Comparative Test Case Specification

Kalyanova, Olena; Heiselberg, Per

Publication date:
2007

Document Version
Publisher's PDF, also known as Version of record

International Energy Agency
Energy Conservation In Buildings and Community Systems Programme

Comparative Test Case Specification

IEA ECBCS Annex 43 / SHC Task 34 Validation of Building Energy Simulation Tools

O. Kalyanova
P. Heiselberg

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

ISSN 1901-726X
DCE Technical Report No. 028

AALBORG UNIVERSITY
Department of Civil Engineering

Aalborg University
Department of Civil Engineering
Indoor climate

DCE Technical Report No. 028

Comparative Test Case Specification

by

O. Kalyanova
P. Heiselberg

August 2007

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Published 2007 by
Aalborg University
Department of Civil Engineering
Sohngaardsholmsvej 57,
DK-9000 Aalborg, Denmark

Printed in Denmark at AAU

ISSN 1901-726X
DCE Technical Report No. 028

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1. General information

1.1. Introduction

This document includes the specification on the IEA task of evaluation building energy simulation computer programs for the Double Skin Facades (DSF) constructions. There are two approaches involved into this procedure, one is the comparative approach and another is the empirical one. In the comparative approach the outcomes of different software tools are compared, while in the empirical approach the modelling results are compared with the results of experimental test cases. The comparative test cases include: ventilation, shading and geometry.

The DSF Test Facility Building at Aalborg University is the prototype for the specified model and empirical test-cases planned. Initially the DSF Test Facility Building will be calibrated for heat transmission, time constants, air tightness, wind profile and pressure coefficients, and opening characteristics. Later on the experiments with different DSF options will be performed.

The test cases planned are subdivided by operational strategy of the DSF into five groups, the visualization of the test case with the flow patterns can be seen on the following Figure 1.

Case DSF100. All the openings are closed. There is no exchange of the zone air with the external or internal environment. The zone air temperature results from the conduction, convection and radiation heat exchange. The movement of the air in the DSF appears due to convective flows in the DSF. The test case is focused on assessment of the resulting cavity temperature in DSF and solar radiation transmitted through the DSF into zone.

Case DSF200. Openings are open to the outside. DSF function is to remove surplus solar heat gains by means of natural cooling. Temperature conditions and air flow conditions in the DSF are to be examined together with the magnitude of natural driving forces.

Case DSF300. Openings are open to the inside. This is similar to the Test Case DSF200, but the external environment (wind and temperature) does not have as strong influence on the cavity temperature, as in the above case. The internal environment of the room behind the DSF is more important now. This test case has not been specified for modelling.

Case DSF400. The bottom opening is open to the outside and the top opening is open to the inside. Such configuration of openings considers DSF with a supply (preheating) option. The influence of the processes in the DSF on thermal conditions in the room is to be revealed.

Case DSF500. The top opening is open to the outside and the bottom opening is open to the inside. This configuration of openings considers DSF of exhaust option, which is similar to the above Case DSF400.

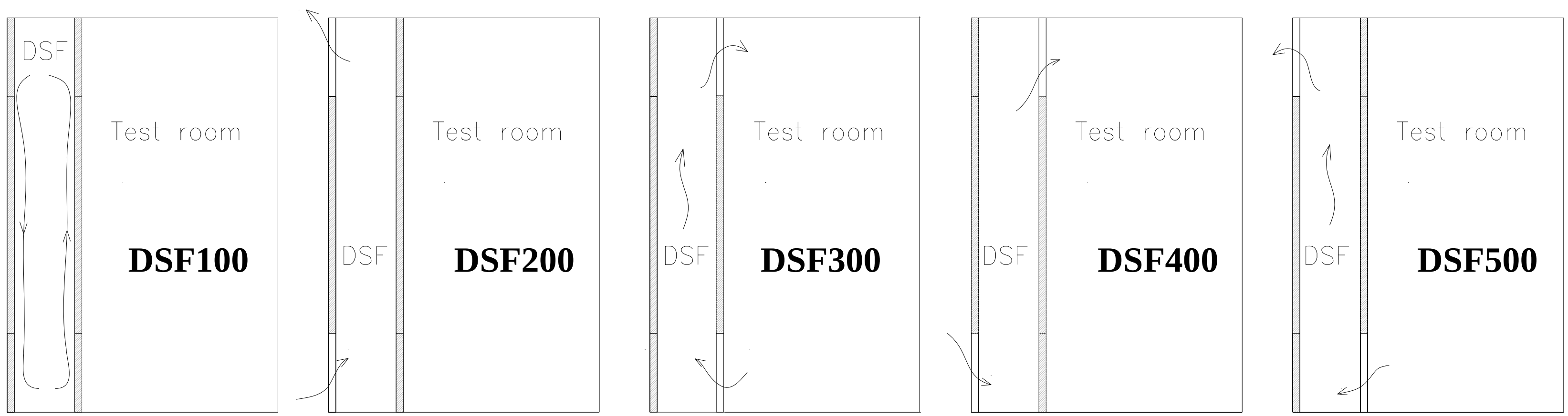


Figure 1. Test Cases. DSF100, DSF200, DSF300, DSF400, DSF500.

Case DSF100 - all openings are closed
Case DSF200 - openings are open to the outside
Case DSF300 - openings are open to the inside
Case DSF400 - bottom opening is open to the outside and the top opening is open to the inside (preheating mode)
Case DSF500 - top opening is open to the outside and the bottom opening is open to the inside (chimney/exhaust mode)

A number of parameters will be varied for each test case. These parameters include:

Solar shading:
- No, solar shading in DSF
- Solar shading applied in DSF

Driving force for airflow:
- Buoyancy force
- Wind force
- Mechanical (fan) force
- Combined natural forces (wind force and buoyancy force)

Internal (thermal)/External (thermal, solar, wind) boundary conditions:
- Both internal, external – constant (only for comparative test cases)
- Internal are constant, external are floating
- Both internal, external - floating

Opening area
- No opening control, full opening areas of openings in DSF
- Controlled openings (temperature, flow rate)

Combining the above number of parameters will result in a large number of test cases. The combinations in Table 1 are selected for the Task34/Annex 43 as the most important for validation of a DSF model. Some of them are only proposed as comparative test cases, while others are also empirical test cases and include comparison with experimental results from the DSF Test Facility at Aalborg University.

According to the discussions during the breakout sessions of Annex meeting, it was agreed to begin with the two comparative test cases: DSF100_2, DSF400_3. The comparative test cases DSF200_3 and DSF200_4 were chosen during the later meetings.

General test case	Test Case	Solar shading		Driving force				Boundary conditions			Openings area		Empirical
		Yes	No	Buoyancy	Wind	Mechanical	Combined	Internal=const External=const	Internal=const External=floating	Internal=floating External=floating	No control	Control	
DSF 100	DSF100_1		X					X					
	DSF100_2		**X**						**X**				**(E)***
	DSF100_3	X							X				E
DSF 200	DSF200_1		X	X				X			X		
	DSF200_2	X		X				X			X		
	DSF200_3		**X**	**X**					**X**		**X**		**(E)***
	DSF200_4		**X**				**X**		**X**		**X**		**E**
	DSF200_5	X					X		X		X		E
DSF 300		undefined											
DSF 400	DSF400_1		X			X		X			X		
	DSF400_2	X				X		X			X		
	DSF400_3		**X**			**X**			**X**		**X**		**(E)***
	DSF400_4	X				X			X		X		E
	DSF400_5	X					X		X			X	E
DSF 500	DSF500_1		X			X			X		X		
	DSF500_2	X				X			X		X		E
	DSF500_3	X					X			X	X		E
	DSF500_4	X					X			X		X	E

* - it is uncertain whether this test case will include empirical validations or not.

Table 1. Summary table of modelling cases. The comparative test cases to be modelled are highlighted.

1.2. Accompanying files for simulations

- Template for the output data
- Weather data files
- Files with additional documentation (*Drawing of window frames.pdf*)

1.3. Rules for the modelling

1.3.1 Modelling methods

Various building simulation software includes different approaches and applications for modelling of the physical processes involved. Initially, it is desired that all case-models involve the same applications for the same parameters in every model and use the most detailed level of modelling allowed by simulation program being tested.

Cases specified for modelling involve interaction of various processes, thus modelling may require different combinations of software applications and their options. For this reason the requirements for the modelling are untied. Design of the model can be performed after the capability of the simulating software and user's decision, but as close as possible to the prescribed one in a physical and mathematical meaning and as close as possible to the specification and other cases modelled by the same task participant. The user is asked to notify whether and where differences exist. It is necessary to include the detailed documentation of changes into the report on modelling results in order to perform the overall comparison of the results.

1.3.2 Input parameters

In the specification for test case modelling the input parameters are prescribed. These are to be used whether it is needed in the simulation software or to be used for approximate estimation of another parameter needed. When the specified parameter is found to be inapplicable for the modelling the user may disregard that and continue the modelling. The notification in modeller report is desirable.

1.3.3 Geometry parameters

In order to simplify the geometry input-parameters for all the building simulation software involved into the Annex 43, the interior volume of the zone 2 is specified. This is the room behind the DSF (the definition of the zones and the geometrical details will be specified further in the document).

For zone 1 (DSF) the location of windows is specified in the following figures, the interior volume is counted from the glass-pane surfaces, which are not symmetrical to the center-line of the window frame. If it is not possible to specify the location of the glass-panes, please find a technique to keep the volume of zone 1, as close as possible to the prescribed one.

1.3.4 *Simulation*

When the simulation software allows the initialization process, then begin the simulation with the zone air conditions equal to the outdoor air conditions.

If the simulation software allows the iterative simulation of an initial time period until temperature or fluxes, or both stabilize at initial value, then use this option.

The duration of the simulations for all the cases has to be complete, correspondingly to the provided weather data. The outputs are prescribed in the case specifications for models.

1.3.5 *Time convention*

The standard local time is used (this is not the solar time!), specified in section 1.6. The full day duration is 0:00-24:00. The duration of the first hour, for instance, is from 0:00 until 1:00.

1.3.6 *Schedule/occupants*

There are no occupants in the zones and no weekend or holiday schedules for the systems. All simulated days are considered to be equal.

1.3.7 *Thermal bridges*

The calculation of heat transmission through thermal bridges is not included into the comparative test cases (it is reasoned by dissimilar approaches used in the different software and it has been decided to avoid at least these dissimilarities and possible errors).

Values for the overall heat transmission from the zones will be given based on measurement results from calibration study on the Test Facility

1.3.8 *Modifications of prescribed values*

Some software may require modifications of values prescribed in this specification to be able to run the simulation. These modifications are undesired, but still might be necessary. The user has to make sure that the new values are obtained on the mathematical and physical basis and that these steps are documented in the modellers report.

1.3.9 *Units*

The specification is completed in SI-units, if you require conversion of units use conversions of ASHRAE.

1.3.10 *Moisture transport*

There is no moisture transport included into the simulations

1.3.11 *Shading by outdoor constructions*

There are no outdoor constructions that shade the model.

1.4. Output results

The list of the output results is specified for every Test Case separately. The comparative test cases do not include an analytical solution, thus the results are compared only between the research groups performed the modelling.

The template file for the output results is delivered in a separate file for each test case. For example:

Output results DSF100_2.xls - file for the output results for the test case DSF100_2.

1.5. Modeller report

This section includes the requirements to the contents and outline of the final modeller report, discussed and agreed on during the breakout session on March, 26 in Colorado. The earlier requirements mentioned in the text of the specification are also summarized.

Besides completing the modeler report participants are asked to fill in a questionnaire about the model and modeling approaches *for the test case DSF200_4*:

C_questionnaire_XXX.doc

XXX - name of the organization
C - corresponds to *Comparative* test cases
As a general requirement the user is asked to notify whether and where differences exist between test case specification and the model. This includes

- Disregarded parameters in specification
- Modification of parameters in specification
- Application of parameters not included in specification

The level of detail in the modeler report must allow anyone, using the same simulation tool, to repeat the model described in the report and achieve the same results.

The scope of this subtask is to perform a validation of the building simulation software for buildings with the double skin façade. As explained in the literature review (**Ref. 1**), the physics of the double skin façade involves complex processes and therefore require detailed calculations of optics, flow regime, convection, natural air flow etc. Often, the building simulation software is not able to perform such detailed level of computations. When the detailed computations are not possible, then the simplified models used as an alternative, as a result it is not always possible to validate the advance physical processes and this is not the objective. The building simulations must be validated on their performance *together with their limitations.*

Although the validation of models for transmission of solar radiation, naturally driven flow, etc. is carried out by the other subtasks, the complexity of the DSF physics results in difficulties for some of the simplified natural air flow models to predict accurately the airflow in the DSF cavity. In fact, results of the comparative test cases from the few rounds of simulations have shown large disagreements in the modeling of air flow rate in the DSF cavity. Therefore the prediction and validation of the natural air flow in the DSF cavity have to be considered as a criterion and also as an objective for validation of building simulation tools for modeling DSF.

On account of importance of the air flow model used when modelling the test cases, participants are asked to include *detailed* description of the airflow model used.

Following is the summary of additionally requested information for the modeler report. However it requires less detailed description than the air flow model does. All modellers are asked to:

- Notify what is the solar model used for simulations
- Describe the main assumptions used for calculation of transmitted and distributed solar radiation to the surfaces in the model (area weighted distribution of solar radiation or distribution according to the view factors; are there any differences when calculate transmitted direct or transmitted diffuse solar radiation?)
- Report on modelling windows (Is the glazing and frame modelled separate?)
- Include into the report the parameters of the glazing optical properties used for the modelling, especially if ones have been calculated on the basis of IGDB number. This information must be attached to the report as a separate Excel-file
- Notify the principle for calculation of the glazing temperature
- Explain assumptions (if there are any) for modeling the cavity air temperature: is there any temperature gradient, how is the temperature gradient defined?
- Describe what are the heat transfer coefficients used in the model, what is the background for calculation of convection heat transfer

In the separate sections of the comparative test case specification the modelers are asked to report on several matters, depending on the design of their model compared to the specification. These requests are summarized below:

The user is asked to notify whether and where differences with the comparative test case specification exist. It is necessary to include the documentation of changes into the report.

The modifications to specification are undesired, but still might be necessary, must be included into the report.

When the parameter given in the specification is inapplicable for the modellng the user may disregard it and continue the modelling. The notification in modeller report is needed.

