



# LM-79-08 TEST REPORT

for

# **RAB Lighting INC**

170 Ludlow Avenue, Northvale, New Jersey 07647 USA

# LED Tube

# Model: T8-13-U1G-830-SD-HYB

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ20090061a

The laboratory that conducted the testing detailed in this report has been accredited for SSL by NVLAP.

Review by: Engineer: April Zou Sep. 29, 2020 Approverties: Marager: Jim Zhang Sep. 29, 2020

Note: This report does not imply product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.



## **TEST SUMMARY**

## Sample Tested: T8-13-U1G-830-SD-HYB

Luminous Efficacy (Lumens /Watt)	Luminous Flux (Lumens)	Pov (Wat	wer tts)/2	Power Factor		
129.6	1995.0	15	.40	0.9974		
ССТ (К)	CRI			tabilization Time Light & Power)		
2912	81.2			60		

Table 1: Executive Data Summary

Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

Test specifications:													
Date of Receipt	: May 15, 2018												
Date of Test	: May 16, 2018- Jul. 14, 2020												
Test item	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy,												
	Correlated Color Temperature, Color Rendering Index, Chromaticity												
	Coordinate, Electrical parameters												
<b>Reference Standard</b>	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric												
	Measurements of Solid-State Lighting Products												
	ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color												
	Rendition												
Keterence Standaru	Measurements of Solid-State Lighting Products ANSI/IES TM-30-18 IES Method for Evaluating Light Source Color												

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## SAMPLE PHOTO

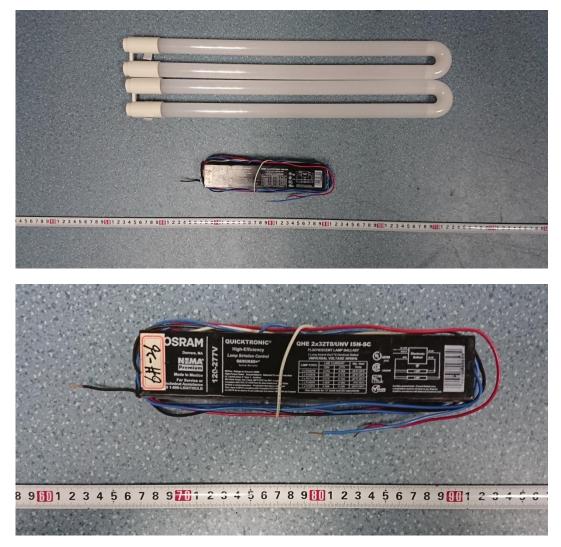


Figure 1- Overview of the sample

<b>Equipment Under Test(EUT)</b>	
Name	: LED Tube
Model	: T8-13-U1G-830-SD-HYB
Electrical Ratings	: 120-277V, 50/60Hz
Product Description	: 2G13 base, 3000K
	LED Tubes supplied by a high frequency fluorescent lamp ballast:
	QHE 2x32T8/UNV ISN-SC

Special Color



# **TEST RESULTS**

Test ambient temperature was  $\underline{25.0}$  °C.

Base orientation was <u>light down</u>. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was  $\underline{60}$  minutes, and the total operating time including stabilization was  $\underline{65}$  minutes.

#### **Sphere-Spectroradiometer Method**

Parameter	Res	ult			
Test Voltage (V)	120.0	277.0			
Voltage frequency (Hz)	60	60			
Test Current (A)	0.257	0.116			
Power Factor	0.9974	0.9633			
Test Power (W)/2	15.40	15.52			
THD A%	4.85	10.80			
Luminous Efficacy (lm/W)	129.6	128.6			
Total Luminous Flux (lm)	1995.0	1995.0			
Color Rendering Index (CRI)	81.2				
R9	1.1				
Correlated Color Temperature (CCT)(K)	2912				
Chromaticity Chroma x	0.4416				
Chromaticity Chroma y	0.4031				
Chromaticity Chroma u	0.2540				
Chromaticity Chroma v	0.3478				
Duv	-0.0010				
Chromaticity Chroma u '	0.2540				
Chromaticity Chroma v'	0.5217				

Special Color											
Renderin	Rendering										
Indices											
R1	79.9										
R2	91.7										
R3	94.1										
R4	78.1										
R5	80.3										
R6	90.3										
R7	80.1										
R8	55										
R9	1.1										
R10	81.5										
R11	77.4										
R12	72.4										
R13	82.8										
R14	97.5										

## Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u',v') diagram, u' = u = 4x/(-2x+12y+3), v' = 3v/2 = 9y/(-2x+12y+3).



### **Goniophotometer Method**

Test ambient temperature was 24.9 °C.

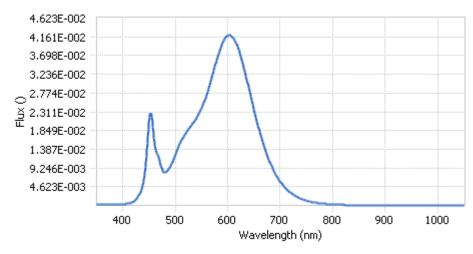
The photometric distance is 30 m.

Luminous data was taken at  $\underline{0.5}$  vertical intervals and  $\underline{10}$  horizontal intervals.

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.258
Power Factor	0.9969
Power (W)/2	15.43
Luminous Efficacy (lm/W)	127.6
Total Luminous Flux (lm)	1967.8
Beam Angle ( <sup>°</sup> )	$107.7 \ (0^{\circ}-180^{\circ}) \ / \ 144.8 \ (90^{\circ}-270^{\circ})$
Center Beam Candle Power (cd)	438
Maximum Beam Candle Power (cd)	438.4 (At: C=130.0, Gamma=1.0)
Spacing Criteria	1.24 (0°-180°) / 1.40 (90°-270°)
Zonal Lumens in the 0 °-60 Zone	54.76%
Zonal Lumens in the 60 °-90 Zone	24.74%
Zonal Lumens in the 90 °-120 Zone	10.73%
Zonal Lumens in the 120 °-180 Zone	9.77%

