Designing Quality Learning Spaces (DQLS) – Lighting and Visual Comfort Addendum

Rationale for Daylighting Performance Metrics and Compliance Requirements

July 2023

Contents

1. Overview

1.1 Introduction

The introduction of the new DQLS - Lighting 2.0 (2020) ("DQLS – Lighting") document included specific daylight performance metrics and required the use of daylight modelling methods when designing complex building forms. The aim of this was to have more assurance on daylighting outcomes, particularly compared to the original DQLS – Lighting V1.0 (2007), which took a more qualitative, guidance-based approach.

A number of research studies on the provision of good daylighting design within schools have indicated a strong correlation with academic performance ([Heschong Mahone Group, 1999, 2003](); [Nicklas & Bailey, 1997](); [Barrett et al, 2015](); [Ackley et al, 2017, 2020]()). 'Good' daylight – or, as an absolute minimum, 'reasonable' daylight - is therefore strongly encouraged as a key outcome of all school designs.

The current DQLS – Lighting requirements are achievable in simpler Ministry reference design learning blocks. This has been demonstrated by both the simple calculation approach, and by more advanced daylight modelling. The Ministry's stated intention is to encourage, wherever possible, the use of standard reference designs, and to avoid more complex and one-off forms. The potential for good daylighting design is essentially 'baked- in' by the use of the reference design building forms.

1.2 Lessons Learned from Recent Projects

User experience with the DQLS – Lighting has shown it is challenging and sometimes impossible to demonstrate compliance with the daylighting performance metrics for deeper, single sided and more complex building forms. This was recognised in the drafting of the DQLS – Lighting. Non-compliance was to be justified by unavoidable factors such as site constraints or the education brief. The expectation was that more complex designs would still be optimised as far as possible within the constraints of these more complex building forms.

In reviewing some projects that have not met standards, it has been evident that early design opportunities to include good design features, and/or use daylight modelling to optimise the design, have not been utilised to their full potential. Some design teams have stated that the design cannot comply, based on verification modelling of a fully developed design, and that there is nothing they can do about it without significant redesign. This was not the intention of the DQLS - lighting and its compliance processes. The expectation was that more complex designs would still be optimised throughout the design process as much as is practical.

Adoption and understanding of the DQLS – Lighting requirements has been somewhat polarising, in that some projects have been able to comply without difficulty, while other projects have not been able to comply despite optimisation.

1.3 Modifications to the Daylighting Requirements

In discussions between the Ministry and the expert advisory panel who helped produce DQLS - Lighting, there has been agreement on developing a compliance pathway that is achievable for all projects, regardless of building form. However, it is important to the Ministry that school buildings have good quality daylighting. Daylight modelling is an important tool to support this outcome.

A review of the existing daylighting metrics and compliance requirements by testing a representative sample of school building forms was carried out (refer to Tables 2 to 21 and Figures 1 to 13 below). A summary of this modelling programme, in which climate-based daylight modelling was used to analyse four representative school blocks, is presented below.

This exercise supported the following recommendations:

- Introduce a more rigorous screening process at the masterplan/briefing/concept stage to strongly encourage simple reference building forms, before accepting more complex or bespoke forms. This will minimise the use of less desirable building forms.
- Keep the current UDI (Useful Daylight Illuminance) metric of 300-2000 lux, which represents a well daylit learning space. Relatively small changes to the lower end of this metric were seen to have a significant impact in terms of percentage compliance in some projects.
- Change the number of school hours this range of useful illuminances must be achieved from 80% down to 60%, to recognise the difficulties for more complex building forms in achieving compliance.
- Keep the area requirement of 50% compliance for the whole building but define more closely which spaces this area compliance applies to. The compliance requirements are limited to general learning spaces where students spend most their time.
- Require daylight reporting for all learning and administrative spaces, and for the building as a whole, to demonstrate that the design has been optimised for daylighting (including some spaces where compliance with the daylighting metrics is not required).

The intention of these recommendations has been to change the compliance requirements from a more nuanced 'pass/justified fail' approach to a more binary 'pass/fail' approach, which will simplify the design assurance process.

Failure to achieve compliance under the revised metrics is likely to indicate a significantly compromised building design that should warrant some revision before being approved by the Ministry's Design Assurance Panel.

Refer to the _DQLS – Lighting and Visual Comfort_ document for the Ministry's full requirements and the _Frequently Asked Questions (FAQ)_.

2. Modelling Rationale

2.1 Method and Report Structure

Four representative school blocks were selected for inclusion in the modelling programme. Each block was subject to daylighting analysis under various combinations of compliance metrics. These included variations to the UDI range (300-2000 lux, 160-2000 lux, 160-3000 lux), % of occupied hours (50%, 60%, 80%), and % of applicable floor area (50%, 60%).

For each example block, daylighting performance is tabulated for each candidate UDI range assuming, firstly, a criterion of 80% of occupied hours, and secondly a criterion of 50% of occupied hours. Block-level results are totalled for all learning spaces, including breakout and specialist spaces. The corresponding daylighting plots are then presented, providing a visual representation of this data. This data informed the selection of the UDI range (300-2000 lux).

For each example block a further three tables are then presented. These tabulate daylighting performance assuming the selected UDI range (300-2000 lux), under varying 'occupied hours' criteria (50%, 60%, 80%), and 'floor area' criteria (50%, 60%). Block-level results are totalled for the main learning spaces only, and exclude breakout and specialist spaces. Comparison of block performance across these metrics informed selection of the most appropriate time (60% of occupied school hours) and area (50% of applicable floor area) criteria.

These results are condensed into a summary table which precedes the modelling analysis, below.

2.2 Modelling Software

The daylight modelling was carried out using the Radiance daylighting engine, via a DesignBuilder v7 front end. Radiance is a validated daylighting analysis package that models the annual amount of daylight in and around buildings. Radiance uses a hybrid of Monte Carlo sampling and deterministic ray tracing to generate a time series of illuminance values over a grid of sensor points to derive the climate-based daylighting metrics. Radiance has been validated against CIE 171:2006 Test Cases to Assess the Accuracy of Lighting Computer Programs.

2.3 Example Block Selection and Characteristics

The example blocks were selected to represent a range of school block typologies, including some that are easy to daylight effectively, and others that are more difficult to daylight. The salient characteristics of each of the modelled school blocks are summarised in Table 1, below. Comparison of the modelling results for each example block informed selection of the daylighting compliance metrics.

Table 1 Building Typologies Modelled

Description	Building Characteristics
Block A	A smaller, primary school, two-storey block of 6 teaching spaces (similar to half a standard Ministry reference design). The floor depth is approximately 13 m, and the design has been reasonably well optimised for daylighting. This block would be expected to pass robust daylighting criteria.
Block B	A large, secondary school, three-storey block of 40 teaching spaces predominantly daylit from a single side, with atrium. The design was modelled while still at a preliminary design stage, and it has therefore not been fully optimised for daylighting. Typical room depth is approximately 8 m; no external overhangs were modelled. Windows have been modelled at 40% window-to-wall area, with a generic distribution. Although not optimised for daylighting, the room depths of this block are suited to single-sided daylighting and would be expected to pass robust daylighting criteria.
Block C	A large, primary school, single storey block of 12 teaching spaces, with a central clerestory. The large learning spaces are daylit from one side, and via the south-facing clerestory. The depth of the main learning spaces is approximately 9.5 m; covered canopies extend 2 m on all sides of the building, giving an effective space depth of 11.5 m. This block represents a challenging design which has not been optimised for daylighting, and which would be expected to fail robust daylighting criteria. The daylighting design could be improved by modifications to the skylight, to the nature and extent of the perimeter overhangs/fins, and to the distribution of glazing. These changes could potentially enable the building to pass the daylighting criteria.
Block D	A medium size, secondary school, two-storey block of 16 teaching spaces, with a mix of single and double sided daylit spaces. It has been modelled at a relatively early stage of design. A south-facing clerestory provides additional daylighting to single-sided learning spaces on the second storey. Typical room depth is approximately 8 m. This block would be expected to pass robust daylighting criteria.

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3. Daylight Modelling – Example School Blocks

Constant parameters applied across all daylight assessments	
UDI % annual hours	80%
Space perimeter exclusion	0.5 m
Working plane	0.5 m
Grid size	0.2 m
Ground plane extension	30 m
Schedule	9am-3pm excl. summer holidays

Variable parameters			
	Variable 1	Variable 1	Variable 3
UDI	300-2000 lx	160-2000 lx	160-3000 lx
UDI % annual hours	80 %	60%	50%
GFA % in range	50%	60%	
Spaces included	Learning, Breakout, & Teachers Rooms	Learning only	

3.1 Summary Results: % floor area within UDI range 300 – 2000 lux

	80% annual hours		60% annual hours		50% annual hours	
	All Learning Spaces	Main Learning Spaces Only	All Learning Spaces	Main Learning Spaces Only	All Learning Spaces	Main Learning Spaces Only
Block A	60.4	60.7	86.3	85.4	89.7	88.9
Block B	29.9	31.9	50.4	53.6	59.7	63.4
Block C	12.5	10.7	43.3	42.0	52.5	52.9
Block D	19.0	19.6	61.1	62.0	72.3	73.5

- ■ < 50% floor area
- ■ < 60% floor area
- ■ < 70% floor area
- ■ > 70% floor area

3D Model Representations
(shading as at 13:00 pm 1st July)

