APPENDIX 1 – FIGURES

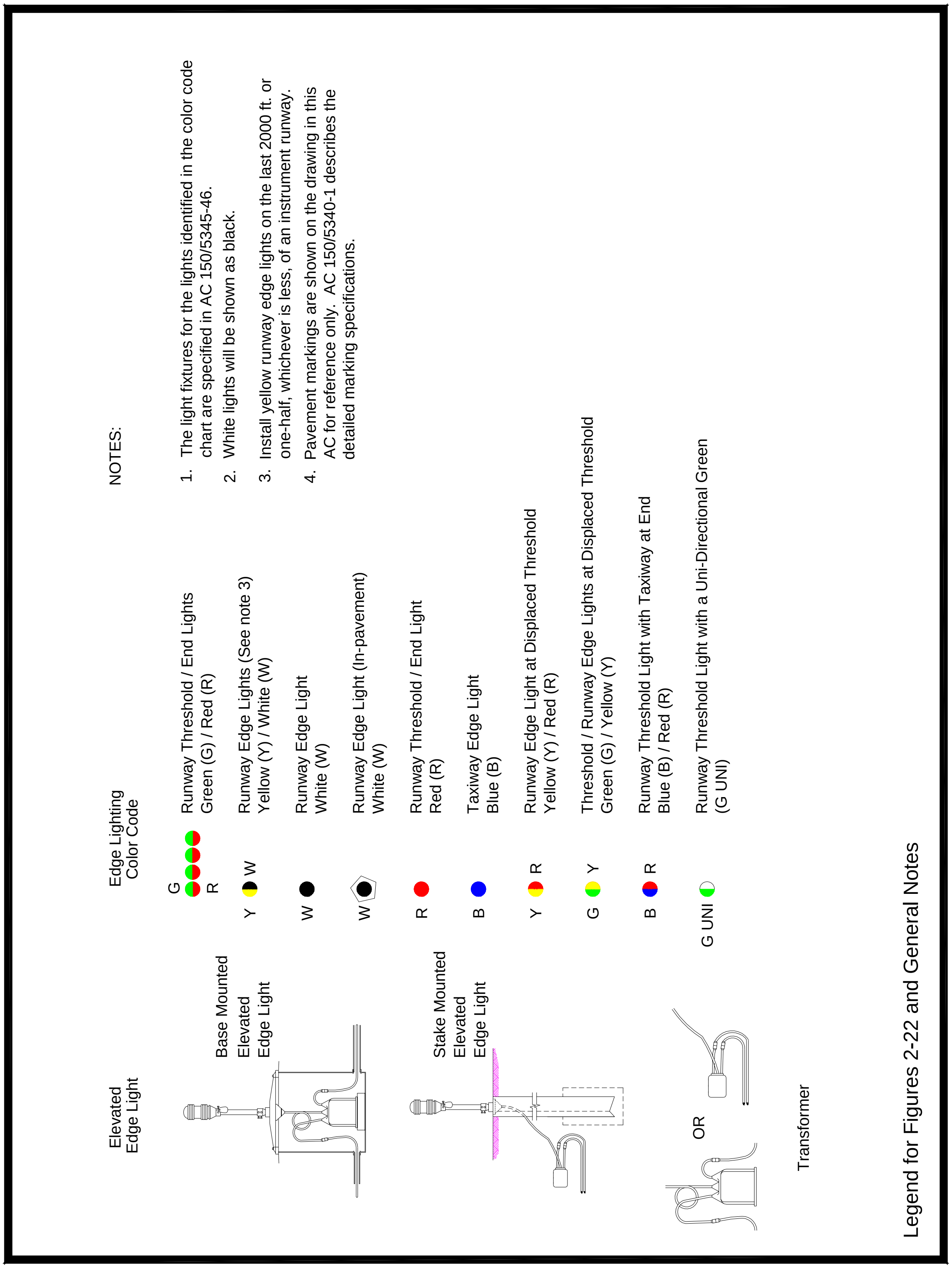


Figure 1 Legend and General Notes

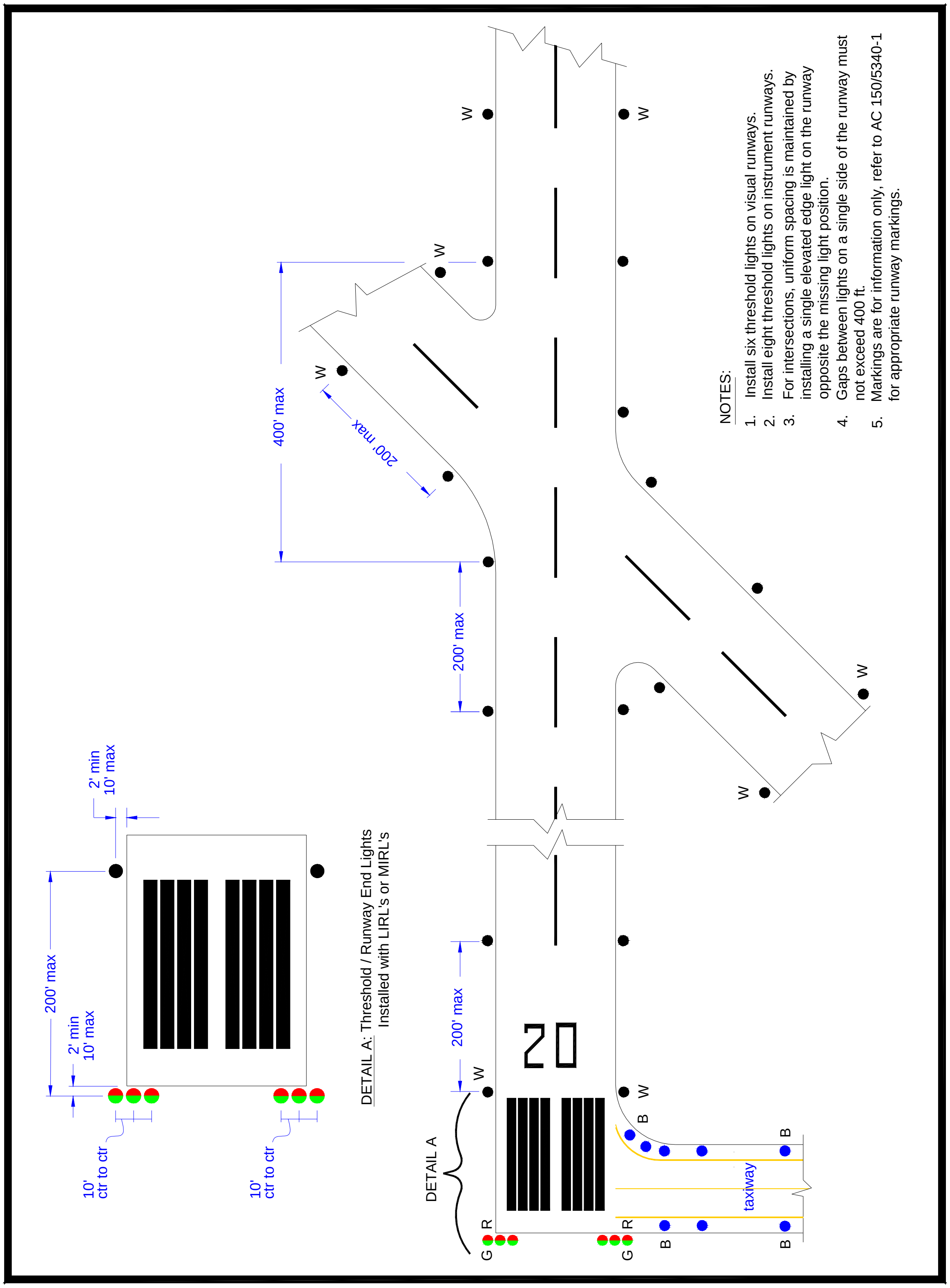


Figure 2 Runway and Threshold Lighting Configuration (LIRL & MIRL)

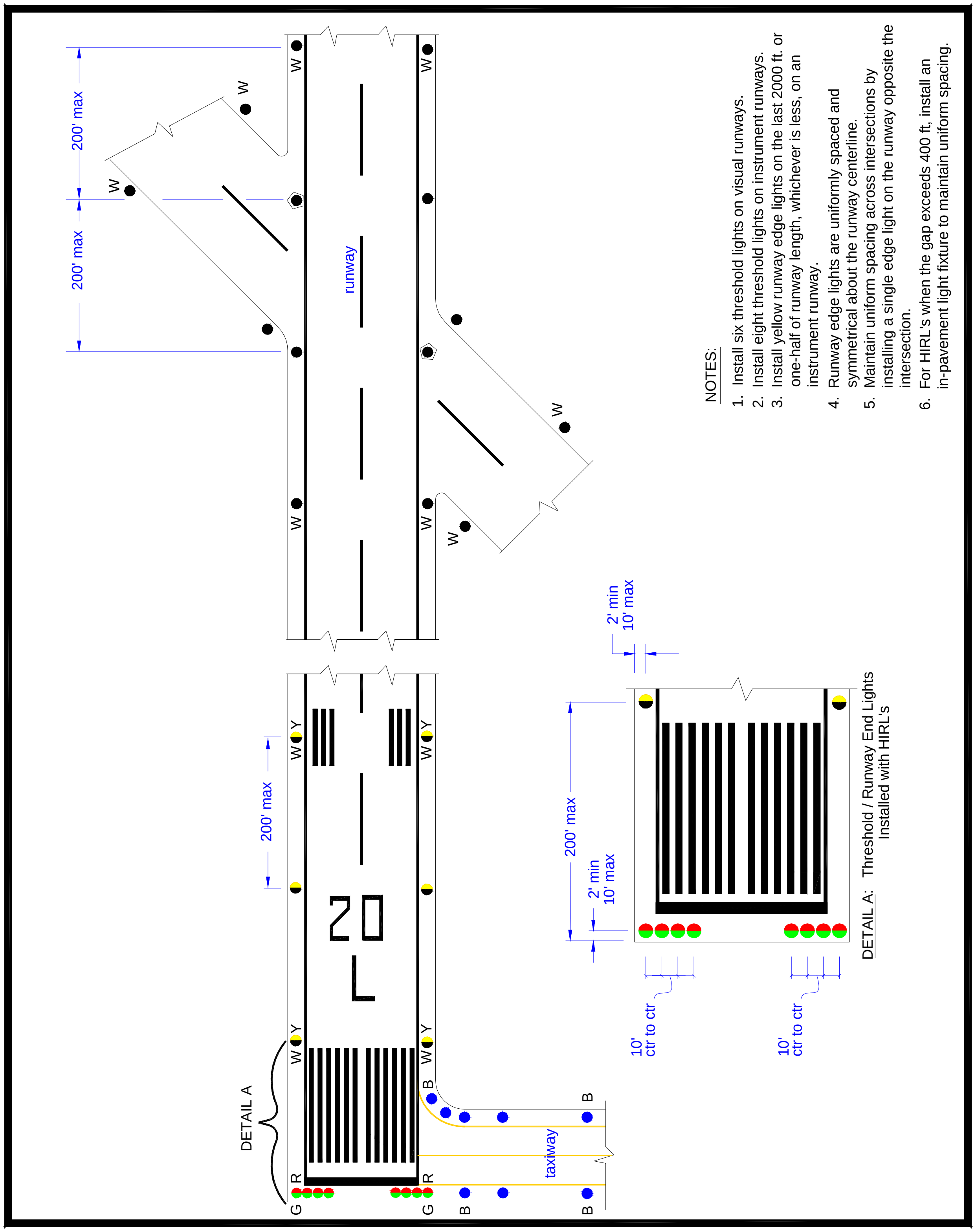


Figure 3 Runway and Threshold Lighting Configuration (HIRL)

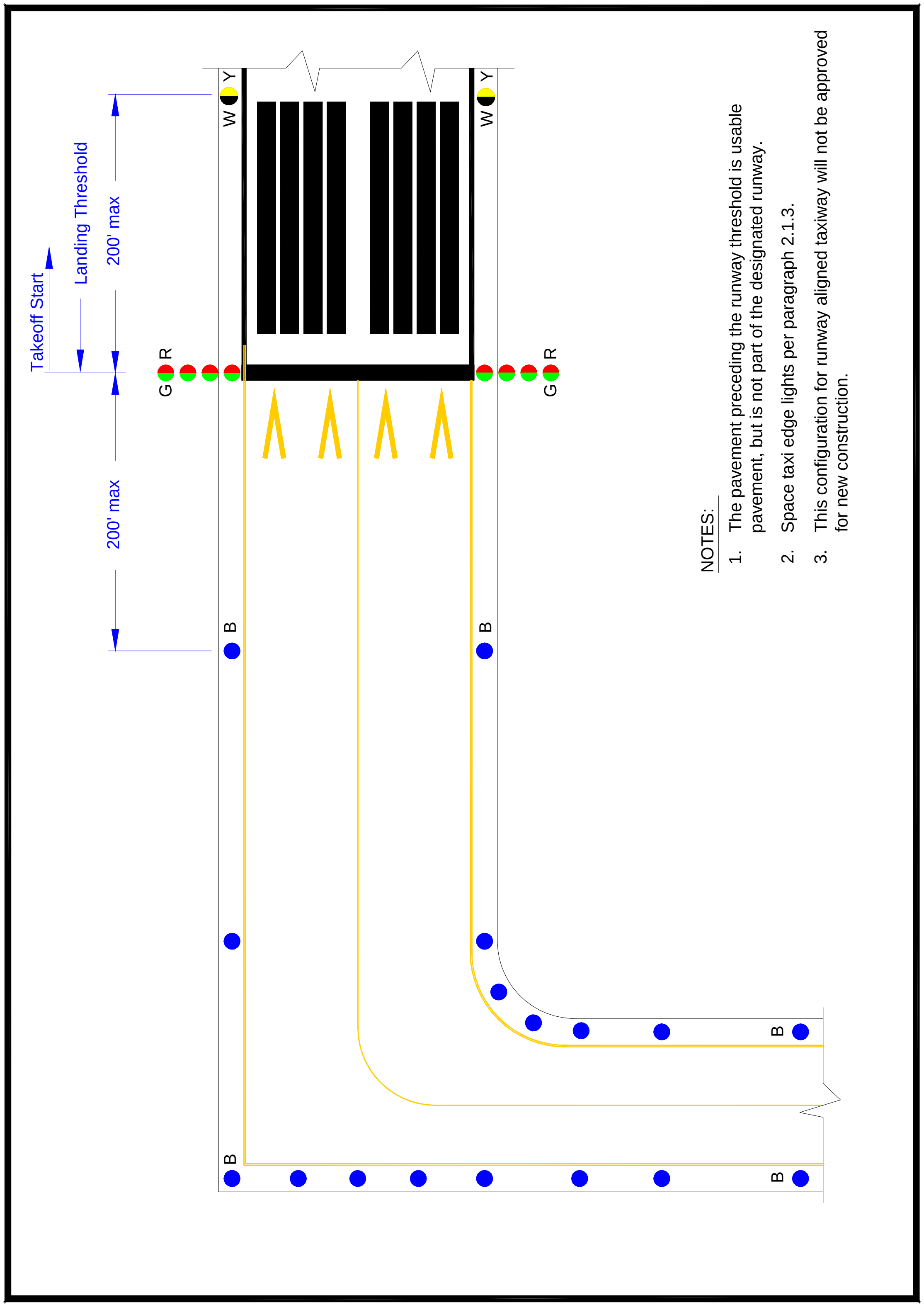


Figure 4 Runway with Taxiway at End

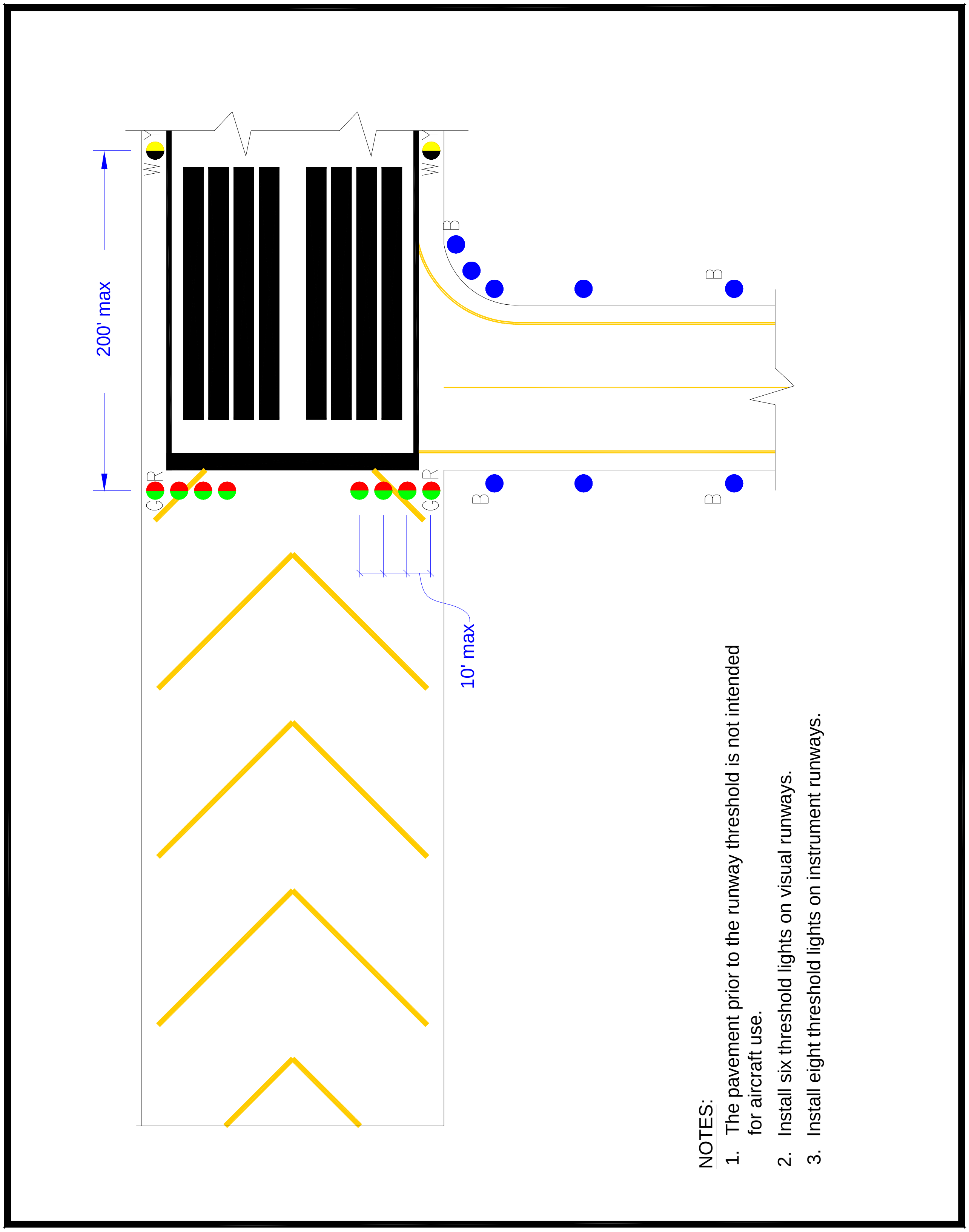


Figure 5 Runway with Blast Pad (No Traffic)

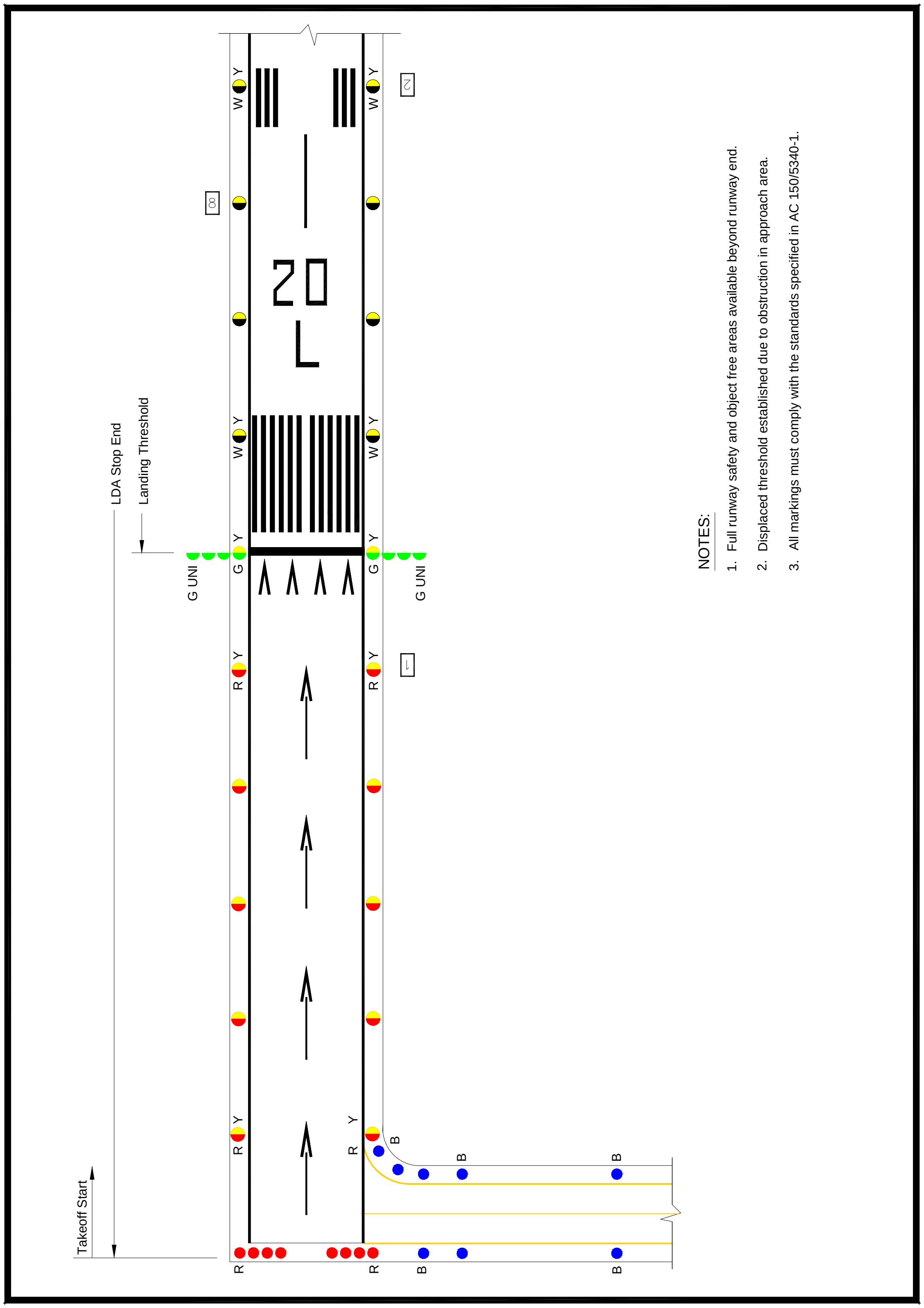


Figure 6 Lighting for Runway with Displaced Threshold

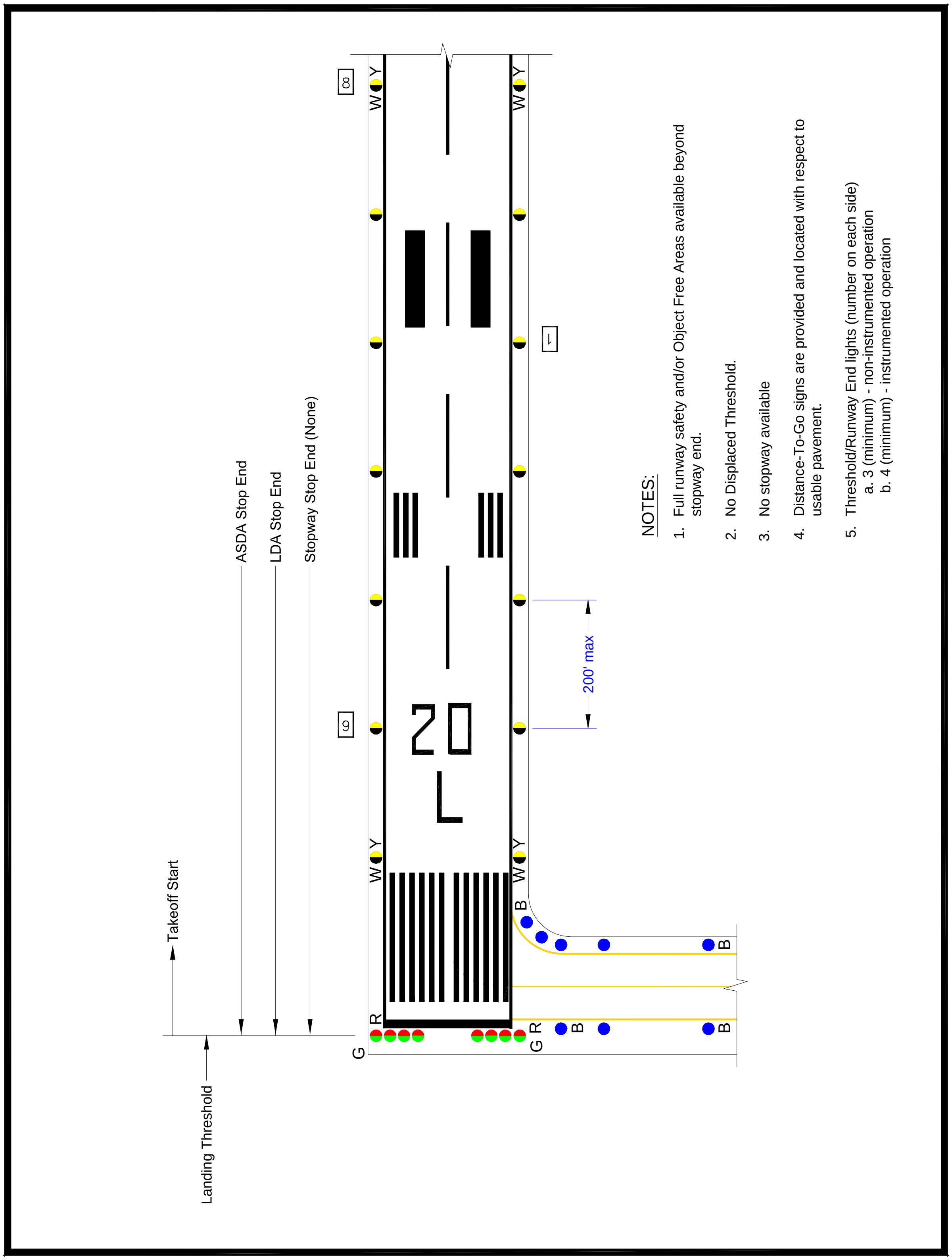


Figure 7 Example 1. Normal Runway with Taxiway

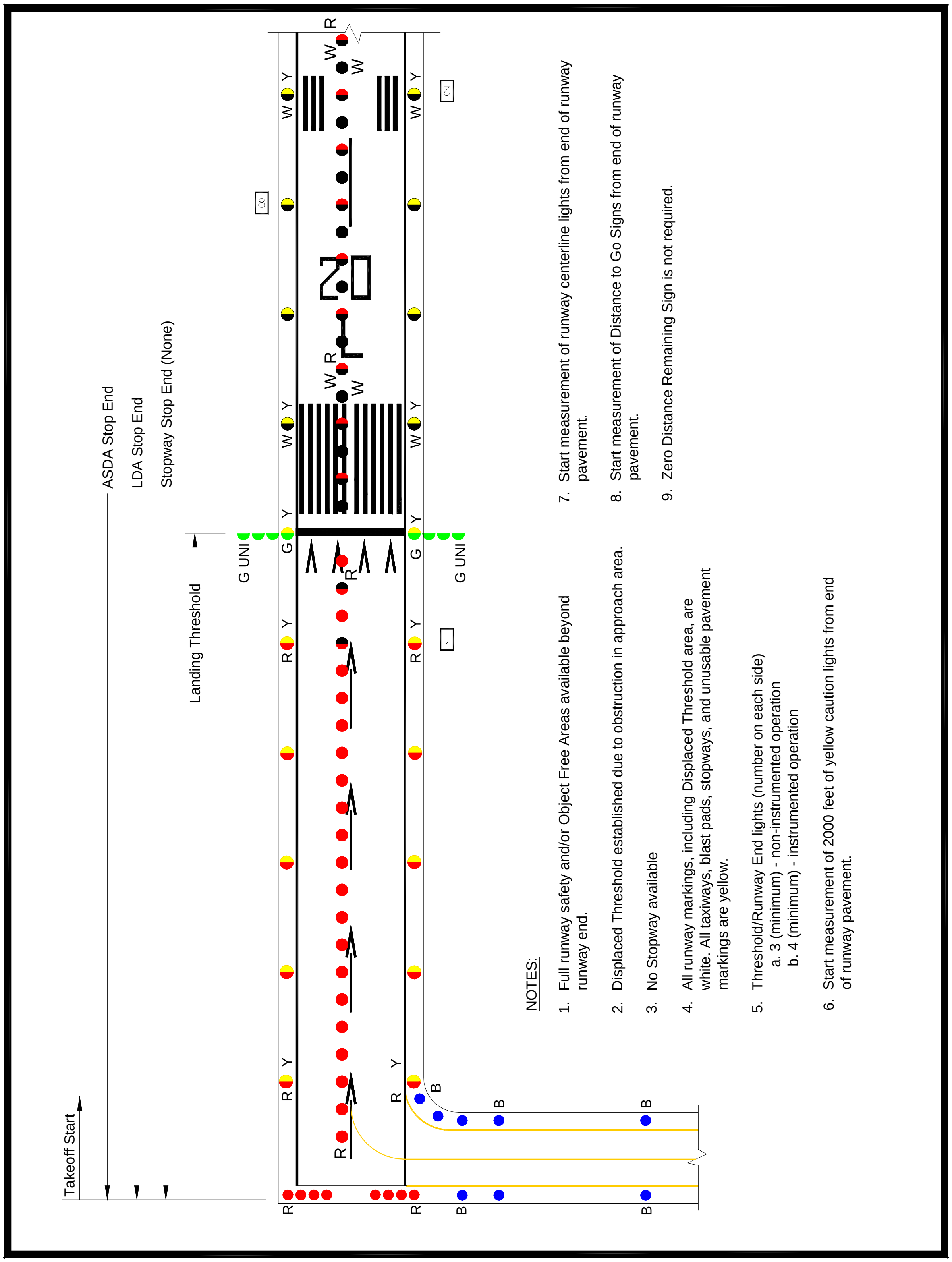


Figure 8 Example 2. Lighting for Runway with Displaced Threshold

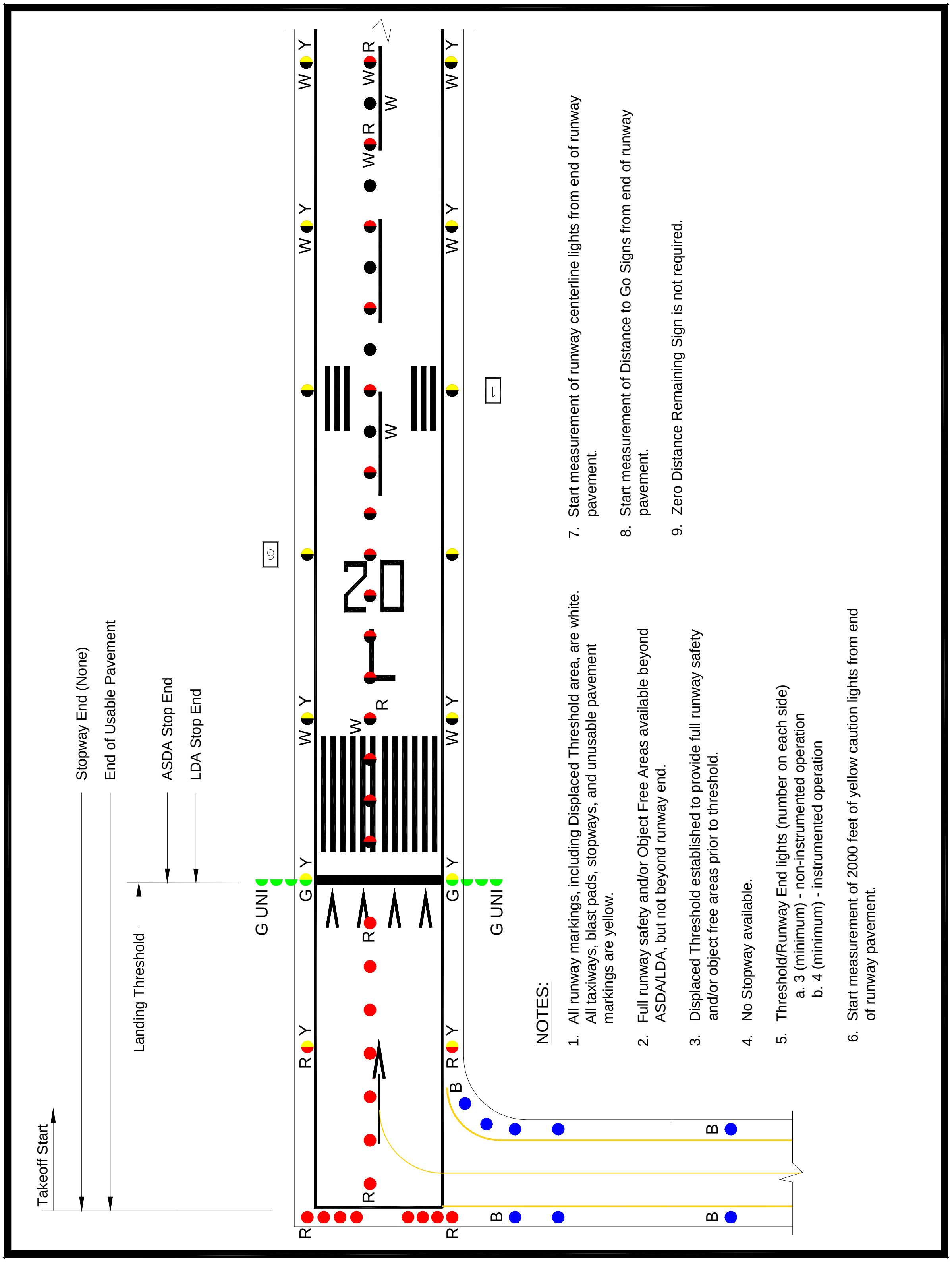


Figure 9 Example 3. Lighting for Runway with Displaced Threshold/Usable Pavement

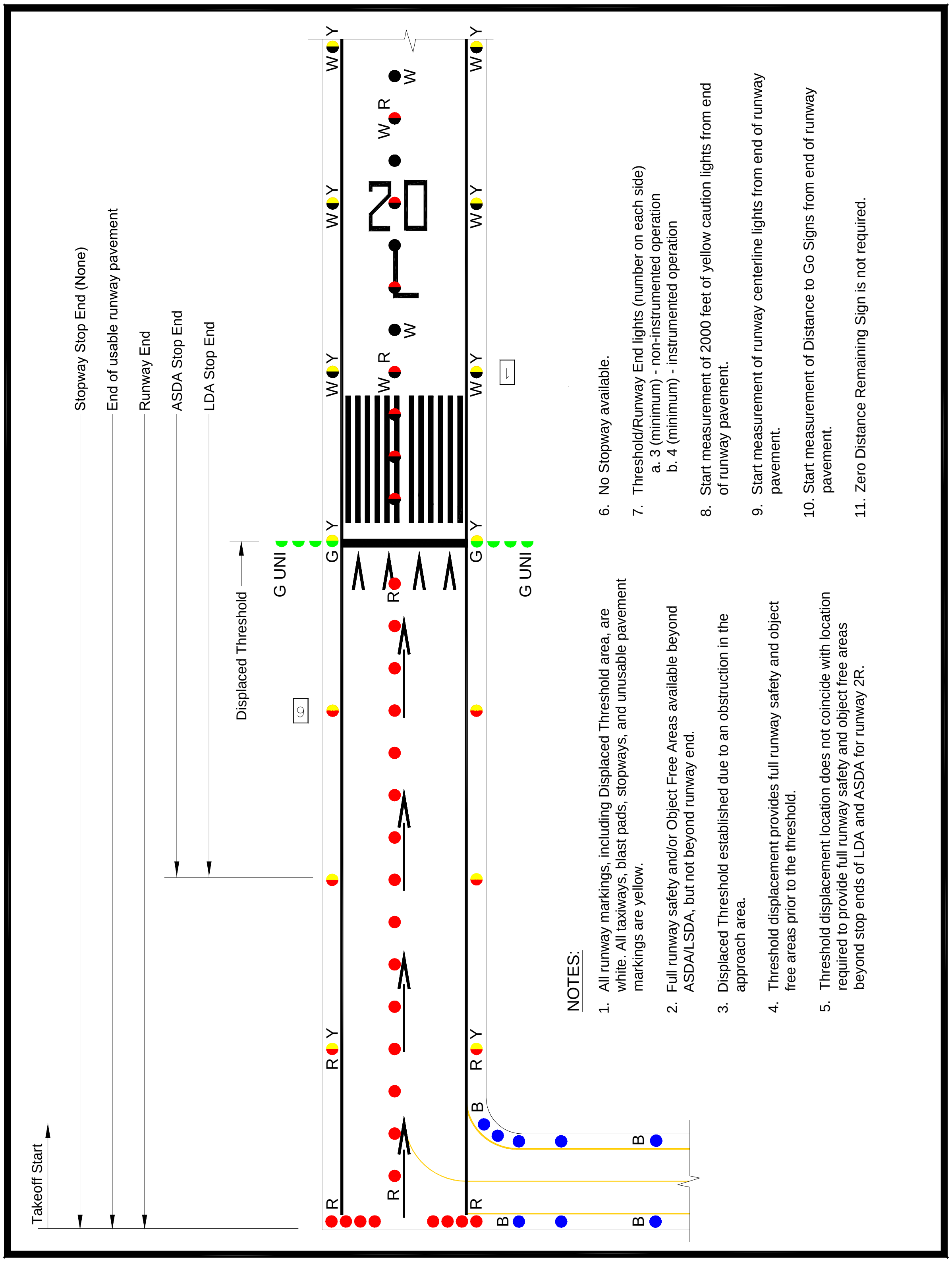


Figure 10 Example 4. Lighting for Runway with Displaced Threshold not Coinciding with Opposite Runway End

