MODELING NOTES FOR ASHRAE STANDARD 140

INTRODUCTION

This document shall include supplemental information about the ASHRAE Standard 140 tests performed. One S140outNotes document shall be provided for each set of tests (e.g., one for the building thermal and fabric load tests of Sections 5.2.1, 5.2.2, and 5.2.3; one for the space cooling equipment analytical verification tests of Sections 5.3.1 and 5.3.2; etc.) The types of information listed below shall be provided in this document, each in a separate section:

a. Software information
b. Alternative modeling methods
c. Equivalent modeling methods
d. Nonspecified inputs
e. Omitted test cases and results
f. Changes made to source code for the purpose of running the tests, where such changes are not available in publicly released versions of the software
g. Anomalous results.

Notes in this document shall be limited to the topics shown above. Notes must be factual and objective and shall only refer to the software being tested. Notes shall not refer to any other software program.

INFORMATIVE NOTE: Text at the start of each section describes the content of the section for the reader and provides instructions for supplying the content. Sample notes are provided in a separate document (S140outNotes_Examples.TXT).

A. SOFTWARE INFORMATION

CONTENT: This section shall include reference information for the software - the vendor, name, and version of the software, plus operating system and computer hardware requirements.

INSTRUCTIONS: Information for items 1 through 7 below shall be provided. Information for Item 8 shall be permitted but is not required.

1. SOFTWARE VENDOR: Thermal Energy System Specialists, LLC and Transsolar Energietechnik GmbH
2. SOFTWARE NAME: TRNSYS with TESS Type 1267 "Be All End All" Ground Coupling Component
3. SOFTWARE VERSION (unique software version identifier): TRNSYS 18.05.0001 and TESS Libs v18
4. OPERATING SYSTEM REQUIREMENTS: Windows 10, Windows 11
5. APPROX HARD DISK SPACE REQUIRED FOR INSTALLATION: Maximum = 415 MB; Minimum (to run input files) = 51 MB
6. MINIMUM RAM REQUIRED FOR SOFTWARE OPERATION: 128 MB
7. MINIMUM DISPLAY MONITOR REQUIREMENTS: VGA with 600x800 resolution and 256 colors

8. OTHER HARDWARE OR SOFTWARE-RELATED REQUIREMENTS: None

INFORMATIVE NOTE: Item 8 can be used to supply additional relevant information.

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B. REPORT BLOCK FOR ALTERNATIVE MODELING METHODS
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CONTENT: If the software being tested provides alternative modeling methods or algorithms for performing the tests, this section shall describe modeling methods used for the tests.

INSTRUCTIONS: If alternative modeling methods are applicable, a separate note for each alternative modeling method or algorithm situation shall be provided. The standard format shown below and a separate number and title for each note shall be applied. If alternative modeling methods are not applicable, specify "NONE" in place of the information below.

NOTE 1 – Heat Transfer to Zone

1.1 Describe the Effect Being Simulated:

1.2 Optional Settings or Modeling Capabilities:
Convection to air node
Zone heat transfer to Type56

1.2.1 Convection to air node:
Physical Meaning: The ground surface interacts with an input air temperature and convection coefficient
1.2.2 Zone heat transfer to Type56:
Physical Meaning: The ground surface interacts with a zone temperature of a detailed building model (Type56). The surface temperature in the zone and the heat transfer through the wall iterate until they converge.

1.3 Setting or Capability Used:
Zone heat transfer to Type56

NOTE 2 – Noding parameters

2.1 Describe the Effect Being Simulated:
The parameters that define the node size for the ground finite difference model

2.2 Optional Settings or Modeling Capabilities:
The node sizes are determined by specifying a minimum node size and a multiplier

2.2.1 Minimum node size:
Physical Meaning: The size of the node at any wall intersection

2.2.2 Node size multiplier:

Physical Meaning: the multiplier used to increase the node sizes away from the minimum node size.

2.3 Setting or Capability Used:
Minimum node size = 0.05
Node size multiplier: 1.5

NOTE 3 – Building Geometry

3.1 Describe the Effect Being Simulated:

3.2 Optional Settings or Modeling Capabilities:
Manual
Mixed
3D Data

3.2.1 Manual:
Physical Meaning: The manual geometry mode allows the user to manually enter the wall surface area. Thus, the user has to provide the necessary
orientation information for the software's radiation processor.

