WCCBO 2 (World Championship in Cybernetic Building Optimization)
Regulations (2023/11/24: Draft)

1. Eligibility for participation
   1) The competitors shall participate in the competition as a team consisting of one or more persons.
   2) When registering, provide a “team name” and a “contact email address.” Anonymous participation is permitted; however, if you wish to receive an award and a supplementary prize, you must disclose your affiliations and other information.
   3) A competitor may not belong to more than one team.
   4) A single legal entity may participate by creating multiple teams using its members.

2. Methods for calculating evaluation indicators
   1) HVAC operating techniques of competitors will be evaluated in terms of two aspects: energy performance and comfort.
   2) One week for each of the summer and winter seasons will be evaluated.†1
   3) The lower the sum of the energy consumption of the VRF and ventilation systems, the higher the energy performance rating. This energy consumption is converted into an evaluation indicator (P_E)†2 using a certain procedure and expressed as a value between 0.0 to 1.0.
   4) The lower the average dissatisfaction rate of the occupants, the higher the comfort rating. The average dissatisfaction rate is calculated based on thermal sensation, cold air draft, vertical temperature difference, and air pollution. The average dissatisfaction rate is converted into an evaluation indicator (P_{DR})†2 using a certain procedure and is expressed as a value between 0.0 to 1.0.
   5) P_E and P_{DR} are the percentile values of the normal distribution of energy consumption and the average dissatisfaction rate, respectively. The closer they are to 1.0, the higher the rating; for example, 0.8 means that the ranking is generally in the top 20%.
   6) P_E and P_{DR} are relative and dynamic indicators whose values change according to the distribution of the HVAC operation results of other competitors at the time of calculation. For example, even if energy consumption is the same, if there are more competitors with relatively high energy consumption, the evaluation will be higher; conversely, if there are more competitors with relatively low energy consumption, the evaluation will be lower.
   7) The *ECI* (Energy and Comfort Index)†2, an integrated energy performance and comfort evaluation indicator, is defined as the synergistic average of P_E and P_{DR} using the following equation.

$$\boldsymbol{ECI} = \sqrt{\boldsymbol{P_E \cdot P_{DR}}}$$

   8) Summer and winter are denoted by subscripts *s* and *w*, respectively. The energy evaluation indicator for the full-year $P_{E,a}$ is defined by the following equation: If $P_{DR,s}$ or $P_{DR,w}$ is less than 0.5, $P_{E,a}$ = 0.

$$\boldsymbol{P_{E,a}} = \sqrt{\boldsymbol{P_{E,s} \cdot P_{E,w}}}$$

9) The energy evaluation indicator for the full year $P_{DR,a}$ is defined by the following equation.

$$\boldsymbol{P_{DR,a} = \sqrt{P_{DR,s} \cdot P_{DR,w}}}$$

10) The integrated evaluation indicator for the full-year ECI_a is defined by the following equation. Note that if $P_{E,s}$, $P_{DR,s}$, $P_{E,w}$, or $P_{DR,w}$ is less than 0.2, ECI_a =0.

$$\boldsymbol{ECI_a = \sqrt{ECI_s \cdot ECI_w} = \sqrt[4]{P_{E,s} \cdot P_{DR,s} \cdot P_{E,w} \cdot P_{DR,w}}}$$

11) The energy consumption and average dissatisfaction rate are calculated using a thermal environment emulator†3 that simulates a thermal environment system (hereafter simply referred to as the emulator). Competitors can operate the air-conditioning equipment (VRF and ventilation system) in the emulator in various ways, which changes the values of energy consumption and average dissatisfaction rate accordingly.

†1 See Appendix 1 for the setting of seasons.

†2 See Appendix 2 for the calculation of P_E and P_{DR}.

†3 See the reference manual for details on using the emulator.

3. How to register calculation results

1) The emulator outputs a calculation result file in which the values of energy consumption and average dissatisfaction rate are recorded. The competitors register their calculation results by uploading the files to the server.†4
2) When a competitor uploads a calculation result file, the server recalculates ECI_a and other evaluation indicators using all result files stored at that time and publishes the latest rankings.
3) Competitors may resubmit their calculation result files as many times as they wish within the competition period.

†4 See Appendix 3 for information on how to output and upload the calculation result file.