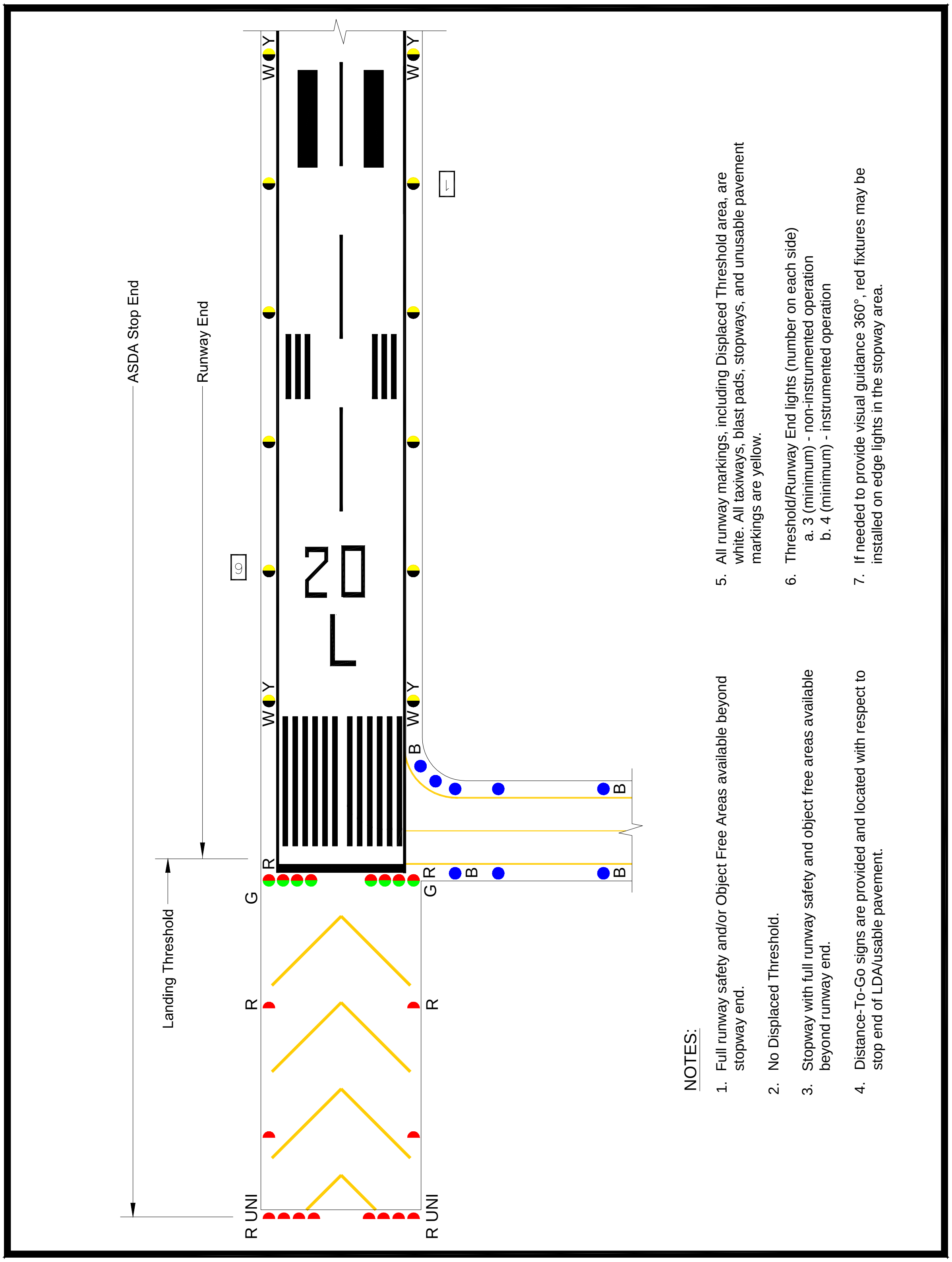


Figure 11 Example 5. Lighting for Runway with Stopway

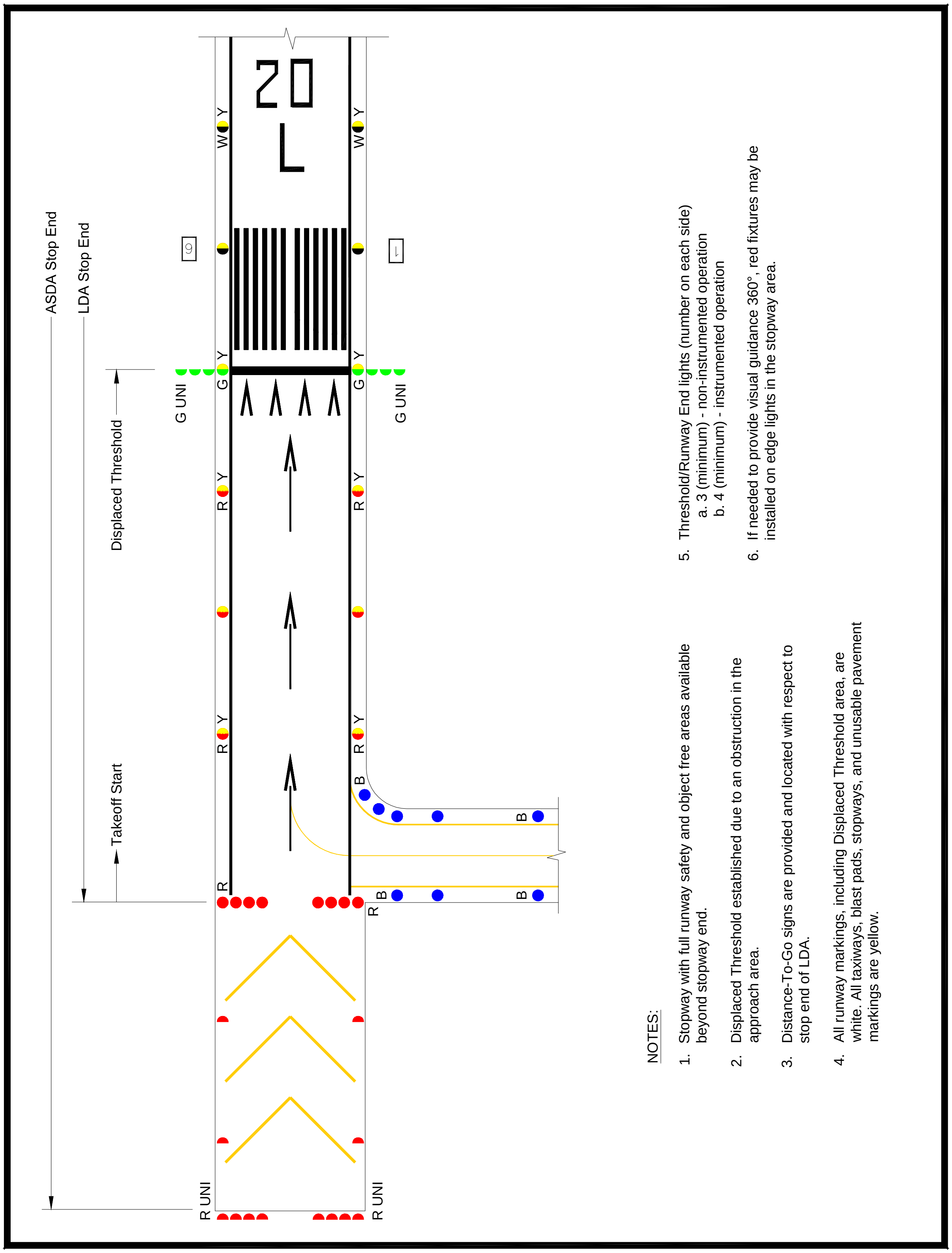


Figure 12 Example 6. Lighting for Runway with Displaced Threshold & Stopway

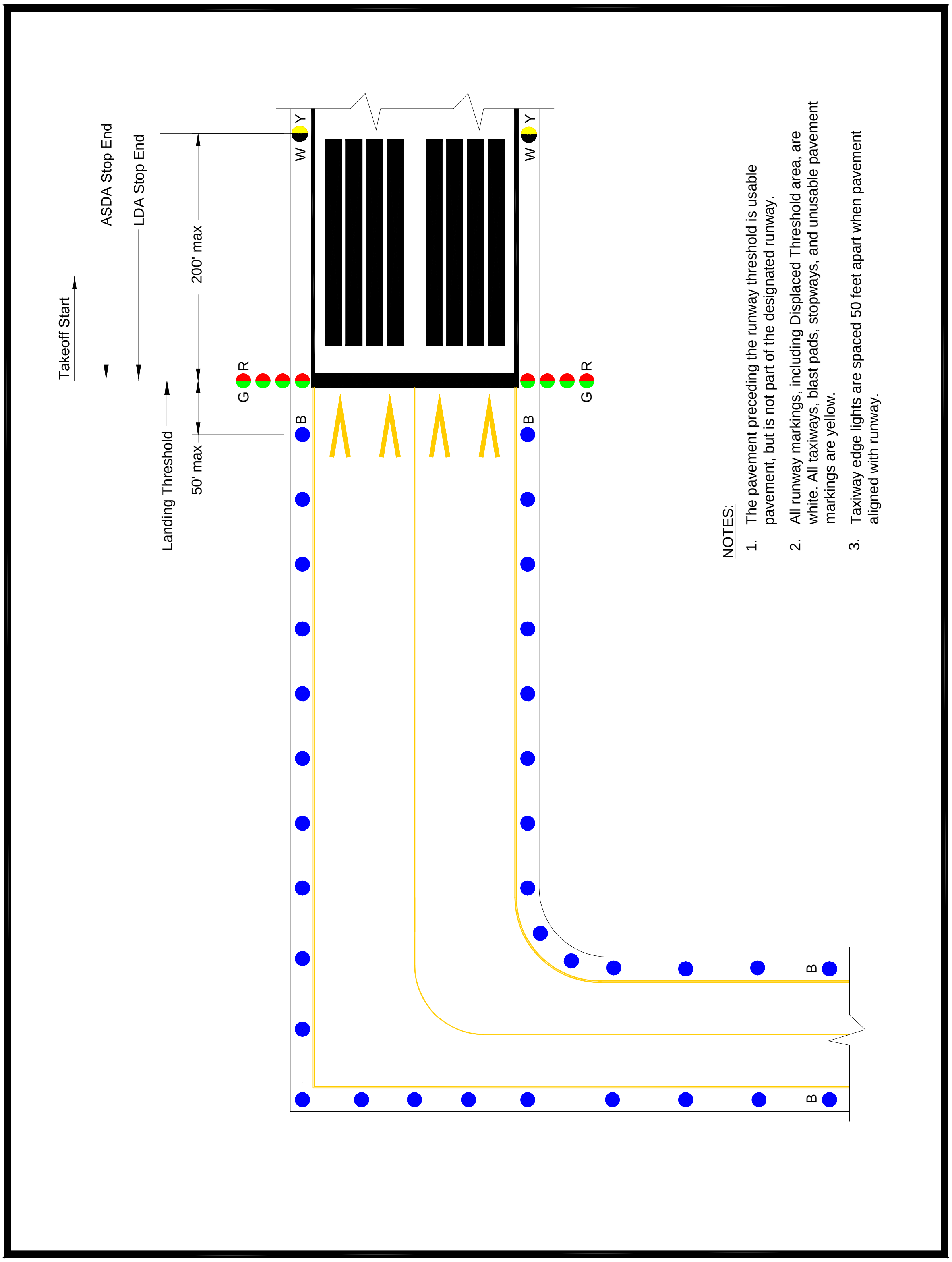


Figure 13 Example 7. Runway with End Taxiway

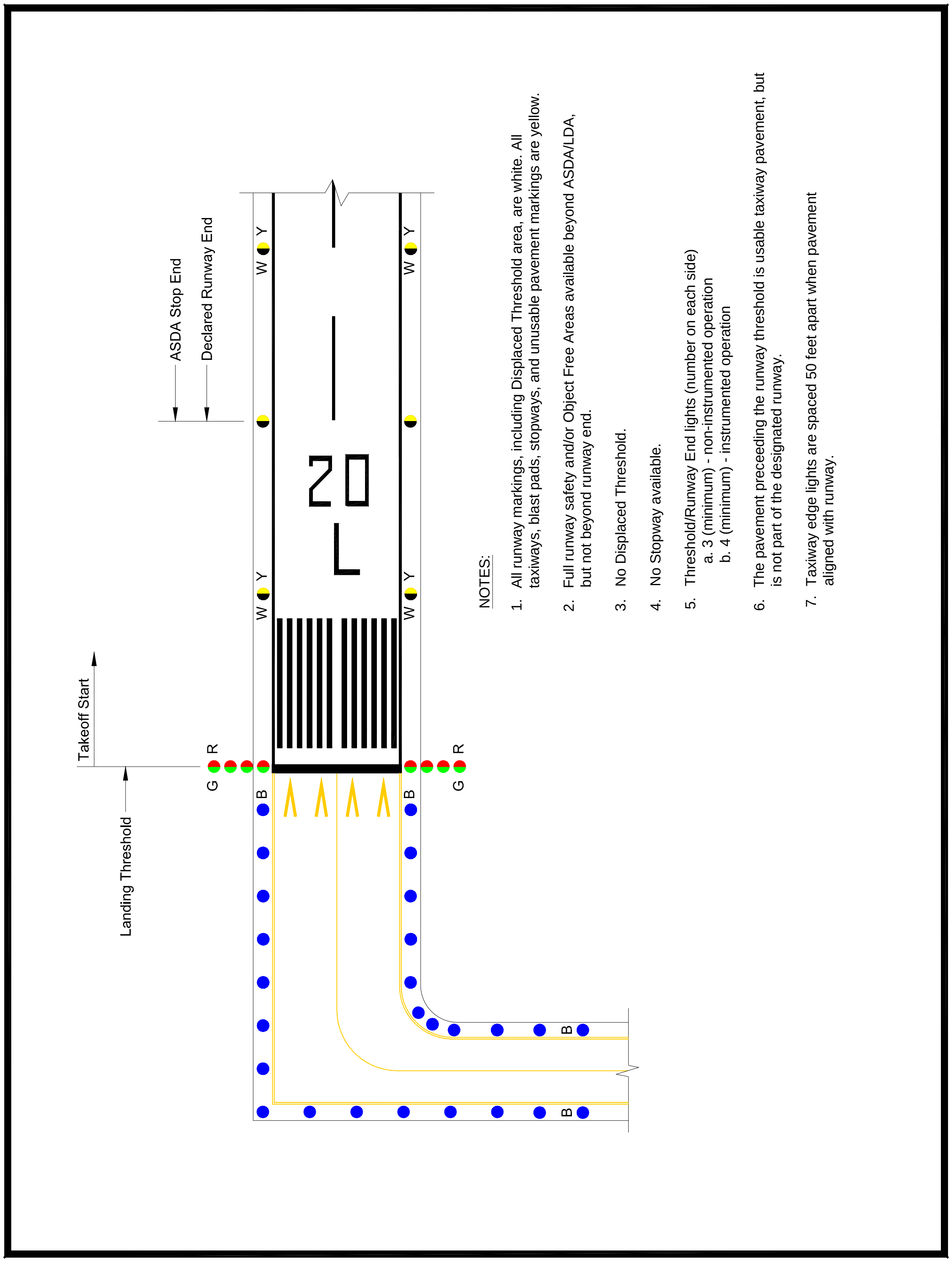


Figure 14 Example 8. Lighting for Runway with End Taxiway and Shortened ASDA

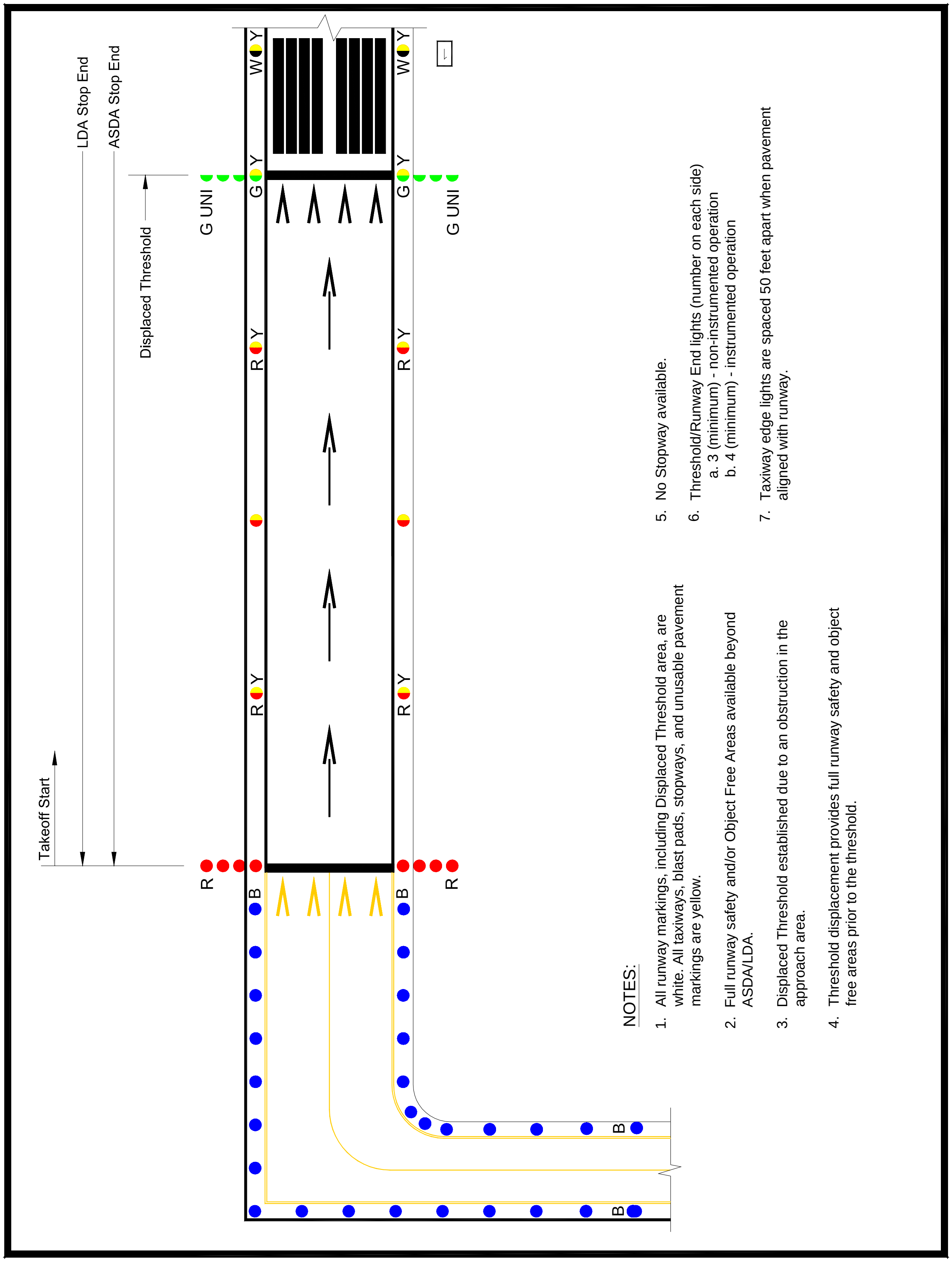


Figure 15 Example 9. Lighting for Runway with End Taxiway and Displaced Threshold not Coinciding with Opposite Runway End

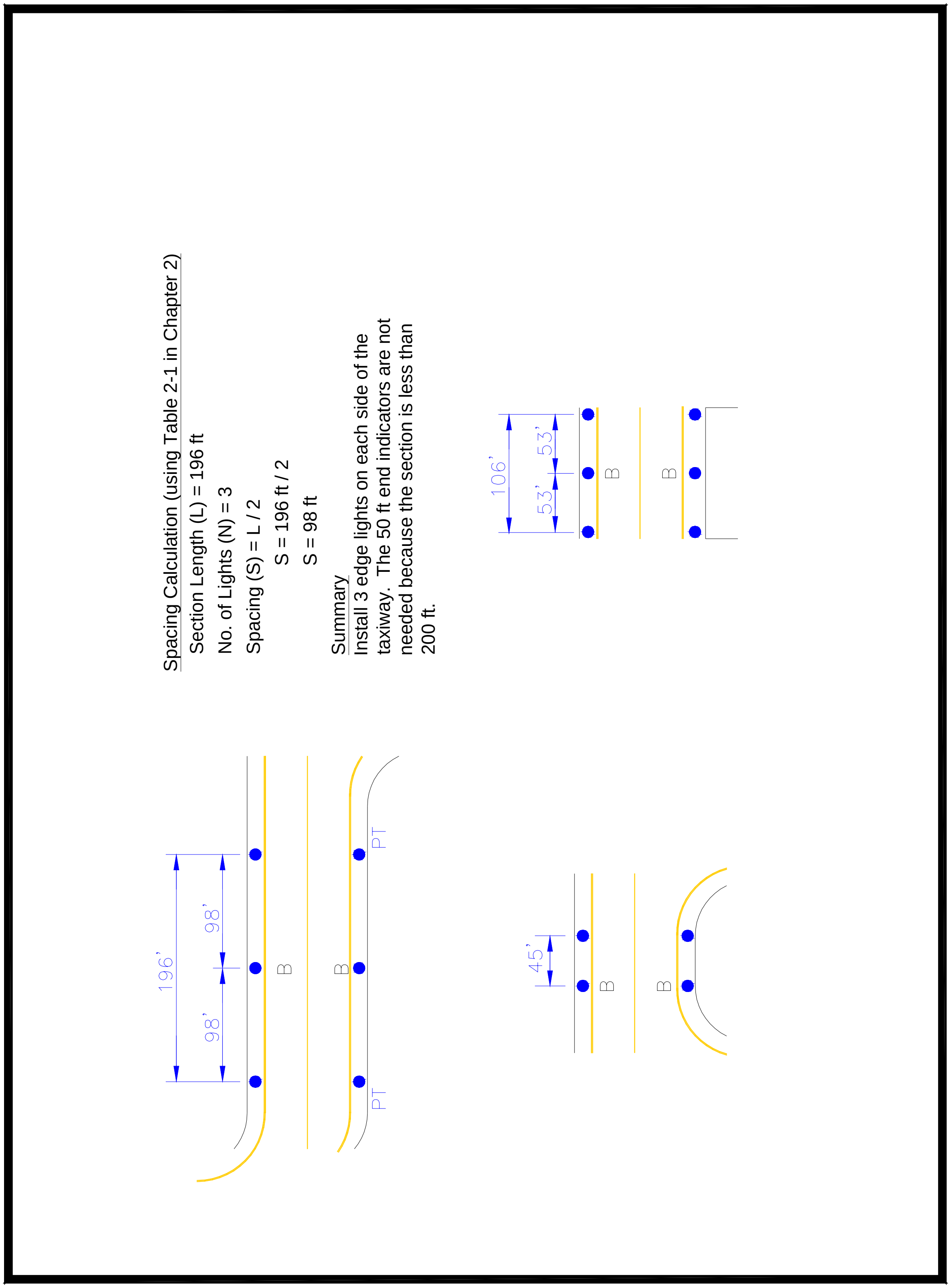
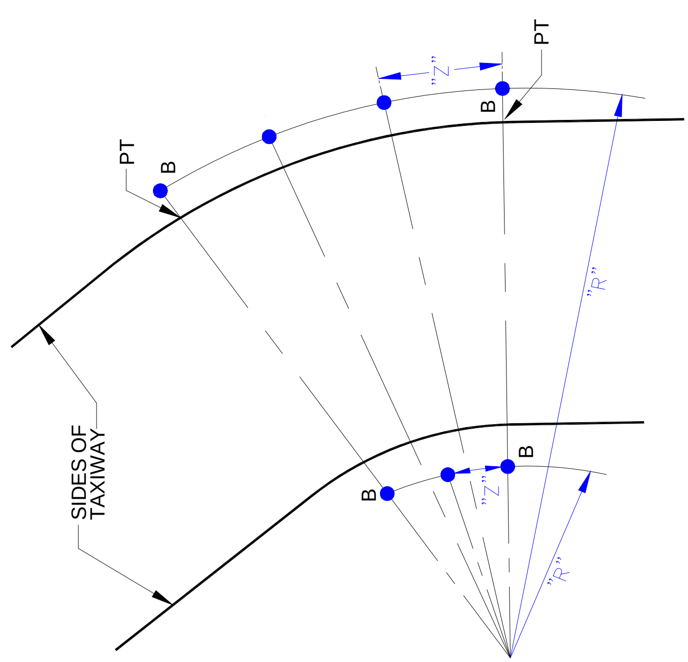


Figure 16 Typical Straight Taxiway Sections (Less Than 200 Feet).

RADIUS "R" OF CURVE IN FEET	DIMENSION "Z" IN FEET
15	20
25	27
50	35
75	40
100	50
150	55
200	60
250	70

RADIUS "R" OF CURVE IN FEET	DIMENSION "Z" IN FEET
300	80
400	95
500	110
600	130
700	145
800	165
900	185
1000	200 MAX.



NOTES:

1. For radii not listed, determine "Z" spacing by linear interpolation.
2. "Z" is the arc length.
3. Uniformily space lights on curved edges. Do not exceed the values determined from the above table.
4. On curved edges in excess of 30 degrees arc, do not install less than three lights including those at the points of tangency (PT).

Figure 17 Spacing of Lights on Curved Taxiway Edges

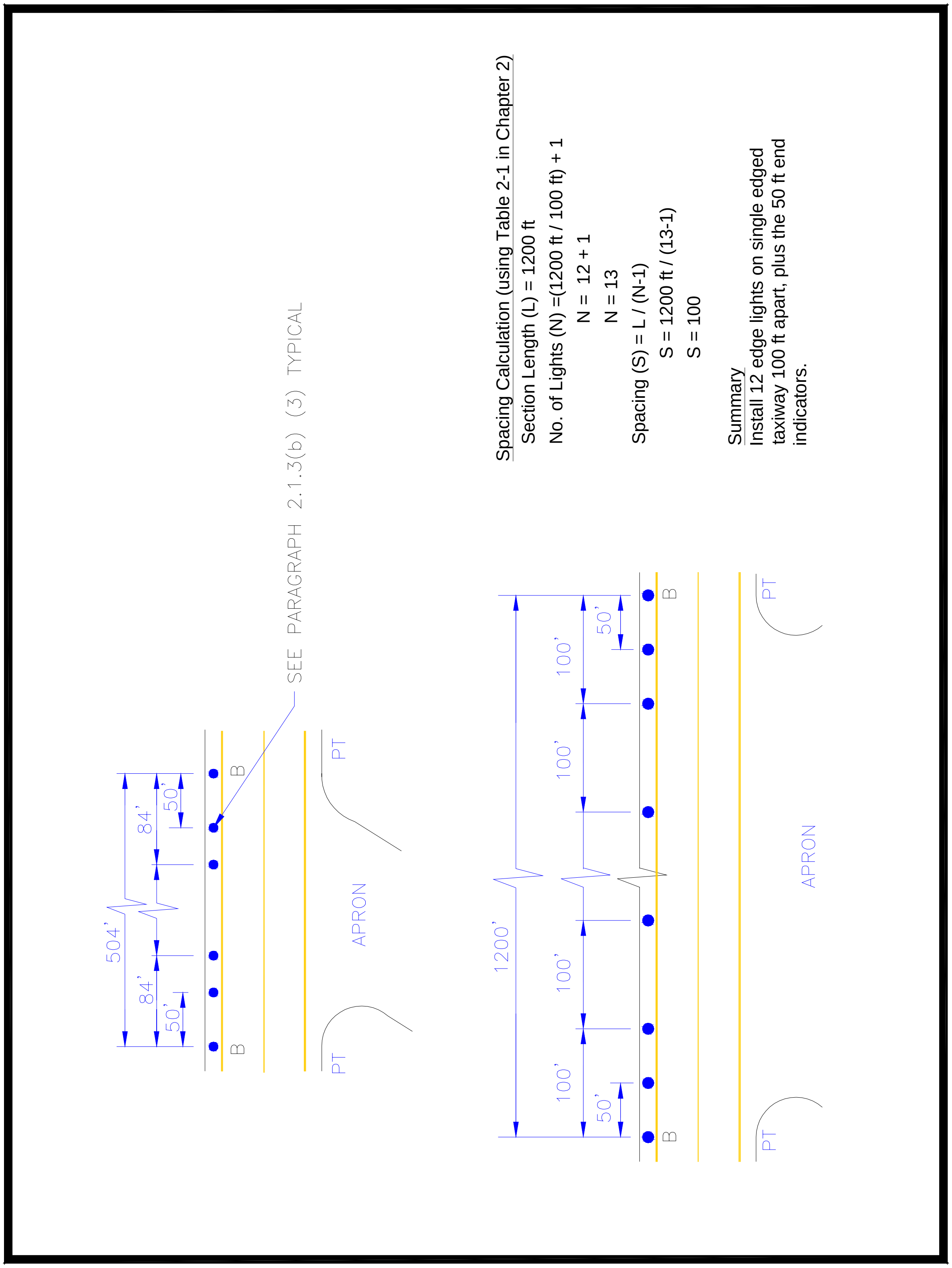


Figure 18 Typical Single Straight Taxiway Edges (More Than 200 Feet)

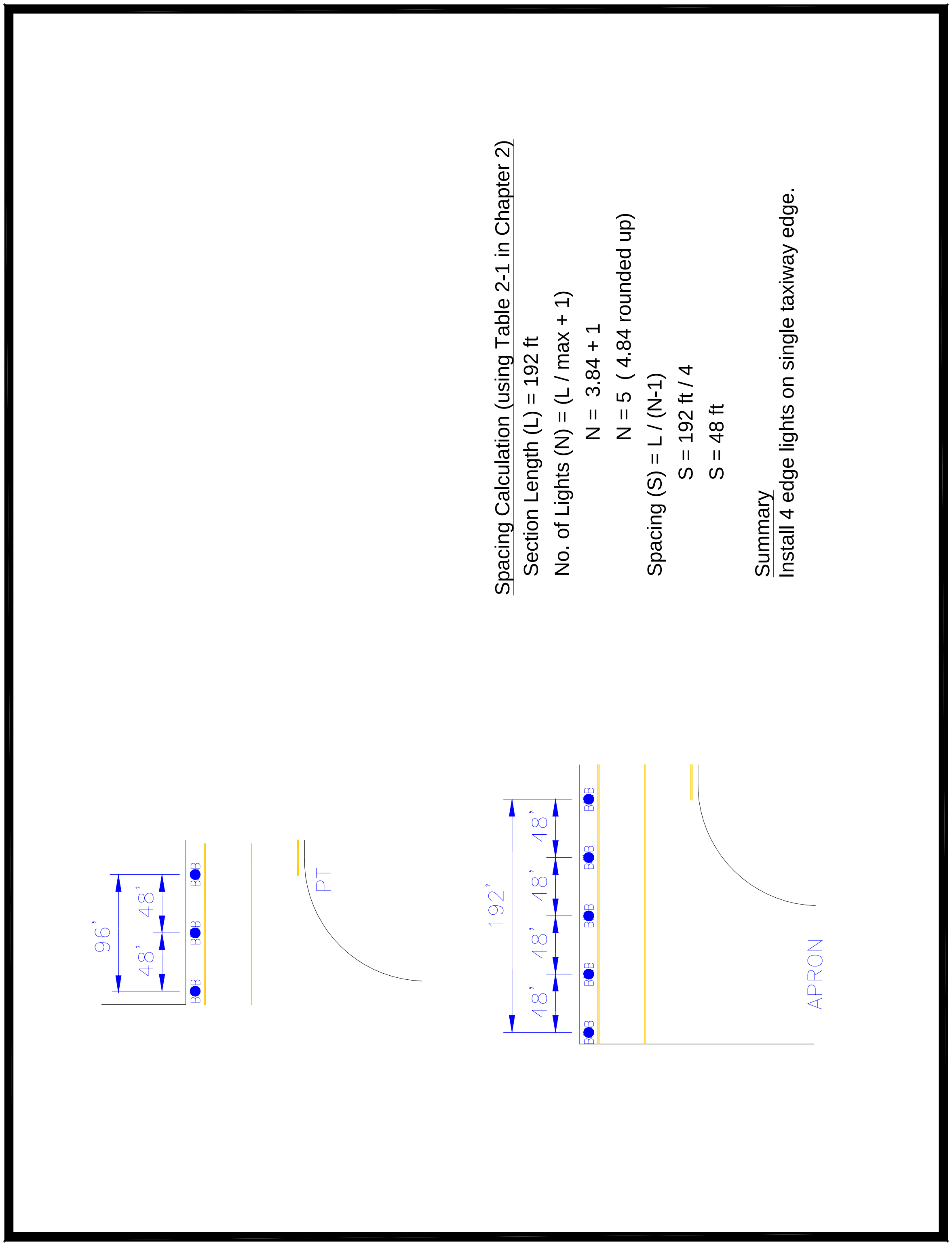


Figure 19 Typical Single Straight Taxiway Edges (Less Than 200 Feet)

