



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION II**  
245 PEACHTREE CENTER AVENUE NE, SUITE 1200  
ATLANTA, GEORGIA 30303-1257

September 15, 2010

Mr. Jon Franke, Vice President  
Crystal River Nuclear Plant (NA1B)  
ATTN: Supervisor, Licensing &  
Regulatory Programs  
15760 West Power Line Street  
Crystal River, FL 34428-6708

**SUBJECT: PUBLIC MEETING SUMMARY – SPECIAL INSPECTION RESULTS  
CRYSTAL RIVER NUCLEAR PLANT – DOCKET NO. 50 – 302**

Dear Mr. Franke:

On September 2, 2010, the Nuclear Regulatory Commission (NRC or the staff) conducted a public meeting at the Crystal River Nuclear Plant EOF/Training Center in Crystal River, FL. The purpose of the meeting was for the NRC to present the results of the Special Inspection that was conducted from October 13, 2009 to September 2, 2010, and that addressed the circumstances surrounding a delamination discovered in the concrete of the containment building at the Crystal River nuclear power plant last fall.

Mr. M. Franke of the NRC staff provided opening remarks. Mr. L. Lake of the NRC staff then presented the results of the inspection, which included a discussion of the delamination and an assessment of Progress Energy's actions to address the issue. Progress Energy then presented additional information and addressed the NRC inspection results. The public was invited to observe the meeting and had opportunities to communicate with the NRC after the business portion of the meeting.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and enclosure will be available electronically for public inspection in the NRC Public Document Room (PDR) or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Should you have any questions concerning this meeting, please contact me at 404-997-4436.

Sincerely,

*/RA/*

Mark Franke, Chief  
Engineering Branch 3  
Division of Reactor Safety

Enclosures:

1. List of Attendees
2. Handout – NRC Presentation Slides ML102440205
3. Handout – Progress Energy Presentation Slides ML102581096

cc w/encl.: (See page 3)

cc w/encl:

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Carolina Power & Light Company  
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Progress Energy Carolinas, Inc.  
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Plant General Manager  
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Stephen J. Cahill  
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Chairman  
Board of County Commissioners  
Citrus County  
110 N. Apopka Avenue  
Inverness, FL 36250

PUBLIC MEETING – CRYSTAL RIVER 3 NUCLEAR PLANT  
EXIT MEETING FOR SPECIAL INSPECTION CONTAINMENT DELAMINATION

SEPTEMBER 2, 2010

ATTENDEES SHEET

NAME	ORGANIZATION
Loretta Murray	Progress Energy Florida
GAIL SIMPSON	Progress Energy Florida
GEORGE THOMAS	NRC/NRR
Kriss Kennedy	NRC/RTI
DOU NEAL	PRIVATE
Sally Price	THE Newscaster
MARK FRANKIE	NRC
GARRY MILLER	PGN
OPHOLIA PAYNE	PUBLIC
BRENDAN COLLINS	NRC/RTI
Charles A. Williams	PGN
Anthony Masters	NRC/RTI
JASON PAISE	NRC
Farideh Saba	NRC
BOB OLIVEIRA	ANI
Mike Fahey	Citizen
ROGER HANNAH	NRC/RTI
TOM MORRISSEY	NRC SRT
Dan Rich	NRC RTI
Victor McCree	NRC

PUBLIC MEETING – CRYSTAL RIVER 3 NUCLEAR PLANT  
 EXIT MEETING FOR SPECIAL INSPECTION CONTAINMENT DELAMINATION

SEPTEMBER 2, 2010

ATTENDEES SHEET

NAME	ORGANIZATION
LOUIS LAKE	NRC
Rick Pellege	Central Power of Line
PAUL FAGAN	Progress Energy
Janet Garvin	Public
John H. Ring	Public (Citrus Vets)
Roger Souweville	Public
Tim KEENUM	Public
DENNIS HERRIN	CR-3 LICENSING
Dan Westcott	CR-3 licensing
SEAN BUTLER	PROGRESS ENERGY.
Brian McCabe	Progress
SUZANNE GRANT	Progress Energy
Chris Van Ormer	Citrus County Chronicle
Cathy Urcani	Public
GAIL DAVIS	Public
JAMES HOLT	Public
Bretlee JORDAN	CESO-REP Coordinator
Pamela Rowe	CESO-REP Assistant
Kathy Morse	Public
Tom DELANEY	Public

**PUBLIC MEETING – CRYSTAL RIVER 3 NUCLEAR PLANT  
EXIT MEETING FOR SPECIAL INSPECTION CONTAINMENT DELAMINATION**

**SEPTEMBER 2, 2010**

**ATTENDEES SHEET**

NAME	ORGANIZATION
Stephen Cahill	Progress Energy
Ronald M Bright	Florida Municipal Power Agency
LARRY Remmele	CITIZEN
BILL SHMIELEWSKI	"
Charlie Dupont	"
Jack Marshall	CITIZEN
ERNEST KARPOWIS	Progress Energy
Jessica Lambert	Progress Energy
Jim Scarola	Sr. VP P&E
MARK Embree	CITIZEN
John STRIKIS	CITIZEN
MARK RIBSBY	PROGRESS ENERGY Mgr SSS
Elmy + Doris Kelley	CITIZEN
Wm F. Serianus	"
MARILYN SERIANUS	"
TOM OVERT	"
BEVERLY OVERT	"
Rickie Doreken	St. Petersburg Times
John York	St. Petersburg Times
DAWN MARIE CLARY	TOWN OF YANKEETOWN

PUBLIC MEETING – CRYSTAL RIVER 3 NUCLEAR PLANT  
EXIT MEETING FOR SPECIAL INSPECTION CONTAINMENT DELAMINATION

SEPTEMBER 2, 2010

ATTENDEES SHEET

NAME	ORGANIZATION
MARK P. KLUTHO	THORN
Pete Judd	Self - Sr. Citizens of
Rogeria Reyes	Clwr & Dunedin, FL
Gail Lowne	IRT - CR
	Admin Assist NRC CR



