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Report No. 103006268CRT-001

MCB Industries, Inc

124 N. Broadway, Suite 90
De Pere, WI 54115
USA

Standards

<i>U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Runway and Taxiway Light Fixtures, AC No. 150/5345-46E dated 3/2/2016.</i>
<i>U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Runway and Taxiway Light Fixtures, AC No. 150/5345-42H dated 11/6/2015</i>

<i>Test Purpose</i>	Research and Development of Isabel System
<i>Test Dates</i>	April 4th, 2017 to April 5th, 2017

Ryan Siddon
Project Engineer
Lighting

Jeremy N. Downs, P.E.
Staff Engineer
Lighting

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Report No.: 103006268CRT-001
 Client: MCB Industries, Inc
 Standard: AC No. 150/5345-46E dated 3/2/2016
 Standard: AC No. 150/5345-42H dated 11/6/2015

Product: Isabel System
 Model(s): N/A

Test Plan and Datasheets			
Client	MCB Industries, Inc	Engineer	Ryan Siddon
Report #	103006268CRT-001	Reviewer	Reviewer Name
Product	Isabel System	Model(s)	N/A
Standard	AC No. 150/5345-46E AC No. 150/5345-42H		

Spec	Test name	Clause	Pass Fail NA
N/A	Torque/Tension Relationships	1	NA
N/A	Torque To Failure Test	2	NA
N/A	Slippage Test	3	NA
46E	Vibration Test / Leakage	4.5.1.1	NA
46E	Horizontal Shear Test	4.5.1.3	NA
42H	Load Test	4.3.1	NA

Sample Information				
Date Rec.	Intertek ID	Description	Condition	Model No.
3/27/2017	CRT1703271005-001	MCB Isabel System	Undamaged	N/A
3/27/2017	CRT1703281106-001-1	Light Fixture Top	Undamaged	N/A
3/27/2017	CRT1703281106-001-2	Light Base Extension + Mud Dam	Undamaged	N/A

Further Sample Description	
Sample:	Isabel System
Bolt Type:	3/8" ASTM F593C Grade 304 SS
Bolt Diameter:	0.368" (3/8" nominal)
Bolt Length:	4.20" (threaded)
Bolt Coated:	Yes
Components:	Bracket, Nut, 1/4 inch Keyed Spacer Ring, Bolt
Clip Bolt Hole Clearance:	0.3995"
Spacer Hole Clearance:	0.422"
Spacer Ring Thickness:	0.25"
Notes:	Bolt Has No head markings. Claimed to be ASTM F593C by MCB. No washers needed. F594G is etched in nut. Nut has red marks to verify if it changed position during testing.

Sample:	Light Fixture Top
Diameter:	12"
Bolt Hole Diameter:	0.435"
Material:	Aluminum
Optics:	1 Glass Window
Notes:	No Electrical Components

Sample:	Spacer Ring With Protective Dam (Mud Dam)
Mud Dam Diameter:	12.25" (inner diameter)
Mud Dam Height:	0.620"
Spacer Ring Diameter:	12"
Spacer Ring Height:	0.755"
Bolt Hole Diameter:	0.427" (drilled clearance hole)
Material:	Carbon Steel - Galvanized
Notes:	N/A

Sample:	Light Base Extension
Base:	L-868B (modified with larger through-holes)
Class:	1A - Galvanized
Bolt Hole Diameter:	0.492" (drilled clearance hole)
Notes:	N/A

Dimensions in sample description measured with items 7 and 19 on equipment list.

Picture(s)



Internal View of Isabel Set-Up
 (Cross-section created by client - representation only)



Top View of Isabel Set-Up

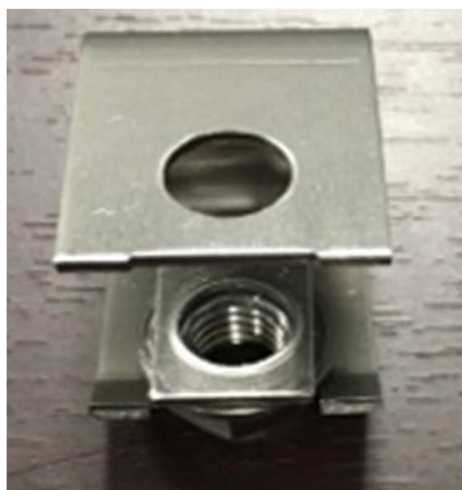
Sample Information



Keyed Portion of 1/4" Spacer Ring (1 of 6)