4. Schedule

1) The period of the event shall be from October 1 to November 1, 2024.
2) IDs and passwords will be distributed to the competitors on the first day of the event. This ID and password will be used to upload the calculation results to the server.†5
3) The period from October 1 to 28 will be a preparation period to familiarize the participants with the use of the emulator and the uploading of calculation results.
4) On October 29, random seeds will be distributed to the competitors to calculate their final scores. By setting this random number seed in the emulator,†6v the weather and occupant behavior conditions will be the same among the competitors, thus ensuring fairness. The final ranking is determined based on the ECI_a and other factors calculated using this random number seed.

5) To calculate P_E and P_{DR}, a distribution of the calculation results is required. This distribution is calculated using all result files uploaded after October 1.

†5 See Appendix 1 for how to set ID and password.

†6 See Appendix 1 for how to set a random number seed.

5. Award

1) The competitor with the largest ECI_a will be awarded the championship, and those with the second to fifth highest ECI_a will be awarded prizes. No duplicate awards may be given.

3) The competitor with the highest value of $P_{DR,a}$ will receive a comfort prize.

4) The competitor with the highest value of $P_{E,a}$ will receive a low energy prize.

5) The award winners will receive the prize money shown in Table 2 as a supplementary prize.†7

6) A supplementary prize may be received only if the competitor plans to report to the society the optimization methods used in the championship using one of the following or similar methods:

a. Participate in and give presentations at academic conferences (such as SHASE and IBPSA).

b. Submission to peer-reviewed journals (such as Transactions of the SHASE of Japan, Building Performance Simulation Journal).

c. Make the presentation at a symposium scheduled to be held after the championship.

d. Cooperate in interviews with competitors after the championship.

†7 This is the target amount as of November 2023. Prize amounts may change due to a lack of sponsors and other factors.

Table 2 Supplementary prize money

Award		Prize money
Championship		500,000 JPY
2nd		400,000 JPY
3rd		300,000 JPY
4th		200,000 JPY
5th		100,000 JPY
Category	Comfort	50,000 JPY
	Low energy	50,000 JPY

Appendix 1: How to change emulator settings

To change emulator settings such as seasons and ID, rewrite "*setting.ini*" located on the same level as "*Shizuku2.exe*". This is a key/value pair separated by semicolons as follows:

```
use_rso=0;
rseed_obhv=1;
use_rsw=0;
rseed_w=1;
rseed_oprm=1;
timestep=60;
schedulller=0;
controller=0;
weather=3;
period=0;
accelerationRate=600;
userid=0;
userpass=0;
outputSpan=60;
```

1) Season

Setting the "*period*" value to "0" results in a summer calculation, and setting it to "1" results in a winter calculation.

2) ID and password

Set the ID and password provided by the championship organizer to the values of "*userid*" and "*userpass*," respectively.

3) Random number seed

If the value of "*use_rso*" is set to "0," the occupant behavior is stochastic and the result changes randomly each time the program is executed. When "1" is set, the occupant behavior is deterministic. The deterministic behavior is determined by the value of "*rseed_obhv*," which is a random number seed. The random number seed is written in "*rseed_obhv*."

Similarly, weather conditions can be made deterministic using "*use_rsw*," and if they are deterministic, it is determined by the value of "*rseed_w*," which is a random number seed.

When submitting the final results, fairness must be ensured by making the calculation conditions identical for all competitors. Hence, the values of "*use_rso*" and "*use_rsw*" are set to "1" and the random number seeds provided by the organizer are set to the values of "*rseed_obhv*" and "*rseed_w*."

4) Example

For example, if the competitor's ID is "15" and the password is "87vh76d?e," the calculation period is winter, and the random number seeds for the final score calculation are "8712" (occupant behavior) and "9890" (weather), "*setting.ini*" should be set as follows.

```
use_rso=1;
rseed_obhv=8712;
use_rsw=1;
rseed_w=9890;
period=1;
userid=15;
userpass=87vh76d?e;
```

Appendix 2: Calculation procedure of P_E, P_{DR}, and *ECI*

1）Common process

To eliminate duplicate data, data with exactly the same pair of values for energy consumption and average dissatisfaction rate will be deleted.

