



**FORM DQP 2.01-1
LEVEL 1 CHECK PRINT SIGN-OFF SHEET**

Client Name: Ohio Department of Transportation
 Job Title: Cleveland Innerbelt Design-Build Contract
 Job Number: CUY-90-14.90
 Document Title: Pier Aesthetic Lighting Fatigue Analysis

Check Level (Mark One): 1A 100% Document Check
 1B 100% Input Check

Enter description below:

	Print Name	Signature	Date
<input checked="" type="checkbox"/> Originator	<u>Kolbe Gravett</u>	<u>[Signature]</u>	<u>6-28-12</u>
<input checked="" type="checkbox"/> Checker	<u>LJ DICKENS</u>	<u>[Signature]</u>	<u>7/9/12</u>
<input checked="" type="checkbox"/> Backchecker	<u>Kolbe Gravett</u>	<u>[Signature]</u>	<u>7-15-12</u>
<input checked="" type="checkbox"/> Updater	<u>Kolbe Gravett</u>	<u>[Signature]</u>	<u>7-15-12</u>
<input checked="" type="checkbox"/> Validator	<u>LJ DICKENS</u>	<u>[Signature]</u>	<u>7/20/12</u>

Insert an "X" in the box to indicate a required QC activity.

For Cleveland Innerbelt	Job no. 49633	Sheet no.
Made by KDG	Checked by LJD	Backchecked by KDG
Date 6-28-12	Date 7/5/12	Date 7-15-12

Check fatigue on Light Pole at top of Cap.

Per section 11.6 Fatigue Category III

Fatigue design for Natural Gust Sec. 11.7.3

Design shall Resist equivalent static wind gust Pressure Range of:

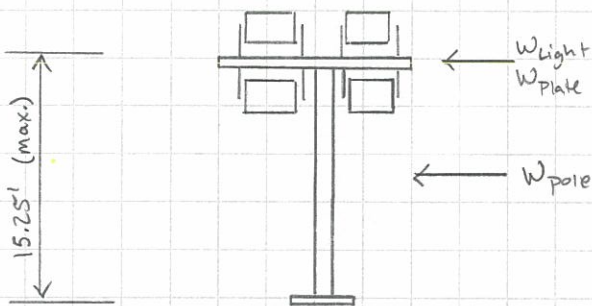
$$P_{nw} = 5.2 C_d I_f$$

$$C_d = 1.7 \quad (\text{Table 3-6})$$

$$I_f = 0.5 \quad (\text{Table 11-1})$$

$$P_{nw} = 4.42 \text{ \#/ft}^2$$

Find Moment @ Top of Base Plate



$$W_{light} = 4 (4.52 \text{ ft}^2) (4.42 \text{ psf}) = 79.91 \text{ \#}$$

$$M_{light} = 79.91 \text{ \#} \left[(15.25(12)) - 0.875 - \frac{0.625}{2} \right]$$

$$= 14,529 \text{ \#}\cdot\text{in}$$

$$W_{plate} = (4') \left(\frac{0.625''}{12} \right) (4.42 \text{ psf}) = 0.92 \text{ \#}$$

$$M_{plate} = 0.92 \text{ \#} (181.81'') = 167.42 \text{ \#}\cdot\text{in}$$

$$W_{pole} = \left(\frac{5''}{12} \right) \left[15.25' - \frac{0.875}{12} - \frac{0.625}{12} \right] (4.42 \text{ psf}) = 28 \text{ \#}$$

$$M_{pole} = 28 \text{ \#} \left[15.25'(12) - 0.625 \right] / 2 = 2553 \text{ \#}\cdot\text{in}$$

$$S_{weld} = b d + \frac{d^2}{3} = 5(5) + \frac{5^2}{3} = 33.33 \text{ in}^2$$

$$M_{Tot} = 14,529 + 167 + 2553 = 17,250 \text{ \#}\cdot\text{in}$$

$$f = \frac{17,250 \text{ \#}\cdot\text{in}}{(33.33)(0.375)(0.707)} = 1.95 \text{ ksi}$$

