EXHIBIT "B"

PUBLIC IMPROVEMENTS

EXHIBIT "B" TO CRA FUNDING AGREEMENT BETWEEN THE HOLLYWOOD, FLORIDA COMMUNITY REDEVELOPMENT AGENCY AND DOWNTOWN HOLLYWOOD HOLDINGS, LLC.

The improvements of certain public properties and public rights-of way along Tyler Street between 21st Avenue and 20th Avenue, consisting of: the installation of sidewalks, driveways, curbed landscape islands, landscape and irrigation, tree-grates, and lighting along the south side of Tyler Street and milling, resurfacing, and striping of one travel lane and one parking lane, as more formally set forth within the specifications below and the Conceptual Site Plan prepared by Bermello Ajamil & Partners, Inc. dated November 16, 2023, which may be subsequently revised at the request of the City of Hollywood, and other authorizing agencies for the purpose of permitting.

Public Improvements:

- Picture-Frame Concrete Sidewalks
- Picture-Frame Concrete Driveways
- Street Trees
    - Total Number: 20
    - Species: Gumbo Limbo Tree
    - Size: 6" Caliper
18' Overall Height
10' Wide Overall Spread
6' Clear Trunk
- Palms:
    - Total Number: 40
    - Species: Montgomery Palms
    - Size: 12" Caliper at 12" Above Finish Grade
14' Wide Overall Spread
15' Overall Height with 6' Clear Truck (20)
20' Overall Height with 12' Clear Truck (20)

- Shrubs:
    - Total Number: 263
    - Spacing: 24” OC
    - Species: Green Island Ficus
    - Size: 1 Gallon, 12” x 12”

- Tree Grates
    - Total Number: 20
    - Size: 4’ x 6’
    - Style: Iron Age Design - Oblio Tree Grate (Oiled Finish)

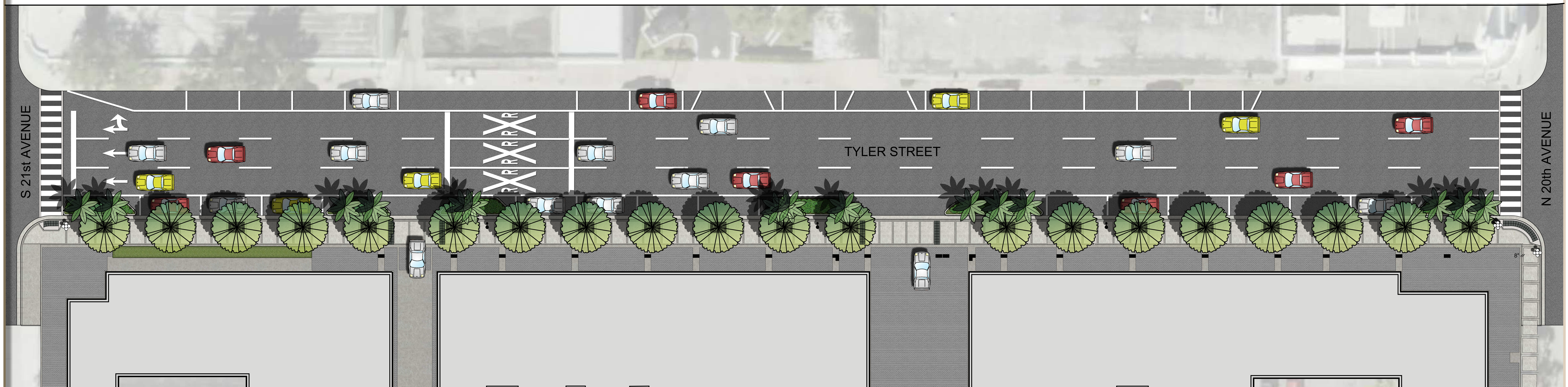
- Light Fixtures:
    - Tear Drop Fixtures:
        - Total: 3
        - Manufacturer: Holophane
        - Fixture Model: ESL3 – Esplanade Tear Drop Large Roadway LED Pendent
        - Arm Model: BCR 30IN 1A
        - Pole Model: Hapco – Arlen Series
        - Pole Size: 14’-0” Length
        - Color: Black

    - Five-Globe Fixtures:
        - Total: 2
        - Manufacturer: Holophane
        - Fixture Model: PSUE3 – Prismasphere Utility LED3
        - Arm Model: PCP36/4T
        - Pole Model: Hapco – Arlen Series
        - Pole Size: 17’-0” Length
        - Color: Black

NOTES: This plan is conceptual and not based on an accurate survey.
The location of light fixtures is conceptual and a detailed photometric plan must be prepared and approved by the Engineer of Record.
All dimensions are approximate and should be field verified.

DIMENSIONED GROUND PLANE PLAN CONCEPT

0' 10' 20' 40'



ILLUSTRATIVE CANOPY TREE AND PALM PLAN

0' 10' 20' 40'

TYLER STREET - STREETSCAPE CONCEPT

CITY OF HOLLYWOOD

November 16, 2023

FLORIDA'S Hollywood
COMMUNITY REDEVELOPMENT AGENCY

5. 2 Standard Paving Sidewalks

The design of standard paving sidewalks and walkways play an integral role in establishing and reinforcing the identity of an area.

For standard paving for sidewalks and pedestrian walkways, it is recommended to use a single sidewalk material.

» Scored concrete is preferred, with a minimum dimension of 5' x 5' squares.

» Concrete is broom finished with smooth/slip resistant picture frame of no less than four inches.

» Transitions between different materials and/or landscaping tree grates are given special attention and designed to minimize change in surface height to prevent hazard.

» Designs prioritize accessibility for people of all ages and abilities, including those with hearing, vision and mobility impairments.

5. 2. 1 Colors

Standard paving sidewalks may be composed of the following color palette.

» Natural/Grey

5. 2. 2 Materials

Standard paving sidewalks may be composed of the following material.

» Concrete

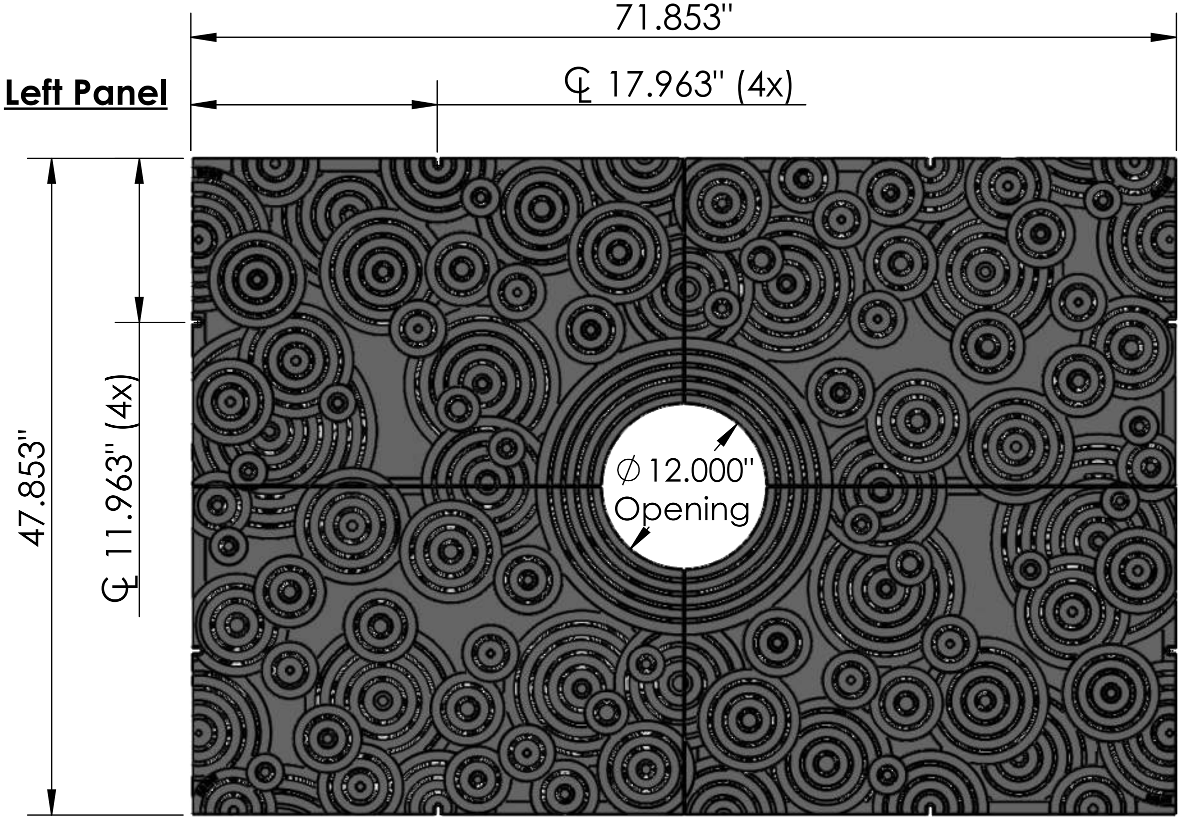
FIGURE 38 – PICTURE FRAME CONCRETE OPEN SPACE

Picure Frame Concrete		
	Application Area	Y/N
Application Area:	Pedestrian Sidewalks -	Y
	Crosswalks -	N
	Intersection Corners -	N
	Public Open Spaces -	N
	On-Street Parking -	N
	Transit Stops	Y

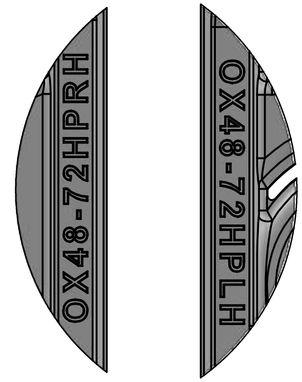
TABLE II – STANDARD PAVING AREAS: PICTURE FRAME CONCRETE

FIGURE 39 – PICTURE FRAME CONCRETE SIDEWALK

TOP VIEW
scale 1:14



CASTING-ID
scale 1:3



ISO-VIEW
scale 1:22

SIDE VIEW
scale 1:14

NOTES:

1. Heelproof: No thru openings greater than ¼".
2. Pieces per Set: 4
3. Due to casting inconsistencies, all dimensions are nominal.
4. Center Opening Options:
   Cast at 12", Breakouts at 14", 16", 18" & 20".
5. Pedestrian Load Only.

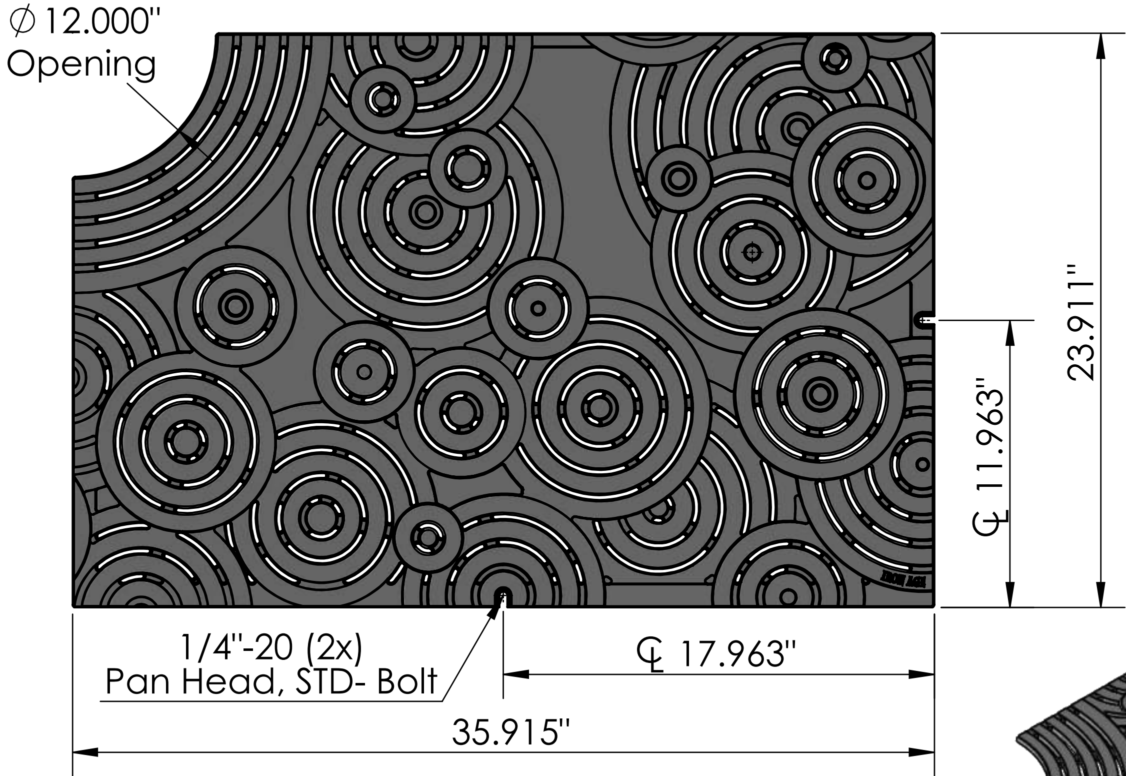
Made in USA

Oblio 4' x 6' Tree Grate - Heel Proof

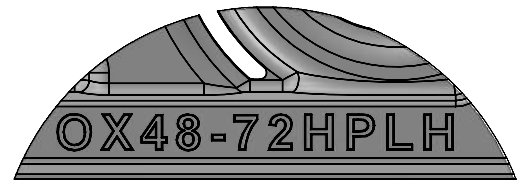
IRON AGE DESIGNS
Telephone 206.276.0925
www.ironagegrates.com

Material: Grey Iron CL 30 or better	**Weight:** 411.86 lbs.	**Free Drain Area:** 275.46 in/sq. or 8.28 %	**By:** MS	**Checked:** MS	**Date:** 4-8-22
Finish: Oiled	**Edge:** 1.250"	**Flow Rate:** 360.85 GPM	**© Registration:** Pending		**Scale:** NTS
Fits: Iron Age Custom Frame SOLD SEPARATELY	**Product ID:** OX48-72I99TGHP	**Drawing Name:** 01_OBL_I_48x72HP_TreeGrate_Comp			

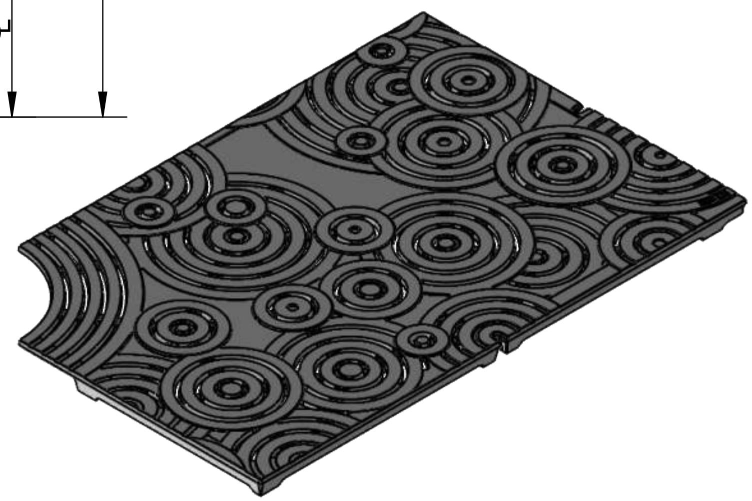
TOP VIEW
scale 1:8



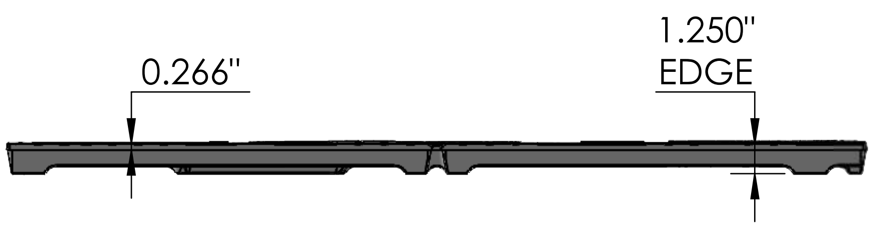
CASTING-ID
scale 1:2



ISO-VIEW
scale 1:10



SIDE VIEW
scale 1:8



NOTES:

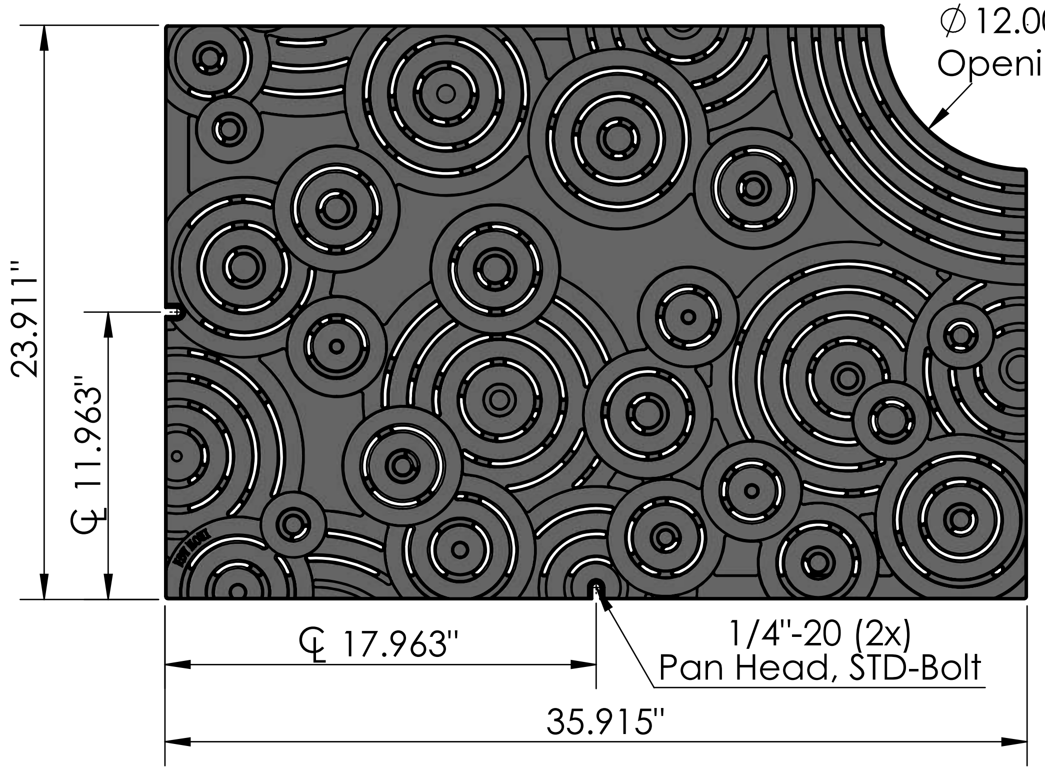
1. Heelproof: No thru openings greater than ¼".
2. Due to casting inconsistencies, all dimensions are nominal.
3. Pedestrian Load Only.

Oblio 4' x 6' Tree Grate - Heel Proof - Left Panel

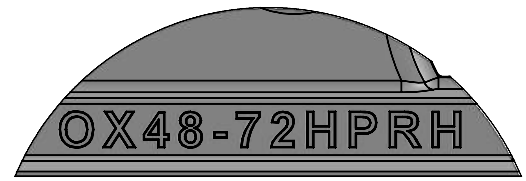
Made in USA

IRON AGE DESIGNS Telephone 206.276.0925 www.ironagegrates.com				
Material: Grey Iron CL 30 or better	**Weight:** 102.33 lbs.	**Free Drain Area:** 97.62 in/sq. or 8.60 %	**By:** MS **Checked:** MS	**Date:** 4-8-22
Finish: Oiled	**Edge:** 1.250"	**Flow Rate:** 93.63 GPM	**© Registration:** Pending	**Scale:** NTS
Fits: Iron Age Custom Frame SOLD SEPARATELY	**Product ID:** OX48-72I99TGHPL	**Drawing Name:** 01_OBL_I_48x72HP_TreeGrate_LeftPanel		Page 2

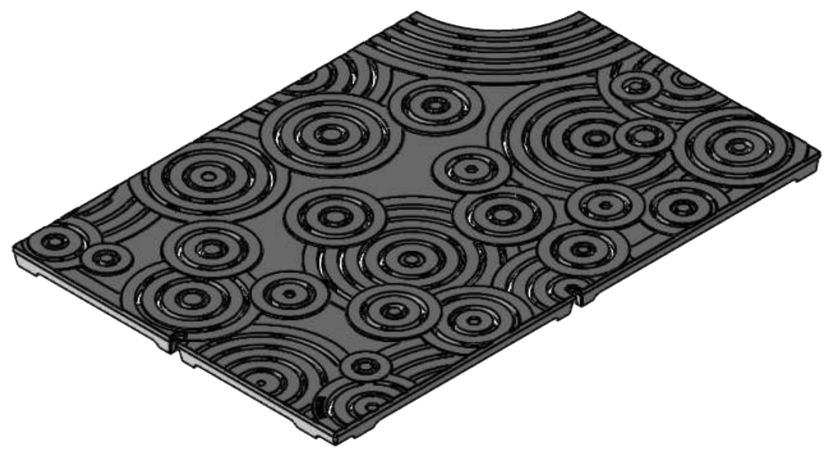
TOP VIEW
scale 1:8



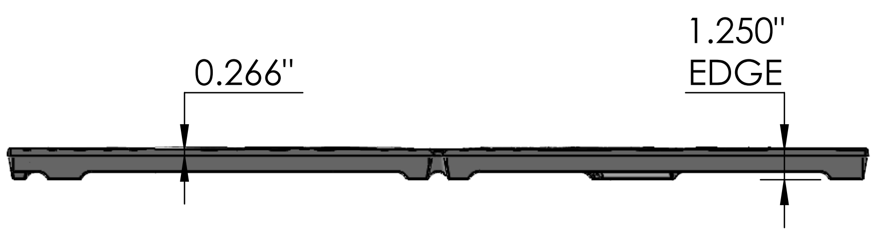
CASTING-ID
scale 1:2



ISO-VIEW
scale 1:10



SIDE VIEW
scale 1:8



NOTES:

1. Heelproof: No thru openings greater than ¼".
2. Due to casting inconsistencies, all dimensions are nominal.
3. Pedestrian Load Only.

Oblio 4' x 6' Tree Grate - Heel Proof - Right Panel

Made in USA

IRON AGE DESIGNS Telephone 206.276.0925 www.ironagegrates.com	**Material:** Grey Iron CL 30 or better	**Weight:** 103.60 lbs.	**Free Drain Area:** 66.25 in/sq. or 7.97 %	**By:** MS	**Checked:** MS	**Date:** 4-8-22
	Finish: Oiled	**Edge:** 1.250"	**Flow Rate:** 86.79 GPM	**© Registration:** Pending		**Scale:** NTS
	Fits: Iron Age Custom Frame SOLD SEPARATELY	**Product ID:** OX48-72I99TGHPR	**Drawing Name:** 01_OBL_I_48x72HP_TreeGrate_RightPanel			

Catalog Number	
Notes	Type

ESL3

Esplanade® Tear Drop Large Roadway LED Pendant

Description
The Esplanade luminaire is styled to replicate the "teardrop" luminaires that lighted boulevards in the first half of the 1900s. Designed for light control and ease of installation and maintenance, the Esplanade has a precision optical system for true street lighting performance.

Mechanical
The luminaire housing:
- Heavy grade A360 cast aluminum (aluminum with <1% copper)
- IP65 rated housing provides a spring-loaded latch for toolless access and a hinge for easy installation and servicing
- Optic door incorporates a hinge and wing nut enabling toolless access to install and service
- EEI- NEMA twist lock photocontrol receptacle can be mounted in electrical housing or externally; housing contains a tempered glass window to allow light to reach the cell for internally mounting

Electrical
- Certified by UL or CSA for wet locations
- A factory programmable electronic driver with 0-10V dimming control leads meets maximum total harmonic distortion (THD) of 20%, >0.90 Power Factor and are ROHS compliant.
- Minimum operating temperature is -40°C. Electronic driver has an estimated minimum life of 100,000 hours at 25°C.
- Optional DALI driver available
- 20kV/10kA surge protection, fail off, with indicator light meets ANSI/IEEE C62.41.2
- Quick disconnect connectors for ease of installation and maintenance.
- Three pole terminal block is standard, with optional prewired leads for ease of installation
- Configurable with CCT options of 2700K, 3000K, 4000K and 5000K, 70 CRI minimum

Finish
- Rigorous multi-stage pre-treating and painting process yields a finish that achieves a scribe creepage rating of 8 (per ASTM D1654) after over 5,000 hours exposure to salt fog chamber (operated per ASTM B117) on standard and RAL finish options.
- RAL (RALxxxxSDCR) paint colors are Super Durable Corrosion Resistant, 80% gloss.

Optical
The optical system is IP66 rated and consists of a precisely molded thermal resistant borosilicate glass refractor mounted within the borosilicate refractor Teardrop, Bowl, Sag shaped glass optic or the tempered Flat glass retained by the cast aluminum door. Designed for Type 2, 3, 4 & 5 distribution, see performance data table for configurations. For zero uplight options the flat glass option or the decorative shallow or deep skirt used with the bowl or sag glass.

Control Options
The control options shall include, but not limited to, the following:
- Field adjustable output to adjust output to luminaire - AO
- Long life photocontrol, 20 years – PCLL, P34 and P48 with DTL
- 3 and 7 pin receptacles internally in housing (PR3, PR7) or externally mounted on the leveling fitter (PR3E, PR7E)
- On externally mounted options, the photocontrol or shorting cap are selected with the leveling fitter

Mounting Style (Leveling Fitter Options)
Three mounting versions are available.
- An arm mount version which is provided with two U-bolts with washers and nuts and two leveling set screws that lock the housing to a 2 inch nominal (2-3/8" O.D.) horizontal arm and allow a +/- 5 degree adjustment from horizontal to the cover.
- A pendant mount version (either 1.25NPT or 1.5NPT) which threads to a vertical NPT male threaded pipe fitting and is locked in place by a stainless-steel set screw.
- A QSM (Quick Lock Stem Mounting), which consists of a vertical stem with flared top that mounts into a matching QSM fitter or arm. The QSM mount can aid in installation speed as it is a quicker installation than the other mounting methods.

Note: the QSM style is compatible with the following leveling fitters:
- Boston Harbor Decorative Arm Fitter (BHDF)
- GlasWerks Decorative Arm Fitter (GWDF)
- West Liberty Decorative Arm Fitter (WLDF)
- Ball Style Decorative Arm Fitter (BADF)

Certification
CSA listing suitable for wet location up to 40°C. Consult factory for details.

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

BUY AMERICAN ACT
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations. Please refer to www.acuitybrands.com/buy-american for additional information.

