PROGRESS ENERGY

CRYSTAL RIVER UNIT 3

PLANT OPERATING MANUAL

PT-407T
SPECIAL PROCEDURE

REACTOR BUILDING CONCRETE EXAMINATION AND TESTING

This procedure expires October 20, 2010

P/ 38

TABLE OF CONTENTS

SECTION PAGE

1.0 PURPOSE ... 3

2.0 REFERENCES ... 3
- 2.1 Developmental References ... 3

3.0 PERSONNEL INDOCTRINATION ... 4
- 3.1 Description ... 4
- 3.2 Responsibilities ... 5
- 3.3 Limits & Precautions ... 5
- 3.4 Acceptance Criteria ... 5
- 3.5 Prerequisites ... 6

4.0 INSTRUCTIONS ... 7
- 4.1 Stage I ... 7

5.0 FOLLOW-UP ACTIONS ... 8
- 5.1 Restoration Instructions ... 8
- 5.2 Contingencies ... 8
- 5.3 Reports ... 8

ENCLOSURES

1 Reactor Building Bay Layout ... 9
2 Reactor Building Bay Designations ... 11
3 Engineering Inspection of Containment Core Drilled Holes Performed IAW EC 74801 ... 26
4 Description of Nondestructive Test Methods ... 28
5 CTLGroup Procedure for Impulse Response Testing ... 31
6 CTLGroup Procedure for Impact Echo (IE) Testing ... 33
7 Test Procedure Guidance for NDT ... 35
8 Exterior Containment Inspection Log ... 36

1.0 **PURPOSE**

The purpose of the procedure is to document the Reactor Building concrete examination and testing in support of the events surrounding the concrete degradation identified during refueling outage R16 (ref. NCR 358724, CR3 SGR Hydrodemolition Exposed Cracks). Individual inspections and testing of selected Reactor Building concrete locations are to be performed to the requirements of this procedure to provide input into the root cause analysis, design basis evaluation, and repair requirements.

2.0 **REFERENCES**

2.1 **Developmental References**

2.1.1 Drawing References

1. 425-001, SH-001, IWE/IWL INSPECTION CONCRETE LAYOUT 0 TO 180
2. 425-002, SH-001, IWE/IWL INSPECTION CONCRETE LAYOUT 180 TO 360
3. 425-003, SH-001, IWE/IWL INSPECTION EXTERIOR DOME LAYOUT
4. 425-004, SH-001, IWE/IWL INSPECTION VERTICAL TENDON LAYOUT
5. 425-005, SH-001, IWE/IWL INSPECTION HOOP TENDON "13" LAYOUT
6. 425-006, SH-001, IWE/IWL INSPECTION HOOP TENDON "42" LAYOUT
7. 425-007, SH-001, IWE/IWL INSPECTION HOOP TENDON "53" LAYOUT
8. 425-008, SH-001, IWE/IWL INSPECTION HOOP TENDON "64" LAYOUT
9. 425-009, SH-001, IWE/IWL INSPECTION HOOP TENDON "51" LAYOUT
10. 425-010, SH-001, IWE/IWL INSPECTION HOOP TENDON "62" LAYOUT

2.1.2 Procedure References

1. CAP-NGGC-0200, Corrective Action Program
2. EGR-NGGC-0005, Engineering Change
3. Administration Instruction, AI-480, Core Drill

2.1.3 Code and Standard References

1. ACI 201.1R-68, Revised 1984, Guide for Making a Condition Survey of Concrete in Service
2. ACI 228.2R, Nondestructive Test Methods for Evaluation of Concrete in Structures

2.1.4 Other References

1. SP-182, Reactor Building Structural Integrity Tendon Surveillance Program, Revision 16, and past surveillance results.
2. EC 63016, Containment Opening (Includes Hydrodemolition, Tendons, Liner Plate and Concrete Mix)
3. EC 74801, Containment Structure Extent-Of-Condition Core Bores

2.1.5 Regulatory and Code Document References

1. Section XI of the ASME Boiler and Pressure Vessel Code, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants, 2001 Edition up to and including the 2003 Addenda as amended by 10CFR50.55a, Codes and Standards

3.0 PERSONNEL INDOCTRINATION

3.1 Description

As part of the current refueling outage at the Crystal River Nuclear Plant, workers cut an opening in the containment building to remove the two original steam generators and install two new ones. The opening was created using high-pressure water jets previously utilized at a number of other nuclear facilities doing similar work. In the course of creating the opening, employees discovered a gap in the concrete near the outer wall of the containment structure.

The Crystal River reactor building is a cylindrical structure, comprised of a 3/8 inch steel liner surrounded by 42 inches of steel-reinforced concrete. Within the concrete wall are steel tendons, which wrap around the building to provide strength. The gap is near the outside wall of the structure.

This temporary procedure will document the Reactor Building concrete examination and testing in support of the events surrounding the concrete degradation identified during refueling outage R16. Individual inspections and testing of selected Reactor Building concrete locations are to be performed to the requirements of this procedure to provide input into the root cause analysis, design basis evaluation, and repair requirements.

The condition assessment is being performed in multiple phases. The initial phase performed trial nondestructive testing (NDT) and concrete core drilling. This phase was used to establish a validation of the NDT processes to be used to evaluate the concrete. This procedure will be executed in multiple stages to accommodate the various phases of the condition assessment. Stage I will facilitate the initial NDT to be performed as the Condition Assessment Plan is being finalized. Stage II incorporates the Condition Assessment.

The following describe the phases of the assessment plan:

3.1.1 Condition Assessment Plan

When developed, the condition assessment will document the population of destructive and nondestructive testing activities. Data will be provided containing each inspection location, activity to be performed, as well as the inspection method. [In development, to be incorporated in Stage II – Later]

3.1.2 Boroscope Inspection

Enclosure 3 provides boroscope inspection instructions. Inspection results will be documented in this enclosure.

3.1.3 Nondestructive Testing

Enclosure 4 provides a description of nondestructive test methods to identify extent of voids and cracking. Enclosure 5 provides a procedure for Impulse Response (IR) testing. Enclosure 6 provides a procedure for Impact Echo (IE) testing. Enclosure 7 provides test procedure guidance for NDT.

3.1.4 Physical testing

Containment concrete samples are to be tested using ASTM standards. The applicable ASTM standards will be specified.

3.2 **Responsibilities**

3.2.1 Condition Assessment Consultant - This procedure is designed and written for work to be performed by an experienced Condition Assessment Consultant. The Condition Assessment Consultant, CTLGroup, shall be responsible for assuring that all individuals under his supervision are properly trained in the use of this procedure and associated equipment. The work supervisor is responsible for the following:

- Performance of the step by step instructions of this procedure
- Assuring that work is completed satisfactorily
- Notifying Engineering for data collection/inspection steps
- Provide personnel qualification records for lead Engineer
- Provide equipment list and associated calibration documentation
- Provide calibration/validation documentation to substantiate the NDT methods to be used and to support the dedication of the software (SMASH) being used to evaluate the NDT data.

3.2.2 Containment Root Cause Team, Condition Assessment Project Manager - Responsible for coordinating site support activities for the Condition Assessment Consultant.

3.2.3 PEF Engineering - Responsible for providing technical support and for the evaluation and disposition of problems as identified during the condition assessment. This includes responsibility for the general walkdown and inspection of the containment, and for the documentation of the results of this inspection.

3.3 **Limits & Precautions**

3.3.1 General

1. Work shall be in compliance with the safety requirements of OSHA and applicable CR3 procedures and policies.
2. For work located in Radiation Controlled areas, due consideration must be given to the ALARA program. This may result in a determination that special preparation and/or precautions are necessary.

3.3.2 Equipment

1. The equipment utilized to perform the NDT was calibrated in the field during trial use by CTLGroup. This method of validating the test process and equipment for a specific application is standard practice for concrete condition assessments utilizing NDT.
2. EC 74801 has dedicated the software (SMASH) associated with the NDT equipment used by the Condition Assessment Consultant to assess the Reactor Building concrete. Use of the software is allowed IAW EC 74801 for work associated with providing information to be used in the root cause investigation, design basis evaluation, and repair plan.
3. Condition Assessment Consultant will ensure that, on an ongoing basis, environmental conditions are acceptable for performing NDT.

3.4 **Acceptance Criteria**

None

3.5 Prerequisites

3.5.1 Equipment

1. ENSURE all platforms and rigging, scaffolding, hoisting equipment, and accessories for access to the area and for performance of condition assessment are ready for use .... ☐
2. ENSURE electrical cables or heavy duty extension cords are available, as necessary, for lights, core drilling equipment, NDT equipment, and other miscellaneous power tools .... ☐
3. ENSURE other, pre-identified miscellaneous material and tools are available, as required .... ☐

3.5.2 Initial Conditions

1. PERFORM a Pre-Job Briefing for each new crew/shift in accordance with AI-607, Pre-Job and Post-Job Briefings. This briefing is required once at the start of the work by that crew .... ☐
2. NOTIFY the Work Control Center at the beginning of each work day that work is to begin on this procedure .... ☐
3. ENSURE all personnel performing work under this procedure read and understand the following sections:
   - Section 3.1, Description .... ☐
   - Section 3.3, Limits & Precautions .... ☐
4. ENSURE that all personnel are familiar with the operating manuals of the equipment to be used during the inspection .... ☐
5. ENSURE that all applicable equipment listed in Section 3.5.1, Equipment, is available and ready to be used .... ☐
6. ENSURE that there is adequate access to all areas that are to be inspected .... ☐
7. ENSURE documents listed in Section 2.0, References, are available for use .... ☐

4.0 INSTRUCTIONS

4.1 Stage I

NOTE

NDT is performed by CTLGroup personnel under the direction of the Containment Root Cause Team, Condition Assessment Project Manager and is supported by various plant organizations.

4.1.1 PERFORM NDT on containment as described in Step 3.1.3 using guidance in the following enclosures:Enclosure 4, Description of Nondestructive Test Methods

- Enclosure 5, CTLGroup Procedure for Impulse Response Testing
- Enclosure 6, CTLGroup Procedure for Impact Echo (IE) Testing

NOTE

Approved Core Drilling locations will be provided by PEF Engineering based on the NDT results provided by CTLGroup.