3.2.2 Mixed:
Physical Meaning: The mixed geometry mode allows 3D data and manually entered wall surface area data.

3.2.3 3D Data
Physical Meaning: The 3D Data geometry mode requires the use of the plugin to create the building envelope. The advantage of using the 3D Data Geometry mode is that it allows the use of the automatic radiation processing for the different surface orientations of the building. It also allows for the ability to use the detailed beam, diffuse, and longwave radiation mode. Furthermore, the detailed radiation modes allow other capabilities including the implementation of emissivity in the longwave radiation mode.

3.3 Setting or Capability Used:
3D Data

NOTE 4 - Material specifications of opaque construction materials

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4.1 Describe the Effect Being Simulated:
Material specifications of opaque construction materials

4.2 Optional Settings or Modeling Capabilities:
"Massive layer"
"Massless layer"

4.2.1 Massive layer:
Physical Meaning: takes into account the thermal capacity of the material

4.2.2 Massless layer:

Physical Meaning: uses a resistive only conduction calculation for this layer.

4.3 Setting or Capability Used:
"Massless layer"

NOTE 5 - Surface Convective Heat Transfer Coefficients

5.1 Describe the Effect Being Simulated:
Convective Heat Transfer Coefficients

5.2 Optional Settings or Modeling Capabilities:
Userdefined
Internal Calculation

5.2.1 Userdefined
Physical Meaning: As a default, the software package has userdefined constant convective heat transfer coefficients for interior surfaces, 11 kJ / h m² K, and for exterior surfaces, 64 kJ / h m² K. The software also allows the user to make this value an input into the Type56 Multizone building component, so a transient value may be used from another component or an equation with a wind velocity correlation. For values less than 0.001 kJ / h m² K, the documentation exclaims the following from the software documentation, "05-MultizoneBuilding.pdf": "For wall types with a known boundary temperature, the convective heat transfer coefficient can be set to a very small value (less than 0.001 kJ/h m² K) to force the surface temperature of the wall to be equal to the boundary temperature. The use of a very small value can be confusing but was kept for backwards compatibility reasons."

4.2.2 Internal Calculation
Physical Meaning: It is possible to choose internal calculation for any surface within a zone if desired for the interior surface. The user has to select whether the wall is a floor a ceiling or vertical to fit the appropriate heat transfer mechanism.

4.3 Setting or Capability Used:
Userdefined for both interior and exterior surfaces

NOTE 5 - Longwave radiation exchange inside

5.1 Describe the Effect Being Simulated:
Longwave radiation exchange inside

5.2 Optional Settings or Modeling Capabilities:
Simple
Standard
Detailed

5.2.1 Simple

Physical Meaning: In the combined mode, no longwave radiation model is applied. It is assumed that the defined value of the "convective" heat includes the longwave radiation heat transfer such that it represents a combined heat transfer factor or no longwave radiation heat transfer occurs.

5.2.2 Standard
Physical Meaning: In the standard mode the longwave radiation exchange is modelled by a star node model which assumes an inside emissivity of 0.9 for opaque surfaces.

5.2.3 Detailed
Physical Meaning: In the detailed mode for each surface Gebhart factors are applied for the longwave radiation exchange which take into account the geometry of the surfaces as well as emissivity.

5.3 Setting or Capability Used:
Detailed for all cases with an inside surface emissivity of 0.

NOTE 6 - Simulation time step

6.1 Describe the Effect Being Simulated:
Simulation time step

6.2 Optional Settings or Modeling Capabilities:
userdefined constant value

6.2.1 userdefined constant value
Physical Meaning: Simulation time step

6.3 Setting or Capability Used:
The simulation time step is 1 hour: Time step = 1

NOTE 7 - Simulation convergence tolerances

7.1 Describe the Effect Being Simulated:
Convergence tolerances

7.2 Optional Settings or Modeling Capabilities:
Absolute Tolerances
Relative Tolerances

7.2.1 Absolute tolerances
Physical Meaning: Specifying an absolute tolerance indicates that TRNSYS should not converge until all connected outputs are changing by a value of TolA and all integration outputs are changing by a value of TolD

7.2.1 Relative tolerances
Physical Meaning: Specifying a relative tolerance indicates that TRNSYS should not move on to the next time step until all connected outputs are changing by less than (100 TolA) percent of their

absolute value and all integrated outputs are changing by (100 TolD) percent of their absolute value.

