Pro-Forma Questionnaire for Building Thermal Fabric Update Tests, July 2015

[Note revisions are based on participant comments during the Round 1 simulation trial. This also integrates selected items from Crawley, Hand, Kummert, and Griffith (1995), "Contrasting the Capabilities of Building Energy Performance Simulation Programs".]

Instructions: Replace empty boxes with symbols just below, as appropriate. Provide additional information and comments as appropriate. ***Some responses may require marking more than one box for a given query.*** *If specific responses require disclosure of proprietary data not normally available to users in the program's engineering manual, leave the response blank.*

☒ Possible to use

■ Used to develop simulation trial results

Program name, including version number

California Simulation Engine (CSE 0.831).

Your name and organization

Neal Kruis, Big Ladder Software .

Date

4/26/17 .

Questions from June 30, 2014 Seattle SSPC 140 Meeting (updated May 2015)

[tkjn: Integrate with other queries topically after sim trials]

1. Are user input constant surface coefficients (not automatically calculated for each time step) applied by the program?

☑ Yes
☐ No

2. If yes for #1, are constant coefficients applied for?

☑ Interior surfaces
☑ Exterior surfaces

3. If yes for #1, were the provided default coefficients of Sections 5.2.1.9, 5.2.1.10, and/or Annex B4 Section B4.1.3 applied?

☑ For all surfaces
☐ For some surfaces (indicate which surfaces)________________________.
☐ No

4. If yes for #1 (whether actually used for simulation results or not), are user input constant coefficients applied as?

For Interior surfaces:
☐ Total Combined Convective and Radiative Heat Transfer
☑ Convection Only
☐ Radiation Only
☐ Other (please specify) ____________________________.
For Exterior surfaces:
☐ Total Combined Convective and Radiative Heat Transfer
☑ Convection Only
☐ Radiation Only
☐ Other (please specify) ____________________________.

5. For user input constant coefficients indicated in #4, are values allowed to vary with individual surfaces and their orientations?

For Interior surfaces:
☑ Yes
☐ No
☐ Other (please specify) ____________________________.
For Exterior surfaces:
☑ Yes
☐ No
☐ Other (please specify) ____________________________.

6. If you provided detailed convective surface coefficient (h_{conv}) results in Sec5-2Aout.xls (rows 910 – 976 [tk]), was this output?

☑ h_{conv} directly provided by the program
☐ h_{conv} calculated per instructions of Section 6.2.1.2.3.4
☐ Other (please specify) ______________________________.

7. If you did not provide h_{conv} results (see #6), was this because?

☐ Insufficient detailed output is provided by the program for calculating h_{conv}
☐ Other (please specify) ______________________________.

8. What is the maximum opaque (non-window) layer insulation R-value (m^2K/W) allowed by your program? If this varies for opaque surface types, provide a listing – for now this query is more pertinent to surface types that could be used for modeling the raised floor.

inifinite m^2K/W.

Pro-Forma Queries from IEA BESTEST (1995), updated May 2015

Note to simulation trial participants: These are included from IEA BESTEST 1995 with a few revisions. Please continue to comment if you feel something should be revised, added, or deleted here as we move forward with the simulation trials.

Program status
☐ Public domain
☑ Open source license available
☐ Commercial
☐ Other (please specify) ____.

General simulation solution approach
☐ Sequential loads, system, plant calculation without feedback
☑ Simultaneous loads, system, and plant solution
☑ Space temperature calculation based on loads-systems feedback
☐ Other (please describe) ____.

Time step approach
☑ User selected
☐ Automatically variable, constant intervals
☐ Automatically variable, dynamically varying based on solution transients
☐ Other (please describe) ____.

Minimum time steps for simulation
☐ One hour
☑ Subhourly (please specify minimum interval) None.
☐ > one hour (please specify interval, e.g., daily, monthly) ______.

Timing convention for meteorological data: sampling interval
☑ Fixed within code (please specify interval) 1 Hour.
☐ User-specified

Timing convention for meteorological data: period covered by first record
☑ Fixed within code (please specify period or time which meteorological record covers) 1 Year.
☐ User-specified

Meteorological data reconstruction scheme
☐ Climate assumed stepwise constant over sampling interval
☑ Linear interpolation used over climate sampling interval
☐ Other (please specify) ______________________.

Output timing conventions
☑ Produces spot output as calculated values at the end of each timestep
☑ Produces spot output as calculated values at end of each hour
☑ Produces average outputs for each hour (please specify period to which value relates, e.g., “Hour 1 = 0:00 to 1:00” or “Hour 1 = 0:30 to 1:30”, etc.) _______.
☐ Other (please specify) _______.

Full geometric description
☐ Walls, roof, floors
☐ Windows
☐ External shading devices
☑ Other (please describe) Tilt, area, and azimuth are input. Overhang and fin geometry defined on per-window bases.

Element conduction solution method ***[Note: This query moved to here for better topical flow]***
☑ Explicit finite difference
☐ Implicit finite difference
☐ Weighting factors
☐ Response factor
☐ Frequency domain
☐ Other (please specify) ______________________________.

