
P3001350 - Dewsbury Market

TM52 Thermal Comfort Report

Doc No: DMTP-BDP-XX-XX-RP-BP-00002
Issue: Planning Issue
Rev: P03
Date: 12/08/2024

BDP.

ISSUE STATUS

Revision	Date	Description	By	Approved
P01	01/03/2024	Stage 2 Issue	JR	RB
P02	12/07/2024	Stage 3 Issue - For planning - Updated Louvre specifications for natural ventilation openings - Amended g-value for external glazing	ABS	RB
P03	12/08/2024	Planning Issue	ABS	RB

CONTENTS

ISSUE STATUS 1

CONTENTS..... 2

INTRODUCTION 3

MODEL INPUTS AND ASSUMPTIONS 4

1 Geometry 4

2 Weather Data..... 4

3 Building Fabric 5

4 Mechanical Services 5

5 Internal Gains..... 6

6 Natural Ventilation free area requirements 7

RESULTS..... 8

1 Iteration 1 9

2 Iteration 2..... 11

3 Iteration 3..... 13

4 Iteration 4..... 15

CONCLUSION 17

INTRODUCTION

CIBSE TM52 is an adaptive methodology developed to assess the predicted level of thermal comfort within a building. TM52 sets three criteria for compliance. Under these criteria, certain variables can be defined as follows:

- ΔT – Difference between operative temperature and the maximum acceptable temperature within a space
- T_{op} – Operative temperature

Compliance is achieved when passing at least two out of three of the criteria below:

Criteria 1 – Hours of exceedance

This criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature. The space fails if the threshold temperature is exceeded 3% or more of the annual occupied hours. This criterion is mandatory for compliance.

(a) *Criterion 1: Hours of exceedance (H_e)*

The number of hours (H_e) during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

If data are not available for the whole period (or if occupancy is only for a part of the period) then 3 per cent of available hours should be used.

Figure 1 – CIBSE TM52, Criterion 1

Criteria 2 – Daily weighted exceedance

This criterion deals with the severity of overheating within any one day. The space fails if the maximum daily degree hours for the space exceeds 6K.

(b) *Criterion 2: Daily weighted exceedance (W_e)*

To allow for the severity of overheating the weighted exceedance (W_e) shall be less than or equal to 6 in any one day where:

$$\begin{aligned} W_e &= (\sum h_e) \times WF \\ &= (h_{e0} \times 0) + (h_{e1} \times 1) + (h_{e2} \times 2) + (h_{e3} \times 3) \end{aligned}$$

Figure 2 – CIBSE TM52, Criterion 2

Criteria 3 – Upper limit temperature

The third criterion sets an absolute maximum daily temperature for a room. The space fails if it is greater than or equal to 4K.

(c) *Criterion 3: Upper limit temperature (T_{upp})*

To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4 K.

Figure 3 – CIBSE TM52, Criterion 3

MODEL INPUTS AND ASSUMPTIONS

The trigger conditions are set out below and include a commentary on their applicability to the proposed works:

1 Geometry

The thermal comfort model was produced in IES Virtual Environment 2023.1.0.0. Model geometry has been taken from the CAD drawings, by importing DXF format into IES.