Table 3: Test data per Goniophotometer Method





## Spectral Power Distribution - Sphere Spectroradiometer Method



Spectral D	istribution over Vis	ible Waveleng	gth				
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.94E-04	485	8.60E-03	590	4.00E-02	695	6.85E-03
385	2.97E-04	490	9.48E-03	595	4.13E-02	700	5.88E-03
390	2.97E-04	495	1.08E-02	600	4.19E-02	705	5.02E-03
395	3.29E-04	500	1.26E-02	605	4.20E-02	710	4.28E-03
400	3.29E-04	505	1.42E-02	610	4.14E-02	715	3.66E-03
405	3.75E-04	510	1.56E-02	615	4.03E-02	720	3.13E-03
410	4.74E-04	515	1.69E-02	620	3.87E-02	725	2.67E-03
415	6.44E-04	520	1.79E-02	625	3.66E-02	730	2.28E-03
420	9.52E-04	525	1.88E-02	630	3.43E-02	735	1.93E-03
425	1.47E-03	530	1.97E-02	635	3.17E-02	740	1.64E-03
430	2.38E-03	535	2.05E-02	640	2.90E-02	745	1.40E-03
435	3.84E-03	540	2.16E-02	645	2.63E-02	750	1.19E-03
440	6.51E-03	545	2.27E-02	650	2.36E-02	755	1.03E-03
445	1.22E-02	550	2.40E-02	655	2.09E-02	760	8.77E-04
450	2.05E-02	555	2.55E-02	660	1.86E-02	765	7.53E-04
455	2.17E-02	560	2.74E-02	665	1.63E-02	770	6.42E-04
460	1.55E-02	565	2.96E-02	670	1.43E-02	775	5.50E-04
465	1.28E-02	570	3.18E-02	675	1.24E-02	780	4.71E-04
470	1.13E-02	575	3.41E-02	680	1.08E-02		
475	8.82E-03	580	3.64E-02	685	9.31E-03		
480	8.07E-03	585	3.85E-02	690	8.00E-03		

Table 4: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method



**Chromaticity Diagram - Sphere Spectroradiometer Method** 

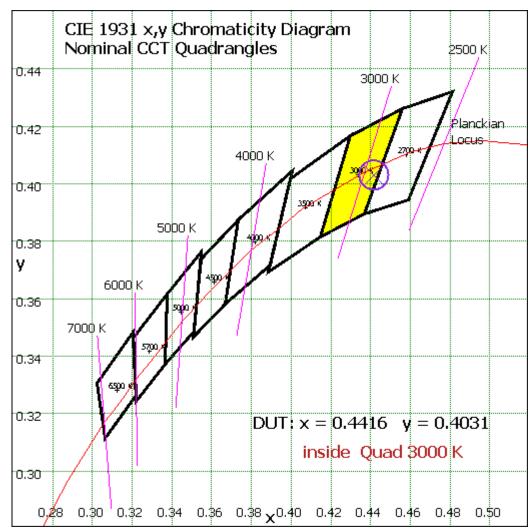
#### 520 530 0.8000 540 510 550 0.7000 560 0.6000 570 500 0.5000 580 590 0.4000 600 610 D65 620 630 490 0.3000 780 0.2000 **4**80 0.1000 470 460 380 0.2000 0.3000 0.7000 0.1000 0.4000 0.5000 0.6000 x

CIE 1931, 2 Degree

Tristimulus values(x, y): (0.4416, 0.4031) Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.





#### Nominal CCT Quadrangles – Sphere Spectroradiometer Method

Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram



### Color Rendition Report – Sphere Spectroradiometer Method

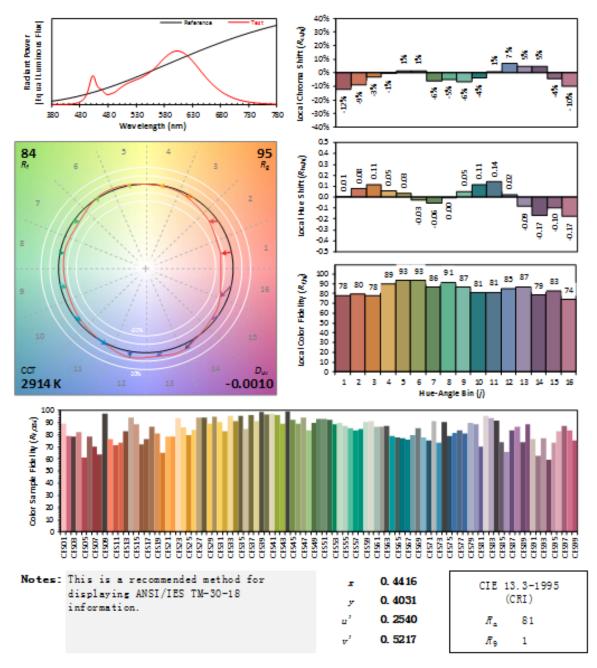
# **ANSI/IES TM-30-18 Color Rendition Report**

Source: LED

**Date:** 2018/05/16

Manufacturer: RAB Lighting INC

#### Model: T8-13-U1G-830-SD-HYB



Colors are for visual orientation purposes only. Created with the ANSI/IES IM-30-18 Calculator Version 2.00.

Chart 4: Full Report Created with the IES TM-30 Calculator

Note: The values in this diagram might be a little different from the values in Table 2 due to rounding.

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## Zonal Lumen Tabulation- Goniophotometer Method

Total
11%
09%
39%
68%
81%
68%
08%
37%
29%
71%
53%
48%
20%
58%
89%
26%
57%
17%
)0%

γ(°)	Lumens	% Total
0- 60	1077.505	54.76%
60- 90	486.859	24.74%
0-90	1564.364	79.50%
90-180	403.392	20.50%
0- 180	1967.8	100%

Table 5: Zonal Lumen



#### **Illuminance Plots- Goniophotometer Method**

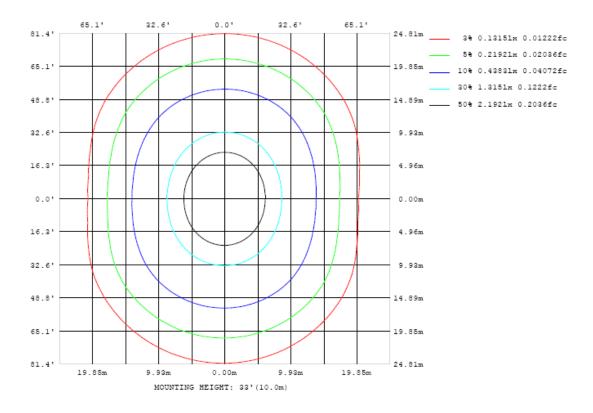


Chart 5: Illuminance Plot (Footcandles)



