



IESVE

Trial Support
Material

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RadianceIES
Climate Based Daylight
Modelling (CBDM)/
Daylight Simulation Metrics

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Radiance (dynamic) calculations are used to investigate the light levels on one or more light sensors in a space, using a selected sky, with fixed dynamic parameters. These are used for the following special types of simulation:

- **Vertical Sky Component** (VSC) will be looked at in the section on Right to Light
- **Useful Daylight Illuminance** (UDI)
- **Annual Sunlight Exposure** (ASE)
- **Spatial Daylight Autonomy** (sDA)

You will find these under the advanced option in the **Simulate** tab, along with the **Vertical Sky Component**, which is addressed as a right to light study [here](#).

These metrics are used to answer questions such as “Is this a daylit space?“, “How much of this space or building is illuminated by daylight?“ or “What is the potential for visual discomfort from too much direct sunlight?“ (from LM_83_2012).

All CBDM simulations are time-based dynamic calculations. https://help.iesve.com/ve2019/dynamic_results.htm#

There are 2 different simulation options available in RadiancelES:

- **rtrace** is a radiance calculation that uses ray-tracing every time step
- **rcontrib** is a radiance calculation that performs one higher quality ray-tracing calculation to create daylight coefficients for sensor or grid points, the coefficients are then used to calculate illuminance at each time step.

NOTE: rcontrib based simulations must use the ‘Dynamic‘ quality settings for UDI / ASE / sDA calculations

Sky resolution enhancements can speed up your simulation time by 25%!

To speed up calculation of daylight coefficients, go to the RadiancelES drop-down menu and select Simulation Options. In this dialogue box, select the Sky Resolution tab. Here you can influence the number of patches used for the calculations to speed up your results.

Dynamic daylighting simulation results, are like any other, best used when comparing scenarios.

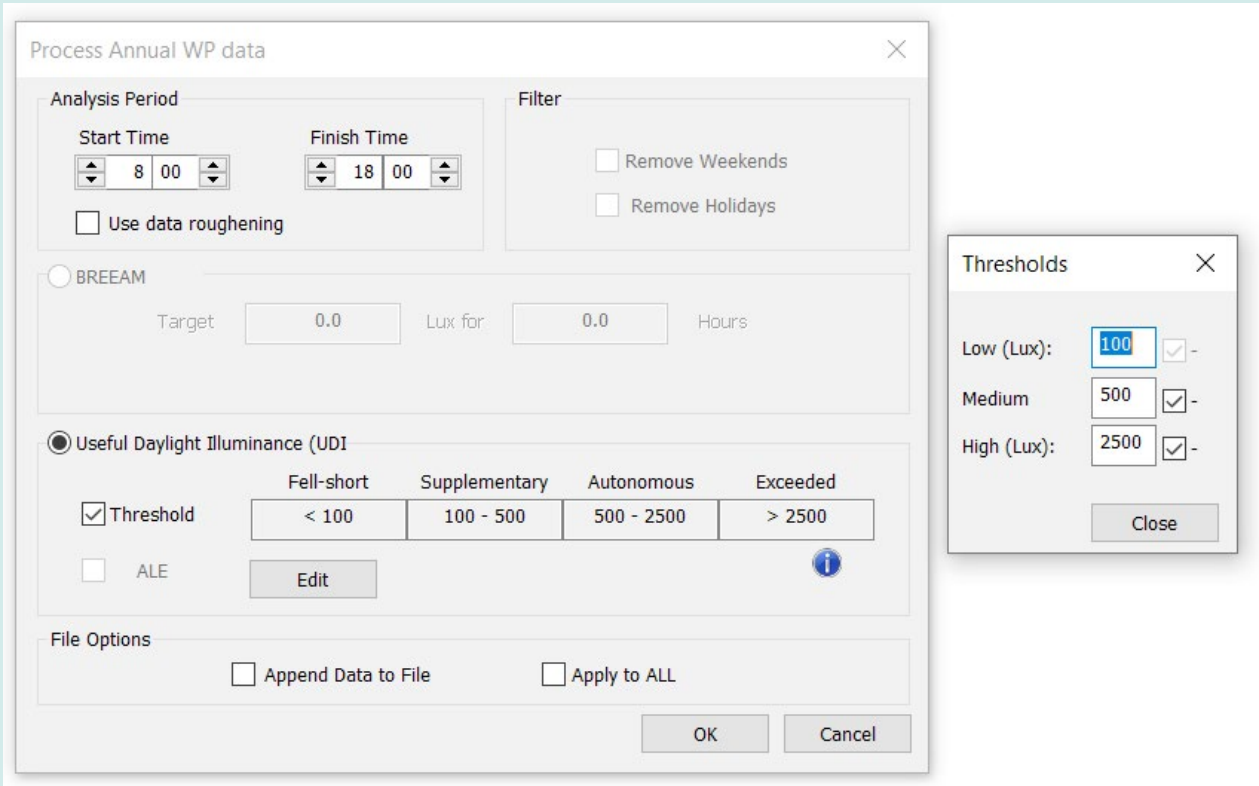
Captured daylight levels will change dependent on building form, orientation, shading, glazing area, Visible Light Transmission (VLT). With the central theme of climate in CBDM metrics, changing the building location and climate files will result in different performance results for the same building geometry.

