Bonding and Grounding

NEC Articles

230, 250

Standard

Specifications

- **8-20.3(9)**

Ground Tile

Approved Acorn Ground Clamp

J-9a

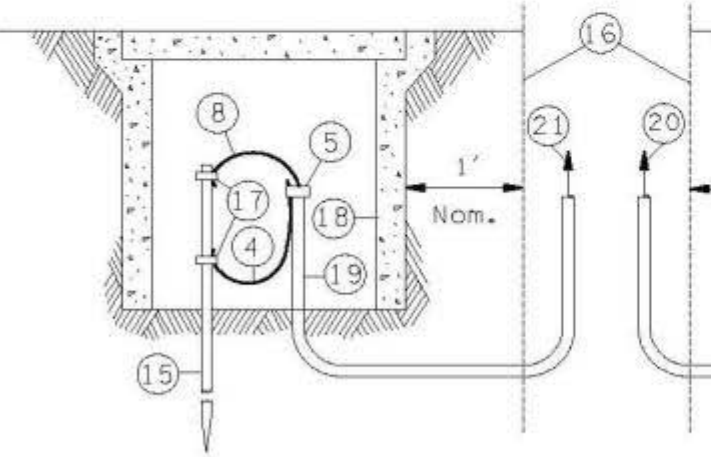
NOTES

1. If parallel circuits of different sizes are contained in one conduit, the size of the grounding conductor shall be determined on the basis of the largest conductor. Only one grounding conductor is required for each conduit regardless of the number of circuits contained.

2. Service ground per serving utility requirement. If the utility uses aluminum service conductors, an approved Al-Cu pressure type ground connector shall be used to secure the service neutral to the copper neutral bar in the service enclosure. Except for the above, all grounding conductors shall be copper.

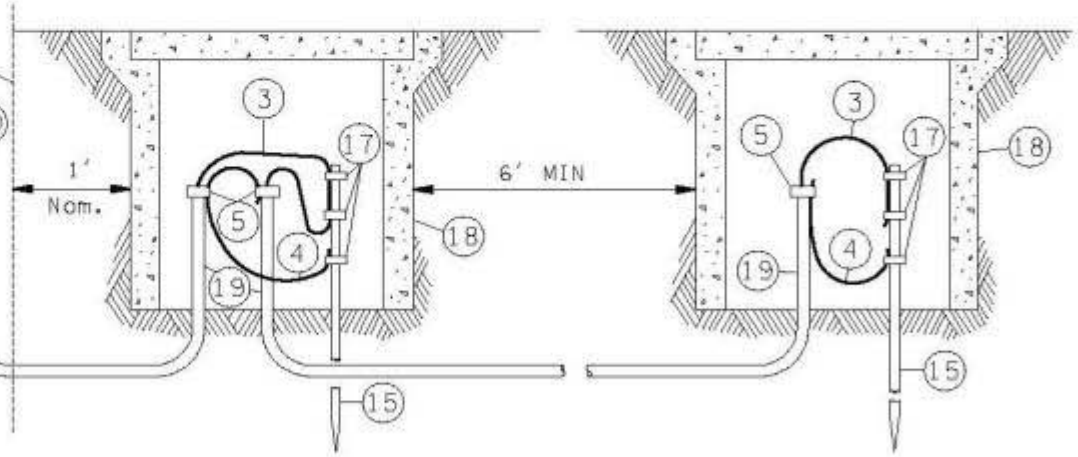
3. Equipment grounding conductors and grounding electrode conductors shall be sized in accordance with the National Electric Code (No. 8 minimum) .

SUPPLEMENTAL GROUND



Required to supplement equipment grounding for luminaire standards with direct burial, aerial feeds, or where required in plans.

SERVICE GROUND



Required at all services and separately derived systems.

GROUND ROD DETAILS

Ground Rod in Tile

Refer to J-3b for foundation installs


OCT 6 2006

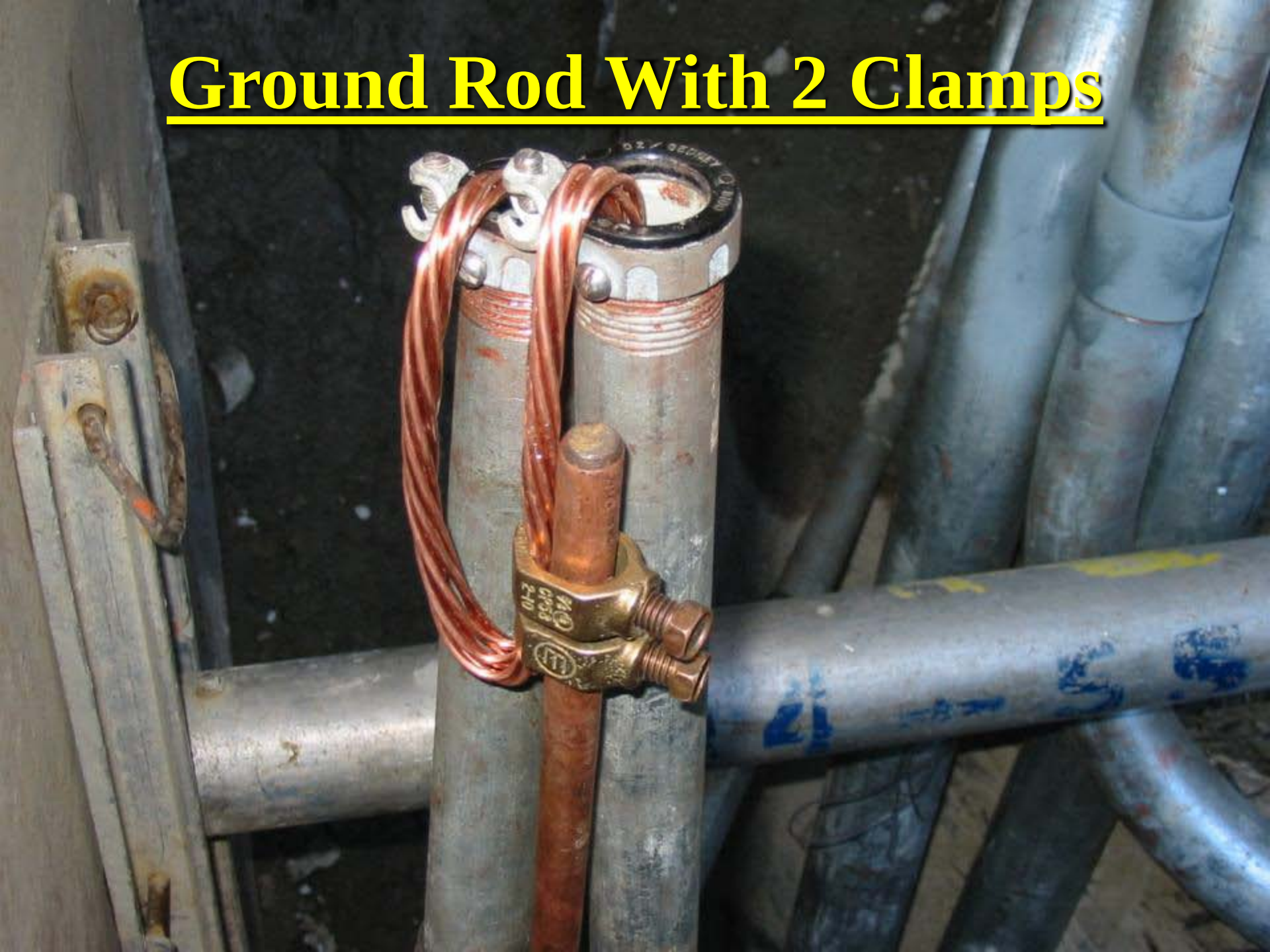

GROUND
OCT 6 2006

The Service Ground

- J-9A Key note 20: To Neutral Buss.
- 8-20.3(9): The first service ground rod shall be connected to a continuous ground electrode conductor running to the service neutral buss.

J-9a

Ground Rod With 2 Clamps



Use SS Hardware to Bond JB Not Zinc Plated

Bond the Box Lid

Crimp Ground Wires to Braided Strap

Exothermal Weld Ground Ring

8-20.3(9) Grounding and Bonding

- All metallic appurtenances containing electrical conductors shall be made mechanically and electrically secure to form a continuous grounding system.
- Where conduit is installed the installation shall include an equipment grounding conductor in addition to the conductors noted in the contract.
- Where an existing conduit is used for new circuits an equipment grounding conductor shall be added unless already existing.
- The ground conductors shall be sized per the NEC to meet the grounding requirements of the largest current carrying conductors in the conduit. Minimum Size #8 WSDOT.

