NVIDIA®
Iray®

VALIDATION OF NVIDIA® IRAY® AGAINST CIE 171:2006

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INTRODUCTION

Rendering software packages have become extremely photorealistic over the last few years. However, few validations have been done to verify their accuracy against real life scenarios.

The following document describes the performance of NVIDIA® Iray® against the CIE Technical report CIE 171:2006 (Test Cases to Assess the Accuracy of Lighting Computer Programs), this document was prepared by the CIE in order to help software users and developers in assessing the accuracy of lighting computer programs and to identify their weaknesses. An abstract of the document can be found at http://www.cie.co.at/publ/abst/171-06.html, this document provides a brief explanation of each test, in order to save the reader the time and expense of purchasing the CIE 171:2006 document; however, for those readers interested, the complete document can be purchased at http://www.techstreet.com/ciegate.tmpl

The validation approach is based on the concept of testing the different aspects of light propagation separately. A suite of tests was designed and each test addressed a specific aspect of the lighting simulation domain.

ACKNOWLEDGMENTS

The author would like to thank all who contributed to the preparation of this report. In particular, the team at NVIDIA® Iray® for their help generating the geometry for the case studies, answering our questions and discussing openly the capabilities and limitations of NVIDIA® Iray®.

TESTING PROCEDURES:

Unless otherwise specified, all testing was conducted with NVIDIA® Iray® 2015.3 (246000.7141), [Scene 5.8 uses a non-standard maximum path length. Scene 5.13 was simulated using build 246000.12764] in the Iray® Viewer application. The testing used the standard settings and features, unless otherwise specified, of the Iray® Photoreal render mode. All scenes disable Firefly Filtering.

ERRORS AND UNCERTAINTIES:

Ranges presented in the tables of section 4 represent uncertainties of +/- 6.7% in the measured (physical) data and uncertainties of +/- 10.5% in the simulation plus measured data. These uncertainties are due to different factors, for more information on specific error and uncertainties calculations, refer directly to the CIE 171:2006 document. For section 5, the author has chosen 5% and 10% variations from the reference values as measurement error and global error respectively.

REPORT FORMAT:

The report follows the document's recommendation on the presentation of experimental measurements. See below for example.

	E (lx) on measurement points			
	A1	A2	A3	A4
Global error upper limit	296	574	606	388
Measurement upper limit	278	539	569	364
Simulation				
Measurement lower limit	237	459	484	310
Global error lower limit	219	424	448	287

Table 1: Example of recommended presentation for experimental measurements

EXECUTIVE SUMMARY

This report provides an analysis and evaluation of the capabilities and accuracy of NVIDIA® Iray® when tested against CIE 171:2006 (Test cases to assess the accuracy of lighting computer programs). In particular the report is focused on Test cases in Sections 4 and 5.

In Section 4, we found NVIDIA® Iray® performed well within the parameters set by the reference document and within the range of measurement error. We found the software to be accurate and it met the requirements set forth in the test document.

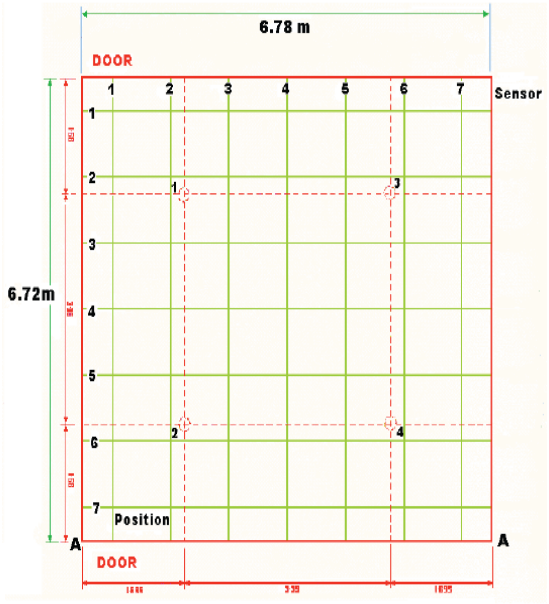
In section 5, we found NVIDIA® Iray® to be accurate. Again, it performed well within the parameters set by the reference document. In the few instances where there are discrepancies between the software and the CIE document, it has been documented in the past and in this analysis as well, that the differences are due to errors in the design of the test itself, or inaccurate values being listed in the reference document.

We are satisfied with the performance of NVIDIA® Iray® under all the different scenarios tested.

TEST CASES

SECTION 4

Room geometry



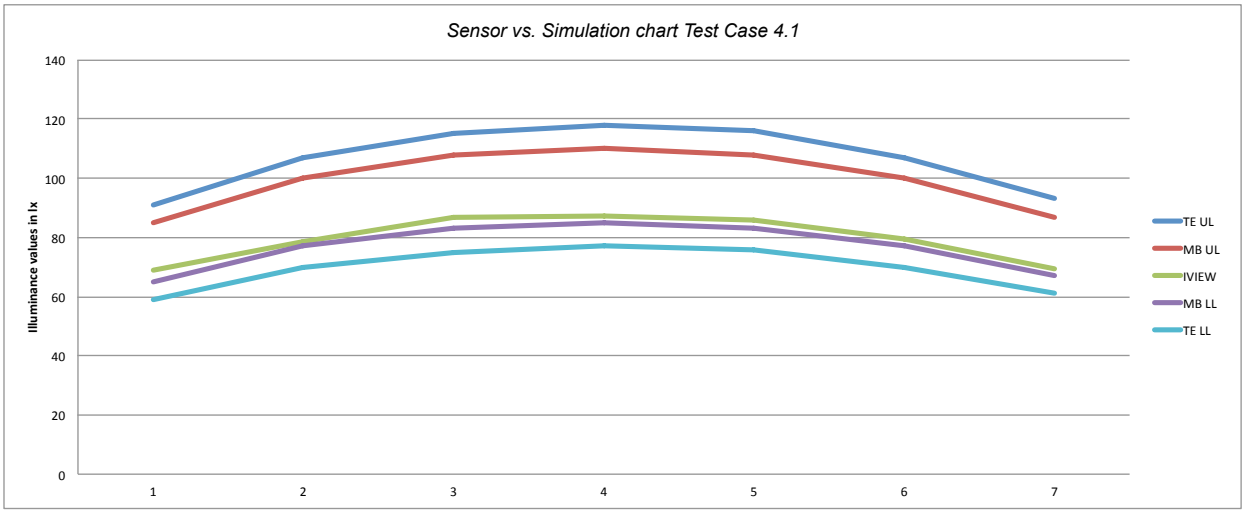
4.1 ARTIFICIAL LIGHTING SCENARIO – CFL, GREY WALL

This scenario was designed to test the ability to measure a set of 4 "lamp only" luminaires in a rectangular room, with grey walls.

Table 1 - Test Case 4.1							
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	91	107	115	118	116	107	93
MB UL	85	100	108	110	108	100	87
IVIEW	69	79	87	87	86	79	70
MB LL	65	77	83	85	83	77	67
TE LL	59	70	75	77	76	70	61
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	103	124	130	129	129	124	105
MB UL	96	116	122	120	121	116	98
IVIEW	80	92	99	100	99	93	81
MB LL	74	89	94	93	93	89	75
TE LL	67	81	85	84	84	81	68
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	112	132	141	141	141	131	113
MB UL	105	123	132	132	132	122	106
IVIEW	86	98	106	108	106	99	88
MB LL	81	95	101	102	101	94	81
TE LL	73	86	92	92	92	86	74
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	115	133	143	146	143	133	116
MB UL	108	124	133	137	133	124	108
IVIEW	87	98	108	109	107	98	88
MB LL	83	96	103	105	103	96	83
TE LL	75	87	93	96	93	87	76
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	113	132	141	140	141	132	112
MB UL	105	124	131	131	131	123	105
IVIEW	87	98	107	108	106	99	87
MB LL	81	95	101	101	101	95	81
TE LL	74	86	92	92	92	86	73
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	103	124	130	127	130	123	104
MB UL	97	116	121	119	121	115	97
IVIEW	80	92	99	100	99	93	81
MB LL	74	89	93	92	93	89	75
TE LL	68	81	85	83	85	81	68
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	92	108	116	117	115	108	92
MB UL	86	100	108	109	107	100	86
IVIEW	69	79	86	87	86	79	70
MB LL	66	77	83	84	83	77	66
TE LL	60	70	76	76	75	70	60

Out of range measurement Out of range global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULTS

THE SOFTWARE SIMULATION RESULTS ALL WERE INSIDE THE MEASUREMENT UPPER AND LOWER LIMITS.

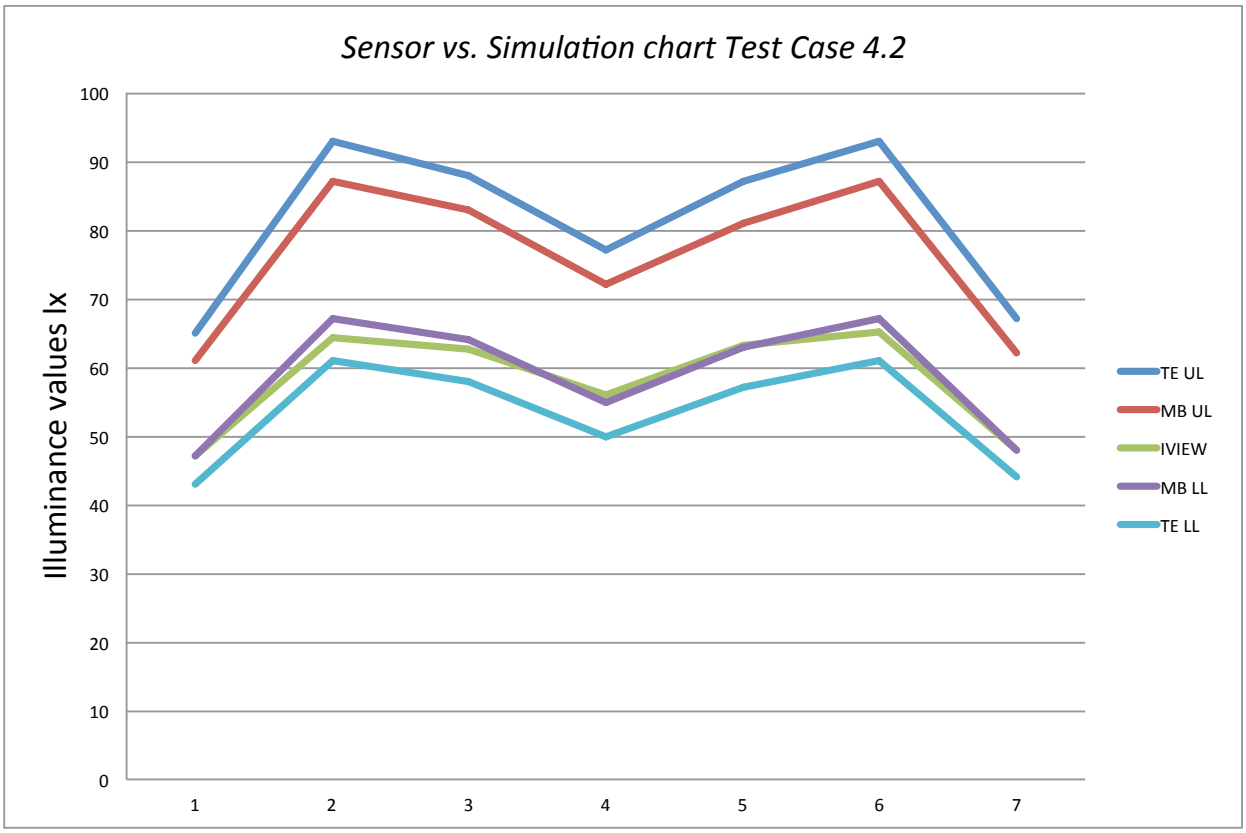
4.2 ARTIFICIAL LIGHTING SCENARIO – OPAL LUMINAIRE, GREY WALL

This scenario was designed to test the ability to measure a set of 4 opal luminaires with specific photometric distributions in a rectangular room, with grey walls. The test protocol is similar to 4.1

Table 2 - Test Case 4.2							
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	50	68	66	60	66	68	51
MB UL	47	63	62	56	61	63	48
IVIEW	36	47	47	44	48	48	37
MB LL	36	49	48	43	47	49	37
TE LL	33	44	43	39	43	44	33
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	65	93	88	77	87	93	67
MB UL	61	87	83	72	81	87	62
IVIEW	47	64	63	56	63	65	48
MB LL	47	67	64	55	63	67	48
TE LL	43	61	58	50	57	61	44
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	65	90	87	77	85	90	66
MB UL	61	84	81	72	80	84	62
IVIEW	47	63	62	57	63	64	49
MB LL	47	65	62	56	61	65	48
TE LL	42	59	57	50	56	59	43
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	61	79	77	72	77	79	61
MB UL	57	74	72	67	72	73	57
IVIEW	44	56	57	56	59	59	47
MB LL	44	57	55	52	55	56	44
TE LL	40	52	50	47	50	51	40
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	66	89	85	75	83	87	64
MB UL	61	83	79	70	78	82	60
IVIEW	47	63	63	59	67	68	51
MB LL	47	64	61	54	60	63	46
TE LL	43	58	55	49	54	57	42
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	65	92	85	74	83	89	63
MB UL	61	86	80	69	78	83	59
IVIEW	47	64	63	58	68	71	52
MB LL	47	66	61	53	60	64	46
TE LL	43	60	56	48	54	58	41
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	50	66	64	57	62	64	48
MB UL	47	62	60	54	58	60	45
IVIEW	36	47	48	46	51	52	40
MB LL	36	48	46	41	45	46	35
TE LL	33	43	42	38	41	42	31

Out of range Measurement Out of range Global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULTS

SOME OF THE SOFTWARE SIMULATION RESULTS WERE OUTSIDE THE MEASUREMENT LOWER LIMIT, HOWEVER, ALL WERE WITHIN THE GLOBAL ERROR LIMITS.

4.3 ARTIFICIAL LIGHTING SCENARIO – SEMI-SPECULAR REFLECTOR LUMINAIRE, GREY WALL

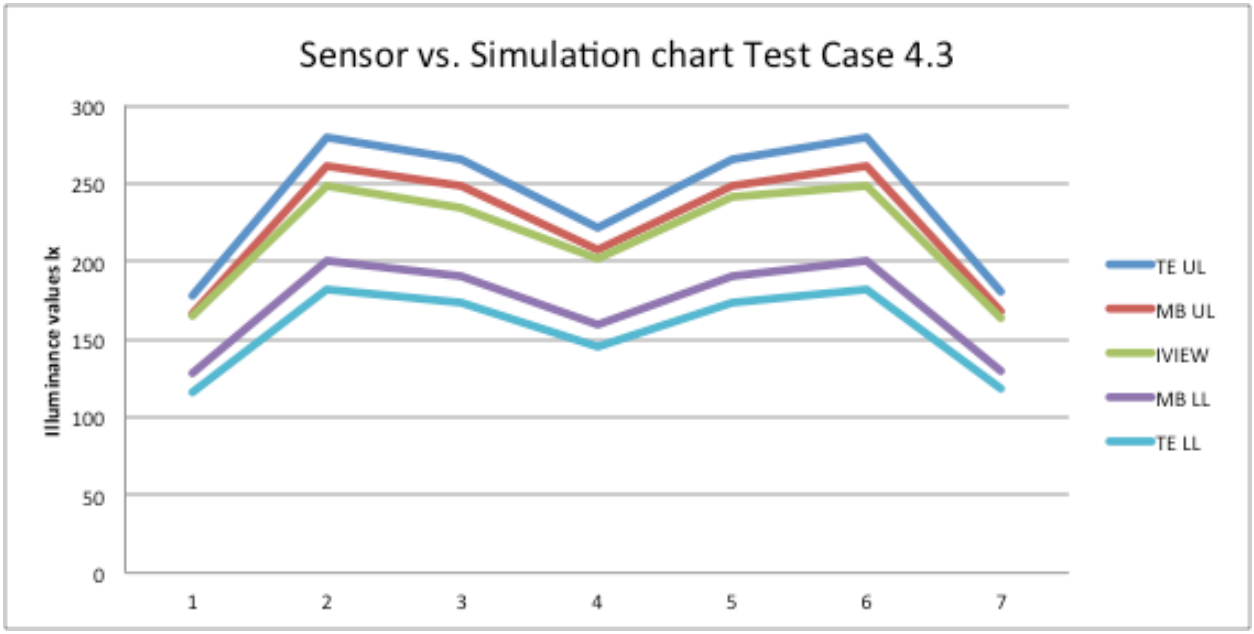
This scenario was designed to test the ability to measure a set of 4 luminaires using semi-specular reflectors with specific photometric distributions in a rectangular room, with grey walls. The test protocol is similar to 4.1

Table 3 - Test Case 4.3

Position	Sensor						
	1	2	3	4	5	6	7
TE UL	178	279	265	222	265	279	180
MB UL	166	261	248	207	248	261	168
IVIEW	165	249	235	202	241	249	163
MB LL	128	201	191	159	191	201	130
TE LL	116	182	173	145	173	182	118
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	206	312	305	258	308	317	214
MB UL	192	291	285	241	288	296	200
IVIEW	178	257	249	222	259	263	182
MB LL	148	224	219	186	222	228	154
TE LL	135	203	199	169	201	207	140
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	229	353	337	281	342	358	232
MB UL	214	330	315	262	319	334	217
IVIEW	201	297	284	248	293	295	198
MB LL	165	254	242	202	246	257	167
TE LL	149	230	220	183	223	234	152
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	209	310	303	265	311	315	207
MB UL	195	290	283	247	290	294	193
IVIEW	197	290	277	244	280	286	191
MB LL	150	223	218	191	224	227	149
TE LL	136	203	198	173	203	206	135
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	230	358	345	286	344	356	229
MB UL	215	334	322	267	321	332	214
IVIEW	201	300	289	248	290	294	198
MB LL	165	257	248	206	247	256	165
TE LL	150	234	225	187	225	232	150
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	221	329	317	264	312	317	209
MB UL	206	308	296	247	291	296	196
IVIEW	181	259	249	218	249	249	173
MB LL	159	237	228	190	224	228	151
TE LL	144	215	207	173	204	207	137
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	188	289	273	229	274	283	180
MB UL	176	270	255	214	255	264	168
IVIEW	164	249	234	200	240	248	160
MB LL	135	208	196	165	197	204	129
TE LL	123	189	178	150	179	185	117

Out of range Measurement Out of range Global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULTS

ONE OF THE SOFTWARE SIMULATION RESULTS WAS OUTSIDE THE MEASUREMENT LOWER LIMIT, HOWEVER, ALL WERE WITHIN THE GLOBAL ERROR LIMITS.