Surface conduction
☑ 1-dimensional
☐ 2- or 3-dimensional
☐ Variable thermal-physical properties

Treatment of zone air
☑ Single temperature (i.e., good mixing assumed)
☐ Stratified model
☐ Simplified distribution model
☐ Full CFD model
☐ Other (please specify) ____________________.

Heat transfer within zones
☐ Radiation and convection combined
☑ Radiation and convection treated separately

Convective heat transfer within zones
☐ Coefficients fixed within code
☐ Coefficients specified by user
☑ Coefficients calculated by code as a function of surface orientation
☑ Coefficients calculated by code as a function of temperature difference
☐ Coefficients calculated by code as a function of surface finishes
☑ Coefficients calculated by code as a function of ventilation airflow
☐ Other (please specify) ____________________.

Longwave radiative heat transfer within zones
☐ Constant linearized coefficients
☑ Linearized coefficients based on viewfactors
☑ Linearized coefficients based on surface emissivities
☐ Non-linear treatment of radiation heat exchange
☑ Other (please specify) Linearized coefficients based on temperature difference

Number of nodes placed within each layer of walls and slabs
☐ Not applicable for this solution method
☐ Fixed number of nodes per layer (please specify) ________________.
☐ User-specified number of nodes per layer
☑ Other (please specify) Calculated to enforce stability.

Airgaps within walls and slabs
☐ Resistance fixed within code
☐ User-specified constant resistance
☐ Resistance calculated within code as a function of orientation
☐ Radiation and convection treated separately across airgaps
☐ Treated as additional zones
☑ Other (please specify) User specified constant or variable resistance.

Windows (heat loss)
☐ Fixed resistance used for window element
☐ Dynamic treatment of window heat loss using same scheme as for opaque elements
☑ Other (please specify) Dynamic treatment using steady-state scheme

Airgaps within windows
☐ Resistance fixed within code
☐ User-specified constant resistance
☐ Resistance calculated within code as a function of orientation
☑ Radiation and convection treated separately across airgaps
☐ Airgaps treated as additional zones
☐ Other (please specify) ________________________.

Windows (transmission of direct shortwave radiation)
☐ Fixed transmission used
☑ Solar heat gain coefficients used
☑ Calculated by code as a function of incidence angle
☐ Calculated by code from user-specified function of incidence angle
☐ Other (please specify) ________________________.

Sky model for diffuse solar radiation
☐ Isotropic
☑ Other (please specify model used) Hay anisotropic model.

Windows (transmission of diffuse radiation)
☑ Diffuse radiation treated as direct from fixed altitude or incidence angle (please specify) At normal incidence
☐ Other (please specify) ________________________.

Advanced fenestration ***[Note: Information useful for consideration of extension cases]***
☐ Data sets of glazing types
☐ Data sets of frame types
☐ Gas fill specifiable as single gas (e.g., Argon) or mixture (e.g., air, Argon/Krypton)
☐ Window frame interaction with edge of glass explicitly modeled
☐ WINDOW data import or calculations (http://windows.lbl.gov/software/window/window.html)
☐ THERM data import or calculations (http://windows.lbl.gov/software/therm/therm.html)
☑ Other (please describe) ASHWAT model with “ratings matching” scheme

Ground reflectance
☐ User defined constant
☑ User defined variation (please specify, e.g., daily, monthly, seasonal) ________________.
☐ Automatically varies hourly or each time step, according to weather data (please describe algorithm, and weather data parameters that drive variation) ____________________________________.
☐ Other (please describe algorithm) ________________.

Shading of windows and walls by a shading object
☑ Only direct beam radiation is shaded
☐ Both direct beam and diffuse radiation are shaded
☐ Reflected solar radiation from ground, other buildings, etc., is shaded
☑ Only one side of a defined shading object actively performs shading
☐ Both sides of a defined shading object actively perform shading
☐ Solar radiation is allowed to be reflected by a shading object
☐ Shading surface transmittance is adjustable
☑ Other (please specify) Shading overhangs and fins applied only to windows.

Distribution of transmitted direct beam solar radiation within zones, and cavity albedo
☐ Fixed within the code
☑ Constant user-specified distribution
☐ Calculated once by code and used throughout (please describe algorithm) ________________.
☐ Calculated as a function of solar position (please describe algorithm) ________________.

Distribution of transmitted diffuse solar radiation within zones, and cavity albedo
☐ Fixed within the code
☑ Constant user-specified distribution
☐ Calculated once by code and used throughout (please describe algorithm) ________________.
☐ Calculated as a function of solar position (please describe algorithm) ________________.

Heat transfer between external surfaces and surrounding environment
☐ Radiation and convection combined
☑ Radiation and convection treated separately

External convection
☐ Coefficients fixed within code
☐ User-specified constant coefficients
☑ Calculated within code as a function of surface orientation
☑ Calculated within code as a function of surface finish
☑ Calculated within code as a function of wind speed
☐ Calculated within code as a function of wind speed and wind direction relative to surface orientation
☐ Other (please specify) ________________________.