CBDM is used for assessments for many voluntary rating systems. For all the assessments, the calculation uses a grid of points to construct a working plane through the space which is then used to determine the area performance.

Use CBDM metrics to:

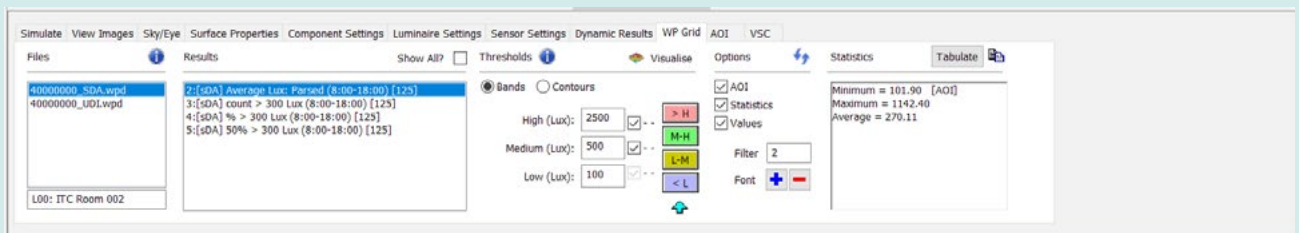
- Prove the quality of a space to use daylight to the benefit of its occupants.
- Show dark spots requiring additional daylight or artificial lighting.
- Show bright spots where shading would be beneficial.
- Show how well a space is daylit and the potential for employing daylight harvesting to reduce artificial lighting energy use.
- Prove how successful shading strategies can capture daylight, while minimising solar gain, which would increase air conditioning needs or increase the risk of overheating. It can be a successful tool in achieving passive design strategies which would look to employ natural ventilation opportunities.

With each of these options the user can select a specific analysis period from a drop-down combo. For the UDI the threshold ranges can be edited (e.g. in some UDI studies the ranges are specified as “less than 100”, “100 to 2000” and “greater than 2000”). The “threshold” can be edited by enabling the “Threshold” check-box and clicking the “Edit” button – this pops-up the following dialog –

