

# Langdon Wind, LLC

700 Universe Blvd.  
Juno Beach, Florida, 33408-2683

August 2, 2007

Ilona A. Jeffcoat-Sacco, Executive Director  
North Dakota Public Service Commission  
600 E. Boulevard, Dept.408  
Bismarck, ND 58505-0480


Subject: **Langdon Wind, LLC: ND PSC Case No. PU-07-26**

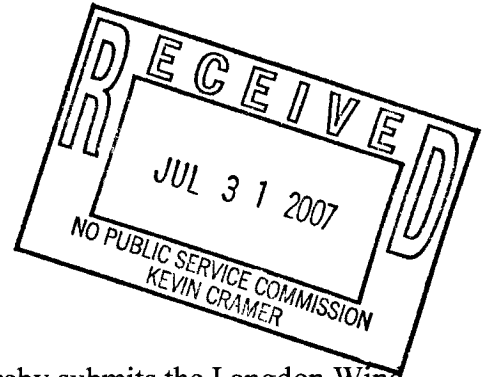
Dear Secretary Jeffcoat-Sacco:

In accordance with the Commission's Order, Langdon Wind, LLC hereby submits the Langdon Wind Substation drawings and diagrams that have been released for construction. Electronic copies of these drawings have been previously submitted to Jerry Lein. We request the Commission waive the requirement for 10 copies due to the volume of this filing.

Please contact me at (561) 691-7240 or [Scott\\_Scovill@fpl.com](mailto:Scott_Scovill@fpl.com) with any questions or comments.

Sincerely,

  
Scott Scovill  
Project Director, FPL Energy





CERTIFICATION BY THE ENGINEERS

The civil and structural construction specifications contained in this document were reviewed and approved by:

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Craig D. Blincow, P.E.

The electrical construction specifications contained in this document were reviewed and approved by:

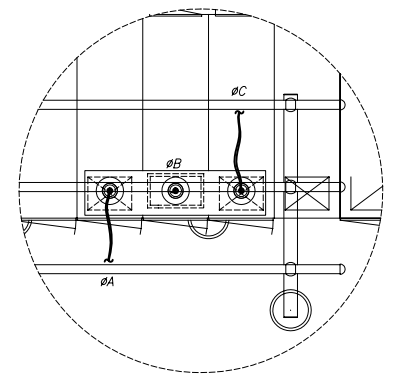
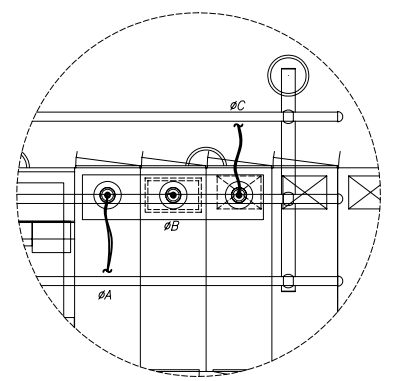
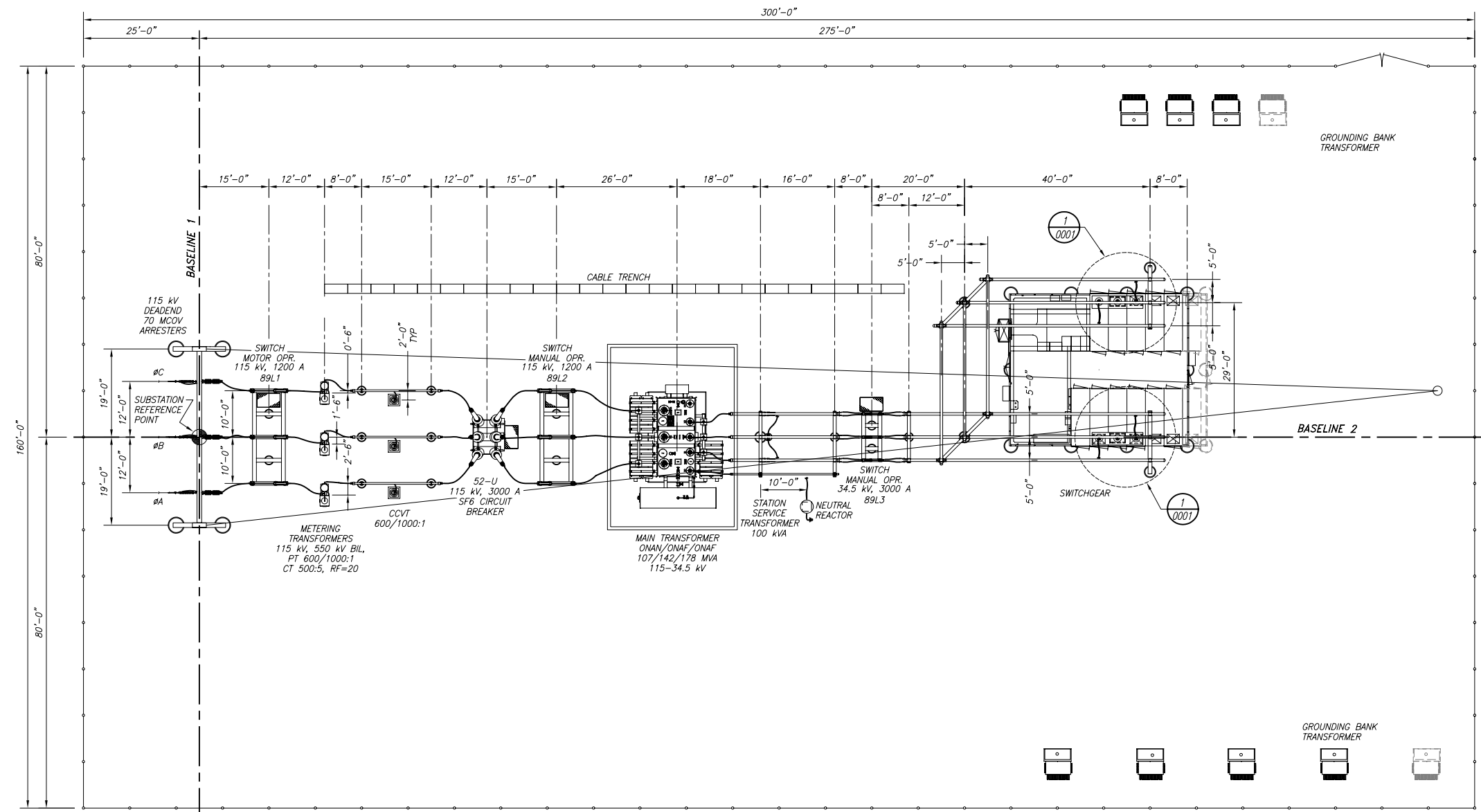
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James K. Phipps, P.E.

**Client: Florida Power and Light Energy- Langdon  
Wind Substation**  
**Title: Construction Specifications**  
**Date: July 25, 2007**  
**Project #: 07-6253**  
**Design by: Todd Crenshaw, Aaron Vienot**  
**Review by: Craig Blincow, James Phipps**

### Included Specifications

- 0201 Rough Grading
- 0202 Final Grading and Surfacing
- 0203 Security Fence
- 0301 Foundation Excavation
- 0302 Caisson Drilling
- 0303 Reinforced Concrete
- 0304 Earthwork and Concrete Testing
- 0401 Conduit System
- 0501 Grounding System
- 0601 Structural Steel Erection
- 0602 Substation Equipment Installation
- 0603 Bus System
- 0604 Heavy Equipment Installation
- 0801 Control Wiring and Cable
- 0803 Fiber Cable
- 1206 Electric Power System Testing



**1 0001** DETAIL  
SWITCHGEAR PHASING

**LEGEND**  
 ——— NEW CONSTRUCTION  
 - - - - - FUTURE CONSTRUCTION

**NOTES**  
 1. REFERENCE DRAWING 62530201 FOR SUBSTATION REFERENCE POINT LOCATION & BASELINE BEARINGS.

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 Golden, Colorado 80402  
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 (303) 462-2600 fax



REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	JKP	JKP	JKP	4/09/07
B	REVISED FOR UPDATED LAYOUT	CTC	CTC	JDS	7/16/07
C	90% SUBMITTAL	JDS	LAB	JDS	07/16/07
D	FOR CONSTRUCTION	JDS	GLJ	CDB	07/27/07

ENG: J. PHIPPS  
 DWN: J. PHIPPS  
 CHK: C. BLINCOW  
 DATE: 07/27/07

CLIENT/PROJECT:	FPL ENERGY LANGDON - WIND SUBSTATION	
TITLE:	GENERAL ARRANGEMENT	
SCALE:	 1 1/2"=20'-0"	DRAWING NUMBER: 62530001
		REVISION: 0

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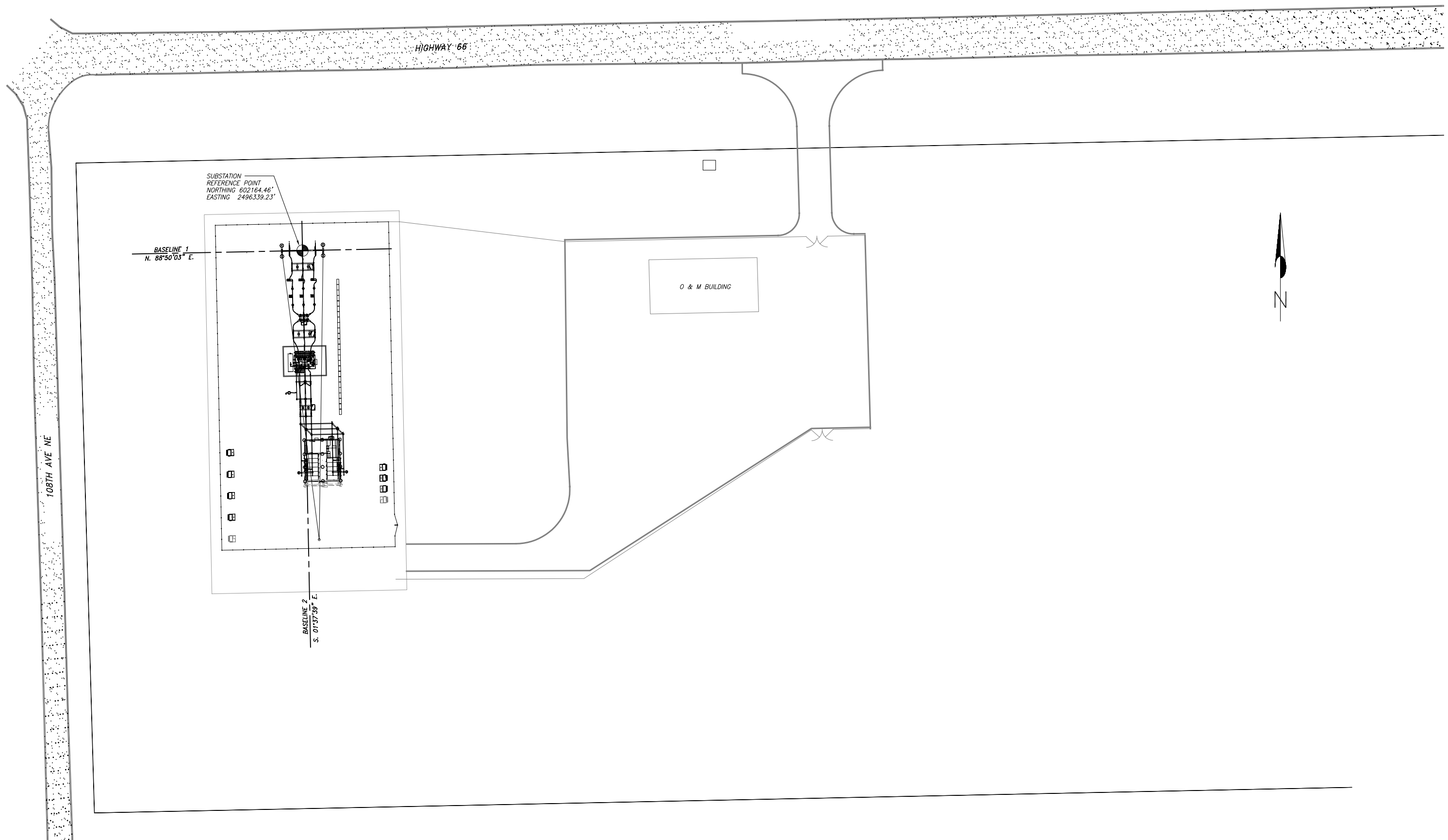
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Golden, Colorado 80402  
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(303) 462-2600 fax



REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	MDG	REC	MDG	07/26/07
0	FOR CONSTRUCTION	MDG	REC	CDB	07/27/07

ENG: M. GRYLICKI  
DWN: R. COLE  
CHK: C. BLINCOW  
DATE: 07/27/07

CLIENT/PROJECT:		FPL ENERGY LANGDON - WIND SUBSTATION	
TITLE:		SITE PLAN	
SCALE:	0 40' 80' 120'	DRAWING NUMBER:	62530201
1"=40'		REVISION:	0



## ROUGH GRADING

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary for rough grading work for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))

##### B. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

### PART 2 - TERMS AND CONDITIONS - (not used)

### PART 3 - PRODUCTS

#### 3.1 MATERIAL

##### A. Fill Material

Material to construct fill sections shall be obtained from cut portions of the work after completion of clearing and grubbing operations, unless such material is determined to be unsuitable due to the presence of organic material, excessive moisture or other deleterious substances.

##### B. Borrow Material

Where excavated material is not sufficient to construct fill areas to the grade and section required, the Contractor shall obtain borrow material as directed by the Owner. Such material shall be a granular material, free of organic material, excessive moisture or other deleterious substances.

#### PART 4 - EXECUTION

##### 4.1 SURVEYING

The Contractor shall be responsible for the layout of the area to be graded using precise survey equipment. The Contractor shall be responsible for checking and maintaining proper grade elevations as shown on the drawings throughout the grading activities.

##### 4.2 CLEARING AND GRUBBING

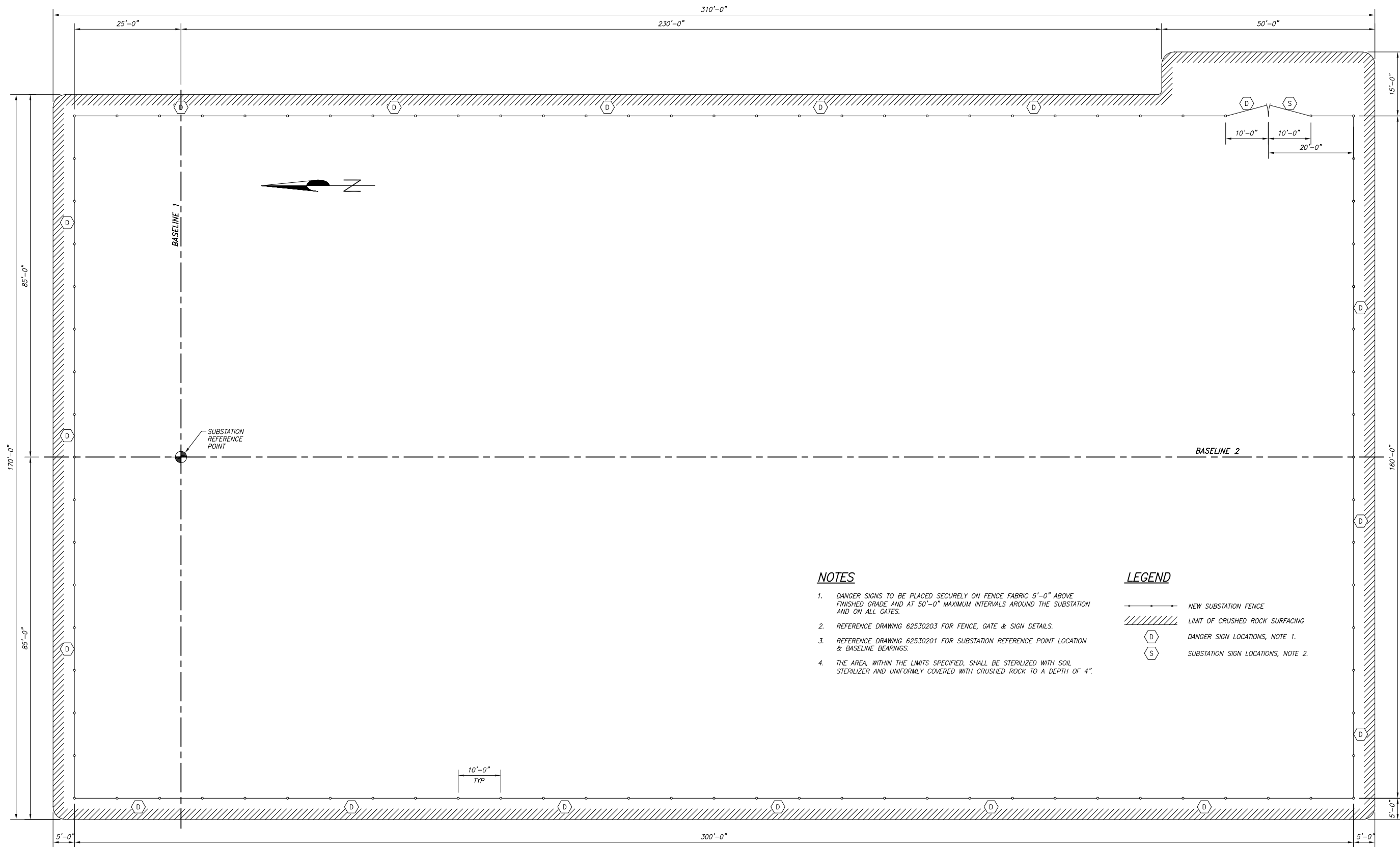
- A. The site, within the limits specified on the preliminary grading drawings, shall be grubbed and cleared of all rocks or other detached stones one half (1/2) cubic yard or smaller, trees, brush, deadfall, grass, and all debris to a depth of six (6) inches below grade.
- B. Stump holes and other holes from which obstructions are removed, shall be backfilled with suitable materials in twelve inch (12") lifts and compacted to a 90% maximum density at optimum moisture content in accordance with ASTM-D1557.
- C. Undisturbed stumps, roots and nonperishable solid objects located two (2) feet or more below the grade may remain in place.
- D. No material or debris shall be disposed of within the project limits. All waste material shall be removed from the site and disposed of in accordance with state and county regulations.

##### 4.3 GRADING

- A. The site shall be graded to the elevations and grades specified on the drawings. This work is to include the grading of drainage ditches and installation of drainage culverts when such work is specified on the drawings.
- B. Prior to beginning grading operations in any area, all necessary clearing and grubbing shall have been performed.
- C. Any rock, intact stone or boulder having a volume of one half (1/2) cubic yard or more shall be removed to a depth of six-inches (6") below grade.

- D. In areas designated for fill, suitable materials shall be used and placed in twelve-inch (12") lifts and compacted to a 90% maximum density at optimum moisture content in accordance with ASTM-D1557.
- E. Fill material shall not be placed when the material is frozen, nor shall any snow, ice or frozen earth be incorporated in the fill.
- F. All surplus material obtained from the grading operation, which is free of trees, brush, large rocks, deadfall, grass and all debris, shall be stockpiled for eventual removal or redistribution.

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**NOTES**

1. DANGER SIGNS TO BE PLACED SECURELY ON FENCE FABRIC 5'-0" ABOVE FINISHED GRADE AND AT 50'-0" MAXIMUM INTERVALS AROUND THE SUBSTATION AND ON ALL GATES.
2. REFERENCE DRAWING 62530203 FOR FENCE, GATE & SIGN DETAILS.
3. REFERENCE DRAWING 62530201 FOR SUBSTATION REFERENCE POINT LOCATION & BASELINE BEARINGS.
4. THE AREA, WITHIN THE LIMITS SPECIFIED, SHALL BE STERILIZED WITH SOIL STERILIZER AND UNIFORMLY COVERED WITH CRUSHED ROCK TO A DEPTH OF 4".

**LEGEND**

- NEW SUBSTATION FENCE
- LIMIT OF CRUSHED ROCK SURFACING
- DANGER SIGN LOCATIONS, NOTE 1.
- SUBSTATION SIGN LOCATIONS, NOTE 2.



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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	JDS	REC	JDS	07/16/07
B	90% SUBMITTAL	JDS	REC	JDS	07/16/07
D	FOR CONSTRUCTION	MDG	GLJ	CDB	07/27/07

ENG: J. SCOTT  
DWN: R. COLE  
CHK: C. BLINCOW  
DATE: 07/27/07

CLIENT/PROJECT: FPL ENERGY  
LANGDON - WIND SUBSTATION  
TITLE: FENCE & SURFACING PLAN

SCALE: 3/32"=1'-0"  
0 8' 16' 24' 32'

DRAWING NUMBER: 62530202

REVISION: 0

## FINAL GRADING AND SURFACING

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary for final grading and surfacing work for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))

##### B. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

#### 1.3 SUBMITTALS

Submit sample of crushed rock surfacing material.

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS

#### A. Crushed Rock Surfacing

Material for the rock surfacing shall consist of crushed or processed rock or stone which shall be thoroughly washed to remove clay, silt, loam, alkali and organic material. The material shall meet the following gradation requirements:

Sieve Designation	Percent Passing by Weight
1-1/2 inch square	100
3/4 inch square	40-50 max
1/4 inch square	10 max
No. 200 mesh	0 max

#### PART 4 - EXECUTION

##### 4.1 FINAL GRADING

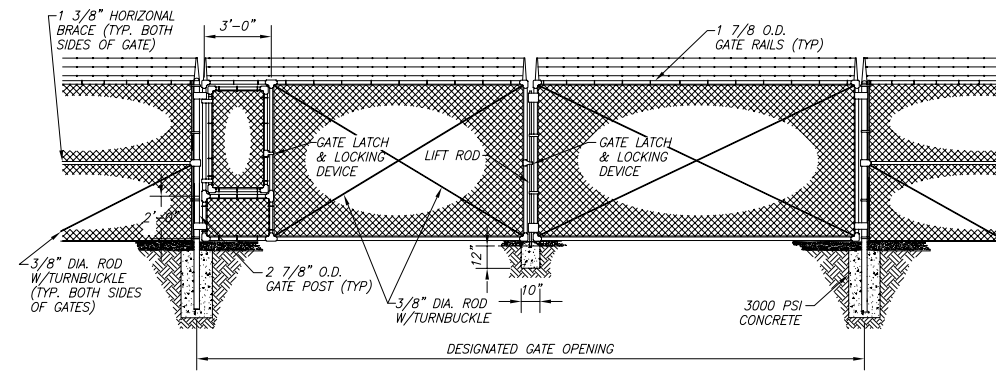
- A. The site shall be final graded to the elevations and slopes specified on the drawings. The final grade immediately adjacent to buildings shall be sloped away from the exterior walls.
- B. The site shall be finished to a smooth and compact surface in all areas of excavations, fills, cuts and sub-grades.
- C. All fill material utilized to meet final grade shall be placed in twelve inch (12") lifts and compacted to a 90% maximum density at optimum moisture content in accordance with ASTM-D1557.

##### 4.2 SOIL STERILIZATION

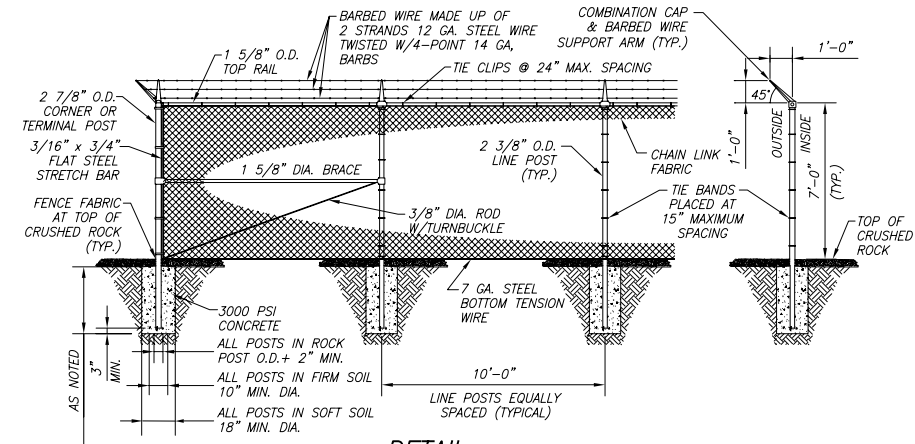
- A. Areas to receive crushed rock surface shall first receive soil sterilizer, which shall be applied in strict accordance with the manufacturer's instruction.
- B. The soil sterilizer shall be DuPont Hyvar X or equal and shall be applied at a rate of twenty pounds (20lbs) per acre.

##### 4.3 CRUSHED ROCK SURFACING

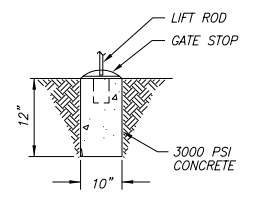
Crushed rock shall be uniformly spread throughout the substation area and shall extend beyond the chain-link fence per the drawings.



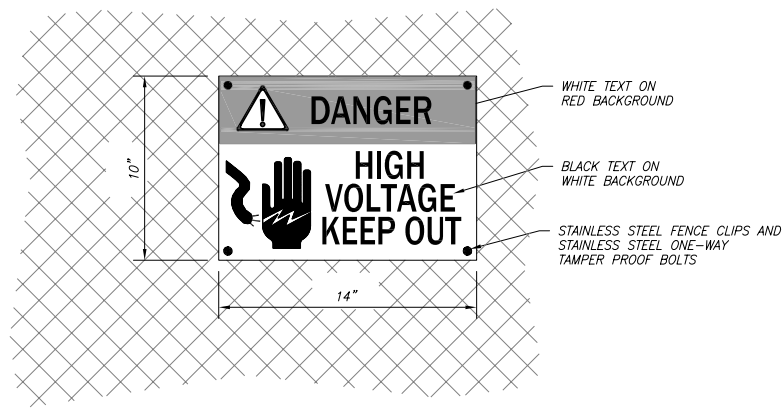
**DETAIL**  
DOUBLE DRIVEWAY GATE  
W/INCLUDED MAN GATE  
INSTALLATION



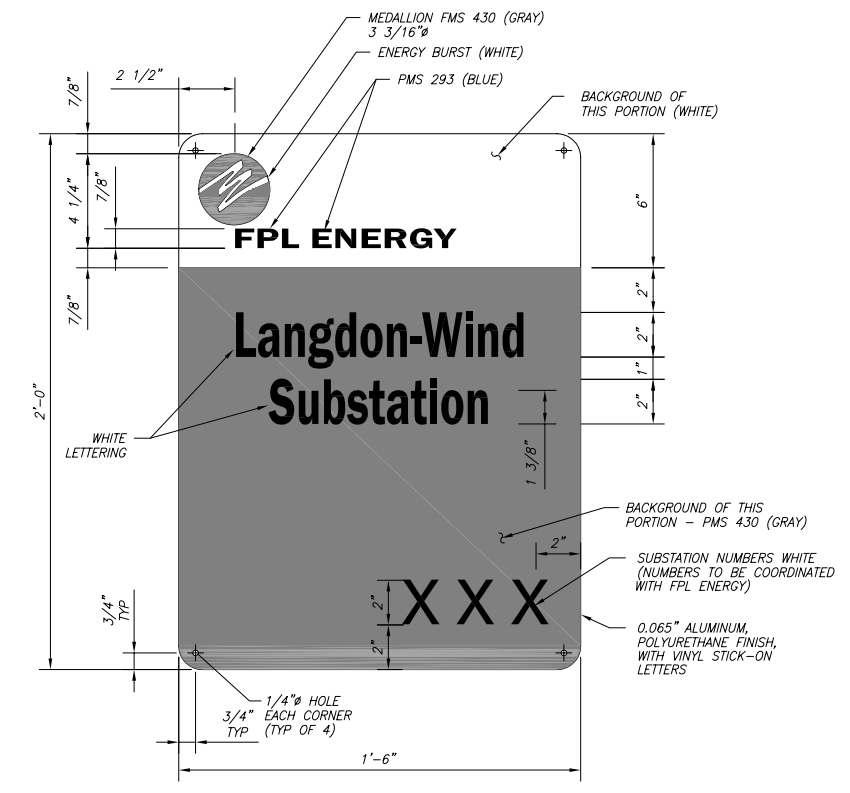
**DETAIL**  
FENCE INSTALLATION



**DETAIL**  
GATE STOP INSTALLATION



**DETAIL**  
DANGER SIGN



**DETAIL**  
SUBSTATION SIGN

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REV	DESCRIPTION	ENG	DWN	CHK	DATE	CLIENT/PROJECT:
A	FOR REVIEW	JDS	REC	JDS	07/16/07	FPL ENERGY
B	90% SUBMITTAL	JDS	REC	JDS	07/16/07	LANGDON - WIND SUBSTATION
D	FOR CONSTRUCTION	JDS	GLJ	CDB	07/27/07	FENCE DETAILS
						SCALE: NONE
						DRAWING NUMBER: 62530203
						REVISION: 0
						DATE: 07/27/07

## SECURITY FENCE

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification shall cover material and installation of non-climbable, galvanized, 84" chain-link steel fence fabric; complete with a 12" high barbed wire extension top, swing gates with integral locks, all accessories, connections and concrete footings.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL - Latest Edition

1. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
3. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
6. ASTM B6 Standard Specification for Zinc

##### B. FEDERAL SPECIFICATIONS - Latest Edition

1. RR-F-191-GEN Fencing, Wire and Post Metal (and Gates, Chain-Link Fence and Accessories)
2. RR-F-191/1 Fencing, Wire and Post Metal (Chain-Link Fence Fabric)
3. RR-F-191/2 Fencing, Wire and Post Metal (Chain-Link Fence Gates)

4. RR-F-191/3 Fencing, Wire and Post Metal (Chain-Link Fence Posts, Top Rails and Braces)

5. RR-F-191/4 Fencing, Wire and Post Metal (Chain-Link Fence Accessories)

C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards

2. Title 29, Part 1926 Safety and Health Regulations for Construction

1.3 SUBMITTALS (not used)

PART 2 - TERMS AND CONDITIONS (not used)

PART 3 - PRODUCTS

3.1 GENERAL

All components, including: fabric, posts, extension arms, barbed wire, top rails and braces, truss rods, nuts, bolts, washers and fittings shall be hot dip galvanized.

