

MODELING NOTES FOR ASHRAE STANDARD 140

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INTRODUCTION  
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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).

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A. SOFTWARE INFORMATION  
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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
2. SOFTWARE NAME: TRNSYS
3. SOFTWARE VERSION (unique software version identifier): 18.05.0001
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 - Solar radiation model - Tilted surface mode

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1.1 Describe the Effect Being Simulated:

Solar radiation model - Tilted surface mode

1.2 Optional Settings or Modeling Capabilities:

Isotropic Sky Model  
Hay and Davies Model  
Reindl Model  
Perez 1988 Model  
Perez 1999 Model

1.2.1 Isotropic Sky Model

Physical Meaning: The isotropic sky model assumes that the diffuse radiation is uniformly distributed over the complete sky dome.

1.2.2 Hay and Davies Model

Physical Meaning: The Hay and Davies model accounts for both circumsolar and isotropic diffuse radiation. Under clear sky conditions, there is an increased intensity of diffuse radiation in the area around the sun (circumsolar diffuse). Hay and Davies weight the amount of circumsolar diffuse by using an anisotropy index.

1.2.3 Reindl Model

Physical Meaning: This model adds a horizon brightening diffuse term to the Hay and Davies model. The horizon brightening is lumped with the isotropic diffuse term and its magnitude is controlled by a modulating factor,  $f$ .

1.2.4 Perez 1988 Model

Physical Meaning: This model accounts for circumsolar, horizon brightening, and isotropic diffuse radiation by empirically derived "reduced brightness coefficients". The reduced brightness coefficients are functions of sky clearness and sky brightness parameters.

1.2.4 Perez 1999 Model

Physical Meaning: The Perez 1999 model is identical in formulation to the Perez 1988 model. It differs only in the curve fit coefficients.

1.3 Setting or Capability Used:  
Perez 1999 Model

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NOTE 2 - Simulation time step  
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2.1 Describe the Effect Being Simulated:  
Simulation time step

2.2 Optional Settings or Modeling Capabilities:  
userdefined constant value

2.2.1 userdefined constant value  
Physical Meaning: Simulation time step

2.3 Setting or Capability Used:  
The simulation time step is 10 minutes: Time step = 1/6

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NOTE 3 - Simulation convergence tolerances  
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3.1 Describe the Effect Being Simulated:  
Convergence tolerances

3.2 Optional Settings or Modeling Capabilities:  
Absolute Tolerances  
Relative Tolerances

3.2.1 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

3.2.2 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.

3.3 Setting or Capability Used:  
Relative Tolerances: 0.001 0.001

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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.

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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.

NONE

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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