2）Calculation procedure of P_E

Let E_n [GJ] be the energy consumption of the n^{th} calculation result submitted by competitors.

To ensure that outliers do not affect the results, remove data with an E_n of 0 (data with no HVAC system running) and remove 5% of the data in order of increasing E_n.

To increase the normality of the data, transform E_n using Box–Cox transformation. Let $E_{n,bc}$ [-] be the data after the transformation. Note that the parameter λ for the transformation uses the optimal value in the range of -10 to 10.

Convert $E_{n,bc}$ into a standard normal distribution with a mean of 0 and standard deviation of 1.0. Let $E_{n,bc,n}$ [-] denote the transformed data.

Using the cumulative distribution function of the standard normal distribution, convert (1-$E_{n,bc,n}$) into a percentile value that takes the value 0.0 to 1.0. Let this value be $P_{E,n}$ [-].

3）Calculation procedure of P_{DR}

Let DR_n [-] be the average unsatisfactory rate of the n^{th} calculation result submitted by competitors.

To ensure that outliers do not affect the results, remove data with an DR_n greater than 0.99 (data with no HVAC system running) and remove 5% of the data in order of increasing DR_n.

To increase the normality of the data, transform DR_n using the Box–Cox transformation. Let $DR_{n,bc}$ [-] be the data after the transformation. Note that the parameter λ for the transformation uses the optimal value in the range of -10 to 10.

Convert $DR_{n,bc}$ into a standard normal distribution with a mean of 0 and standard deviation of 1.0. Let $DR_{n,bc,n}$ [-] denote the transformed data.

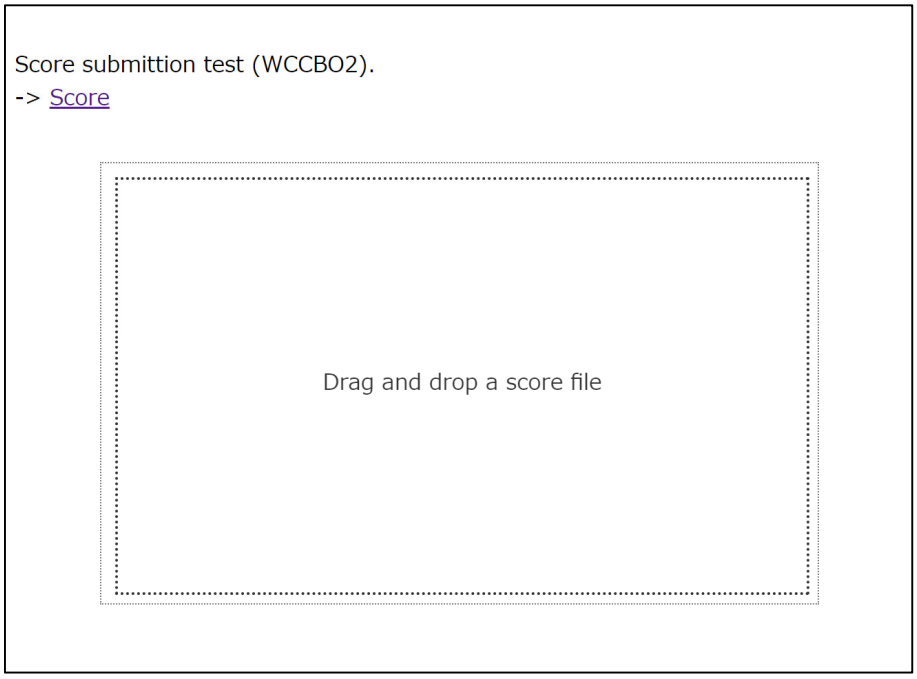
Using the cumulative distribution function of the standard normal distribution, convert (1-$DR_{n,bc,n}$) into a percentile value that takes the value 0.0 to 1.0. Let this value be $P_{DR,n}$ [-].

