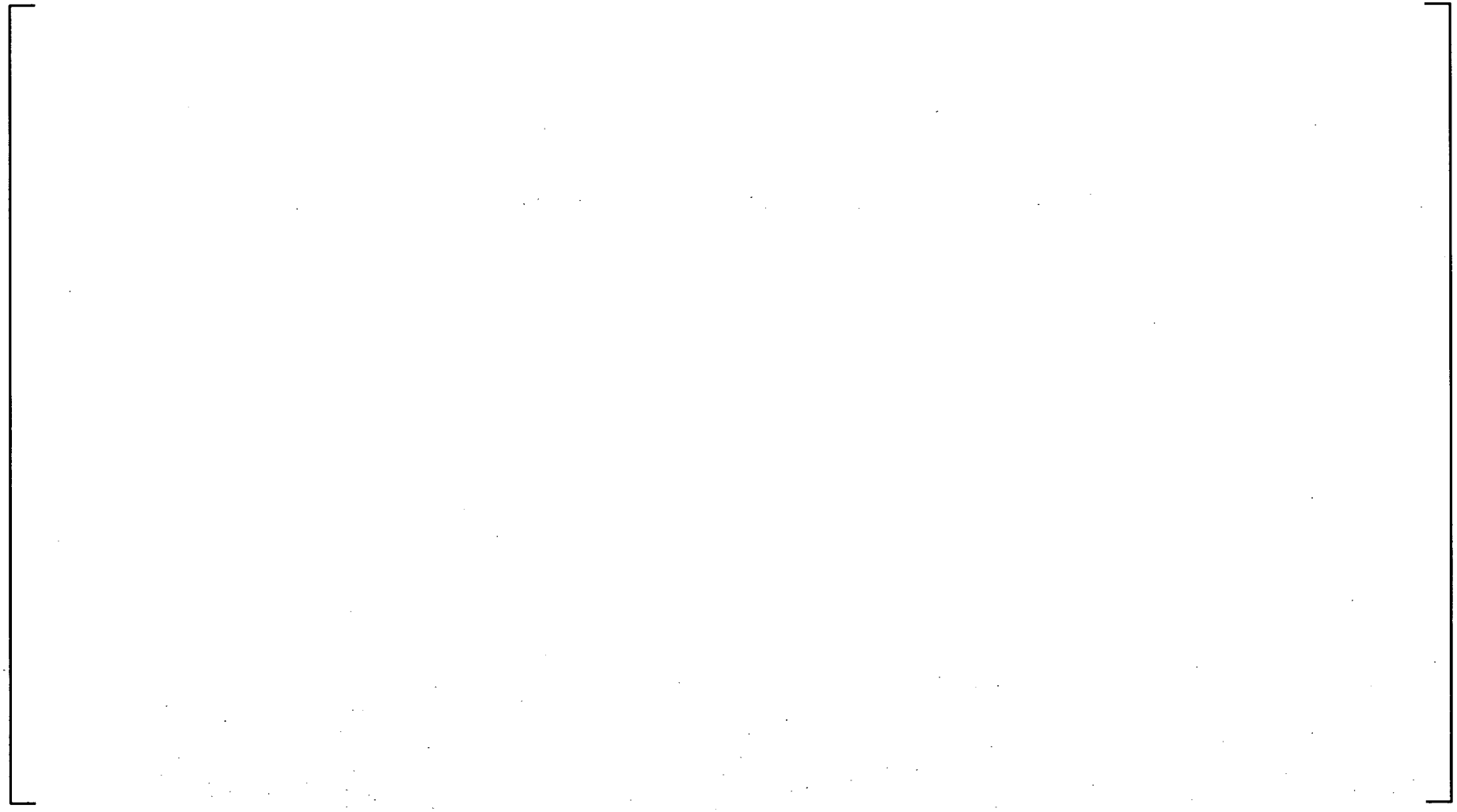
a, b, c



State At Load Level Corresponding to Steel Plate Yielding (1800 Kips)

AP1000

a, b, c



State At Load Level Corresponding to Steel Plate Yielding (1800 Kips)

