Line Loss

WSDOT

Fall / Winter 2004

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OHM'S LAW

P = Watts (Power)

I = CURRENT (AMPERES)

R = RESISTANCE (OHMS)

E = ELECTROMOTIVE FORCE (VOLTS)

$P = EI$ WATTS = AMPERES X VOLTS

$I = \frac{E}{R}$ AMPERES = $\frac{\text{VOLTS}}{\text{OHMS}}$

$R = \frac{E}{I}$ OHMS = $\frac{\text{VOLTS}}{\text{AMPERES}}$

$E = IR$ VOLTS = AMPERES X OHMS

P = WATTS

$$\text{WATTS} = \frac{\text{VOLTS}^2}{\text{OHMS}}$$

$$\text{WATTS} = \text{AMPERES}^2 \times \text{OHMS}$$

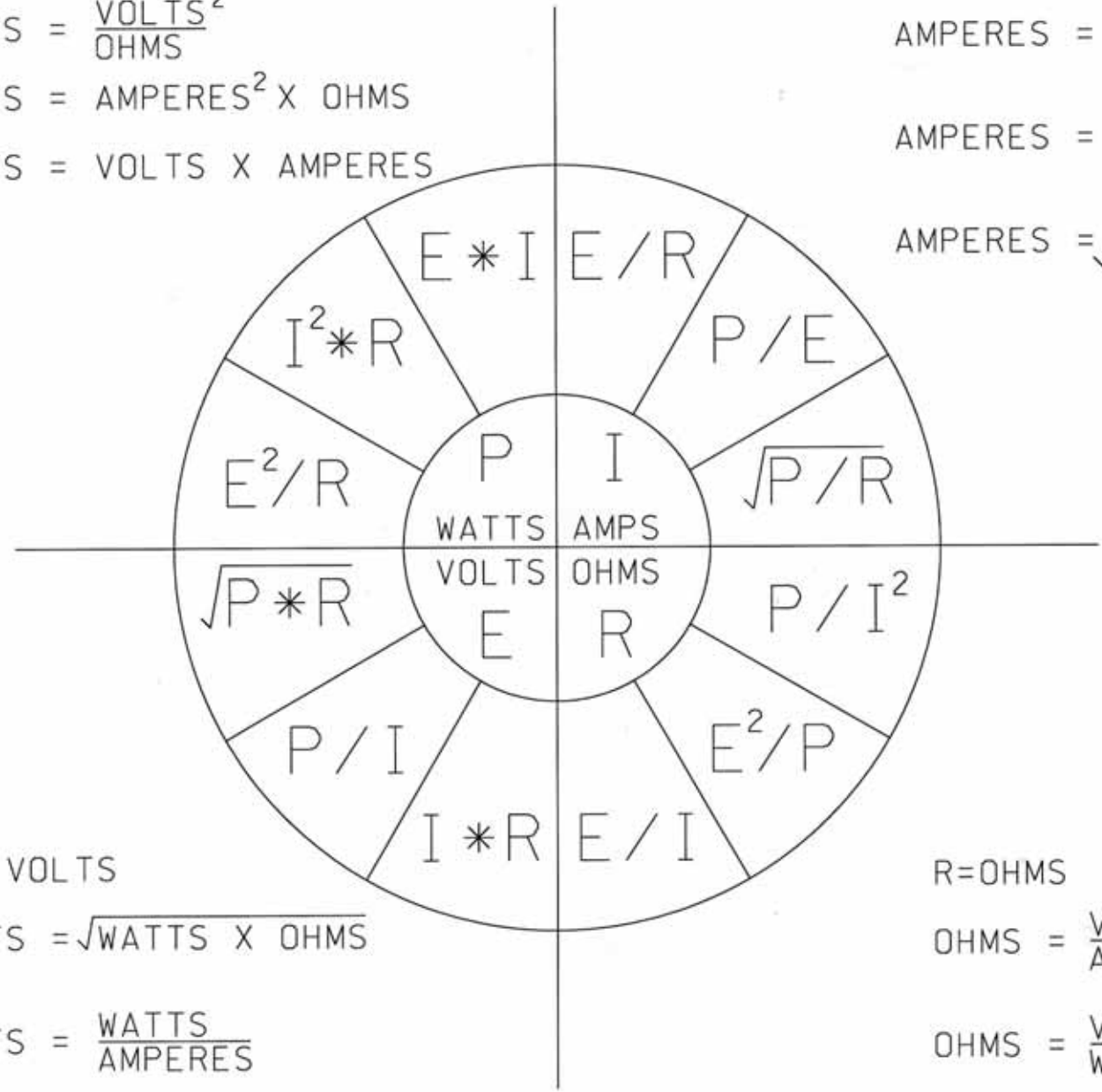
$$\text{WATTS} = \text{VOLTS} \times \text{AMPERES}$$

I = AMPERES

$$\text{AMPERES} = \frac{\text{VOLTS}}{\text{OHMS}}$$

$$\text{AMPERES} = \frac{\text{WATTS}}{\text{VOLTS}}$$

$$\text{AMPERES} = \sqrt{\frac{\text{WATTS}}{\text{OHMS}}}$$



E = VOLTS

$$\text{VOLTS} = \sqrt{\text{WATTS} \times \text{OHMS}}$$

$$\text{VOLTS} = \frac{\text{WATTS}}{\text{AMPERES}}$$

$$\text{VOLTS} = \text{AMPERES} \times \text{OHMS}$$

R=OHMS

$$\text{OHMS} = \frac{\text{VOLTS}}{\text{AMPERES}}$$

$$\text{OHMS} = \frac{\text{VOLTS}^2}{\text{WATTS}}$$

$$\text{OHMS} = \frac{\text{WATTS}}{\text{AMPERES}^2}$$

Clear Catinkus for PIER (Power)

- (P) Power is the amount of current times the voltage level at a given point measured in wattage or watts.

- (I) Current is what flows on a wire or conductor like water flowing down a stream. Current flows from points of high voltage to points of low voltage on the surface of a conductor. Current is measured in (A) amperes or amps.

  (E) Voltage is the difference in electrical potential between two points in a circuit. It's the pressure or push behind current flow through a circuit, and is measured in (V) volts.

  (R) Resistance determines how much current will flow through a component. Resistors are used to control voltage and current levels. A very high resistance allows a small amount of current to flow. A very low resistance allows a large amount of current to flow. Resistance is measured in ohms.

Example

- A circuit having a resistance of 5 ohms is under a pressure of 110 volts. How much current will flow?
- amperes = volts / resistance
- amperes = 110 volts / 5 ohms
- answer = <u>22 amperes</u>

Example

- If the resistance of a circuit is 10 ohms, what is the voltage necessary for a flow of 20 amperes?
- volts = amperes x ohms
- volts = 20 amperes x 10 ohms
- Answer = <u>200 volts</u>

Example

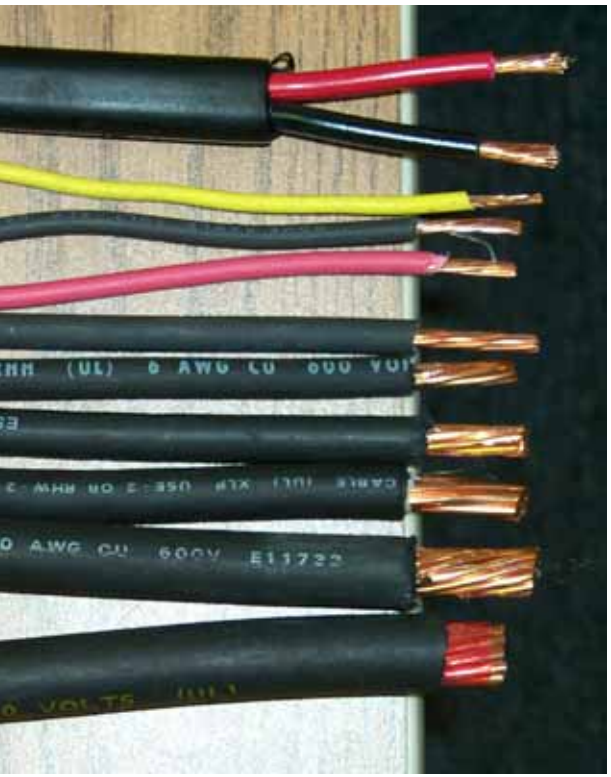
- On a 110 volt circuit what resistance is necessary to obtain a flow of 15 amperes?
- ohms = volts / amperes
- ohms = 110 volts / 15 amperes
- Answer = <u>7.33 ohms</u>