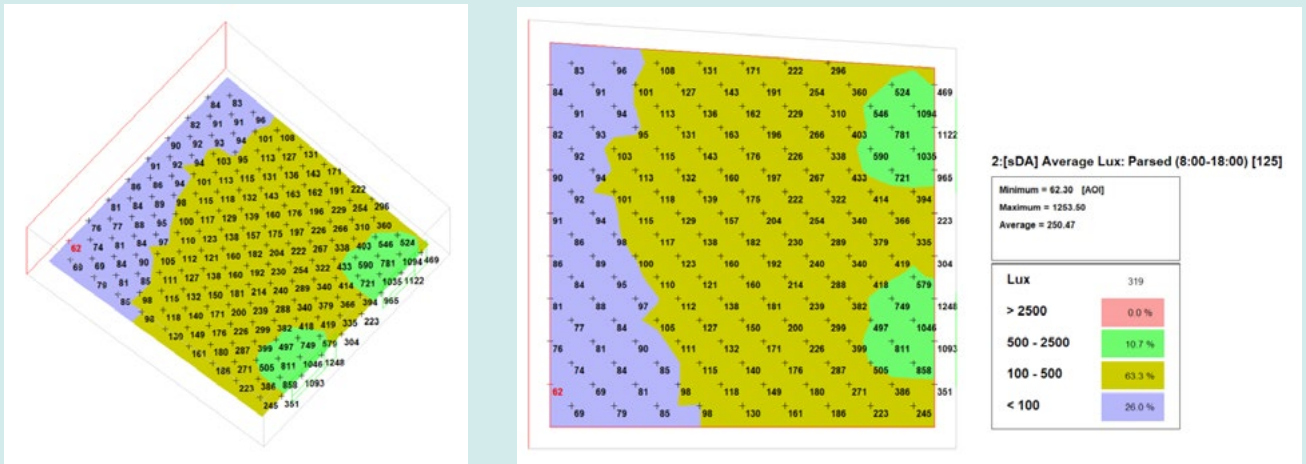


All of these options create a “WP data” file (or append data to an existing file) which the user can view by going into the WP Grid tab.

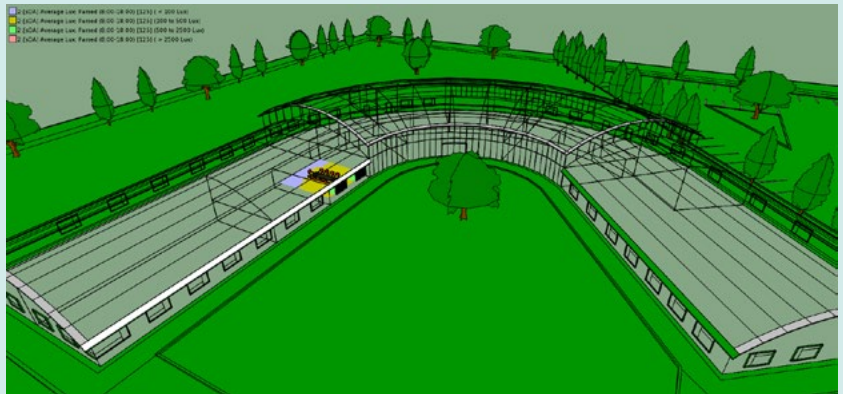
Once in the WP Grid tab, select the results file for the chosen calculation, and then choose which results to display. You can then choose the colours to display for each band, and change the band values if desired.



These results are displayed automatically - at the MODEL level this shows the grid points that define this simulation. When the zone is selected and you go down to SURFACE level then the data values are shown with the colour bands. Going to a PLAN view displays the results in a table alongside, and the statistics and AoI can be turned on.



You can also click on the visualise button to see the results in Model Viewer. If you go back up to model level first, but keep the space selected in the model tree, you will see the results overlaid on the 3D model.



Useful Daylight Illuminance (UDI)

Useful Daylight Illuminance is a metric where the illuminances are categorized into bands that are considered “useful” by occupants. These bands can be edited in post-processing to suit design needs, but by default, they are:

< 100 Lux	Fell-short (i.e. insufficient daylight to offset any electric lighting use)
100-500 Lux	Supplementary (i.e. requires electric light top-up)
500-2500 Lux	Autonomous (i.e. good levels of daylight, sufficient to completely offset electric lighting needs)
> 2500 Lux	Exceeded (i.e. too much daylight, bright environment therefore potential risk of glare)