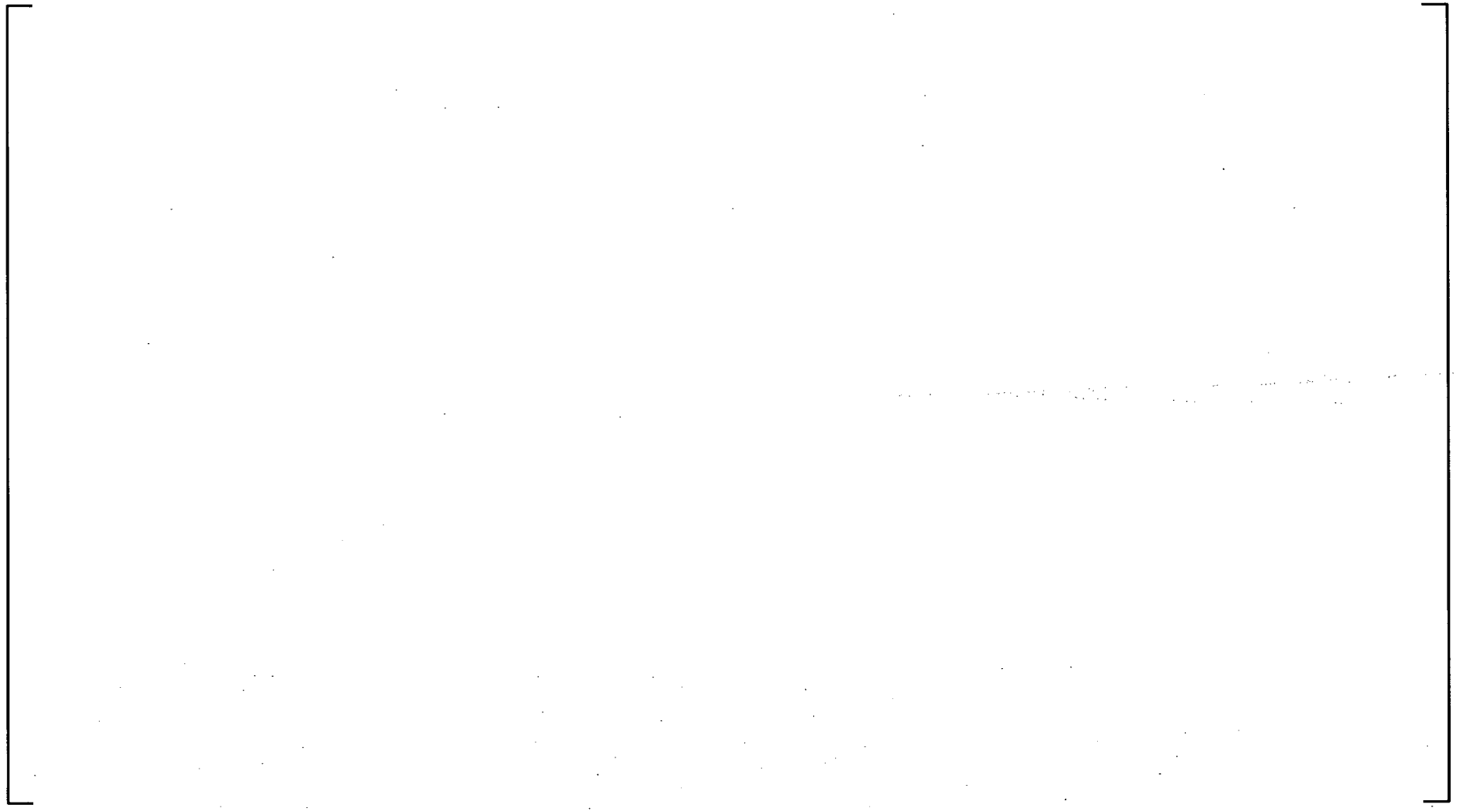
AP1000

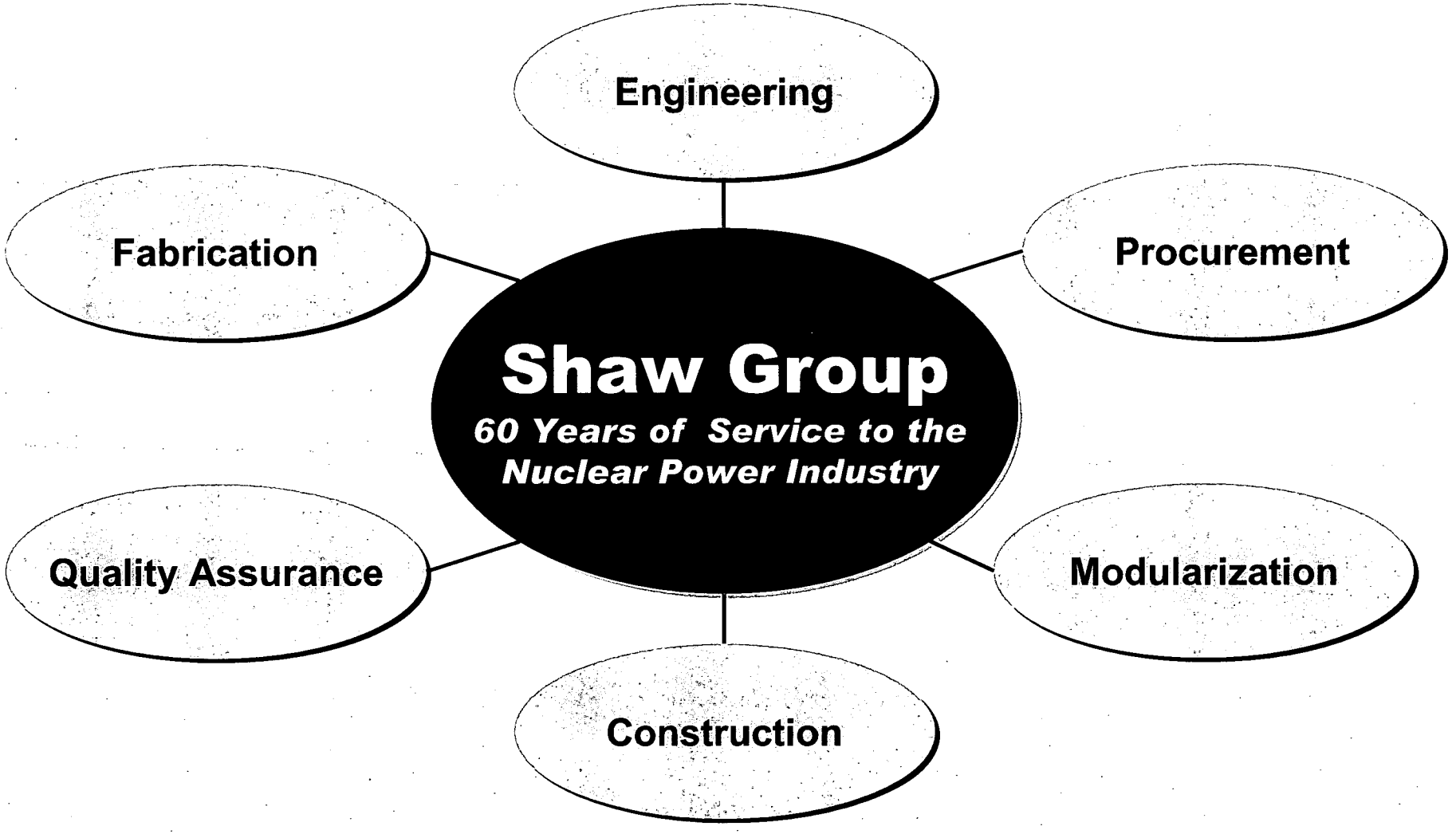
a, b, c

Benchmarking FE Analyses

AP1000

a, c




Engineering
Fabrication
Procurement
Shaw Group
60 Years of Service to the Nuclear Power Industry
Quality Assurance
Modularization
Construction

Shaw Will Address NRC Shield Building Construction and Inspection Concerns

AP1000

- Constructability Reviews
- Shield Building Mock Ups
  - * Mock Ups Goals and Objectives
  - * Shield Building Wall Section
- Construction Sequence
- Concrete Placement Overview
- Self Consolidating Concrete (SCC) and Standard Concrete Construction
- Shield Building Concrete Placement Plan
- Overview of Concrete Inspection
- Weld Inspection

AP1000

Construction Reviews

- Shaw interfaces with Westinghouse for design reviews:
  - Review design for constructability (process is continuous as design progresses)
    - Validate Constructability Processes and Techniques
    - Interfaces with other structures and construction sequencing
    - Installation tolerances
    - Methods of fabrication, erection and installation
    - Access for construction and inspection personnel