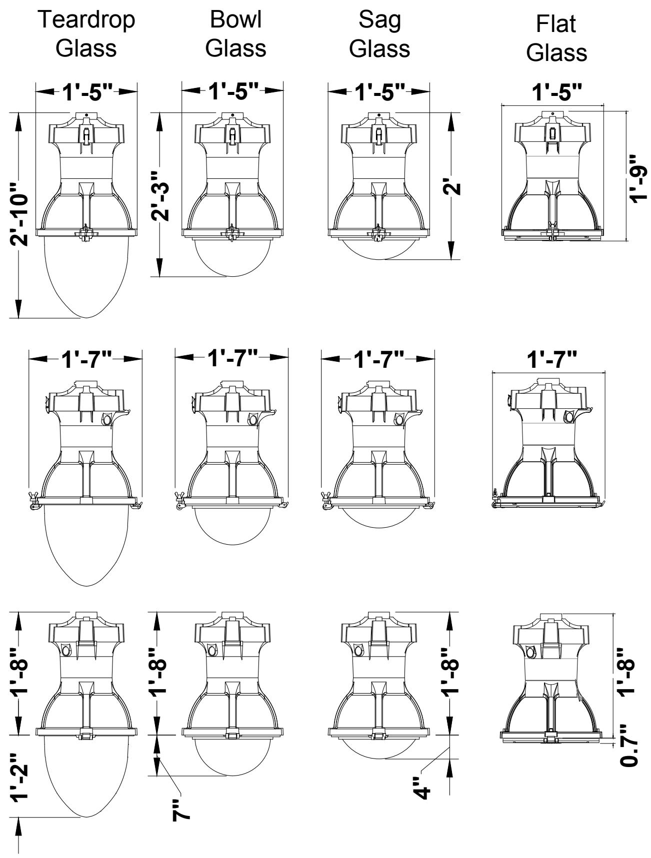
Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

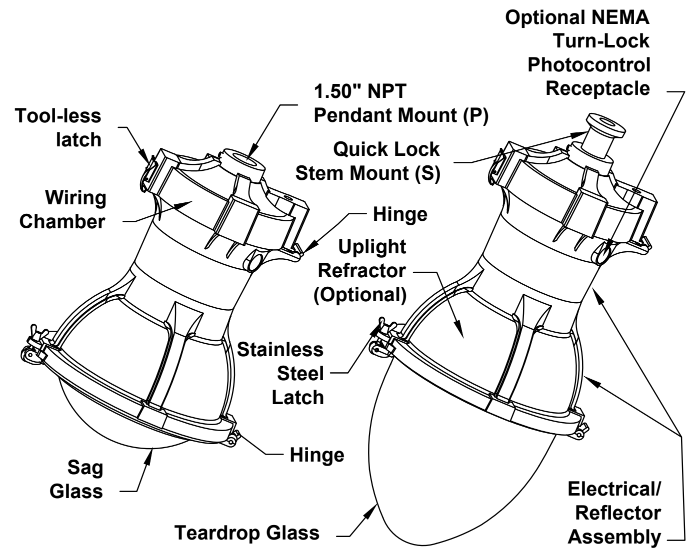
Note:
Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

DIMENSIONAL DATA





Maximum Weight - 69 lbs (Up Light Version)
Maximum Weight - 69 lbs (Down Light Version)
Maximum Effective Projected Area - ESL3 2.62 ft^2, ESL3 SS 2.86 ft^2, ESL3 DS 3.06 ft^2

ORDERING INFORMATION

Example: ESL3 P30S 30K MVOLT TG3 QSM BK

ESL3	P10S		30K	MVOLT
Series	**Lumen/Wattage Package**		**Color Temperature**	**Voltage**
ESL3 Esplanade style housings	P10S Standard housing, 44W	P35S Standard housing, 112W	27K 2700 series CCT	MVOLT Auto-sensing voltage (120 thru 277) 50/60 HZ
	P15S Standard housing, 54W	P40S Standard housing, 132W	30K 3000 series CCT	HVOLT Auto-sensing voltage (347 thru 480) 50/60 HZ
	P20S Standard housing, 73W	P45S Standard housing, 153W	40K 4000 series CCT	
	P20U Uplight housing, 94W	P50S Standard housing, 173W	50K 5000 series CCT	
	P25S Standard housing, 82W	P55S Standard housing, 193W		
	P25U Uplight housing, 109W	P60S Standard housing, 215W		
	P30S Standard housing, 92W	P65S Standard housing, 247W		
	P30U Uplight housing, 122W			

TG3		QSM
Optic		**Mounting**
TG2 Teardrop Glass & Door: Type 2 application	BG4 Bowl Glass & Door: Type 4 application	NPT Threaded top opening - 1.50" NPT
TG3 Teardrop Glass & Door: Type 3 application	BG5 Bowl Glass & Door: Type 5 application	QSM Quick Lock Stem mount
TG4 Teardrop Glass & Door: Type 4 application	SG2 Sag Glass & Door: Type 2 application	
FG3 Flat Glass & Door: Type 3 application	SG3 Sag Glass & Door: Type 3 application	
FG5 Flat Glass & Door: Type 5 application	SG4 Sag Glass & Door: Type 4 application	
BG2 Bowl Glass & Door: Type 2 application	SG5 Sag Glass & Door: Type 5 application	
BG3 Bowl Glass & Door: Type 3 application		

BK	AO	
Finish	**Options**	
BK Black	AO Field Adjustable Output	Prewire Lead Options
DB Dark Blue	PR3 NEMA twistlock photocontrol receptacle - 3 pin	L1H 1.5 ft. prewired leads
GR Grey	PR7 NEMA twistlock dimming photocontrol receptacle - 7 pin	L03 3 ft. prewired leads
GH Graphite	PR3E NEMA twistlock photocontrol receptacle - 3 pin (Externally mounted to Fitter)	L10 10 ft. prewired leads
GN Green	PR7E NEMA twistlock dimming photocontrol receptacle - 7 pin (Externally mounted to Fitter)	L20 20 ft. prewired leads
PP Prime Paint	PCLL Long Life DTL Twistlock Photocontrol for Solid State, Fail Off, MVOLT	L25 25 ft. prewired leads
SL Silver	P34 Long Life DTL Twistlock Photocontrol for Solid State, Fail Off, 347V	L30 30 ft. prewired leads
WH White	P48 Long Life DTL Twistlock Photocontrol for Solid State, Fail Off, 480V	L35 35 ft. prewired leads
BZ Bronze	SH Shorting cap	NEMA Label Options
CMC Custom Match Color Finish		NL1X1 1X1 NEMA Label
RALxxxxSDCR RAL Super Durable Corrosion Resistant, 80% Gloss Paint, replace xxxx with RAL number.		NL3X3 3X3 NEMA Label
CTBS Standard Finish to be determined		Shielding Options
		DS Deep Skirt, 30" diameter
		SS Shallow Skirt, 30" diameter
		HSS90 Factory installed Large TearDrop, Bowl & Flat Glass House Side Shield 90 degrees
		HSS120 Factory installed Large TearDrop, Bowl & Flat Glass House Side Shield 120 degrees
		HSS180 Factory installed Large TearDrop, Bowl & Flat Glass House Side Shield 180 degrees
		HSG90 Factory installed Large Sag Glass House Side Shield 90 degrees
		HSG120 Factory installed Large Sag Glass House Side Shield 120 degrees
		HSG180 Factory installed Large Sag Glass House Side Shield 180 degrees

Accessories: *Order as separate catalog number, ships separately & field installed.*

Shielding Options	
LTD3HSS90	Large TearDrop, Bowl & Flat Glass House side shield 90 degree
LTD3HSS120	Large TearDrop, Bowl & Flat Glass House side shield 120 degree
LTD3HSS180	Large TearDrop, Bowl & Flat Glass House side shield 180 degree
LTD3HSG90	Large Sag Glass House side shield 90 degree
LTD3HSG120	Large Sag Glass House side shield 120 degree
LTD3HSG180	Large Sag Glass House side shield 180 degree
LTDSxx	Deep Skirt, 30" Diameter, replace xx with Finish option
LTSSxx	Shallow Skirt, 30" Diameter, replace xx with Finish option

OPTIONS MATRIX

OPTIONS		Performance Package															Voltage		Options									
		P10S	P15S	P20S	P20U	P25S	P25U	P30S	P30U	P35S	P40S	P45S	P50S	P55S	P60S	P65S	MVOLT	HVOLT	A0	PR3	PR7	PR3E	PR7E	PCLL	P34	P48	SH
Performance Package	P10S		N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P15S	N		N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P20S	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P20U	N	N	N		N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P25S	N	N	N	N		N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P25U	N	N	N	N	N		N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P30S	N	N	N	N	N	N		N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P30U	N	N	N	N	N	N	N		N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P35S	N	N	N	N	N	N	N	N		N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P40S	N	N	N	N	N	N	N	N	N		N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P45S	N	N	N	N	N	N	N	N	N	N		N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P50S	N	N	N	N	N	N	N	N	N	N	N		N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P55S	N	N	N	N	N	N	N	N	N	N	N	N		N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P60S	N	N	N	N	N	N	N	N	N	N	N	N	N		N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P65S	N	N	N	N	N	N	N	N	N	N	N	N	N	N		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Voltage	MVOLT	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		N	Y	Y	Y	Y	Y	Y	N	N	Y
	HVOLT	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N		Y	Y	Y	Y	Y	N	Y	Y	Y
Options	A0	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
	PR3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		N	N	N	Y	Y	Y	Y
	PR7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N		N	N	Y	Y	Y	Y
	PR3E	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N		N	N	N	N	N
	PR7E	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N		N	N	N	N
	PCLL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N		N	N	N
	P34	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	N	N		N	N
	P48	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N		N
	SH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	

OPTICS by PERFORMANCE PACKAGE		Performance Package												
		TG2	TG3	TG4	FG3	FG5	BG2	BG3	BG4	BG5	SG2	SG3	SG4	SG5
Performance Package	P10S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P15S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P20S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P20U	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	P25S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P25U	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	P30S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P30U	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y
	P35S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P40S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P45S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P50S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P55S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P60S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P65S	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

MARK APPROPRIATE BOX FOR TRIM OPTIONS

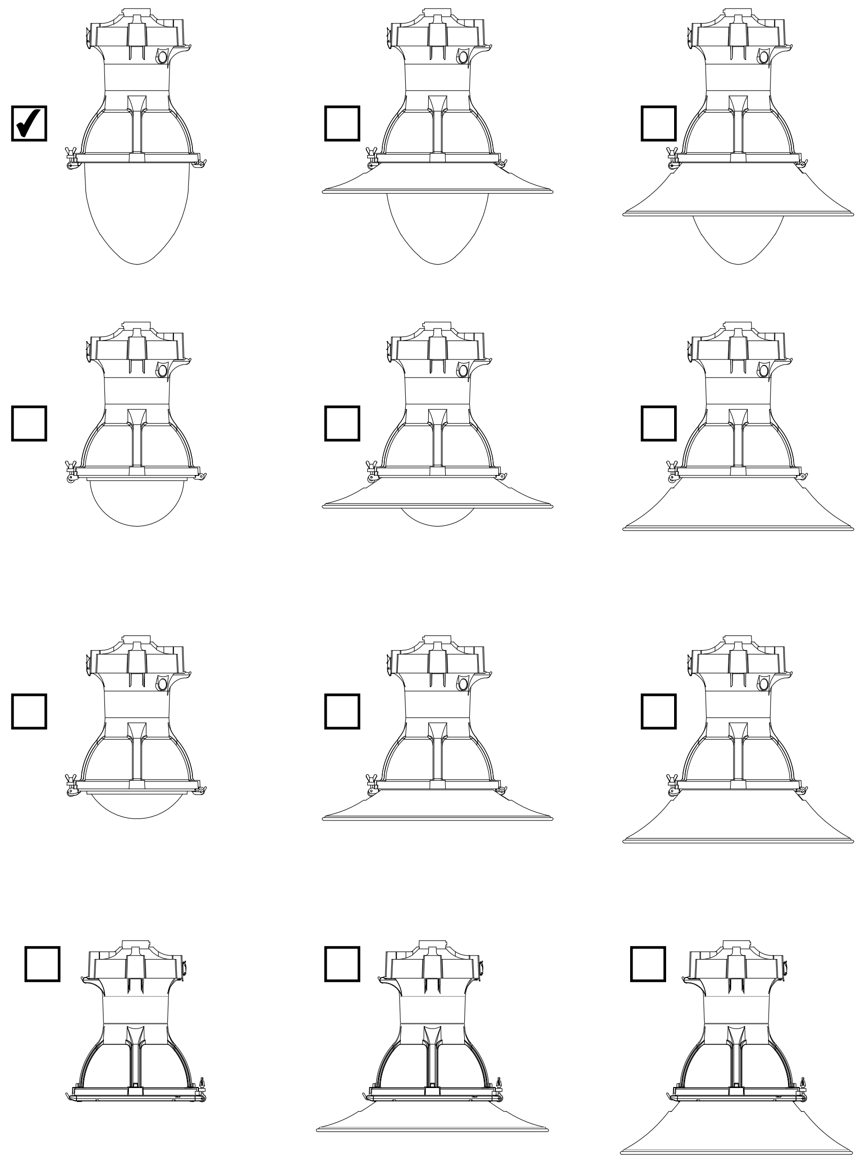
STANDARD | SHALLOW SKIRT | DEEP SKIRT

TEARDROP GLASS
(Asymmetric)

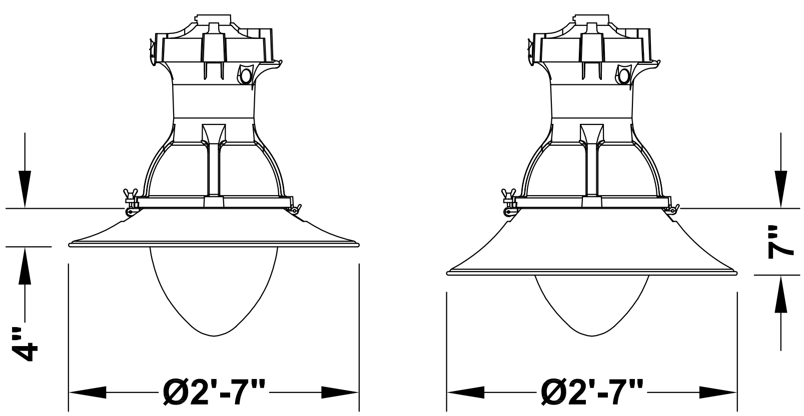
BOWL GLASS
(Asymmetric)
(Symmetric)

SAG GLASS
(Asymmetric)
(Symmetric)

FLAT GLASS
(Asymmetric)
(Symmetric)



SKIRT DIMENSIONS



 Rev. 01/10/23 Specifications subject to change without notice.

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS

PERFORMANCE DATA. FOR SKIRT AND HOUSE SIDE SHIELD OPTIONS, CONSULT FACTORY OR WEBSITE.

LED Package	Glass / Optic	System Watts	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
P10S	TG2	44	6,013	137	1	3	3	6,490	148	2	3	3	6,609	150	2	3	3	6,705	152	2	3	3
	TG3		6,033	137	1	3	3	6,511	148	2	3	3	6,630	151	2	3	3	6,727	153	2	3	3
	TG4		5,671	129	1	3	3	6,121	139	1	3	3	6,233	142	1	3	3	6,324	144	1	3	3
	FG3		3,912	89	1	0	1	4,222	96	1	0	1	4,300	98	1	0	1	4,362	99	1	0	1
	FG5		3,846	87	2	0	1	4,150	94	2	0	1	4,227	96	2	0	1	4,288	97	2	0	1
	BG2		5,750	131	2	3	3	6,206	141	2	3	3	6,320	144	2	3	3	6,412	146	2	3	3
	BG3		5,692	129	2	3	3	6,143	140	2	3	4	6,256	142	2	3	4	6,347	144	2	3	4
	BG4		5,389	122	1	3	3	5,816	132	1	3	3	5,923	135	1	3	3	6,009	137	1	3	4
	BG5		6,004	136	3	3	3	6,480	147	3	3	3	6,599	150	3	3	3	6,695	152	3	3	3
	SG2		5,778	131	1	3	3	6,236	142	1	3	3	6,350	144	1	3	3	6,443	146	1	3	3
	SG3		5,773	131	1	3	3	6,231	142	1	3	3	6,346	144	1	3	3	6,438	146	1	3	3
	SG4		5,452	124	1	3	3	5,884	134	1	3	3	5,992	136	1	3	3	6,079	138	1	3	3
	SG5		6,041	137	3	3	2	6,520	148	3	3	2	6,640	151	3	3	2	6,737	153	3	3	2
P15S	TG2	54	7,487	139	2	3	3	8,080	150	2	3	3	8,229	152	2	3	3	8,348	155	2	3	3
	TG3		7,511	139	2	3	3	8,106	150	2	3	3	8,255	153	2	3	3	8,375	155	2	3	3
	TG4		7,061	131	1	3	3	7,621	141	2	3	3	7,761	144	2	3	3	7,874	146	2	3	3
	FG3		4,871	90	1	0	1	5,257	97	2	0	1	5,353	99	2	0	1	5,431	101	2	0	1
	FG5		4,788	89	2	0	1	5,167	96	2	0	1	5,262	97	2	0	1	5,339	99	2	0	1
	BG2		7,159	133	2	3	4	7,727	143	2	3	4	7,869	146	2	3	4	7,983	148	2	3	4
	BG3		7,086	131	2	3	4	7,648	142	2	3	4	7,789	144	2	3	4	7,902	146	2	3	4
	BG4		6,710	124	1	3	4	7,241	134	2	3	4	7,375	137	2	3	4	7,482	139	2	3	4
	BG5		7,475	138	3	3	3	8,068	149	3	3	3	8,216	152	3	3	3	8,335	154	3	3	3
	SG2		7,193	133	2	3	3	7,763	144	2	3	3	7,906	146	2	3	3	8,021	149	2	3	3
	SG3		7,188	133	2	3	3	7,758	144	2	3	3	7,900	146	2	3	3	8,015	148	2	3	3
	SG4		6,788	126	1	3	3	7,326	136	1	3	3	7,460	138	1	3	3	7,569	140	1	3	3
	SG5		7,522	139	3	3	2	8,118	150	3	3	2	8,267	153	3	3	2	8,387	155	3	3	2
P20S	TG2	73	10,290	141	2	3	3	11,106	152	2	3	3	11,310	155	2	3	3	11,474	157	2	3	3
	TG3		10,323	141	2	3	3	11,141	153	2	3	4	11,346	155	2	3	4	11,511	158	2	3	4
	TG4		9,705	133	2	3	3	10,474	143	2	3	3	10,667	146	2	3	3	10,822	148	2	3	3
	FG3		6,694	92	2	0	1	7,225	99	2	0	2	7,358	101	2	0	2	7,465	102	2	0	2
	FG5		6,581	90	2	0	1	7,102	97	2	0	1	7,233	99	2	0	1	7,338	101	2	0	1
	BG2		9,840	135	2	3	4	10,620	145	2	3	5	10,816	148	2	3	5	10,973	150	3	3	5
	BG3		9,740	133	2	3	5	10,512	144	2	3	5	10,705	147	2	3	5	10,861	149	2	3	5
	BG4		9,222	126	2	3	5	9,953	136	2	3	5	10,136	139	2	3	5	10,283	141	2	3	5
	BG5		10,274	141	3	3	4	11,089	152	3	3	4	11,293	155	4	3	4	11,457	157	4	3	4
	SG2		9,887	135	2	3	3	10,671	146	2	3	3	10,867	149	2	3	3	11,025	151	2	3	3
	SG3		9,879	135	2	3	3	10,662	146	2	3	4	10,859	149	2	3	4	11,016	151	2	3	4
	SG4		9,329	128	2	3	3	10,069	138	2	3	3	10,254	140	2	3	3	10,403	143	2	3	3
	SG5		10,338	142	3	3	3	11,158	153	3	3	3	11,363	156	4	3	3	11,528	158	4	3	3
P20U	TG2	94	12,937	138	2	5	3	13,962	149	2	5	3	14,219	151	2	5	3	14,426	153	2	5	3
	TG3		12,978	138	2	5	4	14,006	149	2	5	4	14,264	152	2	5	4	14,471	154	2	5	4
	TG4		12,201	130	2	5	3	13,168	140	2	5	4	13,410	143	2	5	4	13,605	145	2	5	4
	BG2		12,371	132	2	5	4	13,351	142	3	5	5	13,597	145	3	5	5	13,794	147	3	5	5
	BG3		12,245	130	2	5	5	13,216	141	2	5	5	13,459	143	2	5	5	13,654	145	2	5	5
	BG4		11,594	123	2	5	5	12,513	133	2	5	5	12,744	136	2	5	5	12,929	138	2	5	5
	BG5		12,917	137	3	5	4	13,941	148	4	5	4	14,198	151	4	5	4	14,404	153	4	5	4
	SG2		12,430	132	2	5	3	13,415	143	2	5	3	13,662	145	2	5	3	13,861	147	2	5	3
	SG3		12,421	132	2	5	4	13,405	143	2	5	4	13,652	145	2	5	4	13,850	147	2	5	4
	SG4		11,729	125	2	5	3	12,658	135	2	5	4	12,891	137	2	5	4	13,078	139	2	5	4
	SG5		12,997	138	3	5	3	14,028	149	4	5	3	14,286	152	4	5	3	14,493	154	4	5	3

PERFORMANCE DATA. FOR SKIRT AND HOUSE SIDE SHIELD OPTIONS, CONSULT FACTORY OR WEBSITE.

LED Package	Glass / Optic	System Watts	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
	TG2		11,665	142	2	3	4	12,590	154	3	3	4	12,821	156	3	3	4	13,008	159	3	3	4
	TG3		11,703	143	2	3	4	12,630	154	2	3	4	12,862	157	3	3	4	13,049	159	3	3	4
	TG4		11,002	134	2	3	3	11,874	145	2	3	4	12,092	147	2	3	4	12,268	150	2	3	4
	FG3		7,589	93	2	0	2	8,190	100	2	0	2	8,341	102	2	0	2	8,462	103	2	0	2
	FG5		7,460	91	2	0	1	8,051	98	3	0	1	8,199	100	3	0	1	8,319	101	3	0	1
	BG2		11,155	136	3	3	5	12,039	147	3	3	5	12,261	150	3	3	5	12,439	152	3	3	5
P25S	BG3	82	11,042	135	2	3	5	11,917	145	3	3	5	12,136	148	3	3	5	12,312	150	3	3	5
	BG4		10,454	127	2	3	5	11,283	138	2	3	5	11,491	140	2	3	5	11,658	142	2	3	5
	BG5		11,647	142	4	3	4	12,570	153	4	3	4	12,802	156	4	3	4	12,988	158	4	3	4
	SG2		11,208	137	2	3	3	12,096	148	2	3	4	12,319	150	2	3	4	12,498	152	2	3	4
	SG3		11,200	137	2	3	4	12,087	147	2	3	4	12,310	150	2	3	4	12,488	152	2	3	4
	SG4		10,576	129	2	3	4	11,414	139	2	3	4	11,624	142	2	3	4	11,793	144	2	3	4
	SG5		11,720	143	4	3	3	12,649	154	4	3	3	12,881	157	4	3	3	13,069	159	4	3	3
	TG2		14,701	135	2	5	4	15,866	146	3	5	4	16,158	148	3	5	4	16,393	150	3	5	4
	TG3		14,747	135	2	5	4	15,916	146	3	5	4	16,209	149	3	5	4	16,445	151	3	5	4
	TG4		13,865	127	2	5	4	14,964	137	2	5	4	15,239	140	2	5	4	15,460	142	2	5	4
	BG2		14,058	129	3	5	5	15,172	139	3	5	5	15,451	142	3	5	5	15,675	144	3	5	5
	BG3		13,915	128	3	5	5	15,018	138	3	5	5	15,294	140	3	5	5	15,516	142	3	5	5
P25U	BG4	109	13,176	121	2	5	5	14,220	130	2	5	5	14,481	133	2	5	5	14,692	135	2	5	5
	BG5		14,679	135	4	5	4	15,842	145	4	5	4	16,134	148	4	5	4	16,368	150	4	5	4
	SG2		14,125	130	2	5	4	15,245	140	2	5	4	15,525	142	2	5	4	15,751	145	2	5	4
	SG3		14,115	129	2	5	4	15,233	140	2	5	4	15,514	142	2	5	4	15,739	144	2	5	4
	SG4		13,328	122	2	5	4	14,384	132	2	5	4	14,649	134	2	5	4	14,862	136	2	5	4
	SG5		14,770	136	4	5	3	15,941	146	4	5	3	16,234	149	4	5	3	16,470	151	4	5	3
	TG2		12,968	141	3	3	4	13,996	152	3	3	4	14,254	155	3	3	4	14,461	157	3	3	4
	TG3		13,010	141	3	3	4	14,041	153	3	3	4	14,300	155	3	3	4	14,507	158	3	3	4
	TG4		12,231	133	2	3	4	13,201	143	2	3	4	13,443	146	2	3	4	13,639	148	2	3	4
	FG3		8,437	92	2	0	2	9,106	99	2	0	2	9,273	101	2	0	2	9,408	102	2	0	2
	FG5		8,294	90	3	0	1	8,951	97	3	0	1	9,116	99	3	0	1	9,248	101	3	0	2
	BG2		12,402	135	3	3	5	13,385	145	3	3	5	13,631	148	3	3	5	13,829	150	3	3	5
P30S	BG3	92	12,275	133	3	3	5	13,248	144	3	3	5	13,492	147	3	3	5	13,688	149	3	3	5
	BG4		11,623	126	2	3	5	12,544	136	2	3	5	12,774	139	2	3	5	12,960	141	2	3	5
	BG5		12,949	141	4	3	4	13,975	152	4	3	4	14,232	155	4	3	4	14,439	157	4	3	4
	SG2		12,460	135	2	3	4	13,448	146	2	3	4	13,695	149	2	3	4	13,894	151	2	3	4
	SG3		12,451	135	2	3	4	13,438	146	2	3	4	13,685	149	2	3	4	13,884	151	3	3	4
	SG4		11,758	128	2	3	4	12,690	138	2	3	4	12,923	140	2	3	4	13,111	143	2	3	4
	SG5		13,029	142	4	3	3	14,062	153	4	3	3	14,321	156	4	3	3	14,529	158	4	3	3
	TG2		16,481	135	3	5	4	17,787	146	3	5	4	18,115	148	3	5	4	18,378	151	3	5	4
	TG3		16,533	136	3	5	4	17,843	146	3	5	4	18,172	149	3	5	5	18,436	151	3	5	5
	TG4		15,543	127	2	5	4	16,775	138	2	5	4	17,084	140	2	5	4	17,332	142	2	5	4
	BG2		15,760	129	3	5	5	17,009	139	3	5	5	17,322	142	3	5	5	17,573	144	3	5	5
	BG3		15,600	128	3	5	5	16,836	138	3	5	5	17,146	141	3	5	5	17,395	143	3	5	5
P30U	BG4	122	14,771	121	2	5	5	15,942	131	2	5	5	16,235	133	2	5	5	16,471	135	3	5	5
	BG5		16,456	135	4	5	4	17,760	146	4	5	5	18,087	148	4	5	5	18,350	150	4	5	5
	SG2		15,836	130	2	5	4	17,091	140	3	5	4	17,405	143	3	5	4	17,658	145	3	5	4
	SG3		15,824	130	2	5	4	17,078	140	3	5	4	17,392	143	3	5	4	17,645	145	3	5	4
	SG4		14,942	122	2	5	4	16,126	132	2	5	4	16,423	135	2	5	4	16,661	137	2	5	4
	SG5		16,558	136	4	5	3	17,871	146	4	5	3	18,199	149	4	5	3	18,464	151	4	5	3

PERFORMANCE DATA. FOR SKIRT AND HOUSE SIDE SHIELD OPTIONS, CONSULT FACTORY OR WEBSITE.