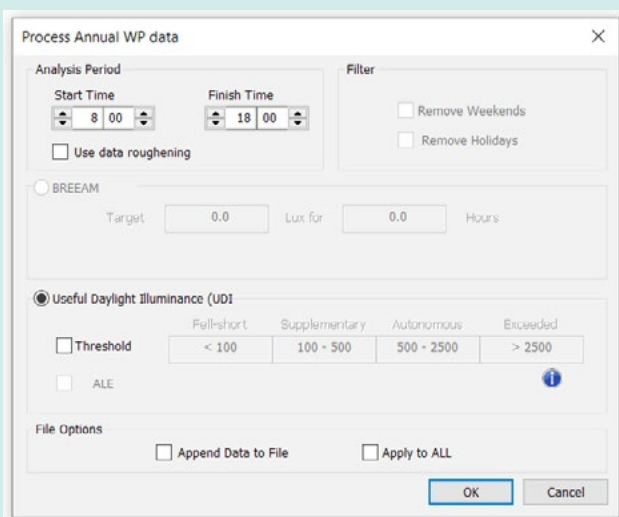
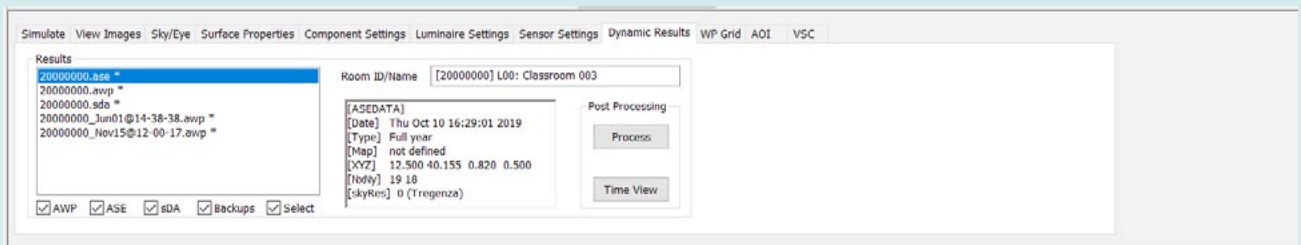
UDI performs calculations for the 10K CIE Overcast Sky from which the Daylight Factor data can be derived and thus the illuminance for the CIE Overcast Sky at each time-step for the simulation period (from the Ground Ambient value). At each time-step the data for the Sunny Sky is generated. From these two extremes we can interpolate an illuminance value based on the OKTA data we read from the Climate file (to check cloud cover).

To run this simulation, select the space, pick the **Special: Annual Dynamic (UDI)** option in the simulate tab, choose your grid and the WP (working plane) height at which you want to run the simulation, and click **Simulate**.

There are five time-step options:

- Full year: 365 days - full 365 days (primary analysis approach)
- Full year: Weekdays only - Monday to Fridays over full year (assumes 1st January is a Monday)
- Full year: Holidays profile - Simulate for days that are not flagged as Holidays
- Monthly: 12 design days - use single “design” day per month (15th of Month)
- Weekly: every 7 days - use every 7th day (starting on 1st January) assume 1st January is Monday

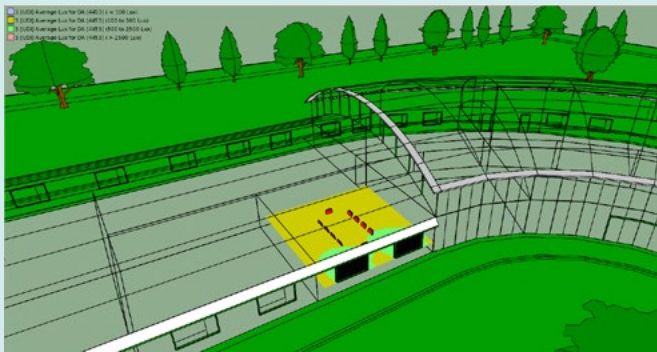
When complete, the results will be listed in the **Dynamic Results** tab. This will display all available results sets for the selected space. Select the working plane results (*.awp)



Click on the **Process** button to set your parameters for processing.