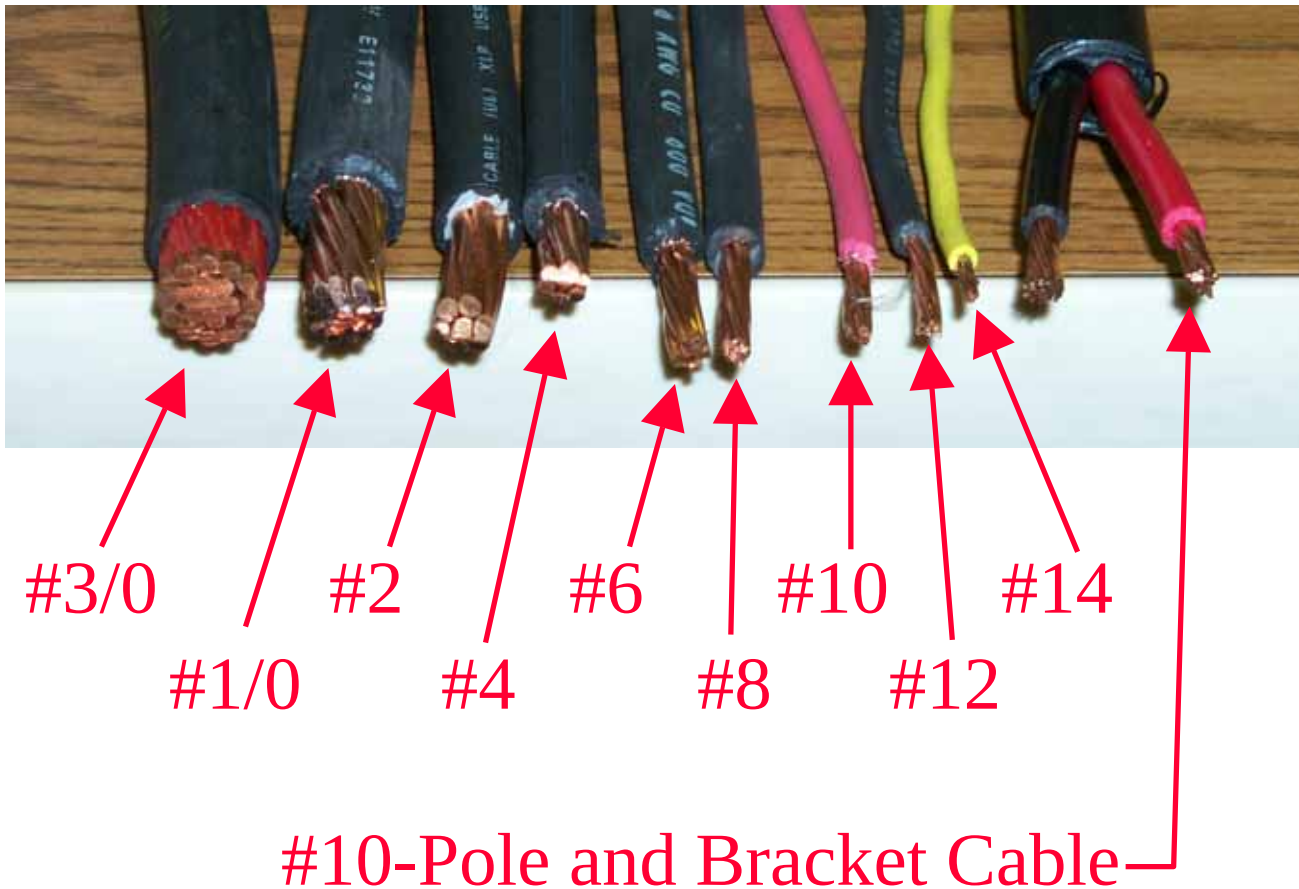
Example

- A water heater is served by a 240 volt circuit. The heating element is 4500 watts. What is the load on this circuit?
- 4500 watt heating element / 240 volts = 18.75 amps
- On this circuit, what resistance is necessary within the heating element to obtain the flow of 18.75 amperes?
- ohms = volts / amperes
- ohms = 240 volts / 18.75 amperes
- Answer = <u>12.80 ohms</u>

Electrical Energy Unit Conversions

- 1 watt = 1 volt x 1 ampere
- watts = volt amperes
- 1 ampere = 1 watt / 1 volt
- 1 volt = 1 watt / 1 ampere
- k = 1000 (accepted convention that “k” indicates 1000) NEC 110-6, comments
- ___ watts / 1000 = ___ kilo volt ampere (kVA)
- ___ kVA x 1000 = ___ watts (or volt amperes)
- 1,528 watts / 1000 = 1.528 kVA
- 3.224 kVA x 1000 = 3,224 watts (or volt amperes)




#3/0
#1/0
#2
#4
#6
#8
#10
#12
#14
#10-Pole and Bracket Cable

What is Line Loss?

- Line Loss is the voltage drop (Vd) between the electrical service and the load. Line loss usually controls wire size determination rather than the allowable ampacities listed in Chapter 3 of the National Electrical Code.

- Recommended allowable voltage drop is discussed in 2002 NEC article 210.19, FPN No.4

Why do we need to worry about Voltage Drop?

- If you have too much Voltage Drop on a circuit, the equipment you are trying to power may not work.

- Inefficiency equals using more power and receiving less output. (see reasonable operating efficiency commentary after NEC 2002 Article 215.2 in the handbook)

- You need to make sure you have enough capacity for future use. (Figure 3-4% for future Illumination loads and 1-2% for future ITS loads.)

Maximum Voltage Drop Requirements

- **High Pressure Sodium** - ultimate loads known Vd = 8%, unknown Vd = 5%.
- **Metal Halide** - ultimate loads known Vd = 8%, unknown Vd = 5%.
- **Mercury Vapor** - ultimate loads known Vd = 10%, unknown Vd = 5%.
- **Temporary Illumination System** (installed & removed within same contract) - Vd = 10%.
- **Traffic Signal** - Vd = 5%.
- **ITS System** - Vd = 3%

Wire size

- On new ITS circuits pick your wire size so that you have **2-3%** voltage drop.
- On new illumination circuits (ultimate load unknown) pick your wire size so that you have **4-5%** voltage drop.
- On new signal circuits pick your wire size so that you have **4-5%** voltage drop.
- On existing ITS circuits where you are replacing the wire the maximum voltage drop allowed is **3%.**
- On existing signal circuits where you are replacing the wire the maximum voltage drop allowed is **5%.**
- On existing illumination circuits (ultimate load known) where you are replacing the wire the maximum voltage drop allowed is **8%.**

How do we calculate Voltage Drop?

order to calculate line loss you need to know:

This formula: **Vd = 2ALR**

Where:
Vd= Voltage Drop.
2 = because the power goes out and back using two wires.
A = **load** being drawn. (Amperes)

L = **distance** the load is being carried. (Feet)

R = **resistance** per foot of wire used. (Ohms) When looking up the "R" factor in the chart you need to know two things:

- The **wire size** carrying the load. (#2, #4, #6, #8, etc.)
- The **type of wire** being used. (**Copper** or Aluminum)

Conductor Size, cross-sectional area, amperage capacity and resistance chart				
Size	X-Section		Copper	Aluminum
(AWG)	(Square Inches)	(Amps)	(ohms/foot)	(ohms/foot)
250 Kcmil	0.4596	255	0.000054	
4/0	0.3718	230	0.000063	
3/0	0.3117	200	0.000080	
2/0	0.2624	175	0.000101	
1/0	0.2223	150	0.000127	
1	0.1900	130	0.000160	
2	0.1333	115	0.000201	
4	0.0973	85	0.000321	0.000509
6	0.0726	65	0.000510	0.000807
8	0.0556	50	0.000809	0.001280
10	0.0330	30*	0.001290	
12	0.0260	20*	0.002051	
14	0.0210	15*	0.003261	
	NEC, Chapter 9, Table 5 - Type RHW* conductors	NEC, Table 310.16 *reduced per Article 240.4(D)	NEC Chapter 9, Table 8	NEC Chapter 9, Table 8

Calculating the distance between loads

- Scale off the distance between each load or the distance between the load and the service.
- Add 5’ when entering the service cabinet or another cabinet to power.
- Add 10’ per in-grade junction box that the wire passes through. This takes into account the conduit sweeps and the 3’ of slack wire.
- Add 5’ to each side of wire run (instead of 10’) when there is a splice in the junction box.
- Add 5’ for the sweep into the luminaire and up to the handhole.
- Add 5’ for NEMA 3 or NEMA 4X junction boxes.
- Add 2’ to each side of wire run (instead of 5’) when there is a splice in the NEMA junction box.
- Add 52’ (for 40’ pole with 16’ mast arm) or 62’ (for 50’ pole with 16’ mast arm) to the distance to accommodate for the last luminaire pole and mast arm on each run. Use a #10 wire (pole & bracket cable) for this distance.
- Add 2’ to enter terminal cabinet and terminate conductor on terminal block.