LED Package	Glass / Optic	System Watts	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
	TG2		15,526	139	3	3	4	16,757	150	3	3	4	17,065	152	3	3	4	17,313	155	3	3	4
	TG3		15,576	139	3	3	4	16,810	150	3	3	5	17,120	153	3	3	5	17,368	155	3	3	5
	TG4		14,643	131	3	3	4	15,804	141	3	3	4	16,095	144	3	3	4	16,328	146	3	3	4
	FG3		10,101	90	3	0	2	10,901	97	3	0	2	11,102	99	3	0	2	11,263	101	3	0	2
	FG5		9,929	89	3	0	2	10,716	96	3	0	2	10,913	97	3	0	2	11,072	99	3	0	2
	BG2		14,847	133	3	3	5	16,024	143	3	3	5	16,319	146	3	3	5	16,556	148	3	3	5
P35S	BG3	112	14,696	131	3	3	5	15,861	142	3	4	5	16,153	144	3	4	5	16,388	146	3	4	5
	BG4		13,915	124	2	3	5	15,018	134	3	3	5	15,294	137	3	3	5	15,516	139	3	3	5
	BG5		15,502	138	4	3	5	16,731	149	4	3	5	17,039	152	4	3	5	17,286	154	4	3	5
	SG2		14,918	133	3	3	4	16,100	144	3	3	4	16,396	146	3	3	4	16,634	149	3	3	4
	SG3		14,906	133	3	3	4	16,088	144	3	3	5	16,384	146	3	3	5	16,622	148	3	3	5
	SG4		14,076	126	2	3	4	15,192	136	2	3	4	15,472	138	2	3	4	15,696	140	2	3	4
	SG5		15,599	139	4	3	3	16,835	150	4	3	3	17,145	153	4	3	3	17,394	155	4	3	3
	TG2		18,148	137	3	3	5	19,586	148	3	3	5	19,947	151	3	3	5	20,236	153	3	3	5
	TG3		18,206	138	3	3	5	19,649	149	3	3	5	20,011	152	3	3	5	20,301	154	3	3	5
	TG4		17,116	130	3	3	4	18,473	140	3	3	5	18,812	143	3	3	5	19,086	145	3	3	5
	FG3		11,806	89	3	0	2	12,742	97	3	0	2	12,977	98	3	0	2	13,165	100	3	0	2
	FG5		11,606	88	3	0	2	12,526	95	3	0	2	12,756	97	3	0	2	12,941	98	3	0	2
	BG2		17,355	131	3	4	5	18,730	142	3	4	5	19,075	145	3	4	5	19,352	147	3	4	5
P40S	BG3	132	17,178	130	3	4	5	18,539	140	3	4	5	18,880	143	3	4	5	19,155	145	3	4	5
	BG4		16,264	123	3	3	5	17,553	133	3	4	5	17,876	135	3	4	5	18,136	137	3	4	5
	BG5		18,120	137	4	3	5	19,556	148	4	3	5	19,916	151	4	4	5	20,205	153	4	4	5
	SG2		17,437	132	3	3	5	18,819	143	3	3	5	19,165	145	3	3	5	19,443	147	3	3	5
	SG3		17,424	132	3	3	5	18,805	142	3	3	5	19,151	145	3	3	5	19,429	147	3	3	5
	SG4		16,453	125	2	3	5	17,758	135	3	3	5	18,084	137	3	3	5	18,347	139	3	3	5
	SG5		18,233	138	4	3	3	19,678	149	4	3	3	20,040	152	4	3	3	20,331	154	4	3	3
	TG2		20,508	134	3	3	5	22,134	145	3	3	5	22,541	147	3	3	5	22,868	149	3	3	5
	TG3		20,574	134	3	3	5	22,205	145	3	3	5	22,613	148	3	3	5	22,942	150	3	3	5
	TG4		19,342	126	3	3	5	20,875	136	3	3	5	21,259	139	3	3	5	21,568	141	3	3	5
	FG3		13,342	87	3	0	2	14,399	94	3	0	3	14,664	96	3	0	3	14,877	97	3	0	3
	FG5		13,115	86	3	0	2	14,155	93	3	0	2	14,415	94	3	0	2	14,625	96	3	0	2
	BG2		19,612	128	3	4	5	21,166	138	3	4	5	21,555	141	3	4	5	21,869	143	3	4	5
P45S	BG3	153	19,412	127	3	4	5	20,951	137	3	4	5	21,336	139	3	4	5	21,646	141	3	4	5
	BG4		18,380	120	3	4	5	19,836	130	3	4	5	20,201	132	3	4	5	20,495	134	3	4	5
	BG5		20,477	134	4	4	5	22,100	144	4	4	5	22,506	147	5	4	5	22,833	149	5	4	5
	SG2		19,705	129	3	3	5	21,266	139	3	3	5	21,658	142	3	3	5	21,972	144	3	3	5
	SG3		19,690	129	3	3	5	21,250	139	3	3	5	21,641	141	3	3	5	21,956	144	3	3	5
	SG4		18,593	122	3	3	5	20,067	131	3	3	5	20,436	134	3	3	5	20,733	136	3	3	5
	SG5		20,604	135	4	3	3	22,238	145	4	3	3	22,647	148	5	3	3	22,976	150	5	3	4
	TG2		22,698	131	3	3	5	24,497	142	3	3	5	24,948	144	3	4	5	25,310	146	3	4	5
	TG3		22,771	132	3	3	5	24,576	142	3	3	5	25,028	145	3	3	5	25,392	147	3	4	5
	TG4		21,408	124	3	3	5	23,104	134	3	3	5	23,529	136	3	3	5	23,871	138	3	3	5
	FG3		14,767	85	3	0	3	15,937	92	3	0	3	16,230	94	3	0	3	16,466	95	3	0	3
	FG5		14,516	84	3	0	2	15,666	91	3	0	2	15,955	92	3	0	2	16,186	94	3	0	2
	BG2		21,706	125	3	4	5	23,426	135	3	4	5	23,857	138	3	4	5	24,204	140	3	4	5
P50S	BG3	173	21,485	124	3	4	5	23,188	134	3	4	5	23,615	137	3	4	5	23,958	138	3	4	5
	BG4		20,342	118	3	4	5	21,955	127	3	4	5	22,359	129	3	4	5	22,684	131	3	4	5
	BG5		22,663	131	5	4	5	24,460	141	5	4	5	24,910	144	5	4	5	25,272	146	5	4	5
	SG2		21,809	126	3	3	5	23,537	136	3	3	5	23,970	139	3	3	5	24,319	141	3	3	5
	SG3		21,792	126	3	3	5	23,520	136	3	3	5	23,952	138	3	3	5	24,300	140	3	3	5
	SG4		20,579	119	3	3	5	22,210	128	3	3	5	22,619	131	3	3	5	22,947	133	3	3	5
	SG5		22,805	132	5	3	4	24,612	142	5	3	4	25,065	145	5	3	4	25,429	147	5	3	4

PERFORMANCE DATA. FOR SKIRT AND HOUSE SIDE SHIELD OPTIONS, CONSULT FACTORY OR WEBSITE.

LED Package	Glass / Optic	System Watts	27K (2700K, 70 CRI)					30K (3000K, 70 CRI)					40K (4000K, 70 CRI)					50K (5000K, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
P55S	TG2	193	24,807	129	3	3	5	26,773	139	3	4	5	27,266	141	3	4	5	27,662	143	3	4	5
	TG3		24,887	129	3	3	5	26,859	139	3	4	5	27,353	142	3	4	5	27,751	144	3	4	5
	TG4		23,397	121	3	3	5	25,251	131	3	3	5	25,716	133	3	3	5	26,089	135	3	4	5
	FG3		16,139	84	3	0	3	17,418	90	3	0	3	17,738	92	3	0	3	17,996	93	3	0	3
	FG5		15,865	82	3	0	2	17,122	89	3	0	2	17,437	90	3	0	2	17,690	92	3	0	2
	BG2		23,723	123	3	4	5	25,603	133	3	4	5	26,074	135	3	4	5	26,453	137	3	4	5
	BG3		23,481	122	3	4	5	25,342	131	3	4	5	25,809	134	3	4	5	26,184	136	3	4	5
	BG4		22,232	115	3	4	5	23,995	124	3	4	5	24,436	127	3	4	5	24,791	128	3	4	5
	BG5		24,769	128	5	4	5	26,732	139	5	4	5	27,224	141	5	4	5	27,620	143	5	4	5
	SG2		23,835	123	3	3	5	25,724	133	3	3	5	26,198	136	3	3	5	26,578	138	3	3	5
	SG3		23,817	123	3	3	5	25,705	133	3	3	5	26,178	136	3	3	5	26,558	138	3	3	5
	SG4		22,491	117	3	3	5	24,274	126	3	3	5	24,720	128	3	3	5	25,079	130	3	3	5
	SG5		24,924	129	5	3	4	26,899	139	5	3	4	27,394	142	5	3	4	27,792	144	5	3	4
P60S	TG2	215	27,208	127	3	4	5	29,364	137	3	4	5	29,905	139	3	4	5	30,339	141	3	4	5
	TG3		27,295	127	3	4	5	29,459	137	3	4	5	30,001	140	3	4	5	30,437	142	3	4	5
	TG4		25,661	119	3	3	5	27,695	129	3	4	5	28,204	131	3	4	5	28,614	133	3	4	5
	FG3		17,701	82	3	0	3	19,104	89	3	0	3	19,455	90	3	0	3	19,738	92	3	0	3
	FG5		17,400	81	3	0	2	18,779	87	4	0	2	19,124	89	4	0	2	19,402	90	4	0	2
	BG2		26,019	121	3	4	5	28,081	131	4	4	5	28,597	133	4	4	5	29,013	135	4	4	5
	BG3		25,754	120	3	4	5	27,795	129	4	4	5	28,306	132	4	4	5	28,718	134	4	4	5
	BG4		24,384	113	3	4	5	26,317	122	3	4	5	26,801	125	3	4	5	27,190	126	3	4	5
	BG5		27,166	126	5	4	5	29,319	136	5	4	5	29,859	139	5	4	5	30,293	141	5	4	5
	SG2		26,142	122	3	3	5	28,214	131	3	3	5	28,733	134	3	3	5	29,150	136	3	3	5
	SG3		26,122	121	3	3	5	28,193	131	3	3	5	28,711	134	3	3	5	29,128	135	3	3	5
	SG4		24,668	115	3	3	5	26,623	124	3	3	5	27,113	126	3	3	5	27,506	128	3	3	5
	SG5		27,336	127	5	3	4	29,502	137	5	3	4	30,045	140	5	3	4	30,481	142	5	3	4
P65S	TG2	247	30,354	123	3	4	5	32,760	133	4	4	5	33,363	135	4	4	5	33,848	137	4	4	5
	TG3		30,452	123	3	4	5	32,866	133	4	4	5	33,470	136	4	4	5	33,956	137	4	4	5
	TG4		28,629	116	3	4	5	30,898	125	3	4	5	31,466	127	3	4	5	31,923	129	3	4	5
	FG3		19,748	80	3	0	3	21,313	86	3	0	3	21,705	88	3	0	3	22,020	89	3	0	3
	FG5		19,412	79	4	0	2	20,951	85	4	0	3	21,336	86	4	0	3	21,646	88	4	0	3
	BG2		29,028	118	4	4	5	31,328	127	4	4	5	31,905	129	4	4	5	32,368	131	4	4	5
	BG3		28,732	116	4	4	5	31,009	126	4	5	5	31,580	128	4	5	5	32,039	130	4	5	5
	BG4		27,204	110	3	4	5	29,360	119	3	4	5	29,900	121	3	4	5	30,335	123	3	4	5
	BG5		30,308	123	5	4	5	32,710	132	5	4	5	33,312	135	5	4	5	33,796	137	5	4	5
	SG2		29,165	118	3	3	5	31,477	127	3	3	5	32,056	130	3	4	5	32,522	132	3	4	5
	SG3		29,143	118	3	3	5	31,453	127	3	4	5	32,032	130	3	4	5	32,497	132	3	4	5
	SG4		27,520	111	3	3	5	29,702	120	3	3	5	30,248	122	3	3	5	30,688	124	3	3	5
	SG5		30,497	123	5	3	4	32,914	133	5	3	4	33,520	136	5	3	4	34,007	138	5	3	4

LUMEN AMBIENT TEMPERATURE (LAT) MULTIPLIERS
Use the factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F)

Ambient Temp.		Lumen Multiplier (by Performance Package)			
°C	°F	P10S, P15S, P20S, P20U, P25S, P25U, P30S, P30U, P35S, P40S, P45S & P50S	P55S	P60S	P65S
0	32	1.03	1.04	1.04	1.04
5	41	1.03	1.03	1.03	1.04
10	50	1.02	1.02	1.03	1.03
15	59	1.01	1.02	1.02	1.02
20	68	1.01	1.01	1.01	1.01
25	77	1.00	1.00	1.00	1.00
30	86	0.99	0.99	0.99	0.99
35	95	0.99	0.98	0.98	0.98
40	104	0.98	0.97	0.97	0.97

PROJECTED LED LUMEN MAINTENANCE
Data references the extrapolated performance projections for the platforms noted in 25°C ambient, based on 6,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11). To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Lumen Maintenance - LLD (by Performance Package)									
Hours		0	25,000	36,000	50,000	60,000	67,500	75,000	100,000
Factor for:	P10S, P15S, P20S, P20U, P25S, P25U, P30S, P30U, P35S, P40S, P45S & P50S	1.00	0.95	0.94	0.91	0.90	0.89	0.88	0.84
	P55S	1.00	0.95	0.93	0.91	0.90	0.89	0.87	0.84
	P60S & P65S	1.00	0.95	0.93	0.90	0.89	0.87	0.86	0.82

FIELD ADJUSTABLE OUTPUT (AO option)
The data is the same for MVOLT & HVOLT.

Performance Package	FAO Position	% Lumen Output	% Wattage
P10S	8	100%	100%
	7	94%	94%
	6	80%	80%
	5	68%	68%
	4	55%	55%
	3	41%	42%
	2	28%	29%
	1	13%	15%
P15S	8	100%	100%
	7	94%	94%
	6	80%	80%
	5	68%	68%
	4	55%	55%
	3	42%	42%
	2	28%	29%
	1	14%	15%
P20S	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	69%	68%
	4	56%	54%
	3	42%	41%
	2	29%	29%
	1	14%	15%
P20U	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	69%	68%
	4	56%	55%
	3	43%	42%
	2	29%	29%
	1	15%	15%
P25S	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	69%	67%
	4	56%	54%
	3	43%	41%
	2	29%	28%
	1	15%	15%

Performance Package	FAO Position	% Lumen Output	% Wattage
P25U	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	69%	68%
	4	56%	54%
	3	43%	41%
	2	30%	29%
	1	15%	15%
P30S	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	69%	67%
	4	56%	54%
	3	43%	41%
	2	30%	28%
	1	15%	15%
P30U	8	100%	100%
	7	94%	94%
	6	81%	80%
	5	70%	67%
	4	57%	54%
	3	44%	41%
	2	30%	29%
	1	15%	15%
P35S	8	100%	100%
	7	94%	94%
	6	81%	79%
	5	70%	67%
	4	57%	54%
	3	44%	41%
	2	30%	28%
	1	15%	15%
P40S	8	100%	100%
	7	95%	94%
	6	82%	79%
	5	70%	67%
	4	57%	54%
	3	44%	41%
	2	31%	28%
	1	16%	15%

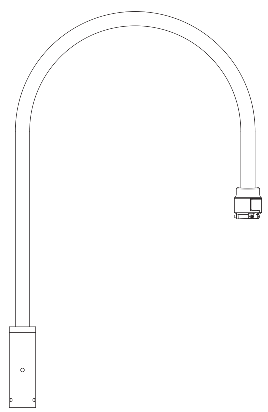
Performance Package	FAO Position	% Lumen Output	% Wattage
P45S	8	100%	100%
	7	95%	94%
	6	82%	79%
	5	71%	67%
	4	58%	54%
	3	45%	41%
	2	31%	28%
	1	16%	14%
P50S	8	100%	100%
	7	95%	94%
	6	82%	79%
	5	71%	67%
	4	59%	54%
	3	45%	41%
	2	32%	28%
	1	16%	14%
P55S	8	100%	100%
	7	95%	94%
	6	83%	79%
	5	72%	67%
	4	59%	54%
	3	46%	41%
	2	32%	28%
	1	17%	14%
P60S	8	100%	100%
	7	95%	94%
	6	83%	79%
	5	72%	67%
	4	60%	54%
	3	47%	41%
	2	33%	28%
	1	17%	14%
P65S	8	100%	100%
	7	95%	94%
	6	84%	79%
	5	73%	67%
	4	61%	53%
	3	48%	40%
	2	33%	28%
	1	18%	14%

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

Catalog Number	
Notes	Type

BCR

Bishop's Crook Aluminum Roadway Arm



General Description

The roadway arms shall be all aluminum, one-piece construction. The arms shall consist of a post or wall bracket mounting piece, a bent tube arm, and an end piece for luminaire mounting. The wall bracket shall have a flat aluminum wall plate for mounting. All welding shall be per ANSI/AWS D1.2. All welders shall be certified per ANSI/AWS D1.2.

Materials

- The post mounting piece and bent tube arm shall be from ASTM 6061 alloy.
- All hardware shall be stainless steel.
- If chosen, the QSM luminaire mounting will be cast aluminum produced from certified ASTM 356.1 ingot per ASTM B179 or ASTM B26.

Installation

- The tenon fitter is designed to slipfit a 3 inch O.D. by 6 inch (C06) tall tenon and attach with socket set screws
- Arms shall have either a QSM (Quick Stem Mount) or a 1-1/2 NPT male threaded end to match the same mounting style on a luminaire
- The wall bracket shall have clearance holes for mounting to the wall (wall mounting hardware furnished by others)
- All hardware shall be tamper resistant stainless steel
- The Sitelink mount will include Tracnuts for bolting to a Sitelink shaft

Finish

- Utilize a polyester powder coat paint to ensure maximum durability.
- Rigorous multi-stage pre-treating and painting process yields a finish that achieves a scribe creepage rating of 8 (per ASTM D1654) after over 5,000 hours exposure to salt fog chamber (operated per ASTM B117) on standard and RAL finish options.
- RAL (RALxxxxSDCR) paint colors are Super Durable Corrosion Resistant, 80% gloss.

Warranty

1-year limited warranty. Complete warranty terms located at (Holophane Pole Warranty):
www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
Specifications subject to change without notice.

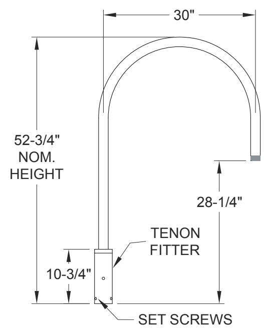
ORDERING INFORMATION

Example: BCR 30IN 1A TN QSM BK

BCR	30IN	1A	TN	QSM		BK
Series	**Height/Length**	**Number of Arms/Orientation**	**Arm Connection**	**Luminaire Mounting**	**Shaft Style**	**Finish**
BCR Aluminum Roadway Arm	30IN 30 Inches	1A Single Roadway Arm 2A Double Roadway Arm, 2 single arms @ 180°	BO Bolt-on mount attaches to side of pole. TN Tenon mount. WB Wall Bracket Mount *Note: BO only available with 1A WB only available with 1A*	NPT 1-1/2" NPT QSM Quick Stem Mount	SiteLink SL4 4.50" fluted, .156 wall SL5 5.25" fluted, .25 wall SL6 5.75" fluted, .25 wall SL8 8.50" fluted, .188 wall ST2 5.75" extruded, .25 wall ST3 8.50" extruded, .22 wall *Note: For 1A arms only, not for use with TN or WB mount.*	BK Black BZ Bronze CMC Customer matching color CTBS Standard color to be selected DB Dark Blue GN Green GH Graphite GR Gray PP Prime Painted RALxxxxSDCR RAL Super Durable Corrosion Resistant, 80% Gloss Paint, replace xxxx with RAL number SL Silver WH White

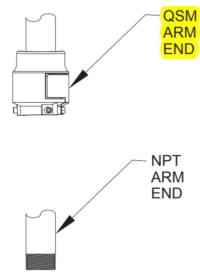
DIMENSIONAL DATA & ORIENTATION

Single Roadway Arm

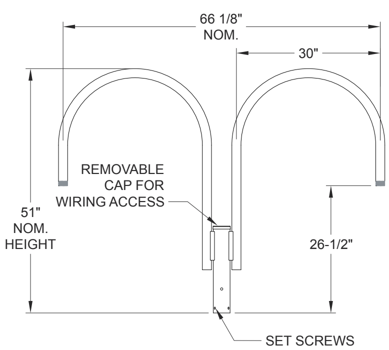


BCR 30IN 1A
((1) 30IN arm)

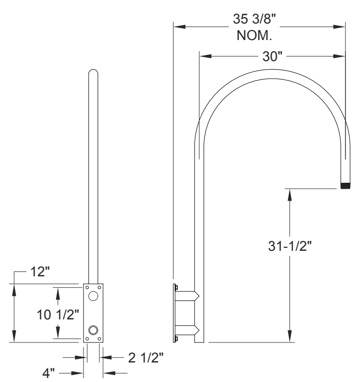
Luminaire Mounting Options



Double Roadway Arm

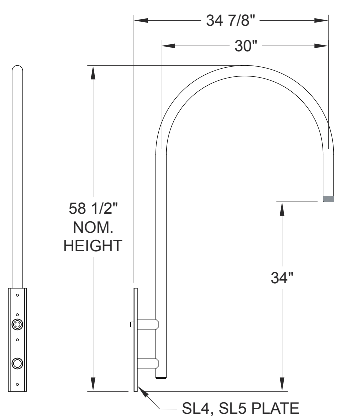


BCR 30IN 2A
((2) 30IN arms at 180°)

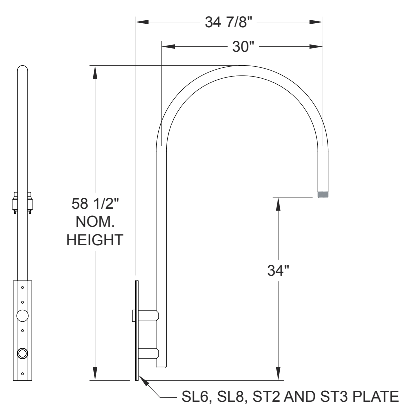


BCR 30IN 1A WB
((1) 30IN Wall Bracket)

Wall Bracket Mount



BCR 30IN 1A BO
((1) 30IN Bolt-on SL4, SL5)

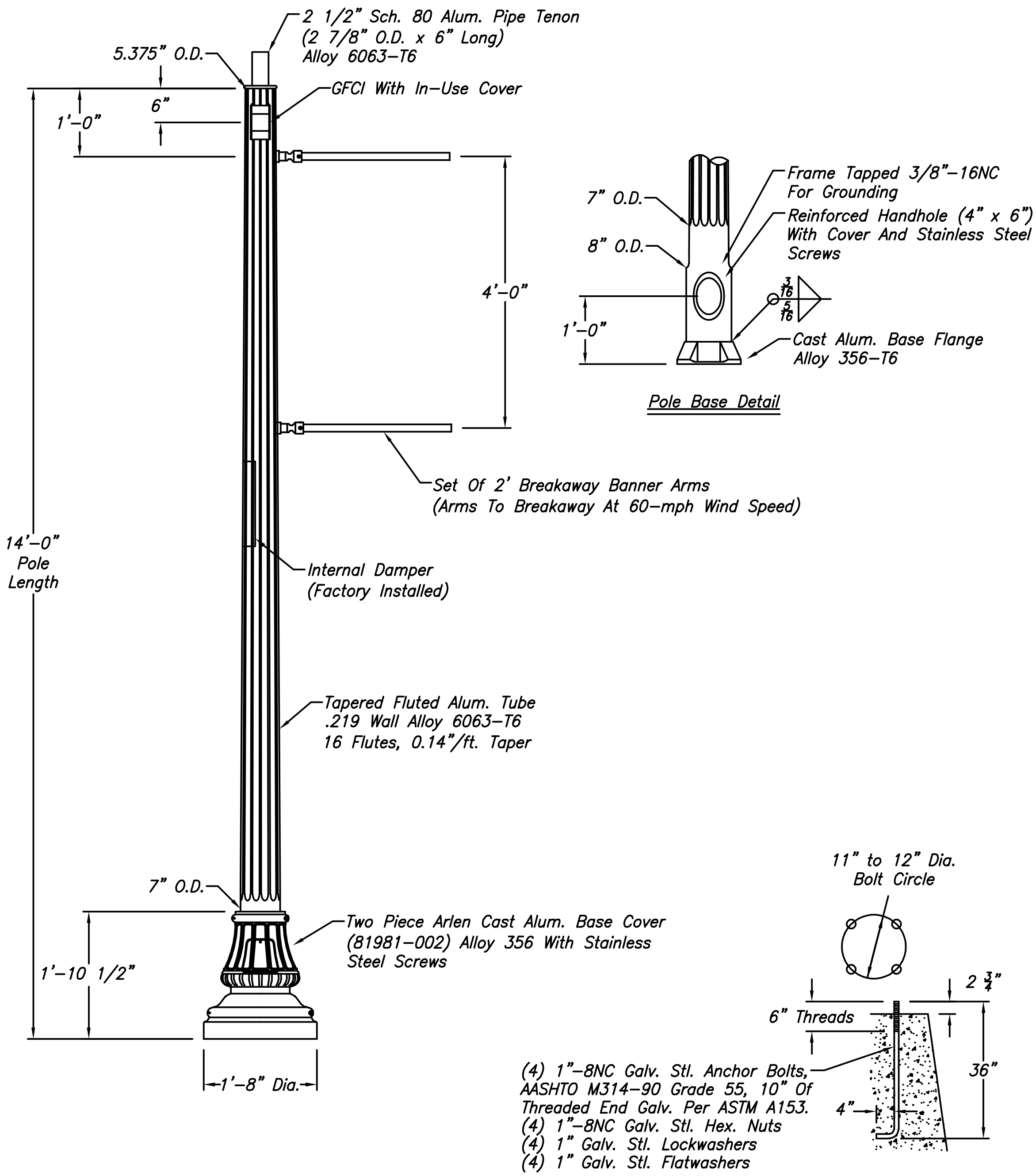


BCR 30IN 1A BO
((1) 30IN Bolt-on SL6, SL8, ST2 or ST3)

ARM	EPA (sqft)	Weight (LBS)
BCR 30IN 1A BO	1.3	25
BCR 30IN 1A TN	1.2	25
BCR 30IN 2A TN	2.22	45
BCR 30IN 1A WB	1.3	25

Design Notes:

1. Shaft heat treated to –T6 temper after welding.
2. Pole is designed per 2020 FBC 7th Edition for a wind speed of 180–MPH, giving a design life of 50–years when supporting the following:
   - 2.1. Luminaire: 1.43–ft^2 EPA & 39–lbs.
   - 2.2. Arm: 1.04–ft^2 EPA & 25–lbs.
   - 2.3. Banner Arms: 2'x4'; Breakaway at 60–mph
3. Pole is designed to be mounted at grade level.
4. Sand Before Fluting!



B105290

WARNING: DO NOT INSTALL LIGHTING POLES WITHOUT LUMINAIRES

NO.	REVISIONS	DATE
1	Assigned PN To Sketch & Added Note 4 (tnb)	10/20
2	Material was .188" Wall (JWD)	05/21
3	Was 2017 FBC (DJY)	06/22

hapco
Abingdon, Va.

TITLE ARLEN SERIES LIGHT POLE	
CUSTOMER HOLOPHANE – FLORIDA	
SCALE 16	DATE 09/25/2020
BY BAD	DWG. NO. B105290
CHK'D	

HOLOPHANE®
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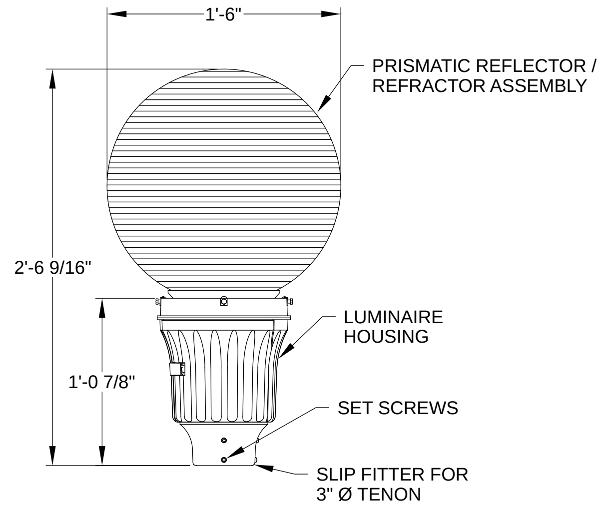
Catalog Number	PSUE3 P20 30K MVOLT MS BK AO L5 AO RFD314784
Notes: 5-fixture Pole Assembly - Downtown	Type: A

* Shown with MS Housing



Maximum weight - 42.5 lbs
Maximum effective projected area - 1.72 sq. ft.

PSUE3

Prismasphere Utility LED3

SPECIFICATIONS

General Description

The Utility Prismasphere LED 3 is designed for ease of maintenance with the plug-in electrical module common to each of the luminaires in Holophane's Utility Luminaire Series. The simple, yet elegant sphere contains a powerful, stalk-mounted Chip-On-Board LED platform with a precision optical system that maximizes post spacings while maintaining uniform illumination.

Mechanical Specifications

The luminaire housing shall:
- Be heavy grade A360 cast aluminum (aluminum with <1% copper)
- IP55 rated housing provides tool-less access with a spring-loaded latch
- Incorporate a hidden hinge door allowing the door to swing open and remain open
- Offer an EEI- NEMA twist lock photocontrol receptacle, the housing must contain a tempered glass window to allow light to reach the cell
- Mount to slip-fitter that will accept 3" high by 2-7/8" to 3-1/8" O.D. pole tenon
- Provide four uniquely designed stainless steel spring clips, enclosed in a clear polyvinyl chloride sleeve and adjusted by 1/4-20 hex-head bolts that securely cradle the prismatic acrylic refractor. The same ¼-20 bolts also support the decorative rib and banding assembly.

The finish shall:
- Utilize a polyester power coat paint to ensure maximum durability
- Meet 5,000-hour salt spray
- Offer Tiger Drylac finishes that are applied by a Tiger Drylac certified facility.

Electrical Specifications

The driver shall meet the following requirements:
- Certified by UL or CSA for wet locations
- A factory programmable electronic driver with 0-10V dimming control leads
- LEDs shall have a minimum of 70 CRI and available in 2700K, 3000K, 4000K, and 5000K CCT
- The electrical system shall be designed to meet ANSI/IEEE C62.41.2 and shall offer a 10kV/5kA surge protection, fail off, as standard with an upgradable 20kV/10kA surge protection, fail off with indicator light, option
- Lumen output can be customized prior to manufacturing by way of FPDxx Options
- The electrical components are mounted on an aluminum plate that is removeable with minimum use of tools. A matching five conductor plug connects to the receptacle in the luminaire housing to complete the wiring. For photoelectric operation, the electrical module is provided with an EEI-NEMA twist-lock photocell receptacle.