4.1.2 WHEN Core Drilling locations are identified, THEN PERFORM Core Drilling as directed by PEF Engineering using the guidance in all of the following: .... ☐

- AI-480, Core Drilling
- Approved Work Order
- EC 74801, Containment Structure – Extent of Condition Core Bores
- Provide for chain of custody record to maintain tracking of core samples

4.1.3 PERFORM Boroscope inspections of Core Drilled holes as directed by PEF Engineering and RECORD findings using guidance in Enclosure 3, Engineering Inspection of Containment Core Drilled Holes Performed IAW EC 74801 .... ☐

4.1.4 Document daily activities on Enclosure 8, Exterior Containment Inspection Log, or similar form to establish a record of completed tasks .... ☐

4.1.5 RETAIN a copy of data files collected each day as an electronic record .... ☐

4.1.6 STORE daily log sheets, Enclosure 8, and electronic record-of-data files in a fireproof cabinet suitable for storing QA records .... ☐

5.0 FOLLOW-UP ACTIONS

5.1 Restoration Instructions

None

5.2 Contingencies

None

5.3 Reports

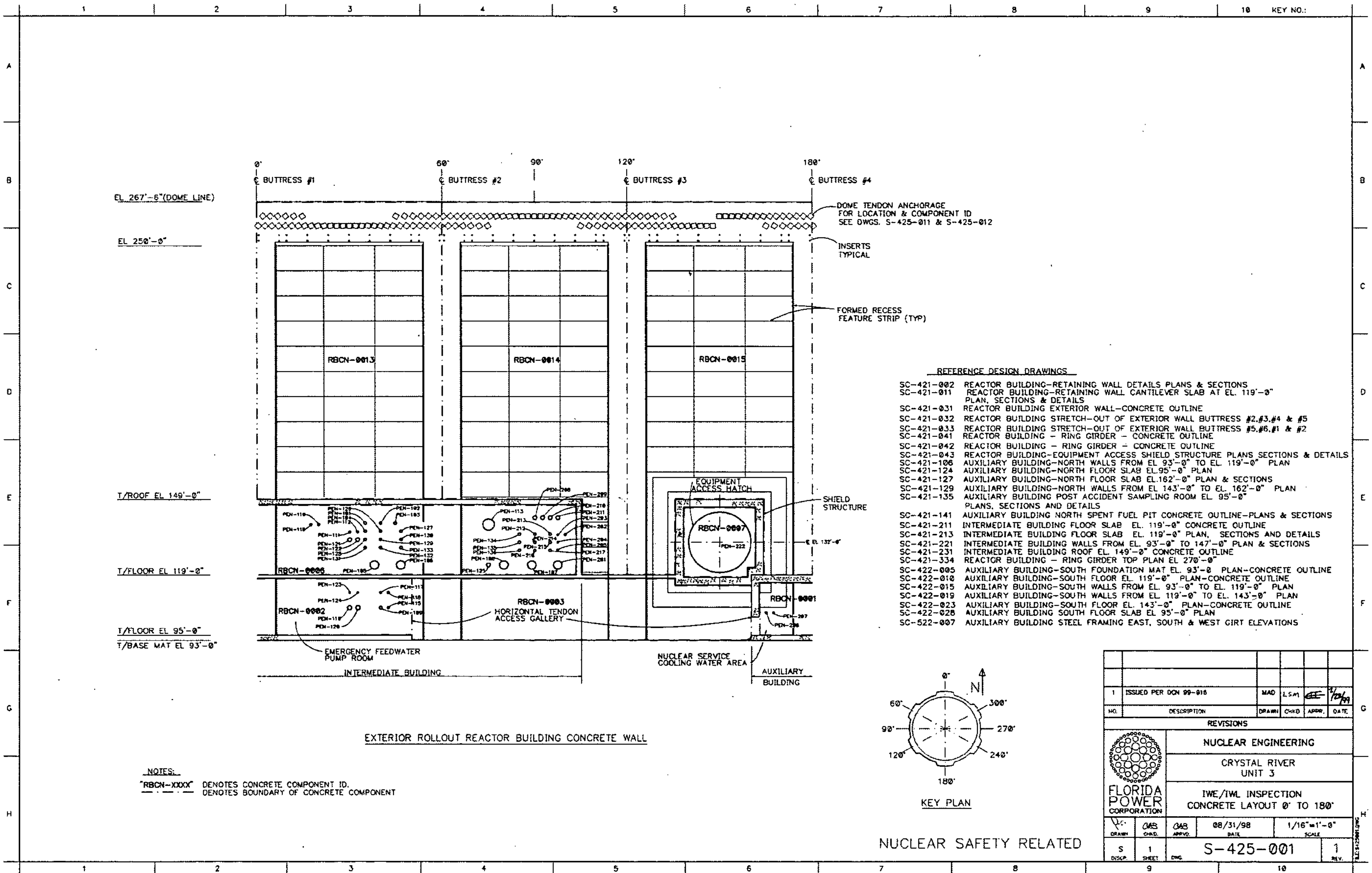
5.3.1 Condition Assessment Consultant Report

The condition assessment consultant approved report and all data shall be forwarded to PEF Engineering. A written report documenting the inspection results, laboratory test results, and condition assessment conclusions for each task shall be prepared following completion of the inspections and tests. The report will include personnel qualification records of lead engineers who performed the NDT. An equipment list with calibration documentation will be provided for the NDT used. The NDT process calibration/validation document will be included in the report. The documentation is used to substantiate the NDT methods and supports the dedication of the software (SMASH) being used to evaluate the NDT data.

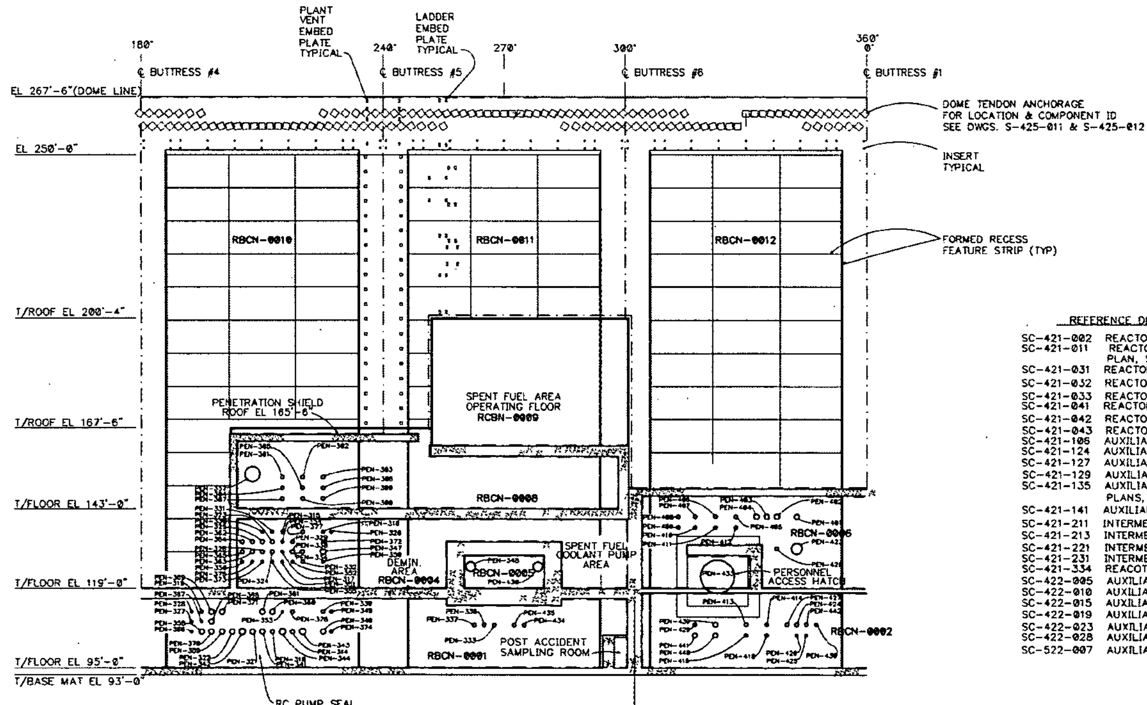
5.3.2 Procedure Closure

Upon completion of the condition assessment, PEF Engineering shall ensure that PT-407T and CTLGroup reports are transmitted to Records Management

REACTOR BUILDING BAY LAYOUT



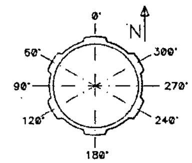
REACTOR BUILDING BAY LAYOUT



NOTES:
"RBCN-XXXX" DENOTES CONCRETE COMPONENT ID.
— · — · — DENOTES BOUNDARY OF CONCRETE COMPONENT

REFERENCE DESIGN DRAWINGS

SC-421-002	REACTOR BUILDING-RETAINING WALL DETAILS PLANS & SECTIONS
SC-421-011	REACTOR BUILDING-RETAINING WALL CANTILEVER SLAB AT EL. 119'-0" PLAN, SECTIONS & DETAILS
SC-421-031	REACTOR BUILDING EXTERIOR WALL-CONCRETE OUTLINE
SC-421-032	REACTOR BUILDING STRETCH-OUT OF EXTERIOR WALL BUTTRESS #2,#3,#4 & #5
SC-421-033	REACTOR BUILDING STRETCH-OUT OF EXTERIOR WALL BUTTRESS #5,#6,#1 & #2
SC-421-041	REACTOR BUILDING – RING GIRDER – CONCRETE OUTLINE
SC-421-042	REACTOR BUILDING – RING GIRDER – CONCRETE OUTLINE
SC-421-043	REACTOR BUILDING-EQUIPMENT ACCESS SHIELD STRUCTURE PLANS SECTIONS & DETAILS
SC-421-106	AUXILIARY BUILDING-NORTH WALLS FROM EL 93'-0" TO EL. 119'-0" PLAN
SC-421-124	AUXILIARY BUILDING-NORTH FLOOR SLAB EL.95'-0" PLAN
SC-421-127	AUXILIARY BUILDING-NORTH FLOOR SLAB EL.162'-0" PLAN & SECTIONS
SC-421-129	AUXILIARY BUILDING-NORTH WALLS FROM EL 143'-0" TO EL. 162'-0" PLAN
SC-421-135	AUXILIARY BUILDING POST ACCIDENT SAMPLING ROOM EL. 95'-0" PLANS, SECTIONS AND DETAILS
SC-421-141	AUXILIARY BUILDING NORTH SPENT FUEL PIT CONCRETE OUTLINE-PLANS & SECTIONS
SC-421-211	INTERMEDIATE BUILDING FLOOR SLAB EL. 119'-0" CONCRETE OUTLINE
SC-421-213	INTERMEDIATE BUILDING FLOOR SLAB EL. 119'-0" PLAN, SECTIONS AND DETAILS
SC-421-221	INTERMEDIATE BUILDING WALLS FROM EL. 93'-0" TO 147'-0" PLAN & SECTIONS
SC-421-231	INTERMEDIATE BUILDING ROOF EL. 149'-0" CONCRETE OUTLINE
SC-421-334	REACOTR BUILDING RING GIRDER TOP PLAN EL 270'-0"
SC-422-005	AUXILIARY BUILDING-SOUTH FOUNDATION MAT EL. 93'-0 PLAN-CONCRETE OUTLINE
SC-422-010	AUXILIARY BUILDING-SOUTH FLOOR EL. 119'-0" PLAN-CONCRETE OUTLINE
SC-422-015	AUXILIARY BUILDING-SOUTH WALLS FROM EL. 93'-0" TO EL. 119'-0" PLAN
SC-422-019	AUXILIARY BUILDING-SOUTH WALLS FROM EL. 119'-0" TO EL. 143'-0" PLAN
SC-422-023	AUXILIARY BUILDING-SOUTH FLOOR EL. 143'-0" PLAN-CONCRETE OUTLINE
SC-422-028	AUXILIARY BUILDING SOUTH FLOOR SLAB EL 95'-0" PLAN
SC-522-007	AUXILIARY BUILDING STEEL FRAMING EAST, SOUTH & WEST GIRT ELEVATIONS