4.4 ARTIFICIAL LIGHTING SCENARIO – CFL, BLACK WALL.

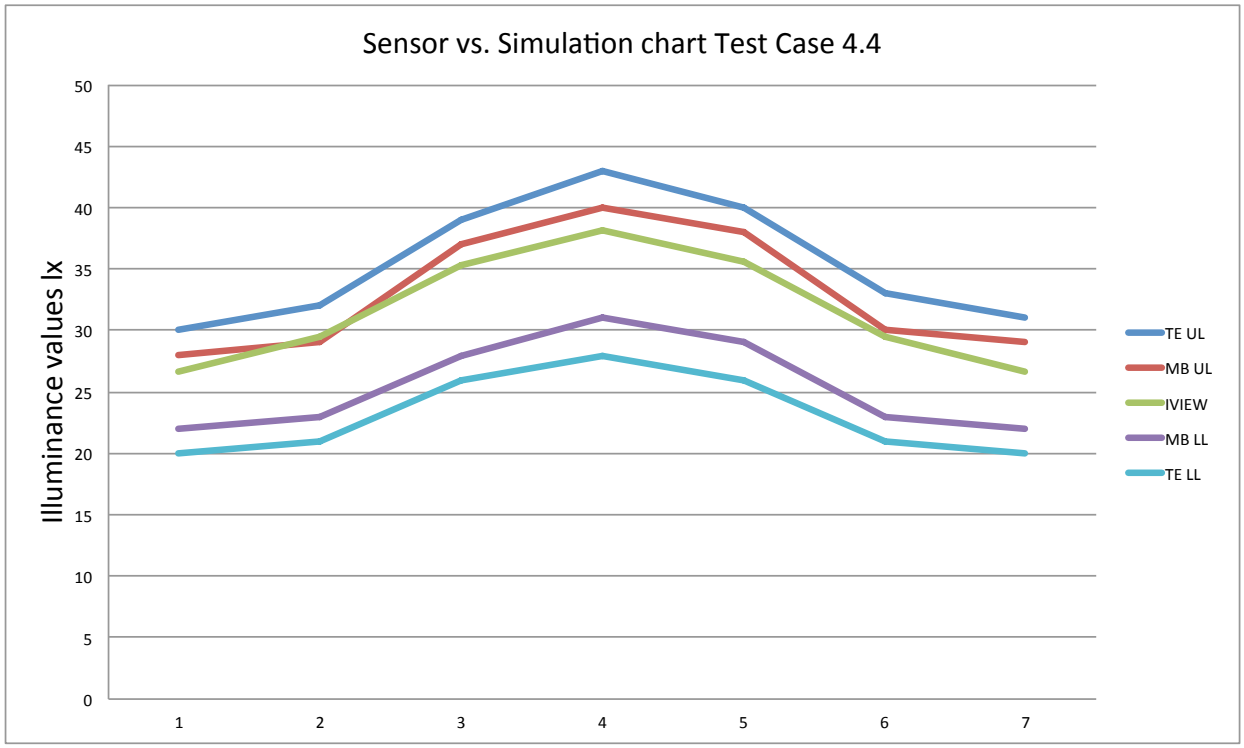
This scenario was designed to test the ability to measure a set of 4 "lamp only" luminaires in a rectangular room, with black walls in order to avoid errors related to inter-reflections. The test protocol is similar to 4.1

Table 4 - Test Case 4.4

Position	Sensor						
	1	2	3	4	5	6	7
TE UL	30	32	39	43	40	33	31
MB UL	28	29	37	40	38	30	29
IVIEW	27	29	35	38	36	29	27
MB LL	22	23	28	31	29	23	22
TE LL	20	21	26	28	26	21	20
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	31	32	39	42	41	33	31
MB UL	28	30	37	39	38	31	29
IVIEW	28	30	37	40	36	30	28
MB LL	22	23	28	30	29	24	23
TE LL	20	21	26	28	27	21	21
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	39	41	51	54	51	40	38
MB UL	36	38	48	51	47	38	35
IVIEW	35	37	44	49	44	37	34
MB LL	28	29	37	39	37	29	27
TE LL	25	27	33	36	33	26	25
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	43	46	57	62	57	46	43
MB UL	40	43	53	57	53	43	40
IVIEW	37	41	50	53	50	41	37
MB LL	31	33	41	44	41	33	31
TE LL	28	30	37	40	37	30	28
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	38	40	51	54	51	41	38
MB UL	35	38	48	51	48	38	36
IVIEW	35	37	45	49	45	37	35
MB LL	27	29	37	39	37	29	28
TE LL	25	26	33	35	34	27	25
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	31	33	41	43	40	33	31
MB UL	29	30	39	40	38	31	29
IVIEW	28	30	36	39	36	30	28
MB LL	23	23	30	31	29	23	23
TE LL	20	21	27	28	26	21	20
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	31	33	42	44	41	33	32
MB UL	29	31	39	41	38	31	30
IVIEW	26	29	35	37	34	29	26
MB LL	22	24	30	32	29	24	23
TE LL	20	21	27	29	26	22	21

Out of range Measurement Out of range Global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULTS

ONE OF THE SOFTWARE SIMULATION RESULTS WAS OUTSIDE THE MEASUREMENT LIMIT, HOWEVER, ALL WERE WITHIN THE GLOBAL ERROR LIMITS.

4.5 ARTIFICIAL LIGHTING SCENARIO – OPAL, BLACK WALL

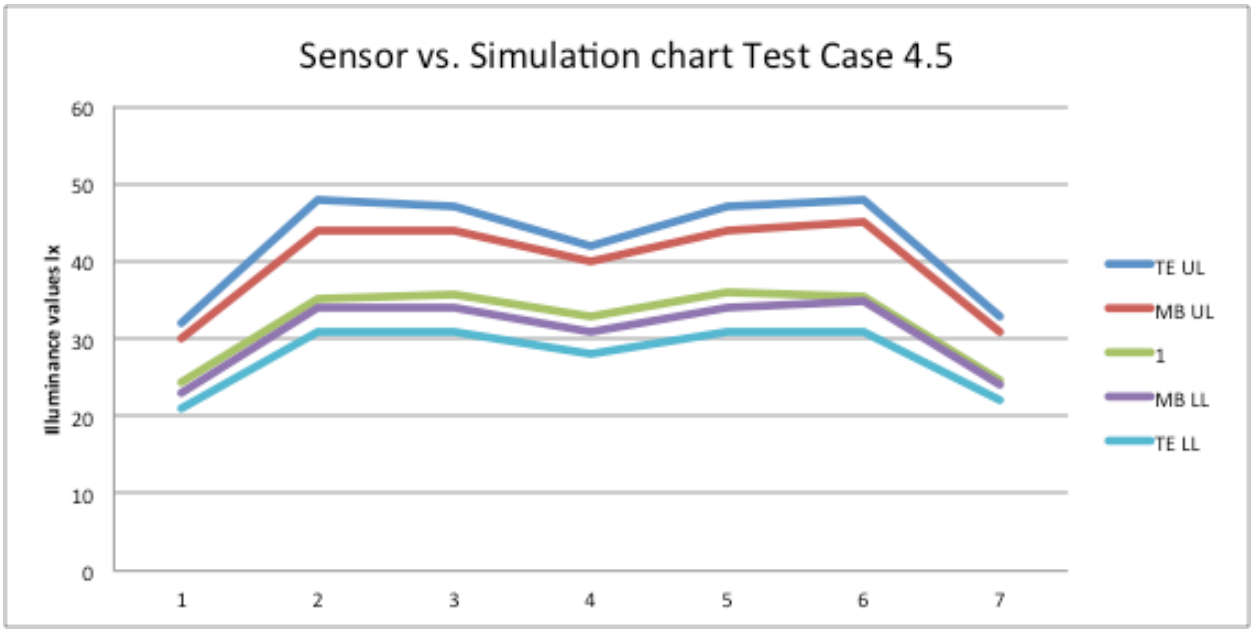
This scenario was designed to test the ability to measure a set of 4 "Opal" luminaires with a specific photometric distribution in a rectangular room, with black walls in order to avoid errors related to inter-reflections. The test protocol is similar to 4.1

Table 5 - Test Case 4.5

Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	32	48	47	42	47	48	33
MB UL	30	44	44	40	44	45	31
1	24	35	36	33	36	36	25
MB LL	23	34	34	31	34	35	24
TE LL	21	31	31	28	31	31	22
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	46	73	70	60	69	74	48
MB UL	43	68	66	56	64	69	44
2	35	53	52	46	53	54	36
MB LL	33	53	51	43	49	53	34
TE LL	30	48	46	39	45	48	31
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	47	71	70	61	69	72	48
MB UL	44	66	65	57	65	67	45
3	36	52	53	48	54	54	37
MB LL	34	51	50	44	50	52	34
TE LL	30	46	45	40	45	47	31
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	43	61	62	56	61	61	43
MB UL	40	57	57	53	57	57	40
4	33	46	48	46	50	49	35
MB LL	31	44	44	40	44	44	31
TE LL	28	40	40	37	40	40	28
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	47	71	68	60	68	70	47
MB UL	44	66	64	56	63	65	43
5	35	52	53	49	57	57	39
MB LL	34	51	49	43	49	50	33
TE LL	31	46	44	39	44	46	30
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	46	72	68	57	66	71	45
MB UL	43	67	63	54	62	66	42
6	35	53	53	48	57	59	39
MB LL	33	52	49	41	47	51	33
TE LL	30	47	44	37	43	46	30
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	32	47	46	40	45	45	31
MB UL	30	44	43	38	42	42	29
7	24	35	36	34	39	39	27
MB LL	23	34	33	29	32	33	23
TE LL	21	30	30	26	29	30	20

Out of range Measurement Out of range Global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULT

THE SOFTWARE SIMULATION RESULTS ALL WERE INSIDE THE MEASUREMENT UPPER AND LOWER LIMITS.

4.6 ARTIFICIAL LIGHTING SCENARIO – SEMI-SPECULAR REFLECTOR LUMINAIRE, BLACK WALL

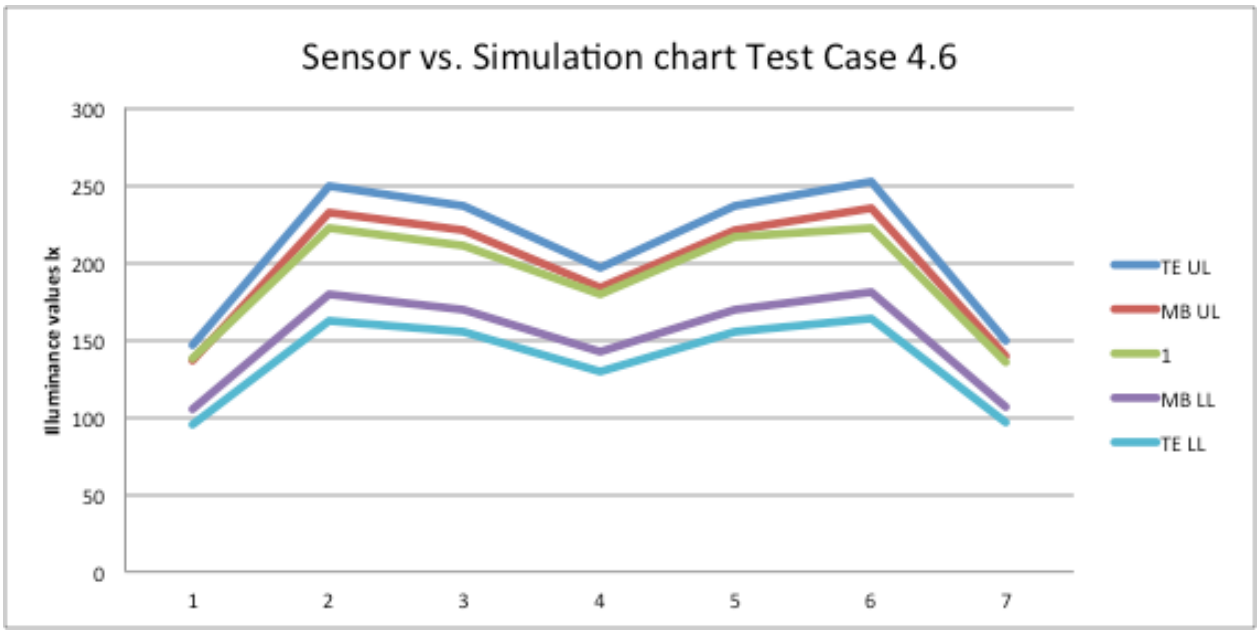
This scenario was designed to test the ability to measure a set of 4 luminaires using semi-specular reflectors with a specific photometric distribution in a rectangular room, with black walls in order to avoid errors related to inter-reflections. The test protocol is similar to 4.1

Table 6 - Test Case 4.6

Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	146	249	237	197	237	252	149
MB UL	136	232	221	184	221	235	139
1	137	222	210	179	216	222	136
MB LL	105	179	170	142	170	181	107
TE LL	95	162	155	129	155	164	97
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	172	288	282	236	284	294	179
MB UL	161	269	263	221	265	275	168
2	151	237	231	204	240	242	154
MB LL	124	207	202	170	204	211	129
TE LL	113	188	184	154	185	192	117
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	195	329	313	258	317	335	196
MB UL	182	307	292	241	296	312	183
3	176	278	267	230	275	276	172
MB LL	140	237	225	185	228	241	141
TE LL	127	215	204	168	207	218	128
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	178	287	278	242	285	290	176
MB UL	166	268	259	226	266	271	164
4	173	272	259	227	263	267	168
MB LL	128	206	200	174	205	209	126
TE LL	116	187	181	158	186	190	115
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	196	334	320	262	319	333	196
MB UL	183	312	299	244	298	311	183
5	176	281	271	231	273	275	172
MB LL	141	240	230	188	230	239	141
TE LL	128	218	209	171	208	217	128
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	186	306	292	242	287	292	175
MB UL	174	286	273	226	268	273	163
6	155	240	231	201	231	229	146
MB LL	134	220	210	174	206	210	126
TE LL	122	200	191	158	187	191	114
Position	**Sensor**						
	1	2	3	4	5	6	7
TE UL	155	258	241	202	242	251	146
MB UL	145	241	225	189	226	234	136
7	138	224	210	178	216	222	133
MB LL	111	186	173	145	174	180	105
TE LL	101	169	157	132	158	164	95

Out of range Measurement Out of range Global error

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULT

SOME OF THE SOFTWARE SIMULATION RESULTS WERE OUTSIDE THE MEASUREMENT LIMIT, HOWEVER, ALL WERE WITHIN THE GLOBAL ERROR LIMITS

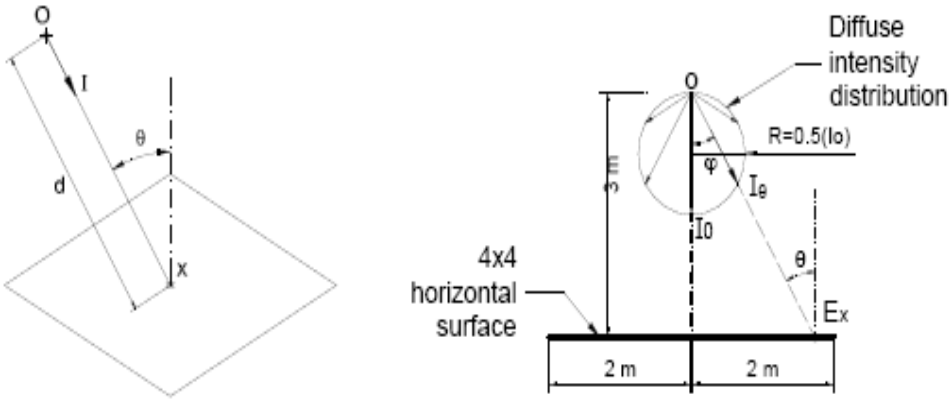
CONCLUSION

NVIDIA® IRAY® PERFORMS WELL WITHIN THE PARAMETERS SET BY THE DOCUMENT AND MOST OF THE TIME WITHIN THE PARAMETERS OF MEASUREMENT ERROR.