AP1000

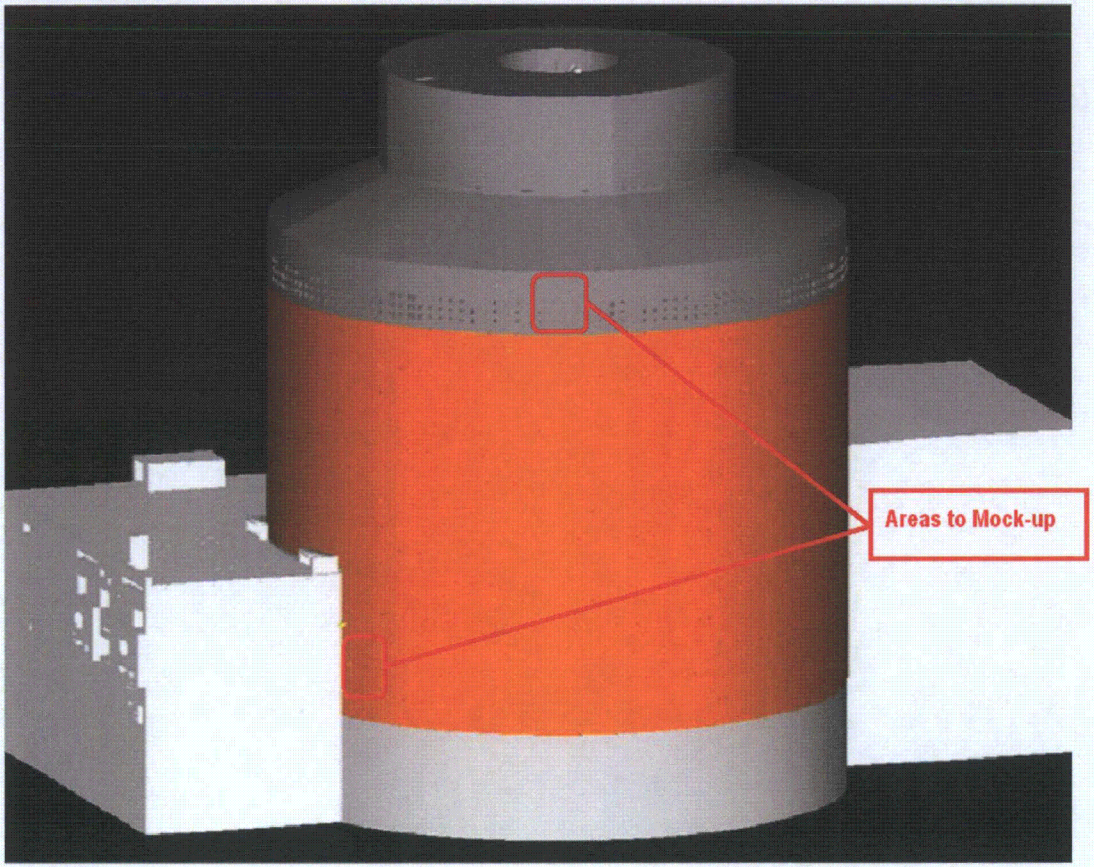
Mock Up Program Goals and Objectives

Goals

- To build replicas of selected areas of the shield building that duplicate the as-designed structure
  - The areas selected for mock-up will represent the most challenging construction conditions
  - To fabricate and construct a physical representation of complex areas of the shield building to provide an opportunity to apply and evaluate processes and procedures
- Evaluate use of Self Consolidating Concrete in areas such as the Air Inlet structure after the design is complete
- To provide training for craft, QC inspectors, and construction supervisors

Mock-up Areas are the SC (Steel & Concrete) to RC (Reinforced Concrete) Connection and the Air Intake Structure

AP1000



Westinghouse

Shaw™

AP1000

Shield Building Wall Section Mock Up

- The fabrication, assembly and erection of a mock up provides actual working conditions, configuration, and challenges encountered in construction
- Construction and examination of the mock-ups for the lower heavily reinforced section of the SC to RC interface and the Air Intake structure provide valuable opportunities to evaluate, monitor, and confirm the adequacy of construction plans
- The results will provide valuable insight and opportunity to change or modify construction and inspection techniques and planning if needed, prior to actual construction

AP1000

Overview of Concrete Inspection

- A Westinghouse, Shaw and Consultant Team has been assembled to evaluate additional inspection techniques
- Concrete mix designs facilitate placement
- Successful mockups validate placement procedures
- Procedures, workmanship and quality control ensure best available construction practices

AP1000

Mockup Construction and Test Plan

- Constructability mockups to include:
  - Field performance testing of the concrete mixes
    - Standard tests including slump, air content, unit weight, and compressive strength cylinders as specified
    - Flow and fill capabilities of concrete at low range and high range of allowable slump or slump flow
    - Identify and monitor obstructions during placement to avoid potential segregation
- Methods of concrete placement:
  - Location and spacing of tremies
  - Control of lift heights
  - Visual placement inspections

AP1000

Mockup Construction and Test Plan

- Post mock-up activities
  - Concrete curing
  - Monitoring of concrete temperatures
  - Visual inspection of exposed concrete surfaces for cracking, laitance and other defects.
  - Preparation of construction joints
  - Disassemble the forms and examine the surfaces for voids and other defects
  - Core or cut sections to inspect the cross section of the concrete
  - Concrete strength verification
  - Issue report on the mockup results
  - Procedures to be revised and mock-ups to be repeated if necessary
  - Site-specific mock-up training will be performed

AP1000

Construction Sequence

- Shield wall SC (steel / concrete composition) installation will interface with and will be closely coordinated with the installation of the Containment Vessel.
- Installation of rebar dowels for connection of SC to RC (reinforced / concrete composition) will start prior to concrete placement to 100'.
- Installation of wall connection plates at the corners will occur after concrete placement to 100'.
- Installation of the first plated walls which are the RC to SC connection 10' in height will begin after Aux Bldg walls are at elevation 117' 6"
- Approximately 6' of concrete will be placed, cured and prepped prior to setting next row of panels.
- Panels will be assembled into larger sections prior to setting into final installation location.