If the testing software tool does not allow manual definition of the wind pressure coefficients and values provided in the specification are different from the ones fixed within the code, then the modeller report has to include detailed information about the values used.

It is required to notify the techniques for computations of the surface heat transfer coefficients in the report.

If the Direct Solar Irradiation+Diffuse Solar Irradiation is used as input in the model instead of Global Solar Irradiation+Diffuse Solar Irradiation then it has to be mentioned in the report.

It is requested to report on the glazing properties used/calculated in the model.

The report has to include the notation for the approach used for calculation of transmitted direct and diffuse solar radiation.

If the software being tested allows the calculation of the longwave radiation exchange with the exterior, use this function, else note it in the report.

If the software being tested allows the calculation of the longwave radiation exchange with the interior, use this function, and note in the report the approach that has been used.

1.6. Geography, site location

The following coordinates define the geographical location of the model Værløse, Copenhagen, Denmark, according to provided weather data:

Time zone	+1 hr MGT
Degrees of longitude	12´´19´ East
Degrees of latitude	55´´46´ North
Terrain type	Open rural country side
Altitude	27 m
Reflection of solar radiation from the ground	(0.2) Include the value for green grass
Emissivity of the ground/surroundings	(0.9) as above

Table 2. Geographical and site parameters for the model.

The orientation of the test facility is illustrated in Figure 2. The user may assume that the model is located in the open, flat country, with all wall-surfaces equally exposed to the wind.

1.7. Geometry

1.7.1 Model geometry

The model-building is subdivided into 2 zones one of the zones represents the indoor environment in the ordinary room behind the DSF, named zone 2. To be able to attain the output results, prescribed above, it is necessary to identify DSF as a separate zone, named zone 1. It has been suggested to prescribe the interior volume of the zones as the first priority, the wall thickness may vary as long as the physical processes are correct (the user may need to perform the recalculation of the wall-thickness together with thermal properties of the wall). Zones are defined in the following figure.

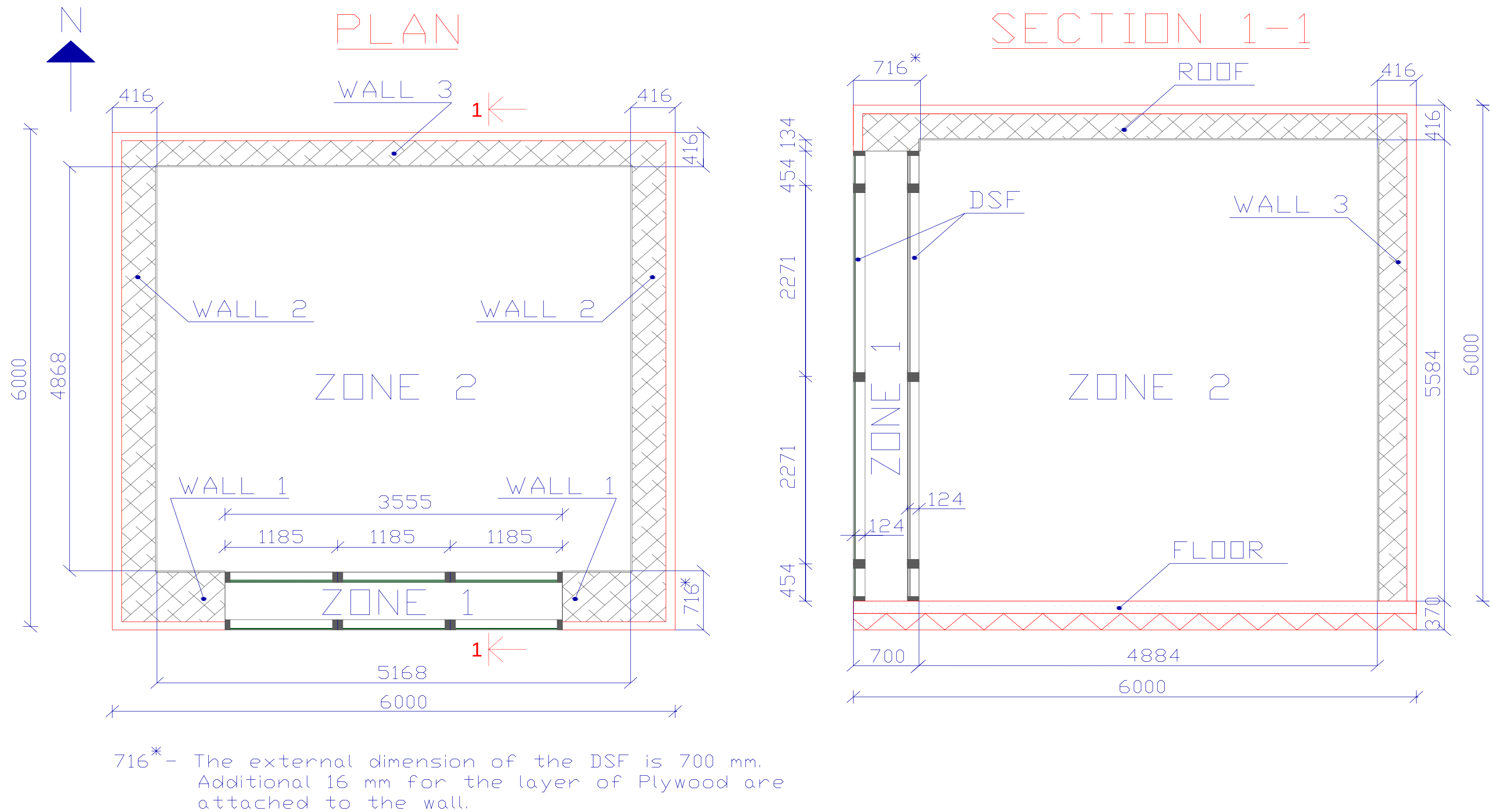


Figure 2. Detailed plan and section of the model.

The prescribed interior volumes are (these dimensions are also specified on the previous figures):

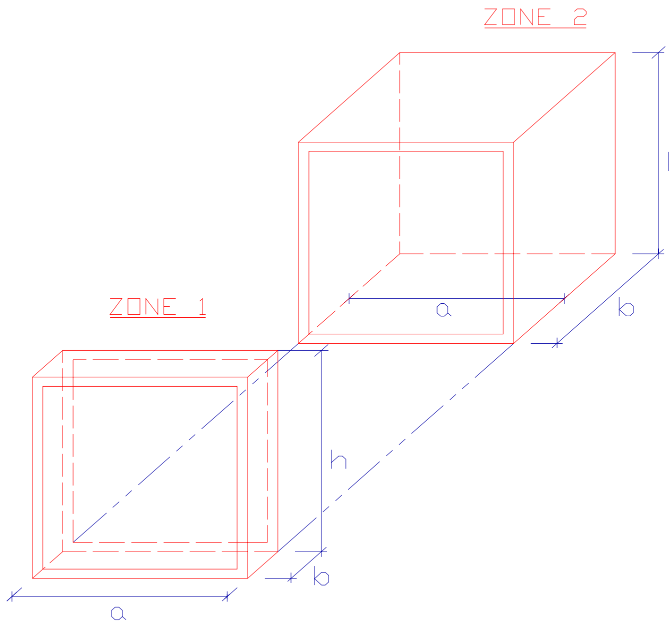


Figure 3. Internal dimensions .

Zone number	*a, mm*	*b, mm*	*h, mm*	*Volume**, m^3
ZONE 1	3555	560*	5450	10.84*
ZONE 2	5168	4979*	5584	143.68*

**Volume of Zone 1 and Zone 2 is calculated to the glass surfaces of the windows and NOT to the window frame*

Table 3. Internal dimensions.

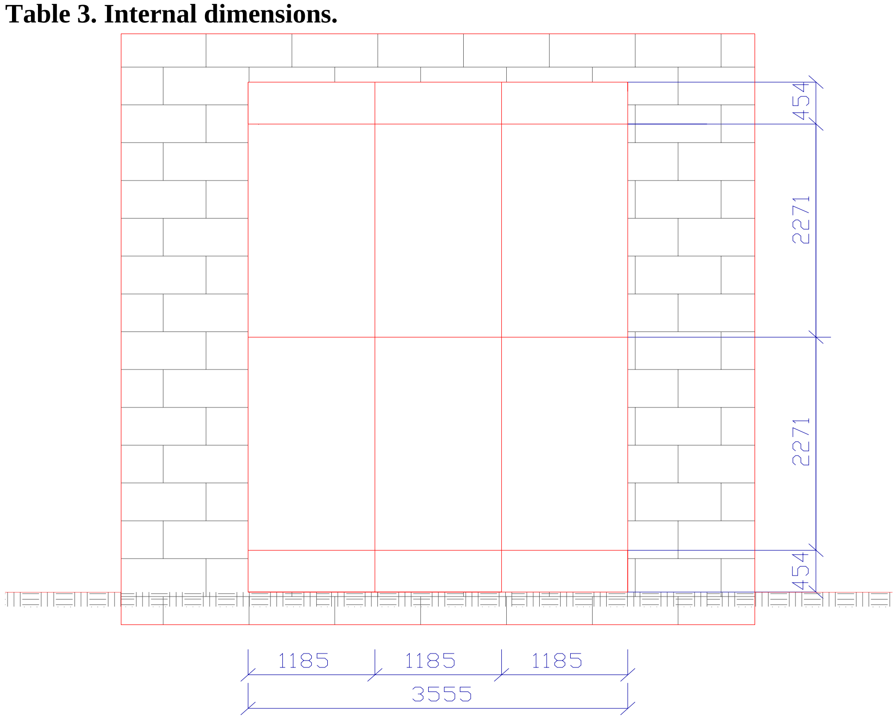


Figure 4. South facade. Dimensions of windows are inclusive frame.

1.7.2 Windows' geometry

It can be recognized six sections of windows V1-V6 (Figure 5), the top and bottom sections of windows are operable and will be modelled as open for some test cases.

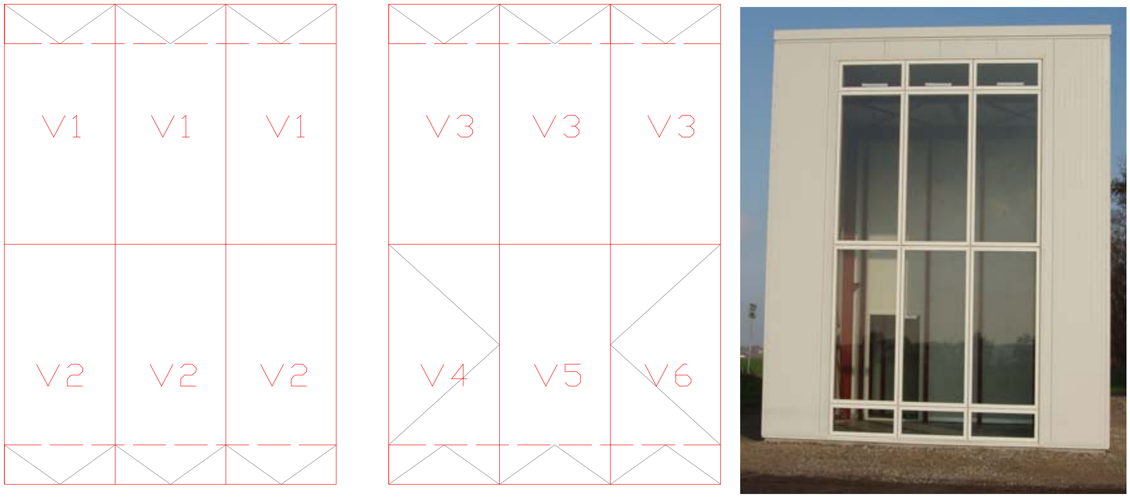


Figure 5. External window sections (left), Internal window section (center), photo of the DSF from the outside (right).

The windows facing external environment are named as external windows and windows facing internal environment - as the internal ones. The dimensions given in Figure 4 are valid both for the internal and external windows. User must pay attention that the window constructions in Figure 5 have different typology, see Table 11 and Table 12.

Dimensions of window sections V1-V6 with the frames are given on the Figure 6; the frame of 54 mm width encloses the glass planes.

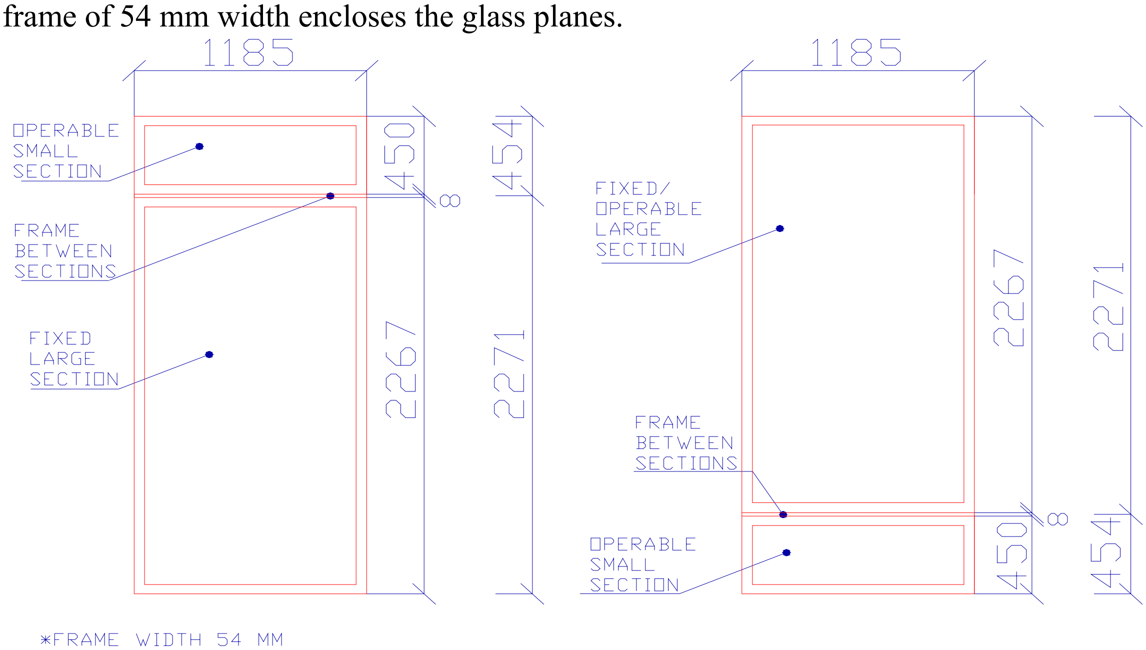


Figure 6. Dimensions of window sections with the operable top-opening (left) and bottom-opening (right).