Different Types of Loads

- There are three different types of loads that we calculate.
  - 1.) Intelligent Transportation System (ITS), previously SC&DI
  - 2.) Traffic Signal System
  - 3.) Illumination System (including sign lights)
- There are different ways to calculate each of these loads

ITS Loads

An ITS circuit is sized for the ultimate load that can be drawn at one time. This is usually controlled by the rated output of the transformer. If there is **no transformer,** use the figures below to calculate your loads.

Ramp Meter (RM) -720W+1800W(GFCI's)=2520W
Camera Cabinet (CC) -324W+1800W(GFCI's)=2124W
Data Station (ES) -252W+1800W(GFCI's)=2052W
Highway Advisory Radio Station (HAR)-200W+1800W(GFCI's)=2000W
Variable Message Sign (VMS)-Contact the ITS designer because each sign requires a different loading. If you are the ITS designer contact the manufacturers for like size and type VMS Sign data.

(Generally, if the load is below 1800 watts, there is not an included GFCI load.) **If the load is larger than 1800 watts, then a GFCI load is assumed to be included.**
Consult with ITS designers to let them know this is your intention and to make sure this will be adequate. If you are the designer, please keep this in mind.)

ITS loads - Example

The basic way a load is calculated is by dividing the wattage (Volt Amperes) by the voltage serving the load.

$$\frac{2520\text{W(or 2.52kVA)}}{\mathbf{120V}} = 21.0\text{Amps}$$

$$\frac{7500\text{W(or 7.5kVA)}}{\mathbf{120V}} = 62.5\text{Amps}$$

$$\frac{2520\text{W(or 2.52kVA)}}{\mathbf{240V}} = 10.5\text{Amps}$$

$$\frac{7500\text{W(or 7.5kVA)}}{\mathbf{240V}} = 31.25\text{Amps}$$

$$\frac{2520\text{W(or 2.52kVA)}}{\mathbf{480V}} = 5.25\text{Amps}$$

$$\frac{7500\text{W(or 7.5kVA)}}{\mathbf{480V}} = 15.625\text{Amps}$$

Signal Loads

A Signal circuit is sized for the ultimate load that can be drawn at one time. This is usually the **sum** of the items below:

300W ------ **Controller**

1800W ----- **2-GFCI's** (receptacles - vent fan & cabinet light(s) are included within this load)

116W ------- multiply by the Total # of **Pedestrian Displays**

165W for 12" heads (signal displays) **or**

69W for 8" heads (flashing beacon displays)-multiply by the **Total # of Vehicle Display Lamps** illuminated at one time (1 Lamp per 3 section display, 2 Lamps per 4 or 5 section display) (and yes, we know LED's draw much less wattage)

USE THESE NUMBERS FOR SIZING CONDUCTORS.

Signal Loads - Example

For a **“T” intersection** use 9-vehicle heads, and 6-pedestrian heads.

$$300W+1800W+(9*165W)+(6*116W)=4281W$$

$$\frac{4281W}{120V}=35.675Amps$$

For a **four legged intersection** use 12-vehicle heads, and 8-pedestrian heads.

$$300W+1800W+(12*165W)+(8*116W)=5008W$$

$$\frac{5008W}{120V}=41.73Amps$$

If there are supplemental heads used in your design these values may be larger. Use these values as a minimum.

Illumination Loads

Each luminaire has a different lamp load factor depending on what **wattage** lamp and what **voltage** you are using. You have to check the manufacturers catalog cuts to see what voltage the particular luminaire draws during it's "start-up" period. This is roughly the same as **multiplying the wattage by 1.2 then dividing by the serving voltage**, but the catalog values are more accurate. These are the numbers from the GE catalog.

Bulb Wattage	Load@ 240V (AMPS)	Load@ 480V (AMPS)
100	0.6	0.3
150	0.9	0.5
175*	0.9	0.5
200	1.1	0.6
250	1.4	0.7
310	1.7	0.9
400	2.1	1.1

* Mercury Vapor

Flashing Beacons

- 8” Lens – incandescent
- 1 lamp = 69 watts
- 2 lamps = 138 watts
- 4 lamps = 276 watts
- 8” Lens – LED
- 1 lamp = 15 watts
- 2 lamps = 30 watts
- 4 lamps = 60 watts

- 12” Lens – incandescent
- 1 lamp = 165 watts
- 2 lamps = 330 watts
- 4 lamps = 600 watts
- 12” Lens – LED
- 1 lamp = 25 watts
- 2 lamps = 50 watts
- 4 lamps = 100 watts

•The dimmable flashing unit draws 0.005 amps at 120 volts. For line loss calculation purposes, you can ignore the dimming flasher unit load.

•A large majority of existing flashers have 1 or 2 eight inch lens. The need would have to be great before you would use twelve inch lens.

Illumination Load Examples

Illumination Circuit A load

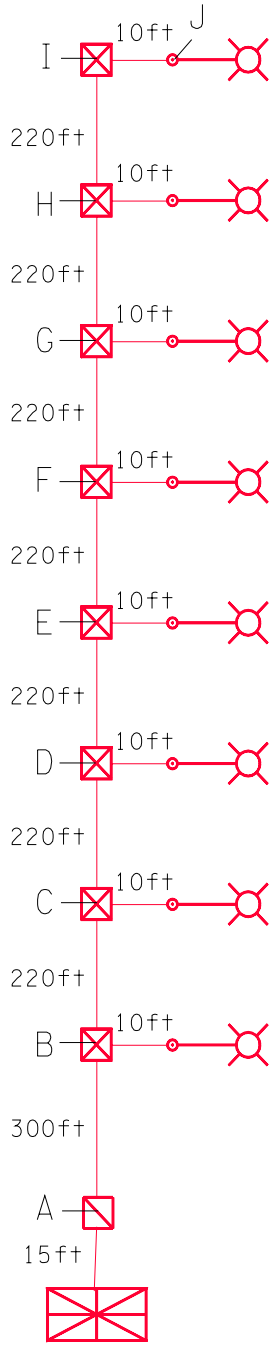
8-400 watt, HPS Luminaires, 240 VAC, 2.1 Amps per luminaire

8 x 2.1 amps = 16.8 Amps

Illumination Circuit B load

11-400 watt, HPS Luminaires, 240 VAC, 2.1 amps per luminaire

11 x 2.1 amps = 23.1 amps



Notes:

1.) Add 10 ft of length for each junction box.

2.) All Luminaires are HPS 400Watt Type III Medium Cutoff.

3.) All luminaires are mounted on 50ft Light Standards.

4.) Double mast arm lengths are 12ft.

5.) Single mast arm lengths are 16ft.

