1. Optional Capabilities

Candidate compliance software may have more capabilities than the minimum required. These *optional capabilities* can be approved for use with the compliance software for compliance purposes. Optional capabilities may not have specific capability tests in Chapter 5. Applicants wishing to receive approval for optional capabilities shall document the capability as required in this chapter and be prepared to defend the technical accuracy of any optional modeling capabilities during the compliance software approval process.

The Commission does not require a compliance software to incorporate optional capabilities, accept inputs for optional capabilities (except for *optional compliance capabilities*), or use optional capabilities procedures in order to become certified. If a compliance software offers optional capabilities to the user, the specific capabilities shall be certified by the Commission and the compliance software shall meet all special conditions, conform to all required calculation procedures, and pass certification tests (when applicable). The special conditions may include the ability to accept special input and produce special output. The assumptions for the optional capabilities shall be included in the vendor's submittal for optional capabilities as described later in this chapter. For the purpose of compliance, the use of any optional capability is considered an exceptional condition requiring special reporting on the certificate of compliance.

Optional capabilities and any non-required compliance software inputs that modify compliance software results in such a way that can result in the compliance software failing to meet the approval criteria for any test in Chapter 5 are specifically prohibited, unless their use has been approved by the Commission as an optional capability. This is especially true for inputs and capabilities that cannot be modeled using the reference computer program. This does not mean that compliance software may not differ in their inputs. For example, compliance software may accept wall heat capacity as an input, while another may use volume, density, and specific heat of the component wall materials to calculate the heat capacity, while another still may assume a heat capacity as a function of wall type. But no compliance software may have an input, for example, for mass of phase change material in the wall and material phase change temperature without specific prior written approval of that capability and its associated inputs, outputs, and internal defaults and restrictions.

If any optional capability is modeled, the option shall be specified on the appropriate compliance form which is automatically generated by the compliance software. Additionally, any optional capability used in compliance shall be listed on the Certificate of Compliance as an exceptional condition.

The compliance software approval application (see ACM Appendix NA) shall list and describe (or reference the description in the ACM User's Manual) all optional capabilities which are certified for compliance.

1.1 Alternations and Additions

The following optional alternations and additions capabilities may be allowed by nonresidential compliance software. There are specific output requirements for these options which are described in this Section and Section 2.2 Compliance Documentation.

1.1.1 Additions & Alterations

If the compliance software is approved for the optional capabilities of alterations or automated calculation of Addition plus Existing Building, the compliance software shall produce approved additional forms for existing building components and systems in accordance with the procedures described in Section 2.2 Compliance Documentation.

The Addition plus Existing Building calculation may also be performed by performing two separate runs. The first run is used to determine the budget for the existing building prior to the addition or alterations and the budget for a standard building similar to the existing building. These budgets are taken from the output for the proposed and standard building energy consumption using either the diagnostic output (if the existing building does not comply) or information from the PERF-1. The addition is modeled separately in the second run to determine the target budget for the addition space from the budget for the standard building for the addition.

The budgets for these spaces are combined to determine a target budget for the combination of the two spaces. Budgets given in energy use per square foot per year are area weighted while budgets given in energy use per year for the total area can be added together.

The altered existing building plus the addition can then be modeled and the proposed building budget from that run shall be less than the combined budget for the spaces above to get compliance.

When the addition is modeled separately and the existing HVAC system is to be expanded to serve both existing and new spaces, the HVAC system for the addition shall be modeled as a separate HVAC system of the same type as the existing HVAC system with similar efficiency characteristics (EER, COP, FPI, etc.)

1.1.2 Alteration or Addition Plus Altered Existing

compliance software that allow automated analysis of alterations of an existing building or an addition in conjunction with an existing building with alterations shall perform compliance analysis of additions and alterations according to Section 149 of the Standards. This procedure also requires special and specific input and reporting procedures that complement the reporting requirements for a new building alone.

compliance software may use a two pass compliance procedure for an Addition plus Existing Building analysis. This technique requires the modeling of two different proposed designs with the compliance software: (1) existing building and (2) the altered existing building combined with the proposed addition.

1.1.3 Duct Sealing in Additions and Alterations

Section 149(a)1 establishes prescriptive requirements for duct sealing in additions and Sections 149(b)1.C. and 149(b)1.D. establish prescriptive requirements for duct sealing and duct insulation for installation of new and replacement duct systems and duct sealing for installation of new and replacement space conditioning equipment. Table NA5-2 provides Duct Leakage Factors for modeling of sealed and tested new duct systems, sealed and tested duct systems in existing buildings, and untested duct systems. Appendix NA5 provides procedures for duct leakage testing and Table NA5-3 provides duct leakage tests and leakage criteria for sealed and tested new duct systems and sealed and tested existing duct systems. These requirements, factors, procedures, tests and criteria apply to performance compliance for duct sealing in Additions and Alterations. The following table specifies the Proposed Design and Standard Design for Additions and Alterations.

Condition	*Proposed Design*	*Standard Design*
Additions Served by Entirely New Duct Systems	The Proposed Design shall be either sealed and tested new duct systems or untested duct systems.	The Standard Design shall be sealed and tested new duct systems.
Additions Served by Extensions of Existing Duct Systems	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed duct systems in existing buildings; or 3) untested duct systems.	The Standard Design shall be sealed and tested duct systems in existing buildings.

Condition	*Proposed Design*	*Standard Design*
Alterations with Prescriptive Duct Sealing Requirements when Entirely New Duct Systems are Installed	The Proposed Design shall be either 1) sealed and tested new duct systems; or 2) untested duct systems.	The Standard Design shall be sealed and tested new duct systems.
Alterations with Prescriptive Duct Sealing Requirements when Existing Duct Systems are extended or replaced or when new or replacement air conditioners are installed	The Proposed Design shall be either 1) sealed and tested new duct systems, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; or 3) untested duct systems.	The Standard Design shall be sealed and tested duct systems in existing buildings.
Alterations for which Prescriptive Duct Sealing Requirements do not apply	The Proposed Design shall be either 1) sealed and tested new duct systems, if the new duct system or the total combined existing plus new duct system meets the leakage requirements for tested and sealed new duct systems; 2) sealed and tested duct systems in existing buildings, if the total combined existing plus new duct system meets the leakage requirements for tested and sealed existing duct systems; or 3) untested duct systems.	The Standard Design shall be untested duct systems.