## Luminous Intensity Distribution Plots- Goniophotometer Method

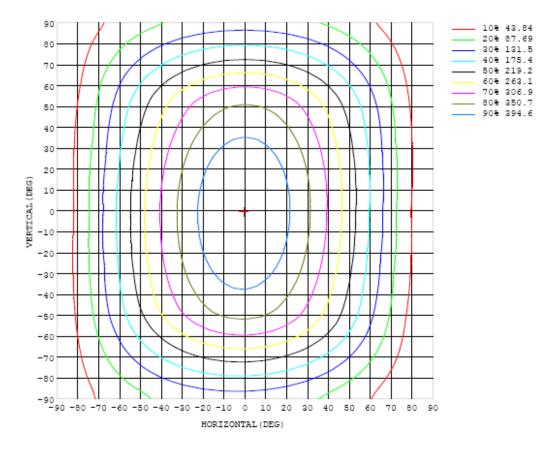


Chart 6: Isocandela Plot

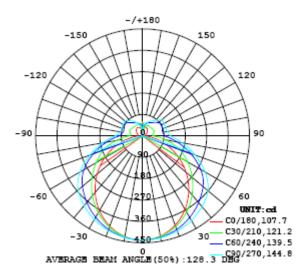


Chart 7: Polar Candela Distribution



## Luminous Intensity Data- Goniophotometer Method

Table1																UNI	T: ed		
C (DEG)																			
y (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438
5	435	436	436	436	436	437	437	437	438	438	438	438	438	437	437	437	437	436	436
10	428	428	429	430	431	432	433	434	435	436	436	435	435	434	433	432	431	430	430
15	416	417	418	420	422	425	427	429	431	432	432	431	429	427	425	423	421	419	419
20	400	401	403	406	410	415	419	423	425	426	426	425	422	418	414	410	407	405	404
25	380	381	385	389	396	402	409	414	417	419	419	417	412	407	401	395	390	386	385
30	357	358	363	370	379	388	396	403	408	411	410	407	401	393	385	377	370	365	363
35	330	332	339	348	359	371	382	391	397	400	400	395	388	378	367	357	347	340	338
40	302	304	312	324	338	353	367	378	385	389	388	382	373	361	348	334	322	314	311
45	271	274	284	298	316	334	350	363	372	376	374	368	357	343	327	310	296	285	281
50	239	243	254	272	293	313	332	346	355	359	358	352	340	324	305	286	268	255	250
55	206	210	224	245	269	293	310	323	330	334	333	328	318	304	283	261	240	224	217
60	172	177	194	219	245	266	282	293	300	303	303	298	289	277	260	236	211	192	185
65	137	144	164	192	217	235	249	259	266	270	269	265	257	245	230	210	183	160	151
70	103	111	136	164	184	201	214	225	231	235	234	230	222	212	198	180	156	129	117
75	71.0	80.6	108	131	150	166	180	191	198	201	201	197	189	178	164	147	127	100	83.8
80	41.0	52.7	77.6	97.3	116	133	147	158	165	169	169	164	156	145	132	115	95.7	73.8	53.7
85	17.1	28.0	46.4	66.8	85.2	102	117	128	135	139	139	134	126	115	101	85.2	66.7	46.7	29.6
90	1.81	7.86	25.2	45.1	64.2	81.2	94.9	106	114	118	117	113	105	94.3	81.1	64.8	46.8	29.0	17.3
95	2.93	9.64	23.7	41.6	59.2	75.3	88.6	98.9	106	110	110	106	98.1	88.2	75.1	59.9	43.5	28.1	17.4
100	5.85	12.9	29.0	43.7	59.1	73.5	86.0	95.1	102	105	105	101	94.4	85.4	73.5	59.9	45.8	30.5	18.7
105	8.75	16.1	33.9	49.0	62.3	74.9	86.0	94.1	100	103	103	99.7	93.6	85.5	74.8	63.0	49.7	31.3	20.8
110	11.9	18.8	34.2	53.7	66.7	78.1	87.9	95.1	100	103	103	100.0	94.4	87.3	77.7	66.6	50.1	32.3	23.4
115	15.1	21.4	35.0	53.2	70.3	81.3	90.4	96.9	102	104	104	101	96.0	89.5	80.5	67.7	48.9	33.6	26.3
120	18.4	23.3	36.0	51.6	69.2	83.8	92.5	98.3	103	105	105	102	97.3	91.3	80.8	64.1	48.1	35.3	29.3
125	21.8	25.8	37.3	50.6	65.3	80.6	93.1	99.1	103	105	105	102	97.7	89.2	75.6	61.2	47.7	37.3	32.2
130	25.3	28.8	38.8	49.8	62.3	74.9	86.7	95.1	101	103	103	99.1	91.7	82.5	70.9	58.8	47.8	39.4	35.0
135	28.6	31.6	40.5	49.3	59.8	70.2	79.7	87.0	92.0	94.4	93.8	90.2	84.7	76.4	66.8	57.0	48.1	41.3	37.6
140	31.9	33.4	41.3	49.3	57.6	65.9	73.6	79.9	84.2	86.4	85.7	82.8	77.8	71.1	63.5	55.8	48.7	43.1	39.9
145	34.7	34.2	42.2	49.5	56.0	62.5	68.4	73.3	76.8	78.5	78.1	75.7	71.8	66.7	60.9	54.8	49.2	43.3	41.0
150	37.0	34.1	43.0	49.3	54.7	59.8	64.2	67.8	70.4	71.7	71.4	69.7	66.8	63.1	58.8	54.2	48.3	41.2	40.4
155	37.9	32.0	39.4	48.2	53.6	57.5	61.0	63.4	65.3	66.2	66.0	64.8	62.8	60.1	57.1	53.4	46.4	39.3	39.1
160	38.3	29.5	36.0	45.2	49.4	54.8	58.3	60.1	61.1	61.7	61.5	60.7	59.4	57.7	55.2	49.9	41.6	36.2	37.0
165	37.9	27.8	31.0	37.8	44.9	49.8	52.9	55.4	57.1	57.6	57.6	57.0	56.0	54.3	50.3	44.8	38.0	33.4	34.2
170	41.1	26.1	25.3	26.9	32.1	40.0	44.7	47.9	49.8	50.9	51.3	50.5	47.2	41.1	36.0	32.0	30.6	30.5	31.8
175	52.0	23.7	23.6	23.6	23.6	24.4	27.9	34.4	38.4	36.5	30.5	25.9	25.7	25.6	26.3	27.1	27.8	28.2	28.3
180	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6