CIRCUIT A

Voltage Drop for Circuit A - 1st try

Vd=2ALR

Total length of Segment

Total load on Segment

Wire out and Back

Resistance of #8 conductor

Service to B=2(16.8)(5+15+10+300+5=335)(0.000809)=9.106104

B to C =2(14.7)(5+220+5=230)(0.000809) =5.470458

C to D =2(12.6)(5+220+5 =230)(0.000809) =4.688964

D to E =2(10.5)(5+220+5 =230)(0.000809) =3.907470

E to F =2(8.4)(5+220+5 =230)(0.000809) =3.125976

F to G =2(6.3)(5+220+5 =230)(0.000809) =2.344482

G to H =2(4.2)(5+220+5 =230)(0.000809) =1.562988

H to I =2(2.1)(5+220+5=230)(0.000809) =0.781494

I to J =2(2.1)(5+10+5=20)(0.000809) =0.067956

J to Light =2(2.1)(62)(0.001290) =0.335916

31.391808

Resistance of #10 conductor

31.391808 /240=0.130799*100=13.1% Vd

13.1% > 5% - Try again with larger wire

Voltage Drop for Circuit A – 2ND try

Vd=2ALR

Total load on Segment

Wire out and Back

Total length of Segment

Resistance of #4 conductor

Service to B=2(16.8)(5+15+10+300+5=335)(0.000321)=3.613176

B to C =2(14.7)(5+220+5 =230)(0.000321) =2.170602

C to D =2(12.6)(5+220+5 =230)(0.000321) =1.860516

D to E =2(10.5)(5+220+5 =230)(0.000321) =1.550430

E to F =2(8.4)(5+220+5 =230)(0.000321) =1.240344

F to G =2(6.3)(5+220+5 =230)(0.000321) =0.930258

G to H =2(4.2)(5+220+5 =230)(0.000321) =0.620172

H to I =2(2.1)(5+220+5=230)(0.000321) =0.310086

I to J =2(2.1)(5+10+5=20)(0.000510) =0.042840

J to Light =2(2.1)(62)(0.001290) =0.335916

12.674340

12.674340/240=0.052810*100=5.3% Vd

5.3% > 5% - Try again with larger wire

Resistance of #6 conductor

Resistance of #10 conductor

Voltage Drop for Circuit A – 3RD try

Total load on Segment

Wire out and Back

Vd=2ALR

Total length of Segment

Resistance of #2 conductor

Service to B=2(16.8)(5+15+10+300+5=335)(0.000201)=2.262456

B to C =2(14.7)(5+220+5=230)(0.000201) =1.359162

C to D =2(12.6)(5+220+5 =230)(0.000201) =1.164996

D to E =2(10.5)(5+220+5 =230)(0.000201) =0.970830

E to F =2(8.4)(5+220+5 =230)(0.000201) =0.776664

F to G =2(6.3)(5+220+5 =230)(0.000201) =0.582498

G to H =2(4.2)(5+220+5 =230)(0.000201) =0.388332

H to I =2(2.1)(5+220+5=230)(0.000201) =0.194166

I to J =2(2.1)(10+5+5=20)(0.000809) =0.067956

J to Light =2(2.1)(62)(0.001290) =0.335916

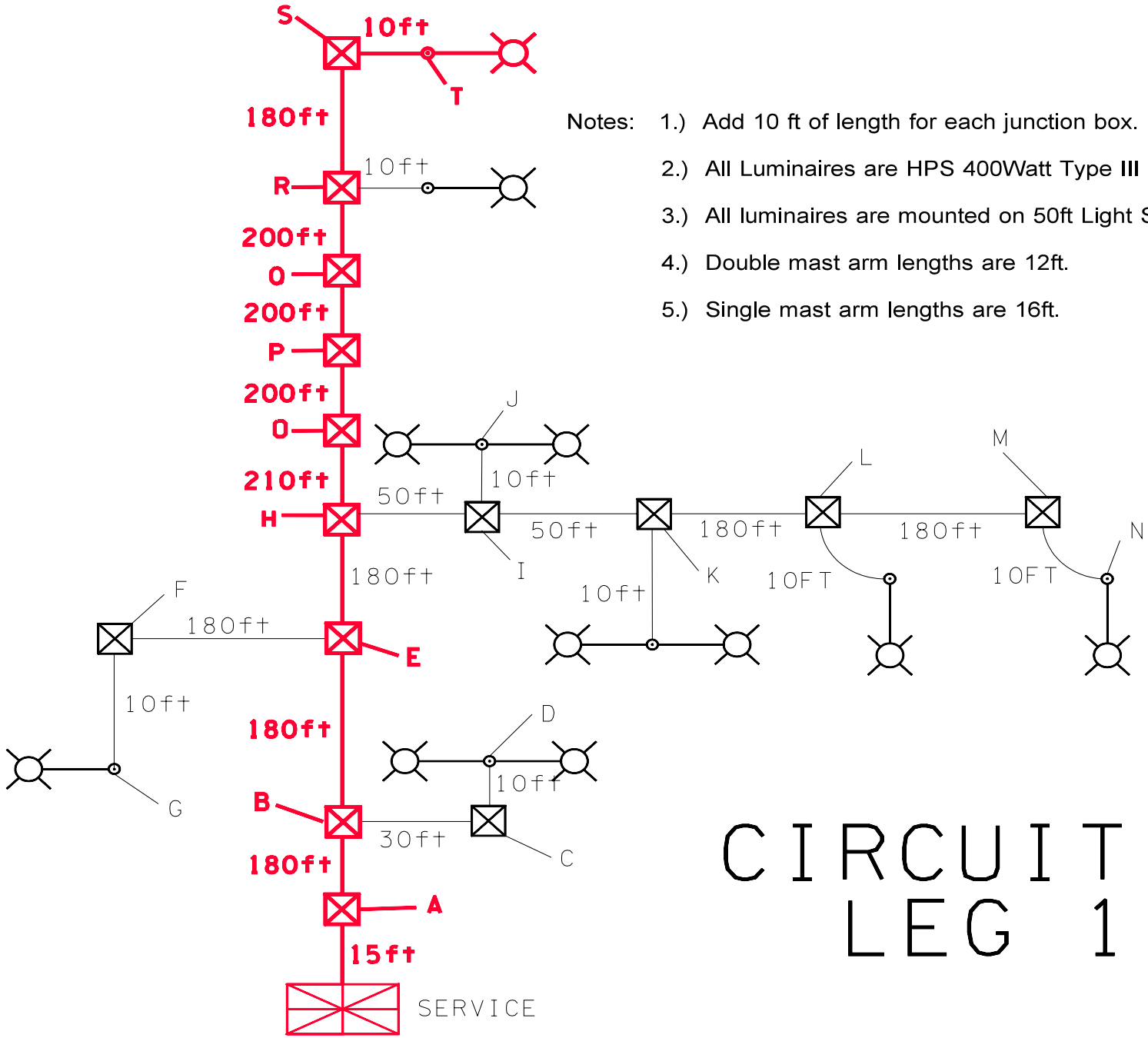
8.102976

Resistance of #8 conductor

Resistance of #10 conductor

8.102976/240=0.0337622*100=3.4% Vd

3.4% < 5% - #2 wire is acceptable



Notes:

1.) Add 10 ft of length for each junction box.

2.) All Luminaires are HPS 400Watt Type **III** Medium Cutoff.

3.) All luminaires are mounted on 50ft Light Standards.

4.) Double mast arm lengths are 12ft.

5.) Single mast arm lengths are 16ft.