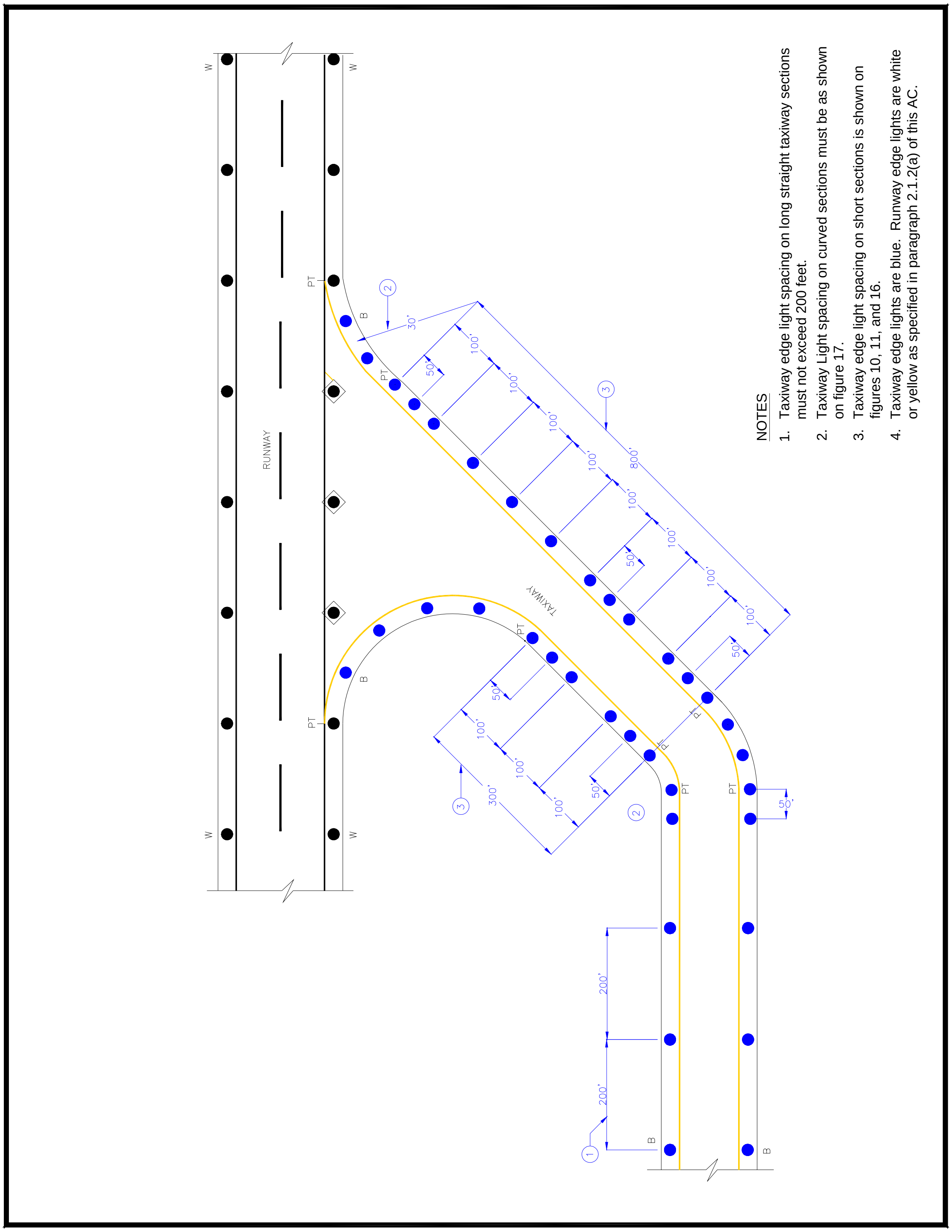


Figure 20 Typical Edge Lighting Configuration

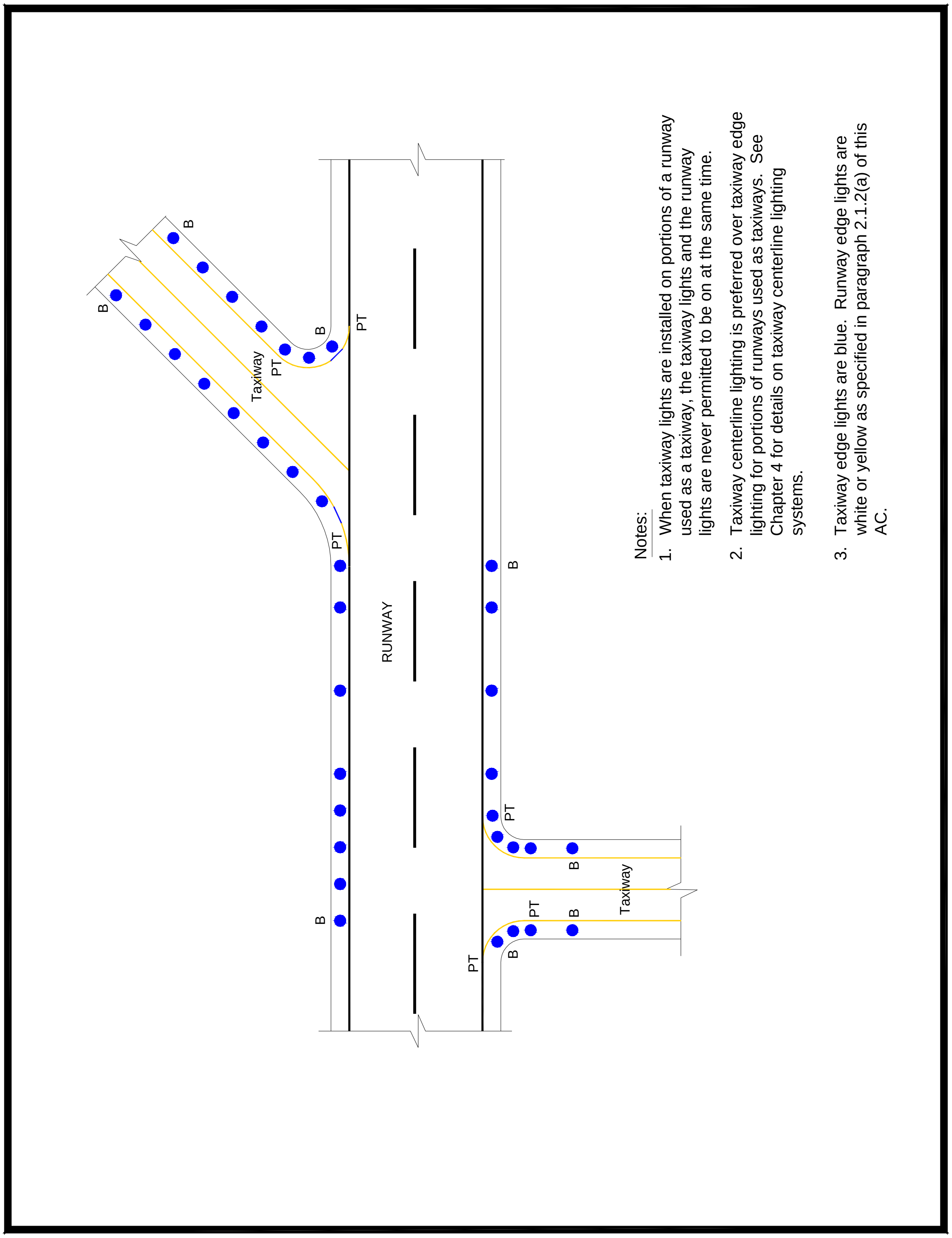


Figure 21 Typical Edge Lighting for Portions of Runways Used as Taxiway (When Taxiway Lights Are “On”)

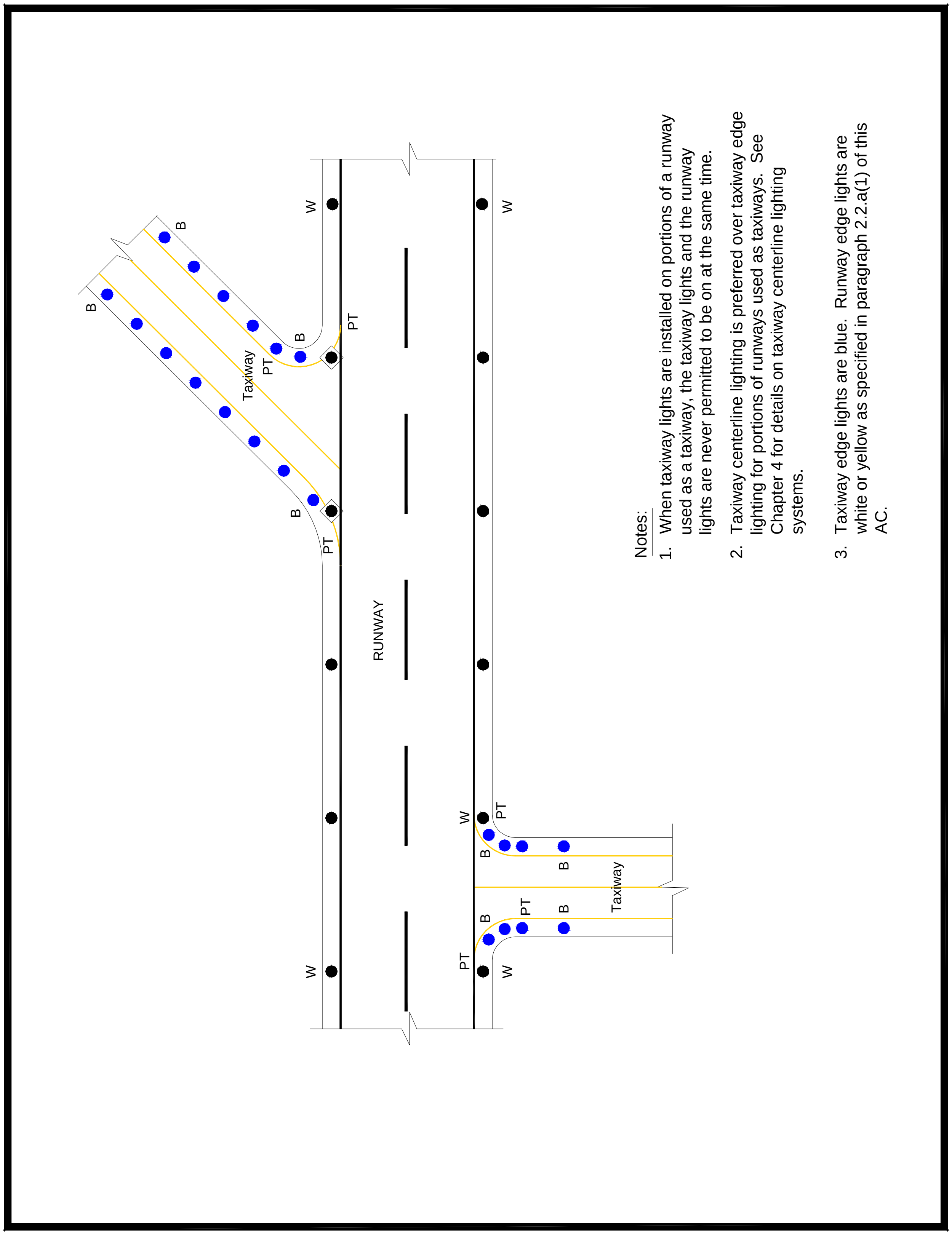


Figure 22 Typical Edge Lighting for Portions of Runways Used as Taxiway (When Runway Lights Are “On”)

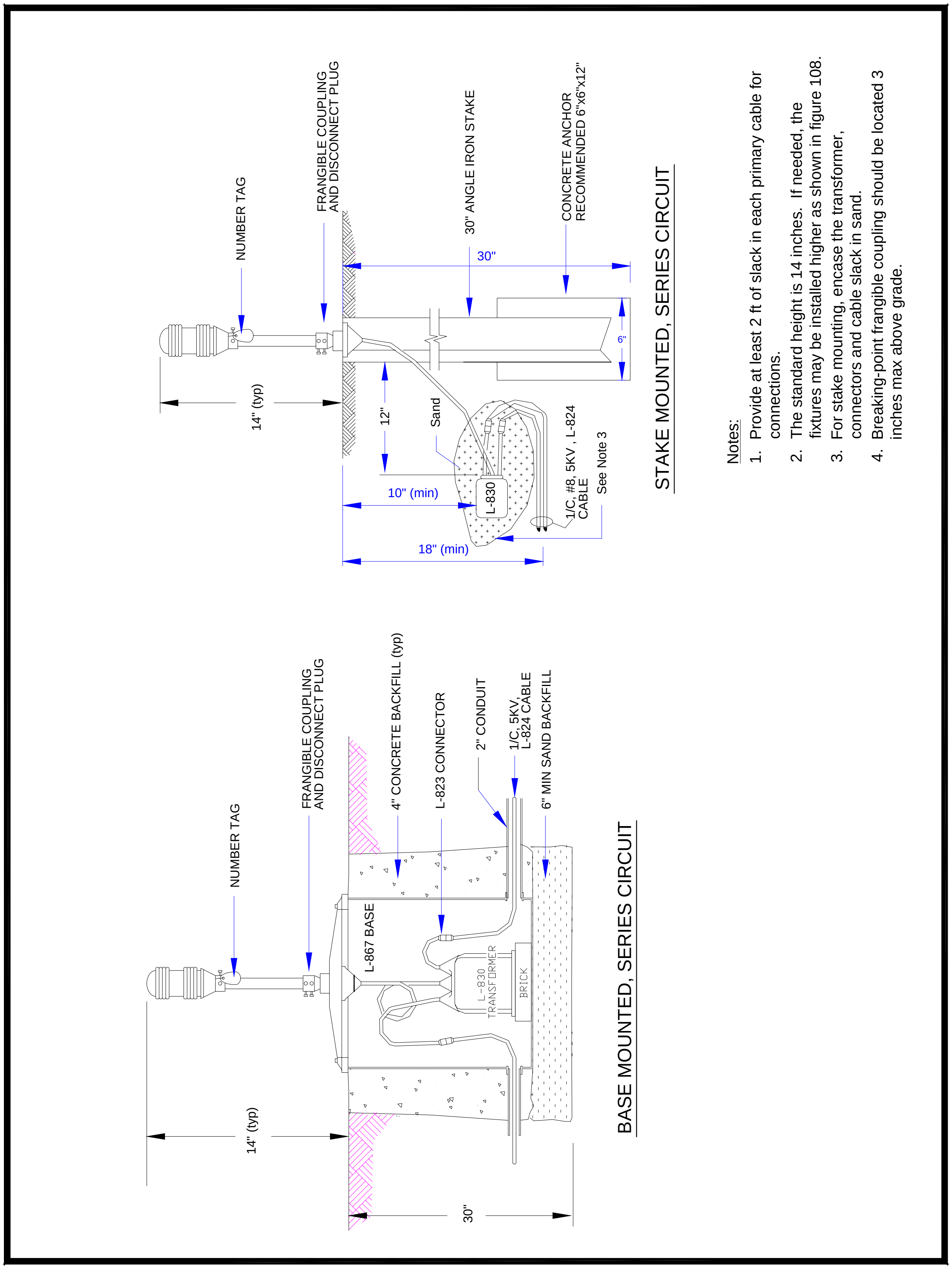


Figure 23 Light Fixture Wiring

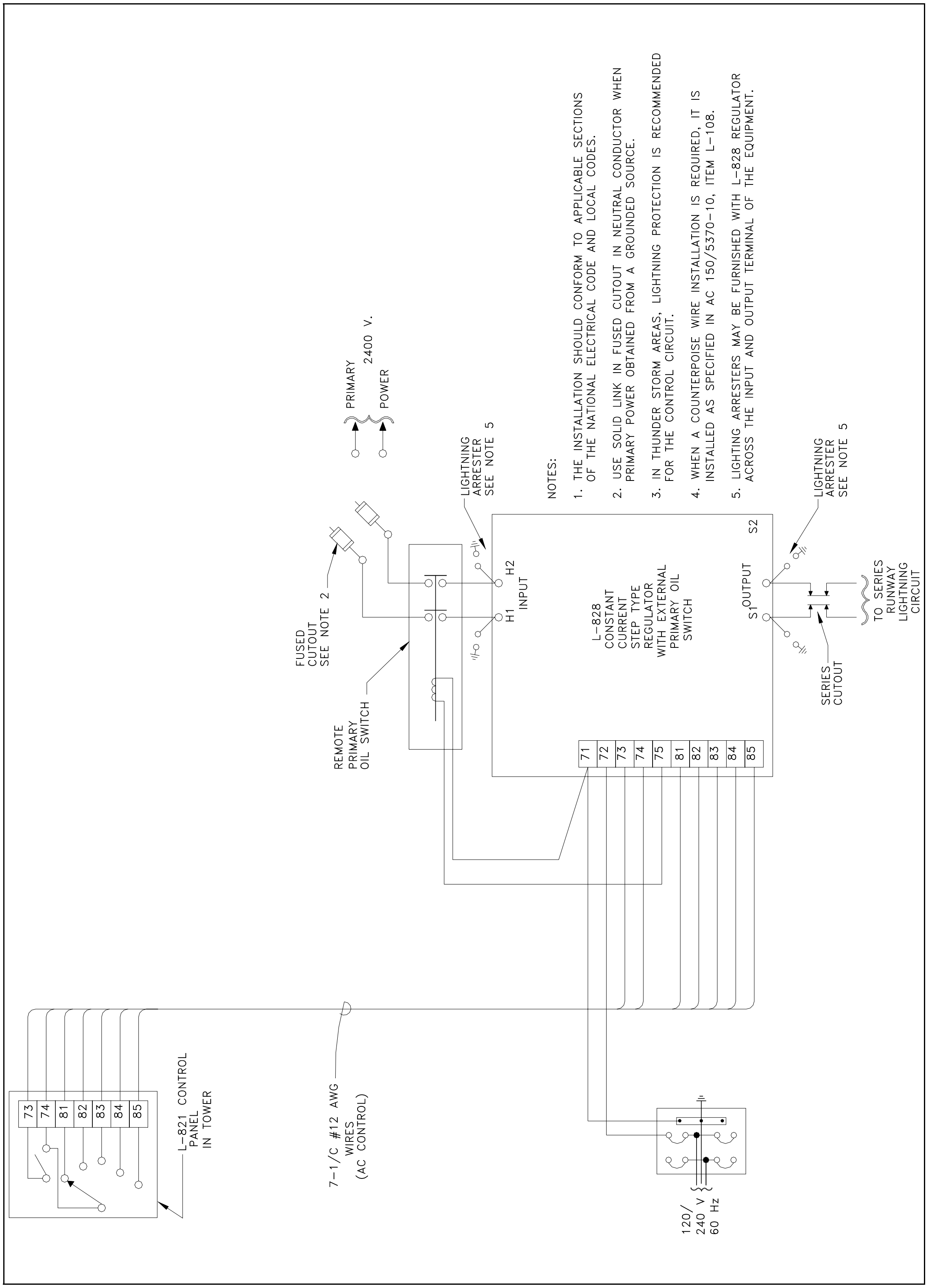


Figure 24 Typical Wiring Diagram Utilizing L-828 Step-type Regulator with External Remote Primary Oil Switch

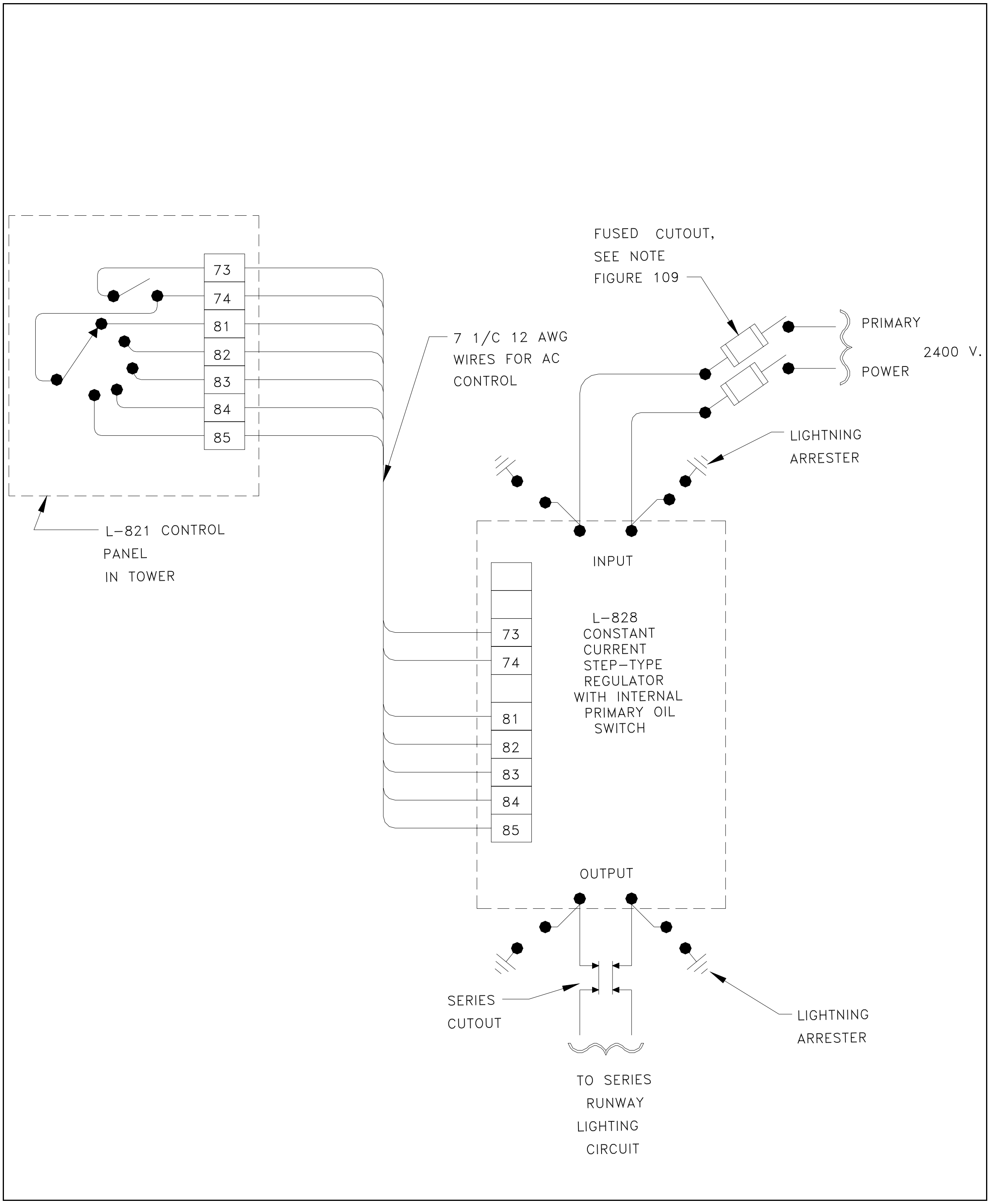


Figure 25 Typical Wiring Diagram Utilizing L-828 Step-type Regulator with Internal Control Power and Primary Oil Switch

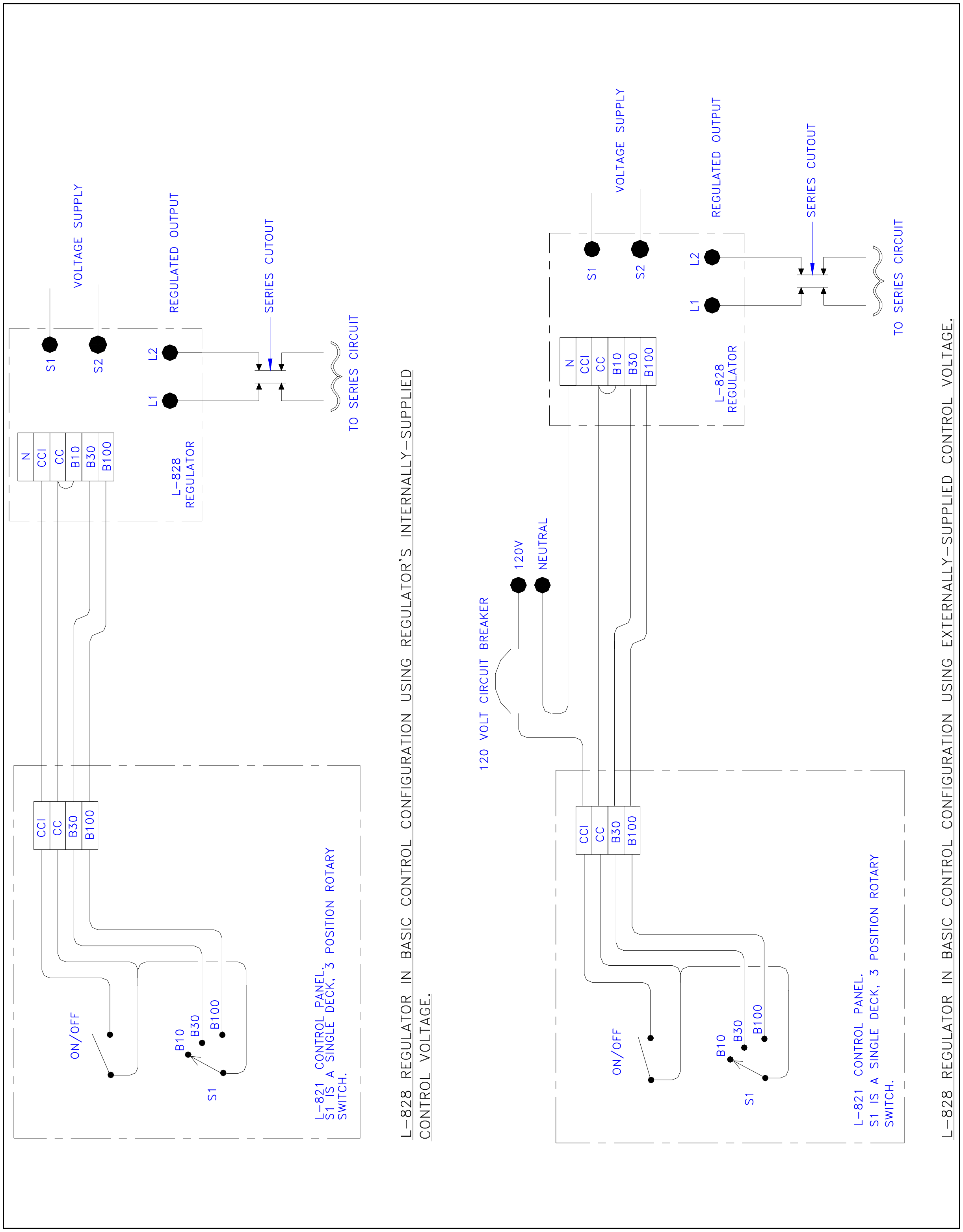


Figure 26 Typical Basic 120 VAC Remote Control System

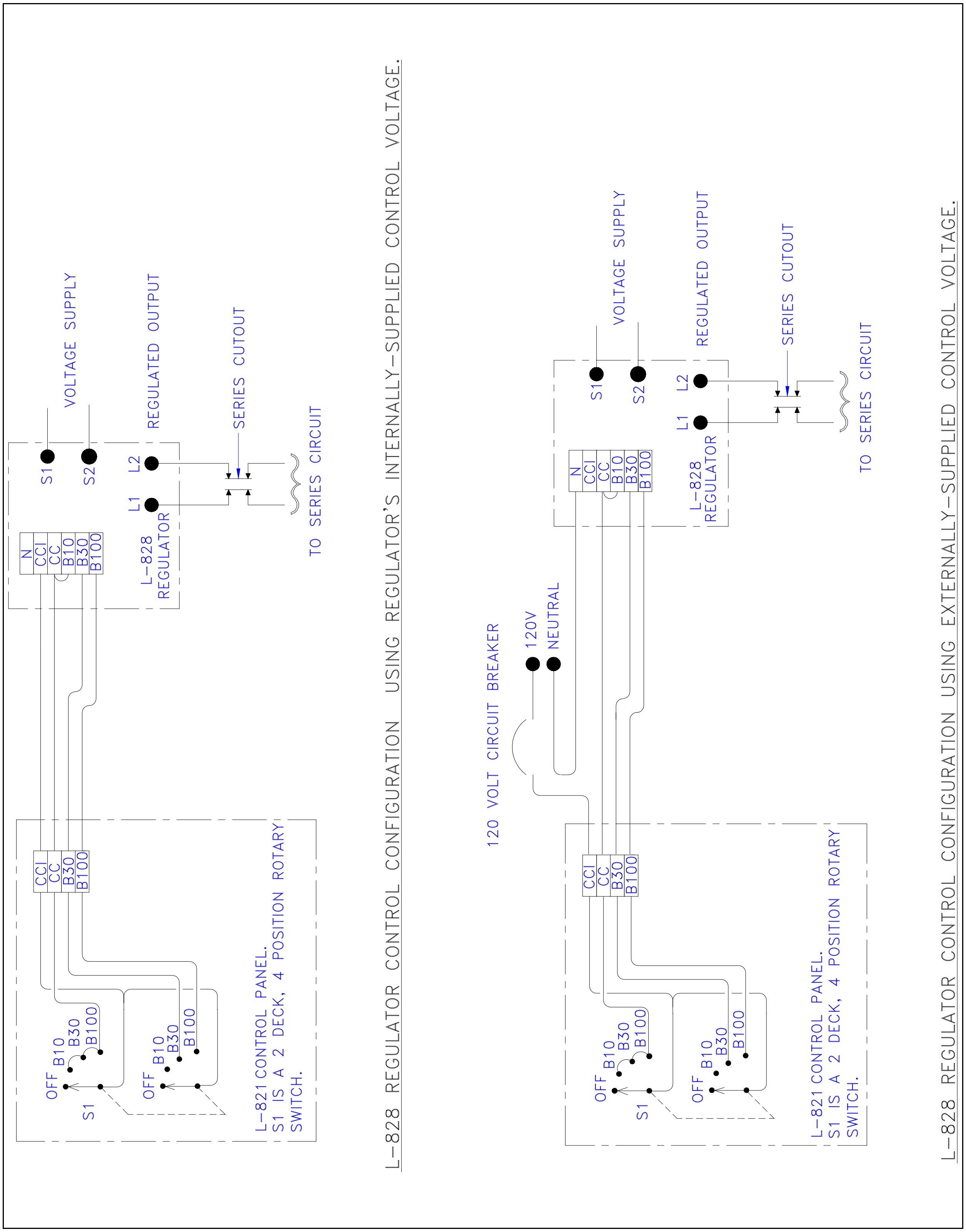


Figure 27 Alternative 120 VAC Remote Control System

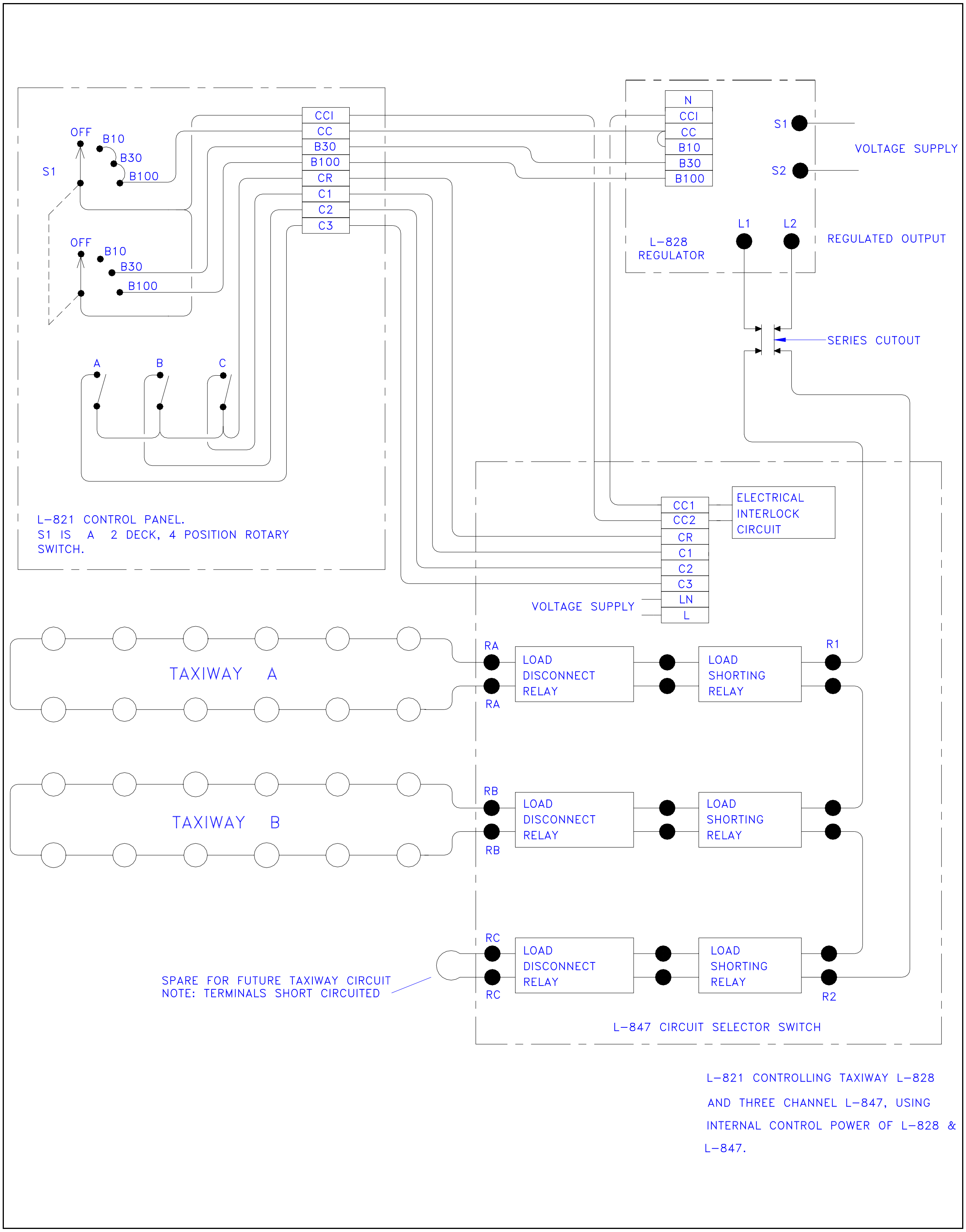


Figure 28 Typical 120 VAC Remote Control System with L-847 Circuit Selector Switch

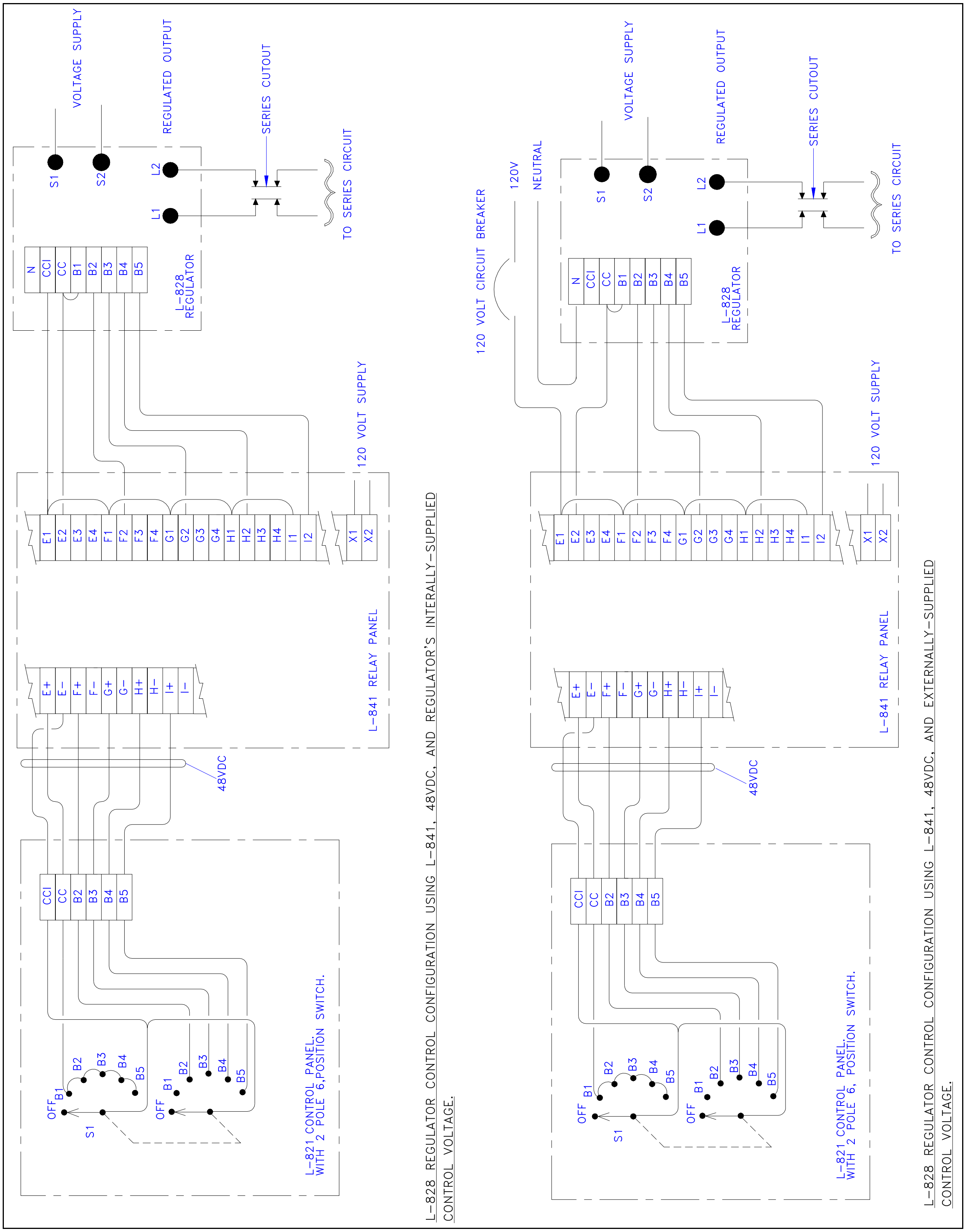


Figure 29 Typical 48 VDC Remote Control System with 5-Step Regulator and L-841 Relay Panel