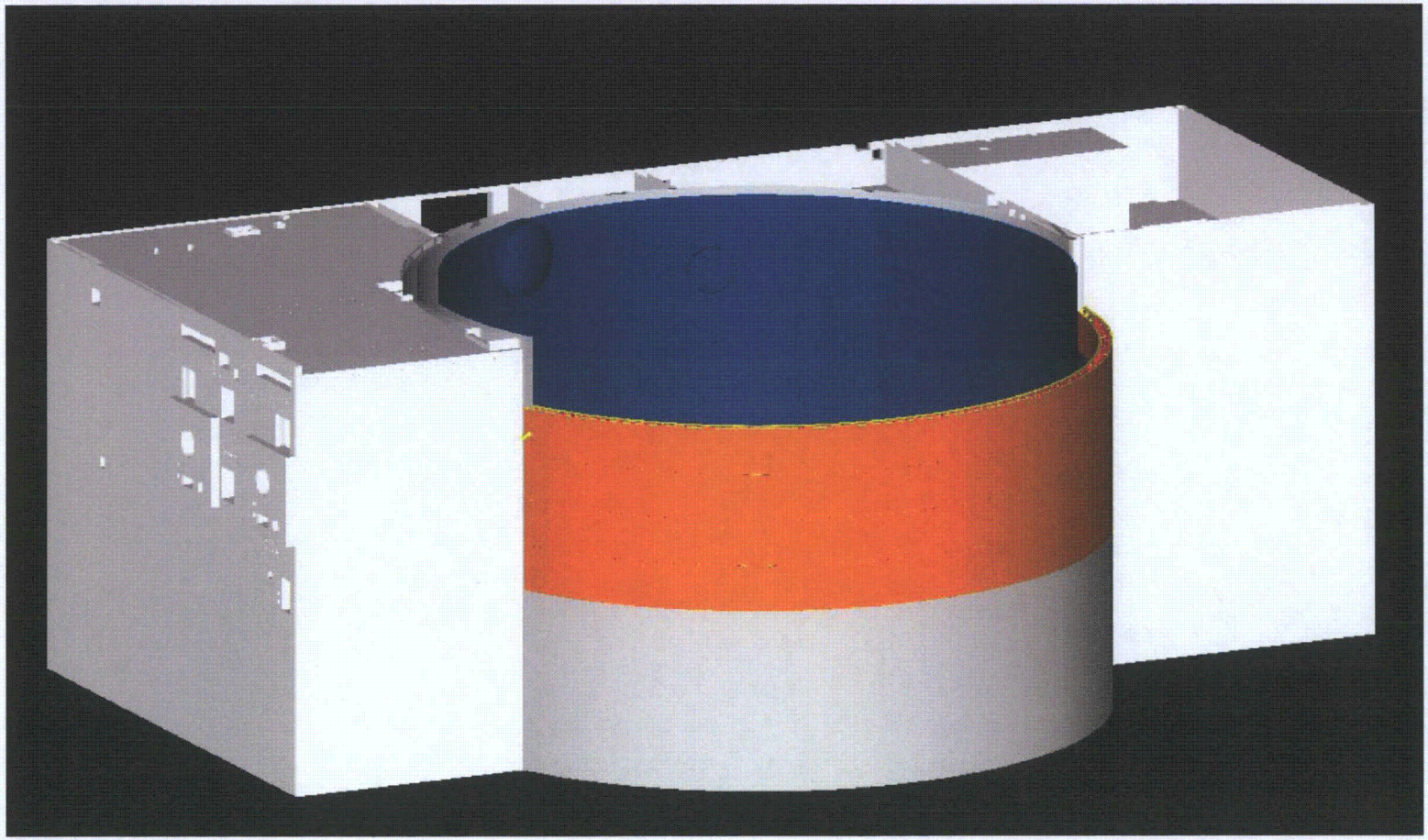
AP1000

Construction Sequence

- SC panels with concrete placement activities will continue where-as schedule and Containment Vessel installation allows to elevation 248' 6".(standard plant design)
- Air Intake structure will be installed in sections from elevation 248'6" to 272'.
- Roof module will be set after concrete curing, major equipment and Containment Vessel top head is installed.
- After rebar installation on the lower roof area concrete will be placed to approx elevation 293'.
- After lower section of the roof concrete is cured the Passive Cooling System tank will be installed, concrete will be placed under tank followed by the interior and exterior walls and the roof.

CV 1st Ring Installed, Aux Building Up to elevation 155' and SC Shield Wall being installed