1.1.4 Output Reports for Existing Buildings

There are special output requirements for existing building components and characteristics that are passed directly to the standard design and compared against themselves in the custom budget process. In general, these shall be reported on separate forms and in a distinctly different typestyle from new or altered building components and characteristics in output reports. To accommodate all printers this is done by using lowercase and UPPERCASE output to differentiate these inputs. See Section 2.2 Compliance Documentation for more details.

To accommodate the optional capabilities of partial compliance and modeling additions with the existing building and alterations and deter circumvention of the standards, all compliance software SHALL report all new or altered user-entered building components and descriptive information completely in UPPERCASE TYPE. Compliance software with the capabilities for partial compliance, modeling additions with the existing building or modeling alterations in an existing building SHALL report all information on existing, previously-approved building components that are not altered in lowercase type. This is to insure that the local enforcement agency can readily determine the use of existing building components that do not have to meet the requirements of the building energy efficiency standards and distinguish these modeled components from those that are new or have been altered.

1.2 Building Occupancy

1.2.1 Alternate Occupancy Selection Lists

The user of a compliance software shall select an occupancy type from certain allowed tables. Compliance software that do not have separate selection lists for ventilation occupancy assumptions and all other occupancy assumptions shall allow the user to select from the occupancies and sub-occupancies listed in Table N2-2 and Table N2-3 or to select from an officially approved alternative sub-occupancy list thatmaps into those occupancies. Compliance software that have separate occupancy selection lists for ventilation assumptions and other assumptions shall use the occupancy selections given in tables in the building energy efficiency standards or approved alternative lists of occupancies. The occupancies listed in Table 121-A in the Standards shall be used for ventilation occupancy selections and the occupancies listed in Table 146-F in the Standards shall be used for selecting the remaining occupancy assumptions. Alternatively specific occupancy selection lists approved by the Commission that map into Tables 121-A or 146-F may be used.

A building consists of one or more occupancy types. Compliance software may not combine different occupancy types. Tables N2-2 and N2-3 describe all of the schedules and full load assumptions for occupants, lighting, infiltration, receptacle loads and ventilation. Full load assumptions are used for both the proposed design and the standard design compliance simulations.

1.2.2 Light Heat to Zone

Description:	The reference method assumes that 100% of the heat due to lighting goes to the zone where the lighting is located. An optional capability may vary the lighting heat to the zone from 70%-100% and, consequently, the lighting heat to the return air from 0% to 30%, as a function of the type of lighting fixtures used in the zone. In the absence of persuasive evidence to the contrary, direct user entry of the allocation of lighting heat to the zone and the return air is considered an enforcement problem and is considered grounds for disqualification of compliance software from the approval process.
DOE Keyword:	LIGHT-TO-SPACE
Input Type:	Required
Tradeoffs:	Neutral
Modeling Rules for Proposed Design:	Compliance software shall model the lighting heat-to-space and lighting heat-to-return air bases on the type of lighting fixtures used in the space as shown in the construction documents.
Modeling Rules for Standard Design (New & Altered Existing):	The standard design shall use the same lighting heat-to-space and lighting heat-to-return air as the proposed design.
Modeling Rules for Standard Design (Existing Unchanged):	The standard design shall model lighting heat-to-space and lighting heat-to-return air based on the lighting fixtures installed in the existing building.

1.3 HVAC Systems and Plants

This section describes the optional HVAC systems and plant capabilities. The compliance software shall use the performance curves in the DOE-2 Supplement (Version 2.1E). If the described optional capability is not a capability of the Commission's reference computer program, vendors shall include the required performance data for that capability. The assumptions in this section may be different than the corresponding assumptions specified in the Required Systems and Plant Capabilities, in order to model optional capabilities accurately.

Standard design requirements are labeled as applicable to one of the following options:

- Existing unchanged
- Altered existing
- New
- Removed

With the default condition for these four specified conditions being "New." compliance software without the optional capability of analyzing additions or alterations shall classify and report all surfaces as "New."

1.3.1 Absorption Cooling Equipment

Description: Compliance software may model heat operated (absorption) cooling equipment with the following features:

- *One-stage absorption.* Heat operated water chiller. With this option, the compliance software shall account for absorber and refrigerant pump energy and purge cycle.
- *Two-stage absorption.* Heat operated water chiller using two-stage or double effect concentrator. With this option, the compliance software shall account for absorber and refrigerant pump energy and purge cycle.
- *Economizer.* For absorption chiller, absorber solution flow to the concentrator is modulated as a function of load.
- *Steam fired.* Absorption chiller uses steam as the heat source.
- *Hot water fired.* Absorption chiller uses hot water as the heat source.
- *Direct fired.* Absorption chiller uses fossil fuel as heat source.

DOE Keyword: PLANT-EQUIPMENT
ABSOR1-CHLR
ABSOR2-CHLR
ABSORG-CHLR

Input Type: Required

Tradeoffs: Yes

Modeling Rules for Proposed Design: The compliance software shall model absorption equipment in the proposed design as input by the user according to the plans and specifications for the building. The compliance software shall use performance relationships according to the DOE 2.1E default equipment curves or the user shall enter manufacturer's performance data for gas absorption chillers as described in Section 2.5.3.16 and the compliance software shall use the performance curves derived from the user-entered data.

