



3933 US Rt 11  
Cortland, NY, 13045  
Telephone: 6077536711  
Facsimile: 6077586637

[www.intertek.com](http://www.intertek.com)

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P.O. No.: 639

Contact: Mary Baetan

Email: [mbaeten@mcb-industries.com](mailto:mbaeten@mcb-industries.com)

Phone No. (920) 983-9740

**Report No. 102710532CRT-001 rev.1**

## **MCB Industries, Inc.**

124 N. Broadway, Suite 90  
De Pere  
WI  
54115

### **Standard**

*U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Runway and Taxiway Light Fixtures, AC No. 150/5345-46E dated 3/02/2016.*

*U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Runway and Taxiway Light Fixtures, AC No. 150/5345-42H dated 11/06/2015.*

Purpose: Performance testing of Isabel fastening system  
Model / Type: Isabel Fastening System  
Test Dates: September 12, 2016 through September 26, 2016

Revision note: This report was revised to include additional torque to failure data for the Isabel fastening system.

**Mike Guy**  
Associate Engineer  
Lighting

**Jeremy N. Downs PE**  
Staff Engineer  
Lighting

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Test Plan and Datasheets			
Client	MCB	Engineer	Mike Guy
Report	102710532CRT-001 rev.1	Reviewer	Jeremy Downs
Product	Isabel system	Model(s)	TBD
Standard	AC No. 150/5345-46E dated 5/19/2009 AC No. 150/5345-42H dated 11/06/2015		

AC No.	Test name	Clause	Pass Fail NA
42H	Load test	4.3.1	NA
46E	Vibration, Leakage	4.5.1.1	NA
46E	Horizontal Shear	4.5.1.3	NA
NA	Torque to failure	Torqfail	NA
NA	Torque versus Tension Evaluation	TorqTen	NA

Sample Information				
Date Rec.	Intertek ID		Condition	Model No.
9/13/16	CRT1609161442-001	Coated, flange head bolts	New	TBD
9/13/16	CRT1609161442-002	Nuts and clips	New	TBD
9/13/16	NA	Fixture cut-away	New	na
8/23/16	CRT1608231126-001	Coated, hex bolts	New	TBD
8/24/16	CRT1608231126-002	Stainless flange nut	New	TBD
8/25/16	CRT1608231126-003	Flat washer	New	TBD
8/26/16	CRT1608231126-004	Hex nut	New	TBD

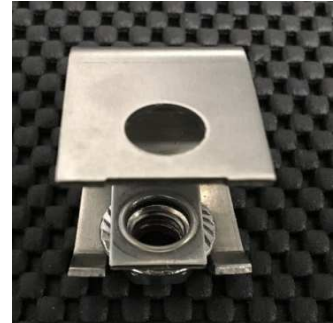
Samples used for Vibration, Horizontal shear and Compressive load testing	
Bolt description	
Length:	4.36 inches (thread length)
Diameter:	3/8 inch
Threads per inch:	16
Material:	ASTM F593C
Blue Coating:	Xylan 1424
Head:	Hex with Flange

Isabel clip and serrated flange nut description	
Nut size:	3/8 inch
Nut Material:	302HQ
Red Adhesive:	Precote 80-3 High Strength and Heat Resistant Thread Coating
Threads per inch:	16
Clip material:	301 SS

Samples used for torque vs. tension comparison, and torque to failure	
Bolt description	
Length:	1.84 inches (thread length)
Diameter:	3/8 inch
Threads per inch:	16
Material:	ASTM F593C
Blue Coating:	Xylan 1424
Head:	Hex
Serrated Flange Nut description	
Nut size:	3/8 inch
Material:	302HQ
Red Adhesive:	Precote 80-3 High Strength and Heat Resistant Thread Coating
Threads per inch:	16

**Sample Information**

Picture(s)



Above pictures of sample representations used for Vibration, Horizontal shear and Compressive load tests