AP1000

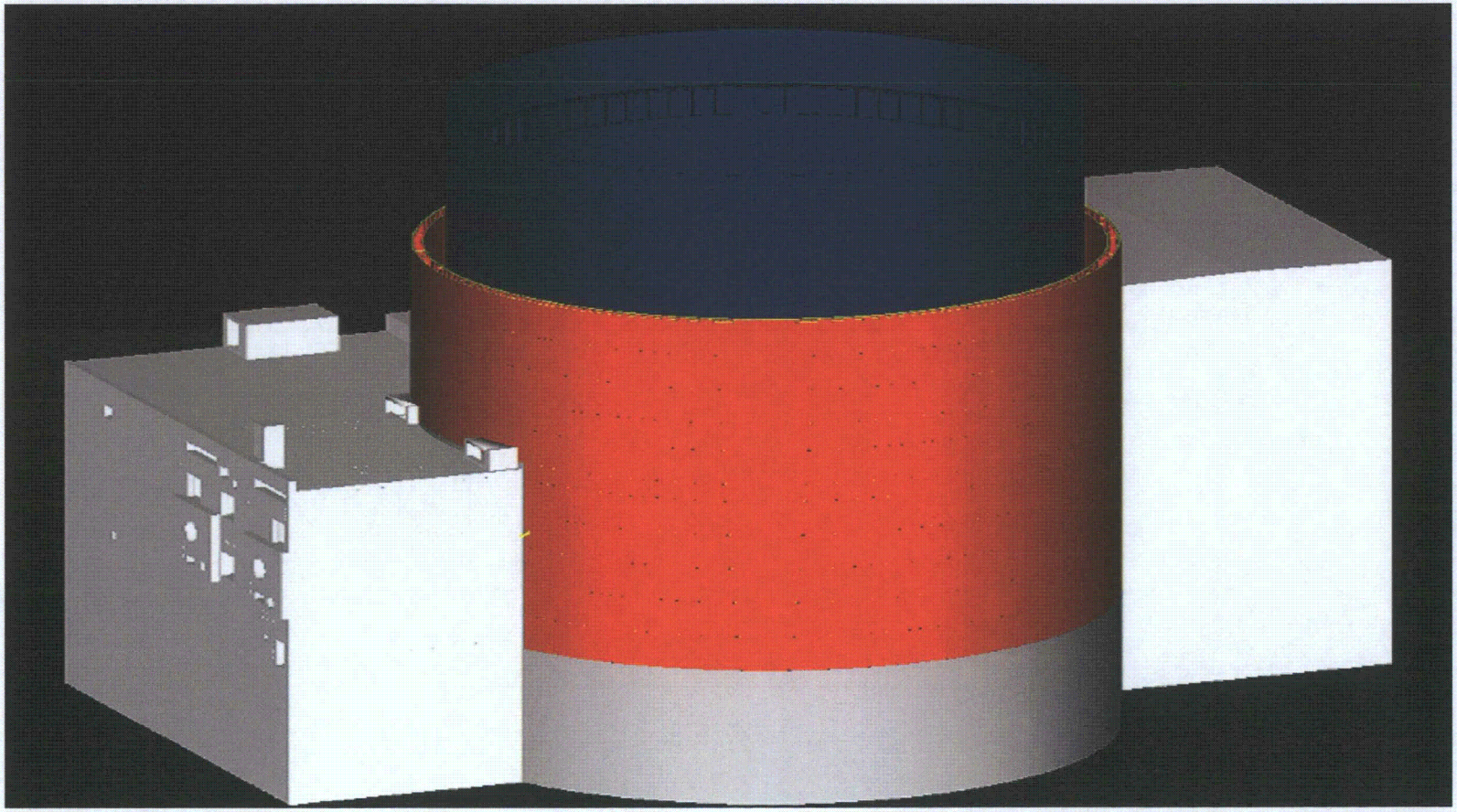


Westinghouse

Shaw™

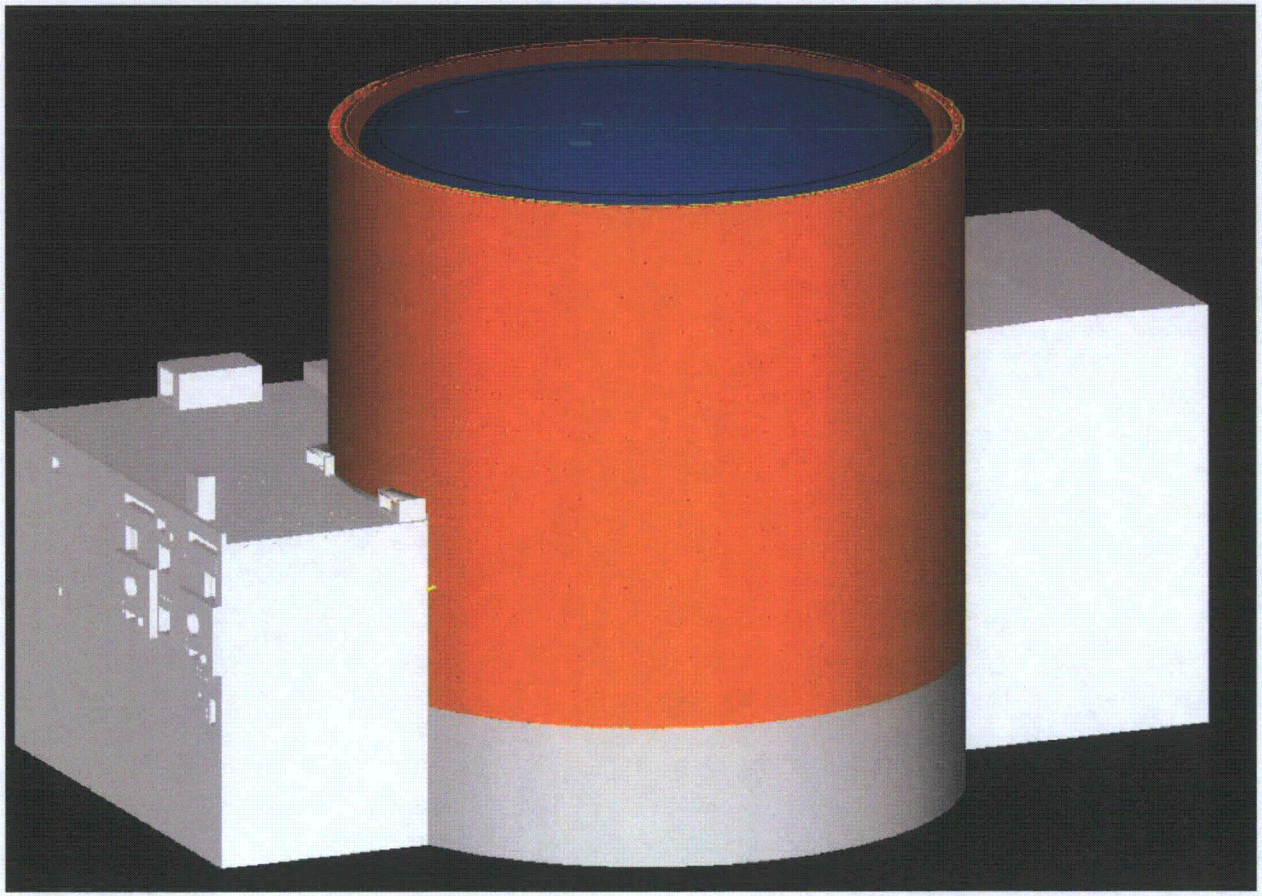
CV 2nd and 3rd Rings Installed, Aux Building concrete complete, SC Shield Wall installation continues

AP1000



AP1000

Shield Wall is installed up to elevation 248'-6"