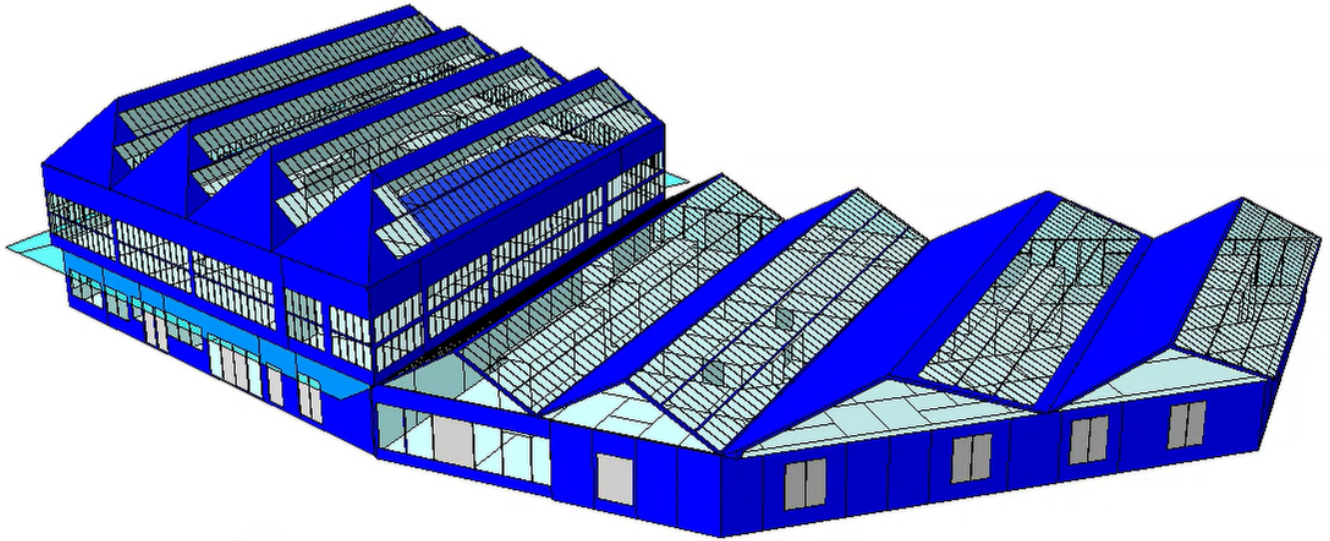


Figure 4 – IES Model View

2 Weather Data

Leeds weather data has been deemed the most appropriate for this study as it is the closest CIBSE weather file to Dewsbury. The following weather file from CIBSE has been used for the assessment:

- DSY1 (Design Summer Year) for the 2020s, high emissions, 50% percentile scenario

3 Building Fabric

The following fabric parameters (Table 1) have been used within the model and agreed with the design team, for rooms within the thermal line only.

U-values have been assumed based on the minimum value required by building regulations at the time of construction. Please note that these values are only for spaces within the thermal line; most areas are unheated and outside the thermal line, therefore do not require U-value targets. Please see DMTP-BDP-00-XX-RP-BP-00001 Part L2 Statement P01 for further information.

Fabric Element	Outside Thermal Line U-value (W/m ² K)	Thermal Line U-value (W/m ² K)	Source
Ground Floor	No specific target	0.18	Part L for new and replacement elements
Existing Roof	No specific target	0.19	Part L for new and replacement elements
External Walls	No specific target	0.26	Part L for new and replacement elements
External Glazing	No specific target	1.60	Part L for new and replacement elements
Rooflights	No specific target	2.20	Part L for new and replacement elements
External Glazing G value	0.35		Minimum required to achieve thermal comfort
Air Permeability	0.75 ACH		EPC conventions Issue 8.0 and the age of the building

Table 1: Building fabric specification.

4 Mechanical Services

4.1 Ventilation Strategy

The Market Hall and Semi-covered Market are to be primary naturally ventilated, though extract fans will provide 4.5m³/s when required. This mechanical ventilation may also continue at night to further cool the spaces.

MVHR (Mechanical Ventilation with Heat Recovery) units will be used to achieve 6-10ACH in WC areas and 10l/s/person in Offices. The Pot Wash will be provided with supply and extract fans at 10ACH.

4.2 Heating Strategy

The Market Hall, Semi-covered Market, stalls, and transient spaces are to be provided with spot heating only with a setpoint of 10°C. WC's, changing spaces, offices and "pot wash" will be heated electrically, including radiant panels and infrared heaters.

5 Internal Gains

The following heat gains have been assumed.

Occupancy has been diversified to a maximum 780 people as agreed with the design team. Occupant internal gains are based on CIBSE Guide A, Table 6.3.