**NRC  
Special Inspection  
Team**

**Exit Meeting for  
Crystal River**

September 2, 2010



# Purpose

- Background
- Inspection
- Results



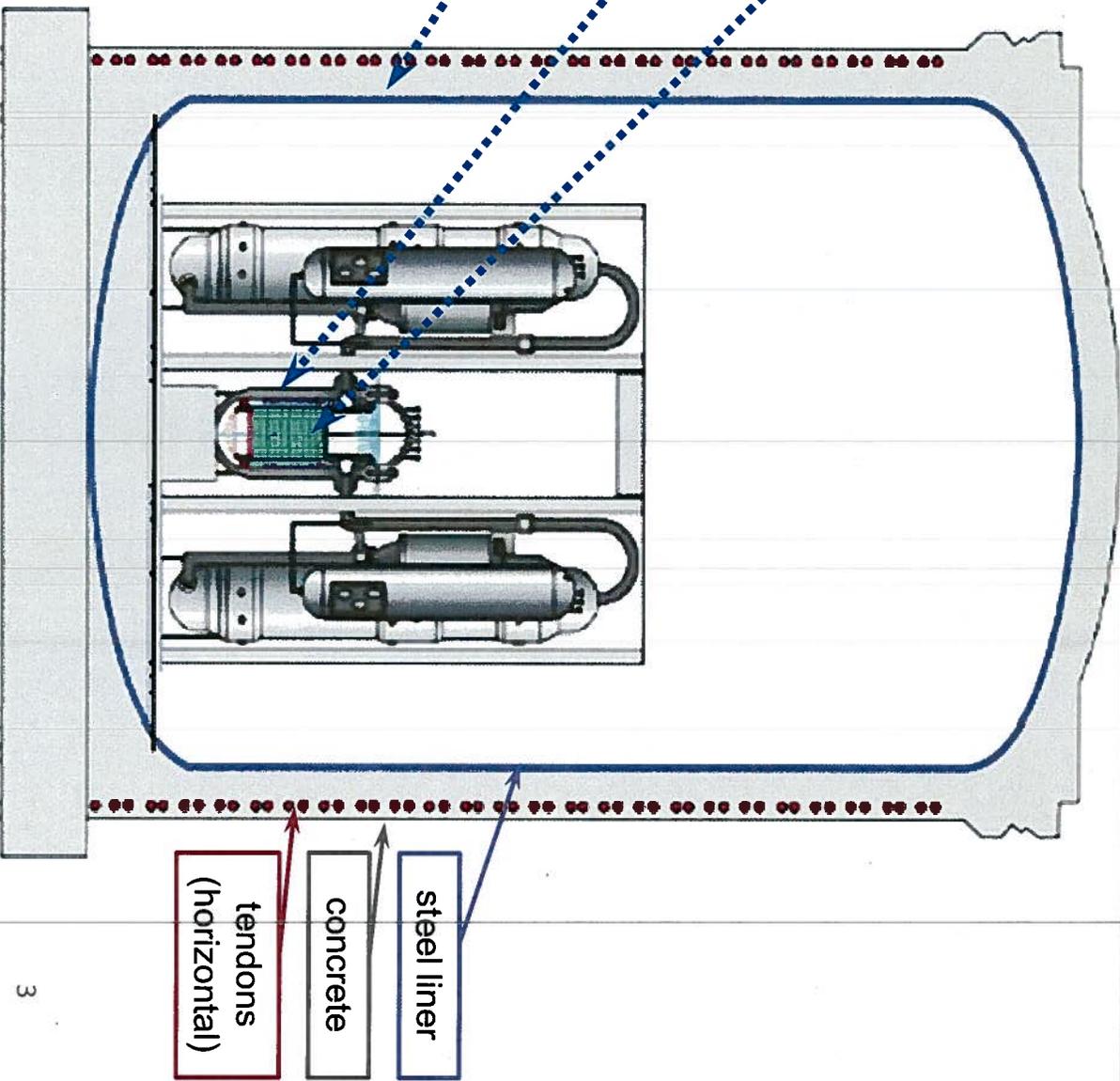


# Fission Product Barriers

Barrier #1:  
cladding enclosing the fuel

Barrier #2:  
reactor vessel & piping

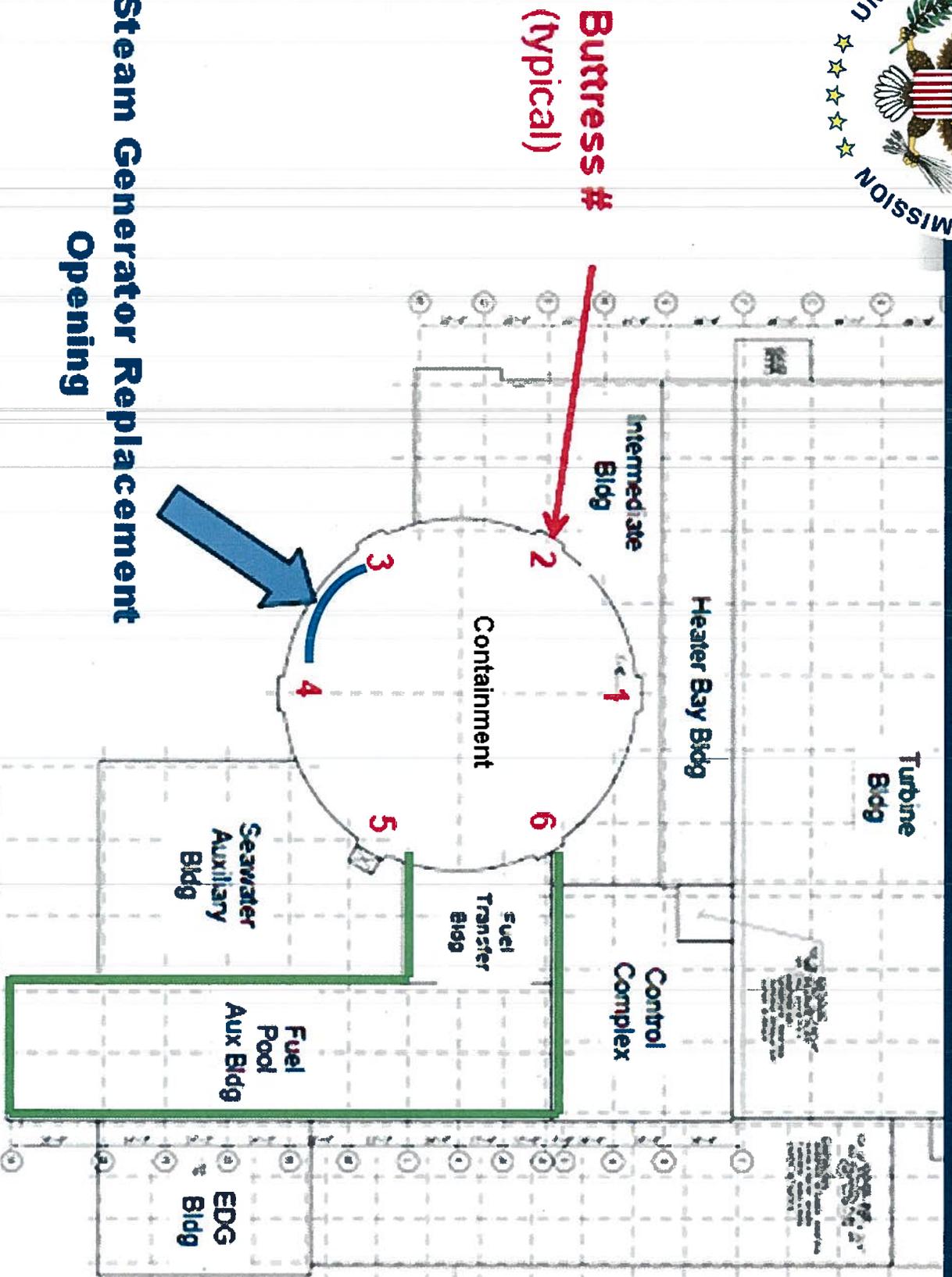