KEY PLAN

NUCLEAR SAFETY RELATED

NO.	DESCRIPTION	DRAWN	CHKD	APPR.	DATE
1	ISSUED PER DCN 99-016	MAD			

REVISIONS

FLORIDA POWER CORPORATION

NUCLEAR ENGINEERING

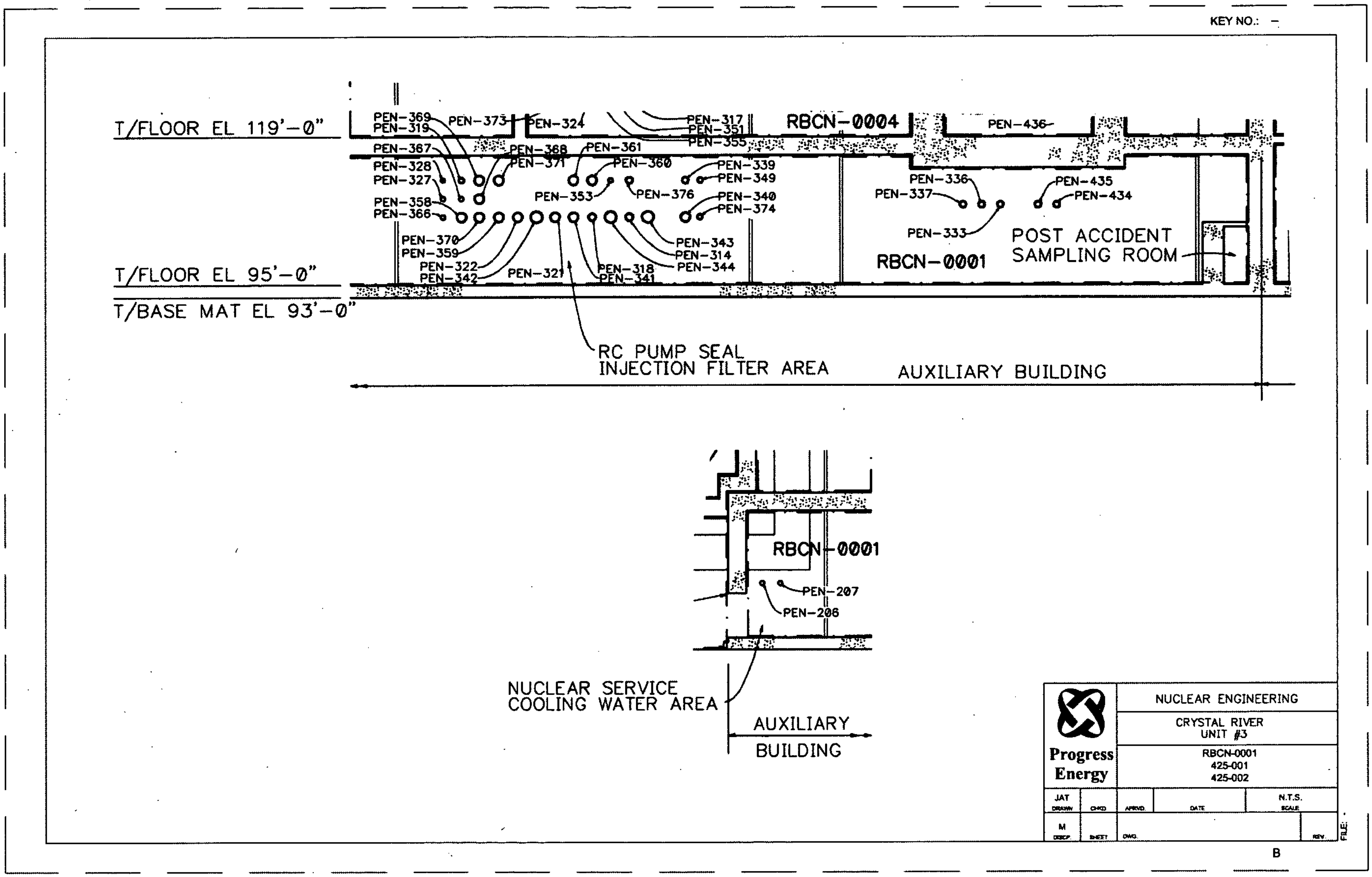
CRYSTAL RIVER UNIT 3

IWE/IWL INSPECTION CONCRETE LAYOUT 180°-360°

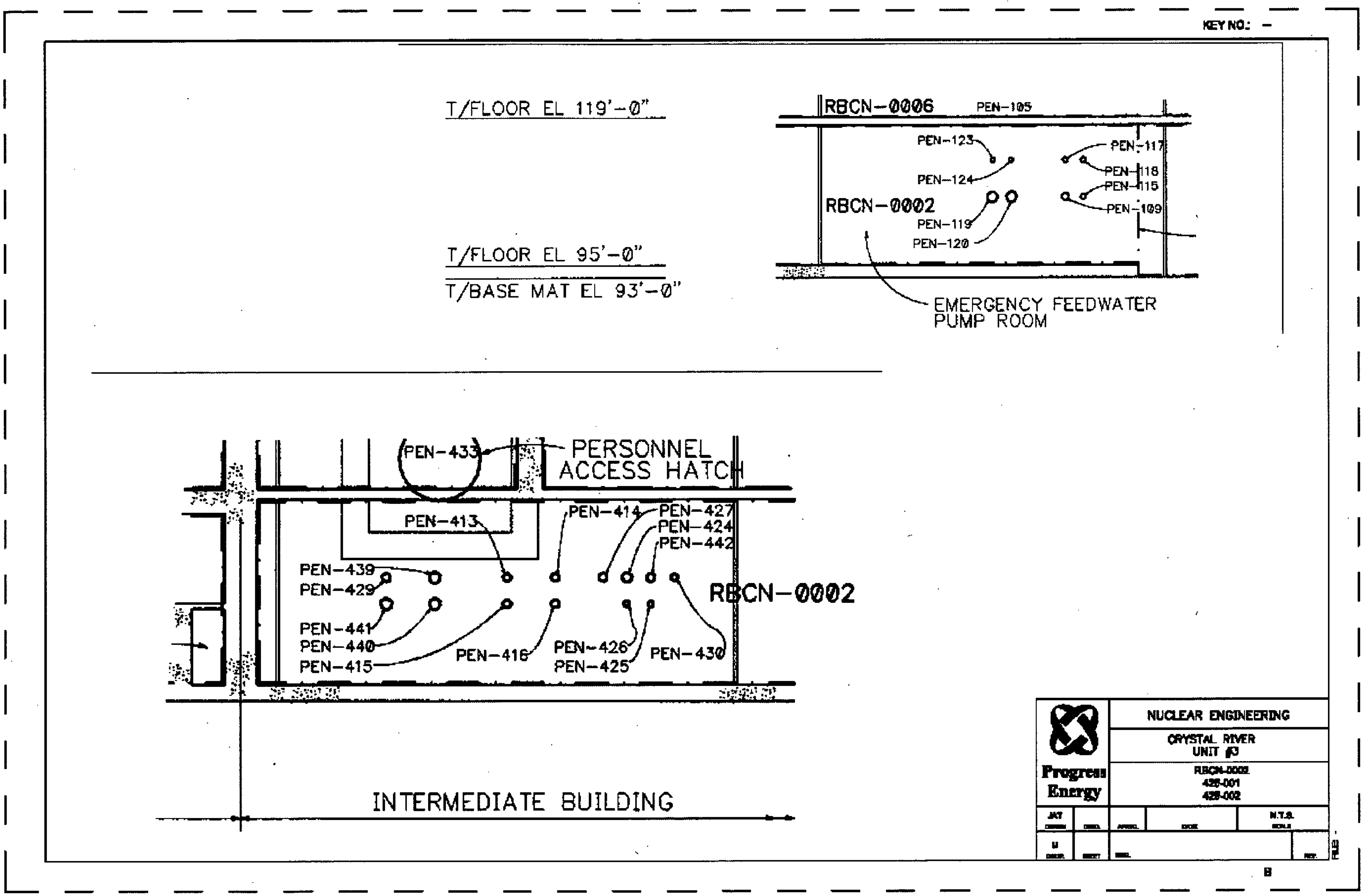
DRAWN	CHKD.	APRVD.	DATE	SCALE
	GAS	GAS	08/31/98	1/16"=1'-0"