**Sample Information**



Above pictures of sample representations used for Torque vs. Tension comparison

**Sample Information**



**Above pictures of fixtures used for testing**

**Load Test AC 150/5345-42H 4.3.1 (excepting Rubber block thickness of 1" from AC 150/5345-46E)**

Perform a static load test on the light fixture. Apply the compressive load in pounds of 450 times the area in inches of the light fixture to the top part of the light fixture through a rubber block at least 1 inch (25.40mm) less than the outside diameter of the light assembly, 1 inch thick, and of a Shore A hardness of 55-70. Apply the load uniformly at a rate of not greater than 10,000 pounds per minute and hold there for 1 minute. Test to be completed 3 times. Check torque between each application of compressive load.

**Results**

Light F Fixture Dia.	12	inches
Light Fixture Area	113	inch sqr
Compressive Load	50868	lbs.

Rubber Block			Req,
Diameter	11	inches	≤ Fixture Dia - 1"
Thickness	1	inches	1" (25.40mm)
Shore "A"	66	NA	55-70

Post Test Observations	Y/N
Permanent Deformation	N
Cracking of material or finish	N
Breaking or damage to Light	N

Bolt identification	Torque values (in.lbs.)			
	Initial torque	1st load	2nd load	After 3rd loading
1	360	320	345	360
2	360	309	315	345
3	360	289	300	310
4	360	300	300	300
5	360	289	310	300
6	360	315	315	325



**Test Results Summary**

Tested By	Mike Guy	Signature or initials	MPG	Comp. Date	9/13/16
Reviewed By	JND	Signature or initials	JND		
Test Equipment Used	1,11,12,13				
Sample ID#	CRT1609161442-001 (1-6)	Ambient (°C)	26.3	RH%	42

CRT1609161442-002

**Vibration**

Subject the light fixture to a sinusoidal vibration along three mutually perpendicular axes. Operate the lamps to monitor the continuity continually. 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. If the lamp filament or envelope is damaged, replace the lamp and repeat the test at 3 Gs. After the test, inspect the interior of the fixture for mechanical failure, loosening of any part, or displacement of any part.

**Results**

Post Test Observations	Y/N
Mechanical Failure of any Component	N
Loosening of any Part or Fastener	Y

Torque values changed after each vibration segment

Note: Fresh bolts and nuts were used for each axis and the adhesive was allowed to set for 30 minutes before testing.

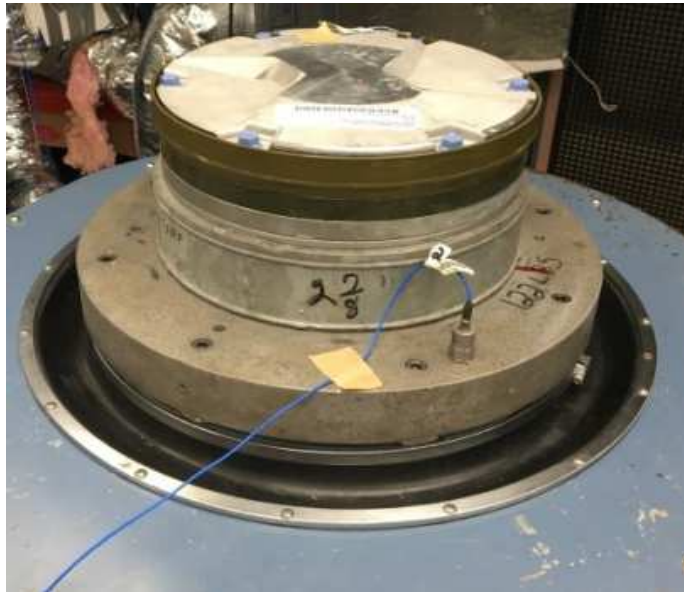
Bolt ident	in. lbs.	in. lbs.
	initial torque	Post Vertical
1	360	320
2	360	320
3	360	330
4	360	330
5	360	300
6	360	335
		Post lateral
7	360	320
8	360	300
9	360	320
10	360	305
11	360	315
12	360	295
		Post horizontal
13	360	320
14	360	305
15	360	305
16	360	315
17	360	320
18	360	320