Modeling Rules for Standard Design (New): Compliance software shall determine the standard design according to the requirements of the Required Systems and Plant Capabilities and Section 2.5.3.16.

Comment [CEC1]: Fixed broken link – added static reference to correct section. –John A.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.2 Gas-Engine Driven Chillers and Heat Pumps

Description: Compliance software may model engine driven cooling equipment with the following

	features: • *Engine Driven Chiller.* Fossil fuel engine driven, compressor water chiller. • *Engine Driven Heat Pump.* Fossil fuel engine driven heat pump. • *Air Cooled Condenser.* Chiller or Heat Pump uses water to cool condenser. • *Water Cooled Condenser.* Chiller or Heat Pump uses water to cool condenser. • *Engine Waste Heat Recovery.* Waste heat is recovered from engine coolant for reuse in a space heating application. • *Exhaust Heat Recovery.* Heat is extracted from engine exhaust gases for reuse in a space heating application (see Section 3.3.4).
DOE Keyword:	PLANT-EQUIPMENT ENG-CHLR or HEAT-SOURCE GAS-HEAT-PUMP
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model gas engine driven equipment in the proposed design as input by the user according to the plans and specifications for the building. The compliance software shall use performance relationships as established by the DOE 2.1 default equipment curves.
Modeling Rules for Reference Standard Design (New):	compliance software shall determine the standard design according to the requirements of the Required Systems and Plant Capabilities and Table N2-10..
Modeling Rules for Reference Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

Comment [CEC2]: Fixed broken link and replaced with static reference to match 2005 language. –John A.

1.3.3 Chiller Heat Recovery

Description:	Compliance software may model double bundle condensers on cooling equipment for heat recovery.
DOE Keyword:	N/A
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model heating equipment options in the proposed design as input by the user according to the plans and specifications for the building.
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.4 Exhaust Heat Recovery

Description:	Compliance software may model the following methods of heat recovery as input by the user. • *Heat pipe.* Heat recovered from exhaust air is transferred to supply air via passive heat transfer coil (typically using refrigerant as the medium). No mechanical energy is required for heat recovery. With this option, the compliance software shall account for additional coil pressure drops. • *Hydronic loop.* Heat recovered from exhaust air is transferred to supply air via hydronic system including coils in each air stream and water circulation system (run-around system). With this option, the compliance software shall account for circulating pump energy and accounts for additional coil pressure drops. • *Heat wheel sensible.* Heat recovered from exhaust air is transferred to supply air via mechanically rotating heat wheel. The wheel may transfer sensible heat. With this option, the compliance software shall account for heat wheel motor energy and accounts for additional coil pressure drops.
DOE Keyword:	RECOVERY-EFF SUPPLY-1 thru SUPPLY-5 DEMAND-1 thru DEMAND-5
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model heat recovery options in the proposed design as input by the user according to the plans and specifications for the building.
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.5 Optional System Types

Description	Compliance software may model HVAC system types not included in the list of 5 minimum standard and proposed system types. Specifically, compliance software may model the following proposed system types: • **System 6:** Hydronic Heat Pump. Zone cooling/heating capability may be provided by a zonal hydronic heat pump connected to a central water heat source/heat rejection loop, shared by other zonal hydronic heat pumps. • **System 7:** Single Fan/Dual Duct. A single fan blows supply air through the heating and cooling coils and into the hot and cold supply ducts, with either a constant or variable volume fan. Zone terminal units mix hot and cold supply air streams to meet zone loads. • **System 8:** Dual Fan/Dual Duct. Two separate central fan systems, one for heating and one for cooling, using either constant or variable fans, distribute air to the building. Zone terminal units mix hot and cold supply air streams to meet zone loads. If this system is included, the compliance software shall also simulate heating supply air reset, described below. • **System 9:** Direct and Indirect Evaporative Cooling. Evaporative cooling may be

modeled as the only cooling system or as a precooler for another cooling system. The systems may utilize direct evaporative cooling only; indirect evaporative cooling only; indirect/direct evaporative cooling; or evaporatively precooled condensers. Direct or indirect evaporative precooling of supply air may also be modeled but no tests or specifications are defined for these options. Users shall be able to specify evaporative cooler fan capacity and brake horsepower (bhp), water pump capacity and brake horsepower (bhp), and whether or not the evaporative cooler can operates in conjunction with another cooling system. When evaporative cooling systems are modeled, default measures of direct and indirect (where applicable) cooling efficiencies shall be supplied. Subject to Commission approval, the user may be allowed to override these defaults.

- **System 10:** Underfloor Air Distribution Systems (UFAD). A central system provides air (typically 60°F to 68°F) to an underfloor plenum. It is distributed to the space using either passive or active grilles (cooling), across reheat coils or through fan-powered boxes (typically variable speed with reheat coils). Although this system uses warmer supply air temperatures it usually has a similar airflow to a conventional overhead system as it provides displacement of some of the thermal loads. The modeling software shall make accommodations for the user to specify the following system features: assignment of a percentage of the lighting, miscellaneous equipment and occupant loads to the return air plenum; application of variable speed fan powered boxes with a minimum airflow setting; application of a demand based pressure reset of the airflow; application of supply temperature reset by either demand or outdoor dry-bulb temperature; and assignment of low system static pressures.

- **System 11:** Single Zone Variable Air Volume Systems.

  Minimum turn down for airflow shall be no lower than that certified by the manufacturer as required to protect the cooling coil from freezing.

Perimeter Systems. Independent HVAC systems (typically heating only) which serve perimeter zones in addition to a primary system (typically cooling only). Perimeter systems differ from zone terminal systems in that they are independent: They do not connect to the primary system but supply heating/cooling through separate air outlets or heat transfer surfaces. There are two common types of perimeter systems.

- **System 12:** Convective/radiant. Zone perimeter system may be a convective or radiant system, such as baseboard or radiant ceiling panels.