This is an E' Fatigue Category under Detail 12 of Table 11-2

Category E' has an allowable stress Range of 2.6 ksi

$$2.6 > 1.95 \quad \text{OK for Fatigue.}$$

Anchor Bolt Fatigue

$$\text{Tension in Bolt} = \frac{17250 \text{ \#}\cdot\text{in}}{8''} / 2 \text{ bolts} = 1080 \text{ \#}$$

$$\text{Bolt Area} = \frac{(0.75)^2 \pi}{4} = 0.442 \text{ in}^2$$

$$f_{fat AB} = \frac{1080 \text{ \#}}{0.442 \text{ in}^2} = 2,443 \text{ psi}$$

Anchor Bolts are a fatigue category D with a stress Range limit of 7 ksi

$$7 > 2.44$$

OK for Fatigue

For	Cleveland Innerbelt	Job no.	49633	Sheet no.	
Made by	KDG	Checked by	LJD	Backchecked by	KDG
Date	6-28-12	Date	7/5/12	Date	7-15-12

Check Fatigue in pole to Plate weld at top of Pole,

Wind on Bot. of Plate

$$W = (4')(4')(4.42 \text{ psf}) = 70.72 \#$$

$$M_{\text{plate}} = 70.72 \# (12") = 849 \# \cdot \text{in}$$

Wind on lights

$$W = (4.42)(4.52) = 19.98 \# / \text{light}$$

$$M_{\text{light}} = 19.98(14" + 14" + 18" + 16") = 1,239 \# \cdot \text{in}$$

$$M_{\text{Total}} = 849 + 1,239 = 2,088 \# \cdot \text{in}$$

$$S_{\text{weld}} = bd + \frac{d^2}{3} = 33.33 \text{ in}^2$$

$$f = \frac{2088}{33.33(0.25)(0.707)} = 0.35 \text{ ksi}$$

Consider this Plate as the "Mast Arm" Fillet welded Directly to a column.

This will be a Category K₂ Fatigue under Detail 19 in Table 11-2

Category K₂ has an allowable Stress Range of 1.0 ksi

$$1.0 > 0.35 \quad \text{OK}$$

Check Fatigue on Pier Face light Brackets

Check welds at light attachment to HSS

$$P_{\text{wz}} = 4.42 \# / \text{ft}^2$$

$$\text{Area of light} = 30.16" (17.04") / 144 = 3.6 \text{ ft}^2$$

$$\text{Area of } 2\frac{3}{8} \text{ HSS} = 2.375" (4") / 144 = 0.1 \text{ ft}^2$$

$$\text{Moment Arm} = 16" + 4" = 20"$$

$$M = [(3.6 + 0.1)(4.42)] 20" = 327 \# \cdot \text{in}$$

$$S_{\text{weld circle}} = \pi r^2 = \pi (2.375)^2 = 17.72$$

$$f = \frac{327}{17.72(0.25)(0.707)} = 0.1 \text{ ksi}$$

$$S_{\text{square weld}} = bd + \frac{d^2}{3} = 16 + \frac{16}{3} = 21.33$$

$$f = \frac{327}{21.33(0.25)(0.707)} = 0.1 \text{ ksi}$$

Consider these details as the Mast Arm Fillet welded Directly to a column.

This will be a category K₂ Fatigue under Detail 19 in table 11-2

Category K₂ has an allowable Stress Range of 1.0 ksi

$$1.0 > 0.1 \quad \text{OK}$$

For	Cleveland Innerbelt	Job no.	49633	Sheet no.	
Made by	FDG	Checked by	LJD	Backchecked by	FDG
Date	6-28-12	Date	7/5/12	Date	7-15-12