**Test Results Summary**

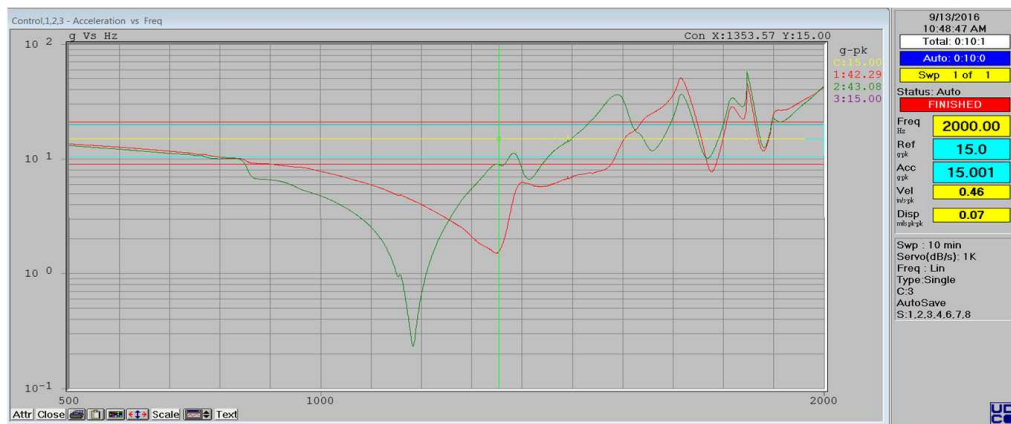
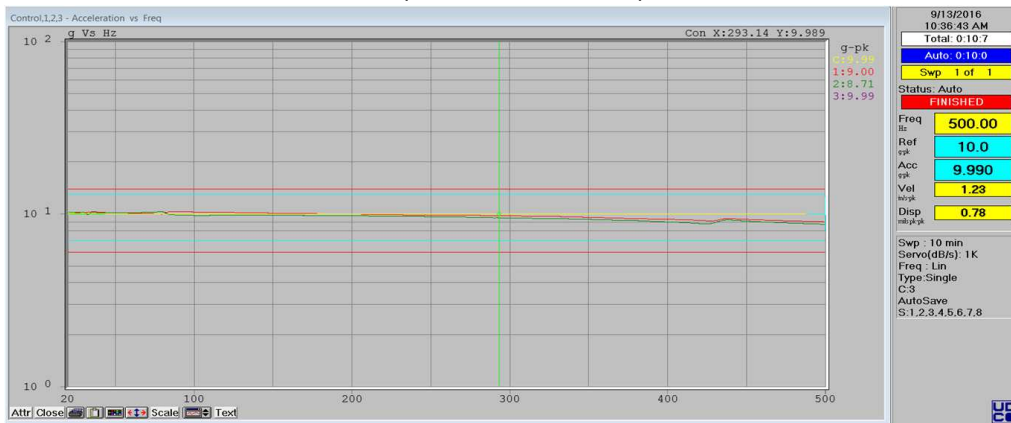
Tested By	Gordon West	Signature or initials	<i>Gordon West</i>	Comp. Date	9/13/16
Reviewed By	JND	Signature or initials	<i>JND</i>		
Test Equipment Used	1,2,3,4,5,6,7,8,9,10,11,12				
Sample ID#	CRT1609161442-001 (1-18)	Ambient (°C)	23.6	RH%	40
	CRT1609161442-002				