5.2 SIMULATION OF POINT LIGHT SOURCES.

This scenario is designed to test the capabilities of the software to calculate the direct illuminance under a point light source described by a photometric distribution file

Test case description



Measurement points distribution

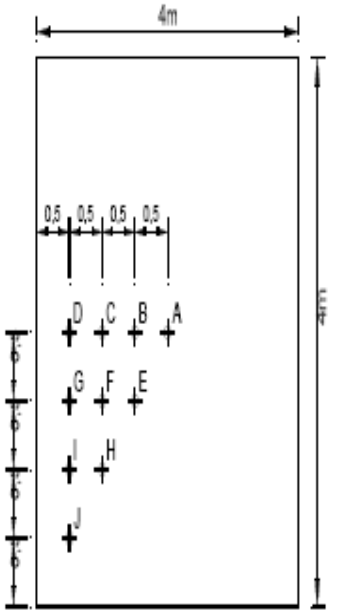
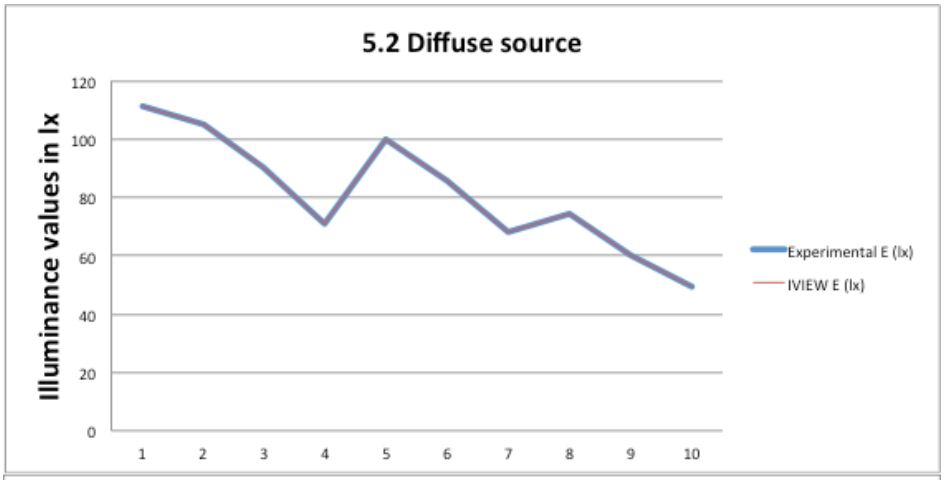
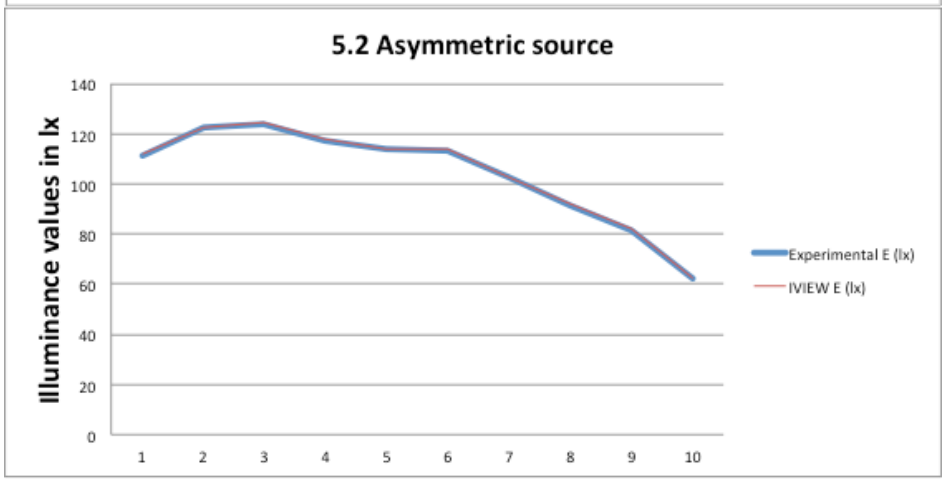


Table 7 - Test Case 5.2								
			Diffuse photometry	Experimental	IVIEW	CIE T9 photometry	Experimental	IVIEW
Points	d (m)	incidence (°)	I (cd)	E (lx)	E (lx)	I (cd)	E (lx)	E (lx)
A	3	0	1000	111.11	111.22	1000	111.11	111.61
B	3.041	9.46	986.4	105.21	105.29	1146.1	122.25	122.81
C	3.162	18.43	948.7	90.02	90.08	1307.7	124.08	124.69
D	3.354	26.57	894.4	71.11	71.16	1475.5	117.31	117.90
E	3.082	13.26	973.3	99.73	99.82	1109.1	113.65	113.94
F	3.202	20.44	937	85.64	85.74	1240.9	113.41	113.77
G	3.391	27.79	884.7	68.06	68.10	1335.4	102.74	102.60
H	3.317	25.24	904.5	74.36	74.44	1113.8	91.57	91.99
I	3.5	31	857.2	59.98	60.01	1166.8	81.65	81.94
J	3.674	35.26	816.5	49.39	49.41	1027.5	62.16	62.44

GRAPHICAL REPRESENTATION OF MEASUREMENTS





RESULT

THE SOFTWARE SIMULATION RESULTS ALL WERE CONSISTENT WITH THE EXPERIMENTAL VALUES.

5.3 SIMULATION OF AREA LIGHT SOURCES.

This scenario is designed to test the capabilities of the software to calculate the direct illuminance under an area light source.

Test case description

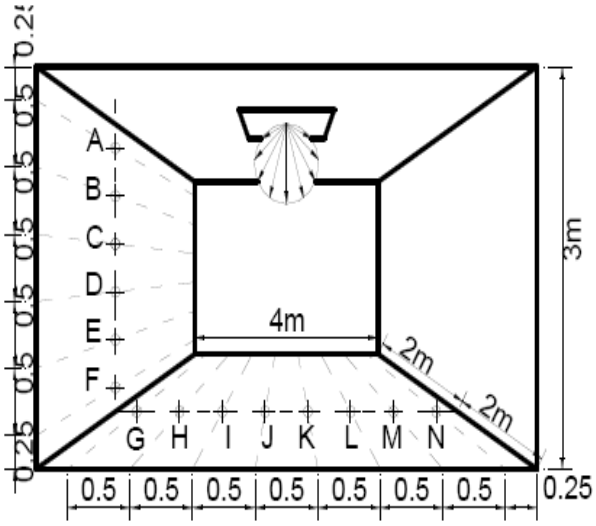


Table 8 - Test Case 5.3.3.1

Reference Points	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Sensor Direct Illuminance	32.68	75.09	81.38	69.12	53.41	39.90	61.27	79.18	95.52	105.89	105.89	95.52	79.18	61.27
IVIEW	32.69	75.23	81.36	69.09	53.42	40.02	61.45	79.29	95.71	105.82	105.82	95.71	79.29	61.45
% Variation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

GRAPHICAL REPRESENTATION OF MEASUREMENTS

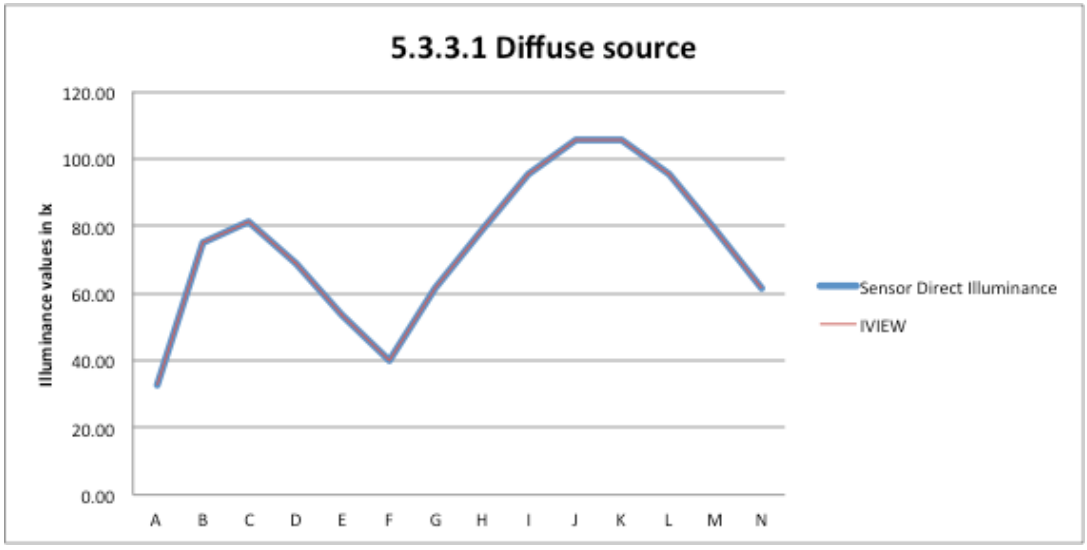
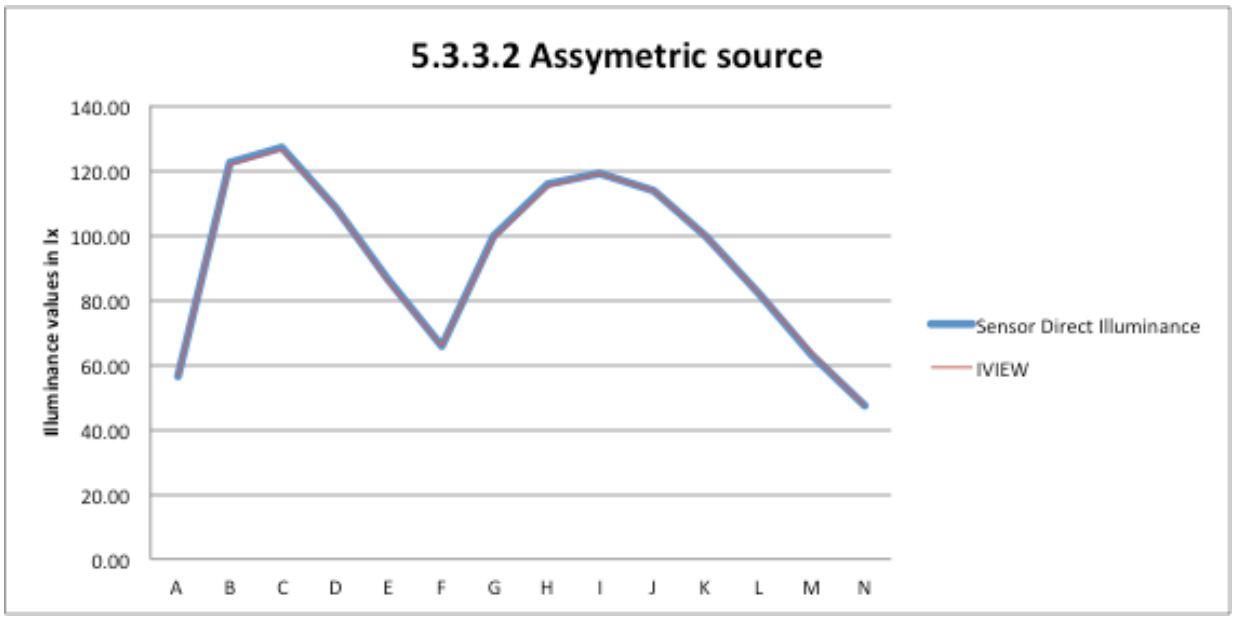


Table 9 - Test Case 5.3.3.2														
Reference Points	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Sensor Direct Illuminance	56.73	122.10	126.95	108.61	86.13	66.07	99.62	115.53	119.34	113.80	99.97	81.98	63.30	47.39
IVIEW	56.28	121.77	126.66	108.25	85.74	65.69	99.10	115.05	119.22	113.61	100.02	81.99	63.50	47.37
% Variation	1%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%

GRAPHICAL REPRESENTATION OF MEASUREMENTS



RESULT

THE SOFTWARE SIMULATION RESULTS ALL WERE CONSISTENT WITH THE EXPERIMENTAL VALUES.

5.5 DIRECTIONAL TRANSMITTANCE OF CLEAR GLASS.

The objective of this section is to test if the transmittance of glass varied with the angle of incident light. The test geometry is a room with an opening in the ceiling covered with glass and parallel beams of light incident on the glass at varying angles.

The directional transmission of glass was determined as the ratio between the total flux in the room with the glass divided by the total flux inside the room without the glass.

The reference table in the CIE document is shown below

θ°	0	10	20	30	40	50	60	70	80	90
τ_θ	0.96	0.96	0.96	0.96	0.96	0.95	0.93	0.84	0.59	0.00
τ_θ/τ_0	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.87	0.61	0.00

Table 13: Clear glass transmittance variation as a function of the incidence angle

Table 10 - Test Case 5.5					
	Reference		Calculated		
Scenario	τ ang	τang / τ 0	Avg. E	τ ang	τang / τ 0
0 deg	0.96	1	1201.21	0.96	1.00
0 deg _no glass			1251.28		
10 deg	0.96	1	1155.06	0.96	1.00
10 deg _no glass			1203.19		
20 deg	0.96	1	1058.39	0.96	1.00
20 deg _no glass			1102.49		
30 deg	0.96	1	927.14	0.96	1.00
30 deg _no glass			965.81		
40 deg	0.96	1	768.50	0.96	1.00
40 deg_no glass			801.08		
50 deg	0.95	0.99	592.33	0.95	0.99
50 deg_no glass			620.62		
60 deg	0.93	0.96	382.24	0.93	0.97
60 deg_no glass			411.02		
70 deg	0.84	0.87	158.20	0.84	0.88
70 deg_no glass			187.98		
80 deg	0.59	0.61	0.00	0.00	0.00
80 deg_no glass			0.00		
90 deg	0	0	0.00	0.00	0.00
90 deg_no glass			0.00		

RESULT

THE CALCULATED VALUES ARE ALL IN CONSISTENT WITH THE ANALYTICAL RESULTS, EXCEPT FOR THE 80-DEGREE MEASUREMENT, WHERE IT IS THE BELIEF OF THE AUTHOR, THAT THE TEST SCENARIO DEFINITION IN THE ORIGINAL DOCUMENT IS NOT ACCURATE AS IT DOES NOT CONSIDER THE THICKNESS OF THE CEILING; AT 80 DEGREES, AND WITH A CEILING/GLASS THICKNESS OF 20 CMS. NO LIGHT ENTERS THE ROOM.

5.6 LIGHT REFLECTION OVER DIFFUSE SURFACES

This section is intended to test the ability of the software to calculate light reflection over diffuse surfaces. Incident light from a specified angle hits a diffuse surface of a particular reflectance. Illuminance values are measured on planes perpendicular to this surface and directly above (facing) the surface. Both these planes don't receive direct illuminance from the source. This test is repeated with varying source incident angles, varying sizes of the reflective surface and varying the reflectance of the surface.

Shown below are the sketches for all 3 scenarios and a sketch showing the measurement points from the CIE report.

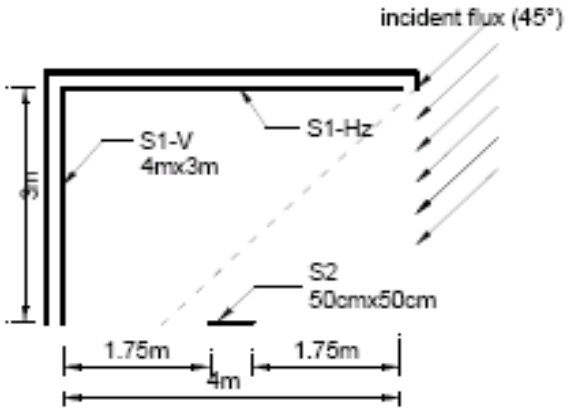


Figure 8: Test case description for S_2 of 50cmx50cm

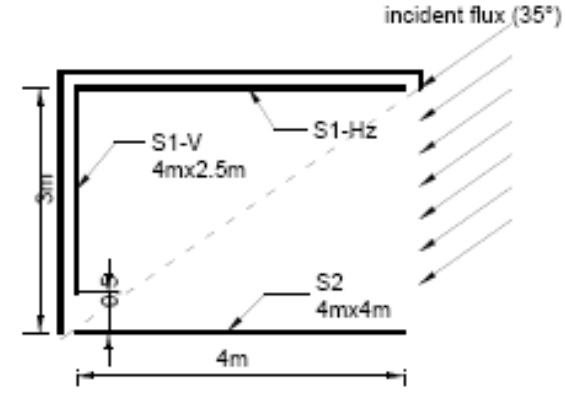


Figure 9: Test case description for S_2 of 4mx4m

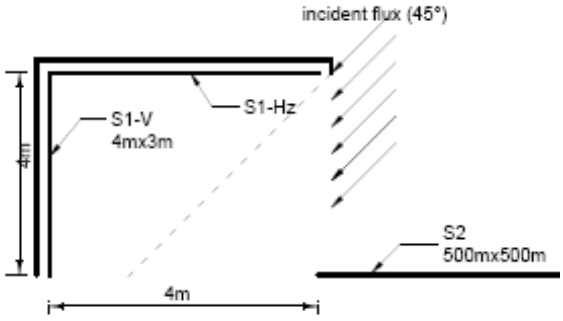


Figure 10: Test case description for S_2 of 500mx500m

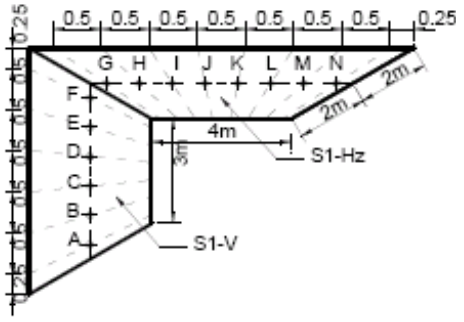


Figure 11: measurement point positions

The table below lists the calculated values for E/ (E_{hz} x ρ) along with the reference values from the CIE for comparison. E represents the illuminance at the different points, E_{hz} is the average horizontal illuminance on the reflective surface and ρ is the reflectance of the surface.