Services and Transformers

NEC Articles

210, 225, 230, 240, 250, T250.66, T250.122, 300, 312, 408, 450

Standard Specifications

- **8-20.3(10)**
- **9-29.24 service cabinets**
- **9-29.24(1) painting**
- **9-29.24(2) electrical circuit breakers and contactors**

Type “B” Service

J-3b

Type “B” Service

“B” Service Inside

Type “D” Service

Multi-Cabinet Foundation

Multi-Cabinet With Labels

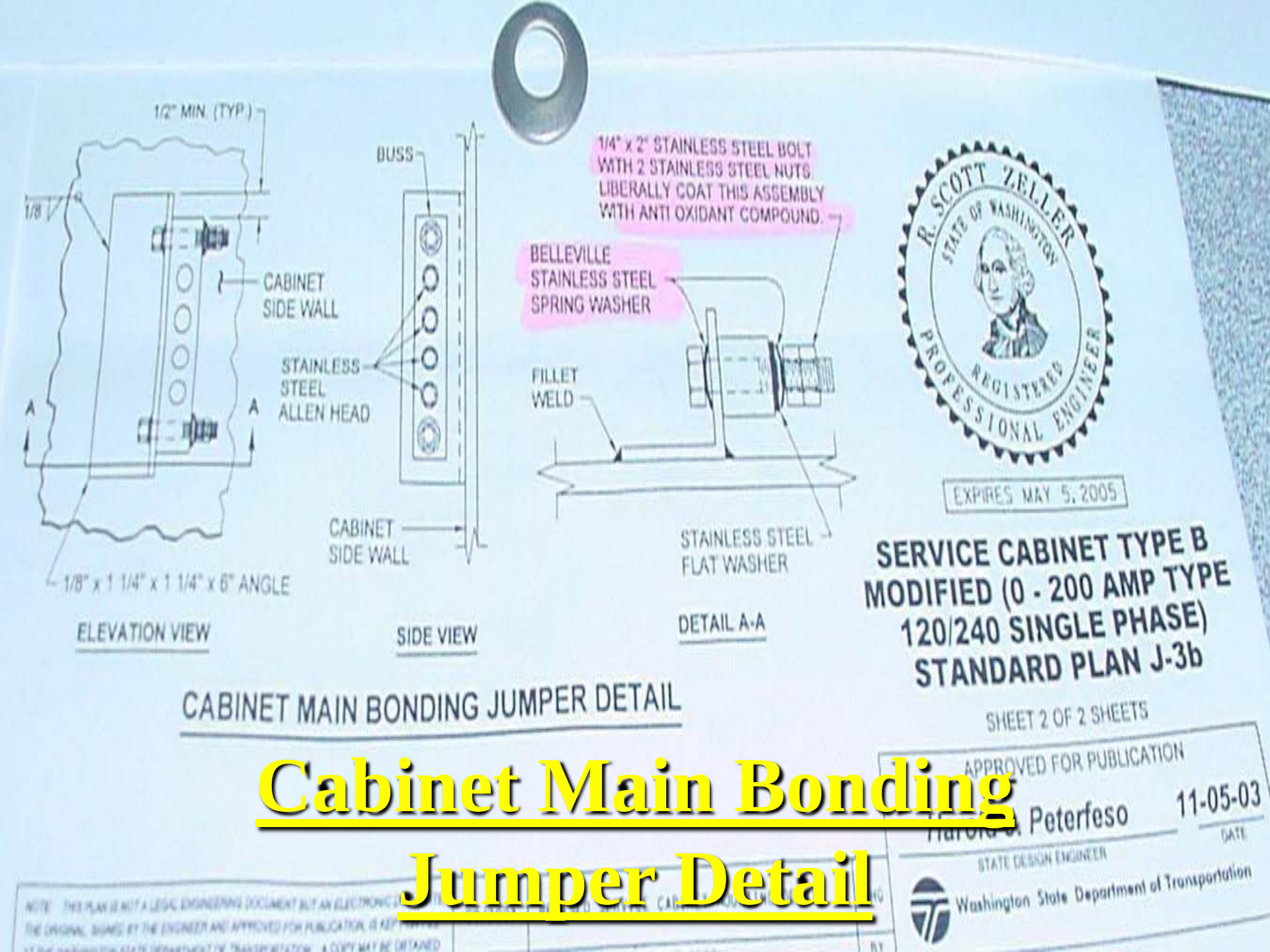
Inside the Type D Service

400 Amp Type D Service

Inside 400 Amp Type D Service

J-3d

Inside the Type “E” Service



Cabinet Main Bonding Jumper Detail

Common Problems

Label Busswork Rating:

J-3b	Key note 21
J-3c	Key note 25
J-3d	Key note 28

Power Conduit Should Extend Into Wireway

Tinned copper, Anti oxidant, Double nuts

J-3d	key note 15

More Problems

Phenolic Tag on bypass switch
General Note 5

Plastic holder on door
Key Note 17 specifies:
“Metal Wiring Diagram Holder”

Minimum Size Panel Boards

- **J-3b Type B Service**

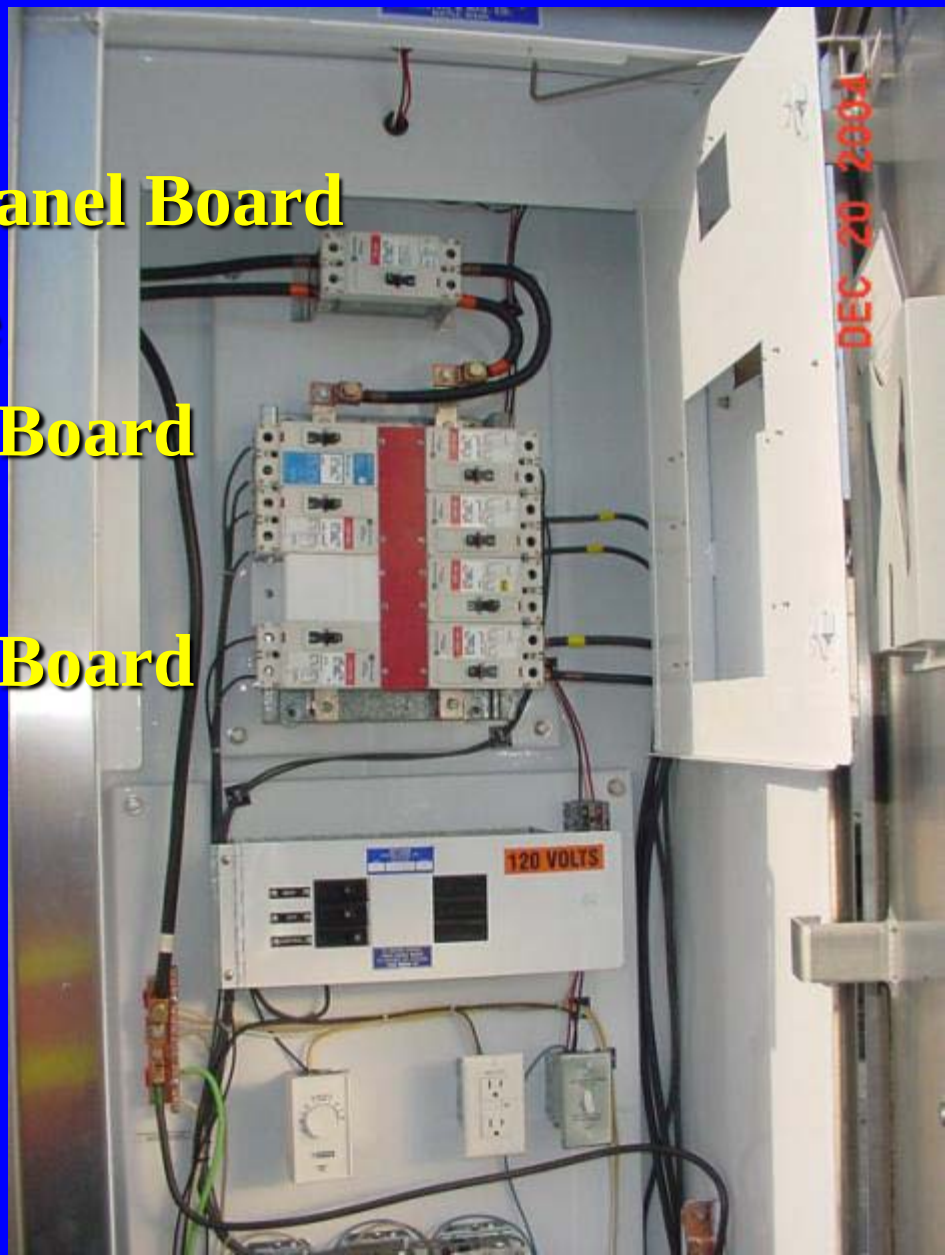
  Key Note 20 - 18 Circuit Panel Board

- **J-3c Type D Service**

  Key 24 - 24 Circuit Panel Board

- **J-3d Type E Service**

  Key 27 - 24 Circuit Panel Board



In this picture this is a 16 Circuit Panel board

Transformer and 120 V Cabinet

Conductors Too Large for Lugs

9-29.24 (B)

If field wiring larger than that which the contactors or breakers will accommodate is required by the contract, a terminal board shall be supplied for use as a splicing block.