Room Template	Maximum Lighting Gain (W/m²)	Maximum Equipment Gain (W/m²)	Maximum Sensible Gain (W/person)	Maximum Latent Gain (W/person)	Occupancy Density (m²/person)
BOH	5	8	-	-	-
Cafe	5	10	63	63	3
Circulation	5	6	-	-	-
Daily License Reg	5	8	63	63	3
F&B	5	10	63	63	5
Food Retail	5	10	63	63	5
Office	5	12	65	65	8
Plant	5	10	-	-	-
Pot Wash	5	10	63	63	3
Market Areas	5	-	63	63	3
Quiet Space	5	12	63	63	8
Server	5	50	-	-	-
Traditional Reg	5	8	63	63	3
WC	5	-	-	-	-

Table 2: Internal Gains Summary

Opening hours are based on information provided by the client. The following opening hours are significantly longer than the current opening hours, where the market usually closes by 4:00pm. This means that internal gains have a longer time to build up, creating more of a challenge to thermal comfort.

Market Hall		
Monday - Thursday	10.00am to 7.00pm	F & B stalls may close on Mondays
Friday & Saturday	10.00am to 10.00pm	
Sunday	10.00am to 8.00pm	
Semi Covered Area		
Year 1: 3 days, Year 2: 3-4 days, Year 3: 4-5 days	10.00am – 5.00/6.00pm	Partial opening by sectioning off areas may be utilised.

Table 3: Opening Hours

6.0 Natural Ventilation free area requirements

General Louvre Specification

The thermal modelling has determined the amount of free area required to provide natural ventilation to each space in order to maintain conditions within the CIBSE TM52 criteria. The equivalent areas established for each space are indicated on the plan in figure 5-6 below align with the louvre as referred from the architectural model as well as manufacturer's data sheets.

The screenshot shows the 'MacroFlo Opening Types' dialog box. On the left, a list of opening types includes 'XTRN0003 Louvres Wall', which is selected. The right pane shows the configuration for this type: Reference ID is 'XTRN0003', Description is 'Louvres Wall', Exposure Type is '05. 1:1 semi-exposed wall', Opening Category is 'Louvre', Openable Area % is '100', Coeff. Discharge is '0.55', Equivalent orifice area is '88.710 % of gross', Crack Flow Coefficient is '0.150 $l/(s \cdot m \cdot Pa^{0.6})$ ', Crack Length is '0 % of opening perimeter', Opening threshold is '0.00 °C', and Degree of Opening (Modulating Profile) is 'on continuously'. At the bottom, there is a checkbox for 'Include effects of wind turbulence?' which is checked, and buttons for 'OK', 'Cancel', and 'Save'.

Figure 5 - Wall Louvre Specifications

The screenshot shows the 'MacroFlo Opening Types' dialog box. On the left, a list of opening types includes 'XTRN0002 Louvres Roof', which is selected. The right pane shows the configuration for this type: Reference ID is 'XTRN0002', Description is 'Louvres Roof', Exposure Type is '01. 1:1 exposed wall', Opening Category is 'Louvre', Openable Area % is '100', Coeff. Discharge is '0.55', Equivalent orifice area is '88.710 % of gross', Crack Flow Coefficient is '0.150 $l/(s \cdot m \cdot Pa^{0.6})$ ', Crack Length is '0 % of opening perimeter', Opening threshold is '0.00 °C', and Degree of Opening (Modulating Profile) is 'on continuously'. At the bottom, there is a checkbox for 'Include effects of wind turbulence?' which is checked, and buttons for 'OK', 'Cancel', and 'Save'.

Figure 6 - Roof Louvre Specifications

Opening attributes in are based on Equivalent Orifice Area; please note this is different from the geometric Free Area.

The free area is a geometric measurement of the area of an opening that is unobstructed, allowing air to pass.

The Equivalent Orifice Area represents the actual sharp edge orifice area as a percentage of the gross physical opening drawn in the model through which air will pass at an identical flow rate, under an identical pressure difference, to the opening in question. This is calculated based on opening dimensions, degree of sheltering, and wind speed, all of which are included in the simulation.