External infrared radiative heat transfer
☐ Non-linear treatment of radiation heat exchange
☐ Constant linearized coefficients (or as constant combined convective + radiative coefficients)
☐ Assumed to be to ambient air temperature
☐ Assumed to be to sky temperature read from met file
☐ Based on calculated sky temperature (please specify algorithm and requirements) _____________.
☑ Includes view factor to sky.
☑ Includes view factor to surrounding obstruction(s).
☑ Includes view factor to ground.
☐ Other (please specify model used) ________________.

Surrounding ground surface temperature
☑ Same as weather data air temperature, and varies by time step with weather data
☐ Other (please describe algorithm) _______.

Detailed zone surface output capabilites
☑ Interior-face surface temperatures
☑ Exterior-face surface temperatures
☑ Interior-face surface heat flow
☑ Exterior-face surface heat flow
☐ Surface heat flows disaggregated by convective and radiative portions
☐ Other (please describe) _______.

Infiltration – *[Note: Information useful for consideration of extension cases]*
☑ User input, constant air exchange rate
☑ User input, scheduled air exchange rate
☑ Calculated from input air leakage data (e.g., effective leakage area, crack dimensions, "ACH50", etc.)
 ☐ Calculated constant value (describe algorithm)_____.
 ☑ Calculated each time step, wind and buoyancy (stack) driven (describe algorithm) Sherman-Grimsrud
 ☑ Nodal network, user input wind pressure coefficients
 ☐ Nodal network, wind pressure coefficients calculated each time step (describe algorithm) Pressure network
 ☐ Link to external calculation program (describe program)_____.
☐ Other (please describe) _______.

Heaters (dynamics)
☑ No dynamics assumed (output is instantaneous)
☐ Simple first order dynamics
☐ Detailed modeling of heat source dynamics

Heaters (output characteristics)
☑ Purely convective
☐ Radiative/Convective split fixed within code
☐ Radiative/Convective split specified by user
☐ Detailed modeling of heat source output

Control temperature
☑ Air temperature
☐ Combination of air and radiant temperatures fixed within the code
☐ User-specified combination of air and radiant temperatures
☐ User-specified construction surface temperatures
☐ User-specified temperatures within construction
☐ Other (please specify) _________________________.

Control laws
☑ Perfect control
☐ On/Off thermostatic control
☐ On/Off thermostatic control with deadband
☐ Proportional control
☐ Other (please specify) _________________________.

Previously applied validation tests related to building thermal fabric load modeling[a]

☐ IEA BESTEST (Judkoff and Neymark 1995a; ASHRAE Standard 140-2014, Sections 5.2.1, 5.2.2, 5.2.3)
☐ IEA 34/43 Multi-zone non-airflow (Neymark et al 2008), cases MZ340, MZ350
☑ HERS BESTEST (Judkoff and Neymark 1995b; ASHRAE Standard 140-2014, Section 7)
☐ ASHRAE 1052-RP (Spitler, Rees, and Xiao 2001) analytical verification tests
☐ Other software-to-software comparative tests (please describe) ________________________.
☐ Other analytical verification tests (please describe) ________________________.
☐ Other empirical validation tests (please describe) ________________________.

[a] *Application of other test cases is recommended. We explicitly requested the simulation trial participants to separately run multi-zone cases MZ340 and MZ350 as part of the simulation trial process.*

Validation Test References

ASHRAE. 2014. ANSI/ASHRAE Standard 140-2014. *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs*. Atlanta GA: ASHRAE

Judkoff, R., and J. Neymark. 1995a. *International Energy Agency Building Energy Simulation Test (BESTEST) and Diagnostic Method*. NREL/TP-472-6231. Golden, CO: National Renewable Energy Laboratory. www.nrel.gov/docs/legosti/old/6231.pdf.

Judkoff, R., and J. Neymark. 1995b. *Home Energy Rating System Building Energy Simulation Test (HERS BESTEST), Volume 1: Tier 1 and Tier 2 Tests User's Manual*. NREL/TP-472-7332a. Golden, CO: National Renewable Energy Laboratory. www.nrel.gov/docs/legosti/fy96/7332a.pdf.

Neymark, J., R. Judkoff, D. Alexander, D., C. Felsmann, P. Strachan, A. Wijsman. 2008. *International Energy Agency Building Energy Simulation Test and Diagnostic Method (IEA BESTEST) Multi-Zone Non-Airflow In-Depth Diagnostic Cases: MZ320–MZ360*. NREL Report No. TP-550-43827. Golden, CO: National Renewable Energy Laboratory. www.nrel.gov/docs/fy08osti/43827.pdf

Spitler, J.D., S.J. Rees, and D. Xiao. 2001. *Development of an Analytical Verification Test Suite for Whole Building Energy Simulation Programs—Building Fabric*. Final Report for ASHRAE 1052-RP. Atlanta: ASHRAE.