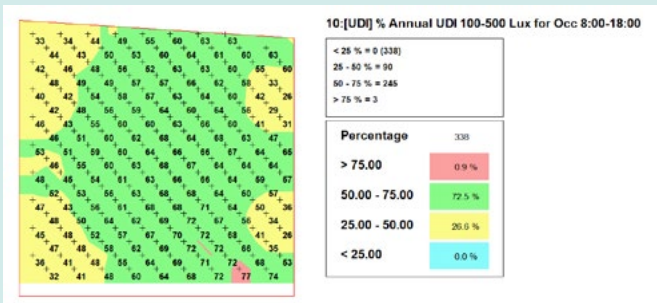
- You can alter the analysis period.
- You can change the threshold bands if required.

You will get a notification on completion that you can view the results in the WP Grid tab.



Switch to the WP Grid tab as instructed, and select the UDI results file and the variable you want to view.

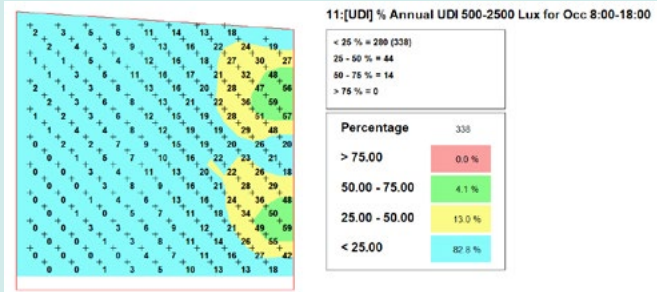
If you are at model level, click **Visualise** to see the space results overlaid on the wireframe model in Model Viewer.




If you drop down to the middle level, viewing a single space, you can view the results file in a plan view with numerical data for each threshold band, or in axonometric view, or click on visualise to view it on the model in Model Viewer.


You can change the default colours in all views as desired, and as you click on the results file for each band, it will update in your view.

You can view the statistics alongside the image by ticking the **statistics** box, and toggle the **values** on and off, when in plan view at the middle level.



You can use the filter box to alter the number of points displayed. Default is 1, and this denotes how many cell values to skip i.e. a value of 1 will show every value, 2 every second value, and 0 will disable the values.

 Press the **refresh** button to refresh the display.

Font  The + / - buttons change the size of the display font.

Spatial Daylight Autonomy (SDA)

The sDA is a metric describing annual sufficiency of daylight levels in interior environments and follows the route described in Illuminating Engineering Society LM-83-12. Therefore a full year analysis (365 days) should be used for producing results.

It is defined in LM 83 as the percent of an analysis area that meets a minimum illuminance level for a specified fraction of the operating hours per year.

For example, $sDA_{300,50\%}$ would be the resultant metrics for an analysis with an illuminance threshold of 300 lux on the chosen horizontal surface that is exceeded for 50% of the annual hours from 8.00am to 6pm.

This metric will first access the number of hours per year that each analysis point, within a given analysis area, meets or exceeds this value from daylight alone. Daylight conditions are based on typical meteorological year data files (e.g. TMY), with the analysis time period extending from 8am to 6pm local clock time (10 hours per day).

The analysis includes the potential impact from the use of blinds/shades to block sunlight penetration into the space. Regular use of the blind would identify a space as over lit.

$sDA_{300,50\%}$ is then reported as the percentage of analysis points across the analysis area that meet or exceed this 300 lux value for at least 50% of the analysis period.

A series of simulations are performed under the Perez sky for a selected weather file for each space for each "Window Group" state – **No blind** and **With blind**

Note: A "Window Group" is defined as co-planar windows having the same shading and operations, i.e. windows on the same façade, currently determined by orientation: North, East, South, West and also horizontal for skylights.

THERE IS NO MODULATION CONTROL FOR THE WINDOW OR BLIND OPERATION.

- The blind is modelled in its maximum shading position.
- The blind is active dependent on a threshold, typically 1000 lux as suggested by LM-83. Its intention is to represent the condition when a blind would be down due to high incoming sunlight.
- LM-83 notes that when a point from the no blind simulation experiences the threshold at a time-step then the point value from the blind simulation will be substituted .
- Each time-step is assessed in the same way, with the end result being a 'parsed' dataset representing the space performance across the year.