Barrier #3:  
containment



**\*NOT TO SCALE\***



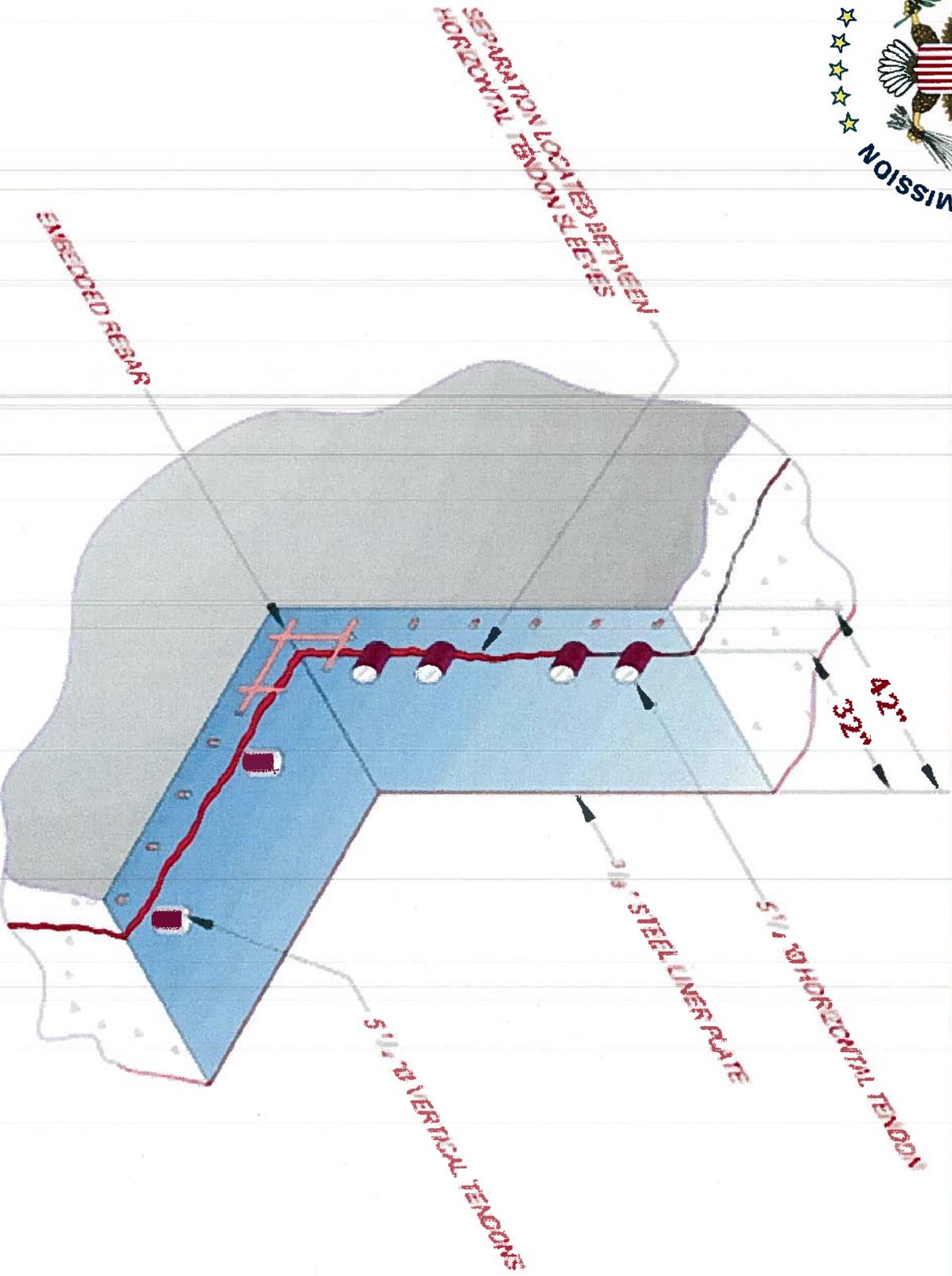
# Plan View



**Steam Generator Replacement  
Opening**

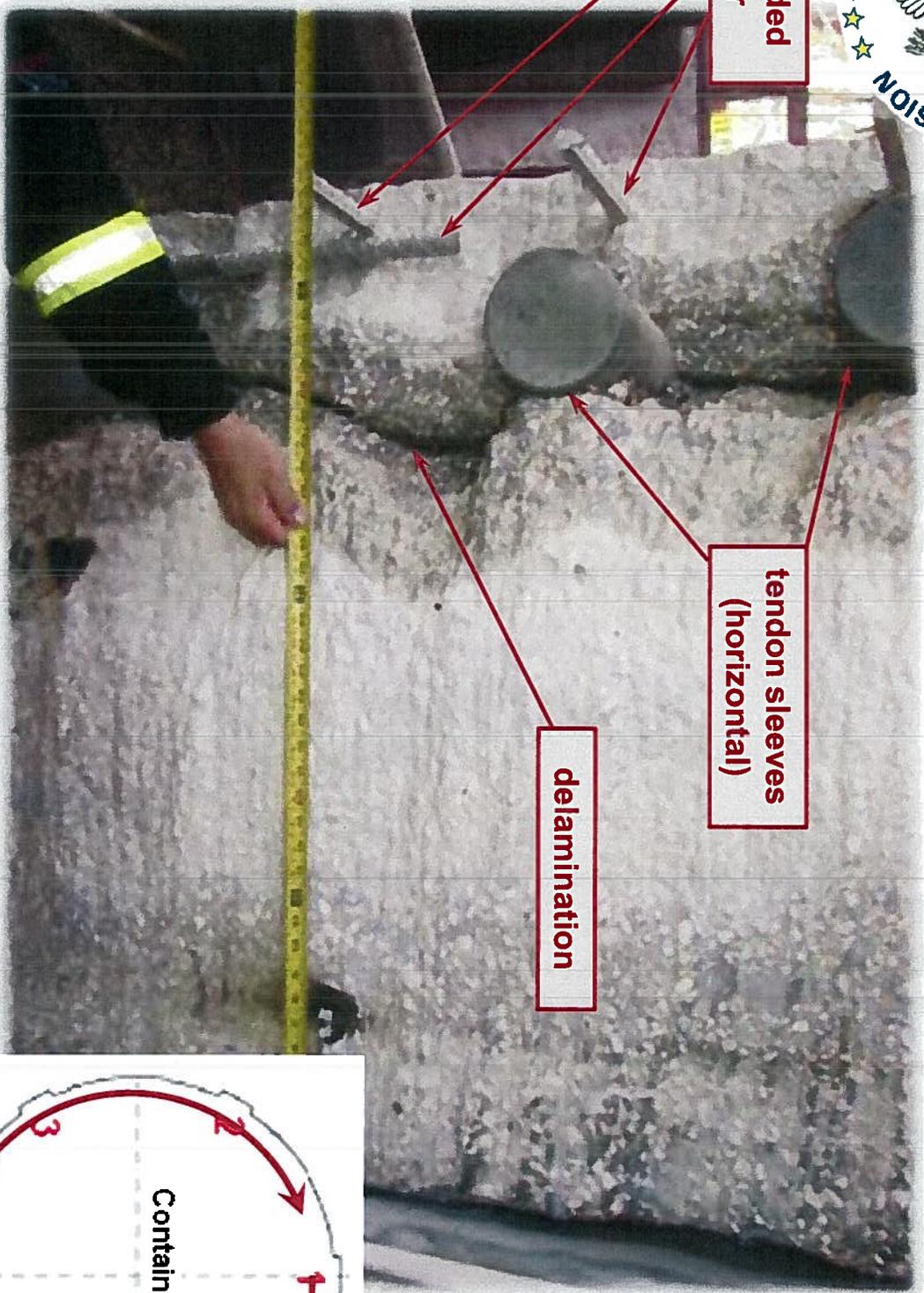


# Delamination Location





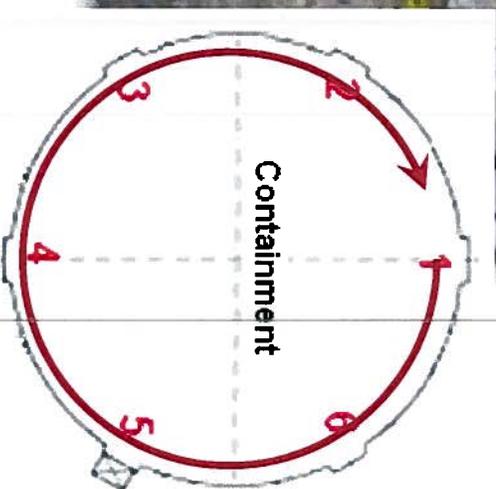
# Delamination Location



embedded rebar

tendon sleeves (horizontal)