Pin connectors could be accepted with approval.

Field Test

Standard Specifications

- **8-20.3(11) Testing (Electrical)**
- **8-20.3(14)D Induction Loops & Lead-in Cable**
- **6-02.3(2)B Commercial concrete**
- **6-02.3(5)A General acceptance of concrete**
- **8-20.3(8)A Signal Controllers**

NW Region Special Provisions

8-20.3 Com. Cable, Fiber, VMS, CCTV, Ramp Meters, & Hars

8-20.3(11) Page 8-85

Check List for Testing Data

CHECK LIST OF TESTING DATA

Northwest Region (revised 12/05)

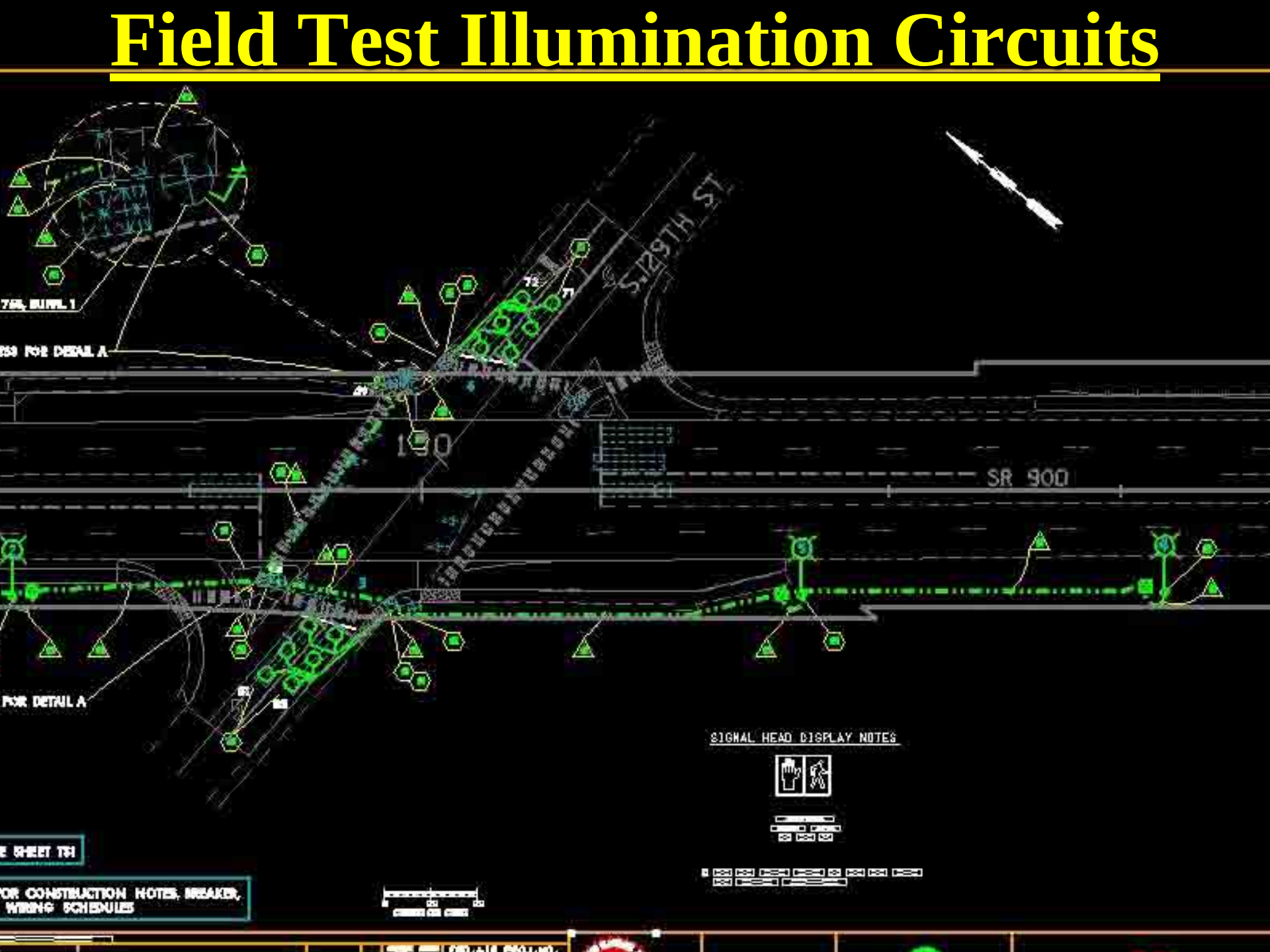
Yes	No	
☐	☐	**1. Power circuit testing 8-20.3(11).**
☐	☐	**2. Induction loops and lead-in cable test 8-20.3(14)D.**
☐	☐	**3. Communication Cable Acceptance Testing Special Provisions 8-20.3(8).**
☐	☐	**4. Signal Controller Testing 8-20.3(14)A.**
☐	☐	**5. Twisted-Pair (TWP) Copper Cable Testing as required in the ITS Special Provisions. S.P. 8-20.3.**
☐	☐	**6. Fiber Optic Cable Testing.**
		a. Attenuation Testing
		b. Optical Time Domain Reflectometer (OTDR) Testing, as required in the Special Provisions. S.P. 8-20.3
☐	☐	**7. Variable Message Signs.**
		a. System testing of the VMS Hardware.
		b. NTCIP testing for the VMS sign.
		c. Acceptance Testing of the VMS sign as required in the Special Provisions. S.P. 8-20.3
☐	☐	**8. Closed Circuit Television System.**
		a. CCTV Test.
		b. Bench CCTV Test.
		c. Local CCTV Test.
		d. Hub CCTV Test.
		e. TMC CCTV Test as required in the Secial Provisions. S.P. 8-20.3
☐	☐	**9. Traffic data accumulation and Ramp Metering System.**
		a. Cabinet testing.
		b. Hardware and Systems Test.
		c. Modem Testing.
		d. Controller Testing.
		e. Turn on Test as required in the Special Provisions. S.P. 8-20.3
☐	☐	**10. HAR System Testing as required in the ITS Special Provisions. S.P. 8-20.3**

Megometer


WARNING HIGH VOLTAGE – SEE MANUAL
Simpson
BATT. TEST
2–200 MΩ
1–5 MΩ
0–4 MΩ
model 400-2
INSULATION TESTER
CONTINUITY CHECK


Inductive
Loop Analyzer
SELECT
Model 550

Field Test Illumination Circuits



8-20.3(14)D Test for Induction Loops and Lead-in Cable

Loop Test 8-20.3(14) D (2006) **Date:** _____

Location: _____ **Contract Number:** _____

Taken By:

		Test A	Test B	Test C
Loop Number	Loop Type 3, 3A, 3B	Ohms. <= 10	Meg. Test Loop/Gr. >= 100	M. Henry R1 >= 75 R3 >= 150
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				
9)				
10)				
11)				
12)				
13)				
14)				
15)				
16)				
17)				
18)				
19)				
20)				
21)				
22)				
23)				
24)				
25)				
26)				
27)				
28)				
29)				
30)				
31)				
32)				
33)				
34)				
35)				
36)				
37)				

Test “A” for long ITS loops should not exceed the values calculated using the formula below:

Resistance per 1000 ft of #14 AWG, R = 3.16 ohms / 1000 ft

$$\frac{R = 3.16 \times \text{distance of lead-in cable (ft)}}{1000 \text{ ft}}$$

6-02.3(2)B Commercial Concrete

- **Commercial concrete shall have a minimum compressive strength at 28-days of 3000-psi in accordance with WSDOT FOP for ASSHTO22**
- **Commercial class concrete shall not be used for structural items such as:**
- **Foundation for High Mast Lights**
- **Foundations for Mast arm Signals**
- **Foundations for Cantilever Signs**
- **Foundations for Sign Bridges**