RadianceES lets the modeller view the maximum captured illuminance (no blind), the minimum captured illuminance (blind) and of course the 'parsed' result which always sits in between.

To run this simulation, select the space, pick the Special: sDA option in the simulate tab, set the height at which you want to run the simulation, choose the time-step from the drop-down menu, and click **Simulate**.

There are five time-step options:

- Full year: 365 days
- Full year: Weekdays only - Monday to Fridays over full year
- Full year: Holidays profile - simulates for days not flagged as Holidays
- Monthly: 12 design days - uses single "design" day per month (15th of Month)
- Weekly: every 7 days - uses every 7th day (starting on 1st January) assume 1st January is Monday

When complete, the results will be listed in the Dynamic Results tab.

Click on the **Process** button to set your parameters for processing. You will get a notification on completion that you can view the results in the WP Grid tab.

Here you can choose which results file you wish to use, and what threshold bands you want. You can visualise in 3D, tabulate all the results, or go down to the floor level of your model tree to view the results in bands or contours in plan view. If you tick show all, the results list will increase to list all the results that comprise this simulation.

Annual Sunlight Exposure (ASE)

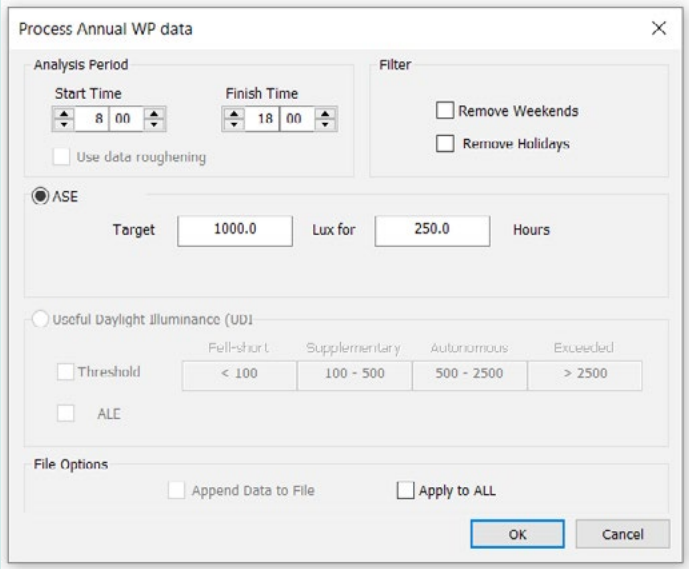
This is a metric also described by LM-83 on the potential for visual discomfort in interior environments. It is defined as the percent of an analysis area that exceeds a specified direct sunlight illuminance level for more than a specified number of hours per year. As it is an annual metric, the simulation must be run for the full 365 day period.

- 1000 Lux was selected as the indicator threshold for direct sunlight.
- Blinds / shades are not modelled.
- All remaining modelling detail same as for sDA.
- Uses the same grid as for sDA.
- Uses same analysis period as sDA.

ASE1000,250 < 10%	Exemplary
ASE1000,250 > 10% and < 20%	Acceptable
ASE1000,250 > 20%	Unacceptable

ASE can suggest a higher risk of glare but is not a definite metric for glare occurring.

The purpose of ASE is to demonstrate if a space is over lit.