3.2 FABRIC

A. Chain-link fencing shall be Type 1, Grade "A", No. 9 gauge wire woven in a 2" chain-link diamond mesh and shall be in all respects in accordance with requirements of Federal Specification No. RR-F-191/1A.

B. Fabric shall have both top and bottom salvage edges twisted and barbed, barbing is to be done by cutting on a bias to create sharp points.

C. Galvanizing shall be done by hot dip process after weaving.

D. Fence Posts, Gates and Accessories

1. All fence posts, gates and accessories shall be in accordance with the requirements of Federal Specification No. RR-F-183, the latest amendment, unless noted otherwise below.

2. Corner, end and pull posts shall be 2-7/8" outside diameter, 2-1/2" IPS and shall not weigh less than 5.794 pounds per linear foot.

3. Intermediate or line posts shall be hot dip galvanized 2-3/8" outside diameter 2" IPS weighing no less than 3.653 pounds per linear foot.

4. Top rail shall be 1-5/8" outside diameter 1-1/2" IPS and weigh not less than 2.27 pounds per linear foot.
5. Top rail shall be provided with couplings approximately every twenty (20) feet.
  - a. Couplings shall be outside sleeve type and shall be at least seven (7) inches long.
  - b. One coupling in every five shall have a heavy spring to compensate for expansion and contraction of the top rail.
  - c. Top rail shall pass through base of line post tops and shall form a continuous brace from end to end of each stretch of fence.
  - d. Top rail shall be securely fastened to terminal posts by pressed steel connections.
6. Stretcher bars shall not be less than 3/16" by 3/4" and shall be equal to the full height of the fabric.
  - a. The stretcher bars shall be arranged for attaching the fabric to all terminal posts by threading through the fabric, by bands, or by other positive mechanical means.
  - b. One stretcher bar shall be provided for each gate and end post, and two for each corner.
7. Bottom tension wire shall be No. 7 gauge galvanized wire.
8. Gate posts shall be hot dip galvanized tubing, the minimum sizes of which shall be in accordance with the following:

Type of Gate	Sizing		
	Outside Diameter	IPS	Pounds/linear foot
Man Gate	2-7/8"	2-1/2"	5.79
Drive Gate	4.0"	3-1/2"	9.11

9. Gate Frames
  - a. Gate frames over six feet (6') in width shall be constructed of: hot dip galvanized pipe, 1-7/8" minimum outside diameter, 1-1/2" IPS and weighing not less than 2.718 pounds per linear foot.
  - b. Gate frames under six feet (6') in width shall be constructed of: hot dip galvanized pipe, 1-5/8" minimum outside diameter, 1-1/2" IPS and weighing not less than 2.27 pounds per linear foot.

- c. Gate leaves shall have vertical intermediate bracing as required spaced so that no members are more than eight feet (8') apart.
  - d. Where corner fittings are used, gates shall have truss rods of 3/8" nominal diameter to prevent sag or twist.
  - e. Corner fittings shall be constructed of: heavy pressed steel, malleable iron ball and socket hinges, catch, stop and center rest.
  - f. Secondary leaf of double-swing gate shall include plunger type latch.
  - g. Gate fabric shall match fence fabric.
10. Braces
- a. Braces shall be hot dip galvanized and of the same material as the top rail.
  - b. Braces shall be spaced midway between the top rail and the ground and shall extend from terminal post to first adjacent line post.
  - c. Braces are to be securely fastened to posts by suitable pressed steel connections, then trussed from line post back to terminal post with 3/8" round rod provided with terminal fittings to permit tightening of truss rod.
11. Extension Arms
- a. Extension arms and fittings shall be hot dip galvanized malleable iron or pressed steel.
  - b. Extension arms shall carry three (3) barbed wires at a 45-degree angle to the outside of the property as indicated in the drawing.
  - c. Barbed wires shall be securely fastened in slots by heavy wire pins.
  - d. Arms having projections to be bent down over barbed wires shall not be used.
12. Gateposts shall have a ball top.
13. Barbed wire shall be constructed of two strands of 12-1/2 gauge wire, twisted with 14 gauge in a four point barb pattern not more than five inches (5") apart.

14. All galvanizing shall be done at the rate of two ounces per square foot of surface.
15. No used, re-rolled or open seam material will be permitted in posts or rails.

#### PART 4 - EXECUTION

##### 4.1 SITE PREPARATION

- A. All surveying and layout work shall be performed by the contractor.
- B. Fence dimensions shall be as specified on the drawings.
- C. Obstructions of every nature that could interfere with the erection of the fence shall be removed prior to commencing erection work on the fence.

##### 4.2 FENCE CONSTRUCTION

###### A. Post Spacing

1. Line posts shall be spaced at intervals not to exceed ten feet (10') when measured from center-to-center between terminal posts.
2. In general, when determining post spacing, measurement will be made parallel to the slope of the natural ground and all posts shall be placed in a vertical position.

###### B. Post Setting

1. Line and gateposts shall be set in holes of ten-inch (10") minimum diameter and thirty-six inch (36") minimum depth.
2. End, corner and pull posts shall be set in holes of ten inch (10") minimum diameter and forty two inch (42") minimum depth.
3. After a post has been set and plumbed, the hole shall be filled with concrete having a minimum 28-day compression strength of 2,500 pounds per square inch.
4. The exposed surface of the concrete shall be crowned.
5. Where solid rock is encountered without an overburden of soil
  - a. All posts shall be set a minimum depth of twenty-four inches (24").

- b. The hole shall have a minimum width of two inches (2") greater than the largest dimension of the post section to be set.
- c. After the post is set and plumbed, the hole shall be filled with grout consisting of one part Portland Cement and three parts clean, well-graded sand.
- d. The grout shall be thoroughly worked into the hole.
- e. Concrete footings shall be constructed from the solid rock to the top of the ground.
- f. Grouting will be required on the portion of the post in solid rock.

C. Terminal Post Setting

- 1. End, corner and gateposts shall be set as defined in B, above.
- 2. Terminal posts shall be braced to the nearest post with a galvanized pipe horizontal brace midway between the top rail and the ground and a galvanized 3/8" steel truss rod and truss tightener used as a tension member.
- 3. All changes in direction of fence line of thirty (30) degrees or more shall be considered as corners.

D. Chain-Link Fabric Installation

- 1. The fabric shall be placed on the outside of fence posts enclosing the area.
- 2. The fabric shall be stretched taut approximately two inches (2") above the finished rock surface and securely fastened to the posts.
- 3. The fabric shall be cut and each span shall be attached independently at all terminal posts.
- 4. Fastening to terminal posts shall be with stretcher bars and fabric bands spaced at fifteen-inch (15") intervals.
- 5. Fastening to line posts shall be with galvanized or non-corrosive tie wire or metal bands attached at maximum fifteen-inch (15") intervals.
- 6. The bottom edge of the fabric shall be fastened to the bottom tension wire with ties at intervals not exceeding twenty-four inches (24").

7. Rolls of wire fabric shall be joined by weaving a single strand into the ends of the rolls to form a continuous mesh.





## FOUNDATION EXCAVATION

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary for excavation of foundations for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))

##### B. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS

#### 3.1 Fill Material

Backfill material shall be the surplus material obtained from the preliminary grading and excavation operations when use of this material is allowed by the Engineer. All backfill material shall be clean and free of debris and organic matter.

### PART 4 - EXECUTION

#### 4.1 EXCAVATION

- A. Sub-grade elevation shall be achieved before any foundation excavation takes place to insure proper drainage of the site throughout construction.

- B. Shoring requirements and side slopes of excavations shall be in accordance with the requirements of the applicable specifications and the recommendation of the Engineer.
- C. The bottom of excavations intended for foundations shall be undisturbed by excavating equipment as nearly as practicable or shall be compacted in accordance with the drawings.
- D. The excavated area shall conform to the outlines of the foundations as shown on the drawings, and shall be of sufficient size to permit placing of the full width and length of the footings shown

#### 4.2 DE-WATERING

Provisions for dewatering shall be made for all excavations. If groundwater is encountered, the groundwater level shall be lowered to a level one foot (1') below the bottom of the excavations by pumping. This level shall be maintained throughout underground construction.

#### 4.3 BACKFILLING

- A. Backfilling shall occur as soon after stripping of forms as possible to minimize the chance of water accumulation; no excavation is to be backfilled when standing water is present.
- B. Backfilling shall be to the elevations specified on the drawings.
- C. All backfill shall be placed in twelve-inch (12") lifts and compacted to a 90% maximum density at optimum moisture content in accordance with ASTM-D1557 (AASHTO T-180).
- D. Excessive use of water during backfilling procedures shall not be permitted.
- E. Compaction equipment or methods that produce horizontal or vertical earth pressures, which may cause excessive displacement or overturning, or may damage structures, shall not be used.

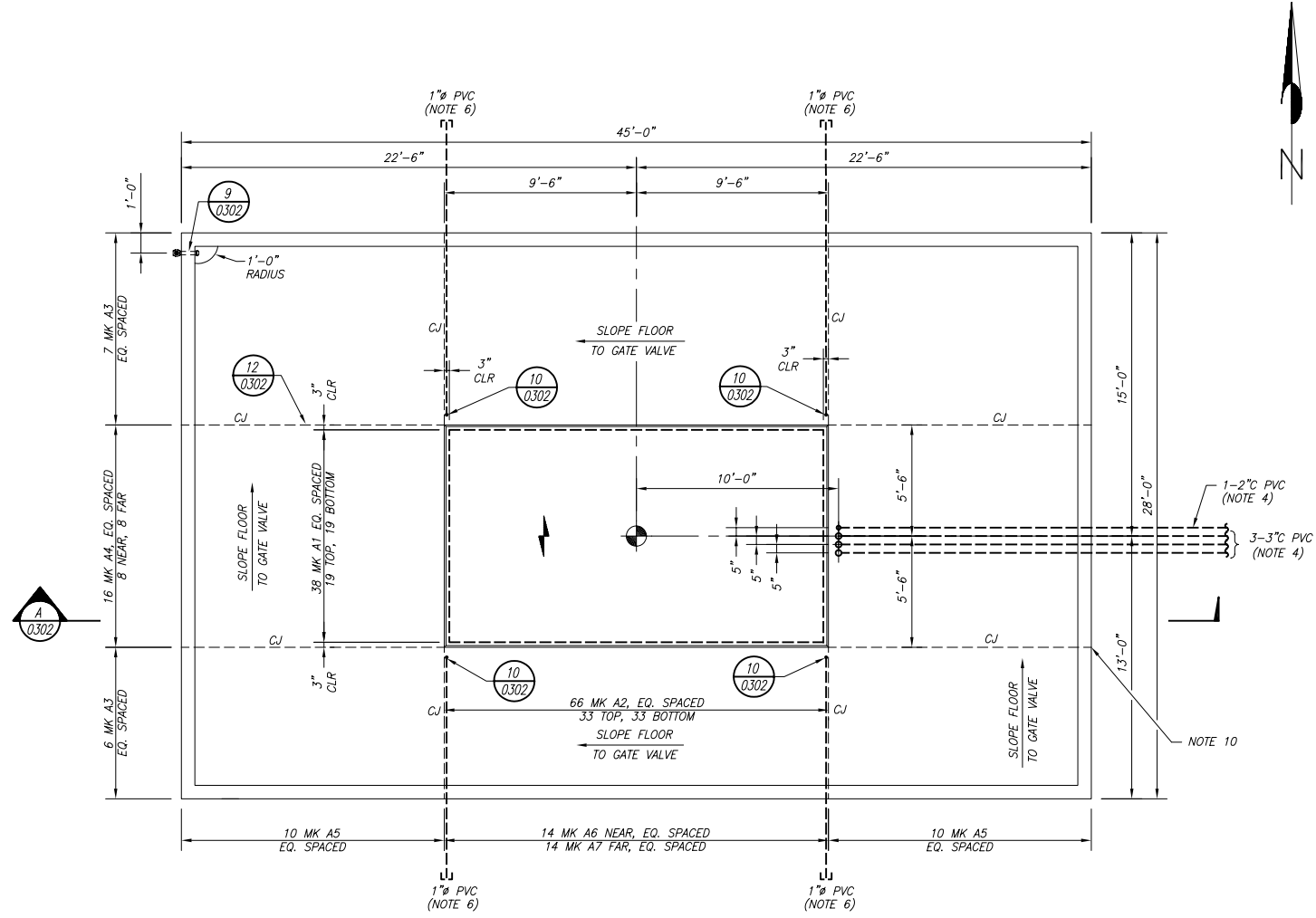
#### 4.4 ROCK EXCAVATION

##### A. DEFINITIONS

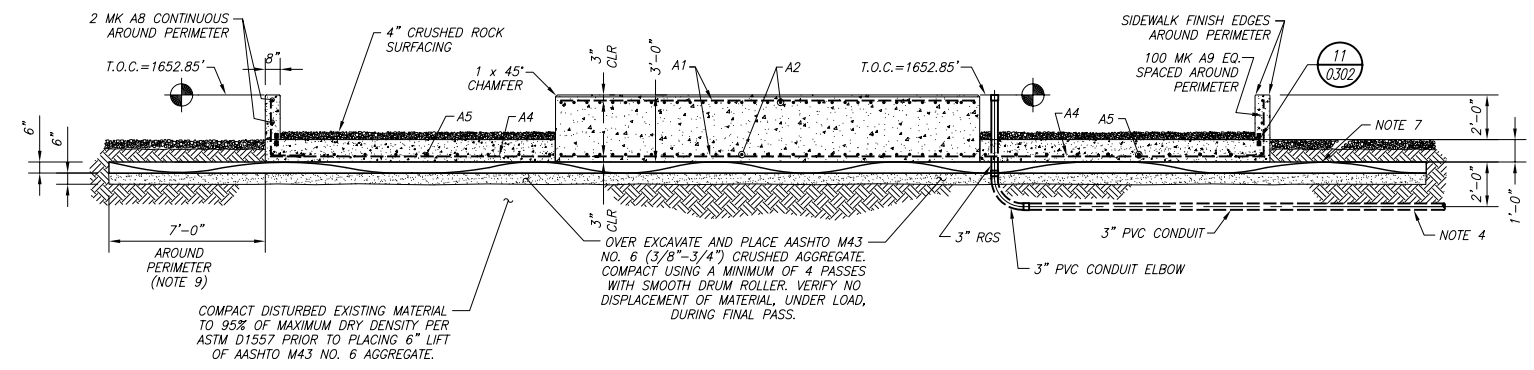
- 1. Rock Boulders shall be defined as individual rocks encountered during excavation over 12" in diameter. Rock Boulders encountered during excavation under 12" in diameter shall be considered normal soil excavation.

2. Solid Rock shall be defined as a layer of material encountered during excavation, which cannot be removed with typical backhoe or trackhoe equipment without blasting or jackhammering.
- B. Rock boulders and Solid Rock shall be removed from excavation and disposed of off of site by Contractor.
  - C. Contractor shall notify Engineer as soon as Rock Boulders or Solid Rock is encountered for direction on continuing excavation and rock unit measuring.

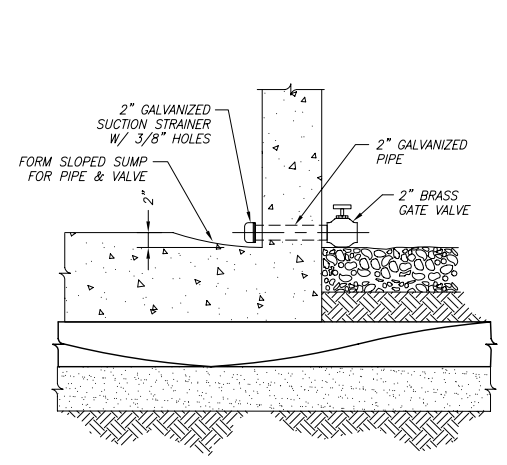
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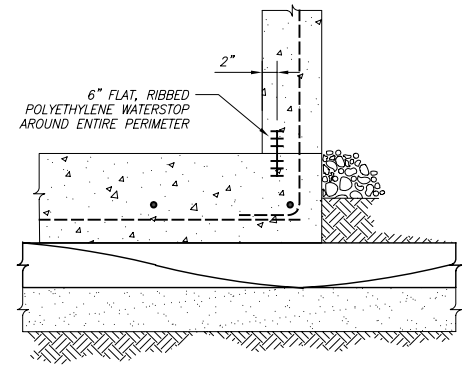
**1 DETAIL**  
 0301 TRANSFORMER FOUNDATION  
 SCALE: 1/4"=1'-0"  
 69.4 C.Y. EA.



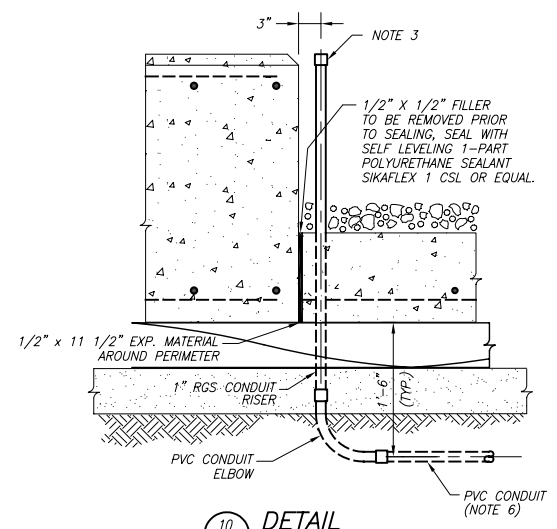
**A SECTION**  
 0302 TRANSFORMER FOUNDATION  
 SCALE: 1/4"=1'-0"



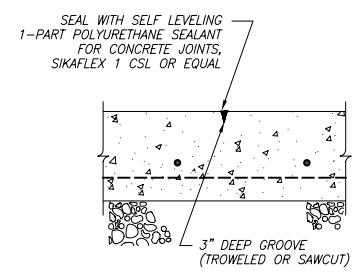
**9 DETAIL**  
 0302 DRAIN VALVE  
 SCALE: 1"=1'-0"



**11 DETAIL**  
 0302 SCALE: 1"=1'-0"



**10 DETAIL**  
 0302 SCALE: 1"=1'-0"



**12 DETAIL**  
 0302 TYPICAL CONTROL JOINT  
 SCALE: 1"=1'-0"

**NOTES**

1. FOUNDATION ORIENTATION.
2. CJ - CONTROL JOINT.
3. LEAVE THREADED COUPLING & CAP CONDUIT LEVEL WITH TOP OF TRANSFORMER FOUNDATION.
4. COORDINATE CONDUIT INSTALLATION DIRECTION AND DEPTH WITH CONDUIT INSTALLER. REFERENCE DWG. 62530401.
5. ALL REBAR TO BE INSTALLED SO AS TO MAINTAIN A 3" MINIMUM CLEAR DISTANCE UNLESS OTHERWISE NOTED.
6. GROUNDING CONDUCTOR CONDUIT. STUB AND CAP 2'-0" BEYOND CONTAINMENT WALL.
7. 6" EXTERIOR GRADE POLYSTYRENE FOAM INSULATION WITH A MINIMUM COMPRESSIVE STRENGTH OF 60 PSI. PENETRATIONS THROUGH FOAM INSULATION SHALL BE NEATLY CUT AND SEALED WITH SPRAY FOAM TYPE INSULATION.
8. PER DRAWING 62530501, CONTRACTOR SHALL INSTALL REQUIRED GROUND GRID PRIOR TO INSTALLING PERIMETER FOAM.
9. CONTROL JOINT SHALL EXTEND VERTICALLY ALONG BOTH SIDES OF CONTAINMENT WALL, TYPICAL 8 PLACES. VERTICAL CONTROL JOINTS SHALL BE SEALED WITH SONOLASTIC NP1 1-PART ELASTOMERIC GUN-GRADE POLYURETHANE SEALANT, SONOLASTIC NP1 OR EQUAL.

REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: J. SCOTT	CLIENT/PROJECT:
A	FOR REVIEW	JDS	GLJ	CDB	07/21/07	DWN: G. JEFFERSON	FPL ENERGY LANGDON - WIND SUBSTATION
0	FOR CONSTRUCTION	JDS	GLJ	CDB	07/21/07	CHK: C. BLINOW	FOUNDATION DETAILS
						DATE: 07/21/07	SCALE: AS SHOWN
							DRAWING NUMBER: 62530302
							REVISION: 0



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## CAISSON DRILLING

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary for the drilling of caissons for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM A36/A36M Standard Specification for Carbon Structural Steel
2. ASTM A444 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Culverts and Underdrains

##### B. AMERICAN WELDING SOCIETY - Latest Edition

1. AWS D1.1/D1.1M Structural Welding Code-Steel

##### C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS

#### 3.1 MATERIAL

##### A. Steel Casing

1. Steel casing shall be ASTM A36 for casing to be withdrawn or ASTM A444 for corrugated casing to remain in place.

2. Furnish casing of sufficient strength to withstand handling stresses, concrete pressure and surrounding earth and/or fluid pressure.
- B. Reinforcing Steel
1. Provide reinforcing steel per Reinforced Concrete specification section.
- C. Concrete
1. Provide ready mixed concrete per Reinforced Concrete specification section.
- D. Sonotube
1. Provide Sonotube forming material as shown on drawings.

#### PART 4 - EXECUTION

##### 4.1 CONSTRUCTION TOLERANCES

- A. Maximum permissible variation of location shall be less than 3 inches.
- B. The center of the reinforcing cage shall be the center of the caisson.
- C. The excavation shall be a maximum out of plumb of not more than 3.0 percent of the caisson length.
- D. The shaft diameter shall be at least 98 percent and shall not exceed 110 percent of that specified on the drawings.

##### 4.2 EXCAVATION

- A. Excavate caissons to dimensions and required elevations shown on the drawings.
- B. Maintain sidewall stability during drilling.
- C. Determine suitability of supporting material at bottom of excavation by inspection and as directed by the Engineer.
- D. Provide gas testing equipment, protective cage or temporary casing of proper diameter, length and thickness and other safety equipment called for by Federal, State or local laws for inspection to protect workers during operations necessitating entry into the shaft.
- E. Check each caisson shaft for toxic and explosive gases prior to personnel entering shaft.

- F. Remove from the bottom of the caissons loose material or free water in quantities sufficient to cause settlement or affect concrete strength. Excavate caisson bottoms to a level plane.
- G. All excavated material shall be kept away from the open shaft excavation. Excavated material shall be stockpiled and disposed by the Contractor as directed by the Engineer.

#### 4.3 CASING

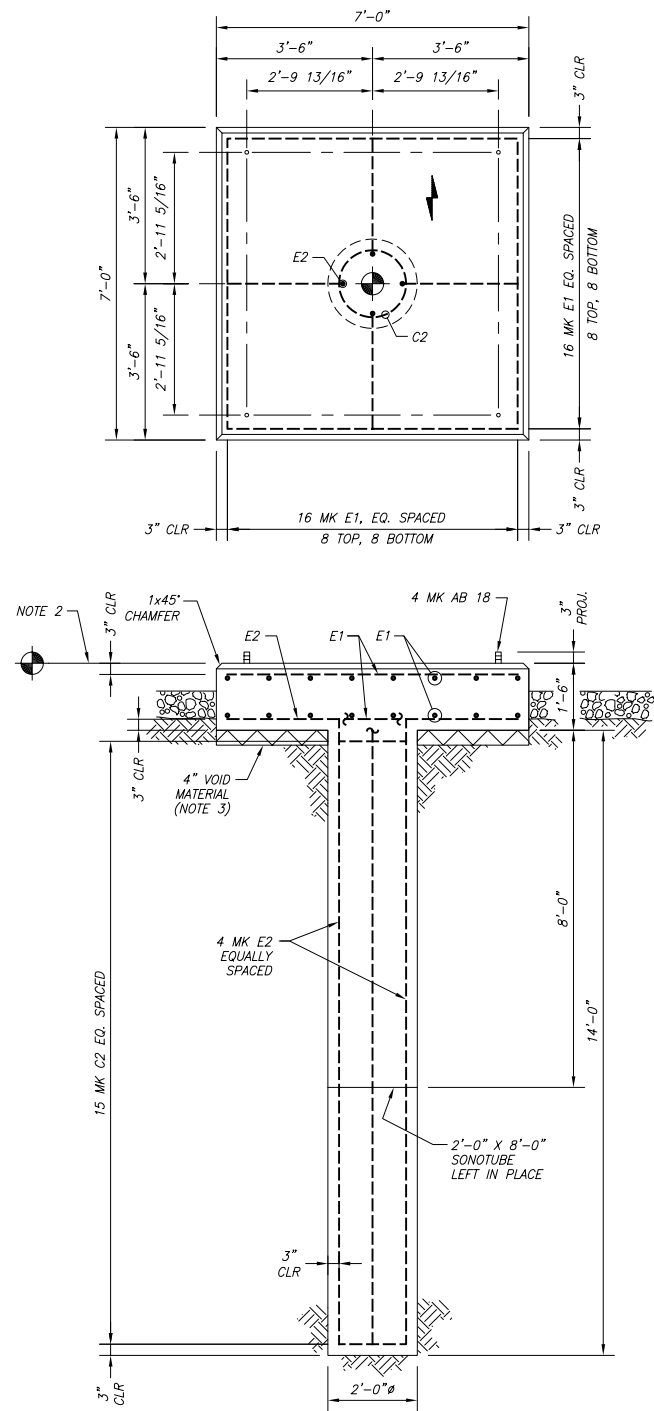
- A. Casing shall be continuously joined and have the strength and rigidity to maintain the required excavation dimensions against earth and water pressures.
- B. Provide steel casing for the shaft excavation as required to prevent caving of the shaft.
- C. Casing may be withdrawn at the option of the Contractor. Casing withdrawal shall be carefully coordinated with concrete placement. An adequate head of concrete shall be maintained to exceed outside soil and water pressure above the bottom of the casing at all times during casing withdrawal. A casing vibratory extractor is permitted. Withdraw casing while concrete is still fluid and plastic and before initial set.

#### 4.4 ROCK DRILLING

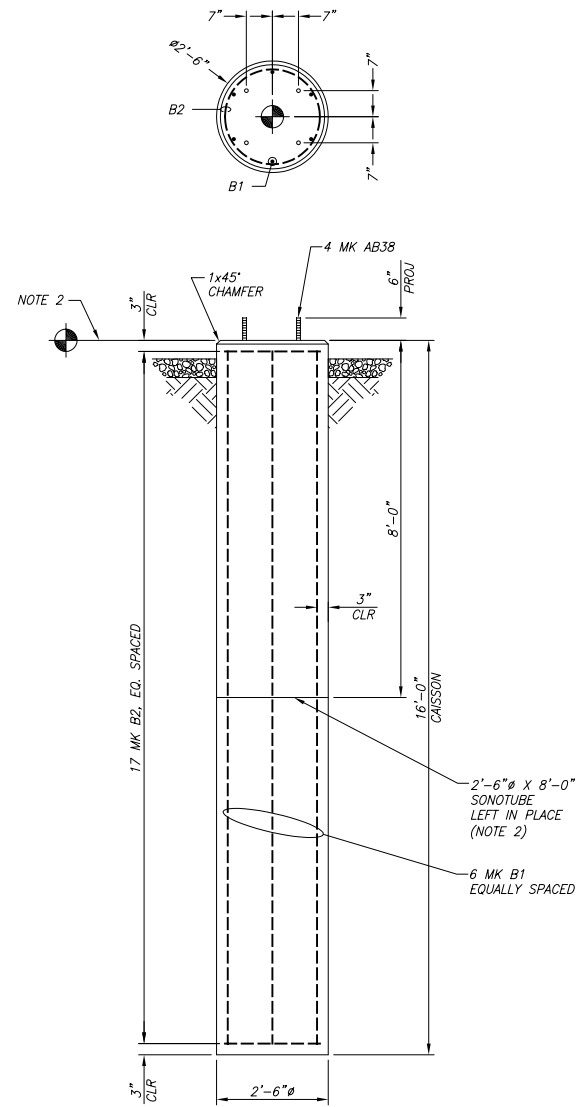
##### A. DEFINITIONS

- 1. Rock Boulders shall be defined as individual rocks encountered during drilling over 12" in diameter. Rock Boulders encountered during drilling less than 12" in diameter shall be considered normal soil excavation.
  - 2. Solid Rock shall be defined as a layer of material encountered during excavation, which cannot be removed with rock drilling augers.
- B. Rock Boulders and Solid Rock shall be removed from caisson shaft and disposed of off of site by Contractor.
  - C. Contractor shall notify Engineer as soon as Rock Boulders or Solid Rock is encountered for direction on continuing drilling and rock unit measuring.