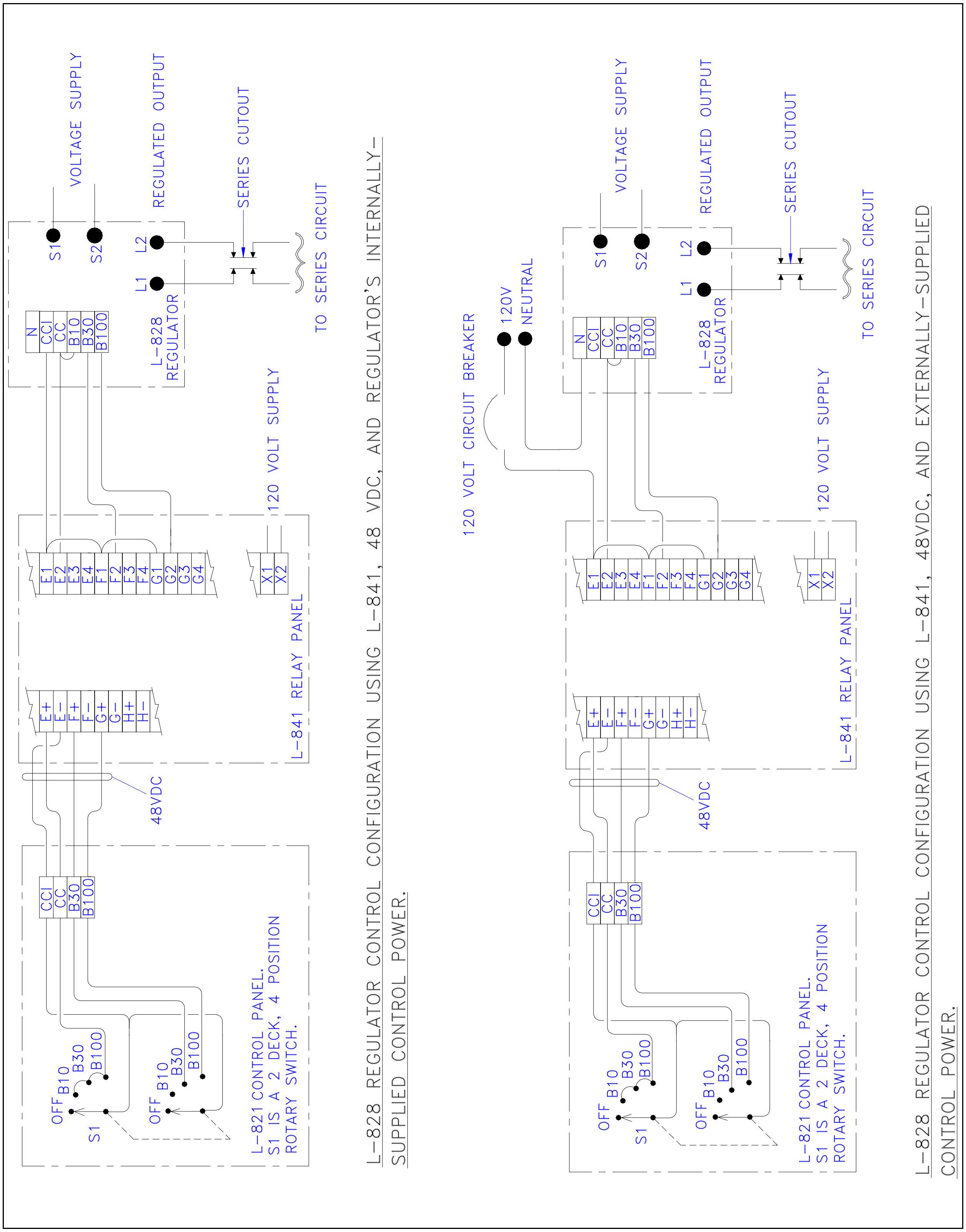


Figure 30 Typical 48 VDC Remote Control System with 3-Step Regulator and L-841 Relay Panel

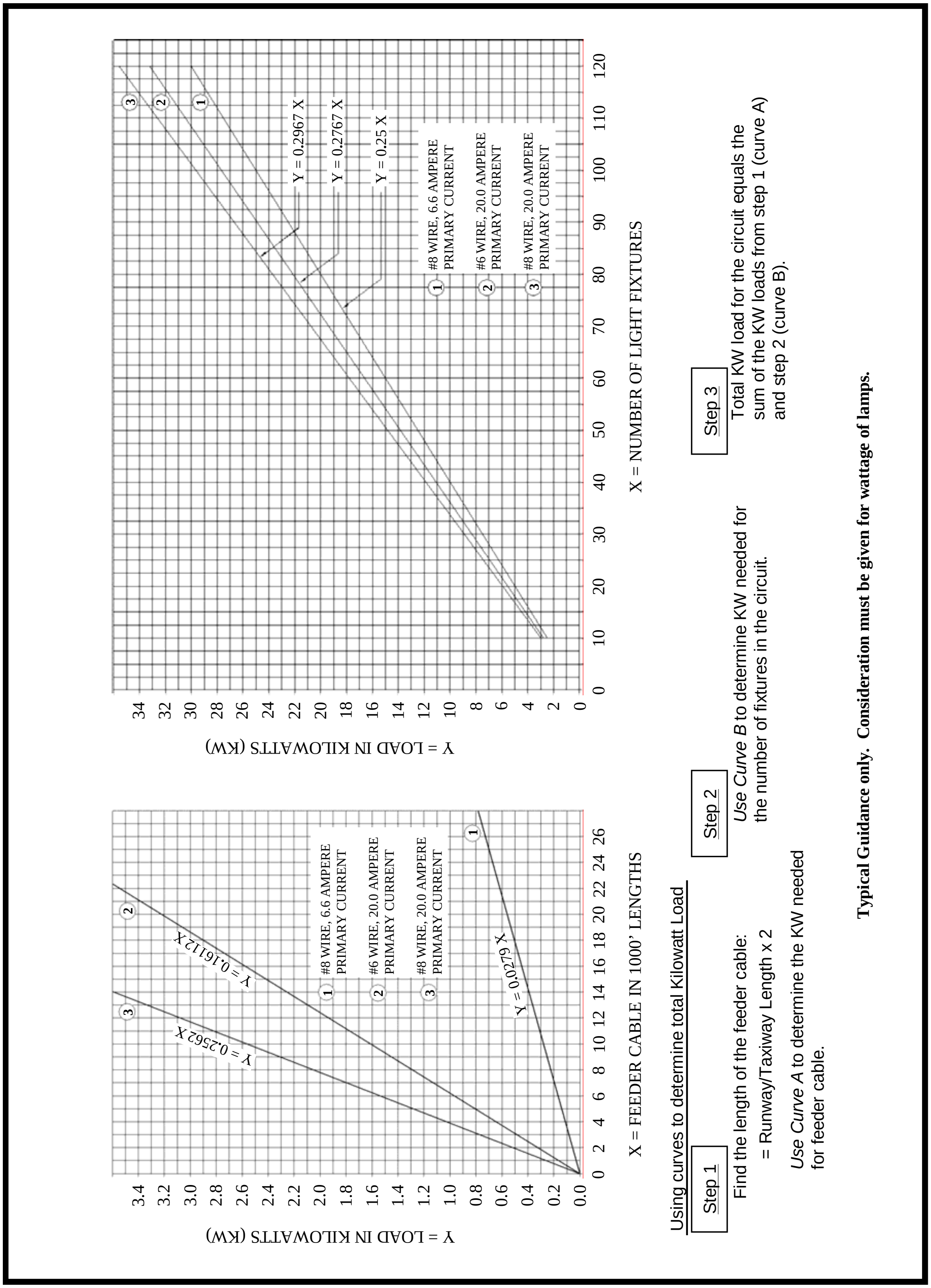
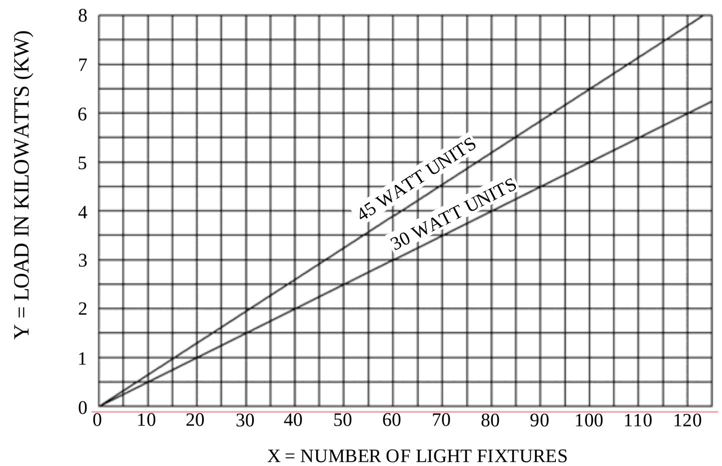
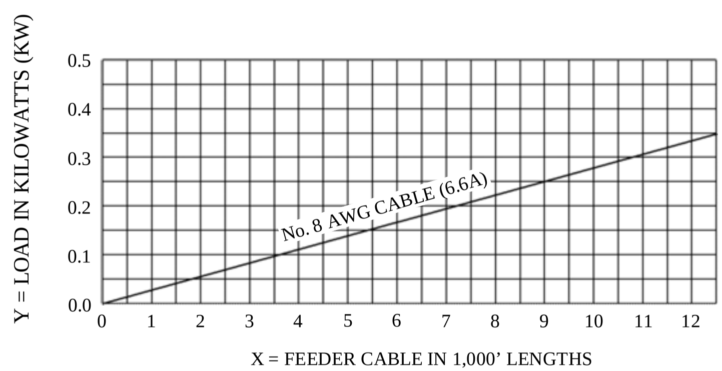


Figure 31 Curves for Estimating Loads in High Intensity Series Circuits





Using curves to determine total Kilowatt Load

1. Computations based on actual circuit load tests.

2. In Curve A find kilowatt load (KW) for the total number of fixtures, using the applicable lines (i.e. 45 watt or 30 watt).

3. Basis for computing unit loads in Curve A:

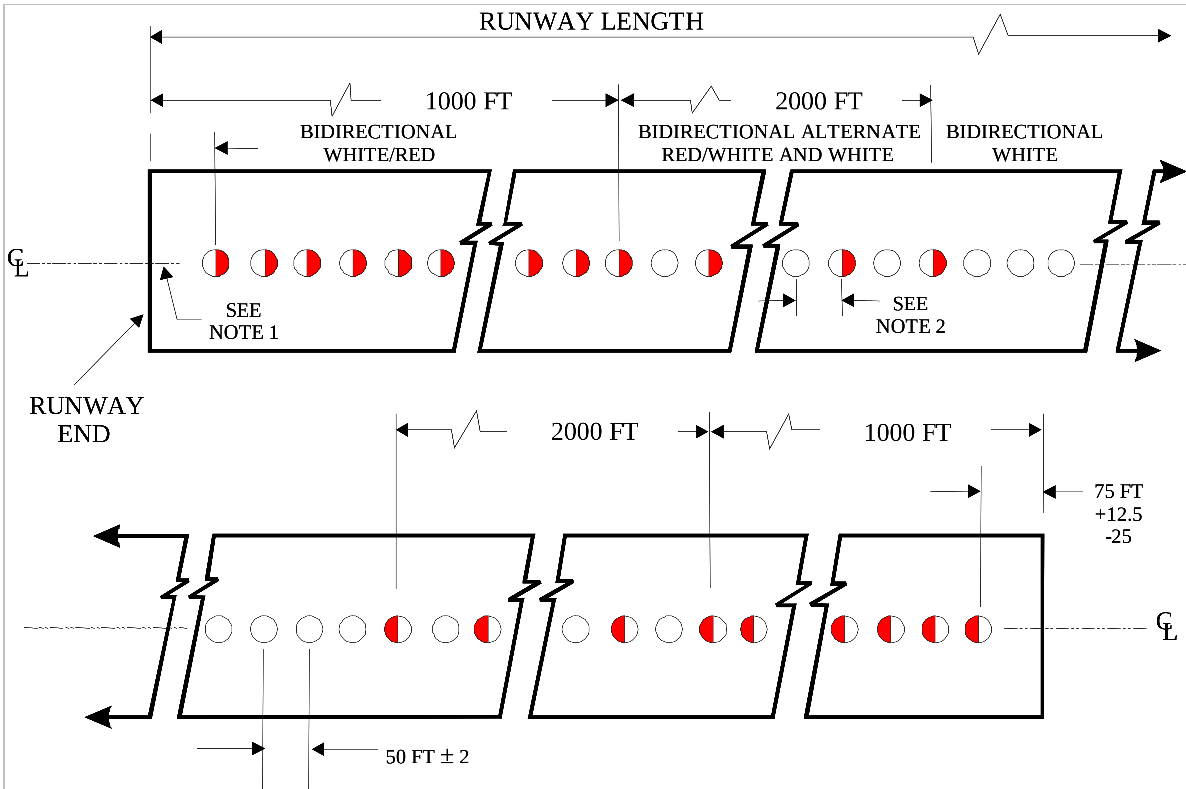
30/45 watt transformer with 45 watt lamp	54.7 watts
Cable loss, lamp tolerance, etc.	10.3 watts
Total estimated load per 45 watt unit	65.0 watts
30/45 watt transformer with 30 watt lamp	40.4 watts
Cable loss, lamp tolerance, etc.	9.6 watts
Total estimated load per 30 watt unit	50.0 watts

4. Basis for computing load per 1000 ft of No. 8 AWG cable in Curve B:

   $I^2R = (6.6A)^2 \times 0.6405$ ohms/1,000 ft = 27.9 watts/1000 ft

5. Total KW load per circuit equal the sum of the KW loads from curve A and curve B.

Figure 32 Curves for Estimating Loads in Medium Intensity Series Circuits



NOTES:

1. THE RUNWAY CENTERLINE (RCL) LINE MAY BE OFFSET NOT MORE THAN 2 FT RIGHT OR LEFT OF THE RUNWAY CENTERLINE. THE LATERAL TOLERANCE FROM THE LINE OF LIGHTS IS ± 1 IN.
2. THE RCL SHALL BE EQUALLY SPACED AT 50 FT FOR FAA TYPE L-850A LIGHTS. THE LONGITUDINAL TOLERANCE IS ± 2 FT.

LEGEND:

○ BIDIRECTIONAL RCL - WHITE BOTH DIRECTIONS

◐ BIDIRECTIONAL RCL - RED IN DIRECTION OF SHADED SIDE,
WHITE IN DIRECTION OF WHITE SIDE

Figure 33 Runway Centerline Lighting Layout

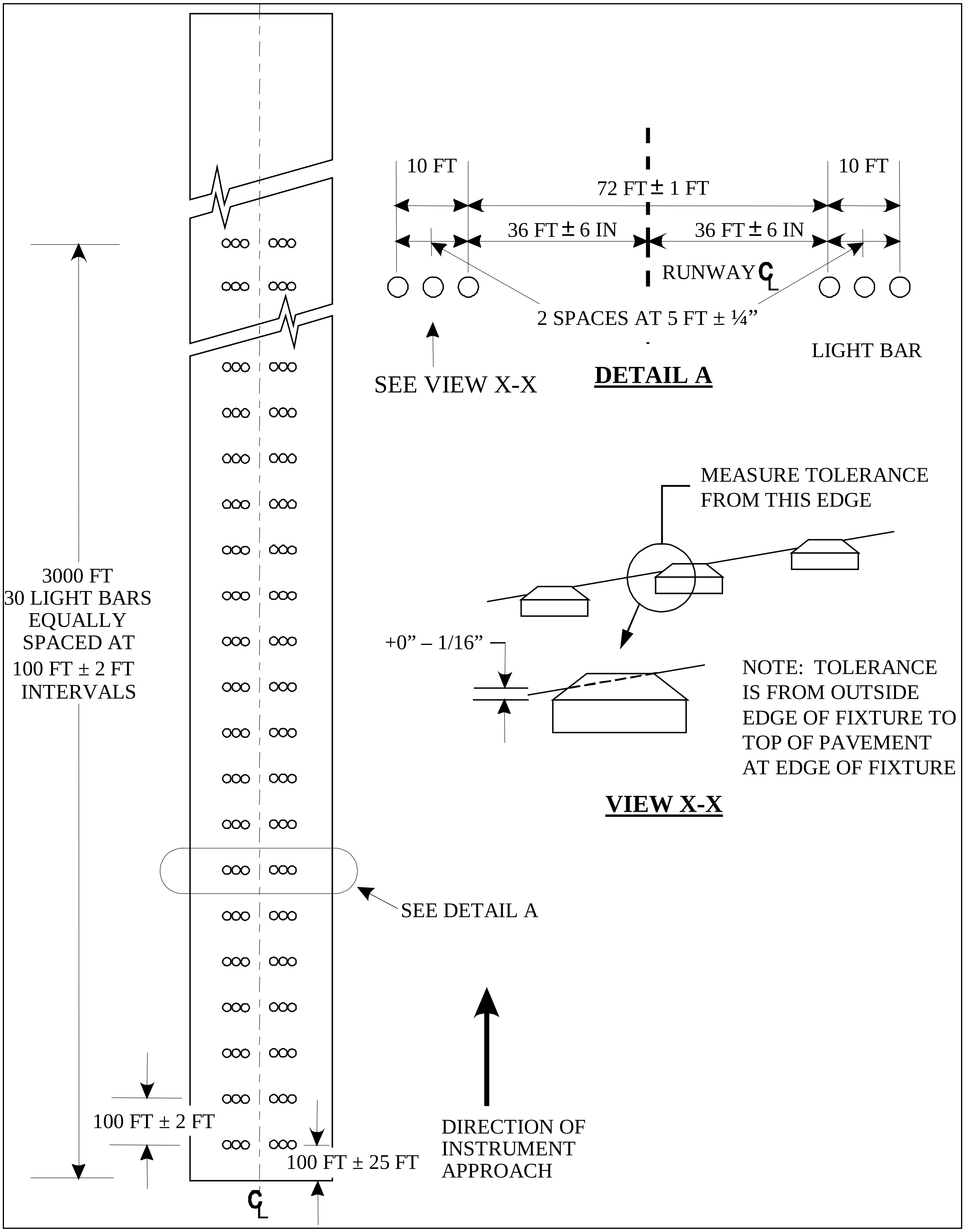
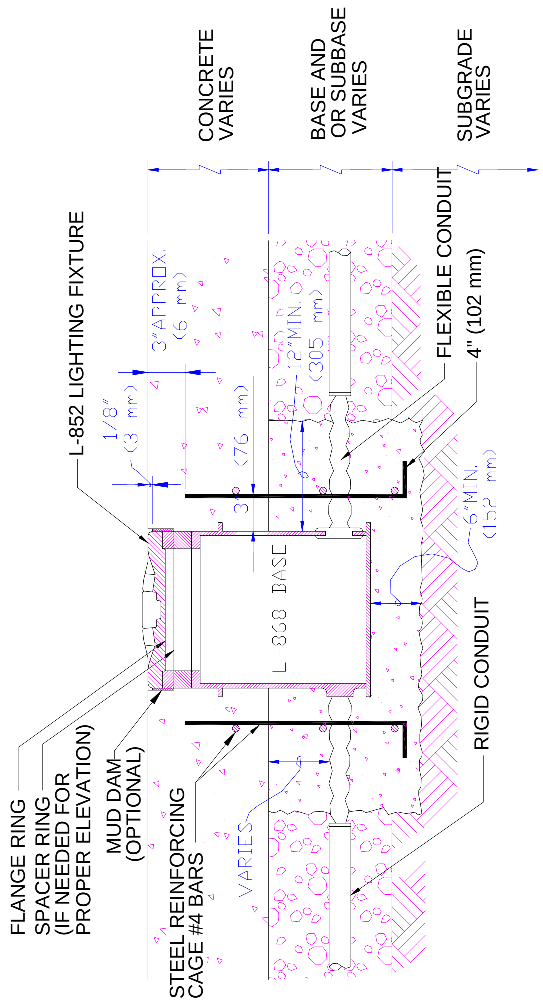


Figure 34 Touchdown Zone Lighting Layout



Notes:
1. Flexible conduit may be connected to the base either through a hub or grommet.

Figure 35 Section Through Non-adjustable Base and Anchor, Base and Conduit System, Rigid Pavement

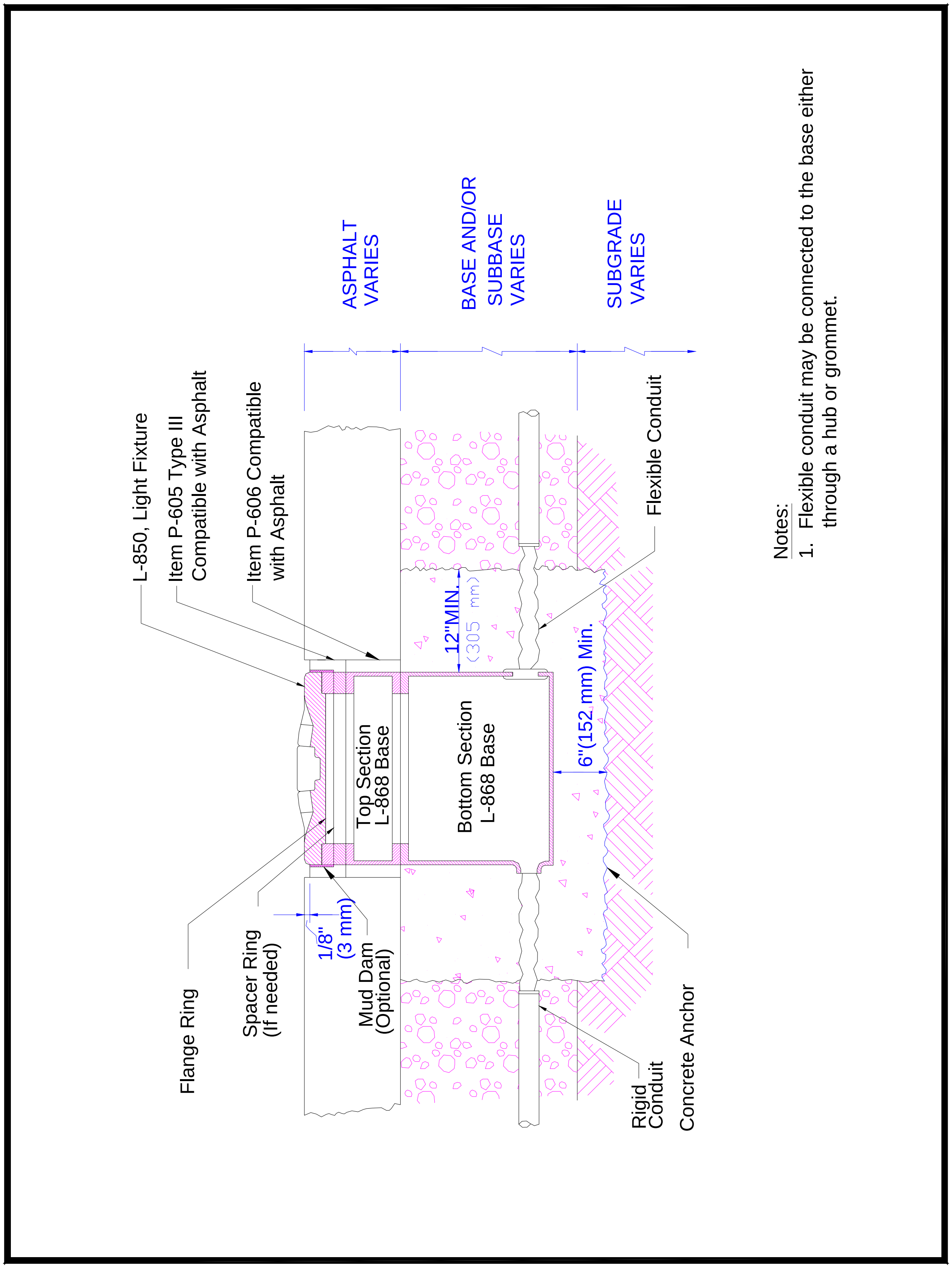


Figure 36 Section Through Non-adjustable Base and Anchor, Base and Conduit System, Flexible Pavement

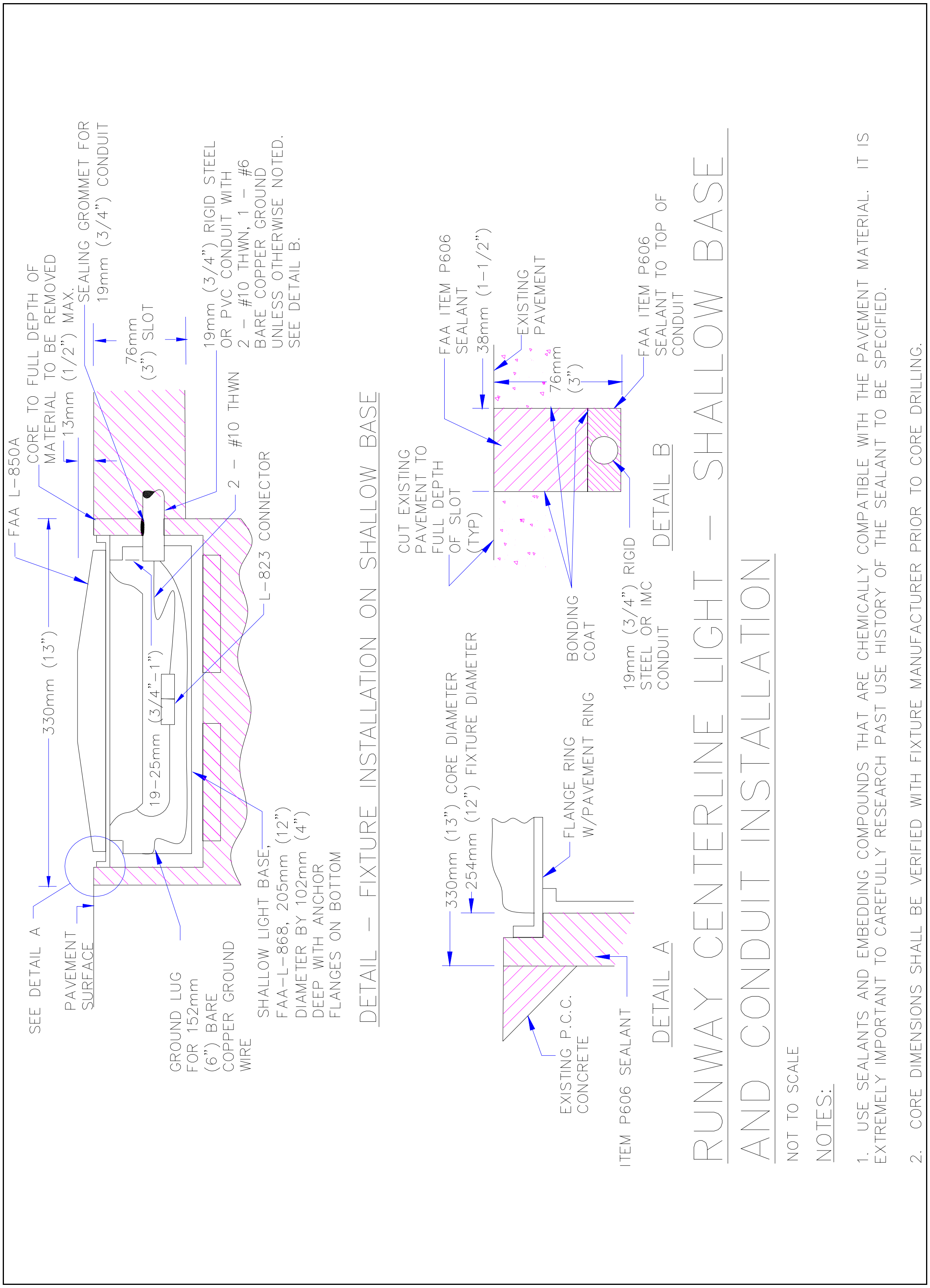
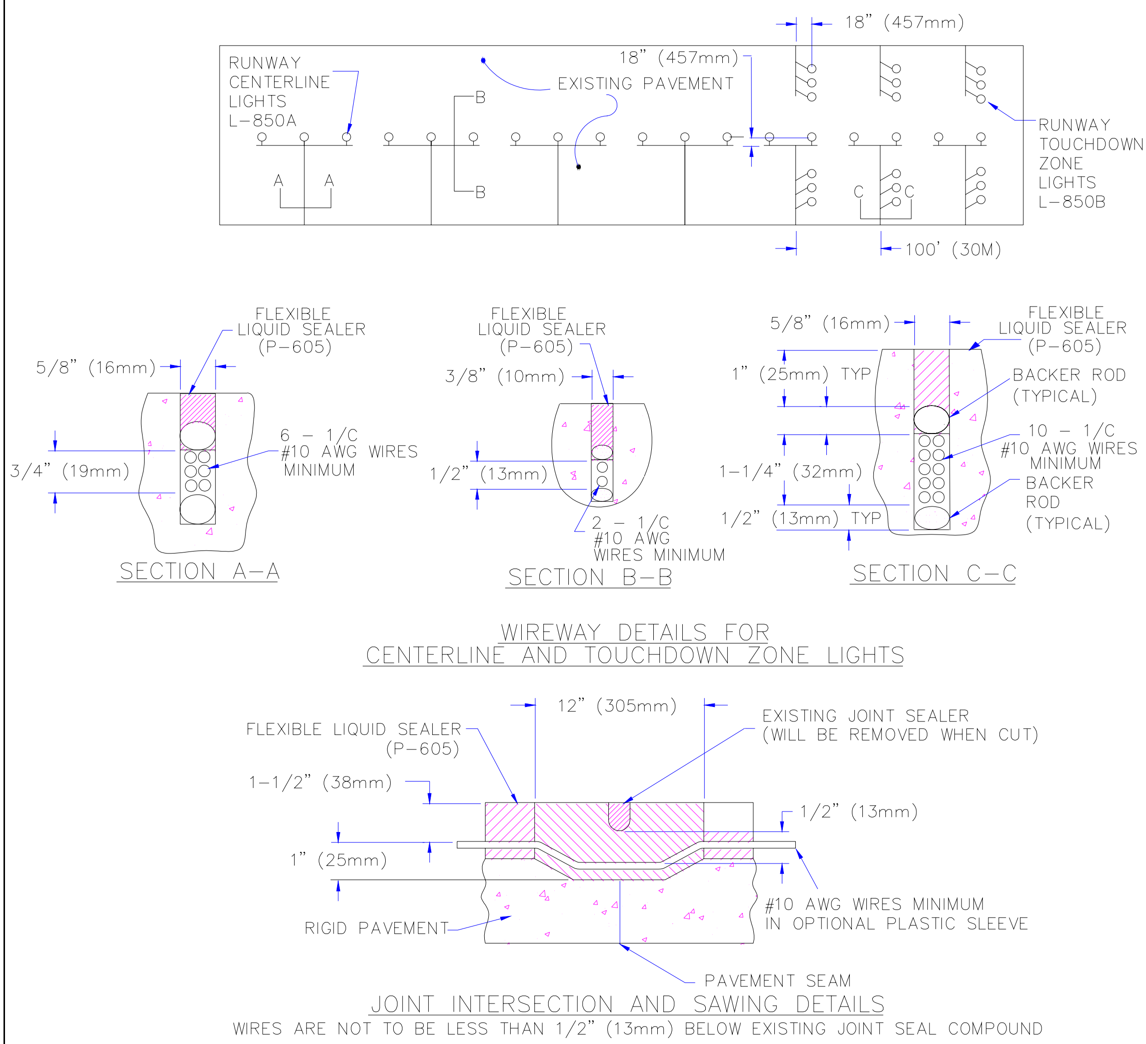


Figure 37 Runway Centerline Light – Shallow Base & Conduit Installation



SAW KERF WIREWAY DETAILS: R/W CENTERLINE & TDZ LIGHTS

NOT TO SCALE

NOTES:

1. DIAMETER OF BACKER ROD SHALL BE 1/4" (6mm) LARGER THAN WIDTH OF SAW KERF.
2. IN EXISTING PAVEMENT, THE EASIEST METHOD OF INSTALLING IN-PAVEMENT LIGHTING IS TO CORE A HOLE FOR THE FIXTURE AND MAKE A SAW KERF FOR THE WIREWAYS. PRIMARY CABLES AND TRANSFORMERS IN THIS CASE ARE LOCATED AT THE EDGE OF THE RUNWAY.
3. TO ASSURE A SUCCESSFULL INSTALLATION, CARE MUST BE TAKEN TO SEE THAT ALL SURFACES ARE SAND BLASTED AND DRIED BEFORE THE SEALER IS APPLIED.
4. USE SEALANTS THAT ARE CHEMICALLY COMPATIBLE WITH THE PAVEMENT MATERIAL. IT IS EXTREMELY IMPORTANT TO CAREFULLY RESEARCH PAST USE HISTORY OF THE SEALANT TO BE SPECIFIED.

Figure 38 Saw Kerf Wireway Details

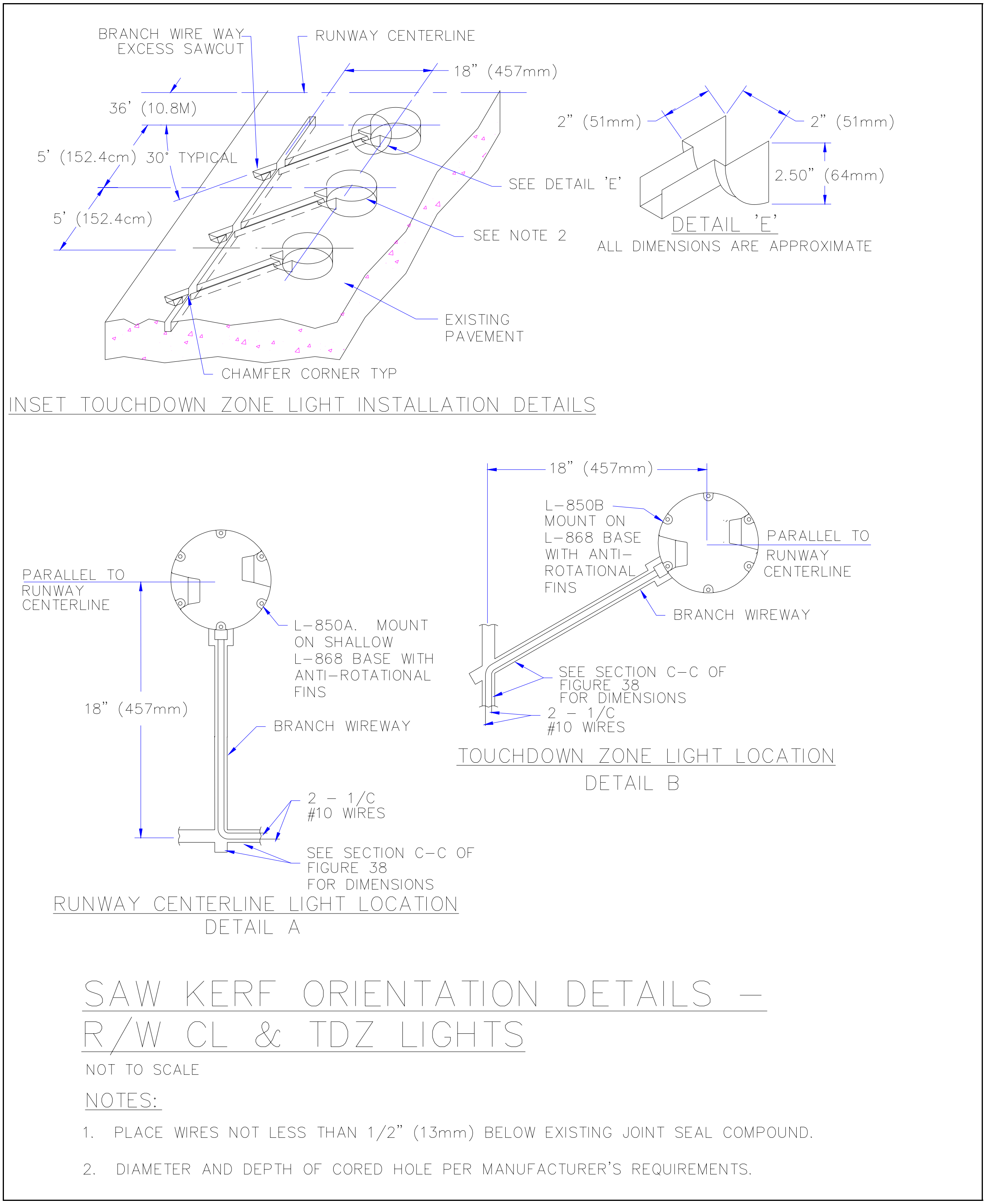
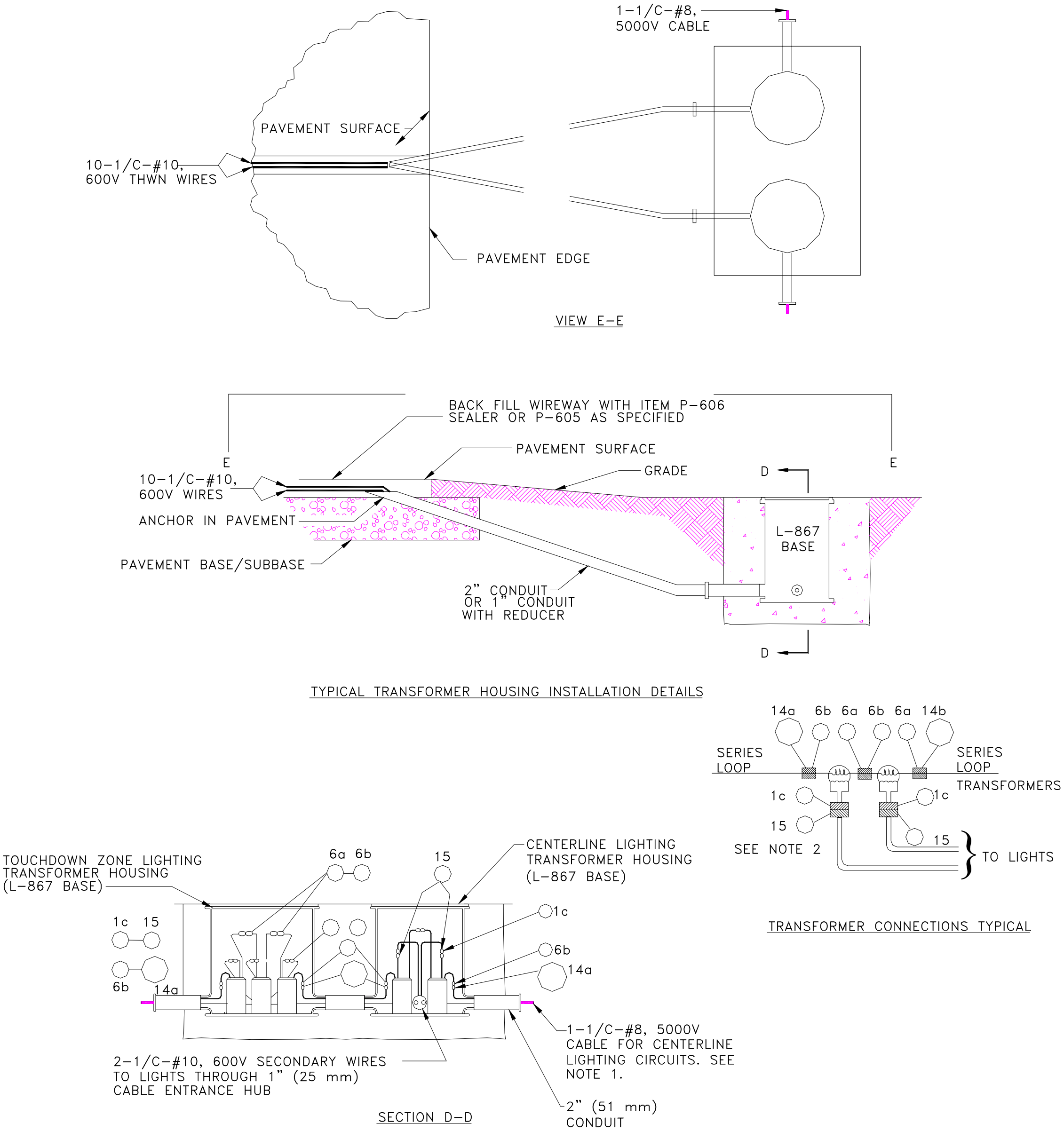


Figure 39 Saw Kerf Orientation Details – R/W Centerline and TDZ Lights



NOTES:

1. THE PRIMARY CABLES ARE INSTALLED IN ACCORDANCE WITH ITEM L-108 OF STANDARDS FOR SPECIFYING CONSTRUCTION OF AIRPORTS.
2. CABLE CONNECTORS - NUMBERS REFER TO SPECIFICATION L-823 FIGURE NUMBERS.