Top View of 1/4" Keyed Spacer Ring



View 1 of Isabel Clip



View 2 of Isabel Clip



View 3 of Isabel Clip



View of Bolt Head

Sample Information



View of Bolt Threading



Spacer Ring with Protective Dam



F594G Marking On Nuts

Torque/Tension Relationships

The test bolts were assembled in the Skidmore-Wilhelm Bolt Tension Calibrator with the supplied nut and simulated light fixture sections. The bolts were then tightened in 5ftlb increments up to 75% of the bolt's proof or yield load. The corresponding force versus torque curves were recorded, and the friction coefficient was calculated using the equation $T=K*D*FP$.
 An extra bolt was tested in each configuration to observe the change in K values over higher torque applications. This bolt was also torque until failure (ultimate tensile stress)

Results

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Bolt Yield or Proof Load (lbs)	5038
75% Bolt Yield or Proof Load (lbs)	3778
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	No Base Extension Used (Nut Only)
Washer Control No.	No Washer Used
Light Fixture Control No.	N/A - Intertek Inventory*

*An aluminum fixture was cut to fit on the Skidmore Wilhelm.

Bolt 1		
Torque T (ft-lbs)	Tension Fp (lbs)	K
5	400	0.400
10	1100	0.291
15	1800	0.267
20	2500	0.256
25	3200	0.250
30	3800	0.253
Average K		0.263

Bolt 2		
Torque T (ft-lbs)	Tension Fp (lbs)	K
5	400	0.400
10	1000	0.320
15	1600	0.300
20	2200	0.291
25	2800	0.286
30	3300	0.291
35	3900	0.287
Average K		0.296



Red K values are not used in the average calculations.

Bolt 3 - To Failure								
Torque T (ft-lbs)	Tension Fp (lbs)	K	Torque T (ft-lbs)	Tension Fp (lbs)	K	Torque T (ft-lbs)	Tension Fp (lbs)	K
5	--	--	40	4000	0.320	--	--	--
10	--	--	45	4500	0.320	--	--	--
15	1500	0.320	50	5000	0.320	--	--	--
20	2000	0.320	55	5500	0.320	--	--	--
25	2500	0.320	60	5500	0.349	--	--	--
30	3000	0.320	65	5250	0.396	--	--	--
35	3500	0.320	--	--	--	--	--	--
Avg K to 40ft-lbs			Total Bolt 3 Avg K:			0.330		

Overall average K 0.293 includes bolt 3 up to 40ft-lbs

Test Notes: Test was conducted without Isabel System clip and spacer ring (only bolt and modified nut).
 K Factor is not with full Isabel System.

Complies: N/A

Tested By:	Ryan Siddon/Mike Guy	Signature or initials:	MPG 	Comp. Date	4/4/17
Reviewed By:	JND	Signature or initials:	JND 		
Test Equipment Used:	1, 2, 3, 4	Sample No:	See above		
Amb (°C):	22.4	RH%:	42		

Torque To Failure	
<p>The light fixture was assembled to the light base extension using a set of bolts installed with the Isabel system. The bolts were torqued in increments of 10ft.-lb. beginning initially at 15 ft.-lb. The bolt tightening process was repeated until the bolt was no longer able to generate additional installation torque and the peak torque value was recorded.</p>	
Results	

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Spacer	Carbon Steel
Spacer Dimensions	1/4" + 3/4" + Mud Dam Spacer
Accessories	Isabel System
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	CRT1703281106-001-2
Washer Control No.	No Washer Used
Light Fixture Control No.	CRT1703281106-001-1
3/4" Spacer Control No.	N/A - Intertek Inventory

Bolt 1 - Threaded Hole	
Peak T (ft-lbs)	118.00
Peak T (in-lbs)	1416.00

Bolt 2 - Threaded Hole	
Peak T (ft-lbs)	122.33
Peak T (in-lbs)	1468.00

Bolt 3	
Peak T (ft-lbs)	97.83
Peak T (in-lbs)	1174.00

Bolt 4	
Peak T (ft-lbs)	126.00
Peak T (in-lbs)	1512.00


Bolt 5	
Peak T (ft-lbs)	118.50
Peak T (in-lbs)	1422.00

Bolt 6	
Peak T (ft-lbs)	122.83
Peak T (in-lbs)	1474.00

Test Notes:	Test was conducted with Isabel System. Test was conducted with same 6 bolts and Isabel system as Vibration test.
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Observation	Could hear Isabel nuts turning in clips at higher torque values. Machining on all fixture bolts holes. No damage to bolt heads. Can has slight abrasion in larger drilled out holes.
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Complies: N/A