Example Block A

Example Block B

Example Block C
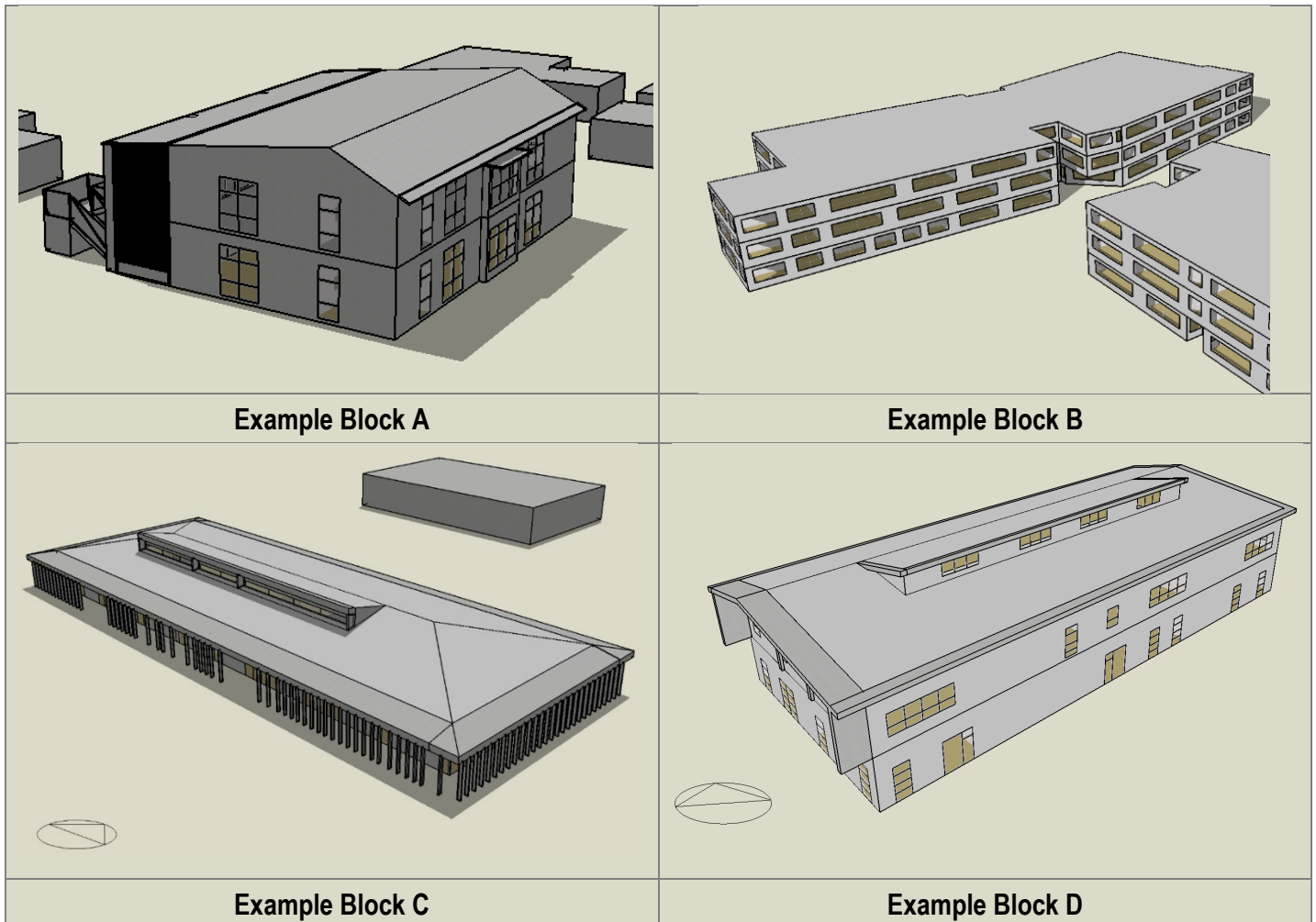
Example Block D

3.2 Example Block A (548.7 m^2) – UDI Variation and Scenarios
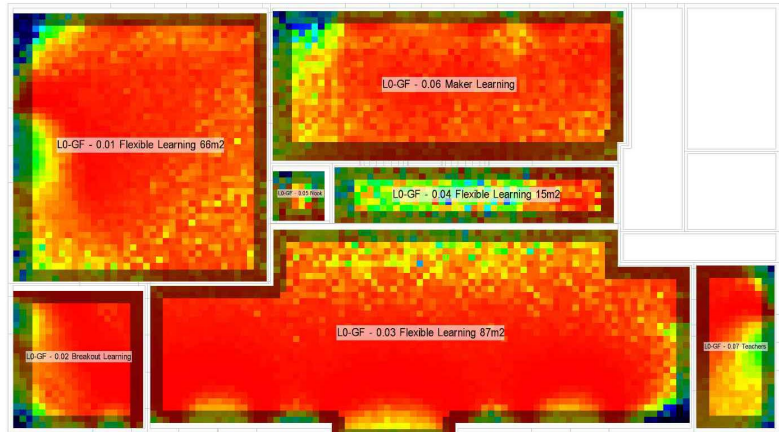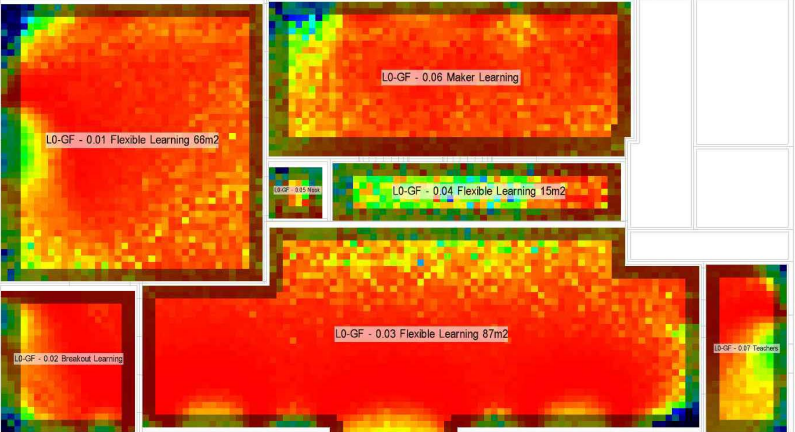
Block A is reasonably well optimised for daylighting, and would be expected to pass robust daylighting criteria. As shown in Tables 2 and 3 and Figures 1 to 3, the building performs well under all combinations of candidate compliance criteria.

Table 2: Example Block A - 80% annual hours

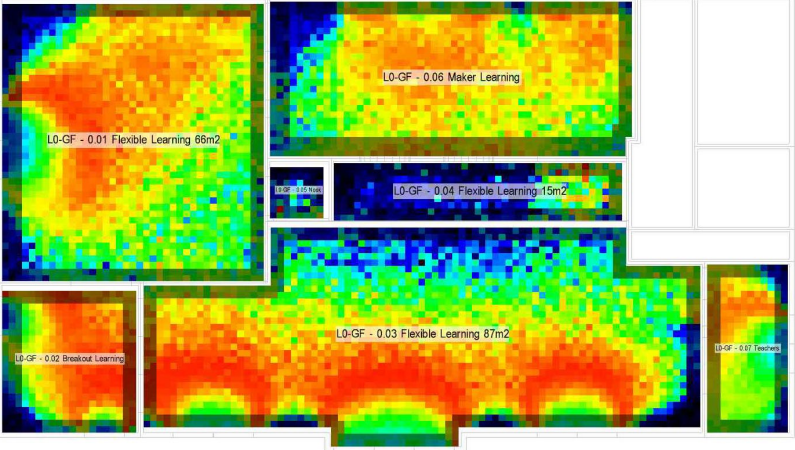| Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass / Fail	Exposure	UDI (m²)	UDI (%)	Pass / Fail	Exposure
		300-2000 lux 80% annual hours				160-2000 lux 80% annual hours				160-3000 lux 80% annual hours			
Ground Floor													
0.2 Breakout	18.6	14.3	77.0	Pass		16.4	88.1	Pass		18.2	97.8	Pass	
0.3 Flexible Learning	100.7	50.9	50.5	Pass		92.8	92.1	Pass		97.4	96.8	Pass	
0.7 Teachers	12.8	4.3	33.5	Fail	Over	7.8	60.8	Pass		10.8	84.7	Pass	
0.6 Maker Learning	53.2	28.7	53.9	Pass		50.2	94.3	Pass		50.5	94.8	Pass	
0.4 Flexible Learning	16.1	0.7	4.2	Fail	Under	7.2	44.7	Fail	Under	7.3	45.3	Fail	Under
0.1 Flexible Learning	68.8	33.6	48.9	Fail	Under	63.6	92.5	Pass		65.9	95.8	Pass	
0.5 Nook	3.1	0	0.0	Excluded		2.6	83.3	Excluded		2.6	83.3	Excluded	
First Floor													
1.2 Breakout	19.0	14.3	75.3	Pass		16.2	84.9	Pass		18.2	95.4	Pass	
1.7 Teachers	13.2	4.5	33.8	Fail	Over	7.4	56.5	Pass		10.9	82.5	Pass	
1.6 Maker Learning	53.8	47.3	87.8	Pass		51.8	96.3	Pass		53.7	99.8	Pass	
1.4 Flexible Learning	15.5	2.8	17.8	Fail	Under	15.1	97.4	Pass		15.1	97.4	Pass	
1.5 Nook	3.1	0.5	16.7	Excluded		3.1	100	Excluded		3.1	100	Excluded	
1.3 Flexible Learning	101.0	71.7	71.0	Pass		94.6	93.7	Pass		99.8	98.8	Pass	
1.1 Flexible Learning	69.7	54.8	78.6	Pass		61.7	88.6	Pass		66.9	96.0	Pass	
Total *(all learning spaces)*	**542.4**	**328**	**60.4**	Pass		**485**	**89.4**	Pass		**515**	**94.9**	Pass	