delamination

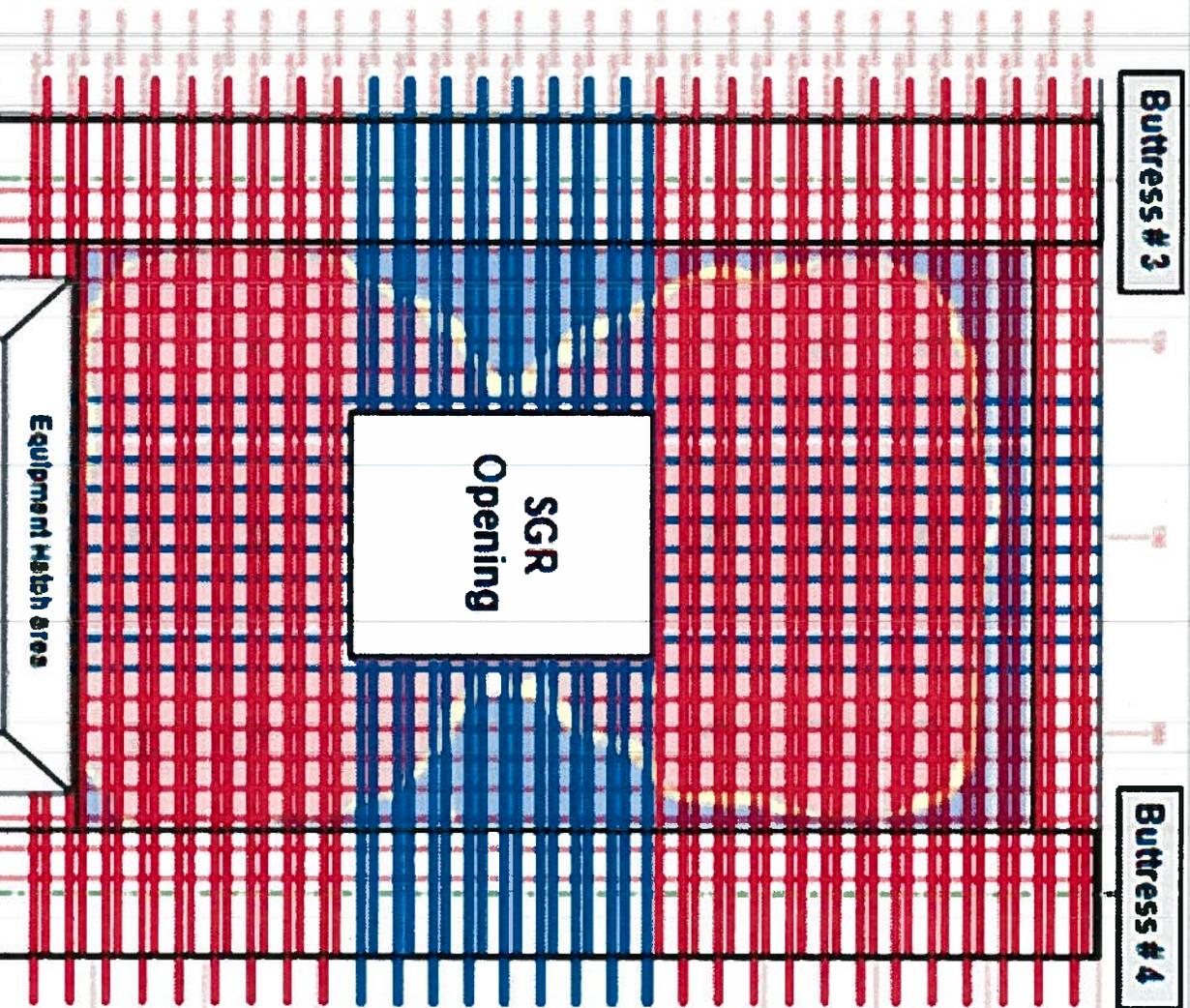




# Tendon Pattern

Tendon Pattern at time  
of cutting  
Steam Generator  
Replacement Opening

- Tensioned
- De-tensioned and  
Removed





# INSPECTION SUMMARY

## Special Inspection

- 6 member team
  - NRC Staff and Independent Experts
- More than 100 years relevant experience