Figure 40 Transformer Housing Installation Details Inset Type Lighting Fixtures

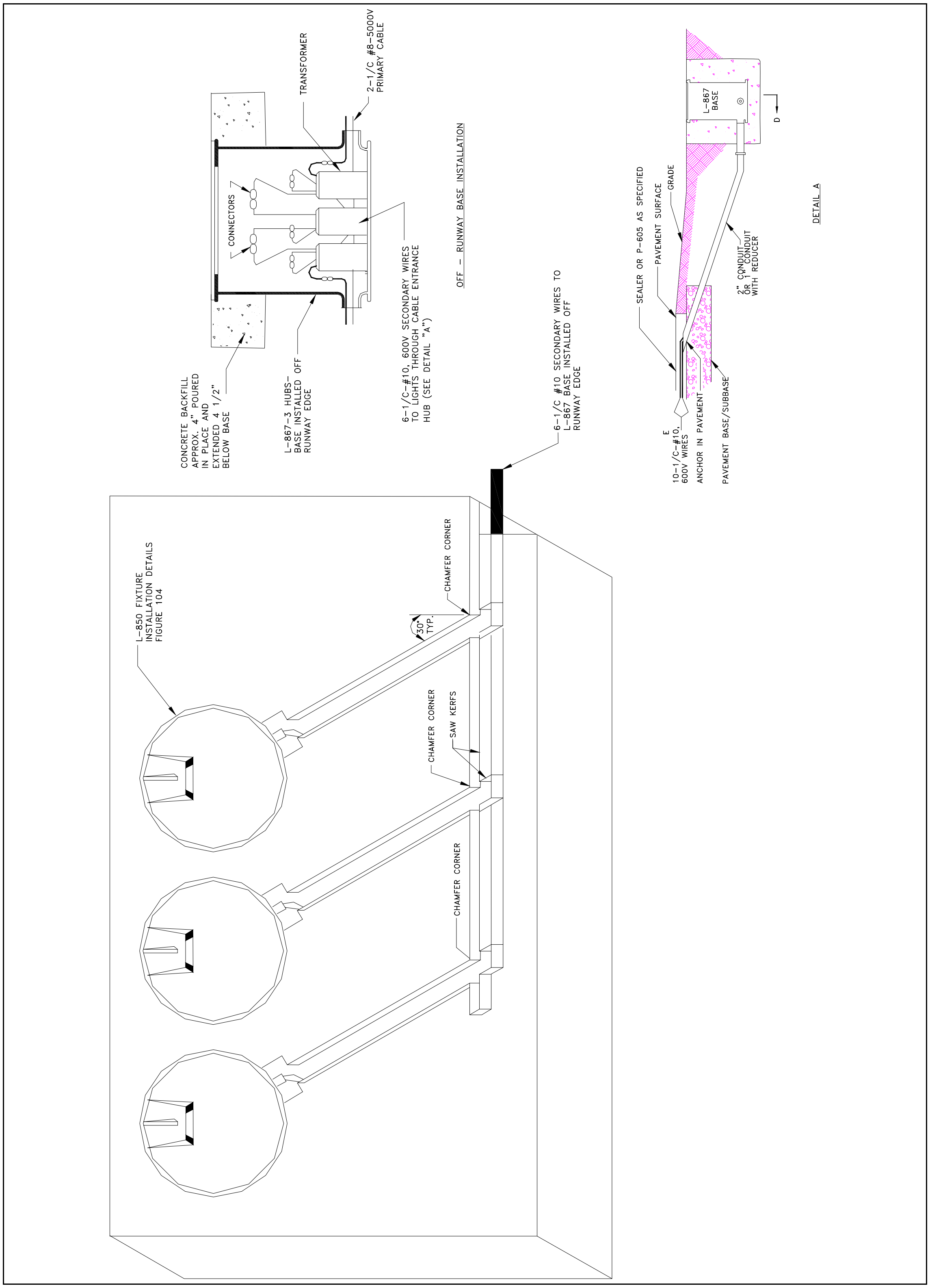
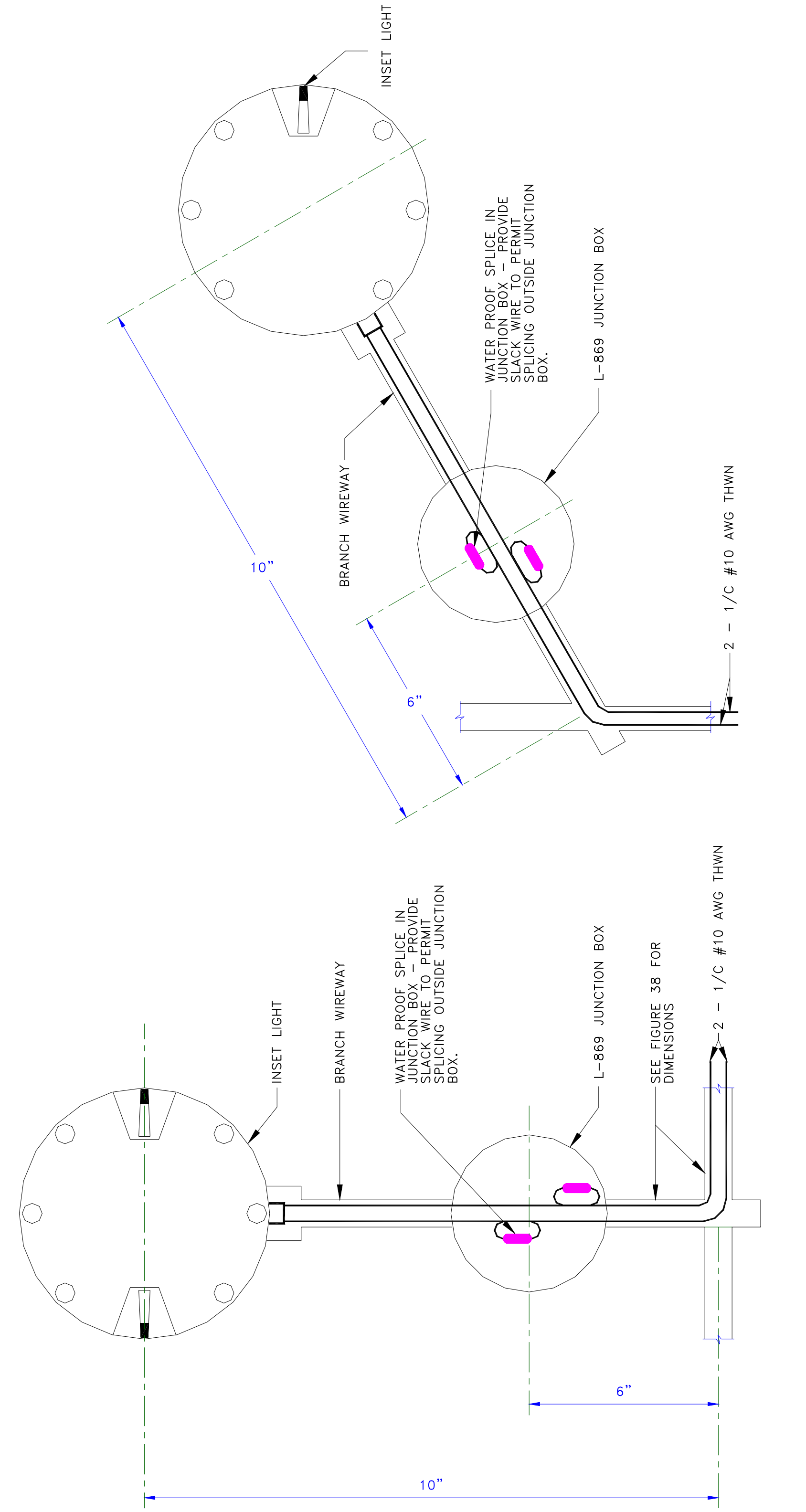


Figure 41 Typical Equipment Layout, Inset Type Lighting Fixtures



NOTES :

1. EITHER CONFIGURATION MAY BE USED, AS REQUIRED BY THE MANUFACTURER.
2. PROVIDE METAL TO METAL CONTACT BETWEEN THE TOP COVER AND THE BASE OF THE JUNCTION BOX.
3. FILL JUNCTION BOX WITH A COMMERCIAL NON-SETTING MATERIAL THIS MATERIAL IS USED TO PREVENT WATER FROM COLLECTING IN THE JUNCTION BOX.
4. PROVIDE A SUITABLE GASKET AND GROMMETS TO CONTAIN NON-SETTING MATERIAL IN JUNCTION BOX.
5. INSTALL THE JUNCTION BOX LEVEL WITH THE SURROUNDING PAVEMENT.

Figure 42 Junction Box for Inset Fixture Installation

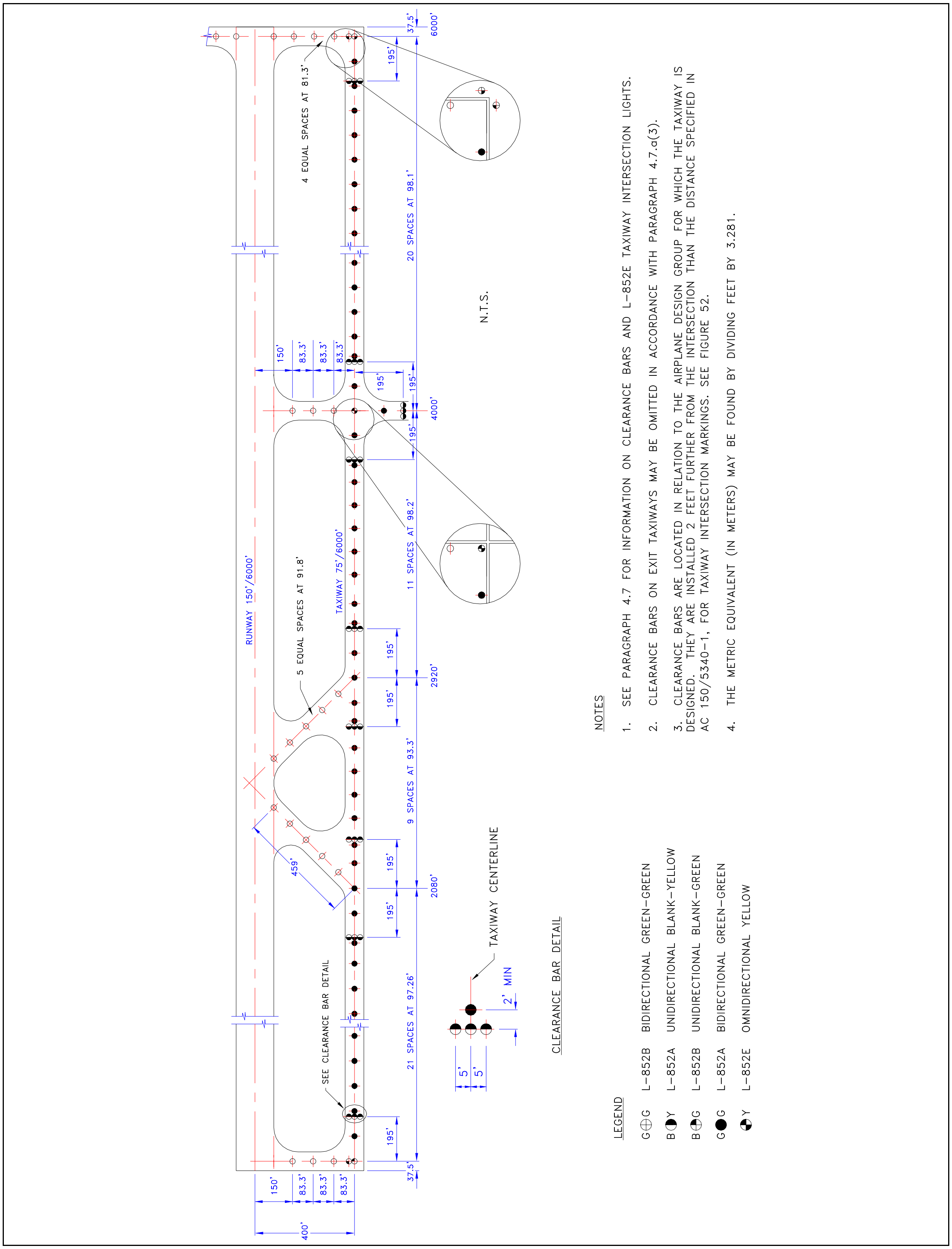


Figure 43 Typical Taxiway Centerline Lighting Configuration for Non-Standard Fillets. (Centerline light spacing for operations above 1,200 feet (365 m) RVR)

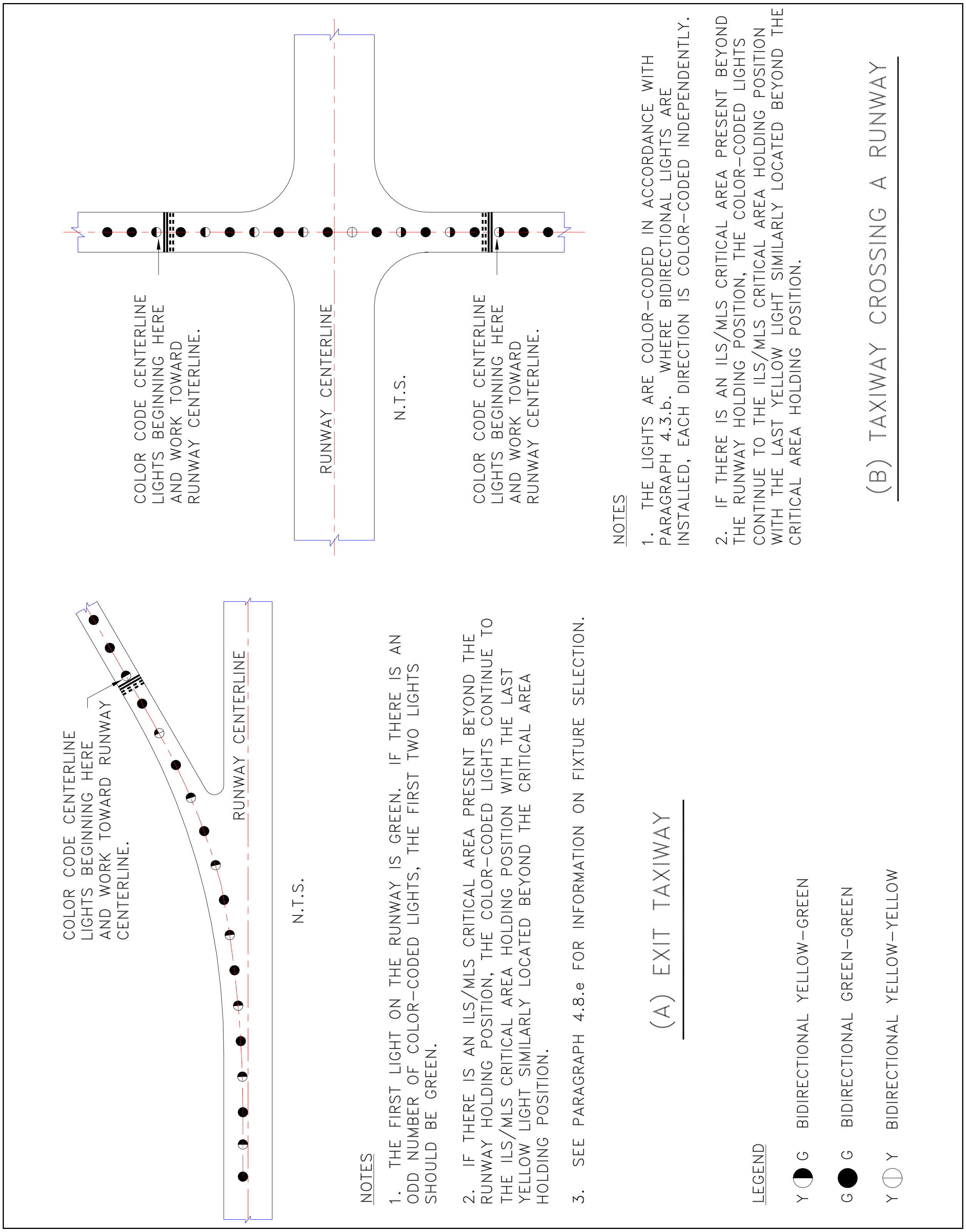


Figure 44 Color-Coding of Exit Taxiway Centerline Lights

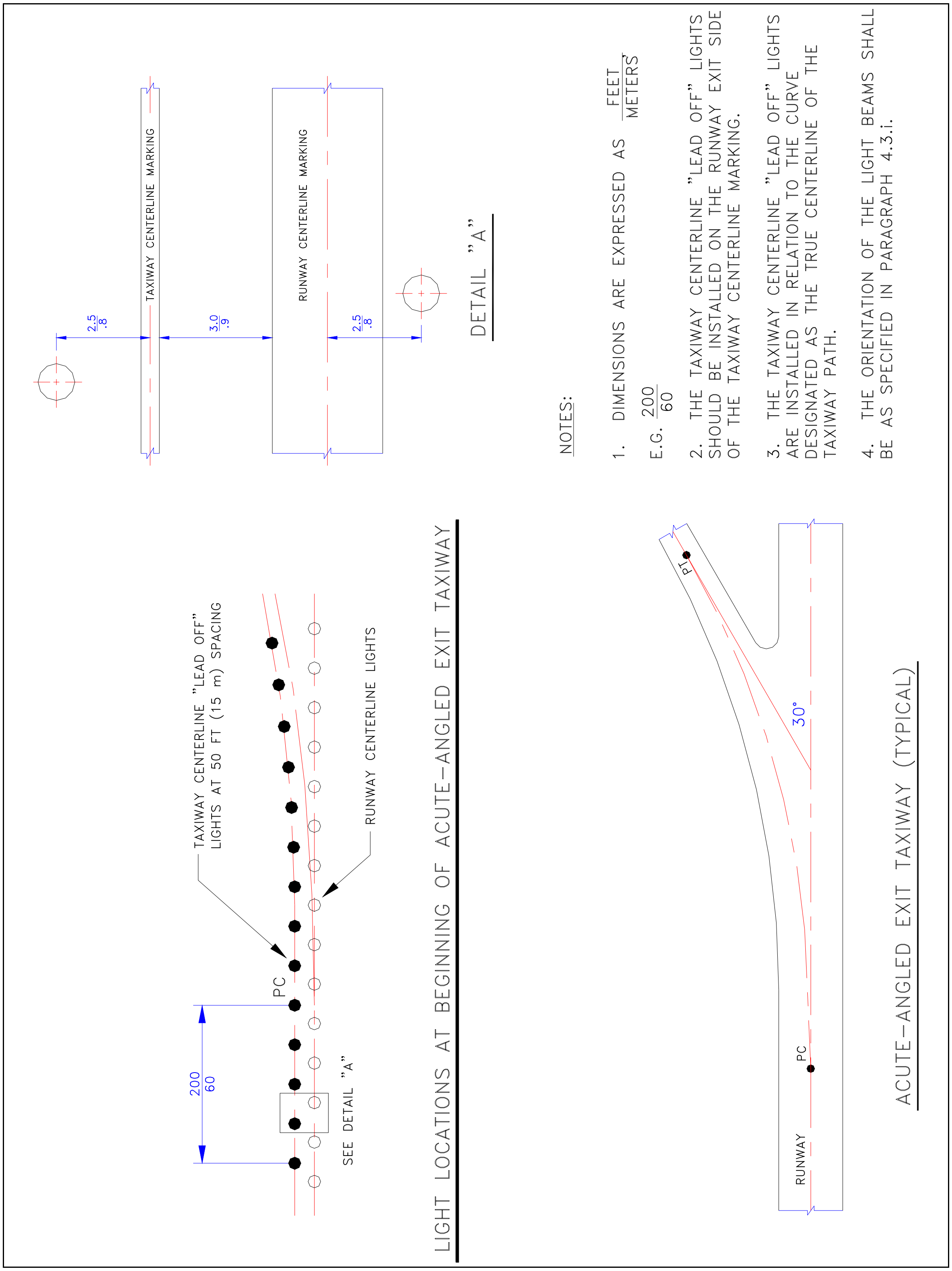


Figure 45 Taxiway Centerline Lighting Configuration for Acute-Angled Exits

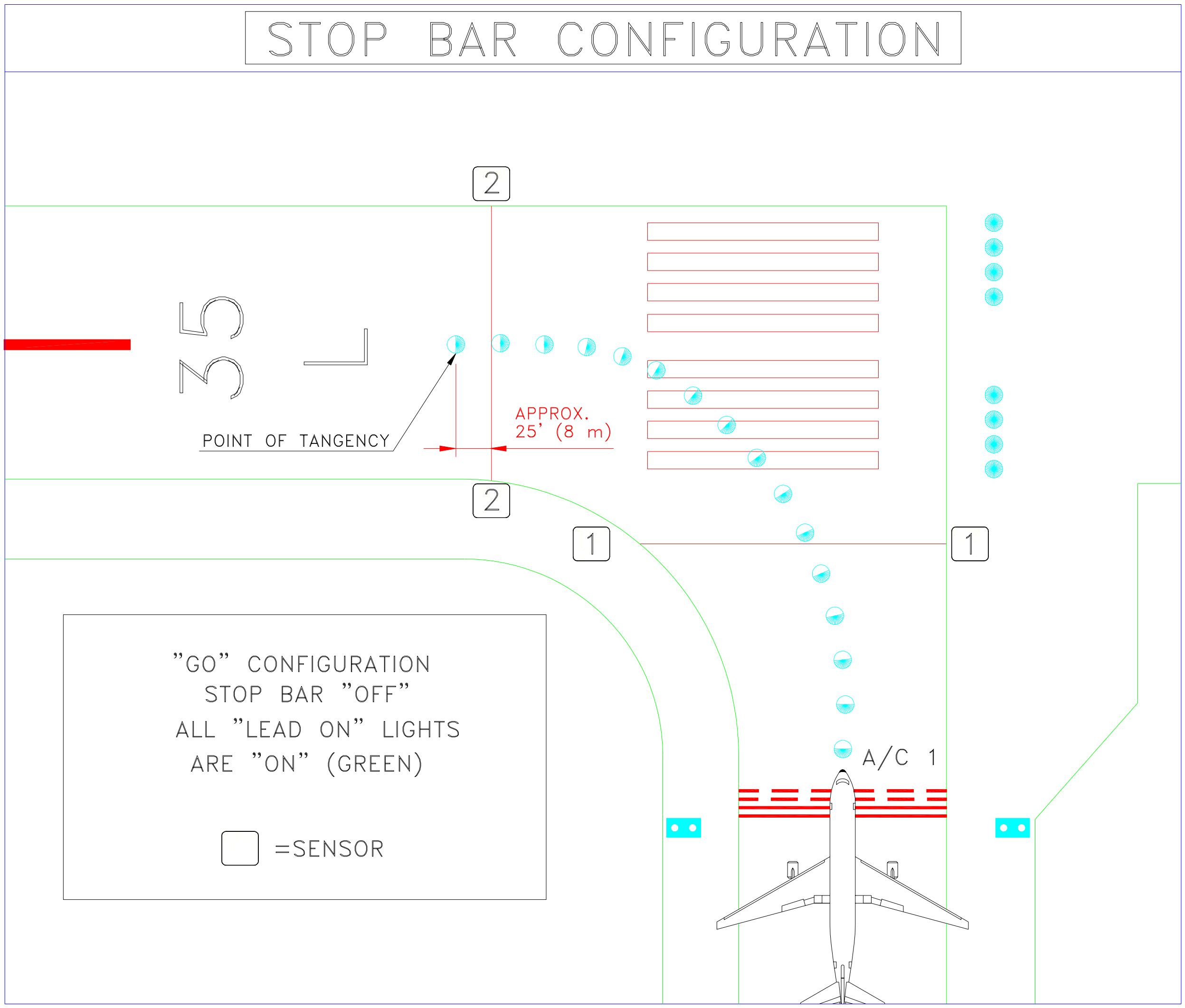


Figure 46 Controlled Stop Bar Design and Operation – "GO" Configuration

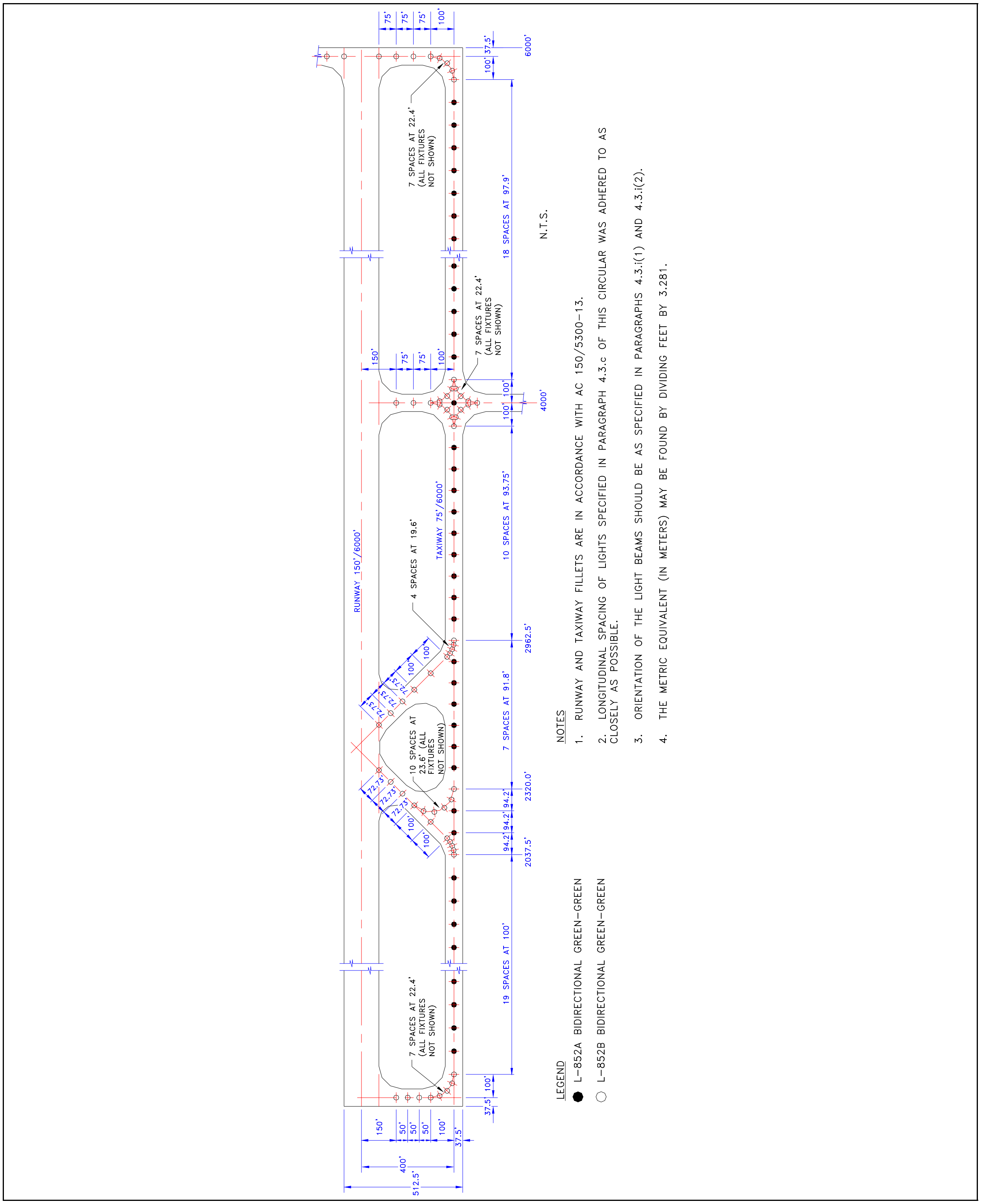
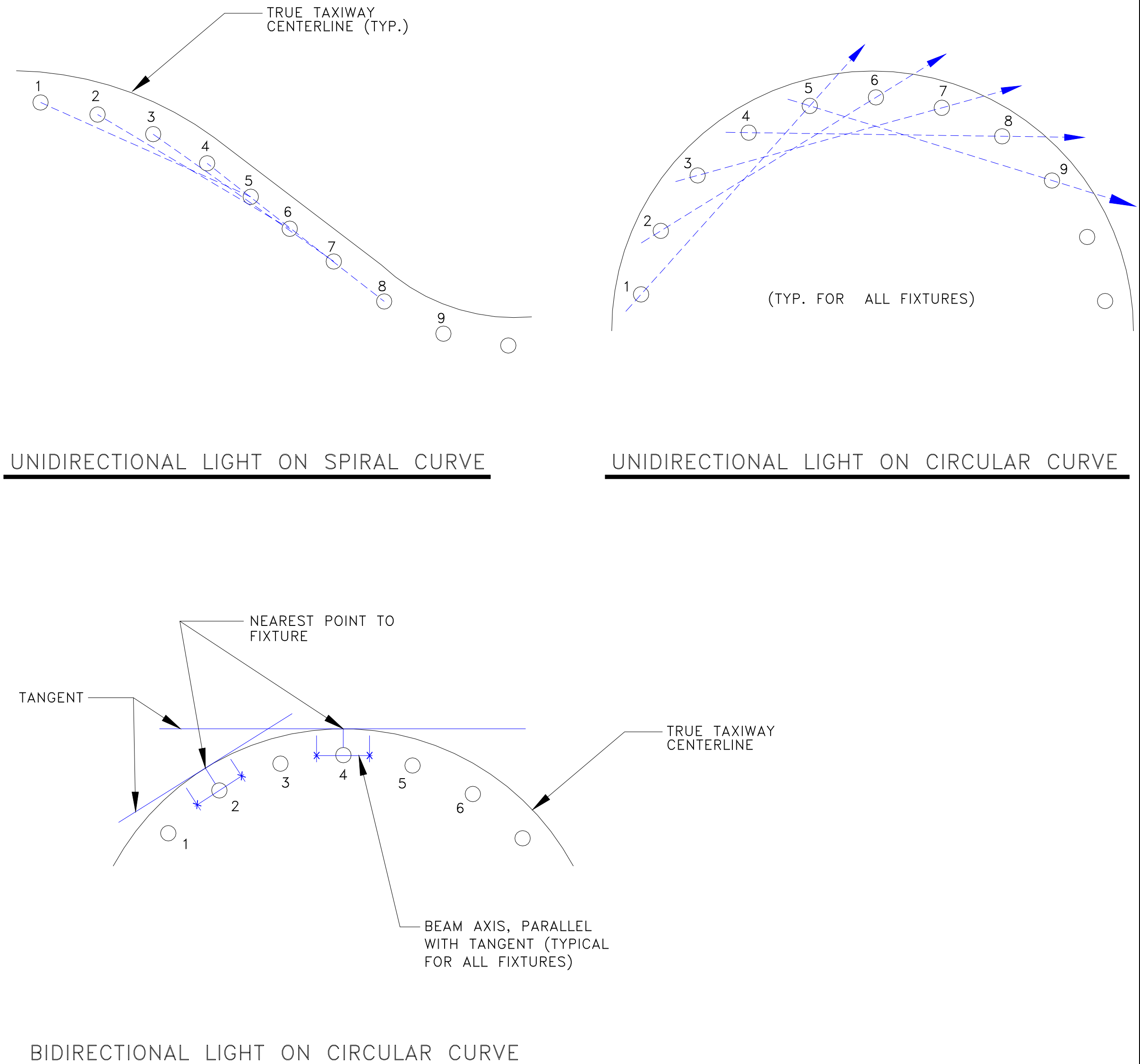


Figure 47 Typical Taxiway Centerline Lighting Configuration for Standard Fillets (Centerline light spacing for operations above 1,200 feet (365 m) RVR)



NOTES:

1. FOR BIDIRECTIONAL LIGHTS, THE AXIS OF THE TWO BEAMS SHALL BE ORIENTED PARALLEL TO THE TANGENT OF THE NEAREST POINT OF THE CURVE DESIGNATED AS THE TRUE CENTERLINE OF THE TAXING PATH.

2. FOR UNIDIRECTIONAL LIGHTS, THE AXIS OF THE BEAM SHALL BE "TOED IN" TO INTERSECT THE CENTERLINE AT A POINT APPROXIMATELY EQUAL
TO FOUR TIMES THE SPACING OF LIGHTS (EVERY FOURTH LIGHT) ON THE CURVE PORTION, AND SUCH SPACING SHALL BE MEASURED ALONG THE CHORD OF THE CURVE.