- **System 13:** Constant volume system. Zone perimeter system provides heating/cooling by constant air volume supply to each zone served. System may or may not have outside air supply capability.

Perimeter systems may incorporate the following features (NOTE that perimeter systems may be specified as serving the same zone(s) as any of Systems 1 through 10):

- *Master zone.* Used when the perimeter system heating/cooling supply is controlled to satisfy the thermostat of a given zone.

- *Multiple zones.* Used when the perimeter system serves more than one zone of the primary system. (This allows modeling of "fighting" between the primary and perimeter system.)

- *Electric.* Used when the perimeter system heating is electric resistance.

- *Hydronic.* Used when the perimeter system cooling/heating coil is served by a central hydronic system.

	• DX. Used when the perimeter system cooling is provided by direct expansion refrigerant coils served by a heat pump or other compression system (see PLANT equipment.)
DOE Keyword:	SYSTEM-TYPE
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Optional proposed systems shall be modeled as input by the user, according to the plans and specifications for the building, subject to all of the restrictions specified in the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (New):	Standard system types and applicable system parameters are chosen according to Table N2-10. The air flow and supply air temperature for the standard design will be optimally controlled in the reference method. All efficiency descriptors shall be determined according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building using DOE-2 default performance curves. If the permit involves alterations, compliance software shall model the system before alterations.

Comment [CEC3]: Fixed broken link with text from 2005 standards. –John A.

1.3.6 Combined Hydronic Systems

1.3.6.1 Nonresidential Buildings

Combined hydronic water heating systems for nonresidential buildings may be modeled as an optional capability. Vendor-proposed prescribed assumptions for this method are crucial. All user-defined inputs shall be enforceable. Variables which are difficult to plan and field verify should be incorporated as prescribed inputs. The residential water heating calculation methodology is a useful example for compliance-based combined hydronic heating system modeling.

1.3.6.2 High-Rise Residential Buildings

Combined hydronic water heating systems evaluation for high-rise residential buildings should be evaluated in a manner consistent with the low-rise residential combined hydronic system methodology. A vendor-proposed optional capability should incorporate the majority of efficiency measures evaluated by the low-rise residential method and should be reasonably consistent with those procedures, especially near the transition between low-rise and high-rise buildings. Inputs and analysis of wood stoves and wood-fired boiler are not required (in fact discouraged) to be included as part of the optional capability.

1.3.7 Alternate Equipment Performance Data

Description

Compliance software may model equipment according to factory supplied performance data. The following performance relationships may be modeled:

All Packaged Cooling Equipment

See Chapter 2.

Packaged VAV Cooling Equipment Only

- Capacity as a function of supply air quantity
- Cooling electrical efficiency as a function of supply air quantity
- Sensible cooling capacity as a function of supply air quantity

Water Chillers

- Capacity as a function of exiting chilled water and entering condenser water temperatures
- Cooling electrical efficiency as a function of exiting chilled water and entering condenser temperatures

Furnaces

- Fossil fuel furnace efficiency

Heat Pumps

- See Chapter 2.

Boilers

- Fossil fuel boiler efficiency

DOE Keyword:	COOLING-EIR HEATING-HIR FURNACE-HIR HW-BOILER-HIR BOILER-EIR BOILER-HIR
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Compliance software shall model performance of proposed systems and plant equipment, except for fans, using DOE-2 default performance curves for the equipment specified in the construction documents for the building.
Low Value:	Minimum efficiency requirement
Modeling Rules for Standard Design (New):	Compliance software shall model performance of all systems and plant equipment, except for fans, according to requirements of the Required Systems and Plant Capabilities, and the default performance curves listed in the DOE 2.1E supplement.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building using the system's actual efficiencies according to requirements of the Required Systems and Plant Capabilities and DOE-2 default performance curves. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.8 Cooling Towers Types

Description: Compliance software may model several options for cooling tower operation which may be specified at the user's option. These options are described below:

- *Closed circuit.* Condenser water is cooled indirectly by a heat exchanger which is evaporatively cooled (fluid cooler). With this option, the compliance software shall account for spray pump energy. If the compliance software has this capability, it shall require the user to specify if the cooling tower uses an open or closed circuit.
- *Axial fan.* An axial fan provides ambient air flow across tower fill or closed tower heat exchanger.
- *Natural draft.* Ambient air flow across tower fill is natural draft (not mechanically driven) as defined by user input tower dimensional data and draft factor.

- *Discharge dampers.* Tower (condenser) capacity is controlled by modulating fan discharge dampers.
- *Bypass.* Tower leaving water temperature is controlled by bypassing tower return water around tower to the supply line, thereby cooling only a portion of the water flow.
- *Variable speed drive.* Tower (condenser) capacity is controlled by varying fan motor speed.

DOE Keyword: TWR-CAP-CTRL
TWR-MIN-FAN-SPEED
FLUID-BYPASS

Input Type: Required

Tradeoffs: Yes

Modeling Rules for Proposed Design: The compliance software shall model all optional cooling tower features as input by the user according to the construction documents for the building.

Modeling Rules for Standard Design (New): The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): Compliance software shall model the existing system as it occurs in the existing building using the system's actual efficiencies. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.9 Pump Controls

Description: Compliance software may model several optional pump design, operation and control strategies which may be specified at the user's option. These options are described below:

- *Variable flow.* Used when the variable flow, constant temperature system flow rate varies as a function of load.
- *Riding curve.* Pump(s) ride characteristic performance curve as a function of head pressure. Head pressure will vary depending on the water demands of cooling and heating coils and the amount of water bypassing different zones.
- *Two-speed/stages.* Used when the pumps are staged, or pump has two-speed motor, to maintain pressure requirements. Pump(s) ride characteristic curve between stages.

Comment [CEC4]: May need added strategy "loops" for multiple circulation loops, per Bruce Maeda.
JA: added language for this in June workshop draft, based on recommendations from JJ Hirsch staff member on DOE2.2 algorithm.