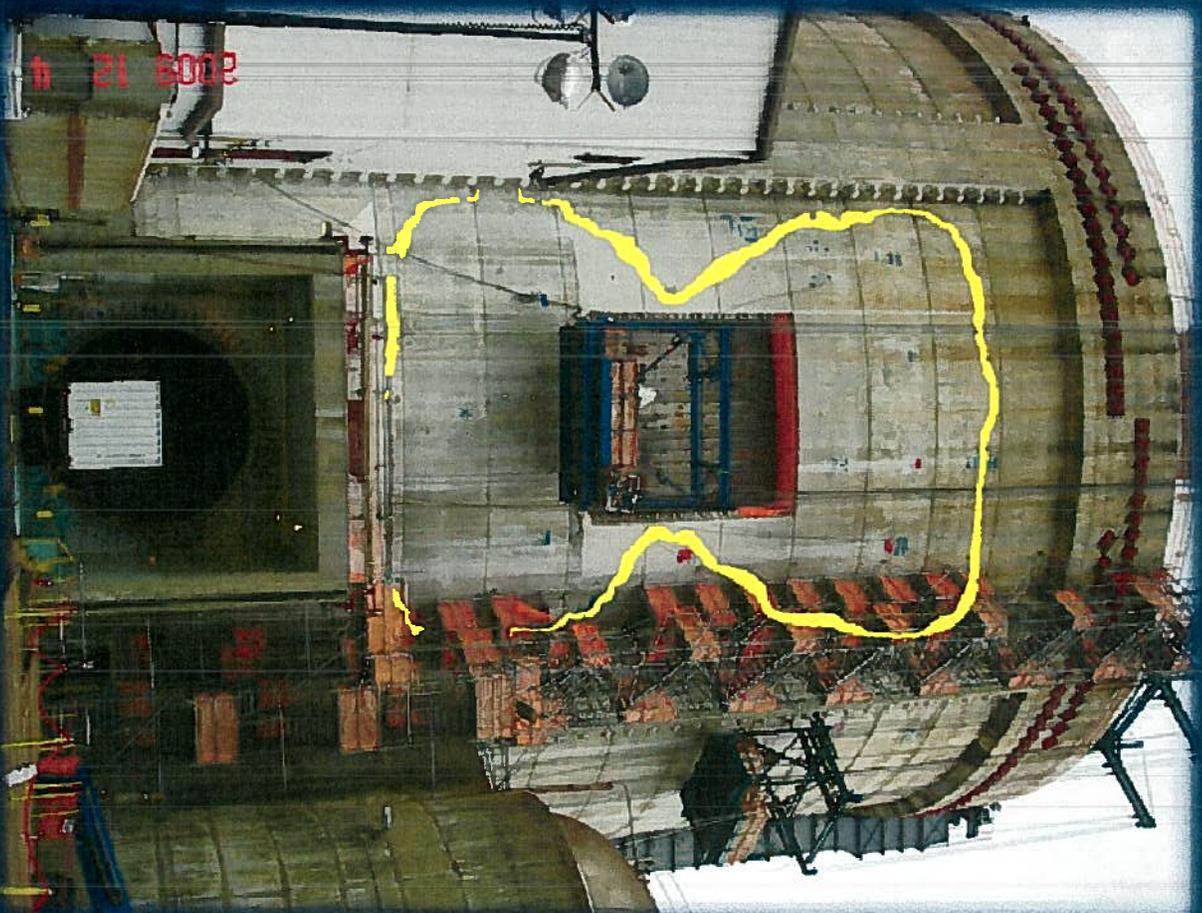


# Inspection Results

- Progress Energy Investigation
- Safety Significance



# Extent of Delamination



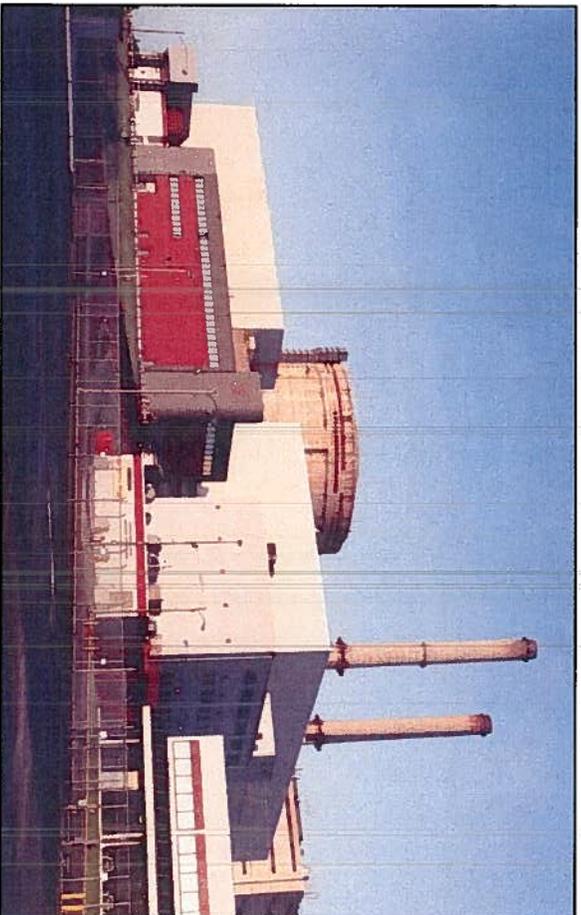


# Inspection Results

- Generic Implications
- Progress Energy Corrective Actions

# Crystal River Unit #3 Containment Investigation and Repair

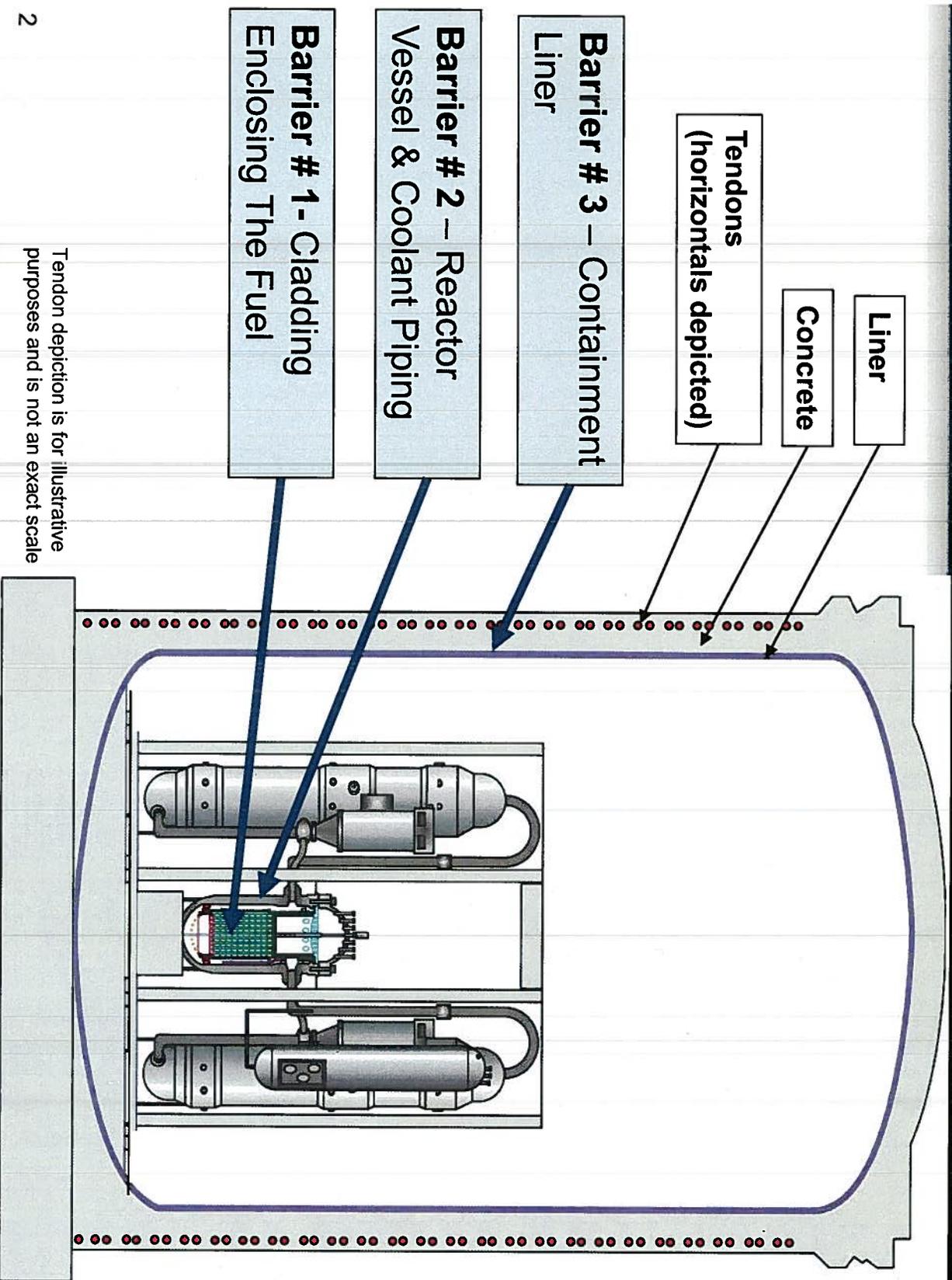
September 2, 2010



**Progress Energy**

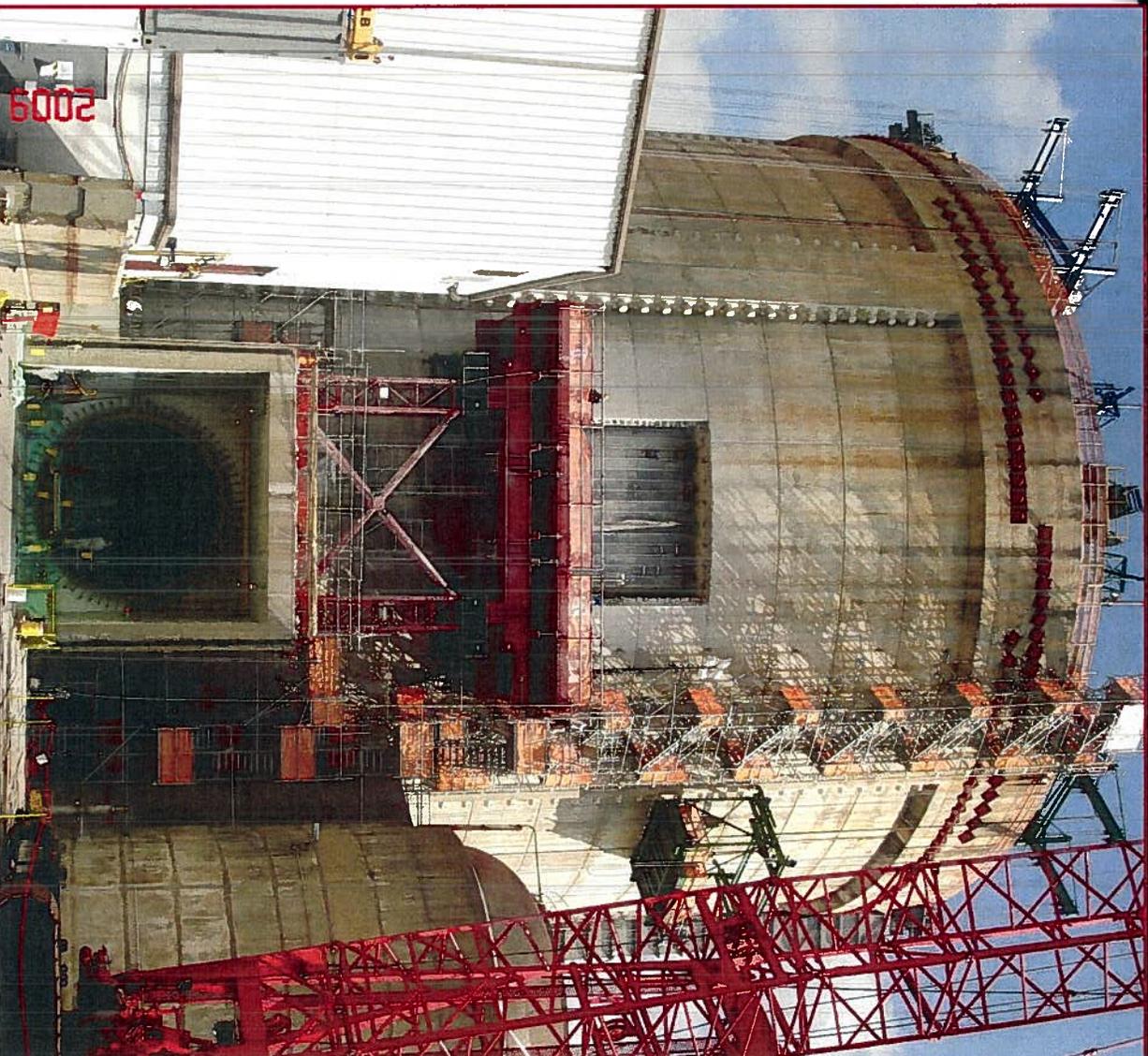
# Fission Product Barriers

## Simplified Schematic



Tendon depiction is for illustrative purposes and is not an exact scale

# Steam Generator Replacement Opening Identification of Issue



## SGR Opening Dimensions

@ Liner  
23' 6" x 24' 9"

@ Concrete Opening  
25' 0" x 27' 0"

- **Comprehensive Team Commissioned**

- Progress Energy personnel - expertise across fleet
- Industry peers:
  - *Exelon*
  - *Southern Company*
  - *SCE&G*
- External expertise:
  - *Performance Improvement International (PII)*
  - *MPR Associates*
  - *AREVA*
  - *Worley Parsons*
  - *Wiss, Janney, Elstner Associates (WJE)*