Table 6: Luminous Intensity Data



$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Table2																UNI	T: cd	
0   138   438	C (DEG)																		
5   436   437   438   434   432   433   433   433   433   433   433   430   430   430   430   430   433   433   433   433   433   433   433   433   433   433   430   430   430   430   430   430   430   430   430   430   430   433   433   433   433   433   433   433   433   433   433   433   343   343   343   343   343	Y (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	
10 430 431 431 432 434 434 434 433 433 432 431 430 432 431 430 420 420 421 422 422 424 4	0	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	438	
15 419 420 421 423 428 429 420 426 424 422 420 418 417   20 405 406 409 412 415 418 421 423 423 423 423 424 414 410 407 403 401   25 366 368 392 397 403 408 412 415 416 415 416 415 416 414 410 407 402 366 380 385 381 371 366 380 381 371 364 355 341 352 354 355 394 385 376 361 370 364 355 361 304 326 316 332 318 306 317 366 318 332 318 302 287 285 271 285 281 231 230 231 230 246 246 247 235 231 230 141 130 333 332 332	5	436	437	437	437	437	437	437	437	437	437	437	437	436	436	436	436	435	
20 405 406 409 412 413 423 423 421 416 414 410 407 403 401   25 386 388 392 377 380 388 395 401 405 405 401 396 390 385 392 403   30 364 367 373 380 388 395 401 405 406 401 396 390 385 397 361 364 350 304 334 401 405 401 335 340 334 381 375 366 354 340 326 316 302 287 277 403 314 330 331 335 315 351 312 316 322 315 322 315 322 315 322 315 322 321 326 315 326 315 326 315 326 315 326 315 326 315 326 315 326 316 316 316<	10	430	431	431	432	432	433	434	434	434	434	433	433	432	431	430	429	428	
25 386 382 397 403 408 412 415 416 412 407 402 396 390 385 382 1   30 364 367 373 380 386 395 401 405 406 405 401 395 371 364 355 403 355 401 394 396 381 371 360 350 340 334 346 357 381 381 371 360 350 340 334 346 357 381 381 371 360 302 287 277   306 287 270 287 282 230 244   302 287 282 230 244  230 244  230 244 220 271 280 226 287 281 230 230 230 131 130 140 180 180 171 169 163 154 141 120 130 130	15	419	420	421	423	425	427	428	429	430	429	428	426	424	422	420	418	417	
30 364 367 373 380 386 395 401 405 406 405 401 395 377 371 364 359   35 339 344 352 352 372 381 386 375 366 354 340 334 344   40 312 319 329 341 354 365 375 381 381 375 366 354 340 326 315 366 354 340 326 375 367 357 367 357 361 349 335 381 371 360 326 315 296 276 259 246 247 257 291 313 330 332 330 324 312 295 201 125 201 133 140 140 150 141 150 141 150 141 150 141 125 101 141 125 141 125 141 125 141 125 141 125 141	20	405	406	409	412	415	418	421	423	423	423	421	418	414	410	407	403	401	
35 339 344 352 362 372 381 389 394 389 381 371 360 350 340 334   40 312 319 329 341 354 365 375 381 383 381 375 366 354 340 326 315 366   45 283 291 304 319 334 348 360 367 367 361 343 352 252 251 252 252 273 294 311 323 330 332 330 324 312 295 273 251 230 214 246   60 190 204 226 250 271 285 261 210 202 200 173 145 140 183   61 174 175 194 129 221 220 220 207 192 173 150 153 141 1125 171 159 141 125 173 150 153 </td <td>25</td> <td>386</td> <td>388</td> <td>392</td> <td>397</td> <td>403</td> <td>408</td> <td>412</td> <td>415</td> <td>416</td> <td>415</td> <td>412</td> <td>407</td> <td>402</td> <td>396</td> <td>390</td> <td>385</td> <td>382</td> <td></td>	25	386	388	392	397	403	408	412	415	416	415	412	407	402	396	390	385	382	
40 312 319 329 341 354 356 375 381 381 375 366 354 340 326 315 306   45 283 291 304 319 334 346 360 367 370 367 361 349 335 318 302 287 277    50 252 263 278 296 314 332 333 332 332 332 332 325 256 273 251 230 214   60 190 204 226 250 271 285 295 301 304 302 296 285 271 250 225 201 173 150   70 124 147 175 194 209 221 220 217 125 127 145 118   75 93.3 120 141 139 141 139 131 110 135 161 171 159 163 154 141	30	364	367	373	380	388	395	401	405	406	405	401	395	387	379	371	364	359	
45 283 291 304 319 334 340 360 367 370 367 361 349 335 318 302 287 277 1   50 252 263 278 296 314 330 343 352 354 352 345 332 315 296 276 259 246 1   60 190 204 226 250 271 285 301 304 302 286 271 250 225 201 183   65 157 176 200 224 21 229 235 236 234 229 220 207 192 173 145 118   70 124 147 175 194 209 221 229 235 236 234 229 220 207 192 173 145 118   75 93.3 120 144 151 141 139 121 131 119 125 160 125	35	339	344	352	362	372	381	389	394	395	394	389	381	371	360	350	340	334	
50 252 263 278 296 314 330 343 352 354 352 345 332 315 296 276 259 246   55 221 234 252 273 294 311 323 330 332 330 324 312 295 273 251 230 214   60 190 204 226 250 271 285 295 301 304 302 296 285 271 250 225 201 183   65 157 176 200 224 241 254 263 254 223 200 173 150   70 124 147 175 194 209 212 229 223 207 192 173 145 118   70 124 147 151 161 170 171 169 163 154 141 125 107 85.5 85.1 35.1 55.1 55.1 55.1 55.1	40	312	319	329	341	354	365	375	381	383	381	375	366	354	340	326	315	306	
55 221 224 252 273 294 311 322 330 332 330 324 312 295 273 251 230 214   60 190 204 226 250 271 285 295 301 304 302 296 285 271 250 225 201 183   65 157 176 200 224 241 254 263 254 241 223 200 173 185 160   70 124 147 175 194 209 221 229 235 236 234 220 207 192 173 145 118   75 93.3 120 144 161 176 186 197 171 169 163 154 141 125 107 86.5 62.0 115   85 41.6 61.6 80.9 98.1 131 125 134 139 131 135 167 163 157 45.4 <td< td=""><td>45</td><td>283</td><td>291</td><td>304</td><td>319</td><td>334</td><td>348</td><td>360</td><td>367</td><td>370</td><td>367</td><td>361</td><td>349</td><td>335</td><td>318</td><td>302</td><td>287</td><td>277</td><td></td></td<>	45	283	291	304	319	334	348	360	367	370	367	361	349	335	318	302	287	277	