Check Fillet weld at HSS to HSS connection @ End of Pier Light

$$W_{\text{Light}} = 3.7 \text{ ft}^2 (4.42 \text{ psf}) = 16.4 \#$$

$$\text{Arm} = 7' (12''/ft) + 20'' = 104''$$

$$M_{\text{Light}} = 1706 \# \cdot \text{in}$$

$$W_{\text{square tube}} = 7' (0.333') (4.42 \text{ psf}) = 10.31 \#$$

$$\text{Arm} = (7' / 2) * 12 = 42''$$

$$M_{\text{tube}} = 10.31 \# (42'') = 433 \# \cdot \text{in}$$

$$M_{\text{total}} = 1706 + 433 = 2139 \# \cdot \text{in}$$

$$S_{\text{weld}} = bd + \frac{d^2}{3} = 16 + \frac{16}{3} = 21.33 \text{ in}^2$$

$$f = \frac{2139}{21.33 (0.25)(0.707)} = 0.6 \text{ ksi}$$

Consider this a Category ET under Detail 19 of table 11-2

Category ET has an Allowable stress Range of 1.2 ksi

$$1.2 > 0.6 \quad \text{OK}$$

Check fatigue in Anchor Bolts

Edge of Pier lights Anchor Bolts conservatively use Moment from HSS to HSS weld at End of Pier Light

$$M_{\text{bt}} = 2139 \# \cdot \text{in}$$

Tension in Anchor Bolt

$$T = \frac{2139}{12''} = 178 \#$$

$$f = \frac{178}{\pi (.75)^2 / 4} = 0.4 \text{ ksi}$$

Anchor Bolt Tension is Cat. D w/ 7 ksi Range
 $7 > 0.4$ OK

Check Fatigue in HSS from Bearing against Anchors, wind from side.

Conservatively use Same Moment

$$M_{\text{tot}} = 2139 \# \cdot \text{in}$$

$$\text{Force Bearing on Each Bolt} = \frac{2139 \# \cdot \text{in}}{12''} = 178 \#$$

$$\sigma = \frac{178}{2(0.75)(0.375)} = 0.32 \text{ ksi}$$

This is a Cat. D fatigue detail with stress Range of 7 ksi

$$7 > 0.32 \quad \text{OK}$$

For	Cleveland Innerbelt	Job no.	49633	Sheet no.	
Made by	KDG	Checked by	LJD	Backchecked by	KDG
Date	6-28-12	Date	7/5/12	Date	7-15-12

Check Fatigue on Anchor Bolts for Brackets at End of Piers

For simplicity assume 2 anchor bolts on one side resist all Load.

Wind on light:

$$W_{light} = 3.7 ft^2 (4.42 \text{ psf}) = 16.4 \#$$

$$\text{Arm} = 7'(12) + 24'' + 20'' - 6'' = 122''$$

$$M_{light} = 16.4 (122) = 2,001 \# \cdot \text{in}$$

Wind on 4x4 HSS Arm

$$W_{arm} = 7' (0.333') (4.42 \text{ psf}) = 10.31 \#$$

$$\text{Arm} = \left[\frac{7'(12)}{2} \right] + 24'' - 6'' = 60''$$

$$M_{arm} = 10.31 (60) = 620 \# \cdot \text{in}$$

wind on 7x3 HSS strut

$$W_{strut} = 8.5 (0.25) (4.42) = 9.4 \#$$

$$\text{Arm} = 24'' - 6'' = 18''$$

$$M_{strut} = 9.4 (18) = 170 \# \cdot \text{in}$$

Wind on 4x4 HSS leg

$$W_{leg} = (2' - 0.5') (0.333') (4.42) = 2.2 \#$$

$$\text{Arm} = (24 - 6) / 2 = 9''$$

$$M_{leg} = 2.2 (9'') = 20 \# \cdot \text{in}$$

$$M_{Total} = 20 + 170 + 620 + 2001 = 2811 \# \cdot \text{in}$$

Tension in Anchor Bolt

$$T = \frac{2811}{8''} = 351 \#$$

$$f = \frac{351}{\frac{1}{4} \pi (0.75)^2} = 0.8 \text{ ksi}$$

Anchor Bolt tension is a Fatigue cat. D with a stress limit of 7 ksi Range

$$7 > 0.8 \text{ OK}$$

Check Fatigue in HSS bearing on Anchor Bolt

Wind on Side of Bracket.