**Vibration**

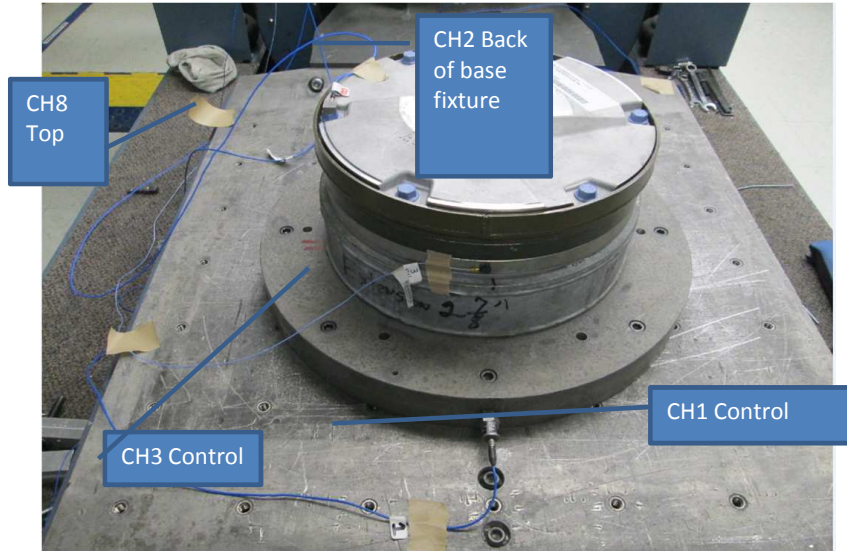


Vertical Axis set up control with ch3 on top of bolt head

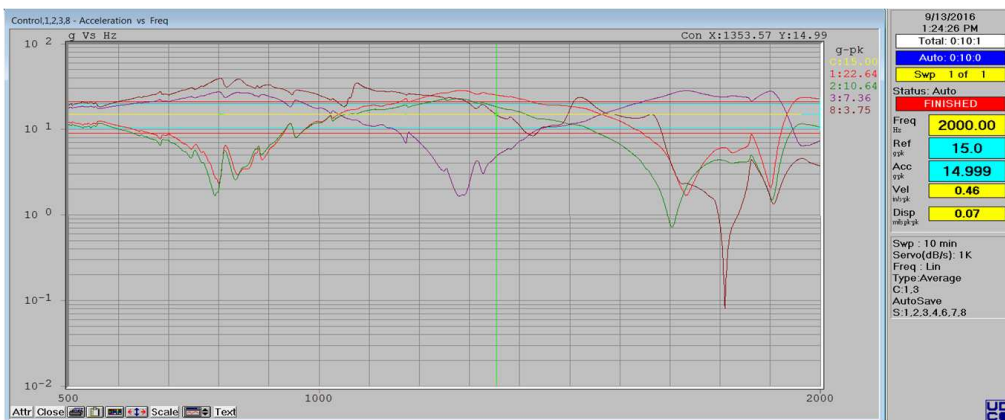
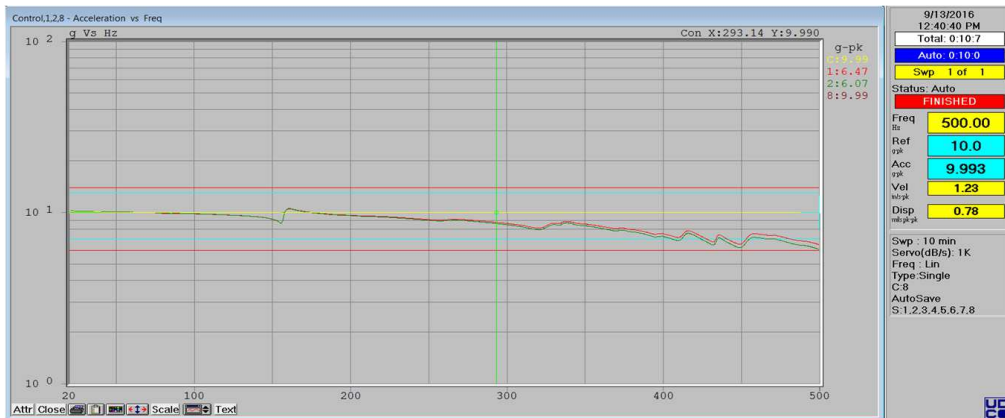