6-02.3(5)A Concrete Acceptance

- **Will be accepted based on conformance to the requirements for temperature, slump, air content for concrete placed above finished ground line and the specified compressive strength at 28-days for sublots as tested and determined by the Contracting Agency.**

NW Region Signal Cabinet Test Report

Aux. Equipment not supplied with cabinet:

- OC Isolators ☐
- Loop amps ☐
- Opticons ☐
- Load switches ☐
- Flashers ☐
- Controller ☐
- Monitor ☐

NW Region Signal Division
Electronics Shop

3700 9th Avenue South
Seattle, Wa. 98134

SIGNAL CABINET TEST REPORT

Cabinet Type _____

Contract or Assignment Number _____

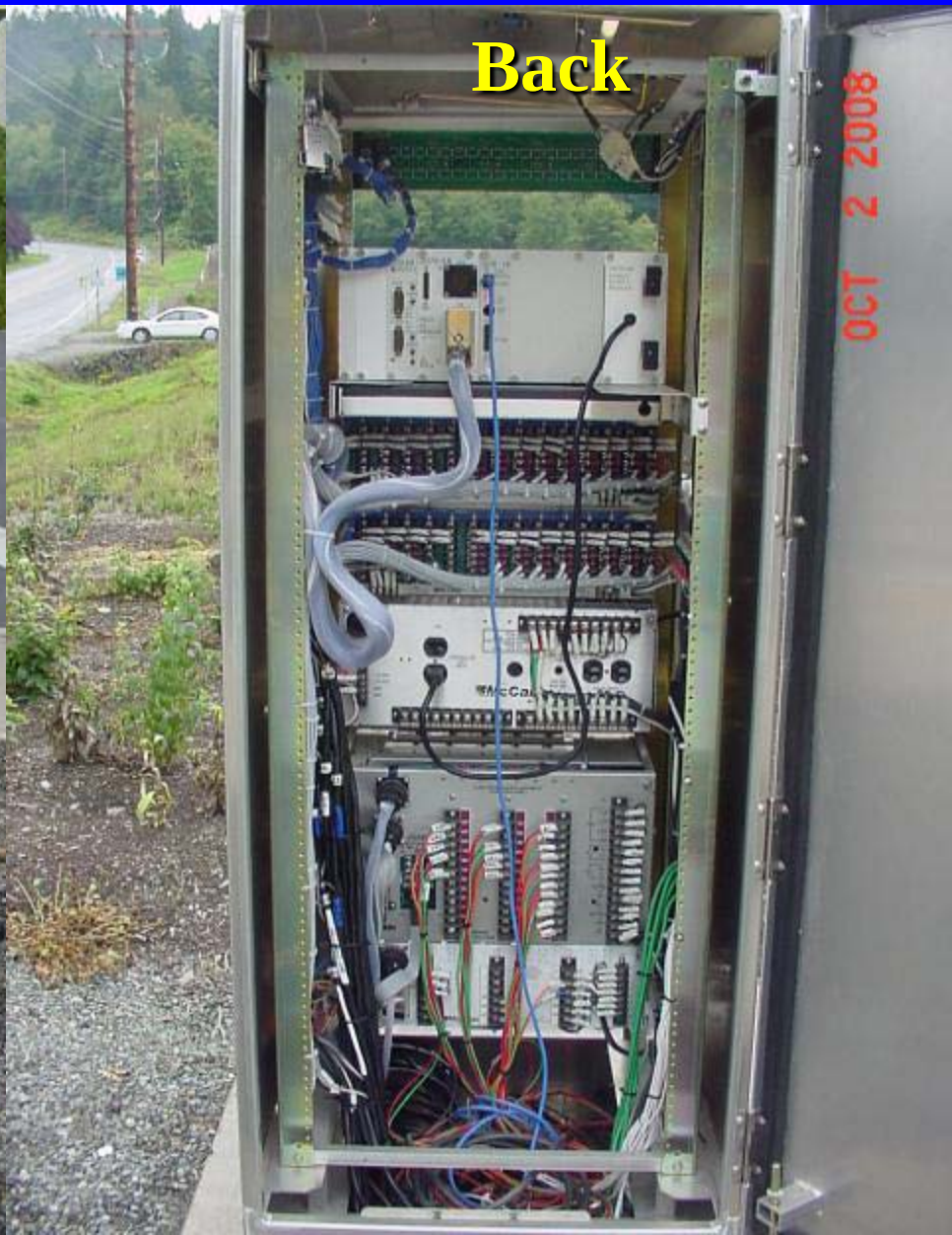
	TEST	Completed
1	Test conflict monitor.	
2	Visually check cabinet for damage.	
3	Check tightness of all connectors.	
4	Visually check 120V AC input service.	
5	Test fan.	
6	Check for proper power distribution.	
7	Test cabinet flash mode.	
8	Test conflict flash mode.	
9	Test watch dog flash mode.	
10	Test all outputs.	
11	Test all vehicle inputs.	
12	Test all preemption inputs.	
13	Test all pedestrian inputs.	
14	Test all police panel switches for proper operation.	
15	Operation of cabinet for a minimum of 48 hours without problems of failures.	
16	Affix WSDOT TESTED sticker on inside top front cabinet door.	
17	Place a copy of this completed form and conflict monitor test report in cabinet.	

I certify this cabinet has met all the above tests and is ready for service.

Signature _____

Name _____

Signal Control Cabinet



Illumination Systems

NEC Articles 110.21, 250, 300.19, 402, 410, 590

Standard Specifications

- **8-20.3(13)**
- **8-20.3(13)a light standards**
- **8-20.3(13)b luminaires**
- **9-29.6 light and signal standards**
- **9-29.6(1) steel light and signal standards**
- **9-29.6(2) slip base hardware**
- **9-29.6(4) welding**
- **9-29.10 luminaires**

Put Together Slip Base

SP J-28.40

Slip base installation shall conform to the following:

1. The slip plane shall be free of obstructions such as protruding conduit or anchor bolts. The conduit, anchor bolts, and other obstructions shall terminate at a height below the elevation of the top of the slip plate.
2. Washers in the slip plane shall be placed between the slip plate and the keeper plate.
3. Anchor bolts shall extend through the top heavy-hex nut two full threads to the extent possible while conforming to the specified slip base clearance requirements. Anchor bolts shall be tightened by the Turn-Of-Nut Tightening Method in accordance with Sections 6-03.3(33) and 8-20.3(4).
4. Clamping bolts shall be tightened in accordance with Sections 6-03.3(33) and 8-20.3(4). The clamping bolts shall be tightened to the specified torque, plus or minus 2 percent, in two stages using an accurately calibrated torque wrench before erecting the light standard. Except as otherwise specified, the Contractor shall install 1 inch diameter clamping bolts in all slip bases to a torque of 95 foot-pounds. The Contractor shall tighten the 1 1/8 inch diameter clamping bolts of slip bases for 50 foot light standards with double 10 foot mast arms or greater to a torque to 104 foot-pounds.
5. The galvanized surfaces of the slip plates, the keeper plate and the luminaire base plate shall be smooth, without irregularities, to reduce friction and to prevent slackening of bolt tension due to flattening of the irregularities.
6. Anchor bolts damaged after the foundation concrete is placed shall not be repaired by bending or welding. The Contractor's repair procedure is to be submitted to the Engineer for approval prior to making any repairs. The procedure is to include removing the damaged portion of the anchor bolt, cutting threads on the undamaged portion to remain, the installation of an approved threaded sleeve nut and stud, and repairing the foundation with epoxy concrete. Epoxy concrete shall meet the requirements of Section 9-26.3(1)B.
7. The grout pad shall not extend above the elevation of the bottom of the anchor plate.
8. Wiring for slip base installation shall conform to details in the Standard Plans.