Optical Specifications

The optical system is IP66 rated and consists of an 18" injection molded acrylic prismatic sphere, mechanically attached to a mounted ring cast of copper free aluminum. Light from a cast aluminum vertical LED stalk is distributed by precisely molded refracting prisms to control brightness and create uniform vertical and horizontal illumination. A soft upward glow is allowed to gently illuminate foliage and building facades, created a luminous environment. Designed only for IES type V distributions.

Control Options

The control options shall include, but not limited to, the following:
- Field adjustable output to adjust output to luminaire - AO
- Long life photocontrol, 20 years – PCLL, P34 and P48 with DTL
- 3 and 7 pin receptacles internally in housing - (PR3, PR7) or inside acrylic lens (PR7E)
- nLight Air rSBOR6 outdoor fixture-mounted motion and photo-sensor, features a dual radio to communicate wirelessly to other nLight Air devices for group response to motion, on/off control in response to daylight and by switch – RSBOR6
- Fixture embedded nLight Air network interface for individual fixture control and dimming - NLTAIR2

Certification and Standards
- Luminaire shall be UL or CSA listed.
- Suitable for operation in an ambient temperature up to 40°C / 105°F per UL or CSA certification
- LM79 compliant
- DesignLights Consortium® (DLC) Premium qualified product and DLC qualified product. Not all versions of this product may be DLC Premium qualified or DLC qualified. Please check with the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.

Warranty – 5 Years Limited

Complete warranty terms located at:
www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.

ORDERING INFORMATION

Example: PSUE3 P30 30K MVOLT MS AL5 BK

PSUE3	P20	30K	MVOLT	MS
Series	**LED Performance Package**	**LED Color temperature**	**Voltage**	**Housing Style**
PSUE3 Prismasphere Utility LED3	P10 3,900 nominal lumens P20 6,600 nominal lumens P30 9,600 nominal lumens P40 13,400 nominal lumens P50 14,700 nominal lumens	27K 2700K CCT 30K 3000K CCT 40K 4000K CCT 50K 5000K CCT	MVOLT Auto-Sensing 120-277V 50/60HZ HVOLT Auto-Sensing 347-480V 50/60HZ	MS Modern Style Swing Open Design LS Leaf Style Swing Open Design

L5 AO	BK	AO	
Optics	**Housing Color**	**Options:** *Option Compatibility Matrix on page 3 of 4*	
AL5 Acrylic, Type V L5 AO Acrylic Type V Opaque	BK Black BZ Bronze GH Graphite GN Green GR Grey PP Prime Paint WH White CMC CustomMatchColor Finish XX STD Finish, TBD RAL RAL Specified	**CONTROLS OPTIONS** AO Field Adjustable Output PR3 NEMA twistlock photocontrol receptacle - 3 pin PR7 NEMA twistlock dimming photocontrol receptacle - 7 pin PR7E NEMA twistlock dimming photocontrol receptacle - 7 Pin (Under Acrylic) PCLL Long Life DTL Twistlock Photocontrol for Solid State, MVOLT P34 Long Life DTL Twistlock Photocontrol for Solid State, 347V P48 Long Life DTL Twistlock Photocontrol for Solid State, 480V SH Shorting Cap RSBOR6 nLight Motion Sensing Photocontrols NLTAIR2 nLight RIO 2.0 Antenna **DRIVER ELECTRICAL OPTIONS** FPDxx Factory Programmed Driver 20KV Extreme surge protection 20kV/10kA, fail off with indicator light	**PREWIRED LEAD OPTIONS** L1H 1.5 ft prewired leads L03 3ft prewired leads L10 10 ft prewired leads L20 20 ft prewired leads L25 25 ft prewired leads L30 30 ft prewired leads

Accessories: *Order as separate catalog number.*
HOUSE-SIDE SHIELD OPTIONS
GVDHSS90 House Side Shield Solid 90˚
GVDHSS12 House Side Shield Solid 120˚
GVDHSS18 House Side Shield Solid 180˚

OPTIONS MATRIX

PSUE3		Housing Style		LED Package					Voltage		Distribution	Options											
		MS	LS	P10	P20	P30	P40	P50	MVOLT	HVOLT	AL5	AO	FPDxx	PR3	PR7	PR7E	PCLL	P34	P48	SH	RSBOR6	NLTAIR2	20kV
Housing Style	MS		N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	LS	N		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
LED Package	P10	Y	Y		N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	P20	Y	Y	N		N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P30	Y	Y	N	N		N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P40	Y	Y	N	N	N		N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P50	Y	Y	N	N	N	N		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Voltage	MVOLT	Y	Y	Y	Y	Y	Y	Y		N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y
	HVOLT	Y	Y	Y	Y	Y	Y	Y	N		Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N	Y
Distributions	AL5	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Options	AO	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
	FPDxx	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	PR3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		N	N	Y	Y	Y	Y	N	N	Y
	PR7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N		N	Y	Y	Y	Y	N	N	Y
	PR7E	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N		Y	Y	Y	Y	N	N	Y
	PCLL	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y		N	N	N	N	N	Y
	P34	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N		N	N	N	N	Y
	P48	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	N		Y	N	N	Y
	SH	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y		N	N	Y
	RSBOR6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	N	N		N	Y
	NLTAIR2	Y	Y	N	Y	Y	Y	Y	Y	N	Y	N	Y	N	N	N	N	N	N	N	N		Y
	20kV	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	

MATRIX KEY

N = Combination Not available
Y = Valid Option Combination

LUMEN AMBIENT TEMPERATURE (LAT) MULTIPLIERS

Use the factors to determine relative lumen output for average ambient temperatures from 0-40°C (32-104°F)

Ambient Temp		Lumen Multiplier	
°C	°F	P10, P20	P30, P40, P50
0	32	1.03	1.04
5	41	1.02	1.04
10	50	1.02	1.03
15	59	1.01	1.02
20	68	1.01	1.01
25	77	1.00	1.00
30	86	0.99	0.99
35	94	0.99	0.98
40	104	0.98	0.97

PROJECTED LED LUMEN MAINTENANCE

Data references the extrapolated performance projections for the platforms noted in 25°C ambient, based on 6,000 hours of LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11). To calculate LLF, use the lumen maintenance factor that corresponds to the desired number of operating hours below. For other lumen maintenance values, contact factory.

Lumen Maintenance - LLD (Same for all LED packages)							
Hours	**0**	**25,000**	**36,000**	**50,000**	**60,000**	**75,000**	**100,000**
Factor	1	0.96	0.94	0.91	0.90	0.87	0.83

The *italicized* data is extrapolated beyond the TM-21 standard.

PERFORMANCE DATA

Performance Package	Distribution	Input Watts	27K (2700K CCT, 70 CRI)					30K (3000K CCT, 70 CRI)					40K (4000K CCT, 70 CRI)					50K (5000K CCT, 70 CRI)				
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	Lumens	LPW	B	U	G
P10	AL5	24	3,366	140	3	3	3	3,820	159	3	3	3	3,891	162	3	3	3	3,962	165	3	3	3
P20	AL5	40	5,698	142	3	4	3	6,467	162	3	4	3	6,587	165	3	4	3	6,707	168	3	4	3
P30	AL5	61	8,277	136	3	4	4	9,395	154	4	4	4	9,569	157	4	4	4	9,744	160	4	4	4
P40	AL5	91	11,561	127	4	5	5	13,123	144	4	5	5	13,366	147	4	5	5	13,609	150	4	5	5
P50	AL5	110	12,717	116	4	5	5	14,434	131	4	5	5	14,702	134	4	5	5	14,969	136	4	5	5

FPDXX DATA OPTIONS

FPDxx Setting	Wattage	P10 27K	P10 30K	P10 40K	P10 50K
		AL5	AL5	AL5	AL5
Standard	24	3,366	3,820	3,891	3,962
FPD95	23	3,208	3,641	3,709	3,776
FPD90	22	2,906	3,299	3,360	3,421
FPD85	21	2,496	2,833	2,885	2,938

FPDxx Setting	Wattage	P20 27K	P20 30K	P20 40K	P20 50K
		AL5	AL5	AL5	AL5
Standard	40	5,698	6,467	6,587	6,707
FPD95	38	5,434	6,169	6,283	6,397
FPD90	36	5,169	5,867	5,976	6,085
FPD85	34	4,902	5,564	5,667	5,770
FPD80	32	4,633	5,259	5,356	5,454
FPD75	30	4,362	4,951	5,043	5,135
FPD70	28	4,216	4,786	4,875	4,963

FPDxx Setting	Wattage	P30 27K	P30 30K	P30 40K	P30 50K
		AL5	AL5	AL5	AL5
Standard	61	8,277	9,395	9,569	9,744
FPD95	59	7,911	8,980	9,146	9,313
FPD90	56	7,540	8,558	8,717	8,875
FPD85	52	7,163	8,131	8,281	8,432
FPD80	49	6,782	7,698	7,841	7,983
FPD75	46	6,396	7,260	7,394	7,529
FPD70	43	6,005	6,817	6,943	7,069

FPDxx Setting	Wattage	P40 27K	P40 30K	P40 40K	P40 50K
		AL5	AL5	AL5	AL5
Standard	91	11,561	13,123	13,366	13,609
FPD95	86	11,068	12,563	12,796	13,029
FPD90	82	10,565	11,992	12,214	12,436
FPD85	77	10,052	11,410	11,621	11,833
FPD80	72	9,530	10,818	11,018	11,219
FPD75	68	9,000	10,216	10,405	10,594

FPDxx Setting	Wattage	P50 27K	P50 30K	P50 40K	P50 50K
		AL5	AL5	AL5	AL5
Standard	110	12,717	14,434	14,702	14,969
FPD95	104	12,201	13,848	14,106	14,362
FPD90	98	11,672	13,248	13,493	13,739
FPD85	93	11,128	12,631	12,866	13,099

OPTIONAL COMPONENTS

AO
Manual field adjustable output dimming device

RSBOR6
Motion and photosensor (Black) communicates wirelessly to other nLight AIR devices

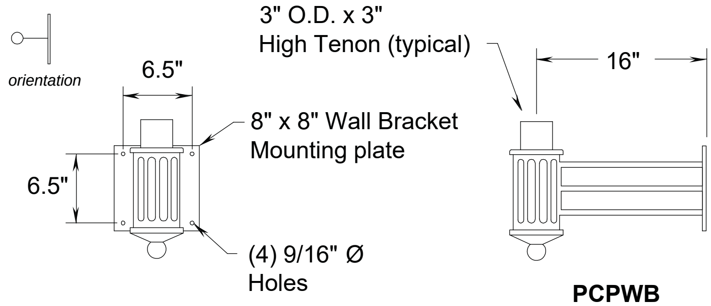
20KV
Safeguard your investment from extreme voltage spikes with our new Extreme 20kV/10kA SPD

NLTAIR2
Fixture embedded nLight AIR network interface provides individual fixture control and digital dimming capabilities

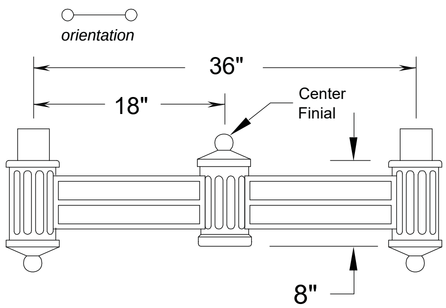
Downtown 5-Fixture
Crossarm

PHILADELPHIA Series

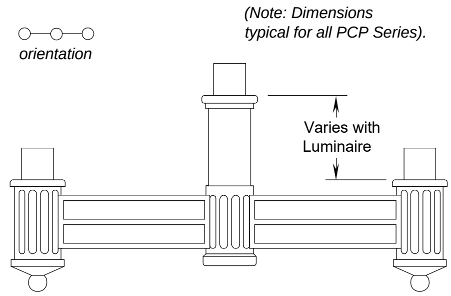
Crossarms & Wall Bracket



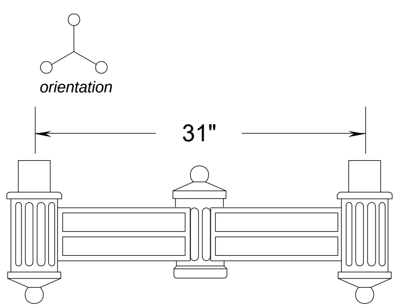
PCPWB
(one way wall mount)



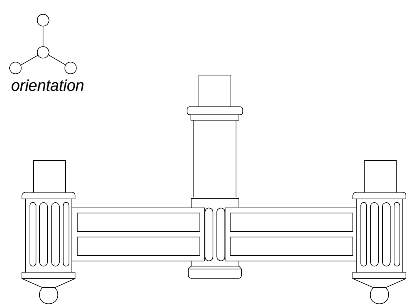
PCP36
(two at 180°)



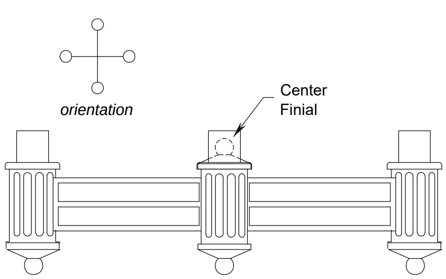
PCP36/2T
(two at 180° w/ one at center)



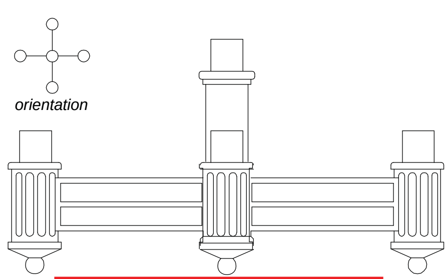
PCP36/3
(three at 120°)



PCP36/3T
(three at 120° w/ one at center)



PCP36/4
(four at 90°)



PCP36/4T
(four at 90° w/ one at center)

SPECIFICATIONS

CONSTRUCTION

The crossarms and wall brackets shall be one-piece construction. For wall brackets the arms shall be welded to a flat wall plate. All welding shall be per ANSI/AWS D1.2-90. All welders shall be certified per ANSI/AWS D1.2-90 Section 5.

MATERIALS

The crossarms and crossarm finials shall be heavy wall, cast aluminum produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95. The center luminaire extension piece, and wall bracket mounting plate shall be aluminum, ASTM 6061 alloy, heat treated to a T6 temper. All hardware shall be stainless steel. All exterior hardware shall be tamper resistant.

INSTALLATION

The crossarms shall slip-fit a post top tenon and attach with socket set screws. The center finial shall be removable. The wall bracket shall have four 9/16" dia. holes for mounting to the wall. (Bracket mounting hardware furnished by others.) Both crossarms and wall bracket shall have 3" O.D. tenons for luminaire mounting.

For finish specifications and color options see "**Finish**" section in catalog.

ORDERING GUIDE

Arms & Bracket Catalog #'s	Number of Luminaires Required
☐ PCPWB	one
☐ PCP36	two
☐ PCP36/2T	three
☐ PCP36/3	three
☐ PCP36/3T	four
☐ PCP36/4	four
☐ PCP36/4T	five

Material / Finish

☐ -CA/BK	Cast Alum/Black
☐ -CA/DB	Cast Alum/Dark Bronze
☐ -CA/DG	Cast Alum/Dark Green
☐ -CA/PP	Cast Alum/Prime Painted
☐ -CA/CC	Cast Alum/Custom Color

HOLOPHANE
LEADER IN LIGHTING SOLUTIONS
An AcuityBrandsCompany
214 OAKWOOD AVENUE - NEWARK, OHIO 43055

Proven Performance hapco pole products

Calculation Submittal for Pole Design SKBD092520A

Downtown 5-Tier Relight
Hollywood, FL
RFD316080
Hapco Quote #: A2007-8-54rev1
Hold for Release PO #: 2109-6871686

Submittal Prepared By: Bryan Davis, EIT, Structural Engineer
Reviewed By: Ray C. Minor, PE, Consulting Engineer
26252 Hillman Highway
Abingdon, VA

Design Assumptions per 2017 Florida Building Code:

Calculations based upon Florida Building Code 2017 Edition ultimate design wind velocity of 180 mph (3 second gust), with a design life of 50 years. $V_A = \sqrt{0.6} * V_U = 139$ mph
The luminaire design size is 1.75 square feet EPA & 80 pounds each, with a total of five luminaires.
All poles are designed to be mounted at grade level.
The allowable stresses are based on aluminum alloy 6063-T6 heat treated after structural welding.

ASCE 7-16 Wind Load Design Assumptions:

- Risk Cat. II, MRI = 700 yrs., Exposure Cat. “C” and Surface Roughness Cat. “D”
- K_z = 1.0, K_d = 1.0, G = 1.14, $V_A = \sqrt{0.6} * V_U$ (FBC 2017 1609.3.1)
- C_f = drag coefficients calculated per AASHTO LTS-6 (ASCE 7-16 C29.4)
- Strength Equations per AASHTO LTS-6 Allowable Stress Increase = 1.33

RAY C. MINOR
CERTIFICATE
No. 39178
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Ray C. Minor

THIS DOCUMENT HAS BEEN DIGITALLY SIGNED AND SEALED BY RAY C. MINOR ON THE DATE ADJACENT TO THE SEAL.

PRINTED COPIES OF THIS DOCUMENT ARE NOT CONSIDERED SIGNED AND SEALED AND THE SIGNATURE MUST BE VERIFIED ON ANY ELECTRONIC COPIES.

Digitally signed by Ray C Minor
Date: 2020.11.16 16:15:10 -05'00'

Load, Analysis, and Design Calculations
For Lighting Pole SKBD092520A

Based on: ***Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*****, 6th Edition, 2013, AASHTO**
(American Association of State Highway and Transportation Officials)

Wind Loading Criteria:

$U = 139.427\,mph$	Basic Wind Speed (3-Second Gust)
$G = 1.14$	Gust Effect Factor
$Dlife = 50$	Design Life (If Applicable)
$Hpier = 0\cdot ft$	Pier Height (Height Above Grade)

Shaft Properties:

$D(0) = 8\cdot in$	Bottom Diameter (Or Width)
$D(Ltotal) = 4.88\cdot in$	Top Diameter (Or Width)
$Twall(0) = 0.219\cdot in$	Nominal Wall Thickness
$Ltotal = 17\cdot ft$	Total Shaft Length
$Lbotst_0 = 1.917\cdot ft$	Length of Bottom Straight
$Ltaper_0 = 15.083\cdot ft$	Length of Taper
$Ltopst_0 = 0\cdot ft$	Length of Top Straight
$n_0 = 1$	Taper Exponent
$Shoe = 3.938\cdot in$	Height of Shoe Base
$LW = 0.219\cdot in$	Size of Lower Base Weld
$UW = 0.313\cdot in$	Size of Upper Base Weld
$E = 1.01\times 10^4\cdot ksi$	Modulus of Elasticity
$Mwt = 0.098\,pci$	Material Density

Foundation Details: (If Applicable)

$Bolt_{Dia} = 1\cdot in$	Anchor Bolt Diameter
$Bolt_{Length} = 36\cdot in$	Anchor Bolt Length
$Bolt_{TPI} = 8\cdot \frac{1}{in}$	Anchor Bolt TPI
$Bolt_{Circle} = 11.5\cdot in$	Bolt Cirlce Diameter
$Bolt_{Fy} = 55\cdot ksi$	Anchor Bolt Yield Strength
$Hxformer = 0\cdot in$	Transformer Base Height
$V_{Xformer} = 0\,lbf$	Wind Shear on Transformer Base

Loading Inputs:

EPAs	Weights	Vertical Location	Horizontal Location
$EPA_0 = 8.75\cdot ft^2$	$pdlEPA_0 = 400\,lbf$	$yEPA_0 = 18\cdot ft$	$xEPA_0 = 0\cdot ft$
$EPA_1 = 2.25\cdot ft^2$	$pdlEPA_1 = 68\,lbf$	$yEPA_1 = 18\cdot ft$	$xEPA_1 = 0\cdot ft$
$EPA_2 = 0\cdot ft^2$	$pdlEPA_2 = 0\,lbf$	$yEPA_2 = 0\cdot ft$	$xEPA_2 = 0\cdot ft$
$EPA_3 = 0\cdot ft^2$	$pdlEPA_3 = 0\,lbf$	$yEPA_3 = 0\cdot ft$	$xEPA_3 = 0\cdot ft$
$EPA_4 = 0\cdot ft^2$	$pdlEPA_4 = 0\,lbf$	$yEPA_4 = 0\cdot ft$	$xEPA_4 = 0\cdot ft$
$EPA_5 = 0\cdot ft^2$	$pdlEPA_5 = 0\,lbf$	$yEPA_5 = 0\cdot ft$	$xEPA_5 = 0\cdot ft$
$EPA_6 = 0\cdot ft^2$	$pdlEPA_6 = 0\,lbf$	$yEPA_6 = 0\cdot ft$	$xEPA_6 = 0\cdot ft$
$EPA_7 = 0\cdot ft^2$	$pdlEPA_7 = 0\,lbf$	$yEPA_7 = 0\cdot ft$	$xEPA_7 = 0\cdot ft$
$EPA_8 = 0\cdot ft^2$	$pdlEPA_8 = 0\,lbf$	$yEPA_8 = 0\cdot ft$	$xEPA_8 = 0\cdot ft$
$EPA_9 = 0\cdot ft^2$	$pdlEPA_9 = 0\,lbf$	$yEPA_9 = 0\cdot ft$	$xEPA_9 = 0\cdot ft$
$EPA_{10} = 0\cdot ft^2$	$pdlEPA_{10} = 0\,lbf$	$yEPA_{10} = 0\cdot ft$	$xEPA_{10} = 0\cdot ft$
$EPA_{11} = 0\cdot ft^2$	$pdlEPA_{11} = 0\,lbf$	$yEPA_{11} = 0\cdot ft$	$xEPA_{11} = 0\cdot ft$
$EPA_{12} = 0\cdot ft^2$	$pdlEPA_{12} = 0\,lbf$	$yEPA_{12} = 0\cdot ft$	$xEPA_{12} = 0\cdot ft$
$EPA_{13} = 0\cdot ft^2$	$pdlEPA_{13} = 0\,lbf$	$yEPA_{13} = 0\cdot ft$	$xEPA_{13} = 0\cdot ft$
$EPA_{14} = 0\cdot ft^2$	$pdlEPA_{14} = 0\,lbf$	$yEPA_{14} = 0\cdot ft$	$xEPA_{14} = 0\cdot ft$
$EPA_{15} = 0\cdot ft^2$	$pdlEPA_{15} = 0\,lbf$	$yEPA_{15} = 0\cdot ft$	$xEPA_{15} = 0\cdot ft$

Design Criteria:

shape = "Fluted"	Pole Shape
aashto = 2013	Design Specification
material = 6063	Type of Material
Embedded = 0	Embed or Anchor Base (1 = Embed)

Hapco Shaft CSR Calculation Solution

PLEASE NOTE:

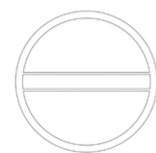
From here forward, calculations are a function of height (z) on the pole. This allows the entirety of the shaft to be calculated, checking the stress at each location to find the limiting point.

Multi-Chamber Properties (if applicable)

Chamber check will eliminate unnecessary calculations, speeding up run time.

$$chamberCheck := \begin{cases} \text{if } chamber \neq 0 \\ \quad \begin{cases} 1 & \text{if } shape = \text{"Round"} \vee shape = \text{"Square"} \\ 0 & \text{otherwise} \end{cases} \\ 0 \quad \text{otherwise} \end{cases}$$

$$xchamber(z) := \begin{cases} 0 \quad \text{if } chamberCheck = 0 \\ \text{otherwise} \\ \quad \begin{cases} \text{if } chamber = 2 \\ \quad \begin{cases} 1\cdot in & \text{if } shape = \text{"Round"} \\ 0 & \text{otherwise} \end{cases} \\ \text{otherwise} \\ \quad \begin{cases} \dfrac{Tweb(z)\cdot \tan\left(\dfrac{\pi}{6}\right)}{2} & \text{if } shape = \text{"Round"} \\ 0 & \text{otherwise} \end{cases} \end{cases} \end{cases}$$



Bi−Chamber Tube

$$Ichamber1(z) := \begin{cases} 0 \quad \text{if } chamberCheck = 0 \\ \text{otherwise} \\ \quad \begin{cases} \dfrac{Tweb(z)^4}{36} & \text{if } shape = \text{"Round"} \wedge chamber = 3 \\ 0 & \text{otherwise} \end{cases} \end{cases}$$

Tri−Chamber Tube

$$Achamber(z) := \begin{cases} 0 \quad \text{if } chamberCheck = 0 \\ \text{otherwise} \\ \quad \begin{cases} \text{if } chamber = 2 \\ \quad \begin{cases} 2\cdot Tweb(z)\cdot D(z) & \text{if } shape = \text{"Round"} \\ Tweb(z)\cdot\left(D(z) - \dfrac{Twall(z)}{2}\right) & \text{otherwise} \end{cases} \\ \text{otherwise} \\ \quad \begin{cases} \dfrac{Tweb(z)^2}{2} + 3\cdot Tweb(z)\cdot\left(\dfrac{D(z)}{2} - Twall(z) - xchamber(z)\right) & \text{if } shape = \text{"Round"} \\ 0 & \text{otherwise} \end{cases} \end{cases} \end{cases}$$

$$\mathrm{Ichamber3}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{chamberCheck} = 0 \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{chamber} = 2 \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{shape} = \text{"Round"} \\
\quad \left|\begin{array}{l}
a \leftarrow \dfrac{\mathrm{xchamber}(z)}{2} \\
b \leftarrow \dfrac{\mathrm{xchamber}(z)}{2} + \mathrm{Tweb}(z) \\
c \leftarrow \mathrm{Twall}(z) - \dfrac{D(z)}{2} \\
d \leftarrow \dfrac{D(z)}{2} - \mathrm{Twall}(z) \\
\dfrac{d-c}{3}\cdot\left(b^3 - a^3\right)
\end{array}\right. \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
a \leftarrow -\mathrm{Tweb}(z) \\
b \leftarrow \mathrm{Tweb}(z) \\
c \leftarrow \dfrac{-D(z)}{2} + \mathrm{Twall}(z) \\
d \leftarrow \dfrac{D(z)}{2} - \mathrm{Twall}(z) \\
\dfrac{d-c}{3}\cdot\left(b^3 - a^3\right)
\end{array}\right.
\end{array}\right. \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{shape} = \text{"Round"} \\
\quad \left|\begin{array}{l}
a \leftarrow \mathrm{xchamber}(z) \\
b \leftarrow \dfrac{D(z)}{2} - \mathrm{Twall}(z) \\
c \leftarrow -\mathrm{Tweb}(z) \\
d \leftarrow \mathrm{Tweb}(z) \\
\dfrac{d-c}{3}\cdot\left(b^3 - a^3\right)
\end{array}\right. \\
0 \ \ \text{otherwise}
\end{array}\right.
\end{array}\right.
\end{array}\right.$$

$$\mathrm{Ichamber2}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{chamberCheck} = 0 \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{chamber} = 2 \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{shape} = \text{"Round"} \\
\quad \left|\begin{array}{l}
a \leftarrow \dfrac{-\mathrm{xchamber}(z)}{2} - \mathrm{Tweb}(z) \\
b \leftarrow \dfrac{-\mathrm{xchamber}(z)}{2} \\
c \leftarrow \mathrm{Twall}(z) - \dfrac{D(z)}{2} \\
d \leftarrow \dfrac{D(z)}{2} - \mathrm{Twall}(z) \\
\dfrac{d-c}{3}\cdot\left(b^3 - a^3\right)
\end{array}\right. \\
0 \ \ \text{otherwise}
\end{array}\right. \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
\text{if } \ \mathrm{shape} = \text{"Round"} \\
\quad \left|\begin{array}{l}
a \leftarrow -\mathrm{Tweb}(z) \\
b \leftarrow \mathrm{Tweb}(z) \\
c \leftarrow \mathrm{xchamber}(z) \\
d \leftarrow \dfrac{D(z)}{2} - \mathrm{Twall}(z) \\
\dfrac{2}{\cos\left(\dfrac{\pi}{3}\right)}\cdot\dfrac{d-c}{3}\cdot\left(b^3 - a^3\right)
\end{array}\right. \\
0 \ \ \text{otherwise}
\end{array}\right.
\end{array}\right.
\end{array}\right.$$

$$\mathrm{Ichamber}(z) := \mathrm{Ichamber1}(z) + \mathrm{Ichamber2}(z) + \mathrm{Ichamber3}(z)$$