Table 3 Example Block A - 50% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pas/Fail	Exposure	UDI (m²)	UDI (%)	Pass/Fail	Exposure	UDI (m²)	UDI (%)	Pass/Fail	Exposure
		300-2000 lux 50% annual hours				160-2000 lux 50% annual hours				160-3000 lux 50% annual hours			
Ground Floor													
0.2 Breakout	18.6	18.1	97.4	Pass		18.6	100	Pass		18.6	100.0	Pass	
0.3 Flexible Learning	100.7	84.7	84.2	Pass		100	99.5	Pass		100.4	99.7	Pass	
0.7 Teachers	12.8	11.9	93.2	Pass		12.3	96.0	Pass		12.8	100.0	Pass	
0.6 Maker Learning	53.2	48.7	91.5	Pass		52.6	98.9	Pass		52.6	98.9	Pass	
0.4 Flexible Learning	16.1	3.2	20.0	Fail	Under	15.3	94.7	Pass		15.3	94.7	Pass	
0.1 Flexible Learning	68.8	62.8	91.3	Pass		67.9	98.6	Pass		68.6	99.7	Pass	
0.5 Nook	3.1	0.5	16.7	Excluded		3.1	100	Excluded		3.1	100	Excluded	
First Floor													
1.2 Breakout	19.0	18.5	97.0	Pass		18.7	98.4	Pass		19.0	100.0	Pass	
1.7 Teachers	13.2	12.2	92.2	Pass		12.2	92.2	Pass		13.2	100.0	Pass	
1.6 Maker Learning	53.8	53.3	99.0	Pass		53.8	100	Pass		53.8	100.0	Pass	
1.4 Flexible Learning	15.5	8.5	54.6	Pass		15.5	100	Pass		15.5	100.0	Pass	
1.5 Nook	3.1	2.1	66.7	Excluded		3.1	100	Excluded		3.1	100.0	Excluded	
1.3 Flexible Learning	101.0	97.5	96.5	Pass		99.4	98.4	Pass		101.0	100.0	Pass	
1.1 Flexible Learning	69.7	67.0	96.1	Pass		67.8	97.3	Pass		69.5	99.7	Pass	
Total *(all learning spaces)*	**542.4**	**486**	**89.7**	Pass		**534**	**98.5**	Pass		**540.3**	**99.6**	Pass	

Rationale for Daylighting Performance Metrics and Compliance Requirements

Example Block A	80% annual hours	50% annual hours

Figure 1 Example Block A - Ground Floor – UDI 300-2000 lux

UDI: 300 - 2000

No. of rooms within threshold: 58%

Floor area within threshold: 60%

UDI: 300 - 2000

No. of rooms within threshold: 92%

Floor area within threshold: 90%

Figure 2 Example Block A - Ground Floor – UDI 160-2000 lux

UDI: 160 - 2000

No. of rooms within threshold: 92%

Floor area within threshold: 89%

UDI: 160 - 2000

No. of rooms within threshold: 100%

Floor area within threshold: 98%

Figure 3 Example Block A - Ground Floor UDI 160-3000 lux

UDI: 160 - 3000

No. of rooms within threshold: 92%

Floor area within threshold: 95%

UDI: 160 - 3000

No.of rooms within threshold: 100%

Floor area within threshold: 100%

Pct Annual Hours	0	8	16	25	33	41	50	58	66	75	83	100

Rationale for Daylighting Performance Metrics and Compliance Requirements

3.3 Example Block A (548.7 m²) – Main learning spaces only

Table 4 Example Block A - 80% annual hours – learning spaces only, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
Ground Floor						
0.2 Breakout	18.6	14.3	77.0	Excluded	Excluded	
0.3 Flexible Learning	100.7	50.9	50.5	Pass	Fail	Under
0.7 Teachers	12.8	4.3	33.5	Excluded	Excluded	
0.6 Maker Learning	53.2	28.7	53.9	Pass	Fail	Under
0.4 Flexible Learning	16.1	0.7	4.2	Fail	Fail	Under
0.1 Flexible Learning	68.8	33.6	48.9	Fail	Fail	Over
0.5 Nook	3.1	0.0	0.0	Excluded	Excluded	
First Floor						
1.2 Breakout	19.0	14.3	75.3	Excluded	Excluded	
1.7 Teachers	13.2	4.5	33.8	Excluded	Excluded	
1.6 Maker Learning	53.8	47.3	87.8	Pass	Pass	
1.4 Flexible Learning	15.5	2.8	17.8	Fail	Fail	Under
1.5 Nook	3.1	0.5	16.7	Excluded	Excluded	
1.3 Flexible Learning	101.0	71.7	71.0	Pass	Pass	
1.1 Flexible Learning	69.7	54.8	78.6	Pass	Pass	
Total (main learning spaces only)	**478.9**	**290.4**	**60.7**	Pass	Pass	

Table 5 Example Block A - 60% annual hours, learning spaces only, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
Ground Floor						
0.2 Breakout	18.6	18.1	97.6	Excluded	Excluded	
0.3 Flexible Learning	100.7	78.0	77.4	Pass	Pass	
0.7 Teachers	12.8	10.8	84.2	Excluded	Excluded	
0.6 Maker Learning	53.2	47.7	89.6	Pass	Pass	
0.4 Flexible Learning	16.1	2.5	15.7	Fail	Fail	Under
0.1 Flexible Learning	68.8	58.7	85.3	Pass	Pass	
0.5 Nook	3.1	0.0	0.0	Excluded	Excluded	
First Floor						
1.2 Breakout	19.0	18.8	98.6	Excluded	Excluded	
1.7 Teachers	13.2	11.2	85.0	Excluded	Excluded	
1.6 Maker Learning	53.8	53.3	99.0	Pass	Pass	
1.4 Flexible Learning	15.5	5.4	34.7	Fail	Fail	Under
1.5 Nook	3.1	0.0	0.0	Excluded	Excluded	
1.3 Flexible Learning	101.0	95.8	94.9	Pass	Pass	
1.1 Flexible Learning	69.7	67.8	97.2	Pass	Pass	
Total (main learning spaces only)	**478.9**	**409.1**	**85.4**	Pass	Pass	

Rationale for Daylighting Performance Metrics and Compliance Requirements

Table 6 Example Block A - 50% annual hours, learning spaces only, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
0.2 Breakout	18.6	18.1	97.4	Excluded	Excluded	
0.3 Flexible Learning	100.7	84.7	84.2	Pass	Pass	
0.7 Teachers	12.8	11.9	93.2	Excluded	Excluded	
0.6 Maker Learning	53.2	48.7	91.5	Pass	Pass	
0.4 Flexible Learning	16.1	3.2	20.0	Fail	Fail	Underexposed
0.1 Flexible Learning	68.8	62.8	91.3	Pass	Pass	
0.5 Nook	3.1	0.5	16.7	Excluded	Excluded	
1.2 Breakout	19.0	18.5	97.0	Excluded	Excluded	
1.7 Teachers	13.2	12.2	92.2	Excluded	Excluded	
1.6 Maker Learning	53.8	53.3	99.0	Pass	Pass	
1.4 Flexible Learning	15.5	8.5	54.6	Pass	Fail	Underexposed
1.5 Nook	3.1	2.1	66.7	Excluded	Excluded	
1.3 Flexible Learning	101.0	97.5	96.5	Pass	Pass	
1.1 Flexible Learning	69.7	67.0	96.1	Pass	Pass	
Total *(main learning spaces only)*	**478.9**	**425.7**	**88.9**	Pass	Pass	

3.4 Example Block B (1918 m² floor area) – UDI Variation and Scenarios

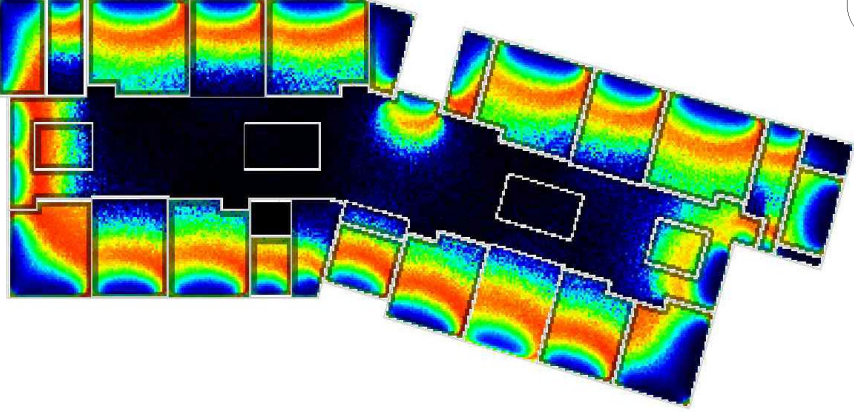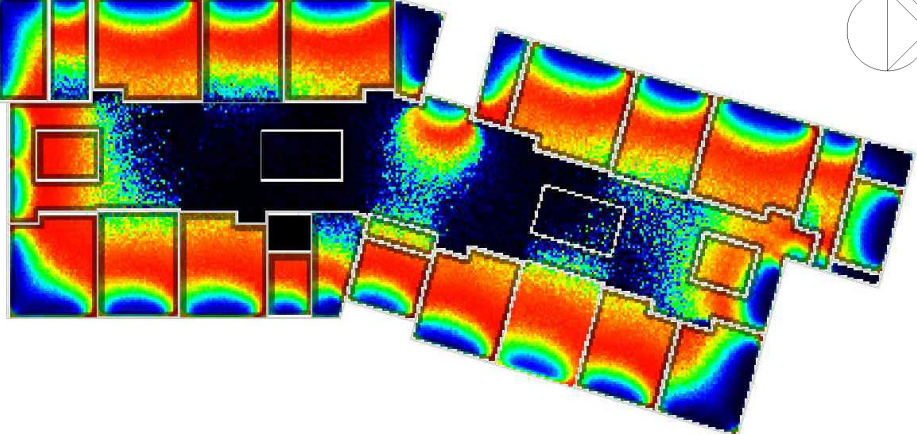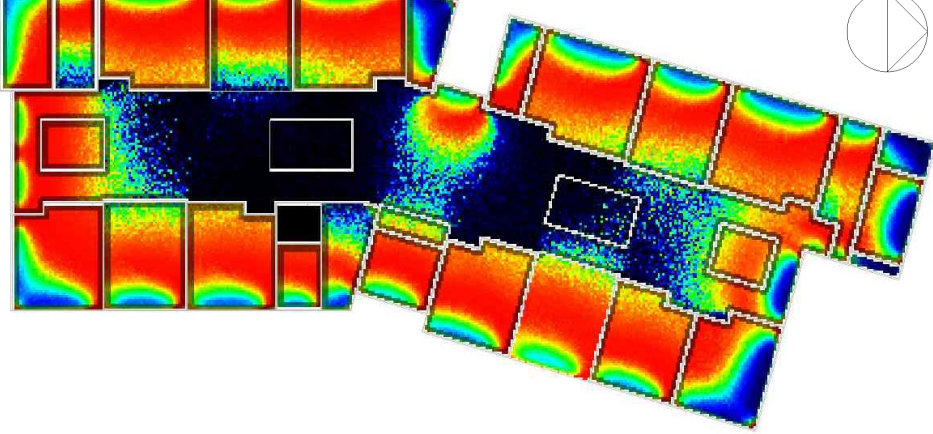*Modelled at 40% window to wall, generic distribution*