Conservatively use same Moment

$$M_{tot} = 2811 \# \cdot \text{in}$$

$$\text{Force Bearing on Each Bolt} = \frac{2811}{8} = 351 \#$$

$$\sigma = \frac{351}{2(0.375)(0.75)} = 0.624 \text{ ksi}$$

this is a Fatigue Cat. D with a Range of 7 ksi.

$$7 > 0.6 \text{ OK}$$



Date: _____ Type: _____

Firm Name: _____

Project: _____

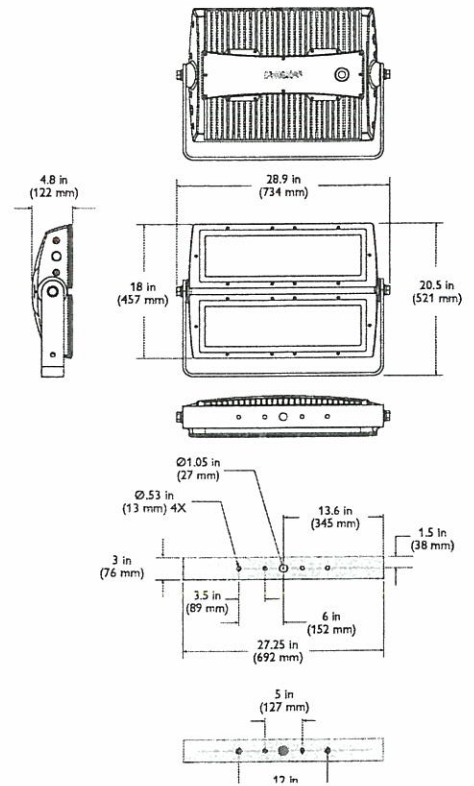
iW Reach Powercore

13° Spread Lens

Intelligent white LED floodlight for signature façades and structures

iW® Reach Powercore, the intelligent white light version of our flagship, high-performance exterior architectural floodlight, is the first LED fixture powerful enough to brilliantly illuminate large architectural façades with washes of white light in color temperatures ranging from a warm 2700 K to a cool 6500 K. Combines all the benefits of LED-based lighting in an elegant fixture specifically designed for commercial skyscrapers, casinos, large retail exteriors, bridges, piers, public monuments, and themed attractions. With significantly more lumen output than any other competitive fixture and unprecedented light projection, this powerful fixture represents the next generation in exterior illumination.

- Integrates Powercore® technology — Powercore technology rapidly, efficiently, and accurately controls power output to fixtures directly from line voltage. The Philips Data Enabler Pro merges line voltage with control data and delivers them to the fixture over a single standard wire, dramatically simplifying installation and lowering total system cost.
- Unparalleled light output — Outputs over 10,000 lumens and projects light over 800 ft (243.8 m). Offers legitimate LED-based, color-controllable white light illumination of large-scale structures and objects.
- Wide range of color temperature and brightness — Channels of warm white and cool white LEDs produce color temperatures ranging from 2700 K – 6500 K. Fixture brightness can be adjusted while varying or maintaining constant color temperature.
- Versatile optics — Exchangeable spread lenses of 8°, 13°, 23°, 40°, 63°, and an asymmetric 5° x 17° support a multitude of applications, including spotlighting, wall grazing, and asymmetric wall washing.
- Unique split design — Spread lenses fit over each fixture half to support diffuser combinations. Use one spread lens on the lower half to bathe a large façade with light at street level, and a different lens to project light hundreds of feet up the building's walls.



- Simple fixture positioning — Rugged, slim-profile mounting bracket allows simple positioning and fixture rotation through a full 360°. Side locking bolts reliably secure fixture with standard wrench.
- Universal power input range — Accepts a universal power input range of 100 – 240 VAC, allowing long fixture runs and consistent installation in any location around the world. Each Data Enabler Pro can support multiple fixtures for illuminating even the largest exterior façades and structures.