Vertical Axis Data

**Vibration**

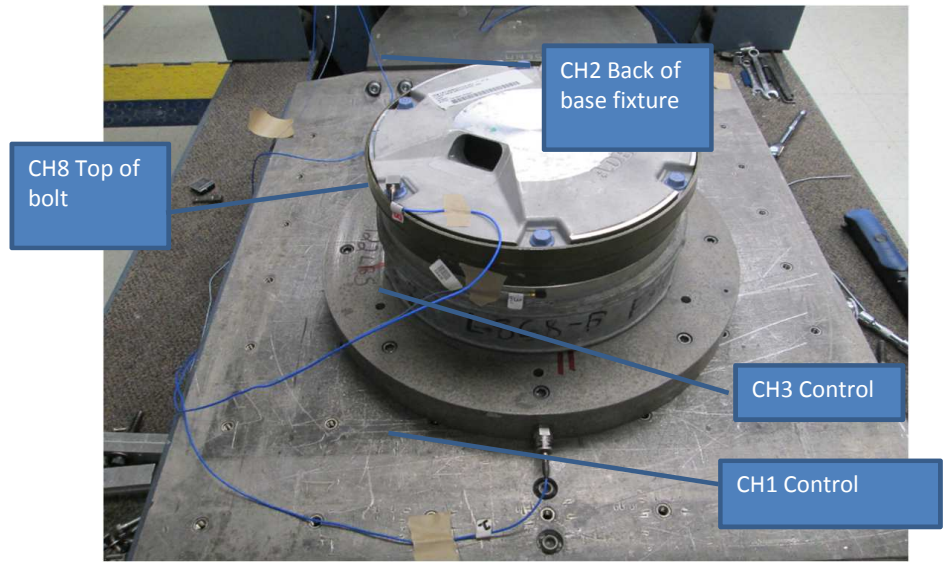


Lateral set up control averaging ch1 and ch3

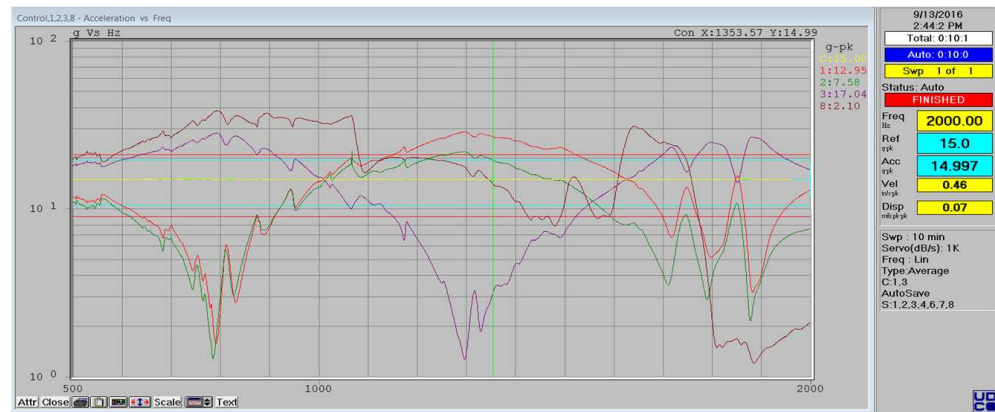
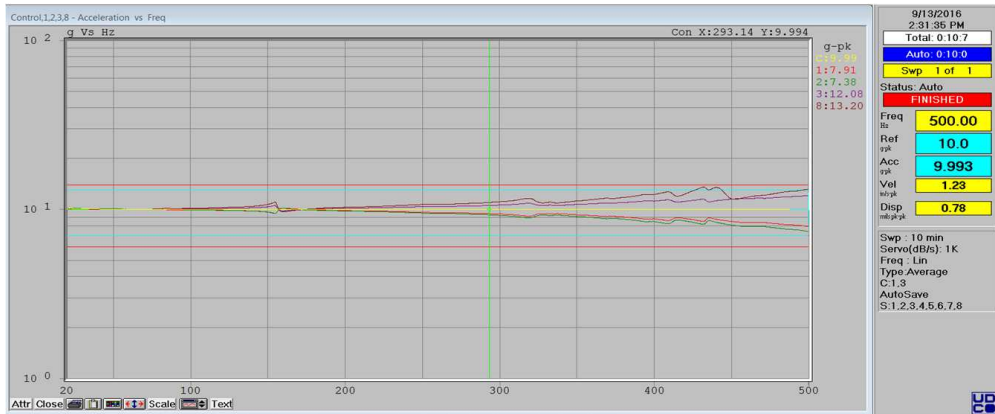