Although not optimised for daylighting, the room depths of Block B are well suited to single-sided daylighting, and the building would be expected to pass robust daylighting criteria. As shown on Tables 7 and 9, the building fails under the most robust combination of compliance criteria (300-2000 lux for 80% of occupied hours, across 50% of the applicable floor area). This indicates that these criteria are too stringent. Relaxing the time criteria to 50% (Table 8) or 60% of occupied school hours (Table 10) allows the building to achieve a pass, under a UDI range of 300-2000 lux. However, the individual space analysis indicated that most spaces were passing at 50%, while at 60%, the problematic spaces were more visible.

Table 7 Example Block B - 80% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass/ Fail	Exposure	UDI (m²)	UDI (%)	Pass/ Fail	Exposure	UDI (m²)	UDI (%)	Pass/ Fail	Exposure
		300-2000 lux 80% annual hours				160-2000 lux 80% annual hours				160-3000 lux 80% annual hours			
Specialist 1	82.2	27.5	33.5	Fail	Under	62.4	75.9	Pass		70.2	85.4	Pass	
Level 2	579.1	28.6	4.9	Excluded		69.8	12.0	Excluded		84.3	14.5	Excluded	
General 1	64.5	19.0	29.5	Fail	Under	38.7	59.9	Pass		44.5	69.0	Pass	
Specialist 2	82.1	25.3	30.8	Fail	Under	57.1	69.6	Pass		64.7	78.8	Pass	
Breakout 2	29.8	0.0	0.0	Fail	Under	0.0	0.0	Fail	Under	0.0	0.0	Fail	Under
Technician	33.0	4.8	14.5	Excluded		10.6	32.1	Excluded		11.8	35.8	Excluded	
Breakout 3	12.6	0.1	0.8	Fail	Under	7.5	59.4	Pass		7.6	60.2	Pass	
Hole	34.7	18.1	52.3	Excluded		22.7	65.3	Excluded		28.2	81.3	Excluded	
Physics Res.	26.9	0.2	0.8	Excluded		0.4	1.5	Excluded		1.7	6.3	Excluded	
Learning RG 1	64.4	16.7	25.9	Fail	Under	33.0	51.2	Pass		38.3	59.4	Pass	
General 4	64.4	21.8	33.9	Fail	Under	45.7	71.0	Pass		52.0	80.7	Pass	
Breakout 1	22.7	8.9	39.4	Fail	Under	22.0	97.0	Pass		22.0	97.0	Pass	
General 3	66.2	30.7	46.3	Fail	Over	31.0	46.8	Fail	Over	43.1	65.1	Pass	
Chemical Str	12.8	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Chemistry Res	20.6	11.8	57.1	Excluded		13.0	62.9	Excluded		16.1	78.2	Excluded	
Learning RG 3	65.1	24.2	37.2	Fail	Under	48.5	74.5	Pass		54.8	84.2	Pass	
Breakout 4	30.7	0.1	0.2	Fail	Under	0.5	1.8	Fail	Under	0.5	1.8	Fail	Under
General 2	64.4	23.3	36.1	Fail	Under	42.2	65.5	Pass		49.0	76.0	Pass	
General 5	61.8	22.7	36.7	Fail	Under	46.3	75.0	Pass		52.0	84.2	Pass	
Breakout 5	21.0	7.5	35.8	Fail	Under	18.8	89.3	Pass		19.9	94.7	Pass	
General 6	62.8	9.4	15.0	Fail	Over	10.1	16.2	Fail	Over	23.8	37.9	Fail	Over
Learning RG 2	64.3	16.6	25.8	Fail	Under	36.2	56.3	Pass		41.9	65.2	Pass	
Biology Res.	24.6	6.3	25.7	Excluded		6.5	26.5	Excluded		12.1	49.5	Excluded	
Specialist 3	82.1	25.1	30.6	Fail	Under	54.4	66.3	Pass		62.3	75.9	Pass	
Specialist 4	82.2	26.8	32.6	Fail	Under	57.9	70.4	Pass		65.8	80.0	Pass	
Stair 2	40.0	8.0	19.9	Excluded		8.2	20.5	Excluded		20.4	50.8	Excluded	
WC 1	34.1	7.7	22.5	Excluded		14.7	43.2	Excluded		17.3	50.7	Excluded	
WC 2	37.8	9.4	24.9	Excluded		23.3	61.8	Excluded		26.7	70.8	Excluded	
Res	14.1	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Stair 1	33.1	0.2	0.7	Excluded		0.6	1.8	Excluded		9.8	29.7	Excluded	
Services 2	4.7	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Total *(all learning spaces)*	**1023**	**305.7**	**29.9**	**Fail**		**612.3**	**59.8**	**Pass**		**712.3**	**69.6**	**Pass**	

Table 8 Example Block B - 50% annual hours

Space Name	Floor Area (m²)	UDI (m²) 300-2000 lux 50% annual hours	UDI (%)	Pass /Fail	Exposure	UDI (m²) 160-2000 lux 50% annual hours	UDI (%)	Pass / Fail	Exposure	UDI (m²) 160-3000 lux 50% annual hours	UDI (%)	Pass / Fail	Exposure
Specialist 1	82.2	57.5	70.0	Pass		72.0	87.5	Pass		78.2	95.0	Pass	
Level 2	579.1	74.1	12.8	Excluded		149.4	25.8	Excluded		158.3	27.3	Excluded	
General 1	64.5	36.0	55.8	Pass		54.5	84.4	Pass		59.4	92.1	Pass	
Specialist 2	82.1	53.8	65.5	Pass		72.1	87.9	Pass		78.2	95.3	Pass	
Breakout 2	29.8	0.3	1.1	Fail	Under	0.7	2.4	Fail	Under	0.7	2.4	Fail	Under
Technician	33.0	10.6	32.1	Excluded		18.2	55.2	Excluded		19.4	58.9	Excluded	
Breakout 3	12.6	2.0	15.8	Fail	Under	12.3	97.7	Pass		12.3	97.7	Pass	
Hole	34.7	28.6	82.5	Excluded		28.7	82.6	Excluded		33.0	95.2	Excluded	
Physics Res.	26.9	2.0	7.6	Excluded		2.2	8.1	Excluded		5.2	19.3	Excluded	
Learning RG 1	64.4	33.7	52.3	Pass		49.7	77.2	Pass		54.0	83.8	Pass	
General 4	64.4	44.6	69.2	Pass		53.8	83.5	Pass		59.1	91.8	Pass	
Breakout 1	22.7	15.7	69.4	Pass		22.7	100.0	Pass		22.7	100.0	Pass	
General 3	66.2	41.8	63.1	Pass		42.0	63.4	Pass		53.5	80.8	Pass	
Chemical Str	12.8	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Chemistry Res	20.6	16.5	80.3	Excluded		16.5	80.3	Excluded		19.0	92.5	Excluded	
Learning RG 3	65.1	45.1	69.3	Pass		55.3	84.9	Pass		60.8	93.4	Pass	
Breakout 4	30.7	0.3	1.0	Fail	Under	1.2	4.0	Fail	Under	1.2	4.0	Fail	Under
General 2	64.4	41.4	64.2	Pass		55.7	86.4	Pass		61.6	95.5	Pass	
General 5	61.8	40.9	66.2	Pass		54.1	87.5	Pass		58.9	95.3	Pass	
Breakout 5	21.0	18.4	87.7	Pass		21.0	100.0	Pass		21.0	100.0	Pass	
General 6	62.8	22.0	35.0	Fail	Over	22.4	35.6	Fail	Over	35.5	56.5	Pass	
Learning RG 2	64.3	36.2	56.4	Pass		53.2	82.8	Pass		58.0	90.3	Pass	
Biology Res.	24.6	11.2	45.6	Excluded		11.2	45.6	Excluded		18.6	76.0	Excluded	
Specialist 3	82.1	56.9	69.3	Pass		68.8	83.7	Pass		75.0	91.3	Pass	
Specialist 4	82.2	64.5	78.4	Pass		68.5	83.3	Pass		75.0	91.3	Pass	
Stair 2	40.0	18.5	46.2	Excluded		18.5	46.2	Excluded		31.8	79.3	Excluded	
WC 1	34.1	15.4	45.2	Excluded		23.6	69.4	Excluded		26.0	76.3	Excluded	
WC 2	37.8	22.9	60.7	Excluded		31.9	84.6	Excluded		34.8	92.3	Excluded	
Res	14.1	0.0	0.0	Excluded		0.0	0.0	Excluded		0.7	4.9	Excluded	
Stair 1	33.1	9.9	30.0	Excluded		10.2	30.8	Excluded		19.2	57.9	Excluded	
Services 2	4.7	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Total *(all learning spaces)*	**1023**	**611.3**	**59.7**	**Pass**		**779.9**	**76.2**	**Pass**		**865.1**	**84.5**	**Pass**	