DISCP	SHEET	DWG.	REV
S	1	S-425-002	1

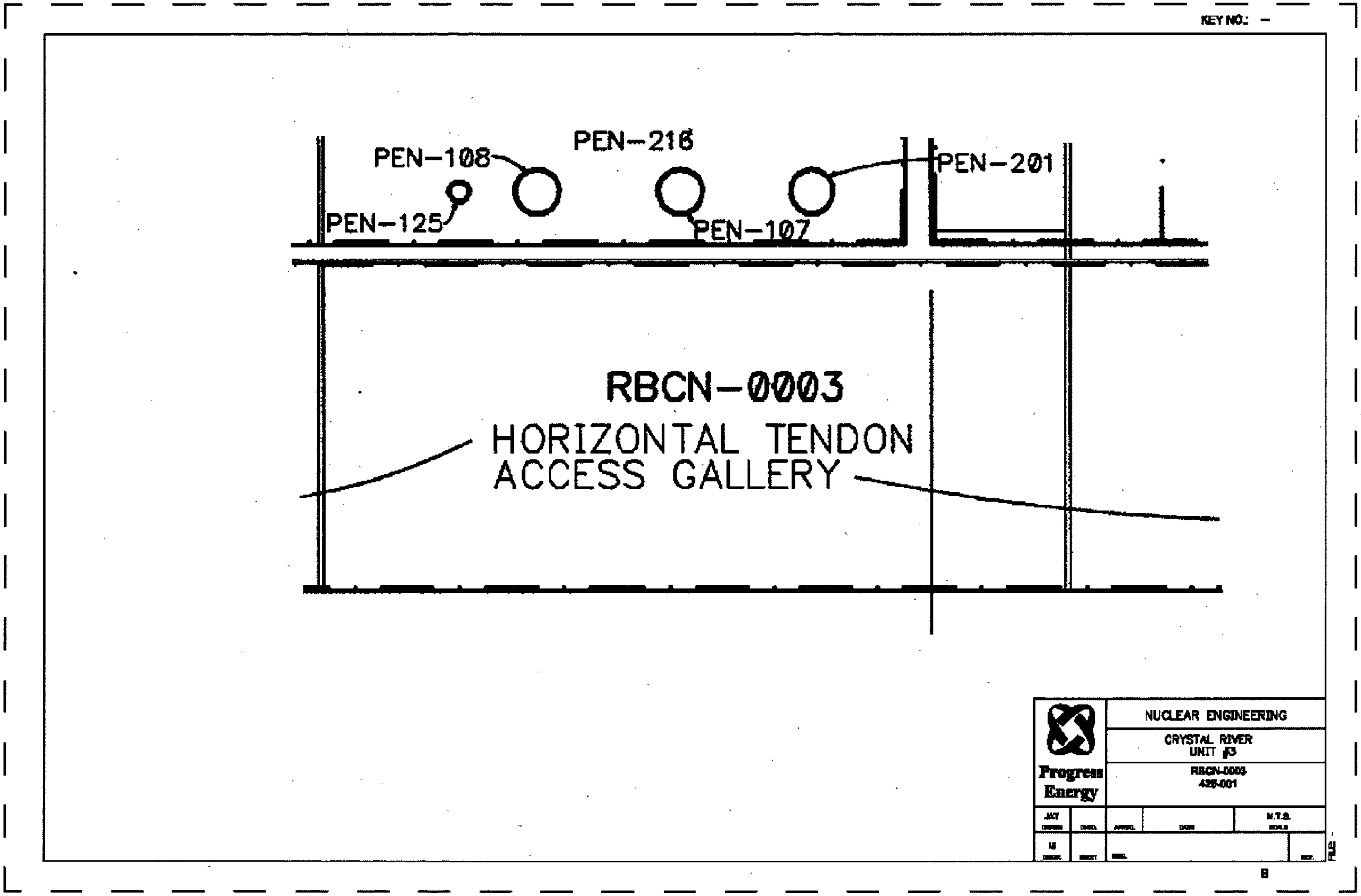
REACTOR BUILDING BAY DESIGNATIONS



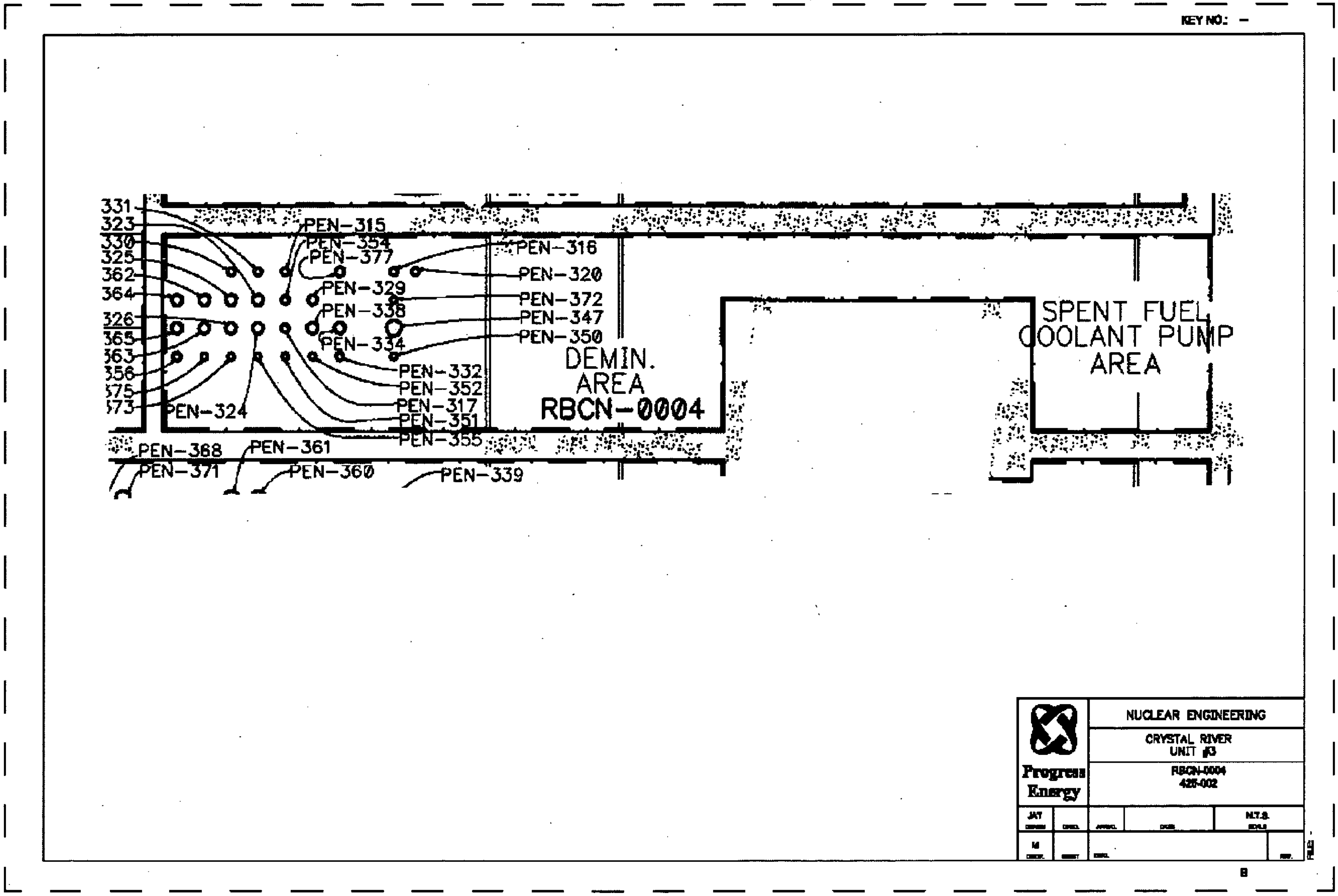
REACTOR BUILDING BAY DESIGNATIONS



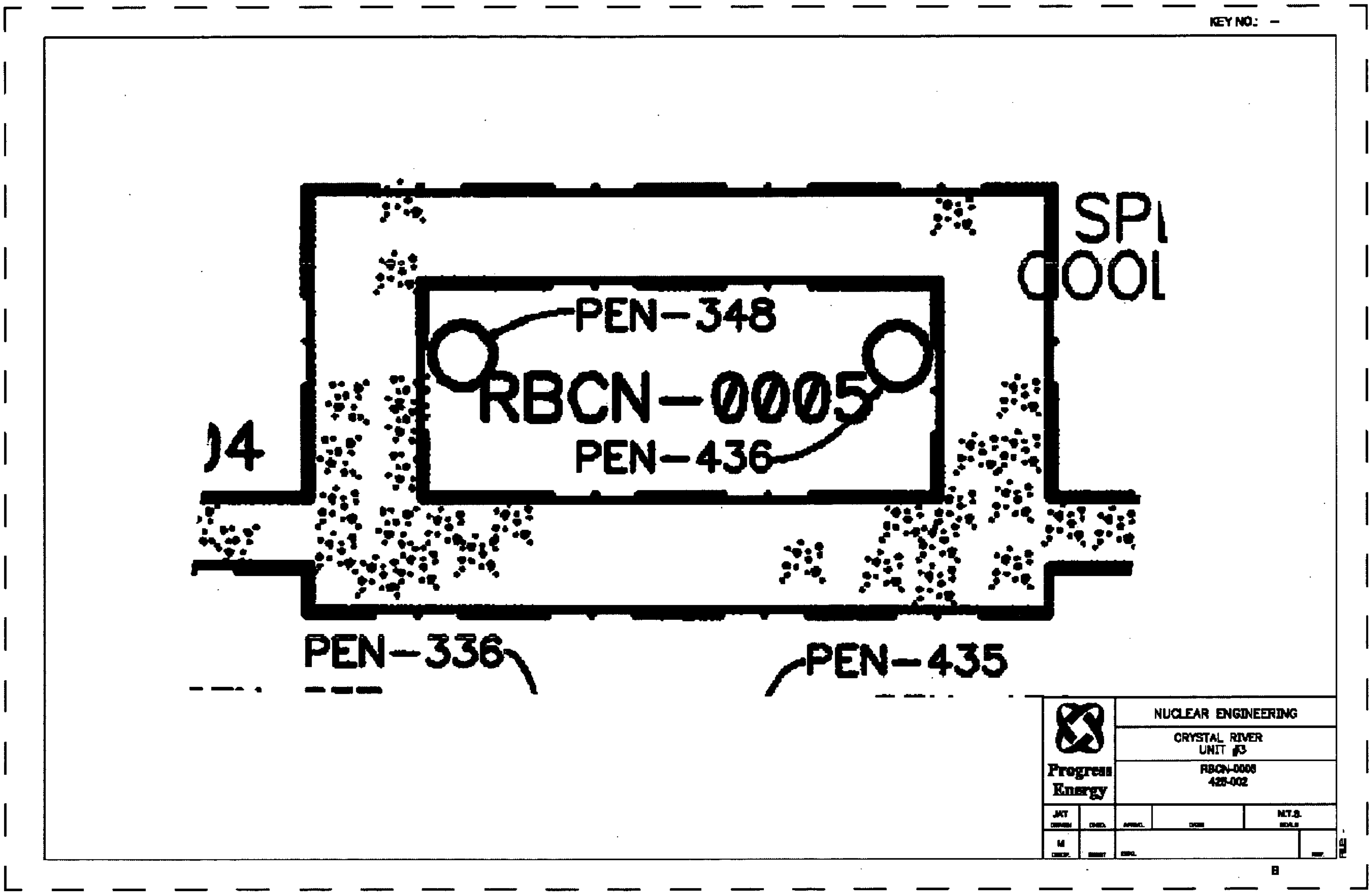
REACTOR BUILDING BAY DESIGNATIONS



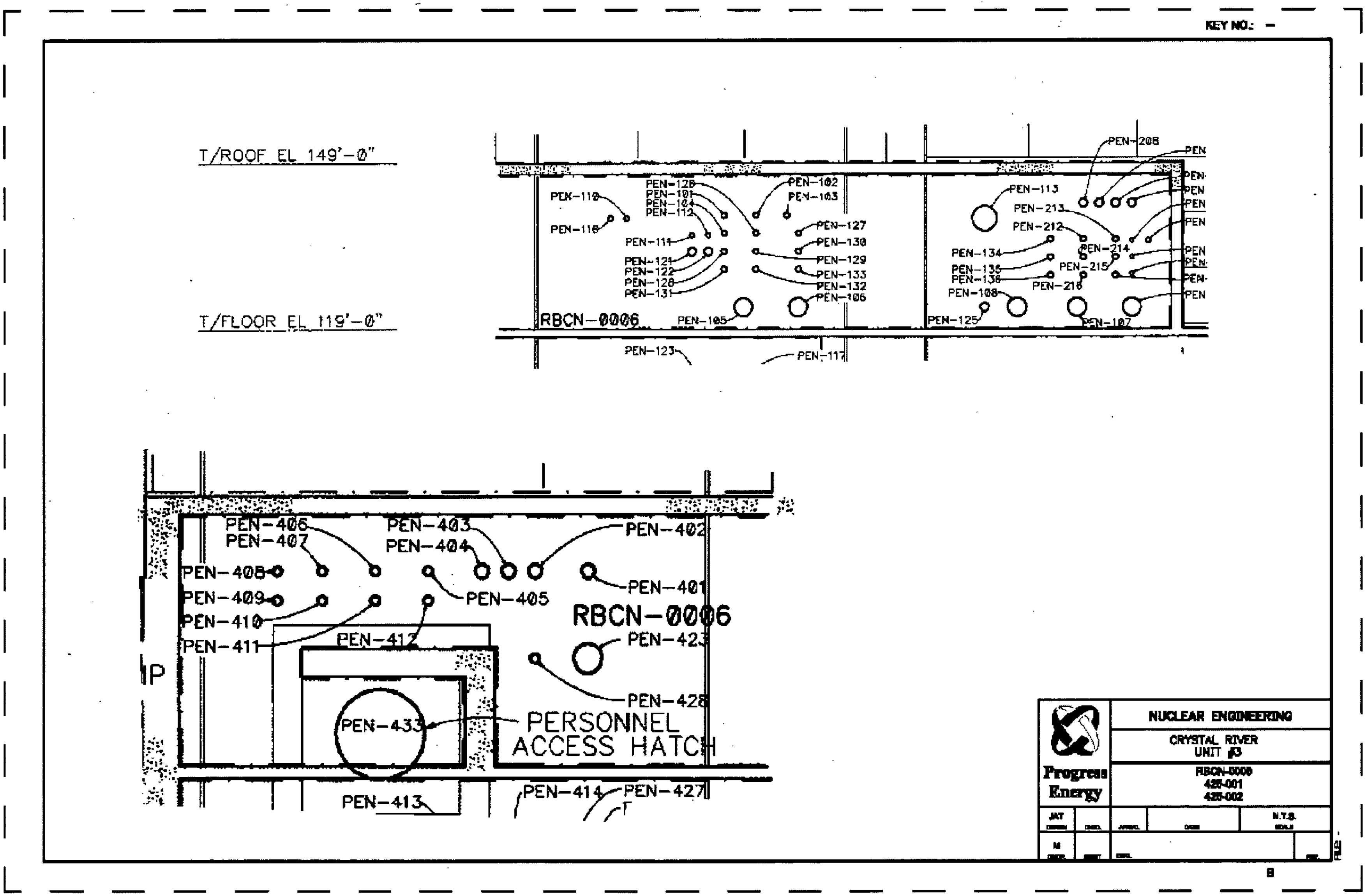
REACTOR BUILDING BAY DESIGNATIONS



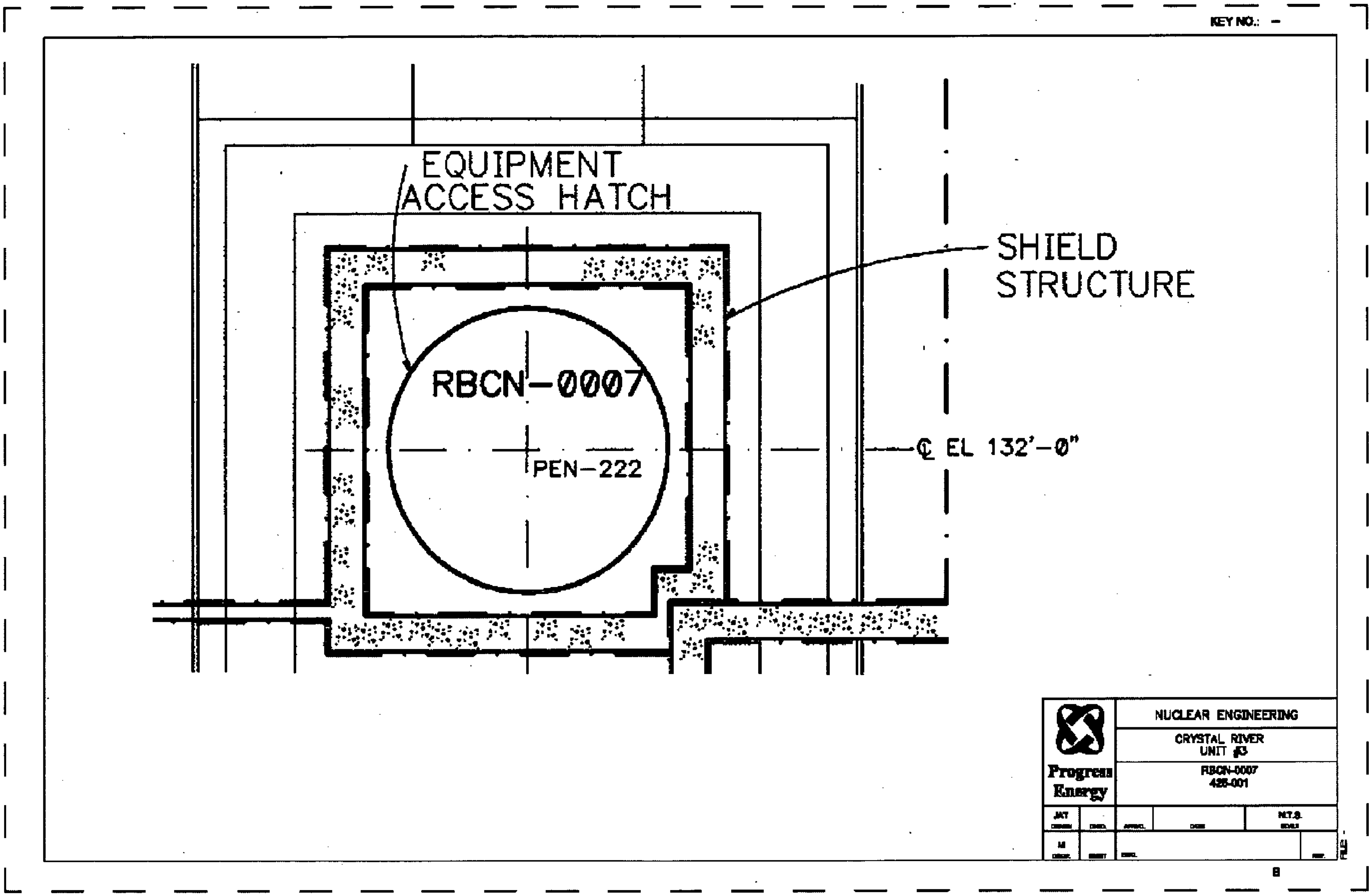
REACTOR BUILDING BAY DESIGNATIONS