The following table is combined as a summary for Figure 6:

Window section	*Total area of visible glazing of window (large and small section), m^2*	*Total frame area of window (large and small section), m^2*	*Total area of window (large and small section), m^2*
V1-V6	2.693	0.536	3.229

Table 4. Glazing and frame areas for the window sections.

Detailed dimensions of the windows, including distances between the glass planes, thickness of the glass and cavity-gap are depicted in Figure 7.

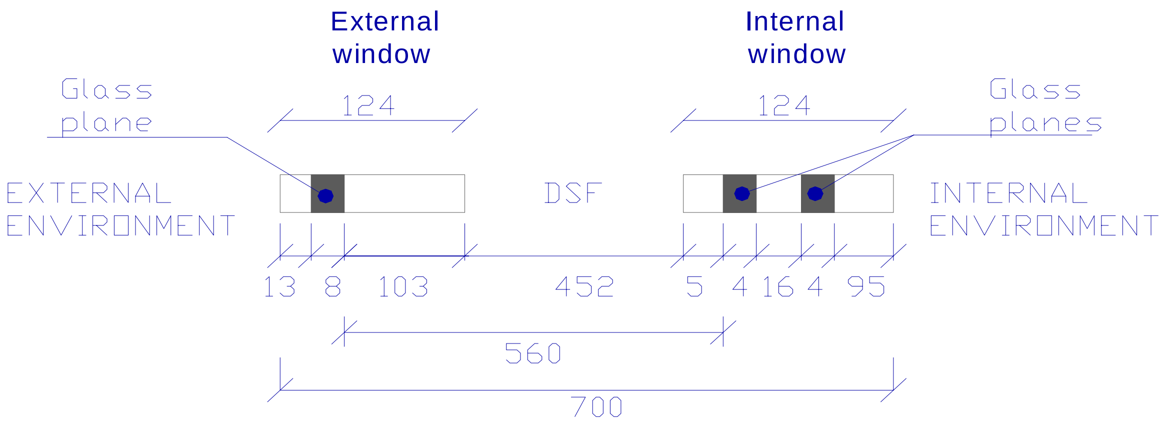


Figure 7. Distances between windows' surfaces in DSF (distances in mm).

As was explained before, the internal and external windows are of different type. The above figure demonstrates that the external window partitions consist of single 8mm-glazing, while the internal windows are double-glazed, filled with 90 %Argon.

In the file *Drawing of window frames.pdf* additional information about the window frames' construction is to be found if necessary. External part of window frame material is Aluminium and the material of the internal one is wood.

Definition of free opening area as well as a drawing of top and bottom windows open is given below.

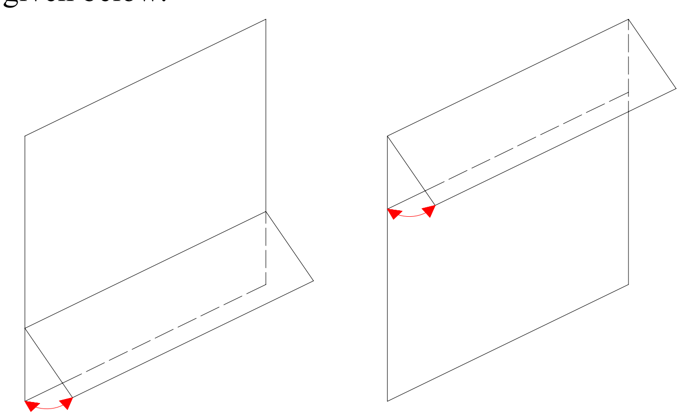


Figure 8. Direction of opening windows. Bottom window (left), top window (right).

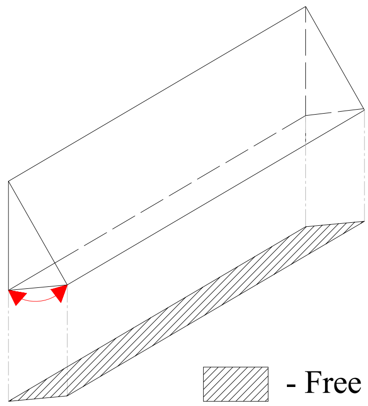


Figure 9. Free opening area

The free area of opening for every small operable section is 0.2 m^2.

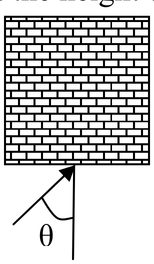
It is expected that this information must be enough to complete the geometrical modelling of the window partitions.

1.7.3 Discharge coefficient

Each opening is defined with the discharge coefficient of 0.65

1.7.4 Wind pressure coefficients

For the empirical test cases the wind pressure coefficients will be obtained by experiments, while for the comparative test cases the wind pressure coefficients are assumed according to **Ref. 2**. Wind pressure coefficients correspond to the wind velocity at the height of the roof of the building (6 m).



Location	*Wind angle*									
	0°	*45°*	**65°*	*90°*	*135°*	*180°*	*225°*	*270°*	**295°*	*315°*
Top openings	0.58	0.22	-0.2	-0.71	-0.5	-0.36	-0.5	-0.71	-0.2	0.22
Bottom openings	0.61	0.33	-0.06	-0.55	-0.5	-0.35	-0.5	-0.55	-0.06	0.33

***** *Interpolated data*

Table 5. Wind pressure coefficients [Ref. 2.**]**

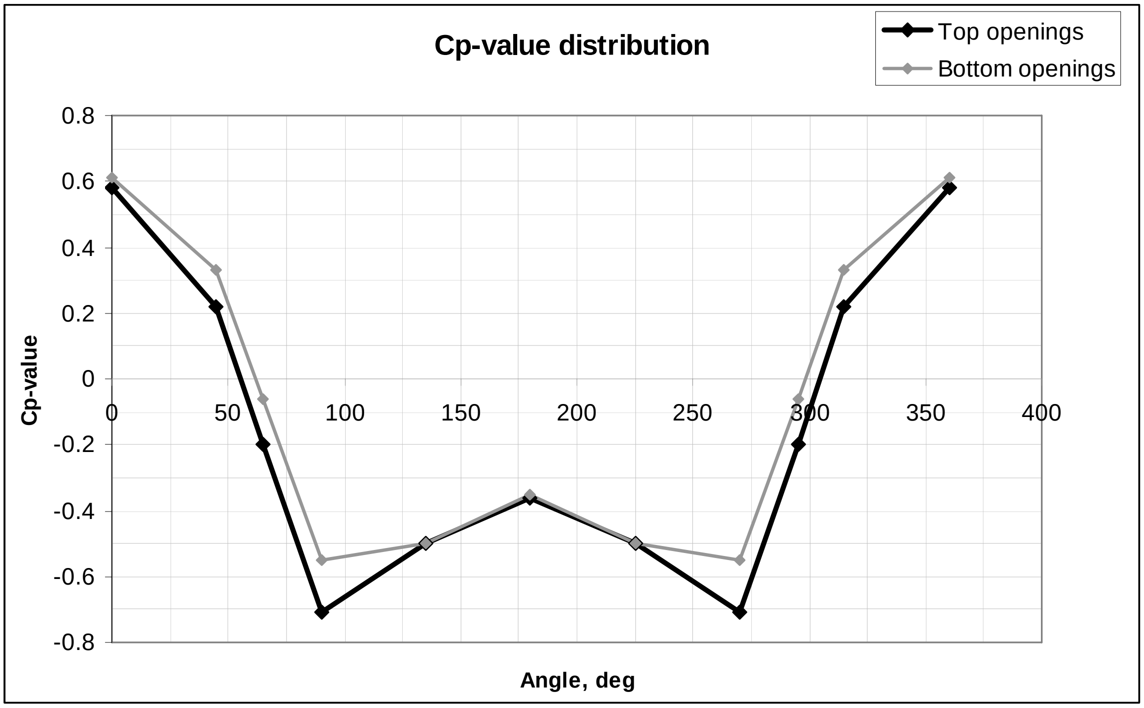


Figure 10. Distribution of wind pressure coefficients.

If the testing software tool does not allow manual definition of the wind pressure coefficients and values different from the above were used in the model, than the modeller report has to include detailed information about the values used.

1.8. Physical properties of the constructions

All constructions in the building are very well insulated. Constructions are subdivided into groups, which are:

- Wall 1- the South façade wall, comprise of external and internal windows
- Wall 2- the East and West façade walls, consist of the same materials.
- Wall 3- facing the North is divided into the three zones, as defined in the section 1.11.7)
- Roof
- Floor

This grouping of the constructions is also depicted in the Figure 2. The material properties are prescribed in the following tables.

The data is given in separate tables for each of previously defined constructions. The physical properties of the constructions are prescribed; these are required to keep unchanged.

The first layer in the table always denotes layer facing the internal environment of the model.

1.8.1 Walls' properties

Wall 1:

Material layer number	*Material*	*Layer thickness, mm*	*Material density, kg/m³*	*Thermal conductivity, W/mK*	*Specific heat capacity, J/kgK*	*Thermal resistance, m²K/W*
1	Plywood	16	544	0.115	1213	0.139
2	Rockwool M39	600	32	0.039	711	15.385
3	Isowand Vario	100	142	0.025	500	4

Table 6. Wall 1. Material properties.

Wall 2:

Material layer number	*Material*	*Layer thickness, mm*	*Material density, kg/m³*	*Thermal conductivity, W/mK*	*Specific heat capacity, J/kgK*	*Thermal resistance, m²K/W*
1	Plywood	16	544	0.115	1213	0.139
2	Rockwool M39	300	32	0.039	711	7.692
3	Isowand Vario	100	142	0.025	500	4

Table 7. Wall 2. Material properties.

Wall 3:

Material layer number	*Material*	*Layer thickness, mm*	*Material density, kg/m³*	*Thermal conductivity, W/mK*	*Specific heat capacity, J/kgK*	*Thermal resistance, m²K/W*
1	Plywood	16	544	0.115	1213	0.139
2	Rockwool M39	300	32	0.039	711	7.692
3	Isowand Vario	100	142	0.025	500	4

Table 8. Wall 3. Material properties.

Roof:

Material layer number	*Material*	*Layer thickness, mm*	*Material density, kg/m³*	*Thermal conductivity, W/mK*	*Specific heat capacity, J/kgK*	*Thermal resistance, m²K/W*
1	Plywood	16	544	0.115	1213	0.139
2	Rockwool M39	300	32	0.039	711	7.692
3	Isowand Vario	100	142	0.025	500	4

Table 9. Roof. Material properties.

Floor:
According to the DS 418, the ground resistance to the heat transmission is 1.5 m^2K/W.

Material layer number	*Material*	*Layer thickness, mm*	*Material density, kg/m³*	*Thermal conductivity, W/mK*	*Specific heat capacity, J/kgK*	*Thermal resistance, m²K/W*
1	Reinforced concrete, levelled and smoothed	150	2400	1.800	1000	0.639
2	Expanded Polystyrene	220	17	0.045	750	4.889

Table 10. Floor. Material properties.

1.8.2 Windows' properties

Grouping of window partitions and their dimensions were specified in the geometry-part. The physical properties of the windows are prescribed for the same groups.

Window	*U-value of window W/m²K*	*U-value of glazing W/m²K*	*U-value of frame W/m²K*
V1,V2- External window partition	5.36	5.70	3.63
V3-V6 Internal window partition	1.60	1.20	3.63

Table 11. Windows. U-value.

1.8.3 Glazing

Windows V1-V6 consist of glazing, which can be found in international glazing database if necessary:

Window	ID in Glass Library*		Producer	Product code	Glass Thickness, mms	
	Glass layer facing outside	*Glass layer facing inside*			*Glass layer facing outside*	*Glass layer facing inside*
External window sections V1, V2	9805*		Pilkington	8	8mm	
Internal window sections V3- V6	9802*	9922*	Pilkington	4-16Ar-SN4**	4mm	4mm***

* *The Glass Library ID is given for the WINDOW 5 database*
** *Filled with 90% Argon*
*** *Energy film SN attached to the surface, it faces a gap with Argon environment*

Table 12. Glazing product code

The above Table 12 defines glazing types, this is the necessary information for calculation optical properties of glazing systems. In case if the software being used is not able to perform this type of calculations, the following data has to be used:

Window	*Total solar heat transmittance, g-value*	*Solar reflectance*	*Direct solar radiation transmittance*
External window sections V1, V2	0.80	0.07	0. 76
Internal window sections V3-V6	0.63	0.24	0.52

Table 13. Glazing properties.

Emissivity of the glass is 0.84

1.8.4 Surface finishes

Consider all internal and external surfaces of the constructions (including window frames): are painted white, with the color fractions of :

Red color	1
Green color	1
Blue color	1

Table 14. Color fractions of the white paint.

The ability of surface to emit, absorb and reflect solar radiation depends on the values, prescribed in the table, these are applicable both for all internal and external surfaces

Longwave emissivity	0.88
Solar absorbance	0.40
Solar reflectance	0.6
Surface roughness, mm	0.03

Table 15. Surface finish properties.

The discussions during the Annex breakout session (October 2005) resulted in an agreement where the computations of surface heat transfer coefficients for the comparative test cases will not be prescribed. Every software tool should be able to present the best possible results of simulations. Still it might be prescribed in the future when the evaluation of some particular options in the software tool will take place.

The surface temperature is very important for the longwave radiation, convection and comfort. Therefore it is advised to use a separate modelling of convection and longwave radiation processes in order to achieve the most accurate results.

It is required to notify the techniques for computations of surface heat transfer coefficients in the report.

1.9. Weather data

1.9.1 General

The weather data is prepared for simulations in xls-file format as it is easy to transform into any other format. The data files are named in correspondence to the name of test case, as shown below:

wDSF100_1.xls – the weather data file for the test case DSF100_1

In the same manner the weather file will be named for all other test cases. The attention is paid that the data-sets for some test-cases may be the same, but still only the weather-file matching to the test case should be used!

In the weather data sets will be included different combinations of fluctuating parameters. These parameters are:

- Temperature
- Wind velocity/direction
- Solar radiation parameters

The duration of the simulation (data set) is 2 weeks period. Parameters in climate data are given constant from 0 to 1 hour. For the two defined comparative test cases DSF100_2 and DSF400_3 the weather data set represents a spring situation with the obvious contrast between the day and night external temperatures. A few days of weather data includes a high diffuse solar radiation, and the remained days are characterized by a high direct solar radiation.