Example Block B	80% annual hours	50% annual hours
 Figure 4 Example Block B – UDI 300-2000 lux	**UDI: 300 - 2000** No. of rooms within threshold: 0% Floor area within threshold: 30%	**UDI: 300 - 2000** No. of rooms within threshold: 78% Floor area within threshold: 60%
 Figure 5 Example Block B – UDI 160-2000 lux	**UDI: 160 - 2000** No. of rooms within threshold: 78% Floor area within threshold: 60%	**UDI: 160 - 2000** No. of rooms within threshold: 83% Floor area within threshold: 76%
 Figure 6 Example Block B - UDI 160-3000 lux	**UDI: 160 - 3000** No. of rooms within threshold: 83% Floor area within threshold: 70%	**UDI: 160 - 3000** Nuo.of rooms within threshold: 89% Floor area within threshold: 85%

Pct Annual Hours   0   8   16   25   33   41   50   58   66   75   83   100

Rationale for Daylighting Performance Metrics and Compliance Requirements

3.5 Example Block B (1918 m^2 floor area) – Main learning spaces only

Table 9 Example Block B - 80% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m^2)	UDI (m^2)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
Specialist 1	82.2	27.5	33.5	Fail	Fail	Over
Level 2	579.1	28.6	4.9	Excluded	Excluded	
General 1	64.5	19.0	29.5	Fail	Fail	Over
Specialist 2	82.1	25.3	30.8	Fail	Fail	Over
Breakout 2	29.8	0.0	0.0	Excluded	Excluded	
Technician Workspace	33.0	4.8	14.5	Excluded	Excluded	
Breakout 3	12.6	0.1	0.8	Excluded	Excluded	
Hole	34.7	18.1	52.3	Excluded	Excluded	
Physics Resource	26.9	0.2	0.8	Excluded	Excluded	
Learning Roll Growth 1	64.4	16.7	25.9	Fail	Fail	Under
General 4	64.4	21.8	33.9	Fail	Fail	Over
Breakout 1	22.7	8.9	39.4	Excluded	Excluded	
General 3	66.2	30.7	46.3	Fail	Fail	Over
Chemical Store	12.8	0.0	0.0	Excluded	Excluded	
Chemistry Resource	20.6	11.8	57.1	Excluded	Excluded	
Learning Roll Growth 3	65.1	24.2	37.2	Fail	Fail	Over
Breakout 4	30.7	0.1	0.2	Excluded	Excluded	
General 2	64.4	23.3	36.1	Fail	Fail	Over
General 5	61.8	22.7	36.7	Fail	Fail	Over
Breakout 5	21.0	7.5	35.8	Excluded	Excluded	
General 6	62.8	9.4	15.0	Fail	Fail	Over
Learning Roll Growth 2	64.3	16.6	25.8	Fail	Fail	Over
Biology Resource	24.6	6.3	25.7	Excluded	Excluded	
Specialist 3	82.1	25.1	30.6	Fail	Fail	Over
Specialist 4	82.2	26.8	32.6	Fail	Fail	Over
Stair 2	40.0	8.0	19.9	Excluded	Excluded	
WC 1	34.1	7.7	22.5	Excluded	Excluded	
WC 2	37.8	9.4	24.9	Excluded	Excluded	
Resource	14.1	0.0	0.0	Excluded	Excluded	
Stair 1	33.1	0.2	0.7	Excluded	Excluded	
Services 2	4.7	0.0	0.0	Excluded	Excluded	
Total *(main learning spaces only)*	**906.6**	**289.1**	**31.9**	**Fail**	**Fail**	Over

Table 10 Example Block B - 60% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
Specialist 1	82.2	47.3	57.5	Pass	Fail	Over
Level 2	579.1	61.5	10.6	Excluded	Excluded	
General 1	64.5	31.2	48.4	Fail	Fail	Over
Specialist 2	82.1	43.0	52.4	Pass	Fail	Over
Breakout 2	29.8	0.1	0.2	Excluded	Excluded	
Technician Workspace	33.0	8.9	27.0	Excluded	Excluded	
Breakout 3	12.6	0.9	7.5	Excluded	Excluded	
Hole	34.7	26.3	75.6	Excluded	Excluded	
Physics Resource	26.9	1.5	5.6	Excluded	Excluded	
Learning Roll Growth 1	64.4	29.0	45.0	Fail	Fail	Over
General 4	64.4	37.8	58.7	Pass	Fail	Over
Breakout 1	22.7	13.6	60.0	Pass	Fail	Under
General 3	66.2	38.7	58.4	Pass	Fail	Over
Chemical Store	12.8	0.0	0.0	Excluded	Excluded	
Chemistry Resource	20.6	15.3	74.5	Excluded	Excluded	
Learning Roll Growth 3	65.1	37.9	58.3	Pass	Fail	Over
Breakout 4	30.7	0.1	0.2	Fail	Fail	Under
General 2	64.4	36.4	56.6	Pass	Fail	Over
General 5	61.8	35.1	56.8	Pass	Fail	Over
Breakout 5	21.0	16.0	76.4	Pass	Pass	
General 6	62.8	17.7	28.1	Fail	Fail	Over
Learning Roll Growth 2	64.3	30.4	47.4	Fail	Fail	Over
Biology Resource	24.6	9.3	37.7	Excluded	Excluded	
Specialist 3	82.1	47.5	57.8	Pass	Fail	Over
Specialist 4	82.2	53.5	65.1	Pass	Pass	
Stair 2	40.0	14.7	36.8	Excluded	Excluded	
WC 1	34.1	13.2	38.7	Excluded	Excluded	
WC 2	37.8	18.2	48.2	Excluded	Excluded	
Resource	14.1	0.0	0.0	Excluded	Excluded	
Stair 1	33.1	5.9	17.8	Excluded	Excluded	
Services 2	4.7	0.0	0.0	Excluded	Excluded	
Total *(main learning spaces only)*	906.6	485.5	53.6	Pass	Fail	Over

Table 11 Example Block B - 50% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass/Fail	60% Area Pass/Fail	Exposure
Specialist 1	82.2	57.5	70.0	Pass	Pass	
Level 2	579.1	74.1	12.8	Excluded	Excluded	
General 1	64.5	36.0	55.8	Pass	Fail	Over
Specialist 2	82.1	53.8	65.5	Pass	Pass	
Breakout 2	29.8	0.3	1.1	Excluded	Excluded	
Technician Workspace	33.0	10.6	32.1	Excluded	Excluded	
Breakout 3	12.6	2.0	15.8	Excluded	Excluded	
Hole	34.7	28.6	82.5	Excluded	Excluded	
Physics Resource	26.9	2.0	7.6	Excluded	Excluded	
Learning Roll Growth 1	64.4	33.7	52.3	Pass	Fail	Over
General 4	64.4	44.6	69.2	Pass	Pass	
Breakout 1	22.7	15.7	69.4	Excluded	Excluded	
General 3	66.2	41.8	63.1	Pass	Pass	
Chemical Store	12.8	0.0	0.0	Excluded	Excluded	
Chemistry Resource	20.6	16.5	80.3	Excluded	Excluded	
Learning Roll Growth 3	65.1	45.1	69.3	Pass	Pass	
Breakout 4	30.7	0.3	1.0	Excluded	Excluded	
General 2	64.4	41.4	64.2	Pass	Pass	
General 5	61.8	40.9	66.2	Pass	Pass	
Breakout 5	21.0	18.4	87.7	Excluded	Excluded	
General 6	62.8	22.0	35.0	Fail	Fail	Over
Learning Roll Growth 2	64.3	36.2	56.4	Pass	Fail	Over
Biology Resource	24.6	11.2	45.6	Excluded	Excluded	
Specialist 3	82.1	56.9	69.3	Pass	Pass	
Specialist 4	82.2	64.5	78.4	Pass	Pass	
Stair 2	40.0	18.5	46.2	Excluded	Excluded	
WC 1	34.1	15.4	45.2	Excluded	Excluded	
WC 2	37.8	22.9	60.7	Excluded	Excluded	
Resource	14.1	0.0	0.0	Excluded	Excluded	
Stair 1	33.1	9.9	30.0	Excluded	Excluded	
Services 2	4.7	0.0	0.0	Excluded	Excluded	
Total *(main learning spaces only)*	**906.6**	**574.5**	**63.4**	**Pass**	**Pass**	

3.6 Example Block C (934 m² floor area) – UDI variation and scenarios

Block C represents a challenging design which has not been optimised for daylighting, and which would be expected to fail robust daylighting criteria. Although the building fails under the most stringent criteria (300-2000 lux, 80% hours, 50% area; Table 12), it passes when the time criterion was relaxed to 50% of occupied school hours (Table 13). When the time criterion was tightened to 60% (Table 15) the building fails.

Similar to Block B, the individual space analysis indicated that most spaces were passing at 50%, while at 60% the problematic spaces were more visible. Hence, it can be inferred that the building and most spaces will easily pass the UDI criterion at 50% of the occupied schools' hours, but at 60%, the building and individual spaces will most likely fail.