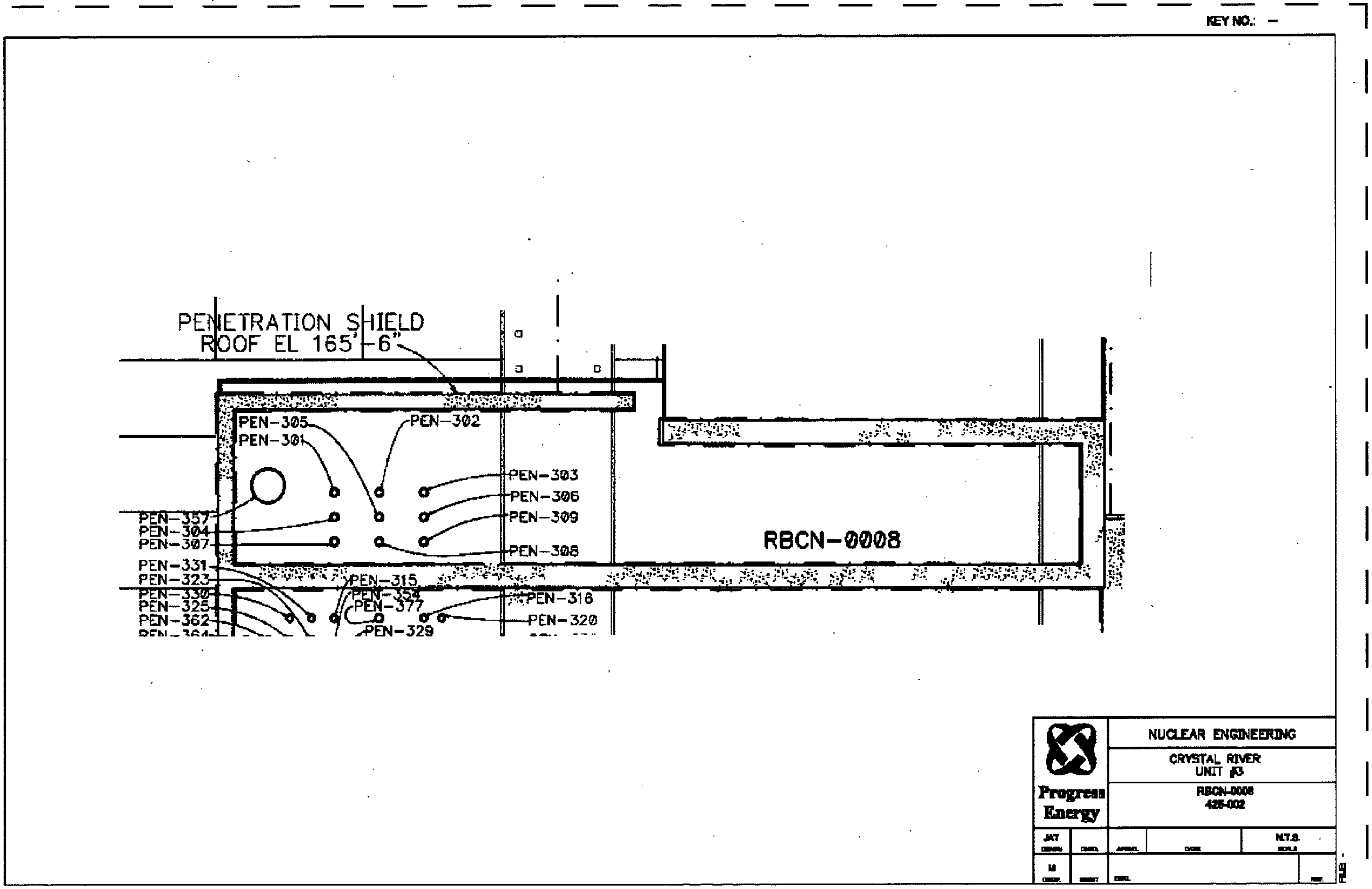
REACTOR BUILDING BAY DESIGNATIONS



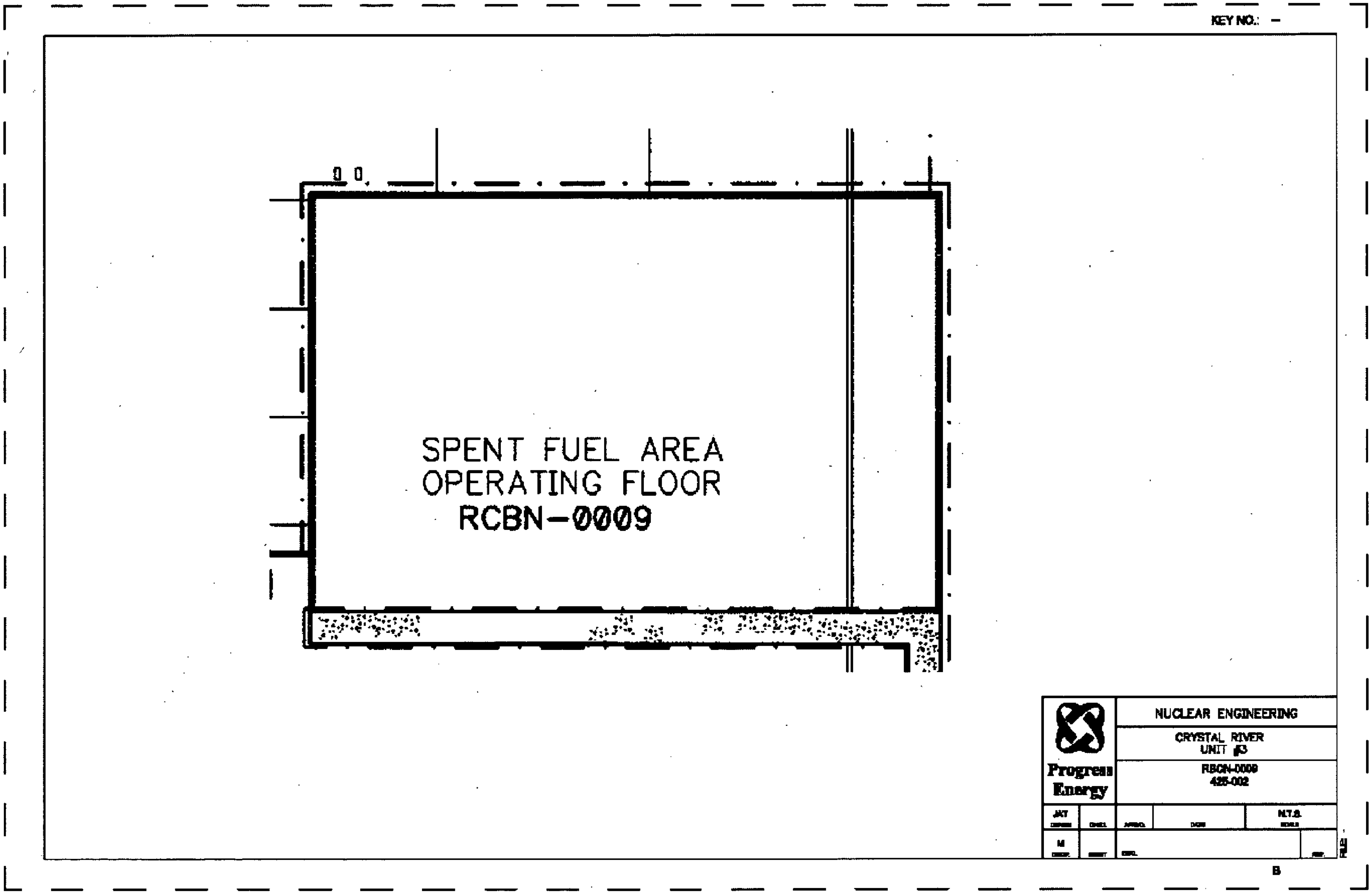
REACTOR BUILDING BAY DESIGNATIONS



REACTOR BUILDING BAY DESIGNATIONS

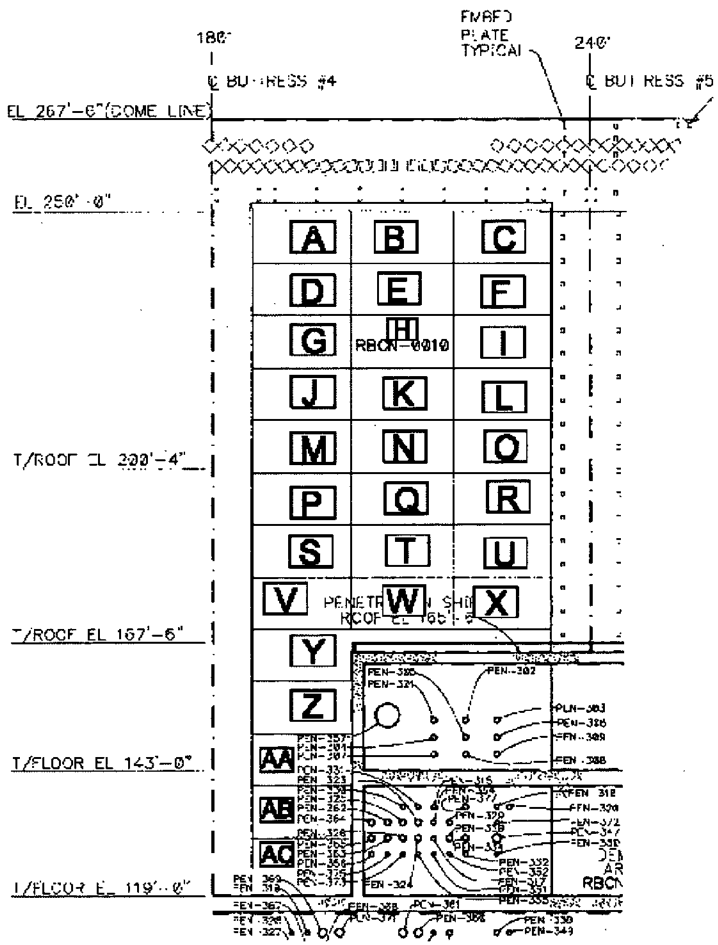


REACTOR BUILDING BAY DESIGNATIONS

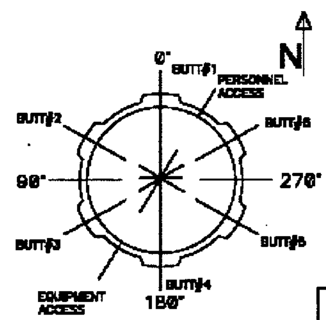


REACTOR BUILDING BAY DESIGNATIONS

KEY NO.: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.