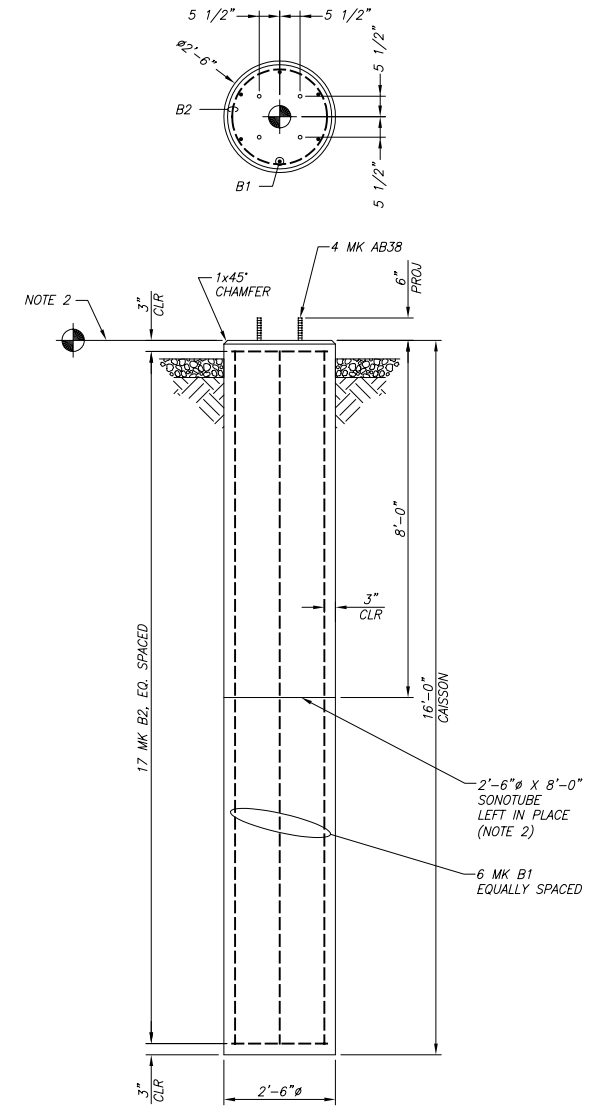
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**2** DETAIL  
 0301 115 KV BREAKER FOUNDATION  
 4.4 C.Y. EA  
 1 REQUIRED



**7** DETAIL  
 0301 EQUIPMENT FOUNDATION  
 2.9 C.Y. EA  
 2 REQUIRED



**8** DETAIL  
 0301 EQUIPMENT FOUNDATION  
 2.9 C.Y. EA  
 1 REQUIRED

**NOTES**

1. FOUNDATION ORIENTATION.
2. REFERENCE DWG. 62530301 FOR TOP OF CONCRETE ELEVATIONS.
3. CONTRACTOR SHALL PROVIDE CUT SHEET ON PROPOSED VOID MATERIAL TO THE ENGINEER FOR APPROVAL.



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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	JDS	GLJ	CDB	07/21/07
0	FOR CONSTRUCTION	AMN	GLJ	CDB	07/23/07

ENG: J. SCOTT  
 DWN: G. JEFFERSON  
 CHK: C. BLINCOV  
 DATE: 07/23/07

CLIENT/PROJECT:	FPL ENERGY LANGDON - WIND SUBSTATION	
TITLE:	FOUNDATION DETAILS	
SCALE:	0 3' 6' 1/2"=1'-0"	DRAWING NUMBER: 62530303
REVISION:	0	

## REINFORCED CONCRETE

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to construct the foundation system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM A82/A82M Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. ASTM A185/A185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
3. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. ASTM C33 Standard Specification for Concrete Aggregates
5. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete
6. ASTM C150 Standard Specification for Portland Cement
7. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
8. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
9. ASTM C-578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

##### B. AMERICAN CONCRETE INSTITUTE (ACI) - Latest Edition

1. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
  2. ACI 318/318R Building Code Requirements for Structural Concrete and Commentary
  3. ACI 305R Hot Weather Concreting
  4. ACI 306R Cold Weather Concreting
  5. ACI 308/308R/308.1 Standard Practice for Curing Concrete
  6. ACI 347/347R Guide to Formwork for Concrete
- C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition
1. Title 29, Part 1910 Occupational Safety and Health Standards
  2. Title 29, Part 1926 Safety and Health Regulations for Construction

### 1.3 SUBMITTALS

- A. The concrete mix design shall be submitted to the ENGINEER for approval no less than 5 days prior to any concrete placement.

The design shall specify the following:

1. 28 day compressive strength.
  2. Dry weight and type of cement
  3. Saturated surface dry weight of aggregates
  4. Water per cubic yard
  5. Air Content
- B. Previous compressive strength data for the proposed mix design.
- C. A Sample Batch Ticket shall be submitted with the proposed mix design. The Batch Ticket must include allowable additional water at the point of discharge.
- D. Data sheets on any proposed admixtures shall be submitted with the proposed mix design.

- E. Data sheets on the proposed Concrete Curing Compound shall be submitted to the ENGINEER for approval.

PART 2 - TERMS AND CONDITIONS (not used)

PART 3 - PRODUCTS

3.1 MATERIAL

A. Ready Mixed Concrete

1. Mix Design

- a. All aggregate shall conform to ASTM C-33. Maximum aggregate size shall be a nominal 1-½ inches.
- b. Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalies, organic materials and other substances that may be deleterious to concrete or reinforcing steel.
- c. Cement type shall be as specified on the drawings. One brand of cement shall be used throughout the project.

2. Admixtures

- a. Air entrainment admixtures shall be added to the concrete mixture in the form of a solution rather than solid and shall meet the requirements of ASTM C-260.
- b. The concrete shall have a total air content in the range of four (4%) to seven (7%) percent by volume. Concrete with an air content outside of this range shall be subject to rejection at the ENGINEERS discretion.
- c. The use of water reducing, retarding, accelerating, and other admixtures shall conform to standard industry practice and are subject to the approval of the ENGINEER.

3. Quality of Concrete

- a. The quality of all ready-mixed concrete along with mixing, delivery and discharge shall be in accordance with ASTM C-94 unless specified otherwise.
- b. The concrete shall attain a minimum 28-day compressive strength (f<sub>c</sub>) of 4000 psi unless otherwise specified on the drawings.
- c. The proportioning of the concrete mixture shall be in accordance with the latest editions of ACI 318 Section 4.2 and ASTM C-94 Section 5.3 Alternative No. 3.
- d. The concrete, at the time of discharge, shall have a slump measured within the limits of the following and in accordance with ASTM C-143. Concrete that exceeds the maximum slump shall be subject to rejection at the ENGINEERS discretion.

Maximum Slump: 5"  
Minimum Slump: 1"

- e. Addition of water to increase the slump at the point of discharge shall be permitted only if the allowable quantity of additional water is shown on the batch ticket. The following conditions must also be met:
  - i. The additional water is injected into the mixer only under such pressure and direction of flow that the requirements of uniformity specified in ASTM C-94 Appendix XI are met.
  - ii. The drum or blades shall be turned an additional 40-50 revolutions or more if necessary, at mixing speed, until the uniformity of the concrete is within the limits specified in ASTM C-94 Appendix XI.
- f. Discharge of the concrete shall be started within 90 minutes and before the drum has turned 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement.
- g. Non-agitating equipment shall not be permitted to transport concrete.
- h. The temperature of the concrete at the time of placement shall not exceed 90° F. Concrete with a temperature greater than 90° F shall be subject to rejection at the ENGINEERS discretion.

## B. Reinforcing Steel

1. All welded wire fabric shall be cold-drawn steel wire, electrically welded and conforming to ASTM A-82 and ASTM A-185. Welded wire fabric shall be furnished in 60-inch widths unless otherwise specified. Welded wire fabric shall be bare steel, unless specified to be galvanized or wire size is less than W 1.2.
2. All carbon steel reinforcing bars shall be deformed, except bars with a diameter less than 3/8 inch, and shall conform to ASTM A-615 (Grade 60).
3. All reinforcing shall conform to the tolerances specified in ACI 315.
4. Reinforcing surfaces must be free from: loose mill scale, loose rust, mud, paint, grease, dirt, oil or any other foreign matter that would reduce or prevent bonding.
5. Reinforcement shall be free from: twists, kinks or unscheduled bends, any of which shall be cause for rejection.
6. All scheduled bends of the reinforcing shall be bent cold without experiencing fracture or reduction of cross-sectional area to the following inside diameters unless otherwise noted on the reinforcing schedule:

Reinforcing Bar Size	Inside Bend Diameter
#3 bars	1-1/2"
#4 bars	2"
#5 through #8 bars	Six bar diameters
#9 through #11 bars	Eight bar diameters

- C. Concrete curing compound shall be a white pigmented liquid membrane-forming compound meeting ASTM C-309.
- D. Rigid Insulation shall be 60 psi Extruded Polystyrene per ASTM C 578-02. (use for cold climates)

#### PART 4 - EXECUTION

##### 4.1 FORMWORK

- A. The CONTRACTOR shall design and furnish suitable and adequate forms conforming to shapes, lines, elevations and dimensions of the concrete shown on the design drawings. ACI 347 shall be used as a guide.
- B. Forms shall be sufficiently strong and tight to prevent leakage of mortar and shall be properly braced and tied to insure position and shape.

- C. Forms shall be suitable for the particular work and shall be of dressed boards, plywood, metal or fiber forms such as Sonotubes. The exposed concrete shall have a smooth surface free from offsets, fins and other similar defects after the removal of the forms.
- D. Completed forms shall be inspected by the ENGINEER prior to concrete placement.
- E. Temporary openings shall be provided at the base of column and wall forms to facilitate cleaning and inspection. Before placing the concrete, all debris shall be removed from inside the forms.
- F. Form material that is to be reused shall have damaged parts repaired and the concrete side thoroughly cleaned.
- G. External corners of concrete above final grade shall be formed to a one-inch chamfer, unless otherwise shown on the drawings.
- H. Form oil shall be a non-staining, liquid chemical bond breaker and shall be applied before placement of reinforcing.
- I. Form removal shall be based on the following:
  - 1. Mass sections of concrete such as footings, equipment piers and pile caps in which form removal results in no stress to the concrete shall be removed no sooner than 24 hours after initial set.
  - 2. Structural sections of concrete such as columns, sides of beams and walls for which the forms do not vertically support the concrete weight shall be removed no sooner than 36 hours after initial set.
  - 3. Structural sections of concrete such as beam soffits, suspended slabs and other parts requiring vertical support of concrete weight shall remain in place until the concrete has attained 70% of its specified 28-day strength.
- J. Form ties shall leave a hole in the exposed surface of the concrete not larger than one inch in diameter and shall be placed such that when the forms and ties are removed, no metal will be within one-half inch of any finished surface.
- K. Form removal shall be performed with care to avoid damage to surfaces, which have not fully hardened.
- L. No concrete section shall be loaded in less than seven (7) days of concrete placement without the prior written authorization of the Engineer.

## 4.2 DEPOSITING CONCRETE

- A. Hot weather concreting shall conform to ACI 305.
- B. Cold weather concreting shall conform to ACI 306.
- C. When required to deposit concrete in freezing weather, all ice shall be removed from excavations, forms and reinforcement. In no case shall concrete be placed on frozen material.
- D. Concrete shall be deposited into the form in a manner that will avoid segregation of the aggregate. Concrete shall not be permitted to drop freely more than four (8) feet. For excavations greater than 8 feet, a trimmie tube shall be used.
- E. Concrete shall be deposited as nearly as practicable to its final position.
- F. Concrete shall be vibrated during placement to eliminate honeycombing and promote compaction. However, excessive use of vibrator equipment shall be discouraged to insure against segregation of aggregate.
- G. Once the concrete depositing operation has begun, it shall continue until the section or panel is completed or it shall continue to a preplanned construction joint.
- H. In placing concrete for walls, girders and beams, the work shall progress from both ends toward the middle for each layer deposited.
- I. Forms, reinforcing and grade shall be thoroughly wetted just prior to placing concrete.

## 4.3 INSTALLATION OF EMBEDDED ITEMS

Embedded items shall include, but not be limited to: reinforcing steel, welded wire fabric, anchor bolts, weld plates, trench and curb angle, expansion joint material, pipe sleeves, water stops and expansion joint shear transfer dowels.

### A. Reinforcing Steel

- 1. The placement of reinforcing steel and welded wire fabric shall be in strict accordance with the requirements of ACI 318 Chapter 7. All reinforcing steel shall have a minimum concrete cover of 3 inches unless otherwise shown on the drawings.
- 2. Reinforcing steel shall be accurately placed and securely tied with 14 gauge steel wire for sizes of number 7 and smaller and 12 gauge steel wire for sizes of number 8 and larger. It shall be adequately supported with concrete or metal chairs and secured against displacement.

3. At the time the reinforcing steel is installed, it shall be free of: loose rust, mud, oil and any non-metallic coatings that would adversely affect bonding.
4. Chairs, ties or other means of securing the reinforcing steel shall be used in such a manner that they will not be exposed on the face of, nor in any way discolor the surface of the finished concrete.
5. Unless otherwise specified on the design drawings, rebar lap splices shall be in accordance with ACI 318 Chapter 7. No lap splice shall be less than thirty (30) bar diameters.
6. Splicing of welded wire fabric shall be in accordance with ACI 318 Chapter 7.
7. In the event it becomes necessary for the Contractor to bend any reinforcing bars in the field, the bars shall be bent in accordance with ACI 318.

**B. Anchor Bolts**

All anchor bolt groups shall be set with a one-piece template in accordance with the design drawings to the following tolerances:

	<b>Plus Tolerance</b>	<b>Minus Tolerance</b>
Bolt Projection	1/4"	0"
Bolt Location	1/8"	1/8"

**C. Other Embedded Items**

1. All other embedded items shall be supported against displacement and installed accurately as shown on the design drawings.
2. Weld plates, trench angle and curb angle shall be securely attached to the forms prior to placement of the concrete.

**4.4 PATCHING AND FINISHING**

**A. Non-Formed Surfaces**

1. All non-formed surfaces shall be screeded to the specified elevation, tamped with a grid tamper until a thin layer of grout forms on the surface, then floated with either a hand or power float to finished grade such that when properly consolidated, the surface shall conform to the line and grade desired.
2. The surface shall receive a broom finish. The corrugations produced shall be uniform in character and width, and not more than 1/16 inch deep.
3. The finished surface shall be free from: porous spots, irregularities, depressions and small pockets or rough spots such as may be caused: by accidental disturbance, during the final brooming or by particles of coarse aggregate embedded near the surface.
4. Control joints shall be located as specified on the drawings.
5. All control and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete.

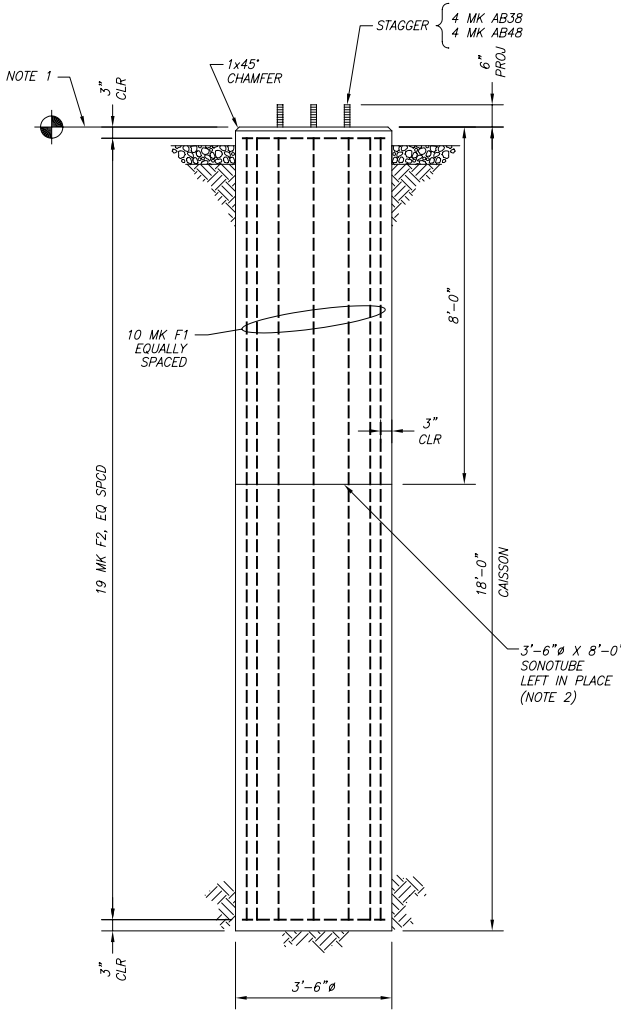
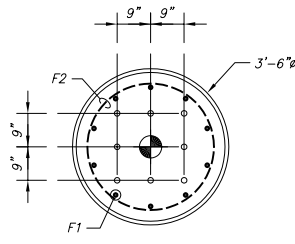
**B. Formed Surfaces**

1. Top surfaces of concrete below finished grade shall be screeded to the elevation specified on the design drawing and given a wood float finish.
2. Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces which are to be exposed. On all surfaces, cavities produced by form ties, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned and after having been kept saturated with water for a period of not less than three hours, shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the concrete being finished. Mortar used in pointing shall not be more than one hour old. The mortar patches shall be cured in the same manner as required for concrete.
3. Finishing
  - a. Horizontal surfaces shall be steel troweled and finished with a light broomed texture.
  - b. Vertical surfaces shall be steel troweled and rubbed with mortar to a smooth and consistent finish.

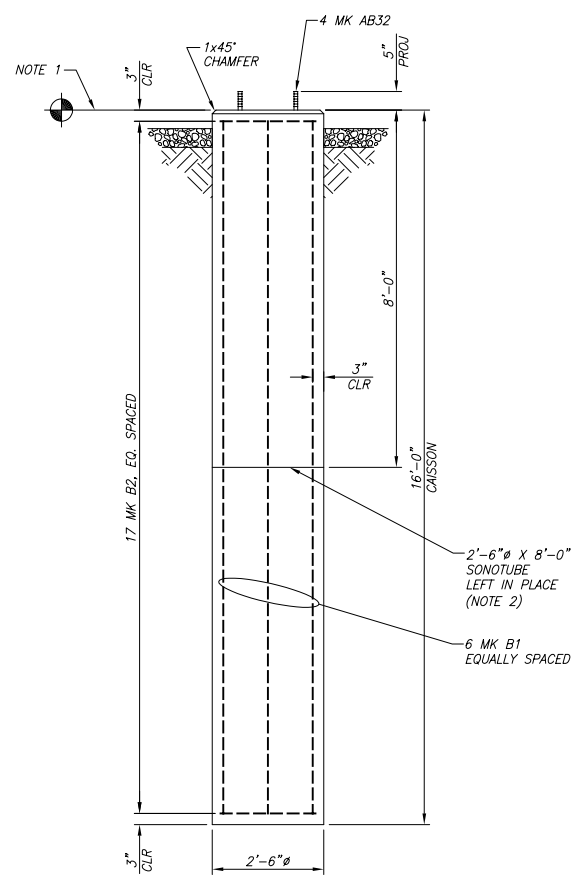
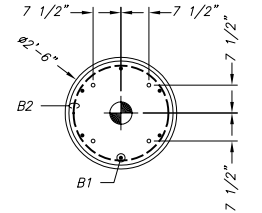
**4.5 CURING**

- A. ACI 308, *Recommended Practice for Curing Concrete*, shall be followed during the curing period.
- B. All concrete shall be protected during the early stages of hardening from injury by construction activity.
- C. Concrete shall be maintained above 50 degrees Fahrenheit (50° F) and in a continually moist condition for the first seven days after placing. It shall be maintained above 40 degrees Fahrenheit (40° F) for the next four days after that point.
- D. During periods of cold weather (air temperature 40 degrees Fahrenheit (40° F) or less), the provisions of ACI 306, *Standard for Cold Weather Concreting*, shall be followed. In any case, proper cover, insulation and heating shall be provided.
- E. Heating of flat concrete work on the ground is not required if air temperature does not drop below 30 degrees Fahrenheit (30° F) and provided the work is properly covered.
- F. During periods of hot weather (air temperature 90 degrees Fahrenheit (90° F) or more in the shade), the provisions of ACI 305, *Standard for Hot Weather Concreting* shall be followed.
- G. Curing compound shall be sprayed on all exposed surfaces of concrete immediately after final finishing of the surface, before all free water on the surface has been evaporated, and within 2-hours of form removal. Curing Compound shall be applied at a rate of 200 square feet per gallon or as recommended by the compound manufacturer.

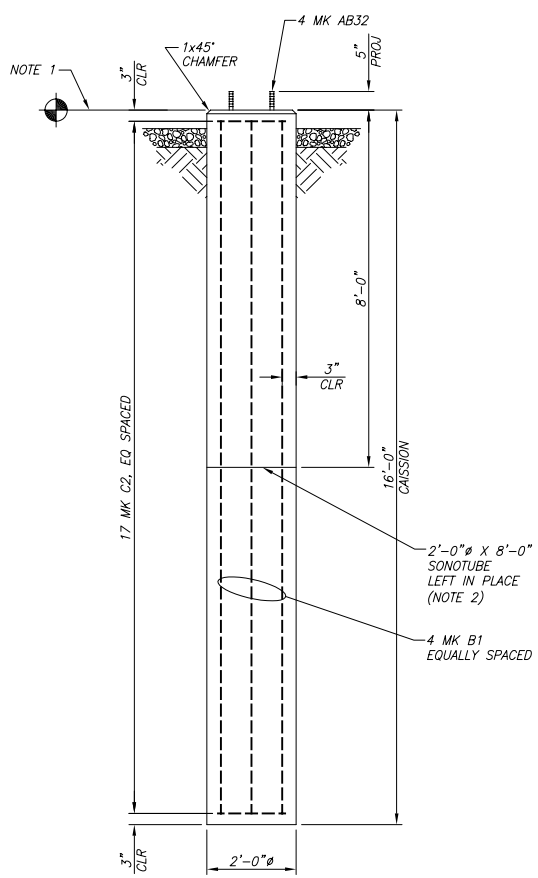
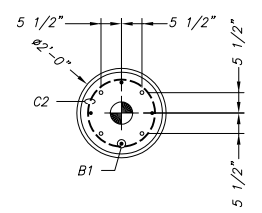
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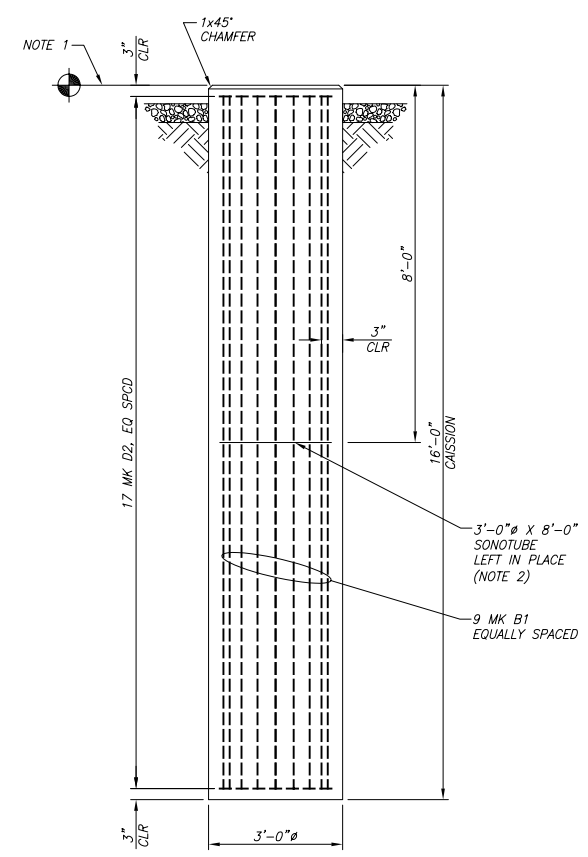
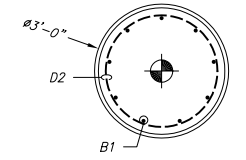
**3 DETAIL**  
 0301 DEADEND FOUNDATION  
 6.2 C.Y. EA.  
 4 REQUIRED



**4 DETAIL**  
 0301 EQUIPMENT FOUNDATION  
 2.9 C.Y. EA.  
 2 REQUIRED



**5 DETAIL**  
 0301 EQUIPMENT FOUNDATION  
 1.9 C.Y. EA.  
 21 REQUIRED



**6 DETAIL**  
 0301 BUILDING FOUNDATION  
 4.2 C.Y. EA.  
 12 REQUIRED

**NOTES**

1. REFERENCE DWG. 62530301 FOR TOP OF CONCRETE ELEVATIONS.
2. AFTER CURING, CONTRACTOR SHALL CUT & REMOVE THAT PORTION OF SONOTUBE EXTENDING ABOVE TOP OF GRADE.

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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	AMN	GLJ	CDB	07/21/07
0	FOR CONSTRUCTION	AMN	BLW	CDB	07/21/07

ENG: A. NORD	CLIENT/PROJECT: FPL ENERGY
DWN: G. JEFFERSON	LANGDON - WIND SUBSTATION
CHK: C. BLINOW	TITLE: FOUNDATION DETAILS
DATE: 07/21/07	SCALE: 1/2"=1'-0"
	DRAWING NUMBER: 62530304
	REVISION: 0

## EARTHWORK AND CONCRETE TESTING

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to inspect and test the earthwork and concrete materials for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL - Latest Edition

1. ASTM C31/C31M Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
3. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
4. ASTM C143/C143M Standard Test Method for Slump of Hydraulic Cement Concrete
5. ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete
6. ASTM C173/C173M Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
7. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))
8. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

##### B. AMERICAN CONCRETE INSTITUTE - Latest Edition

1. ACI 311.5/311.5R Guide for Concrete Plant Inspection and Testing of Ready-Mixed Concrete

C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

1.3 SUBMITTALS

A. The following reports shall be submitted to the Engineer:

1. Reports of all earthwork inspection tests.
2. Reports of all concrete tests including test cylinder number and letter, truck number, time batched, location of sample, strength of concrete, slump, air content, date and time placed.

PART 2 - TERMS AND CONDITIONS (not used)

PART 3 - PRODUCTS

3.1 EQUIPMENT

The laboratory shall be responsible for providing all necessary materials and equipment to perform the testing described herein.

3.2 LABORATORY

The laboratory, including equipment, personnel and procedures shall be a totally independent corporation from the Contractor and the ready mix concrete provider.

PART 4 - EXECUTION

4.1 EARTHWORK TESTING

- A. Imported fill materials utilized for grading or backfilling shall be properly characterized and verified by the Contractor utilizing grain size distribution.
- B. A minimum of one Moisture Density Relation test shall be performed for each type of fill material used.

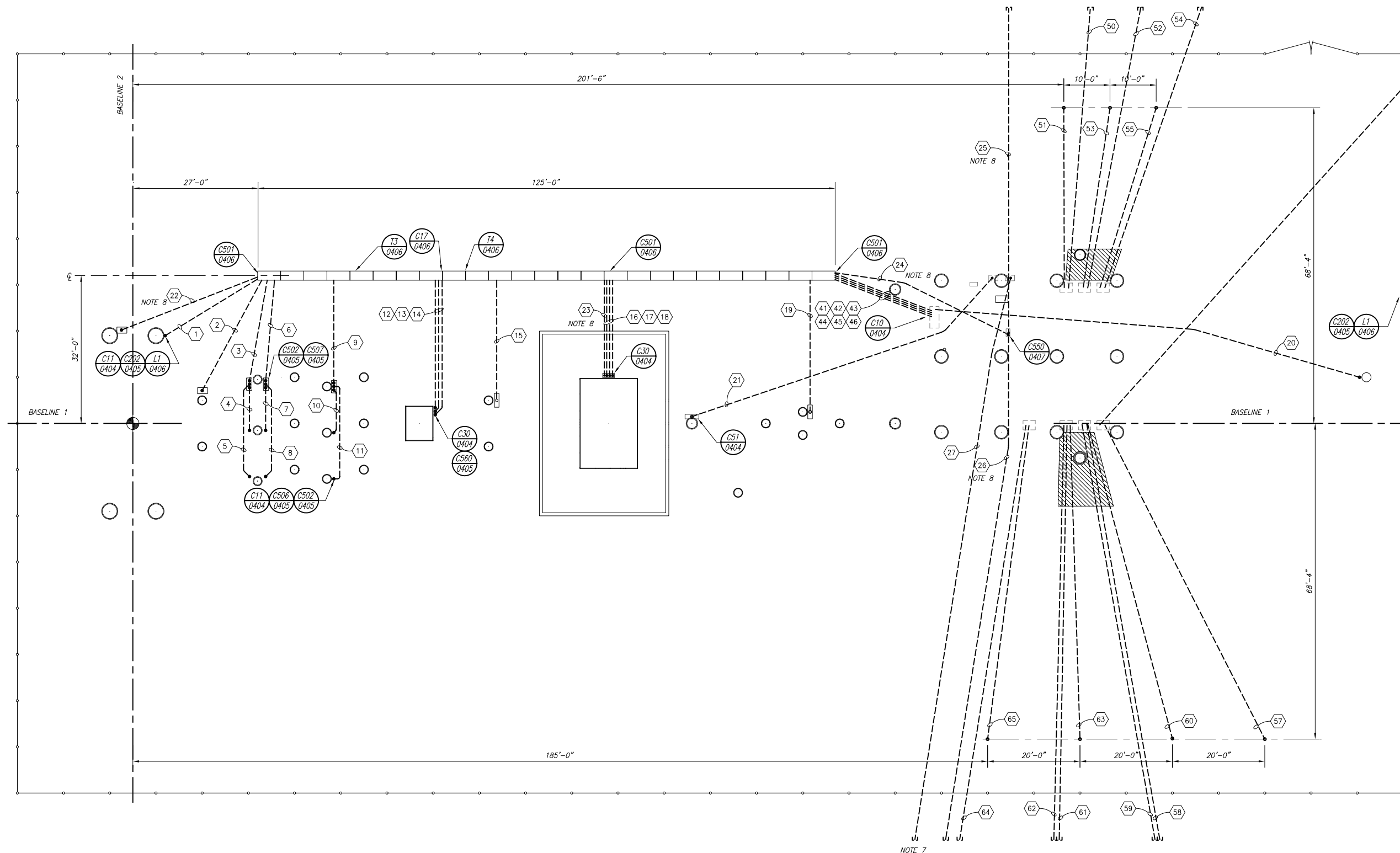
- C. A minimum of one field density test shall be made for each 10,000 square feet of area backfill, and each 100 linear feet of trench backfill. Tests shall be made for each lift of material placed.
- D. Testing firm shall record the approximate location of each field density test performed, type of equipment used, and orientation/location of lift tested.
- E. Testing firm shall report the results of any failed tests or inspection to the Engineer immediately. Subsequent testing on all re-worked areas shall be performed to determine conformance with the specifications and drawings.
- F. A minimum of one field density test shall be performed under each mat type foundation after excavation and after each lift of compacted soil placed under the foundation.
- G. A minimum of one field density test shall be performed at every third crossing or tee of the ground grid and after the trench has been completely filled and compacted.
- H. A minimum of one field density test shall be performed per 200 feet of conduit trench and after the trench has been completely filled and compacted.
- I. Perform additional field density tests as directed by the ENGINEER for non-conformance areas or areas in question.