Lateral Axis Data

**Vibration**



Horizontal set up control averaging ch1 and ch3



Horizontal Axis Data

Vibration



Noted that hex nut was found turned in clip after vibration testing

**Horizontal Shear FAA AC 150/5345-46E 4.5.13 ( excepting load applied was 6000 lbs.)**

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 6000 pounds and release 20 times to each end of the bar. Inspect the sample for any mechanical damage.

**Results**

		Bolt identification					
Direction	Fore	19	20	21	22	23	24
Initial (in.lb)	na	360	360	360	360	360	360
Load 1	X	na	na	na	na	na	na
Load 2	X	na	na	na	na	na	na
Load 3	X	na	na	na	na	na	na
Load 4	X	na	na	na	na	na	na
Load 5	X	na	na	na	na	na	na
Load 6	X	na	na	na	na	na	na
Load 7	X	na	na	na	na	na	na
Load 8	X	na	na	na	na	na	na
Load 9	X	na	na	na	na	na	na
Load 10	X	305	315	290	308	295	318
Load 11	X	na	na	na	na	na	na
Load 12	X	na	na	na	na	na	na
Load 13	X	na	na	na	na	na	na
Load 14	X	na	na	na	na	na	na
Load 15	X	na	na	na	na	na	na
Load 16	X	na	na	na	na	na	na
Load 17	X	na	na	na	na	na	na
Load 18	X	na	na	na	na	na	na
Load 19	X	na	na	na	na	na	na
Load 20	X	323	325	300	320	305	320

		Bolt identification					
Direction	Aft	19	20	21	22	23	24
Initial (in.lb)	na	360	360	360	360	360	360
Load 1	X	na	na	na	na	na	na
Load 2	X	na	na	na	na	na	na
Load 3	X	na	na	na	na	na	na
Load 4	X	na	na	na	na	na	na
Load 5	X	na	na	na	na	na	na
Load 6	X	na	na	na	na	na	na
Load 7	X	na	na	na	na	na	na
Load 8	X	na	na	na	na	na	na
Load 9	X	na	na	na	na	na	na
Load 10	X	288	306	279	320	300	280
Load 11	X	na	na	na	na	na	na
Load 12	X	na	na	na	na	na	na
Load 13	X	na	na	na	na	na	na
Load 14	X	na	na	na	na	na	na
Load 15	X	na	na	na	na	na	na
Load 16	X	na	na	na	na	na	na
Load 17	X	na	na	na	na	na	na
Load 18	X	na	na	na	na	na	na
Load 19	X	na	na	na	na	na	na
Load 20	X	320	323	320	340	325	320

**Horizontal Shear FAA AC 150/5345-46E 4.5.13 ( excepting load applied was 6000 lbs.)**

Test set-up in the Fore position



**Horizontal Shear FAA AC 150/5345-46E 4.5.13 ( excepting load applied was 6000 lbs.)**

Test set-up in the Aft position



Post Test Observations	Y/N
Any Structural Damage	N
Movement of any Part	Y
Loosening of any Fasteners	Y

Movement of spacer rings noted in post test visual exam  
 Torque value changed after load applied

**Test Results Summary**

Tested By	Mike Guy	Signature or initials	MPG	Comp. Date	9/13/16
Reviewed By	JND	Signature or initials	JND		
Test Equipment Used	1,11,12,13				
Sample ID#	CRT1609161442-001 (19-24)	Ambient (°C)	29	RH%	32
	CRT1609161442-002				

**System torque to failure**

The below light fixture/ spacer ring / light base cut-away test fixture was assembled and secured with one Isabel System bolt, and the torque was increased until failure occurred. The components of the assembly were then disassembled and inspected.