S2:50x50cm			Table 11	Iview Values	ρ	IVIEW calculated values/ ρ
	S1-v	A	0.246	0.20	0.80	0.25
		B	0.580	0.47	0.80	0.59
		C	0.644	0.52	0.80	0.65
		D	0.556	0.45	0.80	0.56
		E	0.433	0.35	0.80	0.44
		F	0.325	0.27	0.80	0.33
	S1-hz	G	0.491	0.40	0.80	0.49
		H	0.639	0.51	0.80	0.64
		I	0.778	0.63	0.80	0.78
		J	0.864	0.70	0.80	0.87
		K	0.864	0.70	0.80	0.87
		L	0.778	0.63	0.80	0.78
		M	0.639	0.51	0.80	0.64
		N	0.491	0.39	0.80	0.49

S2:4x4m			Table 12	Iview Values	ρ	IVIEW calculated values/ ρ
	S1-v	A		13.54	0.30	45.12
		B	35.901	10.77	0.30	35.89
		C	27.992	8.39	0.30	27.98
		D	21.639	6.49	0.30	21.62
		E	16.716	5.01	0.30	16.70
		F	12.967	3.89	0.30	12.97
	S1-hz	G	26.28	8.07	0.30	26.88
		H	30.94	9.32	0.30	31.06
		I	33.98	10.24	0.30	34.12
		J	35.57	10.72	0.30	35.72
		K	35.57	10.72	0.30	35.72
		L	33.98	10.24	0.30	34.12
		M	30.94	9.32	0.30	31.06
		N	26.80	8.07	0.30	26.88

S2:500x500m			Table 13	Iview Values	ρ	IVIEW calculated values/ ρ
	S1-v	A	3.080	0.93	0.30	3.09
		B	9.097	2.74	0.30	9.12
		C	14.718	4.43	0.30	14.76
		D	19.767	5.94	0.30	19.81
		E	24.161	7.26	0.30	24.21
		F	27.896	8.39	0.30	27.96
	S1-hz	G	10.95	3.27	0.30	10.90
		H	13.26	3.96	0.30	13.20
		I	16.21	4.84	0.30	16.15
		J	20.00	5.98	0.30	19.93
		K	24.80	7.42	0.30	24.74
		L	30.77	9.21	0.30	30.71
		M	37.87	11.35	0.30	37.83
		N	45.84	13.75	0.30	45.83

RESULT

THE CALCULATED VALUES ARE ALL IN CONSISTENT WITH THE ANALYTICAL RESULTS. NOTE THAT THERE IS NO MEASUREMENT RECORDED IN THE CIE DOCUMENT AT POSITION A S2 4X4M

5.7 DIFFUSE REFLECTIONS WITH INTERNAL OBSTRUCTIONS

The objective of this test case is to verify the capability of a program to simulate the influence of an obstruction to diffuse reflection.

Test case description

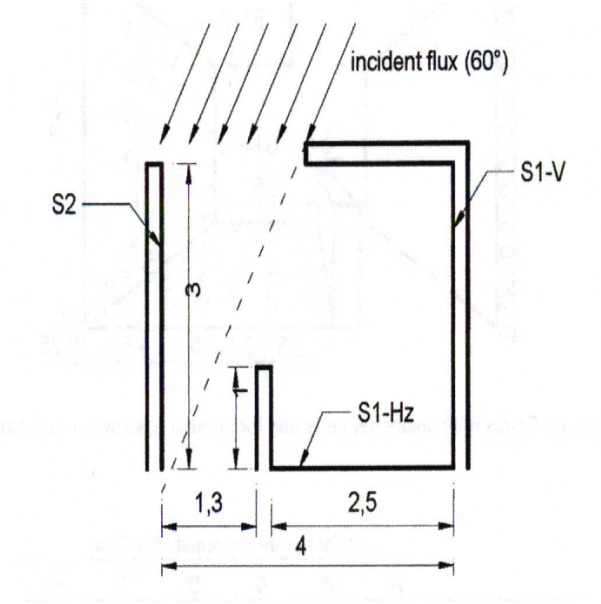


Table 14 - Test Case 5.7				
	Table 19-Correct values E/E_V x ρ	Table 19 Correct values E/E_Hz	Iview Values E/E_Hz	Iview calculated values E/E_V x ρ
A	16.07	5.57	5.57	16.08
B	16.33	5.66	5.66	16.34
C	15.40	5.33	5.34	15.41
D	13.32	4.61	4.62	13.32
E	10.32	3.57	3.58	10.32
F	7.08	2.45	2.45	7.08
G	3.38	1.17	1.17	3.38
H	3.63	1.26	1.26	3.63
I	3.01	1.04	1.05	3.02
J	0.00	0.00	0.00	0.01

RESULT

TABLE 19 OF THE ORIGINAL DOCUMENT LISTS INCORRECT VALUES, THE CORRECT VALUES ARE LISTED ABOVE AND SHOWN WITH A GREEN BACKGROUND. THE CALCULATED VALUES ARE ALL CONSISTENT WITH THE ANALYTICAL RESULTS.

5.8 INTERNAL REFLECTED COMPONENT FOR DIFFUSE SURFACES

The objective of this test case is to assess the accuracy of the diffuse inter-reflections inside a room.

Test case description: The test case geometry is a square room of dimensions 4mx4mx4m with all surfaces being uniform diffusers and spectrally neutral. An isotropic point light source is positioned at the center of the room with an output flux of 10,000 lm

Table 15 - Test Case 5.8

Reflectance	0.00	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
E_{av}	0.00	5.48	11.60	26.00	44.60	69.40	104.00	156.00	243.00	417.00	937.00	1979.00
IVIEW Direct	105.24	105.24	105.24	105.24	105.24	105.24	105.24	105.24	105.24	105.24	105.24	105.24
IVIEW Total	105.24	110.75	116.86	131.39	150.06	174.93	209.74	261.92	348.85	522.61	1041.61	2081.81

RESULT

THE CALCULATED VALUES ARE ALL CONSISTENT WITH THE ANALYTICAL RESULTS. NOTE THAT NVIDIA® IRAY® IS ABLE TO GENERATE OUTPUT FOR DIRECT AND INDIRECT ILLUMINATION SEPARATELY IN ONE SIMULATION STEP; HOWEVER, THIS FEATURE IS CURRENTLY NOT EXPOSED BY IVIEW'S LIGHT ANALYSIS TOOL. IT IS THEREFORE NECESSARY TO OBTAIN THE DIRECT ILLUMINATION VALUE IN A SEPARATE TEST RUN. SUBTRACTING THAT VALUE FROM THE FULL ILLUMINATION RESULT WILL YIELD THE INDIRECT ILLUMINATION VALUE.

5.9 SKY COMPONENT FOR ROOF UNGLAZED OPENING AND CIE GENERAL SKY TYPES

This section is meant to test the ability of the software to calculate the sky component obtained under different sky conditions. The figure for the test geometry from the CIE report is shown.

The sun position is defined as being at 60-degree elevation.

Test Case description

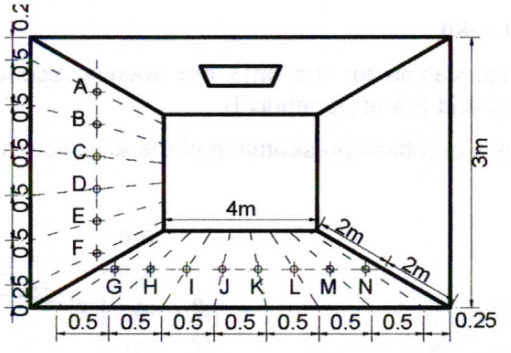


Figure 15: geometry and measurement points description

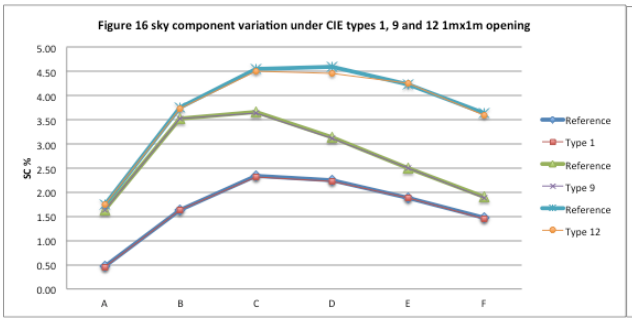
Table 16 Test Case 5.9 1x1 opening

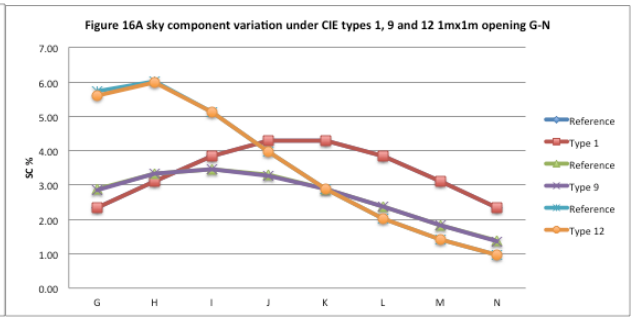
Opening	CIE sky type	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1x1	Reference	0.46	1.64	2.34	2.26	1.88	1.47	2.33	3.11	3.84	4.29	4.29	3.84	3.11	2.33
	Type 1	0.46	1.63	2.31	2.24	1.89	1.45	2.33	3.11	3.84	4.29	4.29	3.84	3.11	2.33
	Reference	0.40	1.72	2.86	3.15	2.90	2.44	4.00	5.00	5.47	5.37	4.73	3.76	2.76	1.90
	Type 2	0.40	1.70	2.83	3.11	2.92	2.41	3.98	4.99	5.47	5.36	4.73	3.77	2.76	1.90
	Reference	1.36	1.78	2.22	2.46	2.05	0.79	2.13	2.80	3.42	3.81	3.81	3.42	2.80	2.13
	Type 3	0.79	2.04	2.44	2.20	1.79	1.35	2.12	2.79	3.42	3.80	3.80	3.42	2.80	2.12
	Reference	0.71	2.17	3.06	3.15	2.79	2.30	3.72	4.58	4.97	4.85	4.27	3.42	2.53	1.77
	Type 4	0.71	2.16	3.03	3.11	2.81	2.28	3.70	4.57	4.97	4.84	4.27	3.41	2.52	1.76
	Reference	1.04	2.39	2.59	2.20	1.70	1.27	1.95	2.52	3.04	3.37	3.37	3.04	2.52	1.95
	Type 5	1.04	2.38	2.57	2.18	1.71	1.26	1.95	2.52	3.05	3.36	3.36	3.05	2.52	1.95
	Reference	0.94	2.58	3.27	3.16	2.71	2.19	3.47	4.20	4.49	4.36	3.84	3.09	2.31	1.65
	Type 6	0.94	2.57	3.24	3.13	2.73	2.16	3.45	4.20	4.49	4.35	3.83	3.09	2.31	1.65
	Reference	0.82	2.52	3.61	3.91	3.69	3.19	5.21	5.96	5.70	4.93	3.92	2.90	2.04	1.39
	Type 7	0.82	2.51	3.57	3.86	3.71	3.15	5.18	5.95	5.71	4.92	3.91	2.90	2.04	1.39
	Reference	0.72	2.43	3.86	4.56	4.60	4.18	6.94	7.65	6.78	5.38	3.93	2.71	1.80	1.17
	Type 8	0.72	2.42	3.80	4.49	4.63	4.12	6.90	7.64	6.79	5.37	3.93	2.71	1.80	1.17
	Reference	1.64	3.53	3.67	3.14	2.49	1.91	2.88	3.34	3.45	3.29	2.89	2.37	1.83	1.37
	Type 9	1.64	3.52	3.64	3.11	2.50	1.89	2.87	3.33	3.45	3.28	2.88	2.36	1.83	1.36
	Reference	1.46	3.52	4.13	3.96	3.45	2.84	4.42	4.85	4.49	3.80	3.02	2.27	1.65	1.18
	Type 10	1.46	3.50	4.09	3.91	3.47	2.81	4.39	4.84	4.49	3.80	3.01	2.27	1.65	1.18
	Reference	1.30	3.46	4.49	4.69	4.39	3.79	6.01	6.36	5.45	4.23	3.09	2.16	1.48	1.01
	Type 11	1.30	3.44	4.44	4.63	4.41	3.74	5.97	6.35	5.45	4.22	3.09	2.16	1.48	1.01
	Reference	1.74	3.76	4.55	4.61	4.24	3.63	5.72	6.01	5.12	3.97	2.90	2.03	1.40	0.96
	Type 12	1.75	3.74	4.50	4.45	4.26	3.58	5.62	6.00	5.12	3.96	2.89	2.03	1.40	0.96
	Reference	1.61	3.76	4.87	5.16	4.89	4.29	6.76	7.01	5.80	4.30	2.98	1.99	1.30	0.86
	Type 13	1.61	3.74	4.81	5.09	4.91	4.21	6.71	7.00	5.80	4.29	2.98	1.98	1.30	0.86
	Reference	2.22	4.01	4.88	5.05	4.72	4.08	6.43	6.64	5.47	4.05	2.81	1.87	1.23	0.82
	Type 14	2.23	4.00	4.83	4.97	4.74	4.03	6.39	6.62	5.47	4.04	2.80	1.87	1.23	0.82
	Reference	2.14	4.16	5.23	5.47	5.11	4.41	6.94	7.19	5.93	4.36	2.96	1.90	1.20	0.76
	Type 15	2.15	4.14	5.17	5.39	5.14	4.35	6.89	7.17	5.93	4.35	2.95	1.90	1.20	0.76
	Reference	0.56	1.78	2.32	2.20	1.82	1.43	2.29	3.07	3.82	4.29	4.29	3.82	3.07	2.29
	Overcast	0.56	1.77	2.30	2.18	1.84	1.41	2.28	3.07	3.83	4.29	4.29	3.82	3.08	2.28

Table 17 Test Case 5.9 4x4 opening															
Opening	CIE sky type	A	B	C	D	E	F	G	H	I	J	K	L	M	N
4x4	Reference	37.84	31.72	26.85	22.10	17.89	14.38	31.87	37.30	41.27	43.35	43.35	41.27	37.30	31.87
	Type 1	35.81	31.53	26.80	22.09	17.91	14.38	31.84	37.26	41.25	43.30	43.30	41.25	37.26	31.84
	Reference	42.03	37.03	32.75	28.13	23.70	19.79	42.01	46.99	49.85	50.08	47.76	42.89	36.40	29.02
	Type 2	40.36	36.88	32.69	28.13	23.75	19.78	41.93	46.95	49.79	50.04	47.70	42.89	36.34	29.00
	Reference	42.77	34.03	27.43	21.81	17.23	13.61	29.16	33.92	37.40	39.22	39.22	37.40	33.92	29.16
	Type 3	40.96	33.86	27.39	21.80	17.26	13.61	29.11	33.85	37.35	39.15	39.15	37.36	33.86	29.11
	Reference	46.85	39.59	33.65	28.08	23.16	19.04	39.19	43.59	46.07	46.17	43.97	39.50	33.60	26.94
	Type 4	45.34	39.45	33.59	28.07	23.21	19.03	39.08	43.52	45.99	46.11	43.88	39.48	33.53	26.91
	Reference	46.74	36.05	28.05	21.67	16.73	12.98	26.80	30.95	33.99	35.58	35.58	33.99	30.95	26.80
	Type 5	45.12	35.89	28.01	21.65	16.76	12.98	26.75	30.89	33.95	35.52	35.52	33.95	30.89	26.75
	Reference	50.91	41.92	34.58	28.15	22.76	18.41	36.63	40.47	42.59	42.57	40.48	36.37	31.03	25.04
	Type 6	49.57	41.79	34.53	28.13	22.81	18.40	36.52	40.41	42.52	42.50	40.40	36.35	30.96	25.01
	Reference	51.83	44.95	38.55	32.55	27.23	22.77	44.08	47.33	48.53	47.09	43.13	36.83	29.80	22.81
	Type 7	51.49	44.92	38.50	32.54	27.30	22.72	43.95	47.28	48.44	47.04	43.06	36.84	29.72	22.79
	Reference	52.27	47.46	41.91	36.33	31.13	26.65	50.65	53.33	53.73	51.05	45.38	37.05	28.56	20.78
	Type 8	53.09	47.53	41.85	36.32	31.24	26.53	50.50	53.31	53.63	51.03	45.31	37.09	28.47	20.78
	Reference	61.28	47.22	36.33	27.92	21.55	16.78	30.7	33.35	34.69	34.41	32.58	29.29	25.19	20.69
	Type 9	60.28	47.12	36.29	27.89	21.59	16.77	30.59	33.27	34.62	34.34	32.50	29.26	25.13	20.66
	Reference	61.85	50.36	40.59	32.56	26.13	21.1	37.82	39.98	40.52	38.95	35.42	30.18	24.58	19.14
	Type 10	61.71	50.33	40.54	32.52	26.19	21.06	37.68	39.91	40.42	38.88	35.34	30.17	24.50	19.12
	Reference	61.99	53.01	44.28	36.68	30.26	25.08	44.36	46.04	45.85	43.1	37.95	30.84	23.89	17.68
	Type 11	62.89	53.07	44.23	36.64	30.35	25.03	44.19	45.99	45.74	43.05	37.88	30.87	23.81	17.67
	Reference	66.34	54.33	44.25	36.1	29.48	24.25	42.33	43.82	43.54	40.85	35.92	29.17	22.62	16.79
	Type 12	67.25	54.40	44.21	36.05	29.56	24.20	42.15	43.75	43.43	40.80	35.84	29.19	22.54	16.78
	Reference	66.63	56.51	47.18	39.24	32.56	27.15	47.07	48.25	47.47	43.96	37.92	29.91	22.38	15.95
	Type 13	68.13	56.63	47.13	39.20	32.66	27.08	46.87	48.20	47.35	43.91	37.85	29.94	22.29	15.95
	Reference	71.83	57.51	46.84	38.44	31.62	26.2	44.95	45.99	45.15	41.74	35.96	28.34	21.22	15.16
	Type 14	73.33	57.59	46.77	38.37	31.69	26.12	44.73	45.89	45.01	41.67	35.86	28.35	21.13	15.15
	Reference	73.2	60.07	49.66	41.13	34.02	28.29	48.42	49.33	48.19	44.25	37.79	29.37	21.53	14.91
	Type 15	74.80	60.17	49.59	41.07	34.11	28.21	48.19	49.25	48.04	44.19	37.69	29.39	21.43	14.89
	Reference	39.28	32.32	26.79	21.78	17.53	14.05	31.36	36.76	40.71	42.76	42.76	40.71	36.76	31.36
	Overcast	37.35	32.15	26.74	21.76	17.54	14.05	31.31	36.71	40.67	42.69	42.70	40.67	36.71	31.32