CIRCUIT B LEG 1

Voltage Drop for Circuit B Leg#1 - 1st try

Vd=2ALR

Total length of Segment

Resistance of #8 conductor

Total load on Segment

Wire out and Back

Service to B=2(23.1)(5+15+10+180+5=215)(0.000809) =8.035797

B to E =2(18.9)(5+180+5=190)(0.000809) =5.810238

E to H =2(16.8)(5+180+5=190)(0.000809) =5.164656

H to R =2(4.2)(5+210+10+200+10+200+10+200+5=850)(0.000809)=5.776260

R to S =2(2.1)(5+180+5=190)(0.000809) =0.645582

S to T =2(2.1)(5+10+5=20)(0.000809) =0.067956

T to Light =2(2.1)(62)(0.001290) =0.335916

25.836405

Resistance of #10 conductor

25.836405/240=0.107652*100=10.8% Vd

10.8% > 5% - Try again with larger wire

Voltage Drop for Circuit B Leg#1 - 2nd try

Total load on Segment

Wire out and Back

$$Vd=2ALR$$

Total length of Segment

Resistance of #6 conductor

Service to B=2(23.1)(5+15+10+180+5 =215)(0.000510)=5.065830

B to E =2(18.9)(5+180+5 =190)(0.000510) =3.662820

E to H =2(16.8)(5+180+5 =190)(0.000510) =3.255840

H to R =2(4.2)(5+210+10+200+10+200+10+200+5=850)(0.000510)=3.641400

R to S =2(2.1)(5+180+5=190)(0.000510) =0.406980

S to T =2(2.1)(5+10+5=20)(0.000809) =0.067956

T to Light =2(2.1)(62)(0.001290) =0.335916

16.436742

16.436742/240=0.068486*100=6.8% Vd

6.8% > 5% - Try again with larger wire

Resistance of #10 conductor

Voltage Drop for Circuit B Leg#1 - 3rd try

Total load on Segment

Wire out and Back

$$Vd=2ALR$$

Total length of Segment

Resistance of #4 conductor

Service to B=2(23.1)(5+15+10+180+5 =215)(0.000321)=3.188493

B to E =2(18.9)(5+180+5 =190)(0.000321) =2.305422

E to H =2(16.8)(5+180+5 =190)(0.000321) =2.049264

H to R =2(4.2)(5+210+10+200+10+200+10+200+5=850)(0.000321)=2.291940

R to S =2(2.1)(5+180+5=190)(0.000321) =0.256158

S to T =2(2.1)(5+10+5=20)(0.000510) =0.042840

T to Light =2(2.1)(62)(0.001290) =0.335916

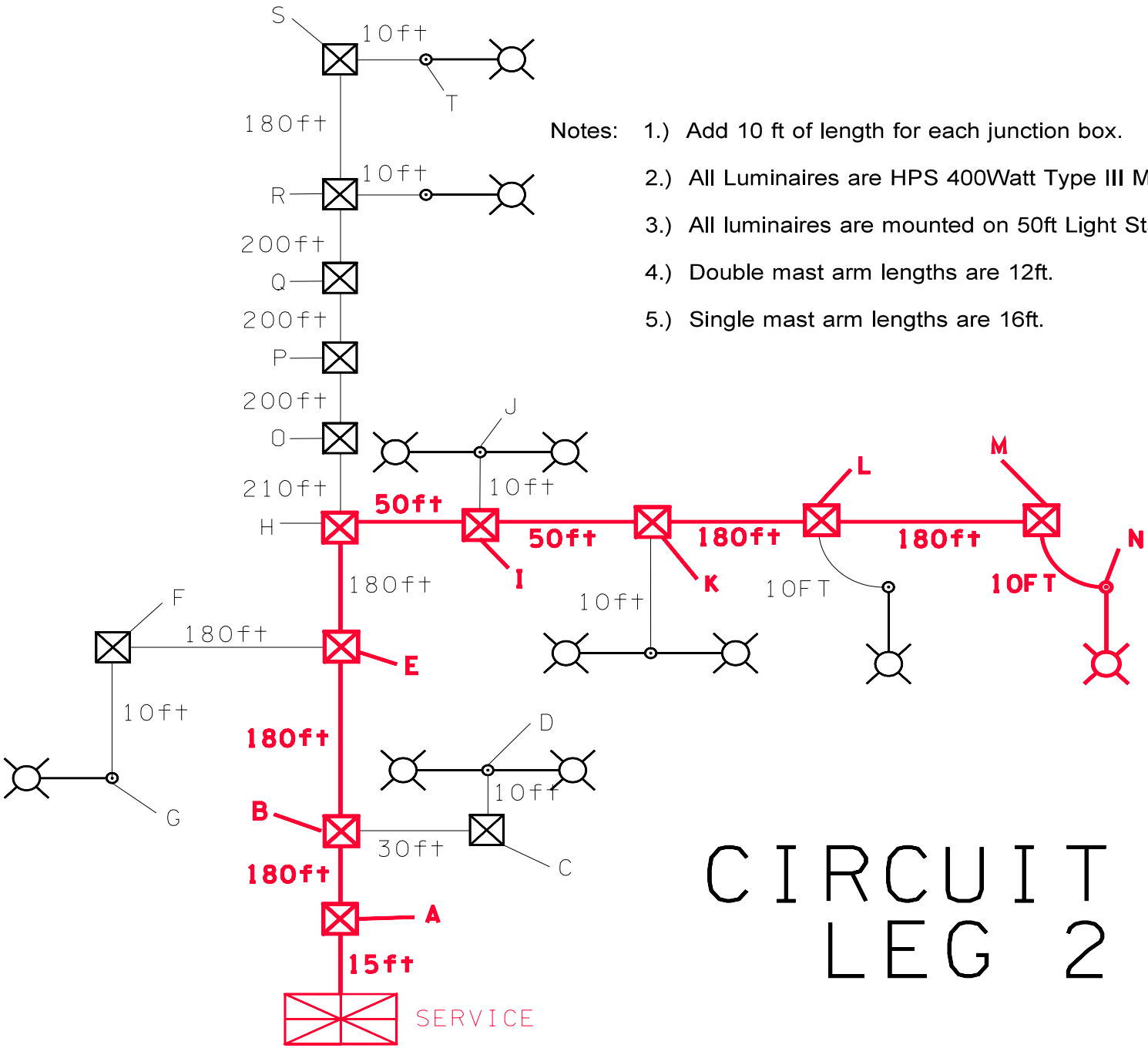
10.470033

Resistance of #6 conductor

Resistance of #10 conductor

10.470033/240=0.043625 *100=4.4% Vd

4.4% < 5% - #4 wire is acceptable



Notes:

1.) Add 10 ft of length for each junction box.

2.) All Luminaires are HPS 400Watt Type III Medium Cutoff.

3.) All luminaires are mounted on 50ft Light Standards.

4.) Double mast arm lengths are 12ft.

5.) Single mast arm lengths are 16ft.

CIRCUIT B LEG 2

Voltage Drop for Circuit B Leg#2 - 1st Try

Vd=2ALR

Total length of Segment

Resistance of #4 conductor

Total load on Segment

Wire out and Back

Service to B=2(23.1)(5+15+10+180+5=215)(0.000321)=3.188493

B to E =2(18.9)(5+180+5=190)(0.000321) =2.305422

E to H =2(16.8)(5+180+5 =190)(0.000321) =2.049264

H to I =2(12.6)(5+50+5=60)(0.000809) =1.223208

I to K =2(8.4)(5+50+5=60)(0.000809) =0.815472

K to L =2(4.2)(5+180+5=190)(0.000809) =1.291164

L to N =2(2.1)(5+180+10+10+5=210)(0.000809) =0.713538

N to Light =2(2.1)(62)(0.001290) =0.335916

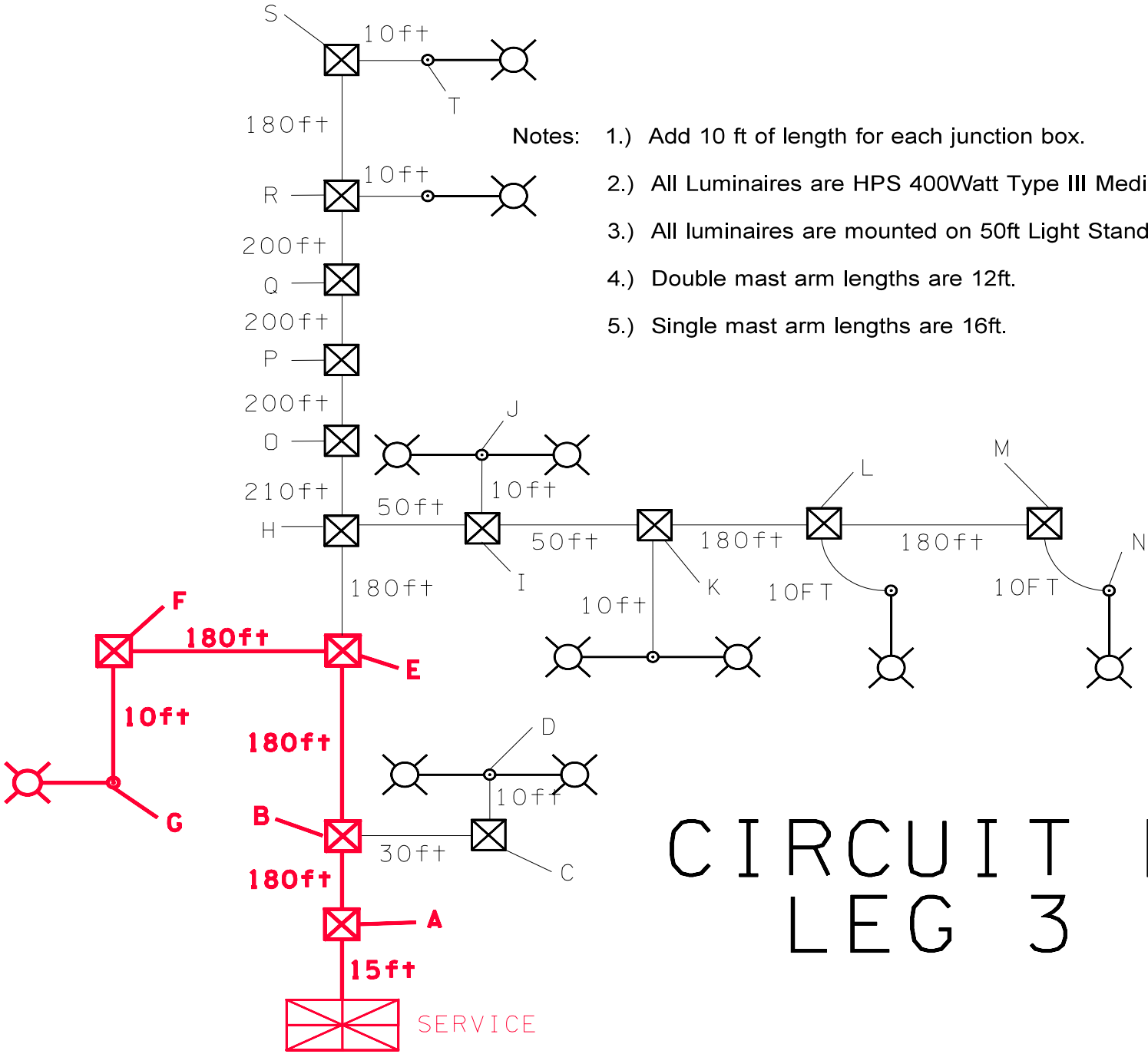
11.922477

Resistance of #8 conductor

Resistance of #10 conductor

11.922477/240=0.049677*100=5.0% Vd

5.0% = 5% - A combination of #4 and #8 wire is acceptable



Notes:

1.) Add 10 ft of length for each junction box.