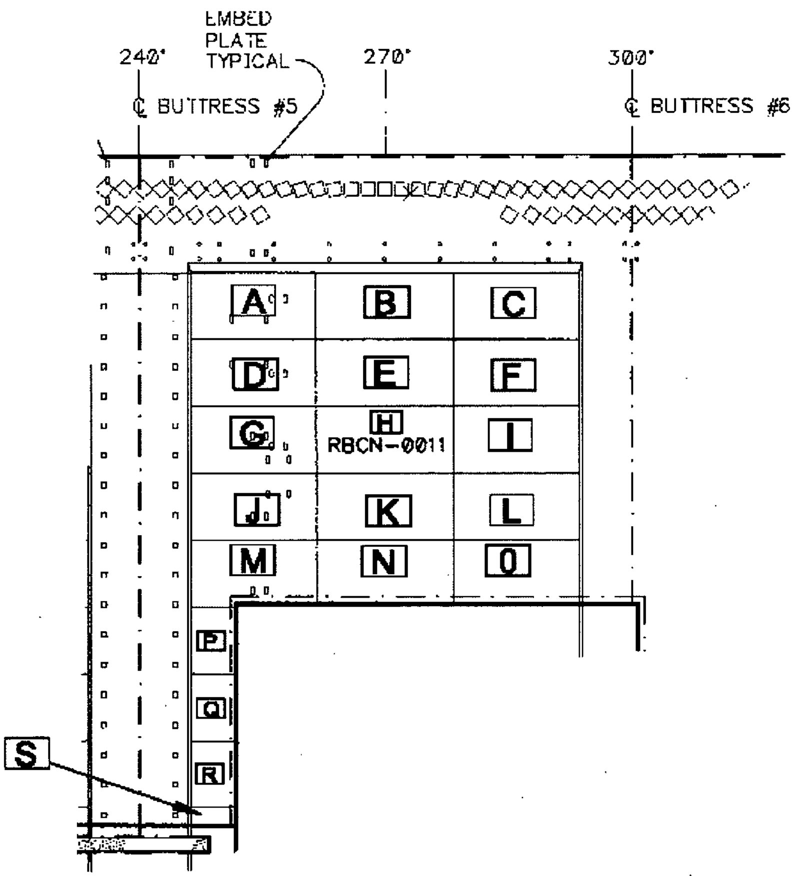


KEY PLAN

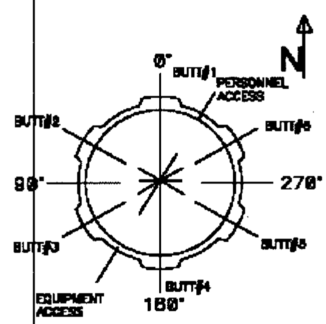
Progress Energy	NUCLEAR ENGINEERING
	CRYSTAL RIVER UNIT #3
	RBCN-0010 426-002
ATS	N.T.S.

REACTOR BUILDING BAY DESIGNATIONS

KEY NO: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.

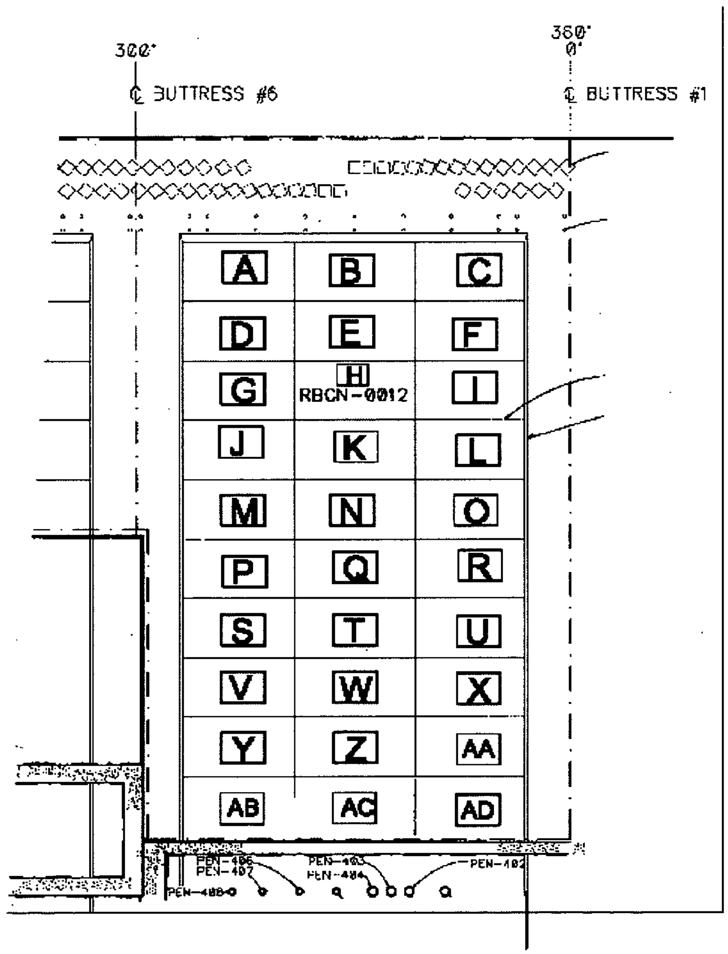


KEY PLAN

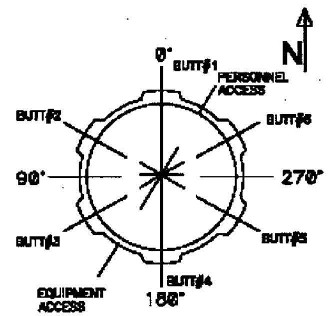
Progress Energy	NUCLEAR ENGINEERING
	CRYSTAL RIVER UNIT #3
	RBCN-0011 425-002
JAT	N.T.S.

REACTOR BUILDING BAY DESIGNATIONS

KEY NO: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.



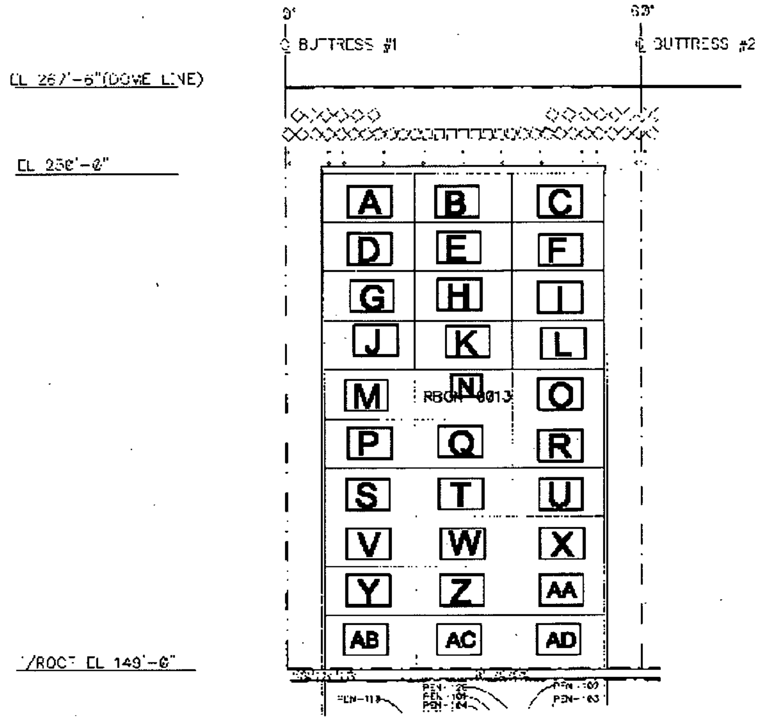
KEY PLAN

Progress Energy	NUCLEAR ENGINEERING
	CRYSTAL RIVER UNIT #3
	RBCN-0012 425-002
JAT	N.T.S.
M	

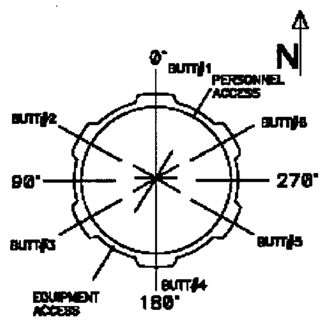
B

REACTOR BUILDING BAY DESIGNATIONS

KEY NO.: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.



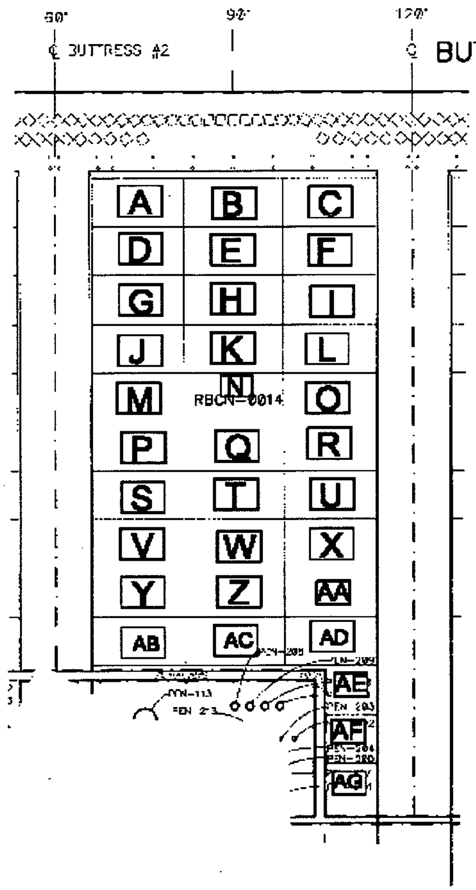
KEY PLAN

Progress Energy	NUCLEAR ENGINEERING
	CRYSTAL RIVER UNIT #3
	RBCN-0013 425-001
JAT	N.T.S.

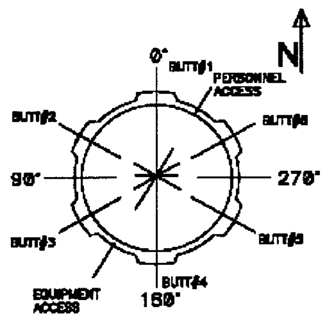
B

REACTOR BUILDING BAY DESIGNATIONS

KEY NO: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.