Table 12 Example Block C - 80% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure
		300-2000 lux 80% annual hours				160-2000 lux 80% annual hours				160-3000 lux 80% annual hours			
Breakout Large W	40.9	10.4	25.4	Fail	Under	38.0	92.9	Pass		38	92.9	Pass	
Wet Area NW	18.5	4.7	25.6	Fail	Under	17.2	92.7	Pass		17.9	96.7	Pass	
Flexible Learning SW	122.2	16.1	13.2	Fail	Under	79.0	64.6	Pass		78.5	64.2	Pass	
Wet Area SW	18.7	4.0	21.4	Fail	Under	14.8	78.9	Pass		15.1	80.7	Pass	
Library Breakout SE	16.3	11.1	68.2	Pass		12.1	73.9	Pass		16.3	100	Pass	
Wet Area SE	19.1	3.4	17.9	Fail	Under	15.5	81.0	Pass		15	78.8	Pass	
Library Breakout NE	16.3	7.9	48.2	Fail	Over	9.4	57.4	Pass		15	91.6	Pass	
Wet Area NE	19.0	1.5	7.8	Fail	Under	15.9	83.6	Pass		18	94.8	Pass	
Library	137.0	30.4	22.2	Fail	Under	102	74.4	Pass		102	74.4	Pass	
Breakout Large E	41.4	0	0.0	Fail	Under	0.7	1.6	Fail	Under	0.7	1.6	Fail	Under
Flexible Learning SE	122.5	14.4	11.8	Fail	Under	57.4	46.8	Fail	Under	57.5	46.9	Fail	Under
Breakout Small 4	14.6	0.2	1.4	Fail	Under	3.6	24.4	Fail	Under	3.6	24.4	Fail	Under
Breakout Small 3	14.6	0.0	0.0	Fail	Under	1.0	6.8	Fail	Under	1.0	6.8	Fail	Under
Flexible Learning NE	120.7	4.8	4.0	Fail	Under	76.8	63.6	Pass		82.0	68.0	Pass	
Flexible Learning C	61.1	0.1	0.1	Fail	Under	1.5	2.5	Fail	Under	1.5	2.5	Fail	Under
Flexible Learning NW	121.5	7.1	5.9	Fail	Under	92.4	76.0	Pass		98.6	81.1	Pass	
Breakout Small 2	14.7	0.1	0.5	Fail	Under	1.2	8.5	Fail	Under	1.2	8.5	Fail	Under
Breakout Small 1	14.6	0.1	0.5	Fail	Under	1.7	11.6	Fail	Under	1.7	11.6	Fail	Under
Total *(all learning spaces)*	**934.0**	**116**	**12.5**	**Fail**		**540**	**57.8**	**Pass**		**564**	**60.3**	**Pass**	

Table 13 Example Block C - 50% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure
		300-2000 lux 50% annual hours				160-2000 lux 50% annual hours				160-3000 lux 50% annual hours			
Breakout Large W	40.9	36.8	89.9	Pass		40.7	99.5	Pass		40.7	99.5	Pass	
Wet Area NW	18.5	18.3	98.7	Pass		18.5	100	Pass		18.5	100	Pass	
Flexible Learning SW	122.2	50.5	41.3	Fail	Under	114.2	93.5	Pass		114.1	93.4	Pass	
Wet Area SW	18.7	11.7	62.4	Pass		18.7	100	Pass		18.7	100	Pass	
Library Breakout SE	16.3	16.3	100	Pass		16.3	100	Pass		16.3	100	Pass	
Wet Area SE	19.1	8.8	46.1	Fail	Under	19.0	99.3	Pass		19.0	99.3	Pass	
Library Breakout NE	16.3	15.5	94.8	Pass		15.6	95.2	Pass		16.3	100	Pass	
Wet Area NE	19.0	18.6	98.1	Pass		18.9	99.6	Pass		19.0	100	Pass	
Library	137.0	92.6	67.6	Pass		132.9	97.0	Pass		132.9	97.0	Pass	
Breakout Large E	41.4	0.2	0.4	Fail	Under	4.3	10.3	Fail	Under	4.3	10.3	Fail	Under
Flexible Learning SE	122.5	31.4	25.6	Fail	Under	105.7	86.3	Pass		105.7	86.3	Pass	
Breakout Small 4	14.6	1.2	8.5	Fail	Under	9.6	65.3	Pass		9.6	65.3	Pass	
Breakout Small 3	14.6	0.1	1.0	Fail	Under	6.3	43.2	Fail	Under	6.3	43.2	Fail	Under
Flexible Learning NE	120.7	85.8	71.1	Pass		112.2	92.9	Pass		115.9	96.0	Pass	
Flexible Learning C	61.1	1.1	1.8	Fail	Under	17.6	28.8	Fail	Under	17.6	28.8	Fail	Under
Flexible Learning NW	121.5	101	82.9	Pass		118.2	97.2	Pass		121.2	99.8	Pass	
Breakout Small 2	14.7	0.3	2.3	Fail	Under	5.6	38.0	Fail	Under	5.6	38.0	Fail	Under
Breakout Small 1	14.6	0.3	2.3	Fail	Under	7.7	52.3	Pass		7.7	52.3	Pass	
Total *(all learning spaces)*	**934.0**	**490.4**	**52.5**	**Pass**		**781.9**	**83.7**	**Pass**		**789.4**	**84.5**	**Pass**	

Example Block C	80% annual hours	50% annual hours

Figure 7 Example Block C - UDI 300-2000 lux

UDI: 300 - 2000

Number of rooms within threshold: 6%

Floor area within threshold: 13%

UDI: 300 - 2000

Number of rooms within threshold: 50%

Floor area within threshold: 53%

Figure 8 Example Block C – UDI 160-2000 lux

UDI: 160 - 2000

Number of rooms within threshold: 61%

Floor area within threshold: 58%

UDI: 160 - 2000

Number of rooms within threshold: 78%

Floor area within threshold: 84%

Figure 9 Example Block C – UDI 160-3000 lux

UDI: 160 - 3000

Number of rooms within threshold: 61%

Floor area within threshold: 60%

UDI: 160 - 3000

Number of rooms within threshold: 78%

Floor area within threshold: 85%

Pct Annual Hours | 0 | 8 | 16 | 25 | 33 | 41 | 50 | 58 | 66 | 75 | 83 | 100

Rationale for Daylighting Performance Metrics and Compliance Requirements

3.7 Example Block C (934 m² floor area) – Main learning spaces only

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Breakout Large - West	40.9	10.4	25.4	Excluded	Excluded	
Wet Area - North West	18.5	4.7	25.6	Excluded	Excluded	
Flexible Learning - South West	122.2	16.2	13.2	Fail	Fail	Under
Wet Area – South West	18.7	4.0	21.4	Excluded	Excluded	
Library Breakout – South East	16.3	11.1	68.2	Excluded	Excluded	
Wet Area – South East	19.1	3.4	17.9	Excluded	Excluded	
Library Breakout – North East	16.3	7.9	48.2	Excluded	Excluded	
Wet Area – North East	19.0	1.5	7.8	Excluded	Excluded	
Library	137.0	30.4	22.2	Fail	Fail	Under
Breakout Large - East	41.4	0.0	0.0	Excluded	Excluded	
Flexible Learning – South East	122.5	14.4	11.8	Fail	Fail	Under
Breakout Small 4	14.6	0.2	1.4	Excluded	Excluded	
Breakout Small 3	14.6	0.0	0.0	Excluded	Excluded	
Flexible Learning - North East	120.7	4.8	4.0	Fail	Fail	Under
Flexible Learning - Center	61.1	0.1	0.1	Fail	Fail	Under
Flexible Learning – North West	121.5	7.1	5.9	Fail	Fail	Under
Breakout Small 2	14.7	0.1	0.5	Excluded	Excluded	
Breakout Small 1	14.6	0.1	0.5	Excluded	Excluded	
Total *(main learning spaces only)*	**685.1**	**73.0**	**10.7**	Fail	Fail	Under

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Breakout Large - West	40.9	33.2	81.0	Excluded	Excluded	
Wet Area - North West	18.5	17.4	93.7	Excluded	Excluded	
Flexible Learning - South West	122.2	36.7	30.0	Fail	Fail	Under
Wet Area – South West	18.7	10.0	53.4	Excluded	Excluded	
Library Breakout – South East	16.3	16.1	98.9	Excluded	Excluded	
Wet Area – South East	19.1	7.1	37.0	Excluded	Excluded	
Library Breakout – North East	16.3	14.3	87.3	Excluded	Excluded	
Wet Area – North East	19.0	17.6	92.5	Excluded	Excluded	
Library	137.0	71.8	52.5	Pass	Fail	Under
Breakout Large - East	41.4	0.1	0.1	Excluded	Excluded	
Flexible Learning – South East	122.5	24.7	20.1	Fail	Fail	Under
Breakout Small 4	14.6	0.7	4.7	Excluded	Excluded	
Breakout Small 3	14.6	0.0	0.0	Excluded	Excluded	
Flexible Learning - North East	120.7	69.3	57.4	Pass	Fail	Over
Flexible Learning - Center	61.1	0.6	0.9	Fail	Fail	Under
Flexible Learning – North West	121.5	84.7	69.7	Pass	Pass	
Breakout Small 2	14.7	0.3	1.9	Excluded	Excluded	
Breakout Small 1	14.6	0.1	0.9	Excluded	Excluded	
Total *(main learning spaces only)*	**685.1**	**287.8**	**42.0**	Fail	Fail	Under