RESULTS

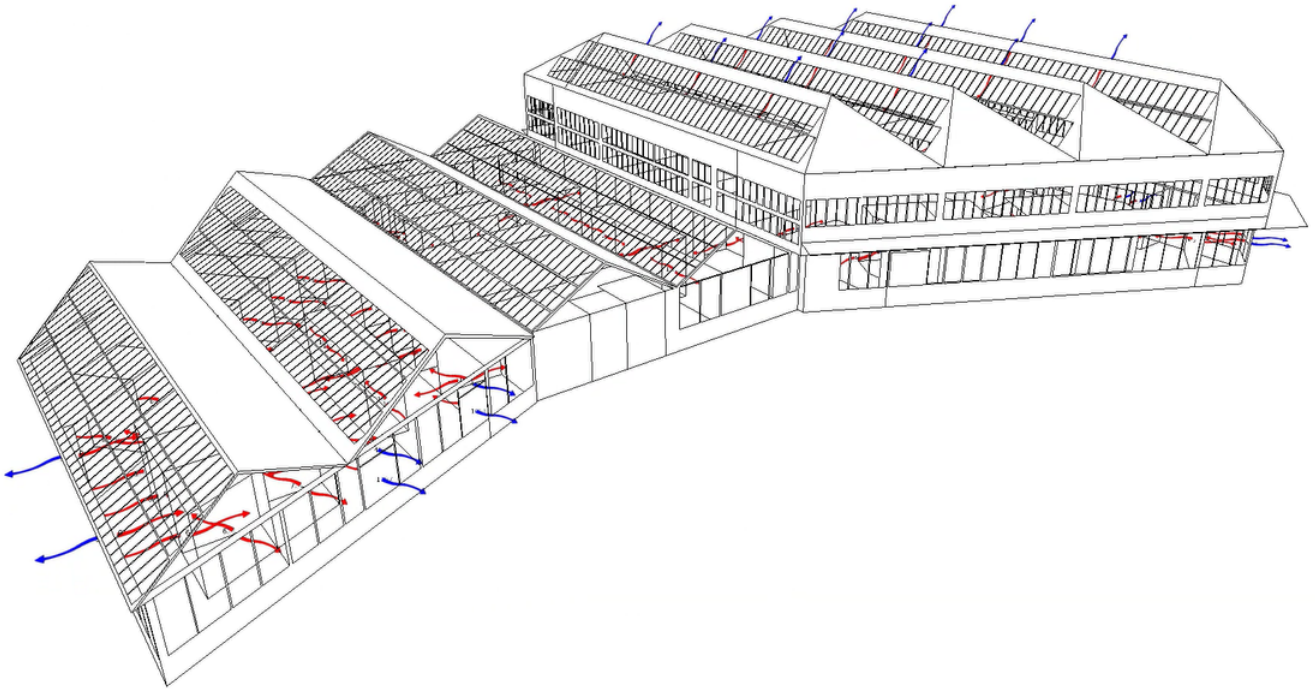


Figure 7 – IES Natural Ventilation View

A number of iterations were run to check various interventions to see if thermal comfort criteria can be achieved. These are as follows:

1. Natural ventilation in market areas, with standard g-value of 0.6
2. Natural ventilation in market areas, with standard g-value and daylight dimming
3. Natural ventilation in market areas, with g-value reduced to 0.35 and daylight dimming
4. Mixed-mode ventilation in market areas, with g-value reduced to 0.35, daylight dimming, and 4.5m³/s mechanical extract fans per market hall

The results indicate that a combination of all of the above measures can help the areas achieve CIBSE TM52 thermal comfort standards for existing buildings.