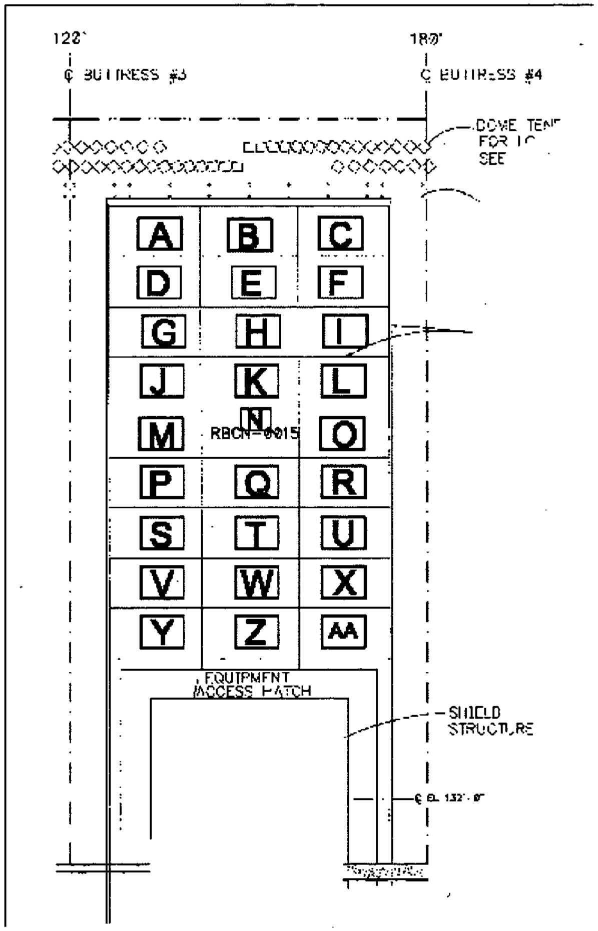
KEY PLAN

Progress Energy	NUCLEAR ENGINEERING
	CRYSTAL RIVER UNIT #3
	RBCN-0014 425-001
JAT	N.T.S.
M	

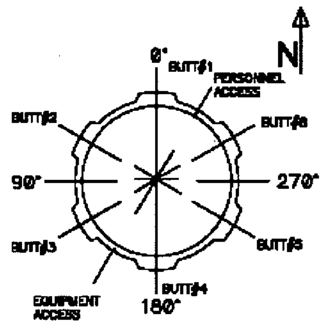
B

REACTOR BUILDING BAY DESIGNATIONS

KEY NO.: –



NOTE:
THE REFERENCE LOCATION FOR DIMENSIONING THE SCAN AREA AND CORE BORE LOCATION FOR INDIVIDUAL PANELS IS THE UPPER LEFT CORNER OF EACH PANEL IDENTIFIED BY THE PERIMETER OF THE FORMED RECESS FEATURE STRIP. THE RAISED CORNER AT THIS LOCATION WILL BE THE ORIGIN, (0,0). HORIZONTAL AND VERTICAL DIMENSIONING WILL BE TAKEN FROM THE ORIGIN TO THE SCAN AREA AND CORE BORES. THE SCAN AREA WILL BE DEFINED BY DIMENSIONING THE UPPER LEFT CORNER OF THE AREA TO BE SCANNED AND WILL MEASURE THE HORIZONTAL AND VERTICAL DISTANCE THAT DEFINES THE AREA OF THE SCAN BOUNDARY. THE CORE BORE WILL BE LOCATED BY DIMENSIONING TO THE CENTER OF THE CORE BORE FROM THE ORIGIN.



KEY PLAN

Progress Energy

NUCLEAR ENGINEERING
CRYSTAL RIVER UNIT #3
RBCN-0015
426-001
N.T.S.

ENGINEERING INSPECTION OF CONTAINMENT CORE DRILLED HOLES PERFORMED IAW EC 74801

1. Work Description

   Perform boroscope inspection of core drilled holes in the outside of containment wall. A vendor will support the boroscope inspection by providing the personnel and equipment necessary to characterize the interior surface of the core drilled holes. PEF Engineering is responsible for directing the inspection performed by the vendor.

2. PERFORM the following to inspect core drilled holes:

   A. Record the core drilled hole designation.

   B. Record diameter and depth of core drilled hole.

   C. Using boroscope equipment, INSPECT the interior surface of the core drilled hole looking for abnormalities.

      a. RECORD results of the boroscope inspection. (Note: cleaning of the interior surface of the hole may be necessary as directed by Engineering)

   D. CHARACTERIZE identified abnormalities using the following parameters, at a minimum, and RECORD findings:

      a. Existence of cracks in plane of containment wall

         1) Depth of crack from exterior face of containment wall.

         2) Length of crack with respect to OD of hole. (Locate start and end of crack by clock location where up is 12:00.)

         3) Width of the crack at enough locations to accurately characterize the crack.

      b. Existence of cracks out of plane of containment wall

         1) Depth of the start of the crack from the exterior face of containment wall.

         2) Depth of the end of the crack from the exterior face of containment wall.

         3) Width of the crack at enough locations to accurately characterize the crack.

      c. Existence of voids in the interior surface of the core drilled hole

         1) Depth of void to approximate center of void from the exterior face of containment wall.

         2) Min/max dimensions of void in axial and circumferential direction.

         3) Maximum depth of void.

      d. Existence of any other abnormality (e.g., embedded object, tendon grease)

         1) Depth of abnormality to approximate center of abnormality from the exterior face of containment wall.

         2) Min/max dimensions of abnormality in axial and circumferential direction.

         3) Determination if abnormality is metallic or organic.

ENGINEERING INSPECTION OF CONTAINMENT CORE DRILLED HOLES PERFORMED IAW EC 74801

Boroscope Log

- DATE: __________________ - WO #: __________________

- COREDRILL DESIGNATION: __________________

- HOLE DIAMETER: __________________ - DEPTH: __________________

- CONCRETE COMPONENT IDENTIFIER'S: __________________

- PANEL ID'S: __________________

- AZIMUTH: __________________

- EQUIPMENT USED: __________________

____

- INSPECTION COMMENTS: __________________

____

____

____

____

____

____

____

____

____

- DOCUMENTED BY: __________________ Date/Time: __________________

- REVIEWED BY: __________________ Date/Time: __________________

DESCRIPTION OF NONDESTRUCTIVE TEST METHODS
CTLGroup

1.0 IMPULSE RESPONSE TEST

The Impulse Response (IRS) test method is a nondestructive, stress wave test, used extensively in the evaluation of machined metallic components in the aircraft industry. Its application to concrete structures in Civil Engineering is less well known, and the method has received far less publicity than the recently developed Impact-Echo (I-E) test (Sansalone & Streett, 1997). Both methods are described in the American Concrete Institute Report ACI 228.2R, *"Nondestructive Test Methods for Evaluation of Concrete in Structures"*.

The IRS method (also referred to in earlier literature as the Transient Dynamic Response or Sonic Mobility method) is a direct descendant of the Forced Vibration method for evaluating the integrity of concrete drilled shafts, developed in France in the 1960's (Davis & Dunn, 1974). The basic theory of dynamic mobility developed at that time has not changed; however, its range of applications to different structural elements has increased to incorporate the following problems:

- Voiding beneath concrete highway, spillway and floor slabs (Davis & Hertlein, 1987),
- Delamination of concrete around steel reinforcement in slabs, walls and large structures such as dams, chimney stacks and silos (Davis & Hertlein, 1995),
- Low density concrete (honeycombing) and cracking in concrete elements (Davis & Hertlein, 1995; Davis *et al,* 1997),
- Depth of ASR attack in drilled shafts used as pylon foundations (Davis & Kennedy, 1998),
- Debonding of asphalt and concrete overlays to concrete substrates (Davis *et al*, 1996),
- Degree of stress transfer through load-transfer systems across joints in concrete slabs (Davis & Hertlein, 1987).

1.1 IRS Testing Equipment

The IRS method uses a low strain impact to send a stress wave through the tested element. The impactor is usually a 1-kg sledgehammer with a built-in load cell in the hammerhead. The maximum compressive stress at the impact point in concrete is directly related to the elastic properties of the hammer tip. Typical stress levels range from 5 MPa for hard rubber tips to more than 50 MPa for aluminum tips. Response to the input stress is normally measured using a velocity transducer (geophone). This receiver is preferred because of its stability at low frequencies and its robust performance in practice. Both the hammer and the geophone are linked to a portable field computer for data acquisition and storage.

DESCRIPTION OF NONDESTRUCTIVE TEST METHODS
CTLGroup

1.2 Method Description

When testing plate-like structures, the Impact-Echo method uses the reflected stress wave from the base of the concrete element or from some anomaly within that element (requiring a frequency range normally between 10 and 50 kHz). The IRS test uses a compressive stress impact approximately 100 times that of the I-E test. This greater stress input means that the plate responds to the IRS hammer impact in a bending mode over a very much lower frequency range (0-1 kHz for plate structures), as opposed to the reflective mode of the I-E test.

Both the time records for the hammer force and the geophone velocity response are processed in the field computer using the Fast Fourier Transform (FFT) algorithm. The resulting velocity spectrum is divided by the force spectrum to obtain a transfer function, referred to as the *Mobility* of the element under test. The test graph of Mobility plotted against frequency over 0-1 kHz contains information on the condition and the integrity of the concrete in the tested elements, obtained from the following measured parameters:

- *Dynamic Stiffness:* The slope of the portion of the Mobility plot below 0.1 kHz defines the compliance or flexibility of the area around the test point for a normalized force input. The inverse of the compliance is the dynamic stiffness of the structural element at the test point. This can be expressed as:

  Stiffness f [concrete quality, element thickness, element support condition]

- *Mobility and Damping:* The test element's response to the impact-generated elastic wave will be damped by the element's intrinsic rigidity (body damping). The mean mobility value over the 0.1-1 kHz range is directly related to the density and the thickness of a plate element, for example. A reduction in plate thickness corresponds to an increase in mean mobility. As an example, when total debonding of an upper layer is present, the mean mobility reflects the thickness of the upper, debonded layer (in other words, the slab becomes more mobile). Also, any cracking or honeycombing in the concrete will reduce the damping and hence the stability of the mobility plots over the tested frequency range.
- *Peak/Mean Mobility Ratio:* When debonding or delamination is present within a structural element, or when there is loss of support beneath a concrete slab on grade, the response behavior of the uppermost layer controls the IRS result. In addition to the increase in mean mobility between 0.1 and 1 kHz, the dynamic stiffness decreases greatly. The peak mobility below 0.1 kHz becomes appreciably higher than the mean mobility from 0.1-1 kHz. The ratio of this peak to mean mobility is an indicator of the presence and degree of either debonding within the element or voiding/loss of support beneath a slab on grade.

DESCRIPTION OF NONDESTRUCTIVE TEST METHODS
CTLGroup

2.0 IMPACT-ECHO TEST

The Impact-Echo (I-E) test and its recommended use for plate structure thickness determination are described in ASTM C1383.

Like the Impulse Response test, the I-E test uses stress waves to detect flaws within concrete structures. Surface displacements caused by reflecting stress waves are recorded as a displacement waveform. The amplitude spectrum of this waveform is computed by Fast Fourier Transform (FFT). This spectrum has a periodic nature, which is a function of the depth to the reflective boundary (either the back of the element, or some anomaly such as a crack in the element under test. The depth of a concrete/air interface (internal void or external boundary) is determined by:

$d = v_c / 2f$ (1)

d is the interface depth, v_c is the primary stress wave velocity and f is the frequency due to reflection of the P wave from the interface.

If the material beyond the reflective interface is acoustically stiffer than concrete (e.g. concrete/steel interface), then the following equation applies:

$d = v_c / 4f$ (2)

The difference in the acoustic impedance of the two materials at an interface determines whether the presence of an interface will be detected by an I-E test. For example, a concrete/grout interface gives no reflection of the stress wave because the acoustic impedance of concrete and grout are nearly equal. In contrast, at a concrete/air interface, nearly all energy is reflected, since acoustic impedance of air is very much less than concrete.