60 190 204 226 250 271 285 295 301 304 302 296 285 271 250 225 201 183   655 157 176 200 224 241 254 263 269 271 269 263 254 241 223 200 173 150   70 124 147 175 194 209 221 229 235 236 234 229 220 207 192 173 145 118   75 93.3 120 144 161 176 188 196 201 203 201 195 187 174 158 140 118 88.5    80 65.5 91.1 113 125 134 113 111 105 15.4 141 125 107 66.5 62.0   30.4 12.5  107 105 163 154 141 125 147.0 17.3 155.1 151	50	252	263	278	296	314	330	343	352	354	352	345	332	315	296	276	259	246	
65 157 176 200 224 241 254 263 269 271 269 263 254 241 223 200 173 150   70 124 147 175 194 209 221 229 235 236 234 229 220 207 192 173 145 118   75 93.3 120 144 161 176 188 196 201 203 201 195 187 174 158 140 118 88.5   80 65.5 91.1 111 129 133 155 164 170 171 169 163 154 141 125 107 86.5 62.0    93 93.7 56.8 72.6 86.5 97.8 106 112 113 111 105 95.3 82.4 66.9 93.3 30.4 12.5 100 24.9 33.4 26.4 14.0 59.5 94.0 92.1 87.4 80.0 76.0 5	55	221	234	252	273	294	311	323	330	332	330	324	312	295	273	251	230	214	
70124147175194209221229235236234229220207192173145118 $75$ 93.312014416117618819620120320119518717415814011888.5 $80$ 65.591.111112914315516417017116916315414112510786.562.0 $85$ 41.661.680.998.111312513413914113913212311093.775.355.135.1 $90$ 23.939.756.872.686.597.810611211311110595.382.466.949.330.412.5 $95$ 23.536.151.265.778.889.197.010210310195.286.174.059.543.426.411.5 $100$ 24.938.550.863.474.984.591.796.197.480.070.359.147.335.520.0 $110$ 27.842.154.164.674.482.889.293.094.092.187.480.070.359.147.335.520.0 $110$ 27.842.154.164.674.482.889.293.594.891.083.476.06	60	190	204	226	250	271	285	295	301	304	302	296	285	271	250	225	201	183	
7593.312014416517618819620120320119518717415814011888.58065.591.111112914315516417017116916315414112510786.562.08541.661.680.998.111312513413914113913212311093.775.355.135.19023.939.756.872.686.597.810611211311110595.382.466.949.330.412.59523.536.151.265.778.589.197.010210310195.286.174.059.543.426.411.510024.938.550.863.474.984.591.796.197.395.289.981.670.657.643.426.411.511027.842.154.164.674.482.889.293.094.092.187.480.070.355.438.422.417.211027.842.259.073.279.185.690.593.594.292.789.183.476.067.156.338.824.511027.842.456.772.381.687.692.294.995.694.39	65	157	176	200	224	241	254	263	269	271	269	263	254	241	223	200	173	150	
80   65.5   91.1   111   129   143   155   164   170   171   169   163   154   141   125   107   86.5   62.0     85   41.6   61.6   80.9   98.1   113   125   134   139   141   139   132   123   110   93.7   75.3   55.1   35.1     90   23.9   39.7   56.8   72.6   86.5   97.8   106   112   113   111   105   95.3   82.4   66.9   49.3   30.4   12.5     95   23.5   36.1   51.2   65.7   78.5   89.1   97.0   102   103   101   95.2   86.1   74.0   59.5   43.4   29.5   17.2     105   26.2   42.1   58.1   67.8   76.3   85.6   90.7   89.1   83.4   76.0   67.1   56.3   88.8   22.7   111   27.8   88.1   89.2 <td>70</td> <td>124</td> <td>147</td> <td>175</td> <td>194</td> <td>209</td> <td>221</td> <td>229</td> <td>235</td> <td>236</td> <td>234</td> <td>229</td> <td>220</td> <td>207</td> <td>192</td> <td>173</td> <td>145</td> <td>118</td> <td></td>	70	124	147	175	194	209	221	229	235	236	234	229	220	207	192	173	145	118	
85 41.6 61.6 80.9 98.1 113 125 134 139 141 139 132 123 110 93.7 75.3 55.1 35.1   90 23.9 39.7 56.8 72.6 86.5 97.8 106 112 113 111 105 95.3 82.4 66.9 49.3 30.4 12.5   95 23.5 36.1 51.2 65.7 78.5 89.1 97.0 102 103 101 95.2 86.1 74.0 59.5 43.4 26.4 11.5   100 24.9 38.5 50.8 63.4 74.9 84.5 91.7 96.1 97.3 95.2 89.9 81.6 70.6 57.6 43.4 29.5 17.2   105 26.2 42.1 58.1 67.8 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.9 72.6 63.0 52.4 38.4 22.2 115   110 27.8 42.2 59.0 71.2 79.1 85.6 <td>75</td> <td>93.3</td> <td>120</td> <td>144</td> <td>161</td> <td>176</td> <td>188</td> <td>196</td> <td>201</td> <td>203</td> <td>201</td> <td>195</td> <td>187</td> <td>174</td> <td>158</td> <td>140</td> <td>118</td> <td>88.5</td> <td></td>	75	93.3	120	144	161	176	188	196	201	203	201	195	187	174	158	140	118	88.5	
90 23.9 39.7 56.8 72.6 86.5 97.8 106 112 113 111 105 95.3 82.4 66.9 49.3 30.4 12.5   95 23.5 36.1 51.2 65.7 78.5 89.1 97.0 102 103 101 95.2 86.1 74.0 59.5 43.4 26.4 11.5 11.5   100 24.9 38.5 50.8 63.4 74.9 84.5 91.7 96.1 97.3 95.2 89.9 81.6 70.6 57.6 43.4 29.5 17.2   105 26.2 42.1 54.1 64.6 74.4 82.8 89.2 93.0 94.0 92.1 87.4 80.0 70.3 59.1 47.3 35.5 20.0   110 27.8 42.1 58.1 67.6 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.0 70.3 54.5 39.2 27.0   112 31.8 42.4 56.7 72.3 81.6 87.6	80	65.5	91.1	111	129	143	155	164	170	171	169	163	154	141	125	107	86.5	62.0	
95 23.5 36.1 51.2 65.7 78.5 89.1 97.0 102 103 101 95.2 86.1 74.0 59.5 43.4 26.4 11.5   100 24.9 38.5 50.8 63.4 74.9 84.5 91.7 96.1 97.3 95.2 89.9 81.6 70.6 57.6 43.4 29.5 17.2   105 26.2 42.1 54.1 64.6 74.4 82.8 89.2 93.0 94.0 92.1 87.4 80.0 70.3 59.1 47.3 35.5 20.0   110 27.8 42.1 58.1 67.8 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.9 72.6 63.0 52.4 38.4 22.2 115   110 27.8 42.2 59.0 71.2 79.1 85.6 90.5 93.3 91.0 85.4 70.0 70.3 54.5 39.2 27.0   1120 31.8 42.4 56.7 72.3 81.6 87.6 92.8	85	41.6	61.6	80.9	98.1	113	125	134	139	141	139	132	123	110	93.7	75.3	55.1	35.1	