Some potential alternative solutions may be utilised but have not been tested:

- Larger vents may be used, however as this is a historic building this may not be feasible
- Ventilation greater than 4.5m³/s may be used to further reduce gains if desired
- Cooling, or tempered air, to the semi-covered area may be useful since it is an almost fully glazed space

1 Iteration 1

Natural ventilation in market areas, with standard g-value of 0.6

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Cafe/Bar	0.4	✓	3	✓	1	✓	-	✓
Cafe/Bar	0.8	✓	6	✓	2	✓	-	✓
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
F&B	1.2	✓	8	✗	2	✓	2	✓
F&B	0.8	✓	6	✓	2	✓	-	✓
F&B	0.6	✓	4	✓	1	✓	-	✓
F&B	0.9	✓	6	✓	2	✓	-	✓
F+B	1.5	✓	9	✗	2	✓	2	✓
F+B	1	✓	7	✗	2	✓	2	✓
F+B	1.3	✓	11	✗	3	✓	2	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	1.5	✓	6	✓	1	✓	-	✓
Food Retail	0.3	✓	5	✓	2	✓	-	✓
Food Retail	0.1	✓	1	✓	1	✓	-	✓
Food Retail	0.5	✓	3	✓	1	✓	-	✓
Food Retail	0.5	✓	3	✓	1	✓	-	✓
Leased	2.3	✓	8	✗	2	✓	2	✓
Leased	2.3	✓	8	✗	2	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	2.5	✓	8	✗	2	✓	2	✓
Leased	2.5	✓	8	✗	2	✓	2	✓
Leased	2.5	✓	8	✗	2	✓	2	✓
Leased	2.5	✓	8	✗	2	✓	2	✓
Leased	2.5	✓	8	✗	2	✓	2	✓
Leased	2.3	✓	8	✗	2	✓	2	✓
Leased	2.3	✓	8	✗	2	✓	2	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	2.8	✓	11	✗	3	✓	2	✓
Leased	2.8	✓	11	✗	3	✓	2	✓
Leased	2.8	✓	12	✗	3	✓	2	✓
Leased	2.8	✓	12	✗	3	✓	2	✓
Leased	4.2	✗	15	✗	4	✓	1 & 2	✗

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.2	✗	14	✗	3	✓	1 & 2	✗
Leased	4.2	✗	14	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.4	✗	14	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.6	✗	14	✗	3	✓	1 & 2	✗
Leased	4.4	✗	16	✗	4	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Market Hall	2	✓	10	✗	3	✓	2	✓
Market Office	0	✓	0	✓	0	✓	-	✓
Quiet Space	0	✓	0	✓	0	✓	-	✓
Semi-Covered Area	5.3	✗	21	✗	5	✗	1 & 2 & 3	✗

Table 4: TM52 Results, Iteration 1

2 Iteration 2

Natural ventilation in market areas, with standard g-value and daylight dimming.

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Cafe/Bar	0.2	✓	2	✓	1	✓	-	✓
Cafe/Bar	0.7	✓	6	✓	2	✓	-	✓
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
Daily License	4.9	✗	18	✗	4	✓	1 & 2	✗
F&B	0.7	✓	5	✓	2	✓	-	✓
F&B	0.7	✓	6	✓	2	✓	-	✓
F&B	0.3	✓	3	✓	1	✓	-	✓
F&B	0.7	✓	6	✓	2	✓	-	✓
F+B	1	✓	6	✓	2	✓	-	✓
F+B	0.7	✓	6	✓	2	✓	-	✓
F+B	1.2	✓	11	✗	3	✓	2	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	1	✓	3	✓	1	✓	-	✓
Food Retail	0.2	✓	3	✓	1	✓	-	✓
Food Retail	0.1	✓	1	✓	1	✓	-	✓
Food Retail	0.1	✓	1	✓	1	✓	-	✓
Food Retail	0.2	✓	2	✓	1	✓	-	✓
Leased	1.5	✓	7	✗	2	✓	2	✓
Leased	1.5	✓	7	✗	2	✓	2	✓
Leased	2.7	✓	10	✗	3	✓	2	✓
Leased	1.9	✓	8	✗	2	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	1.9	✓	8	✗	2	✓	2	✓
Leased	1.5	✓	7	✗	2	✓	2	✓
Leased	1.5	✓	7	✗	2	✓	2	✓
Leased	1.3	✓	6	✓	2	✓	-	✓
Leased	2.7	✓	10	✗	2	✓	2	✓
Leased	2.7	✓	10	✗	2	✓	2	✓
Leased	2.8	✓	11	✗	3	✓	2	✓
Leased	2.8	✓	11	✗	3	✓	2	✓
Leased	4	✗	14	✗	3	✓	1 & 2	✗