#### 4.2 CONCRETE TESTING

- A. Testing shall include compressive tests of molded concrete cylinders and tests for slump and air content of concrete delivered to the project site.
- B. All samples shall be taken at the point of placement, either the discharge of the pump line or the truck chute. All samples shall be taken after the addition of any water to increase slump.
- C. Concrete used for slump, air, and temperature testing shall be taken from the truck prior to placing concrete in project. Concrete used for compressive test cylinders shall be taken from the middle third of the truck.
- D. Secure composite samples in accordance with ASTM C-172. Mold and cure four specimens per set from each sample in accordance with ASTM C-39. Test specimens in accordance with ASTM C-39. Two specimens shall be tested at 28 days for acceptance, one shall be tested at 7 days for information, one shall be a spare. The average strength of the two 28 day specimens from the same sample shall be the strength test result for that sample. The 7-day sample shall attain a strength of at least 70% of the 28-day strength required. The ENGINEER shall be notified immediately of any unsatisfactory 7-day or 28-day test results.

- E. Determine slump of the concrete sample for each strength test and whenever consistency of the concrete appears to vary, using ASTM C-143. Slump tests shall be performed after the addition of any water at the project site.
- F. Determine air content of the concrete sample for each strength test in accordance with ASTM C-173 or C-231.
- G. Tests for slump and air content shall be made for the first batch of concrete produced each day and every 20 cubic yards placed.
- H. The rate of sampling for strength testing shall be at least one set per 20 cubic yards nor less than once per day of placement.

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**LEGEND**

- CONDUIT DETAIL
- CONDUIT NUMBER
- BELOW GRADE CONDUIT
- CONDUIT STUBUP
- CONCRETE BACKFILL
- JUNCTION BOX
- FENCE

- NOTES**
1. REFER TO CONDUIT DETAILS FOR EMBEDMENT AND DEPTH REQUIREMENTS.
  2. ONE ADDITIONAL PULL STRING SHALL BE INSTALLED IN EACH CONDUIT.
  3. STUB AND CAP CONDUIT 10'-0" OUTSIDE SUBSTATION FENCE.
  4. REFER TO DRAWING 62530302 FOR LOCATION OF CONDUITS IN TRANSFORMER FOUNDATION.
  5. FEEDER CONDUITS SHALL HAVE A MINIMUM OF 5'-0" BETWEEN CIRCUITS AND 2'-0" BETWEEN CONDUITS OF THE SAME CIRCUIT.
  6. BACKFILL FEEDER EXITS WITH CONCRETE IN HATCHED AREAS. CONCRETE BACKFILL SHALL SURROUND EACH CONDUIT 10" ABOVE, BELOW AND EACH SIDE OF FEEDER CONDUITS THAT ARE LESS THAN 5'-0" APART.
  7. EXTEND TO PAD MOUNT TRANSFORMER FOR BACK-UP STATION SERVICE.
  8. FIBER OPTIC CONDUITS SHALL HAVE A MINIMUM OF 30" BEND RADIUS.

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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	RJS	REC	RJS	07/16/07
B	90% SUBMITTAL	RJS	JDS	RJS	07/16/07
C	REVISED DETAIL CALLOUTS 501, 502	RJS	LAB	RJS	07/19/07
0	FOR CONSTRUCTION	RJS	BLW	JKP	07/23/07
1	ADDED REFERENCE POINT, DIMENSIONS	RJS	LAB	JKP	07/27/07

CLIENT/PROJECT: **FPL ENERGY LANGDON - WIND SUBSTATION**

TITLE: **CONDUIT PLAN**

SCALE:

DATE: 07/23/07

ENGINEER: R. SCHNEIDER  
DWN: R. COLE  
CHK: J. PHIPPS

DRAWING NUMBER: **62530401**

REVISION: **1**

## CONDUIT SYSTEM

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to construct the conduit system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))
2. ASTM D2992 Standard Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)

##### B. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) - Latest Edition

- ANSI C80.1 American National Standard For Electrical Rigid Steel Conduit (ERSC)

##### C. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition

- IEEE C2 National Electrical Safety Code

##### D. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) - Latest Edition

1. NEMA TC-2 Electrical Polyvinyl Chloride (PVC) Conduit
2. NEMA TC-3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

- E. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition  
NFPA 70                      National Electric Code
- F. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition
  - 1. Title 29, Part 1910    Occupational Safety and Health Standards
  - 2. Title 29, Part 1926    Safety and Health Regulations for Construction

1.3 SUBMITTALS (not used)

PART 2 - TERMS AND CONDITIONS (not used)

PART 3 - PRODUCTS

3.1 CONDUIT

- A. All conduit and fittings installed below grade shall be schedule 40 Polyvinyl Chloride (PVC) type unless otherwise specified on the drawings.
- B. All conduit and fittings installed above grade shall be rigid galvanized steel (RGS) or weather tight PVC coated flexible type unless otherwise specified on the drawings.

3.2 CONDUIT BODIES

All conduit bodies shall be cast metal and have cast covers and neoprene gaskets. The bodies shall be adequately sized to enable the installation of the cable without bending it on a radius less than six times the cable diameter.

3.3 CONDUIT FITTINGS

- A. Conduit fittings shall include all conduit accessories including elbows, connectors, bushings, hubs, clamps, caps, plugs, locknuts and materials for sealing and connecting the end of conduits at outdoor equipment, panel boards and cabinets.
- B. Conduit fittings shall be of a material and type, which is manufactured specifically for the type and size of conduit, specified for the project.

3.4 CABLE TRENCH

- A. Cable trenches shall be pre-cast concrete, single piece or modular, installed at the locations and depths as indicated on the drawings. Trench size shall be as shown on drawings.

## PART 4 - EXECUTION

### 4.1 CONDUIT TRENCH

#### A. Excavation of Trench

1. Trenching for installation of the conduits shall be made to the lines and depths shown on the drawings.
2. The method of excavation shall not weaken surrounding areas nor damage structures nor parts thereof that are completed or under construction. Existing structures and utilities adjacent to excavations shall be protected and supported to prevent settlement. Survey benchmarks and monuments shall be protected by barriers or flagged markers.
3. All trenches that have standing water shall be dewatered before any conduit is placed.

#### B. Conduit Trench Backfill

1. After installation of the conduit and its encasement, the trench shall be backfilled with on-site excavated material.
2. Backfill shall be placed in maximum ten-inch (10") lifts and each lift compacted to 90% of maximum density per ASTM D1557.

### 4.2 INSTALLATION BELOW GRADE

#### A. Routing

All below grade conduits shall be routed and installed in strict accordance with the drawings.

#### B. Joints

1. PVC conduit joints shall be cemented with solvent cement per manufacturer's instructions.
2. Rigid metallic conduit joints shall be threaded with a minimum of five (5) full threads engaged. Steel conduit joints shall be made up with suitable thread compound; thread compound shall not interfere with grounding continuity of conduit system.
3. All PVC to rigid steel conduit transitions shall be accomplished using fittings made by the conduit manufacturer, such as a female-to-threaded

fitting, or a product specifically designed for PVC to rigid steel conduit transitions.

4. For sites where conduit depth is less than frost depth, suitable expansion fittings shall be used and installed per manufacturer's instructions.

C. Conduit Encasement

1. Below grade conduits shall be encased in sand unless otherwise specified on the drawings.
2. The minimum separation maintained between outside surfaces of conduits in duct banks shall be:

Spacing	Conduit Size
1-1/2"	2" or less
2"	2" and 3"
3"	over 3"

3. The encasement surrounding the structure of rigid conduits shall have a minimum thickness of 3" on the top, bottom and sides.
4. The top of the encasement shall be placed at a depth as shown on the drawings.

4.3 INSTALLATION ABOVE GRADE

A. Installation

1. Exposed conduit runs shall be straight and plumb.
2. Exposed conduit shall be parallel with each other and with the centerlines of the room or structures in which they are located unless otherwise directed.
3. All exposed conduits shall be supported from the walls, ceiling or structures at intervals of not more than ten (10) feet unless otherwise specified.

B. Outdoor Support

1. Conduits shall be attached to the outdoor structures with straps at a maximum of every ten (10) feet.
2. A sufficient number of straps shall be used to firmly anchor all conduits, boxes and fittings.

3. Straps shall be secured to the structures by drilling the steel and fastening the straps with suitable self-tapping screws or by tapping the drilled holes.
4. EMT conduit straps shall not be used to support RGS conduit.

C. Indoor Support

Conduit and supports shall comply with the latest edition of the National Electrical Code and be in accordance with the drawings and the following:

1. Supports for the conduit are required within three (3) feet of each: outlet box, junction box, cabinet and fitting. For straight runs, supports shall be provided at least every ten (10) feet.
2. Bends – number in one run. There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points: for example, between conduit bodies and boxes.

4.4 CONDUIT PROTECTION AND CLEANING

A. Conduit Ends

All open ends of conduit shall be capped with pipe caps or conduit pennies with bushings during construction to prevent entrance of foreign materials and to protect threads. Paper or rags are not acceptable protection.

B. Cleaning

1. All conduit shall be cleaned before pulling wire as follows:

Conduit size	Clean using
1-1/2" or smaller	compressed air
2" or larger	wire mandrel (minimum mandrel diameter shall be within 1/4" of conduit inside diameter)

2. Pulling ropes used with aluminum and non-metallic conduit shall be of a non-metallic type such as Dacron or polypropylene.

4.5 CONDUIT TERMINATION

- A. All conduit shall be terminated with insulated bushings to prevent damage to wire during pulling operation except in enclosures where hub design is adequate to prevent insulation damage.
- B. Grounding connections shall be provided on all rigid steel conduit bushings.

- C. PVC conduit terminating in concrete boxes shall have an end bell.

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CONDUIT SCHEDULE					
NO.	SIZE	TYPE	FROM	TO	REMARKS
1	2"	PVC	DEAD END	MAIN TRENCH	FLOOD LIGHT / RECEPTACLE
2	2"	PVC	89 L1	MAIN TRENCH	DC POWER / STATUS
3	2"	PVC	115 kV METERING VT's JUNCTION BOX	MAINTRENCH	MINNKOTA METERING PT CIRCUITS
4	1 1/2"	PVC	115 kV METERING VT Bφ	115 kV METERING VT's JUNCTION BOX	MINNKOTA METERING PT CIRCUITS
5	1 1/2"	PVC	115 kV METERING VT Aφ	115 kV METERING VT's JUNCTION BOX	MINNKOTA METERING PT CIRCUITS
6	2"	PVC	115 kV METERING CT's JUNCTION BOX	MAIN TRENCH	MINNKOTA METERING CT CIRCUITS
7	1 1/2"	PVC	115 kV METERING CT Bφ	115 kV CT's JUNCTION BOX	MINNKOTA METERING CT CIRCUITS
8	1 1/2"	PVC	115 kV METERING CT Aφ	115 kV METERING CT's JUNCTION BOX	MINNKOTA METERING CT CIRCUITS
9	2"	PVC	115 kV CCVT's JUNCTION BOX	MAIN TRENCH	RELAYING PT CIRCUITS
10	1 1/2"	PVC	115 kV CCVT Bφ	CCVT's JUNCTION BOX	RELAYING PT CIRCUITS
11	1 1/2"	PVC	115 kV CCVT Aφ	CCVT's JUNCTION BOX	RELAYING PT CIRCUITS
12	3"	PVC	52-U	MAIN TRENCH	PRIMARY DC CIRCUITS
13	3"	PVC	52-U	MAIN TRENCH	CT CIRCUITS
14	3"	PVC	52-U	MAIN TRENCH	SECONDARY DC CIRCUITS
15	2"	PVC	89L2	MAIN TRENCH	SWITCH STATUS
16	3"	PVC	POWER TRANSFORMER	MAIN TRENCH	DC CIRCUITS
17	3"	PVC	POWER TRANSFORMER	MAIN TRENCH	CT CIRCUITS
18	3"	PVC	POWER TRANSFORMER	MAIN TRENCH	AC POWER
19	2"	PVC	89L3	MAIN TRENCH	SWITCH STATUS
20	2"	PVC	STATIC MAST	MAIN TRENCH	FLOOD LIGHT / RECEPTACLE
21	4"	PVC	STATION SERVICE TRANSFORMER	CONTROL EQUIPMENT ENCLOSURE	STATION SERVICE
22	2"	PVC	DEAD END	MAIN TRENCH	FIBER OPTIC CIRCUITS
23	2"	PVC	POWER TRANSFORMER	MAIN TRENCH	FIBER OPTIC CIRCUITS
24	3"	PVC	MAIN TRENCH	CONTROL EQUIPMENT ENCLOSURE	FIBER OPTIC CIRCUITS
25	6"	PVC	CONTROL EQUIPMENT ENCLOSURE	10 FEET OUTSIDE FENCE	FIBER OPTIC CIRCUITS
26	6"	PVC	CONTROL EQUIPMENT ENCLOSURE	10 FEET OUTSIDE FENCE	FIBER OPTIC CIRCUITS
27	4"	PVC	CONTROL EQUIPMENT ENCLOSURE	10 FEET OUTSIDE FENCE	BACK-UP STATION SERVICE

CONDUIT SCHEDULE					
NO.	SIZE	TYPE	FROM	TO	REMARKS
41	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	AC POWER/METERING
42	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	CT CIRCUITS
43	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	PRIMARY DC/CONTROL
44	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	SECONDARY DC/STATUS
45	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	SPARE
46	4"	PVC	MAIN TRENCH	FIELD TERMINATION CABINET	SPARE
50	8"	PVC	UNIT #3	10 FEET OUTSIDE FENCE	FEEDER (F1)
51	6"	PVC	UNIT #3	GT-1	GROUNDING BANK TRANSFORMER
52	8"	PVC	UNIT #4	10 FEET OUTSIDE FENCE	FEEDER (F2)
53	6"	PVC	UNIT #4	GT-2	GROUNDING BANK TRANSFORMER
54	8"	PVC	UNIT #5	10 FEET OUTSIDE FENCE	FEEDER (F3)
55	6"	PVC	UNIT #5	GT-3	GROUNDING BANK TRANSFORMER
56	8"	PVC	UNIT #6	10 FEET OUTSIDE FENCE	FEEDER (F6)
57	6"	PVC	UNIT #6	GT-6	GROUNDING BANK TRANSFORMER
58	6"	PVC	UNIT #7	10 FEET OUTSIDE FENCE	FEEDER (F7A)
59	8"	PVC	UNIT #7	10 FEET OUTSIDE FENCE	FEEDER (F7B)
60	6"	PVC	UNIT #7	GT-7	GROUNDING BANK TRANSFORMER
61	8"	PVC	UNIT #8	10 FEET OUTSIDE FENCE	FEEDER (F8B)
62	6"	PVC	UNIT #8	10 FEET OUTSIDE FENCE	FEEDER (F8A)
63	6"	PVC	UNIT #8	GT-8	GROUNDING BANK TRANSFORMER
64	8"	PVC	UNIT #10	10 FEET OUTSIDE FENCE	FEEDER (F9)
65	6"	PVC	UNIT #10	GT-9	GROUNDING BANK TRANSFORMER

NOTE 1

NOTE 2

**NOTES**

- CONDUITS 22, 23, 24, 25, AND 26 MUST HAVE A MINIMUM BEND RADIUS OF 30" FOR FIBER OPTIC CABLES IN INTERDUCT.
- COLLECTOR SYSTEM FEEDER CABLE AND EQUIPMENT GROUNDING CONDUCTOR PROVIDED AS PART OF THE COLLECTOR SYSTEM. REFER TO P&E ENGINEERING DRAWINGS FOR DETAILS.



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A	FOR REVIEW	RJS	BLW	RJS	07/16/07		FPL ENERGY LANGDON SUBSTATION
B	90% SUBMITTAL	RJS	JDS	RJS	07/16/07	DWN: B. WATSON	TITLE: CONDUIT SCHEDULE
D	FOR CONSTRUCTION	RJS	BLW	JKP	07/23/07	CHK: J. Phipps	SCALE: NONE
						DATE: 07/23/07	DRAWING NUMBER: 62530402
							REVISION: 0

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**CABLE LIST**

NO.	SIZE	ROUTING	VOLTAGE	TYPE	FROM	TO	REMARKS
1-1	3C #10, #10 GND	1-MT-41	600 V	TC	OUTDOOR LIGHTING CONTACTOR	DEAD END LIGHT	FLOOD LIGHT
1-2	2C #10, #10 GND	1-MT-41	600 V	TC	FIELD TERMINATION CABINET	DEAD END RECEPTACLE	YARD RECEPTACLE
2-1	2C #10	2-MT-43	600 V	TC	FIELD TERMINATION CABINET	89L1 SWITCH	DC MOTOR
2-2	3C #12, #12 GND	2-MT-41	600 V	TC	FIELD TERMINATION CABINET	89L1 SWITCH	AC HEATERS
2-3	12C #12	2-MT-43	600 V	TC	FIELD TERMINATION CABINET	89L1	CONTROL
2-4	12C #12	2-MT-44	600 V	TC	FIELD ERMINATION CABINET	89L1	SWITCH STATUS
3-1	4C #12	3-MT-41	600 V	TC	115 kV METERING PT's JUNCTION BOX	FIELD TERMINATION CABINET	MINNKOTA METERING POTENTIALS
4-1	4C #12	4	600 V	TC	115 kV METERING PT, Bφ	115 kV METERING PT's JUNCTION BOX	PT CIRCUIT Bφ
5-1	4C #12	5	600 V	TC	115 kV METERING PT, Aφ	115 kV METERING PT's JUNCTION BOX	PT CIRCUIT Aφ
PT-C	4C #12	NOTE 4	600 V	TC	115 kV METERING PT, Cφ	115 kV METERING PT's JUNCTION BOX	PT CIRCUIT Cφ
6-1	4C #10	6-MT-41	600 V	TC	115 kV METERING CT's JUNCTION BOX	FIELD TERMINATION CABINET	MINNKOTA METERING CURRENTS
7-1	4C #10	7	600 V	TC	115 kV METERING CT, Bφ	115kV METERING CT's JUNCTION BOX	CT CIRCUIT Bφ
8-1	4C #10	8	600 V	TC	115 kV METERING CT, Aφ	115 kV METERING CT's JUNCTION BOX	CT CIRCUIT Aφ
CT-C	4C #10	NOTE 4	600 V	TC	115 kV METERING CT, Cφ	115 kV METERING CT's JUNCTION BOX	CT CIRCUIT Cφ
9-1	4C #12	9-MT-42	600 V	TC	CCVT's JUNCTION BOX	FIELD TERMINATION CABINET	CCVT's X WINDING (115 V)
9-2	4C #12	9-MT-42	600 V	TC	CCVT's JUNCTION BOX	FIELD TERMINATION CABINET	CCVT's X WINDING (67 V)
9-3	4C #12	9-MT-42	600 V	TC	CCVT's JUNCTION BOX	FIELD TERMINATION CABINET	CCVT's Y WINDING (115 V)
9-4	4C #12	9-MT-42	600 V	TC	CCVT's JUNCTION BOX	FIELD TERMINATION CABINET	CCVT's Y WINDING (67 V)
10-1	6-1C #12	10	600 V	SIS	CCVT, PHASE B	CCVT's JUNCTION BOX	B PHASE CCVT CIRCUITS
11-1	6-1C #12	11	600 V	SIS	CCVT, PHASE A	CCVT's JUNCTION BOX	A PHASE CCVT CIRCUITS
CCVT-C	6- 1C #12	NOTE 4	600 V	SIS	CCVT, PHASE C	CCVT's JUNCTION BOX	C PHASE CCVT CIRCUITS
12-1	2C #10	12-MT-43	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	DC PRIMARY POWER
12-2	12C #12	12-MT-43	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	PRIMARY CONTROL
12-3	12C #12	12-MT-43	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	ALARMS
12-4	12C #12	12-MT-44	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	BREAKER STATUS
13-1	4C #10	13-MT-42	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	CT CIRCUITS 1,3,5-X
13-2	4C #10	13-MT-42	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	CT CIRCUITS 1,3,5-Y
13-3	4C #10	13-MT-42	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	CT CIRCUITS 2,4,6-Y
13-4	4C #10	13-MT-42	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	CT CIRCUITS 2,4,6-X
13-5	3C #8, #10 GND	13-MT-41	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	AC POWER
14-1	2C #10	14-MT-44	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	DC SECONDARY POWER
14-2	12C #12	14-MT-44	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	SECONDARY CONTROL
14-3	2C #8	14-MT-43	600 V	TC	CIRCUIT BREAKER 52 U	FIELD TERMINATION CABINET	DC MOTOR POWER
15-1	4C #12	15-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L2 SWITCH	SWITCH STATUS
15-2	4C #12	15-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L2 SWITCH	SWITCH STATUS
15-3	4C #12	15-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L2 SWITCH	SWITCH STATUS
15-4	4C #12	15-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L2 SWITCH	SWITCH STATUS

NOTE 5

NOTE 5

**CABLE LIST**

NO.	SIZE	ROUTING	VOLTAGE	TYPE	FROM	TO	REMARKS
16-1	12C #12	16-MT-43	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	TRANSFORMER ALARMS
16-2	2C #10	16-MT-43	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	DC POWER
16-3	12C #12	16-MT-44	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	SPARE
17-1	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, H X
17-2	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, H Y
17-3	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, H O
17-4	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, X O
17-5	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, X Y
17-6	4C #10	17-MT-42	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	CT CIRCUITS, X X
18-1	3C #4, #6 GND	18-MT-41	600 V	TC	POWER TRANSFORMER	FIELD TERMINATION CABINET	AC POWER
19-1	4C #12	19-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L3 SWITCH	SWITCH STATUS
19-2	4C #12	19-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L3 SWITCH	SWITCH STATUS
19-3	4C #12	19-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L3 SWITCH	SWITCH STATUS
19-4	4C #12	19-MT-44	600 V	TC	FIELD TERMINATION CABINET	89L3 SWITCH	SWITCH STATUS
20-1	3C #10, #10 GND	20-MT-41	600 V	TC	OUTDOOR LIGHTING CONTACTOR	STATIC MAST LIGHT	FLOOD LIGHT
20-2	2C #10, #10 GND	20-MT-41	600 V	TC	FIELD TERMINATION CABINET	STATIC MAST RECEPTACLE	YARD RECEPTACLE
21-1	3-1C 600 kcmil	21	600 V	THHN	STATION SERVICE TRANSFORMER	TRANSFER SWITCH	STATION SERVICES
22-1	NOTE 6	22-MT-24	NA	SM FIBER	DEAD END	CONTROL ENCLOSURE	FIBER OPTIC TO UTILITY
23-1	NOTE 6	23-MT-24	NA	MM FIBER	POWER TRANSFORMER	CONTROL ENCLOSURE	FIBER OPTIC TO TRANSFORMER
25-1	NOTE 6	25	NA	SM FIBER	CONTROL ENCLOSURE	10 FT. OUTSIDE FENCE	FIBER OPTIC TO TURBINES
26-1	NOTE 6	26	NA	SM FIBER	CONTROL ENCLOSURE	10 FT. OUTSIDE FENCE	FIBER OPTIC TO TURBINES
27-1	3-1C 600 kcmil	27	600 V	THHN	BACK-UP STATION SERVICE	TRANSFER SWITCH	BACK-UP STATION SERVICE
50-1	3-1C 1000 KCMIL	50	35 kV	MV-105 AL	UNIT #3	FEEDER 1	FEEDER (F1)
51-1	3-1C 4/0 AWG	51	35 kV	MV-105 AL	UNIT #3	GT-1	GROUNDING BANK TRANSFORMER
52-1	3-1C 1000 KCMIL	52	35 kV	MV-105 AL	UNIT #4	FEEDER 2	FEEDER ((F2)
53-1	3-1C 4/0 AWG	53	35 kV	MV-105 AL	UNIT #4	GT-2	GROUNDING BANK TRANSFORMER
54-1	3-1C 1000 KCMIL	54	35 kV	MV-105 AL	UNIT #5	FEEDER 3	FEEDER (F3)
55-1	3-1C 4/0 AWG	55	35 kV	MV-105 AL	UNIT #5	GT-3	GROUNDING BANK TRANSFORMER
56-1	3-1C 1000 KCMIL	56	35 kV	MV-105 AL	UNIT #6	FEEDER 6	FEEDER (F6)
57-1	3-1C 4/0 AWG	57	35 kV	MV-105 AL	UNIT #6	GT-6	GROUNDING BANK TRANSFORMER
58-1	3-1C 4/0 AWG	58	35 kV	MV-105 AL	UNIT #7	FEEDER 7A	FEEDER (F7A)
59-1	3-1C 1000 KCMIL	59	35 kV	MV-105 AL	UNIT #7	FEEDER 7B	FEEDER (F7B)
60-1	3-1C 4/0 AWG	60	35 kV	MV-105 AL	UNIT #7	GT-7	GROUNDING BANK TRANSFORMER
61-1	3-1C 1000 KCMIL	61	35 kV	MV-105 AL	UNIT #8	FEEDER 8B	FEEDER (F8B)
62-1	3-1C 4/0 AWG	62	35 kV	MV-105 AL	UNIT #8	FEEDER 8A	FEEDER (F8A)
63-1	3-1C 4/0 AWG	63	35 kV	MV-105 AL	UNIT #8	GT-8	GROUNDING BANK TRANSFORMER
64-1	3-1C 1000 KCMIL	64	35 kV	MV-105 AL	UNIT #10	FEEDER 9	FEEDER (F9)
65-1	3-1C 4/0 AWG	65	35 kV	MV-105 AL	UNIT #10	GT-9	GROUNDING BANK TRANSFORMER

NOTE 5

**NOTES**

- ROUTING COLUMN NUMBERS DESIGNATE CONDUIT NUMBER AND MT DESIGNATES MAIN TRENCH.
- CABLE SHALL BE TYPE TC 75°C RATED INSULATION SUITABLE FOR USE IN DRY AND WET LOCATIONS AND COLOR CODE CORRESPONDING TO ICEA METHOD K2, EXCEPT WHERE NOTED.
- COLLECTOR SYSTEM FEEDER CABLE AND EQUIPMENT GROUNDING CONDUCTOR PROVIDED AS PART OF THE COLLECTOR SYSTEM. REFER TO P&E ENGINEERING DRAWINGS FOR DETAILS.
- THESE CABLES ARE ROUTED IN ABOVE GROUND CONDUITS.
- CABLE DOES NOT TERMINATE IN FTC. PROVIDE SUFFICIENT LENGTH TO ROUTE TO METERING CABINET.
- FIBER OPTIC CABLES AS SPECIFIED BY FPL ENERGY.

REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: R. SCHNEIDER	CLIENT/PROJECT:	FPL ENERGY LANGDON SUBSTATION
A	FOR REVIEW	RJS	BLW	RJS	07/16/07	DWN: B. WATSON	TITLE:	CABLE SCHEDULE
B	90% SUBMITTAL	RJS	JDS	RJS	07/16/07	CHK: J. PHIPPS	SCALE:	NONE
C	REVISED CABLE 18-1 SIZE, UNIT 10	RJS	BLW	RJS	07/19/07	DATE: 07/23/07	DRAWING NUMBER:	62530403
D	FOR CONSTRUCTION	RJS	BLW	JKP	07/23/07	REVISION:	0	

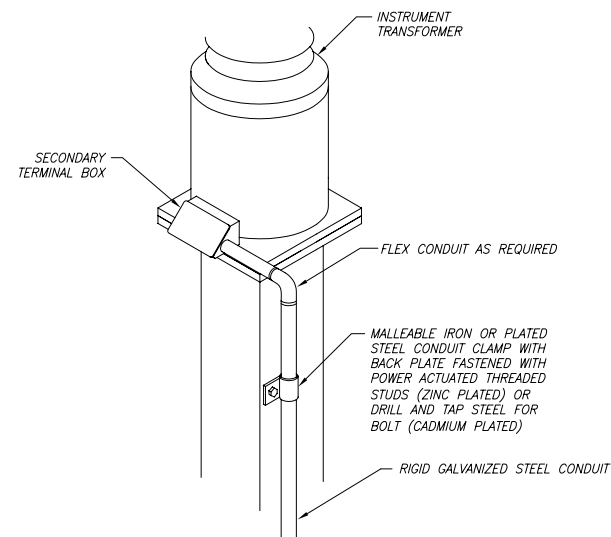


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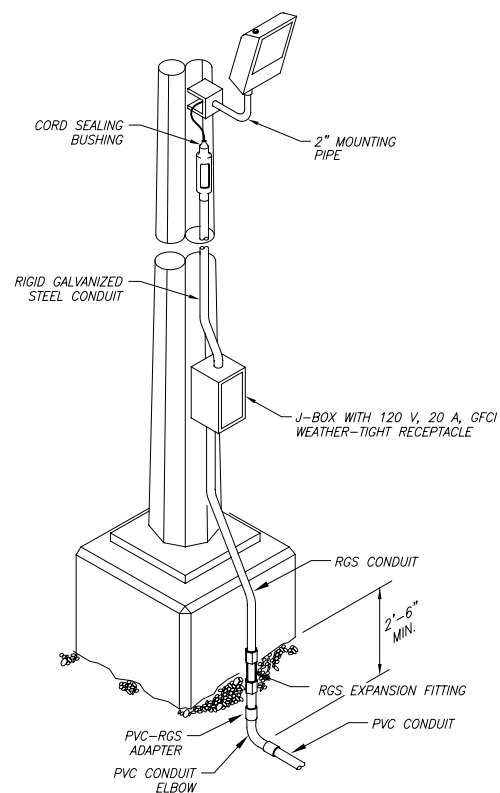




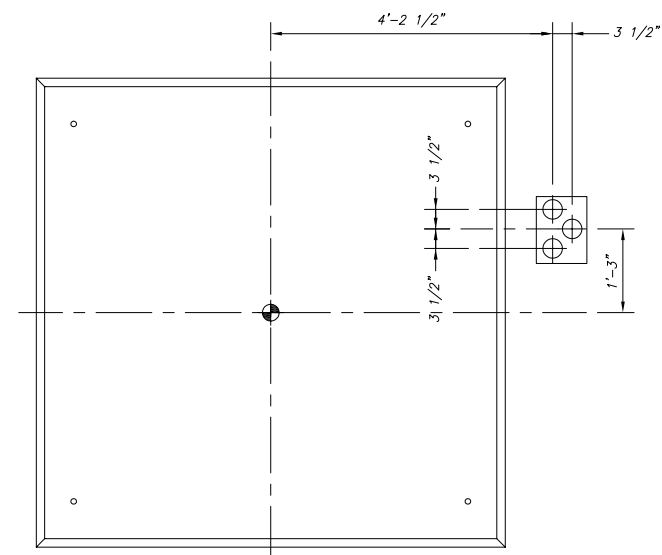
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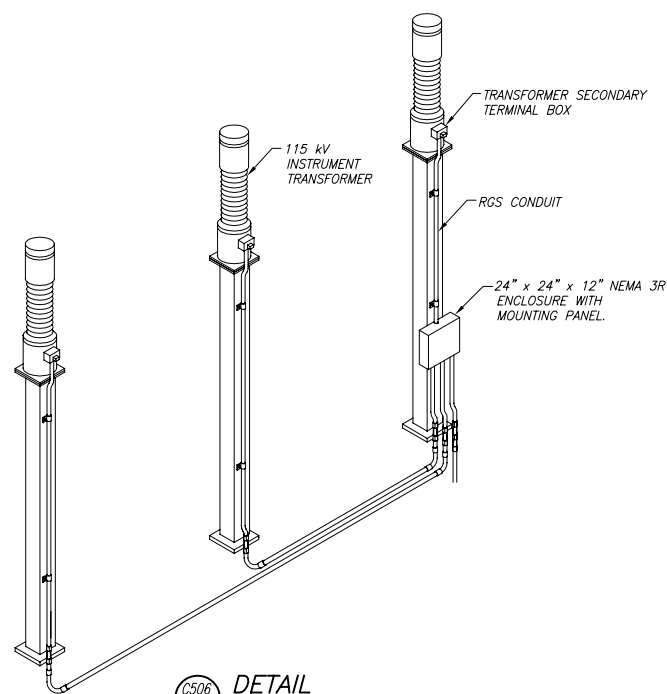
**C502**  
TYP  
**DETAIL**  
COLUMN MOUNTED INSTRUMENT TRANSFORMER CONDUIT



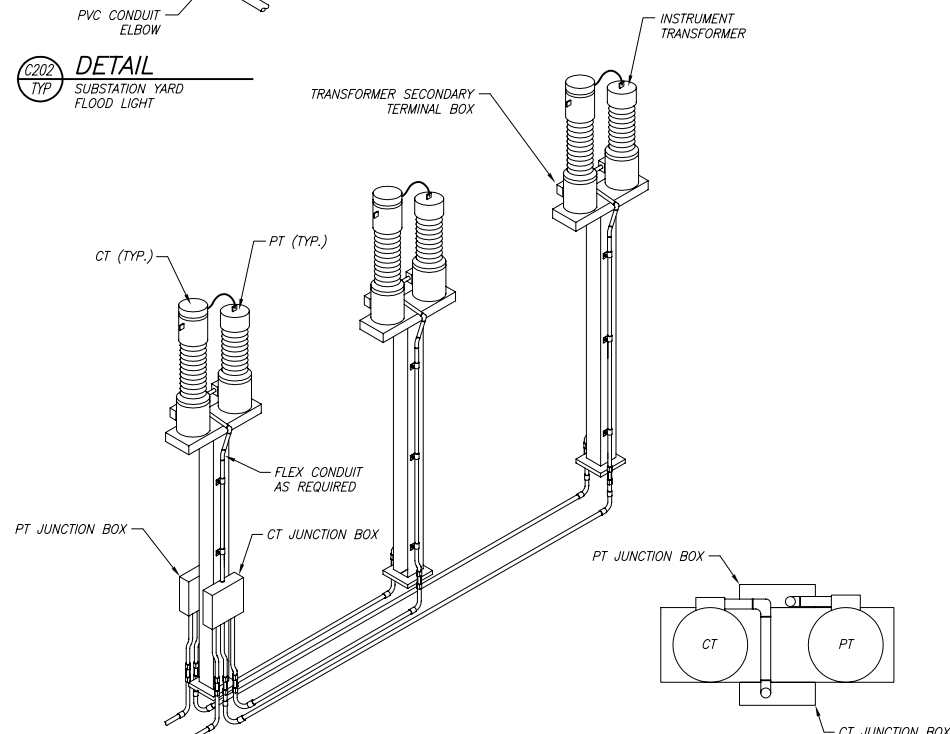
**C202**  
TYP  
**DETAIL**  
SUBSTATION YARD FLOOD LIGHT



**560**  
**640**  
**DETAIL**  
BREAKER CONDUIT INTERFACE  
SCALE: 1/8"=1"



**C506**  
TYP  
**DETAIL**  
CONDUIT ARRANGEMENT FOR 115 kV INSTRUMENT TRANSFORMERS



**C507**  
TYP  
**DETAIL**  
115 kV PT'S & CT'S

**TOP VIEW**



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REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: R. SCHNEIDER	CLIENT/PROJECT:
A	FOR REVIEW	RJS	BLW	RJS	07/16/07		FPL ENERGY LANGDON SUBSTATION
B	90% SUBMITTAL	RJS	JDS	RJS	07/16/07	DWN: B. WATSON	TITLE:
C	REVISED DETAIL REQUIREMENTS	RJS	BLW	RJS	07/19/07	CHK: J. PHIPPS	CONDUIT DETAILS
0	FOR CONSTRUCTION	RJS	BLW	JKP	07/23/07	DATE: 07/23/07	SCALE:
1	ADDED EXPANSION FITTINGS AND DETAIL 560	RJS	LAB	JKP	07/26/07		NONE
							DRAWING NUMBER: 62530405
							REVISION: 1



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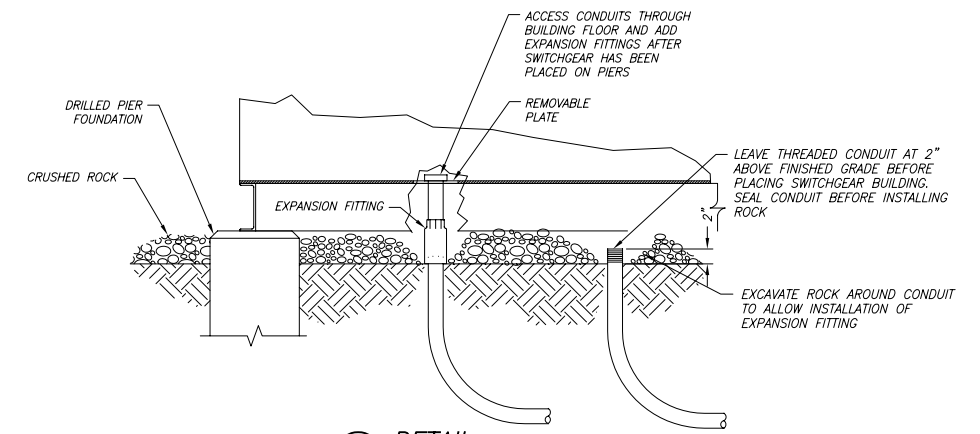
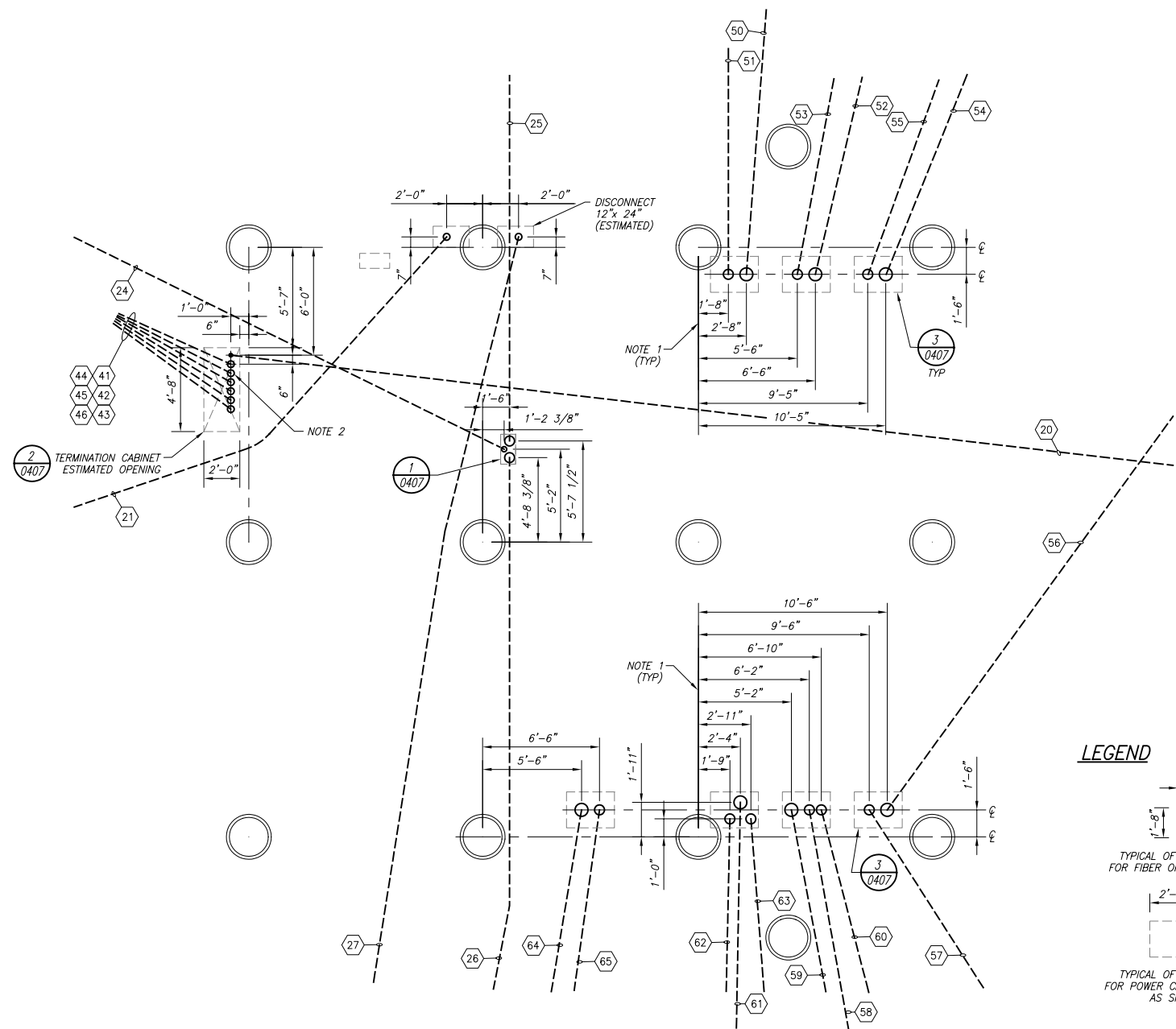


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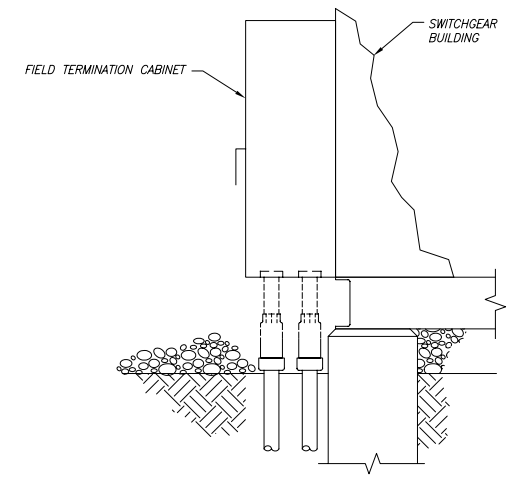


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0	ISSUED FOR CONSTRUCTION	RJS	LAB	JKP	07/26/07

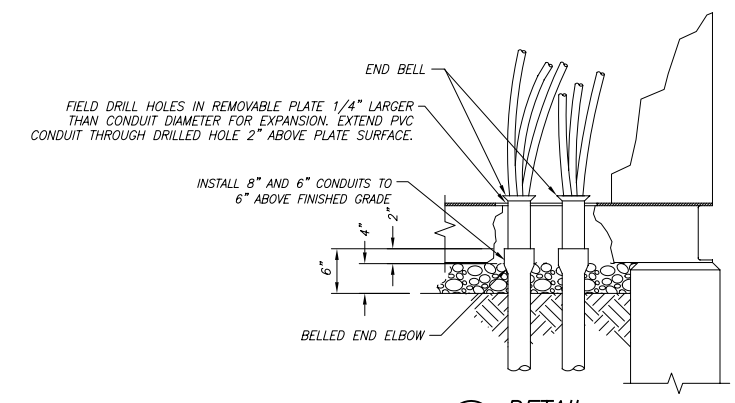
ENG: R. SCHNEIDER	CLIENT/PROJECT:	FPL ENERGY LANGDON SUBSTATION
DWN: L. BRENTON	TITLE:	SWITCHGEAR AND CONDUIT INTERFACE
CHK: J. PHIPPS	SCALE:	NONE
DATE: 07/26/07	DRAWING NUMBER:	62530407
	REVISION:	0



1 DETAIL  
0407 TYPICAL FLOOR ENTRANCE WITH EXPANSION FITTING  
SCALE: NONE

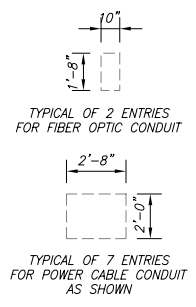


2 DETAIL  
0407 TYPICAL FIELD TERMINATION CABINET INTERFACE  
SCALE: NONE



3 DETAIL  
0407 TYPICAL FEEDER CABLE CONDUIT INTERFACE  
SCALE: NONE

LEGEND



NOTES

1. ALL DIMENSION LINES ARE DRAWN FROM THE CENTER OF THE FOUNDATION(S) TO THE CENTER OF THE CONDUIT(S).
2. SPACE CONDUITS AS REQUIRED TO ALLOW ADEQUATE SPACE FOR EXPANSION FITTINGS.
3. VERIFY ALL FOUNDATION LOCATIONS PER FOUNDATION PLAN PRIOR TO PLACING CONDUIT.

0401 DETAIL  
0401 SWITCHGEAR CONDUIT INTERFACE  
SCALE 1/4"=1'-0"



## GROUNDING SYSTEM

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to construct the grounding system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
2. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>(2,700 kN-m/m<sup>3</sup>))
3. ASTM D2992 Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

##### B. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition

IEEE C2 National Electrical Safety Code

##### C. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) - Latest Edition

ANSI/UL 467 Grounding and Bonding Equipment

##### D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition

NFPA 70 National Electric Code

##### E. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards

2. Title 29, Part 1926 Safety and Health Regulations for Construction

1.3 SUBMITTALS (not used)

PART 2 - TERMS AND CONDITIONS (not used)

PART 3 - PRODUCTS (not used)

PART 4 - GROUNDING CONDUCTOR

- A. The grounding conductor shall be bare copper cable, concentric stranded, soft drawn.
- B. Size of the grounding conductor shall be as specified on the drawings.

4.2 GROUNDING HARDWARE AND CONNECTIONS

- A. All compression and mechanical connectors shall have a current carrying capacity equal to that of the conductor with which they are used.
- B. All fasteners used with grounding connectors shall be silicon bronze.
- C. All grounding fittings shall be copper or bronze.
- D. Connections which are underground shall be heavy-duty type exothermic welded.
- E. Connections that are above ground shall be heavy-duty compression type.

4.3 GROUND RODS

- A. All ground rods shall be ten feet long with a copper jacketed steel core.
- B. Diameter of the ground rods shall be as shown on the drawings.

PART 5 - EXECUTION

5.1 GROUNDING CONDUCTOR TRENCH

- A. Excavation of Trench
  - 1. Trenching for installation of the grounding conductor shall be made to the lines and depths shown on the drawings.
  - 2. Trench crossings shall be cleaned out to allow the grounding conductor to be installed to the depth specified on the drawings.

3. The method of excavation shall not weaken surrounding areas nor damage structures nor parts thereof that are completed or under construction. Existing structures and utilities adjacent to excavations shall be protected and supported to prevent settlement. Survey benchmarks and monuments shall be protected by barriers or flagged markers.
4. All trenches that have standing water shall be dewatered before any grounding conductor is placed.

**B. Backfilling of Trench**

1. After installation of the grounding conductor and connections, the trench shall be backfilled with on-site excavated material.
2. Backfill shall be placed in maximum ten-inch (10") lifts and each lift compacted to 90% of maximum density per ASTM D1557.

**5.2 INSTALLATION OF GROUNDING SYSTEM**

**A. Ground Grid**

1. The ground grid conductor shall be installed as shown on the drawings.
2. The grounding conductor shall extend outside the substation fence and the gate swing radius as shown on the drawings.
3. All grounding conductors shall be straight and free of kinks, breaks and other damage after installation.
4. Conductors shall be thoroughly cleaned prior to making connections.

**B. Connections**

1. All electrical equipment, steel structures, foundations, conduits and exposed metal surfaces shall be connected to the grounding grid with the proper size copper conductor as shown on the drawings.
2. Connections shall be installed per manufacturer recommendations.
3. Paint, scale and other non-conducting materials shall be removed from the contact surfaces before making ground connections; after the connections are made, any paint or galvanized metal finishes that have been damaged or removed shall be restored.

**C. Fence Grounding**

1. The fence shall be grounded as shown on the drawings.

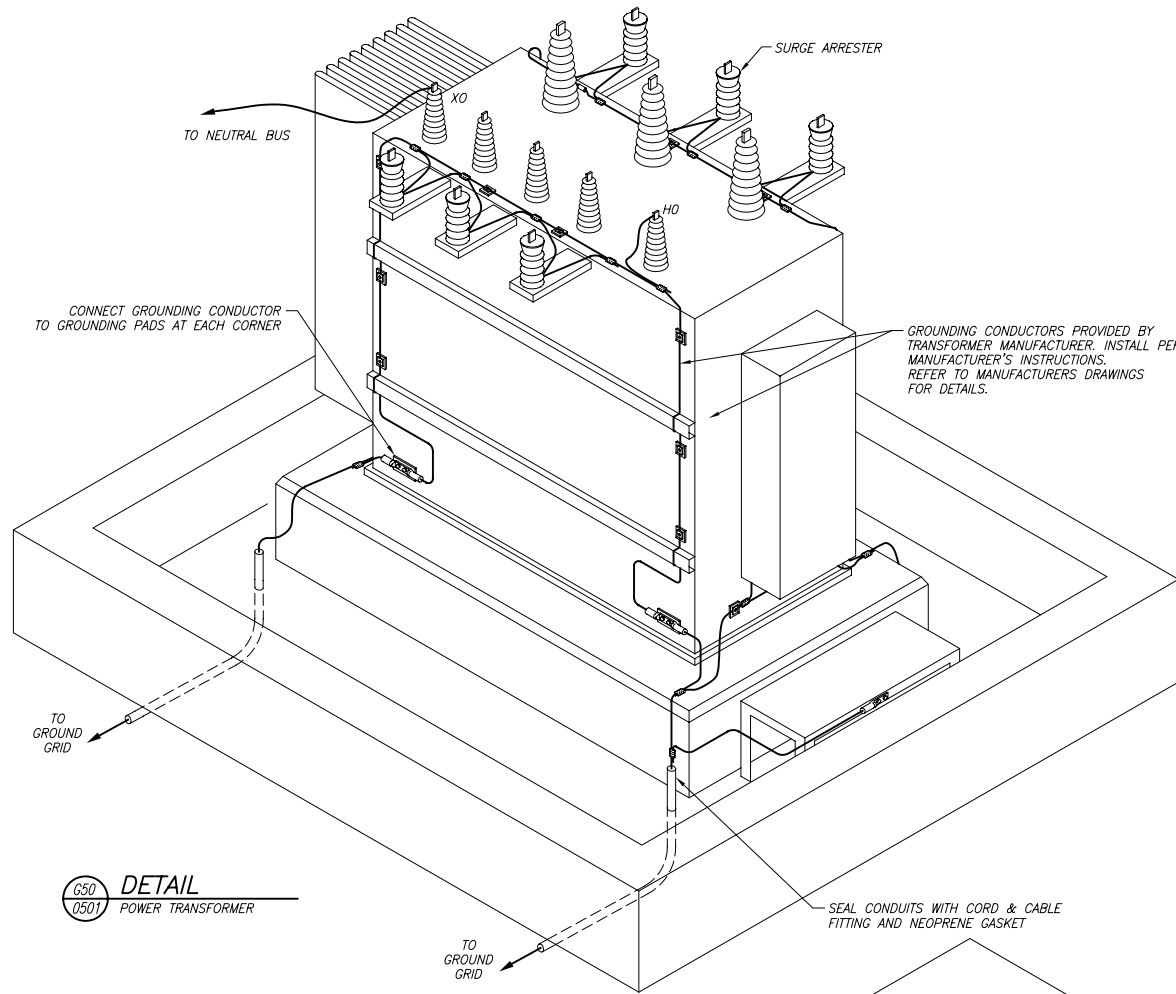
D. Conduit and Cable Trench Grounding

1. All metallic conduits entering cable trays, trenches or equipment enclosures shall be grounded at each end.
2. All grounding conductors in conduits shall be grounded at each end.
3. Ground conduits as shown on the drawings.
4. The entire length of the cable trench shall contain a ground conductor as shown on the drawings.

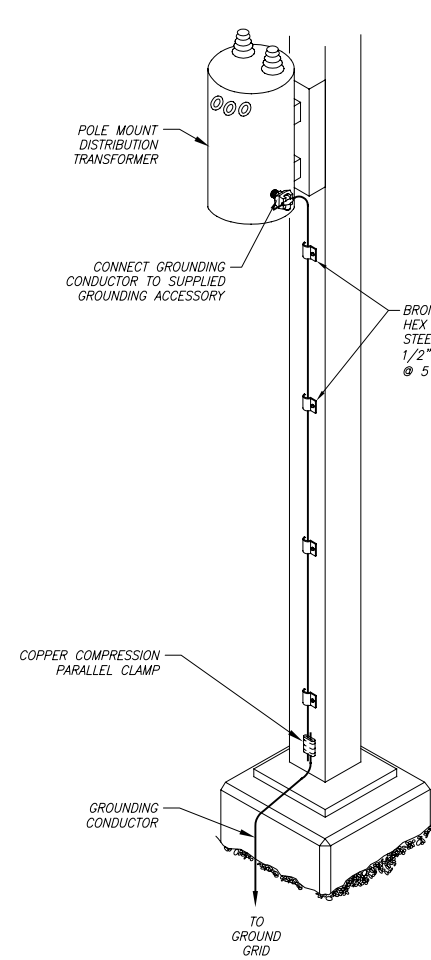
E. Ground Rods

1. The ground rods shall be placed and attached to the ground grid at the locations shown on the drawings.
2. Ground rods shall be driven or drilled vertically into the soil until the top of the rod is level with or below the elevation of the ground conductors.

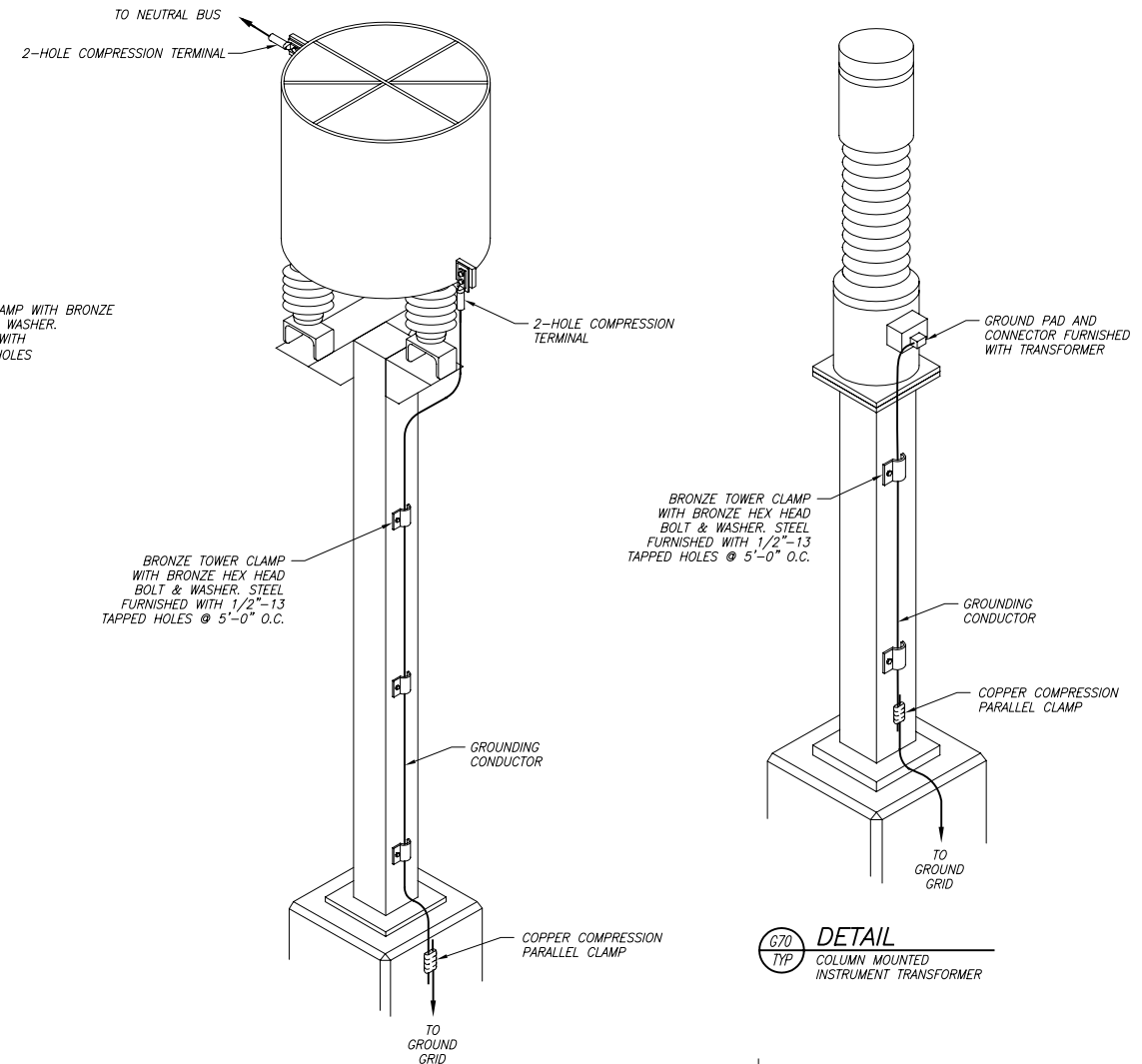




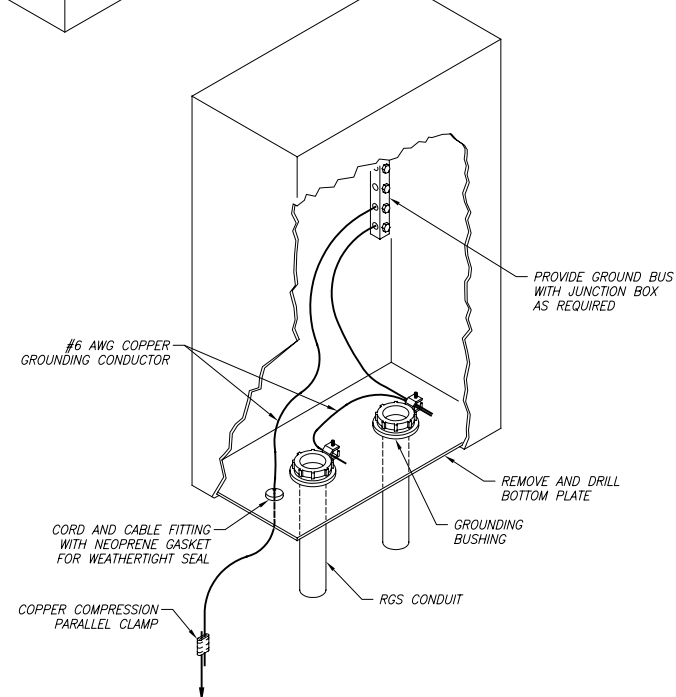
**G50**  
**0501** DETAIL  
POWER TRANSFORMER