Tested By:	Ryan Siddon/Mike Guy	Signature or initials:	MPG 	Comp. Date:	4/4/17
Reviewed By:	JND	Signature or initials:	JND		
Test Equipment Used:	1, 2, 3, 4	Sample No:	See Above		
Amb (°C):	22.4	RH%:	42		

Slippage Test

Perform a test to simulate the shearing load applied to the top surface of an in pavement fixture by a braking aircraft tire. Weld a bar to the top of the fixture parallel to the runway centerline and parallel to the ground plane. Apply a shear load in 500 pounds to the fore end of the bar. Increase the load by 500 pound increments until the light fixture is determined to have moved its maximum clearance with respect to the fixture bolt holes. Inspect the sample for any mechanical damage.

Results

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Bolt Yield or Proof Load (lbs)	5038
75% Bolt Yield or Proof Load (lbs)	3778
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Spacer	Carbon Steel
Spacer Dimensions	1/4" + 3/4"
Accessories	Isabel System
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	CRT1703281106-001-2
Washer Control No.	No Washer Used
Light Fixture Control No.	N/A - Intertek Inventory*
Spacer Control No.	N/A - Intertek Inventory

*Welded bar was observed to be crooked on the client supplied light fixture top.

ITK Inventory Fixture bolt clearance holes measured to be 0.4475"

Mud Dam was not used for testing

Slippage was measured from light base extension to light fixture.

Pre-Test Torque Values						
Bolts	1	2	3	4	5 (Thr)	6 (Thr)
Bolt torques (in-lbs)	415	415	415	415	415	415

Guage Start (in) -0.0192

Force (lbs)	500	1000	1500	2000	2500	3000	3500	4000
	Measured slippage per loading (in)							
Direction	Aft	Aft	Aft	Aft	Aft	Aft	Aft	Aft
Guage Start (in)	-0.0192	-0.0195	-0.0201	-0.03	-0.0435	-0.056	-0.068	-0.0838
Guage End (in)	-0.0195	-0.0201	-0.03	-0.0435	-0.056	-0.068	-0.0838	-0.115
Slippage (in)	0.0003	0.0006	0.0099	0.0135	0.0125	0.012	0.0158	0.0312
Total Slippage(in)	0.0003	0.0009	0.0108	0.0243	0.0368	0.0488	0.0646	0.0958

Force (lbs)	4500	5000	5500	6000	6500	7000	7500	8000
	Measured slippage per loading (in)							
Direction	Aft	Aft	Aft	Aft	Aft	Aft	Aft	Aft
Guage Start (in)	-0.115	-0.14	-0.178	-0.22	-0.2408	-0.25	-0.2565	-0.262
Guage End (in)	-0.14	-0.178	-0.22	-0.2408	-0.25	-0.2565	-0.262	-0.266
Slippage (in)	0.025	0.038	0.042	0.0208	0.0092	0.0065	0.0055	0.004
Total Slippage(in)	0.1208	0.1588	0.2008	0.2216	0.2308	0.2373	0.2428	0.2468

Total Slippage (in) 0.247

Post-Test Torque Values						
Bolts	1	2	3	4	5 (Thr)	6 (Thr)
Bolt torques (in-lbs)	390	300	300	400	350	300

Observation: Fixture bolts hole 2, 3, 4 have slight bolt thread impressions. Slight thread impressions/marks on larger can holes.

Complies: N/A

Tested By:	Ryan Siddon/Jeremy Downs	Signature or initials:		Comp. Date:	4/6/17
Reviewed By:	JND	Signature or initials:			
Test Equipment Used:	2,4,5,18	Sample No:	See Above		
Amb (°C):	20.1	RH%:	32		

Vibration Test

Subject the light fixture to a sinusoidal vibration along three mutually perpendicular axes. Vibrate the fixture over a frequency range of 20 to 500 Hz, with a maximum acceleration of 10 Gs for 10 minutes. Then vibrate the fixture from 500 to 2000 Hz, with a maximum acceleration of 15 Gs for 10 minutes. After the test, inspect the interior of the fixture for mechanical failure, loosening of any part, or displacement of any part.