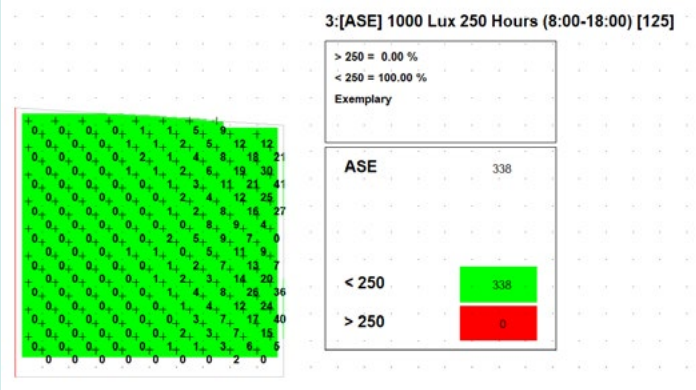


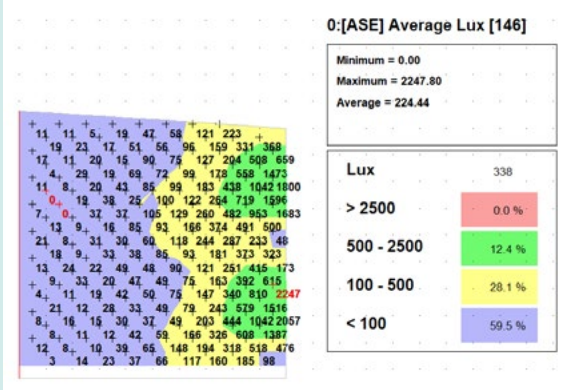
Once you have completed the process dialogue box with the criteria you require, you can again view the results in the WP Grid tab.

Be sure to pick the results file with the metrics you chose when processing, so that you can see the results as a pass/fail value for each point in the space.

As before the statistics can be shown if desired.

ASE results can again be viewed graphically.





Do not confuse this metric with ALE = Annual Light Exposure, which is used in settings such as art galleries or museums to check the light exposure, for protecting artifacts.

LEED V4.1 Daylight Credit Option 1

You can use simulation for these credits: sDA and ASE (2-3 points, 1-2 points Healthcare). The different options require different modelling procedures.

- This credit provides a CBDM option for determining the credit requirement using regularly occupied floor area. Healthcare uses a perimeter area determined under a separate credit.
- The metric of sDA_{300/50%} must be achieved for at least 55%, 75% or 90% of assessed floor area AND ASE_{1000,250} of no more than 10% is achieved.

All CBDM calculations in RadianceIES must be performed with the 'Dynamic' quality setting.

LEED V4.1 Daylight Credit Option 2

You can use simulation for Illuminance Calculations (1-2 points)

The different options require difference modelling procedures.

- This credit provides a CBDM option for determining the credit requirement using regularly occupied floor area. Healthcare uses a perimeter area determined under a separate credit.
- The metric must be achieved for at least 75% or 90% of assessed floor area

Calculate illuminance intensity for sun (direct component) and sky (diffuse component) for clear-sky conditions as follows:

- Use typical meteorological year data, or an equivalent, for the nearest available weather station.
- Select one day within 15 days of September 21 and one day within 15 days of March 21 that represent the clearest sky condition.
- Use the average of the hourly value for the two selected days.

To perform in RadianceIES the calculation must be performed under the following conditions:

- 'Dynamic' quality setting
- A suitable weather file selected in APlocate. To determine and select the appropriate time period for the clearest sky condition then prior analysis of the weather file can be undertaken in VistaPro.
- On the 'Sky/Eye' tab select under 'Sky Time/Date' the Perez Sky condition and the combination for Day / Month / Time. This process will need to be repeated for each combination.
- To perform the simulation select the Illuminance > WP Zone Data (dynamic) simulation. Results can be viewed on the 'WP Grid' tab.
- This method produces a working plane snapshot from which the averaging assessment can be performed.

BREEAM Hea01 Visual Comfort

This credit now provides a route for CBDM/Daylight Simulation Metrics instead of following Daylight Factor and Uniformity.

A series of building type thresholds exist.

The assessment must achieve:

- An average daylight illuminance averaged over an entire space for a set period, e.g. in schools at least 300 lux for 2000 hours per year for minimum 80% area.
- A minimum daylight illuminance at worst lit point, e.g. in schools at least 90 lux for 2000 hours per year for minimum 80% area.

The output on the working plane calculates the number of points and therefore area % that equates to achieving the threshold.

IES Face to face training is available for using RadianceIES, or for Climate Based Daylight Modelling/Daylight Simulation Metrics