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Table 16 Example Block C - 50% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Breakout Large - West	40.9	36.8	89.9	Excluded	Excluded	
Wet Area - North West	18.5	18.3	98.7	Excluded	Excluded	
Flexible Learning - South West	122.2	50.5	41.3	Fail	Fail	Under
Wet Area – South West	18.7	11.7	62.4	Excluded	Excluded	
Library Breakout – South East	16.3	16.3	100.0	Excluded	Excluded	
Wet Area – South East	19.1	8.8	46.2	Excluded	Excluded	
Library Breakout – North East	16.3	15.5	94.8	Excluded	Excluded	
Wet Area – North East	19.0	18.6	98.1	Excluded	Excluded	
Library	137.0	92.6	67.6	Pass	Pass	
Breakout Large - East	41.4	0.2	0.4	Excluded	Excluded	
Flexible Learning – South East	122.5	31.3	25.6	Fail	Fail	Under
Breakout Small 4	14.6	1.2	8.5	Excluded	Excluded	
Breakout Small 3	14.6	0.1	1.0	Excluded	Excluded	
Flexible Learning - North East	120.7	85.8	71.1	Pass	Pass	
Flexible Learning - Center	61.1	1.1	1.8	Fail	Fail	Under
Flexible Learning – North West	121.5	100.7	82.9	Pass	Pass	
Breakout Small 2	14.7	0.3	2.3	Excluded	Excluded	
Breakout Small 1	14.6	0.3	2.3	Excluded	Excluded	
Total *(main learning spaces only)*	**685.1**	**362.1**	**52.9**	Pass	Fail	Under

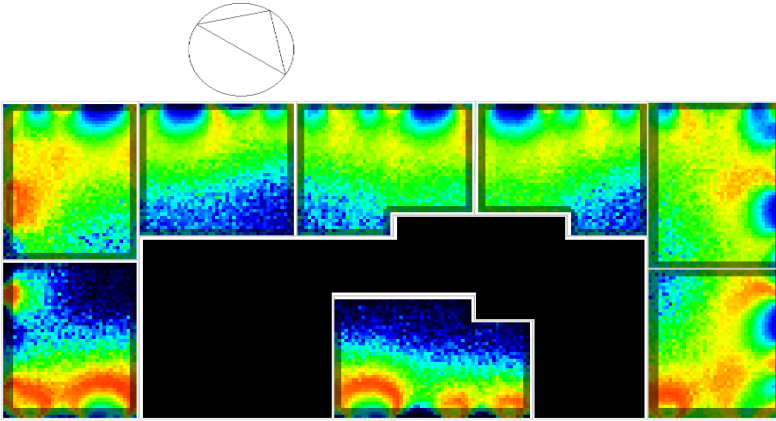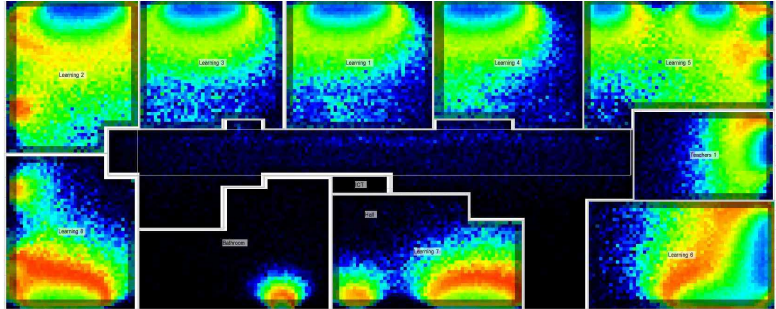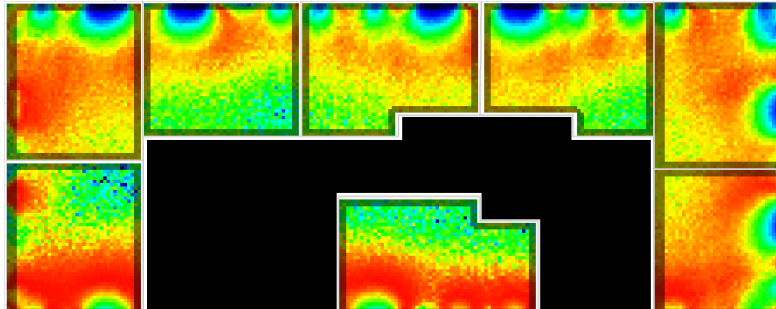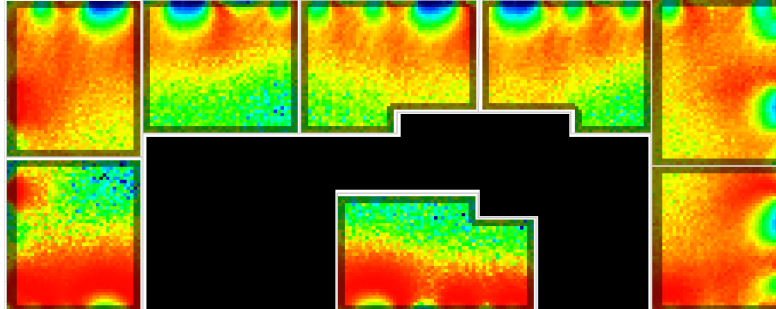## 3.8 Example Block D (1722 m² floor area) – UDI variation and scenarios

The design of Block D is suitable for daylighting, and would be expected to pass robust daylighting criteria. It fails under the most demanding criteria (300-2000 lux, 80% hours, 50% area; Tables 17 and 19), which suggests that this would be too stringent. The building achieves a pass if the time criterion is relaxed to 60% of occupied hours (Table 20), while still highlighting individual spaces that requires improvement, indicating that this may be a more appropriate value for a wide range of school building forms.

Table 17 Example Block D - 80% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure
		300-2000 lux 80% annual hours				160-2000 lux 80% annual hours				160-3000 lux 80% annual hours			
Ground Floor													
Zone 8	77.5	1.0	1.2	Fail	Under	42.1	54.4	Pass		52.9	68.3	Pass	
Zone 2	74.1	0.7	0.9	Fail	Under	39.0	52.7	Pass		49.0	66.1	Pass	
Zone 5	79.5	10.9	13.7	Fail	Over	57.9	72.8	Pass		66.2	83.3	Pass	
Zone 6	75.4	22.2	29.5	Fail	Under	58.4	77.5	Pass		61.4	81.4	Pass	
Circulation	256	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Zone 4	79.7	13.7	17.2	Fail	Under	47.0	59.0	Pass		48.6	61.0	Pass	
Zone 3	71.2	30.8	43.3	Fail	Over	55.4	77.8	Pass		63.8	89.6	Pass	
Zone 7	75.3	26.8	35.6	Fail	Over	53.2	70.7	Pass		65.6	87.1	Pass	
Zone 1	74.0	1.3	1.7	Fail	Under	29.2	39.5	Fail	Under	35.0	47.2	Fail	Under
First Floor													
Learning 8	71.9	17.1	23.8	Fail	Under	45.4	63.2	Pass		48.8	68.0	Pass	
Circulation	158	0.2	0.1	Excluded		0.6	0.3	Excluded		0.6	0.3	Excluded	
Toilets	74.7	1.3	1.7	Excluded		4.2	5.6	Excluded		4.2	5.6	Excluded	
Learning 7	74.3	12.3	16.6	Fail	Under	31.5	42.4	Fail	Under	33.9	45.7	Fail	Under
Learning 6	73.1	17.4	23.8	Fail	Over	33.6	45.9	Fail	Over	41.1	56.2	Pass	
Teachers 1	45.6	1.9	4.1	Fail	Under	13.7	30.1	Fail	Under	16.0	35.1	Fail	Under
Learning 2	72.2	12.4	17.1	Fail	Under	50.9	70.5	Pass		55.6	77.0	Pass	
ICT	3.5	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Learning 5	81.0	6.7	8.3	Fail	Under	50.0	61.8	Pass		58.6	72.3	Pass	
Learning 4	68.1	30.8	43.3	Fail	Over	19.8	29.1	Fail	Under	23.4	34.3	Fail	Under
Learning 1	69.7	26.8	35.6	Fail	Over	20.5	29.4	Fail	Under	24.3	34.8	Fail	Under
Learning 3	67.6	1.3	1.7	Fail	Under	23.0	34.0	Fail	Under	26.6	39.4	Fail	Under
Total *(all learning spaces)*	1230	234	19.0	Fail		671	54.5	Pass		770	62.7	Pass	

Table 18 Example Block D - 50% annual hours

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure	UDI (m²)	UDI (%)	Pass /Fail	Exposure
		300-2000 lux 50% annual hours				160-2000 lux 50% annual hours				160-3000 lux 50% annual hours			
Ground Floor													
Zone 8	77.5	64.2	82.8	Pass		72	92.8	Pass		75.6	97.4	Pass	
Zone 2	74.1	57.5	77.6	Pass		68	91.8	Pass		71.6	96.7	Pass	
Zone 5	79.5	70.4	88.6	Pass		71.0	89.4	Pass		76.7	96.5	Pass	
Zone 6	75.4	51.6	68.5	Pass		74.7	99.2	Pass		74.9	99.4	Pass	
Circulation	256	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Zone 4	79.7	37.6	47.2	Fail	Under	78.3	98.2	Pass		78.5	98.4	Pass	
Zone 3	71.2	66.8	93.8	Pass		67.2	94.3	Pass		69.8	98.0	Pass	
Zone 7	75.3	69.4	92.1	Pass		69.8	92.6	Pass		73.4	97.4	Pass	
Zone 1	74.0	45.9	62.1	Pass		69.9	94.5	Pass		72.1	97.5	Pass	
First Floor													
Learning 8	71.9	36.3	50.5	Pass		67.2	93.5	Pass		67.2	93.5	Pass	
Circulation	158	2.0	1.3	Excluded		10.9	6.9	Excluded		11.0	67.0	Excluded	
Toilets	74.7	3.4	4.5	Excluded		8.2	10.9	Excluded		8.2	10.9	Excluded	
Learning 7	74.3	26.2	35.3	Fail	Under	54.8	73.7	Pass		54.8	73.7	Pass	
Learning 6	73.1	40.9	55.9	Pass		60.7	83.0	Pass		67.4	92.1	Pass	
Teachers 1	45.6	18.0	39.5	Fail	Under	30.2	66.3	Pass		31.5	69.1	Pass	
Learning 2	72.2	58.1	80.5	Pass		65.3	90.4	Pass		68.8	95.3	Pass	
ICT	3.5	0.0	0.0	Excluded		0.0	0.0	Excluded		0.0	0.0	Excluded	
Learning 5	81.0	64.0	79.0	Pass		75.2	92.8	Pass		78.6	97.0	Pass	
Learning 4	68.1	66.8	93.8	Pass		51.2	75.2	Pass		53.9	79.1	Pass	
Learning 1	69.7	69.4	92.1	Pass		59.0	84.6	Pass		61.5	88.2	Pass	
Learning 3	67.6	45.9	62.1	Pass		59.0	87.3	Pass		61.7	91.2	Pass	
Total *(all learning spaces)*	**1230**	**889**	**72.3**	**Pass**		**1094**	**88.9**	**Pass**		**1138**	**92.5**	**Pass**	