100 24.9 38.5 50.8 63.4 74.9 84.5 91.7 96.1 97.3 95.2 89.9 81.6 70.6 57.6 43.4 29.5 17.2 105   105 26.2 42.1 54.1 64.6 74.4 82.8 89.2 93.0 94.0 92.1 87.4 80.0 70.3 59.1 47.3 35.5 20.0   110 27.8 42.1 58.1 67.8 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.9 72.6 63.0 52.4 38.4 22.2 115   29.6 42.2 59.0 71.2 79.1 85.6 90.5 93.5 94.2 92.7 89.1 83.4 76.0 67.1 56.3 38.8 24.5 120   31.8 42.4 56.7 72.3 81.6 87.6 92.2 94.9 95.6 94.3 91.0 85.8 79.0 70.3 54.5 39.2 27.0   125 34.2 43.0 54.8 63.3 81.3 <td>90</td> <td>23.9</td> <td>39.7</td> <td>56.8</td> <td>72.6</td> <td>86.5</td> <td>97.8</td> <td>106</td> <td>112</td> <td>113</td> <td>111</td> <td>105</td> <td>95.3</td> <td>82.4</td> <td>66.9</td> <td>49.3</td> <td>30.4</td> <td>12.5</td> <td></td>	90	23.9	39.7	56.8	72.6	86.5	97.8	106	112	113	111	105	95.3	82.4	66.9	49.3	30.4	12.5	
105 26.2 42.1 54.1 64.6 74.4 82.8 89.2 93.0 94.0 92.1 87.4 80.0 70.3 59.1 47.3 35.5 20.0 110   110 27.8 42.1 58.1 67.8 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.9 72.6 63.0 52.4 38.4 22.2 115   115 29.6 42.2 59.0 71.2 79.1 85.6 90.5 93.5 94.2 92.7 89.1 83.4 76.0 67.1 56.3 38.8 24.5 120   31.8 42.4 56.7 72.3 81.6 87.6 92.2 94.9 95.6 94.3 91.0 85.8 79.0 70.3 54.5 39.2 27.0 125   34.2 43.0 54.8 68.3 81.3 89.2 93.4 95.9 92.7 86.0 75.6 63.8 51.9 40.6 31.8   130 36.5 43.8 53.5 64.6 75.8 85.7 <td>95</td> <td>23.5</td> <td>36.1</td> <td>51.2</td> <td>65.7</td> <td>78.5</td> <td>89.1</td> <td>97.0</td> <td>102</td> <td>103</td> <td>101</td> <td>95.2</td> <td>86.1</td> <td>74.0</td> <td>59.5</td> <td>43.4</td> <td>26.4</td> <td>11.5</td> <td></td>	95	23.5	36.1	51.2	65.7	78.5	89.1	97.0	102	103	101	95.2	86.1	74.0	59.5	43.4	26.4	11.5	
110 27.8 42.1 58.1 67.8 76.3 83.6 89.1 92.5 93.3 91.7 87.4 80.9 72.6 63.0 52.4 38.4 22.2 115   115 29.6 42.2 59.0 71.2 79.1 85.6 90.5 93.5 94.2 92.7 89.1 83.4 76.0 67.1 56.3 38.8 24.5 120   1120 31.8 42.4 56.7 72.3 81.6 87.6 92.2 94.9 95.6 94.3 91.0 85.8 79.0 70.3 54.5 39.2 27.0 125   34.2 43.0 54.8 68.3 81.3 89.2 93.4 95.9 96.6 95.4 92.5 87.8 80.7 63.8 51.9 29.4 141   130 36.5 43.8 53.5 64.6 75.8 85.7 92.8 96.1 97.0 95.8 79.1 70.5 60.6 50.8 41.4 34.2 141   140 40.5 45.9 52.1 59.2	100	24.9	38.5	50.8	63.4	74.9	84.5	91.7	96.1	97.3	95.2	89.9	81.6	70.6	57.6	43.4	29.5	17.2	
115 29.6 42.2 59.0 71.2 79.1 85.6 90.5 93.5 94.2 92.7 89.1 83.4 76.0 67.1 56.3 38.8 24.5   120 31.8 42.4 56.7 72.3 81.6 87.6 92.2 94.9 95.6 94.3 91.0 85.8 79.0 70.3 54.5 39.2 27.0 125   34.2 43.0 54.8 68.3 81.3 89.2 93.4 95.9 96.6 95.4 92.5 87.8 80.7 67.2 53.0 39.9 29.4 130   36.5 43.8 53.5 64.6 75.8 85.7 92.8 96.1 97.0 95.9 92.7 86.0 75.6 63.8 51.9 40.6 31.8   130 36.5 43.8 53.5 64.6 75.8 85.7 92.8 96.1 97.0 95.8 79.1 70.5 60.6 50.8 41.4 34.2 140   40.5 45.9 52.1 59.2 66.4 73.1 78.4 </td <td>105</td> <td>26.2</td> <td>42.1</td> <td>54.1</td> <td>64.6</td> <td>74.4</td> <td>82.8</td> <td>89.2</td> <td>93.0</td> <td>94.0</td> <td>92.1</td> <td>87.4</td> <td>80.0</td> <td>70.3</td> <td>59.1</td> <td>47.3</td> <td>35.5</td> <td>20.0</td> <td></td>	105	26.2	42.1	54.1	64.6	74.4	82.8	89.2	93.0	94.0	92.1	87.4	80.0	70.3	59.1	47.3	35.5	20.0	
120 31.8 42.4 56.7 72.3 81.6 87.6 92.2 94.9 95.6 94.3 91.0 85.8 79.0 70.3 54.5 39.2 27.0   125 34.2 43.0 54.8 68.3 81.3 89.2 93.4 95.9 96.6 95.4 92.5 87.8 80.7 67.2 53.0 39.9 29.4   130 36.5 43.8 53.5 64.6 75.8 85.7 92.8 96.1 97.0 95.9 92.7 86.0 75.6 63.8 51.9 40.6 31.8   135 38.7 44.7 52.6 61.6 70.8 79.0 85.6 89.8 91.3 89.9 85.8 79.1 70.5 60.6 50.8 41.4 34.2   140 40.5 45.9 52.1 59.2 66.4 73.1 78.4 81.8 83.0 81.9 78.4 72.9 65.7 57.5 49.6 42.1 36.6   145 41.6 47.0 51.8 57.4 62.9 67.9 </td <td>110</td> <td>27.8</td> <td>42.1</td> <td>58.1</td> <td>67.8</td> <td>76.3</td> <td>83.6</td> <td>89.1</td> <td>92.5</td> <td>93.3</td> <td>91.7</td> <td>87.4</td> <td>80.9</td> <td>72.6</td> <td>63.0</td> <td>52.4</td> <td>38.4</td> <td>22.2</td> <td></td>	110	27.8	42.1	58.1	67.8	76.3	83.6	89.1	92.5	93.3	91.7	87.4	80.9	72.6	63.0	52.4	38.4	22.2	
125 34.2 43.0 54.8 68.3 81.3 89.2 93.4 95.9 96.6 95.4 92.5 87.8 80.7 67.2 53.0 39.9 29.4   130 36.5 43.8 53.5 64.6 75.8 85.7 92.8 96.1 97.0 95.9 92.7 86.0 75.6 63.8 51.9 40.6 31.8   135 38.7 44.7 52.6 61.6 70.8 79.0 85.6 89.8 91.3 89.9 85.8 79.1 70.5 60.6 50.8 41.4 34.2   140 40.5 45.9 52.1 59.2 66.4 73.1 78.4 81.8 71.9 66.7 60.9 54.4 48.4 42.8 39.0 1   145 41.6 47.0 51.8 57.4 62.9 67.9 72.1 74.8 75.8 74.8 71.9 66.7 60.9 54.4 48.4 42.8 39.0 1   150 42.6 47.7 51.2 55.9 60.0 63.7	115	29.6	42.2	59.0	71.2	79.1	85.6	90.5	93.5	94.2	92.7	89.1	83.4	76.0	67.1	56.3	38.8	24.5	
130   36.5   43.8   53.5   64.6   75.8   85.7   92.8   96.1   97.0   95.9   92.7   86.0   75.6   63.8   51.9   40.6   31.8     135   38.7   44.7   52.6   61.6   70.8   79.0   85.6   89.8   91.3   89.9   85.8   79.1   70.5   60.6   50.8   41.4   34.2     140   40.5   45.9   52.1   59.2   66.4   73.1   78.4   81.8   83.0   81.9   78.4   72.9   65.7   57.5   49.6   42.1   36.6     145   41.6   47.0   51.8   57.4   62.9   67.9   72.1   74.8   75.8   74.8   71.9   66.7   60.9   54.4   48.4   42.8   39.0     150   42.6   47.7   51.2   55.9   60.0   63.7   66.7   69.1   68.5   51.1   47.9   45.9   44.0   43.7     160 <t< td=""><td>120</td><td>31.8</td><td>42.4</td><td>56.7</td><td>72.3</td><td>81.6</td><td>87.6</td><td>92.2</td><td>94.9</td><td>95.6</td><td>94.3</td><td>91.0</td><td>85.8</td><td>79.0</td><td>70.3</td><td>54.5</td><td>39.2</td><td>27.0</td><td></td></t<>	120	31.8	42.4	56.7	72.3	81.6	87.6	92.2	94.9	95.6	94.3	91.0	85.8	79.0	70.3	54.5	39.2	27.0	