Total added moment of inertia from chambers

$$\mathrm{Schamber}(z) := \frac{2\cdot\mathrm{Ichamber}(z)}{D(z)}$$

Total added section modulus from chambers

Cross-Sectional Area Calculation

$$\mathrm{Area}_{RD}(z) := \mathrm{Twall}(z)\cdot\pi\cdot\left(D(z) - \mathrm{Twall}(z)\right)$$

$$\mathrm{Area}_{SQ}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{shape} \neq \text{"Square"} \\
D(z)^2 + 4\cdot\left(\mathrm{InsideRad}(z)^2 - \mathrm{radius}(z)^2\right) + \pi\cdot\left(\mathrm{radius}(z)^2 - \mathrm{InsideRad}(z)^2\right) - \left(D(z) - 2\cdot\mathrm{Twall}(z)\right)^2 \ \ \text{otherwise}
\end{array}\right.$$

$$\mathrm{Area}_{SL}(z) := \left|\begin{array}{l}
\mathrm{ODsleeve}^2 - \left(\mathrm{ODsleeve} - 2\cdot\mathrm{Twsleeve}\right)^2 \ \text{ if } \ \mathrm{shape} = \text{"Square"} \\
\dfrac{\pi}{4}\cdot\left[\mathrm{ODsleeve}^2 - \left(\mathrm{ODsleeve} - 2\cdot\mathrm{Twsleeve}\right)^2\right] \ \ \text{otherwise}
\end{array}\right.$$

$$\mathrm{Area}_0(z) := \left|\begin{array}{l}
\mathrm{Area}_{SQ}(z) \ \text{ if } \ \mathrm{shape} = \text{"Square"} \\
\mathrm{fluteArea}(z) \ \text{ if } \ \mathrm{shape} = \text{"Fluted"} \wedge \mathrm{taperSides} = 0 \\
\mathrm{smartArea}(z) \ \text{ if } \ \mathrm{shape} = \text{"Smart Trac"} \\
\mathrm{TRIfluteArea}(z) \ \text{ if } \ \mathrm{shape} = \text{"Fluted"} \wedge \mathrm{chamber} = 3 \\
\mathrm{Area}_{RD}(z) \ \ \text{otherwise}
\end{array}\right.$$

$$\mathrm{Area}_{Shaft}(z) := \mathrm{Area}_0(z) + \mathrm{Achamber}(z) + \left|\begin{array}{l}
0 \ \text{ if } \ z > \mathrm{Lsleeve} \\
\mathrm{Area}_{SL}(z) \ \ \text{otherwise}
\end{array}\right.$$

$$\mathrm{Area}_{Shaft}(0) = 5.353\cdot in^2$$

Area at Base of Pole

Moment of Inertia Calculation

Square Pole Parameters:

$$\mathrm{ID}(z) := D(z) - 2\cdot\mathrm{Twall}(z) \qquad \mathrm{Outer}(z) := \frac{D(z)}{2} - \mathrm{radius}(z) \qquad \mathrm{Inner}(z) := \frac{\mathrm{ID}(z)}{2} - \mathrm{InsideRad}(z)$$

$$I_{Outer}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{shape} \neq \text{"Square"} \\
\dfrac{1}{3}\cdot D(z)\cdot\mathrm{Outer}(z)^3 + \dfrac{2}{3}\cdot\mathrm{Outer}(z)\cdot\left[\left(\dfrac{D(z)}{2}\right)^3 - \mathrm{Outer}(z)^3\right] \ldots \qquad \text{otherwise} \\
+ \pi\cdot\left(\dfrac{1}{2}\cdot\mathrm{radius}(z)^2\cdot\mathrm{Outer}(z)^2 + \dfrac{1}{8}\cdot\mathrm{radius}(z)^4\right) + \dfrac{4}{3}\cdot\mathrm{Outer}(z)\cdot\mathrm{radius}(z)^3
\end{array}\right.$$

$$I_{Inner}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{shape} \neq \text{"Square"} \\
\dfrac{1}{3}\cdot\mathrm{ID}(z)\cdot\mathrm{Inner}(z)^3 + \dfrac{2}{3}\cdot\mathrm{Inner}(z)\cdot\left[\left(\dfrac{\mathrm{ID}(z)}{2}\right)^3 - \mathrm{Inner}(z)^3\right] \ldots \qquad \text{otherwise} \\
+ \pi\cdot\left(\dfrac{1}{2}\cdot\mathrm{InsideRad}(z)^2\cdot\mathrm{Inner}(z)^2 + \dfrac{1}{8}\cdot\mathrm{InsideRad}(z)^4\right) + \dfrac{4}{3}\cdot\mathrm{Inner}(z)\cdot\mathrm{InsideRad}(z)^3
\end{array}\right.$$

$$I_{SQ}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{shape} \neq \text{"Square"} \\
2\cdot\left(I_{Outer}(z) - I_{Inner}(z)\right) \ \ \text{otherwise}
\end{array}\right.$$

$$I_{SL}(z) := \left|\begin{array}{l}
0 \ \text{ if } \ \mathrm{Twsleeve} = 0 \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
\dfrac{1}{12}\cdot\mathrm{ODsleeve}^4 - \left(\mathrm{ODsleeve} - 2\cdot\mathrm{Twsleeve}\right)^4 \ \text{ if } \ \mathrm{shape} = \text{"Square"} \\
\dfrac{\pi}{64}\cdot\left[\mathrm{ODsleeve}^4 - \left(\mathrm{ODsleeve} - 2\cdot\mathrm{Twsleeve}\right)^4\right] \ \ \text{otherwise}
\end{array}\right.
\end{array}\right.$$

$$I_{RD}(z) := \frac{\pi}{64}\cdot\left[D(z)^4 - \left(D(z) - 2\cdot\mathrm{Twall}(z)\right)^4\right]$$

$$I_0(z) := \begin{cases} I_{SQ}(z) & \text{if } shape = \text{"Square"} \\ fluteMoment(z) & \text{if } shape = \text{"Fluted"} \wedge taperSides = 0 \\ smartMoment(z) & \text{if } shape = \text{"Smart Trac"} \\ TRIfluteMoment(z) & \text{if } shape = \text{"Fluted"} \wedge chamber = 3 \\ I_{RD}(z) & \text{otherwise} \end{cases}$$

$$I_{Shaft}(z) := I_0(z) + Ichamber(z) + \begin{cases} 0 & \text{if } z > Lsleeve \\ I_{SL}(z) & \text{otherwise} \end{cases}$$

$I_{Shaft}(0) = 40.547 \cdot in^4$ Moment of Inertia at Base of Pole

Section Modulus Calculation

$$S_{SQ}(z) := \begin{cases} 0 & \text{if } shape \neq \text{"Square"} \\ \dfrac{2 \cdot I_{Shaft}(z)}{D(z)} & \text{otherwise} \end{cases}$$

$$S_{RD}(z) := \frac{\pi}{32 \cdot D(z)} \cdot \left[D(z)^4 - (D(z) - 2 \cdot Twall(z))^4\right]$$

$$S_{SL}(z) := \begin{cases} \dfrac{1}{6 \cdot ODsleeve} \cdot \left[ODsleeve^4 - (ODsleeve - 2 \cdot Twsleeve)^4\right] & \text{if } shape = \text{"Square"} \\ \dfrac{\pi}{32 \cdot ODsleeve} \cdot \left[ODsleeve^4 - (ODsleeve - 2 \cdot Twsleeve)^4\right] & \text{otherwise} \end{cases}$$

$$S_0(z) := \begin{cases} S_{SQ}(z) & \text{if } shape = \text{"Square"} \\ fluteSection(z) & \text{if } shape = \text{"Fluted"} \wedge taperSides = 0 \\ smartSection(z) & \text{if } shape = \text{"Smart Trac"} \\ TRIfluteSection(z) & \text{if } shape = \text{"Fluted"} \wedge chamber = 3 \\ S_{RD}(z) & \text{otherwise} \end{cases}$$

$$S_{Shaft}(z) := S_0(z) + Schamber(z) + \begin{cases} 0 & \text{if } z > Lsleeve \\ S_{SL}(z) & \text{otherwise} \end{cases}$$

$S_{Shaft}(0) = 10.137 \cdot in^3$ Section Modulus at Base of Pole

Unreinforced Cutout Calculation (if applicable)

$$RHH(z) := \frac{D(z)}{2} \qquad TwHH(z) := Twall(z)$$

$$\theta HH(z,i) := \begin{cases} \operatorname{atan}\left(\dfrac{HHw_i}{D(z)}\right) & \text{if } shape = \text{"Square"} \\ \operatorname{asin}\left(\dfrac{HHw_i}{D(z)}\right) & \text{otherwise} \end{cases}$$

$$\alpha HH(z,i) := HHang_i - \theta HH(z,i)$$

$$ARD_{out}(z,i) := \theta HH(z,i) \cdot RHH(z)^2 \qquad yRD_{out}(z,i) := \frac{2 \cdot RHH(z) \cdot \sin(\theta HH(z,i))}{3 \cdot \theta HH(z,i)}$$

$$ARD_{in}(z,i) := \theta HH(z,i) \cdot (RHH(z) - TwHH(z))^2 \qquad yRD_{in}(z,i) := \frac{2 \cdot (RHH(z) - TwHH(z)) \cdot \sin(\theta HH(z,i))}{3 \cdot \theta HH(z,i)}$$

$$Acut(z,i) := \begin{cases} HHw_i \cdot TwHH(z) & \text{if } shape = \text{"Square"} \\ \theta HH(z,i) \cdot \left[RHH(z)^2 - (RHH(z) - TwHH(z))^2\right] & \text{otherwise} \end{cases}$$

$$Icut(z,i) := \begin{cases} \dfrac{HHw_i}{3} \cdot \left[RHH(z)^3 - (RHH(z) - TwHH(z))^3\right] & \text{if } shape = \text{"Square"} \\ \dfrac{RHH(z)^4 - (RHH(z) - TwHH(z))^4}{8} \cdot \left[2 \cdot \theta HH(z,i) - \dfrac{1}{2} \cdot (\sin(2 \cdot \alpha HH(z,i) + 4 \cdot \theta HH(z,i)) - \sin(2 \cdot \alpha HH(z,i)))\right] & \text{otherwis} \end{cases}$$

$$ycut(z,i) := \left| \begin{array}{l} \text{if } shape = \text{"Square"} \\ \quad \left| \begin{array}{l} f \leftarrow \begin{cases} 0 & \text{if } HHang_i = 0 \vee HHang_i = \pi \\ 1 & \text{if } 0 < HHang_i < \pi \\ -1 & \text{otherwise} \end{cases} \\ f \cdot \left(RHH(z) - \dfrac{TwHH(z)}{2}\right) \end{array} \right. \\ \text{otherwise} \\ \quad \left| \begin{array}{l} temp \leftarrow \dfrac{yRD_{out}(z,i) \cdot ARD_{out}(z,i) - yRD_{in}(z,i) \cdot ARD_{in}(z,i)}{ARD_{out}(z,i) - ARD_{in}(z,i)} \\ temp \leftarrow \begin{cases} (-1 \cdot temp) & \text{if } HHang_i = \dfrac{3 \cdot \pi}{2} \\ temp & \text{if } HHang_i = \dfrac{\pi}{2} \\ 0 & \text{if } HHang_i = 0 \vee HHang_i = \pi \\ temp \cdot \sin(\alpha HH(z,i)) & \text{otherwise} \end{cases} \\ temp \end{array} \right. \end{array} \right.$$

$$yc(z,i) := \frac{-Acut(z,i) \cdot ycut(z,i)}{Area_{Shaft}(z) - Acut(z,i)}$$

$$y_s(z,i) := \begin{cases} RHH(z) - yc(z,i) & \text{if } shape = \text{"Square"} \\ \sqrt{RHH(z)^2 - \left(\dfrac{HHw_i}{2}\right)^2} - yc(z,i) & \text{otherwise} \end{cases}$$

$$I_{HH}(z,i) := I_{Shaft}(z) - Icut(z,i) - Area_{Shaft}(z) \cdot yc(z,i)^2 + Acut(z,i) \cdot yc(z,i)^2$$

$$S_{HH}(z,i) := \frac{I_{HH}(z,i)}{y_s(z,i)}$$

$$I_G(z) := \begin{cases} I_{HH}(z,0) & \text{if } HHlocation_0 - \frac{HHh_0}{2} \le z \le HHlocation_0 + \frac{HHh_0}{2} \wedge HHyes_0 = 1 \\ I_{HH}(z,1) & \text{if } HHlocation_1 - \frac{HHh_1}{2} \le z \le HHlocation_1 + \frac{HHh_1}{2} \wedge HHyes_1 = 1 \\ I_{HH}(z,2) & \text{if } HHlocation_2 - \frac{HHh_2}{2} \le z \le HHlocation_2 + \frac{HHh_2}{2} \wedge HHyes_2 = 1 \\ I_{HH}(z,3) & \text{if } HHlocation_3 - \frac{HHh_3}{2} \le z \le HHlocation_3 + \frac{HHh_3}{2} \wedge HHyes_3 = 1 \\ I_{Shaft}(z) & \text{otherwise} \end{cases}$$

$$S_G(z) := \begin{cases} S_{HH}(z,0) & \text{if } HHlocation_0 - \frac{HHh_0}{2} \le z \le HHlocation_0 + \frac{HHh_0}{2} \wedge HHyes_0 = 1 \\ S_{HH}(z,1) & \text{if } HHlocation_1 - \frac{HHh_1}{2} \le z \le HHlocation_1 + \frac{HHh_1}{2} \wedge HHyes_1 = 1 \\ S_{HH}(z,2) & \text{if } HHlocation_2 - \frac{HHh_2}{2} \le z \le HHlocation_2 + \frac{HHh_2}{2} \wedge HHyes_2 = 1 \\ S_{HH}(z,3) & \text{if } HHlocation_3 - \frac{HHh_3}{2} \le z \le HHlocation_3 + \frac{HHh_3}{2} \wedge HHyes_3 = 1 \\ S_{Shaft}(z) & \text{otherwise} \end{cases}$$

$$A_G(z) := \begin{cases} Area_{Shaft}(z) - Acut(z,0) & \text{if } HHlocation_0 - \frac{HHh_0}{2} \le z \le HHlocation_0 + \frac{HHh_0}{2} \wedge HHyes_0 = 1 \\ Area_{Shaft}(z) - Acut(z,1) & \text{if } HHlocation_1 - \frac{HHh_1}{2} \le z \le HHlocation_1 + \frac{HHh_1}{2} \wedge HHyes_1 = 1 \\ Area_{Shaft}(z) - Acut(z,2) & \text{if } HHlocation_2 - \frac{HHh_2}{2} \le z \le HHlocation_2 + \frac{HHh_2}{2} \wedge HHyes_2 = 1 \\ Area_{Shaft}(z) - Acut(z,3) & \text{if } HHlocation_3 - \frac{HHh_3}{2} \le z \le HHlocation_3 + \frac{HHh_3}{2} \wedge HHyes_3 = 1 \\ Area_{Shaft}(z) & \text{otherwise} \end{cases}$$

$I_G(HHlocation_0) = 40.547 \cdot in^4$	$S_G(HHlocation_0) = 10.137 \cdot in^3$	$A_G(HHlocation_0) = 5.353 \cdot in^2$
$I_G(HHlocation_1) = 40.547 \cdot in^4$	$S_G(HHlocation_1) = 10.137 \cdot in^3$	$A_G(HHlocation_1) = 5.353 \cdot in^2$
$I_G(HHlocation_2) = 40.547 \cdot in^4$	$S_G(HHlocation_2) = 10.137 \cdot in^3$	$A_G(HHlocation_2) = 5.353 \cdot in^2$
$I_G(HHlocation_3) = 40.547 \cdot in^4$	$S_G(HHlocation_3) = 10.137 \cdot in^3$	$A_G(HHlocation_3) = 5.353 \cdot in^2$

Obround Pole Geometry (if applicable)

$$ObroundLength := \begin{cases} 0 \cdot ft & \text{if } shape \ne \text{"Obround"} \\ Ltaper_{L_{index}} + Lbotst_{L_{index}} - Ltaper_{L_{index}} \cdot \left(\frac{Obround_y - TD_{L_{index}}}{BD_{L_{index}} - TD_{L_{index}}} \right)^{\frac{1}{n_{L_{index}}}} & \text{otherwise} \end{cases}$$

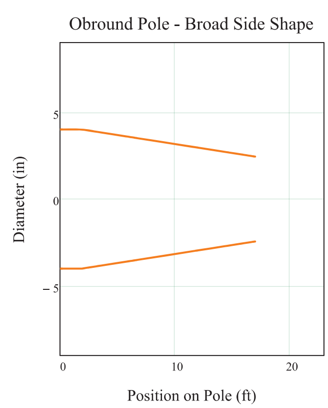
$$Obround_y(z) := \begin{cases} Obround_y & \text{if } shape = \text{"Obround"} \\ D(z) & \text{otherwise} \end{cases}$$

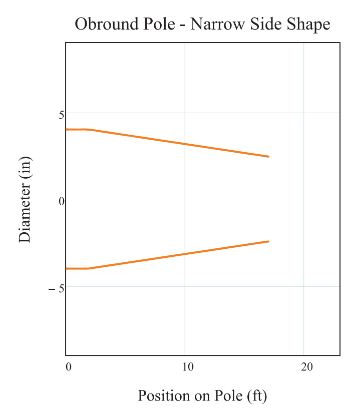
Maximum Obround Length: $ObroundLength = 0 \cdot ft$

$$Obround_x(z) := \begin{cases} D(z) & \text{if } shape \ne \text{"Obround"} \\ \frac{\pi \cdot \left(D(z) - \min\left(Obround_y(z), D(z)\right)\right)}{2} + \min\left(Obround_y(z), D(z)\right) & \text{otherwise} \end{cases}$$

Obround Dimensions: $Obround_x(0) = 8 \cdot in$ $Obround_y(0) = 8 \cdot in$

$Obround_x(ObroundLength) = 8 \cdot in$ $Obround_y(ObroundLength) = 8 \cdot in$





$$\mathrm{oRadius}(z) := 0.5\cdot\begin{cases} D(z) & \text{if shape} \neq \text{"Obround"} \\ \min\left(\mathrm{Obround}_y(z), D(z)\right) & \text{otherwise}\end{cases}$$

$$\mathrm{oD}(z) := 2\cdot\mathrm{oRadius}(z)$$

$$\mathrm{Internal}(z) := \begin{cases} 0\cdot\mathrm{in} & \text{if shape} \neq \text{"Obround"} \\ \text{otherwise} & \begin{cases} \mathrm{Obround}_x(z) - \mathrm{oD}(z) & \text{if } z < \mathrm{ObroundLength} \\ 0\cdot\mathrm{in} & \text{otherwise}\end{cases}\end{cases}$$

$$r(z) := \mathrm{oRadius}(z) - \mathrm{Twall}(z)$$

$$\mathrm{oI}(z) := \begin{cases} I_G(z) & \text{if shape} \neq \text{"Obround"} \\ \frac{\pi}{64}\cdot\left[\mathrm{oD}(z)^4 - \left(\mathrm{oD}(z) - 2\cdot\mathrm{Twall}(z)\right)^4\right] + \frac{\mathrm{Internal}(z)\cdot\mathrm{Twall}(z)^3}{6} + 2\cdot\mathrm{Internal}(z)\cdot\mathrm{Twall}(z)\cdot\left(\frac{\mathrm{oD}(z) - \mathrm{Twall}(z)}{2}\right)^2 & \text{otherwise}\end{cases}$$

$$\mathrm{oS}(z) := \begin{cases} S_G(z) & \text{if shape} \neq \text{"Obround"} \\ \frac{\mathrm{oI}(z)}{\mathrm{oRadius}(z)} & \text{otherwise}\end{cases}$$

Moment of Inertia of Broad Side: $\mathrm{oI}(0) = 40.547\cdot\mathrm{in}^4$

$\mathrm{oI}(\mathrm{ObroundLength}) = 40.547\cdot\mathrm{in}^4$

Section Modulus of Broad Side: $\mathrm{oS}(0) = 10.137\cdot\mathrm{in}^3$

$\mathrm{oS}(\mathrm{ObroundLength}) = 10.137\cdot\mathrm{in}^3$

Final Geometry Calculations

$$\mathrm{Dia}(z) := \begin{cases} D(z) & \text{if shape} \neq \text{"Obround"} \\ \mathrm{Obround}_y(z) & \text{otherwise}\end{cases}$$

$$A(z) := A_G(z)$$

$$I(z) := \begin{cases} I_G(z) & \text{if shape} \neq \text{"Obround"} \\ \mathrm{oI}(z) & \text{otherwise}\end{cases}$$

$$S(z) := \begin{cases} S_G(z) & \text{if shape} \neq \text{"Obround"} \\ \mathrm{oS}(z) & \text{otherwise}\end{cases}$$

$$\mathrm{Rb}(z) := \frac{D(z) - \mathrm{Twall}(z)}{2}$$

$$\mathrm{rgyrF} := \begin{cases} 0.816 & \text{if shape} = \text{"Square"} \\ \text{if shape} = \text{"Fluted"} & \begin{cases} 0.727 & \text{if taperSides} = 1 \\ 0.711 & \text{if taperSides} = 3 \\ 0.75 & \text{otherwise}\end{cases} \\ 0.707 & \text{otherwise}\end{cases}$$

$$r_{gyr}(z) := \begin{cases} \sqrt{\frac{I(0.5\cdot\mathrm{Ltotal})}{A(0.5\cdot\mathrm{Ltotal})}} & \text{if material} = \text{"Steel"} \\ \frac{1}{4}\cdot\sqrt{D(z)^2 + \left(D(z) - 2\cdot\mathrm{Twall}(z)\right)^2} & \text{if shape} = \text{"Obround"} \\ \frac{\mathrm{rgyrF}}{2}\cdot\left(D(z) - \mathrm{Twall}(z)\right) & \text{otherwise}\end{cases}$$

$$\mathrm{rs}(z) := \frac{\mathrm{radius}(z)}{D(z)}$$

$$J(z) := 2\cdot I(z)$$

$$\mathrm{Vol}(z) := \int_z^{\mathrm{Ltotal}} A(z)\,dz$$

Total Volume: $\mathrm{Vol}(0) = 897.881\cdot\mathrm{in}^3$

$$\mathrm{Totwt}(z) := \mathrm{Vol}(z)\cdot\mathrm{Mwt}\cdot\begin{cases} 1.125 & \text{if aashto} = \text{"NAAMM"} \\ 1 & \text{otherwise}\end{cases}$$

Total Weight: $\mathrm{Totwt}(0) = 87.992\ \mathrm{lbf}$

$$\mathrm{Poleice}(z) := \begin{cases} 3\cdot\pi\cdot\frac{\mathrm{lbf}}{\mathrm{ft}^2}\cdot\int_z^{\mathrm{Ltotal}} D(z)\,dz & \text{if IceRegion} = 1 \\ 0 & \text{otherwise}\end{cases}$$

Weight of Ice on Shaft: $\mathrm{Poleice}(0) = 0\ \mathrm{lbf}$

Loading - Wind Loading and Dead Loading

Conversion Factor, Cv

$$\mathrm{Cv25} := \begin{cases} 0.88 & \text{if } U > 100\cdot\mathrm{mph} \wedge \text{aashto} \geq 2009 \\ \text{otherwise} & \begin{cases} .93 & \text{if } U \leq 100\mathrm{mph} \vee \text{aashto} \geq 2009 \\ .89 & \text{otherwise}\end{cases}\end{cases}$$

$$\mathrm{Cv50} := \begin{cases} 1.00 & \text{if } U \leq 100\mathrm{mph} \vee \text{aashto} \geq 2009 \\ 1.00 & \text{otherwise}\end{cases}$$

$$\mathrm{CvAlaska} := \begin{cases} 1.06 & \text{if Dlife} = 100 \\ 1.00 & \text{if Dlife} = 50 \\ .94 & \text{if Dlife} = 25\end{cases}$$

$$\mathrm{Cv100} := \begin{cases} 1.07 & \text{if } U \leq 100\mathrm{mph} \vee \text{aashto} \geq 2009 \\ 1.105 & \text{otherwise}\end{cases}$$

$$\mathrm{Cv} := \begin{cases} \text{if aashto} = 2015 \vee \text{aashto} = 222 & \begin{cases} 0.8 & \text{if } U \geq 105\cdot\mathrm{mph} \\ 1 & \text{otherwise}\end{cases} \\ 1 & \text{if aashto} = 1994 \\ \text{otherwise} & \begin{cases} \mathrm{CvAlaska} & \text{if Alaska} = 1 \\ \text{otherwise} & \begin{cases} \mathrm{Cv100} & \text{if Dlife} = 100 \\ \mathrm{Cv50} & \text{if Dlife} = 50 \\ \mathrm{Cv25} & \text{otherwise}\end{cases}\end{cases}\end{cases}$$

$\mathrm{Cv} = 1$

Importance Factor, Ir

$$Ir25 := \left| \begin{array}{l} 0.77 \ \text{ if } U > 100\cdot mph \wedge aashto \geq 2009 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 0.87 \ \text{ if } U \leq 100mph \vee aashto \geq 2009 \\ 0.80 \ \text{ otherwise} \end{array} \right. \end{array} \right.$$

$$IrAlaska := \left| \begin{array}{l} 1.13 \ \text{ if } Dlife = 100 \\ 1.00 \ \text{ if } Dlife = 50 \\ .89 \ \text{ if } Dlife = 25 \end{array} \right.$$

$$Ir50 := \left| \begin{array}{l} 1.00 \ \text{ if } U \leq 100mph \vee aashto \geq 2009 \\ 1.00 \ \text{ otherwise} \end{array} \right.$$

$$Ir100 := \left| \begin{array}{l} 1.15 \ \text{ if } U \leq 100mph \vee aashto \geq 2009 \\ 1.23 \ \text{ otherwise} \end{array} \right.$$

$$Ir := \left| \begin{array}{l} 1 \ \text{ if } aashto = 2015 \vee aashto = 222 \\ 1 \ \text{ if } aashto = 1994 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} IrAlaska \ \text{ if } Alaska = 1 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} Ir100 \ \text{ if } Dlife = 100 \\ Ir50 \ \text{ if } Dlife = 50 \\ Ir25 \ \text{ otherwise} \end{array} \right. \end{array} \right. \end{array} \right.$$

$$Ir = 1$$

Drag Coefficient, Cd

$$MD(z) := \frac{U}{mph}\cdot\frac{D(z)}{ft} \qquad \tau(z) := taperRadius(z)$$

$$Cd2001(z) := \left| \begin{array}{l} \text{if } Cv\cdot MD(z) \leq 39 \\ \quad \left| \begin{array}{l} \text{if } shape = \text{"Fluted"} \\ \quad \left| \begin{array}{l} 1.10 \ \text{ if } taperSides = 3 \\ 1.20 \ \text{ otherwise} \end{array} \right. \\ 1.10 \ \text{ otherwise} \end{array} \right. \\ \text{if } 39 < Cv\cdot MD(z) < 78 \\ \quad \left| \begin{array}{l} \text{if } shape = \text{"Fluted"} \\ \quad \left| \begin{array}{l} 1.20 \ \text{ if } taperSides = 1 \\ \text{if } taperSides = 3 \\ \quad \left| \begin{array}{l} 0.55 + 71^{-1}\cdot(78.2 - Cv\cdot MD(z)) \ \text{ if } \tau(z) \geq 0.26 \\ 1.37 + 1.08\cdot\tau(z) - 145^{-1}\cdot(Cv\cdot MD(z)) - 36^{-1}\cdot(Cv\cdot MD(z)\cdot\tau(z)) \ \text{ otherwise} \end{array} \right. \\ 10.8\cdot(Cv\cdot MD(z))^{-0.6} \ \text{ otherwise} \end{array} \right. \\ 129\cdot(Cv\cdot MD(z))^{-1.3} \ \text{ otherwise} \end{array} \right. \\ \text{otherwise} \\ \quad \left| \begin{array}{l} \text{if } shape = \text{"Fluted"} \\ \quad \left| \begin{array}{l} 1.20 \ \text{ if } taperSides = 1 \\ \text{if } taperSides = 3 \\ \quad \left| \begin{array}{l} 0.55 \ \text{ if } \tau(z) \geq 0.26 \\ 0.83 - 1.08\cdot\tau(z) \ \text{ otherwise} \end{array} \right. \\ 0.79 \ \text{ otherwise} \end{array} \right. \\ 0.45 \ \text{ otherwise} \end{array} \right. \end{array} \right.$$

$$Cdsmart(z) := \left| \begin{array}{l} -0.0004\cdot\left(\frac{U}{mph}\right) + 1.0011 \ \text{ if } D(z) = 4\cdot in \\ -0.0003\cdot\left(\frac{U}{mph}\right) + 1.0647 \ \text{ if } D(z) = 6\cdot in \\ -0.0024\cdot\left(\frac{U}{mph}\right) + 1.5499 \ \text{ if } D(z) = 8\cdot in \\ 4.4398\cdot\left(\frac{U}{mph}\right)^{-0.237} \ \text{ if } D(z) = 12\cdot in \\ 1.2 \ \text{ otherwise} \end{array} \right.$$

$$CdSq(z) := \left| \begin{array}{l} 2.0 - 6\cdot rs(z) \ \text{ if } rs(z) < .125 \\ 1.45 \ \text{ if } aashto = 1994 \\ 1.25 \ \text{ otherwise} \end{array} \right.$$

$$Cd1994(z) := \left| \begin{array}{l} \text{if } MD(z) \leq 32 \\ \quad \left| \begin{array}{l} 1.1 \ \text{ if } shape = \text{"Round"} \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 1.10 \ \text{ if } taperSides = 3 \\ 1.20 \ \text{ otherwise} \end{array} \right. \end{array} \right. \\ \text{if } 32 < MD(z) < 64 \\ \quad \left| \begin{array}{l} 100\cdot(MD(z))^{-1.3} \ \text{ if } shape = \text{"Round"} \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 1.2 \ \text{ if } taperSides = 1 \\ 9.62\cdot MD(z)^{-0.6} \ \text{ if } taperSides = 2 \vee taperSides = 0 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 0.55 + 58.18^{-1}\cdot(64 - MD(z)) \ \text{ if } \tau(z) \geq 0.26 \\ 1.37 + 1.08\cdot\tau(z) - \frac{MD(z)}{119} - \frac{MD(z)\cdot\tau(z)}{29.7} \ \text{ otherwise} \end{array} \right. \end{array} \right. \end{array} \right. \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 0.45 \ \text{ if } shape = \text{"Round"} \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 0.79 \ \text{ if } taperSides = 0 \vee taperSides = 2 \\ 1.2 \ \text{ if } taperSides = 1 \\ \text{otherwise} \\ \quad \left| \begin{array}{l} 0.55 \ \text{ if } \tau(z) \geq 0.26 \\ 0.83 - 1.08\cdot\tau(z) \ \text{ otherwise} \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right.$$

$$Cdtemp(z) := \left| \begin{array}{l} Cd1994(z) \ \text{ if } aashto = 1994 \\ Cd2001(z) \ \text{ otherwise} \end{array} \right.$$

$$Cd_{Obround}(z) := Cdtemp\left(Obround_y(z)\right)\cdot\left[1 - 0.7\cdot\left(\frac{Obround_x(z)}{Obround_y(z)} - 1\right)^{\frac{1}{4}}\right]$$