In weather data file *wDSF200_3.xls* the wind velocity is set to zero to ensure the buoyancy driven flow.

There are given three parameters for calculation of incident solar radiation. As the priority user is asked to use only two following parameters:

- Global solar irradiation
- Diffuse solar irradiation

The direct solar radiation is given in the weather data for the software tools which may require it as an input. If the direct solar irradiation is used then it has to be mentioned in the report.

1.9.2 Weather data description

- External air temperature = The external air dry bulb temperature
- Dew point temperature= The air dry bulb air temperature and relative humidity are in correspondence
- Global solar irradiation = Global solar irradiation on the horizontal surface
- Diffuse solar irradiation = Diffuse solar irradiation on the horizontal surface
- Direct Solar irradiation = Direct Normal solar Irradiation (calculated from the global, diffuse solar irradiation and solar height)
- Cloud cover in 0.1 octa: The cloud cover is measured in octas from 0 to 8, where 0 – NO Clouds
- 8 – totally covered with clouds
- That means that cloud cover 80 in the data sheet corresponds to the sky covered with clouds on 100 %. For instance the cloud cover 70 corresponds to 70/80=88%
- The wind direction in the data sheet is given in degrees from the North, so East corresponds to 90 degrees.

1.9.3 Ground temperature

The ground temperature during the whole simulation process is specified according to the Danish Norms DS 418:

Ground temperature, ^{o}C	10

Table 16. The ground temperature.

This value of the ground temperature is valid for all test cases.

1.10. Transmission of solar radiation

It is supposed that the calculation of optical glazing properties will be done by modellers, as the glazing properties are treated differently in various software packages. Table 13 defines these properties in a case if the software tool is unable to perform the calculations of the optical glazing properties. It is requested to report on the glazing properties used/calculated in the model.

The report has to include the notation for the approach used for calculation of transmitted direct and diffuse solar radiation.

1.11. Other parameters and specifications

1.11.1 Driving force

In the test case DSF200_3 thermal buoyancy is only the driving force, while in the test case DSF200_4 thermal buoyancy is combined with the wind influence. In both of the test cases driving forces have variable character.

1.11.2 Infiltration

In the comparative test cases the infiltration of the air into the zones due to leakage is neglected (in the empirical test cases infiltration levels will be calculated based on the measured infiltration levels from the calibration study).

1.11.3 Mixing in zone 2

It is assumed that the air in the zone 2 is well mixed. Cooling or heating load is given off to the zone by means of convection.

1.11.4 Distribution of solar radiation in a zone

Whether the software being tested allows the solar incidence to be distributed geometrically correct to surfaces (detailed analyses of the path of direct solar radiation through a building, thus calculating shadowing by constructions, etc.) then this option has to be used. When this is not possible, use the most accurate, physically correct option, able to handle solar radiation heat transmission. Approach for calculation of distribution of transmitted solar radiation to the surfaces has to be documented in the report.

1.11.5 Longwave radiation with external

If the software being tested allows the calculation of the longwave radiation exchange with the exterior, use this function, else note it in the report.

1.11.6 Longwave radiation with internal

If the software being tested allows the calculation of the longwave radiation exchange with the interior, use this function, and note in the report the approach that has been used.

1.11.7 Adiabatic and other features of constructions

For all test cases user shall build up the model with the Wall 3, divided into three parts: one part faces external environment, another part has adiabatic features and the third part separates environments with different temperatures, Figure 12. It is caused by the actual Test Facility Building, which contains two supplementary rooms just behind the Wall 3. These two rooms are not to be modelled for these test cases, but different heat transmission processes through the Wall 3 are necessary to include into calculations.

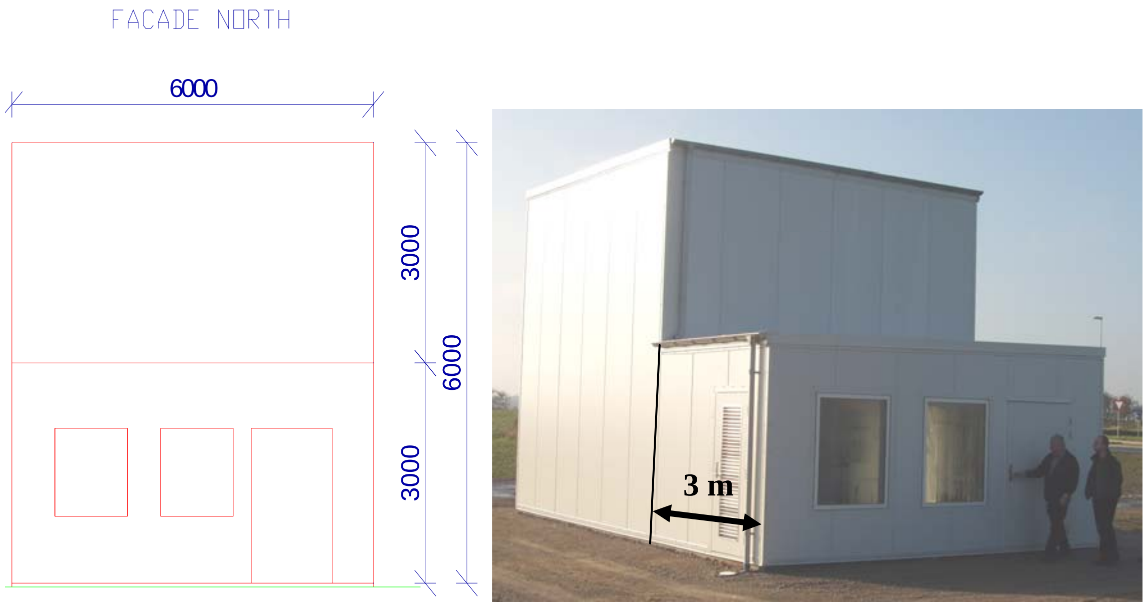


Figure 11. North Facade.

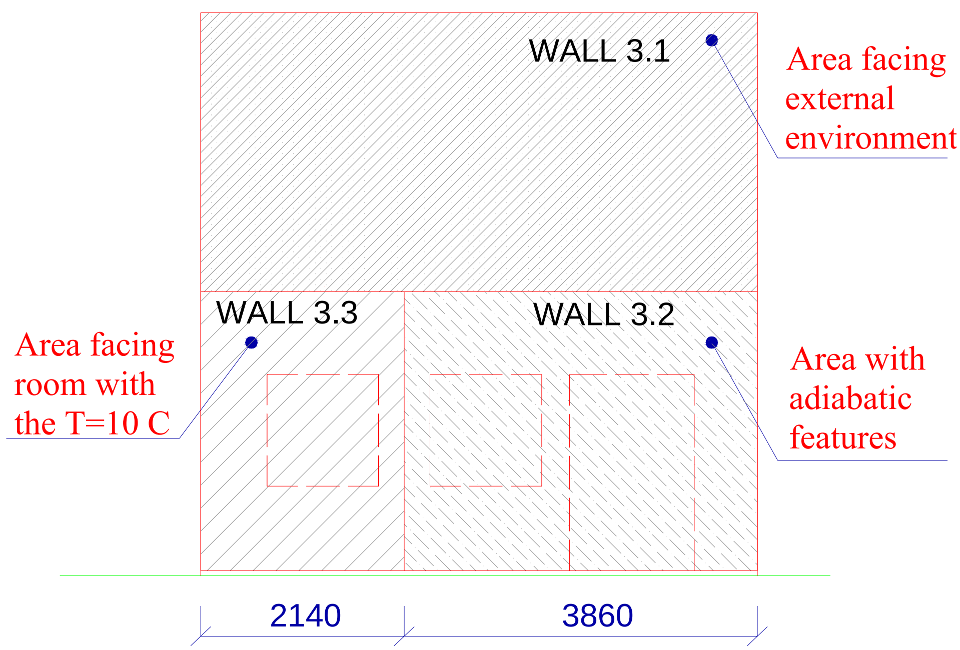


Figure 12. Partitioning of the Wall 3 (view from the outside).

According to the Figure 12 Wall 3 is divided into three sections:

- Wall 3.1 on one side faces zone 2 environment and on the other side faces external environment

- Wall 3.2 on one side faces environment in zone 2 and on the other side the room with the same thermal conditions as in zone 2, thus the heat transmission through this construction will be just about zero and therefore this part of the wall can be treated as adiabatic

- Wall 3.3 on one side faces environment in zone 2 and on the other side faces a room with the 10^oC of mean air temperature

Wall 3.3 and Wall 3.2 face different zones, the depth of both of these zones is 3 m, see Figure 12.

2. Test case DSF100

2.1. Objectives and methods

The main objective of this test case is to test the building simulation software on its general ability to model the transmission of solar heat gains through the two layers of fenestration with the air-gap in between, and its influence on the thermal performance of the room attached to the DSF (zone 2).

All the openings in this test case are sealed and there is no airflow through the DSF. This arrangement of the DSF should have a performance similar to an ordinary window.

This test case includes three models (DSF100_1, DSF100_2 and DSF100_3). These models are assigned to perform the stepwise assessment of influence from the external environment and shading device on solar heat transmission into the room (zone 2) and DSF (zone 1). The test case DSF100_2 has been chosen for comparative test from this group.

The weather data set of floating outdoor conditions is to be applied.

The Cooling/Heating system should be introduced to the model to keep internal mean air temperature in zone 2 constant about 20 ^{o}C.

2.2. Attributes for the test case DSF100_2

№	*Attribute*	*Specification*
1	Internal zone dimensions	As specified above /section Geometry/
2	Windows' dimensions	As specified above /section Geometry/
3	Operable window sections at the top and bottom (Open/Closed)	All windows are closed
4	Open windows properties	These properties are not necessary as the openings are modelled to be closed.
5	Construction materials	As specified above /section Physical properties of constructions/
6	Material properties	As specified above /section Physical properties of constructions/
7	Window properties	As specified above /section Physical properties of constructions/
8	Interior surface heat transfer coefficients	It is not prescribed, as it depends on the techniques used by software tool /section Surface coefficients/. The values (techniques) used for simulations have to be reported
9	Exterior surface heat transfer coefficients	It is not prescribed, as it depends on the techniques used by software tool /section Surface coefficients/. The values (techniques) used for simulations have to be reported
10	Surface finish properties	As specified above. All the surfaces are to be modelled white with the specified reflection and absorbance properties. The roughness of the surface and emissivity of the glass are also prescribed.
11	Weather data	The weather data file is wDSF100_2.xls, prepared for the fluctuating weather conditions
12	Ground temperature	The 10 ^{o}C value is specified above and to be kept the same for whole period of simulation
13	Total solar heat transmittance (g-value)	Calculated by the technique which is included into the program code or by the user decision /section Physical properties of constructions/
14	Transmission of solar radiation	It is not prescribed. The approach of calculation depends on the software package. In the modeller report please notify the approach used for calculations.
15	Distribution of transmitted solar radiation	Whether the software being tested allows the solar incidence to be distributed geometrically correct to surfaces (detailed analyses of the path of direct solar radiation through a building, thus calculating shadowing by constructions, etc.), apply this function. When this is not possible, use the most accurate, physically correct option, able to handle solar radiation heat transmission. This has to be documented in the report /Other parameters and specifications /
16	Longwave radiation with exterior and interior environment	If the software being tested allows the calculation of the longwave radiation exchange with the exterior, use this function, else note it in the report /Other parameters and specifications /

№	*Attribute*	*Specification*
17	Additional definition for the Wall 3	For the all test cases the user shall build up the model with the Wall 3, partly having adiabatic features and partly – facing external environment, as explained earlier /Other parameters and specifications /
18	Internal gains	There are no internal gains considered for this test case
Systems. Zone 1		
19	Shading	No shading devise defined for this test case
20	Driving force	All the windows are closed, thus there is no airflow between the DSF and external environment, thus there is no driving force to be considered
21	Zone air temperature	The zone air temperature is not controlled.
22	Other systems	No other systems included into Zone 1.
Systems. Zone 2		
23	Shading	No shading devise defined for this test case
24	Zone air temperature	The air temperature in zone 2 is regarded to be uniform, with a fixed value of 20^{o}C. In order to keep this temperature constant a cooling/heating control system has to be included, as explained further down.
25	Efficiency of Cooling System	100 %
26	Cooling system	The Zone 2 is provided with a mechanical cooling/heating system to provide constant zone air temperature. Cooling/heating energy has to be provided to the zone air only by means of convection. The controlling sensor has to be located in the same zone. The schedule of the systems has to be always, during the simulation.
27	Control of the openings	No control. All windows are closed.

Table 17. Specification for the test case DSF100_2.

2.3. Output parameters for the test case DSF100_2

The main interest in this test case is to ascertain the transmission of solar radiation into the room (zone 2), when there is no airflow between external and/or internal environment. The surplus heat is extracted from the zone due to the cooling system installed; the cooling load to the zone 2 is the necessary parameter for estimation of the DSF influence on the room and for being a criterion when it is necessary to perform the comparison of the output parameters with other test cases. The heating system is installed to serve exactly the same needs as cooling – to keep constant temperature conditions in the room. The amount of heat supplied can be used as a criterion, similar to the cooling load.

This test case involves floating external conditions, thus the results have to represent the hourly values as outputs.

N	*Output*	*Unit*	*Description*
1	Direct solar irradiation on the window surface	W/m^2	Mean hourly value
2	Diffuse solar irradiation on the window surface	W/m^2	Mean hourly value
3	Total solar irradiation on the window surface	W/m^2	Mean hourly value
4	Total solar radiation received on the external window glass surface	kW	Mean hourly value
5	Solar radiation transmitted from the outside into zone 1	kW	Mean hourly value
6	Solar radiation transmitted from zone1 into zone2 (first order of solar transmission)	kW	Mean hourly value
7	Power used for cooling/heating in the zone 2	kW	Mean hourly value (with the '+'sign for heating and '-'sign for cooling)
8	Hour averaged surface temperature of external window glass pane, surface facing external	^oC	Mean hourly value
9	Hour averaged surface temperature of external window glass pane, surface facing zone1	^oC	Mean hourly values
10	Hour averaged surface temperature of internal window glass pane, surface facing zone1,	^oC	Mean hourly value
11	Hour averaged surface temperature of internal window glass pane, surface facing zone2	^oC	Mean hourly value
12	Hour averaged floor surface temperature in the zone 1	^oC	Mean hourly value
13	Hour averaged ceiling surface temperature in the zone 1	^oC	Mean hourly value
14	Hour averaged floor surface temperature in the zone 2	^oC	Mean hourly value
15	Hour averaged ceiling surface temperature in the zone 2	^oC	Mean hourly value
16	Hour averaged volume weighted air temperature in the zone 1	^oC	Mean hourly value
17	Solar altitude angle	deg	In the middle of the hourly interval

Table 18. Required output parameters for the test case DSF100_2.

