CIBSE TM52: Comfort Analysis

IES Virtual Environment

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1 Introduction

The TM52 Adaptive Comfort analysis tool for the Virtual Environment is capable of assessing overheating of buildings based on the criteria outlined in CIBSE Technical Memorandum (TM) 52 – 2013. Analysis of the occupied spaces in a building model can be assessed in VistaPro using the additional weather and room variables or via the report.
2 Adaptive Comfort Criteria

The following three criteria, taken together, are used to assess the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three criteria is classed as overheating.

1. The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1°C or more during the occupied hours of a typical non-heating season (1st May to 30th September).

2. The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.

3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

Further information on these criteria can be found in TM52 – 2013, section 6.1.2.

2.1 Hours of exceedence

The number of hours 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% of occupied hours. ΔT is defined as operative temperature less the maximum acceptable temperature. ΔT is rounded to the nearest whole degree.

Please note:

If data is not available for the whole period (or if occupancy is only for a part of the period) then 3% of available hours should be used. It may be seen that educational NCM occupancy profiles are inappropriate due to prolonged unoccupied periods in these profiles. The user should assess the appropriate profiles for their models.

2.2 Daily weighted exceedence

To allow for the severity of overheating, the weighted exceedence shall be less than or equal to 6 in any one day.

2.3 Upper limit temperature

To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4 °K.
3 Comfort Input Parameters

To access the TM52 Adaptive Comfort dialog, the user will enter VistaPro, then click on the Comfort settings toolbar button.

The Comfort settings dialog will appear where the user should then tick on the TM52 Adaptive Comfort tick box.

![Comfort Parameters Dialog]

**Figure 1 – Comfort Parameters Dialog**

This will then allow the user to input the relevant information for the assessment.

![TM52 Adaptive Comfort Settings]

**Figure 2 – TM52 Adaptive Comfort Settings**
3.1 Summer (elevated) air speed (m/s)

This air speed is used to calculate the operative temperature of each space in the assessment. The operative temperature is calculated using the formula:

\[
T_{op} = \frac{T_a \sqrt{10 \cdot v} + T_r}{1 + \sqrt{10 \cdot v}}
\]

Equation 1 – Operative Temperature

Where:
- \(T_a\) = indoor air temperature (°C)
- \(T_r\) = mean radiant temperature (°C)
- \(v\) = Summer (elevated) air speed (m/s)

3.2 Building Category

The building category is used in calculating the maximum acceptable temperature \(T_{max}\).

\[
T_{max} = 0.33 \cdot T_{rm} + 18.8 + \text{suggested acceptable range}
\]

Equation 2 – Maximum Acceptable Temperature

Where:
- \(T_{rm}\) = exponentially weighted running mean of the daily mean outdoor air temperature

<table>
<thead>
<tr>
<th>Category</th>
<th>Explanation</th>
<th>Suggested acceptable range (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category I</td>
<td>High level of expectation only used for spaces occupied by very sensitive and fragile persons</td>
<td>2</td>
</tr>
<tr>
<td>Category II</td>
<td>Normal expectation (for new buildings and renovations)</td>
<td>3</td>
</tr>
<tr>
<td>Category III</td>
<td>A moderate expectation (used for existing buildings)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1 – Building Categories

The CIBSE suggestion is that designers should aim to remain within the Category II limits. For TM52, Category II should be used. This will mean that:

\[
T_{max} = 0.33 \cdot T_{rm} + 21.8
\]

Equation 3 – Maximum acceptable temperature Category II TM52
4 Report

The user should select the appropriate results file (*.aps) from the results file section in VistaPro and enter the appropriate air speed and building category into the comfort parameters dialog prior to generating the report. This is produced upon clicking the “Report” button.

The report is saved in the Vista folder of your project folder.

Please Note:
Users should assign appropriate occupancy profiles to all rooms. Only rooms that are occupied will be included in that analysis. Users should read section 6.1.2 with particular attention to 6.1.2 (a).

4.1 Overall

In this section of the report, the number of rooms that pass, fail and are unoccupied (and thus omitted from criteria checks) are presented.

4.2 Data Check

For TM52, the results file must contain data for at least 1st May to 30th September. This shows the dates and days that are contained in the results file, the summer period and if the results are acceptable to TM52.

4.3 Occupancy

This section brings to the user’s attention that educational NCM profiles may be seen as inappropriate for TM52 analysis. Users are recommended to read Section 6.1.2 of TM52, with particular attention to Section 6.1.2 (a).

In this report, only occupied hours are assessed, so the user must select appropriate occupancy profiles for each room, keeping in mind that if occupancy is for only part of the period then the occupancy profile being applied to the space should include available hours.

4.4 Results

This section outlines the rooms that pass, fail and those that are unoccupied. Users are reminded that a room that fails any two of the three criteria is classed as overheating and thus fails the TM52 check.

4.4.1 Occupied days

This shows the number of days in the summer that the space is occupied. Users are recommended to investigate rooms that have low occupancy percentage as this could mean that “available hours” are not being taken into account.
4.4.2 Criteria 1
This displays the percentage hours when the difference in operative temperature minus the maximum acceptable temperature is greater than or equal to 1 K.

4.4.3 Criteria 2
This displays the maximum daily degree hours found for the space. This fails if it is greater than 6 K.

4.4.4 Criteria 3
This displays the maximum $\Delta T$ for the space. This space fails if it is greater than or equal to 4 K.
5 VistaPro Variables

In VistaPro, five new variables are available to perform in depth adaptive comfort analysis. These variables (apart from Daily weighted exceedence) are calculated for all times of the day, not just occupied hours. This means that you can assess multiple iterations of design quickly and by using the range test, perform available hour analysis. You can also perform in depth analysis of individual rooms to optimise the performance of these naturally ventilated spaces.

5.1 Weather Variables

Two additional weather variables are presented in the weather section of VistaPro.

5.1.1 Daily running mean temp.

This is the exponentially weighted running mean of the daily mean outdoor air temperature as outlined in TM52. An alpha value of 0.8 is used to calculate this variable as outlined in TM52. Where an extensive run of days is not available, an approximate calculation method using the mean temperatures for the last seven days is used as outlined in TM52.

5.1.2 Max adaptive temp

This temperature is dependent on the running mean temperature and the building category. Please see section 3.2 - Building Category for further information.

5.2 Room Variables

Three additional room variables are included for in-depth TM52 analysis.

5.2.1 Operative temperature

This is calculated as outlined by TM52. Further information can be found in section 3.1 - Summer (elevated) air speed (m/s).

5.2.2 Degrees > Max. adaptive temp.

This processed variable uses the following formula to address Criteria 1 and 3:

\[ \Delta T = (T_{op} - T_{max}), \text{rounded to nearest whole degree} \]

Equation 4 – Degrees > Max. adaptive temp.

This shows not only the points where you are possibly failing Criteria 1, but also the magnitude of possible failure. For data points that have a magnitude greater than 4 °C would mean a failure of Criteria 3.

5.2.3 Daily weighted exceedence

This processed variable is used for criteria 2. It is only calculated for the occupied hours (When “Number of people” variable is greater than 0.001). It is graphed across a whole day as it is a daily value. A value of greater than 6 is a fail.