135 38.7 44.7 52.6 61.6 70.8 79.0 85.6 89.8 91.3 89.9 85.8 79.1 70.5 60.6 50.8 41.4 34.2   140 40.5 45.9 52.1 59.2 66.4 73.1 78.4 81.8 83.0 81.9 78.4 72.9 65.7 57.5 49.6 42.1 36.6   145 41.6 47.0 51.8 57.4 62.9 67.9 72.1 74.8 75.8 74.8 71.9 66.7 60.9 54.4 48.4 42.8 39.0   150 42.6 47.7 51.2 55.9 60.0 63.7 66.7 69.1 68.5 65.3 60.6 56.0 51.2 47.2 43.4 41.3   155 42.4 47.9 49.9 52.9 57.4 60.3 62.3 63.6 62.6 52.4 58.9 54.5 51.1 47.9 45.9 44.0 43.7   160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 </td <td>125</td> <td>34.2</td> <td>43.0</td> <td>54.8</td> <td>68.3</td> <td>81.3</td> <td>89.2</td> <td>93.4</td> <td>95.9</td> <td>96.6</td> <td>95.4</td> <td>92.5</td> <td>87.8</td> <td>80.7</td> <td>67.2</td> <td>53.0</td> <td>39.9</td> <td>29.4</td> <td></td>	125	34.2	43.0	54.8	68.3	81.3	89.2	93.4	95.9	96.6	95.4	92.5	87.8	80.7	67.2	53.0	39.9	29.4	
140 40.5 45.9 52.1 59.2 66.4 73.1 78.4 81.8 83.0 81.9 78.4 72.9 65.7 57.5 49.6 42.1 36.6 145   145 41.6 47.0 51.8 57.4 62.9 67.9 72.1 74.8 75.8 74.8 71.9 66.7 60.9 54.4 48.4 42.8 39.0 150   150 42.6 47.7 51.2 55.9 60.0 63.7 66.7 69.1 68.5 65.3 60.6 51.2 47.2 43.4 41.3 155   42.4 47.9 49.9 52.9 57.4 60.3 62.3 63.6 62.6 62.4 58.9 54.5 51.1 47.9 45.9 44.0 43.7   160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 58.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1   165 37.3 43.6 48.9 50.5 51.4 54.4 <td>130</td> <td>36.5</td> <td>43.8</td> <td>53.5</td> <td>64.6</td> <td>75.8</td> <td>85.7</td> <td>92.8</td> <td>96.1</td> <td>97.0</td> <td>95.9</td> <td>92.7</td> <td>86.0</td> <td>75.6</td> <td>63.8</td> <td>51.9</td> <td>40.6</td> <td>31.8</td> <td></td>	130	36.5	43.8	53.5	64.6	75.8	85.7	92.8	96.1	97.0	95.9	92.7	86.0	75.6	63.8	51.9	40.6	31.8	
145 41.6 47.0 51.8 57.4 62.9 67.9 72.1 74.8 75.8 74.8 71.9 66.7 60.9 54.4 48.4 42.8 39.0 150   150 42.6 47.7 51.2 55.9 60.0 63.7 66.7 69.1 68.5 65.3 60.6 56.0 51.2 47.2 43.4 41.3 155   155 42.4 47.9 49.9 52.9 57.4 60.3 62.3 63.6 62.6 62.4 58.9 54.5 51.1 47.9 45.9 44.0 43.7 160   160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 58.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1 165   165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 56.0 56.2 52.4 48.3 46.2 44.6 48.5 165   165 37.3 43.6 48.9 50.5 51.4	135	38.7	44.7	52.6	61.6	70.8	79.0	85.6	89.8	91.3	89.9	85.8	79.1	70.5	60.6	50.8	41.4	34.2	
150 42.6 47.7 51.2 55.9 60.0 63.7 66.7 68.7 69.1 68.5 65.3 60.6 56.0 51.2 47.2 43.4 41.3   155 42.4 47.9 49.9 52.9 57.4 60.3 62.3 63.6 62.6 62.4 58.9 54.5 51.1 47.9 45.9 44.0 43.7   160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 58.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1   165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1   165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 53.6 49.4 50.1 46.0 42.2 41.2 41.6 48.5 48.5   170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 </td <td>140</td> <td>40.5</td> <td>45.9</td> <td>52.1</td> <td>59.2</td> <td>66.4</td> <td>73.1</td> <td>78.4</td> <td>81.8</td> <td>83.0</td> <td>81.9</td> <td>78.4</td> <td>72.9</td> <td>65.7</td> <td>57.5</td> <td>49.6</td> <td>42.1</td> <td>36.6</td> <td></td>	140	40.5	45.9	52.1	59.2	66.4	73.1	78.4	81.8	83.0	81.9	78.4	72.9	65.7	57.5	49.6	42.1	36.6	
155 42.4 47.9 49.9 52.9 57.4 60.3 62.3 63.6 62.6 62.4 58.9 54.5 51.1 47.9 45.9 44.0 43.7   160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 58.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1   165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 53.6 49.4 50.1 46.0 42.2 41.2 41.2 42.8 44.6 48.5   170 32.3 33.4 36.8 45.4 53.6 54.5 43.9 39.7 36.1 36.0 37.4 40.7 44.4 46.1   170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 42.8 43.9 39.7 36.1 36.0 37.4 40.7 44.4 50.4   175 28.2 21.5 25.6 47.8 53.8 46.7 44.8 43.0 36.2 </td <td>145</td> <td>41.6</td> <td>47.0</td> <td>51.8</td> <td>57.4</td> <td>62.9</td> <td>67.9</td> <td>72.1</td> <td>74.8</td> <td>75.8</td> <td>74.8</td> <td>71.9</td> <td>66.7</td> <td>60.9</td> <td>54.4</td> <td>48.4</td> <td>42.8</td> <td>39.0</td> <td></td>	145	41.6	47.0	51.8	57.4	62.9	67.9	72.1	74.8	75.8	74.8	71.9	66.7	60.9	54.4	48.4	42.8	39.0	
160 40.7 46.2 49.7 50.7 53.2 57.3 57.9 58.6 56.0 56.2 52.4 48.3 46.2 44.6 44.5 44.4 46.1   165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 53.6 49.4 50.1 46.0 42.2 41.2 41.2 42.8 44.6 48.5 48.5   170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 42.8 43.0 39.7 36.1 36.0 37.4 40.7 44.4 50.4 50.4   170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 42.8 43.0 36.1 36.0 37.4 40.7 44.4 50.4 50.4   175 28.2 21.5 25.6 47.8 53.8 46.7 44.8 43.0 36.2 37.6 33.9 30.2 30.1 32.6 36.6 42.3 48.2 48.2 48.2 48.2 48.2 48.2 48.2	150	42.6	47.7	51.2	55.9	60.0	63.7	66.7	68.7	69.1	68.5	65.3	60.6	56.0	51.2	47.2	43.4	41.3	
165 37.3 43.6 48.9 50.5 51.4 54.4 53.6 53.6 49.4 50.1 46.0 42.2 41.2 41.2 42.8 44.6 48.5   170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 42.8 43.9 39.7 36.1 36.0 37.4 40.7 44.4 50.4   175 28.2 21.5 25.6 47.8 53.8 46.7 44.8 43.0 36.2 37.6 33.9 30.2 30.1 32.6 36.6 42.3 48.2	155	42.4	47.9	49.9	52.9	57.4	60.3	62.3	63.6	62.6	62.4	58.9	54.5	51.1	47.9	45.9	44.0	43.7	
170 32.3 33.4 36.8 45.4 53.7 50.9 49.2 48.5 42.8 43.9 39.7 36.1 36.0 37.4 40.7 44.4 50.4   175 28.2 21.5 25.6 47.8 53.8 46.7 44.8 43.0 36.2 37.6 33.9 30.2 30.1 32.6 36.6 42.3 48.2	160	40.7	46.2	49.7	50.7	53.2	57.3	57.9	58.6	56.0	56.2	52.4	48.3	46.2	44.6	44.5	44.4	46.1	
175 28.2 21.5 25.6 47.8 53.8 46.7 44.8 43.0 36.2 37.6 33.9 30.2 30.1 32.6 36.6 42.3 48.2	165	37.3	43.6	48.9	50.5	51.4	54.4	53.6	53.6	49.4	50.1	46.0	42.2	41.2	41.2	42.8	44.6	48.5	
	170	32.3	33.4	36.8	45.4	53.7	50.9	49.2	48.5	42.8	43.9	39.7	36.1	36.0	37.4	40.7	44.4	50.4	
	175	28.2	21.5	25.6	47.8	53.8	46.7	44.8	43.0	36.2	37.6	33.9	30.2	30.1	32.6	36.6	42.3	48.2	
23.0 23.0 23.0 23.0 23.0 23.0 23.0 23.0	180	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	29.6	