DOE Keyword: TWR-PUMP-HEAD
TWR-IMPELLER-EFF
TWR-MOTOR-EFF
CIRC-IMPELLER-EFF
CIRC-MOTOR-EFF
CIRC-HEAD
CIRC-PUMP-TYPE
DHW-PUMP-ELE

Input Type: Required

Tradeoffs: Yes

Modeling Rules for Proposed Design:	Compliance software shall model optional features of proposed design pumping systems as input by the user according to plans and specifications for the building.
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.10 Air Foil Centrifugal Fan with Discharge Dampers

Description:

The compliance software may model the following optional types of fan volume control, as input by the user. Default fan curves are given in terms of DOE-2 curve-fit instructions.

Air foil centrifugal fan with discharge dampers (ride fan curve). Fan volume is controlled by a controllable damper mounted at the fan discharge, or the fan "rides" its characteristic fan curve against varying system pressure.

```
AF-FAN-W/DAMPERS = CURVE-FIT
TYPE = QUADRATIC
OUTPUT-MIN = 0.68
DATA = (1.0,1.0)
       (0.9,0.95)
       (0.8,0.90)
       (0.7,0.86)
       (0.6,0.79)
       (0.5,0.71)
```

Vane-axial fan with variable pitched blades. Fan volume is controlled by varying blade pitch.

```
VANE-AXIAL-FAN = CURVE-FIT
TYPE = QUADRATIC
OUTPUT-MIN = 0.15
DATA = (1.0,1.0)
       (0.9,0.78)
       (0.8,0.60)
       (0.7,0.48)
       (0.6,0.36)
       (0.5,0.27)
       (0.4,0.20)
       (0.3,0.23)
       (0.2,0.22)
```

DOE Keyword:	FAN-CONTROL
Input Type:	Prescribed
Tradeoffs:	Neutral
Modeling Rules for Proposed Design:	The compliance software shall model supply and return fans chosen by the user and as documented on the plans and specifications for the building for the proposed design fan system. The compliance software shall use the performance data given in this manual.
Modeling Rules for	The compliance software shall model the standard design according to the

Standard Design (New):	requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.11 Separate Control for Supply, Return and Relief Fans

Description:	Compliance software may model different fan volume control strategies for supply, return and relief fans. If the compliance software has this capability the user may specify a different strategy for each fan in the fan system.
DOE Keyword:	FAN-CONTROL
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model fan volume controls for each proposed design fan as input by the user. If different fan volume controls are not input for supply, return and/or relief fans, the compliance software shall assume all fan volume controls for the entire fan system to be the same as that specified for the supply fan.
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.12 Air Economizers Control Strategies

Description: The compliance software may model the following optional economizer control strategies when specified by the user:

- *Outside air enthalpy.* Economizer cooling is enabled as long as the outside air enthalpy is less than 29 Btu/lb.
- *Variable enthalpy.* Equivalent to the Honeywell W7400 or H205 humidity biased enthalpy control using set-curve A.
- *Differential dry-bulb.* Economizer cooling is enabled as long as the return air temperature is greater than the outside air temperature.
- *Differential enthalpy.* Economizer cooling is enabled as long as the return air enthalpy is greater than the outside air enthalpy.
- *Economizer High Limit.* When a differential controller is used, a high limit, above which the economizer cannot operate, may also be added. The high limit controller can either be a dry-bulb (set at 75 degrees), an enthalpy (set at 29 Btu/lb) or a variable enthalpy controller.
- *Non-integrated, two stage operation.* The economizer operates as the first stage of cooling until the cooling load cannot be met by the economizer. At this point, the economizer closes to the minimum position and mechanical cooling is used to meet the cooling load. If this strategy is selected, an outdoor high limit of 70 ODB or 28.5 Btu/lb shall be used.

DOE Keyword:	OA-CONTROL ECONO-LIMIT-T ECONO-LOCKOUT ENTHALPY-LIMIT DRYBULB-LIMIT
Input Type:	Default
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Compliance software shall limit proposed design optional economizer control strategies to those listed in this section, including set points.
Default:	No economizer
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.13 Water Side Economizers

Description

Compliance software may model the following water side economizers when specified by the user:

- *Strainer cycle.* Used when cooling tower water is diverted to the main cooling coil for "free cooling" when the cooling tower leaving water temperature is low enough to meet the total building load. This type of water side economizer can only be used in place of, and cannot be used to supplement, mechanical cooling.
- *Series coil.* A cooling coil, connected to the condenser water loop ahead of the condenser, is placed in the air handler upstream of the main cooling coil. This coil is used to supplement mechanical cooling, when the cooling benefit is greater than the added pumping energy needed to circulate cooling tower water through the cooling coil.
- *Evaporator precooling (heat exchanger).* A heat exchanger is used to transfer heat from condenser water, prior to entering the condenser, and chilled water, prior to entering the evaporator, in order to precool the chilled water. If the difference between the return chilled water temperature and cooling tower leaving water temperature is large enough to provide a cooling benefit, the heat exchanger is used to supplement mechanical cooling.
- *Evaporator precooling (cooling tower).* Chilled water is circulated through a closed loop in the cooling tower before entering the evaporator. If the difference between the chilled water return temperature and outside wet-bulb temperature is large enough to provide a cooling benefit, chilled water is circulated to the cooling tower to supplement mechanical cooling.