  - *Construction Technology Laboratories (CTL)*

# Root Cause Analysis

*Investigation & Design Basis Team (continued)*

- **Material Laboratories Support**
  - *MacTec*
  - *Soil & Materials Engineers (S&ME)*
- **Field Data Support**
  - *Sensing Systems, Inc*
  - *Core Visual Inspection Services (Core VIS)*
  - *Nuclear Inspection & Consulting, Inc*
  - *Precision Surveillance*
  - *Gulf West Surveying, Inc*
  - *AREVA*

# Root Cause Analysis

*Investigation & Design Basis Team (continued)*

- **Numerous PhDs (11) with expertise in:**
  - *Root Cause Investigation Techniques*
  - *Nuclear Engineering*
  - *Nuclear Operations & Maintenance*
  - *Material Science & Testing*
  - *Concrete Standards & Construction*
  - *Concrete Testing*
  - *Concrete Creep*
  - *Concrete Fracture*
  - *Human Performance*
  - *Process Analysis*
  - *Containment Analysis*
  - *Computer Modeling*

## Concrete Operational Experience (OE)

- **Worley Parsons**

- 1976 dome delamination investigation and repair (as Gilbert Commonwealth)

- **Structural Preservation Systems (SPS)**

- Largest Concrete Repair Contractor in the US, 2<sup>nd</sup> largest Concrete Contractor (of any type) in the US
- Performs > 4,000 repair projects per year

- **Wiss, Janney, Elstner Associates, Inc (WJE)**

- Structural engineering and materials science firm specializing in failure investigations and problem solving
- Specialist in structural condition assessments and design of repairs and retro-fits for reinforced and post tension concrete structures
- Conducted original CR3 Structural Integrity Test (SIT)

# Nuclear Safety Oversight Committee (NSOC)

## Containment Sub-Committee Membership

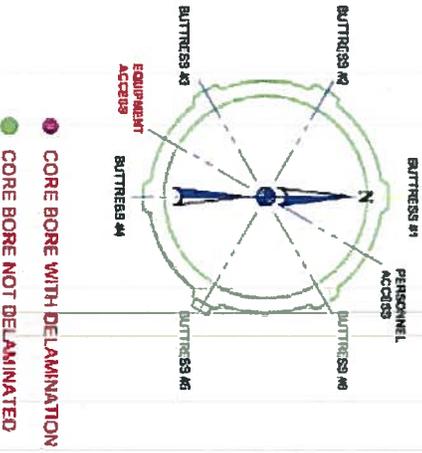
Member	Title
John Elnitsky (PGN)	VP – New Generation Programs and Projects <b>(Chairman)</b>
Joe Donahue (PGN)	VP - Nuclear Oversight
Chris Burton (PGN)	VP - Harris
Greg Selby	Technical Director - EPRI
Dr. Shawn Hughes	VP - Shaw Stone & Webster
Dr. Paul Zia	Civil Engineering Professor, NCSU
Hub Miller	33 years industry oversight experience
Darrell Eisenhut	41 years industry operation and oversight experience