8-20.3(13)A
Pages 8-86,87

Put Together Slip Base

Using the Torque Wrench

- Should not be jerked or hit. A steady pressure should be used until it comes to the specified torque plus or minus 2%. 8-20.3(13)A
- Bolts should be “tightened in 2 stages”. The bolts should be hit with a hammer after the first tightening, and then torque them again. This will help relieve any pressures other than the bolt torque. 8-20.3(13)A
- Torque the bolts with the pole on the ground “before erecting the Light Pole” 8-20.3(13)A
- Never be use a Torque Wrench to loosen bolts
- Using an extension with a torque wrench will diminish accuracy

Put Pole Together


17 11:16AM

Drill Pole, Galvicon and Bolt the Arm

Slip Base Luminaire Pole Bases

Poured Backwards

Correct

Slip Base

OK

Bolts Too High No Plate Washer

SP J-28.40

Plate Washers Must Be Flat

Slip base installation shall conform to the following:

1. The slip plane shall be free of obstructions such as protruding conduit or anchor bolts. The conduit, anchor bolts, and other obstructions shall terminate at a height below the elevation of the top of the slip plate.
2. Washers in the slip plane shall be placed between the slip plate and the keeper plate.
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7. The grout pad shall not extend above the elevation of the bottom of the anchor plate.
8. Wiring for slip base installation shall conform to details in the Standard Plans.

8-20.3(13)A
Page 8-86

Base Needs Material

Base and JB Too Low

Foundation Too Low or Grade Too High

Slip Base After Knock Down

Looking Inside Pole at Conduit

Quick Disconnects

Fuse kit

Fuse holder apart

Pin kit apart

Together

9-29.7
Page 9-165,6

17 1:44PM

Buchanan Fuse Kits (Signal Maintenance)

Screw Together Fuse Kit

Fuse Kits Installed, Improper Wire Markers

8-20.3(8)
Page 8-82

Break Away Couplings

8-20.3(13)A
Page 8-87

Pole Skirt

Pole With Skirt in Place

Fixed Base Pole

SP J-28.30

Lum. Pole Tag

8-20.3(13)A
Page 8-87

Make sure tags on arms and poles match

Identify Pole With 3-inch Series “C” Block Numbers

8-20.3(13)A
Page 8-87,88

SS 8-20.3(13)A

1. **Luminaire Number**
2. **Luminaire Wattage**
3. **Luminaire Voltage**
4. **Service Number**

Numbers on Luminaire Pole

Some Regions Vary. NW Region Requires: Service and Pole Number

Inside the Luminaire With Strain Relief Clamp

Ballast Power Door With Installation Date

8-20.3(13)C
Page 8-88

Luminaire With Wattage Tag

9-29.10
Page 9-169

Wrong

Correct

Street Light/Luminaire Pole Installation Checklist

- Provided in your book

Aerial and Temporary Systems

NEC Articles 110.21, 250, 300, 300.19, 396, 402, 410, 590

Standard Specifications

- 8-20.3(7)
- 8-20.3(13)a Light Standards
  - Minimum Pole burial depth
- 8-20.3(13)b Luminaires
- 9-29.4 Messenger cable fittings
- 9-29.5 Pole line hardware
- 9-29.6(3) Timber Light and Signal Standards

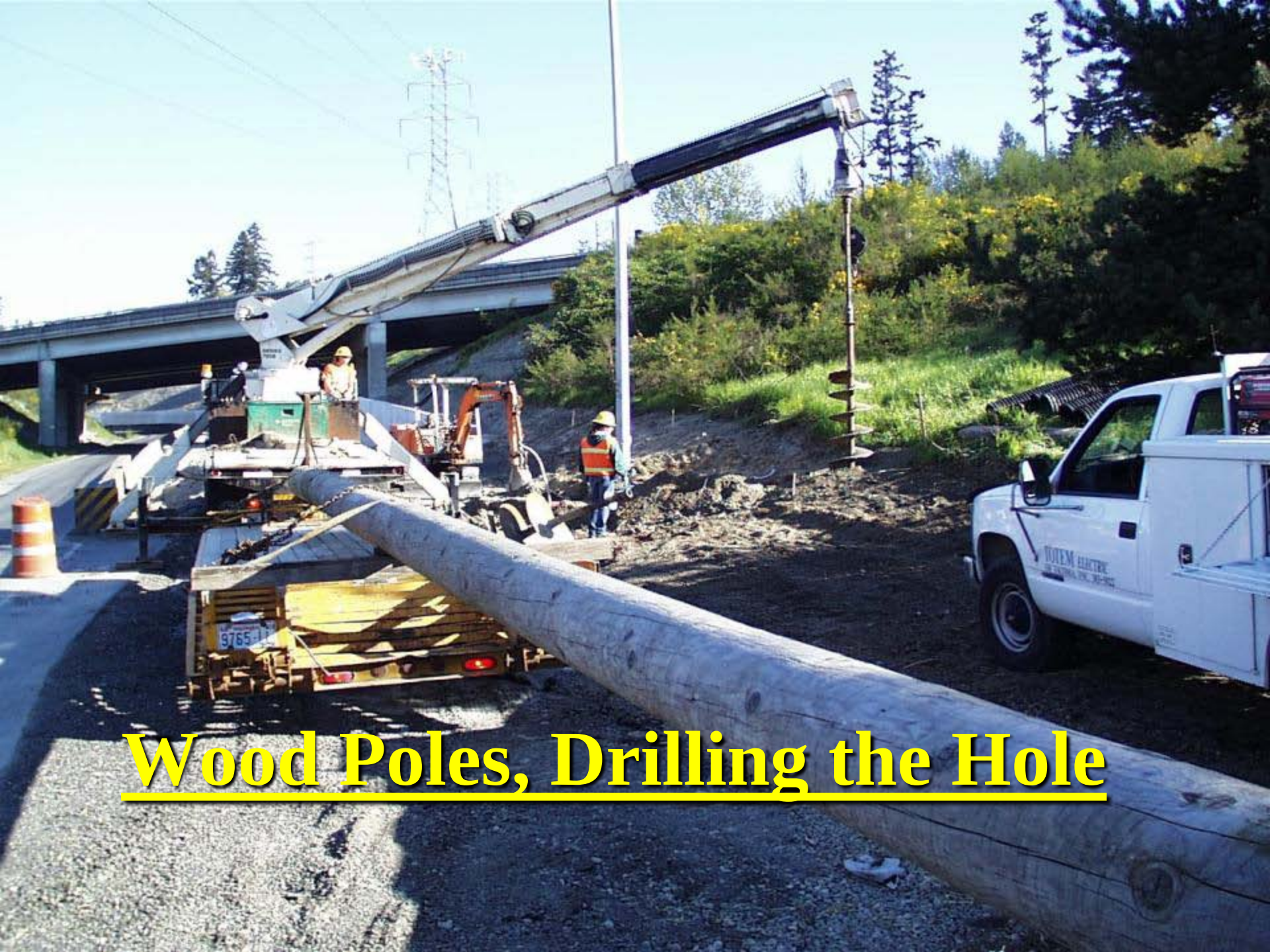
Temp Span used until Permanent is Ready.