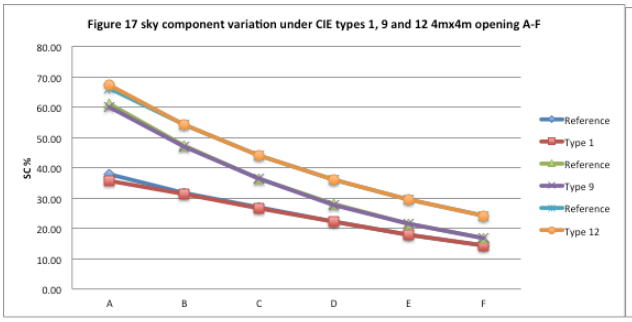
GRAPHICAL REPRESENTATION OF MEASUREMENTS

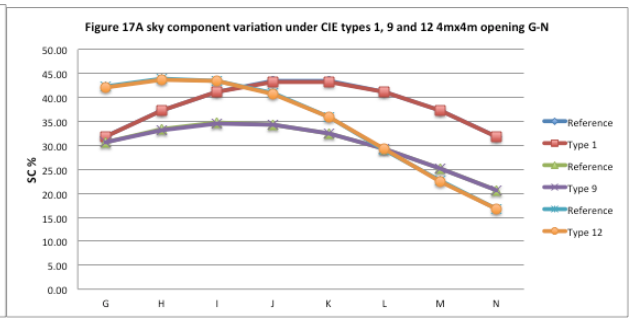
Reference Chart for 1mx1m aperture





Reference Chart for 4mx4m aperture





RESULT

A VERY SMALL PERCENTAGE OF THE SOFTWARE SIMULATION RESULTS WERE OUTSIDE THE MEASUREMENT LIMIT IN THE 1X1 OPENING ANALYSIS, HOWEVER, BASED ON PREVIOUS EXPERIENCE WITH SIMULATION SOFTWARE AND THIS PARTICULAR DOCUMENT, THE AUTHOR BELIEVES THE VALUES LISTED FOR TYPE 3 COLUMNS A-F ARE TRANSPOSED IN THE ORIGINAL DOCUMENT ONCE THE VALUES ARE CHANGED, THE TABLE MATCHES. SEE BELOW:

Reference	1.36	1.78	2.22	2.46	2.05	0.79
Type 3	0.79	2.04	2.44	2.20	1.79	1.35
Transposed	0.79	2.05	2.46	2.22	1.78	1.36

All other values fall within the margin of error.

5.10 SKY COMPONENT UNDER A ROOF GLAZED OPENING.

The objective of this section is to test the ability of the software to calculate the sky component obtained under different sky conditions, under the influence of a glazed opening.

The test geometry and conditions are similar to the one in Section 5.9 (Note: the document incorrectly refers to section 5.8), except there is meant to be a 6mm thick pane of glass covering the opening on the ceiling. Since NVIDIA® Iray® allows for specifying the transmittance of glass, a transmittance value of 0.91 was selected for the tests. This was chosen based calculating values for the first case (1mx1m opening, sky type 1), varying the transmittance values and using the value that yielded results closest to the reference values.

Table 18 Test Case 5.10 1x1 opening

Opening	CIE sky type	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1x1	Reference	0.15	1.17	1.91	1.92	1.62	1.28	2.04	2.73	3.38	3.78	3.78	3.38	2.73	2.04
	Type 1	0.18	1.23	1.93	1.91	1.62	1.25	2.00	2.69	3.32	3.71	3.72	3.32	2.69	2.01
	Reference	0.13	1.22	2.34	2.68	2.50	2.12	3.50	4.39	4.81	4.72	4.16	3.31	2.42	1.67
	Type 2	0.16	1.29	2.36	2.66	2.51	2.07	3.44	4.31	4.74	4.65	4.10	3.26	2.38	1.64
	Reference	0.26	1.45	2.01	1.89	1.54	1.18	1.87	2.46	3.01	3.35	3.35	3.01	2.46	1.87
	Type 3	0.32	1.53	2.03	1.87	1.54	1.16	1.83	2.15	2.96	3.29	3.29	2.96	2.42	1.83
	Reference	0.24	1.54	2.51	2.68	2.41	2.01	3.26	4.03	4.37	4.26	3.76	3.01	2.22	1.55
	Type 4	0.28	1.63	2.53	2.65	2.42	1.96	3.20	3.95	4.30	4.19	3.70	2.96	2.18	1.52
	Reference	0.35	1.69	2.12	1.87	1.47	1.11	1.71	2.22	2.68	2.96	2.96	2.68	2.22	1.71
	Type 5	0.42	1.79	2.14	1.86	1.47	1.09	1.68	2.18	2.64	2.91	2.91	2.64	2.18	1.68
	Reference	0.31	1.82	2.67	2.69	2.34	1.90	3.04	3.69	3.95	3.83	3.37	2.72	2.03	1.44
	Type 6	0.38	1.93	2.70	2.67	2.34	1.86	2.97	3.62	3.89	3.77	3.32	2.67	2.00	1.42
	Reference	0.28	1.78	2.96	3.33	3.19	2.78	4.56	5.23	5.02	4.34	3.45	2.55	1.79	1.22
	Type 7	0.33	1.89	2.98	3.29	3.19	2.71	4.47	5.14	4.93	4.26	3.39	2.51	1.76	1.20
	Reference	0.24	1.73	3.16	3.89	3.98	3.64	6.08	6.72	5.97	4.73	3.46	2.38	1.58	1.03
	Type 8	0.29	1.83	3.18	3.83	3.98	3.55	5.96	6.59	5.87	4.65	3.41	2.35	1.56	1.01
	Reference	0.55	2.49	3.00	2.67	2.15	1.66	2.52	2.93	3.04	2.89	2.54	2.08	1.61	1.20
	Type 9	0.65	2.64	3.03	2.64	2.15	1.63	2.47	2.88	2.99	2.84	2.50	2.05	1.58	1.18
	Reference	0.49	2.48	3.38	3.37	2.98	2.47	3.87	4.26	3.95	3.34	2.65	2.00	1.45	1.03
	Type 10	0.58	2.64	3.40	3.33	2.98	2.42	3.79	4.17	3.88	3.28	2.61	1.96	1.43	1.02
	Reference	0.44	2.45	3.68	4.00	3.79	3.30	5.26	5.59	4.79	3.72	2.72	1.90	1.31	0.89
	Type 11	0.52	2.59	3.70	3.95	3.79	3.22	5.16	5.48	4.71	3.65	2.67	1.87	1.29	0.87
	Reference	0.58	2.65	3.72	3.92	3.66	3.16	5.01	5.28	4.51	3.49	2.55	1.79	1.23	0.84
	Type 12	0.70	2.81	3.75	3.87	3.65	3.09	4.91	5.17	4.43	3.43	2.51	1.76	1.21	0.83
	Reference	0.54	2.66	3.99	4.40	4.23	3.71	5.91	6.16	5.10	3.79	2.62	1.75	1.14	0.75
	Type 13	0.64	2.81	4.01	4.34	4.22	3.62	5.80	6.03	5.01	3.72	2.58	1.72	1.13	0.74
	Reference	0.74	2.83	3.99	4.30	4.08	3.55	5.63	5.84	4.81	3.56	2.47	1.65	1.08	0.72
	Type 14	0.88	3.00	4.02	4.25	4.07	3.47	5.52	5.72	4.72	3.50	2.43	1.62	1.06	0.71
	Reference	0.71	2.94	4.28	4.66	4.42	3.84	6.08	6.32	5.22	3.83	2.60	1.68	1.05	0.66
	Type 15	0.85	3.11	4.31	4.60	4.41	3.75	5.95	6.18	5.12	3.76	2.56	1.65	1.04	0.65
	Reference	0.19	1.26	1.90	1.87	1.57	1.24	2.00	2.70	3.36	3.78	3.78	3.36	2.70	2.00
	Overcast	0.23	1.34	1.91	1.85	1.57	1.22	1.97	2.66	3.31	3.71	3.72	3.31	2.66	1.97

Table 19 Test Case 5.10 4x4 opening															
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
4x4	Reference	28.64	25.36	22.25	18.71	15.34	12.43	27.88	32.69	36.22	38.07	38.07	36.22	32.69	27.88
	Type 1	28.41	26.28	22.88	19.08	15.56	12.53	27.80	32.54	36.03	37.82	37.82	36.03	32.54	27.80
	Reference	32.75	30.05	27.34	23.90	20.36	17.13	36.75	41.18	43.74	43.98	41.96	37.67	31.94	25.42
	Type 2	32.73	31.02	28.00	24.33	20.65	17.24	36.61	41.01	43.49	43.70	41.66	37.48	31.74	25.33
	Reference	30.83	26.68	22.56	18.41	14.76	11.76	25.50	29.73	32.82	34.45	34.45	32.82	29.73	25.50
	Type 3	31.34	27.89	23.28	18.80	14.99	11.86	25.41	29.56	32.63	34.20	34.19	32.63	29.56	25.41
	Reference	35.03	31.59	27.90	23.79	19.87	16.46	34.27	38.19	40.42	40.55	38.63	34.69	29.48	23.59
	Type 4	35.69	32.83	28.68	24.25	20.17	16.58	34.12	38.02	40.16	40.27	38.33	34.48	29.29	23.50
	Reference	32.66	27.87	22.92	18.23	14.31	11.20	23.43	27.12	29.83	31.25	31.25	29.83	27.12	23.43
	Type 5	33.78	29.31	23.74	18.65	14.54	11.31	23.35	26.99	29.65	31.02	31.02	29.65	26.98	23.36
	Reference	37.02	33.01	28.50	23.78	19.50	15.91	32.02	35.45	37.37	37.38	35.56	31.94	27.22	21.92
	Type 6	28.26	34.51	29.38	24.27	19.81	16.03	31.89	35.29	37.14	37.13	35.28	31.75	27.04	21.84
	Reference	38.66	35.90	32.00	27.60	23.37	19.69	38.53	41.45	42.56	41.35	37.90	32.35	26.15	19.98
	Type 7	40.56	37.40	32.87	28.12	23.73	19.80	38.38	41.28	42.31	41.09	37.61	32.18	25.95	19.90
	Reference	39.78	38.32	34.97	30.89	26.76	23.07	44.27	46.70	47.12	44.82	39.88	32.56	25.08	18.21
	Type 8	42.50	39.83	35.83	31.42	27.16	23.17	44.09	46.56	46.85	44.57	39.58	32.40	24.88	18.14
	Reference	41.84	36.14	29.54	23.44	18.41	14.47	26.82	29.20	30.42	30.21	28.61	25.72	22.09	18.10
	Type 9	44.52	38.23	30.67	24.00	18.73	14.60	26.70	29.05	30.23	29.99	28.38	25.56	21.95	18.04
	Reference	43.50	39.15	33.27	27.44	22.36	18.22	33.03	34.99	35.52	34.19	31.11	26.51	21.56	16.76
	Type 10	46.65	41.23	34.39	28.04	22.74	18.35	32.89	34.85	35.30	33.97	30.87	26.36	21.40	16.70
	Reference	44.66	41.73	36.52	31.00	25.93	21.67	38.74	40.29	40.19	37.83	33.34	27.10	20.96	15.49
	Type 11	48.47	43.80	37.64	31.62	26.36	21.81	38.57	40.16	39.95	37.60	33.08	26.97	20.80	15.43
	Reference	46.30	42.34	36.37	30.47	25.25	20.95	36.96	38.34	38.16	35.86	31.56	25.63	19.85	14.71
	Type 12	50.62	44.60	37.55	31.10	25.67	21.08	36.79	38.21	37.93	35.63	31.31	25.50	19.68	14.65
	Reference	47.40	44.42	38.91	33.18	27.90	23.46	41.10	42.22	41.60	38.58	33.32	26.28	19.65	13.98
	Type 13	52.05	46.68	40.11	33.84	28.37	23.59	40.92	42.10	41.37	38.36	33.06	26.15	19.46	13.93
	Reference	49.09	44.76	38.51	32.46	27.08	22.63	39.24	40.23	39.57	36.64	31.60	24.91	18.63	13.29
	Type 14	54.30	47.17	39.74	33.10	27.52	22.75	39.04	40.08	39.31	36.40	31.33	24.77	18.45	13.23
	Reference	50.82	46.97	40.89	34.75	29.15	24.44	42.27	43.16	42.23	38.84	33.21	25.82	18.91	13.07
	Type 15	56.04	49.43	42.17	35.44	29.63	24.57	42.07	43.01	41.96	38.60	32.94	25.67	18.72	13.01
	Reference	29.21	25.63	22.14	18.43	15.03	12.15	27.44	32.23	35.73	37.56	37.56	35.73	32.23	27.44
	Overcast	29.24	26.66	22.79	18.78	15.24	12.25	27.34	32.06	35.53	37.29	37.29	35.53	32.05	27.34

RESULT

THE CALCULATED VALUES ARE ALL IN CONSISTENT WITH THE ANALYTICAL RESULTS.

5.11 SKY COMPONENT AND EXTERNAL REFLECTED COMPONENT FOR FAÇADE UNGLAZED OPENING

This section is meant to test the ability of the software to calculate the separate portions of illuminance from the sky and from reflection off the external ground.

Test case description

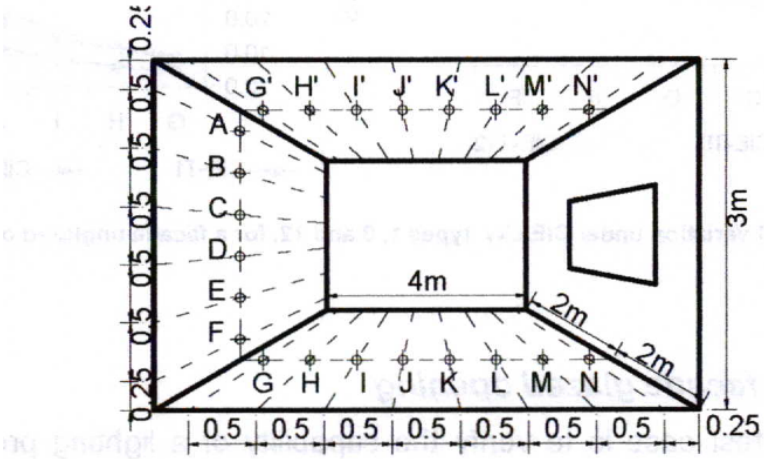


Figure 20: description of geometry and measurement points

The reference tables list the Sky Component (SC) values on the floor, the SC values + External Reflected Component (ERC) values for the wall and the ERC values on the ceiling.

Note that CIE 171:2006 provides only one reference, independent of sky type, for the sensor points on the ceiling (G'--N'). This is incorrect because the shadow the building casts onto the ground affects the amount of light that can be scattered towards wall and ceiling. The shape of the shadow depends on the type of sky. The shape of the shadow furthermore depends on the outside shape of the building (wall thickness, other floors, etc), which is not specified in the test case.