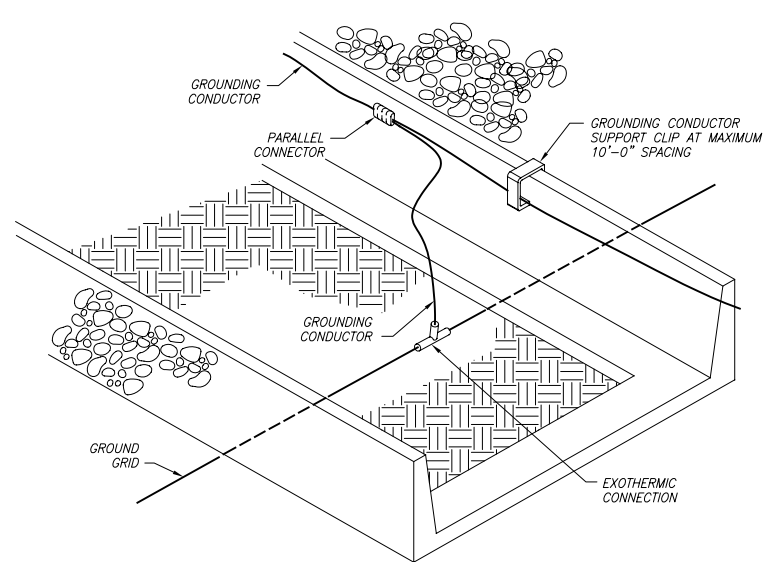
**G55**  
**TYP** DETAIL  
STATION SERVICE TRANSFORMER



**G70**  
**TYP** DETAIL  
COLUMN MOUNTED INSTRUMENT TRANSFORMER

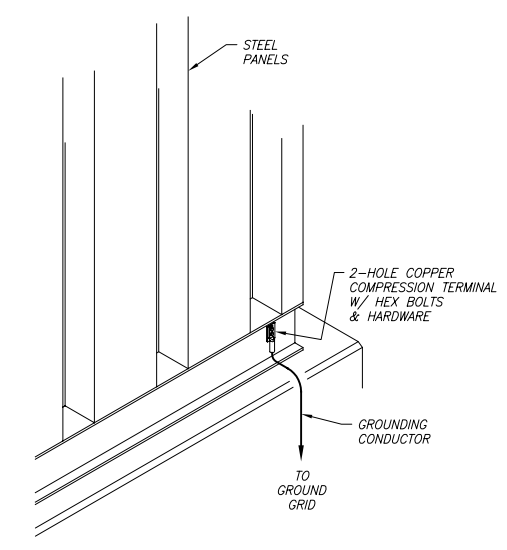


**G80**  
**TYP** DETAIL  
OUTDOOR CONTROL COMPARTMENT OR JUNCTION BOX



**G100**  
**TYP** DETAIL  
SUBSTATION TRENCH

**G550**  
**0501** DETAIL  
NEUTRAL REACTOR



**G204**  
**TYP** DETAIL  
POWER CONTROL HOUSE

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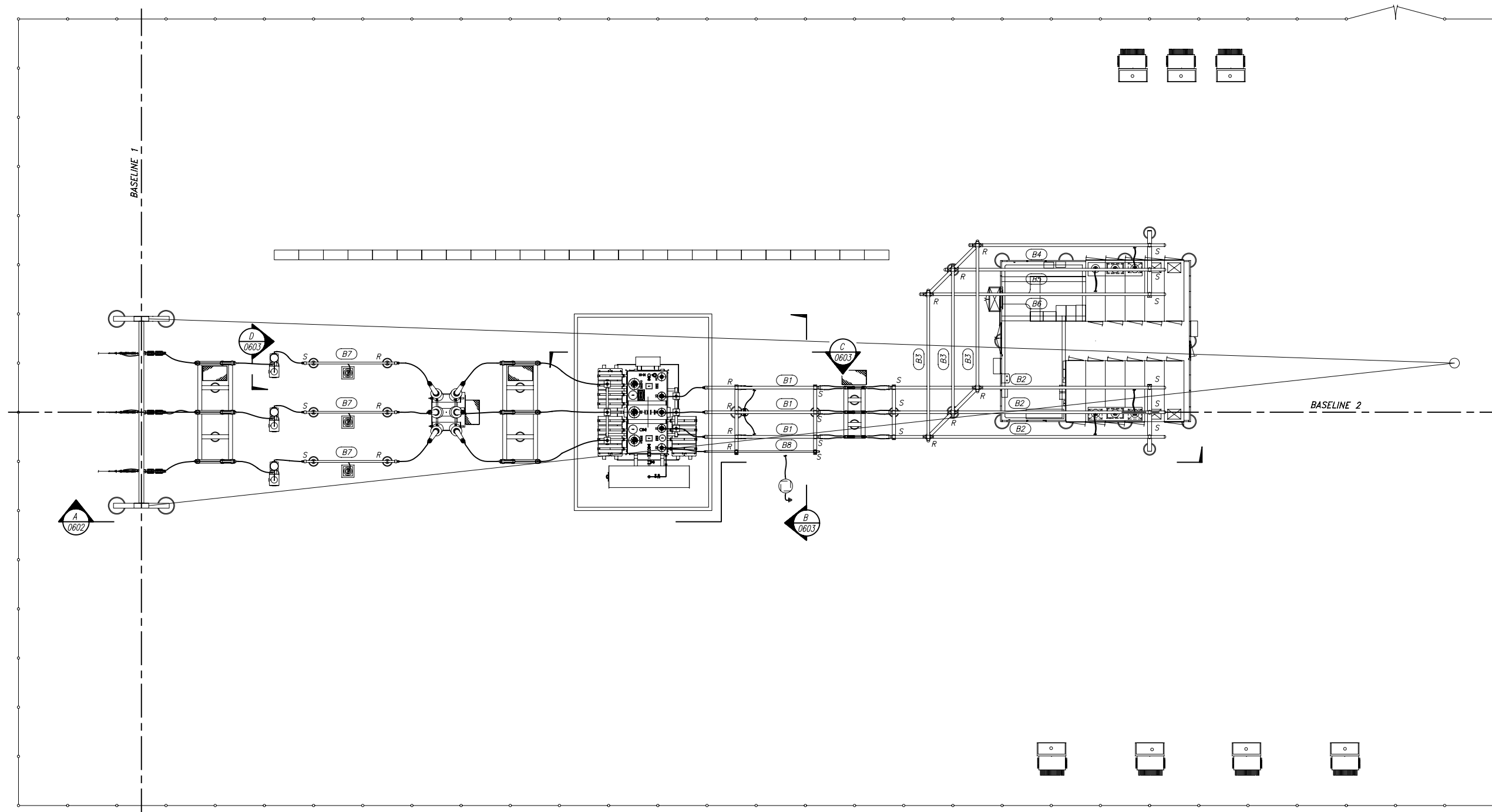
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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	RJS	BLW	RJS	07/16/07
B	90% SUBMITTAL	RJS	JDS	RJS	07/16/07
C	REMOVED GROUND FROM XO, DETAIL G50	RJS	BLW	RJS	07/19/07
D	FOR CONSTRUCTION	RJS	BLW	JKP	07/23/07

ENG: R. SCHNEIDER	CLIENT/PROJECT:	FPL ENERGY LANGDON- WIND SUBSTATION
DWN: B. WATSON	TITLE:	GROUNDING DETAILS
CHK: J. PHIPPS	SCALE:	NONE
DATE: 07/23/07	DRAWING NUMBER:	62530503
	REVISION:	0



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**NOTES**

1. ALL HORIZONTAL BUS RUNS SHALL HAVE A 1/8" WEEP HOLE AT MID SPAN.
2. ALL HORIZONTAL BUS SPANS GREATER THAN 10' SHALL CONTAIN A 477 kcmil ACSR 30/7 STRAND "HEN" DAMPENING CONDUCTOR.
3. AREA BENEATH SWITCHGEAR BUILDING SHALL BE COVERED WITH 4" OF CRUSHED ROCK PER DRAWING 62530202.
4. REFERENCE DRAWING 62530602 FOR RIGID BUS SCHEDULE NUMBER (B9).

**LEGEND**

- R WELD BUS SUPPORT FITTING FOR RIGID CONNECTION.
- S LEAVE BUS SUPPORT FITTING FOR SLIP-FIT CONNECTION.
- (BXX) RIGID BUS SCHEDULE ITEM NUMBER

6" ALUMINUM BUS SCHEDULE						
ITEM NO.	QTY	LENGTH*	TOTAL	DESCRIPTION	# OF 40' LENGTHS	# OF 30' LENGTHS
(B1)	3	25'-0"	75'-0"	CUT FROM ONE 30'-0" LENGTH		3
(B2)	3	57'-0"	171'-0"	CUT FROM ONE 40'-0" LENGTH & ONE 20'-0" LENGTH	3	3
(B3)	3	30'-0"	90'-0"	CUT FROM ONE 30'-0" LENGTH		3
(B4)	1	40'-0"	40'-0"	CUT FROM ONE 40'-0" LENGTH	1	
(B5)	1	45'-0"	45'-0"	CUT FROM ONE 40'-0" LENGTH & REMAINDER OF B1	1	
(B6)	1	50'-0"	50'-0"	CUT FROM ONE 30'-0" LENGTH & ONE 20'-0" LENGTH		1
<b>TOTAL</b>			<b>471'-0"</b>		<b>5 (200)</b>	<b>7 (210)</b>

4" ALUMINUM BUS SCHEDULE						
ITEM NO.	QTY	LENGTH	TOTAL	DESCRIPTION	# OF 40' LENGTHS	# OF 30' LENGTHS
(B7)	3	19'-0"	57'-0"	CUT FROM ONE 20'-0" LENGTH		3
<b>TOTAL</b>			<b>57'-0"</b>			<b>3 (60')</b>

3" ALUMINUM BUS SCHEDULE						
ITEM NO.	QTY	LENGTH	TOTAL	DESCRIPTION	# OF 40' LENGTHS	# OF 30' LENGTHS
(B8)	1	25'-0"	25'-0"	CUT FROM ONE 30'-0" LENGTH		1
(B9)	12	3'-9"	45'-0"	CUT TWELVE FROM ONE 30'-0" LENGTH AND ONE 20'-0" LENGTH		1
<b>TOTAL</b>			<b>71'-0"</b>		<b>2 (60')</b>	<b>1 (20')</b>

REV	DESCRIPTION	ENG	DWN	CHK	DATE	CLIENT/PROJECT:
A	FOR REVIEW	JDS	REC	JDS	07/03/07	FPL ENERGY
B	GENERAL REVISIONS	JDS	LAB	JDS	07/10/07	LANGDON - WIND SUBSTATION
C	90% SUBMITTAL	JDS	JDS	JDS	07/16/07	TITLE:
D	FOR CONSTRUCTION	JDS	BLW	CDB	07/27/07	EQUIPMENT PLAN
						SCALE: 0 8' 16' 24' 32' 3/32"=1'-0"
						DRAWING NUMBER: 62530601
						REVISION: 0



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## STRUCTURAL STEEL ERECTION

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to construct the structural steel supporting system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

- A. AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC) - Latest Edition
  - 1. Code of Standard Practice for Steel Building and Bridges
  - 2. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings
  - 3. Manual of Steel Construction
- B. RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS
  - 1. Specification for Structural Joints Using ASTM A 325 or A 490 Bolts
- C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition
  - 1. Title 29, Part 1910 Occupational Safety and Health Standards
  - 2. Title 29, Part 1926 Safety and Health Regulations for Construction

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS

#### 3.1 MATERIALS

Refer to drawings for all Owner and Contractor furnished materials.

### PART 4 - EXECUTION

4.1 GENERAL

- A. The erection shall be as specified on the erection drawings.
- B. All steel framework shall be carried up true and plumb in accordance with the AISC Code of Standard Practice.
- C. The Contractor shall furnish and install all temporary bracing required during the erection period in accordance with the AISC Code of Standard Practice.
- D. As erection progresses, the work shall be secured to support all dead, wind and erection loads.

4.2 FIELD WELDING

No field welding shall be allowed.

4.3 BOLTED CONNECTIONS

- A. Tightening of high strength bolts shall be performed by the turn-of-nut method shown below or with properly calibrated wrenches in accordance with the AISC Specifications for Structural Joints using ASTM A307, A325 or A490 bolts.
- B. Nut rotation from snug tight condition:

<b>DISPOSITION OF OUTER FACES OF NUT AND BOLT HEAD</b>		
Bolt length up to and including 4 diameters:	Bolt length over 4 diameters But not exceeding 8 diameters:	Bolt length over 8 diameters But not exceeding 12 diameters:
1/2 turn	2/3 turn	3/4 turn
Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned.		
Bolt length is measured from underside of head to extreme end of point.		

- C. Assembled parts shall be brought into close contact and drift pins shall be used only for bringing members into position not to enlarge or distort holes.
- D. Holes that need to be enlarged only slightly to admit the bolt shall be reamed.

4.4 LEVELING

Leveling of the structures shall be as completed by adjusting the structure anchor bolt leveling nuts as shown on the drawings.

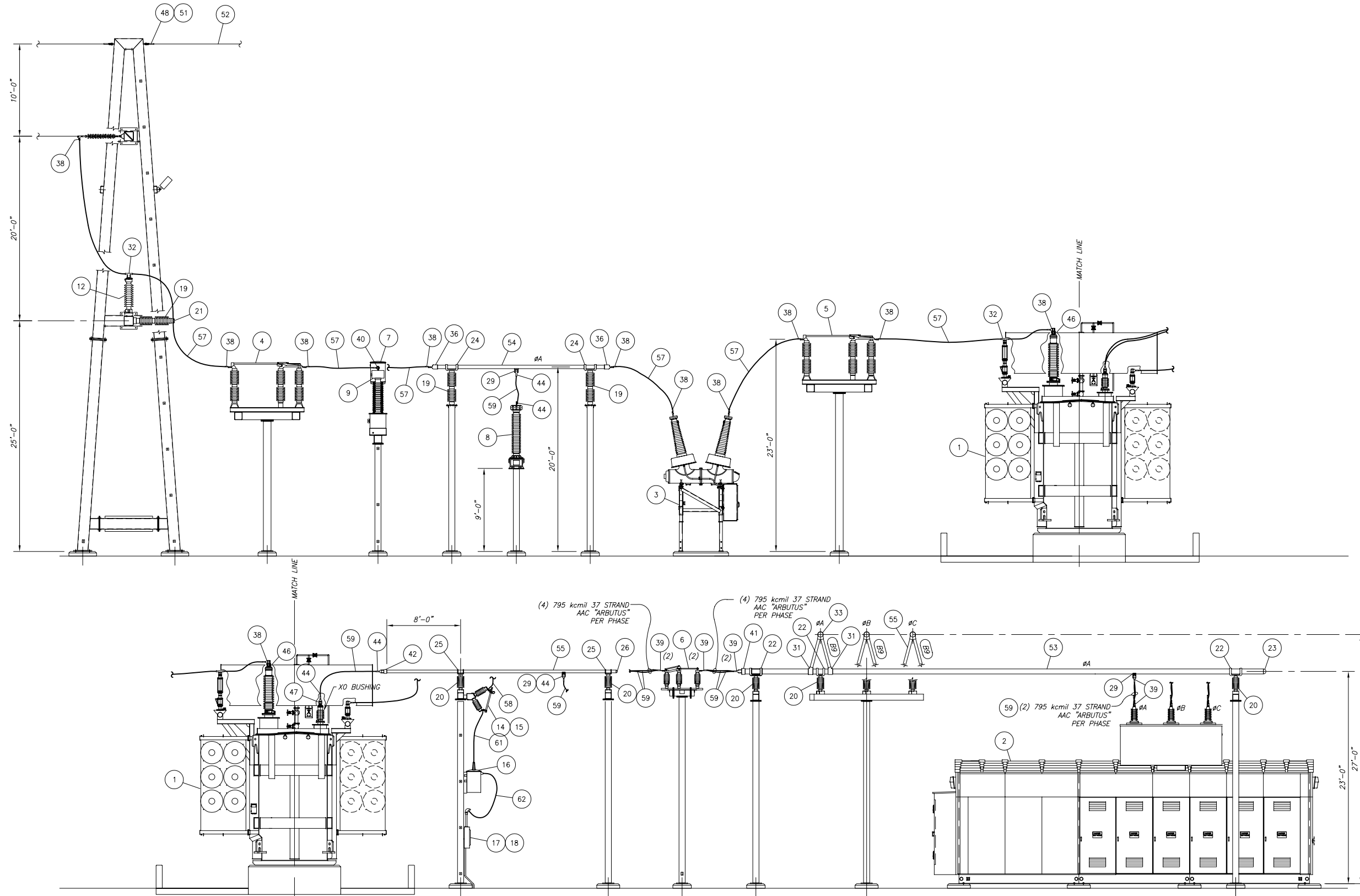
#### 4.5 ERRORS IN FABRICATION

If the contractor encounters errors in fabrication which prevent proper assembly of the parts, one of the following corrective actions shall be taken:

- A. The Contractor shall inform the Engineer who will contact the fabricator to arrange for corrections if such corrections will not adversely affect the project schedule.
- B. The Contractor shall make necessary corrections after consulting with the Engineer and the fabricator to insure that the most efficient method of correction is used.

#### 4.6 SURFACE REPAIR

- A. Damaged areas of the galvanized finish due to handling in shipment and unloading shall be repaired by the Contractor.
- B. Steel work shall be cleaned, heated and otherwise prepared and the repair coating applied in strict accordance with the manufacturer's recommendations.
- C. Repair coating shall be applied over all exposed areas to the required thickness and carefully blended in with existing, adjacent galvanizing.
- D. Thickness of coating shall be equal to that of adjoining galvanizing.



**A** SECTION  
0601 SCALE: 3/16"=1'-0"

1 BILL OF MATERIAL ITEM NUMBER. REFERENCE DRAWING 62530606.

BXX RIGID BUS SCHEDULE ITEM NUMBER

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(303) 462-1100 phone  
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REV	DESCRIPTION	ENG	DWN	CHK	DATE
A	FOR REVIEW	JDS	REC	JDS	07/03/07
B	GENERAL REVISIONS	JDS	LAB	JDS	07/10/07
C	90% SUBMITTAL	JDS	JDS	JDS	07/16/07
D	FOR CONSTRUCTION	JDS	BLW	CDB	07/27/07

ENG: J. SCOTT  
DWN: R. COLE  
CHK: C. BLINCOW  
DATE: 07/27/07

CLIENT/PROJECT:	FPL ENERGY LANGDON - WIND SUBSTATION	
TITLE:	EQUIPMENT SECTIONS	
SCALE:	0 4' 8' 12' 16' 3/16"=1'-0"	DRAWING NUMBER: 62530602
		REVISION: 0

## SUBSTATION EQUIPMENT INSTALLATION

### PART 1 - GENERAL DESCRIPTION

#### 1.01 SUMMARY

This specification covers the supplying of all labor and equipment necessary to install substation equipment for the project.

#### 1.02 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition

1. IEEE C2 National Electrical Safety Code
2. IEEE C37.35 Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Air Disconnecting and Load Interrupter Switches.
3. IEEE C57.93 Guide for Installation of Liquid-Immersed Power Transformers

##### B. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition

1. NFPA 70 National Electrical Code

##### C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS (not used)

### PART 4 - EXECUTION

#### 4.01 PREPARATION

- A. Verify equipment foundations are ready for equipment mounting and anchoring.
- B. Verify that equipment-mounting structures are ready for equipment mounting.
- C. Verify building is ready for mounting of wall or floor mounted equipment.

#### 4.2 INSTALLATION, ERECTION

##### A. Power Transformer

- 1. The power transformer shall be installed by manufacturer.

##### B. Circuit Switcher

- 1. Provide off-loading equipment for the circuit switcher and accessories.
- 2. Un-crate circuit switcher and accessories.
- 3. Install circuit switcher mounting pedestal, switch and interrupter per manufacturers instructions.

##### C. Reclosers

- 1. Provide off-loading equipment for the reclosers and accessories.
- 2. Un-crate reclosers and accessories.
- 3. Assemble recloser substation mounting stands. Install recloser in stand per manufacturers instructions.

##### D. High Voltage Air Break Switches

- 1. Provide off-loading equipment for high voltage switches.
- 2. Un-crate switch poles, insulators, switch operating linkages and operators.
- 3. Assemble switch poles, insulators, operators and linkages.
- 4. Adjust switches per manufacturers instructions.

##### E. Structural Steel

- 1. Provide off-loading equipment for structural steel members.
- 2. Assemble structural steel members per the specifications and drawings.

##### F. Static Masts

1. Provide off-loading equipment for all static masts.
2. Erect and assemble static masts per the specifications and drawings.

G. Building Electrical Equipment

1. Provide off-loading equipment for the building electrical equipment including batteries, battery rack, RTU, relay panel, metering panel, AC and DC panel, heat pump, charger and transfer switch.
2. Un-crate, assemble and install equipment per manufacturers instructions, specifications and the drawings.

H. Control Building

The control building shell will be installed by Others on the Contractor furnished foundation. The building shell will include the exhaust fan, intake louvers and the doors.

I. Instrument Transformers

1. Provide off-loading equipment for the instrument transformers.
2. Un-crate, assemble and install the instrument transformers per the specifications and drawings.

J. Surge Arresters

1. Provide off-loading equipment for the surge arresters.
2. Un-crate, assemble and install the surge arresters per the specifications and drawings.

4.3 CLEANING

A. Acceptance of the Project

The project will not be accepted until the equipment and system installed have been cleaned and are ready for energization.

B. Cleaning

1. Foundation System

Remove all debris, mud, and dirt from the top of all foundations.

2. Conduit and Trench System

- a. Remove all debris, mud, and dirt from all conduits, trench, equipment control boxes, junction boxes and device boxes.
- b. Vacuum all control boxes, junction boxes and device boxes.

3. Grounding System

Remove all debris, mud, dirt from all grounding conductors and fittings.

4. Structural Steel

Remove all debris, mud, and dirt from all surfaces of the structural steel members.

5. Bus System

- a. Remove all scratches, mud, dirt, oils and marks from the rigid bus system using emery cloth.
- b. Remove all mud, dirt and oils from the cable buses.
- c. Remove all excess penetrox compound from bus connectors.
- d. Clean all insulators and bushings on all equipment.

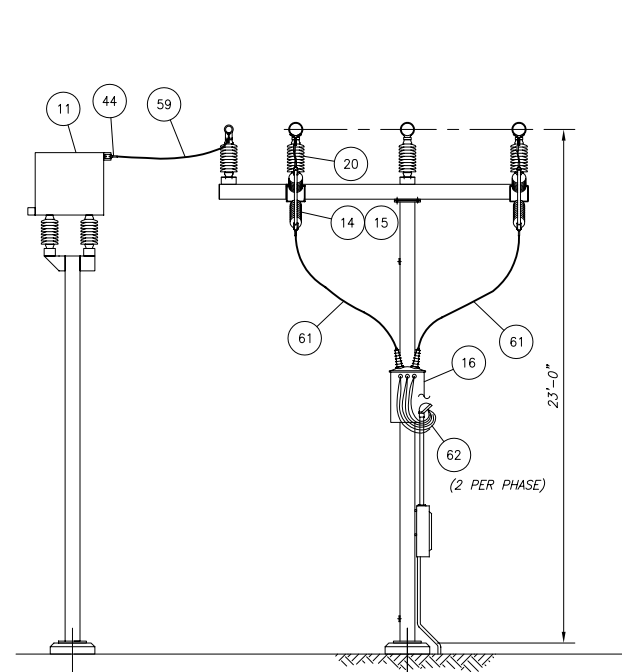
6. Crushed Rock Surfacing

Remove all debris, mud and any oil stained rock from the project site.

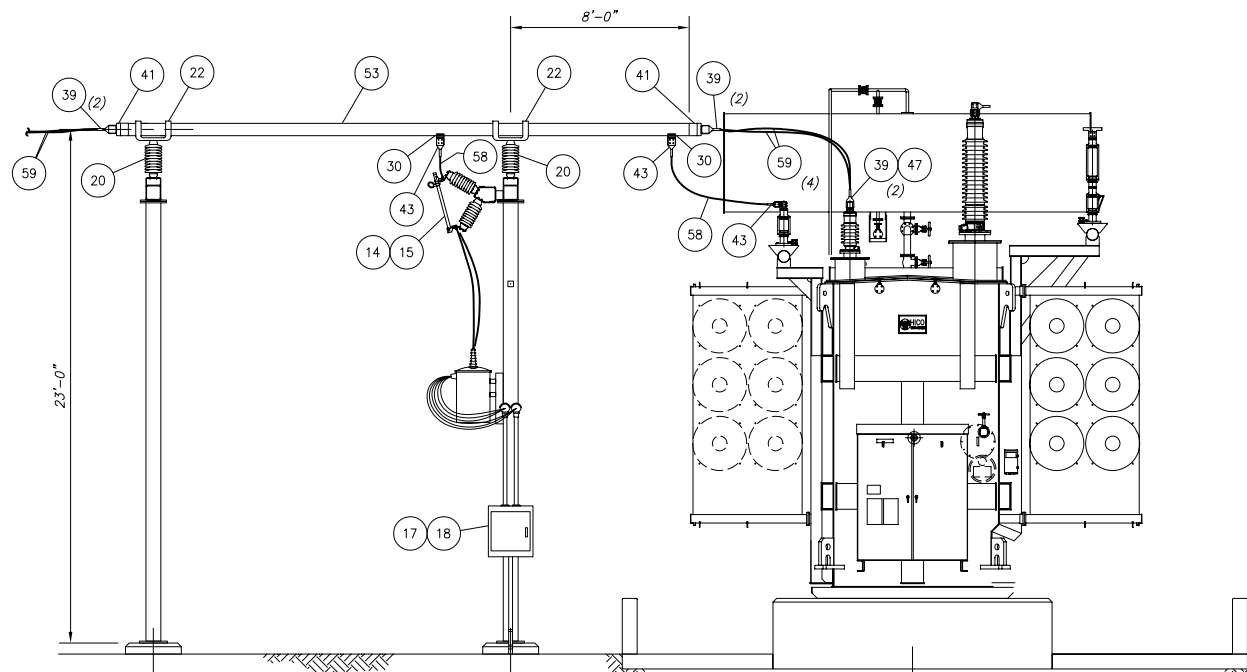
7. Control Building

- a. Remove all debris, mud, dirt from the control building and the equipment installed in the building.
- b. Vacuum the building floor and the outside surfaces of the panels and equipment enclosures within the building.

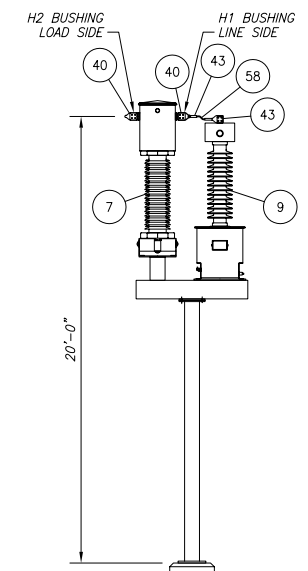
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**B** SECTION  
0601



**C** SECTION  
0601



**D** SECTION  
0601

**LEGEND**

① BILL OF MATERIAL ITEM NUMBER. REFERENCE DRAWING 62530606



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REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: J. SCOTT	CLIENT/PROJECT:	
A	FOR REVIEW	JDS	REC	JDS	07/03/07		FPL ENERGY	
B	GENERAL REVISIONS	JDS	LAB	JDS	07/10/07	DWN: R. COLE	LANGDON - WIND SUBSTATION	
C	90% SUBMITTAL	JDS	JDS	JDS	07/16/07	CHK: C. BLINCOW	EQUIPMENT SECTIONS	
D	FOR CONSTRUCTION	JDS	BLW	CDB	07/27/07	DATE: 07/27/07		
							SCALE: 1/4"=1'-0"	DRAWING NUMBER: 62530603
								REVISION: 0

## BUS SYSTEM

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, equipment and appliances necessary to construct the bus system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

- A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition
  - 1. ASTM B241/B241M Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
- B. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition
  - 1. NFPA 70 National Electrical Code
- C. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition
  - 1. IEEE C2 National Electrical Safety Code
- D. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) - Latest
  - 1. Boiler and Pressure Vessel Code SECTION IX Welding and Brazing Qualifications
- E. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition
  - 1. Title 29, Part 1910 Occupational Safety and Health Standards
  - 2. Title 29, Part 1926 Safety and Health Regulations for Construction

#### 1.3 SUBMITTALS (not used)

### PART 2 - TERMS AND CONDITIONS (not used)

## PART 3 - PRODUCTS

### 3.1 MATERIAL

#### A. Insulators

1. Insulators shall be rated as shown on the drawings.
2. Insulators shall be ANSI 70 light gray in color.

#### B. Rigid Bus

1. Rigid bus shall be sized as shown on the drawings.
2. Scratched, gouged, kinked, or in any way deformed bus shall not be used in the installation.

#### C. Strain and Jumper Bus Conductor

1. Strain and jumper bus conductor shall be sized as shown on the drawings.
2. Scratched, gouged, kinked, or in any way deformed bus conductor shall not be used in the installation.

#### D. Bus Connectors

1. Bus connectors shall be of the type and size as shown on the drawings.
2. All nuts, bolts and washers not furnished by the connector manufacturer with the connector shall be stainless steel.

#### E. Weld Rod and Wire

1. Weld rod for TIG welded fittings shall be 4043 aluminum rod.
2. Weld wire for MIG welded fittings shall be 4043 aluminum wire.

## PART 4 - EXECUTION

### 4.1 INSULATION SYSTEM

- A. Insulation shall include all bus support insulators, suspension insulators and apparatus bushings as shown on the drawings.
- B. All insulators and bushings shall be cleaned of oil, dirt, paper, tape and other foreign materials.