7.3 Setting or Capability Used:
Relative Tolerances: 0.00001 0.00001

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C. REPORT BLOCK FOR EQUIVALENT MODELING METHODS
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CONTENT: This section shall describe equivalent modeling methods used to perform the tests. When the software does not model an effect exactly as stated in the standard or does not permit the input values required, equivalent modeling methods shall be permitted to perform the test.

INSTRUCTIONS: If equivalent modeling methods are applied, a separate note for each instance of equivalent modeling shall be provided. The standard format shown below and a separate number and title for each note shall be applied. If equivalent modeling methods are not applicable, specify "NONE" in place of the information below.

NONE

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D. REPORT BLOCK FOR USE OF NON-SPECIFIED INPUTS
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CONTENT: This section shall describe nonspecified inputs used to perform the tests. Use of nonspecified inputs shall be permitted only for the following specified sections relating to the following topics:

* Alternative constant exterior surface coefficients in Sections 5.2.1.9.3, 5.2.3.1.4.3, 5.2.3.3.2, and 5.3.1.8
* Alternative constant interior surface coefficients in Sections 5.2.1.10.3, 5.2.3.1.4.4, 5.2.3.2.2, and 5.3.1.9
* Alternative constant interior solar distribution fractions in Sections 5.2.1.12, 5.2.2.1.2.2, 5.2.2.1.6.2, 5.2.2.1.7.2, 5.2.2.2.7.4, 5.2.3.9.3, 5.2.3.10.2, and 5.2.3.12.2
* Air density given at specific altitudes for the space-cooling and space- heating equipment cases in Sections 5.3.1.4.3, 5.3.3.4.3, and 5.4.1.4.3.

INSTRUCTIONS: If nonspecified inputs are applied, a separate note for each use of nonspecified inputs shall be provided. The standard format shown below and a separate number and title for each note shall be applied. If nonspecified inputs are not applied, specify "NONE" in place of the information below.

NONE

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E. REPORT BLOCK FOR OMITTED TEST CASES AND RESULTS
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CONTENT: This section shall describe test cases that were omitted and/or individual results of test cases that were omitted along with the reason for the omission.

INSTRUCTIONS: If test cases were omitted, a separate note to describe each type of omission shall be provided. The standard format shown below and a separate number and title for each note shall be applied. If there are no omitted test cases, specify "NONE" in place of the information below.

NOTE 1 – a-series test cases

1.1 List the Case(s) where Results Were Omitted, and which Results Were Omitted
for the Case(s): GC10a, GC30a, GC40a all results are omitted

1.2 Explanation for Omitting the Test Case(s) Results:
The a-series test cases do not include a building and thus do not make sense for tests including the TRNSYS building model. (See the Section 2b results without a building model report for the results for the a-series test cases.)

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F. REPORT BLOCK FOR CHANGES TO SOURCE CODE FOR THE PURPOSE OF RUNNING THE TESTS, WHERE SUCH CHANGES ARE NOT AVAILABLE IN PUBLICLY RELEASED VERSIONS OF THE SOFTWARE

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CONTENT: This section shall describe changes to software source code made to allow the software to run a test, where such changes are not available in a publicly released version of the software.

INFORMATIVE NOTE: This section addresses special situations where a change to source code is necessary to activate a feature or to permit inputs needed for a test when these features are not available in the publicly released version of the software.

INSTRUCTIONS: If changes to the source code for the purpose of running a test are applied, separate notes to describe each source code modification shall be provided. The standard format shown below and a separate number and title for each note shall be applied. If changes to source code are not applied, specify "NONE" in place of the information below.

NONE

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G. REPORT BLOCK FOR ANOMALOUS RESULTS

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CONTENT: Describing anomalous results shall be permitted but is not required. If anomalous test results are described, this section shall be used.

INSTRUCTIONS: If anomalous test results are described, each type of anomalous result shall be described in a separate note. The standard

format shown below and a separate number and title for each note item shall be applied. If anomalous results are not discussed, it shall be permitted to specify "NONE" in place of the information below.

NONE