	Table 20 Test Case 5.11 2x1 opening																						
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**G'**	**H'**	**I'**	**J'**	**K'**	**L'**	**M'**	**N'**
2x1	Reference	0.95	1.06	1.25	1.51	1.70	1.86	0.87	1.31	2.02	3.20	5.07	7.64	9.33	5.09	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 1	0.93	1.05	1.25	1.51	1.70	1.85	0.88	1.30	2.02	3.22	5.05	7.62	9.30	5.08	0.36	0.49	0.68	0.96	1.34	1.76	1.82	0.79
	Reference	0.95	1.06	1.18	1.33	1.55	1.83	0.92	1.42	2.30	3.86	6.58	10.77	13.66	6.33	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 2	0.93	1.06	1.17	1.33	1.54	1.83	0.93	1.42	2.30	3.89	6.55	10.73	13.62	6.32	0.36	0.50	0.70	1.00	1.41	1.87	1.98	0.89
	Reference	0.95	1.06	1.56	2.42	2.75	2.58	1.08	1.54	2.26	3.40	5.11	7.34	8.61	4.56	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 3	0.92	1.05	1.57	2.43	2.73	2.57	1.09	1.53	2.26	3.42	5.09	7.32	8.58	4.57	0.35	0.49	0.68	0.95	1.33	1.74	1.80	0.79
	Reference	0.95	1.06	1.45	2.14	2.53	2.58	1.16	1.71	2.62	4.16	6.73	10.52	12.82	5.80	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 4	0.93	1.06	1.45	2.15	2.53	2.57	1.17	1.70	2.61	4.19	6.70	10.47	12.78	5.79	0.38	0.53	0.75	1.08	1.56	2.14	2.40	1.24
	Reference	0.95	1.06	1.79	3.09	3.54	3.17	1.27	1.75	2.49	3.59	5.19	7.11	7.99	4.13	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 5	0.92	1.05	1.81	3.10	3.52	3.15	1.27	1.73	2.48	3.62	5.15	7.10	7.97	4.12	0.35	0.48	0.67	0.94	1.32	1.72	1.79	0.79
	Reference	0.95	1.06	1.65	2.76	3.32	3.22	1.37	1.97	2.92	4.46	6.91	10.33	12.07	5.30	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 6	0.93	1.05	1.66	2.78	3.31	3.21	1.38	1.94	2.90	4.49	6.87	10.28	12.03	5.29	0.36	0.50	0.69	0.98	1.39	1.84	1.95	0.89
	Reference	0.95	1.06	1.53	2.43	2.96	3.01	1.34	1.98	3.04	4.86	8.04	13.00	15.85	5.97	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 7	0.93	1.06	1.53	2.44	2.95	3.01	1.36	1.96	3.03	4.91	7.99	12.92	15.79	5.96	0.36	0.50	0.70	1.00	1.42	1.90	2.04	0.96
	Reference	0.95	1.06	1.42	2.13	2.64	2.81	1.30	1.96	3.10	5.16	8.96	15.41	19.39	6.50	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 8	0.94	1.06	1.43	2.14	2.64	2.81	1.32	1.94	3.09	5.20	8.92	15.30	19.31	6.48	0.37	0.51	0.71	1.02	1.45	1.95	2.12	1.01
	Reference	0.95	1.06	2.27	4.61	5.52	4.82	1.87	2.55	3.55	5.05	7.19	9.74	10.30	4.19	0.38	0.53	0.75	1.08	1.56	2.14	2.40	1.24
	Type 9	0.92	1.05	2.30	4.64	5.49	4.79	1.88	2.49	3.52	5.09	7.12	9.69	10.26	4.18	0.36	0.49	0.68	0.97	1.37	1.81	1.92	0.89
	Reference	0.95	1.06	2.08	4.10	5.03	4.61	1.87	2.61	3.77	5.61	8.50	12.47	13.77	4.81	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 10	0.93	1.05	2.10	4.13	5.00	4.59	1.89	2.56	3.74	5.65	8.42	12.38	13.71	4.80	0.36	0.50	0.70	0.99	1.40	1.87	2.01	0.95
	Reference	0.95	1.06	1.91	3.65	4.56	4.38	1.84	2.63	3.91	6.04	9.62	15.00	17.13	5.33	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 11	0.93	1.05	1.93	3.67	4.54	4.36	1.86	2.59	3.88	6.10	9.54	14.90	17.05	5.31	0.36	0.50	0.71	1.01	1.43	1.93	2.09	1.00
	Reference	0.95	1.06	2.39	4.93	5.80	5.01	2.00	2.80	4.06	6.13	9.54	14.57	16.35	5.03	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 12	0.93	1.05	2.42	4.96	5.77	4.98	2.02	2.74	4.03	6.19	9.46	14.47	16.27	5.02	0.36	0.50	0.70	1.00	1.43	1.92	2.08	1.00
	Reference	0.95	1.06	2.23	4.52	5.43	4.87	2.00	2.85	4.21	6.52	10.43	16.41	18.67	5.43	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 13	0.94	1.06	2.25	4.54	5.40	4.85	2.03	2.79	4.19	6.59	10.35	16.29	18.58	5.41	0.37	0.51	0.71	1.02	1.45	1.96	2.14	1.04
	Reference	0.95	1.06	3.34	6.87	7.12	5.51	2.14	2.98	4.32	6.55	10.29	15.89	17.28	5.14	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 14	0.93	1.05	3.41	6.92	7.06	5.47	2.16	2.91	4.28	6.61	10.20	15.76	17.73	5.13	0.36	0.50	0.71	1.01	1.45	1.95	2.13	1.03
	Reference	0.95	1.06	3.17	6.54	6.96	5.58	2.22	3.12	4.57	6.99	11.08	17.18	19.25	5.52	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Type 15	0.94	1.06	3.23	6.58	6.91	5.55	2.24	3.05	4.53	7.06	10.98	17.04	19.16	5.49	0.37	0.51	0.72	1.03	1.47	2.00	2.19	1.07
	Reference	0.95	1.06	1.28	1.71	2.06	2.14	0.95	1.38	2.07	3.19	4.97	7.42	9.11	5.04	0.38	0.53	0.75	1.08	1.56	2.14	2.4	1.24
	Overcast	0.92	1.05	1.27	1.71	2.06	2.14	0.95	1.37	2.06	3.21	4.95	7.41	9.09	5.03	0.36	0.49	0.68	0.96	1.34	1.75	1.81	0.79

	Table 21 Test Case 5.11 4x3 opening																						
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**G'**	**H'**	**I'**	**J'**	**K'**	**L'**	**M'**	**N'**
4x3	Reference	5.25	6.11	6.98	7.99	8.77	9.35	4.27	5.92	8.33	11.82	16.84	23.83	33.05	44.06	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 1	4.87	5.79	6.73	7.72	8.60	9.32	4.29	5.94	8.32	11.83	16.84	23.82	33.02	44.08	1.48	1.94	2.58	3.49	4.74	6.47	8.72	11.45
	Reference	5.09	5.78	6.56	7.52	8.49	9.35	4.70	6.71	9.75	14.30	21.00	30.09	41.22	52.94	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 2	4.82	5.54	6.36	7.34	8.34	9.31	4.73	6.74	9.74	14.34	20.99	30.08	41.19	53.34	1.54	2.02	2.70	3.64	4.95	6.75	9.10	11.93
	Reference	5.93	7.75	9.33	11.09	12.03	12.60	5.09	6.84	9.33	12.87	17.86	24.72	33.68	44.76	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 3	5.44	7.44	9.18	10.69	11.84	12.68	5.12	6.87	9.33	12.89	17.86	24.71	33.62	44.31	1.47	1.93	2.57	3.46	4.71	6.42	8.66	11.38
	Reference	5.66	7.23	8.72	10.43	11.64	12.58	5.62	7.76	10.91	15.52	22.17	31.06	41.86	53.53	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 4	5.30	6.98	8.60	10.15	11.48	12.63	5.65	7.80	10.90	15.56	22.16	31.04	41.80	53.51	1.53	2.01	2.68	3.63	4.93	6.72	9.05	11.87
	Reference	6.43	8.96	11.11	13.47	14.57	15.17	5.79	7.63	10.20	13.78	18.76	25.50	34.24	45.29	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 5	5.85	8.64	11.03	12.98	14.36	15.34	5.82	7.66	10.21	13.81	18.76	25.49	34.18	44.51	1.46	1.92	2.55	3.45	4.69	6.39	8.61	11.31
	Reference	6.10	8.34	10.42	12.76	14.21	15.25	6.43	8.70	11.96	16.65	23.25	31.96	42.44	54.02	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 6	5.67	8.09	10.37	12.40	14.04	15.37	6.47	8.74	11.96	16.68	23.24	31.94	42.37	53.69	1.53	2.01	2.67	3.61	4.91	6.69	9.01	11.82
	Reference	5.82	7.72	9.56	11.67	13.19	14.41	6.49	8.99	12.70	18.22	26.22	36.60	48.26	59.49	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 7	5.48	7.51	9.50	11.40	13.03	14.49	6.54	9.04	12.70	18.26	26.21	36.59	48.19	59.78	1.56	2.05	2.74	3.70	5.03	6.85	9.22	12.09
	Reference	5.59	7.18	8.81	10.70	12.23	13.57	6.47	9.14	13.23	19.48	28.80	40.72	53.40	64.13	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 8	5.33	7.01	8.75	10.49	12.10	13.62	6.52	9.20	13.22	19.54	28.79	40.72	53.34	65.09	1.59	2.09	2.79	3.77	5.13	6.99	9.41	12.32
	Reference	7.42	11.65	15.25	19.22	21.12	22.28	8.36	10.89	14.38	19.18	25.67	33.95	43.73	55.27	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 9	6.79	11.39	15.39	18.60	20.91	22.60	8.41	10.94	14.39	19.20	25.65	33.92	43.61	54.04	1.51	1.99	2.65	3.57	4.86	6.62	8.92	11.70
	Reference	7.00	10.71	14.02	17.73	19.81	21.25	8.52	11.33	15.32	20.96	28.76	38.52	49.29	60.36	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 10	6.47	10.49	14.14	17.23	19.61	21.51	8.58	11.39	15.32	21.00	28.75	38.50	49.18	59.81	1.55	2.03	2.71	3.66	4.98	6.78	9.13	11.96
	Reference	6.62	9.87	12.91	16.34	18.51	20.18	8.58	11.61	16.02	22.45	31.52	42.70	54.36	64.85	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 11	6.19	9.69	13.00	15.94	18.34	20.39	8.64	11.68	16.03	22.49	31.50	42.69	54.27	65.02	1.58	2.07	2.77	3.74	5.09	6.93	9.32	12.20
	Reference	7.63	12.15	15.80	19.96	22.13	23.68	9.26	12.35	16.79	23.17	32.10	43.03	54.44	65.07	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 12	7.06	11.98	16.06	19.39	21.96	24.06	9.33	12.43	16.80	23.22	32.09	43.01	54.31	64.83	1.57	2.07	2.76	3.73	5.07	6.91	9.29	12.16
	Reference	7.27	11.39	14.85	18.82	21.13	22.89	9.38	12.66	17.43	24.38	34.19	46.11	58.17	68.48	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 13	6.79	11.25	15.08	18.33	20.97	23.22	9.46	12.73	17.44	24.44	34.18	46.09	58.05	68.71	1.60	2.10	2.80	3.79	5.15	7.02	9.44	12.36
	Reference	9.65	15.54	19.50	24.59	26.56	28.04	10.12	13.45	18.23	25.12	34.76	46.43	58.29	68.51	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 14	8.81	15.47	20.11	23.69	26.46	28.74	10.21	13.52	18.23	25.17	34.72	46.36	58.03	68.47	1.59	2.09	2.79	3.77	5.14	7.00	9.41	12.31
	Reference	9.25	14.90	18.88	23.94	26.17	27.92	10.48	14.00	19.08	26.41	36.64	48.97	61.35	71.65	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Type 15	8.51	14.85	19.45	23.14	26.07	28.56	10.57	14.08	19.09	26.47	36.61	48.91	61.13	71.81	1.62	2.13	2.84	3.84	5.22	7.11	9.56	12.51
	Reference	5.29	6.46	7.67	8.88	9.73	10.29	4.50	6.15	8.53	12.00	16.97	23.91	33.08	44.43	1.74	2.29	3.06	4.14	5.63	7.65	10.27	13.59
	Overcast	4.91	6.14	7.41	8.60	9.54	10.26	4.52	6.17	8.53	12.01	16.97	23.90	33.05	44.09	1.48	1.94	2.58	3.48	4.74	6.46	8.71	11.44

RESULT

FOR COLUMNS A-N, SOME OF THE SOFTWARE SIMULATION RESULTS ON THE 4X3M OPENING WERE LOWER THAN THE MEASUREMENT LIMIT, HOWEVER, ALL WERE WITHIN THE GLOBAL ERROR LIMITS. IT IS NOT POSSIBLE TO ACCURATELY JUDGE THE RESULTS FROM G' TO N'. OUR ASSUMPTION BASED ON THE OTHER RESULTS OBTAINED ON THE TABLE IS THAT THE RESULTS ARE ACCURATE (OR WITHIN THE MARGIN OF ERROR), AND THE DISCREPANCY IS DUE TO WRONG REFERENCE VALUES AS NOTED ON THE CASE DESCRIPTION ABOVE.

5.12 SKY COMPONENT AND EXTERNAL REFLECTED COMPONENT FOR FAÇADE GLAZED OPENING

This section is meant to test the ability of the program to calculate the contribution of reflected daylight from the external ground into a room through a glazed opening. As in Section 5.10, a glass transmission value of 0.91 was assumed. The test geometry and measurements are the same as Section 5.11, except that the openings are covered by glass.

Similar to 5.11, note that CIE 171:2006 provides only one reference, independent of sky type, for the sensor points on the ceiling (G'--N'). This is incorrect because the shadow the building casts onto the ground affects the amount of light that can be scattered towards wall and ceiling. The shape of the shadow depends on the type of sky. The shape of the shadow furthermore depends on the outside shape of the building (wall thickness, other floors, etc), which is not specified in the test case.

Table 22 Test Case 5.12 2x1 opening

Opening	CIE sky type	A	B	C	D	E	F	G	H	I	J	K	L	M	N	G'	H'	I'	J'	K'	L'	M'	N'
2x1	Reference	0.84	0.94	1.10	1.33	1.50	1.63	0.77	1.15	1.77	2.79	4.38	6.44	7.19	2.16	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 1	0.81	0.92	1.09	1.32	1.48	1.62	0.77	1.14	1.77	2.81	4.40	6.60	7.68	2.72	0.31	0.43	0.60	0.84	1.17	1.53	1.52	0.44
	Reference	0.84	0.94	1.04	1.17	1.36	1.61	0.81	1.25	2.01	3.36	5.67	9.07	10.54	2.70	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 2	0.82	0.92	1.03	1.16	1.35	1.60	0.81	1.24	2.01	3.39	5.71	9.29	11.26	3.40	0.32	0.44	0.61	0.87	1.23	1.63	1.66	0.50
	Reference	0.84	0.94	1.38	2.13	2.42	2.27	0.95	1.35	1.98	2.96	4.41	6.19	6.64	1.94	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 3	0.80	0.92	1.37	2.12	2.39	2.25	0.96	1.34	1.97	2.98	4.44	6.34	7.09	2.45	0.31	0.43	0.59	0.83	1.16	1.51	1.51	0.44
	Reference	0.84	0.94	1.27	1.88	2.23	2.27	1.02	1.50	2.29	3.62	5.80	8.86	9.90	2.47	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 4	0.81	0.92	1.27	1.88	2.21	2.25	1.02	1.48	2.28	3.66	5.84	9.06	10.57	3.11	0.32	0.44	0.61	0.87	1.22	1.61	1.65	0.50
	Reference	0.84	0.94	1.58	2.72	3.12	2.79	1.11	1.54	2.18	3.13	4.47	6.00	6.17	1.75	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 5	0.80	0.92	1.58	2.71	3.08	2.76	1.11	1.51	2.16	3.16	4.49	6.15	6.59	2.20	0.31	0.42	0.59	0.83	1.15	1.50	1.49	0.43
	Reference	0.84	0.94	1.45	2.43	2.92	2.83	1.20	1.72	2.55	3.88	5.96	8.70	9.33	2.26	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 6	0.81	0.92	1.45	2.43	2.89	2.80	1.21	1.70	2.54	3.92	5.99	8.90	9.95	2.84	0.32	0.43	0.61	0.86	1.22	1.60	1.63	0.49
	Reference	0.84	0.94	1.34	2.13	2.61	2.65	1.18	1.73	2.66	4.23	6.93	10.95	12.27	2.56	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 7	0.82	0.92	1.34	2.13	2.58	2.63	1.19	1.71	2.64	4.28	6.97	11.18	13.08	3.22	0.32	0.44	0.61	0.88	1.25	1.66	1.71	0.53
	Reference	0.84	0.94	1.25	1.88	2.32	2.47	1.14	1.72	2.71	4.49	7.72	12.97	15.03	2.79	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 8	0.82	0.92	1.25	1.87	2.30	2.45	1.15	1.70	2.70	4.54	7.78	13.24	16.01	3.51	0.32	0.44	0.62	0.89	1.27	1.70	1.78	0.56
	Reference	0.84	0.94	2.00	4.06	4.86	4.24	1.64	2.24	3.11	4.40	6.21	8.22	7.97	1.78	0.33	0.46	0.65	0.94	1.34	1.80	1.85	0.53
	Type 9	0.81	0.92	2.01	4.05	4.79	4.19	1.64	2.18	3.08	4.44	6.21	8.39	8.50	2.25	0.31	0.43	0.60	0.85	1.20	1.58	1.61	0.49
	Reference	0.84	0.94	1.83	3.61	4.42	4.05	1.64	2.29	3.30	4.88	7.33	10.51	10.68	2.06	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 10	0.81	0.92	1.84	3.61	4.37	4.01	1.65	2.24	3.27	4.94	7.35	10.72	11.36	2.59	0.32	0.43	0.61	0.87	1.23	1.63	1.69	0.52
	Reference	0.84	0.94	1.68	3.21	4.02	3.85	1.62	2.31	3.42	5.26	8.29	12.64	13.30	2.29	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 11	0.81	0.92	1.69	3.20	3.97	3.81	1.63	2.27	3.39	5.33	8.32	12.90	14.15	2.88	0.32	0.44	0.62	0.88	1.26	1.68	1.75	0.55
	Reference	0.84	0.94	2.10	4.34	5.11	4.41	1.75	2.45	3.55	5.34	8.23	12.28	12.69	2.16	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 12	0.81	0.92	2.12	4.33	5.04	4.35	1.76	2.39	3.52	5.40	8.25	12.53	13.49	2.72	0.32	0.44	0.61	0.88	1.25	1.67	1.74	0.55
	Reference	0.84	0.94	1.96	3.97	4.78	4.29	1.76	2.50	3.69	5.67	9.00	13.82	14.50	2.34	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 13	0.82	0.92	1.97	3.97	4.72	4.24	1.77	2.44	3.66	5.75	9.03	14.10	15.42	2.94	0.32	0.44	0.62	0.89	1.27	1.71	1.79	0.57
	Reference	0.84	0.94	2.94	6.04	6.26	4.84	1.88	2.61	3.78	5.70	8.87	13.39	13.85	2.21	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 14	0.82	0.92	2.98	6.04	6.17	4.78	1.89	2.55	3.74	5.78	8.89	13.65	14.71	2.78	0.32	0.44	0.62	0.89	1.27	1.70	1.79	0.57
	Reference	0.84	0.94	2.78	5.75	6.12	4.91	1.95	2.47	4.00	6.09	9.55	14.48	14.96	2.38	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Type 15	0.82	0.92	2.82	5.75	6.03	4.85	1.96	2.67	3.95	6.17	9.57	14.75	15.89	2.98	0.32	0.45	0.63	0.90	1.29	1.74	1.84	0.59
	Reference	0.84	0.94	1.12	1.50	1.81	1.89	0.83	1.21	1.81	2.78	4.28	6.26	7.02	2.13	0.33	0.46	0.65	0.94	1.34	1.8	1.85	0.53
	Overcast	0.81	0.92	1.11	1.49	1.80	1.87	0.83	1.19	1.80	2.80	4.32	6.41	7.51	2.69	0.31	0.43	0.59	0.84	1.17	1.52	1.52	0.44