2.) All Luminaires are HPS 400Watt Type III Medium Cutoff.

3.) All luminaires are mounted on 50ft Light Standards.

4.) Double mast arm lengths are 12ft.

5.) Single mast arm lengths are 16ft.

CIRCUIT B LEG 3

Voltage Drop for Circuit B Leg#3 - 1st try

Vd=2ALR

Total length of Segment

Resistance of #4 conductor

Total load on Segment

Wire out and Back

Service to B=2(23.1)(5+15+10+180+5=215)(0.000321)=3.188493

B to E =2(18.9)(5+180+5=190)(0.000321) =2.305422

E to G =2(2.1)(5+180+10+10+5=210)(0.000809) =0.713538

G to Light =2(2.1)(62)(0.001290) =0.335916

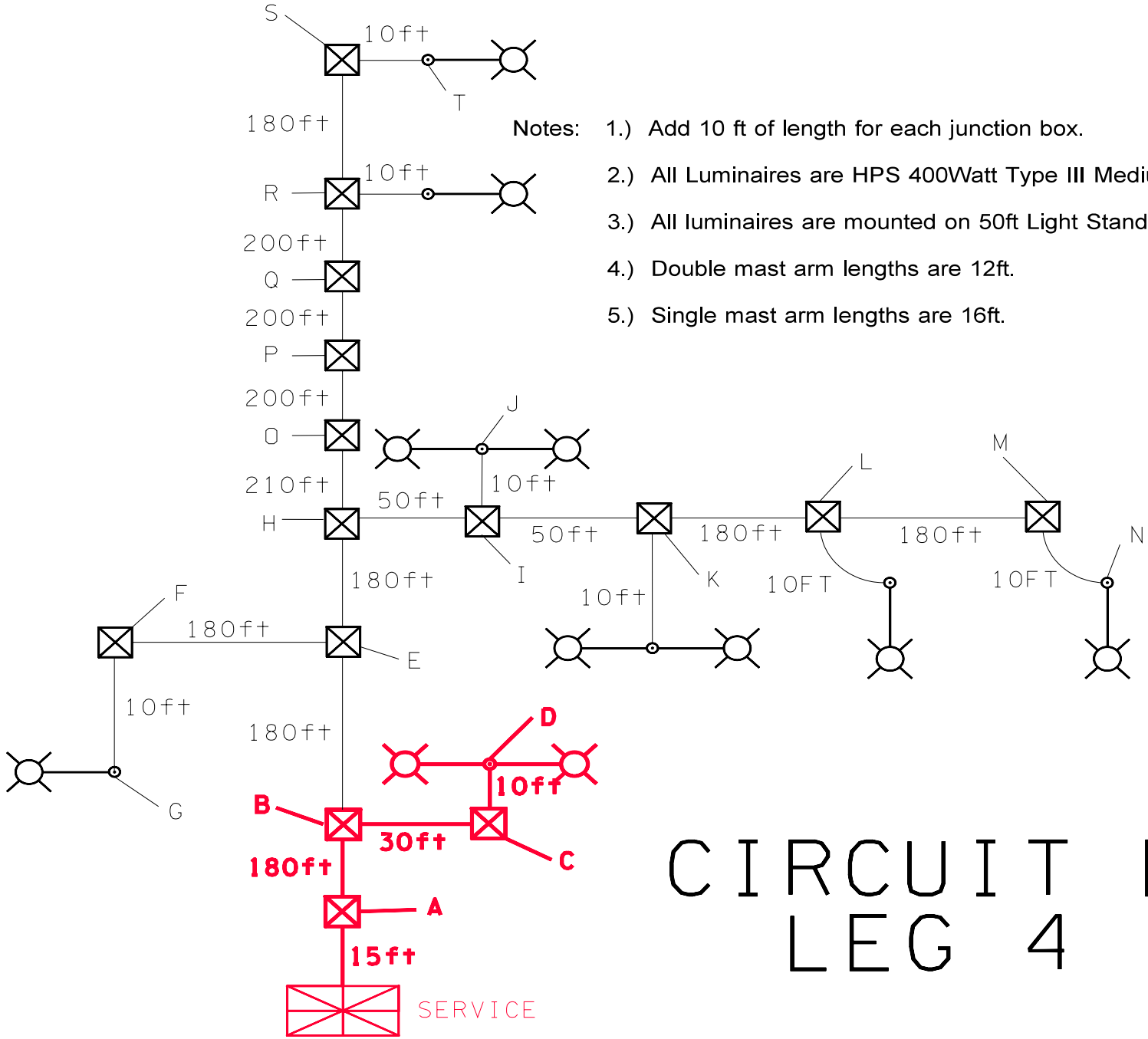
6.543369

Resistance of #8 conductor

Resistance of #10 conductor

6.543369/240=0.027264*100=2.7% Vd

2.7% < 5% - A combination of #4 and #8 wire is acceptable



Notes:

1.) Add 10 ft of length for each junction box.

2.) All Luminaires are HPS 400Watt Type III Medium Cutoff.

3.) All luminaires are mounted on 50ft Light Standards.

4.) Double mast arm lengths are 12ft.

5.) Single mast arm lengths are 16ft.

CIRCUIT B
LEG 4

Voltage Drop for Circuit B Leg#4 - 1st try

Vd=2ALR

Total length of Segment

Resistance of #4 conductor

Total load on Segment

Wire out and Back

Service to B =2(23.1)(5+15+10+180+5=215)(0.000321)=3.188493

B to D =2(4.2)(5+30+10+10+5=60)(0.000809) =0.407736

D to Light =2(2.1)(62)(0.001290) =0.335916

3.932145

Resistance of #8 conductor

Resistance of #10 conductor

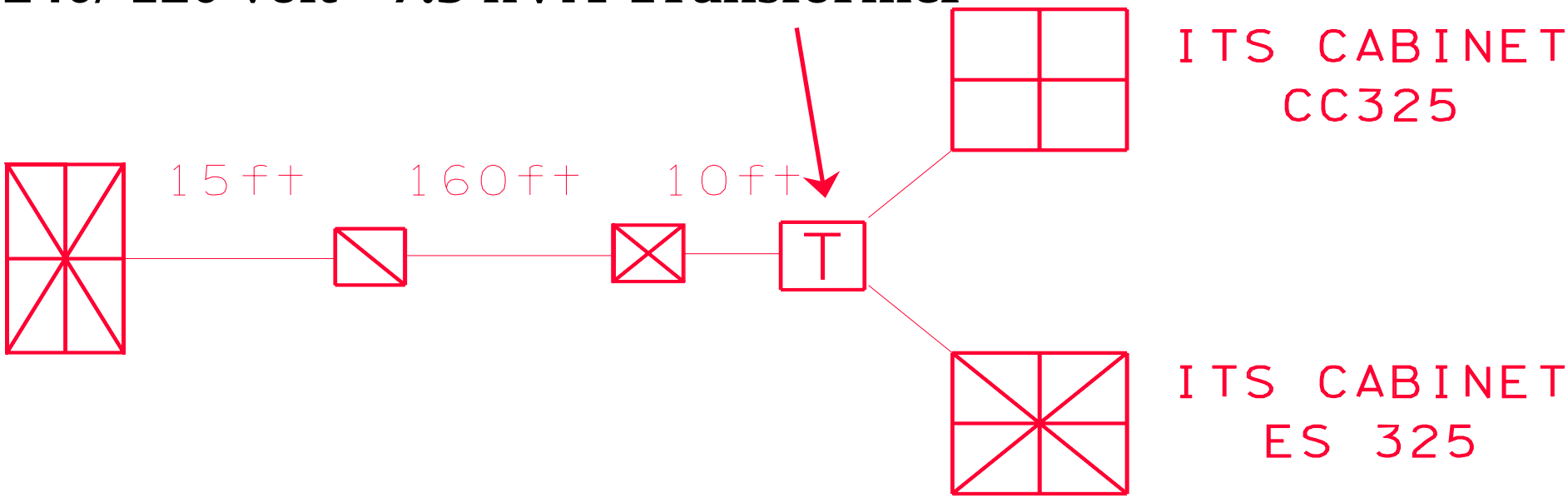
3.932145/240=0.016384*100=1.6% Vd

1.6% < 5% - A combination of #4 and #8 wire is acceptable

Notes: 1.) Add 10 ft of length for each junction box.