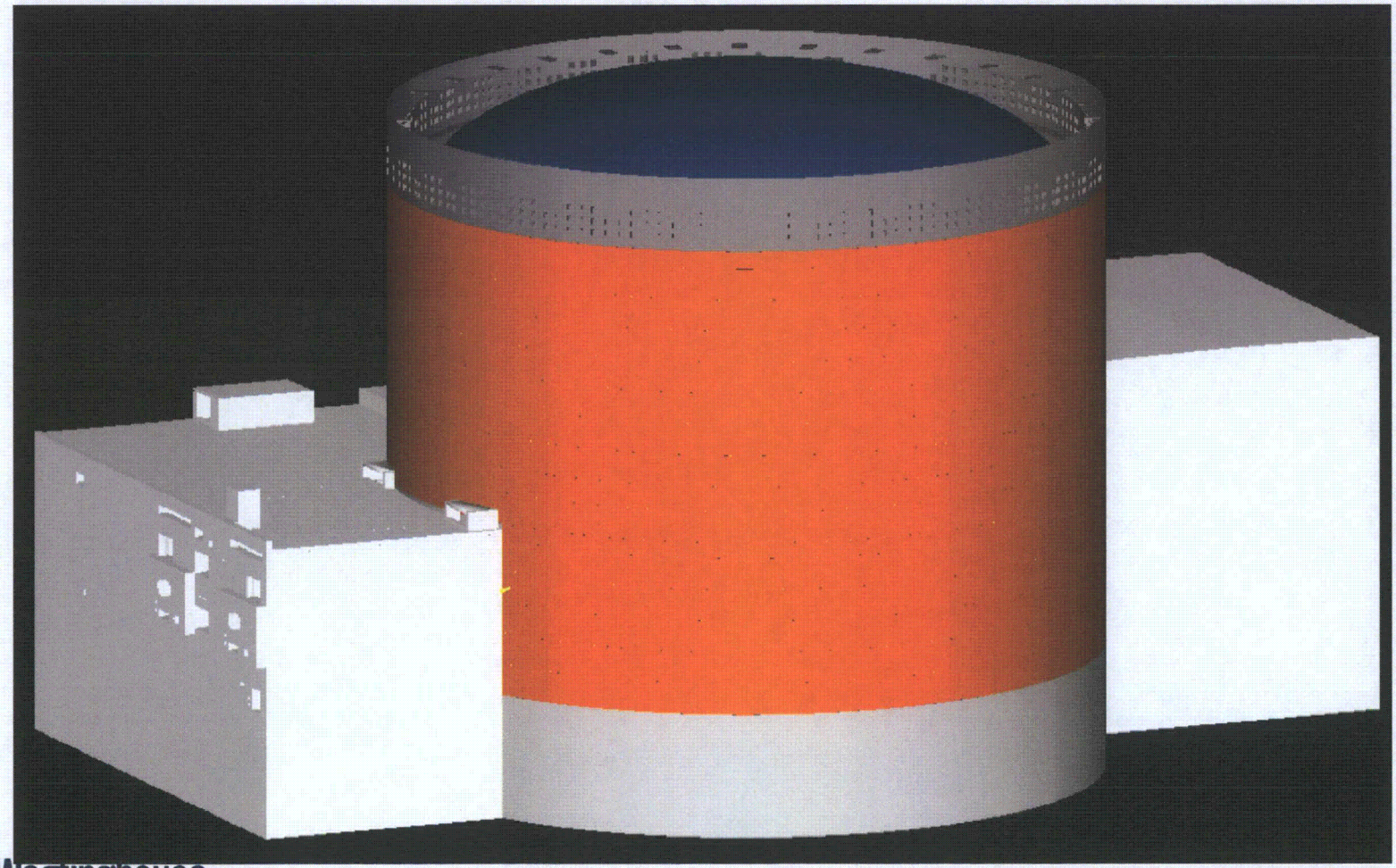


Westinghouse

Shaw

AP1000

Air Inlet Structure Installed and CV Top head installed



Westinghouse

Shaw™

AP1000

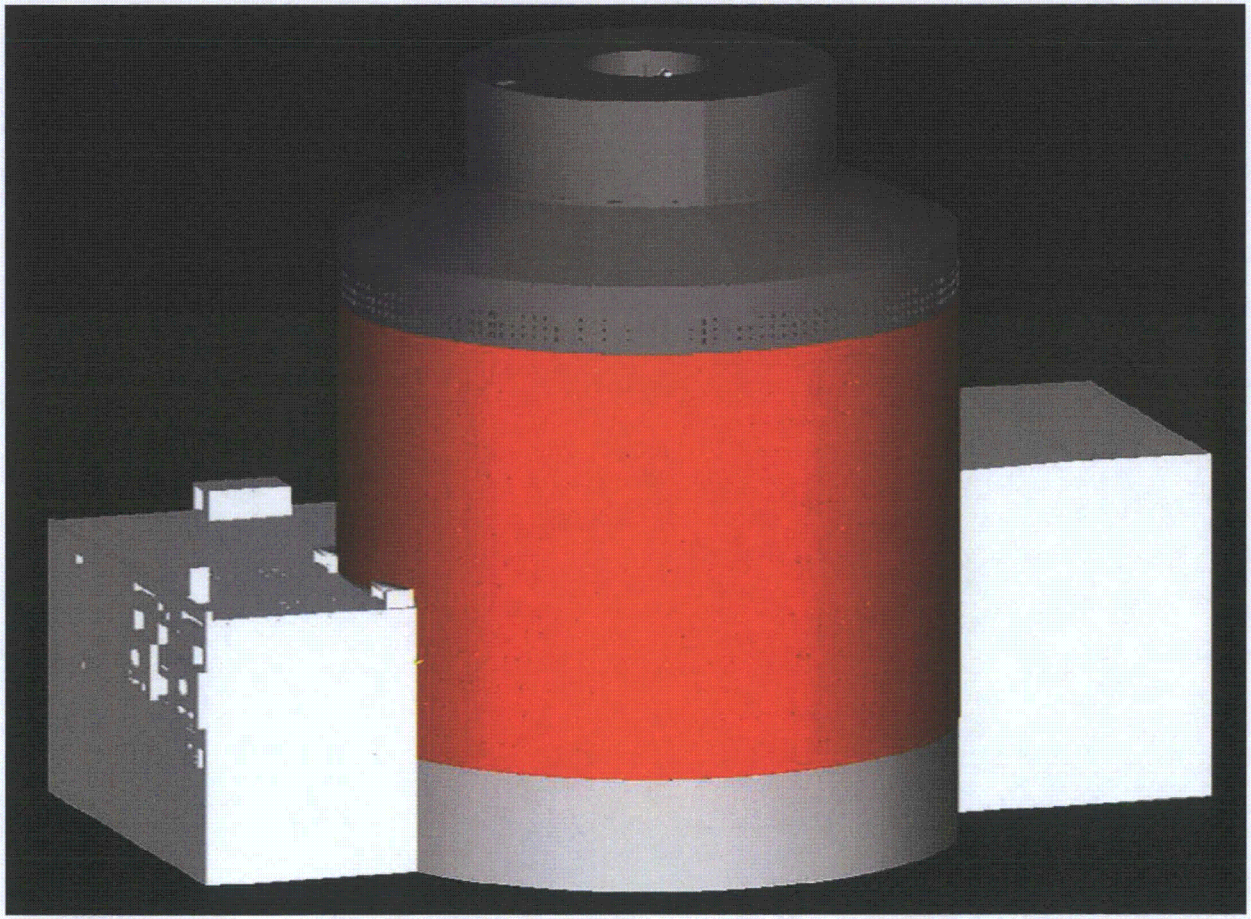
Installation of the Roof Module

Westinghouse

Shaw™

Concrete is placed on the roof to the area of the PCS tank, then the PCS tank is set and remaining concrete is placed.

AP1000



Shield Building Concrete Placement Overview

AP1000

- Develop Shield Building Concrete Placement Plan
  - Placement Mock-up and Classroom Training at each site
    - QA/Quality Control (QC) personnel
    - Construction supervision
    - Craft Workers
  - Utilization of Nuclear Construction procedures
  - Use of pre-qualified concrete mix designs which facilitate placement
  - Controlled rate of concrete placement
  - Concrete placement sign-off record (concrete placement Card)
  - Batch plant qualifications and operations
  - Readiness reviews

AP1000

Shield Building Concrete Placement Plan

- Inspections during concrete placement
  - Slump-flow (SCC), slump (Standard Concrete), temperature, air content, unit weight and test cylinders
  - Segregation, concrete vibration and consolidation, rate of placement, concrete freefall
  - Procedure compliance
  - Quality of workmanship

AP1000

Welding General Requirements

- All structural welding and non-destructive examination (NDE) is to be in accordance with ANSI/AISC N690-1994 "specification for the design, fabrication, and erection of steel safety-related structures for nuclear facilities," and AWS D1.1-2000 "Structural Welding Code-Steel.
- Welding of shear studs shall be accomplished in accordance with Section 7 of AWS D1.1-2000 along with supplemental requirements in APP-VW01-Z0-001 "Shear Stud Welding Specification"
- Non-destructive testing (NDT) of structural steel is to be accordance with ANSI/AISC N690-1994, AWS D1.1/D1.1M, *Structural Welding Code*, unless otherwise specified on design documents.