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3	✗	13	✗	3	✓	1 & 2	✗
Leased	3.8	✗	14	✗	3	✓	1 & 2	✗
Leased	3.4	✗	14	✗	3	✓	1 & 2	✗
Leased	3.2	✗	13	✗	3	✓	1 & 2	✗
Leased	3.2	✗	14	✗	3	✓	1 & 2	✗
Leased	3.2	✗	13	✗	3	✓	1 & 2	✗
Leased	4.2	✗	14	✗	3	✓	1 & 2	✗
Leased	3.2	✗	14	✗	3	✓	1 & 2	✗
Leased	3.4	✗	13	✗	3	✓	1 & 2	✗
Leased	3.4	✗	14	✗	3	✓	1 & 2	✗
Leased	3.4	✗	14	✗	3	✓	1 & 2	✗
Market Hall	1.8	✓	9	✗	3	✓	2	✓
Market Office	0	✓	0	✓	0	✓	-	✓
Quiet Space	0	✓	0	✓	0	✓	-	✓
Semi-Covered Area	4.9	✗	18	✗	5	✗	1 & 2 & 3	✗

Table 5: TM52 Results, Iteration 2

3 Iteration 3

Natural ventilation in market areas, with g-value reduced to 0.35 and daylight dimming.

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Cafe/Bar	0.1	✓	2	✓	1	✓	-	✓
Cafe/Bar	0.3	✓	3	✓	1	✓	-	✓
Daily License	4.4	✗	14	✗	4	✓	1 & 2	✗
Daily License	4.4	✗	14	✗	4	✓	1 & 2	✗
Daily License	4.4	✗	14	✗	4	✓	1 & 2	✗
F&B	0.5	✓	3	✓	1	✓	-	✓
F&B	0.5	✓	3	✓	1	✓	-	✓
F&B	0.2	✓	2	✓	1	✓	-	✓
F&B	0.5	✓	3	✓	1	✓	-	✓
F+B	0.7	✓	6	✓	2	✓	-	✓
F+B	0.5	✓	4	✓	2	✓	-	✓
F+B	0.8	✓	10	✗	3	✓	2	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0.3	✓	2	✓	1	✓	-	✓
Food Retail	0.2	✓	3	✓	1	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0.1	✓	1	✓	1	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	2.8	✓	11	✗	3	✓	2	✓
Leased	2.7	✓	10	✗	3	✓	2	✓
Leased	1.9	✓	7	✗	2	✓	2	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	7	✗	2	✓	2	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	1.5	✓	6	✓	2	✓	-	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	0.8	✓	5	✓	2	✓	-	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Leased	2.5	✓	10	✗	3	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	1.7	✓	8	✗	2	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	2.7	✓	10	✗	3	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	2.7	✓	11	✗	3	✓	2	✓
Leased	3	✗	13	✗	3	✓	1 & 2	✗
Leased	3	✗	12	✗	3	✓	1 & 2	✗
Leased	3.6	✗	12	✗	3	✓	1 & 2	✗
Market Hall	1.4	✓	9	✗	3	✓	2	✓
Market Office	0	✓	0	✓	0	✓	-	✓
Quiet Space	0	✓	0	✓	0	✓	-	✓
Semi-Covered Area	4.7	✗	17	✗	4	✓	1 & 2	✗

Table 6: TM52 Results, Iteration 3

4 Iteration 4

Mixed-mode ventilation in market areas, with g-value reduced to 0.35, daylight dimming, and 4.5m³ mechanical extract fans per market hall.