2.) Add 5 ft of legnth for each cabinet.

240/ 120 volt - 7.5 kVA Transformer



CIRCUIT C

Voltage Drop for Circuit C – 1st try

Vd=2ALR

Given: 240/120 volt - 7.5 kVA transformer.

Find Load: 7.5 kVA x 1000 = 7,500 watts

7,500watts / 240 volts = 31.25 Amps. Load = 31.25 Amps

Total length of Segment

Resistance of #8 conductor

Total load on Segment

Wire out and Back

Service to ES325=2(31.25)(5+15+10+160+10+10+5=215)(0.000809)=10.870938

10.870938/240=0.045296*100=4.5% Vd

4.5% > 3% - #8 wire is not OK

Voltage Drop for Circuit C – 2nd try

Vd=2ALR

Total length of Segment

Resistance of #6 conductor

Total load on Segment

Wire out and Back

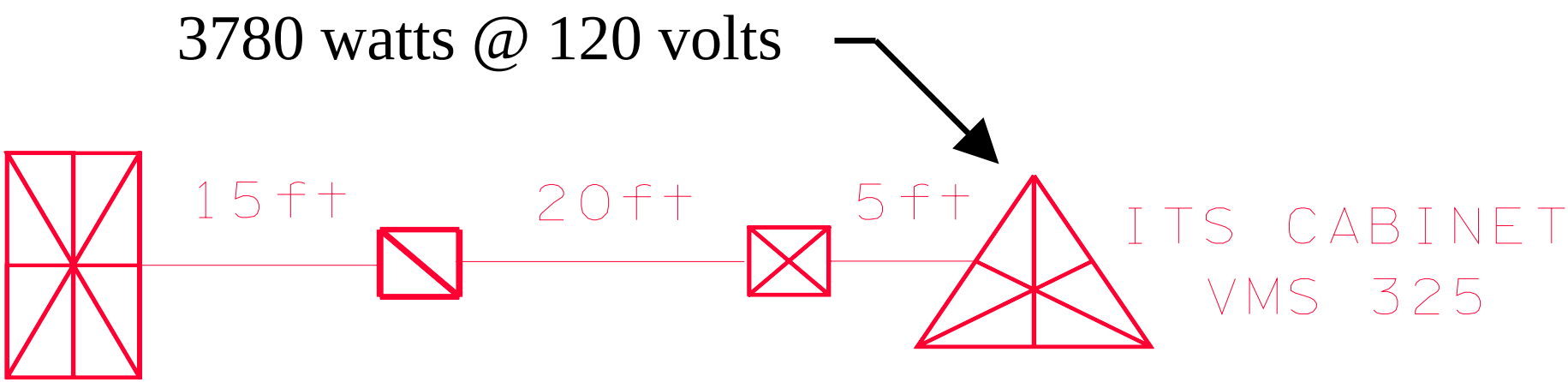
Service to ES325=2(31.25)(5+15+10+160+10+10+5=215)(0.000510)=6.853125

6.853125/240=0.028555*100=2.9% Vd

2.9% < 3% - #6 wire is acceptable

Notes: 1.) Add 10 ft of length for each junction box.

2.) Add 5 ft of legnth for each cabinet.



CIRCUIT D

Voltage Drop for Circuit D

Vd=2ALR

<u>Load equals</u>: 3780 watts / 120 volts = 31.50 Amps

Total length of Segment

Resistance of #8 conductor

Total load on Segment

Wire out and Back

Service to ES326=2(31.5)(5+15+10+20+10+5+5=70)(0.000809)=3.567690

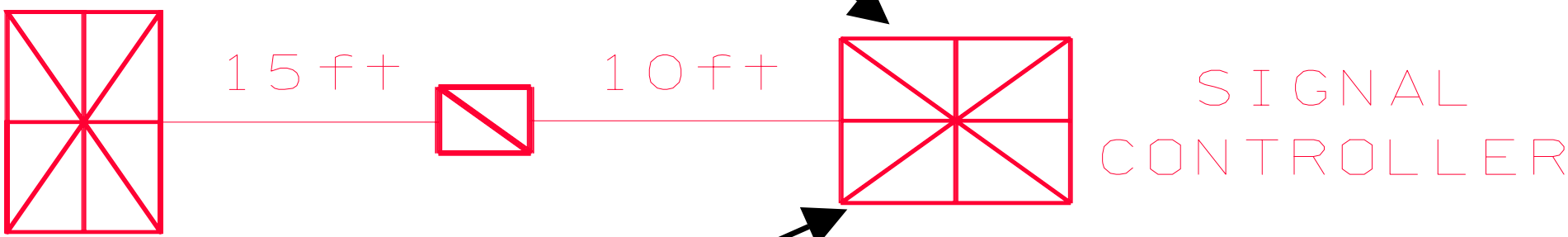
3.567690/120=0.029731*100=3.0% Vd

3% = 3% - #8 wire is acceptable

Notes: 1.) Add 10 ft of length for each junction box.

2.) Add 5 ft of legnth for each cabinet.

5008 watts @ 120 volts



Note: This Traffic Signal Controller serves the four legged intersection as calculated on slide 20. The load is 5008 watts divided by 120 volts equals 41.73 amps.