Table 23 Test Case 5.12 4x3 opening

Opening	CIE sky type	A	B	C	D	E	F	G	H	I	J	K	L	M	N	G'	H'	I'	J'	K'	L'	M'	N'
4x3	Reference	4.62	5.38	6.15	7.03	7.72	8.21	3.74	5.17	7.23	10.18	14.30	19.66	25.63	30.02	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 1	4.29	5.10	5.91	6.77	7.53	8.14	3.75	5.19	7.26	10.31	14.58	20.33	27.10	32.73	1.32	1.73	2.30	3.11	4.21	5.66	7.41	8.97
	Reference	4.47	5.09	5.78	6.62	7.47	8.22	4.11	5.85	8.46	12.30	17.78	24.74	31.91	36.38	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 2	4.25	4.87	5.59	6.44	7.31	8.14	4.13	5.89	8.50	12.48	18.16	25.63	33.78	39.93	1.37	1.81	2.41	3.25	4.41	5.93	7.74	9.32
	Reference	5.21	6.83	8.22	9.76	10.58	11.07	4.46	5.97	8.11	11.10	15.20	20.48	26.34	31.03	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 3	4.79	6.53	8.05	9.36	10.36	11.08	4.47	6.00	8.14	11.22	15.48	21.13	27.73	33.22	1.31	1.72	2.29	3.09	4.18	5.63	7.36	8.91
	Reference	4.98	6.36	7.68	9.18	10.24	11.05	4.92	6.77	9.47	13.37	18.82	25.64	32.64	37.32	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 4	4.67	6.14	7.55	8.89	10.04	11.03	4.94	6.81	9.52	13.55	19.19	26.50	34.42	40.40	1.37	1.80	2.40	3.24	4.39	5.90	7.69	9.27
	Reference	5.65	7.89	9.78	11.86	12.82	13.34	5.07	6.67	8.87	11.91	16.00	21.21	26.96	31.84	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 5	5.14	7.58	9.66	11.36	12.56	13.40	5.08	6.69	8.90	12.03	16.27	21.83	28.29	33.66	1.30	1.71	2.27	3.07	4.16	5.59	7.32	8.85
	Reference	5.36	7.34	9.18	11.24	12.51	13.40	5.63	7.59	10.39	14.35	19.78	26.47	33.31	38.14	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 6	4.99	7.11	9.09	10.86	12.29	13.43	5.65	7.63	10.44	14.52	20.15	27.31	35.02	40.84	1.36	1.79	2.39	3.22	4.37	5.87	7.66	9.23
	Reference	5.12	6.79	8.42	10.28	11.60	12.66	5.68	7.84	11.03	15.69	22.26	30.21	37.78	42.18	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 7	4.83	6.60	8.34	9.98	11.41	12.66	5.71	7.89	11.08	15.90	22.70	31.24	39.78	45.74	1.39	1.84	2.45	3.31	4.48	6.02	7.85	9.42
	Reference	4.92	6.32	7.76	9.42	10.76	11.93	5.66	7.97	11.48	16.76	24.40	33.53	41.74	45.63	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 8	4.70	6.17	7.68	9.19	10.59	11.91	5.70	8.04	11.54	17.01	24.92	34.74	44.02	50.03	1.42	1.88	2.50	3.38	4.58	6.15	8.00	9.59
	Reference	6.53	10.26	13.43	16.92	18.59	19.59	7.33	9.52	12.51	16.58	21.92	28.33	34.80	40.12	1.52	2.00	2.66	3.57	4.80	6.36	8.09	9.55
	Type 9	5.97	10.00	13.48	16.28	18.29	19.75	7.34	9.55	12.56	16.73	22.63	29.10	36.33	41.80	1.35	1.77	2.36	3.19	4.32	5.81	7.58	9.13
	Reference	6.15	9.43	12.35	15.61	17.43	18.68	7.47	9.90	13.32	18.09	24.51	32.03	39.11	43.91	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 10	5.69	9.21	12.39	15.08	17.15	18.80	7.49	9.95	13.38	18.29	24.94	32.98	40.91	46.45	1.38	1.82	2.42	3.27	4.43	5.96	7.76	9.33
	Reference	5.83	8.69	11.37	14.38	16.29	17.74	7.51	10.14	13.92	19.35	26.80	35.40	43.03	47.26	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 11	5.45	8.51	11.39	13.95	16.05	17.82	7.55	10.20	13.99	19.59	27.31	36.52	45.09	50.68	1.41	1.86	2.48	3.34	4.53	6.09	7.93	9.50
	Reference	6.71	10.70	13.92	17.58	19.48	20.82	8.11	10.79	14.60	20.00	27.33	35.75	43.26	47.73	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 12	6.21	10.51	14.07	16.97	19.20	21.02	8.16	10.85	14.66	20.23	27.82	36.83	45.21	50.71	1.40	1.85	2.47	3.33	4.52	6.07	7.90	9.47
	Reference	6.40	10.03	13.08	16.57	18.59	20.13	8.21	11.05	15.15	21.02	29.08	38.24	46.15	50.26	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 13	5.97	9.87	13.22	16.04	18.33	20.29	8.26	11.12	15.22	21.28	29.63	39.45	48.29	53.84	1.43	1.88	2.51	3.39	4.60	6.17	8.03	9.61
	Reference	8.49	13.68	17.17	21.65	23.37	24.65	8.87	11.75	15.85	21.69	29.61	38.60	46.41	50.58	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 14	7.74	13.56	17.60	20.72	23.14	25.11	8.91	11.80	15.91	21.92	30.11	39.71	48.37	53.83	1.42	1.88	2.50	3.38	4.58	6.15	8.00	9.58
	Reference	8.14	13.12	16.63	21.08	23.03	24.54	9.18	12.23	16.59	22.79	31.19	40.68	48.81	52.90	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Type 15	7.48	13.02	17.04	20.25	22.80	24.96	9.23	12.30	16.66	23.05	31.74	41.88	50.93	56.49	1.45	1.91	2.54	3.44	4.66	6.25	8.13	9.72
	Reference	4.65	5.69	6.75	7.82	8.56	9.04	3.94	5.36	7.41	10.34	14.42	19.74	25.70	30.40	1.52	2	2.66	3.57	4.8	6.36	8.09	9.55
	Overcast	4.32	5.40	6.51	7.54	8.35	8.97	3.95	5.39	7.45	10.46	14.70	20.40	27.15	32.78	1.32	1.73	2.30	3.10	4.21	5.66	7.40	8.95

RESULT

SOME OF THE SOFTWARE SIMULATION RESULTS WERE OUTSIDE THE MEASUREMENT LIMIT, SOME IN COLUMN N WERE ALSO OUTSIDE THE GLOBAL ERROR LIMITS. IT IS NOT POSSIBLE TO ACCURATELY JUDGE THE RESULTS FROM G' TO N'. OUR ASSUMPTION BASED ON THE OTHER RESULTS OBTAINED ON THE TABLE IS THAT THE RESULTS ARE ACCURATE (OR WITHIN THE MARGIN OF ERROR), AND THE DISCREPANCY IS DUE TO WRONG REFERENCE VALUES AS NOTED ON THE CASE DESCRIPTION ABOVE. IT IS ALSO WORTH NOTING THAT PREVIOUS ANALYSES PERFORMED BY THE AUTHOR ON OTHER SOFTWARE PACKAGES, SHOW A VERY SIMILAR BEHAVIOUR ON THE M-N COLUMNS.

5.13 SC+ ERC FOR AN UNGLAZED FAÇADE OPENING WITH A CONTINUOUS EXTERNAL HORIZONTAL MASK

This section is meant to test the ability of the software to simulate the effect of a continuous external horizontal mask on interior illuminance from daylighting.

The figure for the test geometry in the CIE report is shown below. The test was done for exterior canopy widths of 0.5m, 1m and 2m respectively.

Test Case description

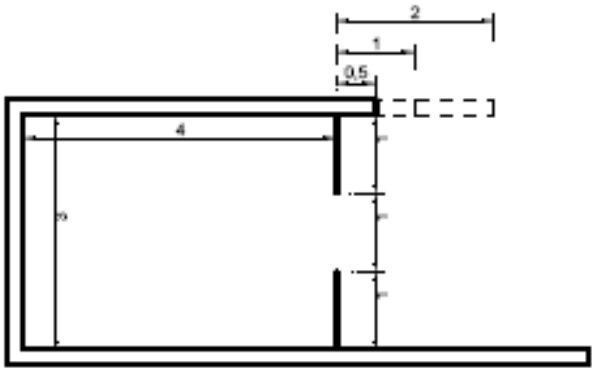


Figure 24: Geometric description for the external horizontal mask test case

Table 24 Test Case 5.13 2x1x.50 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
2x1x.50	Reference	0.87	1.31	2.02	3.20	5.07	7.64	8.27	0.21
	Type 1	0.88	1.31	2.02	3.21	5.06	7.62	8.25	0.21
	Reference	0.92	1.42	2.30	3.86	6.58	10.77	12.08	0.21
	Type 2	0.93	1.42	2.30	3.88	6.56	10.73	12.05	0.21
	Reference	1.08	1.54	2.26	3.40	5.11	7.34	7.65	0.21
	Type 3	1.09	1.54	2.26	3.41	5.10	7.32	7.63	0.21
	Reference	1.16	1.71	2.62	4.16	6.73	10.52	11.37	0.21
	Type 4	1.17	1.70	2.61	4.18	6.71	10.47	11.33	0.21
	Reference	1.27	1.75	2.49	3.59	5.19	7.11	7.13	0.21
	Type 5	1.27	1.74	2.48	3.61	5.17	7.10	7.11	0.21
	Reference	1.37	1.97	2.92	4.46	6.91	10.33	10.74	0.21
	Type 6	1.38	1.95	2.90	4.48	6.88	10.29	10.70	0.21
	Reference	1.34	1.98	3.04	4.86	8.04	13.00	14.11	0.21
	Type 7	1.36	1.96	3.03	4.89	8.00	12.93	14.05	0.21
	Reference	1.30	1.96	3.10	5.16	8.96	15.41	17.27	0.21
	Type 8	1.31	1.95	3.09	5.19	8.93	15.30	17.19	0.21
	Reference	1.87	2.55	3.55	5.05	7.19	9.74	9.24	0.21
	Type 9	1.87	2.51	3.53	5.08	7.14	9.70	9.20	0.21
	Reference	1.87	2.61	3.77	5.61	8.50	12.47	12.35	0.21
	Type 10	1.88	2.57	3.74	5.64	8.44	12.39	12.29	0.21
	Reference	1.84	2.63	3.91	6.04	9.62	15.00	15.36	0.21
	Type 11	1.86	2.60	3.89	6.09	9.56	14.89	15.29	0.21
	Reference	2.00	2.80	4.06	6.13	9.54	14.57	14.68	0.21
	Type 12	2.02	2.75	4.03	6.17	9.48	14.47	14.60	0.21
	Reference	2.00	2.85	4.21	6.52	10.43	16.41	16.76	0.21
	Type 13	2.02	2.81	4.19	6.57	10.37	16.29	16.67	0.21
	Reference	2.14	2.98	4.32	6.55	10.29	15.89	16.01	0.21
	Type 14	2.15	2.92	4.29	6.59	10.20	15.76	15.92	0.21
	Reference	2.22	3.12	4.57	6.99	11.08	17.18	17.29	0.21
	Type 15	2.24	3.06	4.54	7.05	10.99	17.04	17.20	0.21
	Reference	0.95	1.38	2.07	3.19	4.97	7.42	8.07	0.21
	Overcast	0.95	1.37	2.06	3.20	4.96	7.41	8.05	0.21

Table 25 Test Case 5.13 2x1x1 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
2x1x1	Reference	0.87	1.31	2.02	3.20	4.68	5.69	4.08	0.21
	Type 1	0.88	1.31	2.02	3.21	4.65	5.68	4.06	0.21
	Reference	0.92	1.42	2.30	3.86	6.00	7.72	5.78	0.21
	Type 2	0.93	1.42	2.30	3.88	5.96	7.72	5.75	0.21
	Reference	1.08	1.54	2.26	3.40	4.74	5.53	3.83	0.21
	Type 3	1.09	1.54	2.26	3.41	4.71	5.52	3.82	0.21
	Reference	1.16	1.71	2.62	4.16	6.17	7.63	5.51	0.21
	Type 4	1.17	1.70	2.61	4.18	6.12	7.63	5.48	0.21
	Reference	1.27	1.75	2.49	3.59	4.82	5.42	3.63	0.21
	Type 5	1.27	1.74	2.48	3.61	4.79	5.42	3.61	0.21
	Reference	1.37	1.97	2.92	4.46	6.36	7.59	5.28	0.21
	Type 6	1.38	1.95	2.90	4.48	6.31	7.58	5.25	0.21
	Reference	1.34	1.98	3.04	4.86	7.33	9.24	6.79	0.21
	Type 7	1.36	1.96	3.03	4.89	7.26	9.23	6.74	0.21
	Reference	1.30	1.96	3.10	5.16	8.10	10.67	8.21	0.21
	Type 8	1.31	1.95	3.09	5.19	8.03	10.66	8.14	0.21
	Reference	1.87	2.55	3.55	5.05	6.67	7.36	4.71	0.21
	Type 9	1.87	2.51	3.53	5.08	6.60	7.34	4.68	0.21
	Reference	1.87	2.61	3.77	5.61	7.82	9.12	6.15	0.21
	Type 10	1.88	2.57	3.74	5.64	7.73	9.09	6.10	0.21
	Reference	1.84	2.63	3.91	6.04	8.79	10.70	7.54	0.21
	Type 11	1.86	2.60	3.89	6.09	8.69	10.68	7.48	0.21
	Reference	2.00	2.80	4.06	6.13	8.73	10.46	7.25	0.21
	Type 12	2.02	2.75	4.03	6.17	8.64	10.44	7.19	0.21
	Reference	2.00	2.85	4.21	6.52	9.52	11.64	8.21	0.21
	Type 13	2.02	2.81	4.19	6.57	9.41	11.62	8.14	0.21
	Reference	2.14	2.98	4.32	6.55	9.40	11.33	7.89	0.21
	Type 14	2.15	2.92	4.29	6.59	9.28	11.29	7.81	0.21
	Reference	2.22	3.12	4.57	6.99	10.11	12.24	8.50	0.21
	Type 15	2.24	3.06	4.54	7.05	9.98	12.21	8.42	0.21
	Reference	2.22	3.12	4.57	6.99	10.13	12.33	8.73	0.41
	Overcast	0.95	1.37	2.06	3.20	4.56	5.52	3.96	0.21