The only calibration required for the equipment is to measure the value of v_c on site for a sample representing the concrete in the structure being tested, for inclusion in the above equations. The amplitude spectrum produced by the sensor is used for its frequency content only, and the actual amplitude magnitudes are of no import. In this way, actual values for the sensor amplitude are not required in the analysis, and no pre-calibration is necessary.

References

- Davis, A.G. and C.S. Dunn, 1974, "From theory to field experience with the nondestructive vibration testing of piles," *Proc. Inst. Civ. Engrs.* Part 2, 59, Dec., pp. 867-875.
- Davis A.G. and B.H. Hertlein 1987, "Nondestructive testing of concrete pavement slabs and floors with the transient dynamic response method," *Proc. Int. Conf. Structural Faults and Repair,* London, July 1987, Vol. 2, pp. 429-433.
- Davis, A.G. and B.H. Hertlein, 1995, "Nondestructive testing of concrete chimneys and other structures," *Conf. Nondestructive Evaluation of Aging Structures and Dams*, Proc. SPIE 2457, 129-136, Oakland CA, June 1995.
- Davis, A.G., J. G. Evans and B.H. Hertlein, 1997, "Nondestructive evaluation of concrete radioactive waste tanks," *Journal of Performance of Constructed Facilities,* ASCE, Vol. 11, No. 4, November 1997, pp. 161-167.
- Davis, A.G., B.H. Hertlein, M. Lim and K. Michols, 1996, "Impact-Echo and Impulse Response stress wave methods: advantages and limitations for the evaluation of highway pavement concrete overlays," *Conf. Nondestructive Evaluation of Bridges and Highways*, Proc. SPIE 2946, 88-96, Scottsdale AZ, December 1996.
- Davis, A.G. and J. Kennedy, 1998, "Impulse Response testing to evaluate the degree of alkali-aggregate reaction in concrete drilled-shaft foundations for electricity transmission towers", *Conf. Nondestructive Evaluation of Utilities and Pipelines II,* Proc. SPIE 3398, 178-185, San Antonio, TX, April 1998.
- Sansalone, M. and W.B. Streett, 1997, "Impact-Echo: nondestructive evaluation of concrete and masonry," Bullbrier Press, Ithaca, NY.

CTLGROUP PROCEDURE FOR IMPULSE RESPONSE TESTING

s'Mash IR Test System

This device is used for the evaluation of internal defects of reinforced concrete structures.

Operating Instructions:

1. OBTAIN and REVIEW any drawings available pertaining to the concrete element.
2. LAY OUT test grid in the test area.
3. INSPECT the test surface and GRIND SMOOTH if the test point surface is extremely rough.
4. CONNECT geophone and HAMMER onto the connector box.
5. CONNECT the connector box to the data acquisition system.
6. TURN ON the computer to start setup process.
7. CLICK on s'MASH.EXE.
8. Under Project Info., CLICK on IR DATA DIRECTORY and the "Save As" program will appear.
9. CLICK on the location where you want to save the data. (Normally My Docs or Desktop)
10. The selected directory (My Docs or Desktop) will appear.
    - A. CLICK on CREATE FOLDER at the top right of the taskbar.
    - B. TYPE in the title of the new folder.
    - C. CLICK on OPEN FOLDER.
    - D. CLICK on CURRENT FOLDER.
11. The following steps will take you back into the IR Menu:
    - A. CLICK on the box and ENTER the test location designation.
    - B. SET the Geophone Vertical Range Box to "1.0". Other parameters should <u>NOT</u> be changed. If changes are required, document the parameter changes on Enclosure 8.
    - C. SET UP a template for the particular project [Number of Rows, Columns, etc.]
    - D. SET UP test direction parameters.
12. CLICK on ACQUIRE DATA to activate the Test Program.
13. <u>WHEN</u> testing is complete, <u>THEN</u> VERIFY the prompt "Extract Data?" will appear.
14. CLICK OK.
15. CLICK on SAVE IMAGES.
16. CLOSE program.
17. To review data, CLICK on folder where data is saved (My Docs or Desktop).

18. IF testing is NOT complete and will resume,
    THEN PERFORM the following:

    A. CLICK on s'MASH EXE.

    B. CLICK on PROJECT INFO.

    C. CLICK on folder where data is saved (My Docs or Desktop).

    D. TYPE in the file name.

    E. CLICK on SAVE.

    F. CLICK on CURRENT FOLDER.

    G. VERIFY the IR menu appears.

    H. TYPE in the existing grid name.

    I. SET the Geophone Vertical Range Box to "1.0". Do NOT change other parameters.

NOTE

When the start new data box is clicked on, the program will activate. The column and row boxes can be changed at the point the program was last used.

    J. FILL IN the grid information, as done initially.

CTLGROUP PROCEDURE FOR IMPACT ECHO (IE) TESTING

IE Test System

This device is used for the evaluation of internal defects of reinforced concrete structures.

Operating Instructions:

1. OBTAIN and REVIEW any drawings available pertaining to the concrete element.
2. LAY OUT test grid in the test area.
3. INSPECT the test surface and GRIND SMOOTH if the test point surface is extremely rough.
4. CONNECT a displacement transducer or accelerometer to the connector box.
5. CONNECT the connector box to the data acquisition system.
6. TURN ON the computer to start setup process.
7. OPEN the Impact Echo directory.
8. CLICK to start the IE application.
9. Under Project Info., CLICK on IE DATA DIRECTORY and the "Save As" program will appear.
10. CLICK on the location where you want to save the data. (Normally My Docs or Desktop)
11. The selected directory (My Docs or Desktop) will appear.
    - A. CLICK on CREATE FOLDER at the top right of the taskbar.
    - B. TYPE in the title of the new folder.
    - C. CLICK on OPEN FOLDER.
    - D. CLICK on CURRENT FOLDER.
12. The following steps will take you back into the IE Menu:
    - A. CLICK on the grid name designation box and ENTER the name of current test grid.
    - B. SET the Peak Search Range based on the depth of expected reflections. Do NOT change other parameters.
    - C. SET UP a template for the particular project [Number of Rows, Columns, etc.]
    - D. SET UP test direction parameters.
13. CLICK on ACQUIRE NEW DATA to activate the Test Program.
14. <u>WHEN</u> testing is complete, <u>THEN</u> VERIFY the expected reflections are identified clearly by adjusting the ball diameter until data is clear.
15. CONTINUE testing until all rows and columns are completed and the prompt "Extract Data?" is displayed.
16. CLICK OK.
17. CLOSE program.
18. To review data, CLICK on folder where data is saved (My Docs or Desktop).

CTLGROUP PROCEDURE FOR IMPACT ECHO (IE) TESTING

19. IF testing is NOT complete and will resume,
THEN PERFORM the following:

A. CLICK on IE Application icon in the Impact Echo directory.

B. CLICK on PROJECT INFO.

C. CLICK on folder where data is saved (My Docs or Desktop).

D. TYPE in the file name.

E. CLICK on SAVE.

F. CLICK on CURRENT FOLDER.

G. VERIFY the IE menu appears.

H. TYPE in the existing grid name.

NOTE

When the start new data box is clicked on, the program will activate. The column and row boxes can be changed at the point the program was last used.

I. FILL IN the grid information, as done initially.

TEST PROCEDURE GUIDANCE FOR NDT

Test Procedure Guidance for Nondestructive Testing (NDT) of
Containment Wall Structure at Crystal River Power Plant Unit No. 3

An NDT inspection program is being conducted to assess circumstances associated with a crack discovered in the concrete of the referenced containment building. The plant had shut down to replace the steam generators inside containment. To move the large steam generators into the containment building, workers began removing concrete to create the necessary opening. During that work, an in-plane crack in the concrete was found in that area. The containment is about 42 inches thick, contains both horizontal and vertical tensioned steel tendons, and is lined with steel plate.

In cooperation with Progress Energy, CTLGroup has mobilized a nondestructive inspection team to evaluate the planar extent and severity of the anomaly. Progress Energy is performing an analysis of the concrete and overall containment to determine if there are safety implications and what may need to be done prior to the plant restarting.

The following constitutes the interim CTLGroup protocol for nondestructively testing concrete condition at locations selected by Progress Energy or defined by a sampling plan:

1. Perform **Impulse Response** (IR) testing at selected areas by gathering average mobility data. Based on limited trial testing at four general areas and encompassing five core verifications, the IR method was demonstrated to successfully correlate values of Average Mobility (M) with internal condition and concrete soundness, in the outer 20 inches (approximate) of concrete thickness of the containment wall structure. The recorded average mobility values shall be compared to the following threshold values, defining the existence of potential anomalies in the concrete conditions in the test area as follows:

   $M \leq 0.4$: solid concrete

   $0.4<M<1.0$: "gray" area, further test or coring is needed*

   $M \geq 1.0$: potential "delaminated" concrete or other type of anomaly may exist, coring to be performed**

   An orthogonal coordinate grid with a 2-ft square spacing will be established prior to data gathering in each containment wall section selected for testing.

2. In areas where further test is needed (*), first perform Ground Penetrating Radar (GPR) to lay out the reinforcement and tendons. Subsequently, perform IR testing on a finer gridlines (such as 1 ft x 1 ft) considering the tendon locations. In addition, perform IE testing to check the back wall reflection. If the back wall (42 in.) reflection is clearly identifiable based on the evaluation by the CTL Engineer using the frequency spectrum data collected, the section can be considered solid, if not clearly identifiable then core samples will be removed to verify condition. Alternatively, without further NDT, remove a core sample to verify the condition.

3. In areas where potential "delaminations" are identified (**), core samples will be removed to verify the condition. GPR shall be performed prior to the coring operation.

4. In "solid" area, randomly perform IE to get back wall reflection in order to confirm the absence of deeper delamination. Core samples will also be needed at limited location to verify the condition.

It should be noted that the proposed correlation between IR and presence of delaminations is preliminary in view of the limited areas tested so far, and only five cores samples removed. For a critical structure of this scale, more correlation data is desired in order to finalize a more comprehensive calibration. The proposed plan is preliminary and modification may be necessary and a fine-tuned threshold correlation is possible when more data is collected. Any adjustment to the thresholds will require PGN procedure revision, review against tests that have already been completed, and will be dispositioned in the final report.

EXTERIOR CONTAINMENT INSPECTION LOG

DATE: ____________ WO: __________________

BAY DESIGNATION: RBCN-____________

SCAN AREA LOCATION	SCAN AREA SIZE
HORZ: ____________________	WIDTH: ____________________
VERT: ____________________	LENGTH: ____________________
GRID SPACING: ____________	

NDT TECHNIQUES: (Check "√" type used)

GPR...... ☐ ....PERFORMED BY: ____________________

IR.......... ☐ ....PERFORMED BY: ____________________

IE.......... ☐ ....PERFORMED BY: ____________________

OTHER. ☐ ______________ ....PERFORMED BY: ____________________

INITIAL IR MOBILITY RANGE: ____

SUBSEQUENT IR MOBILITY RANGE (IF REQUIRED): ____________________________

INITIAL IE RESULT (IF REQUIRED): ____________________________________

BACKWALL REFLECTOR VERIFIED: YES _____ NO ______

EQUIPMENT PACKAGE NUMBER: ______________________________________

COMMENTS: ____

____

____

____

____

PERFORM DATA TRANSER: ____________________________ Date: ______________

ENGINEERING SIGN-OFF: ____________________________ Date: ______________

ENGINEERING REVIEW: ______________________________ Date: ______________

Revision Summary
PRR 362516 Editorial

SECTION	CHANGE
4.1.4	Corrected typo. Enclosure 8 (not 7) is the Exterior Containment Inspection Log Editorial
Enclosure 2 Pages 10-15 of 15	Replaced images with updated source drawings Editorial