AP1000

NDE General Requirements

- Inspection requirements for plate to plate welding per ANSI/AISC N690-1994 for full penetration groove welds include:
  - 100% Visual Inspection (VT) of weld surfaces
  - 10% volumetric inspection of all welds, UT or RT.

AP1000

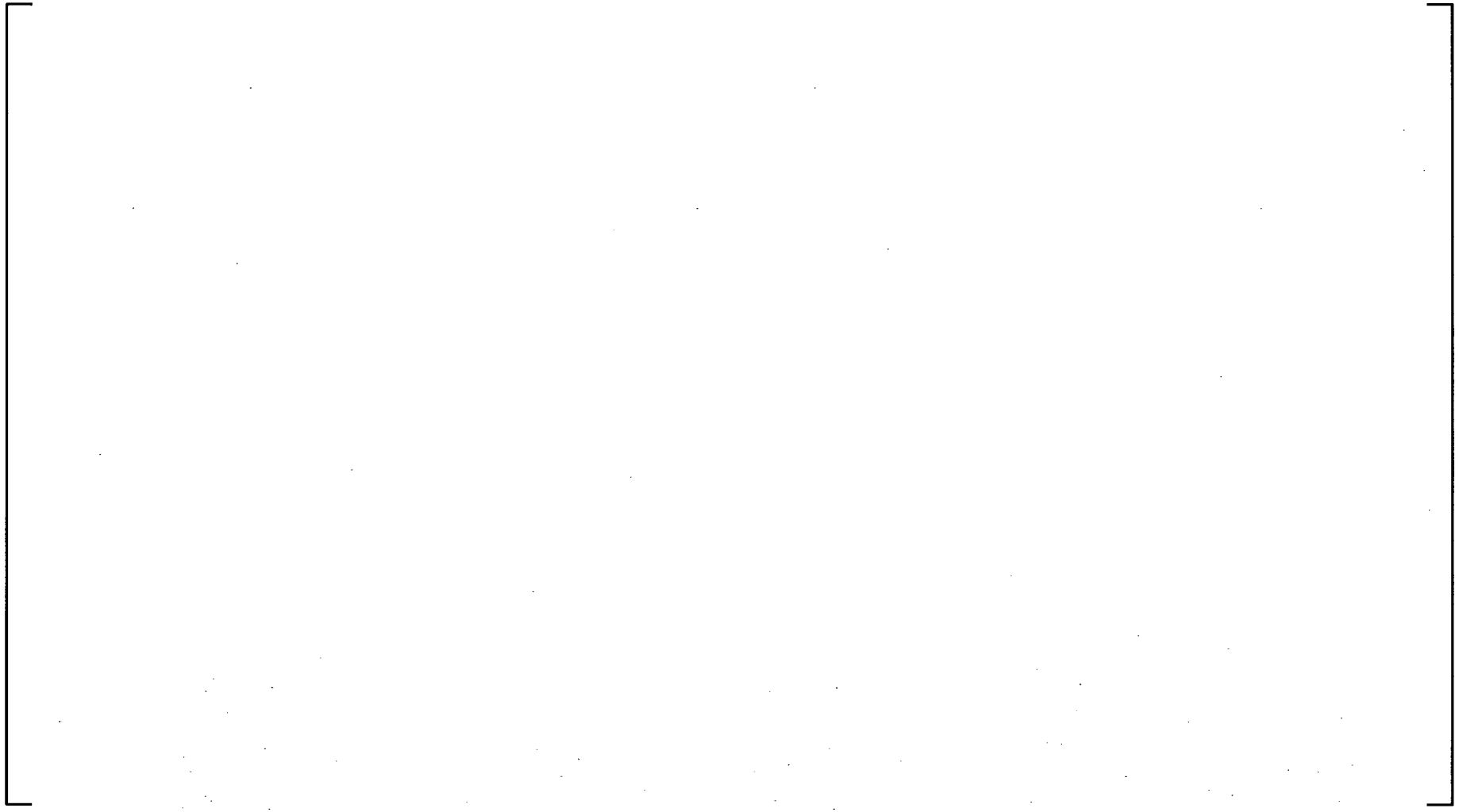
Summary of Construction & Inspection Issues

- Shaw construction is an integrated participant in the design of the AP1000 structures
- Shaw construction is developing an extensive mock-up plan for the Shield Building to ensure that the as-constructed Shield Building meets design requirements - Successful mockups validate placement procedures
- Revisions to the Shield Building design has limited the potential for defect during concrete placement.
- Procedures, workmanship and quality control ensure best available construction practices
- A Westinghouse, Shaw and Consultant Team has been assembled to evaluate additional inspection techniques