CIRCUIT E

Voltage Drop for Circuit E

Vd=2ALR

Total length of Segment

Resistance of #8 conductor

Total load on Segment

Wire out and Back

Service to Sig. Cabinet=2(41.73)(5+15+10+10+5=45)(0.000809)=3.038361

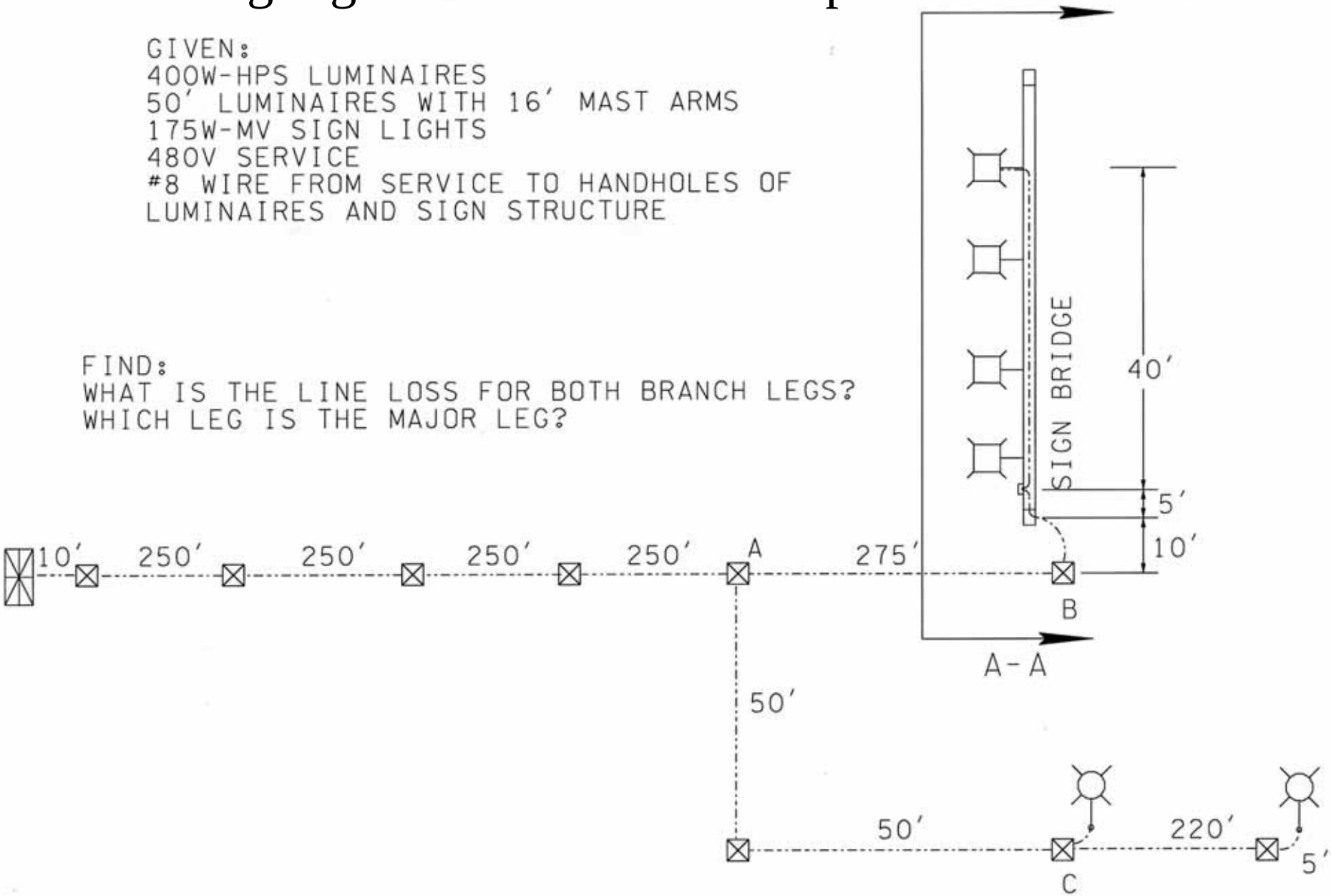
3.038361/120=0.025320*100=2.5% Vd

2.5% < 5% - #8 wire is acceptable

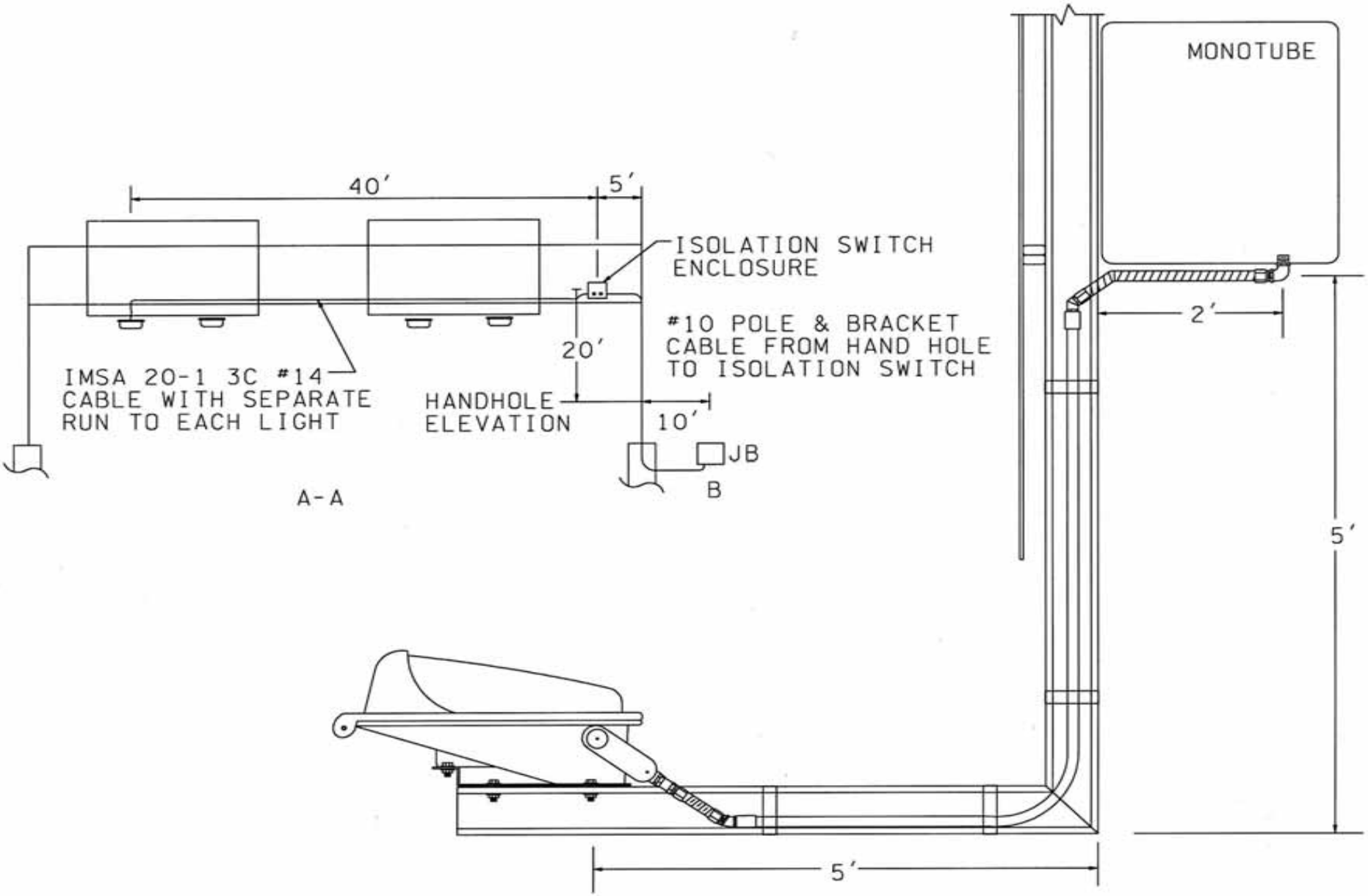
Signlighter & 480 Volt example

GIVEN:
400W-HPS LUMINAIRES
50′ LUMINAIRES WITH 16′ MAST ARMS
175W-MV SIGN LIGHTS
480V SERVICE
#8 WIRE FROM SERVICE TO HANDHOLES OF LUMINAIRES AND SIGN STRUCTURE

FIND:
WHAT IS THE LINE LOSS FOR BOTH BRANCH LEGS?
WHICH LEG IS THE MAJOR LEG?



Signlighter @ 480 Volt example – cont.



Sign lighter & 480 Volt example – cont.

Calculating loads for this circuit

- 400 watt HPS luminaire at 480 volts = 1.1 amps
- 175 watt MV luminaire at 480 volts = 0.5 amps
- Total load for circuit = 2 (1.1) + 4 (0.5)
- Total Load = 4.2 amps

Voltage Drop for 2 Luminaire Circuit

Vd=2ALR

Wire out and Back

Total load on Segment

Total length of Segment

Resistance of #8 conductor

Service to A= (1060)

2(4.2)(5+10+10+250+10+250+10+250+10+250+5)(0.000809) =7.203336

A to C =2(2.2)(5+50+10+50+5=120)(0.000809) =0.427152

C to hand hole =2(1.1)(5+220+10+5+5=245)(0.000809) =0.436051

Hand hole to light =2(1.1)(62)(0.001290) =0.175956

8.242495

8.242495/480=0.017172*100=1.7% Vd

1.7% < 5% - #8 wire is acceptable

Resistance of #10 conductor

Voltage Drop for 4 Sign Light Circuit

Resistance of #8 conductor

Resistance of #10 conductor

Service to A= (1060)

2(4.2)(5+10+10+250+10+250+10+250+10+250+5)(0.000809) =7.203336

A to B =2(2)(5+275+5=285)(0.000809) =0.922260

B to hand hole =2(2)(5+10+5=20)(0.000809) =0.064720

Hand hole to ISO box = 2(2)(20+5+2=27)(0.001290) =0.139320

ISO box to out signlight =2(0.5)(2+40+2+5+5+2=56)(0.003261) =0.182616

8.512252

8.512252/480=0.017734*100=1.8% Vd

1.8% < 5% - #8 wire is acceptable

Resistance of #14 IMSA conductor

Sign lighter & 480 Volt example – cont.

- The leg supplying the sign lights has a voltage drop of 1.8%.
- The leg supplying the luminaires has a voltage drop of 1.7%.
- The major leg is the one supplying the sign lights.

When laying out wire, keep this in mind:

- Keep all conductors from any one service in the junction boxes for that service. Do not **ever** combine conductors from one service with conductors from another service. **Do not share conduit or junction boxes between services.**
- Run 3 wires in the conduit when you are going cabinet to cabinet.
- The quick disconnects for the luminaire poles can only handle a #6 or #8 conductor, so make sure you bring one of these sizes into the luminaire and nothing larger.
- The splice kits for Wye splices or inline splices can only handle up to a #2 without going to a special, more expensive splice kit.
- The smallest size conductor we are allowed to use on an illumination circuit is a #8 (in the conduit) , except for the pole & bracket cable which is a #10 or the #14 3C IMSA cable from the isolation switch to the sign light luminaire. The largest you want to use is a #2 for ease of installation.
- As you move out from the service to the load end of the circuit, the size of the conductors should get smaller as you go. Do not go from a smaller conductor to a larger conductor.

Any Questions?