Figure 48 Taxiway Centerline Light Beam Orientation

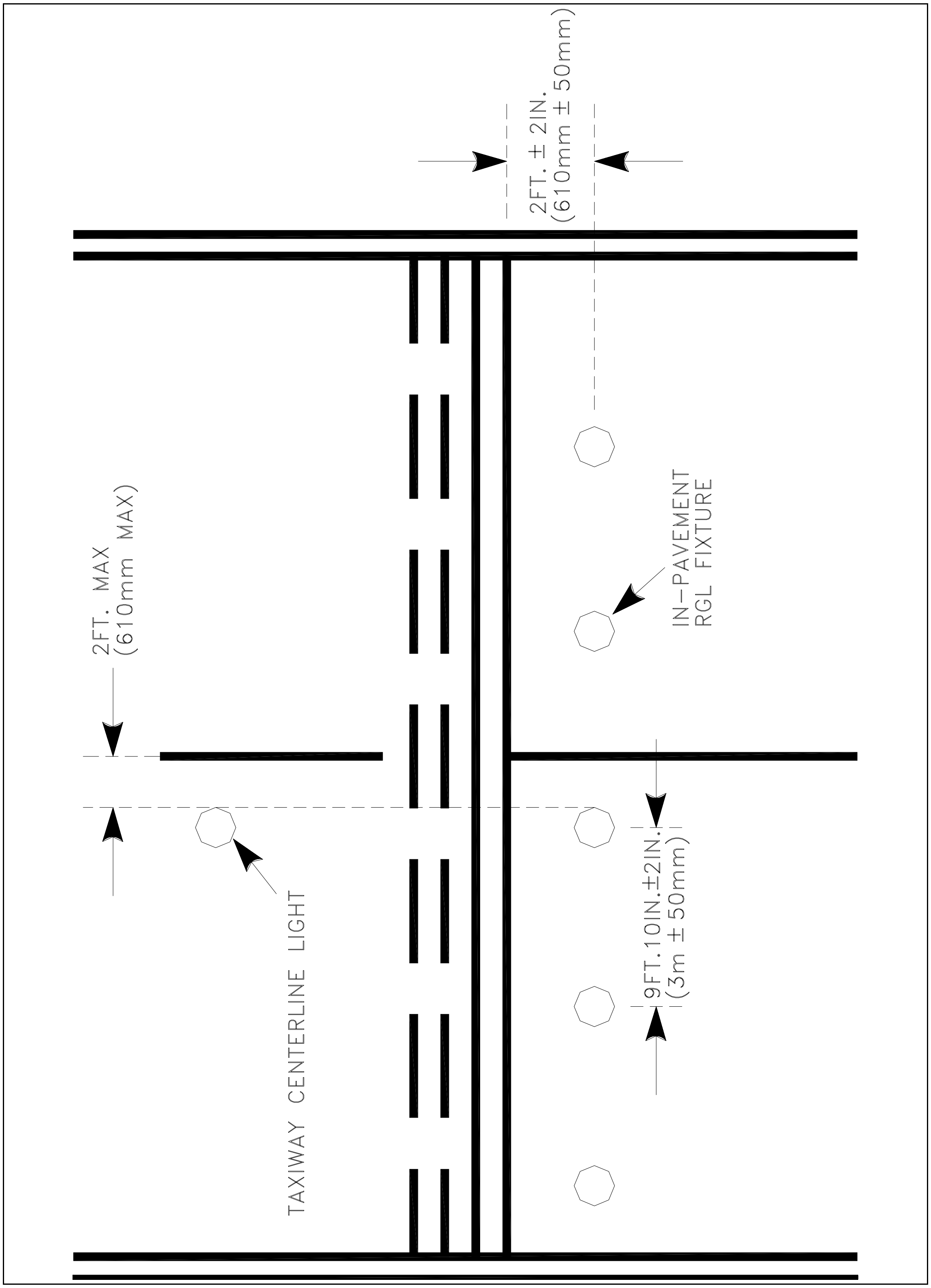


Figure 49 In-Pavement Runway Guard Light Configuration

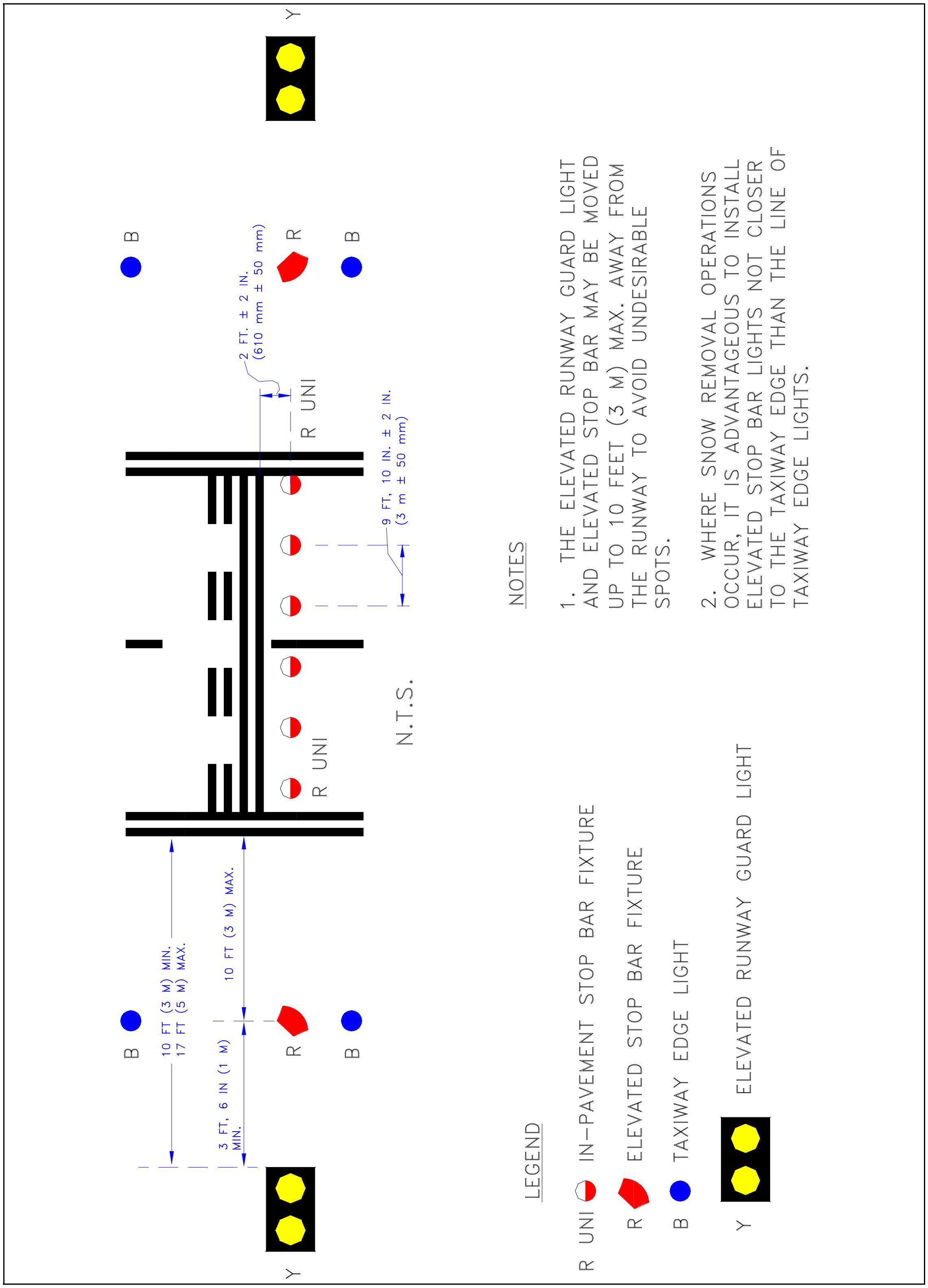


Figure 50 Elevated RGL and Stop Bar Configuration

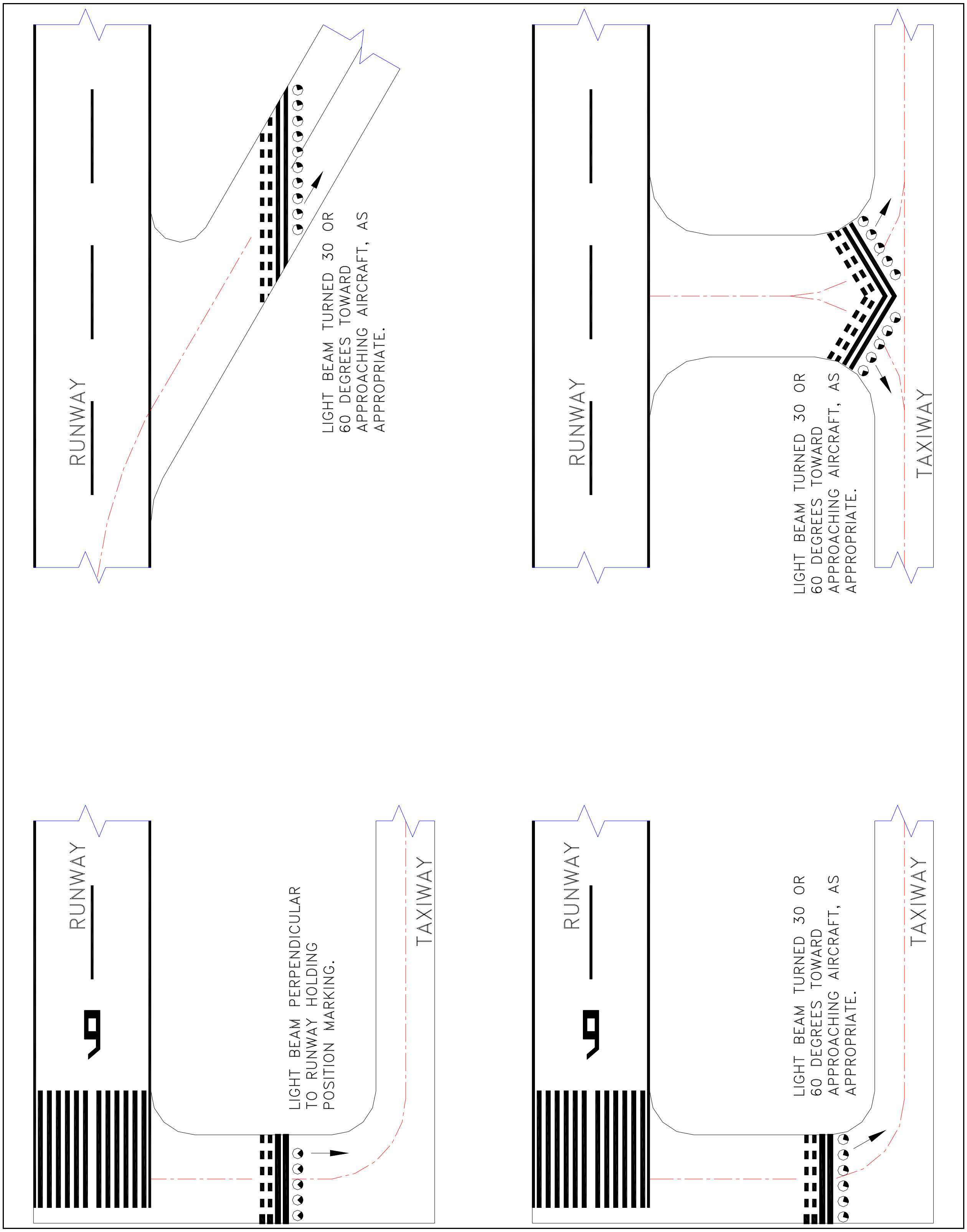


Figure 51 Typical Light Beam Orientation for In-Pavement RGLs and Stop Bars

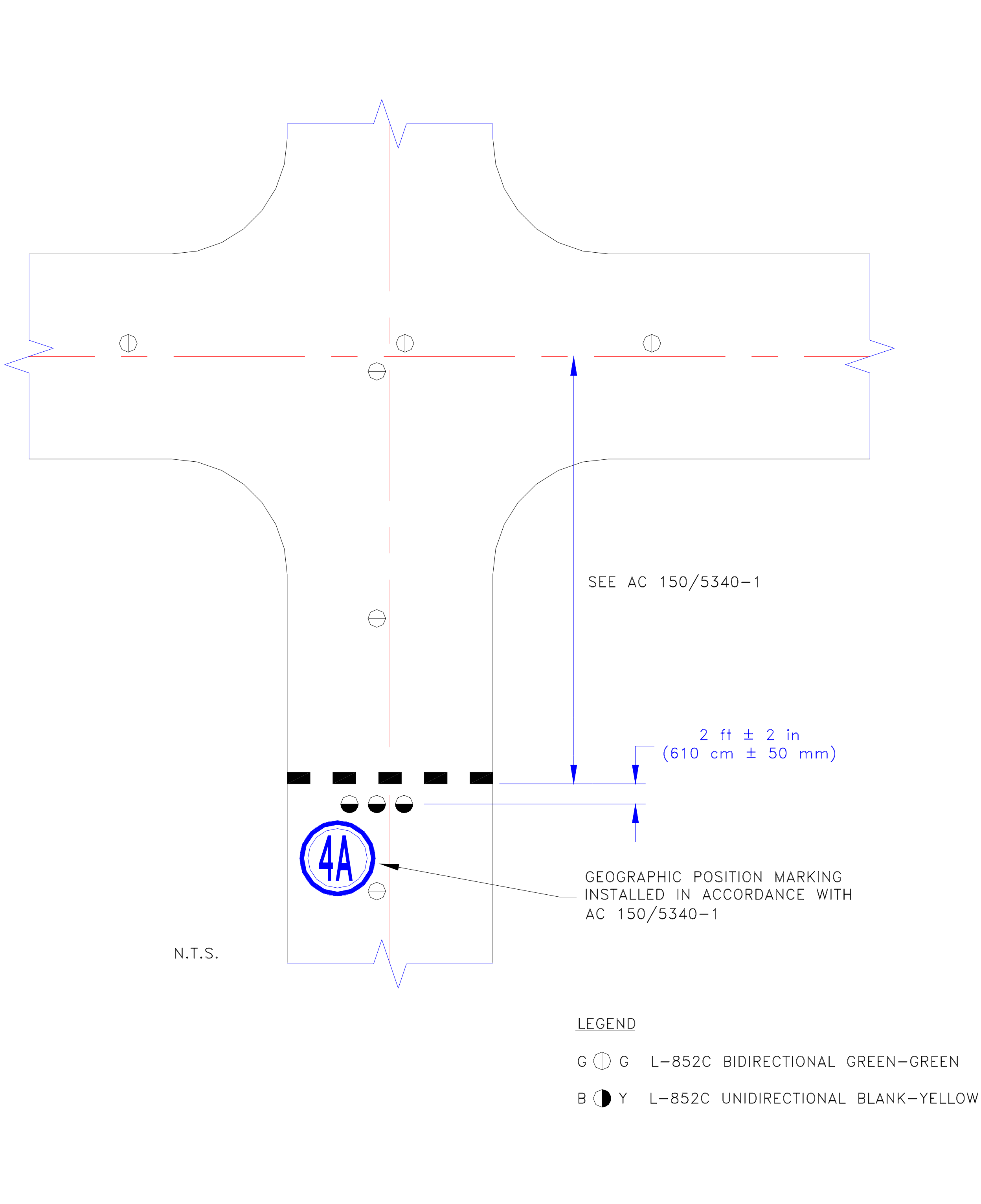


Figure 52 Clearance Bar Configuration at a Low Visibility Hold Point

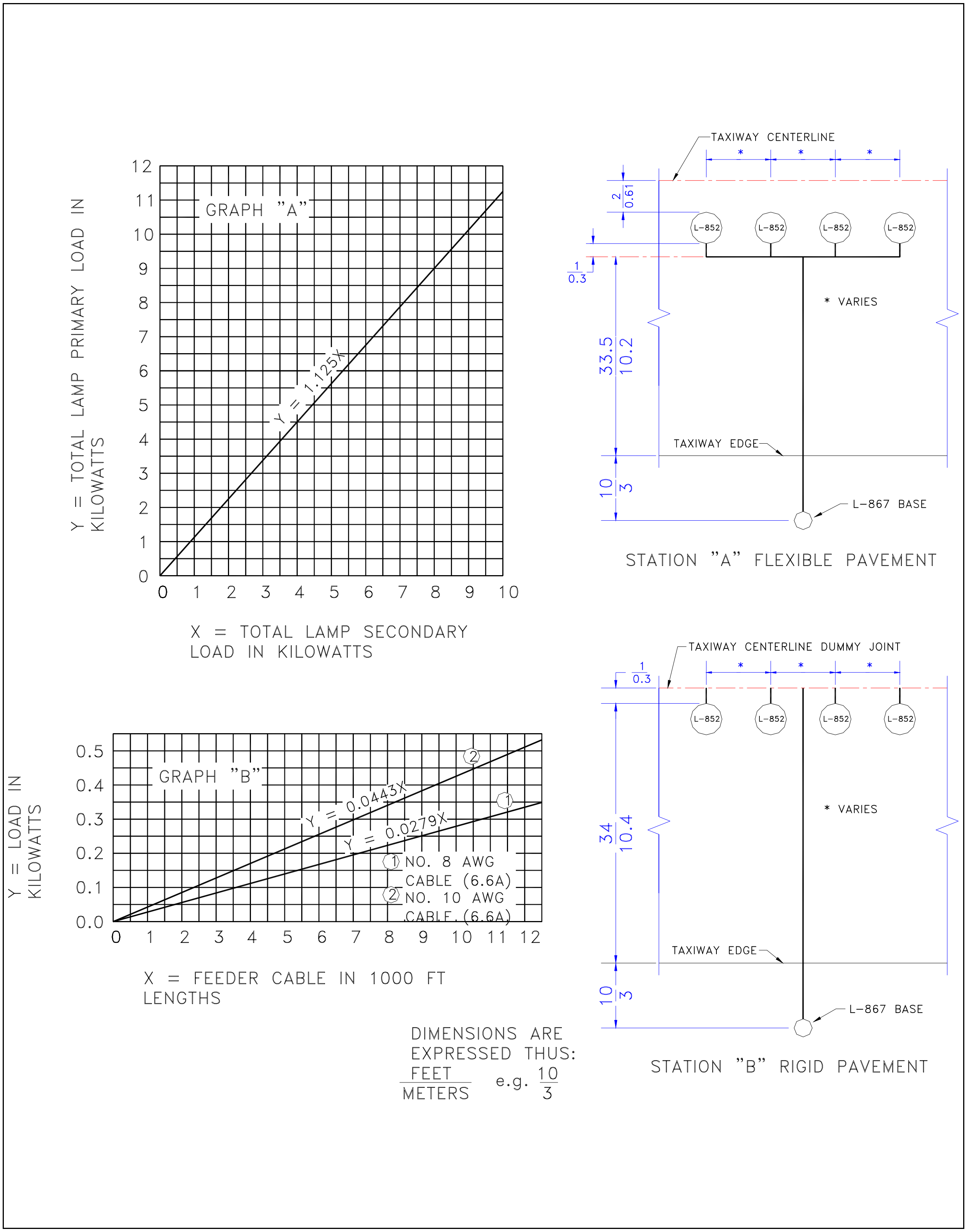
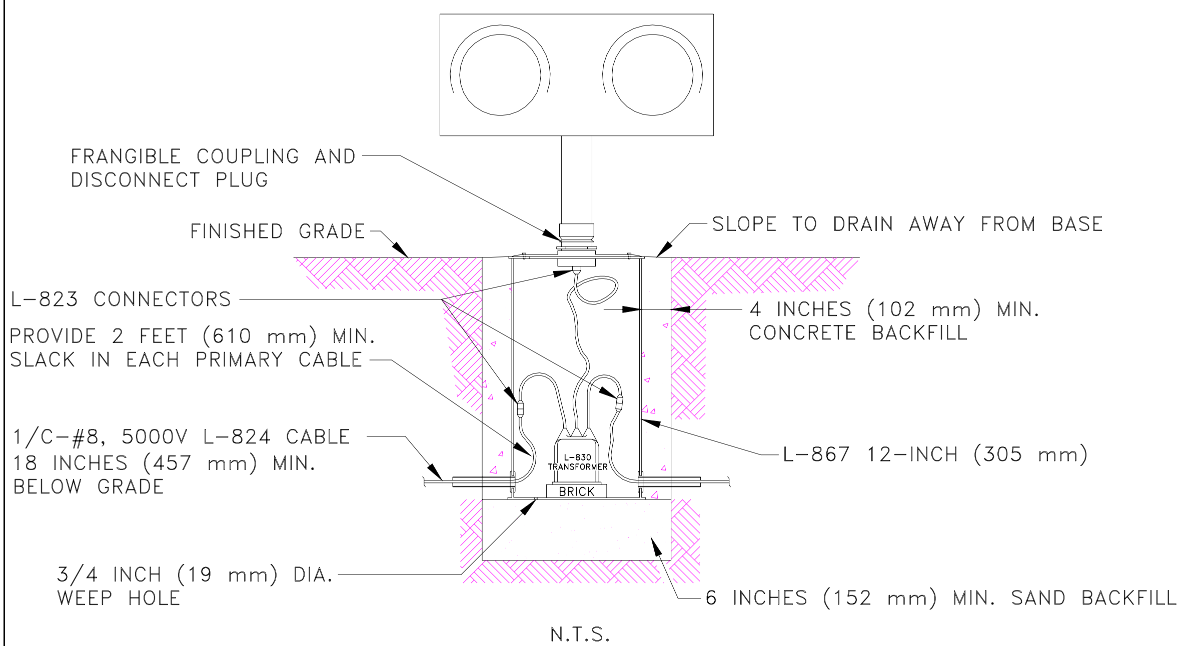


Figure 53 Curves for Estimating Primary Load for Taxiway Centerline Lighting Systems



Notes:

1. Breaking-point frangible coupling should be located 3 inches max above grade.

Figure 54 Typical Elevated RGL Installation Details

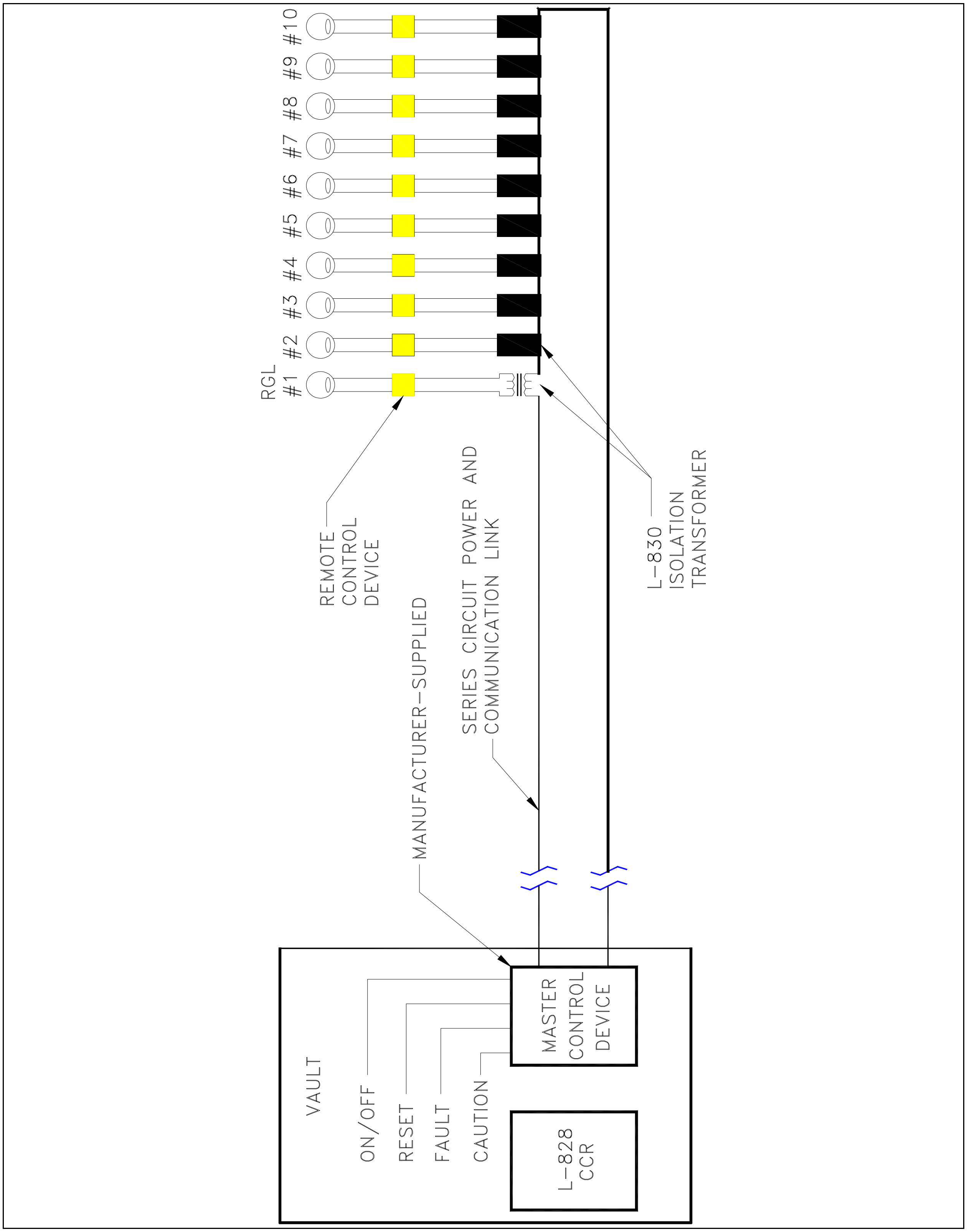


Figure 55 Typical In-Pavement RGL External Wiring Diagram – Power Line Carrier Communication, One Light Per Remote

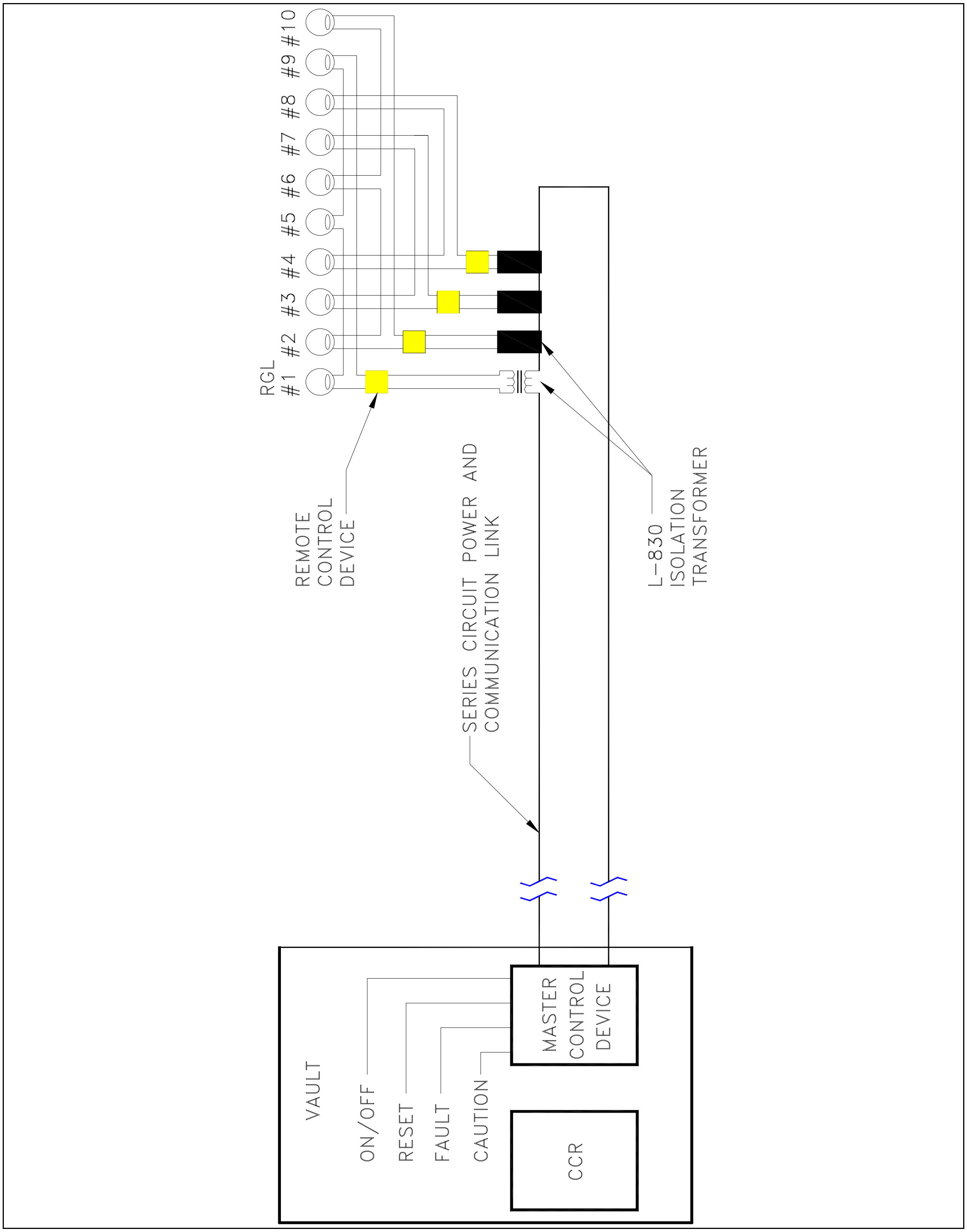


Figure 56 Typical In-Pavement RGL External Wiring Diagram – Power Line Carrier Communication, Multiple Lights per Remote

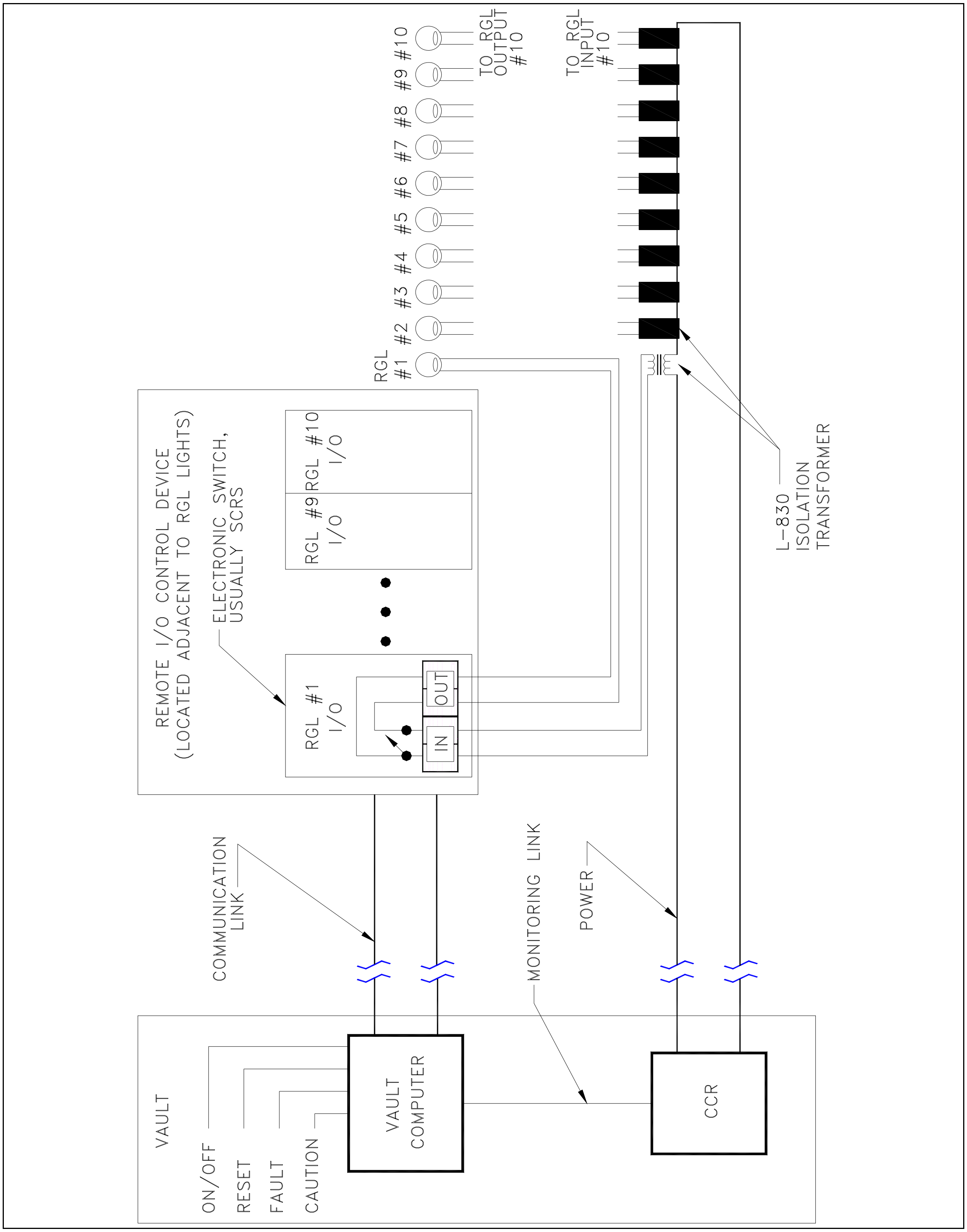


Figure 57 Typical In-Pavement RGL External Wiring Diagram – Dedicated Communication Link