Span System Parts

Johnny Ball Insulator With Guy Wraps Installed

Johnny Ball Insulator

Aerial Terminal Box


Wood Poles, Drilling the Hole

Gain Mark

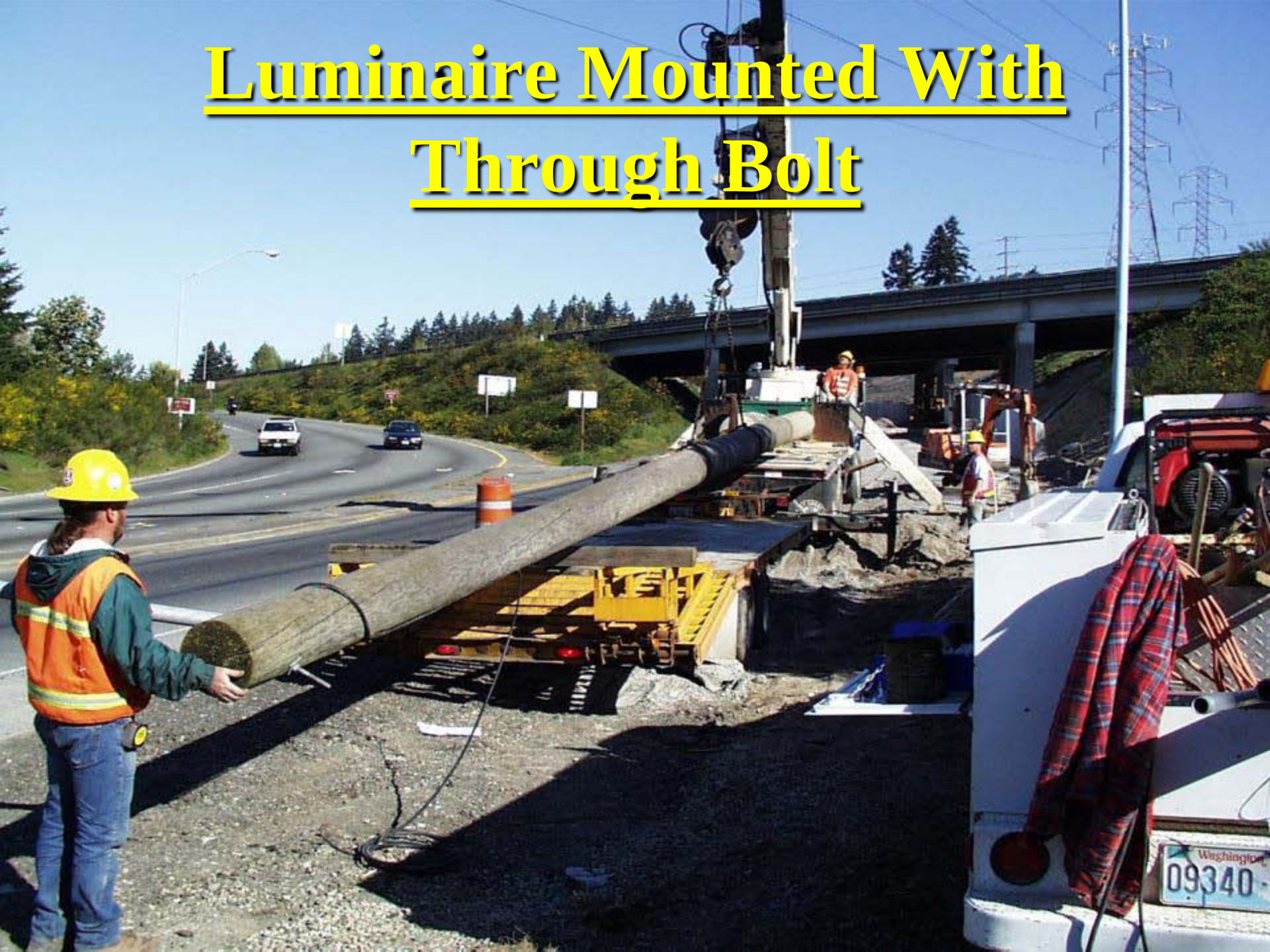
10% of 40-foot pole = 4-feet +2-feet= 6-feet buried

Pole Class Dimensions

Douglas Fir and Southern Pine

Pole Class		Class 1	Class 2	Class 3	Class 4	Class 5
Minimum circumferance at top in inches		27	25	23	21	19
Length of pole	Minimum circumferance at 6 foot from butt in inches					
30		36.5	34.0	32.0	29.5	27.5
40		41.0	38.5	36.0	33.5	31.0
50		45.0	42.0	39.0	36.5	34.0
60		48.0	45.0	42.0	39.0	NA
70		51.0	48.0	45.0	41.5	NA
80		54.0	50.5	47.0	NA	NA
90		56.0	53.0	49.0	NA	NA
100		58.0	55.0	NA	NA	NA

Luminaire Mounted With Through Bolt



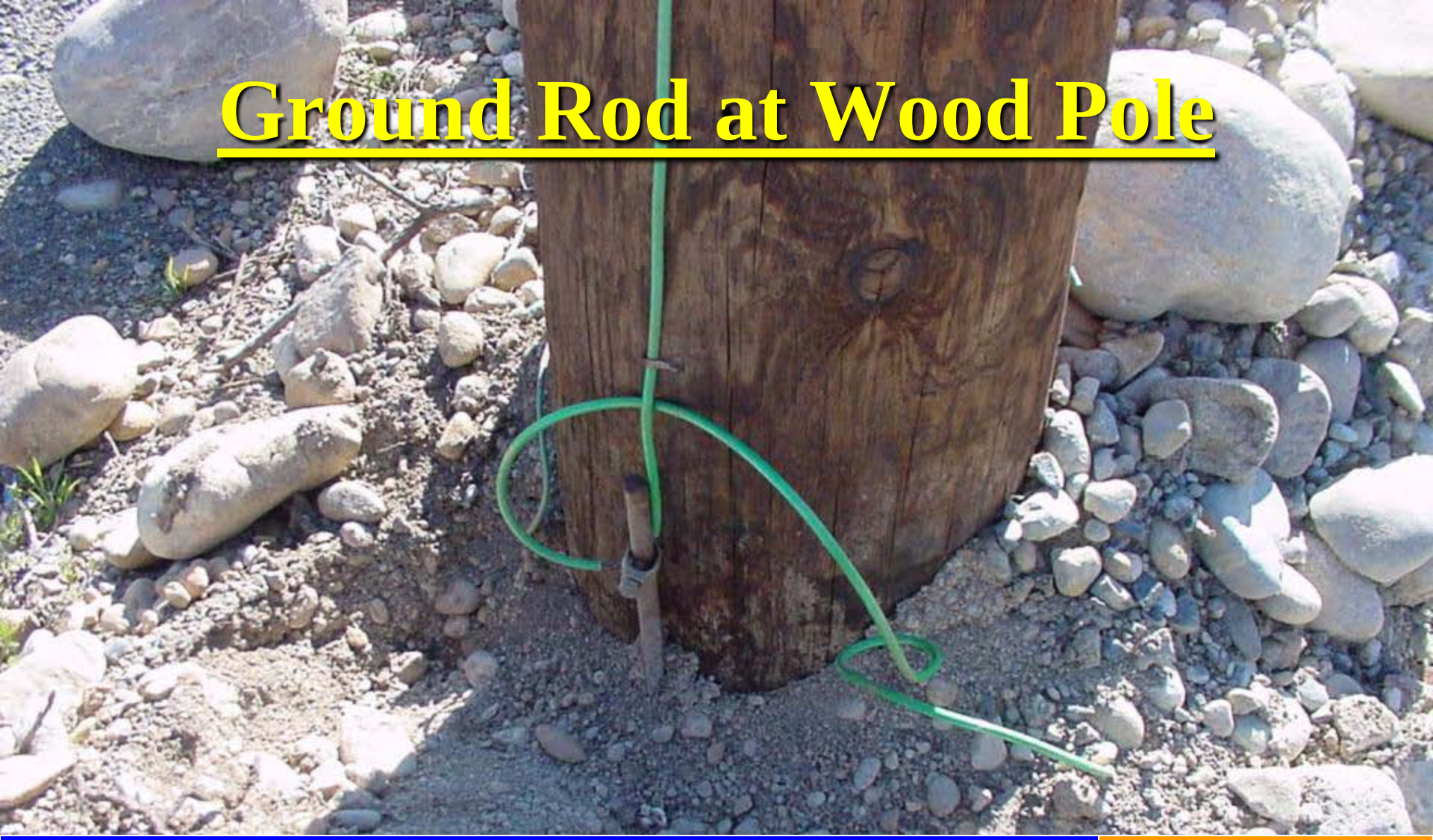
Wedge Clamp
To be used with Tri-Plex only

14 12:53PM

J-1f

Two Temp Lts.

Ground Rod at Wood Pole



Required to supplement equipment grounding for luminaire standards with direct burial, aerial feeds, or where required in the plans.

J-9a

Temp. Lt. Underground Feed

Bonding Jumper Ground Clamp

J-1f

High Mast and Under Deck Lighting

NEC Articles 110.21, 250, 300.19, 402, 410, 590

- **Standard Specifications**
- **8-20.3(4) Foundations**
- **8-20.3(13)C Luminaires**