Shield Building Wrap-Up

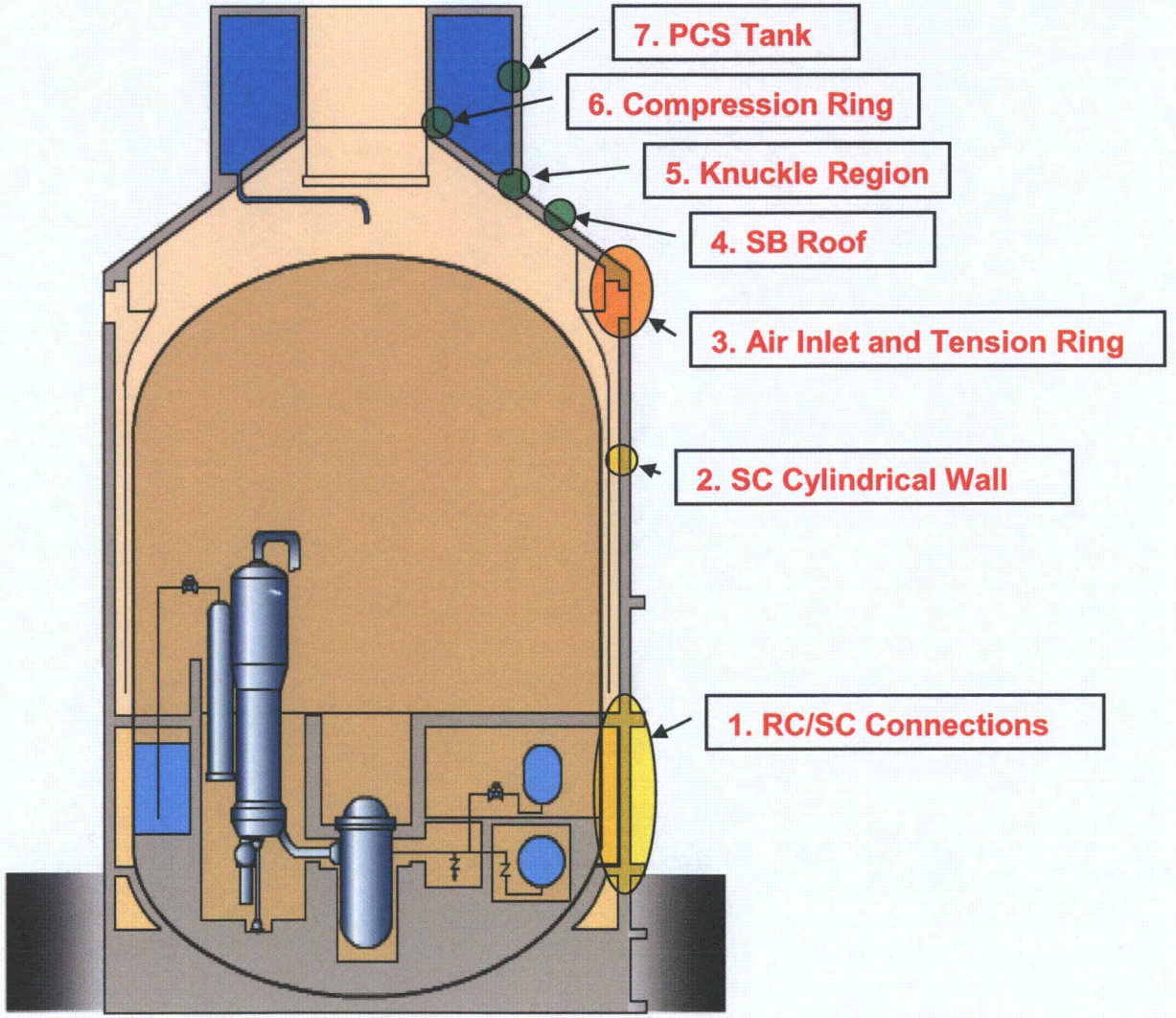
AP1000

a, c



Shield Building Design Features

AP1000



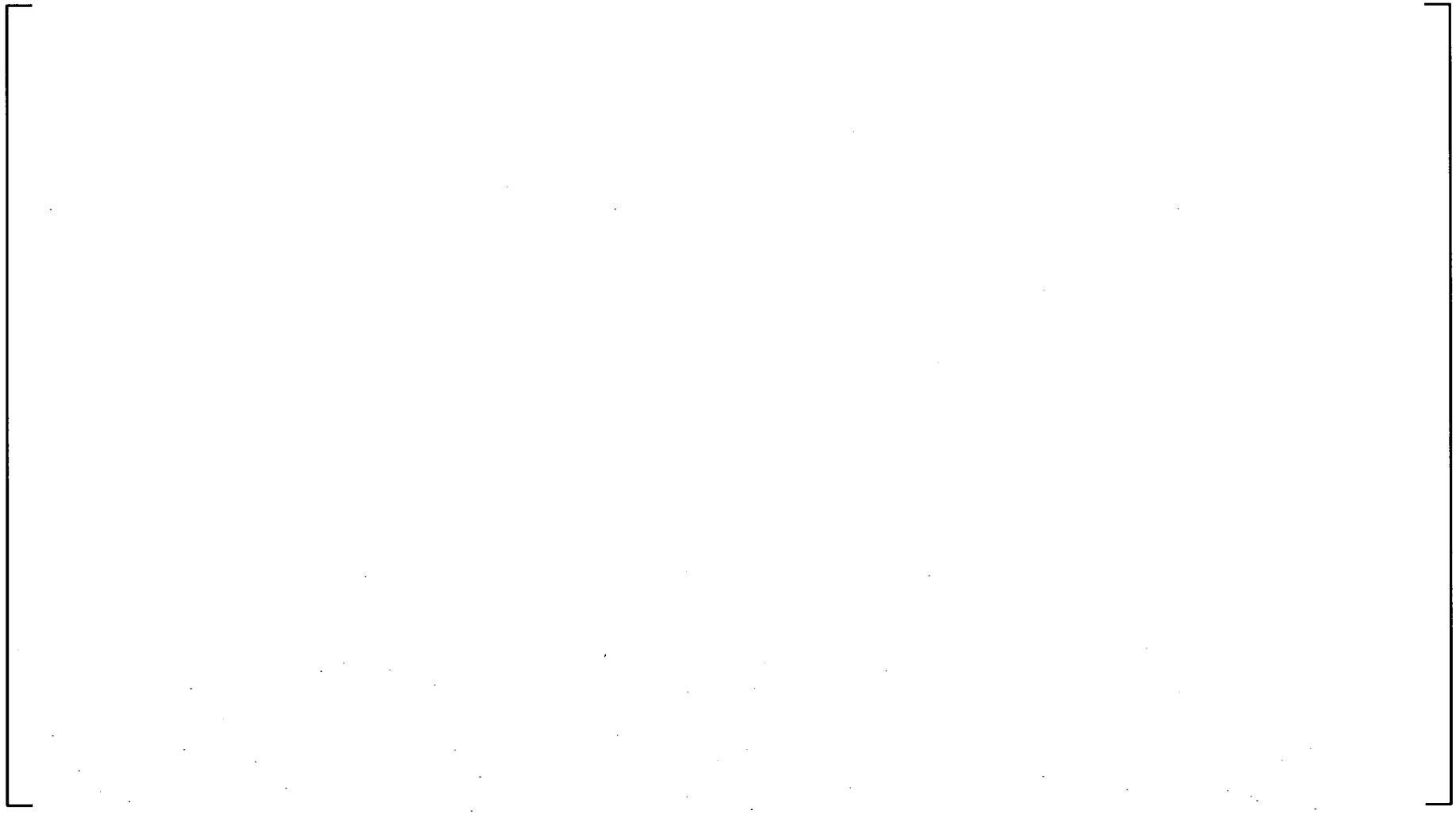
Westinghouse

Shaw

Shield Building Design Process Matrix

AP1000

a, c



AP1000

Conclusion

- Design Process for SB hybrid structure has been outlined
- Design features that make the shield building SC act more as a unit have been described
- Analysis Plan that shows how we plan to use both linear and nonlinear analyses to confirm a safe conservative design have been described
- Implementation of the testing plan is underway and it includes the successful results form the RC/SC connection
- Construction and Inspection methods have been described

AP1000

Questions