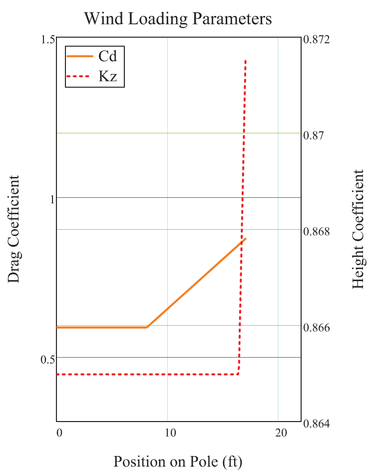
$$Cd(z) := \begin{cases} Cd_{Obround}(z) & \text{if } z < ObroundLength \wedge shape = \text{"Obround"} \\ CdSq(z) & \text{if } shape = \text{"Square"} \\ Cdsmart(z) & \text{if } shape = \text{"Smart Trac"} \\ Cdtemp(z) & \text{otherwise} \end{cases}$$

$Cd(0) = 0.593$ $Cd(Ltotal) = 0.871$

Height Coefficient, Kz

Chooses between table values and equation.

$$Kz(z) := \begin{cases} \text{if } aashto = 1994 \\ \quad \text{if } kztype = \text{"Blocks"} \\ \quad\quad .80 \text{ if } 0 \le Hpier + z \le 14\cdot ft \\ \quad\quad 1.00 \text{ if } 14\cdot ft < Hpier + z \le 29\cdot ft \\ \quad\quad 1.10 \text{ if } 29\cdot ft < Hpier + z \le 49\cdot ft \\ \quad\quad 1.25 \text{ if } 49\cdot ft < Hpier + z \le 99\cdot ft \\ \quad\quad 1.40 \text{ if } 99\cdot ft < Hpier + z \le 149\cdot ft \\ \quad \max\left[0.8, \left(\frac{Hpier + z}{30\cdot ft}\right)^{\frac{1}{7}}\right] \text{ otherwise} \\ \text{if } aashto = 2015 \vee aashto = 222 \\ \quad 2.0\cdot\left(\frac{z + Hpier}{900\cdot ft}\right)^{\frac{2}{9.5}} \text{ if } z + Hpier > 16\cdot ft \\ \quad 2.0\cdot\left(\frac{16}{900}\right)^{\frac{2}{9.5}} \text{ otherwise} \\ \text{otherwise} \\ \quad 2.01\left(\frac{z + Hpier}{900\cdot ft}\right)^{\frac{2}{9.5}} \text{ if } z + Hpier > 16.4\cdot ft \\ \quad 2.01\left(\frac{16.4}{900}\right)^{\frac{2}{9.5}} \text{ otherwise} \end{cases}$$



$Kz(0) = 0.865$

$Kz(Ltotal) = 0.872$

Topographic Factor, Kzt (if applicable)

$Kzt := 1$

Rooftop Wind Speed-Up Factor, Ks (if applicable)

$Ks := 1$

Directionality Factor, Kd (if applicable)

$$Kd := \begin{cases} 0.95 & \text{if } aashto = 222 \\ \text{if } aashto = 2015 \\ \quad 0.90 & \text{if } shape = \text{"Square"} \\ \quad 0.95 & \text{otherwise} \\ 1 & \text{otherwise} \end{cases}$$

Ground Elevation Factor, Ke (if applicable)

$$Ke := e^{-0.0000362\cdot\frac{Elev}{ft}}$$

Shear and Moment on Pole Due to Wind Loading

$$PzF := \begin{cases} 1.3 & \text{if } aashto = 1994 \\ 1 & \text{otherwise} \end{cases}$$

$$Pz(z) := 0.00256\cdot Kz(z)\cdot G\cdot\left(PzF\cdot\frac{U}{mph}\right)^2\cdot Ir\cdot Kd\cdot Kzt\cdot psf\cdot\begin{cases} Ks\cdot Ke & \text{if } aashto = 222 \\ 1 & \text{otherwise} \end{cases}$$

$Ks = 1$

$Kzt = 1$

$Ke = 1$ $Pz(0) = 49.074\cdot psf$

$Kd = 1$ $Pz(Ltotal) = 49.446\cdot psf$

$$Vwindbasepole(z) := \int_z^{Ltotal} Pz(z)\cdot Dia(z)\cdot Cd(z)\,dz$$

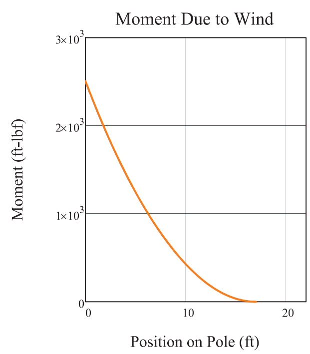
$Vwindbasepole(0) = 300.645\ lbf$

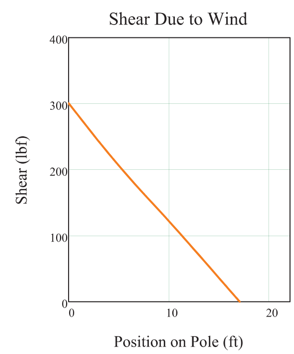
$Vwindbasepole(Ltotal) = 0\ lbf$

$$Mwindbasepole(z) := \int_z^{Ltotal} (x - z)\cdot Pz(x)\cdot Dia(x)\cdot Cd(x)\,dx$$

$Mwindbasepole(0) = 2.506 \times 10^3\ ft\cdot lbf$

$Mwindbasepole(Ltotal) = 0\ ft\cdot lbf$





Shear and Moment on Pole Due to Wind Loading on EPAs

$$\mathrm{Vepa}(z,i) := \begin{cases} \left(\mathrm{Pz}\left(\mathrm{yEPA}_i\right)\cdot \mathrm{EPA}_i\right) & \text{if } z \le \mathrm{yEPA}_i \\ 0 & \text{otherwise} \end{cases} \qquad \mathrm{Mepa}(z,i) := \begin{cases} \left[\mathrm{Pz}\left(\mathrm{yEPA}_i\right)\cdot \mathrm{EPA}_i\cdot\left(\mathrm{yEPA}_i - z\right)\right] & \text{if } \mathrm{yEPA}_i - z > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\mathrm{Tepa}(i) := \mathrm{Pz}\left(\mathrm{yEPA}_i\right)\cdot \mathrm{EPA}_i\cdot \mathrm{xEPA}_i \qquad \mathrm{VEPA}(z) := \sum_{i=0}^{15} \mathrm{Vepa}(z,i) \qquad \mathrm{MEPA}(z) := \sum_{i=0}^{15} \mathrm{Mepa}(z,i) \qquad \mathrm{TEPA} := \sum_{i=0}^{15} \mathrm{Tepa}(i)$$

$\mathrm{VEPA}(0) = 550.493\ \mathrm{lbf}$ $\mathrm{MEPA}(0) = 9.909 \times 10^3\ \mathrm{ft\cdot lbf}$

$\mathrm{TEPA} = 0\ \mathrm{ft\cdot lbf}$ $\mathrm{MEPA}(\mathrm{Ltotal}) = 550.493\ \mathrm{ft\cdot lbf}$

Shear and Moment on Pole Due to Wind Loading on Flags

$$\mathrm{VFlag} := \left| \begin{array}{l} x \leftarrow 0 \\ \text{for } i \in 0..5 \\ \quad \left| \begin{array}{l} \mathrm{temp1} \leftarrow \mathrm{FlagF}_i\cdot \mathrm{lbf}\cdot\left(\dfrac{U}{\mathrm{mph}}\right)^2\cdot\dfrac{\sqrt{\mathrm{FlagVert}_i\cdot \mathrm{FlagHoriz}_i}}{\mathrm{ft}}\cdot \mathrm{Kz}(\mathrm{Ltotal} - x)\cdot G \\ x \leftarrow x + \mathrm{FlagVert}_i \\ \mathrm{temp} \leftarrow \begin{cases} \mathrm{temp1} & \text{if } i = 0 \\ \mathrm{temp} + \mathrm{temp1} & \text{otherwise} \end{cases} \end{array}\right. \\ \mathrm{temp} \end{array}\right.$$

$$\mathrm{MFlag}(z) := \left| \begin{array}{l} x \leftarrow 0 \\ \text{for } i \in 0..5 \\ \quad \left| \begin{array}{l} \mathrm{temp1} \leftarrow \mathrm{FlagF}_i\cdot \mathrm{lbf}\cdot\left(\dfrac{U}{\mathrm{mph}}\right)^2\cdot\dfrac{\sqrt{\mathrm{FlagVert}_i\cdot \mathrm{FlagHoriz}_i}}{\mathrm{ft}}\cdot \mathrm{Kz}(\mathrm{Ltotal} - x)\cdot G\cdot\left(\mathrm{Ltotal} - \dfrac{\mathrm{FlagVert}_i}{2} - x - z\right) \\ x \leftarrow x + \mathrm{FlagVert}_i \\ \mathrm{temp} \leftarrow \begin{cases} \mathrm{temp1} & \text{if } i = 0 \\ \mathrm{temp} + \mathrm{temp1} & \text{otherwise} \end{cases} \end{array}\right. \\ \mathrm{temp} \end{array}\right.$$

$\mathrm{VFlag} = 0\ \mathrm{lbf}$

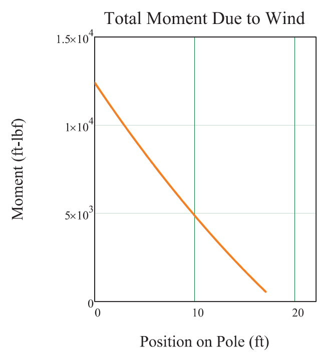
$\mathrm{MFlag}(0) = 0\ \mathrm{ft\cdot lbf}$

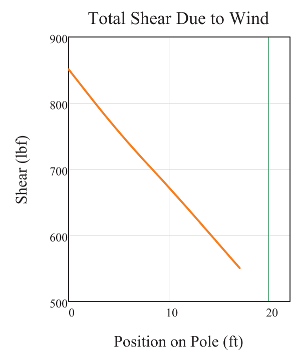
$\mathrm{MFlag}(\mathrm{Ltotal}) = 0\ \mathrm{ft\cdot lbf}$

Total Wind Loading

$$V(z) := \mathrm{Vwindbasepole}(z) + \mathrm{VEPA}(z) + \begin{cases} \mathrm{VFlag} & \text{if aashto} = \text{"NAAMM"} \\ 0 & \text{otherwise} \end{cases}$$

$$M(z) := \mathrm{Mwindbasepole}(z) + \mathrm{MEPA}(z) + \begin{cases} \mathrm{MFlag}(z) & \text{if aashto} = \text{"NAAMM"} \\ 0 & \text{otherwise} \end{cases}$$





$M(0) = 1.241 \times 10^4\ \mathrm{ft\cdot lbf}$ $V(0) = 851.138\ \mathrm{lbf}$

$M(\mathrm{Ltotal}) = 550.493\ \mathrm{ft\cdot lbf}$ $V(\mathrm{Ltotal}) = 550.493\ \mathrm{lbf}$

Dead Loading

$$\mathrm{Pdlt}(z) := \gamma\cdot\sum_{i=0}^{15}\left(\begin{cases} 0 & \text{if } z > \mathrm{yEPA}_i \\ \mathrm{pdlEPA}_i & \text{otherwise} \end{cases}\right) \qquad \mathrm{Picet}(z) := \gamma\cdot\sum_{i=0}^{15}\left(\begin{cases} 0 & \text{if } z > \mathrm{yEPA}_i \\ \mathrm{Pice}_i & \text{otherwise} \end{cases}\right)$$

$$\mathrm{Mdl}(z) := \gamma\cdot\sum_{i=0}^{15}\left(\begin{cases} 0 & \text{if } z > \mathrm{yEPA}_i \\ \mathrm{pdlEPA}_i\cdot \mathrm{xcgEPA}_i & \text{otherwise} \end{cases}\right) \qquad \mathrm{Mice}(z) := \gamma\cdot\sum_{i=0}^{15}\left(\begin{cases} 0 & \text{if } z > \mathrm{yEPA}_i \\ \mathrm{Pice}_i\cdot \mathrm{xegice}_i & \text{otherwise} \end{cases}\right)$$

$\mathrm{Pdlt}(0) = 468\ \mathrm{lbf}$ $\mathrm{Picet}(0) = 0\ \mathrm{lbf}$

$\mathrm{Mdl}(0) = 0\ \mathrm{ft\cdot lbf}$ $\mathrm{Mice}(0) = 0\ \mathrm{ft\cdot lbf}$

Dead Load via Span Wire (if applicable)

$$Vcable(z) := \begin{cases} 0 & \text{if } z > L_{cable} \\ \text{otherwise} & \begin{cases} 0 & \text{if } sag = 0 \\ \dfrac{W_{cable} \cdot span^2}{8 \cdot sag} & \text{otherwise} \end{cases} \end{cases}$$

$Vcable(0) = 0\ lbf$

$$Mcable(z) := \begin{cases} \gamma \cdot Vcable(z) \cdot (L_{cable} - z) & \text{if } z \le L_{cable} \\ 0 & \text{otherwise} \end{cases}$$

$Mcable(0) = 0\ ft \cdot lbf$

Total Dead Load Moment

$$Mdlbase(z) := Mcable(z) + Mdl(z) + Mice(z)$$

$Mdlbase(0) = 0\ ft \cdot lbf$

Stresses Due to Loading - Bending, Shear/Torsional, & Axial

Axial Stress

$$fa(z) := \frac{Totwt(z) + Pdlt(z) + Picet(z) + Poleice(z)}{A(z)}$$

$fa(0) = 103.858\ psi$

$fa(Ltotal) = 145.939\ psi$

Shear Stress

$$fsh(z) := \frac{V(z) + Vcable(z)}{A(z)} \cdot \begin{cases} 2.25 & \text{if } shape = \text{"Square"} \\ 2.0 & \text{otherwise} \end{cases}$$

$fsh(0) = 317.981\ psi$

$fsh(Ltotal) = 343.328\ psi$

Torsional Stress

$$Tcrit := \begin{cases} 0.15 \cdot \displaystyle\sum_{i=0}^{15} \left(\sqrt{EPA_i} \cdot Pz(yEPA_i) \cdot EPA_i \right) & \text{if } TEPA = 0 \\ TEPA & \text{otherwise} \end{cases}$$

$Tcrit = 219.631\ ft \cdot lbf$

$$ftor(z) := \begin{cases} \dfrac{Tcrit}{2 \cdot S(z)} & \text{if } aashto = 1994 \wedge shape \ne \text{"Square"} \\ \dfrac{kt \cdot Tcrit}{2 \cdot Twall(z) \cdot (D(z) - Twall(z))^2} \cdot \begin{cases} 1.12 & \text{if } aashto = 1994 \\ 1 & \text{otherwise} \end{cases} & \text{if } shape = \text{"Square"} \\ \dfrac{Tcrit}{\dfrac{6.28}{4} \cdot Twall(z) \cdot (D(z) - Twall(z))^2} & \text{otherwise} \end{cases}$$

$ftor(0) = 126.608\ psi$

$ftor(Ltotal) = 352.835\ psi$

$$fs(z) := fsh(z) + ftor(z)$$

$fs(0) = 444.588\ psi$ Total Shear Stress at Base

$fs(Ltotal) = 696.163\ psi$ Total Shear Stress at Top

Bending Stress

$$M_{Dec}(z) := M(z) + 0.165 \cdot Shoe^2 \cdot Cd(z) \cdot D(z) \cdot Pz(z)$$

$$BL(z) := \begin{cases} M(Shoe) & \text{if } z \le Shoe \\ M(z) & \text{otherwise} \end{cases}$$

$BL(0) = 1.214 \times 10^4\ ft \cdot lbf$

$BL(Shoe) = 1.214 \times 10^4\ ft \cdot lbf$

$BL(Ltotal) = 550.493\ ft \cdot lbf$

$$Mc1_{Dec}(z) := \sqrt{M_{Dec}(z)^2 + (0.2 \cdot M_{Dec}(z) + Mdlbase(z))^2}$$

$$Mc_{1994}(z) := \sqrt{M(z)^2 + (0.2 \cdot M(z) + Mdlbase(z))^2}$$

$$Mc1(z) := \sqrt{BL(z)^2 + (0.2 \cdot BL(z) + Mdlbase(z) + Mice(z))^2}$$

$$Mc2(z) := \sqrt{(0.6 \cdot BL(z))^2 + (0.3 \cdot BL(z) + Mdlbase(z) + Mice(z))^2}$$

$$Mc1_{2015}(z) := BL(z)$$

$$Mc2_{2015}(z) := Mdlbase(z) + Mice(z)$$

$$Mc3_{2015}(z) := 0.75 \cdot \sqrt{BL(z)^2 + Mc2_{2015}(z)^2}$$

$$Mc_{Sq}(z) := \max[BL(z) + 0.2 \cdot (BL(z) + Mdlbase(z) + Mice(z)), 0.6 \cdot BL(z) + 0.3 \cdot (BL(z) + Mdlbase(z) + Mice(z))]$$

$$Mc(z) := \begin{cases} Mc_{1994}(z) & \text{if } aashto = 1994 \\ Mc_{Sq}(z) & \text{if } shape = \text{"Square"} \\ Mc1_{Dec}(z) & \text{if } BaseHt > 0 \\ \max(Mc1_{2015}(z), Mc2_{2015}(z), Mc3_{2015}(z)) & \text{if } aashto = 2015 \vee aashto = 222 \\ \max(Mc1(z), Mc2(z)) & \text{otherwise} \end{cases}$$

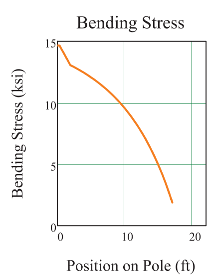
$$fb(z) := \frac{Mc(z)}{S(z)}$$

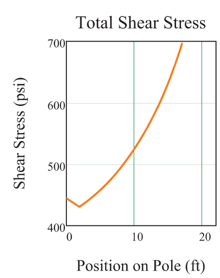
$Mc(0) = 1.238 \times 10^4\ ft \cdot lbf$

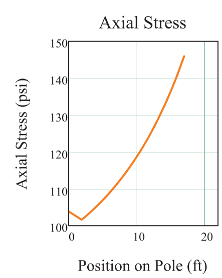
$Mc(Ltotal) = 561.395\ ft \cdot lbf$

$fb(0) = 1.465 \times 10^4\ psi$

$fb(Ltotal) = 1.883 \times 10^3\ psi$







Allowable Stresses/Strengths - Bending, Shear/Torsional, & Axial

Buckling Constants - B, D, & C

$$B_c(z) := Fcy(z)\cdot\left(1 + \sqrt{\frac{Fcy(z)}{2250\cdot ksi}}\right) \qquad D_c(z) := \frac{B_c(z)}{10}\cdot\sqrt{\frac{B_c(z)}{E}} \qquad C_c(z) := 0.41\cdot\frac{B_c(z)}{D_c(z)}$$

$$B_p(z) := Fcy(z)\cdot\left(1 + \sqrt[3]{\frac{Fcy(z)}{1500\cdot ksi}}\right) \qquad D_p(z) := \frac{B_p(z)}{10}\cdot\sqrt{\frac{B_p(z)}{E}} \qquad C_p(z) := 0.41\cdot\frac{B_p(z)}{D_p(z)}$$

$$B_t(z) := Fcy(z)\cdot\left(1 + \sqrt[5]{\frac{Fcy(z)}{50000\cdot ksi}}\right) \qquad D_t(z) := \frac{B_t(z)}{4.5}\cdot\sqrt[3]{\frac{B_t(z)}{E}} \qquad C_t(z) := 0.70\cdot\sqrt{\frac{E}{Fcy(z)}}$$

$$B_{tb}(z) := 1.5\cdot Fcy(z)\cdot\left(1 + \sqrt[5]{\frac{Fcy(z)}{50000\cdot ksi}}\right) \qquad D_{tb}(z) := \frac{B_{tb}(z)}{2.7}\cdot\sqrt[3]{\frac{B_{tb}(z)}{E}} \qquad C_{tb}(z) := \left(\frac{B_{tb}(z) - B_t(z)}{D_{tb}(z) - D_t(z)}\right)^2$$

$$B_s(z) := Fsy(z)\cdot\left(1 + \sqrt[3]{\frac{Fsy(z)}{800\cdot ksi}}\right) \qquad D_s(z) := \frac{B_s(z)}{10}\cdot\sqrt{\frac{B_s(z)}{E}} \qquad C_s(z) := 0.41\cdot\frac{B_s(z)}{D_s(z)}$$

$$B_{br}(z) := 1.3\cdot Fcy(z)\cdot\left(1 + \sqrt[3]{\frac{Fcy(z)}{340\cdot ksi}}\right) \qquad D_{br}(z) := \frac{B_{br}(z)}{20}\cdot\sqrt{\frac{6\cdot B_{br}(z)}{E}} \qquad C_{br}(z) := \frac{2\cdot B_{br}(z)}{3\cdot D_{br}(z)}$$

Resistance Factors - Per LRFD Methods (2015 AASHTO)

$\phi_{ty} := 0.9 \qquad \phi_{tu} := 0.75 \qquad \phi_c := 0.9 \qquad \phi_b := 0.9 \qquad \phi_v := 0.9 \qquad \phi_t := 0.9$

Allowable Bending - Round Aluminum, Per AASHTO Years 1994-2015 & NAAMM

$Fb_{1994RDAL}(z) := 18\cdot ksi$

$$Fb_{2015RDAL}(z) := \left|\begin{array}{l} F_{yield} \leftarrow 1.17\cdot\phi_{ty}\cdot Fty(z) \\ F_{rupture} \leftarrow 1.24\cdot\phi_{tu}\cdot\dfrac{Ftu(z)}{kt} \\ F_{comp} \leftarrow 1.17\cdot\phi_b\cdot Fcy(z) \\ \min(F_{yield}, F_{rupture}, F_{comp}) \end{array}\right.$$

$$Fb_{Flag}(z) := \left|\begin{array}{l} FbFlag \quad \text{if } FbFlag > 0 \\ \text{otherwise} \\ \quad \left|\begin{array}{l} \lambda \leftarrow \dfrac{Rb(z)}{Twall(z)} \\ 24\cdot ksi \quad \text{if } \lambda \le 33 \\ (27.7 - 1.70\cdot\sqrt{\lambda})\cdot ksi \quad \text{otherwise} \end{array}\right. \end{array}\right.$$

$$Fb_{2013RDAL}(z) := \left|\begin{array}{l} F_{tension} \leftarrow \min\left(\dfrac{1.17\cdot Fty(z)}{ny}, \dfrac{1.24\cdot Ftu(z)}{kt\cdot nu}\right) \\ F_{comp} \leftarrow \left|\begin{array}{l} \lambda \leftarrow \dfrac{Rb(z)}{Twall(z)} \\ \lambda_1 \leftarrow \left(\dfrac{B_{tb}(z) - 1.17\cdot Fcy(z)}{D_{tb}(z)}\right)^2 \\ \lambda_2 \leftarrow \left(\dfrac{\frac{nu}{ny}\cdot B_{tb}(z) - B_t(z)}{\frac{nu}{ny}\cdot D_{tb}(z) - D_t(z)}\right)^2 \\ temp \leftarrow \left|\begin{array}{l} 1.17\cdot\dfrac{Fcy(z)}{ny} \quad \text{if } \lambda \le \lambda_1 \\ \dfrac{1}{ny}\cdot\left(B_{tb}(z) - D_{tb}(z)\cdot\sqrt{\lambda}\right) \quad \text{if } \lambda_1 < \lambda < \lambda_2 \\ \dfrac{\pi^2\cdot E}{16\cdot nu\cdot\lambda\cdot\left(1 + \frac{\sqrt{\lambda}}{35}\right)^2} \quad \text{otherwise} \end{array}\right. \\ temp \end{array}\right. \\ \min(F_{tension}, F_{comp}) \end{array}\right.$$

$$Fb_{RDAL}(z) := \left|\begin{array}{l} Fb_{1994RDAL}(z) \quad \text{if } aashto = 1994 \\ Fb_{2015RDAL}(z) \quad \text{if } aashto = 2015 \lor aashto = 222 \\ Fb_{Flag}(z) \quad \text{if } aashto = \text{"NAAMM"} \\ Fb_{2013RDAL}(z) \quad \text{otherwise} \end{array}\right.$$

Allowable Bending - Square Aluminum, Per AASHTO Years 1994-2015

$Fb_{1994SQAL}(z) := 18\cdot ksi$

$$Fb_{2015SQAL}(z) := \left|\begin{array}{l} F_{yield} \leftarrow 1.30\cdot\phi_{ty}\cdot Fty(z) \\ F_{rupture} \leftarrow 1.42\cdot\phi_{tu}\cdot\dfrac{Fty(z)}{kt} \\ F_{comp} \leftarrow 1.30\cdot\phi_b\cdot Fcy(z) \\ \min(F_{yield}, F_{rupture}, F_{comp}) \end{array}\right.$$

$$Fb_{2013SQAL}(z) := \left|\begin{array}{l} F_{tension} \leftarrow \min\left(\dfrac{Fty(z)}{ny}, \dfrac{Ftu(z)}{kt \cdot nu}\right) \\ F_{comp} \leftarrow \left|\begin{array}{l} \lambda \leftarrow \dfrac{Ltotal \cdot S(z)}{0.5 \cdot \sqrt{I(z) \cdot J(z)}} \\ \lambda_1 \leftarrow \left(\dfrac{B_c(z) - Fcy(z)}{1.6 \cdot D_c(z)}\right)^2 \\ \lambda_2 \leftarrow \left(\dfrac{C_c(z)}{1.6}\right)^2 \\ temp \leftarrow \left|\begin{array}{ll} \dfrac{Fcy(z)}{ny} & \text{if } \lambda \le \lambda_1 \\ \dfrac{1}{ny} \cdot \left(B_c(z) - 1.6 \cdot D_c(z) \cdot \sqrt{\lambda}\right) & \text{if } \lambda_1 < \lambda < \lambda_2 \\ \dfrac{\pi^2 \cdot E}{2.56 \cdot ny \cdot \lambda} & \text{otherwise} \end{array}\right. \\ temp \end{array}\right. \\ \min\left(F_{tension}, F_{comp}\right) \end{array}\right.$$

$$Fb_{SQAL}(z) := \left|\begin{array}{ll} Fb_{1994SQAL}(z) & \text{if } aashto = 1994 \\ Fb_{2015SQAL}(z) & \text{if } aashto = 2015 \vee aashto = 222 \\ Fb_{2013SQAL}(z) & \text{otherwise} \end{array}\right.$$