Depending on the software tool used for modelling and its accuracy the minimum required outputs defined in the above table. Besides that a modeller is asked to report on the additional outputs, if this is possible:

- Solar radiation absorbed in the opaque surfaces in zone 1 and zone 2 (mean hourly values)
- Convective/ radiative heat fluxes at the glass surfaces (mean hourly values)
- Vertical temperature distribution of the DSF-air, when provide this data, then please provide data for vertical temperature distribution of all window glass surfaces
- Anyone using CFD, please provide vector plots together with the data sheets

Modellers are asked to report on how the transmitted solar radiation is calculated and distributed to the surfaces, besides it is necessary to report on the glazing properties used/calculated in the model.

3. Test Case DSF200

3.1. Objectives and methods

The main objective of this test case is to test the building simulation software on its general ability to model the transmission of solar heat gains through the two layers of fenestration combined with airflow motion through the DSF cavity. The transmission of solar heat gains has been already investigated in the DSF100_2 test case, the influence of the naturally driven air flow through the cavity is included in the present test case. This time, the air movement exists only between the cavity and external, and the air temperatures in the cavity are mainly influenced by external environmental temperatures and solar radiation. The internal conditions remain constant, as in the previous DSF100_2 case. The Cooling/Heating system should is introduced to the model to keep internal temperature in the zone 2 constant to 20 degrees.

3.2. Attributes for the test case DSF200_3 and DSF200_4

№	*Attributes*	*Specification*
1	Internal zone dimensions	As specified above / section Geometry/
2	Windows' dimensions	As specified above /section Geometry/
3	Operable window sections at the top and bottom (Open/Closed)	The external top and bottom operable windows are open. The free area of one open section is 0.2 m^2 – it is the maximal value for the every small operable section, that corresponds to 0.6 m^2 of total opening area at the top of DSF and 0.6 m^2 at the bottom.
4	Open windows properties	The discharge coefficient for all openings is set to be 0.65.
5	Construction materials	As specified / section Physical properties of constructions/
6	Material properties	As specified / section Physical properties of constructions/
7	Window	As specified / section Physical properties of constructions/
8	Interior surface heat transfer coefficients	This is not prescribed, as it depends on the techniques used by software tool / section Surface coefficients/. The values (techniques) used for simulations have to be reported
9	Exterior surface heat transfer coefficients	This is not prescribed, as it depends on the techniques used by software tool / section Surface coefficients/. The values (techniques) used for simulations have to be reported
10	Surface finish properties	All the surfaces are to be modelled white with the specified reflection and absorbance properties. The roughness of the surface and emissivity of the glass are also prescribed
11	Weather data	The weather data file is wDSF200_3.xls for the test case DSF200_3 and the weather data file is DSF200_4 for the test case DSF200_4 The weather data files for the test cases differ one from another
12	Ground temperature	The 10 ^{o}C value is specified above and to be kept the same for whole period of simulation.
13	Total solar heat transmittance (g-value)	Calculated by the technique which is included into the program code or by the user decision section Physical properties of constructions/
14	Transmission of solar radiation	It is not prescribed. The approach of calculation depends on the software package. In the modeller report please notify the approach used for calculations.
15	Distribution of transmitted solar radiation	Whether the software being tested allows the solar incidence to be distributed geometrically correct to surfaces (detailed analyses of the path of direct solar radiation through a building, thus calculating shadowing by constructions, etc.), apply this function. When this is not possible, use the most accurate, physically correct option, able to handle solar radiation heat transmission. This has to be documented in the report / Other parameters and specifications/
16	Longwave radiation with exterior and interior	If the software being tested allows the calculation of the longwave radiation exchange with the exterior, use this function, else note it in the report / Other parameters and specifications /

№	*Attributes*	*Specification*
17	Additional definition for the Wall 3	The user shall build up the model with the Wall 3, partly having adiabatic features and partly – facing external environment, as explained above / Other parameters and specifications /
18	Internal gains	There are no internal gains considered for this test case
Systems. Zone 1		
19	Shading	No shading devise defined for this test case
20	Driving force	The driving force in the DSF is thermal buoyancy in the test case DSF200_3 and thermal buoyancy combined with the wind forces in the test case DSF200_4(this is determined by the weather conditions)
21	Zone air temperature	The zone air temperature is not controlled.
22	Other systems	No other systems included into Zone 1.
Systems. Zone 2		
23	Shading	No shading devise defined for this test case
24	Zone air temperature	The air temperature in zone 2 is regarded to be uniform, with a fixed value of 20^{o}C. In order to keep this temperature constant a control of cooling/heating system has to be included, as explained further down.
25	Efficiency of cooling/heating system	100 %
26	Heating/Cooling system	The Zone 2 is provided with a mechanical heating/cooling system to provide constant zone air temperature. The energy has to be provided to the zone air only by means of convection. The controlling sensor has to be located in same zone. The schedule of the systems has to be *always,* during the simulation.
28	Control of the openings	Small operable sections facing the external environment at the bottom and internal environment at the top are fully open. No control.

Table 19. Specification for the test case DSF200_3 and DSF200_4.

3.3. Output parameters for the test case DSF200_3 and DSF200_4

The output parameters for these cases are almost the same as for the case DSF100_2 and DSF400_3.

N	*Output*	*Unit*	*Description*
1	Direct solar irradiation on the window surface	W/m^2	Mean hourly value
2	Diffuse solar irradiation on the window surface	W/m^2	Mean hourly value
3	Total solar irradiation on the window surface	W/m^2	Mean hourly value
4	Total solar radiation received on the external window glass surface	kW	Mean hourly value
5	Solar radiation transmitted from the outside into zone 1	kW	Mean hourly value
6	Solar radiation transmitted from zone 1 into zone2 (first order of solar transmission)	kW	Mean hourly value
7	Power used for cooling/heating in the zone 2	kW	Mean hourly value (with the '+'sign for heating and '-'sign for cooling)
8	Hour averaged surface temperature of external window glass pane, surface facing external	^oC	Mean hourly value
9	Hour averaged surface temperature of external window glass pane, surface facing zone1	^oC	Mean hourly value
10	Hour averaged surface temperature of internal window glass pane, surface facing zone1,	^oC	Mean hourly value
11	Hour averaged surface temperature of internal window glass pane, surface facing zone2	^oC	Mean hourly value
12	Hour averaged floor surface temperature in the zone 1	^oC	Mean hourly value
13	Hour averaged ceiling surface temperature in the zone 1	^oC	Mean hourly value
14	Hour averaged floor surface temperature in the zone 2	^oC	Mean hourly value
15	Hour averaged ceiling surface temperature in the zone 2	^oC	Mean hourly value
16	Hour averaged volume weighted air temperature in the zone 1	^oC	Mean hourly value
17	Mass flow rate in the zone 1	kg/h	Mean hourly value, including the sign convention: '+'sign for the upwards flow and '-'sign for the downwards flow

Table 20. Required output parameters for the test case DSF200_3 and DSF200_4.

Depending on the software tool used for modelling and its accuracy the minimum required outputs defined in the above table. Besides that a modeller is asked to report on additional outputs, if this is possible:

- Solar radiation absorbed in the opaque surfaces in zone 1 and zone 2 (mean hourly values)
- Convective/ radiative heat fluxes at the glass surfaces (mean hourly values)
- Vertical temperature distribution of the DSF-air, when provide this data, then please provide data for vertical temperature distribution of all window glass surfaces

- Anyone using CFD, please provide vector plots together with the data sheets

Modellers are asked to report on how the transmitted solar radiation is calculated and distributed to the surfaces.

4. Test case DSF400

4.1. Objectives and methods

This test case is upgraded with a few more aspects, compared to the test case DSF100. The DSF100 involves mainly the heat transfer processes, while the DSF400 – combines heat transfer with the flow of external air through the DSF into the room (zone 2).

The main objective of this test is to investigate the ability of building simulation tools to predict the transmission of solar radiation combined with the airflow through the DSF attached to the room (zone 2) and it's entire influence on the conditions in the room (zone 2).

The test case DSF400_3 has been chosen as a comparative test case.

The heating/cooling system is introduced to the model to keep internal temperature in the zone 2 constant to 20 degrees.

The constant air flow rate is extracted from the zone 2, creates an underpressure and the air is sucked though the openings in the DSF into the zone 2. The air change rate in the zone 2 is approximately 15.0 h^{-1} that corresponds to velocities in the DSF of approximately to 0.3 m/s (2155 m^3/h).

4.2. Attributes for the Case DSF400_3

№	*Attributes*	*Specification*
1	Internal zone dimensions	As specified above /section Geometry/
2	Windows' dimensions	As specified above /section Geometry/
3	Operable window sections at the top and bottom (Open/Closed)	The external bottom and internal top sections of small operable windows are open. The free area of the open section is 0.2 m^2 – it is the maximal value for the every small operable section that corresponds to 0.6 m^2 of total opening area at the top of DSF and 0.6 m^2 at the bottom. Operable sections can be seen on Figure 5 and Figure 6. Free area is defined in Figure 9.
4	Open windows properties	The discharge coefficient for the opening is set to be 0.65.
5	Construction materials	As specified above /section Physical properties of constructions/
6	Material properties	As specified above /section Physical properties of constructions/
7	Window	As specified above /section Physical properties of constructions/
8	Interior surface heat transfer coefficients	It is not prescribed, as it depends on the techniques used by software tool /section Surface coefficients/. The values (techniques) used for simulations have to be reported
9	Exterior surface heat transfer coefficients	It is not prescribed, as it depends on the techniques used by software tool /section Surface coefficients/. The values (techniques) used for simulations have to be reported
10	Surface finish properties	As specified above. All the surfaces are to be modelled white with the specified reflection and absorbance properties. The roughness of the surface and emissivity of the glass are also prescribed.
11	Weather data	The weather data file is wDSF400_3.xls; it will be prepared for floating weather conditions.
12	Ground temperature	The 10 ^{o}C value is specified above and to be kept the same for whole period of simulation.
13	Total solar heat transmittance (g-value)	Calculated by the technique which is included into the program code or by the user decision /section Physical properties of constructions/
14	Transmission of solar radiation	It is not prescribed. The approach of calculation depends on the software package. In the modeller report please notify the approach used for calculations.
15	Distribution of transmitted solar radiation	Whether the software being tested allows the solar incidence to be distributed geometrically correct to surfaces (detailed analyses of the path of direct solar radiation through a building, thus calculating shadowing by constructions, etc.), apply this function. When this is not possible, use the most accurate, physically correct option, able to handle solar radiation heat transmission. This has to be documented in the report /Other parameters and specifications /
16	Longwave radiation with exterior and interior	If the software being tested allows the calculation of the longwave r½adiation exchange with the exterior, use this function, else note it in the report /Other parameters and specifications /
17	Additional definition for the Wall 3	The user shall build up the model with the Wall 3, partly having adiabatic features and partly – facing external environment, as

№	Attributes	Specification
		explained above /Other parameters and specifications /
18	Internal gains	There are no internal gains considered for this test case
Systems. Zone 1		
19	Shading	No shading devise defined for this test case
20	Driving force	The driving force in the DSF is caused by fan, which extracts a constant airflow in amount of: 15.0 ACH (for zone 2), that corresponds to 2155 m^3/h
21	Zone air temperature	The zone air temperature is not controlled.
22	Other systems	No other systems included into Zone 1.
Systems. Zone 2		
23	Shading	No shading devise defined for this test case
24	Zone air temperature	The air temperature in zone 2 is regarded to be uniform, with a fixed value of 20^{o}C. In order to keep this temperature constant a control of cooling/heating system has to be included, as explained further down.
25	Efficiency of cooling/heating system	100 %
26	Heating/Cooling system	The Zone 2 is provided with a mechanical heating/cooling system to provide constant zone air temperature. The energy has to be provided to the zone air only by means of convection. The controlling sensor has to be located in same zone. The schedule of the systems has to be *always,* during the simulation.
27	Fan	Exhaust fan with the constant airflow of 15.0 ACH (for zone 2), that corresponds to 2155 m^3/h. The air intake is from the DSF (top opening), the bottom opening to the outside in the DSF is open too.
28	Control of the openings	Small operable sections facing the external environment at the bottom and internal environment at the top are fully open. No control.

Table 21. Specification for the test case DSF400_3.

4.3. Output parameters for the test case DSF400_3

The output parameters for this case are the same as for DSF100_2, but the results are expected to be principally different.
Additional outputs defined for the previous case are also desirable.

N	*Output*	*Unit*	*Description*
1	Direct solar irradiation on the window surface	W/m^2	Mean hourly value
2	Diffuse solar irradiation on the window surface	W/m^2	Mean hourly value
3	Total solar irradiation on the window surface	W/m^2	Mean hourly value
4	Total solar radiation received on the external window glass surface	kW	Mean hourly value
5	Solar radiation transmitted from the outside into zone 1	kW	Mean hourly value
6	Solar radiation transmitted from zone 1 into zone2 (first order of solar transmission)	kW	Mean hourly value
7	Power used for cooling/heating in the zone 2	kW	Mean hourly value (with the '+'sign for heating and '-'sign for cooling)
8	Hour averaged surface temperature of external window glass pane, surface facing external	^{o}C	Mean hourly value
9	Hour averaged surface temperature of external window glass pane, surface facing zone1	^{o}C	Mean hourly values
10	Hour averaged surface temperature of internal window glass pane, surface facing zone1,	^{o}C	Mean hourly value
11	Hour averaged surface temperature of internal window glass pane, surface facing zone2	^{o}C	Mean hourly value
12	Hour averaged floor surface temperature in the zone 1	^{o}C	Mean hourly value
13	Hour averaged ceiling surface temperature in the zone 1	^{o}C	Mean hourly value
14	Hour averaged floor surface temperature in the zone 2	^{o}C	Mean hourly value
15	Hour averaged ceiling surface temperature in the zone 2	^{o}C	Mean hourly value
16	Hour averaged air volume weighted temperature in the zone 1	^{o}C	Mean hourly value
17	Solar altitude angle	deg	In the middle of the hourly interval

Table 22. Required output parameters for the test case DSF400_3.