- C. Any insulator or bushing damaged in any way shall not be installed.
- D. The Engineer shall review the complete insulation system to assure correct and complete installation.

#### 4.2 RIGID BUS INSTALLATION

- A. Rigid bus shall be free of kinks, indentations and flattened surfaces.
- B. Splices shall be placed as specified on the drawings.
- C. Bus bends shall be standard radius unless otherwise specified on the drawings.
- D. Rigid horizontal bus lengths shall contain a vibration dampening cable as specified on the drawing.
  - 1. Cable shall be a continuous, un-spliced length.
  - 2. Cable shall be completely unrestrained.
- E. Corona bell end plugs shall be installed at open bus ends.
- F. All horizontal rigid bus sections shall be drilled with a 1/8" hole for condensation weeping. The location of the hole shall be at mid-span, between insulators on the bottom side of the bus.

#### 4.3 BUS WELDING

- A. Welding buses and connections shall be tungsten-arc inert gas shielded welded (TIG) or metal inert gas (MIG) only.
- B. All oil, grease and water in the vicinity of welding shall be removed.
- C. Conductor and connector areas to be welded shall be cleaned with a stainless steel brush.
- D. Welds shall be performed by certified welders capable of meeting the Fillet-Weld soundness test of the Standard Qualifications for Welding Procedure, Section IX of the ASME Boiler and Pressure Vessel Code.
- E. Prior to welding a connection, a test bead should be made upon an aluminum casting to test the weld settings.
- F. Due to manufacturing tolerances on aluminum tubular bus, the tube shall be positioned to the weldment cavity and tack welded before starting the final weld.

- G. Begin welding by "burning into" the casting and proceeding into the tube.
- H. Wire brush the original weld if more than one weld pass is required using a stainless steel brush.
- I. All welds shall be smooth without roughness.

**4.4 STRAIN BUS, JUMPER BUS INSTALLATION**

- A. Strain bus and jumper bus conductors shall be installed in complete accordance with the drawings.
- B. Strain bus, static conductors and associated guying shall be tensioned per the drawings.
- C. Joints, splices and sleeves shall not be allowed in strain buses or jumper buses.
- D. Abraded cables shall not be allowed.

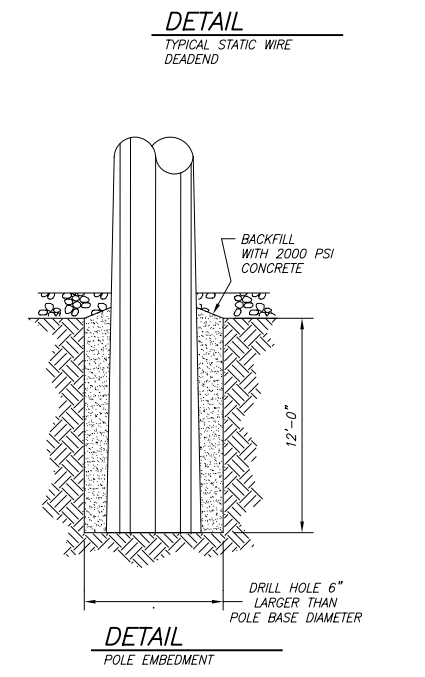
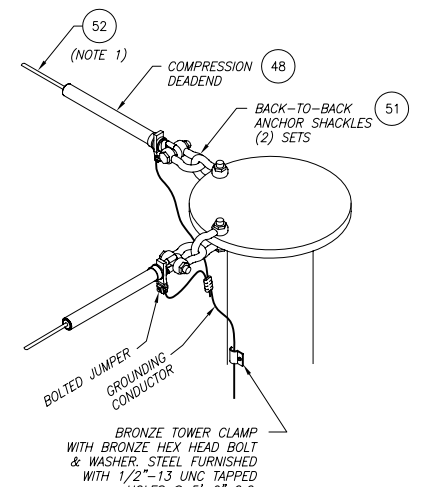
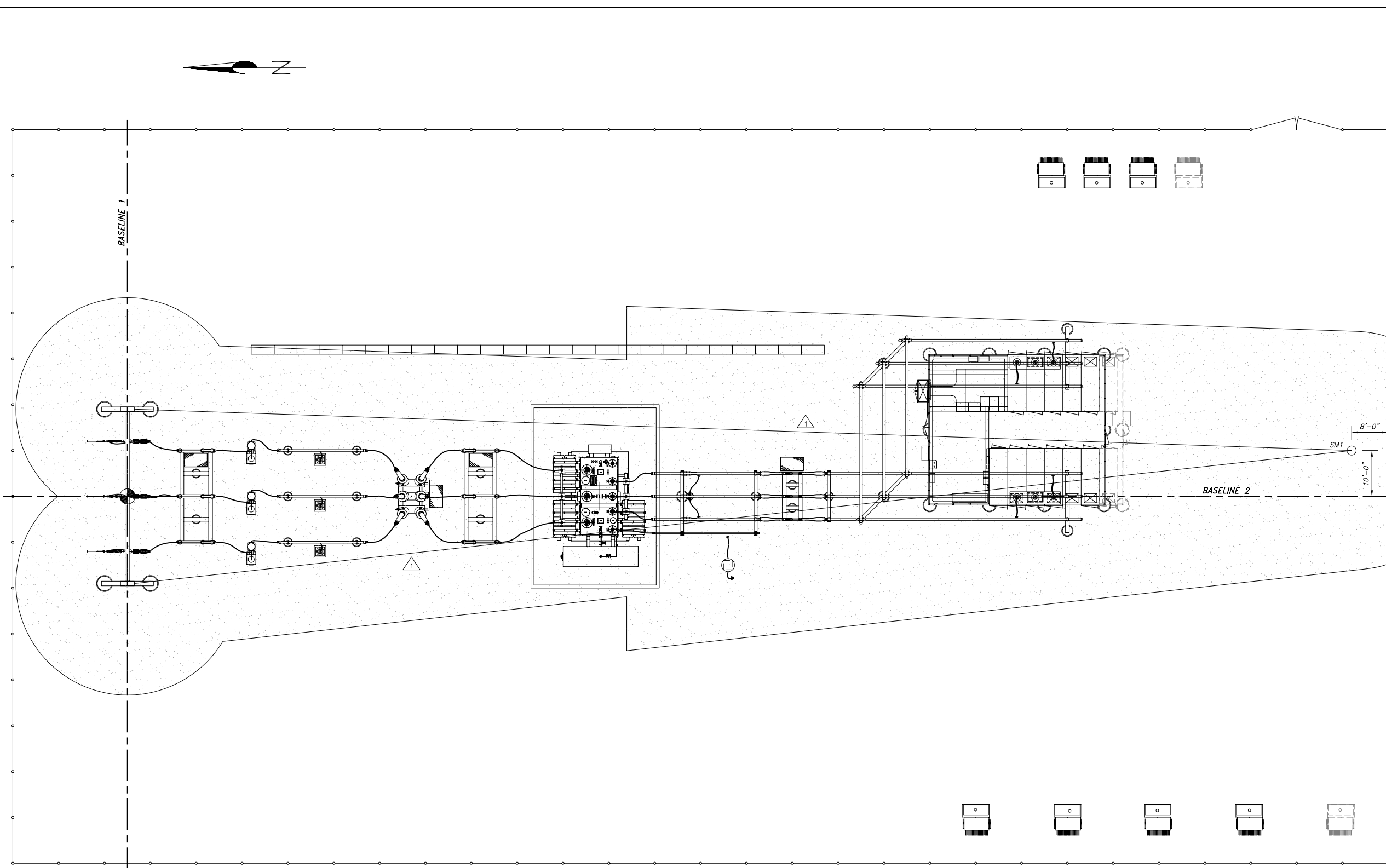
**4.5 BOLTED BUS CONNECTOR INSTALLATION**

- A. Bolts shall be tightened in accordance with the following torque chart:

<b>RECOMMENDED TORQUE VALUES FOR CONNECTOR BOLTS</b>		
<b>Bolt Diameter (inches)</b>	<b>Recommended Torque Non-lubricated Stainless Steel and Silicon Bronze Hardware (pound-inches)</b>	<b>Recommended Torque Lubricated Hardware (pound-inches)</b>
5/16"	180	120
3/8"	240	168
1/2"	480	300
5/8"	660	480
3/4"	840	720

- B. Utmost care shall be exercised in installing clamps, connectors and other bolted and compression devices.
- C. The contact surface of the clamp or connectors and the bonding surface of the wire shall be clean and bright and an oxide inhibitor shall be applied.
- D. Penatrox A, or approved equal, shall be applied to all aluminum connectors.
- E. U-bolts clamping stranded conductor directly shall be tightened enough to flatten the lock washers, but not tight enough to deform or damage the conductor.

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- NOTES**
1. STATIC WIRE TO BE 3/8" EHS STEEL.
- LEGEND**
- AREA PROTECTED USING ROLLING SPHERE METHOD FOR 115 KV SIDE AND FIXED ANGLE METHOD FOR 34.5 KV SIDE
  - STATIC MAST DESIGNATION
  - SPAN DESIGNATION
  - BILL OF MATERIAL ITEM NUMBER. REFERENCE DRAWING 62530606.

		LINE INSTALLATION SAG & TENSION DATA							
		TEMP. (°F.)							
SPAN DESIGNATION	20	30	40	50	60	70	80	90	
△ 1	267'	2.26' 1075 lb	2.41' 1010 lb	2.56' 950 lb	2.72' 895 lb	2.88' 845 lb	3.04' 800 lb	3.21' 758 lb	3.38' 721 lb

REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: J. SCOTT	CLIENT/PROJECT:	FPL ENERGY LANGDON - WIND SUBSTATION
A	FOR REVIEW	JDS	REC	JDS	07/03/07	DWN: R. COLE	TITLE:	LIGHTNING PROTECTION PLAN
B	GENERAL REVISIONS	JDS	LAB	JDS	07/10/07	CHK: C. BLINCOW	SCALE:	0 8' 16' 24' 32' 3/32"=1'-0"
C	90% SUBMITTAL	JDS	JDS	JDS	07/16/07	DATE: 07/27/07	DRAWING NUMBER:	62530604
D	FOR CONSTRUCTION	JDS	BLW	CDB	07/27/07	REVISION:	0	

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# HEAVY EQUIPMENT INSTALLATION

## PART 1 - GENERAL DESCRIPTION

### 1.1 SUMMARY

This specification covers the transportation of heavy equipment. In addition to the following specifications, any movement of equipment shall be in accordance with manufacturer's instructions.

### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

#### A. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS - Latest Edition

1. IEEE 37.20.2 Standard for Metal-Clad Switchgear
2. IEEE C57.93 Guide for Installation of Liquid-Immersed Power Transformers

#### B. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910 Occupational Safety and Health Standards
2. Title 29, Part 1926 Safety and Health Regulations for Construction

## PART 2 - TERMS AND CONDITIONS (not used)

## PART 3 - PRODUCTS

### 3.1 SPREADER BARS, ROLLERS, SLINGS

Furnish all required spreader bars, rollers, slings for the moving and setting of heavy equipment. All spreader bars, rollers and slings shall be of a rating sufficient for the lift or move with safety factor included.

**PART 4 - EXECUTION**

**4.1 MOVING HEAVY EQUIPMENT BY CRANE**

- A. Only lifting equipment (from a reputable manufacturer) within its rated capacity shall be used.
- B. Lifting hooks or hitches shall be attached only to the lifting eyes or hooks provided on the equipment structure.
- C. When using a single point hitch, the angle between cables (when viewed from the front or long side of the equipment) shall not exceed 60 degrees.

**4.2 MOVING HEAVY EQUIPMENT BY ROLLING OR SKIDDING**

**A. Jacking**

- 1. The transporting vehicle's deck shall be raised off its springs and securely blocked to maintain a level and firm surface.
- 2. The equipment shall be raised using jacks placed only under the jack pads built onto the equipment structure.
- 3. The equipment shall never be raised at only one corner.
- 4. Jacks alone shall never be used to support the equipment in a raised position.
- 5. The equipment shall never be tilted more than 15 degrees from vertical in any direction.

**B. Skidding or Rolling**

- 1. Rollers shall be placed only under the equipment perpendicular to the direction of movement.
- 2. Rollers shall be double extra strong IPS pipe of the following number and size:

<b>SIZE AND NUMBER OF DOUBLE EXTRA STRONG PIPE</b>						
<b>Weight [x 1000 lbs]</b>	<b>1 in.</b>	<b>2 in.</b>	<b>3 in.</b>	<b>4 in.</b>	<b>5 in.</b>	<b>6 in.</b>
100 – 150	52	26	18	14	10	8
150 – 200	70	34	24	18	14	12
200 – 250	86	44	30	22	18	14
250 – 300	104	52	34	26	20	18
300 – 350	122	60	40	30	24	20
350 – 400	138	70	46	34	28	24

3. Skidways or rollways shall be level and firm. Skidway timber shall be solid and firm. When rollers are to be used, a one-half inch (1/2") thick steel plate that is wider than the rollers shall be securely attached to the top of each timber.
4. A tow and drag winching system shall be used to move the equipment along the skidway or rollway. One winch shall pull in the direction of movement and a second winch on the far side shall pay-out slack to insure a controlled movement.
5. Tow cables shall be attached only to jack pads provided on the equipment. Spreading yokes shall be used to equalize towing forces on the transformer.
6. The equipment shall never be pushed or shoved in any direction by pressure against the sides or attachments.

#### 4.3 MOVING OF ACCESSORIES

- A. Equipment accessories shall be unloaded using extreme care to insure no damage is incurred.
- B. Accessories shall remain intact in their shipping package from shipping point to site.

#### 4.4 HAULING HEAVY EQUIPMENT

- A. The equipment shall be securely fastened to the tractor-trailer during transit to insure no movement and that no damage is incurred.
- B. During transit, the equipment transporter shall have both a front and rear escort vehicle.
- C. The Contractor shall abide by all Federal, State and local regulations concerning size and weight of loads during transit.
- D. The equipment shall be transported at safe speeds governed by load and highway or road being used.



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BILL OF MATERIAL				
ITEM	QTY	UNIT	DESCRIPTION	MANUFACTURERS C/N
1	1	EA	POWER TRANSFORMER: 107/142/178 MVA, 115-34.5 kV, ONAN/ONAF/ONAF	HICO
2	1	EA	SWITCHGEAR: 38 kV, 2000 A SPLIT BUS, 40 KA, 200 KV BIL, SHELTERED AISLE, 7 FEEDERS	POWERCON
3	1	EA	CIRCUIT BREAKER: 115 kV NOMINAL, 145 kV MAXIMUM, 3000 A, 40 KA INTERRUPT, 550 KV BIL	mitsubishi
4	1	EA	SWITCH: 115 kV, 1200 A, 550 kV BIL, VERTICAL BREAK, MOTOR OPERATED	PASCOR
5	1	EA	SWITCH: 115 kV, 1200 A, 550 kV BIL, VERTICAL BREAK, MANUAL SWING OPERATOR	PASCOR
6	1	EA	SWITCH: 34.5 kV, 3000 A, 250 kV BIL, VERTICAL BREAK, MANUAL SWING OPERATOR	PASCOR
7	3	EA	CT: 115 kV, 550 kV BIL, RATIO 500:5 SR, OIL FILLED	KUHLMAN CAT.#: K8905005A-YYY
8	3	EA	CCVT: 115 kV, 550 kV BIL, RATIO=600/1000.1	
9	3	EA	VT: 115 kV, 550 kV BIL, RATIO 1000/600:1:1, OIL FILLED	KUHLMAN CAT.#: K711000TB-HAC
11	1	EA	NEUTRAL REACTOR:	
12	3	EA	ARRESTER: 70 kV MCOV, STATION CLASS, METAL TOP, NEMA 4-HOLE TERMINAL PAD, PORCELAIN TYPE, UPRIGHT MOUNTING	ABB OR EQUAL
14	2	EA	FUSE HOLDER: 34.5 kV, 200 kV BIL, STATION RIGHT-ANGLE TYPE, CYPOXY INSULATORS, TYPE SMD-20, WITH EYE BOLT CONNECTORS	S&C CAT.#: 192234R3-E-M OR EQUAL
15	2	EA	FUSE UNITS: 10 A, CURRENT LIMITING TYPE	COOPER CAT.#: 23FD10HD3A
16	1	EA	TRANSFORMER: 100 kVA, 34,500-120/240 V, 200 kV BIL, SINGLE-PHASE, 2-BUSHING, POLE MOUNT	COOPER OR EQUAL
17	1	EA	SAFETY SWITCH: HEAVY DUTY, FUSED, 240 VAC, SINGLE-PHASE, 3-WIRE, 400 A, NEMA 3R ENCLOSURE	SQUARE D OR EQUAL
18	2	EA	FUSE: FOR SAFETY SWITCH, CLASS H, 400 A	BUSSMANN OR EQUAL
19	9	EA	INSULATOR: 115 kV, 550 kV BIL, STANDARD STRENGTH, 5" BOLT CIRCLE TOP & BOTTOM, T.R. 286	LAPP CAT.#: 315286-70 OR EQUAL
20	23	EA	INSULATOR: 34.5 kV, 200 kV BIL, HIGH STRENGTH, 5" BOLT CIRCLE TOP & BOTTOM, T.R. 231	LAPP CAT.#: 315231-70 OR EQUAL
21	3	EA	BUS SUPPORT: 1272 kcmil ACSR, 54/19 STRAND TO 5" BOLT CIRCLE, BOLTED, ALUMINUM	SEFCOR CAT.#: ASCR1-53-5 OR EQUAL
22	21	EA	BUS SUPPORT: 6" IPS SCHEDULE 40 TO 5" BOLT CIRCLE, SLIP-FIT/WELDED RIGID, ALUMINUM	SEFCOR CAT.#: ASWH-69-5-SE OR EQUAL
23	15	EA	END CAP: FOR 6" SCHEDULE 40 BUS, ALUMINUM, WELDED	SEFCOR CAT.#: WEB-69 OR EQUAL
24	6	EA	BUS SUPPORT: 4" IPS SCHEDULE 40 TO 5" BOLT CIRCLE, SLIP-FIT/WELDED-RIGID, ALUMINUM	SEFCOR CAT.#: ASWH-64-5-SE OR EQUAL
25	2	EA	BUS SUPPORT: 3" IPS SCHEDULE 40 TO 5" BOLT CIRCLE, SLIP-FIT/WELDED RIGID, ALUMINUM	SEFCOR CAT.#: ASWH-62-5-SE OR EQUAL
26	1	EA	END CAP: FOR 3" SCHEDULE 40 BUS, ALUMINUM, WELDED	SEFCOR CAT.#: WEB-62 OR EQUAL
29	10	EA	TEE: 3"-6" IPS ALUMINUM BUS MAIN TO 4-HOLE NEMA PAD, WELDED, ALUMINUM	SEFCOR CAT.#: WTF-6269-4B OR EQUAL
30	5	EA	TEE: 3"-6" IPS ALUMINUM BUS MAIN TO 2-HOLE NEMA PAD, WELDED, ALUMINUM	SEFCOR CAT.#: WTF-6269-2B OR EQUAL
31	12	EA	TEE: 6" IPS SCHEDULE 40 MAIN TO 3" IPS SCHEDULE 40 TAP @ 15", WELDED ALUMINUM	SEFCOR CAT.# WFTT15-6962 OR EQUAL

BILL OF MATERIAL				
ITEM	QTY	UNIT	DESCRIPTION	MANUFACTURERS C/N
32	6	EA	TEE: 1272 kcmil, 54/19 STRAND ACSR TO 4-HOLE NEMA PAD, COMPRESSION, ALUMINUM	SEFCOR CAT.#: ATCF-1385-4B OR EQUAL
33	6	EA	TEE: 6" IPS SCHEDULE 40 MAIN TO (2) 3" IPS SCHEDULE 40 TAP @ 15", WELDED ALUMINUM	SEFCOR CAT.# WFT15-6962 OR EQUAL
36	6	EA	TERMINAL: 4" IPS SCHEDULE 40 TO 4-HOLE NEMA PAD, CENTERFORMED, WELDED, ALUMINUM	SEFCOR CAT.#: WFTOC-67-4B OR EQUAL
38	30	EA	TERMINAL: 1272 kcmil, 54/19 STRAND ACSR TO 4-HOLE NEMA PAD, COMPRESSION, ALUMINUM	SEFCOR CAT.#: AL-1385-4B OR EQUAL
39	48	EA	TERMINAL: (2) 795 kcmil AAC, 37 STRAND TO 4-HOLE NEMA PAD, WELDED, ALUMINUM	SEFCOR CAT.#: WFC2-29-4A OR EQUAL
40	6	EA	TERMINAL: 1272 kcmil, 54/19 STRAND ACSR TO 4-HOLE NEMA PAD @ 90', COMPRESSION, ALUMINUM	SEFCOR CAT.#: AL-1385-4B-90 OR EQUAL
41	9	EA	TERMINAL: 6" IPS SCHEDULE 40 TO (2) 4-HOLE NEMA PADS, WELDED, ALUMINUM	SEFCOR CAT.#: WFTD-69-4B OR EQUAL
42	1	EA	TERMINAL: 3" IPS SCHEDULE 40 TO 4-HOLE NEMA PAD, CENTERFORMED, WELDED, ALUMINUM	SEFCOR CAT.#: WFTOC-62-4A OR EQUAL
43	14	EA	TERMINAL: 250 kcmil, 19 STRAND AAC TO 2-HOLE NEMA PAD, WELDED, ALUMINUM	SEFCOR CAT.#: WFC-13-2B OR EQUAL
44	10	EA	TERMINAL: 795 kcmil AAC 37 STRAND TO 4-HOLE NEMA PAD, COMPRESSION, ALUMINUM	SEFCOR CAT.#: AL-1031-4A OR EQUAL
45	1	EA	STUD CONNECTOR: FOR HO BUSHING	
46	3	EA	STUD CONNECTOR: FOR H1-H3 BUSHINGS	
47	4	EA	STUD CONNECTOR: FOR X1-X3 AND X0 BUSHINGS	
48	4	EA	DEADEND: 3/8" E.H.S. STEEL TO EYE, GALVANIZED, COMPRESSION, WITH U-BOLT JUMPER	ANDERSON CAT.#: 861225J OR EQUAL
49	5	EA	COUPLER: 6" IPS SCHEDULE 40 TO 6" IPS SCHEDULE 40, STRAIGHT, WELDED ALUMINUM	SEFCOR CAT.#: WSC-6969 OR EQUAL
50	20	EA	ANCHOR: 5/8" x 8 1/2", DRILL-IN WEDGE TYPE, STAINLESS STEEL, FOR SWITCHGEAR BUILDING	HILTI CAT.#: KBII-45407 5/8 x 8 1/2 OR EQUAL
51	8	EA	ANCHOR SHACKLE: 30,000 lb. ULTIMATE STRENGTH, 2 25/32" MINIMUM INSIDE LENGTH, GALVANIZED	ANDERSON CAT.#: AS-25-L OR EQUAL
52	600	FT	SHIELD WIRE: 3/8 E.H.S. STEEL, GALVANIZED	
53	490	FT	BUS: 6" IPS SCHEDULE 40, ALUMINUM 6063-T6 ALLOY, LENGTHS PER BUS SCHEDULE, DRAWING 62530601	
54	60	FT	BUS: 4" IPS SCHEDULE 40, ALUMINUM 6063-T6 ALLOY, LENGTHS PER BUS SCHEDULE, DRAWING 62530601	
55	80	FT	BUS: 3" IPS SCHEDULE 40, ALUMINUM 6063-T6 ALLOY, LENGTHS PER BUS SCHEDULE, DRAWING 62530601	
56	600	FT	CONDUCTOR: 477 kcmil ACSR, 30/7 STRAND, "HEN" (BUS DAMPING)	
57	400	FT	CONDUCTOR: 1272 kcmil ACSR, 54/19 STRAND, "PHEASANT"	
58	100	FT	CONDUCTOR: 250 kcmil AAC, 19 STRAND, "VALERIAN"	
59	400	FT	CONDUCTOR: 795 kcmil AAC, 37 STRAND, "ARBUS"	
61	AS REQ'D	FT	POWER CABLE: 600 V, TYPE RRH, #4 AWG, COPPER	OKONITE CAT.#: 112-24-2251 OR EQUAL
62	AS REQ'D	FT	POWER CABLE: 600 V, TYPE RRH, RWH-2 OR US2-2, 4/0 AWG, COPPER	OKONITE CAT.#: 112-24-2411 OR EQUAL

REV	DESCRIPTION	ENG	DWN	CHK	DATE	ENG: J. SCOTT	CLIENT/PROJECT:
A	FOR REVIEW	JDS	REC	JDS	07/03/07		FPL ENERGY
B	GENERAL REVISION	JDS	LAB	JDS	07/10/07	DWN: R. COLE	LANGDON - WIND SUBSTATION
C	90% SUBMITTAL	JDS	JDS	JDS	07/16/07	CHK: C. BLINCOV	TITLE:
D	FOR CONSTRUCTION	JDS	BLW	CDB	07/27/07	DATE: 07/27/07	SCALE:
							NONE
							DRAWING NUMBER:
							62530606
							REVISION:
							0



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## CONTROL WIRING AND CABLE

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of all labor, material and equipment necessary to construct the wiring system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

##### A. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition

NFPA 70                      National Electrical Code

##### B. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition

IEEE C2                      National Electrical Safety Code

##### C. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition

1. Title 29, Part 1910      Occupational Safety and Health Standards

2. Title 29, Part 1926      Safety and Health Regulations for Construction

#### 1.3 SUBMITTALS (not used)

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS

#### 3.1 MATERIAL

##### A. Cable

1. Multi-conductor cable for use in trench, cable tray or underground conduit shall be tray cable with a PVC jacket. Shielding shall be as shown on the drawings.

2. Single conductor wiring for use in control building contained in conduit shall be THHN.
  3. Single conductor wiring for use on structure mounted, above ground equipment shall be SIS or THHN.
  4. Conductors shall be stranded copper.
  5. Insulation type shall be as shown on the drawings and shall be rated 600 Volts.
  6. Conductors shall be sized as shown on the drawings.
  7. The schedule of color coding for control and DC circuits shall be compatible with the ICEA Method E-2 colors (previously known as K-2).
  8. The schedule of color coding for AC power circuits shall be compatible with the ICEA Method E-1 colors (previously known as K-1).
- B. Cable Terminals

All conductors shall be terminated with ring type, insulated barrel, solderless pressure connectors.

C. Cable Labels

Each cable shall be labeled with a non-conductive marker permanently attached to the cable similar to the "FASTTAG" System by Tech Products. The use of permanent marker on light colored electrical tape is not acceptable.

## PART 4 - EXECUTION

### 4.1 CONDUIT CLEANING AND PREPARATION

- A. All conduit shall be cleaned prior to installation of wire and cable.
- B. No wire or cable shall be installed in conduit unless it is free of all foreign material.
- C. Wire and cable shall be installed in such a manner so as not to cause any cuts, abrasions or other mechanical damage to conductor, insulation or cable jacket.
- D. An approved lubricating material approved by the cable manufacturer shall be used when necessary to prevent mechanical damage to the cable due to pulling tension or side wall pressure.

- E. Any wire or cable that is damaged during installation shall be removed and replaced at the Contractor's expense.

#### 4.2 WIRING

- A. All wiring shall be installed as shown on the drawings and cable schedule.
- B. All cables in conduits shall be pulled at the same time.
- C. Sufficient length shall be left at all ends of wires and cables to make connections conveniently to equipment and devices.
- D. Spare conductors at the end of a multi-conductor cable shall be coiled neatly and retained in a length equal to that of the longest single conductor at each end of the multi-conductor cable.
- E. All exposed cable or wire runs within a cabinet shall be gathered and tied together approximately every three inches on center.
- F. No splices shall be made in any cable or wire.
- G. All AC power circuits shall be accompanied by a bare copper equipment grounding conductor sized as shown in the drawings.
- H. Identification of cables and conductors shall be as follows:
  - 1. Multi-conductor cable shall be labeled as shown on the drawings.
  - 2. Individual conductors in multi-conductor cables shall not be labeled and shall be terminated according to color.
  - 3. Single conductors shall have labels or colors as shown on the drawings.

#### 4.3 TESTING WIRE FOR CONTINUITY

The control wiring shall be checked for continuity before terminating to terminal blocks and devices.

## FIBER CABLE

### PART 1 - GENERAL DESCRIPTION

#### 1.1 SUMMARY

This specification covers the supplying of labor, material and equipment necessary to construct the fiber optic system for the project.

#### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

- A. ANSI/TIA/EIA-568-B.3 - Latest Edition  
Optical Fiber Cabling Components Standard
- B. ANSI/TIA/EIA-492AAAA-A - Latest Edition  
62.5/125 Graded Index Multi Mode Optical Fibers
- C. ANSI/TIA/EIA-598-A - Latest Edition  
Fiber Optic Color Coding
- D. ANSI/IECA S-87-640 - Latest Edition  
Fiber Optic Outside Plant Communications Cable
- E. NEC - Latest Edition  
Section 770 Fiber Optic Cables and Raceways

#### 1.3 SUBMITTALS

- A. Manufactures product information (cut sheets)
- B. Test Reports, as listed in testing section.