**Results**

The bolt broke within the threaded region as pictured below. The system was able to be disassembled with basic hand tools, and removed.



Cut-away test fixture



Clip, nut, and bolt after test

Tested By	Mike Guy	Signature or initials	MPG	Comp. Date	9/13/16
Reviewed By	JND	Signature or initials	JND		
Test Equipment Used	10,12				
Sample ID#	CRT1609161442-003	Ambient (°C)	29	RH%	32



The below light fixture/ spacer ring / light base test fixture was assembled and secured with six Isabel System bolts, and the torque was increased on three bolts until failure occurred. The components of the assembly were then disassembled and inspected.

**Results**

The bolt broke within the threaded region as pictured below. The system was able to be disassembled with basic hand tools, and removed.

	Description
	2.84" (thread length) blue coated 593C bolt, flat washer, SS serrated flange nut and Isabel system clip
Sample	Peak torque
1	640 Inlbs
2	440 Inlbs
3	450 Inlbs



Clip, nut, and bolt after test



Disassembled fixture w/ broken bolts as found post test



Test set-up shown above

The below light fixture/ spacer rings / light base test fixture was assembled and secured with six Isabel System bolts, and the torque was increased on three bolts until failure occurred. The components of the assembly were then disassembled and inspected.

**Results**

The bolt broke within the threaded region as pictured below. The system was able to be disassembled with basic hand tools, and removed.

	Description
	4.36" (thread length) blue coated flange bolt, SS serrated flange nut and Isabel system clip
Sample	Peak Torque
1	>999, <1200 Inlbs
2	>999, <1200 Inlbs
3	>999, <1200 Inlbs



Clip, nut, and bolt after test



Test set-up shown above

Tested By	Mike Guy	Signature or initials	MPG	Comp. Date	9/27/16
Reviewed By	JND	Signature or initials	JND		
Test Equipment Used	10,12,16				
Sample ID#	CRT1609161442-001, 002	Ambient (°C)	21.8	RH%	40
	CRT1608231126-001, 003				

**Bolt Torque vs. Bolt Tension Evaluation**

A variety of fastening arrangements were assembled with a Skidmore-Wilhelm Bolt Tension Calibrator, and tightened to a range of torque values to evaluate the bolt torque / tension relationship, and to compare the friction coefficient (K) values of the bolted joints. The K values were calculated with the following equation:  $T=K \cdot D \cdot F$ . This data was also used to determine a torque value to be used with the Isabel System during the other mechanical tests. The below bolt tension values were obtained from the client's Skidmore - Wilhelm Bolt Tension Calibrator that did not possess a current calibration, so those values are provided for information only and are not presented as official Intertek data.

**Results**

Test configuration	Torque (inlbs)	Bolt Tension (lbs)	K	average K
Blue coated hex head bolt 593C Flat washer Hex nut (stainless)	50	800	0.17	0.17
	100	1400	0.19	
	150	2400	0.17	
	200	3200	0.17	
	230	4000	0.15	
Blue coated hex head bolt 593C Flat washer Hex nut (stainless)	50	1000	0.13	0.16
	100	1600	0.17	
	150	2400	0.17	
	200	3200	0.17	
	230	4000	0.15	
Blue coated hex head bolt 593C Flat washer Hex nut (stainless)	50	800	0.17	0.18
	100	1400	0.19	
	150	2100	0.19	
	200	2800	0.19	
	250	3600	0.19	
	270	4000	0.18	
Blue coated hex head bolt 593C Flat washer Hex nut (stainless)	50	800	0.17	0.19
	100	1400	0.19	
	150	2000	0.20	
	200	2800	0.19	
	280	3800	0.20	
	290	4000	0.19	
18-8 Stainless bolt Flat washer Anti-seize on bolt threads and nut surface	60	1100	0.15	0.15
	100	1700	0.16	
	150	2600	0.15	
	200	3600	0.15	
	220	4000	0.15	
18-8 Stainless bolt Flat washer Anti-seize on bolt threads and nut surface	60	1200	0.13	0.15
	100	1900	0.14	
	150	2600	0.15	
	200	3600	0.15	
	250	4400	0.15	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	50	800	0.17	0.18
	100	1400	0.19	
	150	2200	0.18	
	200	2800	0.19	
	250	3800	0.18	
	285	4000	0.19	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	460	6500	0.19	NA
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	570	7900	0.19	NA
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	80	1200	0.18	0.20
	100	1400	0.19	
	150	1900	0.21	
	200	2600	0.21	
	250	3400	0.20	
	300	4000	0.20	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	60	750	0.21	0.22
	100	1100	0.24	
	150	1700	0.24	
	200	2800	0.19	
	250	3200	0.21	
	310	4000	0.21	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	70	800	0.23	0.26
	100	1200	0.22	
	150	1500	0.27	
	200	2000	0.27	
	250	2500	0.27	
	300	3000	0.27	
	400	4000	0.27	

Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	70	700	0.27	0.30
	100	900	0.30	
	150	1300	0.31	
	200	1700	0.31	
	250	2100	0.32	
	300	2600	0.31	
	350	3200	0.29	
	400	3700	0.29	
	430	4000	0.29	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	75	850	0.24	0.29
	100	1000	0.27	
	150	1400	0.29	
	200	1700	0.31	
	250	2100	0.32	
	300	2600	0.31	
	350	3100	0.30	
	400	3600	0.30	
	435	4000	0.29	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	89	1000	0.24	0.23
	177	2000	0.24	
	266	3000	0.24	
	301	4000	0.20	
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	350	4000	0.23	NA
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	410	4400	0.25	NA
Blue coated hex head bolt 593C Flat washer SS serrated flange nut w/ red adhesive	300	4000	0.20	NA
Blue coated hex head bolt 593C - 2.5" SS serrated flange nut w/ red adhesive Flat washer	360	4800	0.20	NA
Breakaway after 30 min.set time	250	NA	NA	NA
Blue coated hex head bolt 593C - 1.5" SS serrated flange nut w/ red adhesive Flat washer	360	4400	0.22	NA
Breakaway after 30 min.set time	300	NA	NA	NA

Tested By	Mike Guy	Signature or initials	MPG	Comp. Date	9/12/16				
Reviewed By	JND	Signature or initials	JND						
Test Equipment Used	10,12,14								
Sample ID#	CRT1608231126-001-004	Ambient (°C)	29	RH%	32				

Equipment list				
#	Intertek ID No.	Description	Manufacturer	Calibration Due
1	N580	Torque Wrench	Dresser	08-Jul-2017
2	T1486	Digit Hygro-Thermometer	Extech	16-Mar-2017
3	dated 5/19/2009	Signal Conditioner	Unholtz-Dickie	01-Feb-2017
4	V393	Vibration Controler	Unholtz-Dickie	15-Jul-2017
5	V255	Accelerometer	Unholtz-Dickie	24-Feb-2017
6	V253	Accelerometer	Unholtz-Dickie	24-Mar-2017
7	V358	Accelerometer	PCB Piezotronics	18-Nov-2016
8	V328	Accelerometer	PCB Piezotronics	02-Dec-2016
9	V272	Signal Conditioner	Unholtz-Dickie	27-Jun-2016
10	N1456	Torque Wrench	Westward	12-Feb-2017
11	82718	Load cell	Tinius-Olsen	14-Apr-2017
12	T1362	Hygrothermometer	Extech	28-Mar-2017
13	N1449	Digital Calipers	General	21-Jan-2017
14	3804 (S/N)	Bolt Tension Calibrator	Skidmore - Wilhelm	05-Dec-2015
15	N797	Shore A durometer	Fowler	29-Apr-2017
16	K110	Torque Wrench	~~~	01-Aug-2017
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**Note: For measurement uncertainty, refer to the calibration certificates for all the test equipment located in the equipment files**