DOE Keyword:	WS-ECONO WS-ECONO-MIN-DT WS-ECONO-XEFF CONDENSER-TYPE FLUID-VOLUME

	COND-FLOW-TYPE COND-WTR-FLOW
Input Type:	Default
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model the proposed system water side economizer as input by the user, according to the plans and specifications for the building. If a strainer cycle is specified, changeover temperature from economizer to mechanical cooling shall be set at 50^{o}F.
Default:	No economizer
Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.14 Zone Terminal Controls

Description: Compliance software may model the following optional features for zone terminal controls, as input by the user:

- *Constant volume.* Zone receives a constant volume of air regardless of thermostat signal.
- *Mixing hot deck/cold deck.* Zone temperature is controlled by mixing hot and cold air.
- *Induction.* Supply air induces room or return plenum air into the supply air stream.
- *Fan powered induction.* Zonal fan supplies return or room air optionally mixed with system supply air (if any).
- *Series.* Fan powered induction system where zonal fan is in series with primary system supply air. Fan runs continuously when central system is on providing constant volume to space.
- *Parallel.* Fan powered induction system where zonal fan is in parallel with primary system supply air. Primary supply is usually VAV. Fan cycles on only when heating is required.
- *Series/Parallel.* Fan powered induction system where zonal fan is in parallel with primary system supply air. Primary supply is usually VAV. Fan cycles on to maintain a minimum supply volume and when heating is required.

DOE Keyword:	TERMINAL-TYPE
Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The compliance software shall model optional zone terminal control features as input by the user according to the plans and specifications for the building. If the TERMINAL-TYPE is specified as SERIES-PIU (series fan-powered induction system), the compliance software shall use the following fan power: ZONE-FAN-KW = 0.000225

Modeling Rules for Standard Design (New):	The compliance software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.15 Solar Thermal Energy

Description:	The depletable energy savings associated with solar collector systems shall be analyzed by the Commission. A nonresidential compliance software may be approved with the optional capabilities of built-in solar collector performance calculations. Vendors who wish to have their Nonresidential compliance software approved with either of these capabilities shall meet the requirements described in the Residential ACM Manual.
DOE Keyword:	N/A
Input Type:	Default
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Compliance software may model solar water heating as an energy source for service hot water heating only.
Default:	No renewable energy is used.
Modeling Rules for Standard Design (New):	Compliance software shall not model renewable energy sources for any of the standard design energy use.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, compliance software shall model the system before alterations.

1.3.16 Multiple Hydronic Circulation Loops1

Description:	The reference computer program, DOE2.1E, is structurally designed to ~~Compliance Software~~ models ~~s~~ a single circulation loop for each loop type (chilled water, heated water and condenser water). ~~A n~~Nonresidential Compliance Software may optionally model multiple circulation loops. If this is done, the Compliance Software must calculate a single design head for chilled water loops, hot water loops and condenser water (cooling tower) loops for the proposed design. This design head is a flow-weighted average head that is used in the calculation of pump energy according to procedures in Section 2.5.3.13. For compliance software using the DOE2.1E computer program as the computational simulation engine where the proposed design has hydronic chillers and one or more cooling towers, a primary-secondary loop system may be modeled for the chiller by combing the condenser and primary pumps by determining the combined total flow of the condenser water pump and the primary chilled water pump into the COMP-TO-TWR-WTR DOE2.1E entry and using the flow-weighted average head for TWR-PUMP-HEAD entry. The standard design must be modeled in the same way.
DOE Keyword:	CCIRC-HEAD

HCIRC-HEAD

TWR-PUMP-HEAD

Input Type: Required

Tradeoffs: Neutral

Modeling Rules for Proposed Design: Compliance software may model multiple distribution loops for chilled water, hot water and condenser water systems (cooling towers). The total design head of the proposed design shall be determined according to the following equation:

$$\Delta H_{avg} = \frac{\sum_{i}^{nP} (GPM_i \times \Delta H_i)}{\sum_{i}^{nP} GPM_i}$$

Where i is an index indicating each unique chilled water pump, hot water circulation pump or condenser water circulation pump,

GPM_i is the volumetric flow rate of the pump

ΔH_i is the system head of the proposed design pump, in feet of water

ΔH_{avg} is the proposed design total system head for chilled water, hot water or condenser water. The proposed design total system head shall be subject to the limits as specified in Section 2.5.3.13.

Comment [CEC5]: Capped at 100ft for ch water and hot water loops, 80 ft for cond water loop.

Default: A single circulation loop for chilled water, hot water and condenser water is modeled according to Section 2.5.3.13.

Modeling Rules for Standard Design (New): Compliance software shall model the standard design as indicated in Section 2.5.3.13.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing): Compliance software shall model the existing system as it occurs in the existing building. If the permit involves alterations, Compliance Software shall model the system before alterations.

1.3.17 Underfloor Air Distribution (UFAD) Systems2

Description: A central system provides air (typically 60°F to 65°F) to an underfloor plenum. It is distributed to the space using either passive or active floor diffusers (cooling). The interior systems usually differ from the perimeter ones due to heating and architectural concerns in the perimeter zones. Overall, typical systems fall into two broad categories plus additional options, representing current practice:

1. **Type 1 UFAD:** Interior swirl (passive) diffusers plus perimeter fan coil units (FCU) with variable speed drive (VSD) – This system is configured with swirl diffusers in the interior spaces where the airflow is modulated by varying the pressure in the supply plenum in response to interior thermostats, and variable speed fan coil units in the perimeter typically supplying linear bar grille diffusers.
2. **Type 2 UFAD:** VAV diffusers throughout – This system consists of controlled damper/diffusers in both interior and perimeter zones. The supply plenum pressure is held constant. A constant speed fan coil unit is used for heating only, typically in the perimeter.
3. Other options – Variations on these two system types include: alternative

heating at perimeter (e.g., baseboards), constant volume interior, alternative configuration of diffusers (e.g., swirl at perimeter vs. linear bar grille), air source for series FCU (supply plenum vs. room), pressure and supply air temperature reset strategies.

Although a UFAD system generally uses warmer supply air temperatures, its airflow depends on the level of stratification in the room, and the magnitude of heat transfer to the underfloor supply plenum. The primary areas where the use of UFAD may impact building energy use are fan and cooling energy. Fan energy impacts are due to the effects of supply temperature, heat transfer to the plenum, and stratification. Cooling energy impacts are due to differences in how the economizer operates for different supply temperatures.