Table 7: Luminous Intensity Data

## EQUIPMENT LIST

Test Equipment	Model	Equipment	Calibration	Calibration
		No.	Date	Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 02, 2019	Aug. 01, 2020
Digital Power Meter	PF2010A	HZTE028-01	Aug. 02, 2019	Aug. 01, 2020
AC Power Supply	DPS1060	HZTE001-06	Aug. 02, 2019	Aug. 01, 2020
DC Power Supply	WY12010	HZTE004-03	Aug. 02, 2019	Aug. 01, 2020
Temperature recorder	JM624U	HZTE018-08	Aug. 02, 2019	Aug. 01, 2020
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 02, 2019	Aug. 01, 2020
Standard source	D908	HZTE012-01	Aug. 02, 2019	Aug. 01, 2020
Integrate Sphere system	3M	HZTE015-04	Aug. 02, 2019	Aug. 01, 2020
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2019	Aug. 01, 2020
AC Power Supply	PCR 500L	HZTE001-07	Aug. 02, 2019	Aug. 01, 2020
DC Power Supply	IT6154	HZTE004-04	Aug. 02, 2019	Aug. 01, 2020
Standard source	SCL-1400	HZTE012-02	Aug. 02, 2019	Aug. 01, 2020
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 02, 2019	Aug. 01, 2020
Temperature Meter	TES1310	HZTE017-01	Aug. 02, 2019	Aug. 01, 2020

Table 8: Test Equipment List

## **TEST METHODS**

#### Seasoning of SSL Product

For the purpose of rating new SSL products, SSL products shall be tested with no seasoning. Therefore, no seasoning was performed.

#### Sphere-Spectroradiometer Method- Photometric and Electrical Measurements

A Labsphere Model CDS 2100 Spectroradiometer and Two Meter Sphere was used to measure correlated color temperature, chromaticity coordinates, and the color rendering index for each SSL unit. The coating reflectance of each sphere is 98%. The measure geometry is  $4\pi$ . Self-absorption correction is conducted in testing. Bandwidth of spectroradiometer is 350nm-1050nm.

Ambient temperature was measured at a position inside the sphere. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Yokogawa Power Analyzer.

The standard reference of the integrated sphere system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Standards and Technology.

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The uncertainty of integrating sphere system reported in this document is expended uncertainty is 2.1% with a coverage factor k=2.

### **Goniophotometer Method**

#### **Photometric and Electrical Measurements**

An EVERFINE Type C Model GO-R5000 Goniophotometer was used to measure the intensity at each angle of distribution for each sample. The photometric distance is 2.475m for near-field measurement or 30m for far-field measurement. Bandwidth of spectroradiometer is 380nm-780nm.

Ambient temperature was measured at the same height of the sample mounted on the Goniophotometer equipment. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Everfine Digital Power Meter.

Some graphics were created with Photometric Plus software.

The standard reference of the Goniophotometer system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Metrology P.R. China.

The uncertainty of goniophotometer system reported in this document is expended uncertainty is 2.3% with a coverage factor k=2.

#### **Color Characteristics Measurements**

The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as values that are spatially average, weighted to intensity, over the angular range where light is intentionally emitted from the SSL product. The color characteristics measurements are using gonio-spectroradiometer.

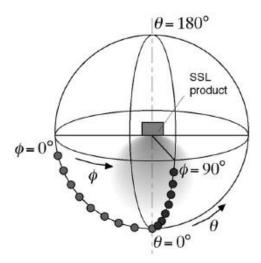
## **Color Spatial Uniformity**

The characteristics of SSL products may be spatially non-uniform, the chromaticity coordinate shall be measured at two vertical planes (C= $0.9180^{\circ}$  and C= $90.9270^{\circ}$ ) and at  $10^{\circ}$  or less intervals for vertical angle until the light output dropped to below 10% of the peak intensity. The averaged weighted chromaticity coordinate



was calculated from these points. The data was then analyzed to check for delta color differences of the u', v' chromaticity coordinates. The spatial non-uniformity of chromaticity,  $\Delta u'v'$ , is determined as the maximum deviation (distance on the CIE (u', v') diagram) among all measured points from the spatially averaged chromaticity coordinate.

The geometry for the chromaticity measurement using gonio-spectroradiometer is shown as following.



#### \*\*\* End of Report \*\*\*

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