Allowable Axial - Round Aluminum, Per AASHTO Years 1994-2015 & NAAMM

$$Fa_{1994RDAL}(z) := 18 \cdot ksi$$

$$Fa_{Flag}(z) := \left|\begin{array}{ll} \dfrac{\pi^2 \cdot E}{1.95 \cdot \left(\dfrac{2 \cdot Ltotal}{r_{gyr}(z)}\right)^2} & \text{if } FyFlag = 0 \\ FyFlag & \text{otherwise} \end{array}\right.$$

$$Fa_{2015RDAL}(z) := \left|\begin{array}{l} \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ \lambda_2 \leftarrow C_c(z) \\ F_{yield} \leftarrow \phi_{ty} \cdot Fty(z) \\ F_{rupture} \leftarrow \phi_{tu} \cdot Ftu(z) \\ F_{comp} \leftarrow \left|\begin{array}{l} \phi_c \cdot \dfrac{0.85 \cdot \pi^2 \cdot E}{\lambda^2} \quad \text{if } \lambda \ge \lambda_2 \\ \text{otherwise} \\ \quad \left|\begin{array}{l} F1 \leftarrow \phi_c \cdot \left[0.85 \cdot \left(B_c(z) - D_c(z) \cdot \lambda\right)\right] \\ F2 \leftarrow \phi_c \cdot Fcy(z) \\ \min(F1, F2) \end{array}\right. \end{array}\right. \\ F_{local} \leftarrow \left|\begin{array}{l} \lambda \leftarrow \dfrac{D(z) - Twall(z)}{2 \cdot Twall(z)} \\ \lambda_1 \leftarrow \left(\dfrac{B_{tb}(z) - B_t(z)}{D_{tb}(z) - D_t(z)}\right)^2 \\ \lambda_2 \leftarrow C_t(z) \\ \phi_b \cdot \left(B_{tb}(z) - D_{tb}(z) \cdot \sqrt{\lambda}\right) \quad \text{if } \lambda \le \lambda_1 \\ \phi_b \cdot \dfrac{\pi^2 \cdot E}{16 \cdot \lambda \cdot \left(1 + \dfrac{\sqrt{\lambda}}{35}\right)^2} \quad \text{if } \lambda \ge \lambda_2 \\ \phi_b \left(B_t(z) - D_t(z) \cdot \sqrt{\lambda}\right) \quad \text{otherwise} \end{array}\right. \\ F_{inter} \leftarrow \left|\begin{array}{l} \phi_c \cdot \sqrt[3]{\dfrac{0.85 \cdot \pi^2 \cdot E}{\left(\dfrac{k \cdot Ltotal}{r_{gyr}(z)}\right)^2} \cdot F_{local}{}^{\frac{2}{3}}} \quad \text{if } F_{local} < F_{comp} \\ F_{comp} \quad \text{otherwise} \end{array}\right. \\ \min\left(F_{yield}, F_{rupture}, F_{comp}, F_{local}, F_{inter}\right) \end{array}\right.$$

$$
Fa_{2013RDAL}(z) := \left|\begin{array}{l}
F_{tension} \leftarrow \min\left(\dfrac{Fty(z)}{ny}, \dfrac{Ftu(z)}{kt \cdot nu}\right) \\
F_{comp} \leftarrow \left|\begin{array}{l}
\lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\
\lambda_1 \leftarrow \dfrac{B_c(z) - \dfrac{nu \cdot Fcy(z)}{kc(z) \cdot ny}}{D_c(z)} \\
\lambda_2 \leftarrow C_c(z) \\
temp \leftarrow \left|\begin{array}{l}
\dfrac{Fcy(z)}{kc(z) \cdot ny} \;\; \text{if } \lambda \le \lambda_1 \\
\dfrac{1}{nu} \cdot \left(B_c(z) - D_c(z) \cdot \lambda\right) \;\; \text{if } \lambda_1 < \lambda < \lambda_2 \\
\dfrac{\pi^2 \cdot E}{nu \cdot \lambda^2} \;\; \text{otherwise}
\end{array}\right. \\
temp
\end{array}\right. \\
F_{buckle} \leftarrow \left|\begin{array}{l}
Fc \leftarrow F_{comp} \\
\lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\
Fec \leftarrow \dfrac{\pi^2 \cdot E}{\lambda^2} \\
Fcr \leftarrow \dfrac{\pi^2 \cdot E}{16 \cdot \left(\dfrac{Rb(z)}{Twall(z)}\right) \cdot \left(1 + \dfrac{\sqrt{\dfrac{Rb(z)}{Twall(z)}}}{35}\right)^2} \\
\dfrac{1}{ny} \cdot \sqrt[3]{Fec} \cdot \sqrt[3]{Fcr^2} \;\; \text{if } \dfrac{Fcr}{nu} < Fc \\
Fc \;\; \text{otherwise}
\end{array}\right. \\
\min\left(F_{tension}, F_{comp}, F_{buckle}\right)
\end{array}\right.
$$

$$
Fa_{RDAL}(z) := \left|\begin{array}{l}
Fa_{1994RDAL}(z) \;\; \text{if } aashto = 1994 \\
Fa_{Flag}(z) \;\; \text{if } aashto = \text{"NAAMM"} \\
Fa_{2015RDAL}(z) \;\; \text{if } aashto = 2015 \vee aashto = 222 \\
Fa_{2013RDAL}(z) \;\; \text{otherwise}
\end{array}\right.
$$

Allowable Axial - Square Aluminum, Per AASHTO Years 1994-2015

$$Fa_{1994SQAL}(z) := 18 \cdot ksi$$

$$
Fa_{2013SQAL}(z) := \left|\begin{array}{l}
F_{tension} \leftarrow \min\left(\dfrac{Fty(z)}{ny}, \dfrac{Ftu(z)}{kt \cdot nu}\right) \\
F_{comp} \leftarrow \left|\begin{array}{l}
\lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\
\lambda_1 \leftarrow \dfrac{B_c(z) - \dfrac{nu \cdot Fcy(z)}{kc(z) \cdot ny}}{D_c(z)} \\
\lambda_2 \leftarrow C_c(z) \\
temp \leftarrow \left|\begin{array}{l}
\dfrac{Fcy(z)}{kc(z) \cdot ny} \;\; \text{if } \lambda \le \lambda_1 \\
\dfrac{1}{nu} \cdot \left(B_c(z) - D_c(z) \cdot \lambda\right) \;\; \text{if } \lambda_1 < \lambda < \lambda_2 \\
\dfrac{\pi^2 \cdot E}{nu \cdot \lambda^2} \;\; \text{otherwise}
\end{array}\right. \\
temp
\end{array}\right. \\
F_{buckle} \leftarrow \left|\begin{array}{l}
Fc \leftarrow F_{comp} \\
\lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\
Fec \leftarrow \dfrac{\pi^2 \cdot E}{\lambda^2} \\
Fcr \leftarrow \dfrac{\pi^2 \cdot E}{\left(\dfrac{1.6 \cdot D(z)}{Twall(z)}\right)^2} \\
\dfrac{1}{ny} \cdot \sqrt[3]{Fec} \cdot \sqrt[3]{Fcr^2} \;\; \text{if } \dfrac{Fcr}{nu} < Fc \\
Fc \;\; \text{otherwise}
\end{array}\right. \\
\min\left(F_{tension}, F_{comp}, F_{buckle}\right)
\end{array}\right.
$$

$$
Fa_{2015SQAL}(z) := \left|\begin{array}{l}
F_{yield} \leftarrow \phi_{ty} \cdot Fty(z) \\
F_{rupture} \leftarrow \phi_{tu} \cdot Ftu(z) \\
F_{comp} \leftarrow \left|\begin{array}{l}
\lambda \leftarrow k \cdot \dfrac{Ltotal}{r_{gyr}(z)} \\
\lambda_2 \leftarrow C_c(z) \\
\phi_c \cdot \dfrac{0.85 \cdot \pi^2 \cdot E}{\lambda^2} \quad \text{if } \lambda \geq \lambda_2 \\
\text{otherwise} \\
\quad \left|\begin{array}{l}
F1 \leftarrow \phi_c \cdot \left[0.85 \cdot \left(B_c(z) - D_c(z) \cdot \lambda\right)\right] \\
F2 \leftarrow \phi_c \cdot Fcy(z) \\
\min(F1, F2)
\end{array}\right.
\end{array}\right. \\
F_{local} \leftarrow \left|\begin{array}{l}
\lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\
\lambda_1 \leftarrow \dfrac{B_p(z) - Fcy(z)}{1.6 \cdot D_p(z)} \\
\lambda_2 \leftarrow \dfrac{k1 \cdot B_p(z)}{1.6 \cdot D_p(z)} \\
\phi_c \cdot Fcy(z) \quad \text{if } \lambda \leq \lambda_1 \\
\phi_c \cdot \left(B_p(z) - 1.6 \cdot D_p(z) \cdot \lambda\right) \quad \text{if } \lambda_1 < \lambda < \lambda_2 \\
\phi_c \cdot \dfrac{k2 \cdot \sqrt{B_p(z) \cdot E}}{1.6 \cdot \lambda} \quad \text{otherwise}
\end{array}\right. \\
F_{inter} \leftarrow \left|\begin{array}{l}
\phi_c \cdot \sqrt[3]{\dfrac{0.85 \cdot \pi^2 \cdot E}{\left(\dfrac{k \cdot Ltotal}{r_{gyr}(z)}\right)^2}} \cdot \sqrt[3]{F_{local}{}^2} \quad \text{if } F_{local} < F_{comp} \\
F_{comp} \quad \text{otherwise}
\end{array}\right. \\
\min\left(F_{yield}, F_{rupture}, F_{local}, F_{inter}, F_{comp}\right)
\end{array}\right.
$$

$$
Fa_{SQAL}(z) := \left|\begin{array}{l}
Fa_{1994SQAL}(z) \quad \text{if } aashto = 1994 \\
Fa_{2015SQAL}(z) \quad \text{if } aashto = 2015 \vee aashto = 222 \\
Fa_{2013SQAL}(z) \quad \text{otherwise}
\end{array}\right.
$$

Allowable Shear/Torsion - Round Aluminum, Per AASHTO Years 1994-2015 & NAAMM

$$
Fs_{2015RDAL}(z) := \left|\begin{array}{l}
Rb \leftarrow \dfrac{D(z) - Twall(z)}{2} \\
\lambda \leftarrow 2.9 \cdot \left(\dfrac{Rb}{Twall(z)}\right)^{\frac{5}{8}} \cdot \left(\dfrac{Ltotal}{Rb}\right)^{\frac{1}{4}} \\
F_{shear} \leftarrow \left|\begin{array}{l}
\lambda_1 \leftarrow \dfrac{1.3 \cdot D_s(z) - Fsy(z)}{1.63 \cdot D_s(z)} \\
\lambda_2 \leftarrow \dfrac{C_s(z)}{1.25} \\
\phi_v \cdot Fsy(z) \quad \text{if } \lambda \leq \lambda_1 \\
\phi_v \cdot \dfrac{1.3 \cdot \pi^2 \cdot E}{(1.25 \cdot \lambda)^2} \quad \text{if } \lambda \geq \lambda_2 \\
\phi_v \cdot \left(1.3 \cdot B_s(z) - 1.63 \cdot D_s(z) \cdot \lambda\right) \quad \text{otherwise}
\end{array}\right. \\
F_{torsion} \leftarrow \left|\begin{array}{l}
\lambda_1 \leftarrow \dfrac{B_s(z) - Fsy(z)}{1.25 \cdot D_s(z)} \\
\lambda_2 \leftarrow \dfrac{C_s(z)}{1.25} \\
\phi_t \cdot Fsy(z) \quad \text{if } \lambda \leq \lambda_1 \\
\phi_t \cdot \dfrac{\pi^2 \cdot E}{(1.25 \cdot \lambda)^2} \quad \text{if } \lambda \geq \lambda_2 \\
\phi_t \cdot \left(B_s(z) - 1.25 \cdot D_s(z) \cdot \lambda\right) \quad \text{otherwise}
\end{array}\right. \\
Fs \leftarrow \min\left(F_{shear}, F_{torsion}\right) \\
Fs
\end{array}\right.
$$

$$
Fs_{2013RDAL}(z) := \left|\begin{array}{l}
FsR \leftarrow \dfrac{D(z)}{2} \\
\lambda \leftarrow 2.9 \cdot \sqrt[8]{\left(\dfrac{FsR}{Twall(z)}\right)^5} \cdot \sqrt[4]{\dfrac{Ltotal}{FsR}} \\
\lambda_1 \leftarrow \dfrac{B_s(z) - Fsy(z)}{1.25 \cdot D_s(z)} \\
\lambda_2 \leftarrow \dfrac{C_s(z)}{1.25} \\
\dfrac{Fsy(z)}{ny} \quad \text{if } \lambda \leq \lambda_1 \\
\dfrac{B_s(z) - 1.25 \cdot D_s(z) \cdot \lambda}{ny} \quad \text{if } \lambda_1 < \lambda < \lambda_2 \\
\dfrac{\pi^2 \cdot E}{ny \cdot (1.25 \cdot \lambda)^2} \quad \text{otherwise}
\end{array}\right.
$$

$$
Fs_{1994RDAL}(z) := \left|\begin{array}{l}
FsR \leftarrow D(z) - Twall(z) \\
\lambda \leftarrow 2.9 \cdot \sqrt[8]{\left(\dfrac{FsR}{2 \cdot Twall(z)}\right)^5} \cdot \sqrt[4]{\dfrac{2 \cdot Ltotal}{FsR}} \\
\lambda_1 \leftarrow \left|\begin{array}{l} 39 \quad \text{if } material = 6063 \\ 36 \quad \text{otherwise} \end{array}\right. \\
\lambda_2 \leftarrow \left|\begin{array}{l} 78 \quad \text{if } material = 6063 \\ 65 \quad \text{otherwise} \end{array}\right. \\
8.5 \cdot ksi \quad \text{if } \lambda \leq \lambda_1 \\
\dfrac{39000}{\lambda^2} \cdot ksi \quad \text{if } \lambda \geq \lambda_2 \\
(10.7 - 0.056 \cdot \lambda) \cdot ksi \quad \text{otherwise}
\end{array}\right.
$$

$$
Fs_{Flag}(z) := \left|\begin{array}{l}
FsFlag \quad \text{if } FsFlag > 0 \\
11.33 \cdot ksi \quad \text{otherwise}
\end{array}\right.
$$

$$
Fs_{RDAL}(z) := \left|\begin{array}{l}
Fs_{Flag}(z) \quad \text{if } aashto = \text{"NAAMM"} \\
Fs_{1994RDAL}(z) \quad \text{if } aashto = 1994 \\
Fs_{2015RDAL}(z) \quad \text{if } aashto = 2015 \vee aashto = 222 \\
Fs_{2013RDAL}(z) \quad \text{otherwise}
\end{array}\right.
$$

Allowable Shear/Torsion - Square Aluminum, Per AASHTO Years 1994-2015

$$Fs_{1994SQAL}(z) := \left| \begin{array}{l} FsR \leftarrow D(z) - Twall(z) \\ \lambda \leftarrow \dfrac{D(z) - 2\cdot radius(z)}{r_{gyr}(z)} \\ \lambda_1 \leftarrow \left| \begin{array}{l} 39 \text{ if material} = 6063 \\ 36 \text{ otherwise} \end{array} \right. \\ \lambda_2 \leftarrow \left| \begin{array}{l} 78 \text{ if material} = 6063 \\ 65 \text{ otherwise} \end{array} \right. \\ 12\cdot ksi \text{ if } \lambda \le \lambda_1 \\ \dfrac{39000}{\lambda^2}\cdot ksi \text{ if } \lambda \ge \lambda_2 \\ (15.6 - 0.099\cdot\lambda)\cdot ksi \text{ otherwise} \end{array} \right.$$

$$Fs_{2013SQAL}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z) - 2\cdot radius(z)}{Twall(z)} \\ \lambda_1 \leftarrow \dfrac{B_s(z) - Fsy(z)}{1.25\cdot D_s(z)} \\ \lambda_2 \leftarrow \dfrac{C_s(z)}{1.25} \\ \dfrac{Fsy(z)}{ny} \text{ if } \lambda \le \lambda_1 \\ \dfrac{B_s(z) - 1.25\cdot D_s(z)\cdot\lambda}{ny} \text{ if } \lambda_1 < \lambda < \lambda_2 \\ \dfrac{\pi^2\cdot E}{ny\cdot(1.25\cdot\lambda)^2} \text{ otherwise} \end{array} \right.$$

$$Fs_{2015SQAL}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z) - 2\cdot radius(z)}{Twall(z)} \\ \lambda_1 \leftarrow \dfrac{B_s(z) - Fsy(z)}{1.25\cdot D_s(z)} \\ \lambda_2 \leftarrow \dfrac{C_s(z)}{1.25} \\ \phi_v\cdot Fsy(z) \text{ if } \lambda \le \lambda_1 \\ \phi_v\cdot\left(B_s(z) - 1.25\cdot D_s(z)\cdot\lambda\right) \text{ if } \lambda_1 < \lambda < \lambda_2 \\ \phi_v\cdot\dfrac{\pi^2\cdot E}{(1.25\cdot\lambda)^2} \text{ otherwise} \end{array} \right.$$

$$Fs_{SQAL}(z) := \left| \begin{array}{l} Fs_{1994SQAL}(z) \text{ if aashto} = 1994 \\ Fs_{2015SQAL}(z) \text{ if aashto} = 2015 \vee \text{aashto} = 222 \\ Fs_{2013SQAL}(z) \text{ otherwise} \end{array} \right.$$

Allowable Bending - Round Steel, Per AASHTO Years 1994-2015 & TIA

$$Fb_{2013RDST}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\ \lambda_p \leftarrow 0.13\cdot\dfrac{E}{Fy} \\ \lambda_r \leftarrow 0.26\cdot\dfrac{E}{Fy} \\ \lambda_{max} \leftarrow 0.45\cdot\dfrac{E}{Fy} \\ 0.66\cdot Fy \text{ if } \lambda \le \lambda_p \\ 0.39\cdot Fy\cdot\left[1 + \dfrac{0.09\cdot\left(\frac{E}{Fy}\right)}{\lambda}\right] \text{ if } \lambda_p < \lambda \le \lambda_r \\ 0.39\cdot Fy\cdot\left[1 + \dfrac{0.09\cdot\left(\frac{E}{Fy}\right)}{\lambda}\right] \text{ otherwise} \end{array} \right.$$

$$Fb_{2015RDST}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\ \lambda_p \leftarrow 0.07\cdot\dfrac{E}{Fy} \\ \lambda_r \leftarrow 0.31\cdot\dfrac{E}{Fy} \\ \lambda_{max} \leftarrow 0.45\cdot\dfrac{E}{Fy} \\ \phi_b\cdot Fy \text{ if } \lambda \le \lambda_p \\ \phi_b\cdot Fy\cdot\left[0.77 + \dfrac{0.016\cdot\left(\frac{E}{Fy}\right)}{\lambda}\right] \text{ if } \lambda_p < \lambda \le \lambda_r \\ \phi_b\cdot Fy\cdot\left[\dfrac{0.25\cdot\left(\frac{E}{Fy}\right)}{\lambda}\right] \text{ otherwise} \end{array} \right.$$

$$Fb_{2001RDST}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\ \lambda_p \leftarrow 0.1259\cdot\dfrac{E}{Fy} \\ \lambda_r \leftarrow 0.2616\cdot\dfrac{E}{Fy} \\ 0.66\cdot Fy \text{ if } \lambda \le \lambda_p \\ Fy\cdot\left[0.39 + \dfrac{\left(\frac{E}{Fy}\right)}{29.41\cdot\lambda}\right] \text{ if } \lambda_p < \lambda \le \lambda_r \\ Fy\cdot\left[0.39 + \dfrac{\left(\frac{E}{Fy}\right)}{29.41\cdot\lambda}\right] \text{ otherwise} \end{array} \right.$$

$$Fb_{1994RDST}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{Fy}{E}\cdot\dfrac{Rb(z)}{Twall(z)} \\ \lambda_p \leftarrow 0.063 \\ \lambda_r \leftarrow 0.21 \\ 0.66\cdot Fy \text{ if } \lambda \le \lambda_p \\ Fy\cdot\left(0.39 + \dfrac{0.017}{\lambda}\right) \text{ if } \lambda_p < \lambda \le \lambda_r \\ Fy\cdot\dfrac{0.10}{\lambda} \text{ otherwise} \end{array} \right.$$

$$Fb_{TIARDST}(z) := \left| \begin{array}{l} \lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\ efy \leftarrow E\cdot Fy^{-1} \\ \lambda_p \leftarrow 0.0714\cdot efy \\ \lambda_r \leftarrow 0.309\cdot efy \\ \lambda_{max} \leftarrow 300 \\ \phi_f \leftarrow \left| \begin{array}{l} 0.90 \text{ if } Fy < 52\cdot ksi \\ 0.97 \text{ otherwise} \end{array} \right. \\ \phi_f\cdot Fy \text{ if } \lambda \le \lambda_p \\ \phi_f\cdot 0.330\cdot E\cdot\lambda^{-1} \text{ if } \lambda_r < \lambda \le \lambda_{max} \\ \phi_f\cdot Fy\cdot\left(1 + 0.0207\cdot efy\cdot\lambda^{-1}\right) \text{ otherwise} \end{array} \right.$$

$$Fb_{RDST}(z) := \left| \begin{array}{l} Fb_{2015RDST}(z) \text{ if aashto} = 2015 \\ Fb_{TIARDST}(z) \text{ if aashto} = 222 \\ Fb_{2001RDST}(z) \text{ if aashto} = 2001 \\ Fb_{1994RDST}(z) \text{ if aashto} = 1994 \\ Fb_{2013RDST}(z) \text{ otherwise} \end{array} \right.$$

Allowable Bending - Square Steel, Per AASHTO Years 1994-2015 & TIA

$$Fb_{2001SQST}(z) := \left| \begin{aligned} &\lambda \leftarrow \frac{1}{Twall(z)}\cdot(D(z) - 2\cdot Twall(z) - \min(2\cdot InsideRad(z), 8\cdot Twall(z))) \\ &efy \leftarrow E\cdot Fy^{-1} \\ &\lambda_p \leftarrow 1.116\cdot\sqrt{efy} \\ &\lambda_r \leftarrow 1.527\cdot\sqrt{efy} \\ &0.60\cdot Fy \quad \text{if } \lambda \le \lambda_p \\ &0.815\cdot Fy\cdot\left(1 - \frac{0.2374\cdot\lambda}{\sqrt{efy}}\right) \quad \text{if } \lambda_p < \lambda \le \lambda_r \\ &0.74\cdot Fy\cdot\left(1 - \frac{0.1941\cdot\lambda}{\sqrt{efy}}\right) \quad \text{otherwise} \end{aligned} \right.$$

$$Fb_{1994SQST}(z) := \left| \begin{aligned} &\lambda \leftarrow \frac{1}{Twall(z)}\cdot(D(z) - 2\cdot Twall(z) - \min(2\cdot InsideRad(z), 8\cdot Twall(z))) \\ &\lambda_p \leftarrow \frac{6000}{\sqrt{Fy\cdot psi^{-1}}} \\ &\lambda_r \leftarrow \frac{7500}{\sqrt{Fy\cdot psi^{-1}}} \\ &Kp \leftarrow 1.12 \\ &0.60\cdot Fy \quad \text{if } \lambda \le \lambda_p \\ &0.52\cdot Fy\cdot\left[5\cdot(1 - Kp)\cdot\left(\frac{\sqrt{Fy\cdot psi^{-1}}\cdot\lambda}{7500} - 0.80\right) + Kp\right] \quad \text{if } \lambda_p < \lambda \le \lambda_r \\ &0.52\cdot Fy\cdot\left[1 - \sqrt{0.10\cdot\left(\frac{\sqrt{Fy\cdot psi^{-1}}\cdot\lambda}{7500} - 1\right)}\right] \quad \text{otherwise} \end{aligned} \right.$$

$$Fb_{2013SQST}(z) := \left| \begin{aligned} &\lambda \leftarrow \frac{1}{Twall(z)}\cdot(D(z) - 2\cdot Twall(z) - \min(2\cdot InsideRad(z), 8\cdot Twall(z))) \\ &efy \leftarrow E\cdot Fy^{-1} \\ &\lambda_p \leftarrow 1.12\cdot\sqrt{efy} \\ &\lambda_r \leftarrow 1.53\cdot\sqrt{efy} \\ &0.60\cdot Fy \quad \text{if } \lambda \le \lambda_p \\ &0.82\cdot Fy\cdot\left(1 - \frac{0.24\cdot\lambda}{\sqrt{efy}}\right) \quad \text{if } \lambda_p < \lambda \le \lambda_r \\ &0.74\cdot Fy\cdot\left(1 - \frac{0.19\cdot\lambda}{\sqrt{efy}}\right) \quad \text{otherwise} \end{aligned} \right.$$

$$Fb_{2015SQST}(z) := \left| \begin{aligned} &\lambda \leftarrow \frac{1}{Twall(z)}\cdot(D(z) - 2\cdot Twall(z) - \min(2\cdot InsideRad(z), 8\cdot Twall(z))) \\ &efy \leftarrow E\cdot Fy^{-1} \\ &\lambda_p \leftarrow 1.12\cdot\sqrt{efy} \\ &\lambda_r \leftarrow 1.53\cdot\sqrt{efy} \\ &\lambda_{max} \leftarrow 2.14\cdot\sqrt{efy} \\ &\phi_b\cdot Fy \quad \text{if } \lambda \le \lambda_p \\ &\phi_b\cdot Fy\cdot\left(1.37 - \frac{0.33\cdot\lambda}{\sqrt{efy}}\right) \quad \text{if } \lambda_p < \lambda \le \lambda_r \\ &\phi_b\cdot Fy\cdot\left(1.23 - \frac{0.23\cdot\lambda}{\sqrt{efy}}\right) \quad \text{otherwise} \end{aligned} \right.$$

$$Fb_{SQST}(z) := \left| \begin{aligned} &Fb_{1994SQST}(z) \quad \text{if } aashto = 1994 \\ &Fb_{2001SQST}(z) \quad \text{if } aashto = 2001 \\ &Fb_{2015SQST}(z) \quad \text{if } aashto = 2015 \vee aashto = 222 \\ &Fb_{2013SQST}(z) \quad \text{otherwise} \end{aligned} \right.$$