5. List of references

Ref. 1. Poirazis H. (2006). "Double Skin Facades for Office Buildings - Literature Review Report" (9.86MB). Division of Energy and Building Design, Department of Construction and Architecture, Lund Institute of Technology, Lund University, Report EBD-R—04

Ref. 2. Straw M.P. (2000). Computation and Measurement of Wind Induced Ventilation: PhD thesis/ Nottingham University

Appendix

Questionnaire

GENERAL

1 Program name and version number

2 Name of organization performed the simulations

3 Name of person performed simulations and contact information

4 Program status

☐ Freeware
☐ Commercial
☐ Other, please specify

5 Time convention for weather data: first interval in the weather input lasts 00:00-01:00, climate is assumed constant over the sampling interval

☐ Yes
☐ No, please specify

CALCULATION OF BOUNDARY CONDITIONS

6 Please specify the solar model for calculation of incident solar radiation

7 Transmission of the direct solar radiation into zone 1

☐ Calculated with the constant solar heat gain coefficient (g-value)
☐ Calculated with the g-value as a function of incidence (function of incidence is fixed within code)
☐ Calculated with the g-value as a function of incidence (function of incidence is user defined)
☐ Other, please specify

8 Transmission of the direct solar radiation into zone 2

☐ Treated as diffuse solar radiation and calculated with the constant g-value
☐ Calculated with the g-value as a function of incidence (function of incidence is fixed within code)
☐ Calculated with the g-value as a function of incidence (function of incidence is user defined)
☐ Other, please specify

9 Transmission of the diffuse solar radiation into zone 1

☐ Calculated with the solar heat gain coefficient at the solar incidence 60^o
☐ Other, please specify

10 Distribution of solar radiation to the surfaces in the zone 1

☐ Distributed equally to all surfaces
☐ Calculated according surface area weighting
☐ Calculated according to solar path and view factors
☐ Other, please specify

11 Distribution of solar radiation to the surfaces in the zone 2

☐ Distributed equally to all surfaces
☐ Calculated according surface area weighting
☐ Calculated according to solar path and view factors
☐ Other, please specify

MODEL DEFINITIONS

12 Air temperature in the zone 1 is calculated as:

☐ One node temperature
☐ Few zones are stacked on the top of each other and the air temperature in each of zones is calculated, please specify number of stacked zones
☐ Other, please specify

13 Air temperature in the zone 2 is calculated as:

☐ One node temperature
☐ Few zones are stacked on the top of each other and the air temperature in each of zones is calculated, please specify number of stacked zones
☐ Other, please specify

HEAT EXCHANGE WITH EXTERIOR

14 External heat transfer coefficients

☐ Split radiative/convective
☐ Combined radiative/ convective
☐ Other, please specify

15 External heat transfer coefficients are calculated with identical assumptions for all surfaces (window frame, window glazing, walls etc.)

☐ Yes
☐ No, please specify

16 External convection

☐ Constant coefficients fixed within code
☐ User-specified constant coefficients
☐ Calculated within code as a function of orientation
☐ Calculated within code as a function of wind speed
☐ Calculated within code as a function of wind speed and direction
☐ Other, please specify

17 External radiative heat exchange

☐ Assumed to be ambient temperature
☐ Assumed to be sky temperature
☐ Other, please specify

HEAT TRANSFER WITHIN ZONES

18 Internal heat transfer coefficients

☐ Split radiative/convection
☐ Combined radiative/ convective
☐ Other, please specify

19 Internal heat transfer coefficients are calculated with identical assumptions in all zones and for all surfaces (window frame, window glazing, walls etc.)

☐ Yes
☐ No, please specify

20 Internal convection

☐ Constant coefficients fixed within code
☐ User-specified constant coefficients
☐ Calculated within code as a function of orientation (vertical/horizontal)
☐ Calculated within code as a function of temperature difference
☐ Calculated within code as a function of air velocity in the zone
☐ Calculated within code as a function of surface finishes
☐ Other, please specify

21 Longwave radiation exchange within zone

☐ Constant linearized coefficients
☐ Linearized coefficients based on view factors
☐ Linearized coefficients based on surface emissivities
☐ Nonlinear treatment of radiation heat exchange
☐ Other, please specify

WINDOW

22 Window

☐ Window frame and glazing are modelled as separate elements of construction
☐ Window frame and glazing are modelled as separate elements of construction, but the total U-value is calculated within the code
☐ Window frame and glazing are modelled as separate elements of construction, but the total U-value and g-value are calculated within the code
☐ Other, please specify

23 Glazing temperature

☐ Calculated for 1 nodal point on the basis of fixed resistance
☐ Calculated dynamically, using the same scheme as for opaque elements
☐ Other, please specify

AIRFLOW MODEL

24 Discharge coefficient

- ☐ Fixed within the code
- ☐ User-specified fixed value
- ☐ Calculated by code, please specify what are the parameters involved in code calculations
- ☐ Other, please specify

25 Pressure difference coefficients

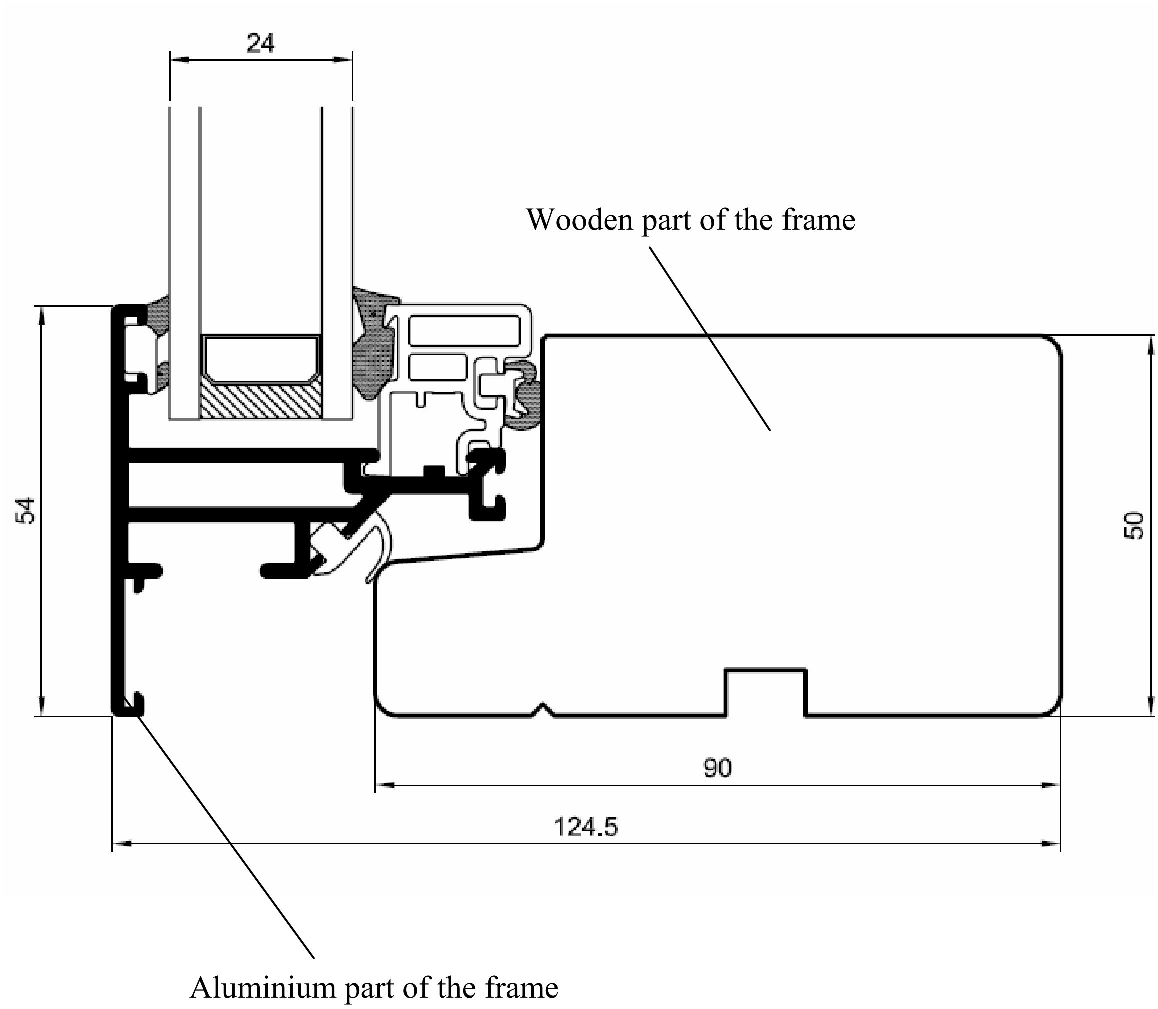
- ☐ Fixed within the code, identical for all openings sharing the same surface
- ☐ User-specified, identical for all openings sharing the same surface
- ☐ User-specified for every opening
- ☐ Other, please specify

26 Calculated mass flow rate in the model is a function of

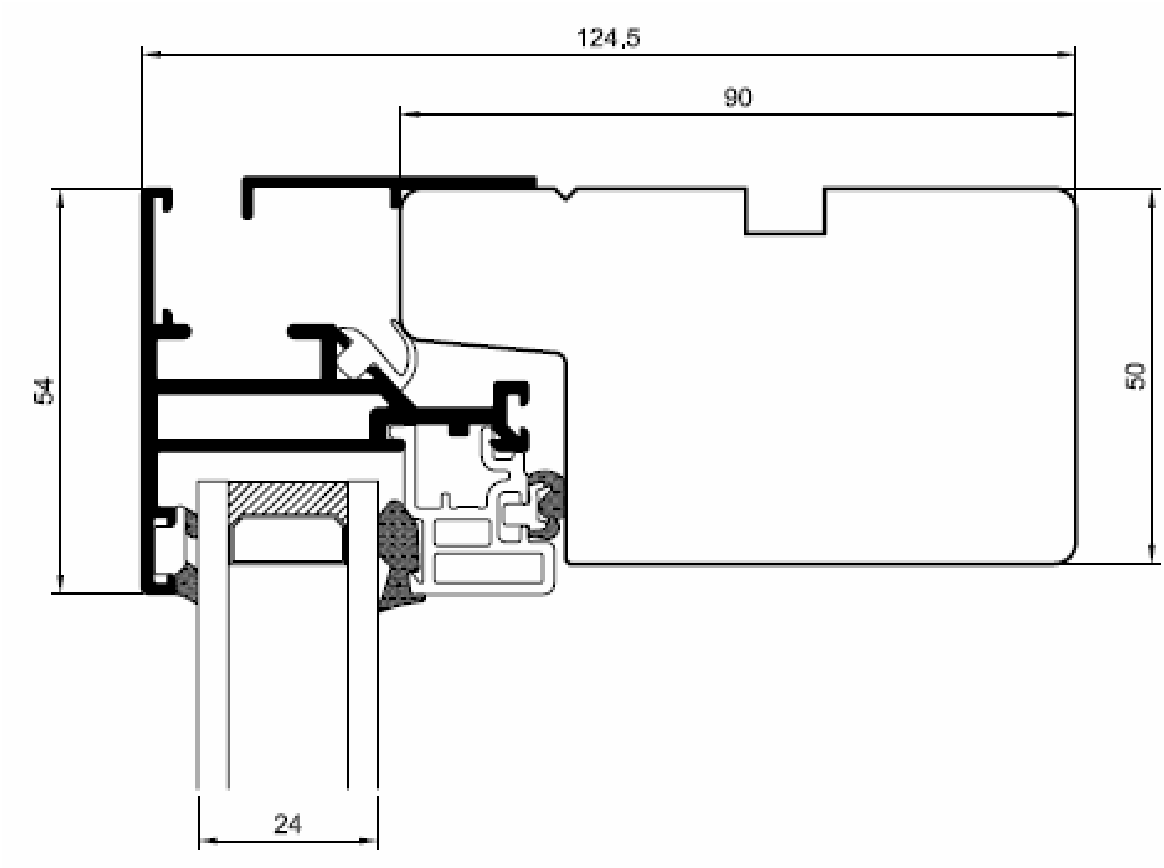
- ☐ Buoyancy force
- ☐ Wind pressure
- ☐ Wind turbulence
- ☐ Other, please specify