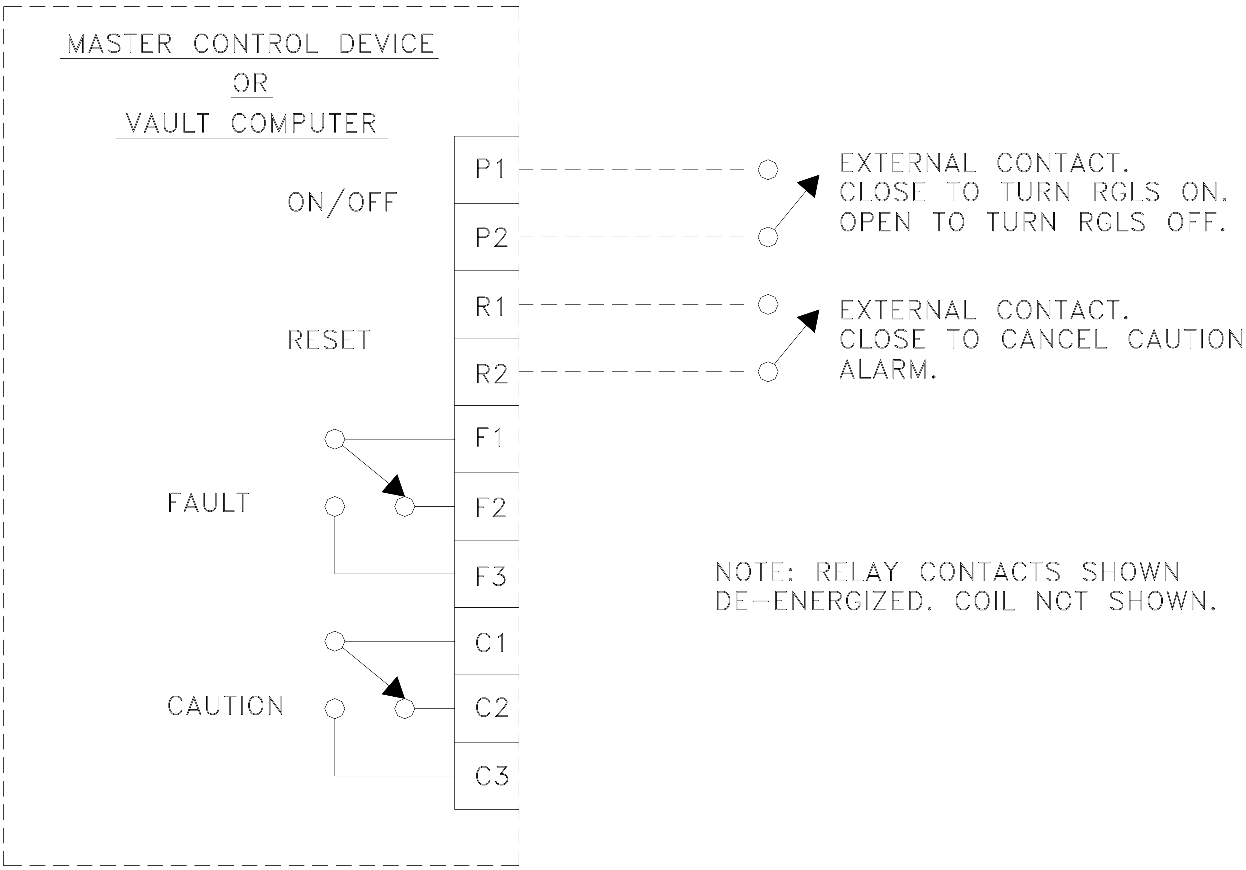


Figure 58 In-Pavement RGL Alarm Signal Connection

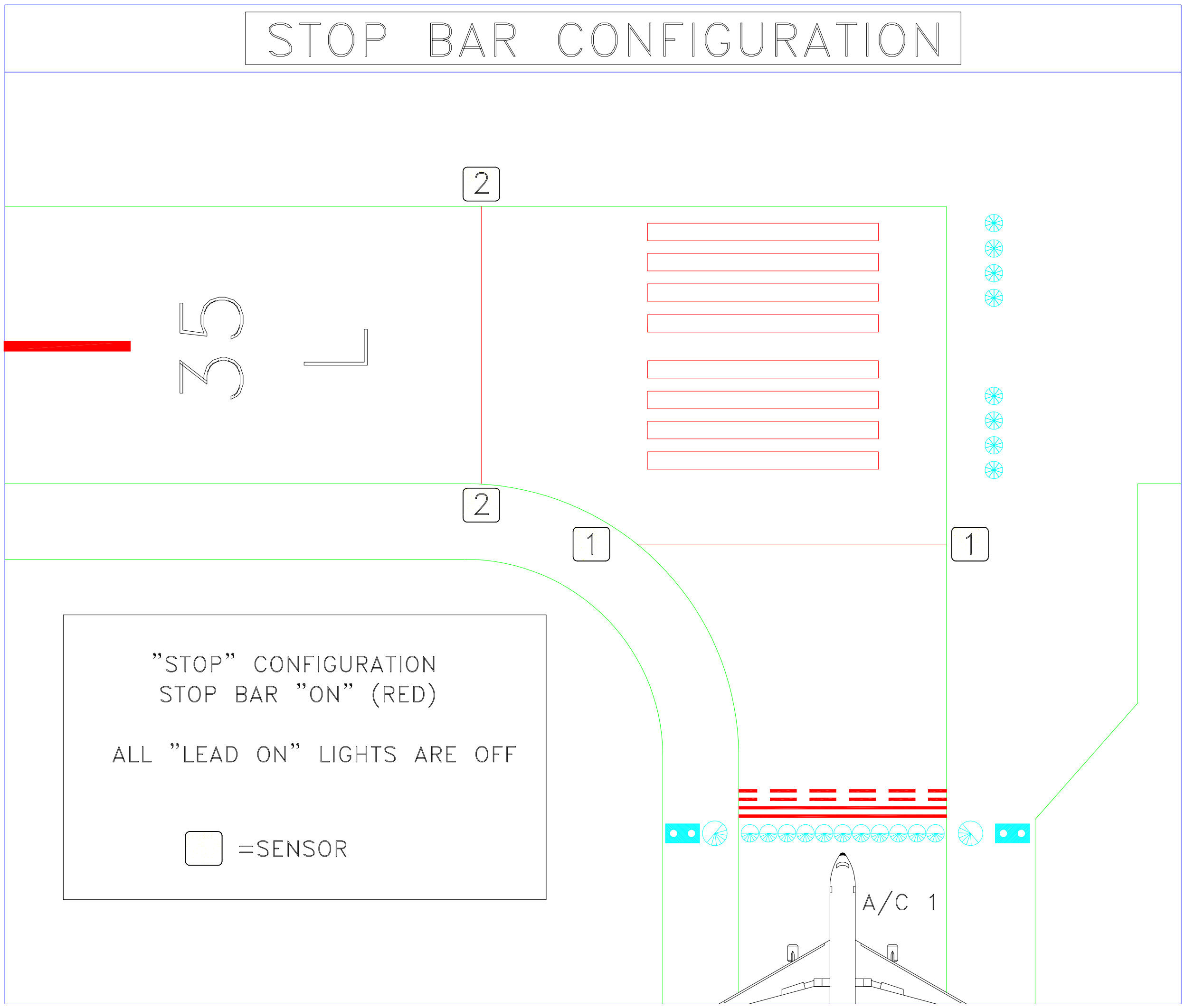


Figure 59 Controlled Stop Bar Design and Operation – "STOP" Configuration

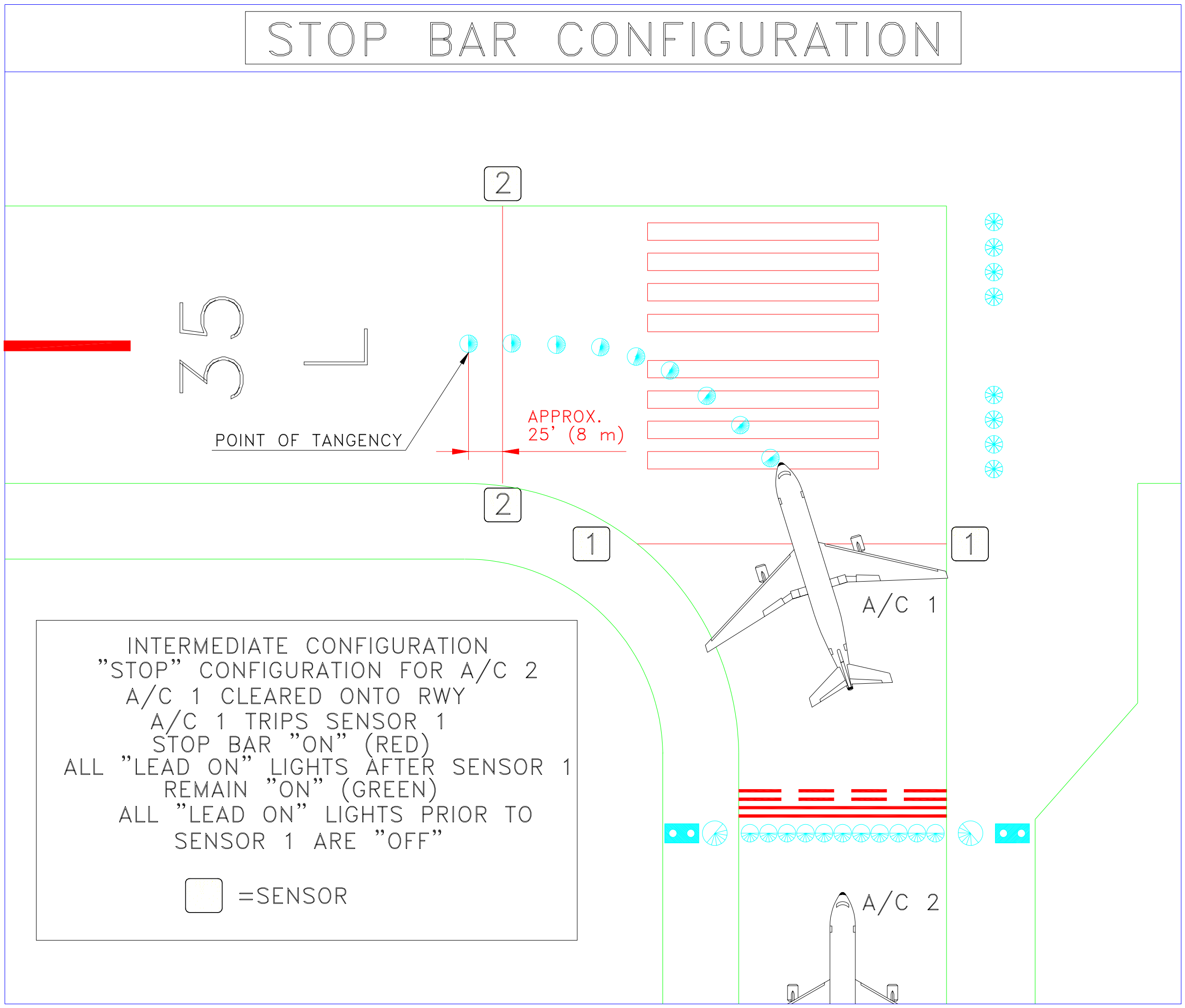


Figure 60 Controlled Stop Bar Design and Operation – Intermediate Configuration

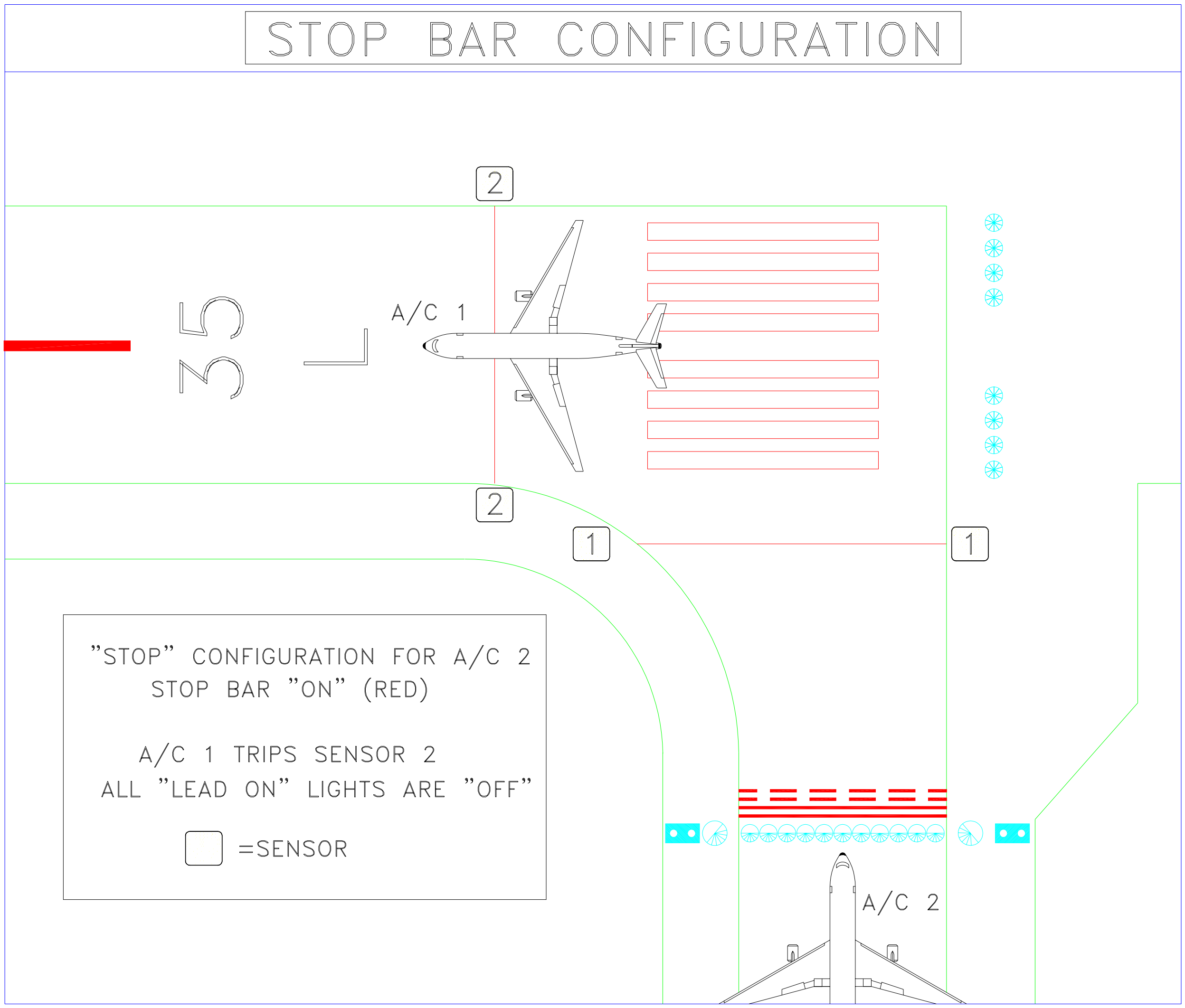


Figure 61 Controlled Stop Bar Design and Operation – "STOP" Configuration for A/C 2

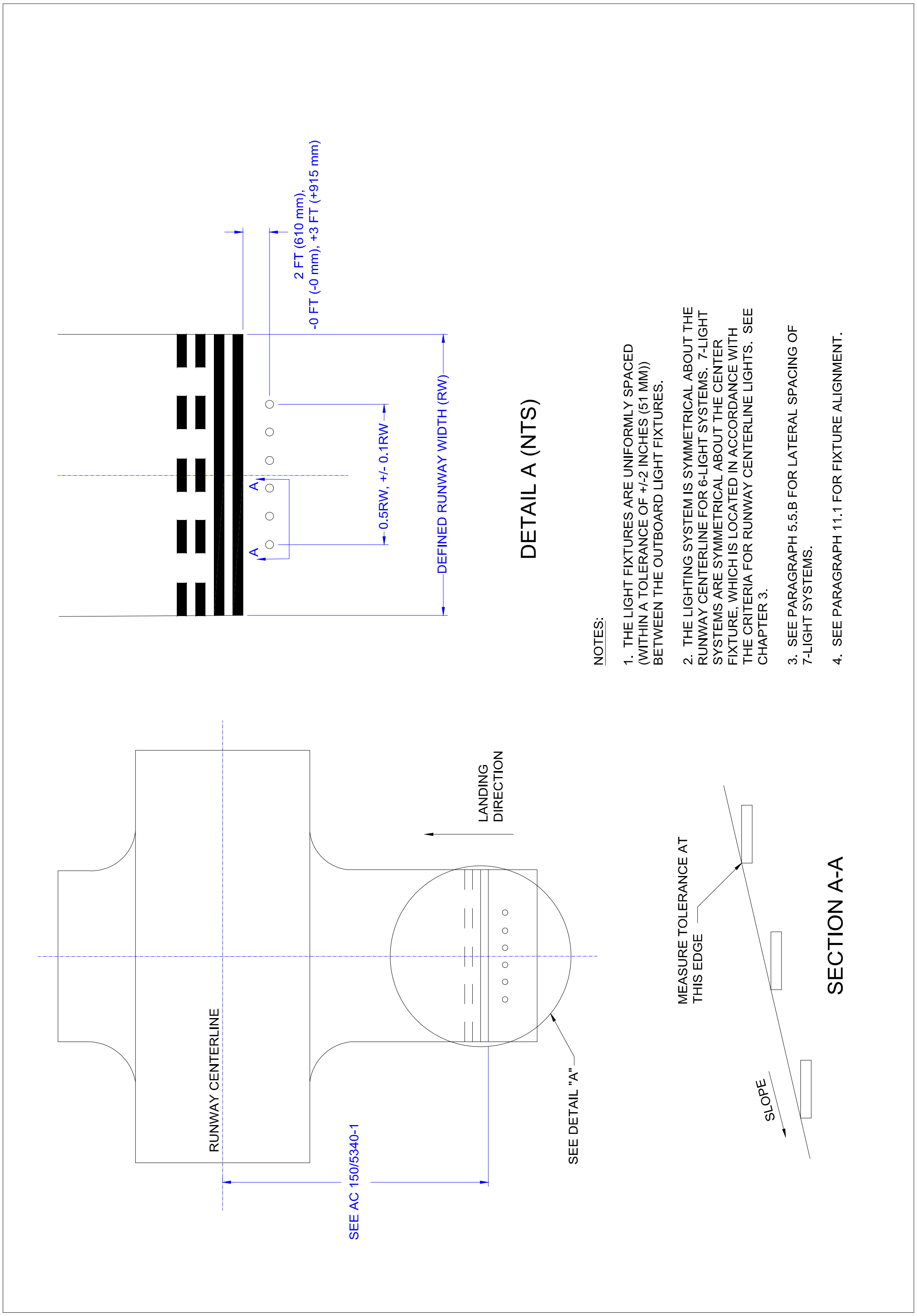
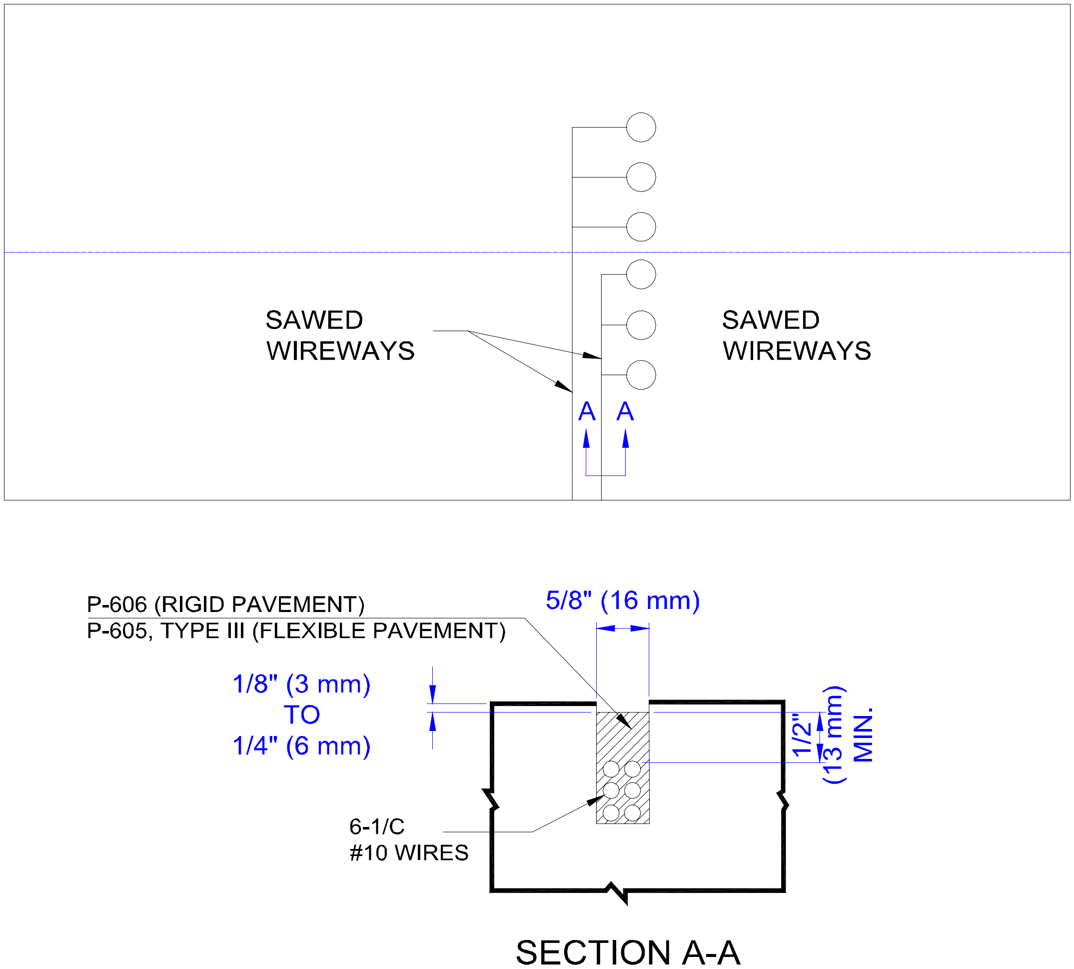


Figure 62 Typical Layout for Land and Hold Short Lights



GENERAL NOTES

1. THE INSTALLATION DETAILS SHOWN ARE FOR RIGID OR FLEXIBLE PAVEMENT UNLESS OTHERWISE SPECIFIED.

2. THE DIAMETERS AND DEPTHS OF HOLES FOR DIRECT-MOUNTED LIGHTING FIXTURES ARE IN ACCORDANCE WITH FIGURE 64.

3. THE ALIGNMENT OF DRILLED HOLES FOR THE FIXTURES SHOULD NOT VARY MORE THAN 2 INCHES.

4. WHERE WIREWAYS CROSS JOINTS IN RIGID PAVEMENT, THEIR DEPTH IS INCREASED AS SHOWN ON PLANS. SEE FIGURE 64 FOR A TYPICAL DETAIL OF JOINT INTERSECTION.

Figure 63 Typical Wireway Installation Details for Land & Hold Short Lights

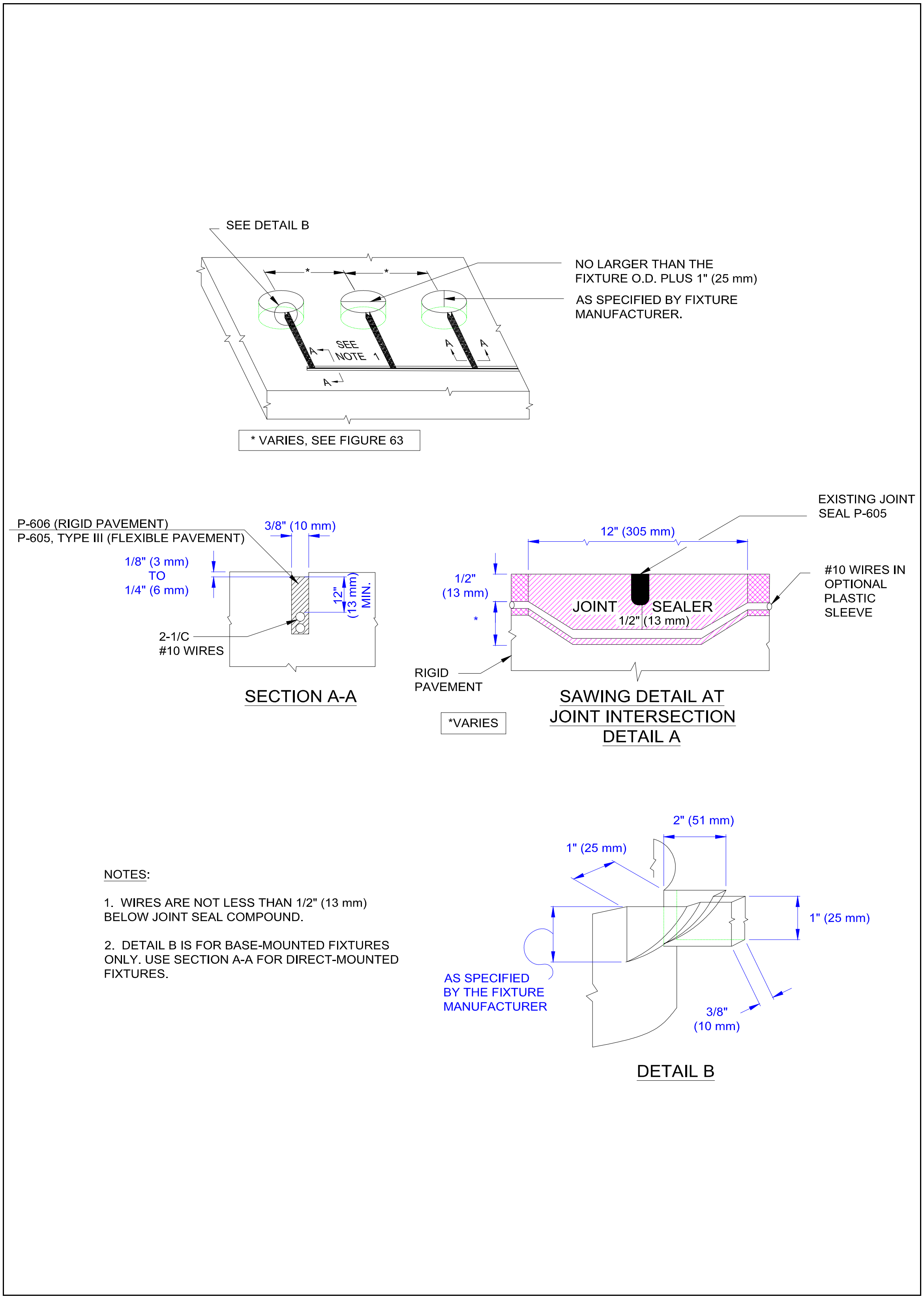


Figure 64 Sawing & Drilling Details for In-pavement Land & Hold Short Lights

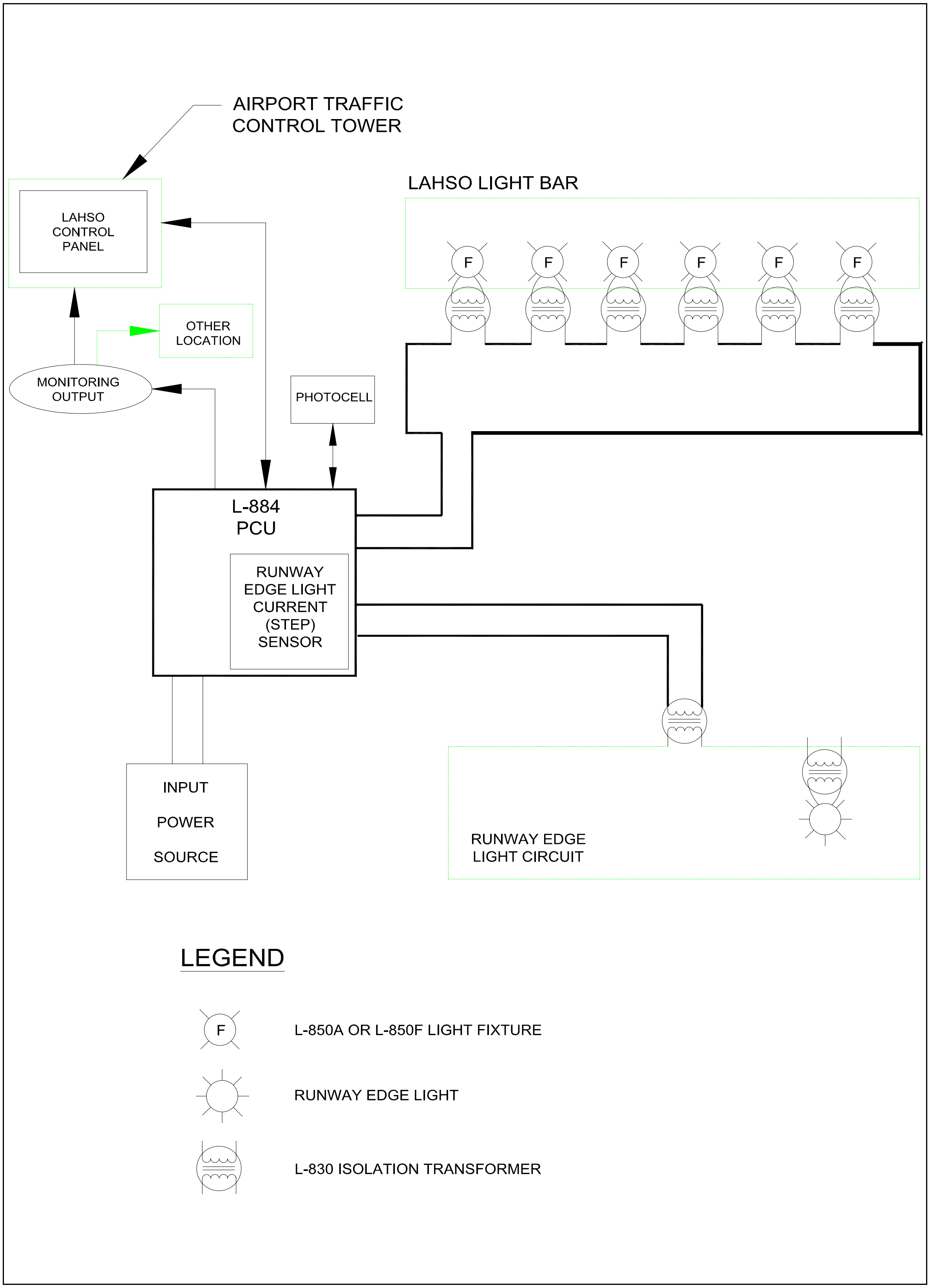


Figure 65 Typical Block Diagram for Land & Hold Short Lighting System

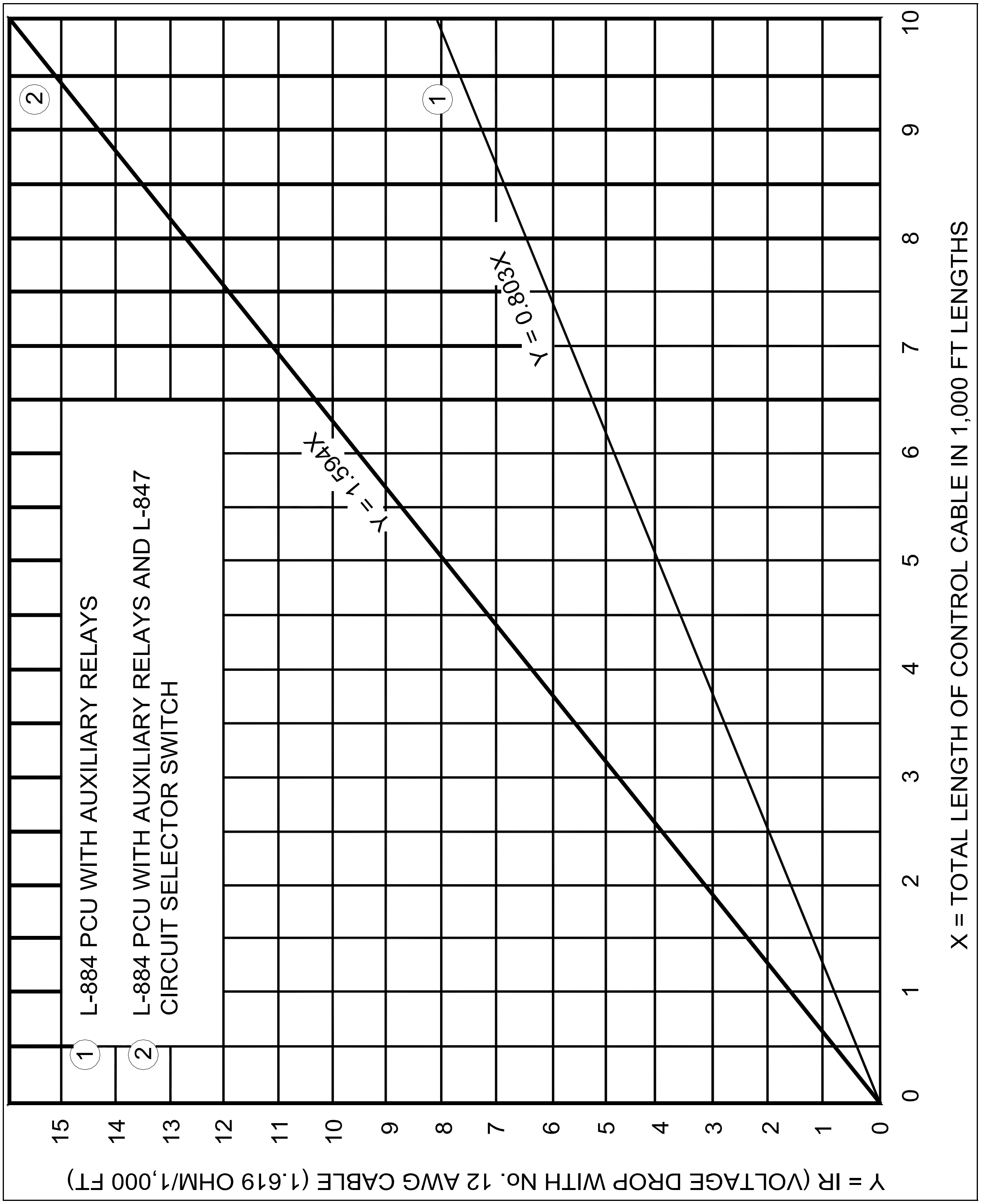


Figure 66 Typical Curve for Determining Maximum Separation Between Vault and Control Panel with 120-volt AC Control

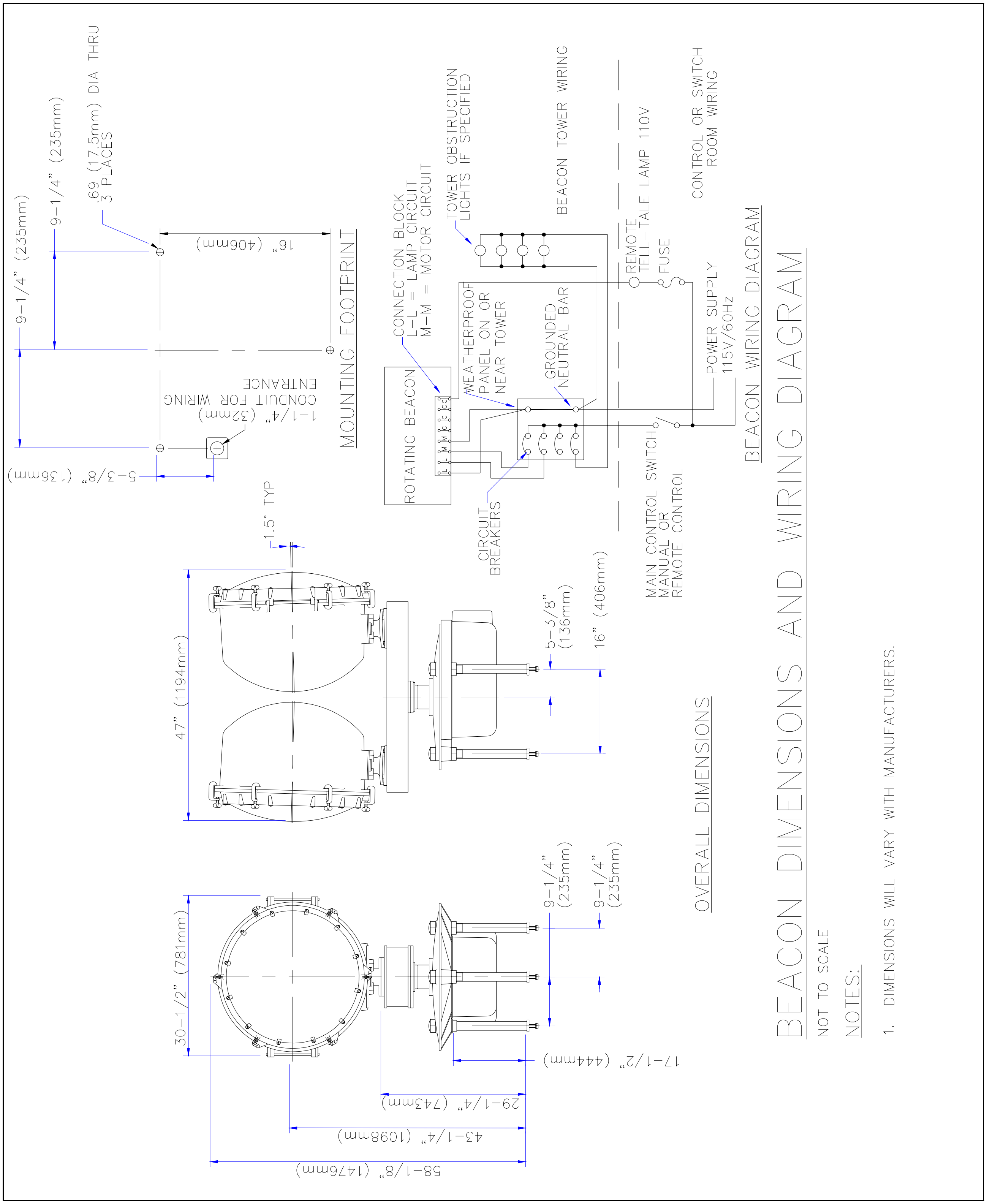


Figure 67 Beacon Dimensions and Wiring Diagram

COPPER-WIRE, AMERICAN WIRE GAUGE B&S

B&S GAUGE NO.	OHMS PER 1 000 FEET 25° C., 77°F.	AREA CIRCULAR MILS	DIAMETER IN MILS AT 20°C.	APPROXIMATE POUNDS PER 1,000 FEET
2	0.1593	66,370	257.6	201
4	0.2523	41,740	204.3	126
6	0.4028	26,250	162.0	79
8	0.6405	16,510	128.5	50
10	1.018	10,380	101.9	31
12	1.619	6,530	80.81	20

Calculations

1. To determine the AWG size wire necessary for a specific connected load to maintain the proper voltage for each miscellaneous lighting visual aid, use the above table and Ohms Law $I = \frac{E}{R}$ as follows:

   a. Example. What size wire will be necessary in a circuit of 120 volts AC to maintain a 2 percent voltage drop with the following connected load which is separated 500 feet from the power supply?

      (1) Lighted Wind Tee Load - 30 lamps, 25 watts each = 750 watts.

      (2) The total operating current for the wind tee is $I = \frac{watts}{volts} = \frac{750}{120} = 6.25\, amperes$.

      (3) Permissible voltage drop for homerun wire is 120 volts x 2% = 2.4 volts.

      (4) Maximum resistance of homerun wires with a separation of 500 feet (1,000 feet of wire used) to maintain not more than 2.4 volts drop is $R = \frac{E}{I} = \frac{2.4\, volts}{6.25\, amperes} = 0.384\, ohms$ per 1,000 feet of wire.

      (5) From the above table, obtain the wire size having a resistance per 1,000 feet of wire that does not exceed 0.384 ohms per 1,000 feet of wire. The wire size that meets this requirement is No. 4 AWG wire with a resistance of 0.2523 ohms per 1,000 feet of wire.

      (6) By using No. 4 AWG wire in this circuit, the voltage drop is E=IR=6.25-amperes x 0.2523 ohms=1.58 volts which is less than the permissible voltage drop of 2.4 volts.

2. Where it has been determined that it will require an extra large size wire for homeruns to compensate for voltage drop in a 120-volt power supply, one of the following methods should be considered.

   a. A 120/240-volt power supply.

   b. A booster transformer, in either a 120-volt or 120/240-volt power supply, if it has been determined its use will be more economical.