For detailed product information, please refer to the iW Reach Powercore Product Guide at www.colorkinetics.com/ls/intelliwhite/iwreach/

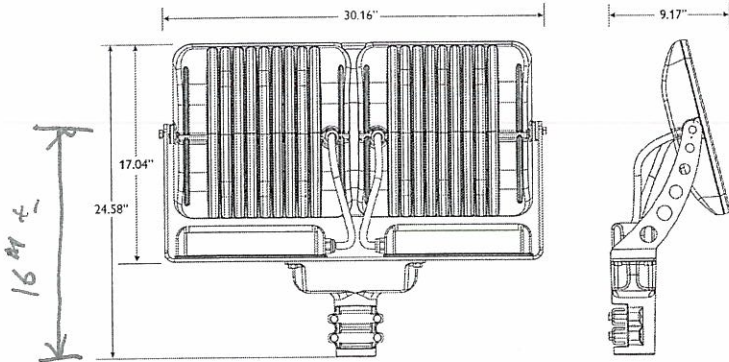
PHILIPS

LEDGINE LED Flood Light (FX2) Specification Sheet

Project Name:	Location:	MFG: Philips Hadco
Fixture Type:	Catalog No.:	Qty:

Ordering Guide

Example: FX2 160 T A S W A 3 E DA S



Product Code	FX2	LEDGINE LED Flood Light
LED BOARDS	160 128	160 LED'S 128 LED'S
Mounting	T	Tenon Mount (1.5"- 2.375" O.D.)
Finish	A B H I J	Black White Bronze Gray Green
Distribution	S N M W H F	Spot Narrow Medium Wide Horizontal Forward Throw
Color Temperature	W N C	3000K 4000K 5700K
Voltage	A B	120-277 VAC 347-480 VAC
Drive Current	3 5	350 mA 530 mA
Photo Control	E H K N	120 VAC Button Eye 208/240/277 VAC Button Eye 347V Button Eye None
Dimming Control	DA DB DC DD DE DF DG DH DJ DZ N	4 Hrs 25% Reduction 4 Hrs 50% Reduction 4 Hrs 75% Reduction 6 Hrs 25% Reduction 6 Hrs 50% Reduction 6 Hrs 75% Reduction 8 Hrs 25% Reduction 8 Hrs 50% Reduction 8 Hrs 75% Reduction Custom Dimming Schedule None
Surge Suppression	S A	Standard Built In <3kV Additional 10kV/10kA

*1 B Voltage not available with dimming.

*2 If using dimming in conjunction with a motion sensor consult factory

Specifications

APPLICATIONS:

This LED Flood Light has a sleek design with precision injection molded optics. Six different optic plates provide versatility for use in many outdoor lighting applications.

CONSTRUCTION:

The housing is constructed of low copper die-cast aluminum with a sleek contemporary design and low EPA. The housing is a unique thermal dissipating design with wide channels that allow for natural removal of dirt and debris. The six different precision designed, injection molded optic plates and three mounting options provide versatility for use in many outdoor lighting applications. The tempered glass lens is held in place with a low copper die cast aluminum lens frame and stainless steel hardware. The optics chamber is IP66 rated and uses an IP67 rated Anti-Wicking connector that is removable and flexible. The flood light is rotatable in 10 degree increments. 180 Degrees backward and 90 degrees forward.

MOUNTING:

The FX2 has one mounting option, Tenon Mount. The tenon mount option includes a cast aluminum adaptor, cast from low-copper aluminum allow for mounting to a 1.5" to 2.375" O.D. vertical tenon. The FX2 utilizes a dual clamp mounting system made from HSLA steel that is zinc plated to protect against corrosion. The FX2 is field rotatable by 10 degree increments (180 degrees backward and 90 degrees forward) on a yoke which is formed from a 1/4" thick, laser-cut aluminum sheet.

ISO 9001:2008 Registered

Page 1 of 2



Note: Philips reserves the right to modify the above details to reflect changes in the cost of materials and/or production and/or design without prior notice.
100 Craftway Drive, Littlestown, PA 17340 | P: +1-717-359-7131 F: +1-717-359-9289 | <http://www.hadco.com> | Copyright 2011 Philips
HW2