Frame drawings

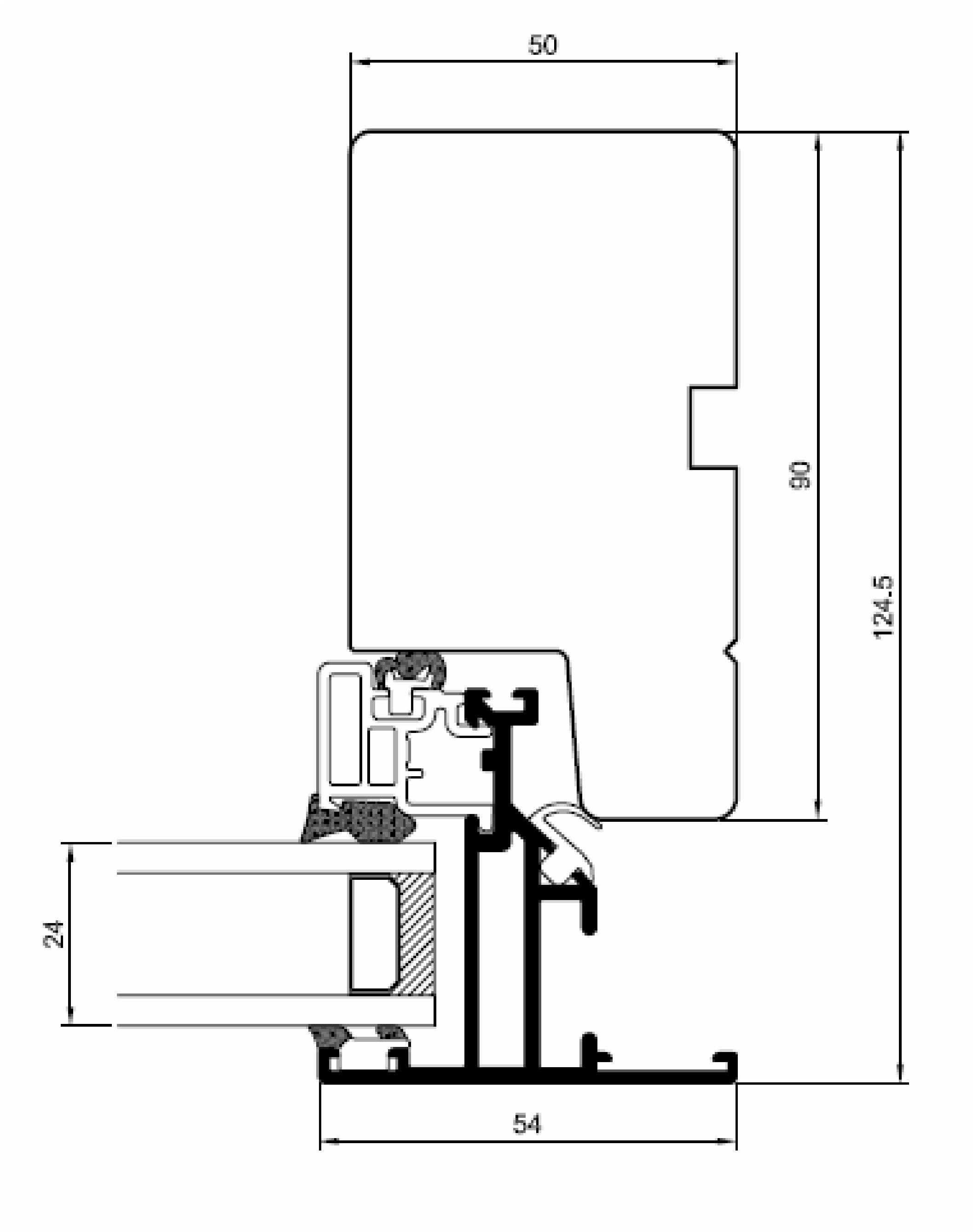
Bottom frame



Top frame



Side frame



Climate data

Climate data for the test case DSF100_2, DSF200_4 and DSF400_3

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m²	Diffuse solar irradiation, W/m²	Direct solar irradiation, W/m²	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	17	1	4.3	3.2	0	0	0	0	280	5	102000	93
4	17	2	4.1	3.3	0	0	0	10	280	5.1	101970	95
4	17	3	4.1	3.5	0	0	0	10	270	5.7	101930	96
4	17	4	4	3.6	0	0	0	20	270	6	101900	97
4	17	5	4	3.7	0	0	0	40	270	6.7	101900	98
4	17	6	4.3	4	35	32	49	50	260	7	101900	98
4	17	7	4.8	4.2	105	87	90	70	260	7.7	101900	96
4	17	8	5.1	3.8	276	175	297	70	260	8.2	101900	91
4	17	9	5.9	3.5	317	225	196	70	270	8.9	101900	85
4	17	10	6.7	2.9	329	267	108	70	270	9.3	101900	77
4	17	11	7.5	2.2	461	328	204	70	270	10.7	101870	69
4	17	12	8.1	1.2	485	333	219	70	280	11.5	101830	62
4	17	13	8.7	0.6	350	285	93	70	280	14	101800	57
4	17	14	9	0.2	354	307	70	60	290	12.8	101770	54
4	17	15	9.2	0	372	294	129	60	290	12	101730	52
4	17	16	9	0.1	523	227	587	50	300	11.8	101700	54
4	17	17	8.5	0.4	386	135	656	50	290	10.8	101700	57
4	17	18	7.7	0.7	204	69	551	40	290	9.8	101700	61
4	17	19	6.7	1.1	45	28	166	40	280	8.2	101700	67
4	17	20	6	1.7	2	2	0	40	280	7.7	101730	74
4	17	21	5.2	2.1	0	0	0	40	280	7	101770	80
4	17	22	4.9	2.7	0	0	0	40	280	6.2	101800	86
4	17	23	4.5	2.9	0	0	0	30	280	5.7	101800	89
4	17	24	4.2	3	0	0	0	30	270	4.8	101800	92
4	18	1	3.7	2.7	0	0	0	20	270	3.7	101800	93
4	18	2	2.7	2	0	0	0	20	270	3	101830	95
4	18	3	1	0.6	0	0	0	20	270	2	101870	97
4	18	4	-0.1	-0.2	0	0	0	20	0	0	101900	99
4	18	5	0.6	0.6	0	0	0	30	50	1.5	101970	100
4	18	6	2.5	1.8	46	31	239	30	50	2	102030	95

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	18	7	4.2	1.3	191	71	585	40	50	2.1	102100	81
4	18	8	5.6	-1.2	302	94	602	50	60	2.6	102170	60
4	18	9	6.8	-4.6	438	123	665	50	60	3	102230	40
4	18	10	8	-7.3	537	158	654	60	70	3.1	102300	28
4	18	11	8.9	-8.5	665	117	834	50	30	4	102300	24
4	18	12	9.5	-8.6	801	101	1000	50	350	4.6	102300	23
4	18	13	10	-8.2	821	94	1031	40	310	5.2	102300	23
4	18	14	10.2	-8.1	715	88	931	40	310	5.1	102270	23
4	18	15	10	-8.3	617	97	857	30	310	5.1	102230	23
4	18	16	9.7	-8.6	384	125	509	30	310	5.1	102200	22
4	18	17	9	-9	400	168	600	40	340	5	102200	22
4	18	18	8.2	-9	231	91	561	50	10	4.1	102200	24
4	18	19	7.2	-8.2	72	55	159	60	40	3.9	102200	27
4	18	20	5.8	-6.6	1	1	0	60	40	3	102200	35
4	18	21	4.4	-4.6	0	0	0	60	40	2	102200	47
4	18	22	3	-2.8	0	0	0	60	0	0	102200	62
4	18	23	1	-2.6	0	0	0	50	0	0	102200	73
4	18	24	-0.5	-2.9	0	0	0	30	0	0	102200	80
4	19	1	-1	-2.6	0	0	0	20	0	0	102200	86
4	19	2	-1.4	-2.6	0	0	0	20	0	0	102170	89
4	19	3	-1.5	-2.3	0	0	0	10	0	0	102130	93
4	19	4	-1	-1.7	0	0	0	10	0	0	102100	94
4	19	5	-0.7	-1.4	0	0	0	20	0	0	102070	94
4	19	6	1	-0.4	46	28	270	40	0	0	102030	90
4	19	7	3.6	0.2	201	70	623	50	0	0	102000	78
4	19	8	5.6	-1.5	297	139	450	60	150	2.5	101970	58
4	19	9	7.7	-3.6	405	181	468	60	150	3.5	101930	41
4	19	10	9	-5.5	453	228	385	70	150	5.3	101900	32
4	19	11	9.9	-5.8	600	270	499	60	150	5.3	101870	29
4	19	12	9.6	-5.8	590	243	493	60	160	5.3	101830	30
4	19	13	9.3	-5.4	582	297	402	50	160	5.1	101800	31
4	19	14	9.7	-4.7	514	287	335	50	150	5.1	101730	33
4	19	15	10	-4.2	516	321	319	60	140	5.1	101670	34
4	19	16	10	-3.6	229	173	109	60	130	5.1	101600	36
4	19	17	9.1	-3.1	74	64	26	60	130	5.7	101530	40
4	19	18	8.4	-1.7	38	36	8	70	140	5.7	101470	47

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	19	19	7.3	-0.6	36	35	9	70	140	6	101400	57
4	19	20	6.4	0.5	2	2	0	70	140	4	101370	66
4	19	21	6	1.6	0	0	0	70	140	2.6	101330	73
4	19	22	5.7	2.7	0	0	0	70	0	0	101300	81
4	19	23	5.9	3.9	0	0	0	70	0	0	101200	87
4	19	24	6.2	5	0	0	0	80	0	0	101100	92
4	20	1	6.4	5.7	0	0	0	80	0	0.9	101000	95
4	20	2	6.7	6.4	0	0	0	80	0	0	100930	98
4	20	3	6.8	6.7	0	0	0	80	0	0	100870	99
4	20	4	6.9	6.9	0	0	0	80	0	1	100800	100
4	20	5	7	7	1	1	0	80	0	1	100700	100
4	20	6	7.4	7.4	4	4	0	80	0	1	100600	100
4	20	7	7.9	7.9	13	13	0	80	0	1	100500	100
4	20	8	8.4	8.4	46	41	14	80	260	2.1	100470	100
4	20	9	8.9	8.9	110	78	66	80	260	3.1	100430	100
4	20	10	9	9	99	81	31	80	260	5	100400	100
4	20	11	8.8	8.7	136	107	44	80	260	6.1	100400	99
4	20	12	8.1	7.9	149	117	45	80	270	7.9	100400	99
4	20	13	7.7	7.4	80	68	17	80	270	9.3	100400	98
4	20	14	7.3	7.1	111	90	31	80	280	7.4	100430	99
4	20	15	7.1	7	91	77	23	80	290	6	100470	99
4	20	16	7	7	59	49	19	80	300	4.3	100500	100
4	20	17	7	7	63	53	25	80	300	4	100530	100
4	20	18	6.8	6.8	31	31	0	80	310	3.6	100570	100
4	20	19	6.7	6.7	17	16	9	80	310	3.1	100600	100
4	20	20	6.3	6.3	1	1	0	80	320	3	100630	100
4	20	21	6.3	6.3	0	0	0	80	320	2.6	100670	100
4	20	22	6	6	0	0	0	80	330	2.3	100700	100
4	20	23	5.8	5.8	0	0	0	80	330	3	100730	100
4	20	24	5.4	5.4	0	0	0	80	340	3.3	100770	100
4	21	1	5.2	5.2	0	0	0	80	340	4.1	100800	100
4	21	2	5	5	0	0	0	80	340	4	100830	100
4	21	3	5	4.9	0	0	0	80	340	3.5	100870	99
4	21	4	5	5	0	0	0	80	340	3.1	100900	100
4	21	5	4.7	4.7	0	0	0	80	330	3.6	100970	100
4	21	6	4.6	4.6	8	8	0	80	330	4	101030	100

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	21	7	4.9	4.9	28	27	5	80	320	4.3	101100	100
4	21	8	5.3	4.8	103	84	53	80	320	4.7	101130	97
4	21	9	6	5	139	111	57	70	320	5	101170	93
4	21	10	6.2	5	285	242	72	70	320	5.1	101200	92
4	21	11	5.8	4.9	242	205	55	70	340	5	101300	94
4	21	12	5.3	4.8	258	218	56	80	360	4.7	101400	97
4	21	13	5	4.6	144	113	43	80	20	4.3	101500	97
4	21	14	5	4	154	119	51	80	10	4.1	101600	93
4	21	15	5.1	3.2	98	80	29	80	350	4.1	101700	87
4	21	16	5.3	2.6	54	47	13	80	340	4.1	101800	83
4	21	17	5.4	2.3	75	63	30	80	340	4	101870	80
4	21	18	5.2	2	33	32	4	80	340	4	101930	80
4	21	19	5	2.1	23	21	17	80	340	4	102000	81
4	21	20	4.7	2.2	5	5	0	80	340	2.9	102070	84
4	21	21	4	2	0	0	0	70	340	2.1	102130	87
4	21	22	3.8	2.2	0	0	0	70	0	1	102200	89
4	21	23	3.5	2.1	0	0	0	60	0	0.9	102230	91
4	21	24	3.2	2	0	0	0	40	0	0.7	102270	92
4	22	1	2.6	1.7	0	0	0	30	0	1	102300	94
4	22	2	2.2	1.6	0	0	0	50	0	0	102330	96
4	22	3	2	1.8	0	0	0	60	0	0	102370	99
4	22	4	2.2	2.1	0	0	0	80	0	0	102400	99
4	22	5	3	2.6	1	1	0	70	210	1.7	102430	97
4	22	6	4	2.9	25	25	0	70	210	2.5	102470	93
4	22	7	5	3.3	100	83	75	60	210	3	102500	89
4	22	8	5.7	3.5	293	195	268	60	230	3.4	102530	86
4	22	9	6.4	3.8	337	271	134	60	240	4	102570	83
4	22	10	7	4.2	344	286	97	60	260	5	102600	82
4	22	11	7.5	4.6	226	194	47	60	270	5.6	102600	82
4	22	12	8	4.9	244	208	50	70	270	6.2	102600	81
4	22	13	8.3	5	261	230	43	70	280	7.2	102600	80
4	22	14	9	5.4	250	212	55	70	270	6.9	102600	78
4	22	15	9.9	6.1	292	241	82	80	270	6.2	102600	77
4	22	16	10.3	6.8	395	302	177	80	260	6	102600	79
4	22	17	10.3	7.6	67	56	27	80	260	5.1	102600	83
4	22	18	9.7	8.1	29	29	0	70	270	4.6	102600	90

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	22	19	9.1	8.3	25	23	16	70	270	3.7	102600	95
4	22	20	9	8.3	4	3	36	70	270	4	102630	95
4	22	21	8.9	7.9	0	0	0	70	270	4	102670	93
4	22	22	8.4	7.3	0	0	0	70	270	4.1	102700	93
4	22	23	7.6	6.8	0	0	0	60	270	3.6	102700	95
4	22	24	6.5	6.1	0	0	0	60	270	3	102700	97
4	23	1	6	5.9	0	0	0	50	270	2.7	102700	99
4	23	2	5.8	5.7	0	0	0	50	270	3.1	102700	99
4	23	3	5.9	5.7	0	0	0	50	280	4.1	102700	99
4	23	4	6	5.8	0	0	0	50	280	5.5	102700	99
4	23	5	6	6	0	0	0	40	280	5	102700	100
4	23	6	6.1	6.1	57	37	222	40	270	4.6	102700	100
4	23	7	6.6	6.6	210	71	601	30	270	4.1	102700	100
4	23	8	7.8	6.2	340	110	620	40	280	5.6	102700	90
4	23	9	9.2	5.4	443	166	556	50	280	7	102700	77
4	23	10	10.6	4.7	526	209	526	60	290	8.2	102700	67
4	23	11	11.2	3.8	627	236	576	60	300	8.3	102670	60
4	23	12	11.4	3.2	753	313	610	70	300	8.7	102630	57
4	23	13	11.8	3.3	539	419	165	70	310	8.9	102600	56
4	23	14	11.9	3.4	504	396	156	70	300	8.7	102600	56
4	23	15	11.9	3.6	433	343	144	70	300	8.3	102600	57
4	23	16	11.7	3.9	394	279	218	70	290	8	102600	59
4	23	17	11.5	4.4	269	201	167	50	280	7	102570	62
4	23	18	11.2	5	158	104	200	40	280	6	102530	66
4	23	19	10.8	5.8	30	30	0	20	270	5	102500	71
4	23	20	9.9	6.4	7	6	38	20	270	3.1	102500	79
4	23	21	8.2	6.4	0	0	0	30	270	2.1	102500	88
4	23	22	6.8	6.2	0	0	0	30	0	0	102500	96
4	23	23	6	6	0	0	0	20	0	0	102500	100
4	23	24	5.4	5.4	0	0	0	20	0	0	102500	100
4	24	1	5	5	0	0	0	10	0	0	102500	100
4	24	2	4	3.9	0	0	0	10	0	0	102470	99
4	24	3	3.2	3.1	0	0	0	10	0	0	102430	99
4	24	4	3	3	0	0	0	10	0	0	102400	100
4	24	5	3.5	3.5	0	0	0	30	0	0	102370	100
4	24	6	4.5	4.5	22	21	11	60	0	0	102330	100