Results

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Bolt Yield or Proof Load (lbs)	5038
75% Bolt Yield or Proof Load (lbs)	3778
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Spacer	Carbon Steel
Spacer Dimensions	1/4" + 3/4" + Mud Dam Spacer
Accessories	Isabel System
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	CRT1703281106-001-2
Washer Control No.	No Washer Used
Light Fixture Control No.	CRT1703281106-001-1
Spacer Control No.	N/A - Intertek Inventory

Pre Test Torque Check	
K Factor	.293
Bolt Diameter	.375 in
75% Yield Load	3778 lbs
Calculated Torque	415 in-lbs
Bolt Torque	410-420 in-lbs

Test Run	Lateral	Horizontal	Vertical
Bolt 1 Torque	380 in.lbs.	380 in.lbs.	350 in.lbs.
Bolt 2 Torque	380 in.lbs.	390 in.lbs.	390 in.lbs.
Bolt 3 Torque	385 in.lbs.	390 in.lbs.	415 in.lbs.
Bolt 4 Torque	390 in.lbs.	380 in.lbs.	360 in.lbs.
Bolt 5 Torque	400 in.lbs.	400 in.lbs.	400 in.lbs.
Bolt 6 Torque	390 in.lbs.	400 in.lbs.	370 in.lbs.

Lateral Test Observation	No apparent damage to can, flange, bolts, or fixture top.
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Horizontal Test Observation	Underside Clamp Nut 2(180deg) turned. No apparent damage to can, flange, bolts, or fixture top.
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Vertical Test Observation	No apparent damage to can, flange, bolts, or fixture top.
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Post Test Observations	Y/N
Mechanical Failure of any Component	N
Loosening of any Part or Fastener	Y See bolt torque values above
Loss of Continuity	N

Test Notes:	N/A
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Complies: N/A

Tested By:	Ryan Siddon/Gordie West	Signature or initials:		Comp. Date:	4/4/17
Reviewed By:	JND	Signature or initials:			
Test Equipment Used:	2, 9, 10, 11, 12, 13, 14, 15, 16, 17	Sample No.:	See above		
Amb (°C):	22.3	RH%:	27		

Horizontal Shear Test

Perform a test to simulate the shearing load applied to the top surface of an in pavement fixture by a braking aircraft tire. Weld a bar to the top of the fixture parallel to the runway centerline and parallel to the ground plane. Apply a shearing load of 3000 pounds and release 20 times to each end of the bar. Inspect the sample for any mechanical damage.

Results

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Bolt Yield or Proof Load (lbs)	5038
75% Bolt Yield or Proof Load (lbs)	3778
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Spacer	Carbon Steel
Spacer Dimensions	1/4" + 3/4" + Mud Dam Spacer
Accessories	Isabel System
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	CRT1703281106-001-2
Washer Control No.	No Washer Used
Light Fixture Control No.	N/A - Intertek Inventory*
Spacer Control No.	N/A - Intertek Inventory

*Welded bar was observed to be crooked on the client supplied light fixture top.
 ITK Inventory Fixture bolt clearance holes measured to be 0.4475"

Pre Test Torque Check		
K Factor	.293	
Bolt Diameter	.375	in
75% Yield Load	3778	lbs
Calculated Torque	415	in-lbs
Bolt Torque	415	in-lbs

Direction	Fore	Aft
Load 1	X	X
Load 2	X	X
Load 3	X	X
Load 4	X	X
Load 5	X	X
Load 6	X	X
Load 7	X	X
Load 8	X	X
Load 9	X	X
Load 10	X	X
Load 11	X	X
Load 12	X	X
Load 13	X	X
Load 14	X	X
Load 15	X	X
Load 16	X	X
Load 17	X	X
Load 18	X	X
Load 19	X	X
Load 20	X	X

Target Load			
Required		Measured	
3000	lbs.	3117	lbs.

Post shear loading observaion	
Bolt location	Measured torque (in./lbs.)
1	325
2	300
3	370
4	360
5	415
6	350

Post Test Observations	Y/N
Any Structural Damage	No
Movement of any Part	NA
Loosening of any Fasteners	Yes

X represents that the load was achieved.

Complies: N/A

Tested By:	Mike Guy	Signature or initials:	MPG	Comp. Date	4/5/17
Reviewed By:	JND	Signature or initials:	JND		
Test Equipment Used:	2,4,5	Sample No:	see above		
Amb (°C):	20.1	RH%	32		

Type L-868, Class IA and Class IB Load Test

Subject the sample light base to a load test. Place the light base on a flat steel plate in a standard testing machine for testing. Apply a load to the top part of the container through a rubber block having a durometer hardness of 55 to 70 and 1 1/2 inches thick, with a diameter equal to the cover plate. Apply the load of 450 psi (L-868) uniformly at a rate not exceeding 10,000 lbs. per minute. Repeat the test three times. After each loading, check the bolts for loss of tension after initially being torqued to the manufacturer's recommended service tension.