Allowable Axial - Round Steel, Per AASHTO Years 1994-2015 & TIA

$$Fa_{1994RDST}(z) := \left| \begin{aligned} &F_{tension} \leftarrow 0.6\cdot Fy \\ &\lambda \leftarrow \frac{k\cdot Ltotal}{r_{gyr}(z)} \\ &\lambda_1 \leftarrow \sqrt{\frac{2\cdot\pi^2\cdot E}{Fy}} \\ &F_{comp} \leftarrow \left| \begin{aligned} &0.52\cdot\frac{\pi^2\cdot E}{\lambda^2} \quad \text{if } \lambda \ge \lambda_1 \\ &0.52\cdot Fy - \frac{0.13\cdot Fy^2}{\pi^2\cdot E}\cdot\lambda^2 \quad \text{otherwise} \end{aligned} \right. \\ &\min(F_{tension}, F_{comp}) \end{aligned} \right.$$

$$Fa_{2013RDST}(z) := \left| \begin{aligned} &F_{tension} \leftarrow \min(0.6\cdot Fy, 0.5\cdot Ft) \\ &\lambda \leftarrow \frac{k\cdot Ltotal}{r_{gyr}(z)} \\ &\lambda_1 \leftarrow \sqrt{\frac{2\cdot\pi^2\cdot E}{Fy}} \\ &F_{comp} \leftarrow \left| \begin{aligned} &\frac{Fy\cdot\left(1 - \frac{\lambda^2}{2\cdot\lambda_1^2}\right)}{\frac{5}{3} + \frac{2\cdot\lambda}{8\cdot\lambda_1} - \frac{\lambda^3}{8\cdot\lambda_1^3}} \quad \text{if } \lambda < \lambda_1 \\ &\frac{12\cdot\pi^2\cdot E}{23\cdot\lambda^2} \quad \text{otherwise} \end{aligned} \right. \\ &\min(F_{tension}, F_{comp}) \end{aligned} \right.$$

$$Fa_{TIARDST}(z) := \left|\begin{array}{l} \lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\ efy \leftarrow E \cdot Fy^{-1} \\ \lambda_p \leftarrow 0.114 \cdot efy \\ \lambda_r \leftarrow 0.448 \cdot efy \\ \lambda_{max} \leftarrow 300 \\ FY \leftarrow \left|\begin{array}{ll} Fy & \text{if } \lambda \le \lambda_p \\ Fy \cdot \left(\dfrac{2}{3} + \dfrac{0.0379 \cdot efy}{\lambda}\right) & \text{if } \lambda_p < \lambda \le \lambda \\ \dfrac{0.337 \cdot E}{\lambda} & \text{otherwise} \end{array}\right. \\ \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ \lambda_1 \leftarrow 4.71\left(\sqrt{E \cdot FY^{-1}}\right) \\ Fe \leftarrow \dfrac{\pi^2 \cdot E}{\lambda^2} \\ F_{buckle} \leftarrow \left|\begin{array}{ll} FY \cdot 0.658^{FY \cdot Fe^{-1}} & \text{if } \lambda \le \lambda_1 \\ 0.877 \cdot Fe & \text{otherwise} \end{array}\right. \\ F_{buckle} \leftarrow F_{buckle} \cdot \left|\begin{array}{ll} 0.97 & \text{if } Fy \le 52 \cdot ksi \\ 0.90 & \text{otherwise} \end{array}\right. \\ F_{yield} \leftarrow Fy \cdot \left|\begin{array}{ll} 0.97 & \text{if } Fy \le 52 \cdot ksi \\ 0.90 & \text{otherwise} \end{array}\right. \\ F_{rupture} \leftarrow Ft \cdot \left|\begin{array}{ll} 0.81 & \text{if } Fy \le 52 \cdot ksi \\ 0.75 & \text{otherwise} \end{array}\right. \\ F_{tension} \leftarrow \min\left(F_{yield}, F_{rupture}\right) \\ \min\left(F_{buckle}, F_{tension}\right) \end{array}\right.$$

$$Fa_{2015RDST}(z) := \left|\begin{array}{l} F_{yield} \leftarrow \phi_{ty} \cdot Fy \\ F_{rupture} \leftarrow \phi_{tu} \cdot Ft \\ F_{tension} \leftarrow \min\left(F_{yield}, F_{rupture}\right) \\ efy \leftarrow E \cdot Fy^{-1} \\ \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ Fe \leftarrow \dfrac{\pi^2 \cdot E}{\lambda^2} \\ \lambda_r \leftarrow 0.11 \cdot E \cdot Fy^{-1} \\ Q \leftarrow \left|\begin{array}{ll} 1 & \text{if } \dfrac{D(z)}{Twall(z)} \le \lambda_r \\ 0.67 + \dfrac{0.038 \cdot Twall(z)}{D(z)} \cdot \dfrac{E}{Fy} & \text{otherwise} \end{array}\right. \\ \lambda_1 \leftarrow 4.71 \cdot \sqrt{\dfrac{efy}{Q}} \\ F_{buckle} \leftarrow \left|\begin{array}{ll} Q \cdot Fy \cdot 0.658^{Q \cdot Fy \cdot Fe^{-1}} & \text{if } \lambda \le \lambda_1 \\ 0.877 \cdot Fe & \end{array}\right. \\ F_{buckle} \leftarrow \phi_c \cdot F_{buckle} \\ \min\left(F_{buckle}, F_{tension}\right) \end{array}\right.$$

$$Fa_{RDST}(z) := \left|\begin{array}{ll} Fa_{TIARDST}(z) & \text{if aashto} = 222 \\ Fa_{2015RDST}(z) & \text{if aashto} = 2015 \\ Fa_{1994RDST}(z) & \text{if aashto} = 1994 \\ Fa_{2013RDST}(z) & \text{otherwise} \end{array}\right.$$

Allowable Axial - Square Steel, Per AASHTO Years 1994-2015 & TIA

$$Fa_{1994SQST}(z) := \left|\begin{array}{l} F_{tension} \leftarrow 0.6 \cdot Fy \\ \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ \lambda_1 \leftarrow \sqrt{\dfrac{2 \cdot \pi^2 \cdot E}{Fy}} \\ F_{comp} \leftarrow \left|\begin{array}{ll} 0.52 \cdot \dfrac{\pi^2 \cdot E}{\lambda^2} & \text{if } \lambda \ge \lambda_1 \\ 0.52 \cdot Fy - \dfrac{0.13 \cdot Fy^2}{\pi^2 \cdot E} \cdot \lambda^2 & \text{otherwise} \end{array}\right. \\ \min\left(F_{tension}, F_{comp}\right) \end{array}\right.$$

$$Fa_{2013SQST}(z) := \left|\begin{array}{l} F_{tension} \leftarrow \min(0.6 \cdot Fy, 0.5 \cdot Ft) \\ \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ \lambda_1 \leftarrow \sqrt{\dfrac{2 \cdot \pi^2 \cdot E}{Fy}} \\ F_{comp} \leftarrow \left|\begin{array}{ll} \dfrac{Fy \cdot \left(1 - \dfrac{\lambda^2}{2 \cdot \lambda_1^{\,2}}\right)}{\dfrac{5}{3} + \dfrac{2 \cdot \lambda}{8 \cdot \lambda_1} - \dfrac{\lambda^3}{8 \cdot \lambda_1^{\,3}}} & \text{if } \lambda < \lambda_1 \\ \dfrac{12 \cdot \pi^2 \cdot E}{23 \cdot \lambda^2} & \text{otherwise} \end{array}\right. \\ \min\left(F_{tension}, F_{comp}\right) \end{array}\right.$$

$$Fa_{2015SQST}(z) := \left|\begin{array}{l} F_{yield} \leftarrow \phi_{ty} \cdot Fy \\ F_{rupture} \leftarrow \phi_{tu} \cdot Ft \\ F_{tension} \leftarrow \min\left(F_{yield}, F_{rupture}\right) \\ \lambda \leftarrow \dfrac{k \cdot Ltotal}{r_{gyr}(z)} \\ efy \leftarrow E \cdot Fy^{-1} \\ \lambda_1 \leftarrow 4.71 \cdot \sqrt{efy} \\ Fe \leftarrow \dfrac{\pi^2 \cdot E}{\lambda^2} \\ F_{buckle} \leftarrow \left|\begin{array}{ll} Fy \cdot 0.658^{Fy \cdot Fe^{-1}} & \text{if } \lambda \le \lambda_1 \\ 0.877 \cdot Fe & \text{otherwise} \end{array}\right. \\ \min\left(\phi_c \cdot F_{buckle}, F_{tension}\right) \end{array}\right.$$

$$
Fa_{TIASQST}(z) := \left|\begin{array}{l}
\lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\
efy \leftarrow E\cdot Fy^{-1} \\
\lambda_p \leftarrow 0.47\cdot\sqrt{efy} \\
\lambda_r \leftarrow 0.85\cdot\sqrt{efy} \\
\lambda_{max} \leftarrow 25 \\
FY \leftarrow \left|\begin{array}{l}
Fy \ \text{ if } \lambda \le \lambda_p \\
Fy\cdot\left(1.677 - 0.677\cdot\dfrac{\lambda}{0.47\cdot\sqrt{efy}}\right) \ \text{ if } \lambda_p < \lambda \le \lambda_r \\
\dfrac{0.0332\cdot\pi^2\cdot E}{\lambda^2} \ \text{ otherwise}
\end{array}\right. \\
\lambda \leftarrow \dfrac{k\cdot Ltotal}{r_{gyr}(z)} \\
\lambda_1 \leftarrow 4.44\cdot\sqrt{E\cdot FY^{-1}} \\
Fe \leftarrow \dfrac{\pi^2\cdot E}{\lambda^2} \\
F_{buckle} \leftarrow \left|\begin{array}{l}
FY\cdot\left(1 - 0.25\cdot FY\cdot Fe^{-1}\right) \ \text{ if } \lambda \le \lambda_1 \\
Fe \ \text{ otherwise}
\end{array}\right. \\
F_{yield} \leftarrow 0.97\cdot Fy \\
F_{rupture} \leftarrow 0.81\cdot Ft \\
F_{tension} \leftarrow \min\left(F_{yield}, F_{rupture}\right) \\
\min\left(F_{tension}, F_{buckle}\right)
\end{array}\right.
$$

$$
Fa_{SQST}(z) := \left|\begin{array}{l}
Fa_{TIASQST}(z) \ \text{ if } aashto = 222 \\
Fa_{2015SQST}(z) \ \text{ if } aashto = 2015 \\
Fa_{1994SQST}(z) \ \text{ if } aashto = 1994 \\
Fa_{2013SQST}(z) \ \text{ otherwise}
\end{array}\right.
$$

Allowable Shear/Torsion - Round Steel, Per AASHTO Years 1994-2015 & TIA

$$
Fs_{2015RDST}(z) := \left|\begin{array}{l}
Fs1 \leftarrow \dfrac{1.60\cdot E}{\sqrt{\dfrac{Ltotal}{D(z)}\cdot\left(\dfrac{D(z)}{Twall(z)}\right)^{\frac{5}{4}}}} \\
Fs2 \leftarrow \dfrac{0.78\cdot E}{\left(\dfrac{D(z)}{Twall(z)}\right)^{\frac{3}{2}}} \\
F_{shear} \leftarrow \min(Fs1, Fs2, 0.6\cdot Fy)\cdot\phi_v \\
Ft1 \leftarrow \dfrac{1.23\cdot E}{\sqrt{\dfrac{Ltotal}{D(z)}\cdot\left(\dfrac{D(z)}{Twall(z)}\right)^{\frac{5}{4}}}} \\
Ft2 \leftarrow \dfrac{0.6\cdot E}{\left(\dfrac{D(z)}{Twall(z)}\right)^{\frac{3}{2}}} \\
F_{torsion} \leftarrow \min(Ft1, Ft2, 0.6\cdot Fy)\cdot\phi_t \\
\min\left(F_{shear}, F_{torsion}\right)
\end{array}\right.
$$

$$
Fs_{2013RDST}(z) := \left|\begin{array}{l}
\lambda \leftarrow \dfrac{D(z)}{Twall(z)} \\
\lambda_1 \leftarrow 1.16\cdot\left(\dfrac{E}{Fy}\right)^{\frac{2}{3}} \\
0.33\cdot Fy \ \text{ if } \lambda \le \lambda_1 \\
\dfrac{0.41\cdot E}{\lambda^{\frac{3}{2}}} \ \text{ otherwise}
\end{array}\right.
$$

$$
Fs_{1994RDST}(z) := \left|\begin{array}{l}
\lambda \leftarrow \dfrac{Fy}{E}\cdot\left(\dfrac{D(z)}{2\cdot Twall(z)}\right)^{\frac{3}{2}} \\
\lambda_1 \leftarrow 0.44 \\
0.33\cdot Fy \ \text{ if } \lambda \le \lambda_1 \\
0.143\cdot E\cdot\left(\dfrac{2\cdot Twall(z)}{D(z)}\right)^{\frac{3}{2}} \ \text{ otherwise}
\end{array}\right.
$$

$$
Fs_{RDST}(z) := \left|\begin{array}{l}
Fs_{2015RDST}(z) \ \text{ if } aashto = 2015 \vee aashto = 222 \\
Fs_{1994RDST}(z) \ \text{ if } aashto = 1994 \\
Fs_{2013RDST}(z) \ \text{ otherwise}
\end{array}\right.
$$

Allowable Shear/Torsion - Square Steel, Per AASHTO Years 1994-2015 & TIA

$$
Fs_{2013SQST}(z) := \left|\begin{array}{l}
efy \leftarrow E\cdot Fy^{-1} \\
b \leftarrow D(z) - 2\cdot radius(z) \\
\lambda \leftarrow \dfrac{b}{Twall(z)} \\
\lambda_1 \leftarrow 2.23\cdot\sqrt{efy} \\
0.33\cdot Fy \ \text{ if } \lambda \le \lambda_1 \\
\dfrac{1.64\cdot E}{\lambda^2} \ \text{ otherwise}
\end{array}\right.
$$

$$
Fs_{1994SQST}(z) := \left|\begin{array}{l}
b \leftarrow D(z) - 2\cdot radius(z) \\
\lambda \leftarrow \dfrac{b}{Twall(z)} \\
\lambda_1 \leftarrow \dfrac{12000}{\sqrt{\dfrac{Fy}{psi}}} \\
0.33\cdot Fy \ \text{ if } \lambda \le \lambda_1 \\
\dfrac{47520000}{\lambda^2}\cdot psi \ \text{ otherwise}
\end{array}\right.
$$

$$Fs_{2015SQST}(z) := \begin{array}{|l} kv \leftarrow 5 \\ b \leftarrow D(z) - 2\cdot radius(z) \\ \lambda \leftarrow \dfrac{b}{Twall(z)} \\ efy \leftarrow E\cdot Fy^{-1} \\ \lambda_1 \leftarrow 1.10\cdot\sqrt{kv\cdot efy} \\ \lambda_2 \leftarrow 1.37\cdot\sqrt{kv\cdot efy} \\ CV \leftarrow \begin{array}{|ll} 1 & \text{if } \lambda \le \lambda_1 \\ \dfrac{1.10\cdot\sqrt{kv\cdot efy}}{\lambda} & \text{if } \lambda_1 < \lambda \le \lambda_2 \\ \dfrac{1.51\cdot kv\cdot E}{\lambda^2\cdot Fy} & \text{otherwise} \end{array} \\ 0.6\cdot\phi_v\cdot Fy\cdot CV \end{array}$$

$$Fs_{SQST}(z) := \begin{array}{|ll} Fs_{2015SQST}(z) & \text{if } aashto = 2015 \vee aashto = 222 \\ Fs_{1994SQST}(z) & \text{if } aashto = 1994 \\ Fs_{2013SQST}(z) & \text{otherwise} \end{array}$$

Allowables - Round & Square, Per AASHTO Years 1994-2015 & TIA

$$Fa_{SQ}(z) := \begin{array}{|ll} Fa_{SQST}(z) & \text{if material} = \text{"Steel"} \\ Fa_{SQAL}(z) & \text{otherwise} \end{array} \qquad Fa_{RD}(z) := \begin{array}{|ll} Fa_{RDST}(z) & \text{if material} = \text{"Steel"} \\ Fa_{RDAL}(z) & \text{otherwise} \end{array}$$

$$Fb_{SQ}(z) := \begin{array}{|ll} Fb_{SQST}(z) & \text{if material} = \text{"Steel"} \\ Fb_{SQAL}(z) & \text{otherwise} \end{array} \qquad Fb_{RD}(z) := \begin{array}{|ll} Fb_{RDST}(z) & \text{if material} = \text{"Steel"} \\ Fb_{RDAL}(z) & \text{otherwise} \end{array}$$

$$Fs_{SQ}(z) := \begin{array}{|ll} Fs_{SQST}(z) & \text{if material} = \text{"Steel"} \\ Fs_{SQAL}(z) & \text{otherwise} \end{array} \qquad Fs_{RD}(z) := \begin{array}{|ll} Fs_{RDST}(z) & \text{if material} = \text{"Steel"} \\ Fs_{RDAL}(z) & \text{otherwise} \end{array}$$

$$Fa(z) := \begin{array}{|ll} Fa_{SQ}(z) & \text{if shape} = \text{"Square"} \\ Fa_{RD}(z) & \text{otherwise} \end{array}$$

$$Fb(z) := \begin{array}{|ll} Fb_{SQ}(z) & \text{if shape} = \text{"Square"} \\ Fb_{RD}(z) & \text{otherwise} \end{array}$$

$$Fs(z) := \begin{array}{|ll} Fs_{SQ}(z) & \text{if shape} = \text{"Square"} \\ Fs_{RD}(z) & \text{otherwise} \end{array}$$

$Fa(0) = 2.131 \times 10^3\ psi$ $\quad Fa(Ltotal) = 764.76\ psi$

$Fb(0) = 17.727\cdot ksi$ $\quad Fb(Ltotal) = 17.727\cdot ksi$

$Fs(0) = 8.029\cdot ksi$ $\quad Fs(Ltotal) = 8.479\cdot ksi$

Final Allowables - Per Corrective Factors, Per AASHTO Years 1994-2015 & TIA

$$FA(z) := Fa(z)\cdot \begin{array}{|ll} 1 & \text{if } aashto = 2015 \vee aashto = 222 \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ 0.9\cdot 1.4 & \text{if } aashto = 1994 \\ 1.33 & \text{otherwise} \end{array} \cdot \begin{array}{|ll} 1 & \text{if material} = \text{"Steel"} \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ Weld(z) & \text{otherwise} \end{array}$$

$$FB(z) := Fb(z)\cdot \begin{array}{|ll} 1.4 & \text{if } aashto = 1994 \\ 1 & \text{if } aashto = 2015 \vee aashto = 222 \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ 1.33 & \text{otherwise} \end{array} \cdot \begin{array}{|ll} 1 & \text{if material} = \text{"Steel"} \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ Weld(z) & \text{otherwise} \end{array}$$

$$FS(z) := Fs(z)\cdot \begin{array}{|ll} 1.4 & \text{if } aashto = 1994 \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ 1 & \text{if } aashto = 2015 \vee aashto = 222 \\ 1.33 & \text{otherwise} \end{array} \cdot \begin{array}{|ll} 1 & \text{if material} = \text{"Steel"} \\ 1 & \text{if } aashto = \text{"NAAMM"} \\ Weld(z) & \text{otherwise} \end{array}$$

$FA(0) = 2.409 \times 10^3\ psi$ $\quad FB(0) = 20.041\cdot ksi$ $\quad FS(0) = 9.077\cdot ksi$

$FA(Shoe) = 2.409 \times 10^3\ psi$ $\quad FB(Shoe) = 20.041\cdot ksi$ $\quad FS(Shoe) = 9.077\cdot ksi$

$FA(Ltotal) = 1.017 \times 10^3\ psi$ $\quad FB(Ltotal) = 23.577\cdot ksi$ $\quad FS(Ltotal) = 11.277\cdot ksi$

Coefficient of Amplification - Second Order Effects Consideration/Accommodation

$$P(z) := Pdlt(z) + Picet(z) + Poleice(z) + Totwt(z)$$

$$Test(z) := \begin{array}{|ll} 1 \ \text{if} & \begin{array}{|ll} 2\cdot\pi\cdot\sqrt{\dfrac{E}{Fcy(z)}} \le \dfrac{k\cdot Ltotal}{r_{gyr}(z)} & \text{if } aashto = 2015 \vee aashto = 222 \\ \sqrt{\dfrac{2\cdot\pi^2\cdot E}{Fcy(z)}} \le \dfrac{k\cdot Ltotal}{r_{gyr}(z)} & \text{otherwise} \end{array} \\ 0 & \text{otherwise} \end{array}$$

$$Ca1994 := \begin{array}{|ll} \dfrac{1}{0.52} & \text{if } aashto = 1994 \vee aashto = \text{"NAAMM"} \\ 1 & \text{otherwise} \end{array}$$

$$Pequiv := \sqrt[3]{\frac{I(0)}{I(Ltotal)}}\cdot(Pdlt(0) + Picet(0)) + 0.38\cdot(Totwt(0) + Poleice(0))$$

$$Peuler := \begin{cases} \dfrac{\pi^2 \cdot E \cdot I(0)}{[k\cdot(Ltotal - Shoe)]^2} & \text{if } aashto = 2015 \vee aashto = 222 \\ 2.46\cdot\dfrac{E\cdot I(0)}{(Ltotal - Shoe)^2} & \text{otherwise} \end{cases}$$

$$Ca(z) := \begin{cases} \text{if } Test(z) = 1 \\ \quad \begin{cases} \dfrac{1}{1 - \dfrac{Pequiv}{Peuler}} & \text{if } aashto = 2015 \vee aashto = 222 \\ \dfrac{1}{1 - Ca1994\cdot\dfrac{Pequiv}{Peuler}} & \text{otherwise} \end{cases} \\ 1 \quad \text{otherwise} \end{cases}$$

$Ca(0) = 1.033$

$Ca(Ltotal) = 1.033$

Combined Stress Ratio

$$CSR(z) := \frac{fa(z)}{FA(z)} + Ca(z)\cdot\frac{fb(z)}{FB(z)} + \left(\frac{fs(z)}{FS(z)}\right)^2$$

Maximum CSR & Location of Maximum CSR

$$MaxCSRmatrix := \begin{array}{|l} \text{for } z \in Shoe, Shoe + 1\cdot in\,..\,Ltotal \\ \quad \begin{array}{|l} temp \leftarrow CSR(z) \\ W \leftarrow \begin{array}{|ll} \dfrac{z}{ft} & \text{if } maxp < temp \\ W & \text{otherwise} \end{array} \\ maxp \leftarrow \max(maxp, temp) \end{array} \\ \begin{pmatrix} maxp \\ W \end{pmatrix} \end{array}$$

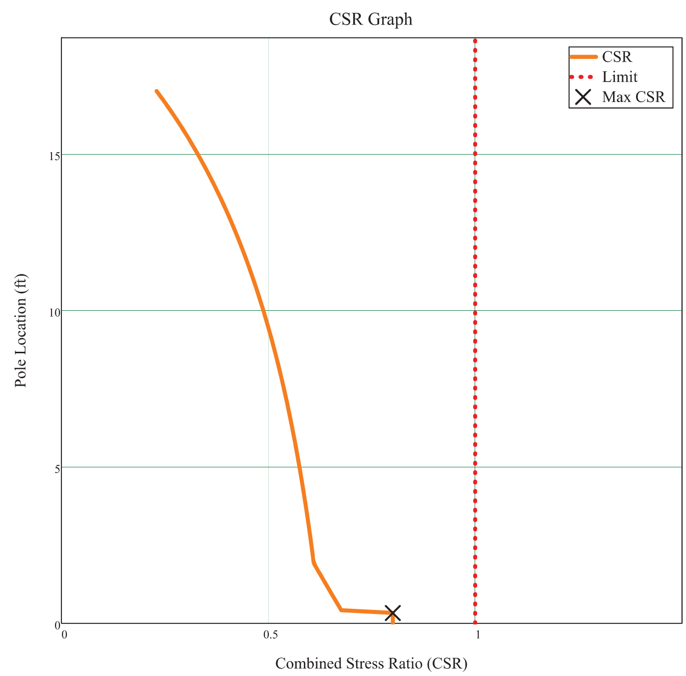
$MaxCSR := MaxCSRmatrix_0$

$MaxCSRlocation := MaxCSRmatrix_1 \cdot ft$

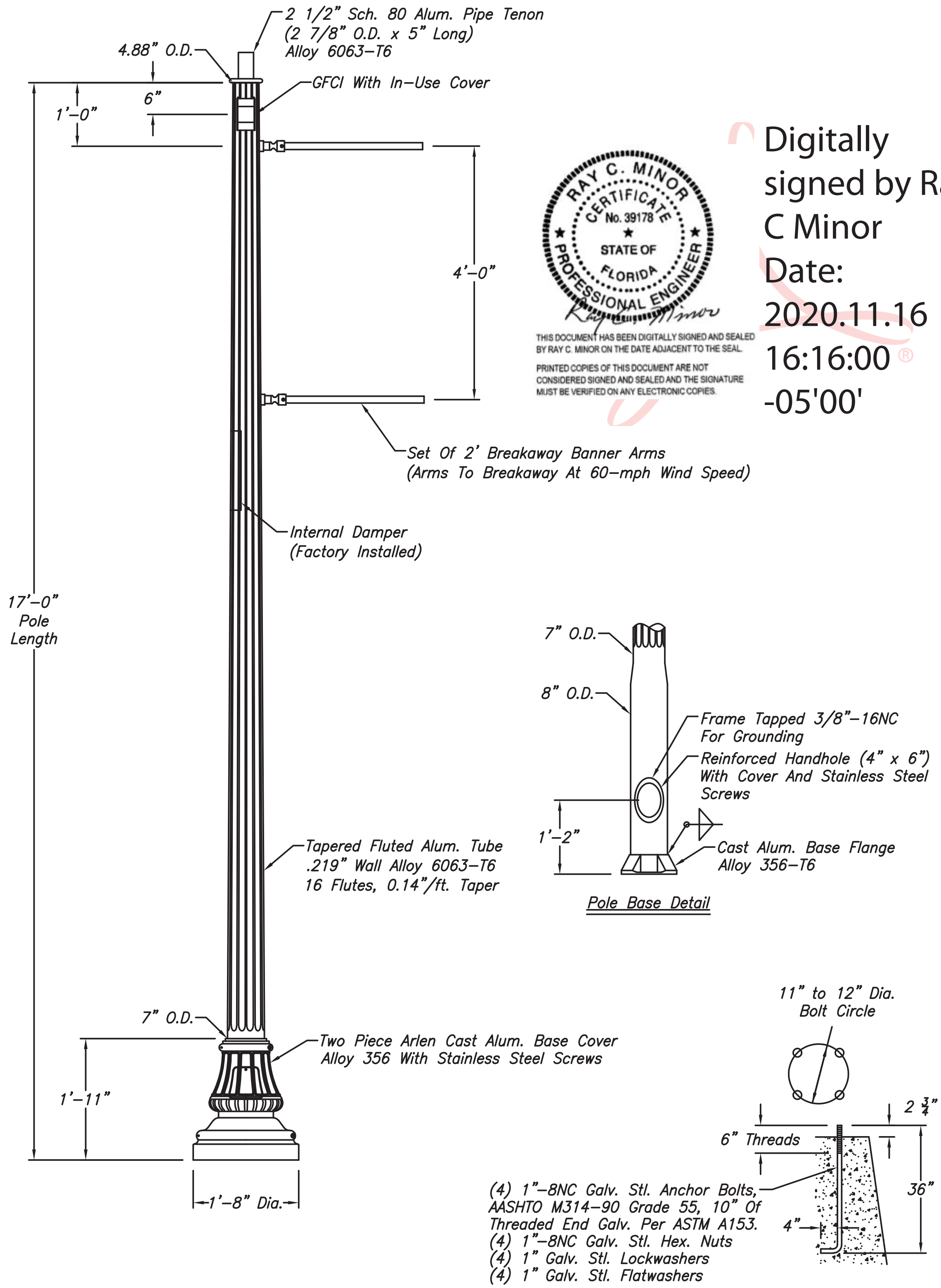
Pole Calculations

$\boxed{MaxCSR = 0.801}$ ***If <= 1, then okay.***

$\boxed{MaxCSRlocation = 3.938\ in}$



Design Notes:
1. *Shaft heat treated to –T6 temper after welding.*
2. *Pole is designed per 2017 FBC for a wind speed of 180–MPH, giving a design life of 50–years when supporting the following:*
   - 2.1. *Luminaire: (5) 1.75–ft^2 EPA & 80–lbs. (each)*
   - 2.2. *Arm: 2.25–ft^2 EPA & 68–lbs.*
   - 2.3. *Banner Arms: 2'x4'; Breakaway at 60–mph*
3. *Pole is designed to be mounted at grade level.*



RAY C. MINOR
CERTIFICATE
No. 39178
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

THIS DOCUMENT HAS BEEN DIGITALLY SIGNED AND SEALED BY RAY C. MINOR ON THE DATE ADJACENT TO THE SEAL.

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Digitally signed by Ray C Minor
Date: 2020.11.16 16:16:00 -05'00'

SKBD092520A

WARNING: DO NOT INSTALL LIGHTING POLES WITHOUT LUMINAIRES

NO.	REVISIONS	DATE

hapco
Abingdon, Va.

TITLE *ARLEN SERIES LIGHT POLE*	
CUSTOMER *HOLOPHANE – FLORIDA*	
SCALE *16*	DATE *09/25/2020*
BY *TNB*	DWG. NO.
CHK'D	SKBD092520A