Rationale for Daylighting Performance Metrics and Compliance Requirements

Example Block D	80% annual hours	50% annual hours
Figure 10 Example Block D, Ground Floor, UDI 300-2000 lux	**UDI: 300 - 2000** **Ground Floor only** Number of rooms within threshold: 0% Floor area within threshold: 18%	**UDI: 300 - 2000** **Ground Floor only** Number of rooms within threshold: 82% Floor area within threshold: 76%
Figure 11 Example Block D, First Floor, UDI 300-2000 lux	**Ground & first floor** Number of rooms within threshold: 0% Floor area within threshold: 19%	**Ground & first floor** Number of rooms within threshold: 88% Floor area within threshold: 74%
Figure 12 Example Block D, Ground Floor, UDI 160-2000 lux	**UDI: 160 - 2000** **Ground Floor only** Number of rooms within threshold: 88% Floor area within threshold: 63% **Ground & first floor** Number of rooms within threshold: 63% Floor area within threshold: 55%	**UDI: 160 - 2000** **Ground Floor only** Number of rooms within threshold: 100% Floor area within threshold: 94% **Ground & first floor** Number of rooms within threshold: 100% Floor area within threshold: 89%
Figure 13 Example Block D, Ground Floor, UDI 160-3000 lux	**UDI: 160 - 3000** **Ground Floor only** Number of rooms within threshold: 88% Floor area within threshold: 73% **Ground & first floor** Number of rooms within threshold: 69% Floor area within threshold: 63%	**UDI: 160 - 3000** **Ground Floor only** Number of rooms within threshold: 100% Floor area within threshold: 98% **Ground & first floor** Number of rooms within threshold: 100% Floor area within threshold: 93%

Pct Annual Hours 0 8 16 25 33 41 50 58 66 75 83 100

Rationale for Daylighting Performance Metrics and Compliance Requirements

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3.9 Example Block D (1722 m² floor area) – Main learning spaces only

Table 19 Example Block D - 80% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Ground Floor						
Zone 8	77.5	1.0	1.2	Fail	Fail	Under
Zone 2	74.1	0.7	0.9	Fail	Fail	Under
Zone 5	79.5	10.9	13.7	Fail	Fail	Over
Zone 6	75.4	22.2	29.5	Fail	Fail	Under
Circulation	255.6	0.0	0.0	Excluded	Excluded	
Zone 4	79.7	13.7	17.2	Fail	Fail	Under
Zone 3	71.2	30.8	43.3	Fail	Fail	Over
Zone 7	75.3	26.8	35.6	Fail	Fail	Over
Zone 1	74.0	1.3	1.7	Fail	Fail	Under
First Floor						
Learning 8	71.9	17.1	23.8	Fail	Fail	Under
Circulation	158.1	0.2	0.1	Excluded	Excluded	
Toilets	74.7	1.3	1.7	Excluded	Excluded	
Learning 7	74.3	12.3	16.6	Fail	Fail	Under
Learning 6	73.1	17.4	23.8	Fail	Fail	Over
Teachers 1	45.6	1.9	4.1	Excluded	Excluded	
Learning 2	72.2	12.4	17.1	Fail	Fail	Under
ICT	3.5	0.0	0.0	Excluded	Excluded	
Learning 5	81.0	6.7	8.3	Fail	Fail	Under
Learning 4	68.1	30.8	43.3	Fail	Fail	Over
Learning 1	69.7	26.8	35.6	Fail	Fail	Over
Learning 3	67.6	1.3	1.7	Fail	Fail	Under
Total *(main learning spaces only)*	**1184.5**	**232.2**	**19.6**	**Fail**	**Fail**	**Under**

Rationale for Daylighting Performance Metrics and Compliance Requirements

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Table 20 Example Block D - 60% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Ground Floor						
Zone 8	77.5	49.3	63.5	Pass	Pass	
Zone 2	74.1	46.1	62.2	Pass	Pass	
Zone 5	79.5	65.0	81.8	Pass	Pass	
Zone 6	75.4	42.6	56.5	Pass	Fail	Under
Hall	255.6	0.0	0.0	Excluded	Excluded	
Zone 4	79.7	30.6	38.4	Fail	Fail	Under
Zone 3	71.2	61.5	86.4	Pass	Pass	
Zone 7	75.3	62.7	83.3	Pass	Pass	
Zone 1	74.0	32.4	43.8	Fail	Fail	Over
First Floor						
Learning 8	71.9	31.4	43.6	Fail	Fail	Under
Hall	158.1	1.0	0.7	Excluded	Excluded	
Bathroom	74.7	2.7	3.6	Excluded	Excluded	
Learning 7	74.3	21.9	29.5	Fail	Fail	Under
Learning 6	73.1	33.6	45.9	Fail	Fail	Over
Teachers 1	45.6	13.9	30.4	Excluded	Excluded	
Learning 2	72.2	47.3	65.6	Pass	Pass	
ICT	3.5	0.0	0.0	Excluded	Excluded	
Learning 5	81.0	53.6	66.1	Pass	Pass	
Learning 4	68.1	61.5	86.4	Pass	Pass	
Learning 1	69.7	62.7	83.3	Pass	Pass	
Learning 3	67.6	32.4	43.8	Fail	Fail	Over
Total *(main learning spaces only)*	**1185**	734.7	62.0	Pass	Pass	

Rationale for Daylighting Performance Metrics and Compliance Requirements

Table 21 Example Block D - 50% annual hours, 50% & 60% area, UDI 300-2000 lux

Space Name	Floor Area (m²)	UDI (m²)	UDI (%)	50% Area Pass /Fail	60% Area Pass /Fail	Exposure
Ground Floor						
Zone 8	77.5	64.2	82.8	Pass	Pass	
Zone 2	74.1	57.5	77.6	Pass	Pass	
Zone 5	79.5	70.4	88.6	Pass	Pass	
Zone 6	75.4	51.6	68.5	Pass	Pass	
Circulation	255.6	0.0	0.0	Excluded	Excluded	
Zone 4	79.7	37.6	47.2	Fail	Fail	Under
Zone 3	71.2	66.8	93.8	Pass	Pass	
Zone 7	75.3	69.4	92.1	Pass	Pass	
Zone 1	74.0	45.9	62.1	Pass	Pass	
First Floor						
Learning 8	71.9	36.3	50.5	Pass	Fail	Under
Circulation	158.1	2.0	1.3	Excluded	Excluded	
Toilets	74.7	3.4	4.5	Excluded	Excluded	
Learning 7	74.3	26.2	35.3	Fail	Fail	Under
Learning 6	73.1	40.9	55.9	Pass	Fail	Over
Teachers 1	45.6	18.0	39.5	Excluded	Excluded	
Learning 2	72.2	58.1	80.5	Pass	Pass	
ICT	3.5	0.0	0.0	Excluded	Excluded	
Learning 5	81.0	64.0	79.0	Pass	Pass	
Learning 4	68.1	66.8	93.8	Pass	Pass	
Learning 1	69.7	69.4	92.1	Pass	Pass	
Learning 3	67.6	45.9	62.1	Pass	Pass	
Total (main learning spaces only)	**1185**	**871.2**	**73.5**	**Pass**	**Pass**	

Rationale for Daylighting Performance Metrics and Compliance Requirements

4. Summary

Summarily, the above analysis has shown that:

- Relaxing the occupied school hours to 50% generally indicated that the designs were mostly passing, and this will not encourage good daylight design. Hence, setting the standard too low to allow all buildings to pass would be counter-productive to the aim of the daylighting performance requirements.

- While 80% is robust and have been demonstrated to be achievable by simpler Ministry Reference Design learning blocks, it is more difficult and sometimes impossible to achieve for deeper, single sided and more complex building forms.

- 60% occupied school hours is an appropriate value for the UDI time criterion, as buildings failing 60% will indicate a significantly compromised building design that should warrant some revision.

Therefore, it is recommended that:

- The number of school hours UDI must be achieved should be changed from 80% to 60%, to accommodate a fuller range of school building forms and exceptional site, climate, or planning circumstances.

- The UDI requirement should focus on learning spaces where children spend most of their time, while transient and ancillary spaces should be excluded from the analysis.

- Requiring both overall area compliance for the building, and reporting of individual space performance will encourage selective tuning and diagnostics by revealing which spaces are overlit or underlit and requiring that window to wall ratio (WWR) is reported for each space will provide a supplementary indicator.

5. References

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