The Compliance Software shall semi-automatically include provisions to accurately simulate the following factors:

1. Heat transfer to the underfloor supply plenum and its effect on net room load and thus airflow requirements (see below)
2. Effect on airflow requirements due to room supply and return temperatures greater than conventional overhead systems.
3. Effect on AHU leaving temperature and thus economizer performance (and its impact on cooling energy use) of the combination of higher room supply temperatures and heat gain to the supply plenum.
4. Potentially lower central fan static pressure requirements
5. Effect on total building fan energy due to variable speed fan coils for cooling
6. Realistically simulate typical UFAD system types.

The Compliance Software shall use the following guidance to accurately simulate realistic energy performance of UFAD systems:

- Reduce zone load to simulate heat transfer to the supply plenum (for ACMs that do not explicitly model supply plenums) – zone heat gain is reduced by applying a Room Cooling Load Ratio (RCLR) to the people, lighting and equipment loads. The Compliance Software shall use an RCLR of 0.6, meaning that 60% of the heat gain shall remain in the space and 40% shall be assumed to transfer into the underfloor supply plenum.
- Split the remaining space load determined above between room and return plenum to simulate room air stratification. The Compliance Software shall automatically assign the following factors to each of occupant, lighting and equipment heat gains: 85% to space and 15% to return plenum.
- The diffuser discharge temperature (i.e., supply to the zone) shall be assumed to be 65°F. The required supply air temperature from the air handler shall be calculated using the Room Cooling Load Ratio definition above.

The Compliance Software shall allow the use of a higher supply air temperature, as well as the application of supply temperature reset by either demand or outdoor dry-bulb temperature. Additionally, the Compliance Software may also optionally accommodate higher chilled water temperatures on systems that utilized chilled water coils.

The Compliance Software shall make an entry in the special features and remarks section of the PERF-1 report noting the use of an underfloor air distribution system.

DOE Keyword: LIGHTING-W/SQFT

EQUIPMENT-W/SQFT

	AREA/PERSON
	MIN-SUPPLY-T
	CHILL-WTR-T
	AHU SAT
	Economizer type
	PIU W/CFM
	AHU design static pressure
Input Type:	Default
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	The Compliance Software shall model all optional underfloor air distribution system features as input by the user according to the construction documents for the building. Additional supporting calculations can be included to assist the user in determining appropriate input.
Default:	n/a
Modeling Rules for Standard Design (New):	The Compliance Software shall model the standard design according to the requirements of the Required Systems and Plant Capabilities.
Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):	Compliance Software shall model the existing system as it occurs in the existing building. If the permit involves alterations, Compliance Software shall model the system before alterations.

1.3.18 Thermal Energy Storage (TES) Systems3

This system consists of a thermal energy storage component used in conjunction with a conventional chilled water air conditioning system. Since it is possible for the user to specify a TES system that has insufficient capacity to meet the load, the ACM shall ensure that the cooling load is met. This shall be accomplished by switching to compressor direct efficiency.

Description:	The TDV energy savings associated with storing cooling energy during off-peak periods for use during high demand periods may be modeled by the Compliance Software. The Compliance Software shall simulate the TES system according to the following rules, criteria, inputs, and outputs: The system includes a storage tank for storing cooling energy on-site.
	The storage of cooling energy (charging) is accomplished though an active mechanism such as the pumping of chilled water and not a passive mechanism such as the storage of energy through the thermal mass of the building.
	Charging is accomplished through an onsite chilled medium such as water or a eutectic solution but not by a direct expansion cooling system.
	The system includes automatic controls that allow energy storage to occur during off-peak hours.
	The system (TES-TYPE) is one of the following:
	Chilled Water Storage
	Ice-on-Coil
	Ice Harvester

Brine

Ice-Slurry

Eutectic Salt

CHS

DOE Keyword: TES-TYPE

SIZE

COOL-STORE-RATE

COOL-SUPPLY-RATE

COOL-STORE-SCH

CTANK-BASE-T

CTANK-T-RANGE

CTANK-LOSS-COEF

COMP-KW/TON-START

COMP-KW/TON-END

EVAP-DELTA-T

REFRIG-T-AT-PC

PER-COMP-REDUCT/F

PUMP+AUX-KW

EVAP-DELTA-T - The evaporator delta T (EVAP-DELTA-T) shall specify the drop in refrigerant temperature as the system begins to charge. Values shall be set by the ACM as follows: Chilled Water - n/a, Ice-on-Coil Systems – 4 º F, Ice Harvester 4 º F, Brine (Encapsulated Ice) – 4 º F, Ice Slurry - 4 º F, Eutectic Salt - 0 º F, CHS - n/a

The refrigerant temperature (REFRIG-T-AT-PC) shall specify the refrigerant temperature at the start of the storage phase change. Values shall be set by the ACM as follows: Chilled Water - n/a, Ice-on-Coil Systems - 22 º F, Ice Harvester - 22 º F, Brine (Encapsulated Ice) - 22 º F, Ice Slurry - 22 º F, Eutectic Salt - 41 º F, CHS - n/a

For TES systems that use ice as storage medium, additional parameters shall specify the efficiency of the chiller when it begins the charging process to make ice (COMP-KW/TON-START) and the efficiency of the chiller at the end of the charging process when ice making is complete (COMP-KW/TON-END). In addition, the reduction in chiller capacity that occurs as the temperature of the refrigerant is reduced during the ice making process (PER-COMP-REDUCT/F) shall be specified.

The thermal energy storage tank shall be simulated through the following additional ACM inputs:

Storage capacity (SIZE) shall specify the total storage capacity of the system.

Storage rate (COOL-STORE-RATE) shall specify the maximum rate at which the chiller can add cooling into the storage tank.