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Cafe/Bar	0	✓	0	✓	0	✓	-	✓
Cafe/Bar	0.1	✓	2	✓	1	✓	-	✓
Daily License	2.3	✓	9	✗	3	✓	2	✓
Daily License	2.3	✓	9	✗	3	✓	2	✓
Daily License	2.3	✓	9	✗	3	✓	2	✓
F&B	0.1	✓	2	✓	1	✓	-	✓
F&B	0.1	✓	2	✓	1	✓	-	✓
F&B	0	✓	0	✓	0	✓	-	✓
F&B	0.1	✓	2	✓	1	✓	-	✓
F+B	0.3	✓	3	✓	1	✓	-	✓
F+B	0.3	✓	3	✓	1	✓	-	✓
F+B	0.5	✓	6	✓	2	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0.1	✓	1	✓	1	✓	-	✓
Food Retail	0.1	✓	2	✓	1	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Food Retail	0	✓	0	✓	0	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	1.7	✓	6	✓	2	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	1.3	✓	6	✓	2	✓	-	✓
Leased	1.1	✓	5	✓	2	✓	-	✓
Leased	0.8	✓	4	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	0.4	✓	2	✓	1	✓	-	✓
Leased	1.3	✓	6	✓	2	✓	-	✓
Leased	1.1	✓	6	✓	2	✓	-	✓

Space Name	Criterion 1		Criterion 2		Criterion 3		Overall Compliance	
	ΔT (%) {Target ≤ 3 }	Pass / Fail	Daily Weighted Exceedance {Target ≤ 6 }	Pass / Fail	ΔT (K) {Target ≤ 4 }	Pass / Fail	Number of Failing Criteria	Pass / Fail
Leased	0	✓	0	✓	0	✓	-	✓
Leased	0.6	✓	3	✓	1	✓	-	✓
Leased	0.6	✓	3	✓	1	✓	-	✓
Leased	1.1	✓	4	✓	1	✓	-	✓
Leased	1.1	✓	6	✓	2	✓	-	✓
Leased	1.1	✓	6	✓	2	✓	-	✓
Leased	0.6	✓	3	✓	1	✓	-	✓
Leased	0.6	✓	3	✓	1	✓	-	✓
Leased	2.5	✓	7	✗	2	✓	2	✓
Leased	1.1	✓	6	✓	2	✓	-	✓
Leased	1.1	✓	5	✓	2	✓	-	✓
Leased	1.1	✓	6	✓	2	✓	-	✓
Leased	1.1	✓	6	✓	2	✓	-	✓
Market Hall	0.7	✓	7	✗	2	✓	2	✓
Market Office	0	✓	0	✓	0	✓	-	✓
Quiet Space	0	✓	0	✓	0	✓	-	✓
Semi-Covered Area	2.8	✓	12	✗	3	✓	2	✓

Table 7: TM52 Results, Iteration 4

CONCLUSION

The results indicate that the following measures are required to achieve thermal comfort within Dewsbury Market: Mixed-mode ventilation in market areas, with g-value reduced to 0.35, daylight dimming, and 4.5m³/s mechanical extract fans per market hall.

The revised louvre specifications depict an improvement from P01, with better coefficient discharge across all occupied rooms according to all three criteria. However, iteration 4 as described above is still the only scenario that passes thermal comfort compliance.

Although most of the market area falls outside the thermal line and does not need to achieve a specific U-value target, a g-value target of circa 0.35 would reduce solar gains into the spaces and cut peak temperatures.

Daylight dimming also cuts internal gains significantly by reducing lighting gain when daylight is sufficient to light the spaces.

Finally, extract fans are needed to cool the remaining spaces that still do not achieve TM52 criteria after all of the above.

Any increase in internal gains or reduction in fabric efficiency (i.e. worse g-value) may result in a non-compliant building.