# Root Cause Analysis

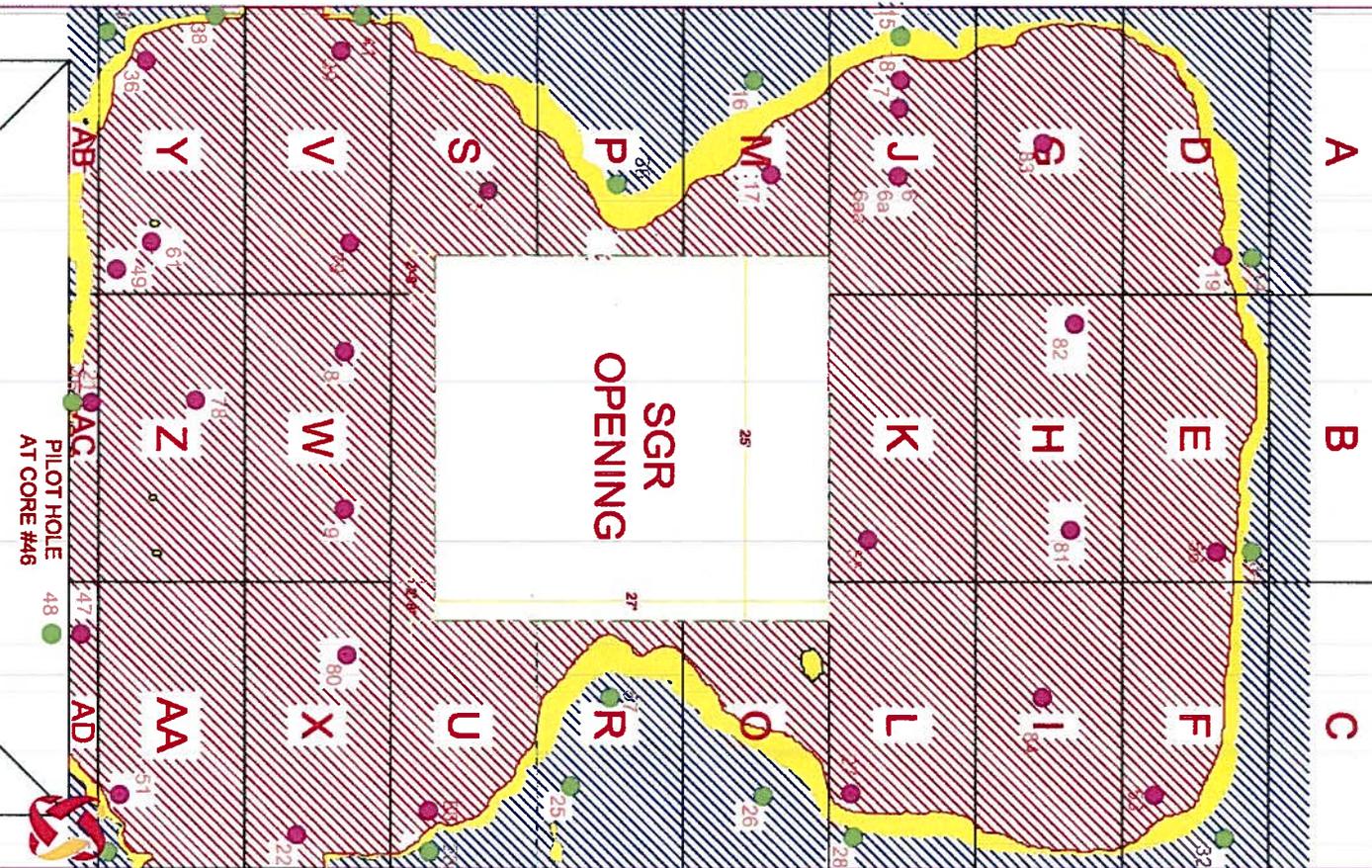
## *Investigation Approach*

- **Complex Investigation with 75 Potential Failure Modes Considered**
- **Non-Destructive Testing (NDT) of Containment Wall Surfaces**
  - Use of Impulse Response (IR) Method and Ground Penetrating Radar (GPR)
    - Over 8,000 IR data points taken
  - Comprehensive on all accessible areas
- **Concrete Core Bores**
  - Over 150 core bores performed
  - Ranged from 1" to 8" diameter, 6" to 32" long
  - Validated Impulse Response (IR) data, along with boroscopic inspections
  - Laboratory testing

# Core Borings



**Conclusion** – Physical observation of core boring has validated the delamination boundary, as accurately predicted by Impulse Response (IR).



POUR 16

EL. 240'

POUR 15

EL. 230'

POUR 14

EL. 220'

POUR 13

EL. 210'

POUR 12

EL. 200'

POUR 11

EL. 190'

POUR 10

EL. 180'

POUR 9

EL. 170'

POUR 8

EL. 160'

# Root Cause Analysis

## Laboratory Analysis

- **Concrete Core Laboratory Analyses**
  - Petrographic Examination
  - Modulus of Elasticity and Poisson's Ratio
  - Density, Absorption, and Voids
  - Compressive Strength, Splitting Tensile Strength, and Direct Tensile Strength
  - Fracture Energy
  - Accelerated Creep Test
  - Accelerated Alkali Silica Reaction (ASR) Test
  - Chemistry and Contamination Test
  - Scanning Electron Microscope (SEM) Examination of Micro-Cracking

## Root Cause Analysis

### *Finite Element Analysis (FEA) Modeling Tools*

- Existing Industry Analysis Techniques Predicted Acceptable Margin to Delamination at CR3
- Investigation Required Development of New FEA Tools of Progressively Increasing Complexity based on Data Obtained from the Delamination
  - 360° global containment model
  - Visco-elastic / non-linear model
  - Model includes individual tendons, rebar, liner, etc.
  - Sub-models (1" mesh) provide higher resolution of localized behavior

# Root Cause Analysis

## Summary

### Conclusions

- Design is Acceptable for Normal and Emergency Operations
- Construction was in Accordance with Design
- Delamination Occurred During the Outage
- Investigation was Thorough and Comprehensive
- New State-of-the-Art Analytical Methods had to be Created to Analyze Containment Response
- **Root cause:** De-tensioning scope and sequence resulted in redistribution of stresses that exceeded tensile capacity
  - *Could not have been predicted based on existing information and models at that time*

# Design Basis & Repair

## *FSAR Structural Design Parameters*

- **Containment Design Features Remain Unchanged**
  - Prestressed concrete cylindrical wall (shell), shallow dome roof
  - Carbon steel liner serves as fission product barrier
  - Liner anchored to concrete

- **Containment Design Basis Maintained**
  - Leak-tight structure to contain Design Basis LOCA
  - Elastic response to design basis loading to protect liner
  - Design loads and combinations based on operating, accident and applicable code requirements
  - Load factors applied to provide safety margin

# Design Basis Repair

## FSAR Design Loads

- **All Containment Design Loads Analyzed**
  - Live, Prestress, Dead Loads
  - Wind
  - Tornado Wind
  - Tornado Pressure
  - Tornado Missiles
  - Seismic
  - Temperature Loads
  - Accident Pressure (LOCA)
  - Accidental Containment Spray Actuation Pressure

## Design Basis & Repair Summary

- **Final repair condition expected to be acceptable under 10 CFR 50.59**
  - Design basis loading conditions will be satisfied
  - Design code requirements will be met
  - Changes to analysis inputs accepted by 50.59 evaluation
  - Analysis consistent with the existing FSAR described Method of Evaluation

# Design Basis & Repair Repair Sequence

- **Stress Relief Cut - Complete**
- **De-tensioning - Complete**
- **Concrete Removal - Complete**
- **Concrete Placement - In Progress**
- **Re-tensioning**
- **Post-Repair Testing**
- **Unit Restart**



## Post Repair Testing *Pressure Tests*

- **Integrated Leak Rate Test (ILRT) required per ASME XI code**
  - For removing / replacing liner in SGR opening
- **Plan to perform a Structural Integrity Test (SIT)**
  - Normally a one-time initial construction structural test
  - Test intent: measures structural integrity and deformation at 1.15 Peak Design Pressure (63.3 psig)
  - SIT will be followed by ILRT

## Summary

- Containment original design and construction are acceptable for normal and emergency operations
- Planned repair approach meets design basis requirements and code requirements
- The final repair condition is expected to be acceptable under 10 CFR 50.59
- Containment will be fully capable of meeting its design safety function upon completion of repairs and testing