Results

Bolt Type	ASTM F593C Grade 304 SS
Nominal Bolt Length (inches)	4.5
Marine Grade Anti-Seize (Yes/No)	No
Bolt Diameter (inches)	0.375
Bolt Yield or Proof Load (lbs)	5038
75% Bolt Yield or Proof Load (lbs)	3778
Light Fixture Type	Aluminum
Light Base Extension Type	Class 1A
Spacer	Carbon Steel
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Accessories	Isabel System
Bolt Control No.	CRT1703271005-001
Light Base Extension Control No.	CRT1703281106-001-2
Washer Control No.	No Washer Used
Light Fixture Control No.	CRT1703281106-001-1
Spacer Control No.	N/A - Intertek Inventory

Test / Sample Information		
Size (diameter)	12.0	inches
Area	113	inch sqr
Specified load	50868	lbs.
Height	11/16	inches
Load pad thickness	1	inches
Load pad shore A durometer hardness	62	shore A

Pre Test Torque Check		
K Factor	.293	
Bolt Diameter	.375	in
75% Yield Load	3778	lbs
Calculated Torque	415	in-lbs
Bolt Torque	410-420	in-lbs



Test Run	1	2	3
Measured Load	51021.7 lbs	50913.9 lbs	50984.5 lbs
Bolt 1 Torque	380 in.lbs.	415 in.lbs.	415 in.lbs.
Bolt 2 Torque	350 in.lbs.	415 in.lbs.	415 in.lbs.
Bolt 3 Torque	350 in.lbs.	415 in.lbs.	415 in.lbs.
Bolt 4 Torque	290 in.lbs.	415 in.lbs.	415 in.lbs.
Bolt 5 Torque	250 in.lbs.	415 in.lbs.	415 in.lbs.
Bolt 6 Torque	325 in.lbs.	415 in.lbs.	415 in.lbs.

Test 1 Observation	Underside Clamp Nuts 6(180deg), 5(90deg), 2(180deg), 4(90deg) turned. No apparent damage to can, flange, bolts, or fixture top.
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Test 2 Observation	Underside Clamp Nuts clicked on 1 and 4 returned to original position -- heard click when torquing bolts after test 1. No apparent damage to can, flange, bolts, or fixture top.
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Test 3 Observation	No change in position on the underside clamp nuts. No apparent damage to can, flange, bolts, or fixture top.
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Complies: N/A

Tested By:	Ryan Siddon/Mike Guy	Signature or initials:	MPG 
Reviewed By:	JND	Signature or initials:	JND 
Test Equipment Used:	2, 4, 5, 6, 7, 8	Completion Date:	4/4/2017
Amb (°C):	22.4	RH%	42
		Sample No:	See above

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	M279	Digital Torqe Wrench	Imada	07-Nov-2017
2	M278	Dial Torque Wrench	CDI Torque Products Inc.	05-Dec-2017
3	M280	Bolt Tension Calibrator	Skidmore Wilhelm	15-Nov-2017
4	T1469	Hygro-Thermometer	Cole Parmer	01-Mar-2018
5	S108	Load Cell	Tinius Olsen	14-Apr-2017
6	N1313	Stop Watch	Oslo	13-Jan-2018
7	N1342	Tape Measure	Stanley	27-Dec-2017
8	N797	Shore Scale Durometer	Fowler	29-Apr-2017
9	N1456	Digital Torqe Wrench	Westward	16-Feb-2018
10	V358	Accelerometer	PCB Piezotronics	29-Nov-2017
11	M274	Digit Hygro-Thermometer	Extech	05-Nov-2017
12	V252	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
13	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2017
14	V393	Vibration Controler	Unholtz-Dickie	15-Jul-2017
15	V334	Accelerometer	PCB Piezotronics	08-Mar-2018
16	V253	Accelerometer	Unholtz-Dickie	17-Mar-2018
17	N831	Accelerometer	Unholtz-Dickie	19-May-2017
18	N1266	Digital Indicator	B.C. Ames Co.	13-Jan-2018
19	M283	Digital Calipers	Mitutoyo	13-Apr-2018

Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files