Figure 68 Calculations for Determining Wire Size

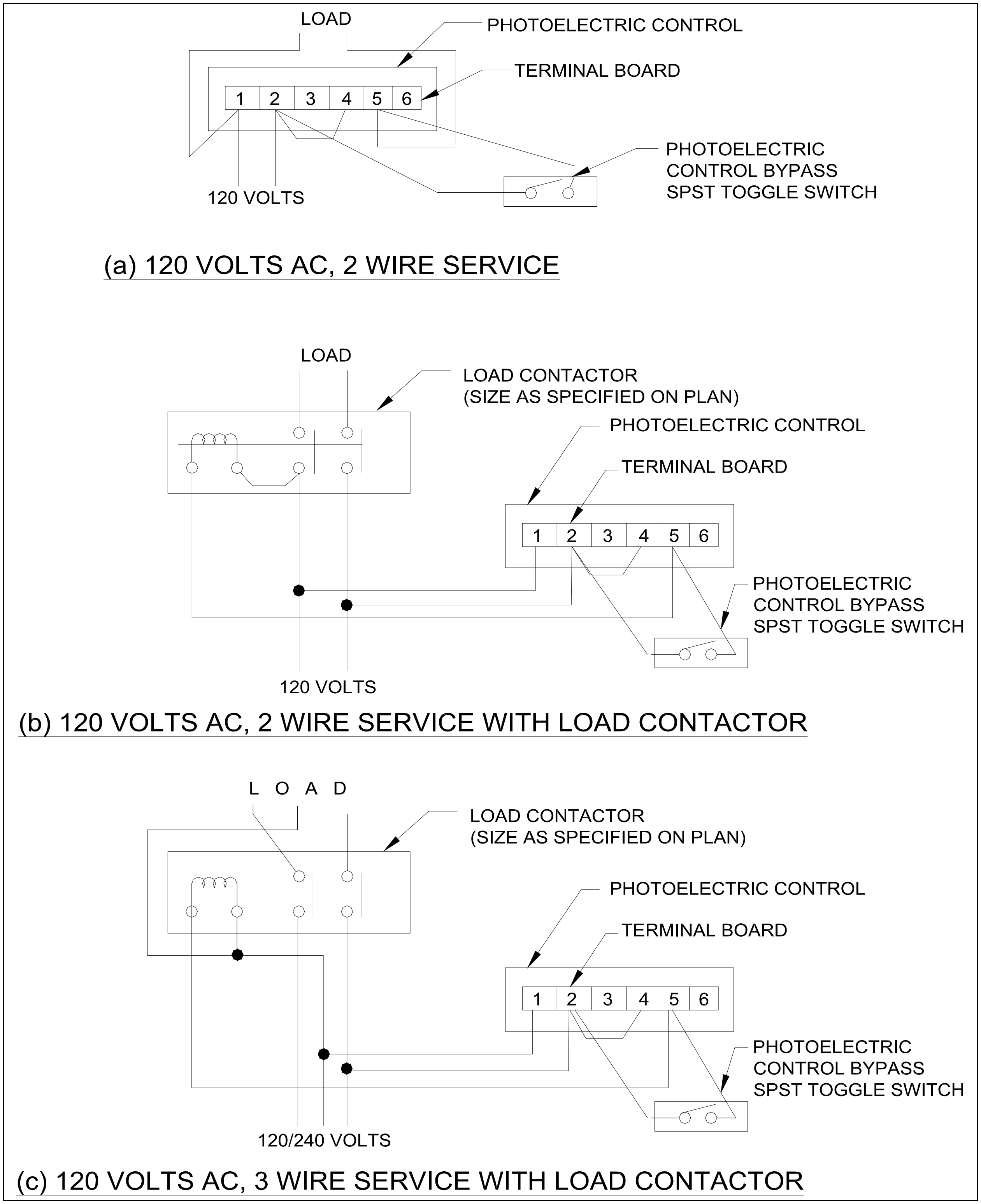


Figure 69 Typical Automatic Control

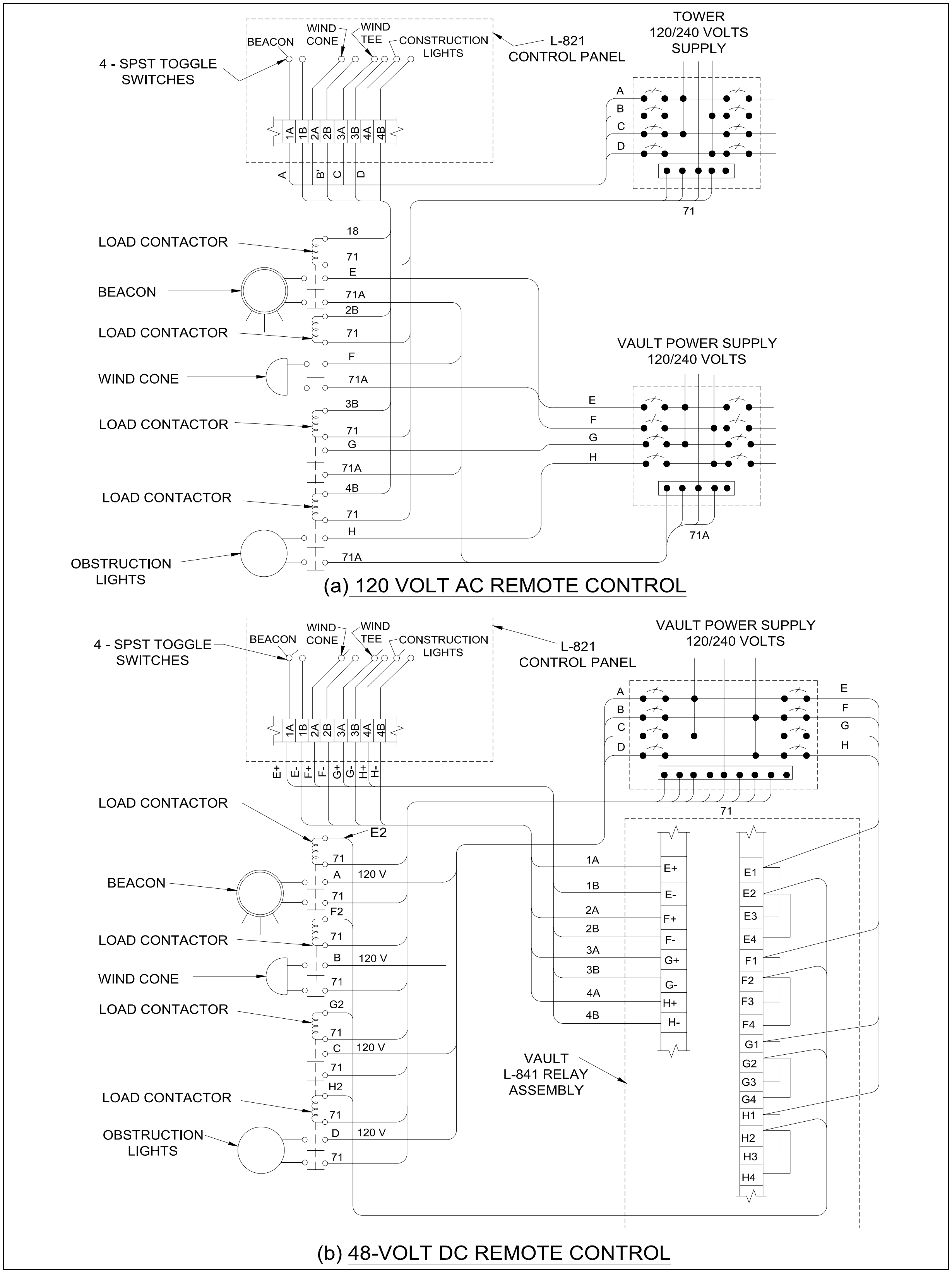


Figure 70 120-Volt AC and 48-Volt DC Remote Control

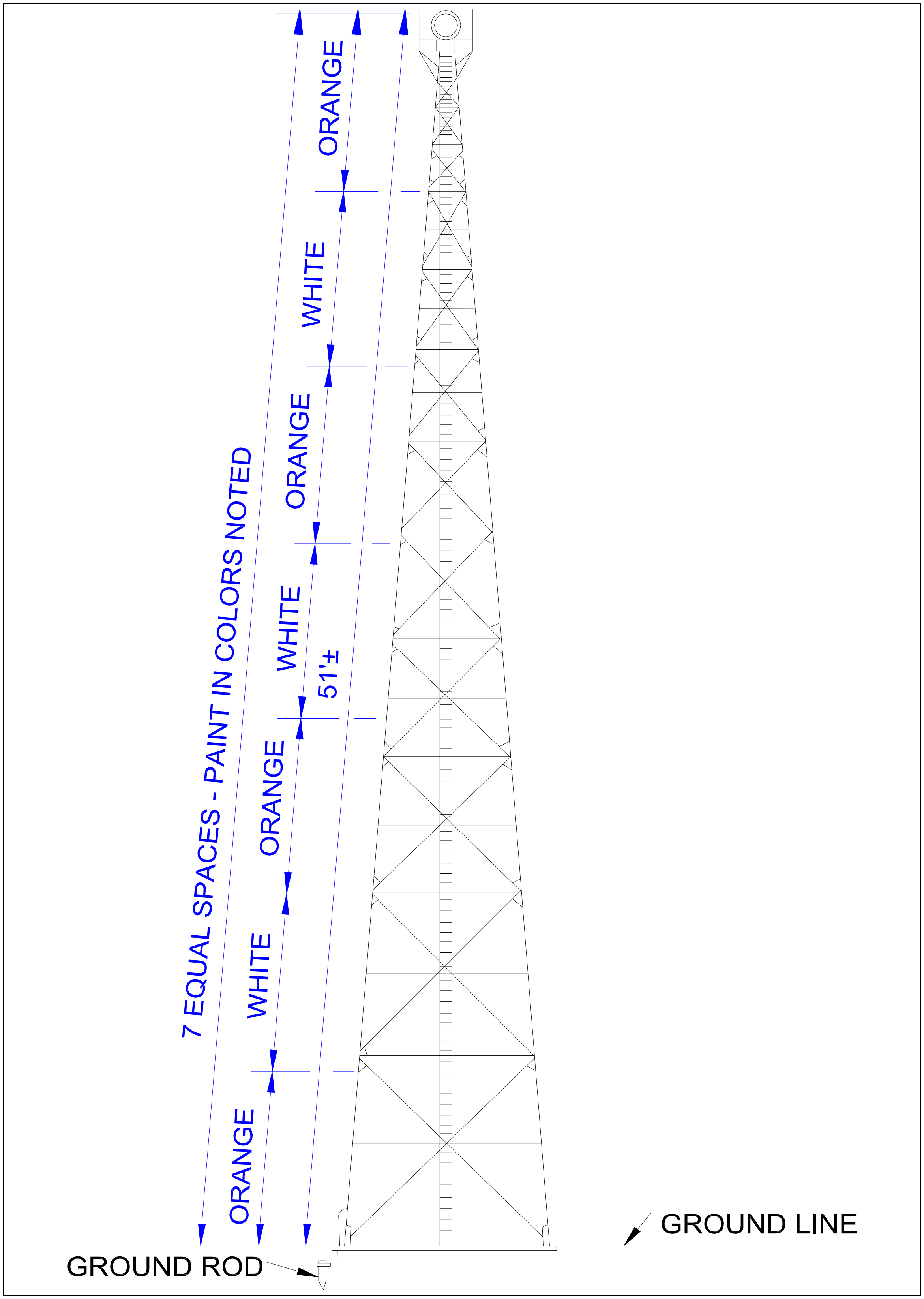
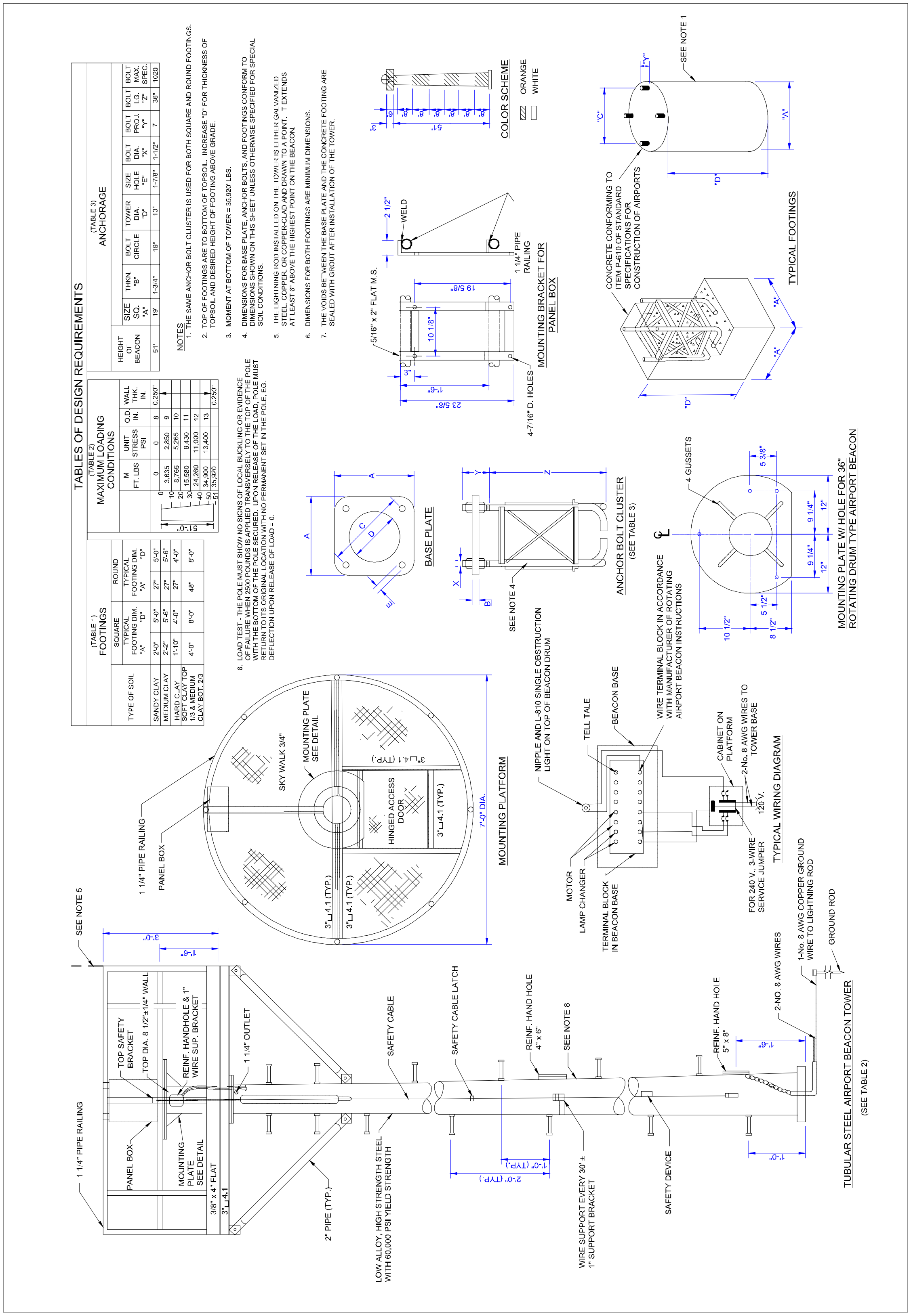


Figure 71 Typical Structural Beacon Tower



TABLES OF DESIGN REQUIREMENTS

(TABLE 1) FOOTINGS

TYPE OF SOIL	SQUARE TYPICAL FOOTING DIM. "A"	SQUARE TYPICAL FOOTING DIM. "D"	ROUND TYPICAL FOOTING DIM. "A"	ROUND TYPICAL FOOTING DIM. "D"
SANDY CLAY	2'-0"	5'-0"	27"	5'-0"
MEDIUM CLAY	2'-2"	5'-6"	27"	5'-6"
HARD CLAY	1'-10"	4'-0"	27"	4'-0"
SOFT CLAY TOP 1/3 & MEDIUM CLAY BOT. 2/3	4'-0"	8'-0"	48"	8'-0"

(TABLE 2) MAXIMUM LOADING CONDITIONS

51'-0"	M FT. LBS	UNIT STRESS PSI	O.D. IN.	WALL THK. IN.
0	0	0	8	0.250"
10	3,635	2,850	9	
20	8,765	5,265	10	
30	15,580	8,430	11	
40	24,260	11,000	12	
50	34,900	13,400	13	
51	35,920			0.250"

(TABLE 3) ANCHORAGE

HEIGHT OF BEACON	SIZE SQ. "A"	THKN. "B"	BOLT CIRCLE	TOWER DIA. "D"	SIZE HOLE "E"	BOLT DIA. "X"	BOLT PROJ. "Y"	BOLT LG. "Z"	BOLT MAX. SPEC.
51'	19'	1-3/4"	19"	13"	1-7/8"	1-1/2"	7	36"	1020

NOTES

1. THE SAME ANCHOR BOLT CLUSTER IS USED FOR BOTH SQUARE AND ROUND FOOTINGS.
2. TOP OF FOOTINGS ARE TO BOTTOM OF TOPSOIL. INCREASE "D" FOR THICKNESS OF TOPSOIL AND DESIRED HEIGHT OF FOOTING ABOVE GRADE.
3. MOMENT AT BOTTOM OF TOWER = 35,920' LBS.
4. DIMENSIONS FOR BASE PLATE, ANCHOR BOLTS, AND FOOTINGS CONFORM TO DIMENSIONS SHOWN ON THIS SHEET UNLESS OTHERWISE SPECIFIED FOR SPECIAL SOIL CONDITIONS.
5. THE LIGHTNING ROD INSTALLED ON THE TOWER IS EITHER GALVANIZED STEEL, COPPER, OR COPPER-CLAD AND DRAWN TO A POINT. IT EXTENDS AT LEAST 8" ABOVE THE HIGHEST POINT ON THE BEACON.
6. DIMENSIONS FOR BOTH FOOTINGS ARE MINIMUM DIMENSIONS.
7. THE VOIDS BETWEEN THE BASE PLATE AND THE CONCRETE FOOTING ARE SEALED WITH GROUT AFTER INSTALLATION OF THE TOWER.
8. LOAD TEST - THE POLE MUST SHOW NO SIGNS OF LOCAL BUCKLING OR EVIDENCE OF FAILURE WHEN 2500 POUNDS IS APPLIED TRANSVERSELY TO THE TOP OF THE POLE WITH THE BOTTOM OF THE POLE SECURED. UPON RELEASE OF THE LOAD, POLE MUST RETURN TO ITS ORIGINAL LOCATION WITH NO PERMANENT SET IN THE POLE, EG. DEFLECTION UPON RELEASE OF LOAD = 0.

Figure 72 Typical Tubular Steel Beacon Tower

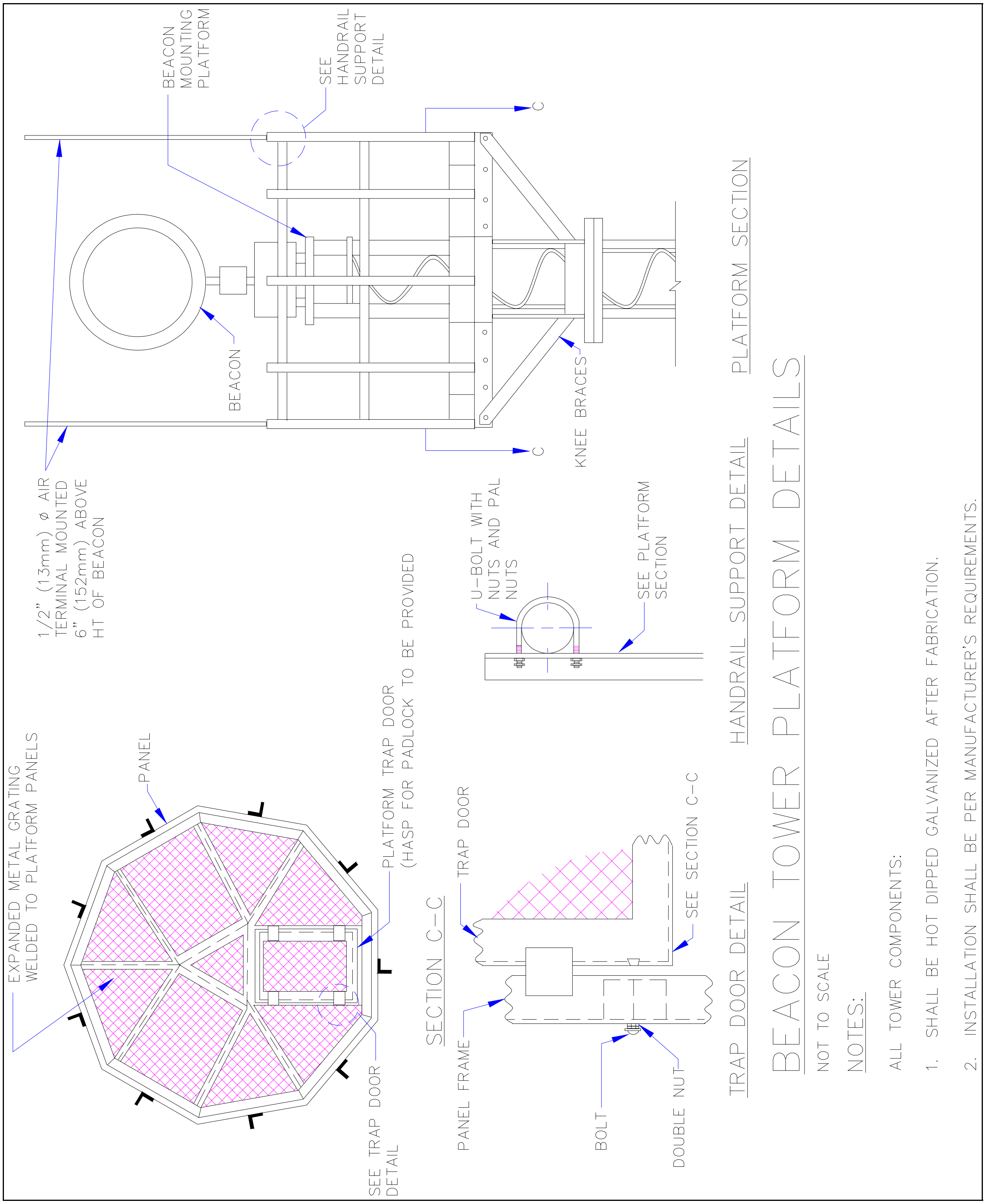


Figure 73 Typical Pre-fabricated Beacon Tower Structure

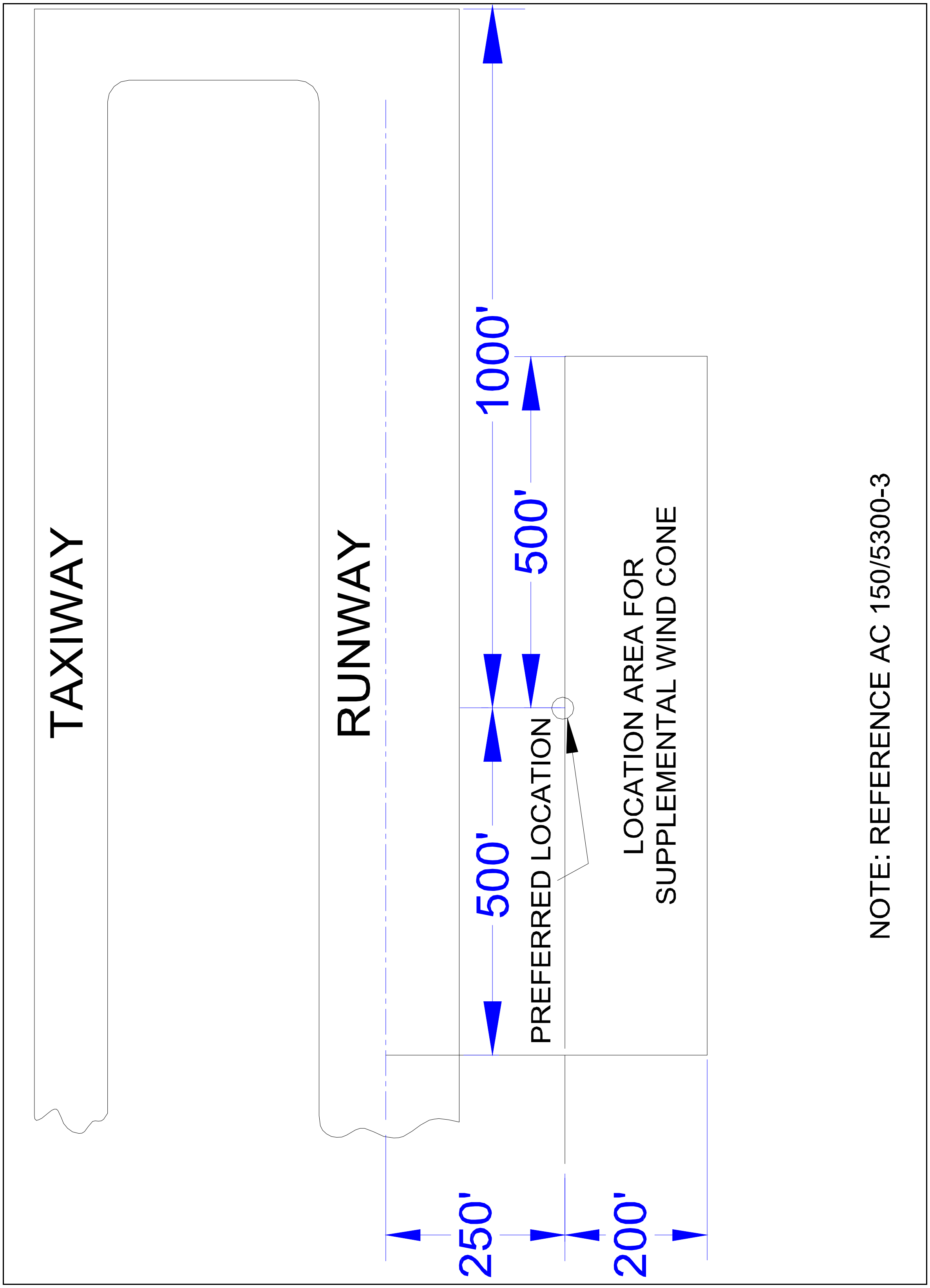


Figure 74 Typical Location of Supplemental Wind Cone

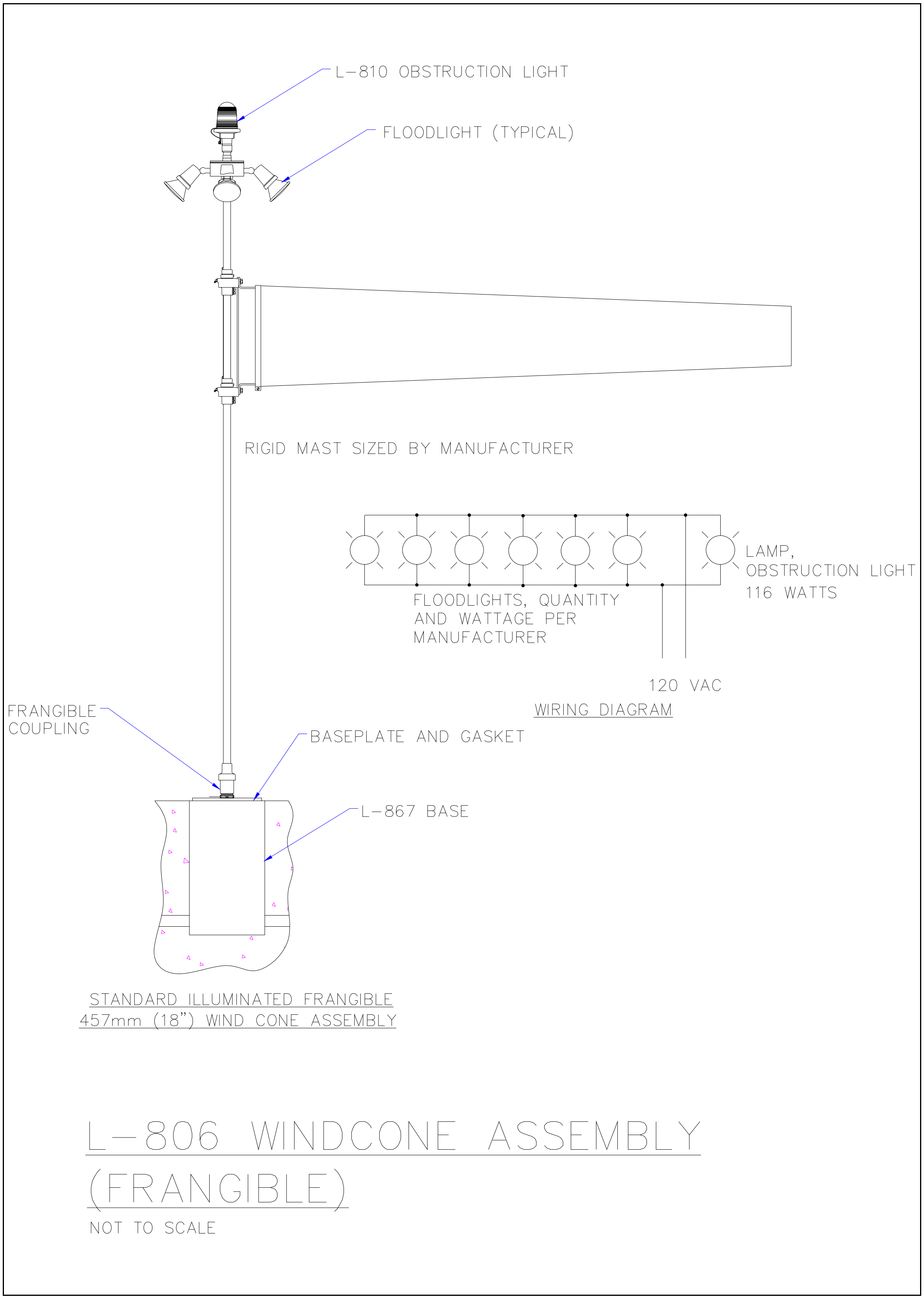


Figure 75 Externally Lighted Wind Cone Assembly (Frangible)

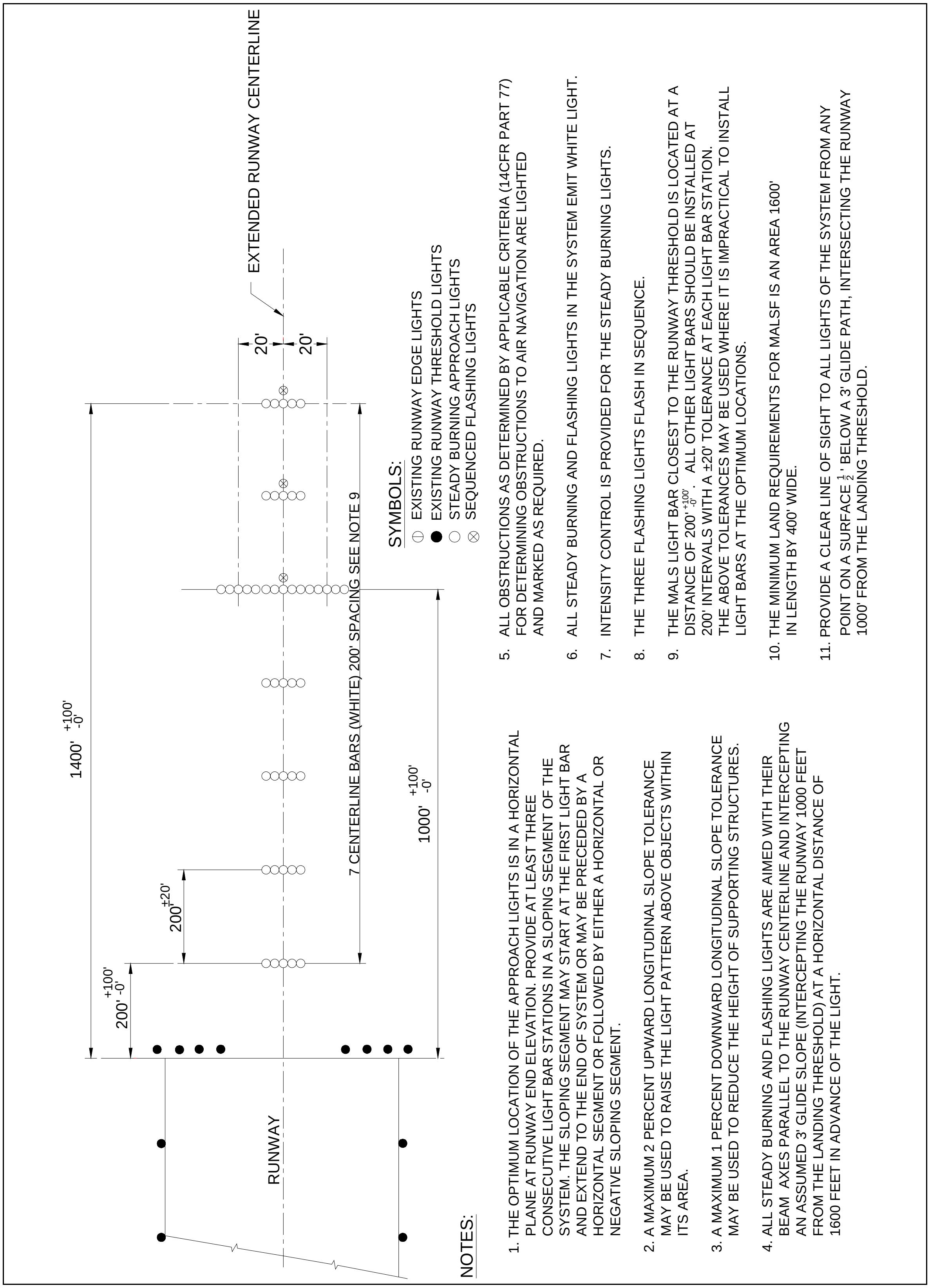


Figure 76 Typical Layout for MALSF

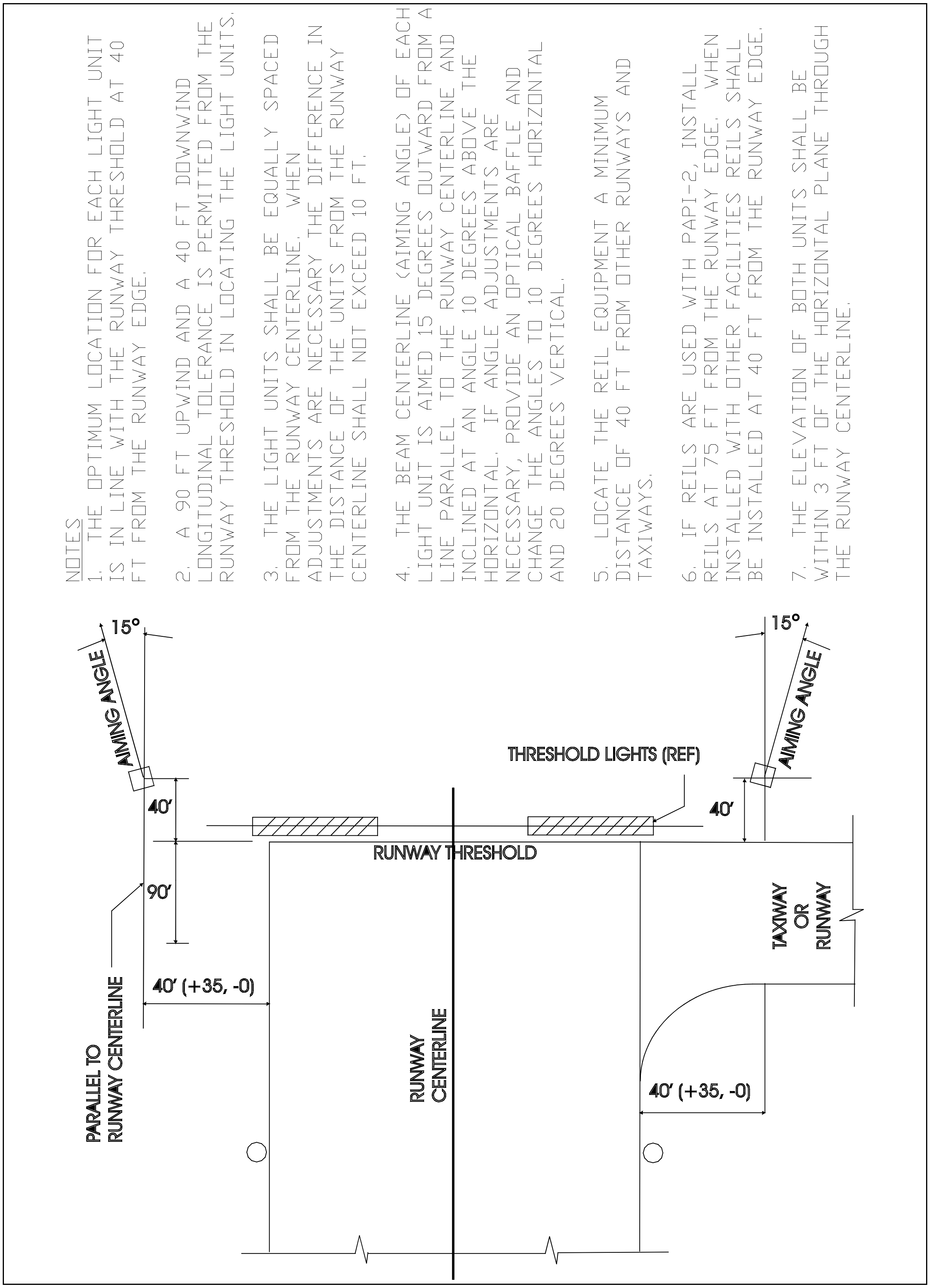


Figure 77 Typical Layout for Runway End Identifier Lights (REILs)