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	24	7	6	6	78	66	51	80	0	0	102300	100
4	24	8	7.9	6.2	162	128	90	70	280	1.5	102270	89
4	24	9	9.3	5.4	267	223	88	60	280	2	102230	77
4	24	10	10.7	4.8	464	281	301	50	280	2.3	102200	67
4	24	11	11	3.9	575	346	335	40	280	3	102170	62
4	24	12	11.3	3.5	700	248	623	30	290	5	102130	59
4	24	13	11.7	3.3	713	311	551	20	290	6.7	102100	56
4	24	14	12	2.9	683	291	562	20	300	5.7	102030	54
4	24	15	12.2	2.5	545	235	492	30	310	5	101970	51
4	24	16	12.2	2.3	478	176	567	30	320	4.1	101900	51
4	24	17	11.8	2.6	362	161	489	30	320	4	101870	53
4	24	18	11.1	3.2	216	125	332	30	310	3.6	101830	58
4	24	19	10.6	4.4	82	62	151	30	310	3.1	101800	65
4	24	20	9.5	5.1	9	9	0	30	310	2.8	101800	74
4	24	21	8.6	5.9	0	0	0	30	310	2	101800	83
4	24	22	7.9	6.5	0	0	0	30	0	0	101800	91
4	24	23	7	6.4	0	0	0	30	0	0	101770	96
4	24	24	6.7	6.3	0	0	0	20	0	0	101730	97
4	25	1	6	5.7	0	0	0	20	0	0	101700	98
4	25	2	5.2	4.9	0	0	0	20	0	0	101670	98
4	25	3	4.7	4.5	0	0	0	20	0	0	101630	99
4	25	4	4.2	4.2	0	0	0	20	0	0	101600	100
4	25	5	4.3	4.3	1	1	0	20	280	1.9	101600	100
4	25	6	5.1	5.1	48	35	131	20	280	2.4	101600	100
4	25	7	6.3	6.3	203	109	390	20	280	3	101600	100
4	25	8	7.8	6.4	314	159	407	20	280	3.4	101570	91
4	25	9	9.4	5.9	436	199	467	20	290	4	101530	79
4	25	10	10.7	5.3	561	220	558	20	290	5	101500	69
4	25	11	11.3	4.5	655	226	624	20	300	4.8	101470	63
4	25	12	12	4.2	744	214	727	10	320	4.6	101430	59
4	25	13	12.5	3.8	736	213	713	10	330	4.3	101400	55
4	25	14	12.7	2.9	674	198	679	10	320	4.6	101370	51
4	25	15	12.7	1.9	611	161	710	10	310	5	101330	48
4	25	16	12.3	0.9	499	131	686	10	300	5.1	101300	46
4	25	17	12	0.6	390	106	684	10	310	5.1	101300	45
4	25	18	11.6	1	256	76	646	0	310	5.1	101300	48

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	25	19	11	2	95	45	368	0	320	5.1	101300	54
4	25	20	9.4	2.9	0	0	0	0	310	4.6	101300	64
4	25	21	7.2	3.4	0	0	0	10	290	3.6	101300	77
4	25	22	5.7	4	0	0	0	10	280	3	101300	89
4	25	23	5.3	4.4	0	0	0	20	280	2.5	101330	94
4	25	24	5.7	4.7	0	0	0	20	280	1.9	101370	93
4	26	1	6.4	4.7	0	0	0	30	0	0	101400	89
4	26	2	7	4.6	0	0	0	40	80	2.7	101500	85
4	26	3	7.4	4.5	0	0	0	50	80	4.1	101600	82
4	26	4	7.7	4.2	0	0	0	60	80	6.3	101700	78
4	26	5	7.6	3.7	3	3	0	50	80	6.7	101800	76
4	26	6	7.3	2.9	42	40	19	40	80	6.7	101900	74
4	26	7	7	2.1	147	93	219	30	80	6.6	102000	71
4	26	8	7	1.4	358	91	693	20	70	5.7	102070	67
4	26	9	7	0.5	451	97	692	20	70	5	102130	63
4	26	10	7.6	-0.2	651	104	888	10	60	4	102200	57
4	26	11	8.3	-1	637	152	701	20	80	3.4	102230	51
4	26	12	9	-1.6	704	251	618	20	110	3	102270	46
4	26	13	9.8	-1.6	768	185	791	30	130	3	102300	43
4	26	14	10	-1.2	731	167	800	30	150	3	102300	45
4	26	15	9.4	-0.9	633	136	779	30	160	3.3	102300	48
4	26	16	8.7	-0.2	519	123	733	30	180	3.6	102300	53
4	26	17	7.7	0.3	416	138	664	20	170	3.6	102330	59
4	26	18	6.7	0.5	249	101	523	20	170	3.6	102370	65
4	26	19	5.7	0.4	99	56	303	10	160	3.8	102400	69
4	26	20	5	-0.1	0	0	0	10	160	3	102430	69
4	26	21	4.3	-0.7	0	0	0	10	150	2.9	102470	69
4	26	22	3.8	-0.8	0	0	0	10	150	2.1	102500	71
4	26	23	3.3	-0.1	0	0	0	10	150	2	102570	78
4	26	24	3	1.2	0	0	0	10	150	1.5	102630	88
4	27	1	2.1	1.6	0	0	0	10	0	0.3	102700	96
4	27	2	1.7	1.6	0	0	0	10	0	0.3	102730	99
4	27	3	1	0.8	0	0	0	0	0	0.5	102770	99
4	27	4	1	0.6	0	0	0	0	0	0.5	102800	97
4	27	5	1.8	1.4	4	3	43	20	240	2	102830	97
4	27	6	3	2.6	89	46	394	40	240	2.7	102870	97

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	27	7	4.2	2.9	214	157	227	60	240	3.1	102900	91
4	27	8	5.6	2.3	326	160	426	50	250	4	102900	79
4	27	9	7	1.2	489	112	731	30	250	4.7	102900	67
4	27	10	8.5	0.2	613	126	785	20	260	5.3	102900	56
4	27	11	9.7	-0.4	687	154	767	30	260	5.7	102900	49
4	27	12	10.4	-1	721	206	699	40	250	5.8	102900	44
4	27	13	10.7	-1.6	760	319	595	50	250	6	102900	41
4	27	14	10.9	-2.1	670	216	641	60	260	6	102900	39
4	27	15	11	-2.4	532	292	374	60	260	6	102900	37
4	27	16	11	-2.6	468	245	410	70	270	6	102900	37
4	27	17	11	-2.5	263	211	123	70	260	5.1	102870	37
4	27	18	10.8	-2.4	133	106	94	70	250	4.6	102830	38
4	27	19	10.6	-2.2	64	52	83	70	240	4	102800	39
4	27	20	10.2	-2	7	7	0	70	240	3.8	102830	41
4	27	21	9.2	-2.3	0	0	0	70	240	3.8	102870	42
4	27	22	8.8	-1.8	0	0	0	70	240	3.6	102900	46
4	27	23	8.3	-1	0	0	0	70	240	4	102900	51
4	27	24	8	0	0	0	0	60	250	4	102900	57
4	28	1	7.7	1	0	0	0	60	250	4.1	102900	62
4	28	2	7.2	1.5	0	0	0	50	250	4	102870	67
4	28	3	6.8	2	0	0	0	40	250	3.6	102830	71
4	28	4	6.5	2.2	0	0	0	30	250	3.1	102800	74
4	28	5	6.8	2.7	3	3	0	40	250	3.7	102830	75
4	28	6	7.3	2.9	61	51	88	40	260	4.4	102870	74
4	28	7	8.3	2.5	160	121	153	50	260	5	102900	67
4	28	8	9.6	1.3	251	191	152	40	260	6.1	102900	56
4	28	9	10.8	-0.4	374	247	244	40	260	7.2	102900	45
4	28	10	11.5	-2.1	535	256	447	30	260	8.9	102900	37
4	28	11	12.4	-2.6	644	261	548	20	260	8	102870	33
4	28	12	13	-2.5	692	251	596	20	260	7.7	102830	32
4	28	13	13.5	-2.1	726	238	655	10	260	7	102800	32
4	28	14	14	-1.7	681	189	691	10	260	6.9	102770	33
4	28	15	14.2	-1.5	594	177	647	10	260	6.2	102730	33
4	28	16	14.7	-1	495	163	607	10	260	6	102700	33
4	28	17	14.4	-1.2	388	129	607	10	260	4	102700	33
4	28	18	13.7	-1.3	266	82	634	0	250	2.9	102700	35

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	28	19	13.1	-1	104	49	370	0	250	1.5	102700	37
4	28	20	12.1	-0.5	12	12	0	20	250	1.3	102700	41
4	28	21	11	0.3	0	0	0	30	250	1	102700	48
4	28	22	10	1.3	0	0	0	50	0	1	102700	55
4	28	23	8.3	1.4	0	0	0	30	0	1	102700	62
4	28	24	7	1.8	0	0	0	20	0	1	102700	69
4	29	1	5.7	2.1	0	0	0	0	0	1	102700	78
4	29	2	4.7	2.6	0	0	0	0	0	1	102700	86
4	29	3	4	2.8	0	0	0	0	0	0.7	102700	92
4	29	4	4	2.6	0	0	0	0	0	1	102700	91
4	29	5	5.4	2.3	4	4	0	0	170	1.9	102670	80
4	29	6	7.8	2	81	43	323	10	170	2.5	102630	67
4	29	7	10.5	1.8	224	72	584	10	170	3	102600	55
4	29	8	11.6	0.4	353	98	639	10	170	3	102570	46
4	29	9	13	-0.4	482	114	702	10	160	3.3	102530	39
4	29	10	13.7	-1.4	608	124	771	10	160	3.6	102500	34
4	29	11	14.7	-1.8	689	129	796	20	160	5	102430	31
4	29	12	15	-2.7	776	143	851	20	160	6.2	102370	28
4	29	13	14.9	-3.3	785	146	854	30	160	7.9	102300	26
4	29	14	15.4	-2.8	696	147	767	30	160	7.7	102270	27
4	29	15	16.1	-1.8	621	127	762	20	160	7.9	102230	28
4	29	16	16.6	-0.9	509	114	717	20	160	7.7	102200	30
4	29	17	15.9	-1.2	398	108	674	30	150	6.7	102130	30
4	29	18	14	-2.3	248	80	571	30	150	5.3	102070	31
4	29	19	13.2	-1.5	119	60	386	40	140	4.1	102000	35
4	29	20	12	-0.1	21	20	26	30	140	4	101970	43
4	29	21	10.9	2	0	0	0	30	140	4	101930	54
4	29	22	9.6	3.6	0	0	0	20	140	4	101900	66
4	29	23	8.5	4.4	0	0	0	20	130	3.3	101900	75
4	29	24	8	5.1	0	0	0	10	110	3	101900	82
4	30	1	7.7	5.6	0	0	0	10	100	3	101900	87
4	30	2	7.5	5.9	0	0	0	10	110	3	101830	90
4	30	3	7.4	6	0	0	0	10	110	3	101770	91
4	30	4	7.8	6.2	0	0	0	10	120	3	101700	90
4	30	5	8.4	6.3	5	4	27	20	120	3.1	101670	87
4	30	6	9.5	6.4	79	61	146	40	130	3.3	101630	81

Month	Date	Hour	External air temperature, °C	Dew point temperature, °C	Global solar irradiation, W/m^2	Diffuse solar irradiation, W/m^2	Direct solar irradiation, W/m^2	Cloud cover, 0.1octa	Wind direction, deg	Wind speed, m/s	Atmospheric pressure, Pa	Relative humidity, %
4	30	7	10.7	6.4	207	135	272	50	130	3.1	101600	75
4	30	8	11.3	5.5	335	188	365	50	140	3.6	101570	67
4	30	9	12.4	4.9	419	233	352	50	140	4	101530	60
4	30	10	13.3	3.9	497	263	370	50	150	4	101500	53
4	30	11	15.1	3.7	648	289	508	60	160	4.6	101470	46
4	30	12	17.1	4.2	547	373	233	60	160	4.6	101430	42
4	30	13	18.9	5.2	578	357	294	70	170	5	101400	41
4	30	14	18.2	4.9	550	301	346	70	170	4.3	101370	41
4	30	15	17.5	5.4	327	265	95	70	170	4	101330	45
4	30	16	15.7	5.2	212	180	58	70	170	3.3	101300	50
4	30	17	13.9	5	177	145	74	70	170	2.7	101300	55
4	30	18	13.3	5.9	81	68	44	70	170	2	101300	61
4	30	19	12.9	7.1	62	53	57	70	0	1	101300	68
4	30	20	12.8	8.5	6	6	0	70	0	1	101300	75
4	30	21	12.6	9.6	0	0	0	70	0	1	101300	82
4	30	22	11.2	9.4	0	0	0	70	0	1	101300	89
4	30	23	8.3	7.3	0	0	0	70	0	0.7	101730	93
4	30	24	4	3.6	0	0	0	70	0	0	102170	97

Climate data for the test case DSF200_3

Climate data in the test case DSF200_3 is exactly the same as for the test case DSF100_2, DSF200_4 and DSF400_3, except for the column "Wind speed, m/s", which contents is replaced by zero-values.

ISSN 1901-726X
DCE Technical Report No. 028