9-29.10(3) High Mast Luminaires

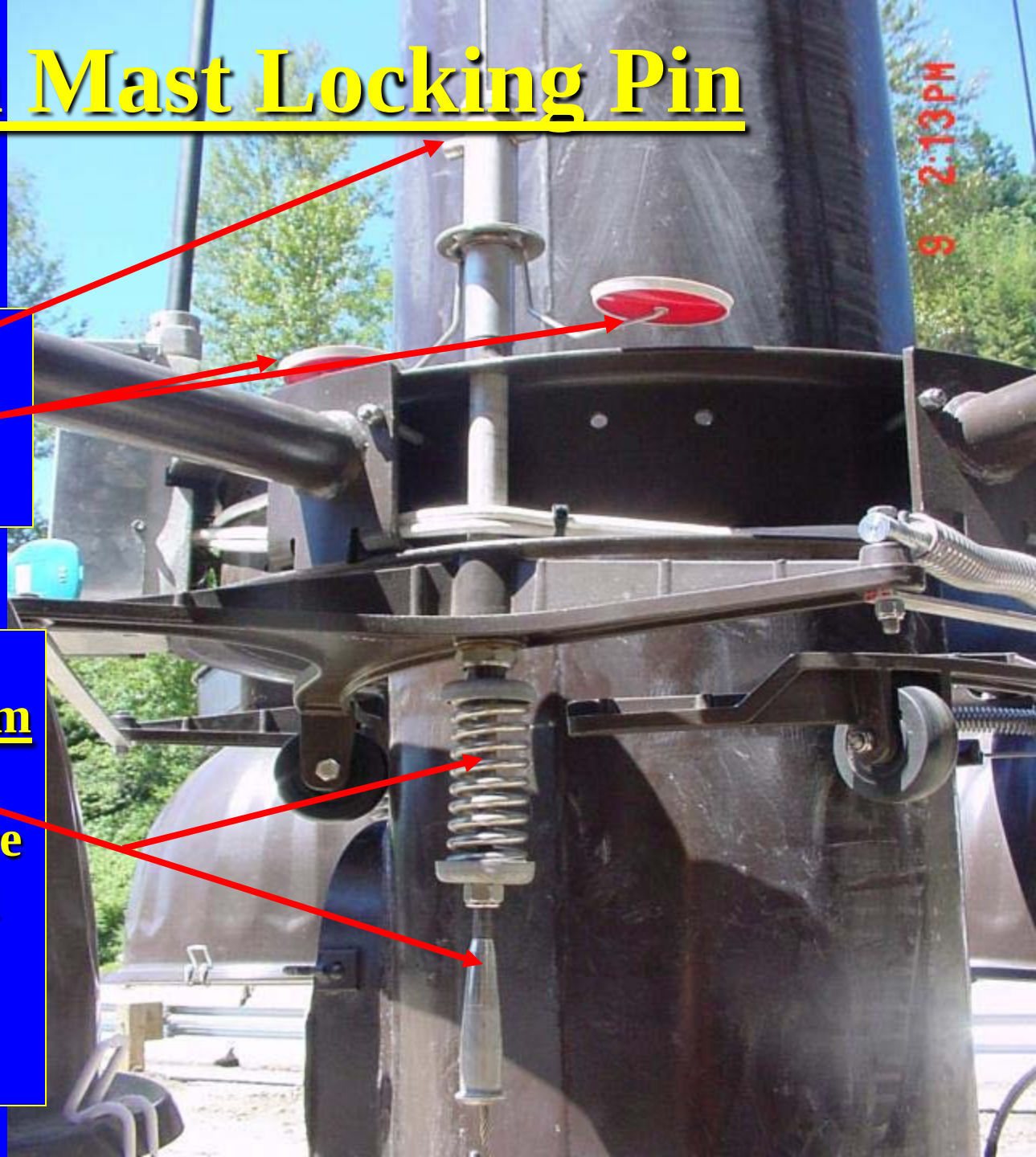
9-29.10(4) Under Deck and Wall Mount Luminaires

100 Foot Pole With Fixture Lowered

High Mast Pole With Fixture Lowered

Lowered High Mast Fixture With Adjusting Blocks Installed

High Mast Locking Pin



Pin Indicator

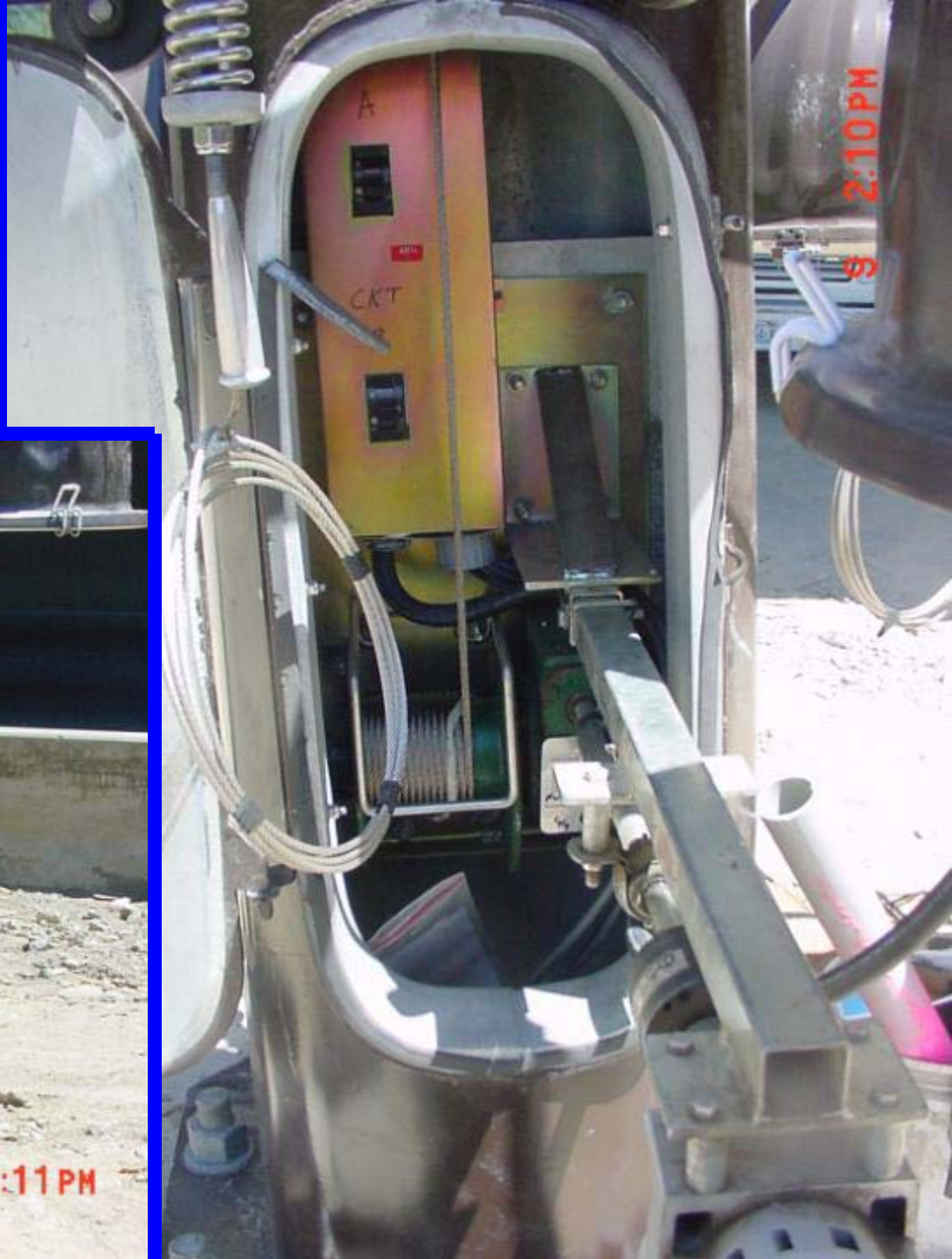
Adjusting Mechanism

Used to adjust fixture so it hangs level and all pins hit locks simultaneously.