### PART 2 - TERMS AND CONDITIONS (not used)

## PART 3 - PRODUCTS

### 3.1 MATERIAL

#### A. Multi Mode Fiber Cable

1. Cable shall feature 62.5/125 Multi Mode Fiber. It shall be designed for underground duct or direct burial. Core tube shall contain fiber counts as shown on drawings.
2. Direct buried fiber shall be armored and polyurethane jacketed. Armored cable shall be grounded at one end.
3. Direct Burial of non-armored loose-tube cable in flexible HDPE ducting rated for direct burial is acceptable. Cable may be preinstalled or a preinstalled pull string, footage or meter marked, in internally ribbed and smooth outer diameter HDPE duct is required
4. In conduit and trench fiber shall be protected in innerduct and separated from power and control cables. Split innerduct is acceptable.
5. Maximum attenuation less than: 3 db/km @ 850 nm & 1 db/km @ 1300 nm.
6. Minimum bending radius loaded installation 11 inches, long term 5.5 inches.
7. Minimum bandwidth: 500 MHz/ km @1300nm and 160 MHz/ km @850nm.
8. The schedule of fiber color coding shall follow TIA/EIA-598-A.
9. Cable shall be Graded Index.
10. Cable shall be Loose Tube.
11. Cable shall be treated to prevent the migration of water: gel-filled or water blocking tape.
12. Temperature range -40 to 75 degrees Celsius.

B. Single Mode Fiber Cable

1. Cable shall feature 9/125 Single Mode Fiber. It shall be designed for underground duct or direct burial. Core tube shall contain fiber counts as shown on drawings.
2. Direct buried fiber shall be armored and polyurethane jacketed. Armored cable shall be grounded at one end.
3. Direct Burial of non-armored loose-tube in flexible HDPE ducting rated for direct burial is acceptable. Cable may be preinstalled or a preinstalled pull string, footage or meter marked, in internally ribbed and smooth outer diameter HDPE duct is required.
4. In conduit and trench fiber shall be protected in innerduct and separated from power and control cables. Split innerduct is acceptable.
5. Maximum attenuation: less than 0.4 db/km @ 1310 nm & 0.3 db/km @ 1500 nm.
6. Minimum bending radius loaded installation 11 inches, long term 5.5 inches.
7. The schedule of fiber color coding shall follow TIA/EIA-598-A.
8. Cable shall be Loose Tube.
9. Cable shall be treated to prevent the migration of water: gel-filled or water blocking tape.
10. Temperature range -40 to 75 degrees Celsius.

C. Cable Termination/Splicing

1. All fibers shall be terminated with pre-connector pigtails using fusion splice method.
2. Shrink wrap tubes shall be utilized over splices. All splices will be protected in a splice tray.
3. Connectors shall be SC or ST as shown on drawings.
4. All fibers will terminate in the patch panel unless otherwise specified in the drawings.

## PART 4 - EXECUTION

### 4.1 CONDUIT CLEANING AND PREPARATION

- A. Conduit shall be cleaned prior to installation of cable.
- B. No cable shall be installed in conduit unless it is free of all foreign material.
- C. Cable shall be installed in such a manner so as not to cause any cuts, abrasions or other mechanical damage to fiber or cable jacket.
- D. An approved lubricating material approved by the cable manufacturer and specially formulated for fiber optic installation will be utilized for all runs over 50 feet, to prevent mechanical damage to the cable due to pulling tension or side wall pressure. Waxed based lubricants shall not be allowed.
- E. Any cable that is damaged during installation shall be removed and replaced at the Contractor's expense.

### 4.2 Installation

- A. All cables shall be installed as shown on the drawings and cable schedule.
- B. All cables in conduits shall be pulled at the same time.
- C. Sufficient length shall be left at all ends of cables to make connections conveniently to equipment with a minimum of a 20 foot cable loop.
- D. Spare fibers at the end of a multi-fiber cable shall be coiled neatly and retained in a length sufficient for future use.
- E. All exposed cable or wire runs within a cabinet shall be gathered and tied together approximately every three inches on center. Care shall be taken not to crush or otherwise damage the cable.
- F. No splices shall be made in any cable without engineer's approval.
- G. Each cable shall be labeled as indicated on drawings. Each Fiber shall be numbered in the patch panel.
- H. Duct pathways shall not exceed 50% fill.
- I. Maximum tension shall not to exceed manufacturer's recommendation.

### 4.3 TESTING

- A. The fiber cable shall be tested on the spool, prior to installation. Testing shall be done with OTDR (Optical Time Domain Reflectometer) end to end, in both directions, for each strand. Multi mode shall be tested at 850 nm & 1300 nm. Single mode shall be tested at 1310 nm & 1550 nm.
- B. Certified report of all OTDR test shall be provided.
- C. After installation all connectorized strands shall be tested using a stabilized light source and a fiber optic power meter. Attenuation values for each connection (end to end) shall be provided.
- D. Test shall not exceed the manufacturer's typical db/km attenuation values plus the following:
  - 1. Fusion splices shall not exceed 0.2 db.
  - 2. SC connectors shall not exceed 0.5 db.
  - 3. ST connectors shall not exceed 0.6 db.
- E. If testing indicates loss values that exceed values listed above then OTDR testing is required, as previously detailed. Cable not meeting the specification shall be adjusted or replaced as necessary, to comply with this specification, and retested.

# ELECTRIC POWER SYSTEM TESTING

## PART 1 - GENERAL DESCRIPTION

### 1.1 SUMMARY

This specification covers the supplying of all labor and equipment necessary to perform testing of the power equipment for the project.

### 1.2 REFERENCE STANDARDS, CODES AND SPECIFICATIONS

Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the referenced standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply.

#### A. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM) - Latest Edition

1. ASTM D877 Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
2. ASTM D923 Standard Practices for Sampling Electrical Insulating Liquids
3. ASTM D971 Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method
4. ASTM D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration
5. ASTM D1298 Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
6. ASTM D1500 Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
7. ASTM D1524 Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field
8. ASTM D1533 Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration

- 9.     ASTM D3284           Standard Practice for Combustible Gases in the Gas Space of Electrical Apparatus Using Portable Meters
- 10.    ASTM D3612           Test Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography
  
- B.     NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) - Latest Edition
  - 1.     NFPA 70               National Electrical Code
  
- C.     INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) - Latest Edition
  - 1.     IEEE C2               National Electrical Safety Code
  
- D.     INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA) - Latest Edition
  - 1.     NETA ATS             Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
  - 2.     NETA MTS             Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems
  
- E.     OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - Latest Edition
  - 1.     Title 29, Part 1910   Occupational Safety and Health Standards
  - 2.     Title 29, Part 1926   Safety and Health Regulations for Construction

### 1.3 SUBMITTALS

- A.     Qualifications shall be submitted as specified in Qualifications section.
- B.     Test results shall be submitted as specified in Reporting of Results section.

### PART 2 - TERMS AND CONDITIONS (not used)

### PART 3 - PRODUCTS (not used)

### PART 4 - EXECUTION

#### 4.1 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a totally independent corporation from the Contractor or the manufacturer of the equipment to be tested.
- B. The testing firm shall have at least three years experience testing similar types of equipment and systems as found in the project. The firm shall also provide references for three systems similar to the project which the firm has completed testing within the last three years.
- C. All testing personnel shall be full-time employees of the testing firm. The on-site supervisor shall have been involved in testing of at least three systems similar to the project in the past five years.
- D. Resumes of all personnel anticipated to work on the project shall be submitted to the Owner for review.

#### 4.2 DIVISION OF RESPONSIBILITY

- A. The testing firm shall provide all material, equipment, labor and technical supervision to perform such tests and inspections as specified herein.
- B. The testing firm is responsible for programming all protective and alarming devices with the proper settings provided by the Engineer. Settings shall not be changed or applied to any device without written authorization from the Owner.
- C. The testing firm shall notify the Owner immediately upon the discovery of any defective equipment or incorrect system design or installation.
- D. The testing firm shall notify the Owner 24 hours before commencement of the testing.
- E. The testing firm shall provide an experienced person on-site during energizing, with appropriate test equipment to provide assistance in the event of a malfunction during the system start-up process.
- F. The testing firm shall supply a suitable source of electrical power at the project location for testing purposes.

#### 4.3 TEST EQUIPMENT

- A. All test equipment shall be designed specifically for electrical power system testing and for the specific purpose for which it is being used.
- B. Dated calibration labels shall be visible on all test equipment with calibration occurring within 6 months for analog devices and 12 months for digital devices.

Calibration accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).

- C. All meters shall be true RMS reading devices.
- D. All test equipment shall be in a state of good repair and working order.

#### 4.4 ELECTRICAL INSPECTION

- A. Equipment nameplate information shall be verified with the drawings.
- B. Size of all buses, cables, wiring shall be verified.

### PART 5 - TESTS

#### 5.1 POWER TRANSFORMER

- A. Visual and Mechanical Inspection
  1. Inspect physical and mechanical condition.
  2. Verify correct liquid level in all tanks.
  3. Verify that positive pressure is maintained on nitrogen-blanketed transformers.
  4. Verify equipment and system grounding.
  5. Verify that cooling fans operate correctly.
  6. Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.
  7. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
  8. Verify correct LTC and NLTC operation if present.
- B. Electrical Tests
  1. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground with test voltage in accordance with NETA ATS 2003 Table 100.5. Resistance values to be temperature corrected in accordance with NETA ATS 2003 Table 100.5. Calculate polarization index.

2. Perform a turns-ratio test at each LTC tap position with the NLTC set at the nominal tap, and at each NLTC tap position with the LTC set at the nominal tap. Verify that winding polarities are in accordance with nameplate. Turns-ratio test results shall not deviate more than one-half percent from either the adjacent coils or the calculated ratio.
3. Perform insulation power-factor/dissipation-factor tests on all windings and correct for 20° C in accordance with test equipment manufacturer's instructions.
4. Perform insulation power-factor/dissipation-factor tests (or hot collar watts-loss tests) on bushings and correct to 20° C in accordance with test equipment manufacturer's instructions.
5. Measure the resistance of each high-voltage winding in each no-load tap-changer position. Measure the resistance of each low-voltage winding in each load tap-changer position.
6. Perform excitation current tests on each high-voltage winding in each no-load tap-changer position with the LTC set at the nominal tap. Perform excitation current tests on each low-voltage winding on load tap-changer positions 1L through 16R with the NLTC set at the nominal tap.
7. Verify proper core grounding if accessible.
8. From the main tank and the LTC (if present), remove a sample of insulating liquid in accordance with ASTM D-923. Sample shall be tested for the following:
  - a. Dielectric breakdown voltage: ASTM D-877 and/or ASTM D-1816.
  - b. Acid neutralization number: ASTM D-974.
  - c. Specific gravity: ASTM D-1298.
  - d. Interfacial tension: ASTM D-971 or ASTM D-2285.
  - e. Color: ASTM D-1500.
  - f. Visual Condition: ASTM D-1524.
  - g. Perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 (*IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers*) or ASTM D-3612.

- h. Parts per million water: ASTM D-1533. Required on 25 kV or higher voltages.
- i. Measure total combustible gas (TCG) content in accordance with ANSI/IEEE C57.104 (*IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers*) or ASTM D-3284.

## 5.2 NEUTRAL GROUNDING RESISTOR

### A. Visual and Mechanical Inspection

- 1. Inspect physical condition.
- 2. Verify equipment and system grounding.
- 3. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.

### B. Electrical Tests

- 1. Perform insulation-resistance test from terminals to case for one minute. Test voltage and minimum resistance shall be in accordance with NETA ATS 2003 Table 100.1.
- 2. Verify ohmic value of resistor.

## 5.3 VOLTAGE REGULATOR

### A. Visual and Mechanical Inspection

- 1. Inspect physical and mechanical condition.
- 2. Verify removal of any shipping bracing and vent plugs after final placement.
- 3. Verify motor and drive train for correct operation and automatic motor cut-off at maximum lower and maximum raise.
- 4. Verify appropriate liquid level in all tanks and bushings.
- 5. Perform specific inspections and mechanical tests as recommended by the manufacturer.
- 6. Test air-tight integrity of seals by removing pressure relief valve and connecting to nitrogen source with pressure gauge. Apply 5 psi of

nitrogen to tank and verify that pressure is maintained for 15 minutes. Re-seat pressure relief valve to provide air-tight seal.

7. Verify equipment grounding.
8. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.

#### B. Electrical Tests

1. Perform insulation-resistance tests on each winding-to-ground in the neutral position with the test voltage in accordance with NETA ATS 2003 Table 100.5. Resistance values to be temperature corrected in accordance with NETA ATS 2003 Table 100.14. Calculate polarization index.
2. Measure winding-resistance of source windings in the neutral position. Measure resistance of all taps on load windings.
3. Perform special tests and adjustments as recommended by manufacturer.
4. Perform turns ratio test on each voltage step position. Verify that the indicator correctly identifies all tap positions.
5. Verify accurate operation of voltage range limiter.
6. Verify functioning and accuracy of bandwidth, time delay, voltage and line-drop compensation adjustments.
7. Remove a sample of insulating liquid in the main tank or common tank in accordance with ASTM D-923. Sample shall be tested for the following:
  - a. Dielectric breakdown voltage: ASTM D-877 and/or ASTM D-816.
  - b. Acid neutralization number: ASTM D-974.
  - c. Specific gravity: ASTM D-1298.
  - d. Interfacial tension: ASTM D-971 or ASTM D-2285.
  - e. Color: ASTM D-1500.
  - f. Visual condition: ASTM D-1524.

### 5.4 MEDIUM VOLTAGE VACUUM CIRCUIT BREAKER

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify the unit is clean.
5. Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.
6. Measure critical distances such as contact gap as recommended by manufacturer.
7. Inspect bolted electrical connections for high resistance using one of the following methods:
  - a. Use of low-resistance ohmmeter.
  - b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
  - c. Perform thermographic survey.
8. Lubrication requirements
  - a. Verify appropriate lubrication on moving current-carrying parts.
  - b. Verify appropriate lubrication on moving and sliding surfaces.
9. Perform time-travel analysis. Compare with manufacturer's values. (Optional)
10. Record as-found and as-left operation counter readings.

B. Electrical Tests

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable. Compare with similar connections.
2. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with circuit breaker closed and across each open pole for

one minute. Test voltage shall be in accordance with manufacturer's published data or NETA ATS 2003 Table 100.1.

3. Perform a contact/pole-resistance test. Compare with manufacturer's recommended values.
4. Perform minimum pickup voltage tests on trip and close coils in accordance with NETA ATS 2003 Table 100.20.
5. Verify trip, close, trip-free, and antipump functions.
6. Trip circuit breaker by operation of each protective device.
7. Perform vacuum bottle integrity (overpotential) test across each vacuum bottle with the breaker in the open position in strict accordance with manufacturer's published data. **Do not exceed maximum voltage stipulated for this test.** Provide adequate barriers and protection against x-radiation during this test. Do not perform this test unless the contact displacement of each interrupter is within manufacturer's tolerance. (Be aware that some dc high-potential test sets are half-wave rectified and may produce peak voltages in excess of the breaker manufacturer's recommended maximum.)
8. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation. Results shall be 2.0 megaohms minimum.
9. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Compare with manufacturer's values. (Optional)
10. Perform power-factor or dissipation-factor tests on each bushing. Use hot collar procedures if bushings are not equipped with a power-factor tap. Compare with manufacturer's values. (Optional)
11. Perform an overpotential test in accordance with manufacturer's published data.

## 5.5 HIGH VOLTAGE SF<sub>6</sub> CIRCUIT BREAKER

### A. Visual and Mechanical Inspection

1. Complete installation shall be inspected for physical damage.

2. Equipment nameplate information shall be compared with the drawings and specifications.
3. Equipment shall be inspected for anchorage, alignment and grounding.
4. Check SF<sub>6</sub> gas pressure of all three phases, and test for gas leaks in accordance with manufacturers instructions.
5. Verify correct operation of all SF<sub>6</sub> gas pressure alarms and cutouts.
6. Remove a sample of SF<sub>6</sub> gas and test in accordance with NETA ATS 2003 Table 100.13.
7. Perform a circuit breaker time-travel analysis.
8. Slow close/open the circuit breaker and check for binding.
9. Verify tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
10. Record as-found and as-left operation counter readings.

B. Electrical Tests

11. Measure contact resistance on all poles.
12. Perform insulation-resistance test pole-to-pole, pole-to-ground, and across open poles. Determine from the manufacturer's instructions the allowable procedures for this test.
13. Test current transformers for ratio and polarity in accordance with manufacturer's instructions.
14. Determine dropout voltage and time delay of breaker dc-circuit undervoltage relay.
15. Perform minimum pick-up voltage test on trip and close coils.
16. Verify trip, close, trip-free, and antipump functions.

## 5.6 RECLOSER

A. Visual and Mechanical Inspection

1. Complete installation shall be inspected for physical damage.

2. Equipment shall be inspected for anchorage, alignment and grounding.
3. Mechanical operation and contact alignment tests in accordance with the manufacturer's instructions shall be performed.
4. Tightness of bolted electrical connections shall be checked by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
5. Insulating fluid levels shall be inspected.

B. Electrical Tests

6. Contact resistance shall be measured.
7. Insulating fluids shall be sampled in accordance with ASTM D-923 and with the following tests performed:
  - a. Dielectric breakdown voltage: ASTM D-877
  - b. Color: ASTM D-1500
  - c. Visual condition: ASTM D-1524
8. Perform insulation-resistance test on each circuit-to-frame. Determine from the manufacturer's instructions the allowable procedures for this test.
9. Perform dc high-potential test on the recloser and vacuum interrupter per manufacturer's instructions.
10. Test current transformers for ratio and polarity in accordance with manufacturer's instructions.
11. Controller shall be tested according to the manufacturer's instructions. The following shall be verified:
  - a. Trip and close operations shall be tested.
  - b. Number of operations to lockout shall be tested.
  - c. Minimum trip current value shall be tested for phase and ground overcurrent.
  - d. Adherence to time-current curves shall be tested.

## 5.7 CIRCUIT SWITCHER

### A. Visual and Mechanical Inspection

1. Physical and mechanical condition shall be inspected.
2. Proper anchorage shall be checked.
3. Verify correct operation of interrupters.
4. Verify correct SF<sub>6</sub> pressure if applicable.
5. Test all interlocking systems for correct operation.
6. All components shall be inspected according to manufacturer's instructions.
7. Record as-found and as-left operation counter readings.

### B. Electrical Tests

1. Perform insulation-resistance test of the circuit switcher at 1000 volts dc in the following manner:
  - a. Open: Each pole to ground, pole 1 to 2, pole 3 to 4 and pole 5 to 6.
  - b. Closed: Pole 1 to ground, pole 3 to ground, and pole 5 to ground.
2. Perform a minimum to trip test at 70% or less of the nominal DC control voltage.
3. Perform a contact resistance test.
4. Perform a timing test showing the time from trip initiation to circuit switcher opening.

## 5.8 AIR BREAK SWITCH

### A. Visual and Mechanical Inspection

1. Physical and mechanical condition shall be inspected.
2. Proper anchorage shall be checked.
3. Mechanical operator operations shall be performed according to manufacturer's instructions.

4. Verify correct blade alignment, blade penetration, travel stops and arc interrupter operation.
5. Proper grounding of operator and switch operator platform shall be in accordance with industry standards and project specifications.
6. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.

B. Electrical Tests

1. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute. Test voltage should be in accordance with manufacturer's published data or NETA ATS 2003 Table 100.1.
2. Perform contact-resistance test across each switchblade and fuse holder. Contact resistance shall be determined in microhms. Investigate any value exceeding 500 microhms or any values which deviate from adjacent poles or similar switches by more than 25 percent.

## 5.9 OUTDOOR BUS

A. Visual and Mechanical Inspection

1. Bus arrangement shall be checked for compliance with the drawings.
2. Bus and supports shall be examined for defects such as cracked welds, chipped porcelain, etc.
3. Tightness shall be checked on accessible bolted bus joints using a calibrated torque wrench in accordance with NETA ATS 2003 Table 100.12.

B. Electrical Tests

1. Perform 1000 volt megger test on each bus, phase-to-ground with other phases grounded.
2. Measure resistance of bus section joints with low-resistance ohmmeter.

## 5.10 SURGE ARRESTERS

A. Visual and Mechanical Inspection

1. Physical and mechanical conditions shall be inspected.
2. Proper anchorage shall be checked.
3. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.

B. Electrical Tests

1. An insulation resistance test shall be performed at voltage levels in NETA ATS 2003 Table 100.1.
2. Verify low resistance of grounding connection.

## 5.11 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection

1. Inspect physical and mechanical condition.
2. Verify correct connection of transformers with system requirements.
3. Verify that adequate clearances exist between primary and secondary circuit wiring.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
5. Verify that all required grounding and shorting connections provide contact.
6. Verify correct primary and secondary fuse sizes for potential transformers.

B. Electrical Tests – Current Transformers

1. Perform insulation-resistance test of the current transformer and wiring-to-ground at 1000 volts dc. Do not perform this test on solid-state devices.
2. Perform a polarity test of each current transformer.

3. Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1 (*IEEE Guide for Field Testing of Relaying Current Transformers*).
4. Perform an excitation test on transformers used for relaying applications in accordance with ANSI C57.13.1. (*IEEE Guide for Field Testing of Relaying Current Transformers*).
5. Current transformer circuits must be checked for proper connections. Continuity must be checked by applying 5 amp secondary current at the current transformer block and reading current in each phase of the protective relay. The current transformer circuits must be checked for loose wiring and parallel current paths. Verify that only one ground exists on the total current transformer circuit.
6. Measure current circuit burdens at transformer terminals and determine the total burden.
7. When applicable, perform insulation-resistance and dielectric withstand tests on the primary winding with secondary grounded. Test voltages shall be in accordance with NETS ATS 2003 Tables 100.1 and 100.9 respectively.

C. Electrical Tests – Voltage Transformers

1. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Test voltages shall be applied for one minute in accordance with NETA ATS 2003 Table 100.1. Do not perform this test with solid-state devices connected.
2. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.
3. Perform a turns ratio test.
4. Measure potential circuit burdens at transformer terminals and determine the total burden.
5. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. The dielectric voltage shall be in accordance with NETA ATS 2003 Table 100.9. The test voltage shall be applied for one minute.

## 5.10 PROTECTIVE RELAYS

### A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect relays and cases for physical damage.
3. Tighten case connections. Inspect any relay and meter covers for correct gasket seal. Clean cover glass. Inspect shorting hardware, connection paddles, and/or knife switches. Remove any foreign material from the case. Verify target reset.
4. Verify tightness of all wiring connections.
5. Set relays in accordance with coordination study and/or data files supplied by the engineer. Microprocessor-based relays will require a lap-top computer for uploading data files.
6. All relays shall be tested in their case using relay test switches or test paddle ports.

B. Electrical and Functional Tests

The Micro-processor based DOBLE test set including the PC and DOBLE supporting software shall be used as part of the relay testing. The DOBLE test equipment shall have independent three phase voltages and currents that are controlled by the PC and associated software, for the inputs to the testing relays.

The DOBLE PROTEST Software System shall be used for the relay testing. A typical DOBLE hierarchy shall be used to record the test data/reports. The test and commissioning shall be submitted to the Engineer upon completion.

1. The testing firm shall use the electrical and functional tests recommended by the relay manufacturer for each specific relay used.
2. The relay test points will be documented or specified in the Relay Setting document provided by the Owner.
3. In general, the following tests shall be performed for each relay functions applied in the relay setting document
4. Inspect targets and indicators. Verify operation of all light-emitting diode indicators.
5. Functional Operation - Test as per owner requirements or manufacturer recommendations.

- a. Special Case - 63/63LTC Transformer/LTC Sudden Pressure

Relay Determine rate-of-rise or the pickup level of suddenly applied pressure in accordance with manufacturer's specifications. Verify operation of the sudden pressure seal-in circuit (if applicable). Verify trip circuit to remote breaker or lockout relay.

6. Verify that each of the relay contacts performs its intended function in the control scheme including breaker trip tests, close inhibit tests, 86 lockout tests, and alarm functions. Trip checks of all relays must be performed with secondary current injection and shall be witnessed by Engineer or Owner.
7. After the equipment is initially energized, verify balanced voltage and phase rotation. Verify voltage and current input to all relays and transducers.

C. Test Values

1. When not otherwise specified, use manufacturer's recommended tolerances.
2. When critical test points are specified, the relay function should be calibrated to those points even though other test points may be out of tolerance.

## 5.12 METERING DEVICES

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify tightness of electrical connections.
4. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.
5. Verify the unit is clean.
6. Verify freedom of movement, end play, and alignment of rotating disk(s).

B. Electrical Tests

1. Verify accuracy of meters at all cardinal points.
2. Calibrate meters in accordance with manufacturer's published data.

3. Verify all instrument multipliers.
4. Verify that current transformer and voltage transformer secondary circuits are intact.

### 5.13 BATTERY AND CHARGER

#### A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
4. Measure electrolyte specific gravity and temperature and visually check fill level if applicable.
5. Verify presence of flame arresters.
6. Verify adequacy of battery support racks, mounting, anchorage, and clearances.
7. Verify ventilation of battery room or enclosure.
8. Verify existence of suitable eyewash equipment.

#### B. Electrical Tests

1. Set charger float and equalizing voltage levels.
2. Verify all charger functions and alarms.
3. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.
4. Measure intercell connection resistances.
5. Perform cell impedance test.
6. Perform a capacity load test in accordance with manufacturer's specifications and the following ANSI/IEEE standards:

- a. ANSI/IEEE Std 450-1987. Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.
- b. ANSI/IEEE Std 1106-1987. Recommended Practice for Maintenance, Testing and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations

## 5.14 SWITCHGEAR

### A. Visual and Mechanical Inspection

1. Inspect physical, electrical, and mechanical condition.
2. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
3. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
4. Verify tightness on accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS 2003 Table 100.12.
5. Make key exchange with devices operated in off-normal positions.
6. Inspect insulators for evidence of physical damage or contaminated surfaces.
7. Verify correct barrier and shutter installation and operation.
8. Exercise all active components.
9. Inspect all mechanical indicating devices for correct operation.
10. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding, in accordance with Instrument Transformers Section.
11. Inspect control power transformers.
12. Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
13. Verify that primary and secondary fuse ratings or circuit breakers match manufacturer's drawings.

14. Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

B. Electrical Tests

1. Perform tests on all instrument transformers in accordance with the Instrument Transformers Section.
2. Perform ground-resistance tests in accordance with the Grounding Systems Section.
3. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground. Verify that breakers and instrument transformers are in the racked-out position.
4. Perform a dc high-potential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with NETA ATS 2003 Table 100.2. The test voltage shall be applied for one minute. Do not perform test until acceptable insulation-resistance test values are obtained.
5. Perform phasing check on double-ended switchgear to insure correct bus phasing from each source.
6. Perform the following tests on control power transformers.
  - a. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with NETA ATS 2003 Table 100.1 unless otherwise specified by manufacturer.
  - b. Verify correct function of control transfer relays located in switchgear with multiple power sources in following energized source for control power transformers.
7. Verify operation of switchgear heaters.

5.15 MEDIUM VOLTAGE POWER CABLE (not used)

5.16 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection

Verify ground system is in compliance with drawings and specifications.

B. Electrical Tests

1. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main substation and remote grounding system.
2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points. (Reference: IEEE Standard 142.)
3. The resistance between the main substation ground grid and ground shall be no greater than one (1) ohm.

5.17 LOW VOLTAGE (600V AND UNDER) AND CONTROL CABLES

A. Visual and Mechanical Inspection

1. Compare cable data with drawings and specifications.
2. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
3. Inspect compression-applied connectors for correct cable match and indentation.
4. Inspect for correct identification and arrangements.
5. Inspect jacket insulation and condition.
6. Verify that cable termination points match drawings.

B. Electrical Tests

Cables shall be terminated prior to when the testing contractor arrives on site. If the visual and mechanical inspection reveals any cable damage, or if any system functional tests fail because of suspected cable damage, then the following tests shall be performed:

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.
2. Perform continuity tests to insure correct cable connection.

C. Test Values

1. Insulation-resistance values should not be less than 50 megohms.

## 5.18 AUTOMATIC TRANSFER SWITCH

### A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, grounding, and required clearances.
4. Verify the unit is clean.
5. Verify lubrication requirements
6. Verify tightness of all control connections.
7. Perform manual transfer operation.
8. Verify positive mechanical interlocking between normal and alternate sources.

### B. Electrical Tests

1. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute. For units with solid-state components or for control devices that can not tolerate the applied voltage, follow manufacturer's recommendation.
2. Perform a contact/pole-resistance test.
3. Verify settings and operation of control devices.
4. Calibrate and set all relays and timers.
5. Verify phase rotation, phasing, and synchronized operation as required by the application.
6. Perform automatic transfer tests:
  - a. Simulate loss of normal power.

- b. Return to normal power.
  - c. Simulate loss of emergency power.
  - d. Simulate all forms of single-phase conditions.
7. Verify correct operation and timing of the following functions:
- a. Normal source voltage-sensing relays.
  - b. Time delay upon transfer.
  - c. Alternate source voltage-sensing relays.
  - d. Automatic transfer operation.
  - e. Interlocks and limit switch function.
  - f. Time delay and retransfer upon normal power restoration.

C. Test Values

- 1. Compare bolted connection resistances to values of similar connections.
- 2. Bolt-torque levels should be in accordance with NETA 2003 ATS Table 100.12 unless otherwise specified by manufacturer.
- 3. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- 4. Insulation-resistance values should be in accordance with NETA 2003 ATS Table 100.1.

## 5.19 SYSTEM FUNCTION TESTS

It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.

Perform system function tests upon completion of the acceptance tests on specified equipment. Provide yellow highlighted control, one-line and three-line drawings to verify the following system checks:

1. Develop test parameters and perform tests for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of all sensing devices, alarms, indicating devices, lock-out relays, control switches etc.
4. Verify all voltage and current sensing circuits (PT and CT secondary circuits) by applying full load values and measuring magnitude and phase at each terminal point in the circuit.
5. Verify control wiring through system functional checks.

## 5.20 SPECIAL TESTS

- A. Visual and Mechanical Inspection
- B. Electrical Tests