Table 26 Test Case 5.13 2x1x2 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
2x1x2	Reference	0.83	1.09	1.44	1.88	2.22	1.72	0.40	0.21
	Type 1	0.83	1.09	1.45	1.87	2.22	1.71	0.40	0.21
	Reference	0.87	1.17	1.59	2.14	2.63	2.10	0.40	0.21
	Type 2	0.87	1.17	1.59	2.13	2.63	2.10	0.40	0.21
	Reference	1.03	1.31	1.66	2.06	2.33	1.72	0.40	0.21
	Type 3	1.03	1.30	1.66	2.06	2.32	1.72	0.40	0.21
	Reference	1.10	1.42	1.86	2.39	2.81	2.14	0.40	0.21
	Type 4	1.10	1.42	1.85	2.38	2.80	2.14	0.40	0.21
	Reference	1.21	1.50	1.86	2.24	2.44	1.73	0.40	0.21
	Type 5	1.21	1.49	1.85	2.23	2.43	1.74	0.40	0.21
	Reference	1.30	1.66	2.11	2.63	2.98	2.18	0.40	0.21
	Type 6	1.31	1.65	2.10	2.62	2.97	2.18	0.40	0.21
	Reference	1.27	1.65	2.14	2.74	3.23	2.45	0.40	0.21
	Type 7	1.28	1.65	2.14	2.74	3.22	2.45	0.40	0.21
	Reference	1.23	1.62	2.14	2.81	3.40	2.66	0.40	0.21
	Type 8	1.24	1.62	2.14	2.80	3.39	2.66	0.40	0.21
	Reference	1.78	2.18	2.66	3.13	3.33	2.25	0.40	0.21
	Type 9	1.78	2.16	2.64	3.12	3.30	2.25	0.40	0.21
	Reference	1.78	2.21	2.75	3.33	3.67	2.57	0.40	0.21
	Type 10	1.78	2.20	2.73	3.33	3.64	2.56	0.40	0.21
	Reference	1.75	2.21	2.80	3.47	3.93	2.84	0.40	0.21
	Type 11	1.76	2.20	2.79	3.46	3.91	2.83	0.40	0.21
	Reference	1.90	2.36	2.94	3.58	3.97	2.82	0.40	0.21
	Type 12	1.91	2.34	2.92	3.57	3.94	2.81	0.40	0.21
	Reference	1.90	2.39	3.01	3.72	4.21	3.04	0.40	0.21
	Type 13	1.91	2.38	3.00	3.72	4.19	3.03	0.40	0.21
	Reference	2.04	2.52	3.12	3.79	4.22	3.00	0.40	0.21
	Type 14	2.04	2.49	3.09	3.78	4.18	2.98	0.40	0.21
	Reference	2.11	2.63	3.28	4.02	4.50	3.20	0.40	0.21
	Type 15	2.12	2.60	3.26	4.01	4.46	3.19	0.40	0.21
	Reference	0.90	1.16	1.50	1.90	2.20	1.68	0.40	0.21
	Overcast	0.90	1.16	1.50	1.90	2.20	1.68	0.40	0.21

RESULT

THE SOFTWARE SIMULATION RESULTS WERE ALL WELL ALIGNED WITH THE REFERENCE VALUES, EXCEPT FOR THE OVERCAST SKY SCENARIO WITH A 1M CANOPY. PREVIOUS EXPERIENCE WITH THIS PARTICULAR TEST INDICATES THE REFERENCE VALUES ARE WRONG:

- **SKYTYPES 1 AND OVERCAST ARE SIMILAR IN NATURE AND SHOULD HAVE VALUES THAT ARE SIMILAR.**
- **THE OVERCAST SKY IS MOSTLY UNIFORM, THE 1M OBSTRUCTION SHOULD NOT STRONGLY DEVIATE FROM THE 0.5M AND THE 2M OBSTRUCTIONS (BUT IT DOES IN THE REFERENCE)**
- **A CLOSER LOOK ALSO SEEMS TO INDICATE THAT THE CIE REPORT INCORRECTLY USED THE SC FROM SKY TYPE 15 (SINCE THE VALUES MATCH WITH THAT FOR POSITIONS A-D)**

5.14 SC+ ERC FOR AN UNGLAZED FAÇADE OPENING WITH A CONTINUOUS EXTERNAL VERTICAL MASK

This section is meant to test the ability of the software to simulate the effect of a continuous external vertical mask on interior illuminance from daylighting

The figure for the test geometry from the CIE report is shown below.

External canopy heights of 3m, 6m and 9m are considered for the test scenarios. As before a vertical sun angle of 60 degrees was maintained.

Test Case description

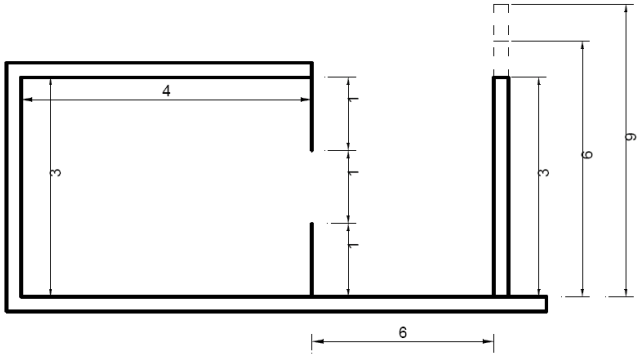


Table 27 Test Case 5.14 4x3_3 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
4x3_3	Reference	0.82	1.28	2.02	3.20	5.07	7.64	9.33	5.09
	Type 1	0.82	1.28	2.02	3.21	5.06	7.62	9.31	5.08
	Reference	0.86	1.39	2.30	3.86	6.58	10.77	13.66	6.33
	Type 2	0.86	1.39	2.30	3.88	6.56	10.73	13.63	6.32
	Reference	1.00	1.50	2.26	3.40	5.11	7.34	8.61	4.56
	Type 3	1.00	1.49	2.26	3.41	5.10	7.32	8.59	4.57
	Reference	1.06	1.66	2.62	4.16	6.73	10.52	12.82	5.80
	Type 4	1.07	1.65	2.61	4.18	6.71	10.47	12.78	5.79
	Reference	1.15	1.70	2.49	3.59	5.19	7.11	7.99	4.13
	Type 5	1.15	1.69	2.48	3.61	5.17	7.10	7.98	4.12
	Reference	1.24	1.90	2.92	4.46	6.91	10.33	12.07	5.30
	Type 6	1.24	1.89	2.90	4.48	6.88	10.29	12.03	5.29
	Reference	1.22	1.92	3.04	4.86	8.04	13.00	15.85	5.97
	Type 7	1.23	1.91	3.03	4.89	8.00	12.93	15.80	5.96
	Reference	1.19	1.90	3.10	5.16	8.96	15.41	19.39	6.50
	Type 8	1.20	1.89	3.09	5.19	8.93	15.30	19.32	6.49
	Reference	1.66	2.45	3.55	5.05	7.19	9.74	10.30	4.19
	Type 9	1.65	2.42	3.53	5.08	7.14	9.70	10.26	4.19
	Reference	1.67	2.51	3.77	5.61	8.50	12.47	13.77	4.81
	Type 10	1.66	2.48	3.74	5.64	8.44	12.39	13.71	4.80
	Reference	1.65	2.54	3.91	6.04	9.62	15.00	17.13	5.33
	Type 11	1.65	2.52	3.89	6.09	9.56	14.89	17.06	5.32
	Reference	1.78	2.69	4.06	6.13	9.54	14.57	16.35	5.03
	Type 12	1.77	2.65	4.03	6.17	9.48	14.47	16.28	5.02
	Reference	1.78	2.74	4.21	6.52	10.43	16.41	18.67	5.43
	Type 13	1.78	2.71	4.19	6.57	10.37	16.29	18.59	5.42
	Reference	1.89	2.86	4.32	6.55	10.29	15.89	17.82	5.14
	Type 14	1.88	2.82	4.29	6.59	10.20	15.76	17.73	5.13
	Reference	1.96	2.99	4.57	6.99	11.08	17.18	19.25	5.52
	Type 15	1.95	2.95	4.54	7.05	10.99	17.04	19.16	5.50
	Reference	0.88	1.34	2.07	3.19	4.97	7.42	9.11	5.04
	Overcast	0.88	1.34	2.06	3.20	4.96	7.41	9.09	5.03

Table 28 Test Case 5.14 4x3_6 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
4x3_6	Reference	0.41	0.47	0.79	1.79	3.73	7.40	9.33	5.09
	Type 1	0.30	0.42	0.80	1.80	3.72	7.38	9.31	5.08
	Reference	0.31	0.36	0.73	2.02	4.77	10.43	13.66	6.33
	Type 2	0.23	0.32	0.74	2.04	4.76	10.38	13.63	6.32
	Reference	0.47	0.53	0.88	1.88	3.73	7.11	8.61	4.56
	Type 3	0.35	0.48	0.88	1.89	3.73	7.08	8.59	4.57
	Reference	0.35	0.40	0.80	2.11	4.80	10.17	12.82	5.80
	Type 4	0.26	0.36	0.81	2.13	4.79	10.11	12.78	5.79
	Reference	0.51	0.59	0.95	1.96	3.75	6.89	7.99	4.13
	Type 5	0.38	0.53	0.95	1.97	3.75	6.86	7.98	4.12
	Reference	0.38	0.44	0.86	2.20	4.86	9.97	12.07	5.30
	Type 6	0.28	0.39	0.87	2.22	4.84	9.92	12.03	5.29
	Reference	0.33	0.38	0.83	2.39	5.71	12.58	15.85	5.97
	Type 7	0.24	0.34	0.85	2.42	5.70	12.50	15.80	5.96
	Reference	0.28	0.32	0.80	2.54	6.44	14.93	19.39	6.50
	Type 8	0.21	0.29	0.82	2.57	6.43	14.82	19.32	6.49
	Reference	0.47	0.54	1.00	2.39	4.91	9.38	10.30	4.19
	Type 9	0.35	0.48	1.02	2.41	4.90	9.32	10.26	4.19
	Reference	0.40	0.46	0.98	2.62	5.85	12.03	13.77	4.81
	Type 10	0.30	0.42	0.99	2.65	5.83	11.93	13.71	4.80
	Reference	0.34	0.39	0.94	2.81	6.68	14.49	17.13	5.33
	Type 11	0.26	0.35	0.96	2.85	6.66	14.37	17.06	5.32
	Reference	0.38	0.44	0.99	2.84	6.61	14.07	16.35	5.03
	Type 12	0.28	0.39	1.02	2.88	6.59	13.96	16.28	5.02
	Reference	0.32	0.37	0.96	2.98	7.23	15.85	18.67	5.43
	Type 13	0.24	0.33	0.98	3.02	7.21	15.71	18.59	5.42
	Reference	0.37	0.43	1.02	3.01	7.13	15.36	17.82	5.14
	Type 14	0.28	0.38	1.04	3.06	7.10	15.21	17.73	5.13
	Reference	0.29	0.34	0.96	3.11	7.58	16.58	19.25	5.52
	Type 15	0.22	0.30	0.99	3.16	7.55	16.43	19.16	5.50
	Reference	0.42	0.48	0.81	1.78	3.65	7.19	9.11	5.04
	Overcast	0.31	0.44	0.81	1.79	3.65	7.17	9.09	5.03

Table 29 Test Case 5.14 4x3_9 opening									
Opening	**CIE sky type**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
4x3_9	Reference	0.77	0.90	1.04	1.19	1.27	3.97	9.33	5.09
	Type 1	0.30	0.42	0.60	0.86	1.24	3.95	9.31	5.08
	Reference	0.59	0.69	0.79	0.90	0.97	5.18	13.66	6.33
	Type 2	0.23	0.32	0.46	0.66	0.95	5.14	13.63	6.32
	Reference	0.88	1.02	1.19	1.35	1.45	3.93	8.61	4.56
	Type 3	0.35	0.48	0.68	0.98	1.42	3.92	8.59	4.57
	Reference	0.66	0.77	0.89	1.02	1.09	5.08	12.82	5.80
	Type 4	0.26	0.36	0.51	0.74	1.07	5.04	12.78	5.79
	Reference	0.97	1.12	1.30	1.48	1.59	3.90	7.99	4.13
	Type 5	0.38	0.53	0.75	1.08	1.56	3.89	7.98	4.12
	Reference	0.72	0.84	0.97	1.11	1.19	4.98	12.07	5.30
	Type 6	0.28	0.39	0.56	0.81	1.16	4.94	12.03	5.29
	Reference	0.62	0.72	0.83	0.95	1.02	6.20	15.85	5.97
	Type 7	0.24	0.34	0.48	0.69	1.00	6.13	15.80	5.96
	Reference	0.53	0.61	0.71	0.81	0.87	7.35	19.39	6.50
	Type 8	0.21	0.29	0.41	0.59	0.85	7.26	19.32	6.49
	Reference	0.89	1.03	1.19	1.36	1.46	4.75	10.30	4.19
	Type 9	0.35	0.48	0.68	0.99	1.42	4.72	10.26	4.19
	Reference	0.76	0.89	1.03	1.17	1.26	5.88	13.77	4.81
	Type 10	0.30	0.42	0.59	0.85	1.23	5.82	13.71	4.80
	Reference	0.65	0.75	0.87	0.99	1.07	6.99	17.13	5.33
	Type 11	0.26	0.35	0.50	0.72	1.04	6.90	17.06	5.32
	Reference	0.72	0.84	0.97	1.10	1.19	1.02	16.35	5.03
	Type 12	0.28	0.39	0.56	0.80	1.16	6.76	16.28	5.02
	Reference	0.61	0.71	0.82	0.93	1.00	7.57	18.67	5.43
	Type 13	0.24	0.33	0.47	0.68	0.98	7.45	18.59	5.42
	Reference	0.70	0.82	0.95	1.08	1.16	7.43	17.82	5.14
	Type 14	0.28	0.38	0.54	0.78	1.11	7.33	17.73	5.13
	Reference	0.56	0.65	0.75	0.86	0.92	7.76	19.25	5.52
	Type 15	0.22	0.30	0.43	0.62	0.90	7.64	19.16	5.50
	Reference	0.80	0.93	1.08	1.23	1.32	3.93	9.11	5.04
	Overcast	0.32	0.44	0.62	0.89	1.29	3.91	9.09	5.03

RESULT

THE REFERENCE VALUES AND THE TEST VALUES ARE SIMILAR FOR ALL POINTS FOR THE 3M HIGH CANOPY. FOR THE 6M CANOPY, THE TEST VALUES FOR POINTS A AND B ARE LOWER THAN THE REFERENCE VALUES; FOR THE 9M HIGH CANOPY THE TEST VALUES FOR POINTS A, B, C, AND D ARE AGAIN LOWER THAN THE REFERENCE VALUES.

THIS ERROR IN THE REFRENCE FILE HAS ALREADY BEEN POINTED OUT. PLEASE REFER TO APPENDIX A FOR A MORE DETAILED EXPLANATION.

THE AUTHOR CONSIDERS THE OUT-OF-RANGE VALUE ON TYPE 12 – F TO BE AN ANOMALY AND LIKELY A TYPO IN THE REFERENCE DOCUMENT.

CONCLUSION

NVIDIA® IRAY® IS ACCURATE. IT PERFORMED WELL WITHIN THE PARAMETERS SET BY THE REFERENCE DOCUMENT.

THERE ARE A FEW INSTANCES WHERE THERE ARE DISCREPANCIES BETWEEN THE SOFTWARE AND THE CIE DOCUMENT, IN THESE SCENARIOS, IT HAS BEEN DOCUMENTED IN PAST ANALYSES PERFORMED BY THE AUTHOR, AND IN THIS ANALYSIS AS WELL, THAT THE DIFFERENCES ARE DUE TO ERRORS IN THE DESIGN OF THE TEST, OR INACCURATE VALUES BEING LISTED IN THE REFERENCE DOCUMENT.

IT IS IMPORTANT TO MENTION AS WELL THAT WHEN THE RESULTS DIFFER FROM THE DOCUMENT, NVIDIA® IRAY® RESULTS ARE IN AGREEMENT WITH OTHER SOFTWARE PACKAGES WE HAVE REVIEWED IN THE PAST, WHICH THE AUTHOR HAS FOUND TO BE ACCURATE.

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March 24th, 2009

Analysis of Test Case 5.14

CIE 171:2006

Test Cases to Assess the Accuracy of Lighting Computer Programs

The objective of Test Case 5.14, "SC+ERC for an unglazed façade opening with a continuous external vertical mask," is to "verify the capability of a lighting program to simulate the influence of an external vertical mask on the internal direct illuminance."

Unfortunately, this test case is fundamentally flawed. It assumes an external vertical mask of uniform luminance L_{ob}, which is derived in Section 5.14.1.1 from the external horizontal ground illuminance. It does not however consider the shadowing influence of the black room that it is illuminating through the façade opening.

As noted in *Validation of AGi32 against CIE 171:2006*, Dau Design and Consulting, 2007, pp. 41-42:

> "The reference values and the test values are similar for all points for the 3m high canopy. For the 6m canopy, the test values for points A and B are lower than the reference values. This tends to become more pronounced for the 9m high canopy where the test values for points A, B, C, D, and E are lower than the reference values. This disparity in results that increases with the height of canopy suggests that the Sky Component is being partially blocked by the canopy. This blocking may not have been accounted for in the reference values."

As explained above, this empirical analysis is correct.

We thank Ilya Zimnovich of the scientific research group of Prof. Deomid V. Bakharev (www.bakharev.org – Russian language Web site) for bringing this issue to our attention.