High Mast Fixture

Access Door on High Mast Pole

Winch and Circuit Breakers



Under Deck Lights

9-29.10(4)
Page 9-171

Plan Reading

LUMINAIRE SCHEDULE — SERVICE NO. SAC 5003

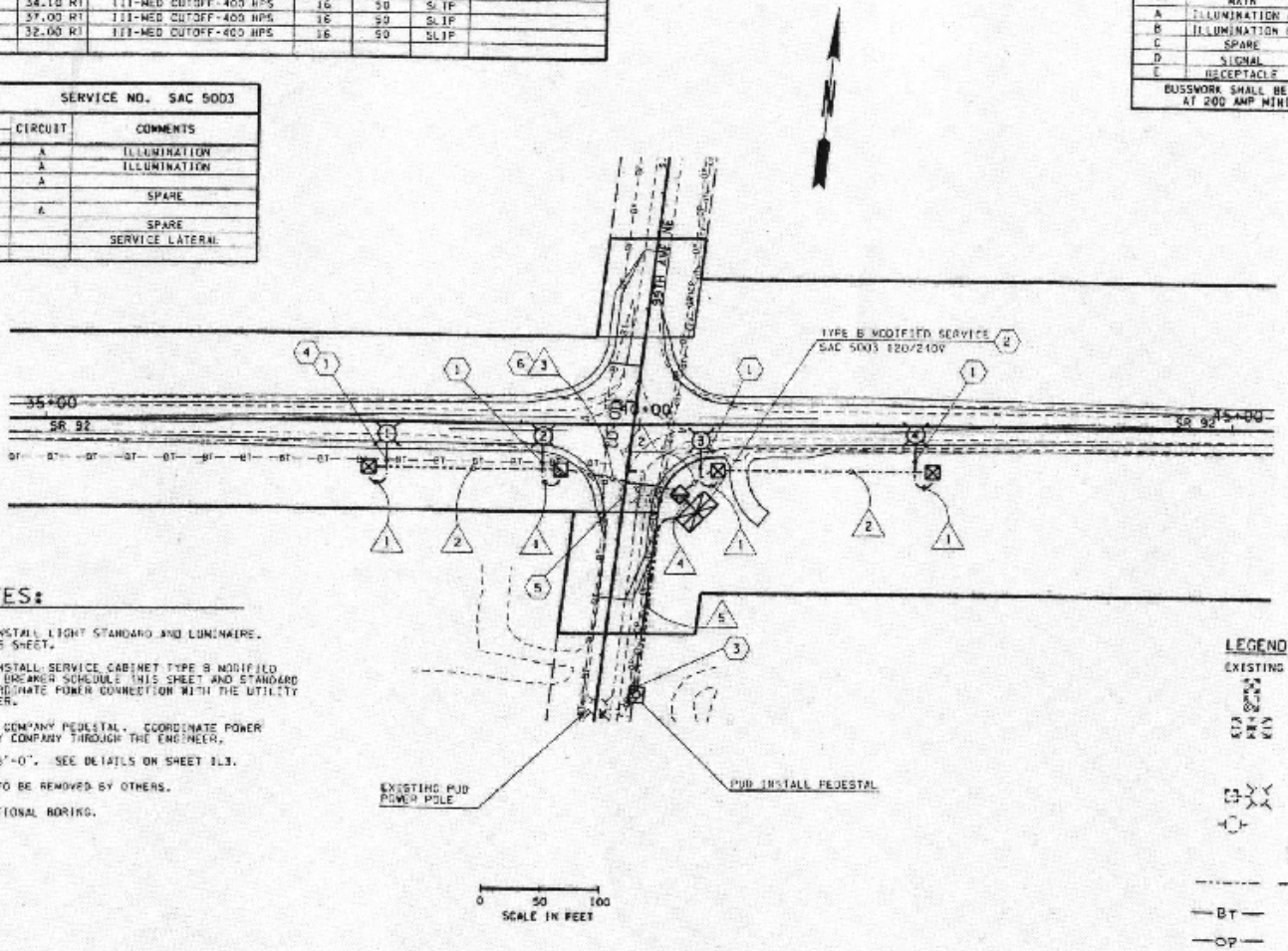
LUMINAIRE NUMBER	CIRCUIT	LOCATION STATION	LOCATION OFFSET	TYPE-DISTRIBUTION-WATTAGE	MAST ARM	MH	BASE TYPE	COMMENTS
1	A	SR 92 37+87	54.25 RT	III-MED CUTOFF-400 HPS	16	50	SLIP	ON 2:1 SLOPE
2	A	SR 92 39+37	34.10 RT	III-MED CUTOFF-400 HPS	16	50	SLIP	
3	A	SR 92 40+52	37.00 RT	III-MED CUTOFF-400 HPS	16	50	SLIP	
4	A	SR 92 42+32	32.00 RT	III-MED CUTOFF-400 HPS	16	50	SLIP	

WIRING SCHEDULE — SERVICE NO. SAC 5003

NO.	CONDUIT SIZE	CONDUCTORS EXISTING	CONDUCTORS NEW	CIRCUIT	COMMENTS
1	1"		2-#8	A	ILLUMINATION
2	1½"		2-#8	A	ILLUMINATION
3	2"		2-#8	A	
	3"				SPARE
4	2"		2-#8	A	
	2"				SPARE
5	2-5"		3-3/0		SERVICE LATERAL

BREAKER SCHEDULE — SAC 5003
TYPE B SERVICE — 120/240V

CIRCUIT	DESCRIPTION	BREAKER RATING	CONTACTOR RATING	VOLTAGE	LOAD (KVA)
---	MAIN	200 AMP	N/A	240	
A	ILLUMINATION A	20 AMP	30 AMP	240	2.1
B	ILLUMINATION B	30 AMP	30 AMP	240	
C	SPARE	30 AMP	N/A	240	
D	SIGNAL	50 AMP	N/A	120	
E	RECEPTACLE	20 AMP	N/A	120	1.8
BUSSWORK SHALL BE RATED AT 200 AMP MINIMUM			PEAK		3.9
			CONTINUOUS		2.1



CONSTRUCTION NOTES:

1. CONSTRUCT FOUNDATION AND INSTALL LIGHT STANDARD AND LUMINAIRE. SEE LUMINAIRE SCHEDULE THIS SHEET.
2. CONSTRUCT FOUNDATION AND INSTALL SERVICE CABINET TYPE B MODIFIED PER BREAKER SCHEDULE. SEE BREAKER SCHEDULE THIS SHEET AND STANDARD PLAN J36 FOR DETAILS. COORDINATE POWER CONNECTION WITH THE UTILITY COMPANY THROUGH THE ENGINEER.
3. ROUTE CONDUIT INTO UTILITY COMPANY PEDESTAL. COORDINATE POWER CONNECTION WITH THE UTILITY COMPANY THROUGH THE ENGINEER.
4. FOUNDATION DEPTH SHALL BE 6'-0". SEE DETAILS ON SHEET IL3.
5. EXISTING TIMBER LUMINAIRE TO BE REMOVED BY OTHERS.
6. INSTALL CONDUITS USE DIRECTIONAL BORING.

LEGEND

EXISTING	NEW	
		TYPE 1 JUNCTION BOX
		TYPE 2 JUNCTION BOX
		ELECTRICAL SERVICE CABINET
		LUMINAIRE STANDARD
		TIMBER LUMINAIRE
		POWER POLE
		UTILITY COMPANY PEDESTAL
		CONDUIT
—BT—		BURIED TELEPHONE
—OP—		OVERHEAD POWER

FILE NAME S:\41626\Electrical\IL\0702\0702ilsh.dgn
TIME 08:52:00 AM
DATE 04/01/2004
DESIGNED BY
ENTERED BY
CHECKED BY
PROJ. ENGR.
REGIONAL ADM.

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED. AID PROJ. NO.
JOB NUMBER 03A054
CONTRACT NO.
LOCATION NO.

4/1/04
P.E. STAMP BOX | DATE

Washington State Department of Transportation

SR 92
SR 9 TO 84TH ST NE VIC
CHANNELIZATION & SAFETY IMPROVEMENTS

ILLUMINATION PLAN

PLOT | IL1 | SHEET 100 OF 125 SHEETS

Print Reading Questions

1. What is the service type?
2. What is the service agreement number?
3. How many luminaries and what are the wattages?
4. Is the service lateral underground or overhead?
5. What is Luminaire #2 stationing?
6. What is the conduit size and wire size between Luminaire #1 and #2?
7. What is Luminaire base type?
8. What is the offset to the foundation for Luminaire #3?
9. How is conduit run #3 to be installed?
10. What is the depth of foundation Luminaire #1?
11. How is the service lateral to be connected to serving utility?
12. What is the legend symbol for overhead power?
13. What is the location of this intersection?
14. The JB next to Luminaire # 2 is what type?
15. List the conduits and their sizes that enter the Luminaire #2 JB.
16. How many inches of conduit are shown in JB above?

Print Reading Questions with Answers

1.	What is the service type?	Type “B mod”
2.	What is the service agreement number? . .	SAC 5003
3.	How many luminaries and what are the wattages? .	4 Luminaries and 400 watt
4.	Is the service lateral underground or overhead? .	Underground
5.	What is Luminaire #2 stationing? . .	SR-92-39+37
6.	What is the conduit size and wire size between Luminaire #1 and #2?	Wire schedule #2 11/2” and two #8s
7.	What is Luminaire base type?.	Slip
8.	What is the offset Lum #3?. .	37.00 RT
9.	How is conduit run #3 to be installed? . . .	Construction note #6, directional bore
10.	What is the depth of foundation Luminaire #1? .	Construction note #4, 6’ 0”
11.	How is the service lateral to be connected to serving utility? . .	C. note #3, coordinate through Engineer
12.	What is the legend symbol for overhead power? .	OP
13.	What is the location of this intersection? . .	SR-92 & 99th Ave NE
14.	The JB next to Luminaire # 2 is what type? . .	Type 2
15.	List the conduits and their sizes that enter the Luminaire #2 JB. .	4 conduits, 1”, 1.5”, 2” & 3”
16.	How many inches of conduit are shown in JB above?	7.5 inches of conduit