Discharge rate (COOL-SUPPLY-RATE) shall specify the maximum rate at which cooling energy can be extracted from the storage tank.

Base temperature (CTANK-BASE-T) shall specify the highest temperature of the

storage medium delivered. This shall be fixed at 50 º F.

Temperature range (CTANK-T-RANGE) shall specify the temperature difference between the Base temperature and the coldest storage temperature of the system. Values shall be set by the ACM as follows: Chilled Water - 10 º F, Ice-on-Coil Systems - 18 º F, Ice Harvester - 18 º F, Brine (Encapsulated Ice) - 18 º F, Ice Slurry - 18 º F, Eutectic Salt - 6 º F, CHS - 6 º F

Storage tank heat loss Coefficient (CTANK-LOSS-COEF) shall specify the product of the U-Value and area of the storage tank for determining the heat transfer loss between the storage tank and ambient conditions.

The Compliance Software shall use a non-varying charging and discharging schedule for all TES systems (COOL-STORE-SCH). Charging will occur starting at 9:00 p.m. and ending at 9:00 a.m. Discharging will begin at noon and end at 6:00 p.m. The cooling load between 6:00 p.m. and 9:00 p.m. is met by the TES system (when the stored energy is available) or by the compressor (when the stored energy is not available). Between 9 a.m. and noon the tank does not discharge, and the cooling load is met by the compressor only.

Auxiliary energy use (PUMP+AUX-KW) shall specify any pumping or energy usage from devices such as air blowers used in the TES system.

Special requirements for Compliance Software developers:

The PERF-1, Special Features and Modeling section must have a note to alert the building department to inspect the TES system using the MECH-2-C (TES) form.

The PERF-1 must alert the building department to the need for a Certificate of Acceptance for TES systems, MECH-9-A.

Input Type:	Required
Tradeoffs:	Yes
Modeling Rules for Proposed Design:	Compliance Software shall model features of TES systems as input by the user according to plans and specifications for the building.
Modeling Rules for Standard Design:	Compliance Software shall model the system without TES systems according to the required systems and plant capabilities and selection rules in Table N2-10.
Modeling Rules for Standard Design (Existing, Unchanged, and Alterations):	Compliance Software shall model the existing system as it occurs in the existing building. If the permit involves alterations, Compliance Software shall model the system before alterations.

1.3.19 Distributed Energy Storage DX AC System (DES/DXAC)

This system uses thermal energy storage in conjunction with a conventional direct-expansion (DX) air conditioning system. The condenser coil and outdoor fan and evaporator coil and indoor fan are the same as that used on a conventional DX system (such as a split system or packaged rooftop unit). This system is similar to the thermal energy storage component used above, but uses refrigerant to directly charge the thermal storage.

The reference Compliance Software does not have the capability to model DES/DXAC systems directly; however, the Compliance Software can use a DOE-2 function that has been developed to model this system type.

Description: ACMs may model DES/DXAC systems using the DOE-2 function listed in Nonresidential ACM Appendix F for the following proposed system types:

1. PSZ: Packaged Single Zone System
2. PVAVS: Packaged Variable Air Volume System
3. PMZS: Packaged Multi-Zone System
4. PVVT: Packaged Variable Volume Variable Temperature System

DOE Keyword: FUNCTION = (*NONE*, *ISACFunc*). This keyword should be inserted right after the SYSTEM-TYPE keyword for each system that uses DES/DXAC. This keyword basically means the ISACFunc routine which calculates the cooling energy use of a DES/DXAC system will be called after DOE-2 completes calculation for a system.

Input Type: Required

Tradeoffs: Yes

DES/DXAC DOE-2 Function: The ISAC DOE-2 function written in FORTRAN code is listed in Appendix A. The ISAC function should be inserted between the system "END .." line and the "COMPUTE SYSTEMS .." line. This can also be done by inserting an include statement "##INCLUDE ISAC.func", and put the actual DOE-2 function file ISAC.func at the DOE-2 executable files folder.

Modeling Rules for Proposed Design:

Optional proposed systems shall be modeled as input by the user, according to the plans and specifications for the building, subject to all of the restrictions specified in the Required Systems and Plant Capabilities. User inputs for a DES/DXAC system include –

1. Change Condenser Type to DES/DXAC from Air-Cooled for the four packaged system types
2. Specify cooling capacity of the system

The makeup system cooling efficiency will be based on Title 24-2005 rules. There is no credit or penalty for the makeup system compared with the Standard Design.

Modeling Rules for Standard Design (New):
Standard system types and applicable system parameters are chosen according to Table N2-10. The air flow and supply air temperature for the standard design will be optimally controlled in the reference method. All efficiency descriptors shall be determined according to the requirements of the Required Systems and Plant Capabilities.

Modeling Rules for Standard Design (Existing Unchanged & Altered Existing):
ACMs shall model the existing system as it occurs in the existing building using DOE-2 default performance curves. If the permit involves alterations, ACMs shall model the system before alterations.

1.4 Vendor Defined Optional Capabilities

Vendors may propose other optional capabilities not specifically described in this manual. In the proposal for vendor specified optional capabilities, the vendor shall include:

- Theoretical background and simulation algorithms
- Testing data and validation analysis for all specified capabilities
- Standard and proposed design assumptions
- Specific documentation requirements, addressing enforceability by building department personnel

1 This capability is based on language proposed by JJ Hirsch and Associates to reflect modeling capabilities of DOE2.2.

2 This change is based on Dodd, http://www.energy.ca.gov/title24/2008standards/documents/2006-02-22+23_workshop/templates/UNDERFLOOR-AIR-DISTR_ENERGYSOFT_2006-02-02.PDF, Feb workshop, with updates by Fred Bauman and Tom Webster of UC Berkeley's Center for the Built Environment.

3 From Thermal Energy Storage Compliance Option, Staff Draft Report, Dec. 2006. CEC document 400-2006-010-SD.