Appendix 3: How to output and upload calculation result file

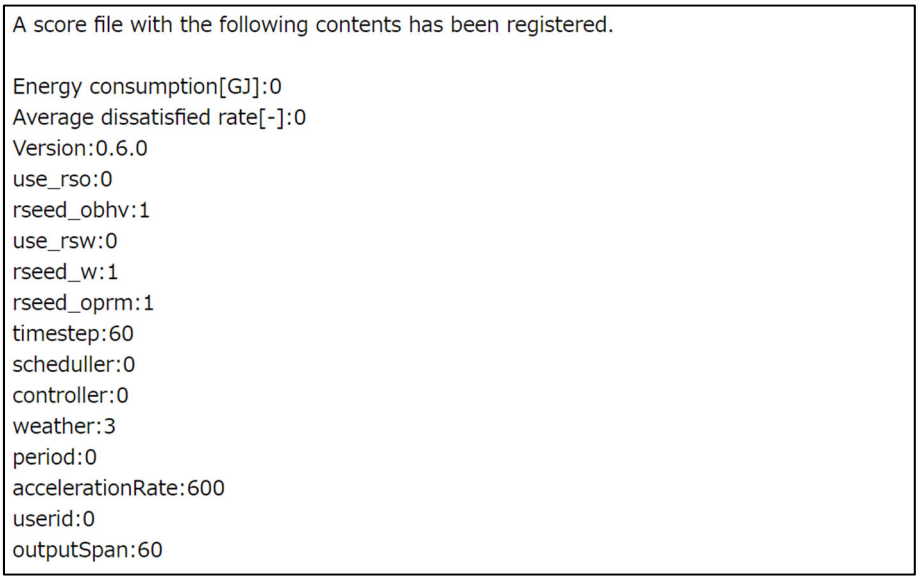
When the emulator finishes the calculation, a file named "*result.szk*" is generated in the "*data*" directory. This is the calculation result file.

Connect to the following URL using a browser to display the form for uploading the calculation result file:

https://www.wccbo.org/score/submit.php



After dragging and dropping "*result.szk*," the following screen appears and the calculation result file is registered with the server.



The score of all competitors can be viewed at “https://www.wccbo.org/score”.

Summer score

Total ranking

Rank	ID	ECI	P_E	P_D	E [GJ]	DR [-]	Vers.	Date
1	C5	0.6942	0.5022	0.9597	8.154	0.2070	0.6.0	2023/10/01 00:00:05
2	C4	0.6098	0.5031	0.7390	8.152	0.2150	0.6.0	2023/10/01 00:00:04
3	C2	0.5547	0.9202	0.3343	6.830	0.2260	0.6.0	2023/10/01 00:00:02
4	C1	0.4827	0.5013	0.4648	8.156	0.2220	0.6.0	2023/10/01 00:00:01
5	C6	0.3917	0.5003	0.3066	8.158	0.2270	0.6.0	2023/10/01 00:00:06
6	C7	0.2572	0.0815	0.8122	9.262	0.2130	0.6.0	2023/10/01 00:00:07
7	C8	0.1929	0.9212	0.0404	6.823	0.2510	0.6.0	2023/10/01 00:00:08
8	C3	0.1513	0.0747	0.3066	9.296	0.2270	0.6.0	2023/10/01 00:00:03

Energy efficient ranking

Rank	ID	ECI	P_E	P_D	E [GJ]	DR [-]	Vers.	Date
1	C4	0.6098	0.5031	0.7390	8.152	0.2150	0.6.0	2023/10/01 00:00:04
2	C5	0.6942	0.5022	0.9597	8.154	0.2070	0.6.0	2023/10/01 00:00:05
3	C7	0.2572	0.0815	0.8122	9.262	0.2130	0.6.0	2023/10/01 00:00:07

Thermal comfort ranking

Rank	ID	ECI	P_E	P_D	E [GJ]	DR [-]	Vers.	Date
1	C5	0.6942	0.5022	0.9597	8.154	0.2070	0.6.0	2023/10/01 00:00:05
2	C4	0.6098	0.5031	0.7390	8.152	0.2150	0.6.0	2023/10/01 00:00:04
3	C1	0.4827	0.5013	0.4648	8.156	0.2220	0.6.0	2023/10/01 00:00:01
4	C2	0.5547	0.9202	0.3343	6.830	0.2260	0.6.0	2023/10/01 00:00:02
5	C6	0.3917	0.5003	0.3066	8.158	0.2270	0.6.0	2023/10/01 00:00:06
6	C8	0.1929	0.9212	0.0404	6.823	0.2510	0.6.0	2023/10/01 00:00:08